Deliverable 1: Inception Mission

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

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INITIAL REPORT:
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I – Meetings in BiH

1. Federation of BiH

Participants:
Taric Begic: Head of electric power department
Amira Pintul: Assistant Minister
Esad Djukanovic: IMG
Xavier Vallvé: TTA
Antoine Graillot: TTA
Nuria Sáenz-López Pérez: AECI
Ditka Bukva: AECI

Place and Date:

Main comments:
• Presentation of the Work Plan by TTA
• Mr. Taric Begic presented an overview of the Energy sector in BiH and especially in the Federation. Thermal and hydro plants represent most of the electrical generation. Wind, solar and biomass are not used yet. In the Southern part of the Federation, a study showed the potential for 550 MW of wind power which will be implemented by 2012. In total the installed power in BiH is around 4,000 MW (50% thermal plants; 50% hydro plants). There are three electrical companies: two in the Federation and one holding in the Srpska Republic. Many projects of new plants are foreseen. For hydro plants BiH plans an investment of around 3,500 million euros and the target to be reached is 2,000 additional MW (hydro and thermal).
• Ms. Pintul made some comments about the Work Plan. The first point dealt with the activity 2. During the evaluation of the potential for deployment of solar energy, we will have to compare it with the wind potential. In the activity 3, TTA will have to address a comparative report on the different policies in two or three European countries in term of incentives, legal framework and mechanisms for the development of solar energy.
• Mr. Djukanovic explained that there will be around 80,000 € available for the pilot projects implementation and perhaps 20,000 € more that have to be confirmed.

2. Srpska Republic

Participants:
Ljubo Glamocic: Assistant Minister
Nada Milovcevic: Head of electric power department
Esad Djukanovic: IMG
Xavier Vallvé: TTA
Antoine Graillot: TTA
Nuria Sáenz-López Pérez: AECI
Ditka Bukva: AECI

Place and Date:
Ministry of economy, energy and development of Republika Srpska, Banja Luka. January the 10th, 2008.

Comments:
• Presentation of the Work Plan by TTA
• Ms. Milovcevic said that she was convinced about the project quality and that the Renewable Energy technologies haven’t been used enough, also for lack of regulation frame. The few examples of solar were not followed. Many studies show the potential of solar energy, mainly in the Southern part of the country. The minister and all the team fully support this project and have the same view with TTA and AECI. It is important to involve the private sector and also the academic sector. It is not necessary to involve formally all these persons in the core group but only one responsible person from the ministry. The idea of the comparison with other countries about the schemes and mechanisms of law, regulation, and framework seems very interesting also.
• Ljubo Glamocic presented an overview of the electric sector in the Srpska Republic. There are around 1.500 of installed MW managed by one holding divided into 5 entities for generation and distribution. Many projects are under study: thermal (410 MW) and hydro (only 30% under exploitation; 280 MW of mini-hydro).

3. OTC (Technical Office of Cooperation)

Participants:
Esad Djukanovic: IMG
Blanca Yáñez Minondo: AECI
Xavier Vallvé: TTA
Antoine Graillot: TTA

Place and Date:

Main comments:
Blanca Yáñez made a small presentation of the OTC and its strategy. BiH is in the category considered as Country with special attention. OTC Balkans was created in 2002. According to the Strategic plan, there are three main areas divided into those categories:
- Institutional: public administration, citizen participation, transformation for the EU integration, etc
- Economical development: micro-credits, etc
- Prevention of conflicts

The projects supported by the OTC have to fit into one of these categories. This presented project fits into the category “transformation for the EU integration”.
4. Conclusions

The main conclusions after the three meetings are the following:

- Both entities fully support the project with a strong interest. They will be involved in the project and give support to TTA.
- Both entities have an idea where the pilot projects could be installed. They agree that the location could be the south part (probably district 7 of the Federation and region 7 of the Republika Srpska).
- TTA has to include a comparative study of the existing mechanisms and scheme for supporting the development of Solar Energy use. This study should compare 2-3 European countries.
- The team will be composed by one representative of each entity and TTA.
- TTA need to contract a local representative for translation, logistic and information collection in BiH.
- The project will end on March the 15th 2009.
II – Work plan

This is the new version reviewed of the Work Plan. From now onwards, it is considered as the definitive version.

1. Initial Phase

1.1 Coordination of the work group
1.2 Organization of a meeting for the project
1.3 Contacts with key institutions of BiH involved
1.4 Draft of the work plan for the activities
1.5 Workshop: Discussion of the work plan

In this activity TTA will contact and visit the different stakeholders of BiH and after consultation define the Work Plan of the Project, including all details of schedule, contents and deliverables as well as the programmation of the field trips during the projects. During the first month, the team will realize a trip in BiH and assist to a workshop for discussion of this Work Plan.

All the team will be associated in this activity.

2. Analysis of existing offer and existing demand in BiH of solar thermic and photovoltaic technologies

2.1 List of manufacturers distributors of solar collectors, materials and accessories, engineering, installers and the map of existing installations of solar thermic and photovoltaic installations realized in BiH
2.2 Analysis of potential demand for solar thermic systems
2.3 Evaluation of solar thermic energy which can be used having in mind different sectors of application and different climate areas in the country
2.4 Analysis of the potential demand focused on the autonomous production
2.5 Evaluation of the RVS power (kW) that can be installed and of electric energy of solar origin (kWh) which could be produced in autonomous applications

Thanks to the information gathered on site, TTA will set a list of the different actors of the sector of Solar Energy in BiH, limiting it to the only manufacturer, distributors, engineering and installers (not the institutional and economical actors). During this activity fields trips will be organized to visit some installations and realize a map of the past experience. TTA will also try to get feedback information and lessons learned of these experiences in order to prepare the following activities.

The rest of the activity will represent one of the most important issues, since it assesses the potential demand of Thermal Solar and PV energy and evaluates the typical installations that could be realized in BiH. This kind of “market study” will be very useful for the definition and implementation of the pilot projects and also for further projects or programmes.
The project director and the technical manager will be responsible of this activity and will realize two short trips of evaluation.

3. Analysis of the institutional, regulatory and normative frames and analysis of possible instruments of financial support

3.1 Analysis of institutional and regulatory frame existing in the BiH and its Entities
3.2 Analysis of the existing normative frame for homologation and certification of installers and thermic and electric installations
3.3 Comparison of the regulatory frame with other countries in Europe
3.4 Analysis of feasibility of introduction of financial mechanisms of support to the sector based on domestic and international resources for promotion of the solar energy sector.

This task will be led by the project director with an active participation of the Policy and Economic Manager. Both will realize one trip to meet the institutional stakeholders (Ministry, Agency, etc) of the Renewable Energy sector and especially the Solar sector.

The main tasks will be the assessment of the framework at the institutional level and also regulatory and normative in order to understand all the mechanisms of implementation.

Also, a comparative study about the different schemes and mechanisms used in other European countries (Spain, France, etc) will be done in order to illustrate and give examples to the policy makers in BiH.

Finally the Policy and Economic Manager will study the possibilities of financial schemes for such projects, not only locally but also at the European and international level.

4. Analysis of possibilities and strategic guidelines to be planned for development of solar energy in BiH

4.1 Design of the strategic guidelines for development of solar energy in BiH

All the team will be involved in this critical activity as well as the beneficiaries, as it is shown in the activity 7 which represents the field trip in Spain. Thanks to all the information and studies realized, TTA will propose a strategy of development of the Solar Energy in BiH. No trip of TTA is foreseen since all the information would be gathered during previous trip. The presentation of the results will be done during a former trip for the next activity.

5. Evaluation and execution of a pilot projects, in both Entities, for the use of thermic solar and photovoltaic solar technology

5.1 Definition of different types of pilot projects to be developed and selection of the best possible solution
5.2 Design of pilot projects
5.3 Elaborate terms of reference with the purpose of organizing the tender of equipment of pilot projects
5.4 Carry out the evaluation of received offers
5.5 Supervision of equipment acquisition, the works management and the pilot projects work termination certificate

During this activity, pilot projects will be realized in both entities of BiH. The tasks of TTA will occur before and after the implementation. First, TTA and the beneficiary’s entity will select and define the pilot projects. TTA will proceed to the redaction of the technical documentation for the tender. After reception of the offers, TTA will carry out the evaluation of the received offers.

During the implementation of the projects, TTA will supervise and inspect the work progress thanks to various trips and a prolonged stay in the region. Finally, the technical manager will realize the commissioning of the installations and certificate them.

6. Definition of a Program of Diffusion and Training in solar technologies

6.1 Analysis of existing training in BH in the area of renewable energies (specially, of solar energy)
6.2 Evaluation of needs for training in solar energy of engineers, architects, installers and design programs of training.
6.3 Design a strategy of diffusion and education in schools about renewable energies (solar energy in particular)

After a first analysis of the existing formations in BiH related to Renewable Energy, TTA will assess the need and design the strategy for the training and capacity building at two levels.

First, at university level, with the training for professional actors: engineers, architects, installers, etc. Secondly, at school level, with the aim of dissemination and diffusion and trying to raise awareness to this issue thanks to very graphical and visual support material.

TTA has a strong experience in the organization, design and realization of Capacity Building, seminars and specialized courses at the University.

7. Study visit in Spain

7.1 Study visit in Spain for 3 members of the beneficiary's staff and IMG

It is foreseen to organize a visit in Spain for three members of the beneficiary’s entity in order to see concrete applications of Solar Energy. TTA will accompany the members during their visit and try to give a large overview of the benefits and applications of solar energy projects. For example, it will be interesting to have a look to the installation of the organization SEBA which Technical Assistance is realized by TTA. They manage more than 500 installations and have created, in collaboration with TTA, an interesting management and tariff scheme. Mainly the visit will be aimed to institutional representatives in order to illustrate the results of the previous activities (from 1 to 5). This visit will be organized in September or October.
III – Human resource and function

During the first mission, the core group has been established. It is composed by TTA and one representative of each ministry. For TTA, the team is composed by three people based in Barcelona and realizing field trips and one local representative to assure logistical, management and technical tasks directly on the field and in permanent contact with the other members of the core group as well as the resource of information.

Additionally, in order to take decisions about the project, as the evaluation and selection of the bid for the implementation of the pilot projects, a Committee will be created. The composition will be as it follows:

Core group:
- Representative of TTA (Xavier Vallvé, Antoine Graillot, Judith Gámez and a local person, Vedran Salihodžić),
- Representative of the Ministry of the Federation (Amira Pintul)
- Representative of the Ministry of the Srpska Republic (Nada Milovcevic)

Committee:
- Core group
- Representative of the client IMG: Esad Djukanovic
- Representative of AECI: to be determined
## Annex 2: Work plan Schedule

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<tr>
<td><strong>Management</strong></td>
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<tr>
<td>8.1</td>
<td>Project Monitoring</td>
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<td>8.2</td>
<td>Project Evaluation</td>
<td></td>
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<td>8.3</td>
<td>Project Reporting</td>
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</tbody>
</table>
## Annex 3: List of Deliverables

<table>
<thead>
<tr>
<th>Deliverables</th>
<th>Activity</th>
<th>Deadline</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D1</strong></td>
<td>Initial report (Work Plan and Workshop conclusions)</td>
<td>1</td>
<td>Month 2</td>
</tr>
<tr>
<td><strong>D2</strong></td>
<td>List of actors of the solar business</td>
<td>2</td>
<td>Month 4</td>
</tr>
<tr>
<td><strong>D3</strong></td>
<td>Map of past projects</td>
<td>2</td>
<td>Month 4</td>
</tr>
<tr>
<td><strong>D4</strong></td>
<td>Report on demand and potential for solar energy implementation</td>
<td>2</td>
<td>Month 5</td>
</tr>
<tr>
<td><strong>D5</strong></td>
<td>Report on the institutional, regulatory and normative frameworks and comparison with other countries</td>
<td>3</td>
<td>Month 10</td>
</tr>
<tr>
<td><strong>D6</strong></td>
<td>Report possible financial schemes</td>
<td>3</td>
<td>Month 10</td>
</tr>
<tr>
<td><strong>D7</strong></td>
<td>Report on the strategy for development of solar energy in BiH</td>
<td>4</td>
<td>Month 11</td>
</tr>
<tr>
<td><strong>D8</strong></td>
<td>Selection and design of pilot projects</td>
<td>5</td>
<td>Month 8</td>
</tr>
<tr>
<td><strong>D9</strong></td>
<td>Terms of Reference for Tender</td>
<td>5</td>
<td>Month 9</td>
</tr>
<tr>
<td><strong>D10</strong></td>
<td>Results of tender evaluation</td>
<td>5</td>
<td>Month 10</td>
</tr>
<tr>
<td><strong>D11</strong></td>
<td>Report on the commissioning of the projects</td>
<td>5</td>
<td>Month 15</td>
</tr>
<tr>
<td><strong>D12</strong></td>
<td>Assessment of the existing training and formation on Renewable Energy</td>
<td>6</td>
<td>Month 13</td>
</tr>
<tr>
<td><strong>D13</strong></td>
<td>Programmes of training for high school level</td>
<td>6</td>
<td>Month 14</td>
</tr>
<tr>
<td><strong>D14</strong></td>
<td>Strategy for dissemination at scholar level</td>
<td>6</td>
<td>Month 15</td>
</tr>
<tr>
<td><strong>D-A</strong></td>
<td>Progress report 1</td>
<td>Management</td>
<td>Month 4</td>
</tr>
<tr>
<td><strong>D-B</strong></td>
<td>Progress report 2</td>
<td>Management</td>
<td>Month 7</td>
</tr>
<tr>
<td><strong>D-C</strong></td>
<td>Progress report 3</td>
<td>Management</td>
<td>Month 10</td>
</tr>
<tr>
<td><strong>D-D</strong></td>
<td>Progress report 4</td>
<td>Management</td>
<td>Month 13</td>
</tr>
<tr>
<td><strong>D-Final</strong></td>
<td>Final report</td>
<td>Management</td>
<td>Month 15</td>
</tr>
</tbody>
</table>
Annex 4: CV of the local person representing TTA

PERSONAL DETAILS
Full Name Vedran Salihodzic
Address Ferhadija 35, 71000 Sarajevo, Bosnia and Herzegovina
Telephone +37833656905
Mobile +38763184334
e-mail s_vedran@bih.net.ba
Date of birth 29.12.1982

EDUCATION AND QUALIFICATIONS

<table>
<thead>
<tr>
<th>Name and address of school, college or university</th>
<th>Dates attended</th>
<th>Subjects/courses taken and qualifications obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catholic school centre “St. Joseph” - Mehmed-paše Sokolovica 11, 71000 Sarajevo Bosna i Hercegovina</td>
<td></td>
<td>General – program secondary school</td>
</tr>
<tr>
<td>Faculty of Economic Science - Trg oslobodenja - Alija Izetbegovic 1 71000 Sarajevo Bosna i Hercegovina</td>
<td></td>
<td>Two years of Management (unfinished)</td>
</tr>
<tr>
<td>Faculty of Philosophy in Sarajevo - Franje Rackog 1 Sarajevo Bosna i Hercegovina 71000</td>
<td></td>
<td>Philosophy and Sociology - 4 years (graduating year)</td>
</tr>
</tbody>
</table>

EMPLOYMENT HISTORY

<table>
<thead>
<tr>
<th>Name of employer and address or location</th>
<th>Position held (job title) and List of duties or responsibilities</th>
</tr>
</thead>
</table>
| ITM CONTROLS d.o.o. - Ferhadija 39, 71000 Sarajevo Bosnia and Herzegovina | System manager
- realization of GPS tracking system through satellite surveillance (as own business)
- participating in project of installation (technical help) hydrometric stations in Bosnia and Herzegovina (powered with solar energy)
- organising workshop presentation for ITM Controls, IMS
- production of promotion materials |
OTHER SKILLS AND ADDITIONAL INFORMATION

List any courses attended (with institution and dates), computer literacy (including level and packages used), any languages, prizes or awards


HOBBIES, INTERESTS OR ACTIVITIES
List any hobbies, sports and leisure activities

Semi - professional photographer
Trama TecnoAmbiental

Deliverable 2: List of actors of the solar business

Deliverable 3: Map of existing installations

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

Esad Djukanovic
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71000 Sarajevo, Bosnia and Herzegovina

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Project Director
Xavier.vallve@tta.com.es

Antoine Graillot
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Barcelona, May the 13th, 2008
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  2. Others ......................................................................................................................4
  3. Conclusions ..............................................................................................................4
II – Description of the activity of the companies ......................................................4
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I – List of actors

For finding out companies or other organizations involved in solar energy there is existing inadequacy of categorization for Renewable Energy Sources. For example, if a company deals with RES, for instance offers Solar Energy Heaters, it is classified in category much wider, since, because of the limited market size, there is no interest to sell exclusively solar heaters. On the other side, it is caused by insufficient level of knowledge of RES or other sources of energy, from which quantity of market demand depends. Since it has been impossible to find out involved companies using data from the chamber of commerce, other data have been used: internet researches for companies and projects, phone call to NGOs and Universities and interview with the partners in both ministries.

1. Companies

   (i) Federation of BiH

   1. NARODNO GRIJANE ([Igmanska bb, Sarajevo - email: info@narodnogrijanje.com ])
      It’s the biggest company on BiH market offering solar heating, as one type of license, so the price is maximally adjusted for all consumer categories. They offer bio-mass solar installations. Beside this they offer design, services for heating systems, and education of final users. They are present in Croatia, Slovenia and Serbia market.

   2. SBH COMPANY (Brčko Distrikt, Ul. Mostarska 21 – email: info@solanissistemi.ba)

   3. TECHNOPLUS (Tuzla, Rudarska 63 – www.technoplus.ba) – offers beside solar: geothermal heating for houses

   (ii) Srpska Republic

   1. BEMIND (Banja Luka, email: bemind@inecco.net)

   2. KOMING (Gradiška, www.rskoming.net)

   3. KLENIK (Gradiška, klenik@blic.net)

   4. TOPLING (Pnjavor, topling@blic.net)

   5. PAVLOVIC MONT (Banja Luka, usluge@pavlovic-mont.com)

From gathered information the first four companies (Republic Srpska) are part of so called “Solar group” Currently this group is doing pilot project in Lazarevo (part of Banja Luka). This project will enable first results for distribution of solar energy in Republic Srpska (by the end of this year). Also they are planning to develop first Bosnian solar system for heating. Remark: The results of this “group” are unknown and therefore are not presented.
2. Others

(i) Universities

From the academic sector, there is also very few actors. Some universities provide one module or few classes about the topic of the Solar Energy. The Deliverable 12 related to the activity 6 of the project will describe more into details the existing formation and training available.

Until now, three universities with a Solar Energy component have been identified:

Architectonic university in Sarajevo (contact person: Prof. dr. Ahmet Hadrovic)
The university has three subjects where RES is been studying systematically:
1. Architectonic Physics
2. Bioclimatic architecture
3. Architecture as Energetic System

University of Electrotechnics in Sarajevo – The department for electroenergetic studies solar energy as part of other subjects.

University of Electrotehnics in Banja Luka – Department for electroenergetic, similar as mentioned university, studies solar energy as part of other subjects.

(ii) NGOs

One local NGO is relatively active in the field of Solar Energy. Its name is “Centar za ekologiju i eneriju” (Center for Energy and Ecology) and it is based in Tuzla. Two years ago, they organized a workshop about “building your own solar collectors for heating water”.

3. Conclusions

The Solar Energy sector is not developed yet. There is no structure or professional or academic organization. Most of the actors involved in Solar Energy do it as a secondary or marginal activity. The private businesses are not structured with interaction between the academic, professional and institutional sectors.

Within the solar sector, the technology which is the most developed in BiH is the Solar Thermal (companies, universities, etc). There are almost no organizations involved in photovoltaic. The only exception is the experience of the very concrete professional applications in remote locations which are described in the following section: traffic flow meters and hydrological stations.

II – Description of the activity of the companies

The following describes the activity of the different organizations involved in the solar sector in BiH.
### 1. Overview

**Remark:** This information has been gathered by telephone. The missing data means that the information couldn’t be checked.

<table>
<thead>
<tr>
<th>Company</th>
<th>PV*</th>
<th>Solar Thermal (Solar hot water)</th>
<th>Years of experience in RE</th>
<th>Number of installations in the last year</th>
<th>Number of installations in the last 5 years</th>
<th>Manufacturer (YES/NO)</th>
<th>Dealer (YES/NO)</th>
<th>Installer (YES/NO)</th>
<th>Products imported from...</th>
<th>% of RE in yearly turn over</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEMIND</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KOMING</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEB d.o.o.</td>
<td>NO</td>
<td>YES</td>
<td>5</td>
<td>10</td>
<td>40</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>Various (international)</td>
<td>10%</td>
</tr>
<tr>
<td>NARODNO GRIJANJE</td>
<td>No</td>
<td>Yes</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>Sweden (International)</td>
<td></td>
</tr>
<tr>
<td>PAVLOVIC MONT</td>
<td>NO</td>
<td>-</td>
<td>5</td>
<td>4</td>
<td>10</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>Various (international)</td>
<td>20%</td>
</tr>
<tr>
<td>SBH COMPANY</td>
<td>Yes</td>
<td>Yes</td>
<td>3</td>
<td>7</td>
<td>40 (international) 15 (domestic)</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td></td>
<td>100%</td>
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<tr>
<td>TECHNOPLUS</td>
<td>Yes</td>
<td>Yes</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>Vaillant (international)</td>
<td>-</td>
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<tr>
<td>TOPLING</td>
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<td>2</td>
<td>2</td>
<td>2</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td>1%</td>
</tr>
</tbody>
</table>

* PV – Photovoltaic technology
2. Comments

The analysis of the companies' activities gave some valuable information. The main comments and conclusions are as it follows:

1. There is no manufacturer. One company is assembling solar collectors from Sweden but does not manufacture them. Everything is imported.

2. All of them are importing from different countries: Germany, Greece, Croatia, and Sweden.

3. In both technologies, thermal and photovoltaic, there are installers and dealers, which is interesting for the implementation of the pilot project and the possible training in the future.

4. 90% companies are doing central heating and if customer demands solar energies they are importing, if they can find, the best offer for solar collectors.

5. TECHNOPLUS and SBH Companies are the only one (from the list) dealing with photovoltaic technology. SBH Company, which is fully dedicated to Renewable Energy, has very large number of installations and large experience. They have installations in Bosnia, Croatia and Serbia also.

III – Existing installations

1. Solar Photovoltaic

   (i) Traffic flow meters

1. Companies that have installed system for traffic control (measuring the traffic flow) are coming from Croatia. Tender was domestic and international (done for Road Directorate of Federation) system was designed by this company together with photovoltaic panel.

2. Several types have been observed (no info on technical specification)

   ![Fig. 1 and 2: Stand-alone OPV systems for traffic control](image-url)
(ii) Hydrological stations

The hydrological stations measure water level, temperature, acidity level, conductivity and redox.

In remote location, stand-alone PV systems have been installed to supply electricity to the measurement devices. The pictures show two different installations. There are like 30 stations like those ones in BiH.

The equipments are imported. Actually the local companies import the whole system and install them by their own.

The modules used are crystalline modules between 55 and 60 Wp (maximum output is around 19V). The technical specifications for the batteries are 12V/27Ah and for the charge controller, 12V/6.6A.

Fig. 3 and 4: Stand-alone PV systems for hydrological stations
2. Solar Thermal

In the field of solar thermal technologies, even if there is more experience, there are quite a few existing installations. Mostly they were installed before the beginning of the war, when there were some local manufacturers. The installation in Neum is an illustration (Fig. 8).

The next pictures show two installations, one in a Hotel Marsal on mountain Bjelasnica (fig. 6 and fig. 7) and the other on in Neum. The installations are quite new (less than 6 years) and no one is working properly.
3. Map of installation

MAP OF INSTALLATIONS

Legend:

- Approximate line of Dayton agreement

- Approx. position of hydrological* stations with solar panels (photovoltaic)

- Approx. position of stations for measuring traffic flow (photovoltaic)

- Facilities with complete solar thermal installations (hotels)

- Private solar installations (private houses)
  - * approx. 30 stations
  - ** approx. 30 stations

Bosnia and Herzegovina 2008
Deliverable 4: Report on Demand and Potential for solar energy implementation

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

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Barcelona, January the 28th, 2009

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  2. Glossary and explanation ........................................................................... 3
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Report on Demand and Potential for solar energy implementation

I – Solar resources

The aim of this chapter is to introduce and identify the local solar resources in Bosnia and Herzegovina (B&H). The following maps show the solar irradiation in the country. The figure 1 is the yearly sum of global horizontal irradiation (kWh/m²) depending on the area.

B&H can be counted among the more favourable locations in Europe with solar irradiation figures of 1,240 kWh/m² in the north of the country and up to 1,600 kWh/m² in the south.

The figure 2 describes the yearly sum of solar energy received by optimally tilted solar modules (applicable for both modules and collectors).

The value that we can see on the scale is also the equivalent of the total number of hours of sun at maximum power.

Figure 1. Solar Irradiation on a horizontal face

Figure 2. Solar irradiation on an Optimally titled surface
II – Demand and potential for solar PV technology

1. Introduction

Currently, it exists a huge variety of sizes and topologies for PV installations. A first important division should be done between the installations designed to supply electricity in locations that the conventional grid does not reach, called stand-alone or autonomous installations, and the installations connected to the distribution grid, called grid-connected or grid-tied systems. For this last configuration, in many countries where the legal framework has fixed “feed-in tariff”, the electricity is sold to the grid. In the case of B&H, in 2002 the government adopted a resolution where the electricity suppliers or grid operators are obliged to accept electricity from renewable energy sources in their grids and to pay a fixed rate for it.

In any case, all the PV installations are based on the 4 main components which are:

1. Generation of electricity: PV modules or PV array.
2. Regulation and control: the charge controller (autonomous inst.) or the Maximum Power Point Trackers, data logger (grid connected inst.).
3. Transformation and load: inverters and electrical protections.
4. Storage: Battery (autonomous inst.) or the grid itself (grid connected inst.)

---

**Figure 3. Configuration of a PV Stand-alone system**

**Figure 4. Configuration of a PV Grid-connected system**
2. Glossary and explanation

- **PV module or PV array**
  The light from the sun generates on a PV cell a flow of electrons. There is no mobile or mechanical part in the system. The cells are connected electrically in order to form the PV module. The characterisation of the power is the Watt peak (Wp). The output is always DC current. A PV module of 1Wp generates 1W of electricity if it is exposed at a 1,000 W/m² solar irradiation. If the irradiation is less, the generation will be less. Several modules connected form a PV array.

- **Inverter**
  Inverters convert DC current into AC current. This conversion is very important for both configurations (stand-alone and connected) since it allows the use of conventional electro domestic devices which do not run with DC current (stand-alone applications) and since the distribution grid transports AC current (grid-connected applications). The characterisation of the power is in Watt (W).

- **Maintenance**
  Due to the absence of mobile parts, there is no heavy and complicated maintenance. The basic and main maintenance is the periodic cleaning of the modules and a general inspection once or twice a year. The inverter and in general the power conditioning unit is designed to run automatically: switch on when there is enough sun for generating and switch off when the night comes.

3. Context of B&H

**Electricity Market**

Prior to the war, the energy sector played a key role in the economy, producing eight percent of Gross Domestic Product in 1992. At the time, there was a countrywide, vertically integrated state-owned power company. The power sector in BiH now consists of three vertically integrated monopolies: Elektroprivreda Bosne i Herzegovine (“EPBiH”), Elektroprivreda of the Republic of Srpska (“EPRS”) and Elektroprivreda Hrvatske Zajednice Herceg-Bosna (“EPHZHB”). The power companies are synchronised and interconnected but there is no competition among them; they are virtual monopolies within their exclusive ethnically based service territories.

Electricity supplies in Bosnia and Herzegovina are essentially based on coal-fired steam-turbine power stations and the exploitation of hydropower (*Table 1*).

As a consequence of the war in the 1990s, about 56% of the generating capacity and 60% of the transmission and distribution grid were heavily damaged and the most infrastructures have been re-established later.

As a consequence of the war in the 1990s, about 56% of the generating capacity and 60% of the transmission and distribution grid were heavily damaged and the most infrastructures have been re-established later.
In general, the electricity sector is facing a number of challenges. The multiple companies have led to major problems and inefficiencies in supplying customers in a cost-effective manner. All the companies are struggling with losses and revenue collection.

**Electricity grid**

Electric energy transmission is carried out on 400, 220 and 110 kV voltage levels and the total line length was around 5,370 km in 1990s.

After the war, gradually there have been implementations for a new grid line and in year 2003, the total length of the grid has been 5,337 km.

The following map (figure 5) shows the main transmission lines (high and medium voltage) in B&H (Republika Srpska and the Federation). We can also see the electric power plants of the country distributed mainly in Hydro power plant and Thermal power plants.

The majority of the territory is reached by the distribution grid. The area where there is no grid is generally locations where the grid was destroyed during the war. In the next chapters we will quantify and analyze this issue.

It is worth mentioning that, in general, the PV grid connected systems can provide important benefits to distribution systems, depending on the characteristics and operating conditions distribution grid, as well as their location within it.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL INSTALLED CAPACITY</td>
<td>MW</td>
<td>3,99</td>
<td>N.D</td>
</tr>
<tr>
<td>hydro</td>
<td>MW</td>
<td>2,04 (51%)</td>
<td>N.D</td>
</tr>
<tr>
<td>coal-fired power stations</td>
<td>MW</td>
<td>1,96 (49%)</td>
<td>N.D</td>
</tr>
<tr>
<td>ELECTRICITY GENERATION</td>
<td>GWh</td>
<td>9,30</td>
<td>9,30</td>
</tr>
<tr>
<td>ELECTRICITY CONSUMPTION</td>
<td>GWh</td>
<td>6,97</td>
<td>6,97</td>
</tr>
</tbody>
</table>

*Table 1. Installed capacity, electricity generation and consumption in Bosnia and Herzegovina; Source: Platts – Energy in East Europe 2003; US Department of Commerce 1998*
4. Grid-connected

(i) Demand

Currently the use of grid connected photovoltaic power in B&H comes down to isolated cases installed in public buildings (orphanage, school…) with demonstration and training purposes.

In 2005 the PV installed capacity was estimated at <1% of total energy supply in B&H by Commission of the European Communities Research Directorate (see table 2).

Due to the relatively high cost related with the photovoltaic up to the moment existing facilities are carried out with support from grants and international projects.
Typical Target Group

The grid connected PV systems are mainly addressed to the private sector (household or investment). The public sector should also give examples and realize projects in urban areas.

Typical features

In regard to PV systems, there is no typical installed power. It would depend on economic investment capacity of the user.

In Spain and France, for instance, the average size for individual grid-connected PV systems is 2-3 kWp. The generation associated to such a system corresponds to the average yearly consumption of a typical household.

(ii) Potential

The technical potential for renewable energy, even with the preliminary studies, is significant. In less than 5 years the renewable could generate 10% of the total energy supply (Knezevic 2005).

The next table shows the Potential for Renewable Energy in B&H in 2005:

<table>
<thead>
<tr>
<th>ENERGY SOURCE</th>
<th>INSTALLED CAPACITY</th>
<th>PLANNED ADDITIONAL CAPACITY</th>
<th>TECHNICAL POTENTIAL CAPACITY</th>
<th>POTENTIAL CLASSIFICATION</th>
<th>RELEVANT NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal</td>
<td>None</td>
<td>1 MW plant with vol. flow of 240 l/s and water t=56°C</td>
<td>33 MW</td>
<td>HIGH</td>
<td>Water temperatures at important locations: 52°-62°</td>
</tr>
<tr>
<td>Hydro potential</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large HPP’s</td>
<td>2054 MW (52.8% of total installed electricity capacity)</td>
<td>394.5 MW</td>
<td>790 MW</td>
<td>HIGH</td>
<td>Construction of a 450 MW plant was deferred due to an EIA assessment. Potential for additional 114 Large HPP’s</td>
</tr>
<tr>
<td>Small HPP’s</td>
<td>31 MW</td>
<td>31.8 MW</td>
<td>662 MW</td>
<td>HIGH</td>
<td>20 additional small HPP’s are planned in the next 4 years. Potential for additional 242 small HPP’s</td>
</tr>
<tr>
<td>Wind</td>
<td>None</td>
<td>N/A</td>
<td>600 MW Indicated by preliminary studies</td>
<td>N/A, possibly HIGH</td>
<td>Preliminary studies show that the capacity of 600 MW is economically feasible and can be developed by 2010 with right incentives</td>
</tr>
<tr>
<td>Biomass</td>
<td>6.5% of total energy consumption as 2005</td>
<td>N/A</td>
<td>14% of total energy supply</td>
<td>HIGH</td>
<td>52% of BH is covered by coniferous deciduous trees. Energy values of annual increment obtained at estimated wood density of 500 kg/m3 are 72.5 PJ. Annual out = 7,400,000 m3 which produces 1,780,000 m3 of wood waste.</td>
</tr>
<tr>
<td>Solar</td>
<td>Estimated at &lt;1% of total energy supply</td>
<td>N/A</td>
<td>Solar irradiation is 1.242 kWh/m²/a to 1,500 kWh/m²/a</td>
<td>MODERATE</td>
<td>There are a number of PV installations in service sector for personal use/savings.</td>
</tr>
</tbody>
</table>

Table 2. Potential for Renewable Energy in B&H. Source: ECRD, 2005
The forecast energy scenario and the support of the Bosnian government by remuneration for in-feed of renewable energy favour the future development of renewable energy and solar energy specifically PV grid connected in B&H. (Figure 6).

Long term scenario: increased reliance on renewable

The forecast of a general increase in energy demand (Figure 7) and an increase in the price of fossil sources (including the coil which represents nearly half of the resource currently used in B&H for electricity supply) make it necessary to find a viable transition supply that is compatible with the environment and based on secure resource.

In addition to that, the increase of the use of PV will provoke a reduction of its costs. From 2020 onwards the PV energy will be competitive (Figure 8).

Short term scenario: Remuneration for in-feed of renewable energy

In 2002 the government adopted a resolution to promote the generation of electricity from renewable energy sources. In this, the electricity suppliers or grid operators are obliged to accept electricity from renewable energy sources in their grids and to pay a
fixed rate for it. The medium voltage tariff is multiplied by a correction coefficient depending on the type of renewable energy involved in order to obtain the applicable feed tariff. This resolution will be explained in detail in the later report D5.

It must be pointed out that in order to introduce the photovoltaic on the market the promotion of institutional and regular local programmes is necessary. In a later report (D5) the effective ways to integrate the PV energy in B&H by an institutional and regulatory framework will be analyzed.

Taking into account all factors showed and good solar resource available in B&H, especially in the Southern part, the potential use of PV grid-connected will be slow but constant.

5. Stand-alone applications

(i) Demand

Despite of having the most part connected to the electricity grid there is consumers far from the utility grid and areas where the network was damaged during the war. Currently the PV stand-alone applications demand is low and the installations are dependent on promotion and programmes of international projects.

Typical Target Group

The potential users mainly are coming from areas that suffered destruction during the war and where there isn’t electricity grid anymore.

Typical features

Photovoltaic generators can offer flexible solutions to provide sustainable electricity for special energy needs with high service quality. Some examples can be:

<table>
<thead>
<tr>
<th>Addressed to:</th>
<th>Suitable Energy Consumption</th>
<th>Energy requirements: (Wh/day)</th>
<th>Power up to (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smalls Household, weekend houses</td>
<td>Lighting and small consumption</td>
<td>Up to 1.375</td>
<td>275</td>
</tr>
<tr>
<td>Household and small mixed farming</td>
<td>Lighting and electric consumptions</td>
<td>825-2.200</td>
<td>2.400</td>
</tr>
<tr>
<td>Household, mixed farming, and local tourism</td>
<td>Lighting and electric consumptions</td>
<td>1.650-4.125</td>
<td>3.600</td>
</tr>
<tr>
<td>Mixed farming, small agroindustries, local tourism</td>
<td>Lighting and electric consumption</td>
<td>3.850-8.250</td>
<td>3.600</td>
</tr>
</tbody>
</table>

(ii) Potential

The potential users of stand-alone photovoltaic systems in B&H could be the houses not connected to the grid and the areas where the grid is damaged/destroyed.

The following table shows the demand from all boroughs of B&H. The data is divided on two main categories: realized and planned return of refugees.
The basis for the information is been gathered through ministry of human rights and refugees of B&H.

<table>
<thead>
<tr>
<th>Borough</th>
<th>Realized return</th>
<th>Planned return</th>
<th>Total*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Num. of units</td>
<td>Costs* of recovery</td>
<td>Num. of units</td>
</tr>
<tr>
<td>Bratunac</td>
<td>143</td>
<td>1,370,00</td>
<td>1,113</td>
</tr>
<tr>
<td>Bihac</td>
<td>30</td>
<td>467,644</td>
<td>31</td>
</tr>
<tr>
<td>Bos. Grahovo</td>
<td>127</td>
<td>2,094,000</td>
<td>54</td>
</tr>
<tr>
<td>Bos. Krupa</td>
<td>280</td>
<td>1,813,200</td>
<td>0</td>
</tr>
<tr>
<td>Bos. Brod</td>
<td>179</td>
<td>483,000</td>
<td>208</td>
</tr>
<tr>
<td>Capljina</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Derventa</td>
<td>43</td>
<td>213,000</td>
<td>426</td>
</tr>
<tr>
<td>Doboj</td>
<td>41</td>
<td>445,000</td>
<td>200</td>
</tr>
<tr>
<td>Foča</td>
<td>142</td>
<td>2,634,000</td>
<td>394</td>
</tr>
<tr>
<td>Glamoc</td>
<td>34</td>
<td>505,000</td>
<td>180</td>
</tr>
<tr>
<td>Grad Mostar</td>
<td>1</td>
<td>105,000</td>
<td>410</td>
</tr>
<tr>
<td>Prozor</td>
<td>13</td>
<td>136,000</td>
<td>8</td>
</tr>
<tr>
<td>Klobuc</td>
<td>80</td>
<td>1,003,200</td>
<td>0</td>
</tr>
<tr>
<td>Konjic</td>
<td>6</td>
<td>965,790</td>
<td>56</td>
</tr>
<tr>
<td>Istocni Mostar</td>
<td>1</td>
<td>117,500</td>
<td>18</td>
</tr>
</tbody>
</table>

Total amount of houses not connected to the grid is approximately 25346. Approximately 2033 hoses are in use, and approx. 23313 houses are not (houses that are still destroyed, waiting to be repaired or in the process of repairing.)

Despite the low potential for the use of FV isolated the added-value by the availability of electricity is very high and this application should be taken into account seriously by the authorities when they decide to re-build a line or connect a cluster or one house to the grid.
III – Demand and potential for solar thermal technology

1. Introduction
Solar heat can be used for solar water heating, solar space heating in buildings, and solar pool heaters.

Solar water heaters and solar space heaters are constructed of solar collectors, and all systems have some kind of storage, except solar pool heaters and some industrial systems that use energy immediately. The systems collect the sun's energy to heat air or a fluid. The air or fluid then transfers solar heat directly to a building, water, or pool.

Due to the usage of wood and fossil fuel to heat water is very high in B&H, the solar water heating systems would allow minimize the expense of fuel and reduce the associated environmental impacts.

Solar water heaters use the sun to heat either water or a heat-transfer fluid in the collector. Heated water is then held in the storage tank ready for use, with a conventional system providing additional heating as necessary. The tank can be a modified standard water heater, but it is usually larger and very well insulated.

2. Glossary and explanation
Solar water heating systems can be either active or passive:

**Active solar water heaters**
Active solar water heaters rely on electric pumps, and controllers to circulate water, or other heat-transfer fluids through the collectors. These are the two types of active solar water-heating systems:

*Direct-circulation systems* use pumps to circulate pressurized potable water directly through the collectors. These systems are appropriate in areas that do not freeze for long periods.

*Indirect-circulation systems* pump heat-transfer fluids through collectors. Heat exchangers transfer the heat from the fluid to the potable water.

![Figure 9. Configuration of Active solar water heater system into a building](image)

**Passive solar water heaters**
Passive solar water heaters rely on gravity and the tendency for water to naturally circulate as it is heated. Because they contain no electrical components, passive systems are generally more reliable, easier to maintain, and possibly have a longer work life than active systems. The two most popular types of passive systems are:
**3. Context of B&H**

In B&H, District heating (DH) often fuelled by natural gas was available in most cities with a population of over 25 000 before the war, and served 120,000 households (Austrian Energy Agency, 2006). These installations were badly damaged by lack of maintenance. While there was some direct shelling, most damage came from the corrosion and cracking of boilers, pipes and building installations during years of disuse. By early 1996, functioning district heating connections had dropped by two-thirds. At the same time, natural gas connections had increased sixfold, including a large number of dangerous self-made connections.

More than 90 percent of flats in Sarajevo have been reconnected to the district heating system and substantial improvements in cost recovery have been made with the installation of new billing and collections systems.

However, the district heating networks remain to be repaired in Banja Luka and 36 other smaller towns and cities. As Bosnia and Herzegovina urbanizes, district heating and natural gas will likely become increasingly important.

The heavily dependent on gas from other countries is dangerous because Europe's gas markets are dominated by monopoly practices. The lack of competition in Europe has very profound energy security implications.

**4. Individual installations**

**(i) Demand**

Currently the use of individual solar heating is negligible (> 1%) and the main current use is in small service sector buildings (restaurants, bars...).

**Typical Target Group**

In household without or damage district heating the usage of wood as a fuel predominantly for heating is extremely high in Bosnia – across all income quintiles. The lowest income quintiles spend almost twice the amount on wood as they do on other essential services. While there are no identifiable health impacts from the heavy reliance on wood...
on wood fuels, its high cost is a burden and there is a clearly a negative impact on the environment.

For this reason the main typical target group of individual solar water is household where used coal or wood as fuel for heating.

**Typical features**

In South Mediterranean countries a typical individual installation for supply domestic hot water and heating is by natural loop solar water heater with support of an existing boiler and in Western Europe usual configuration is forced circuit solar water heater with support of existing boiler.

There are no typical demand segments, but it is proportional to the number of members of the household.

The district heating is available only in 40% of urban areas and gas is available in 20% of urban areas, as shown in Figure 11. In non-urban and mixed areas it is virtually unavailable and poverty rates here vary from 20% to 24%. (World Bank’s Poverty Reduction Strategy Report).

![Figure 11. Household connections to network infrastructure by settlement type. Source: LSMS 2001](image)

About 30% of the heating for residential units in B&H are individual boilers and other resources (Table 3). Most of the existing individual heating is boiler gas, wood stoves or electric boilers.

<table>
<thead>
<tr>
<th>Geographic area</th>
<th>Steam heating from district heating (%)</th>
<th>Condominium heating (%)</th>
<th>Individual boilers and other resources (%)</th>
<th>Total (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBIH</td>
<td>43.5</td>
<td>26.6</td>
<td>29.8</td>
<td>166</td>
</tr>
<tr>
<td>RS</td>
<td>36.5</td>
<td>33</td>
<td>30.5</td>
<td>66</td>
</tr>
<tr>
<td>Distrikit Brcko</td>
<td>/</td>
<td>80.2</td>
<td>/</td>
<td>2</td>
</tr>
<tr>
<td>BiH</td>
<td>41.2</td>
<td>28.9</td>
<td>29.8</td>
<td>233</td>
</tr>
</tbody>
</table>

*Table 3. Type of the heating for residential units*
(ii) Potential

The typical applications of solar Individual heating are the permanent residences, small service sector buildings (restaurants, etc). The following table shows the statistical data for this potential users existing only in the Federation of B&H (Table 4).

<table>
<thead>
<tr>
<th>Category</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekend houses</td>
<td>145</td>
<td>79</td>
<td>145</td>
<td>169</td>
</tr>
<tr>
<td>Permanently living</td>
<td>9350</td>
<td>9370</td>
<td>10635</td>
<td>11055</td>
</tr>
<tr>
<td>Agriculture and live stock buildings</td>
<td>118</td>
<td>104</td>
<td>118</td>
<td>84</td>
</tr>
</tbody>
</table>

Table 4. Statistical data for potential users of individual solar installations

5. Collective installations

(i) Demand

B&H and more generally all the Balkan countries have developed the use of solar thermal energy in the 70’s and 80’s. Unfortunately, due to the lack of maintenance and the war, many collective installations in B&H are not working anymore or are not working properly. Moreover most of the former companies which installed those systems do not exist anymore. The main examples were application in hotel as we can see on Figure 12.

![Figure 12. Example of the use of solar water heating in B&H](image)

Typical Target Group

The potential users of solar collective installations are mainly the residence buildings, public facilities (hospitals, schools, care centres, orphanages etc), and service sector buildings (hotels, hostels).

Typical features

The usual configuration of solar collective installations is forced circuit solar water heater with support of existing gas or oil boiler.

As for individual systems, the size of the systems depends on the use and size of the building. Some typical values can be found concerning a household, a hospital, etc.

The sizing of a solar thermal installation is done to cover at least 70% of the needs of hot water. The rest is usually got form a conventional boiler.
Some examples of design and demand could be:

<table>
<thead>
<tr>
<th>Addressed to:</th>
<th>Supply up to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community health centre, kinder garden, small sports centres</td>
<td>400 litres per day</td>
</tr>
<tr>
<td>Medium consumer</td>
<td>900 litres per day</td>
</tr>
<tr>
<td>Hospitals, students or old people residences</td>
<td>1800 litres per day</td>
</tr>
</tbody>
</table>

Table 5. Examples of typical levels of consumption by different kind of users

(ii) Potential

The follow table shows the statistical data for the hotels existing only in the Federation of B&H:

<table>
<thead>
<tr>
<th>Category</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotels (with restaurants)</td>
<td>70</td>
<td>61</td>
<td>56</td>
<td>57</td>
</tr>
</tbody>
</table>

Table 6. Hotels existing in the Federation of B&H in different years

The follow table shows the statistical of the care centres existing in Federation of B&H and Republika Srpska estimated in 2002.

<table>
<thead>
<tr>
<th>Category</th>
<th>Federation of B&amp;H</th>
<th>Republika Srpska</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical centres</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>General hospitals</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Specialized hospitals</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Small district hospitals</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td>Primary health care (ambulantas and Dom zdravljas)</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>Total beds</td>
<td>8751 (beds occupancy rate 65.9%) (excluding Posavina, Zapadna Hercegovina and Hercegbosanski and Croat cantons)</td>
<td>7500</td>
</tr>
</tbody>
</table>

IV – Conclusions

The main conclusions of the analysis are:

The solar resource in most of the area is high enough to allow the use of solar photovoltaic and solar thermal energy, particularly in the southern part of the country (Herzegovina Region).

Almost half of the electricity generation is assured by fossil fuel, which is mainly coal. Gas is also widely used for the heat production. Due to the increase of price of those fuels, the environmental problems associated and the dependence of supply from other countries (gas from Russia), it’s necessary to increase diversification thanks to a use more important of the solar energies (PV and thermal).

The potential for solar PV grid-connected development is linked with the solar irradiation and the public policies for its promotion. As we have seen before, the first point is verified. For the second point, a later report will describe the actions to lead for its achievement.

Concerning the PV stand-alone applications, even if there is a low potential in B&H due to the reduced number of non-connected households, the added-value that offer those kinds of systems is not negligible and has to be taken into account when public authorities plan to re-built remote network or connect remote households.

In household without or damage district heating the usage of wood or coil as a fuel predominantly for heating is extremely high in Bosnia its high cost is a burden and there is a clearly a negative impact on the environment. Individual or collective solar installations would be a suitable solution to reduce the use of the conventional resources. The potential is high for the private households, the public facilities and service sector (hotels, etc). Former experiences in the beginning of the 80’s confirm this possibility.

To introduce the solar energy on the market is necessary the promotion of institutional and regular local programmes and a suitable institutional and regulatory framework. In a later report (D5) the effective ways to integrate the solar energy in B&H by an institutional and regulatory framework will be analyzed.
Trama TecnoAmbiental

D5 : Report on the institutional and regulator frameworks and comparison with other countries

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

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D5 : Report on the institutional and regulator frameworks and comparison with other countries

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D5 : Report on the institutional and regulator frameworks and comparison with other countries

I – Introduction
The objective of this report is to analyse the effective ways to integrate the solar energies in B&H by an effective institutional and regulatory framework, analyzing the barriers and obstacles.

This report provides an analysis of historical experiences of the solar sector in three key countries which are considered as reference in Europe for the promotion of Solar energy: Spain, Germany and France. All of them have a very different context, and some of the lessons learned can be applied in the case of B&H.

II – Legal framework and norms in BiH

- Solar Energy

Solar Thermal
With regard to solar irradiation, Bosnia and Herzegovina can be counted among the more favourable locations in Europe with solar irradiation figures of 1,240 kWh/m² in the north of the country and up to 1,600 kWh/m² in the south. Despite this, the use of solar energy can only be described as insignificant.

The thermal exploitation of solar energy with flat-plate collectors is also practiced to only a limited extent.

Nevertheless, B&H has an interesting background starting using solar thermal system in the late 70’s and 80’s for collective applications (hotels, hospital, etc).

Solar Photovoltaic

One of the first PV installations is being fitted on the roof of an orphanage in Trebinje with assistance from the GTZ. The installation is also intended to be used for training purposes for the local electrical trade. In view of the relatively high cost involved, the introduction of photovoltaic on the market beyond very small-scale consumers far from the utility grid is dependent on promotion programmes and international projects.

- Legal Framework

The definition of the term “renewable energies” in the Bosnian regulation governing electricity in-feed differs from the EU directive on the promotion of electricity from renewable energy sources in the internal electricity market. Furthermore, the sections on ‘national indicative targets' and 'guarantee of origin of electricity produced from renewable energy sources' stated in the EU directive are not taken into account in the regulation adopted by the Federation of Bosnia and Herzegovina. Discussions are therefore currently in progress to produce an in-feed directive that would be standard for the whole of B&H and in conformance with EU policy

Remuneration for in-feed of renewable energy in Federation B&H

In 2002 the government adopted a resolution to promote the generation of electricity from renewable energy sources and this is the only legislative act related to renewable energy: “Decision about Methodology for the Determination of Purchase Prices from

In this, the electricity suppliers or grid operators are obliged to accept electricity from renewable energy sources in their grids and to pay a fixed rate for it.

The level of remuneration for the in-feed of electricity from renewable energy sources with a maximum installed capacity of 5 MW is coupled to the amount of the medium-voltage tariff. This tariff is multiplied by a fixed correction coefficient depending on the type of renewable energy involved in order to obtain the applicable in-feed tariff. The following table shows the correction coefficients and the feed-in tariffs for electricity produced in 2004 from RES:

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Correction coefficient</th>
<th>Feed-in tariff (eurocent/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small-scale hydropower plants</td>
<td>0.80</td>
<td>3.96</td>
</tr>
<tr>
<td>Landfill-gas and biogas plants</td>
<td>0.77</td>
<td>3.81</td>
</tr>
<tr>
<td>Wind and geothermal power plants</td>
<td>1.00</td>
<td>4.95</td>
</tr>
<tr>
<td>Photovoltaic installation</td>
<td>1.10</td>
<td>5.45</td>
</tr>
</tbody>
</table>

Table 1 Feed-in tariff for electricity produced in 2004 from RES

Although preferential prices for RES are guaranteed in B&H through this system, they are ensured only for the current year, without any sort of motivational guarantee for investors that they will receive the same preferential price for an extended period of years that would be needed to ensure that the investment costs are paid back. Therefore the support scheme in its current form does not ensure sufficient economic stability in the sector of RES

Local government and the state do not give any additional support like subsidies or loans to the development of RES. Nor does the EBRD have any investment presence in B&H for RES. Instead they invest their money in roads, the power transmission network, etc. because that is their priority currently.

Except for the above-mentioned governmental decision, B&H does not have any other specific document covering rights for connecting to the grid and the capability of the grid to integrate energy from RES.

III – General mechanisms for supporting solar energy

- PV technology

Policy makers have started understanding the urgency of the situation about fossil fuel dependence and climate change and several policies to support renewable electricity are being put in place.

In order to support solar Photovoltaic electricity in particular, it is necessary to implement powerful and efficient tools supporting the use of solar electricity.

A number of different support schemes at various locations around the world have been tried over the years.

Some general criteria should be used to evaluate such support schemes:
- Investor security: every support scheme that poses any risk for investors will fail
- Simplicity and facility of implementation: this is key to reach small scale investors like the ones investing in private PV systems
- Cost effectiveness
- Triggering the growth for a mix of technologies: only a support scheme that includes new technologies with immense potential, can lead to a sustainable energy future
- The simplest evaluation of the above criteria is the following: have a look at all countries where support schemes are put in place and ask where it worked out best, and then, follow similar way.

There are many different ways to support renewable electricity, including awareness building and removing barriers such as limited access to the electricity grid.

The following figure gives an overview about existing support instruments for renewable electricity in general and PV in particular.

![Security of Energy Supply, Climate](image)

- **Renewable Energy**
  - **Direct Financial**
    - Voluntary mechanism
    - Investment based mechanism
    - Quota system
    - Fixed price
  - **Indirect Financial Instrument**
    - Voluntary demand
    - Investment subsidies
    - Tax Credits
    - Low interest
    - Tradable Green Certificate
    - Tendering
    - Feed-in Tariff
    - Premium
    - Taxation of fossil fuels
    - Reduce subsidies for

Figure 1: Origins and Structure of Support Mechanisms

a) Direct support mechanisms

i. *Fixed price systems*

Feed-in Tariff

Contrary to a quota system, in a feed-in tariff schemes, a price for each kWh that is produced is fixed.

The basic idea behind a feed-in tariff is very simple. Producers of solar electricity

- have the right to feed renewable electricity into the public grid
- receive a tariff per generated kWh reflecting the benefits of solar electricity compared to electricity generated from fossil fuels or nuclear power
- receive the tariff over a fixed period of time
All three aspects are simple but it took considerable efforts to establish them. For many years, the power utilities did not allow the input of solar electricity into their grid; this continues to be the case in numerous countries to this day.

Feed-in tariffs are a temporary measure to develop the competitiveness that will result from economies of scale. Competitiveness with conventional electricity sources will be reached in different regions at different times. Feed-in tariff systems therefore need to be adapted to national conditions. However, it is important that tariffs are paid over a period of roughly 20 years from the day the system is connected to the grid because the costs will be related to the initial investment. In a few years, investment costs will be low enough to be paid off without using the support of feed-in tariffs.

The feed-in program works independently from the state economy, and the extra cost which each electricity consumer has to pay in order to increase the share of renewable energy in the national electricity portfolio is very small.

In the past many programs were financed through government budgets. The disadvantage of this approach has been that if the money ran out, or was curtailed, the program could be stopped. Feed-in tariff models which are financed by through the regular electricity bill do not suffer from this drawback.

A feed-in tariff needs to be well designed and to be high enough interest investor but should not exceed a publicly acceptable level.

*Feed-in Tariffs – Core Elements*

- An efficient tool that has already proved to be successful
- A temporary mechanism
- Not a burden on taxpayers
- The driver for further cost reductions and economies of scale
- Ensures high quality PV systems and good performance
- Creates secure conditions for potential investors

*Premium Feed-in Tariffs*

Premium feed-in tariffs work similarly to the regular feed-in tariff schemes. The investor is guaranteed to receive a certain price for each kWh produced. However, with a premium feed-in tariff, the tariff consists of 2 separate payments. First the produced electricity is sold to the electricity market at regular market prices. As market prices vary according to demand and supply, any shortfalls are paid to the investor in the form of a premium tariff.

In regular feed-in tariff scheme investors receive a pre-determined fixed rate. The premium feed-in tariff is rarely used as a support mechanism for PVs as it is a complex arrangement for owners of small installations. Premium feed-in tariffs are used however, to support wind electricity initiatives in Spain

*ii. Investment based support*

*Investment subsidies*

Investment subsidies are a frequently applied form of support for all kinds of goods and services. PVs are no exception as grants are a commonly used tool. A specific part of the
investment costs (usually a fixed amount per kWp rather than relative share) is covered by a funding institution. The subsidy is dependent on the rated power capacity (kWp) and not on the annual electricity production (kWh). Compared to other support schemes which focus on annual electricity production, investment grants do not sufficiently motivate investors to invest in highly efficient PV systems. As the actual production is not subsidized, less efficient modules will be used to keep investment costs down. For the same reason, maintenance efforts will be rather low. A properly maintained PV system can significantly increase the electricity output over its lifetime. Investment grants can easily be combined with other forms of support. However, the above mentioned disadvantage can not be entirely avoided by such a combination. Also a digression rate may be applied in order to compensate the annual price reduction of PV systems.

**Tax credits**

Tax related benefits could be designed in various ways. VAT, income tax, energy tax or other forms of tax could be addressed by policy makers. Also accelerated depreciation might be appreciated under certain circumstances by investors. Whether an incentive is either a cash payment or a tax related benefit does not have much impact on the economic evaluation from an investor’s perspective. However, politically there can be a difference depending on who is providing the payment. Tax increases to provide direct subsidies might result in political difficulties.

**Bank loans**

Bank loans with beneficial interest rates can be a very suitable supplementary tool to trigger demand for PV systems. The successfully operating feed-in scheme in Germany is supported by a low interest loan offered by KfW Forderbank. Up to 100% of the investment (max. 50,000) can be subject to a low interest loan for private costumers. The KfW payback period can be as long as the feed-in tariff program (20 years). Similar programs are provided for commercial investors.

**iii. Quota systems – Government fixes the quota**

Quota systems can be designed in a variety of different ways. The main principle is that the government compels producers, providers or consumers of electricity to have a certain share of renewable electricity in its mix. While the quota is imposed, the price is set through competition between different project developers and also different technologies. A quota system does not need to be combined with other support tools.

However, quota obligations are commonly combined with the following mechanisms: **Tendering and Tradable Green Certificates.**

**Tendering**

Tendering, or competitive bidding, has been used for wind energy in different countries (such as Ireland, UK and France). Under a tendering scheme, project developers submit projects and indicate the wholesale price they would like to get for the produced electricity.

The company with the lowest productions costs will be able to ask for the lowest price and will finally get the order. The project developer enters a contract which guarantees that the electricity will be bought over a defined period of time (power purchase agreement).
The difference between the current market price and the contracted price in the power purchase agreement represents the value that needs to be financed either by a public promotion fund or a levy on the electricity bill.

Obviously, for small scale PV system, this mechanism is too complicated and transactions costs are too high. Also for bigger systems, tendering has a major drawback.

**Tradable Green Certificates (TGC)**

Tradable Green Certificates resemble the Tendering mechanism. Instead of entering a power purchase agreement, in a TGC scheme, prices are set on a frequent basis. Due to varying prices (values of certificates), investors lose security on their returns on investment.

A typical TGC scheme works as follows: governments set a usually increasing quota for renewable energy in the supply portfolio. The producers, wholesalers, retailers or consumers (depending on who is obliged) are obliged to supply or consume a certain percentage from renewable electricity sources. For each unit of renewable electricity a certificate is generated and issued to the producer. This certificate serves as proof that the renewable electricity was delivered into the grid.

Certificates can be bought from other generation plants or from broker who often acts as an intermediate or a supplier owns generation’s plants.

In order to enforce the scheme, penalties need to be set if quotas are not reached. Penalties need to be considerably higher than the expected value of certificates in order to motivate quota compliance.

The value of the certificates increases until a sufficient number of investors see a sufficiently high return on investment. An underlying aim of this support scheme is that the target should be fulfilled in the cheapest way. Technologies with the lowest costs will be able to operate under TGC scheme.

Technologies like PV are currently not competitive with other renewable technologies. However, their long term potential in cost reduction is immense and their potential of contribution to future production is larger than for other technologies source.

TGC scheme have proven not to be cost efficient and turn out to be more expensive than feed-in tariff scheme.

**iv. Voluntary mechanism**

**Voluntary demand**

In theory, voluntary demand for renewable electricity could lead to a faster deployment of PV. High voluntary demand for clean electricity could attract new investors in renewable electricity. A new market would be created. However, investors need secured demand over years in order to payback the investment costs and generate profit. A voluntary support scheme can hardly guarantee demand over years.

The positive aspect about voluntary demand is that it is independent of policy support. A number of utilities offer a high share of green electricity in their electricity mix. Although a high number of these offers can be found, they have not shown to be successful by convincing a significant share of electricity consumers to switch to cleaner electricity technologies.
b) Indirect mechanisms

Certainly there are also a number of indirect financial support mechanisms for renewable electricity in general and PV in particular. In order to reflect the external costs of conventional electricity sources, fossil and nuclear technologies can be taxed to compensate those external costs adequately. Consequently, PV and others renewable technologies would find it much easier to compete with conventional technologies. Reducing subsidies for those technologies would lead to a similar effect.

Programs for industrial development which facilitate the settling of PV component manufacturers in European countries would reduce start up costs for potential uprising technologies. Also national and European R&D funding programs have a major impact on the development of PV. Adequate public funding in fundamental as well applied research and demonstration projects is needed to develop new Photovoltaic technologies and improve existing technologies. A possibility of creating synergies is the inclusion of PV in other support programs for other sectors. Integrating PV in building policies is an example.

As demonstrated, there is a variety of different support mechanisms, instruments and supporting actions that can help PV become a major global energy source. The core of each support program should be a well designed feed-in tariff.

Kyoto based mechanisms

The aim of the Kyoto Protocol is a mandatory limitation of greenhouse gas emissions to the signatory nations. United States are featured among notable exceptions. Other countries, like India and China, which have ratified the protocol, are not required to reduce carbon emissions under the present agreement.

ETS

The overall target of the ETS is to reduce emissions in the most cost effective way. Within the ETS, the main EU industries can trade emissions. Member States assign quotas for those main industries (energy, steel, cement, glass, brick making, and paper/cardboard).

The main industries in Europe have to reduce their CO₂ emissions, however PV was not used reach this obligation.

CDM

Under the CDM, industrialized countries can do projects for greenhouse gas emissions reduction in non-industrialized countries. The generated CO₂ reductions (so called CER – Certified Emission Reductions) are purchased by the industrialized country for a specific price. CER can be used for the domestic emission reduction target.

The Joint Implementation Mechanism (JI)

This mechanism works very similarly to the CDM except that under the JI scheme, industrialized countries can do projects in other industrialized countries, mostly in transitional Eastern Europe and the former Soviet Union, where the costs of reducing emissions are considered lower.
Overview of the Initiatives supporting photovoltaic power systems

An outline of the range of PV support mechanisms in place in different countries during 2007 can be found in the table below.

2007 saw a consolidation of the notion that the feed-in tariff (FiT) approach is the prime mechanism for promoting grid-connected PV applications. This was reinforced by strong growth in PV markets in France, Germany, Italy, Korea, Portugal and Spain.

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<thead>
<tr>
<th>Enhanced feed – in tariffs</th>
<th>AUS</th>
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<td>Green electricity schemes</td>
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<td>Investment funds for PV</td>
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<td>Commercial bank activities</td>
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<td>Sustainable building requirements</td>
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</table>

**Figure 2. PV support mechanism by selected countries**

An evaluation of the different support schemes in different countries made by European Photovoltaic Industry Association shows that a feed-in tariff support scheme is being successful. The following figure summarizes the results:

<table>
<thead>
<tr>
<th>Investor Security</th>
<th>Simplicity</th>
<th>Proven Success</th>
<th>Cost Effectiveness</th>
<th>Guarantying a mix of different technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feed-in tariff</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Quota systems</strong></td>
<td>-</td>
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<tr>
<td><strong>Investment subsidies</strong></td>
<td>+</td>
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<tr>
<td><strong>Voluntary demand</strong></td>
<td>-</td>
<td>+</td>
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</tbody>
</table>

**Figure 3: Evaluation of Different Support Mechanisms for PV**
**Solar thermal technology**

Solar thermal can be successfully implemented at all altitudes because factors like general awareness of the environment, public support and the quality of the products offered by the industry have proven to be at least as important as climatic condition.

Success or failure to grow is never due to a single reason, but rather to a mix of conditions. To understand the reason for success as well as the potential barriers to growth, it is necessary to examine the specific characteristic of each market segment.

The possible barriers and the solutions relevant for solar thermal in general are:

<table>
<thead>
<tr>
<th>Barriers to growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ High upfront costs and relative long payback times</td>
</tr>
<tr>
<td>▪ Not yet perceived as a standard option for heating – therefore the decision-maker must be specially motivated</td>
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<tr>
<td>▪ Higher transaction costs (information, procurement, installation works) compared with the conventional heating (default option)</td>
</tr>
<tr>
<td>▪ Low awareness of energy savings and environment</td>
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<tr>
<td>▪ Low awareness of solar thermal, especially among the relevant decision makers</td>
</tr>
<tr>
<td>▪ Lack of availability of motivated and specifically skilled installers</td>
</tr>
<tr>
<td>▪ Solar thermal not yet fully integrated into mainstream heating and construction sectors</td>
</tr>
<tr>
<td>▪ Harmonized standards, certification and quality labels not yet widely recognized in the market and by public authorities – this barrier being solved through EN standards and Solar Key mark</td>
</tr>
<tr>
<td>▪ Applications with high potential not yet available in standard solutions (combisystems) or still in demonstration phase (solar cooling, process heat)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reasons for success</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Regulations making solar thermal mandatory</td>
</tr>
<tr>
<td>▪ Stable and well-designed financial incentives to investment</td>
</tr>
<tr>
<td>▪ Expected price increase of conventional heating fuels</td>
</tr>
<tr>
<td>▪ General awareness of energy savings and environment</td>
</tr>
<tr>
<td>▪ Awareness of solar thermal, especially among the relevant decision-maker</td>
</tr>
<tr>
<td>▪ Public campaigns promoting solar thermal</td>
</tr>
<tr>
<td>▪ Highly visible demonstration projects – often with public authorities serving as model</td>
</tr>
<tr>
<td>▪ Availability of motivated and specifically skilled installers</td>
</tr>
<tr>
<td>▪ High trust through quality products and recognized quality label</td>
</tr>
<tr>
<td>▪ Availability of standard products and applications – explaining the success of solar thermal particularly in small residential buildings</td>
</tr>
</tbody>
</table>

For this reason is necessary to define an effective action plan to support solar thermal from beginning. The first part of the action plan is structured along areas of action relevant for solar thermal in general, basic elements common to all markets segments:
• Regulations
• Financial incentives
• Awareness and promotion
• Improving market structures / EU market integration
• Research and development

The second part is structured along market segments and their specific barriers to growth.

The table below gives an overview of the priority level of each areas for market segment, the values range from 1 (highest) to 5 (low priority).

<table>
<thead>
<tr>
<th>Segments</th>
<th>Residential</th>
<th>Tertiary</th>
<th>Industrial</th>
<th>Other</th>
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<tbody>
<tr>
<td></td>
<td>DHW &amp; Space Heating</td>
<td>DHW &amp; Space heating</td>
<td>Process heat</td>
<td>District heating</td>
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<td>One-family houses</td>
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<td>Multi-family buildings</td>
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<td>Awareness</td>
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<td>Market structures</td>
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<tr>
<td>R&amp;D</td>
<td>5</td>
<td>5</td>
<td>2</td>
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</table>

**Figure 4. Priority actions for each markets segments**

In order to maximize their impact, effective programs to support solar thermal should:

• Be targeted at overcoming the key barriers to growth.
• Take into account the most important reasons for success.
• Consist of a combination of measures – single actions have hardly any impact.
• Be stable over several years – stop-and-go support leads to straw fires but not to sustained growth.

The largest part of the potential use of solar thermal is not economically viable, under present market conditions. The main barrier to growth is the high level of upfront investment costs.

To help overcome these disadvantages, many national, regional and local governments and in some cases even utilities offer financial incentives for the installation of solar thermal systems. Public incentives are fully justified by the positive external effects of a solar thermal installation.

So far, financial incentives have been a key element for the development of the solar thermal market. Currently, subsidies are provided by most European countries, except Denmark Finland and Greece. Under present conditions, the abolition of the incentives usually leads to a collapse of the market. The experience of the last few years in Greece
shows that, the market can be self-sustainable even without financial incentives, once a minimum critical mass is reached.

For financial incentives, quantity is not everything: they must be carefully designed to provide the right incentives for a healthy market growth.

There is a high potential for economies of scale at different stages of the value chain: for manufacturing, but above all for distribution, marketing and maintenance costs. Once critical mass in the European market is reached and the social costs of the use of fossil fuels are highlighted, the need for financial incentives will disappear.

i. Regulations

Experiences show that regulations are the single most effective tool to promote solar thermal.

In EU the implementation of the EC Buildings Directive (Directive 2002/91/EC) plays a key role for solar thermal. It was transposed into national legislation in 2006. Within the framework of the directive, a methodology of calculation of the energy performance of buildings must be developed at national or regional level. Based on this methodology, minimum requirements of energy performance must be set for new buildings and for large buildings undergoing major renovation. Furthermore, energy performance certificates will be mandatory every time a building is constructed, sold or rented out. This has produced very positive results.

To fully develop the potential for solar thermal, stronger regulations are necessary. In certain market segments, solar thermal is not used where it would be financially sound. Only binding regulations can directly overcome this barrier to growth. By creating larger market volumes, binding regulation leads to higher awareness for solar thermal and indirectly to cost reductions even in other market segments. Such regulation can be implemented at local, regional or national level.

The first and most effective option is:

• Obligation to install solar thermal systems on new buildings and on buildings undergoing a major renovation. However, since solar thermal collectors are widely used also in one-family houses, the regulation should include these as well.

As flanking measures or as alternatives in case the previous model is not yet politically feasible, a series of regulations should be considered:

• Permission to start construction of new buildings should be granted only after an assessment of the potential for use of renewable energy sources.

• Obligation to install solar thermal systems, at least for certain categories of buildings with large heat consumption (swimming pools, hospitals) or publicly owned buildings with high visibility.

• Obligation to install hot water pipes up to the roof of new buildings and on buildings undergoing a major renovation. This increases only marginally the costs at time of construction/renovation, but makes it much easier and cheaper to install a solar thermal system later on.

• Abolition of regulations hampering the diffusion of solar thermal. In some areas, it is necessary to ask a permission to install a solar system on the roof. The long procedure discourages potential users. The permission may even not be granted, due for example to aesthetic restrictions, often set without reflecting on the consequences for solar energy.
• Household applications (dishwasher, washing machine) compatible with solar thermal systems (adapted to get hot water from pipes) should be widely available on the market. The highest category in quality labels should be given only in this case. Customers should be explicitly informed if this is not the case. Such measures are useful also to promote other renewable heating technologies and cogeneration used in district heating networks.

• As many heat tanks as possible should be compatible with solar thermal systems to make integration at a later time possible. Customers should be explicitly and clearly informed if this is not the case.

ii. Financial incentives

Two of the main barriers to growth for solar thermal are of a financial nature:

• High upfront costs - initial investment makes up most of the costs of a solar system
• In many cases, relatively long payback times – depending on prices of conventional heating

These barriers will decrease once economies of scale are realized. Until mandatory regulations are in effect, stable and well-designed financial incentives and fiscal measures are necessary to stimulate the market. Certain aspects of financial incentive schemes should take specific national conditions into consideration.

Stop-and-go disrupts the market

The stability of financial incentives is a key condition for a sustainable growth of the solar thermal market. For this reason, regulation or incentives based on law have stronger effects than short-term incentive programs based on ad-hoc budget decisions.

Simple interaction between investors and public hand

The administrative burden linked to direct incentives is often too high. The transaction costs should be minimized. In countries where incentives are provided by different kind of authorities (national, regional, local), the national government should ensure that a potential investor can get all information and apply for all incentive programs by interacting with a single office, such as the national or regional energy agency.

Harmonization of technical conditions

The technical requirements that a solar system must fulfil in order to receive a direct incentive should be harmonized as much as possible, to boost the development of an open European market. The CEN/CENELEC Solar Key mark should be the reference for all financial incentives provided in Europe.

Fiscal measures

Fiscal measures have the advantage of being usually more stable than direct incentives, if the latter are not designed to function in the long-term.

VAT exemption or reduction on solar thermal products and services are key measures.

As seen above, in some countries a family pays more for VAT than it receives in form of a direct incentive. However, this is relevant only for those market segments (mainly small residential buildings) in which the investor cannot deduct VAT. Another important fiscal measure can be the deductibility of the investment on solar thermal from income and/or building property tax.
Financing schemes

Particularly for larger solar thermal installations (large buildings, solar supported district heating, industrial process heat) facilitated access to credits for investors should be guaranteed.

National or regional authorities could provide special financial guarantees. At EU level it must be ensured that state aid rules fully allow such schemes.

Internalization of social costs (CO₂ and energy tax)

Last but absolutely not least: the competitive disadvantage of solar thermal and renewables in general is to a great extent politically determined. Fossil fuels and nuclear power fuels receive substantial subsidies, directly and indirectly. Society pays for their external costs in terms of environmental damage, health risks and import dependency, with heavy consequences on the international political stability. CO₂ and/or energy taxes, gradually aiming at full cost internalization are the solution.

iii. Awareness and promotion

Raising awareness among potential users is decisive for market development. The industry is still too small to launch systematic promotion campaigns. Support from public authorities is needed and should be motivated by the contribution of solar thermal to public policy goals.

Campaigns targeted to raise awareness among the general public must be adapted to national/regional conditions. Additional campaigns should focus on specific target groups and address their particular needs. Such focused campaigns can be significantly supported at the European level, by creating specific informational tools and disseminating information on best practices.

There are good reasons why public authorities should actively contribute to such campaigns:

- Contribution to achieve public policy goals, like reduction of emissions and security of energy supply
- Promotion campaigns are a necessary complement to other measures taken by public authorities, such as financial incentives or regulations.
- The solar thermal industry is not yet big enough to be able to finance and run autonomously campaigns targeted at the general public or high profile campaigns targeted at specific market segments

The main goals of promotion campaigns can be:

- To create awareness of the use of solar thermal
- To provide knowledge about financial and technical issues
- To motivate potential users to assess the potential for solar thermal in their building
- To assist potential users by providing independent information to facilitate their decision to install a system

There is a wide scope also for direct involvement of institutions at the European level and international level. For example, the European Commission can play an important role as an opinion maker, by enhancing sustainable heating on the political agenda and by
providing clear recommendations to national or regional energy agencies. Moreover, projects such as Soltherm1 can be very useful to boost information transfer about promotional campaigns and other activities and provide a useful framework to learn from each other’s experiences.

**iv. Improving market structures**

In most countries, the solar thermal market is still at an early stage of development. Once a critical mass is reached, market structures will ripen spontaneously.

Most important in this area: the motivation of craftsmen to install solar thermal systems must be improved. The following actions are proposed:

- Installations should be made as simple as possible (Industry)
- Campaigns should be targeted at installers to increase their knowledge about solar thermal, create preference and to motivate them to actively market solar thermal technologies (Industry and public authorities)
- Installers should be encouraged to participate in specific training courses (Industry and public authorities)
- Potential users of solar thermal should be enabled to recognize specially trained installers (Industry and public authorities).

In the early phase of market development, solar thermal training should be strictly voluntary.

The European SUNTRAIN and QUALISOL projects aim at developing a criteria catalogue to evaluate the quality of solar thermal training courses.

**EU Market Integration – Promoting the Solar Keymark**

European quality label for solar thermal products and systems was launched: The CEN/CENELEC Solar Keymark. The Solar Keymark was developed by the industry and test institutes with the support of the European Commission. It certifies conformity with the relevant EN standards.

**v. Research and development**

Substantial progress has been achieved during the last three decades. A broad range of highly efficient solar collectors is now available. While domestic hot water applications are fully developed, further R&D is necessary to fully commercialize other applications, able to realize huge potential for use of solar thermal energy.

The main barriers to successful research and development in the solar thermal sector are:

- The bulk of the industry still consists of small and medium enterprises, lacking financial resources for medium and long-term R & D activities.
- Available public funds are in general too low, in some countries not existing at all.
- Public research programs with a specific focus on solar thermal are very seldom.

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1 Sholtherm is supported by ALTENER program of DG Energy and Transport of the European Commission. [www.soltherm.org](http://www.soltherm.org)
• Public research programs with general focus on energy efficiency and/or renewable energy sources are often not easily accessible for small and medium enterprises.

IV – Legal frameworks and regulation in three European Countries

Spain

a) PV technology

i. Overview of the market situation

The target under the Renewable Energy Programme 1991-2000 (as part of the Plan for Energy Savings and Efficiency) was to increase the installed capacity of solar PV to 2.5 MW. In fact, photovoltaic capacity increased by 5 MW from 1993 to 2000.

Since publication of the national “Plan de Fomento (PFER)” in 1999 the Spanish government follows a clear strategy to promote PV; the Spanish PV industry plays a leading role in Europe, even before the national market really took off.

The publication of the royal decree 436/2004 and later superseded by royal decree 661/2007 has given the decisive boost to the Spanish PV market; investment conditions suddenly are among the best across Europe and attract investors from Spain and abroad; the market is currently at a similar stage as Germany about 5 years ago.

Annual installed PV power in Spain in 2007 reached 512 MW – more than five times the size of the market previous year which, in turn had been four times the size of the market in 2005.

The Spanish PV market has been focusing, so far, on ground-mounted installations, which represent 95% of the total installed capacity for 2007.

The main barriers to the development of solar photovoltaic power have been economic. Moreover, the modifications in the feed in tariffs system introduced in 2004 and modified in 2007 have represented an improvement to the development of the area.

Nowadays, some technical and administrative barriers are still in force although the royal decree should simplify administrative procedures in order to allow the deployment of small installations in the residential sector; moreover the grid access procedures must be clarified, especially where the distribution grid is concerned.

ii. National PV incentives systems

Spain follows a clear political strategy to which the policy framework has been aligned; the government has provided incentives for the installation of PV systems since 1991. Incentives are available at both the national and regional level.
Key elements of the regulatory framework are a feed-in-tariff system combined with soft loans and direct subsidies granted by the national energy agency IDAE and regional counterparts;

PV policy as outlined in the national promotion plan is coordinated by the Ministry for industry and Energy which has assigned operational management functions to IDAE; initiatives on the national, regional and local levels are coordinated by so-called consultative Committees.

The main support mechanisms for Photovoltaic energy are:

**Direct Financial Instrument**

- **Feed-in-tariff system**: key instrument is the “special regime” offering specific feed-in-tariffs for RES producers including PV; In 1994 Royal Decree determined the fixed tariff for solar PV at € 0.06/kWh. This tariff was insufficient to stimulate the market and no additional capacity came on-line between 1995 and 1998. Under the 1998 Royal Decree, the tariff was raised to €0.39/kWh. This tariff applies to installations with capacity less than 5 kW. The feed-in-tariff system has been amended in 2004 with publication of the RD 436/2004 and superseded by royal decree in 2007 (661/2007).

- **Building Technical Code**: Upon its publication in the EU Official Journal on 4 January 2003, the EU Directive on the Energy Performance of Buildings (EPBD) entered into EU law. Member States, including Spain, were granted until 4 January 2006 to transpose the EPBD into domestic law. The code indicates the obligation to install PV systems in specific buildings of the service sector.

- **Investment support schemes**: additional support can be obtained by means of a centralized funding scheme called “financing line ICO-IDAE“ which combines soft loans with direct subsidies granted by IDAE; the maximum that can be financed in a project is 70% of the investment by means of loans at low interest rates. The beneficiaries are 1. private individuals, 2. corporations; financed are grid-connected PV systems; in addition, all autonomous regions and various municipalities offer subsidies, although most have been cut down following the amendment of the feed-in-tariff system to avoid “over-subsiding” of the market;

- **Fiscal incentives**: exist, but are of minor importance in comparison to the aforementioned instruments.

**Summary. Solar PV Policy Time**

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<th>Solar PV Policy Timeline</th>
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<td>- Royal Decrees (feed-in tariffs)</td>
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<td>- Law 24/01 (tax incentives)</td>
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<td>- Building Technical Code</td>
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*Denotes a significant change to a policy, such an extension, repeal or revision*
iii. Regulatory framework

Electricity sector regulations relevant for the PV market

Plant authorization: The Royal Decree 1663/2000 established the technical conditions for the connection of photovoltaic systems to the low voltage grid. It applies to photovoltaic installations of nominal power not higher than 100 kVA and whose connection to the distribution grid is low voltage (i.e., not more than 1 kV). If the nominal power of a PV installation is more than 5 kW, the connection to the grid will be through three-phase inverters. This connection can be made through one or various single-phase inverters at each phase, with power less than 5 kW.

In this moment the procedures are clearly defined in Electricity and Renewables Act RD 661/2007; in charge of authorization procedures for electricity producers and final commissioning permission are the respective authorities of the Autonomous Region; they also facilitate the centralised registration under the “special regime”; This Decree supersede the before decree 436/2004).

• Sector regulation: ensured by national regulator CNE;
• National plant register: very transparent register for all installations under the “special regime” (REPE) in place since 2004 and is accessible for the general public on DGPEM website.

Building sector regulations relevant for the PV market

• Building standards: the new technical building code (CTE, due in 2005) defines energy efficiency standards for new or refurbished buildings;
• Solar building obligations: Spain has been the first country to implement solar building obligations on municipal levels (“Barcelona model”); PV market are indirectly capitalising on these > 50 “ordenanzas solares” that have been implemented in the meantime;

PV industry regulations relevant for the PV market

• Quality standards for PV products: international/ European quality standards (IEC) for PV products and installations have to be complied with;
• Quality standards for PV installations: specific national regulations regarding safety standards of installations;
• Quality standards for PV installers: have to comply with the general standards of electricians; specific qualification labels for “solar installers” are voluntary so far.

Key PV Legislation Royal Decree 436/2004 and 661/2007

The Royal Decree 436/2004 provided incentives for new installed capacity of renewable energy sources in one of two ways.

1. Generators, who sell their production to a distributor, receive a fixed tariff that is defined as a percentage of a regulated tariff. The percentage is established on a technology by technology basis. The reference tariff for 2004, is indirectly based on the production market price, and has a value of 0.072/kWh.
2. Generators, who sell their electricity on the free market, receive the negotiated market price of electricity, an incentive for participating, and a premium, if eligible.

PV < 100 kW receive a fixed tariff of 575% of the regulated tariff
PV > 100 kW receive a tariff of 300% of the regulated tariff. These tariffs remain in effect for the first 25 years, after which the fixed tariff for PV is reduced to 460% (PV < 100 kW) and 240% (PV > 100 kW) of the reference price.

The royal decree 661/2007 superseded Royal Decree 436/2004, establishing new tariffs and premiums for each kind of facility covered and incorporating renewable energy, waste to energy and cogeneration plants into the special regime.

While previous regulations allowed alternative energy producers with a capacity of at least 50 megawatts to either accept price regulation or to sell electricity at market value with the help of subsidies, the new decree guarantees producers a variable subsidy adapted to changes in the market value of electricity.

Guarantees for processing new applications: The decree provides that those requesting new production facilities in the special regime must present a guarantee for an amount equivalent to 500 per kW for the photovoltaic facilities or 20 per kW for all other facilities.

The feed in tariff in 2007:

- 0.44 €/kWh > 100 kW for 25 years (575 % of average electricity price). Then 0.3523 €/kWh
- > 100 kWp < 10 MWp: 0.4145 €/kWh for 25 years then 0.332 €/kWh
- 0.23 €/kWh > 10 MWp for 25 years (300% of average electricity price) after 25 years 240 % of average electricity price.

iv. Lessons learned

- Subsidies was abolished in 2006 (for grid connected systems), as the feed-in tariffs are enough for the adequate development of the market.
- Administrative procedure simple is basic for achieving a good development of PV solar sector.
- At first, there were excellent conditions to the PV development: specific solar yields + feed-in-tariff+ loans up to 80 % extremely attractive for investors in 2005 (ICO-IDAE); Direct subsidies up to 20 % in 2005(Grid connected systems) 30 % (isolated systems) + regional subsidies.
- There was very consistent PV strategy: clearly defined targets, ambitious promotion plan, well-conceived mix of instruments; full commitment of relevant authorities on federal and regional level
- Advanced approach to market monitoring and policy performance measurement.

Weaknesses national PV policy framework

- Limited budget led to suspension of the whole ICO-IDAE programme in summer 2004, bringing the exploded market to a sudden halt;
- Bureaucratic application procedures for grants (esp. on regional level);
• Most focus of investors on subsidies/public aid; it is coming funds of financial sector (banks etc.) In 2005, there were some private funding models (commercial bank credits, project financing etc.);
• Cap limiting large-scale megawatt parks;

v. Perspectives

There is some concern about growth rates being experienced in the Spanish PV market, the relative lack of PV installation in the residential sector and the ability of locally produced PV products to compete with cheap imports (particularly from China).

Targets set by the Royal Decree have been surpassed. Consequently, revisions of the feed-in tariff scheme have been proposed to encourage smaller systems and applications on building.

Target: Currently Spain lacks a target for photovoltaic. It had a 400 MW objective (371 MW on-grid) for 2010, but this was reached in October 2007. Now, the new royal decree has to establish new targets, at least, for 2009 and 2010 until the approval of the Renewable Energy Plan 2011-2020.

b) Solar thermal technology

i. Overview of the market situation

The Spanish solar thermal market has finally overcome the situation characterized with the words “small size and unable to grow”.

The impulse of Thermal energy began with the Plan for the Development of Renewable Energies (PFER), which was approved by the Spanish Government on 31 December 1999.

In 2006 the Spanish market increased by over 60% newly installed capacity and 183 MWth of capacity were newly installed during 2007 (262.000 m2), 50% more than in the previous year. This increase is due to the introduction of a nation-wide solar obligation for new buildings. The regulation, which builds on the success of the many “Solar Ordinances”, came into force in September of 2006 and applies to almost any building, either newly constructed or undergoing major refurbishment. The experience at municipal level has shown a time lag of 1-3 years until a solar obligation is fully effective. In spite of this as most buildings constructed in 2007 were planned before the new building code came into effect, the solar obligations have not yet had a significant effect on the market.

The impact should start to show in 2008. However, Spain currently experiences a slowdown of the construction sector, which may also have an effect on how the CTE is applied.
The Solar market in Spain is growing very fast, though starting from very low levels. More proactive public policies linked with growing awareness of the solar thermal potential are now stimulating the market. High growth rates can be expected, as market structures mature. The specific target fixed by the Government for solar thermal collectors is to achieve around 5 million m2 installed in 2010.

ii. National incentives systems

The procedure developed by the Spanish Government to promote, not only solar heating and cooling activities, but the whole spectrum of renewable energies is the Program for Promotion of Renewable Energies 2005-2010 (PPER or PFER in Spanish).

The Spanish government has made IDAE the spearhead of the PFER, but the authorities have not exactly specified how the targets should be reached.

The actions on the national level have largely replaced activities of regional governments and have served to facilitate the application for incentives. At the same time, autonomous municipalities are allowed to continue supporting solar thermal with own programs as long as they are inline with Spanish and EU regulation. Surprisingly, the municipalities – following the example of Barcelona – have become the main actors in this field, making solar thermal mandatory for domestic water heating in medium and big buildings. This could only be achieved by securing support from the building developers. The political support from the local authorities is clearly more than just a “fashion”, and is largely based on the positive image of solar energy amongst citizens. Being seen as supporting renewable energies could therefore improve the government’s chances of being re-elected.

At the same time they must balance local energy policy to also include the electric and natural gas industries, which have received the most attention in the past.

The main actions to support Thermal Energy have been:

• Law on Fiscal Administrative and Social Measures: The Law (24/2001) offers corporate tax deductions for investments in renewable energy sources. Those investments that were originally for Royal Decree 1663/2000 have been incorporated into this Law. Eligible investments entitle firms to a 10% tax deduction in the case of investments in installations or equipment using solar power. This reduction of the interest rate on private and commercial loans directly improved the competitiveness of solar thermal. Manufacturers are beginning to use the good return on investment as a marketing argument.

• Financing schemes: ICO-IDAE Financing Line. In 2002 under the Renewable Energy Plan 2000-2010 - a financing line has been provided by the Official Credit Institute (ICO) and the Institute for Diversification and Energy Saving (IDAE) for renewable energies and improving efficiency projects

• New regulations: Building Technical Code (Royal Decree 314/2006) requires all new or renovated buildings to cover 30%-70% of the Domestic Hot Water demand with solar thermal energy. Barcelona was the first to enact such a regulation: new buildings with more than 22 dwellings must use solar thermal if their daily hot water consumption exceeds 2,500 litres at 45°C. The experience of the city of Barcelona is already showing considerable success. This has motivated other cities to announce that they will follow the example of Barcelona (amongst them Pamplona, Madrid, Seville,
and Valencia). The Code promotes solar energy by recommending public subsidies, tax benefits and interest-free loans for construction companies to install solar panels.

Summary. Solar Thermal Policy Time

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<td>Building Technical Code</td>
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- Denotes a significant change to a policy, such an extension, repeal or revision

iii. Regulatory framework

The main standards for thermal installation are in Building Technical Code:

A package of minimum construction standards, Spain's Building Technical Code (CTE - Código Técnico de la Edificación) will, specifically promotes solar energy by recommending public subsidies, tax benefits and interest-free loans for construction companies to install solar panels. Though nationally-applicable, these subsidies are likely to differ in amount from region to region.

The range of supply of solar energy supplied to domestic hot water heating varies between 30% and 70%, depending on household consumption and climatic zone. The code indicates the obligation to install PV systems in specific buildings of the service sector.

The CTE supports Spain's goal to install 5 million square meters of thermal panels with 143MW capacity by 2010.

v. Lessons learned

Two main events improved the Spanish Solar market: the government endorsed more money for solar thermal (6 million €) and detailed regulations covering both technical and economic quality became mandatory for installers. This stimulated the market, as consumers received much better quality. The publication of this regulation also signified the strong determination of the Spanish government to support the solar thermal market.

It seems that these regulations had the expected impact, at least for medium and large scale installations. For smaller installations it proved to be quite complicated, as installers had difficulties with the complexity of the regulation. These installers were allowed to prove their qualification by showing a “sufficient number” of systems they had previously installed.

This regulation also sparked actions by other authorities; municipalities especially realised that their support for solar energy could improve their image, and thus established their own solar thermal regulations (beginning with the city of Barcelona). However, as these are mostly linked to building constructions (new built or major refurbishment) it takes at least one year for the results to show.
The main reason for the recent success of solar thermal has been the clear support from the Spanish government.

*Typical consumer motivation*

The motivation is usually the same for private and commercial installations, in this order of importance:

Economic: Direct subsidies have been decisive in developing the market, especially in the case of big installations (e.g. in hotels). As the interest rates decreased in 2002, solar thermal systems became economically viable even without subsidies. Payback times are estimated at 6–8 years.

Growing ecological awareness.

**vi. Perspectives**

To overcome the current barriers concerted actions are needed. Proposals for concrete actions are:

- Regulatory: Continuation of the successful new buildings regulations. The regulations should make solar thermal mandatory in newly built buildings, but should avoid creating new bureaucratic burdens. A model for such a municipal regulation has been developed by IDAE to be used by interested municipalities.

- Institutional: Achieving a better coordination of the efforts of national, regional and municipal authorities.

- Economic: The collaboration between the different market actors needs to be improved.

- Educational: A closer co-ordination of the numerous but separate actions in this field must be achieved, including education on solar energy from elementary school to higher education.

The future for solar thermal in Spain looks more promising then ever, due to the sensitisation of both political decision makers and the general public.

**Target**: 5 million square meters of thermal panels with 143MW capacity by 2010.

**Germany**

a) PV technology

**i. Overview of the market situation**

In the last 7 years Germany has developed to the leading PV market worldwide;

From 1990 to 2001, solar PV capacity grew by more than 50% per year, and electricity production from solar PV grew by nearly 60% per year. Total capacity was 195 MW in 2001. While the share of solar PV in total renewable use is still quite small compared to biomass and wind, growth has been spectacular since 1990. A combination of feed-in tariffs and production subsidies has spurred this growth.

The main driver of this development has been the Renewable Energy Law (EEG) launched in 2000 and amended in 2004, in 2006 and 2008- which guarantees sufficiently attractive and secure feed-in-tariff for PV investors.
At the moment, the cumulative installed power of PV systems in Germany increased to 3.8 GW by the end of 2007.

Annually installed power in 2007 was approximately 1100 MW.

Germany remained the most important global PV market. About half of the global installations took place in Germany. Although the absolute market figures keep growing in Germany, the market share of Germany in Europe was shrinking Europe during the last year as markets like Spain and Italy finally followed the successful German path. Germany has a diverse mix of PV applications. In 2007 30% of the German PV systems were installed on residential homes (1-10 kW). 53% were installed on farm houses, multi-family houses, public and social buildings or were commercial plants in the range between 10-100 kW.

7% were very large commercial roof top systems (>100 kW) and 10% of the PV systems were installed as very large ground mounted systems.

0.6% of electricity consumption in Germany can already be provided by PV. From the currently installed PV capacity one can estimate a share for PV of roughly 3% of the renewable power generated in Germany.

ii. National PV incentives systems

The history of the now successful “German model” build around the Renewable Energy law (EEG) started at the beginning of the 90’es with a first subsidy programme (“1.000 solar roof-tops”) and preliminary feed-in- law (“Stromeinspeisungsgesetz”). These measures, and not even the new subsidy programme (“100.000 rooftops” – HTDP) started in 1999 were sufficient to help the national PV market to take-off – this effect was not achieved before the EEG started in 2000; only the combination between EEG and HTDP secured commercially oriented PV investors a full payback of their investment and the breakthrough of the market;

The national strategy for PV promotion is based on a simple formula: fixed, but decreasing feed-in- tariff (until 2004 to be combined with investment subsidies as soft loans);

The PV policy framework is widely homogeneous nationwide; on the federal level it is co-ordinated by the Ministry for the Environment; the HTDP programme is managed by the public promotion bank KfW; in addition, some German regions run additional support schemes interesting for PV investors.

The main support mechanisms for Photovoltaic energy have been:

**Direct Financial Instrument**

- Feed-in-tariff system: regulated by the Renewable Energy Law (EEG), amended in 2004 and 2006 and 2008 its terms for PV investors have been improved further;
• **Investment support schemes:** On the national level, the HTDP programme managed by the KfW has been abolished on behalf of the amended EEG; the same applies to many regional subsidy schemes, but in some regions they are still in place; The KfW Programme producing Solar Power, introduced in 2005, offers low-interest loans for small investments in solar PV generation. Private investors are the main beneficiaries as only projects with an overall investment up to 50,000 €.

• **Fiscal incentives:** exist, but are of limited relevance;

• **Green pricing models:** yes, various municipal utilities offer green offerings as a voluntary option for their customers to support RES by paying a premium on their electricity bill.

• **Voluntary mechanism:** Voluntary programmes such as the Green Electricity Programme and Full Cost Rates were very important in the 1990s in bridging time gaps in public support and in providing independent funds. However, since the introduction of the EEG, the importance of these programmes has diminished.

**Indirect policy issues**

• **Ecological tax:** Next to the publication of the guidelines for the 100,000 Roofs solar Power Programme”, on 1st April 1999, the German Government realized the first stage of and ecological tax reform. Prices of fuel oil, natural gas, gasoline/diesel and electrical power were increased. The additional steps were increased this price during the next years.

Following the introduction of the ecological tax reform in 1999, the decision was taken to continue the reform until 2003. In 2003, the Act on the Further Development of the Ecological Tax Reform entered into force, and the expansion to an ecological fiscal reform (EFR) was initiated.

**Summary. Solar PV Policy Time**

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• Denotes a significant change to a policy, such an extension, repeal or revision

**iii. Regulatory framework**

The German Feed in Law (EEG) has inspired many countries all over the world. This law has been the driver not only for the German PV industry, it has also shown the rest of the world that political commitment can help to achieve environmental goals and lead to
industrial development at the same time. In June 2007 the German parliament decided to amend the EEG. Annual digression rates will increase as from 2009. Furthermore, there will no longer be a bonus for façade integrated systems. If the growth of the PV market (new installations) in a year will be stronger or weaker than the defined growth corridor, the digression in the following year will increase or decrease by one percentage point respectively.

Electricity sector regulations relevant for the PV market

• Electricity plant authorisation: defined in electricity act and EEG in line with EU directives; promoters obtain status as electricity producer by local fiscal authorities;
• Grid access code: included in the Renewable Energy Law (modified in 2008) and in line with EU legislation; grid access and grid use contracts have to be signed with local utility;
• Sector regulation: new independent regulator in place since 2005;

Building sector regulations relevant for the PV market

• Building standards: a building permission is only required in special cases (e.g. installations in protected areas); new energy efficiency regulations for the building sector have no direct relevance for the PV sector;
• Solar building obligations: various pilot initiatives have been implemented by German municipalities, but their direct relevance for the PV sector is yet limited;
• Regulations for building-integrated PV: various regulations affect BIPV; it depends on the type of installation and the respective regional building code if a specific permission is required.

PV industry regulations relevant for the PV market

• Quality standards for PV products: international/ European quality standards (IEC) for PV products and installations have to be complied with.
• Quality standards for PV installations: have to comply with general norms for electro-technical installations;
• Quality standards for PV installers: have to meet specific professional regulations and technical guidelines; installations and grid connection have to be undertaken by certified professionals.

Key PV support: Renewable Energy Law (EEG) and 100.000 solar roof-top programme

Renewable Energy Law (EEG)

The Electricity Feed-In Law of 1991 granted approximately € 0.09/kWh to photovoltaic power fed into the grid. On its own, this feed-in tariff was insufficient to adequately foster PV deployment. The Renewable Energy Sources Act 2000 increased the remuneration to € 0.51/kWh in 2000. This rate decreases annually by 5% for newly built systems. This remuneration together with grants and soft loans provided within the 100,000 Roofs
Programme has resulted in rapid growth of PV systems since 1999. Slight increases in the remuneration under the Renewable Energy Sources Act are expected to promote further deployment. PV technology has been a focus of public promotion of RD&D in the renewable energy field.

The EEG provides a reliable legal framework for investments in solar power, wind energy, hydropower, bioenergy and geothermal energy. The objective of the Renewable Energy Sources Act is to increase the share of total power supply which is derived from renewables to at least 12.5 per cent by 2010 and at least 20 per cent by 2020.

- Type of system: fixed feed-in-tariff system;
- Start/expiry date: EEG in place since 01.04.2000 and in 2004 was replaced for other one and amended in 2006 and 2008.
- The EEG is a further development of the old feeding law from 1991 whose terms were yet insufficient to leverage the PV sector; in retrospective the approval of the new law in 2000 has to be credited to “lucky conditions” under the majority of the red-green-majority in the parliament at the time;
- Beneficiaries: any PV producers;
- Feed-in-tariffs: The basic rate for power from solar radiation was 45.7 cents/kWh in 2004. If the installation is attached to or built on top of a building, the payment for an installed capacity of up to 30 kW is 57.4 cents/kWh, for over 30 kW it is 54.6 cents/kWh and for over 100 kW 54.0 cents/kWh. Facade-mounted installations qualify for an additional 5 cents/kWh. Payments for solar power shall be made for 20 years. If the installation is not integrated into the facade or on the roof of a building, it is only eligible for payment if it has been commissioned for certain legally defined land categories and within the framework of a local development plan pursuant to the Building Code and a planning procedure pursuant to the Building Code. From 1 January 2005 the annual decrease for new installations was 5%. For installations which are not integrated into the facade or roof of a building or sound barrier, the rate of decrease was 6.5% p.a. from 1 January 2006.

**The Feed-in tariffs in 2007:**

Fee-in-Tariff for 20 years with built-in annual decrease of 5% from 2005 onward. For plant, neither on buildings non sound barriers, the annual decrease is 6.5 % from 2006 onward.

Tariffs for new installation in 2007:

- Free standing systems: 0.3796 €/kWh
- Systems on buildings and sound barriers: 0.4921 €/kWh < 30 kWp; 0.4682 €/kWh > 30 kWp and 0.4630 €/kWh > 100 kWp.
- For façade integration there is an additional bonus of 0.05 €/kWh.

**PV support schemes: 1000 Roofs Programme and 100.000 solar roof-top**

In 1991, the large scale PV demonstration programme, the 1 000 Roofs Programme, offered subsidies for production costs of 60% in the east federal states and 50% in the western federal states. When the programme was completed in 1995, 2,100 units with total peak generating power of 5.3 MW had been installed. The 100 000 Roofs
Programme commenced in 1999 with the goal of increasing capacity by 300 MW by the end of 2003.

The programme supported the installation or extension of PV systems larger than 1 kW. Loans, with interest rates 4.5% below market conditions, were offered with a repayment period of ten years and two years of deferred payments. The possible share of financing was up to 100% and a maximum of € 500,000. Furthermore, for installations smaller than 5kW, the loans were limited to € 6,750/kW and for installations larger than 5kW, the loans were limited to € 3,375/kW.

Starting in 2001, these limits were reduced by 5% annually. Initially, the tenth repayment instalments were waived, but this stipulation was abandoned in 2001. The programme was targeted to develop 300 MW of additional capacity. The programme ended in July 2003 having supported 55,000 installations and 261 MW of additional capacity.

General characteristics of support schemes
- Type of system: soft-loan scheme for grid-connected PV installations; one part of “two-column” support model with EEG
- Start / expiry date: started in 1999 and expired in 2003 (5 years);
- Administration: managed by public promotion bank KfW;
- Targets of programme: “100,000 solar roofs”; targets defined are clearly industry political rather than energy or even environmental political: market development, industry development, cost reduction;
- Total budget: € 1.700 Mio. over 5 years (65,702 projects), excluding regional funds;
- Funding: federal budget of Ministries for the Economy and Environment;
- Beneficiaries: 1. private individuals; 2. corporations (SMEs); 3. Associations, foundations – the programme is mainly responsible on the current market structure in Germany (focus on small roof-top systems on private family houses);
- Type of support: soft loan (interest rate up to 4.5% below market rates, e.g. 1.91% in 2003);
- Level of support: maximum budget 6.230 €/kWp for installations < 5 kWp; max. 3.115 €/kWp for each kWp for installations > 5 kWp.

iv. Lessons learned
- Essential success factor for a feed-in-tariff system is the exact, country-specific calculation of the threshold for the profitable operation of PV plants (break-even point) + 5–6% risk surplus. Market demand does not respond proportionally to the amount of the feed-in-tariff (like politicians tend to think), but very sensitively to the smallest investment barriers.
- Subsidy programmes can be a very effective short term measure to stimulate the market (“PR-effective”); however, a sustainable promotion strategy for PV should not depend on the usual budget constraints of subsidy schemes; without the parallel introduction of the EEG the German HTDP programme would definitely not have been successful;
- Survey results have to be “handled with caution”, since PV companies tend to be dishonest with figures, in different ways and for different reasons.
• Requirements for a valid market monitoring system are extremely high; therefore considerable budgets to set up and run a system are compulsory. At the same time, rather than only improving national approaches there is a need for a consistent monitoring system on a European scale.

**Strengths of national PV policy framework**

• EEG enables profitable operation of PV plants
• EEG: long-term security of investments, legally guaranteed
• EEG: Feed-in-tariff avoids administration problems (easier to handle than subsidy programmes);
• EEG: No artificial limitation ("cap") of market growth of the new EEG;
• EEG: No “stop & go” policy due to budget constraints and administrative processes;
• HTDP: Specific “charme” of the HTDP programme was that not major budgets within the medium-term financial planning had to be provided for; the cost for interest rate reductions were distributed between federal budgets over the entire lifetime of soft loans, so over 10 years;
• HTDP: The possibility to finance up to 100 % of initial cost enabled many investors to face such a considerable investment – very important especially in an early stage of market development, eventually risk reduction for investors by 50 % liability exemption (risk taken over by the state).

**Weaknesses national PV policy framework**

• HTDP: limited duration/timeframe;
• HTDP: limit ("cap") building an artificial barrier of market growth.
• HTDP: like all subsidy programmes the HTDP financed by federal budgets was exposed to “stop & go” effects; this fact reduces planning security for investors considerably.
• Market monitoring is still insufficient, especially since HTDP programme has expired; especially off-grid sectors, as well as import/export relations are not considered in a sufficient way.

**v. Perspectives**

The EEG (German Feed-In Law) must continue to be the driver of the German PV market.

For some more years not only will domestic installations depend on this successful support scheme, but a whole industry sector, many employers and a lot of Know-How would be at stake. Although Feed-in Tariffs will decrease faster than in previous years, the industry will do its best to keep pace with cost reductions in order to deliver competitive products.

For the electricity sector, the Federal Government set a national target for renewable energies of 20% by 2020.

**Target**: The industry believes that until 2012 the annual market could grow to 2.400 MW under favourable conditions.
b) Solar thermal technology

i. Overview of the market situation

Germany is by far the biggest market in Europe. Its high growth rates, combined with the large population, have made developments in Germany decisive for the whole European market.

The German growth shows the high potential of solar thermal in Europe, especially when taking into account that its conditions in terms of climate, built environment and energy prices are not particularly favourable. The key factors for the development of the German market have been a positive political framework (financial incentives, information campaigns), widespread environmental motivation and a well-established network of market actors.

From 1995 to 2001 the German solar thermal market showed furthermore a very good development. The demand for solar thermal systems rose by an average of 30% per year. There were three main reasons for this market success. First the public awareness of solar energy and therefore the interest in the use of solar thermal increased. Second the government strengthened subsidies for solar thermal systems. Third the solar branch – with established solar companies and several companies – worked very hard to build up the market and to active plumbers to sell and install solar systems.

In 2002 the market dropped by about 40% for several reasons. The consumption in general decreased due to the uncertainty to the public because of the new Euro, the terrorism 11 September 2001 and the increasing economic problems in Germany. In addition, the amount of subsidies was reduced. At the beginning of 2003 the amount of subsidies increased and the interest in solar thermal systems grew up.

In summer 2005, the financial incentive scheme was changed in order to give a higher incentive to combisystems and a somewhat lower incentive to domestic hot water system. As expected, this had led to an increase in the average system size installed.

Due to a series of factors, the German domestic market for solar thermal products shrank by 37% in 2007 compared with 2006.

ii. National incentives systems

The market stimulation programme is part of the political strategy of the German Federal Government to expand the share of renewable energy. In addition to the subsidies in the MSP, low-interest loans for solar thermal systems are also available in the CO₂ reduction programme. However, these loans have been utilised only to a very limited extent.

The main procedures developed by the German Government to promote the solar thermal have been:
• **More Public awareness:** One further reason for the interest in solar energy is the growing discussion about the danger of climatic change and the end of fossil energy resources. Solar energy is seen as one indispensable future energy resource by the public. Most of the people would use solar energy, if it was not more expensive than oil or gas.

In order to increase the public awareness has been several solar thermal campaigns:

`Solar - na klar!` (‘Solar – that’s clear!’) was launched in 1999. Under the management of the environmental organisation of the industry, B.A.U.M., the organisations of the plumbers (ZVSHK), the solar thermal energy branch (BSE and DFS, who merged in 2002 to form BSi), German Section of the International Solar Energy Society (DGS), the architects (BDA) and the environmental association DNR, developed and realised the campaign from 1999 up to 2001. The concept was to interest people by means of PR work, mainly with articles in magazines and newspapers, reports from radio stations and presentations on TV. Due to the limited budget, only small advertisement in house building magazines were placed. The interested persons could request a brochure with information about the reasons for the use of solar thermal energy, the techniques of the different systems, the requirements for its use and the subsidies available.

In 2002 the follow up of the solar campaign was planned. Under the direction of the German energy agency (dena), the plumbers and the solar industry associations relaunched the campaign with the new name "**Initiative Solarwärme plus**". Due to the increased knowledge of the public about solar thermal energy, the new campaign will focus more on the sales process and will provide support to the plumbers for the selling of solar systems.

In addition to this campaign, the solar companies increased their own advertisement activities for solar thermal energy systems and media reports about them. Due to the growing number of buildings with solar systems integrated into their roof, solar systems are now accepted more and more as the mature and reliable technology which they are.

• **Investment subsidies:** Subsidies for solar thermal systems were given by the government and by the individual German federal states.

  - From 1995 to 1998 the government launched the ‘Marktanreizprogramm’ (market stimulation program). 51 million Euro were given out over the whole period of 4 years for solar thermal and other renewable energies. Solar thermal systems for one-family houses were subsidised.

  - In 1999, the newly elected government of the Social Democrat and the Green Party extended the Marktanreizprogramm and increased the total sum of the public funds involved. Therefore the market grew by about 45% per year in 2000 and 2001.

  - Up to July 2001 the individual subsidy was 250 DM (128 Euro) per m² flat plate collector and 325 DM (166 Euro) per m² vacuum tube collector. In July 2001, the subsidy amount was reduced to 170 DM (87 Euro) per m² for both types. Up to March 2001, every owner of a building got the double subsidy if he replaced a more than 10 year old boiler in combination with the installation of a solar thermal system. The boiler subsidy was reduced in March 2001 to 500 DM (256 €) and finally expired in July 2001. About 50% of the requests for subsidies were in combination with this boiler subsidy. This strategy intended to activate the plumbers
to sell combined systems and to offer solar systems in every case an old boiler had to be replaced.

- In order to give the solar thermal market new impetus after the market decrease in 2002, the re-elected government decided to increase subsidies from February 2003 to 125 Euro per m². It is expected that the market will grow again in 2003. Due to limited money for subsidies it has been decided as well to reduce this rate to 110 Euro per m².

- In 2000 subsidies for 750,000m² and in 2001 for 875,000m² were granted. Due to this strong engagement by the government, most of the German federal states ended their individual subsidy programs.

  - Eco-bonus: In addition to the market stimulation program, builders of new houses and buyers of residences got the ‘ökazulage’ (eco bonus), which was 2% of their investment on solar systems in their dwelling over 8 years, in sum 16%, but a maximum of 4,000 DM (2,045 €) in total. This program ended in February 2002 synchronously with the start of the new ‘Energie-einsparverordnung’ (energy saving regulation). In summer 2005, the financial incentive scheme was changed in order to give a higher incentive to combisystems and a somewhat lower incentive to domestic hot water system.

The main subsidy programs for solar thermal systems are as follows:

<table>
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<tr>
<th>Kind of incentive/given by</th>
<th>Amount of subsidy/systems subsidized</th>
<th>Recipient/reachable market</th>
<th>Comment</th>
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<tr>
<td>‘Marktanreizprogramm’ (market stimulation program) of the ministry of economy</td>
<td>125 Euro subsidy per m² collector area</td>
<td>mostly smaller systems for DHW and room heating support, mainly private investors, about 80% of the whole market</td>
<td>at the present the most important subsidy program</td>
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<td>‘Ökazulage’ (eco-bonus) for new buildings</td>
<td>for 8 years 2% of investment amount, total 16%, max. 250 € per year = 2,000 €</td>
<td>new buildings or newly acquired building used by the owner, about 10% of the whole market</td>
<td>amount, total 16%, max.</td>
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<td>Incentives of individual federal states or from local authorities</td>
<td>only in some cases if there is no national subsidy, varying conditions similar to national programs</td>
<td>partially aimed at recipients which are not reached by national programs like municipalities</td>
<td>not additional to national subsidy</td>
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<td>‘Investitionszulage’ (investment bonus) in the new federal states</td>
<td>15% bonus</td>
<td>planning reliability due to legitimate claim</td>
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<td>‘Solarthermie 2000’ of the ministry of economy</td>
<td>subsidy for large systems and district heating on public buildings</td>
<td>demonstrational program for public buildings (residential home for elderly, dormitories etc.) and solar district heating systems</td>
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• **Eco-tax**: The first step of the “eco-tax” was introduced on 1st April, 1999. The tax of fossil fuels and electricity was increased by 2.05 € Cent/litter light fuel oil and 0.164 € Cent/kWh gas with an additional increase every year. The last step of eco-tax followed on 1st January 2003.

**Summary. Solar Thermal Policy Time**

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- Denotes a significant change to a policy, such an extension, repeal or revision

**iii. Regulatory framework**

As a part of the *Solar Thermal Action Plan*, the Energy Agency of the region of Kassel, Energie2000 studied the implementation of this solar regulation.

Several regulations and incentive programmes of the Federal Government support the utilization of renewable energies and rational use of energy and energy conservation in buildings. These include:

**Topic: Solarthermie-2000 and Solarthermie2000Plus**

1993-2002: This programme aimed to demonstrate the feasibility of large-scale solar thermal heating systems in residential and public buildings, as well as the feasibility of solar driven small district heating systems. It also analysed the long-term behaviour of solar thermal collectors. Sixty-three large installations and seven district heating systems, some of them with seasonal thermal storage, were promoted. The subsidy programme for big solar thermal systems demands that solar water heating systems bigger than 100 m² provide ‘Guaranteed Solar Results’.

The successor programme “Solarthermie2000plus” was launched February 2004.


The sub-program ENOB comprises both new and existing buildings.

High priority is given in the Energy Research Program to the topic “Energy efficiency and utilization of renewable energies in buildings”. There is still a tremendous energy saving and substitution potential both in new and existing buildings.

**iv. Lessons learned**

The German solar thermal market made a singular development in recent years. On the basis of positive surroundings, it left the status as a niche market and became a part of modern heating technology. The professionalism of the solar branch significantly grew and firms of reputation entered into the solar thermal market.
The crafts more and more recognise solar thermal systems as an important market. They have professional training and distribute solar systems actively. Solar systems are recognised to be a mature technology. Most of the house owners are open-minded towards solar thermal technology. In cases that they are not applied, it is so because people are waiting for the price of solar systems becoming cheaper – or the prices for oil and gas more expensive.

**Typical consumer motivation**

Most of the consumers are currently owners of one or two-family houses, which they themselves inhabit. Most of the systems are installed in buildings already existing. In new buildings the costs for an installation of a solar system would be a bit lower, but mostly it is turned down due to the high costs of the new building. But often the possibility of a later installation is taken into account by the preparation of piping from the roof to the cellar for a solar circuit.

**The main factors which influence consumer motivation are:**

- The awareness of environmental problems and of the finiteness of fossil fuel.
- The increasing costs of fossil fuels.
- The subsidies for solar thermal systems.
- The advertisement for solar thermal systems.
- The modernity of solar thermal systems.
- The maturity and technically reliability of the solar thermal systems.

According to a recent survey of 2001, environmental friendliness has been the main reason for the installation of a solar system.

For new buildings the now established EnEV (Energieeinsparverordnung, the regulation for the saving of energy) will be an additional factor of motivation, because it takes into account that solar heat reduces the consumption of conventional energy for the heating of the whole building and thus avoids emissions of CO₂. Therefore the builder can install a solar system instead of increasing the insulation of the building.

### v. Perspectives

However, relative to the population, Germany is still far behind Austria and Greece. The full exploitation of its large potential for solar thermal is necessary if the industry is to reach the ambitious growth targets at EU level. Germany will continue to play a key role, although there is a need to ensure a more balanced development at European level. This can be achieved once substantial growth in other promising countries occurs.

One premise is a subsidy situation which is stable in the long run. Due to the market success in recent years, the subsidies for the private sector can be reduced in the coming years, but the market for multi-family houses and industrial usage of solar thermal needs a new strong engagement from the government. Solar thermal energy still needs some years of promotion in these sectors before the potentials to reduce its costs, which lie in mass production and further development, can be realised.

To overcome the current barriers concerted actions are needed. Proposals for concrete actions are:
• Economic: The only important reason for most of the people not to use solar thermal energy is that heat from solar thermal energy is still more expensive than from oil or gas today. Therefore the industry will make further efforts to reduce the prices by technical developments and the economy of scale. Second, the solar thermal market will speed up its growth, for the fossil energy prices will raise. Third, the government will subsidise new market sectors in order to achieve the aim of doubling the share of renewable energies up to 2010.

• Cultural: People will be learning to understand, that it is necessary and in the long run more economic to invest today and save money over 20 years – as they can do with the installation of solar thermal systems. Since the price of fossil fuels over the next 20 years is unpredictable, the costs of solar and fossil heat are not directly comparable today. But it is necessary to understand that oil and gas will become more expensive in the future and therefore solar thermal energy is more competitive than largely assumed today.

• Educative: Today a big share of plumbers is offering solar thermal systems in Germany. Many of them have had a professional training and first experiences in installing solar thermal systems. Schools and special training courses are arranged so that now the craftsmen have to be motivated in joining them.

Another important task is to integrate the knowledge about solar thermal systems into the basic education of the plumbers, the planners and the architects.

France

a) PV technology

i. Overview of the market situation

The National PV market started with small stand-alone systems for the electrification of rural areas in the early 80ies; this segment has sustained an important role until today especially in the overseas departments and is supported by the state as well as EDF; the grid-connected market started in the early 90ies mainly with research or demonstration projects, the took off between 2002-2004 following the introduction of a feed-in-tariff system plus investment subsidy schemes on both federal and regional level.

The recent switch from the mainly subsidy-driven system to a stronger focus on tax credits in 2005 is expected to stop the positive dynamics of the market.

For 2007, the French annual PV market was estimated at 32 MW. A considerable part of those installations (47%) took place in the French overseas regions and the other part in continental France.

The PV acceptance is quite high among general public, in spite of being clearly of second priority to other RES like wind, biomass, but also solar thermal in official public campaigns.
### ii. National PV incentives systems

National energy policy is co-ordinated by a department of the Ministry for Industry (DIDEME); on the operational level regional offices of this Ministry (DRIRE) and the grid-operators (mainly EDF) are in charge of permission procedures; the regulatory framework based on tax credits is co-ordinated by the Ministry for Finance. In October 2007, in his conclusion speech on the “Grenelle de l’environnement” (a series of public meeting involving stakeholders from environment field) the president of the Republic has stressed his willingness to promote the development of renewable energies.

The main support mechanisms for Photovoltaic energy have been:

**Direct Financial Instrument**

- **Feed-in-tariff system:** national PV policy is more than ever a mix of various instruments; key legislative instrument is a feed-in-tariff system. Under the Electricity Law 2000, further feed-in tariffs were introduced on 10 July 2005. These apply for contracts of 20 years for photovoltaic systems.

- **Investment support schemes:** From 1995 Rural electrification bodies using renewable (PV, hydro or wind) receive funding from FACE specific fund. The grants support up to 65 % of investment cost.

  Additional support can be obtained by means of investment subsidies granted both on the national level by ADEME end on the regional level by regional governments; since the introduction of the new tax credit system in 2005 the investment subsidies by ADEME have been drastically reduced;

- **Average payback period for PV investments (under given conditions):** the average payback time for a typical small-scale private PV roof-top can be evaluated between 15 and 30 years, according to the Regional grant regime.

- **Fiscal incentives:** tax credits have been increased by the new Finance Law for 2005 from 15 to 40 % of investment cost (excluding labour expenses) for private persons only, while companies are eligible to a one year accelerated depreciation. In 2006 Tax credit amounts to 50 % of PV modules and other equipments costs capped to 8 000 € per income-tax paying person.

- **Green pricing schemes** are rare in France; some utilities offer “green products” to their customers, but without the same level of transparency as in Austria;

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**Summary. Solar PV Policy Time**

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<th>Solar PV Policy Timeline</th>
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<tr>
<td>. Grants – Rural Electricity</td>
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<td>. Feed-in Tariffs</td>
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<td>. Tax Credit</td>
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*Denotes a significant change to a policy, such an extension, repeal or revision*
iii. Regulatory framework

Electricity sector regulations relevant for the PV market

- Electricity plant authorisation: defined in Electricity Sector Law from 2000 in line with EU Directive 96/92 CE in charge of procedures is DIDEME at national level;
- Grid access code: based on the national Electricity Act from 2000 (modified in 2004) in line with EU legislation; in charge are local grid operators/utilities (usually EDF-ARD); the feed-in-contract is closed with another department of utility (usually EDF-AOA);
- Sector regulation: legal rights and non-discrimination of PV operators supervised by regulator CRE;
- National plant register: none so far, but all authorizations granted by DIDEME are published in the “Official Journal”.

Building sector regulations relevant for the PV market

- Building standards: new regulation RT 2005 (due in 2005) defines energy efficiency standards for new buildings; it is expected that for the first time PV installations are acknowledged to meet these standards; a regulatory barrier for PV is the “town-planning” code: a certified architect (ABF) may always refuse the building permission for conflicts with aesthetic standards;
- Solar building obligations: not yet been implemented in France;
- Regulations for building-integrated PV: no specific regulations for BIPV; current “construction code” is a barrier for BIPV systems mainly with regards to the compulsory traditional 10 years insurance system (“garantie décennale”) imposing for each type of PV product a long-lasting and costly certification procedure (ATEC or ATEX) by a single body (CSTB)

PV industry regulations relevant for the PV market

- Quality standards for PV products: international / European quality standards (IEC) for PV products and installations have to be complied with; an expert group works on new minimum standards with the “electrical certification union (UTE)”;
- Quality standards for PV installations: national standard for grid-connected PV installations that corresponds to the German standard “DIN VDE 0126”, except for ENS which is not required in France;
- Quality standards for PV installers: no standards in terms of service quality and qualification of PV installers; there are requirements defined in ADEME’s regulations to receive subsidies, but given the switch to the new tax credit system, this quality control measure loses relevance.

Key PV legislation: Electricity law

General characteristics of legislation

One part of the Energy Law of 10 February 2000, addresses the obligatory purchase of electricity from renewable sources and cogeneration at fixed feed-in tariffs. The law regulates the free access of independent energy producers to the grid and lays the foundation for higher feed-in tariffs for electricity production from renewables and a new tender scheme for renewable energy production capacity
Type of system: Fixed feed-in-tariff system, offering additional options for tendering (not used yet).

The feed-in tariff was fixed in 2000, modified in 2002 and in 2005. All tariffs (old and new) will be adjusted annually in accordance to the inflation during their duration. The beneficiaries are all operators of RES installations < 12 MW.

In 2000 the following feed-in tariffs were established under the Electricity Law. Solar (PV or any radioactive technology): The rate is 0.305/kWh in the overseas departments and Corsica, and 0.0155/kWh on mainland France. It also provides a grant of 4.6/watt for direct grid-connected installations.

In 2002, feed-in tariffs were set for the following renewable energy sources. - Solar photovoltaics (Arreté of 13 March 2002): A tariff of 0.305 per kWh has been set in the overseas departments (DOM), in the islands of Saint Pierre et Miquelon and Corsica and of 0.152 per kWh for mainland France.

In that moment, further feed-in tariffs were introduced on 10 July 2005. These apply for contracts of 20 years for photovoltaic. They are as follows: - Photovoltaic: 30 €cents/kWh, with a construction bonus of 25 € cents/kWh for mainland France and 40 € cents/kWh, with construction bonus of 15 € cents in the outer French territories;

The 5% tariff digression for new installations was cancelled. All tariffs (old a and new) will be adjusted annually in accordance to the inflation during their duration.

**PV support schemes: national programme by ADEME**

*General characteristics of support schemes*

- Type of system: heterogeneous mix of instruments; until 2004 direct investment subsidies, in addition to the low feed-in-tariff, were the key instrument for PV promotion in France; since 2005 for grid-connected systems it has been widely replaced by the new tax credit system; but still pre-dominant instrument for stand-alone systems;

- Administration: subsidies by ADEME; tax credits by fiscal authorities;

- Start/expiry date: subsidies from ADEME started in 1999, tax credits in 2002 at 15 %, increased to 40 % for 2005 and 50 % for 2006 with and expiry date for 2009;

- Funding: 1. ADEME subsidies from federal budgets (by three ministries) (re-)defined on an annual basis; 2. regional subsidies from regional budgets; 3. tax credits from federal budget.

- Beneficiaries: 1. private individuals; 2. corporations; 3. public bodies;

- Type of support: originally ADEME subsidies could be combined with feed-in-tariff, additional regional subsidies and a tax credit of 15 %; this combination resulted in payback times of 10–15 years;

**iv. Lessons learned**

- National support scheme by ADEME has proved effective to kick-off an embryonic market when no feed-in-tariff was in place yet;
• Feed-in-tariff approach has proved as both effective and efficient support mechanism;
• Even a fairly low feed-in-tariff has aroused growth and hopes in France;
• Tax credit system is less bureaucratic than subsidies;

**Weaknesses national PV policy framework**

• Complex administrative procedures both for general authorisation and subsidy applications;
• Feed-in-tariffs too low/unattractive; tax credit scheme in contrast offers no long-term security for investors beyond 2009;
• Lack of political commitment and stability for PV policy;
• Support schemes depend on (always limited) public budgets and are therefore insecure (inevitable delays, stop & go effect);
• Negative effect of tax credit system: lower subsidy amount and longer delays until it is claimed after annual income tax declaration; in addition direct competition of PV with other RES technologies;

**v. Perspectives**

France maintains the feed in tariff (57 cts €/kWh for BIPV and 31 cent for non-BIPV) and for residential sector and below described the tax credit. In order to achieve the 2011 and 2020 target, the French support scheme need to be improved. Specific feed-in tariffs for semi-integrated PV and ground-mounted installations would be needed, modifications in the building code are necessary.

Regarding the market for PV applications, the new feed-in tariffs and the environmental concerns should drive private investors whereas, in the past, investments originated mostly from the local communities.

**Target:** The French target for cumulative capacity for 2011 is 1.1 GW. Until 2020 the capacity should grow to 5.4 GW

**b) Solar thermal technology**

**i. Overview of the market situation**

The period from 1987 to 1999 was regarded as the “age of desert”. The market decreased steadily in metropolitan France, and was concentrated in the French overseas territories. In 1999 for the metropolitan France, ADEME (French agency for the environment and energy management) has launched “Helios 2006” or “plan Soleil”.

This medium-term solar thermal development plan (six years), envisions the installation of 50.000 domestic solar thermal systems by 2006. To have the advantage of the subsidies, the solar domestic hot water systems need to be installed by
a professional member of the “Q7ualisol Chart” and the system model must have been approved by a national committee.

In France the largest part of the market has been so far concentrated in the small oversees territories, showing an even larger potential for growth in metropolitan France.

There was a increase of solar thermal applications in mainland France in the 2000-2003 period.

Between 1998 and 2007, the market in Metropolitan France grew by almost 40% per year. With just 16% growth over the previous year, 2007 itself remained somewhat behind this average.

Thermal renewables are promoted through grants, particularly in two multi-year programmes managed by ADEME on wood and solar thermal, and regulatory and fiscal measures.

**ii. National Thermal incentives systems**

In 1999, approval was given by the government to the French Agency for Environment and Energy Management (ADEME) to launch Plan Soleil. This plan (1999-2006) was designed to support the development of solar hot water heaters. The first phase of this programme, specific to individual solar hot water heaters, was extended to collective applications of solar water heating.

From 2005 to 2007, a join call program has been conducted between ADEME and ANR, called Prebat (Performance in Buildings). It was the following of a previous one called PBH 2010, set up in 2002 by ADEME in partnership with PUCA (Ministry of Housing) in order to reanimate RTD activities in the building sector in the aim to prepare the building sector to reach the performance objectives of 2010. Projects concerning solar thermal components, systems and technologies have been presented essentially in the technological part of Prebat.

- **Investment subsidies:** In order to promote the dissemination of solar thermal equipment, financial supports aimed at the private individual (individual solar boilers and solar combi-systems) and at the private and public owners (collective installations for the production of solar hot water) were proposed in the frame of the national program, Plan Soleil.

These financial supports could be supplemented within the framework of regional agreements concluded between ADEME and the regional or general councils. Along this program there were also other public financial supports and tax exemptions, some of them being specific to the solar heating sector, while others concern more generally the renewable energy sector. The success of Plan Soleil appears obvious.

- **Tax-credit:** The most important progression was observed for individual systems (SHW and SCS), as a consequence of the application of the tax-credit scheme for renewable energy systems. In spite of this when examining the evolution of costs of systems, results are not so good. A constant and significant rising has been observed for individual system costs.

For private individuals, the simplicity of the tax credit system, which permits recuperating 50% of the equipment price upon simple fiscal declaration, is particularly attractive. The incentive system is completed by financial assistance from local administrations (notably the Regional Councils) that is deductible from the tax base on which the tax credit is calculated.
After the end of Plan Soleil, even if Face Sud plan program has been cited in 2005 Energy law, no real new plan has been set up. But tax-credit scheme still remains in action up to 2009. For large scale solar hot water production installations, public subsidy scheme has run on same basis during all the year 2007 with the partnership between ADEME and regional councils.

**Summary. Solar Thermal Policy Time**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>Plan Soleil (grants)</td>
</tr>
<tr>
<td>1994</td>
<td>Tax Credit</td>
</tr>
</tbody>
</table>

* Denotes a significant change to a policy, such as an extension, repeal or revision

### iii. Regulatory framework

The Plan Face Sud, incorporated into the programme law setting the orientations of the energy policy (POPE law) dated 13 July 2005, New tools and devices have been created and implemented to reach this market level: 2005 and 2010 thermal regulation, High-Performance Energy Labels (HPE ENR), Very High Performance Energy Renewable Energies (VHPE Renewables), Low Consumption Building (LCB), government subsidized COS, Energy saving Certificates (ESCs). It is now advisable to continue the efforts made in order to raise the solar applications to the level of true construction standards.

Moreover, the new thermal regulations (RT 2005), applicable to building permits filed since 1st September 2006, established an improvement in the thermal performance of new constructions of at least 15% with respect to RT 2000, with a prospect of progress every five years so as to reach a 40% improvement in 2020. RT 2005 improves the taking of renewable energies into consideration, in particular in introducing them in reference. In concrete terms, an individual house (using both electricity and fossil fuels) shall have to be equipped with 2 m² of solar collectors and a collective housing using electricity shall have to be equipped with 1 m² of solar collectors per housing unit or, failing that, economise the equivalent energy by means of additional insulation or high performance heating systems.

Thermal Regulation 2005 (Regulation Thermique 2005) directly replaces Thermal Regulation 2000, introducing more stringent regulations of thermal insulation and heating systems. TR 2005 extends the scope of TR 2000's regulation to include the following:

- calculated consumption will be limited by an absolute, rather than project-related, value;
- calculation methodology now includes values for implantation and orientation to better account for a building's exterior climate. Calculations now include natural lighting and renewable energy sources, and the reference project now uses thermal panelling of the water supply;
- imposition of distinct summer and winter requirements to encourage bioclimatic architecture;
- calculation of air-conditioned buildings to discourage their use and construction in France
iv. Lessons learned

- Urban development should only take place under the condition of high or very high energy efficiency
- Reference to SDHW should be included in all heating regulations by 2005 (implementation of EU Buildings Directive)
- Systematic examination of the possibilities of using SDHW in new social housing projects
- Examination of an obligation to use SDHW in newly built or refurbished public buildings especially those that have large demand for hot water.

Typical consumer motivation

The main motivations to buy solar thermal systems are

- to reduce the annual invoice for (conventional) water heating
- to act positively for the environment

v. Perspectives

The Plan Face Sud, incorporated into the programme law setting the orientations of the energy policy (POPE law) dated 13 July 2005, has displayed ambitious objectives, in the order of one million s.q.m of solar collectors installed each year by 2010, i.e. the equivalent of 200,000 solar water heaters 2010

V – Comparison tables

- Spain Policy Chronology

<table>
<thead>
<tr>
<th>Name of the policy</th>
<th>Type</th>
<th>Target</th>
<th>Status</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Regime for the Production of Electricity from Renewable Energy Sources (Royal Decree 661/2007)</td>
<td>Financial, Incentives/Subsidies</td>
<td>Bioenergy, Multiple RE, Solar, Wind</td>
<td>In force</td>
<td>2007</td>
<td>The special regime for the production of electricity from renewable sources (wind, solar and biomass) was contemplated by in the Electricity Act 54/1997, which is still in force. Royal Decree 661/2007, , regulates the production of electricity under this special regime. This royal decree supersedes Royal Decree 436/2004, passed in March 2004, establishing new tariffs and premiums for each kind of facility covered and incorporating renewable energy, waste to energy and cogeneration plants into the special regime. Guarantees for processing new applications: The decree provides that those requesting new production facilities in the special regime must present a guarantee for an amount equivalent to € 500 per kW for the photovoltaic facilities or € 20 per kW for</td>
</tr>
<tr>
<td></td>
<td>Spanish Strategy on Climate Change and Clean Energy 2007-2012-2020.</td>
<td>• Policy Processes</td>
<td>• Multiple REs</td>
<td>2007</td>
<td>Strategy is focused in 198 measures and 75 indicators in order to reach an effective emission reduction in GHGs, related to energy and the accomplishment of Kyoto targets.</td>
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</tr>
<tr>
<td></td>
<td>Building Technical Code - Solar Panel Requirements / Implementation of the Energy Performance of Buildings Directive</td>
<td>• Education and Outreach</td>
<td>• Policy Processes</td>
<td>• Regulatory Instruments</td>
<td>• Incentives/Subsidies</td>
</tr>
<tr>
<td></td>
<td>Special Regime for the production of electricity from RES (Royal Decree 436/2004)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Renewable Energy &amp; Energy Efficiency Partnership (REEEP)</td>
<td>• Education and Outreach</td>
<td>• Incentives/Subsidies</td>
<td>• Policy Processes</td>
<td>• Voluntary</td>
</tr>
</tbody>
</table>
## Agreement

The partnership promotes investment opportunities, supports business and institutional models, bundles small projects to a bankable size, links to carbon finance and replicates successful financing mechanisms. It aims to ensure that policies and regulatory structures encourage the integration of clean energy, promote the efficient use of power and attract investment into the sector.

<table>
<thead>
<tr>
<th>ICO-IDAE Financing Line</th>
<th></th>
<th></th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the Renewable Energy Plan 2000-2010 - a financing line has been provided by the Official Credit Institute (ICO) and the Institute for Diversification and Energy Saving (IDAE) for renewable energies and improving efficiency projects</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Law on Fiscal Administrative and Social Measures</th>
<th></th>
<th></th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>This Law (24/2001) offers corporate tax deductions for investments in renewable energy sources. Those investments that were originally for Royal Decree 1663/2000 have been incorporated into this Law. Eligible investments entitle firms to a 10% tax deduction in the case of investments in installations or equipment using solar power.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Electricity Law 54/1997</th>
<th></th>
<th></th>
<th>1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>This regulation of the electric sector liberalised the electricity sector and guaranteed electricity supply at lowest possible cost. It elaborated the plan for the promotion of renewable energy and the plan for achieving the goal of 12% of primary energy consumption from renewable sources by 2010. The law also established a special regime for producers, which are not allowed to surpass a maximum of 50 MW power. This law is implemented through royal decrees, most notably Decree 2818/1998, which specified the feed-in tariffs from which the generating plants under the &quot;special regime&quot;.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Germany Policy Chronology

<table>
<thead>
<tr>
<th>Name of the policy</th>
<th>Type</th>
<th>Target</th>
<th>Status</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Climate Change and Energy Programme</td>
<td>• Policy Processes</td>
<td>Multiple REs</td>
<td>In force</td>
<td>2007</td>
<td>The European Council set the parameters for an integrated European climate and energy policy. This will include climate protection targets and targets for the expansion of renewable energies and increases in energy efficiency.</td>
</tr>
<tr>
<td>Funding for Solar Power Development Centre</td>
<td>• RD &amp; D</td>
<td>PV Solar Thermal</td>
<td>In force</td>
<td>2006</td>
<td>Providing testing facilities and equipment on the scale of a modern industrial production line, the Photovoltaic Technology Evaluation Centre (PV-Tec) forms part of the public-private Fraunhofer Institute for Solar Energy Systems (ISE).</td>
</tr>
<tr>
<td>Energy Industry Act (Energiewirtschaftsgesetz)</td>
<td>• Education and Outreach</td>
<td>Multiple REs</td>
<td>In force</td>
<td>2005</td>
<td>A framework policy to enhance competition, security of supply and sustainable energy production, Germany’s Energy Industry Act requires electricity labelling according to type of energy source.</td>
</tr>
<tr>
<td>Fifth Energy Research Programme (5.Energieforschungsprogramme - Innovation und neue Energietechnologien)</td>
<td>• R&amp;D</td>
<td>Multiple REs</td>
<td>In force</td>
<td>2005</td>
<td>This programme continuously sets the framework for public R&amp;D&amp;D support in energy technologies at large. Support for the development of renewable energies is only one part of the overall funding scheme.</td>
</tr>
<tr>
<td>KfW-Programme Producing Solar Power</td>
<td>• Incentives/Subsidies</td>
<td>PV</td>
<td>In force</td>
<td>2005</td>
<td>This programme, introduced in 2005, offers low-interest loans for small investments in solar PV generation. Private investors are the main beneficiary as only projects with an overall investment up to € 50,000 are supported. 100% of the investment cost can be financed.</td>
</tr>
<tr>
<td>Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz EEG) 2004</td>
<td>• Incentives/Subsidies</td>
<td>Multiple REs</td>
<td>In force</td>
<td>2004 (amended 2006 and 2008)</td>
<td>The Act of 2004 replaces the Renewable Energy Sources Act of 2000 while maintaining the prior act’s general principals. The EEG amendment assists the implementation of the September 2001 European Union directive on the promotion of renewable energies in the electricity sector, by ensuring that all the renewable energies defined in the directive fall under the</td>
</tr>
<tr>
<td>Programme</td>
<td>Type</td>
<td>Incentives/Subsidies</td>
<td>Sector</td>
<td>Status</td>
<td>Details</td>
</tr>
<tr>
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</tr>
<tr>
<td>Solarthermie 2000Plus</td>
<td><strong>Incentives/Subsidies</strong></td>
<td><em>RD &amp; D</em></td>
<td>Solar Thermal</td>
<td><em>In force</em></td>
<td>2004</td>
</tr>
<tr>
<td>Law to Amend the Mineral Oil Tax Law and Renewable Energy Law</td>
<td></td>
<td></td>
<td>Bioenergy</td>
<td><em>In force</em></td>
<td>2002</td>
</tr>
<tr>
<td>CO2 Building Restructuring Programme (CO2 Gebäude Sanierungsprogramm)</td>
<td><strong>Incentives/Subsidies</strong></td>
<td></td>
<td>Bioenergy Geothermal PV Solar Thermal</td>
<td><em>In force</em></td>
<td>2001</td>
</tr>
<tr>
<td>Combined Heat and Power (CHP) Extra Law</td>
<td><strong>Incentives/Subsidies</strong></td>
<td><em>Regulatory Instruments</em> <em>Voluntary Agreement</em></td>
<td>Multiple REs</td>
<td><em>Superseded</em></td>
<td>2000</td>
</tr>
<tr>
<td>Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz EEG)</td>
<td><strong>Incentives/Subsidies</strong></td>
<td><em>Regulatory Instruments</em></td>
<td>Multiple REs</td>
<td><em>Superseded</em></td>
<td>2000</td>
</tr>
</tbody>
</table>
renewable energy plants and purchase the electricity at premium prices is shifted from the utilities to the grid operators. The tariffs are set for each individual technology, based on its actual generation cost.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Incentives/Subsidies</th>
<th>Technology</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 000 Roofs Solar Power Programme</td>
<td>Incentives/Subsidies</td>
<td>PV</td>
<td>Superseded 1999</td>
<td>The programme supported the installation or extension of PV systems larger than 1 kW.</td>
</tr>
<tr>
<td>Market Stimulation Programme (Marktanreizprogramm)</td>
<td>Incentives/Subsidies</td>
<td>Multiple REs</td>
<td>In force 1999</td>
<td>As a successor of the &quot;100 Million Programme,&quot; the Market Stimulation Programme (Marktanreizprogramm), under the auspices of the Ministry of Economics and Technology, was introduced in 1999. The Programme primarily serves the expansion of heat generation from biomass, solar power and geothermal energy. Smaller installations of private investors are supported with grants.</td>
</tr>
<tr>
<td>Preferential Loan Programmes offered by the Reconstruction Loan Corporation (KfW)</td>
<td>Incentives/Subsidies</td>
<td>Multiple REs</td>
<td>In force 1999</td>
<td>The Reconstruction Loan Corporation (KfW) offers several soft loans schemes which indirectly support renewable energy technologies. In the private building sector, the KfW offers financing programmes. These programmes include the use of renewable energy sources and the conversion of heating systems. Furthermore, investment credits are granted for photovoltaic systems (solar power generation”), for the new construction of energy saving houses (“ecological construction”) and for modernisation measures in the housing inventory (“housing modernisation”).</td>
</tr>
<tr>
<td>Federal Building Codes for Renewable Energy Production</td>
<td>Regulatory Instruments</td>
<td>Multiple REs</td>
<td>In force 1997</td>
<td>The Renewable Energy Sources Act also includes several cross-references to federal building codes (e.g. for re-powering measures, for PV-installations on undeveloped land, etc.).</td>
</tr>
<tr>
<td>Green Power</td>
<td>Public Investment</td>
<td>Hydro</td>
<td>Multiple REs</td>
<td>In force 1996</td>
</tr>
</tbody>
</table>
Wind

a premium on the market. This “green electricity” entered the market as a new product which could be purchased instead of electricity generated in conventional plants. Most utilities and electricity suppliers offer a choice between tariffs to their customers.

<table>
<thead>
<tr>
<th>Program</th>
<th>Incentives/Subsidies</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Eco Grant (Eigenheim-Ökozulage)</td>
<td></td>
<td>Ended 1995</td>
<td>Under this programme households could receive federal grants for purchasing houses and flats. In addition to the standard grant, up to DM 256 per year over eight years are granted if solar thermal collectors or heat pumps are installed. Heat pumps need to supply at least four times the energy they require as electrical input. The grant is paid out annually by reducing personal tax payments.</td>
</tr>
<tr>
<td>100 Million Programme</td>
<td></td>
<td>Ended 1998</td>
<td>This federal program, administrated by the Ministry of Economics, encouraged increased use of renewable energy via capital subsidies (up to a limit which varied by technology). Particular emphasis was given to solar collectors and heat pumps, small hydropower installations, large wind turbines (450 kW to 2 MW), PV installations greater than 1 kW, and biomass installations.</td>
</tr>
<tr>
<td>Full Cost Rates (Kostendeckende Vergütung)</td>
<td></td>
<td>Ended 1993</td>
<td>Under this legislation a tariff was granted to electricity from photovoltaic installations. Twenty-five municipal utilities had introduced such schemes by the end of 1999. Often they were forced by the local parliaments to do so. Approximately 1,000 photovoltaic installations with a total capacity of 4.5 MW were installed as a result of these programmes. The programmes became obsolete after the introduction of the 100,000 Roofs Programme and the enhanced remuneration according to the Renewable Energy Sources Law.</td>
</tr>
<tr>
<td>Electricity Feed-In Law</td>
<td></td>
<td>Supers 1991</td>
<td>The 1991 Electricity Feed-in Law ensured grid access for electricity</td>
</tr>
</tbody>
</table>
The Reconstruction Loan Corporation (KfW) (formerly the Deutsche Ausgleichsbank (DfA)), has provided low-interest loans for private companies, freelancers and public private partnerships who take suitable measures to save energy, or who plan to use renewable energies since 2003.

Although German federal laws and federal funds have had substantial influence in the deployment of renewable energies, federal states (Länder) also provide considerable support for renewables. While the most successful instruments of support on the federal level are concerning the use of renewable energies for electricity generation, on a regional/state level the promotion of renewable technologies focuses on heating and cooling. Photovoltaic and biogas systems receive a majority of the support from regional programs, and as such gain the largest profit.

<table>
<thead>
<tr>
<th>French Policy Chronology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name of the policy</strong></td>
</tr>
<tr>
<td>Le Grenelle de L'Environnement</td>
</tr>
<tr>
<td>National Strategy for Research and Development in the field of Energy</td>
</tr>
</tbody>
</table>
sources that limit GHG emissions and/or increase energy efficiency. In the field of renewable energy, the Strategy emphasises RD&D include Photovoltaic energy area.

<table>
<thead>
<tr>
<th>Policy Type</th>
<th>Incentives/Subsidies</th>
<th>Regulatory Instruments</th>
<th>In force</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy Feed-In Tariff (IV)</td>
<td></td>
<td>Multiple RE</td>
<td></td>
<td>2007</td>
</tr>
<tr>
<td>Renewable Energy Feed-in Tariffs (III)</td>
<td></td>
<td>Multiple RE</td>
<td></td>
<td>2006</td>
</tr>
<tr>
<td>Flexible depreciation</td>
<td></td>
<td>Multiple RE</td>
<td></td>
<td>2003</td>
</tr>
<tr>
<td>Extension of Tax Credit in Favour of Renewable Energy Equipment in New Housing</td>
<td>Financial</td>
<td>Multiple RE</td>
<td>2002</td>
<td></td>
</tr>
<tr>
<td>Extension of the Law on Reduced VAT for Residential Renewable Energy Equipment</td>
<td>Financial</td>
<td>Multiple RE</td>
<td>2002</td>
<td></td>
</tr>
</tbody>
</table>

Under the Electricity Law 2000, a feed-in tariff was introduced on 1 March 2007 for hydropower installations with contracts of 20 years.

- Under the Electricity Law 2000, further feed-in tariffs were introduced on 10 July 2005. These apply for contracts of 20 years for photovoltaic systems. Photovoltaic: 30 € cents/kWh, with a construction bonus of 25 € cents/kWh for mainland France and 40 € cents/kWh, with construction bonus of 15 € cents in the outer French territories;

By way of this programme, industrial companies investing in renewable energy projects have the possibility to apply for accelerated depreciation of their investments (100% in one year) if they have the fiscal structure to use this bonus.

The finance law of 2003 extended the tax credit for the acquisition of large collective equipment, renewable energy equipment and thermal insulation and heating-regulation material to 31 December 2005.

The Finance law of 2003 extends the tax credit for acquiring energy production equipment which uses a renewable source of energy, and which is installed in new housing. The credit is equal to 15% of the amount of the purchase price.

Under the 2003 Finance Law, the reduced VAT rates applying to equipment for renewable energy production and use which is installed in primary or secondary residencies.
<table>
<thead>
<tr>
<th>Policy Area</th>
<th>Program Overview</th>
<th>Funding Source</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Renewable Energy &amp; Energy Efficiency Partnership (REEEP)</strong></td>
<td>The Renewable Energy and Energy Efficiency Partnership (REEEP) was conceived at the World Summit on Sustainable Development in August 2002. It is a global public-private partnership that structures policy and regulatory initiatives for clean energy, and facilitates financing for energy projects.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Renewable Energy Feed-in Tariffs (II)</strong></td>
<td>In 2003, feed-in tariffs were set for the following renewable energy sources. This completed the list of tariffs provided for in the Electricity Act. All sites benefiting from the mandatory buyback rates must be under 12 MW of nominal capacity: Solar photovoltaics (Arreté of 13 March 2002): A tariff of €0.305 per kWh has been set in the overseas departments (DOM), in the islands of Saint Pierre et Miquelon and Corsica and of €0.152 per kWh for mainland France.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Campaign SOS Climat</strong></td>
<td>This information campaign aimed to raise public awareness of climate protection issues and to inform them of the positive impact that renewable energy utilisation can have on the climate.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fonds d'Intervention pour l'Environnement et la Maîtrise de l'Energie (FIDEME)</strong></td>
<td>FIDEME is a fund for environment and energy efficiency, and a specific financial scheme to support private investors (maximum financial share of 25% of the total project costs).</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Government Crediting and Loan Guarantee for Energy Efficiency and Renewable Energy Investment - FOGIME</strong></td>
<td>The FOGIME was created in 2000 in co-operation with the French development bank for small and medium size enterprises (SMEs) and ADEME. The guarantee fund for investments in energy sustainability (efficiency and renewables) has</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **Renewable Energy Feed-in Tariffs (I)** | **Incentives/Subsidies** | **Multiple RE** | **In force** | **2001** | The following feed-in tariffs were established under the Electricity Law of 2000. All sites benefiting from the mandatory buyback rates must be under 12 MW of nominal capacity: For Solar (PV or any radioactive technology): The rate is 0.305/kWh in the overseas departments and Corsica, and 0.0155/kWh on mainland France. It also provides a grant of 4.6/watt for direct grid-connected installations.

| **Contrat de Plan Etat-ADEME** |  |  | **2000** | This pluriannual contract concerns incentives to foster investments in RE projects (under ADEME umbrella): several RE schemes have been defined and implemented, and a general agreement has been reached between State and ADEME on objectives to be met and funds to be raised and employed on the 2000-2006 period.

| **Electricity Law 2000** | **Incentives/Subsidies** | **Regulatory Instruments** | **Multiple RE** | **In force** | **2000** | One part of the Energy Law of 10 February 2000, addresses the obligatory purchase of electricity from renewable sources and cogeneration at fixed feed-in tariffs. The law regulates the free access of independent energy producers to the grid and lays the foundation for higher feed-in tariffs for electricity production from renewables and a new tender scheme for renewable energy production capacity. These tariffs have subsequently been updated in 2001, 2002, 2003, 2006 and 2007 (see separate database entries).

| **Solar Water Heaters: “Plan Soleil”** |  |  | **2000** | In 1999, approval was given by the government to the French Agency for Environment and Energy Management (ADEME) to launch Plan Soleil. This plan is designed to support the development of solar hot water heaters. The first phase of this programme, specific to individual solar hot water heaters, was extended to collective applications of
The objective is to reach 112,000 m² per year of collector surfaces installed and 330,000 m² between 2000 and 2006.

<table>
<thead>
<tr>
<th>Survey and Pre-feasibility Assistance: Disposition Général des Aides à la Décision</th>
<th>Education and Outreach, Regulatory Instruments, Multiple RE</th>
<th>2000</th>
<th>Starting in 2000, ADEME provided surveys and pre-feasibility studies in the areas of renewables, energy efficiency, waste management, pollution.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax Credit for Renewable Energy in New Buildings</td>
<td>Financial, Multiple RE</td>
<td>Superseded 2000</td>
<td>The budget for 2001 introduced a tax credit equivalent to 15% of investment costs in renewable energy production equipment installed in primary residences.</td>
</tr>
<tr>
<td>Chauffe-eau Solaires dans les DOM</td>
<td></td>
<td>1999</td>
<td>This programme grants investment support for solar thermal installations in France's overseas departments (DOM). By 2003, the volume of solar water heaters installed was 13,000 representing a surface of solar collectors of 45,000 m². The programme's initial objective had already been met in 2000.</td>
</tr>
<tr>
<td>District Heating Classification</td>
<td>Regulatory Instruments, Multiple RE</td>
<td>1999</td>
<td>A decree on 5 May 1999 introduced a simplified procedure for classifying district heating using renewable energy or cogeneration, allowing local authorities to obligate new buildings in specified zones to be connected to the district heating grid.</td>
</tr>
<tr>
<td>Reduced VAT for Residential Renewable Energy Equipment</td>
<td>Bioenergy, Geothermal, PV, Solar Thermal</td>
<td>Superseded 1999</td>
<td>Reduced rates of VAT applied to equipment for renewable energy production and use installed in primary or secondary residencies. The reduced VAT of 5.5% applied in France and Corsica; and 2.1% in Guadeloupe, Martinique and Reunion.</td>
</tr>
<tr>
<td>Renewable energy market development (support for demonstration and diffusion)</td>
<td>Incentives/Subsidies, Multiple RE</td>
<td>1999</td>
<td>In addition to available grants for surveys, pre-feasibility and feasibility studies, ADEME provides support for demonstration projects and diffusion in the renewable energy sector. Grants for demonstration projects can go up to 30 to 40% of project costs depending on the energy</td>
</tr>
</tbody>
</table>
source and targeted sector. The programme covers, among others, electricity from renewables, and energy.

<table>
<thead>
<tr>
<th>Renewable Energy Purchasing Conditions</th>
<th>Regulatory Instruments</th>
<th>Multiple RE</th>
<th>In force</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIPP (tax on Petroleum products)</td>
<td></td>
<td></td>
<td>1998</td>
<td></td>
</tr>
<tr>
<td>FACE (Fonds d'amortissement des charges d'électrification) Programme</td>
<td>Incentives/Subsidies</td>
<td>Multiple RE</td>
<td>Ended</td>
<td>1995</td>
</tr>
<tr>
<td>Rural electrification using RES</td>
<td>Incentives/Subsidies</td>
<td>Multiple RE</td>
<td>1995</td>
<td></td>
</tr>
<tr>
<td>Renewable Energy Development in Overseas French Islands</td>
<td></td>
<td></td>
<td>In force</td>
<td>1980</td>
</tr>
</tbody>
</table>

This policy provided the enabling conditions for EdF to purchase electricity produced from renewable sources such as hydro, co-generation, waste incineration and photovoltaics.

TIPP (tax on petroleum products) is the main tax on petroleum products used as fuel (diesel, petrol, LPG; heavy and light oil) or heating fuel. The tax on fossil fuels was modified in 1998 and provides funds to ADEME to support programmes for energy conservation and renewable energy deployment.

This programme has made available a special budget for the electrification of isolated sites. The major objective being to avoid the high costs of installing grids in remote areas.

Funds from this programme with funds from ADEME cover up to 95% of costs for electricity producing photovoltaic installations which are not connected to the public grid. For grid-connected installations, support will be up to 4,6 euros/Wp.

Rural electrification bodies using renewables (PV, hydro or wind) receive funding from the FACE specific fund (decision taken at national level). The grants support up to 65% of investment cost.

This fiscal scheme was designed for financial, institutional or industrial companies to develop investments for renewable energy in French islands. This scheme has been operating since the 1980s and is still in place today.
VI – Conclusion

With this comparative study, many conclusions can be drawn. In this conclusion, we will try to express the lessons learned and some recommendations based on the three successful examples of Spain, Germany and France.

One can observe that it is usually a combination of several instruments that makes a successful solar promotion package. Nevertheless, in most countries one or two instruments dominate over others.

Specific recommendations for B&H will be defined in the followings Deliverables D6 and D7.

From experience, the following lessons have been drawn about support mechanisms of solar energy in general and, especially, of PV and thermal energy.

Solar Energy

- Financial Incentive Schemes (FIS) in the form of direct grants have played an important role in the development of the leading solar thermal markets in Europe;
- The analysis of case studies from different EU Member States has clearly shown that it is not so much the type of incentive but the concrete design and implementation – including flanking measures such as awareness raising, training of professionals – that makes a FIS succeed or fail;
- The single most important success factor for the long-term stimulation of a solar thermal market through a FIS has been continuity: With short-term programmes or insufficient budgets, FIS have failed to create healthy market structures, which are the basis for continuous growth;
- Announcements of new or higher financial incentives in the future have a destructive effect on the market in the near-term, as consumers wait for the FIS to be enacted;
- Lack of continuity leads to stop-&-go dynamics, which discourage the industry from investing into solar thermal long-term (e.g. into new production facility, marketing, training of professionals). Under such circumstances a healthy market cannot develop;
- A long-term support strategy, consisting of a financial incentive scheme and suitable flanking measures (especially awareness raising, training of professionals) has shown to have the highest impact on market growth;
- To guarantee continuity of the FIS, sufficient funds must be available at all times – if this cannot be guaranteed from the public budget, other sources should be tapped;
- Easy and lean application and payment procedures (where necessary) are necessary for broad acceptance of the FIS;
- Quality requirements which are fully compatible with the relevant European Norms (EN standards) strengthen the consumers’ confidence in solar thermal technology and contribute to further market growth;
- Ambitious, long-term targets for PV and thermal market development (e.g. until 2010, 2020) provide orientation for the PV industry and investors;
- Solar building obligations are a powerful regulatory instrument as long as rooftop or façade-integrated PV and thermal systems are acknowledged to meet the respective energy standards;
• Demonstration by public authorities (e.g. municipalities) can be very effective “shining examples” for private investors; these projects should be aesthetical and visible to the public;

• A reasonable combination of different promotions schemes is highly effective especially in the early stages of PV market growth; for example, limited subsidies by regional / provincial / local authorities are appropriate instruments to complement a national feed-in-tariff system over a limited period of time (e.g. 5 years);

• A consistent PV strategy based on ambitious targets, a clearly defined implementation programme and a well-conceived mix of instruments as a foundation for success; at the same time, politicians have to ensure the commitment of relevant authorities on federal, regional and local levels that are key actors in putting the strategy and programmes into practice;

• Tax incentives with long-term perspectives have the “charme” of being far less bureaucratic and time-consuming than direct subsidy programmes – an advantage especially acknowledged by professional investors and promoters;

• A decrease mechanism (e.g. 2€% p.a.) is an appropriate measure to reflect efficiency gains achieved by the PV and thermal industry in the process of dynamic market development; it also acts as an insurance that these gains are actually passed on to the investors; In case of PV, an annual adaptation of the feed-in-tariffs to the inflation rate is also well-conceived by investors;

• To be an effective incentive for investors, a minimum of investment cost must be covered by grants (depends on the other incentives within the PV (or RE) support package;

• Soft loan schemes need the support of a sufficient number of commercial banks supporting the financing and application process; interest rates must be below commercial levels;

• The requirements to obtain subsidies should be linked to quality standards for installations and installers (accreditation, minimum warranty on the system), as well as effective monitoring / control mechanisms.

**Thermal**

• Complicated and slow administration procedures do not work if the consumer needs a new heating/cooling system soon (e.g. because the existing conventional heating system broke down).

**Photovoltaic**

• A feed-in-tariff system – or other effective instruments – combining attractiveness of conditions with long-term investor security leads to the creation of strong demand and sustainable market growth;

• A feed-in tariff intrinsically takes care of quality control of PV systems;

• A net metering system is easy to implement and may be effective in the segment for small-scale systems (< 20 kWp) installed on the rooftops;

• The tariffs should be differentiated according to type of installations and natural conditions (specific solar yields);
• The feed-in-tariff system should be made transparent by monitoring the solar electricity fed into the grid;

• Subsidy schemes remain the most effective instrument for the promotion of the off-grid market; this segment should not be neglected following the introduction of a feed-in-law that is specifically designed to promote the grid-connected market.
Trama TecnoAmbiental

Deliverable 6: Financing Sources and Mechanisms for Solar Energy Development in BiH.

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

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Barcelona, October the 31st, 2008

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1. The Importance of Financing Renewable Energies

Significant improvements in energy efficiency and conservation and a global transition to renewable energy is now being the result of, and still will require in the future, huge investments in national and local energy infrastructures in every country. These investments need to come from both the public and private sectors, and they take many forms: including financial incentives from government; loans and capital investment from banks, private investors, venture capital funds and communities; as well as new innovative markets that contribute to the benefits of renewable energy and energy efficiency.

1.1. The Current Situation

According to the publication *Renewables 2007: Global Status Report* (1), an estimated $71 billion was invested in new renewable energy capacity worldwide in 2007, up from $55 billion in 2006 and $40 billion in 2005. In figure 1, it can be seen that almost all of the increase was due to increased investment in solar PV and wind power. Technology shares of the $71 billion annual investment were wind power (47 percent), solar PV (30 percent), and solar hot water (9 percent), followed by smaller shares of small hydropower, biomass power and heat, and geothermal power and heat.

![Figure 1. Annual Investment in New Renewable Energy Capacity, 1995-2007. Source: Renewables 2007: Global Status Report](image)

New Energy Finance (2) manifests that renewable energy and energy-efficient technologies are ready to be a large part of the world’s energy future, and financial markets can sustain increases in investment. However, New Energy Finance estimates that a three to five-fold increase in renewable energy investment will be needed over the next decade if there is to be a meaningful switch away from fossil fuels and no increase in nuclear power capacity. Factors that might limit this investment include the stability of incentive programs, planning processes and regulations; a lack of support mechanisms for investment in the developing world; general lack of information, skills and incentives for deal-makers and in general all the different barriers, which, for the case of B&H, have been stated in D-7. Barriers that may prevent the development of solar energy in this country.
The largest country shares of renewable energies annual investment (not considering subsidies and feed in tariffs) were in Germany, China, the United States, Spain, Japan, and India. Investment in Germany increased to over $14 billion in 2007, mostly for wind and solar PV, and investment in China was $12 billion, mostly in small hydropower, solar hot water, and wind power. The United States was number three, with over $10 billion (3).

In addition to renewable energy capacity investment, there were substantial capital investments in new manufacturing plants and equipment during 2006/2007 for solar PV and biofuels. Investment in solar PV plant and equipment was expected to reach $10 billion in 2007, up from $8 billion in 2006.

As has already been mentioned, sources of finance and investment for renewable energy now come from a diverse array of private and public institutions. From private sources, both mainstream and venture capital investment is accelerating, for both proven and developing technologies. The largest institutional investors and global banks have already been lending for renewable energy over the past several years. And more banks are serving the retail level developing new products like “green mortgages” and special loans for solar energy technologies in residences and small businesses.

Venture capital financing for renewable energy boomed during 2006/2007, particularly for solar PV and biofuels, exceeding $3 billion worldwide in 2006. Individual venture capital sums now exceed the $100 million level, either in single funding rounds or spread over extended technology development periods.

Energy utilities are also embracing renewable generation as a key element of their generation portfolios, with many looking for new ways to compete in this growing field. To demonstrate this commitment, Europe’s top 20 utilities have outlined investment plans to double their renewable energy capacity over the next five years. (4)

Multilateral, bilateral, and other public financing flows for new renewable energies in developing countries (overseas development assistance) grew significantly during 2005–2007, exceeding $600–700 million per year. In addition to infrastructure investments, a significant portion of these funds supports training, policy development, market facilitation, technical assistance, and other non-investment needs. The three largest sources of funds have been Germany’s KfW Entwicklungsbank (development bank), the World Bank Group, and the Global Environment Facility (GEF).

Other sources of public financing include bilateral assistance agencies, United Nations agencies, and the contributions of recipient-country governments to development assistance projects. Several agencies and governments are providing aid for new renewable energies in the range of (typically) $5–25 million per year, including the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD), the Inter-American Development Bank (IDB), UNDP, UNEP, the U.N. Industrial Development Organization (UNIDO), Denmark (Danida), France (Ademe and FFEM), Germany (GTZ), Italy, Japan (JBIC),and Sweden (Sida). The Spanish Agency AECID is financing renewable energy projects in different developing countries mainly in Latin America, Africa and in some Balkan countries as is the case of this project in B &H and a similar one being formulated for Serbia. Financing for renewable energy in developing countries has also grown with the involvement of many public and private domestic banks, government funds, and rural microcredit lenders.
1.2. Unique Aspects of Renewable Energy Technologies

Renewable energy technologies and specifically solar energy technologies are unique in that they require higher up-front investment than conventional energy sources, while at the same time providing multiple benefits that are not reflected in their cost. Innovative strategies and policies are therefore needed to increase investment, spread cost over the life cycle, and reflect the multiple benefits of renewable energies.

Many renewable energy technologies are commercially available but still in the cost-reduction phase. In the case of the solar energy technologies considered only solar thermal technologies for space heating and hot water production and solar PV (including some concentrating technologies) for electricity production are at the commercial stage. Experience shows that the cost of renewable energy technologies falls approximately 20% every time accumulated production doubles. However they face many non-price market barriers, such as, lack of consumer understanding and capability, lack of product and service availability, and few means to recover the extra cost through savings.

There are three financing issues that need to be considered in any renewable energy strategy:

1. Sources of financing—loans, investment capital, environmental markets, international facilities and partnerships;
2. Policies that leverage increased investment—financial incentives, standing offers, market transformation, training and infrastructure development; and
3. Financing mechanisms—micro-finance, on-bill payment, leasing/rental, local improvement charges.

1.2.1. Sources of Financing

Sources of financing include financial institutions that lend to developers of new facilities like wind and solar PV farms, or bio-fuel production plants. These institutions also lend to energy users who purchase renewable energy or energy-efficient equipment. Governments have also established loan funds for renewable energy, such as the Green Fund managed also by some Municipalities. Investment capital can come from venture capital organizations, corporations, stock markets, etc., but it can also come from community funds and bond issues where community or co-operative ownership is used.

A new source of financing comes from the sale of environmental attributes such as greenhouse gas emission reduction credits, renewable energy (green) certificates, etc. The multiple co-benefits of renewable energy and also of energy efficiency include greenhouse gas reductions, air-quality improvements, fixed prices in a era of rising prices, reliability in areas where weather plays havoc with grid and fuel infrastructure, distributed economic development and job creation, and security of energy supply.

The benefits of greenhouse gas reductions are being partially monetized in the expanding markets for emission reduction credits like the Clean Development Mechanism (CDM) and the European Union Emissions Trading System. Other environmental benefits are captured in various green certificate programs around the world.

Finally, there are a number of national and international funds that have been set up to provide grants or interest-free loans to developers of energy efficiency and renewable energy projects. These include the Global Environmental Facility (GEF) (5), the Global Village Energy Partnership (GEVP) (6) and the Renewable Energy and Energy Efficiency Partnership (REEEP) (7). The purpose of these facilities is to provide financing that addresses the environmental and
developmental value not included in the conventional financing of these projects, and also to
demonstrate innovative approaches that can be replicated.

1.2.2. Policies for leveraging investment

The most common government policies for leveraging investment in renewable energy and energy efficiency are financial incentives, regulation and market support. Financial incentives—such as production or user tax credits, standing-offer contracts that provide a fixed higher tariff for renewable power or efficiency gains, and direct financial assistance in the form of rebates or free installation—are effectively a public source of financing. Regulation includes removing inefficient and conventional investment options from the market through performance requirements in building codes and equipment standards. Legally binding targets for renewable energy and energy efficiency can also be set. Market support policies include certification and training, information and technical assistance to users, market transformation and other programs that remove investment barriers. In deliverable D-7 these policies will be analysed in the framework of the strategic guidelines proposed for the development of solar energy in B&H.

1.2.3. Financing mechanisms

Renewable energy financing mechanisms, as they will be seen in 2.2, allow the purchaser or developer to pay back a loan or provide a return to investors at a rate less than or equal to the income or savings achieved. For example, micro-credit schemes used in many developing countries allow buyers of solar-home systems to pay for the system at the same rate as they would have had to pay for kerosene or battery charging. If a building-efficiency improvement is financed by a municipality and repaid as a local improvement charge, the cost is associated with the property and not the owner, allowing transfer of costs and benefits from owner to owner.

1.3. The Unlevel Playing Field

While investment in renewable energy technologies is increasing, it still lags far behind conventional energy investments. A major reason for this imbalance is the persistent focus of investors, governments and lending institutions on conventional energy sources such as fossil fuels, large hydro and nuclear energy. The United Nations Environment Program has demonstrated that “global estimates of fossil-fuel consumption subsidies have been placed at around [US] $230 billion” per year.(8). No information has been obtained for B&H reporting the existence of subsidies for the oil and gas industry.

International financial institutions (IFIs) like the World Bank and the European Investment Bank have adopted targets for their renewable energy portfolios. These targets are significant but do not make renewable energy their primary focus. The World Bank target has been criticized for only requiring a percentage increase. Due to its current low level of investment, this increase would not result in significant funding for renewable energies, especially when compared to its fossil-fuel lending portfolio. (9)

Other International Financial Institution, such as the European Bank for Reconstruction and Development (EBRD) has no targets at all. This inaction exists despite the call in the Political Declaration adopted by many countries (B&H did not participate) at the 2004 Bonn Renewable Energy Conference for “International Financial Institutions, including the World Bank and the Regional Development Banks [to] significantly expand their investments in renewable energies and energy efficiency and [to] establish clear objectives for renewable energies in their portfolios.” (10)
NGOs and other stakeholders are calling on IFIs to significantly increase their renewable energy and energy efficiency portfolios by setting meaningful targets and making real changes in their lending portfolios. European NGOs are calling on the EBRD to adopt two separate targets: one for energy efficiency, and one for renewable energy. The policy should link the targets to overall EBRD energy sector investments, making lending for energy efficiency 50% of total EBRD energy sector investments in 2006–2010, and for renewable projects in the same time period, 10% of total EBRD investments. (11)

More and more private capital is being invested in renewable energy. On the equity side, dedicated venture-capital pools are being set up, while on the debt side financial institutions that have long served the energy sector (as well as some new entries) are setting up special facilities to finance renewable energy projects. According to New Energy Finance’s Global Energy Innovation Index, total renewable energy capitalization at the end of 2005 was US $27 billion, up 28% from 2004. This venture-capital and private-investment portion in renewable energy and energy efficiency investment has been rising steadily over the past few years but is still less than US $2 billion/year—very little compared to conventional energy. Because investors and lenders are trying to chase low-risk projects, project developers must be extra diligent in minimizing risks during planning, construction, operation and decommissioning. (12)


Countries such as Spain, Germany, India, Italy and the United Kingdom as well as some US States are leading the world in the implementation and manufacturing of renewable energy systems, such as wind turbines and solar systems. These efforts provide clear examples of what can be quickly achieved when the right policy mechanisms are in place. Their leadership and success is based on a set of common factors:

• very active political commitment to renewable energy;
• supportive education initiatives for R&D, training and public awareness;
• strong incentive systems to achieve wide public participation; and
• the implementation of supportive policies such as renewable energy standing-offer contracts or feed-in tariffs, renewable energy obligations and financial incentives.

The strong leadership in these countries is reflected in the Ernst and Young Renewable Energy Country Attractiveness Index. Table 1 summarizes some of the policies used to maximize investment.

<table>
<thead>
<tr>
<th>Country</th>
<th>Index</th>
<th>Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>1</td>
<td>• Carbon penalties on fossil fuels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Option of fixed (standing offer) or market-based tariffs for renewable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>power sources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Solar thermal incentives</td>
</tr>
<tr>
<td>United States</td>
<td>2</td>
<td>• Renewable Energy Production Tax Credit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• State Renewable Portfolio Standards and renewable energy certificate</td>
</tr>
<tr>
<td>Germany</td>
<td>3</td>
<td>• 20-year guaranteed feed-in tariff/standing offer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• National targets for 2010 and 2020</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>4</td>
<td>• Certificate based Renewable Obligations</td>
</tr>
<tr>
<td>India</td>
<td>5</td>
<td>• Regional (state) feed-in tariffs/standing offer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• State level renewable obligations</td>
</tr>
<tr>
<td>Italy</td>
<td>6</td>
<td>• Renewable obligations and green certificates program (with long-term</td>
</tr>
<tr>
<td></td>
<td></td>
<td>value)</td>
</tr>
</tbody>
</table>


The potential of renewable energy resources is significant. Theoretically they could provide a multiple of current world energy demand. However this theoretical potential cannot be tapped with given technologies, only the technological potential. Economics prevents the technological potential from being realised. In reality the actual market penetration of technologies is even below their economic potential. Figure 2 shows symbolically these potentials. Policies to improve the market penetration of a technology have to address the series of barriers renewable energy faces. Adequate financing of renewable energy applications has been identified as one of the key barriers.

The World Bank has estimated that developing countries alone over the next four decades will require five million megawatts of new electrical generating capacity to meet anticipated needs. Thus, even if the World Bank's estimate is too high, we will have to double the world's installed capacity during the next few decades.

In financial terms, this amount of new capacity will require approximately five trillion dollars of new investment. While it is true that renewable energies can anticipate capturing only a fraction of this market, every one percent of that market in developing countries represents approximately US$50 billion of investments. If renewable can capture several percent of that market, we're looking at a potential for several hundred billion dollars of renewable technology sales worldwide and creation of many new jobs over the next decades. (13)

In the case of B&H the potential demand of solar systems it is going to be determined in Deliverable 4 considering different hypothesis.
2.1. The Role of International Finance and Partnerships

2.1.1. The World Bank

As can be seen in table 2 in financial year 2007, Bank Group financing, from the World Bank, the International Finance Corporation (IFC), the Multilateral Investment Guarantee Agency (MIGA), as well as Carbon Finance operations and co-financed projects by the Global Environment Facility (GEF) included:

- $421 million for new-renewable energy – wind, solar, biomass, geothermal, and hydropower up to 10 MW;
- $262 million for energy efficiency; and
- $751 million for hydropower projects with capacities larger than 10MW.

<table>
<thead>
<tr>
<th>Source of Funds</th>
<th>New Renewable Energy</th>
<th>Hydro&gt;10MW</th>
<th>Energy Efficiency</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Bank (IBRD/IDA)</td>
<td>70</td>
<td>430</td>
<td>49</td>
<td>549</td>
</tr>
<tr>
<td>GEF (World Bank)</td>
<td>121</td>
<td>0</td>
<td>7</td>
<td>128</td>
</tr>
<tr>
<td>World Bank (Carbon Finance)</td>
<td>68</td>
<td>66</td>
<td>10</td>
<td>144</td>
</tr>
<tr>
<td>IFC (Own Funds)</td>
<td>154</td>
<td>140</td>
<td>156</td>
<td>450</td>
</tr>
<tr>
<td>IFC (Carbon Finance)</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>MIGA</td>
<td>0</td>
<td>115</td>
<td>40</td>
<td>155</td>
</tr>
<tr>
<td>Total</td>
<td>421</td>
<td>751</td>
<td>262</td>
<td>1,433</td>
</tr>
</tbody>
</table>

*Table 2. World Bank Group Commitments for Renewable Energy and Energy Efficiency in Fiscal Year 2007 (millions of dollars). Source: World Bank Group. Note: Some columns may not add up exactly due to rounding*

There has been a steady rise in the share of financing the World Bank Group committed for renewable energy and energy efficiency projects since 1990, with total financing topping $11 billion. It was 40 percent of the Bank Group’s commitments in the energy sector in the 2007 financial year (14).

The World Bank Group supported 63 renewable energy and energy efficiency projects in 32 countries with funding coming from various parts of the organization.

- International Bank for Reconstruction and Development (IBRD) and International Development Association (IDA), $549 million plus $128 million in co-financing from the GEF and $144 million from carbon funds;
- International Finance Corporation (IFC), including trust funds, $457 million; and
- Multilateral Investment Guarantee Agency (MIGA), $155 million.

The International Finance Corporation, the private sector arm of the World Bank, is composed of different organisations and programmes such as:

- The Solar Development Corporation (SDC), conceived as a free-standing, commercial enterprise, is being established by the IFC. Its primary objective is the development of viable, private sector business activity in the distribution, retail and financing of off-grid PV applications in developing countries.
• The Prototype Carbon Fund (PCF) has also been launched by the World Bank after Kyoto. The fund will buy carbon offsets at a competitive price and ensure that buyers and sellers of offsets receive a fair share of the value added. The price of the carbon offsets would cover the cost of additional emissions reductions and also include a margin to share the benefits from the offset between the investor and host.

• The IFC’s Renewable Energy and Energy Efficiency Fund (REEF) is expected to be the first global fund dedicated to investing in private sector renewable energy and energy efficiency in developing countries. The fund is expected to provide $150-210 million of private and IFC capital for financing on/off-grid projects of less than 50MW.

• The Photovoltaic Market Transformation Initiative (PVMTI) is a $30 million fund operated by the IFC. This will be used to accelerate the growth of PV markets in India, Kenya and Morocco by providing leverage to private companies on a competitive basis.

• The Small and Medium Scale Enterprise Program (SME) is a $21 million activity of IFC supported by GEF. It finances biodiversity and/or climate change projects carried out by small and medium scale enterprises in GEF-eligible countries. Contingent, concessional loans are provided to financial intermediaries (FIs). These FIs then finance the SMEs.

2.1.2. United Nations Development Programme (UNDP)

UNDP has an Energy and Atmosphere Programme (EAP), a component of which is focused on energy issues including promotion of renewable energy and energy efficiency through such activities as the joint UNDP/World Bank Energy Sector Management Programme (ESMAP); the FINESSE (Financing Energy Services for Small-scale Energy-users) programme; and building linkages with the UNDP-GEF unit on energy efficiency, renewable energy, and greenhouse gas issues. The EAP completed the UNDP Initiative for Sustainable Energy (UNISE) in 1996. UNISE was based on the fact that traditional approaches to energy make energy a barrier to socio-economic development and are not sustainable. Renewable energy was one of the focus areas in the UNISE. (13)

2.1.3. United Nations Environmental Programme (UNEP)

UNEP is not a bank and therefore does not directly finance projects or companies. Rather, UNEP works with banks and other financial actors to increase their engagement in the sustainable energy sector, essentially those industries producing or deploying renewable energy (RE) or energy efficiency (EE) technologies and systems. Through different approaches UNEP helps financiers develop new financial products, buys down transaction costs, builds capacity and addresses various other barriers that restrict their ability to create and grow sustainable energy investment portfolios. This work, usually led by UNEP’s Division of Technology, Industry and Economics (DTIE), is carried out in partnership with other UNEP teams and collaborating agencies.

The finance sector is an industry that, like the other sectors with which UNEP engages, has a need to integrate environmental sustainability into business practices. Working from its core mission, DTIE is well positioned to mobilise the finance community to begin increasing capital commitments to the clean energy sectors.
Energy programme activities within UNEP DTIE are managed through the Energy Branch. This Branch is divided into two teams: an Energy and Transport Policy Unit which promotes policies that place energy and transport within a broader sustainable development context and a Renewable Energy and Finance Unit (REFU) that works to steer project developers and the investment community toward greater support of renewable energy and energy efficiency projects. (15)

Achieving critical mass will require investment, finance and insurance products to create the liquidity necessary for vibrant markets in sustainable energy. As the environmental agency of the United Nations, the UN Environment Programme is working with the finance sector in much the same way that it works with other industries. By providing first mover financiers with the tools support and networks to drive the cycle of financial innovation, it is hoped that this work can help move the sector from a niche market to a more mainstream status acceptable to conventional financial institutions. (13)

2.1.4. Joint initiatives by international agencies

• Global Environment Facility (GEF) funds projects that provide global environmental benefits and local development gains in developing countries. The GEF provides grant financing to mitigate greenhouse gas emissions and projects covered in this component are targeted at lowering barriers to the success of renewable energy and energy efficiency technologies. The World Bank, UNDP and UNEP are the executing agencies for GEF projects.

• The Energy Sector Management Assistance Program (ESMAP) is a global technical assistance programme sponsored by UNDP, the World Bank and bilateral donors. Renewable energy projects are an important component of the ESMAP. The programme also features innovative financing mechanisms such as the solar PV concession systems for Argentina. ESMAP has reached to the poorest in Africa also through its micro PV lantern demonstration projects

• The Renewable Energy Partnership (REP) Programme is being proposed by the World Bank and the Global Environment Facility (GEF) to provide increased and more flexible Bank and GEF funding to emerging market countries that make serious commitments to renewable energy development. The key to the eligibility will lie in making a renewable energy-friendly policy, regulatory changes and other steps to foster renewable energy development.

2.1.5. Kyoto mechanisms

The new climate change regime also offers an opportunity for renewable energy as it meets the two basic conditions to be eligible for assistance under the United Nations Framework Convention on Climate Change implementing mechanisms: they contribute to global sustainability through greenhouse gas (GHG) mitigation; and they conform to national priorities by leading to development of local capacities and infrastructure. While the Kyoto Protocol has not yet proposed any binding emissions limitation commitments for developing nations, flexible instruments such as the Clean Development Mechanism and the possibilities of emissions trading are likely to provide economic incentives for significant emissions abatement in developing countries. The altered competitive dynamics should also prove favourable for renewable energy.

B&H ratified two of the three Kyoto principles on 16th April 2007. As a transition country B&H ratified the Kyoto agreement and the involvement in CDM; but still has to establish a CMD institution.
2.1.6. Non-Governmental Organisations

Besides the long list of NGO’s, which are developing many social projects with some component including renewable energy technologies, there are several international and national NGOs involved in promoting renewable energy in various countries. They have developed innovative financing mechanisms to support the renewable energy on a sustained basis.

- **E & CO**’s mission is “to promote developing country energy enterprises that create economically self sustaining energy projects; use environmentally superior technologies; and produce a more equal distribution of energy, especially to the poor”. To this end E & CO participates in enterprise development to share risk and leveraging funding from conventional sources. E & CO was conceived by the Rockefeller Foundation to address the barriers in promotion of renewable energy and energy efficient technologies in developing countries. E & CO provides small loans, technical assistance, intermediary services and direct investment for (i) innovative implementation of aproven technology; (ii) technology innovation that is high risk by nature but shows potential for innovation in energy production; (iii) promoting new energy delivery techniques in rural areas where end-users of energy have poor ability to pay; and (iv) innovative financing (including credit, loan and equity) of energy enterprises to provide cost effective energy services to potential end users currently without access to such services.

- **Enersol Associates, Inc.** is a non-profit organisation promoting use of solar energy for rural development in developing countries. Enersol has created a solar fund (*Fondo Solar*) which helped NGOs in Dominica and Honduras to raise finance for solar energy development. NGOs can secure commercial bank loans in local currency guaranteed with “*Fondo Solar*” funds. This familiarised NGO implementers and rural beneficiaries with credit procedures, and also helped the formal banking sector’s forays into this area. Enersol has helped develop a local network of independent local enterprises which sell, install, and maintain solar-electric systems in rural communities of the Dominican Republic and Honduras. The entrepreneurs are provided with training and technical assistance. The micro-enterprises in the Dominican Republic have installed over 6000 PV systems which provide electricity to rural homes, farms, schools, businesses, community centres and health clinics. The financing of these systems was arranged through the NGOs.

- **SEBA** is a non-profit organisation which gathers a growing number of users of solar energy and other renewable energies’ installations in Spain and Portugal with the aim of offering a quality energy supply without causing an environmental impact. Since 1989, SEBA promotes, manages, maintains and stimulates installations which use the solar energy to offer a basic energy service, especially the electricity supply.

  On the other hand, more than ten years ago the organisation started putting at the service of the rural development in developing countries its experience and know-how in the use and management of solar installations. In this sense, SEBA is carrying out cooperation projects in the energy field together with other NGO’s or organisations which act as counterparts in the target countries and counts on the subsidies of Catalan, Spanish and European public donors to implement them. (16)

- **Grameen Bank** (i.e. Village Bank) in Bangladesh is well known for its small-scale rural credit schemes. The Bank has now initiated a programme to finance renewable energy in rural areas, that constitute 85% of the country ’s population, most of it without access to electricity.
The International Fund for Renewable Energy and Energy Efficiency (IFREE)’s goal is to promote the sustainable use of renewable energy and energy efficient technologies in less developed and transition economies.

Polyene Film Industries (PFI), a manufacturer of solar PV water pumps in South India, linked up with a local commercial finance company (Nagarjuna Group) to use low cost funds provided by the Indian Renewable Energy Development Agency (IREDA) and tax incentives offered by the Government of India to make the pumping systems affordable to rural farmers.

Triodos Bank. The Dutch bank has decided to invest several million guilders in PV technology in developing countries. The investment will be through a new Solar Investment Fund. The objective is to provide solar energy at an affordable cost to rural households and small businesses in developing countries.

Solar Electric Light Company (SELCO) has raised equity funding from Swiss, German and U.S. investors. The company has lined up an additional $28 million in debt from various lending institutions and investment funds for consumer finance of solar home systems. SELCO will sell and service solar PV household lighting and power systems on a global scale, focusing on emerging market countries.

Solar Bank TM is an initiative by the finance community that will seek to tap the global capital markets for a continuum of funds for the PV markets. The Solar Bank will act as a secondary lender to existing local primary financial institutions such as banks, cooperatives, credit unions, electric utilities, energy service companies, micro-enterprise lenders and others who are in a position to finance local PV markets. That is, the Solar Bank will purchase PV loans from primary lenders, and will manage the credit risk and interest rate risk on a portfolio basis.

2.2. Innovative Financing Mechanisms

2.2.1. Introduction: Innovative approaches

From the previous paragraph it can be concluded that the key financing issue in developing countries is the availability of capital to renewable energy developers and rural end-users, while issues in developed countries involve the cost of money, the ease of obtaining low-cost funds, and institutional complexities that hinder financing and market growth. B&H can be considered to be in an intermediate position (transition country) between a developing and a developed country and all these issues have to be considered. As has been seen, several innovative financing mechanisms for renewable energy developers and end users have been devised and tested by international organisations, governments and NGOs to promote renewable energy. As a general policy, there is a move away from the traditional government-and-subsidy-centred approach to promoting renewable energy to the new, market-oriented approach in which consumer-side financing or fee based service is the key issue.

Innovative approaches are needed at different administrative levels of the country to allow the up-front costs of solar energy to be spread out over the lifetime of the technology, and to monetize the multiple benefits of this technology. There are a number of ways to help spread up front costs over a period long enough to provide a positive cash flow for solar energy developers: providing revolving funds for micro-finance and solar energy technology and service providers; bundling programs into larger investments; offering guarantees to reduce loan risk; and providing long-term purchase agreements for solar energy power.
Innovative market mechanisms such as the issuing of certificates for verified solar energy production (green certificates) includes utilities that are legally required to meet renewable energy targets as well as individuals, organizations and corporations that want, voluntarily, to “green” their energy purchasing. Some companies are now also becoming investors moving beyond purchasing green energy to also investing in it (17).

A new option for financing long-payback energy efficiency and renewable energy improvement in buildings is the use of local improvement charges. The cost of the renewable energy equipment or building upgrade is financed by the municipality and repaid through the property tax system. By associating the cost with the property and not the owner, the cost and benefits are passed from owner to owner, allowing equipment of a much higher cost to be installed. This option would be ideal for financing a distributed generation system (e.g. cogeneration, solar PV) that sells power to the grid under a long-term standing-offer feed-in tariff contract.

Risk reduction is another important practice for developers of renewable energy. Delays, cost overruns, resource uncertainty (in quantity and in price), technical risk, maintenance costs, sales price/volume, renewable energy premiums and tax environment are all risks that need to be identified and managed. Because investors and lenders typically have a low threshold for risk, renewable energy investments will only grow as low-risk projects become available (18).

2.2.2. Financial Incentives for the promotion of solar energy

Financial incentives can be classified in several types applicable to different segments of the solar thermal market as the urban houses (new or existing), social or rural house, industrial or agricultural companies or even building of the service sector including the public and institutional ones. Some of the incentives detailed below can also be applied for stand alone photovoltaic energy applications. For PV grid connected applications, it is necessary to study the possibility to suggest a legal framework which allows the implementation of a feed-in-tariff.

These financial incentives have been applied with more or less success in different countries and from diverse sources and types of financing as:

- Direct grants (e.g. German Market Stimulation Programme)
- Tax reductions (e.g. income tax break in France)
- Loans at reduced rates
- Green heat or energy efficiency certificates
- Third party financing. (e.g Austria)
- Feed-in Tariff (Germany, Spain, etc.)

Grant Programmes

Grants can be available to different economic sectors from government funds. Some grant programmes focus on research and development, while others are designed to help a project achieve commercialisation. Also subsidies coming from the social/environmental/economical benefits of the solar technology can be designed for the consumer sector.

Leasing/Lease Purchase Programmes

Utility leasing programmes target remote power customers for which line extension would be very costly. Also collective solar thermal installations can be targeted by utilities as a demand
side management strategy. The customers can lease the technology from the utility, and in some cases, the customer can opt to purchase the system after a specified number of years.

**Loan Programmes**

Loan programmes offer financing for the purchase of renewable energy equipment. Low-interest or no-interest loans for solar thermal energy are a very common strategy for demand-side management by utilities. Also banks are serving the retail level developing new products like “green mortgages” and special loans for solar energy technologies in residences and small businesses.

**Personal Income Tax Incentives**

Personal income tax credits or deductions are designed to cover the expense of purchasing and installing solar energy equipment up to a certain percentage or predetermined amount.

**Rebate Programmes**

Rebate programmes are offered at the state, local, and utility levels to promote the installation of renewable energy equipment. The majorities of the programmes are available from state agencies and municipally owned utilities and support SWH and/or photovoltaic systems. Eligible sectors usually include residents and businesses, although some programmes are available to industry, institutions, and government agencies as well. In some cases, rebate programmes are combined with low or no-interest loans.

**Clean Development Mechanisms (CDM)**

The Clean Development Mechanism allows industrialised countries to invest in projects in developing countries which contribute to the reduction of greenhouse gas emissions in that country. These projects must have the approval of the CDM Executive Board, and must also generate measurable emissions reductions against a business-as-usual baseline. They must satisfy ‘additionality’ - it must be clear that the projects would not have happened anyway. They should also be designed to contribute to sustainable development in the partner developing countries.

**Third Party Financing**

Third Party Financing (TPF) is a very useful instrument for financing sustainable energy projects but requires careful market preparation. It can be described as an optimum combination of a guarantee of the necessary finance and professional technical assistance. Third Party financiers for energy projects are referred to as “Energy Service Companies,” or ESCOs. ESCOs are businesses that design, build, install, finance, and maintain projects designed to provide energy through energy generation and/ or reduced demands. Generally, the types of ESCOs are:

- Utility owned subsidiaries
- Service arms of energy equipment manufacturers
- Independent energy companies
- Energy marketers
The services can be provided through Energy Saving Performance Contracts (ESPCs) or Independent Energy Producer (IEP) arrangements. The IEP arrangement is a purchase of energy, as for instance solar hot water, similar to the purchase of energy from the local utility franchise. Leasing can also be an option to be considered as a third party financing instrument.

**Feed-in Tariff**

Over a number of years, the premium feed-in tariff has proved its power and efficiency in developing new markets. The simplicity of the concept, and its low administrative costs, mean that it is a highly effective tool for boosting the contribution of solar electricity in national energy mixes. The basic idea behind a feed-in tariff is very simple. Producers of solar electricity have the right to feed solar electricity into the public grid receiving a premium tariff per generated kWh over a fixed period of time.

**3. Renewable Energy Financing Context in B&H**

**3.1. Administrative Subdivisions of B&H**

Bosnia and Herzegovina has several levels of political structuring under the federal government level which are important to be considered in order to make some recommendations for country policies and financial support. In the next text extracted from Wikipedia are exposed the four administrative levels of B$H.

Most important of these levels is the division of the country into two entities: Republika Srpska and the Federation of Bosnia and Herzegovina. The Brcko district in the north of the country was created in 2000 out of land from both entities. It officially belongs to both, but is governed by neither, and functions under a decentralized system of local government. The third level of Bosnia and Herzegovina’s political subdivision is the cantons. They are unique to the Federation of Bosnia and Herzegovina entity, which consists of ten of them. The fourth level of political division in Bosnia and Herzegovina is municipalities. The Federation of Bosnia and Herzegovina is divided in 74 municipalities and Republika Srpska in 63. Municipalities also have their own local government, and are typically based around the most significant city or place in their territory. Besides entities, cantons, and municipalities, Bosnia and Herzegovina also has four “official” cities. These are: Banja Luka, Mostar, Sarajevo, and East Sarajevo. The territory and government of the cities of Banja Luka and Mostar corresponds to the municipalities of the same name, while the cities of Sarajevo and East Sarajevo officially consist of several municipalities. Cities have their own city government whose power is in between that of the municipalities and cantons (or the entity, in the case of Republika Srpska).
3.2. Renewable energies currently established policies.

At the state level no energy or environmental ministry/agency exists. Environment and energy fall under the responsibility of the Ministry of Foreign Trade and Economic Relations. At the entity levels the Ministry of Energy, Mining and Industry of the Federation of BiH and the Ministry of Economy, Energy and Development of the Republika Srpska are responsible for energy.

Although a report on the institutional, regulatory and normative frameworks and a report on the strategy for development of solar energy in BiH will deal with this issue, is important, in this renewable energy (RE) financing context analysis, to consider the RE currently established policies. In this sense, an Energy Strategy is being developed through the EC CARDS Programme as a “Technical Assistance to Support the Energy Department of Ministry of Foreign Trade and Economic Relations in B&H”. As a first step a comprehensive background energy sectors study towards the national energy strategy is in preparation phase financed by the World Bank.

Besides this study there are no official plans for the promotion of RE sources and for increasing energy efficiency. Nevertheless a tariff system for RES electricity do exists and the decision on methodology for the determination of purchase prices of electric power from RES up to 5 MW was adopted (Of. Gazette FB&H 32/2002, Of. Gazette RS 71/2003). Two power utility companies in B&H are obliged to take over the electricity produced from RES. According to decisions, the tariff systems for RES electricity are:

- Small Hydro plants: 3.96 € cents/kWh
- Landfill biogas and biomass plants: 3.81 € cents/kWh
- Wind and geothermal plants: 4.95 € cents/kWh
- Solar power plants: 5.44 € cents/kWh

Financing Incentives do not exist as well as specialized institutions and training and education activities.

There are some projects (USAID, UNDP) and associations of citizens (CETEOR, COOR, CENER, CEET) and also centres dealing with this issue within the Faculties of University in Sarajevo, Banja Luka, Tuzla, and Mostar.

UNDP runs several Area Based Development programmes in BiH, which aim to re-establish viable multi ethnic communities in a sustainable manner with the design of projects that involve several components such as reconstruction of housing and infrastructure, strengthening local government capacities, support to local economic development and job creation, and development of civil society. Energy efficiency and renewable energy projects could be build on the structure already in place, lessons learned and expertise gained through the ABD programmes.

There is no official structure that could network municipalities in the field of Municipal Energy Efficiency but initiatives as the Municipal Network for Energy Efficiency (MUNEE) and the SUTRA Initiative (Sustainable Transfer to Return related Authorities) have been established; although the information about their activities should be brought out to date.

One final and important aspect, to be exposed in the next paragraph, is the BISE process awareness in which B&H is involved.
3.3. Better Integration for Sustainable Energy (BISE)

BISE aims at encouraging the creation and strengthening of networks of towns and cities promoting energy efficiency in the New Member States, Candidate Countries, Western Balkan Countries and Ukraine.

It is a pan-European process that brings together local, national and European partners involved in energy efficiency in order to:

- reduce the gap between these countries and the former EU15 countries,
- accelerate the integration process of the EU,
- highlight the importance of municipalities and improve local capacities.

In practical terms, three key areas of action have been identified:

- hiring of energy managers in all municipalities
- improvement of energy management in municipal properties
- funding of municipal projects and networking activities

This project, although it is not dealing with the promotion of energy efficiency, solar thermal energy applications can be considered as an energy efficiency strategy to be implemented at different administrative levels, mainly at municipal level.

A Delegation of Bosnia and Herzegovina (BiH) participated in the First BISE on “Intelligent Energy in Municipalities of the New Member States, Candidate countries and Western Balkans. Held in Grenoble in 2004 was represented by the participants from the Ministry of Energy, Mining and Industry of Federation of BiH, two municipalities and the Association of municipalities in (F) BiH.

As was stated in the BISE paper (19) the principal channels of information exchange between municipalities in BiH in the field of municipal energy efficiency are: workshops and training, seminars, municipal meetings, forums for municipal representatives related to energy issues.

The priority topics listed in by B&H municipalities are:
- Development capacity of municipalities in managing the use of energy resources.
- Sustainable development of municipal energy sector.
- Clean and safe environment.
- Financing municipal energy efficiency.
- Increasing living standards and quality of public services

The three major topics where information exchange at country level needs to be intensified are:
- Strategic planning and management of municipal energy and water sector
- Information about financial sources
- Better awareness with municipal energy efficiency issues

And the three major topics where information exchange at European level needs to be intensified are:
- Mode of development of energy efficiency projects and financial mechanisms
- Implementation of European legislation and regulation (EC Directives, standards etc.)
- Organizational and institutional issues

No cities from BiH are members of Energie-Cités but a few are participating in city twinning programs.
The network MUNEE, mentioned before, was planned for energy efficiency projects in Canton Sarajevo and other municipalities and for providing training to the municipalities that participate in the Municipal Board for Energy Efficiency on energy management, energy efficiency planning, and development of energy efficiency studies. On the other hand, the SUTRA Initiative was designed for enabling government structures at the municipal level to develop and utilise more effective and efficient mechanisms for the design and implementation of projects in support of the return and reintegration of refugees and displaced persons (could be based on ABD programmes).

3.4. Financial Barriers in B&H

In deliverable 7 they will be analyzed the different existing barriers to the development of solar energy in B&H:

i. Perception issues.
ii. Lack of leadership
iii. Capabilities barriers
iv. Legal barriers
v. Economic barriers
vi. Financial barriers
vii. Codes and standards

Although financing solar energy projects are affected by different barriers, in this chapter, they are only going to be considered some aspects related with the existing financial barriers in B&H.

In general it can be considered that the existing financing barrier is the absence of financing mechanisms to overpass the economic barrier represented by the high initial investment of a solar installation. As has been seen there exists a diverse menu of possible financing mechanisms. Some of them can provide medium term economies which can be a barrier if the financing culture of potential users is limited.

Banks in B&H have a null or limited experience with energy which leads them to consider such projects too new or uncertain to be comfortable in providing financing, and negatively affects all key terms and conditions that may be granted for the implementation of RE and EE projects.

As will be seen in D-7 the success of a financing mechanism does not mainly depend on the type, but on the continuity and on the quality of design and implementation, including the flanking measures as well as the guarantees about certain technical standards. In this sense, recommendations not only have to consider how to overpass the financing barrier; but also the other barriers related.

The federal government of B&H considering the two entities: Republika Srpska and the Federation of Bosnia and Herzegovina as well as the Brcko district should play a leadership and enabling role to increase investment in and financing of solar energy and in general of renewable energy and energy efficiency as part of a national strategy so that B&H can become an attractive place to invest in these resources. Specifically, the objectives of the entities and district should be to remove barriers, level the playing field, and maximize private and public investment.

Two aspects have to be considered leadership and financing.

Leadership

- Make a strong political commitment to renewable energy and energy efficiency and their many benefits such as economic development, job creation, energy security and reliability.

- Implement ecological tax reform in which financial incentives for conventional energy sources such as oil, gas, and coal are significantly reduced and diverted into incentives for renewable energy and energy efficiency. Mechanisms like fee-bates should be used make new technologies more appealing to users.

Financing

- Establish a national renewable energy and energy efficiency investment facility with major banks and credit unions. Investment targets should be set for each technology and end-use. In this sense, solar PV and solar thermal should be targeted.

- Encourage the private sector to establish B&H venture capital funds and revolving funds for investment in and debt financing of renewable energy and efficiency.

- Encourage electricity companies to consider renewable generation as a key element of their generation portfolios and jointly develop a fee for service mechanism.

- Encourage corporations and institutions purchase green energy (power, fuels, and heat) and energy efficiency by buying tradable certificates and investing in community power and fuels projects.

- Develop and implement a national solar energy market development action plan that includes financial support for commercialization and cost reductions in the possible existing manufacturing; training and certification of the designers, installers, operators and inspectors of large and distributed systems; financial incentives for manufacturers, builders, suppliers, etc.; and risk-reduction strategies for project developers.

- Support innovative financing strategies such as a federal tradable certificates system for renewable energy and energy efficiency investments that would work with cantonal and municipal financing using local improvement charges. Use established organizations such as the Federation of Municipalities, the Gas and the Electrical Associations, etc.

- In relation with International Co-operation and Assistance:
- Be aware of all the possible cooperation programmes and establish contacts with the International Financing Institutions mentioned in chapter 2.1 that promote the financing of renewable energy and energy efficiency, technology transfer and collaboration.
- Work with stakeholders, NGOs and local governments: cantons and municipalities to improve B&H investment attractiveness for solar energy development. Sponsor an annual renewable energy Finance Forum.
- Take global action to remove trade barriers to renewable energy investments

5. Recommendations for cantons and municipalities

Experience shows that when a country centralizes a great deal of authority and cities have little budgetary power there is little incentive to invest in energy efficiency and consequently in solar thermal energy. In contrast, in countries with decentralized power on the local level, energy efficiency investments in the municipal sector have increased.

Cantons and municipalities in B&H should put policies and programs in place that will maximize private, community and public investment in solar energy. These policies should be part of a politically-supported, comprehensive strategy which includes targets and milestones, financial incentives, new funding sources, regulations, capacity building and training. In this sense, is important to adopt state, entity and mainly local policies related to housing in Bosnia, including policies that encourage rehabilitation of homes, metering, establishment of housing maintenance companies and subsidies that encourage the development of solar thermal energy.

At the local level, investment in renewable energy should be supported in the following ways:

- Provide incentive mechanisms that take into account the technology’s relative position on the cost curve and its social value and optimize the available financing resources. One example of good usage of local and international resources is the ABD program of UNDP – Energy Efficient Housing project in 21 municipalities of Brcko, Travnik and Srebrenica region, managed by local UNDP field offices. Also Third Party Financing and ESCO approach are very good samples of effective usage of local, private and international resources for implementation of common actions, locally and regionally.

- Make changes to the public support (tax breaks, subsidies, royalty reductions) of conventional energy to divert investments into renewable energy, especially at the local level.

- Provide training and other programs that build a local infrastructure to manufacture, assemble, distribute, install, operate and maintain all types of centralized and distributed renewable energy technologies.

- Municipalities can encourage community investment in energy efficiency and renewable energy through the establishment of community power corporations, green funds and the use of local improvement charges for project financing.

- Corporations and institutions can purchase green energy (power, fuels, and heat) and energy efficiency by buying tradable certificates and investing in community power and fuels projects.
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Trama TecnoAmbiental

Deliverable 7: Analysis of possibilities and strategic guidelines to be planned for development of solar energy in BiH

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

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1. **Barriers to the development of the solar energy market in B&H**

There are several barriers to the development of Solar Energy projects in B&H, most of which are associated with the fact that these projects are still new in the country, and are often still perceived as representing a “conceptual market”. Most of these barriers are common to both solar thermal and solar PV applications, although there are specific barriers for each one of these technologies and also for their applications.

Experience shows that the majority of barriers to the development of the solar thermal market are linked to the lack of a critical mass. In this sense, where solar thermal has reached a sufficient level of market penetration, these barriers vanish.

1.1 **Perception issues**
This barrier is considered first given that in different ways it permeates all others. There is a considerable perception problem for solar energy in B&H, and it involves all key stakeholders. The general public has limited awareness of the benefits of solar energy and of the need for commitment to sustainable energy. Banks have very limited or even not experience at all in financing energy-related projects, are unaware of their profitability and for the time being do not trust that an energy policy and price framework will allow investments to be profitable. Public institutions have not yet fully managed to convey to the public their strong and unequivocal commitment to solar energy and renewable energies in general within a coherent policy providing leadership, communication and incentives. In particular, there is a failure to adequately recognize the benefits and quantify the value of investing in RE, albeit more costly, to mitigate fuel price volatility, which remains a hidden cost. Solar thermal energy is not yet perceived as a standard option for heating, not being fully integrated into mainstream heating and construction sectors; therefore the decision maker must be especially motivated.

1.2 **Lack of leadership**
There is no one institution specifically dedicated to promote EE and RE in B&H and provided with adequate means to do so effectively. Moreover, the administrative division of the country is not helping to this aim. Barriers to a true market transformation, however, can not be overcome unless leadership is provided by an entity that has the means to effectively reach out to all stakeholders and dramatically increase their awareness; to promote the development and enforcement of necessary incentives and policies; and to coordinate the various initiatives in the country, optimizing their results.

1.3 **Capabilities barriers**
There is a shortage of technical capabilities for sustainable energy in B&H, both in terms of quality and quantity. This lack of education is evident in each one of the three different axes where it should be guaranteed: i) the decision level: engineers and architects, economists and administration...
personal; ii) installers and maintenance professionals and iii) general public or potential users. This shortage is manifested in general terms with a i) low level of awareness and knowledge on advantages of energy efficiency and renewable energies; ii) poor ability to prepare project documents, feasibility studies, business plans, etc.; iii) lack of knowledge and experience concerning the use of energy demand planning and solar energy design tools, and iv) lack of experience in installing and maintaining solar installations because of a lack of availability of motivated and specifically skilled installers.

### 1.4 Legal barriers

The legal and regulatory framework for RE and EE has to be created. The lack of relevant legislation and regulation hinders the development of an energy efficiency strategy and the exploitation of renewable energy sources.

### 1.5 Economic barriers

Electricity production with solar energy is still more expensive than conventional energy. The gap between the price acceptable to the B&H Government and that acceptable to potential independent power producers can prevent RE projects and specifically grid connected solar energy from being actually implemented. On the other hand, the higher upfront costs of a solar installation for the production of hot water in relation to the cost of a conventional system using for instance electricity is the main economical barrier to be considered. With the increase of prices of conventional energy sources solar energy implementation should be favoured as far as the prices of conventional energy are correctly valued.

In this context the most important economical barriers to be considered for solar thermal energy are:

- Higher upfront equipment costs than conventional heating and cooling technologies and also higher transaction costs (information, procurement, installation works) compared with conventional heating
- Pay-back times often too long and fluctuating as a function of conventional energy tariffs, cost of equipment and repayment period.
- The social benefits of solar thermal energy in terms of energy security and reduction of environmental impacts are not considered. That is to say the positive externalities (economical, environmental and social) from the use of solar thermal technologies.
- There are also social and physical barriers as for instance in a resident’s association may exist, depending on the type of building, barriers related with the physical space to install solar collectors or other social barriers that difficult the installation.
1.6 Financial Barriers in B&H

In general it can be considered that the existing financing barrier is the absence of financing mechanisms to overpass the economic barrier represented by the high initial investment of a solar installation. As has been seen in deliverable 6 there exists a diverse menu of possible financing mechanisms. Some of them can provide medium term economies which can be a barrier if the financing culture of potential users is limited.

Banks in B&H have a null or limited experience with energy which leads them to consider such projects too new or uncertain to be comfortable in providing financing, and negatively affects all key terms and conditions that may be granted for the implementation of RE and EE projects.

As will be seen, the success of a financing mechanism does not mainly depend on the type, but on the continuity and on the quality of design and implementation, including the flanking measures as well as the guarantees about certain technical standards. In this sense, recommendations not only have to consider how to overpass the financing barrier; but also the other barriers related.

1.7 Codes and standards

In B&H there are still no standards and labelling programs for efficient equipment import and marketing.

The most important barriers are:

- Lack of labelling associated to the quality and operation standards of the solar systems operation and installation. In this sense, harmonise standards, certification and quality labels should be recognised in the B&H market and by public authorities.

- Lack of professional skills to guarantee the good installation and the maintenance of systems as a guide or code of practice for the installation, functioning and maintenance of solar systems.

2. Strategy to growth of the solar energy market

Two different strategies have to be considered for solar PV and solar thermal energy markets.

Experience shows that support policies play a major role in kicking off the growth of a national solar energy market. In general, but mainly in the case of solar thermal energy, once a critical mass of the market is reached, the intensity of political support can be gradually reduced until the market is fully self-sustained. In this sense, when a country has reached a minimal market volume, growth tends to become self-sustained, even with very low political support, as has been the case of the Greek solar thermal energy market. On the other hand, in countries where there is low demand, a vicious circle
tends to inhibit growth and the market stagnates. Policy support can help break out of this vicious circle by kicking off, and maintaining, market growth until the critical mass of the market is reached.

2.1 Continuity and coherence
As discussed overleaf, public support policies can be a decisive factor for growth, particularly if they are long term oriented, well designed and implemented. A coherent strategy for strong and sustained growth must take into account the local situation. It should be based on clear targets and include a comprehensive set of measures.

A solar thermal strategy should set and pursue clear growth targets. This helps overcome one of the most common shortcomings of public support policies: the lack of continuity. Policies oriented towards a longer term target are less likely to be frequently interrupted. Stop-&-go support does not create the necessary confidence of market actors. Both on the supply and on the demand side, decision makers tend to postpone investment decisions, as they take on a wait-&-see attitude.

Considering PV electricity production at European level, the renewable electricity Directive set national and EU-wide targets for this sector. It is widely accepted that these targets and the policies they induced were vital for the huge investments and successes in electricity generation from renewable energy. A similar approach must now also be taken for RES and specifically for PV electricity production at B&H national level.

2.2 Support strategies: Vertical and horizontal
Effective support strategies address not only one, but several barriers to growth. For example: The lack of public awareness can be overcome with an awareness raising campaign. But the higher initial investment costs might be addressed with a financial incentive scheme. The limited availability of informed and motivated professionals can only be tackled by specific training and education programmes.

The best support strategies consist of a coherent mix of complementing measures. These measures should be well-targeted and not contradictory. Even the most powerful support measure, solar regulations (“Barcelona model”), should be accompanied by flanking measures. Information campaigns targeted at raising quality awareness amongst consumers and installers ensure that the installed systems are used most effectively.

A National B&H Solar Energy Plan it is recommended to be developed. This Solar Energy Plan should be structured in subprograms to be grouped in horizontal or vertical according to the type of actions considered.

The horizontal activities have the objective of assuring the confidence in the provision of services offered and in increasing awareness. This type of actions will impact on the barriers related with:
The vertical subprograms have a quantifiable impact translated into the objectives of the programme. They are two subprograms: regulation and financing, which have an incidence on the following barriers:

- Institutional
- Legal
- Economical
- Financial

### 2.3 Horizontal strategies

#### 2.3.1. Capacity building, training and public awareness

2.3.1.1. Introduction
In every development process the availability of qualified human resources is crucial. It is precisely in the area of solar energy where the lack of skills in developing countries is alarming as it is, more or less, the case of B&H.

Training in the field of solar energy must be ensured along three distinct axes: i) the decision level: engineers and architects, economists and administration personal; ii) installers and maintenance professionals and iii) general public or potential users. Distinction should also be made among different sectors as public, academic and private sectors and different solar technologies and applications as solar thermal and stand alone and grid connected solar PV.

Also Public Awareness and Training have to be differentiated. For instance, in the case of solar thermal technologies, the lack of knowledge or doubts is the primary reason for not choosing solar energy for heating in regions where solar is still a niche product as in B&H. An uninformed end-consumer will not buy or even enquire about a solar thermal system. An uninformed architect, planner or installer is an even bigger problem: If professionals do not know about solar thermal or if they feel insecure about it they will not recommend it to their customers. One uneducated or untrained professional means many lost opportunities in the market.

Public awareness rising can help educate consumers and create market pull. In the more and more mature markets, marketing by solar thermal suppliers will supersede the need for public campaigns.

Professionals in the construction sector, including heating, ventilation and air-conditioning (HVAC) installers have an important role in the market: More often than not, they are the gatekeepers to the final decision makers. In effect, they are the ones who decide whether or not a new building is equipped with a solar thermal system and whether the new heating system is based on renewable energies.
2.3.1.2. Proposed actions

Strategic actions will be proposed and developed in deliverables D-12 to D-14; but some actions are going to be drawn here.

First of all is important to point out that in order to respond in a better way to the needs of training, education and information, the identification and analysis of needs appears to be one of the high priority tasks to be undertaken. In this sense it is recommended to conduct a survey to identify the existing solar energy training courses and academic activities in B&H. Different levels should be considered: university, secondary education, technicians, decision-makers, industrialists and users.

Once the survey has been conducted and the needs identified the following different actions should be planned:

- Establishment of reference teaching programmes for the training of ordinary and specialist technicians and for the development of training models for maintenance technicians of solar technologies. In the private construction sector, professionals, as the installers, have to be motivated to learn about solar energy and even to invest their own resources in training. In many countries, public bodies have supported the development and implementation of training courses targeted at these professionals crucial for the success of specifically the solar thermal technology. The strategy here is to help and support people working in conventional fields to get specialized in solar energy. For example, the local or national authorities should organize additional training for plumbers or electricians so that they become experts in Solar Thermal and PV energy. As has been said, training plays a vital role in motivating installers to recommend and actually sell solar thermal products.

- Preparation of educational packages on solar technologies using modern teaching aids. This activity consists in preparing educational material for sensitizing and diffusion. It must be adapted to the different target groups. For example at secondary school level, demonstration solar kits can be introduced; CD-Rom with design tools for engineers and architects, etc.

- Preparation and dissemination of information documents targeting the general public. Typically, the goals can be reached using brochures explaining the principles and advantages of the different technologies.

- Cooperation with third party countries in the fields of education and training.

- The provision of continuing education and proficiency courses as summer schools, the inclusion of the basics of the utilization of solar energy in secondary school and the establishment of a teaching
programme as a reference for a Masters degree for engineers and architects.

2.3.2. Standards

The use of internationally accepted standards, quality management processes and organizational training in the design, fabrication, installation, sales and services of PV and solar thermal systems has to be promoted.

International and national certification programs are to guarantee the entry of only the highest quality products into the marketplace. Technical norms like homologation, certification, guarantee of solar results, etc. have played an important role in the development of solar technologies in the well established markets.

For PV solar components (modules, BOS, storage, etc) and system’s installations, the most used international standards have been established under the responsibility of IEC through the Technical Committee 82. Also, in the framework of the IEC through regional and national committees but also in the framework of the International Energy Agency, several working groups are developing and improving new and existing standards dealing with components, systems and installations.

For Solar Thermal technologies, the norms EN 12975, EN 12976 and EN 12977 cover all the aspects of certification from the manufacturing technical characteristics of each component to the installation itself (test for commissioning, etc).

The CEN certification mark - The Keymark - is a general voluntary mark, developed by the European Committee for Standardisation (CEN). The clear and simple message of The Keymark is that the product complies with the European Standard(s) covering the product. The Solar Keymark certification scheme has been developed with support from EU-Altener (Solar Keymark - AL/2000/144) and EU-IEE (Solar Keymark II - EIE/05/052/SI2.420194).

The Keymark for solar thermal products will assist users to select quality solar collectors and systems. This "Solar Keymark" is the result of a voluntary certification scheme supported by the European Solar Thermal Industry Federation - ESTIF.

The basic elements in the certification scheme are:

- Certificates are delivered by Keymark empowered certification bodies
- Test reports are delivered by accredited test laboratories
The products are delivered by Keymark licensed manufacturers fulfilling the requirements for factory production control.

On the other hand, besides the certification of the solar products a quality level for installers has been established in many countries as for instance Qualisol in France.

The proposed actions for B&H are the following:

- To adopt the recognized standards for the national manufactured solar components based in the international standards (IED, ISO, etc), mentioned above.
- To develop a Quality Label for solar energy installers (of PV and Solar Thermal technologies) linked to the training actions to be designed.

### 2.3.3. Demonstration projects

Demonstration projects represent an activity linked to the promotion of solar technologies in incipient markets as the one in B&H. Specifically they illustrate and reinforce awareness campaigns and also the training activities. Hospitals, community centres, schools, etc. are good candidates for pilot projects. In general all the public facilities are excellent targets that can be used for diffusion and training. Also the character of replication is important in this kind of facilities. In this project, it has been decided to explore many possible applications of the solar energy. In this sense, two projects are dedicated to Solar Thermal energy and other two to Photovoltaic energy. All the projects are implemented in public facilities.

#### Solar thermal

There are a lot of different technologies that can be used, depending of the application, space available, economical issues and efficiency considerations. The two projects will use the same technology even if the application is a little different. The first one in Mostar is an ‘individual’ system installed in a school for mentally handicapped children: “Los Rosales”. One of its buildings hosts a family which takes care of 12 children of the school. The other project, in Trebinje, is a ‘collective’ system in a geriatric residence hosting more than 100 persons. The technology is one of the most used and already experimented in B&H, which will allow an easy replication of the system.

#### Photovoltaic

Two different applications: grid-connected systems and ‘stand-alone’ or ‘autonomous’ systems are considered. Both of them are installed in the framework of this project in order to provide a wide overview of the possibilities of the PV technologies in B&H. The PV grid-connected system is located in Mostar in the school “Los Rosales” mentioned above. The ‘stand-alone’ system will be installed in a technical school or university in Republika...
Srpska. For the moment the exact location has not been defined. This system will be use essentially for training purposes and studies.

For all the projects, a follow-up and monitoring have to be performed at least one year after the implementation; as well as the dissemination of these results.

2.4 Vertical strategies

2.4.1. Institutional strategies

As it is described above in paragraph 1.2, one of the main barriers in B&H is the lack of leadership. This is why one of the first actions to be developed should be the creation of a joint Ministry of Energy at the State level. In the meantime, it will be necessary to coordinate the Renewable Energy activities of the Ministries of Energy of both entities.

Also, besides the national strategy, local authorities must get involved in the promotion of the solar energy (see part 5 of the D6). There exist several support policies that can be used in order to promote and provide incentives to the use of the solar energy at the local (municipal, regional) level.

2.4.2. Regulation and legal actions

2.4.2.1. Introduction

In relation with the solar thermal energy market is important to consider that future new buildings will last into the second half of the 21st century and longer. By then, fossil fuels will be very scarce and expensive. Adapting the building stock will be a steady process. At least new buildings, and those undergoing major renovation, should be equipped for future conditions. In this sense, solar thermal regulations are highly recommended having the following benefits:

- The building stock can be gradually prepared for the post-oil and gas era
- Solar thermal is cheaper and more cost effective if installed at the construction stage
- If solar is not included, the window of opportunity will be closed for a long time
- An obligation solves the tenant-owner dilemma: the fuel costs are not paid by the same person who pays for the investment to save fuels
- Implementation requires little administration effort over usual building permits and controls
• Minimal impact on public budgets

• Avoids stop-&-go market dynamics and thus creates a positive investment climate for the solar thermal industry

A reference and positive experience with solar obligations is the case of the City of Barcelona, which enacted, in 1999, a Solar Ordinance later replicated by many other Spanish local councils. This paved the way for the solar obligation to be included in the new Spanish national building code, approved in 2006.

With reference to solar PV regulations discussions are currently in progress in B&H to produce an in-feed directive that would be standard for the whole of B&H and in conformance with EU policy. In the existing law: “OG of B&H” 32/2002, “OG of RS” 71/2003 although preferential prices for RES are guaranteed in B&H, they are ensured only for the current year, without any sort of motivational guarantee for investors to receive the same preferential price for an extended period of years that would be needed to ensure that the investment costs are paid back. Therefore the support scheme in its current form does not ensure sufficient economic stability in the sector of PV solar grid connected. On the other hand, except for the above-mentioned governmental decision, B&H does not have any other specific document covering rights for connecting to the grid and the capability of the grid to integrate energy from RES.

2.4.2.2. Proposed actions

• Create the regulations of the existing law (“OG of B&H” 32/2002, “OG of RS” 71/2003) to assure its application. This law fixes the price that the electricity company has to pay when a generation system based on Renewable Energy Sources (PV, Hydro, Wind, etc) is connected to the grid.

• Study a revision (increasing) of the feed-in tariff from Renewable Energy Sources, at least the one related to PV energy as mentioned in the existing law, in order to better promote solar energy uses. The tariffs established in the law are not sufficient to promote the private investment. The aim of this action is to increase the incentive for the private sector to create a solar PV market helping to decrease the current PV system costs and develop a whole trained and prepared PV sector.

• Study the possibilities of introducing solar thermal regulations at local level by means of a solar municipal bylaw or ordinance (local and municipal level) and at national level through the establishment of a new building code.
2.4.3. Financial Incentive schemes

The success of a Financial Incentive Scheme (FIS), as already has been said, does not mainly depend on the type, but on the continuity and on the quality of design and implementation, including the flanking measures. In chapters 4 and 5 of deliverable 6 they have been pointed out some recommendations addressed respectively to the Federal Government and to Cantons and Municipalities.

The European Solar Federation has provided some guidelines for solar energy financing which can be useful to be mentioned:

- FIS should be part of a comprehensive approach, including coherent flanking measures, such as awareness raising, training and demonstration projects
- FIS should last for several years under stable conditions. This maximises the impact on investments and creates conditions for self-sustained growth
- No early announcement of improved financial conditions, to avoid consumers postponing purchase
- Funds must be available to guarantee the continuity of the FIS over some years - if the public budget cannot do it, the “Polluter Pays Principle” should be applied
- Easy and lean procedures increase the effectiveness of the FIS
- Product requirements should be fully compatible with the European Standards and certification procedures, to guarantee high quality without creating barriers to trade
- Quality criteria on the installation should be set, in line with the specific situation of the country/region, to avoid low quality installations without creating artificial hurdles
- The amounts offered should be high enough to provide a real incentive

Taking into the current local situation and also thanks to the elements developed in deliverables D5 and D6, the first proposed action is the creation of a solar fund supported by the European Commission through the structural funds schemes and/or any other multi-lateral entity (GEF, World Bank, etc).

For the Solar Fund it is proposed a structure that features different windows offering specific types of financial products or support, organized within the Fund overseen by a single administrative organization. The objective of this structure is to provide multiple types of horizontal support or flanking
measures, as described above, and of financing incentives (vertical support) as mentioned in D-6. Both have to be consistent with observed needs, while maintaining flexibility and management capacity for the specific interventions over the longer term, and concentrating the promotional aspect of the initiative with a single institution. In addition, this structure allows for a phased implementation that will allow for the management of diversified donor support coming from multiple institutions with differing timetables and varying objectives.

This Solar Fund can be the embryo of a National B&H Solar Energy Plan to be structured in subprograms and to be grouped in horizontal or vertical according to the type of actions considered.

This fund will assure the promotion of the solar energy using several tools and financing schemes. The following list is an example of the way of giving incentive:

- Reduction of VAT for the investment of solar products (PV and thermal) for particular users
- Difference of the price of the feed-in tariff and the regulated tariff of conventional electricity
- Low-interest or no-interest loans for the investment of a PV grid-connected system and a solar thermal system

Also, this fund can be used for the financing of the public awareness campaigns and of the trainings.
Deliverable 8-A: Technical Project description – PV installation in Mostar

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

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I – Purpose

The purpose of this document is the description of the conditions and the minimum technical specifications for the supply and the installation of a solar photovoltaic generator interconnected to the grid of the School “Los Rosales” in Mostar. It describes the activities and tasks corresponding to supply, installation, commissioning of the installation and the report ‘as built’ and maintenance logbook.

In case that the proposed solutions are different from the described conditions in this document, the bidder shall justify in details his choice and demonstrate that they will exceed the minimum requirements and qualities, described in this document. The offers shall be presented in English or Spanish language.

II – General Description

1. Data of the site

The building CENTER "LOS ROSALES" is located in:

JUZNI LOGOR bb
88000 MOSTAR
BOSNIA & HERCEGOVINA

2. Standards

The standards applicable for the general electric connections are the general Spanish code for low voltage connected PV installation (R.D. 842/2002. Reglamento Electrotécnico de Baja Tensión) or any other similar European standards.

3. Occupation and hours

The school is occupied from Monday to Friday during the normal hours and closes during the two months of summer (July and August). Additionally the assisted residence is used everyday of the week and closes only during the month of July.

4. Detailed description

The installation proposed is an interconnected Photovoltaic system with 3.6 kWp of generation with a 2.75 kW nominal power inverter. The generated current will be single phase. There are two options for the interconnection point, which will depend on final negotiations with the local utility. The option I deals with the injection of the entire generated energy to the public grid at a price defined in the law (“Sluzbene novine Federacije BiH”, br.1/94 I 8/95). The option II deals with the injection of the generated energy in the internal grid and foresee the substitution of the existing 3-phase meter by a bi-directional one in case of excess energy like in July during the holydays. In this case there won’t be any incentive for the purchase of the PV energy but it will be sold at the same price (net metering).
4.1. PV array and modules

The PV modules will be crystalline and should fulfil the standards and conditions described in this tender.

Also, the modules will be certified according to the European Standards EUR-503 and will fulfil the standards IEC-61215-2. The ingress protection of the module junction box will be IP65. Each module will have the following minimum information: brand, model, serial number and nominal power.

Only one model of PV module will be used. The total nominal capacity of the PV array will be 3,600 Wp minimum. The module will be SUNTECH STP 180 or similar. The power will be 180 Wp for each module. The range of the Open circuit voltage will be 42-46 V, which corresponds to modules with 72 cells in series.

The PV array will be divided electrically in two strings of equal nominal power. The configuration of the PV modules of each string will be homogeneous intern of orientation and will have two different inclinations (24° and 19°).

Each string will be connected directly to one input of the inverter. Before realizing the parallel connection a fuse with the adapted value for short-cut current of the string will be put. All the feeders will go through independent conduits according to the polarity from the roof until the technical room where the power conditioning unit is placed.

The wiring will be done respecting the acceptable voltage drop between the PV array and the inverter and the losses will never exceed 1%. The minimal sections to be used are specified in the part III dealing with calculation.

The PV array will be installed on the roof as it is described in the drawings (Part V). The orientation will be the building orientation (0° S). As the roof is curve we will have two different inclinations both each series. One will have an inclination of 24° and the other one 19°. This will allow a good use of the available space, a good integration to the existing structure. The total area will be 30 m2 approximately.

The bidder shall described the characteristics of the modules, with the electric values in STC (nominal power, current and voltage at maximum power, shortcut current and open circuit voltage), the characteristic curve for temperature and irradiation and the mechanical characteristics.

4.2. Support structure

The structures above which the PV array will be fixed shall assure the functional and structural stability with respect to the loads and wind actions. The set structure-modules shall resist wind load up to 125 Km/h and possible overload for snow (40 Kp/m2).

It has to be rust proof and compatible chemically (galvanic corrosion) with the material of the modules frames and the roof material.

The design of the structure and the fastening system should allow the thermal expansion without transferring stresses which could affect the integrity of the modules.
In case that the structure is made with hot-dipped galvanized steel, the thickness shall be higher than 80 micrometers. No drilling could be done after the galvanization. The fastening of the modules on the roof shall be done without affecting the water proofing of it.

The fasteners shall be stainless steel.

4.3. Inverter

The DC electricity generated by the PV array has to be converted into AC (at 230 Vac) and 50 Hz in order to be used by the School for the normal supply of the electric devices. The working voltage of the inverter is then defined at 230 V. The output has to be single phase.

The model of inverter will be SB 3000 of the brand SMA, which fulfils the following requirements:

- The inverters shall include an MPPT for the PV array.
- Islanding protection.
- Protection against AC shortcuts.
- Manual control for switching on/off the inverter.
- Euro-efficiency above 90% working above 25% and up to 100% of the nominal power.
- Power factor above 0.97 working at least 25% of the nominal power
- Temperature range: –15 y +45°C
- Ambient humidity range: 0 a 90%
- The internal measurement device of the grid impedance must be deactivated.
- The self-consumption has to be less than 0,5% of the maximum power.
- The harmonic distortion will be less than 3% in Standard conditions of maximum load.

The inverter will be located in the technical room described in the clause 4.8.

4.4. Measurement devices

Data logging

A follow-up of the installation will be done as well as the analysis of the main parameters of the PV plant. The monitoring system will have the following objectives:
- Analysis of the performance ratio (PR) of the installation
- Quick detection of operational errors
- Survey of the proper operation
- Demonstration for the public and user of the facility
- Possibility of visualization of the data in real time

The PV installation will be equipped with a reference cell for the solar irradiation and with a sensor of temperature of the modules as well as a data logging system. All the
data (electricity generation, solar irradiation, temperatures, etc) will be registered. The meter pulses output shall be also recorded. For the monitoring, at least the registered information will be:
- Temperature of the modules
- Solar irradiation
- Total generated energy
The sensors and reference cell used to register the information must be compatible with the inverter.

### Energy meters

The data about the generated electricity will be registered by the data logger (see previous chapter). Also, for both options, it is foreseen to install a single phase bi-directional digital meter certified by the electrical company with pulses output.

In the case of the option I, the existing 3-phases meter will remain but in the case of the option II, a 3-phases bi-directional digital meter certified by the electrical company will substitute the existing one.

#### 4.5. Visualization

The contractor should propose a model of screen connected (if necessary) to the inverter or to the meter for visualization. This screen should fit in the adapted place and allow the good visualization by the public of the data in real time and the accumulated values as well. The connection will be either via the RS232 port of the inverter or the pulses output of the meter.

This screen will be located at the entrance of the building for dissemination of the proper running of the system.

#### 4.6. Protections and Earthing.

The safety measures of the installations should guarantee the protection against the direct and indirect contacts, conserve the grid quality and have earth protection.

**DC Protections**

For protection against direct and indirect contacts, as well as for over currents on the DC side, single-pole wire double insulated will be used. So the positive and negative wires will be separated.

For each PV string, it is foreseen one fuse of 10A for each polarity (negative and positive) and one circuit breaker which will open both negative and positive wire. These protections will be located in the technical room just before the inverter.

Between the protection box and the inverter, one surge arrester with the value equal to the open circuit voltage of each sub array will be installed (one between positive and earth and one between negative and earth).

The fuses, circuit breakers and surge arresters will be installed just before the inverter in the technical room.
AC Protections
At the output of the inverter, a manual circuit breaker will be installed in order to be able to disconnect the inverter from the grid without disconnecting the whole installation. For using it as well as a protection, this circuit breaker will consist in a magnetothermic switch of 16A.

Additionally, a differential switch (sensitivity of 30 mA) will be added just after the inverter and the 16A magnetothermic switch.

General protection box
The main combiner box will be located just next to the connection point of the public grid (same room). It will be accessible from the personnel of the electrical company as well as for the intern staff in charge of the maintenance.
It has general AC protections and metering included.

At the time of standards of the works it will be decided the final set up for metering. The bidder must offer the most expensive option (I or II).

OPTION I
In the case that it is decided to sell all the energy to the grid, the combiner box will contain:
- general switch tetrapolar ICP of 16A
- Single phase bi-directional digital meter
- Two 63A fuses after the meter to protect the phase and neutral

OPTION II
In the case that the only the excess energy is injected to the grid, the combiner box will contain:
- 16A switch
- Single phase bi-directional digital meter
- Three phases bi-directional digital meter

Earthing
The earth protection of the PV plant will be done respecting the existing local standards and avoiding modifying the conditions of earth protection of the public grid.

The metallic structure of the PV array, the metallic frames of the modules and the framework of the inverter will be connected to the earth of the building through a copper wire of 16 mm2.
4.7. **Interconnection**

The interconnection with the low voltage grid will be realized according the layout described in the part IV (Drawings).

In the case of the option I, this interconnection will be made according to authorized connection layout by the utility (drawing number 5).

In the case of the option II, the connection will be made inside the internal grid (after the 3-phases meter) connecting the AC wire coming from the inverter to one of the three phases (drawing number 7). The choice of the phase will be to the phase which has more connected load or, in case that the 3 phases are well balanced, the one which is connected to daytime loads.

4.8. **Technical room and layout of the equipments**

The technical room, where the electronic equipment and protections will be arranged, will be conditioned in order to fulfil with the following minimum requirements:

- natural or forced ventilation
- lock in the access door
- signs according to the following clause 4.10
- a minimum of 1,5 m. wide for the wall where the inverters will be fixed not less than 1,1m. of distance between the opposite wall it will have a drain if the room floor is under the access corridor level

The inverters fixed in the wall will be placed in an appropriate height to allow inspection. The minimum height for the inferior part will be 2 m., for the superior 2 m. The minimum distance between the superior part of the inverter and the roof will not be less than 40 cm. In case of requiring more than one inverter, at least 20 cm. will be left between them or the wall.

4.9. **Labelling**

The installation will be signposted with the corresponding indications and danger. The different equipment, wiring, etc. will be identified. Also will be the following signs in Bosnian, Spanish and English or with suitable international symbols.

In the access to the PV generator:

- Warning about electrical danger
- Warning about voltages and direct current
- Warning about “Generator always active, even for PV installations disconnected from the electrical grid”.

On the access door to the equipment room:

- Warning of exterior security, with the electrical danger signal.

Beside the inverters:

- Electrical danger signal.
- Danger – high voltage

Beside the energy counter:
4.10. Wiring and Calculation of the theoretical sections

The sections of the wires will be adapted taking into account:
- Minimum section for the wiring between modules of the same serie: 2.5 mm².
- Minimum section for the wiring of each serie to the inverter: 2.5 mm². Voltage drop <1%.
- Minimum section for the wiring between the inverter and the interconnection point: 6 mm². Voltage drop <1%.
- Earthing: 16 mm².

III – Calculation

The following tables represent the calculation for the wire section applicable:

**DC SIDE**

<table>
<thead>
<tr>
<th>Line</th>
<th>Nº modules</th>
<th>Lenght (m)</th>
<th>Power (W)</th>
<th>I max. (A)</th>
<th>Section (mm²)</th>
<th>Voltage Drop (%)</th>
<th>Voltage Drop (V)</th>
<th>Max. Power losses (W)</th>
<th>Voltage (V)</th>
<th>I max. Conductor (I)</th>
<th>Coef. Correction</th>
<th>I max. Corrected (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERIE 1</td>
<td>10</td>
<td>15</td>
<td>1.800</td>
<td>5.40</td>
<td>2.5</td>
<td>0.20</td>
<td>0.87</td>
<td>3.52</td>
<td>444.00</td>
<td>20</td>
<td>0.95</td>
<td>19.00</td>
</tr>
<tr>
<td>SERIE 2</td>
<td>10</td>
<td>15</td>
<td>1.800</td>
<td>5.40</td>
<td>2.5</td>
<td>0.20</td>
<td>0.87</td>
<td>3.52</td>
<td>444.00</td>
<td>20</td>
<td>0.95</td>
<td>19.00</td>
</tr>
</tbody>
</table>

**AC SIDE**

<table>
<thead>
<tr>
<th>Line</th>
<th>Lenght (m)</th>
<th>Power (W)</th>
<th>Power factor</th>
<th>I max. (A)</th>
<th>Section (mm²)</th>
<th>Voltage Drop (%)</th>
<th>Voltage Drop (V)</th>
<th>Max. Power losses (W)</th>
<th>Voltage (V)</th>
<th>I max. Conductor (I)</th>
<th>Coef. Correction</th>
<th>I max. Corrected (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inv.-AC Protec.</td>
<td>1</td>
<td>3.000</td>
<td>1</td>
<td>13.00</td>
<td>2.5</td>
<td>0.08</td>
<td>0.19</td>
<td>2.42</td>
<td>230.00</td>
<td>20</td>
<td>0.95</td>
<td>19.00</td>
</tr>
<tr>
<td>AC Protec.-Met. cab.</td>
<td>39</td>
<td>3.000</td>
<td>1</td>
<td>13.00</td>
<td>6.0</td>
<td>1.32</td>
<td>3.00</td>
<td>36.36</td>
<td>230.00</td>
<td>33</td>
<td>0.95</td>
<td>31.35</td>
</tr>
</tbody>
</table>

In order to estimate the energy generated by the PV plant, a simulation has been made using the following hypothesis for the solar irradiation:
These data have been gathered in the SODA web page which gives values of solar irradiation in European and Mediterranean countries. We can observe the value on the horizontal plan and also on inclined plans at 15° and 25°.

These solar irradiation values have been entered in the PV SYST software as well as the characteristics of the different devices. For the PV modules model a standard model has been used.

The results of the simulation are shown in the following graphs and tables:
## Grid-Connected System: Simulation parameters

### Project: Mostar

<table>
<thead>
<tr>
<th>Geographical Site</th>
<th>Mostar</th>
<th>Country</th>
<th>Yugoslavia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Situation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latitude</td>
<td>43.2°N</td>
<td>Longitude</td>
<td>17.5°E</td>
</tr>
<tr>
<td>Legal Time</td>
<td></td>
<td>Altitude</td>
<td>108 m</td>
</tr>
<tr>
<td>Albedo</td>
<td>0.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Meteo data:** Mostar, synthetic hourly data

**Simulation Variant:** Simulation variant

**Simulation date:** 30/07/08 18h17

### Simulation parameters

- **Heterogeneous field, double orientation**
  - Array#1 tilt: 24°
  - Array#2 tilt: 19°
  - Proportion of array #1: 50%

- **Horizon:** Free Horizon

- **Near Shadings:** No Shadings

### PV Array Characteristics

- **PV module:** Si-mono
- **Model:** STP 180S-24/Aa
- **Manufacturer:** Suntech
- **Number of PV modules:** 10 modules
- **Total number of PV modules:** 20
- **Array global power:** 3.6 kWp
- **Array operating characteristics (50°C):**
  - U mpp: 327 V
  - I mpp: 10 A
- **Total area:** 25.5 m²

**PV Array loss factors**

- Heat Loss Factor
  - ko (const): 29.0 W/m²K
  - kv (wind): 0.0 W/m²K / m/s
  - Nominal Oper. Coll. Temp.: (800 W/m², Tamb=20°C, wind 1 m/s)
  - NOCT: 45 °C
- Wiring Ohmic Loss: 1065.0 mOhm
- Serie Diode Loss: 0.7 V
- Module Quality Loss
  - Loss Fraction: 3.0 %
- Module Mismatch Losses
  - Loss Fraction: 2.0 % at MPP

**Incidence effect, ASHRAE parametrization**

IAM = 1-bo (1/cos i - 1)

**bo Parameter:** 0.05

### System Parameter

- **System type:** Grid-Connected System

### Inverter

- **Model:** Sunny boy SB 3000
- **Manufacturer:** SMA
- **Operating Voltage:** 268-600 V
- **Unit Nom. Power:** 2.8 kW AC

**Repartition on fields**

- Field #1: 1 string on the mixed inverter
- Field #2: 1 string on the mixed inverter

**User’s needs:** Unlimited load (grid)
Grid-Connected System: Main results

Project: Mostar
Simulation Variant: Simulation variant

Main system parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>System type</td>
<td>Grid-Connected</td>
</tr>
<tr>
<td>PV Field Orientation</td>
<td>Double orientation/ field #1 (50 % tilt 24°, azimuth 0°)</td>
</tr>
<tr>
<td>PV Field Orientation</td>
<td>field #2 tilt 19°, azimuth 0°</td>
</tr>
<tr>
<td>PV modules Model</td>
<td>STP 180S-24/Aa Pnom 180 Wp</td>
</tr>
<tr>
<td>PV modules Model</td>
<td>Pnom total 3.6 kWp</td>
</tr>
<tr>
<td>PV Array Nb. of modules</td>
<td>Sunny boy SB 3000 Pnom 2.80 kW ac</td>
</tr>
<tr>
<td>Inverter Model</td>
<td>Unlimited load (grid)</td>
</tr>
</tbody>
</table>

Main simulation results

<table>
<thead>
<tr>
<th>Performance Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Production</td>
<td>Produced Energy 4615 kWh/year</td>
</tr>
<tr>
<td>Performance Ratio PR</td>
<td>77.2 %</td>
</tr>
<tr>
<td>Specific</td>
<td>1282 kWh/kWp/year</td>
</tr>
</tbody>
</table>

Normalized productions (per installed kWp): Nominal power 3.6 kWp

Performance Ratio PR

Simulation variant

Balances and main results

<table>
<thead>
<tr>
<th>Month</th>
<th>GlobHor kWh/m²</th>
<th>T Amb °C</th>
<th>GlobInc kWh/m²</th>
<th>GlobEff kWh/m²</th>
<th>EArray kWh</th>
<th>EOOutInv kWh</th>
<th>EffArrR %</th>
<th>EffSysR %</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>50.4</td>
<td>7.10</td>
<td>66.9</td>
<td>66.2</td>
<td>212.1</td>
<td>198.3</td>
<td>12.07</td>
<td>11.28</td>
</tr>
<tr>
<td>February</td>
<td>66.1</td>
<td>7.30</td>
<td>84.9</td>
<td>81.9</td>
<td>261.6</td>
<td>245.1</td>
<td>12.06</td>
<td>11.30</td>
</tr>
<tr>
<td>March</td>
<td>111.7</td>
<td>9.10</td>
<td>131.3</td>
<td>126.8</td>
<td>405.4</td>
<td>381.3</td>
<td>12.09</td>
<td>11.37</td>
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<tr>
<td>April</td>
<td>147.4</td>
<td>13.20</td>
<td>158.2</td>
<td>153.1</td>
<td>480.3</td>
<td>452.0</td>
<td>11.89</td>
<td>11.19</td>
</tr>
<tr>
<td>May</td>
<td>187.7</td>
<td>19.20</td>
<td>191.1</td>
<td>185.4</td>
<td>561.5</td>
<td>527.9</td>
<td>11.50</td>
<td>10.82</td>
</tr>
<tr>
<td>June</td>
<td>195.6</td>
<td>23.00</td>
<td>192.8</td>
<td>186.8</td>
<td>557.1</td>
<td>524.2</td>
<td>11.32</td>
<td>10.65</td>
</tr>
<tr>
<td>July</td>
<td>217.3</td>
<td>24.80</td>
<td>216.3</td>
<td>209.8</td>
<td>618.3</td>
<td>581.8</td>
<td>11.19</td>
<td>10.53</td>
</tr>
<tr>
<td>August</td>
<td>187.2</td>
<td>25.50</td>
<td>198.3</td>
<td>192.5</td>
<td>568.3</td>
<td>535.1</td>
<td>11.22</td>
<td>10.57</td>
</tr>
<tr>
<td>September</td>
<td>140.1</td>
<td>20.10</td>
<td>162.7</td>
<td>157.7</td>
<td>478.4</td>
<td>450.4</td>
<td>11.51</td>
<td>10.84</td>
</tr>
<tr>
<td>October</td>
<td>94.9</td>
<td>16.80</td>
<td>121.1</td>
<td>116.9</td>
<td>361.3</td>
<td>339.6</td>
<td>11.69</td>
<td>10.99</td>
</tr>
<tr>
<td>November</td>
<td>54.1</td>
<td>12.50</td>
<td>73.5</td>
<td>70.8</td>
<td>220.3</td>
<td>206.1</td>
<td>11.74</td>
<td>10.98</td>
</tr>
<tr>
<td>December</td>
<td>42.5</td>
<td>7.50</td>
<td>60.8</td>
<td>58.3</td>
<td>185.7</td>
<td>173.2</td>
<td>11.97</td>
<td>11.16</td>
</tr>
<tr>
<td>Year</td>
<td>1495.0</td>
<td>15.56</td>
<td>1660.1</td>
<td>1606.3</td>
<td>4910.4</td>
<td>4614.8</td>
<td>11.58</td>
<td>10.89</td>
</tr>
</tbody>
</table>

Legends:
- GlobHor: Horizontal global irradiation
- T Amb: Ambient Temperature
- GlobInc: Global incident in coll. plane
- GlobEff: Effective Global, corr. for IAM and shadings
- EArray: Effective energy at the output of the array
- EOOutInv: Available Energy at Inverter Output
- EffArrR: Eff. Eout array / rough area
- EffSysR: Eff. Eout system / rough area
**Grid-Connected System: Loss diagram**

**Project:** Mostar  
**Simulation Variant:** Simulation variant

<table>
<thead>
<tr>
<th>Main system parameters</th>
<th>System type</th>
<th>Grid-Connected</th>
<th>PB Field Orientation</th>
<th>PB Field Orientation</th>
<th>PB Field Orientation</th>
<th>PB Field Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Field Orientation</td>
<td>Double orientation/ field #1(50 %)</td>
<td>tilt 24°, azimuth 0°</td>
<td>STP 180S-24/Aa</td>
<td>field #2</td>
<td>tilt 19°, azimuth 0°</td>
<td>180 Wp</td>
</tr>
<tr>
<td>PV modules</td>
<td>Model</td>
<td>Pnom</td>
<td>20</td>
<td>Pnom total</td>
<td>3.6 kWp</td>
<td>2.80 kW ac</td>
</tr>
<tr>
<td>PV Array</td>
<td>Nb. of modules</td>
<td>Pnom total</td>
<td>3.6 kWp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverter</td>
<td>Model</td>
<td></td>
<td>Sunny boy SB 3000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>User’s needs</td>
<td>Unlimited load (grid)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Loss diagram over the whole year**

- **Horizontal global irradiation**  
  1495 kWh/m²  
  +11.0%  
  -3.2%

- **Global incident in coll. plane**  
  1606 kWh/m²  
  * 26 m² coll.  
  efficiency at STC = 14.3%

- **Effective irradiance on collectors**  
  5855 kWh  
  -4.6%  
  -5.3%  
  -3.2%  
  -2.2%  
  -1.8%  
  -4.6%

- **Array nominal energy (at STC effic.)**  
  4910 kWh  
  -6.0%  
  -0.0%  
  0.0%  
  -0.0%  
  -6.0%

- **Array virtual energy at MPP**  
  4615 kWh  
  -6.0%  
  -0.0%  
  0.0%  
  -0.0%  
  -6.0%

- **Available Energy at Inverter Output**  
  4615 kWh  
  -6.0%  
  -0.0%  
  0.0%  
  -0.0%  
  -6.0%
IV - Bill of material

<table>
<thead>
<tr>
<th>Ut.</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>CHAPTER 1. STRUCTURES</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wp. Metallic structure and auxiliar material</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td><strong>CHAPTER 2. PV GENERATOR</strong></td>
<td></td>
</tr>
<tr>
<td>Ut.</td>
<td>PV Module Suntech STP 180 or similar</td>
<td>20</td>
</tr>
<tr>
<td>ml.</td>
<td>Cu UNE RZK1 (AS) 0.6/1kV 1x2,5 mm2 LH</td>
<td>120</td>
</tr>
<tr>
<td>ml.</td>
<td>Corrugated conduit insulated 63 mm</td>
<td>15</td>
</tr>
<tr>
<td>Ut.</td>
<td>Surge arrester - 500V</td>
<td>4</td>
</tr>
<tr>
<td>Ut.</td>
<td>Circuit breaker with 10 A cylindrical fuse single-pole 10x38</td>
<td>4</td>
</tr>
<tr>
<td>Ut.</td>
<td>Manual Circuit breaker</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td><strong>CHAPTER 3. CONVERSION DC-AC, CONTROL AND MONITORING</strong></td>
<td></td>
</tr>
<tr>
<td>Ut.</td>
<td>Inverter SMA SB 3000</td>
<td>1</td>
</tr>
<tr>
<td>Ut.</td>
<td>WebBox SMA</td>
<td>1</td>
</tr>
<tr>
<td>Ut.</td>
<td>Single-phase bidirectional meter 16A 230-400V</td>
<td>1</td>
</tr>
<tr>
<td>Ut.</td>
<td>Display for visualization</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>CHAPTER 4. PROTECTIONS, AC WIRING AND EARTHING</strong></td>
<td></td>
</tr>
<tr>
<td>Ut.</td>
<td>Magnetothermic switch 16A</td>
<td>1</td>
</tr>
<tr>
<td>Ut.</td>
<td>Differential switch 25A (2P) 0.03A</td>
<td>1</td>
</tr>
<tr>
<td>Ut.</td>
<td>Earthing rod 1000mm and 14.6mm</td>
<td>2</td>
</tr>
<tr>
<td>ml.</td>
<td>Copper wire single pole section 1x16mm2</td>
<td>40</td>
</tr>
<tr>
<td>ml.</td>
<td>Cu UNE RZK1 (AS) 0.6/1 kV 1x2,5mm2</td>
<td>4</td>
</tr>
<tr>
<td>ml.</td>
<td>Cu UNE RZK1 (AS) 0.6/1 kV 1x6mm2</td>
<td>80</td>
</tr>
<tr>
<td>Ut.</td>
<td>Magnetothermic switch 16A ICP (1P+N) 6000A (option I only)</td>
<td>1</td>
</tr>
<tr>
<td>Ut.</td>
<td>Circuit breaker with 63 A cylindrical fuse single-pole (option I only)</td>
<td>2</td>
</tr>
<tr>
<td>Ut.</td>
<td>Connection box (option II only)</td>
<td>1</td>
</tr>
<tr>
<td>Ut.</td>
<td>3 phases bidirectional meter (option II only)</td>
<td>1</td>
</tr>
</tbody>
</table>
V – Drawings

The drawing explains the location of the PV array, the connections to be done and the general layout of the installation.

For the drawings an example has been done with one specific model of PV module. The bidder will propose an exact type of module and will join new drawings explaining his solution, respecting the configuration of the PV array and adapting with the dimensions of the chosen module.
Py GENERATOR WIRING LAYOUT

Py INSTALLATION COMPOSED OF 2 STRINGS OF 10 MODULES

Py ARRAY WITH 270kW SINGLE PHASE INVERTER
Deliverable 8-B: Technical Project description – Solar Thermal installation in Mostar

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

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Barcelona, July the 29th, 2008
I – Purpose

The objective of this project is to define the characteristics of the installation of thermal solar energy to heat the sanitary hot water of the Resident Care Facility for disabled children in Mostar, Bosnia Herzegovina, for its implementation.

The execution of the installation will be carried out by qualified personnel according to the country’s regulations. The installer will be responsible for the correct operation of the installation and the fulfilment of the applicable regulations, standards and instructions.

The installation will have a collection field with the following surface:

<table>
<thead>
<tr>
<th>Field of thermal solar energy panels</th>
<th>Opening surface (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.34 m²</td>
<td></td>
</tr>
</tbody>
</table>

II – General Description

1. Data of the site

The building CENTAR "LOS ROSALES" is located in:

JUZNI LOGOR bb
88000 MOSTAR
BOSNIA & HERCEGOVINA

2. Standards

This project will be implemented according to the regulation in force in Spain, considering it adequate and sufficient in terms of quality, safety and energetic efficiency. In any case, it should be highlighted that this project will make reference only to the modifications and extensions that will be performed to the current thermal installations and that the installer will be responsible for executing the installation in compliance with the local standards.

- Spanish Royal Decree 1027/2007, of 20 July, that approves the Building Regulation of Thermal Installations, and its subsequent modifications.


- UNE standards of application.

Other standards to consider:
- Spanish Royal Decree 865/2003, of 4 July, that establishes the hygienic-sanitary criteria for the prevention and control of legionnaire’s disease.
- Spanish Decree 152/2002, of 28 May, that establishes the hygienic-sanitary conditions for the prevention and the control of legionnaire’s disease.
- Spanish Royal Decree 1627/1997, of 24 October, that establishes the minimum safety and health dispositions in the construction work.
3. Architectonic description of the building
The resident care facility has two floors and a deck. On the first floor, is the kitchen where there is currently a sanitary hot water tank. On the deck of the building, there is also a room that houses the washing machine.

4. Occupation and hours
The school is occupied from Monday to Friday during the normal period of scholarship and closes during the two months of summer (July and August). Additionally the assisted residence is used everyday of the week and closes only during the month of July.

5. Detailed description
The sanitary hot water will be produced through three energetic sources; the principal generation source will be solar energy, and auxiliary sources include the existing generation methods: the diesel boiler, and electrical resistance. The auxiliary sources will be connected in series with the solar installation, and will guarantee that the temperature of the SHW at the collection deposit exit will be the pre-defined, including during periods of little solar radiation. In regards to the order of priorities, when the diesel boiler is operating, the electrical resistance will not, just as in the past.

5.1. Heat production plants
Do not proceed, because it will not be modified.

5.2. Piping network
The heating circuit piping will be made of welding black steel, just as it is now. The distribution piping of the SHW will be made of galvanized steel, just as it is now. The primary circuit of solar energy piping will be copper.

The indoor piping that is installed and brings thermally treated water will also be duly insulated according to the regulation in force.

The outdoor piping will be thermally insulated and protected from the UV radiation with aluminium sheeting.

To compensate the dilatations of the piping, dilators will be installed in compliance with the UNE 100.156 standard. If plastic piping is to be used, the codes of good practices UNE 53.394, UNE 53.399 and UNE 53.495/2 will be taken into account.

- Thermal insulation.

The characteristics and materials used for the thermal insulation and as a barrier against the vapour and its placement will comply with that specified in the instruction UNE 100.171.

5.3. Design of the expansion system
It will have an expansion system for the primary circuit of the solar installation, and another for the SHW circuit, in accordance with the increase of SHW volume caused by the installation of a new SHW deposit.

The calculation annexes describe the method of calculation used and the volumes obtained.
5.4. Detailed description of the adopted control sub-systems

The installation of thermal solar energy will have its own control system. The functions are defined in the plan of the hydraulic layout of the attached installation.

Principal functions of the control system to highlight:

- Heating of the two SHW deposits with solar energy
- Treatment against legionnaire’s disease: every day, if the system has not reached the predetermined temperature, the recirculation will start up so that all the water in the collectors reaches the predetermined temperature.
- Protection of the solar panels: the start-up of the unit heater will avoid the solar panels reaching more than 105ºC.
- Control of the resistance: the resistance is controlled in such a way that it gives preference to the generation of solar energy, whenever possible.
- Control of the SHW temperature through a three-way valve in the boiler circuit.
- Measurement solar energy consumed: with a flow meter and two temperature probes, the solar control will measure the solar contribution in the heating of SHW.

6. Treatment against legionella disease

A complete fulfilment of the standard related to legionnaire’s disease is not anticipated. Frequent 70ºC thermal treatments are forecasted, but not a continuous 60ºC SHW output of the tank.

7. Location of the solar installation

7.1. Minimum requirements

As shown in the attached plans, installation of the solar panels is planned for the deck. The panels and pumping equipment will be located on the deck terrace. According to the executive building project, the maximum overload of the area where the panels will be installed is 100kp/m², and the terrace is 500kp/m². This data is waiting to be corroborated with the response of the authors of the executive project (Architects without Frontiers). These limitations will impede installation of minimum weight under the structures of the solar panels regulated by Spanish rules.

7.2. Collection room

In order to take advantage of the collection room, it is forecasted to be covered with a sandwich-like cover with a window.

8. Commissioning tests

According to the instruction nº IT-2 of the new Building Regulation of Thermal Installations, pressure and mechanical tests will be performed before commissioning the installation.

III – Calculation
1. **Calculation of the SHW demand**

According to the Technical Building Code, an estimation of the demand has been carried out and is summed up in the following table:

<table>
<thead>
<tr>
<th>Demand Criteria</th>
<th>SHW Liters/day at 60°C</th>
<th>Number units full occupancy</th>
<th>liters/ day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing (old age, students, etc)</td>
<td>55 per bed</td>
<td>15</td>
<td>825</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>825</strong></td>
</tr>
</tbody>
</table>

2. **Determination of the number of solar thermal collectors**

The following table shows the sizing of the solar facility that contributes to the SHW heating:
### SHW Fraction Covered by Means of Solar Energy

<table>
<thead>
<tr>
<th>MONTH</th>
<th>JANUARY</th>
<th>FEBRUARY</th>
<th>MARCH</th>
<th>APRIL</th>
<th>MAY</th>
<th>JUNE</th>
<th>JULY</th>
<th>AUGUST</th>
<th>SEPTEMBER</th>
<th>OCTOBER</th>
<th>NOVEMBER</th>
<th>DECEMBER</th>
<th>Yearly total</th>
<th>Daily average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total SHW Demand</td>
<td>925</td>
<td>925</td>
<td>825</td>
<td>825</td>
<td>825</td>
<td>825</td>
<td>825</td>
<td>825</td>
<td>825</td>
<td>825</td>
<td>825</td>
<td>825</td>
<td>301,950</td>
<td>15.68</td>
</tr>
<tr>
<td>SHW/°C</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Average Ta cold water Mostar °C</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Total thermal energy demand for SHW kWh/°C</td>
<td>36.500</td>
<td>38.775</td>
<td>37.950</td>
<td>38.200</td>
<td>32.825</td>
<td>32.175</td>
<td>32.175</td>
<td>31.350</td>
<td>33.825</td>
<td>35.475</td>
<td>37.125</td>
<td>38.775</td>
<td>15.68</td>
<td>15.68</td>
</tr>
<tr>
<td>M/°C</td>
<td>965.77</td>
<td>162.31</td>
<td>158.98</td>
<td>151.95</td>
<td>141.59</td>
<td>134.68</td>
<td>134.68</td>
<td>131.23</td>
<td>141.59</td>
<td>148.56</td>
<td>155.41</td>
<td>162.31</td>
<td>15.68</td>
<td>15.68</td>
</tr>
<tr>
<td>kWh/°C</td>
<td>0.05</td>
<td>0.05</td>
<td>0.15</td>
<td>0.21</td>
<td>0.21</td>
<td>0.22</td>
<td>0.22</td>
<td>0.22</td>
<td>0.29</td>
<td>0.17</td>
<td>0.19</td>
<td>0.19</td>
<td>0.09</td>
<td>1.09</td>
</tr>
<tr>
<td>kWh/month</td>
<td>1,427</td>
<td>1,308</td>
<td>1,368</td>
<td>1,266</td>
<td>1,219</td>
<td>1,122</td>
<td>1,160</td>
<td>1,130</td>
<td>1,180</td>
<td>1,279</td>
<td>1,295</td>
<td>1,398</td>
<td>15.68</td>
<td>15.68</td>
</tr>
<tr>
<td>MJ/month</td>
<td>5,128.73</td>
<td>4,707.00</td>
<td>4,924.62</td>
<td>4,588.85</td>
<td>4,369.33</td>
<td>4,040.54</td>
<td>4,175.22</td>
<td>4,066.16</td>
<td>4,247.74</td>
<td>4,603.45</td>
<td>4,662.16</td>
<td>5,031.95</td>
<td>54.547</td>
<td>54.547</td>
</tr>
</tbody>
</table>

### Solar Energy Available

- **Solar radiation Mostar, 45° inclination, south kWh/MJ/month**: 12.24, 14.6, 17.83, 19.73, 20.76, 21.2, 22.02, 22.09, 21.78, 18.78, 14.22, 12.09, 18.32
- **Average Ta panels °C**: 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90
- **Average Ta environment, Mostar °C**: 9, 14, 19, 24, 29, 34, 39, 44, 49, 54, 59, 64, 69, 74
- **Hours of solar light h**: 7.5, 8, 9, 9.5, 9.5, 9.5, 8, 7
- **Average intensity kWh/°C**: 469.72, 486.75, 517.21, 549.33, 570.38, 593.00, 610.00, 631.88, 653.78, 675.48, 464.13, 450.68
- **Total panel performance %**: 65%, 65%, 65%, 65%, 65%, 65%, 65%, 65%, 65%, 65%, 65%, 65%, 65%, 65%
- **Global facility performance %**: 54%, 55%, 56%, 57%, 58%, 59%, 60%, 61%, 62%, 63%, 64%, 65%, 66%, 67%

### Available Energy

- **Available energy kWh/MJ/month**: 6.65, 7.9, 8.57, 10.08, 11.39, 12.12, 12.43, 13.52, 12.93, 9.59, 7.98, 8.09
- **Solar coverage system kWh/MJ/month**: 94.62, 109.40, 136.06, 143.38, 141.59, 134.68, 134.68, 131.23, 141.59, 136.32, 109.14, 86.50, 125.06

### Conclusion

The study on the possibilities of using and developing solar energy in BiH indicates significant potential, with a total yearly energy demand of 301,950 kWh, covering 54% of the annual energy needs. The most favorable conditions are expected in the months of July and August, with peak solar radiation and temperatures, providing optimal conditions for solar energy utilization.
For the calculations in the previous table, it was assumed that the solar panels are oriented towards the south, with an inclination of 45°. Considering panels with specific performances, we obtain the following panel surface necessary:

<table>
<thead>
<tr>
<th>PANEL DATA</th>
<th>Optical performance</th>
<th>SUP. PANELS (M2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro C20 HTF Wagner</td>
<td>0.82</td>
<td>14.22</td>
</tr>
<tr>
<td>k1 (W/(m2·K))</td>
<td>3.47</td>
<td></td>
</tr>
</tbody>
</table>

According to the building standard of Thermal Facilities and the Technical Building Code, the collection volume can be found between these two values:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. volume collection</td>
<td>711</td>
</tr>
<tr>
<td>Max. volume</td>
<td>2559.6</td>
</tr>
</tbody>
</table>

3. **Weight of the solar field structure**

The calculation of the weight required according to NBE-AE-88 necessary to avoid slippage and lifting of the solar field is shown in the following table:

<table>
<thead>
<tr>
<th>Calculation of the rack load according to the NBE-AE-88</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel longitude (m)</td>
</tr>
<tr>
<td>Panel width (m)</td>
</tr>
<tr>
<td>Weight of the full panel (kg)</td>
</tr>
<tr>
<td>Inclination of the panel</td>
</tr>
<tr>
<td>Number of panels per structure</td>
</tr>
<tr>
<td>Height placement panels in regards to the ground (m)</td>
</tr>
<tr>
<td>Maximum wind speed (m/s)</td>
</tr>
<tr>
<td><strong>Load to place to insure no lifting and slippage (kg)</strong></td>
</tr>
</tbody>
</table>

**kg/m²** 121,6775

*Note: to calculate the total action on the ground of the surface, it is necessary to consider the maximum snow load possible according to the area*
Taking into account the structural limitations of the surface (100kp/m²), the NBE-AE-88 could not be fulfilled. The sizing of the concrete blocks is shown in the following table:

<table>
<thead>
<tr>
<th>Sizing concrete blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density of concrete (kg/m³)</td>
</tr>
<tr>
<td>Block length (cm)</td>
</tr>
<tr>
<td>Block width (cm)</td>
</tr>
<tr>
<td>Block height (cm)</td>
</tr>
<tr>
<td>Block volume (m³)</td>
</tr>
<tr>
<td>Block weight (kg)</td>
</tr>
<tr>
<td>Number blocks</td>
</tr>
<tr>
<td>Total weight (kg)</td>
</tr>
<tr>
<td>Solar panel weight (kg)</td>
</tr>
<tr>
<td>Solar panel Structure weight (kg)</td>
</tr>
<tr>
<td>Total weight (kg)</td>
</tr>
<tr>
<td>Load (kg/m² area collector)</td>
</tr>
</tbody>
</table>

### 4. Expansion system

The expansion system of the networks has been calculated according to the UNE 100.155 instruction. Below is the table of results:

<table>
<thead>
<tr>
<th>SIZING ATS EXPANSION BASIN FOR THE NEW BUILD-UP DEPOSIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volume water installation</strong></td>
</tr>
<tr>
<td>Volume SHW recirculation</td>
</tr>
<tr>
<td>Volume inertia deposits</td>
</tr>
<tr>
<td>Additional volume</td>
</tr>
<tr>
<td>Total volume</td>
</tr>
<tr>
<td><strong>System operating temperature</strong></td>
</tr>
<tr>
<td>Ta discharge</td>
</tr>
<tr>
<td>Ta return</td>
</tr>
<tr>
<td>Average Ta (max. operation)</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Expansion coefficient</td>
</tr>
<tr>
<td>Increase installation volume of 4°C up to max operating Ta</td>
</tr>
<tr>
<td>Calculation work pressure</td>
</tr>
<tr>
<td>Ptarred safety valve (absolute)</td>
</tr>
<tr>
<td>Maximum Pabsolute installation work</td>
</tr>
<tr>
<td>Geometric height installation (in relation to expansion basin)</td>
</tr>
<tr>
<td>Minimum Pabsolute to avoid cavitation</td>
</tr>
<tr>
<td>Calculation pressure coefficient</td>
</tr>
<tr>
<td>Cp expansion basin closed with diaphragm</td>
</tr>
<tr>
<td>Volume expansion basin</td>
</tr>
<tr>
<td>Exchange power</td>
</tr>
<tr>
<td>Diameter minimum connection</td>
</tr>
</tbody>
</table>

**SIZING EXPANSION BASIN PRIMARY CIRCUIT**

<table>
<thead>
<tr>
<th>Volume water installation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Recirculation volume</td>
<td>18.8496</td>
</tr>
<tr>
<td>Collectors volume</td>
<td>7.8 l</td>
</tr>
<tr>
<td>Heat exchangers volume</td>
<td>10 l</td>
</tr>
<tr>
<td>Total volume</td>
<td>36.65 l</td>
</tr>
</tbody>
</table>

**Sizing expansion basin**

<p>| Volume hydraulic interceptor | 3 l |
| Pressure tarred safety valve | 5.5 bar |
| Max. Ta safety valve         | 120 °C |
| Height static installation   | 4 m |
| Minimum volume expansion basin | 36 l |
| Cold pressure primary circuit (to avoid formation of vapor) | 1.5 bar |
| Initial expansion basin pressure | 1.9 bar |</p>
<table>
<thead>
<tr>
<th>Exchange power</th>
<th>14.40 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter minimum connection</td>
<td>20.69 mm</td>
</tr>
</tbody>
</table>
### IV - Bill of material

<table>
<thead>
<tr>
<th>Num.</th>
<th>Ut</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.-</td>
<td>OVERALL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.1</td>
<td>L</td>
<td>Antifreeze propylene glycol based or similar, specially used for solar systems (protection against frozen and corrosion), unharful for man and environment. Antifreeze mixed up to 60% with water. Freeze protection guaranteed up to -19ºC. Installed</td>
<td>25.0</td>
</tr>
<tr>
<td>1.2.-</td>
<td>SOLAR FIELD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.1</td>
<td>U</td>
<td>Automatic bleeder for solar systems with brass elbow and hand valve, 3/4&quot; thread size. Installed</td>
<td>6.0</td>
</tr>
<tr>
<td>1.2.2</td>
<td>U</td>
<td>Roof ground aluminium made mount system for solar panel (2151x1215x110), adjustable tilt from 30ºC to 50ºC, installed on concrete blocks. Included mounting screws and accessories</td>
<td>6.0</td>
</tr>
<tr>
<td>1.2.3</td>
<td>U</td>
<td>Concrete block of 21kg weight, and size: 40x15x15cm, used to hold roof ground mount for solar panel. Installed.</td>
<td>24.0</td>
</tr>
<tr>
<td>1.2.4</td>
<td>U</td>
<td>Brass ball valve, 3/4&quot;. Max pressure 25bar, temperature range -10/+150ºC. Installed.</td>
<td>12.0</td>
</tr>
<tr>
<td>1.2.5</td>
<td>U</td>
<td>Flat-plate, horizontally mounted type collector, approx size 2151x1215x110mm, absorbing surface 2,4m2 according to DIN 4757, anodized aluminum case, mineral fibre insulation with 60mm thickness. Solar safety glass cover, 4mm thick (minimum transmissivity 91%). Minimum optical efficiency Ro=81,4%, max heat losses k1=3,47W/(m2·K). Maximum operational pressure 10bar, copper absorver. Connection 1/2&quot;. Installed.</td>
<td>6.0</td>
</tr>
<tr>
<td>1.2.6</td>
<td>U</td>
<td>Brass Flow regulator for solar systems, 0.6-2.4 l/min, 3/4&quot;, Installed.</td>
<td>6.0</td>
</tr>
<tr>
<td>1.2.7</td>
<td>U</td>
<td>Safety brass valve (2-6 bar), suitable for solar energy systems (antifreeze flux, max temp=160º) Size 3/4&quot;. Installed.</td>
<td>1.0</td>
</tr>
<tr>
<td>1.3.-</td>
<td>DISSIPATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.1</td>
<td>U</td>
<td>Heat sink fan-type 15kW cooling pipe, at the operating temperature of 85ºC, suitable for solar systems. 1-phase electric motor 220V. Installed.</td>
<td>1.0</td>
</tr>
<tr>
<td>1.3.2</td>
<td>U</td>
<td>3 way-motorized valve, 3/4&quot;, suitable for solar systems, including the 3 set points electromotor, 230V/50Hz. Installed.</td>
<td>2.0</td>
</tr>
<tr>
<td>1.3.3</td>
<td>U</td>
<td>Brass ball valve, 3/4&quot;. Max pressure 25bar, temperature range -10/+150ºC.</td>
<td>2.0</td>
</tr>
</tbody>
</table>
### EXPANSION TANK

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4.1 U</td>
<td>Expansion Tank, 50l capacity, suitable for solar systems, approx. dimensions 360x750mm (Diameter x height). Tmax=130ºC, Preload=2.5bar. Installed</td>
</tr>
<tr>
<td>1.4.2 U</td>
<td>Brass ball valve, 3/4&quot;. Max pressure 25bar, temperature range -10/+150ºC. Installed</td>
</tr>
</tbody>
</table>

### PUMPING AND SAFETY

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5.1 U</td>
<td>Solar circulation unit (antifreeze), working point at flow=500l/h, Pressure=0.3bar. The solar circulation unit has three different speeds available, two thermometers, one flow regulator, a non return valve, safety valve set at 6bar according to standard EN 12977, manometer. Connections with 3/4&quot; thread.</td>
</tr>
<tr>
<td>1.5.2 U</td>
<td>Brass ball valve, 3/4&quot;. Max pressure 25bar, temperature range -10/+150ºC. Installed</td>
</tr>
<tr>
<td>1.5.3 U</td>
<td>Strainer filter PN-16, 3/4&quot;, brass made. Max temp=120ºC. Installed</td>
</tr>
<tr>
<td>1.5.4 U</td>
<td>2-Way solenoid valve, 3/4&quot;, suitable for solar systems. Installed</td>
</tr>
</tbody>
</table>

### FILLING/ EMPTY

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6.1 U</td>
<td>Manual filling pump, suitable for solar systems. max. filling pressure=4 bar. Connection diameter of 15mm, including flexible hose of 225mm length. Installed</td>
</tr>
<tr>
<td>1.6.2 U</td>
<td>Tank with cover of mineral fibre (100l), for filling/emptying water-glycol. Installed</td>
</tr>
<tr>
<td>1.6.3 U</td>
<td>Assembly of Filling and empty ball valves, for a solar circuit, 1&quot;.Installed</td>
</tr>
<tr>
<td>1.6.4 U</td>
<td>2-Way solenoid valve, 3/4&quot;, suitable for solar systems. Installed</td>
</tr>
</tbody>
</table>

### AIR SEPARATOR

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7.1 U</td>
<td>Air separator for solar systems, with air bleeder, hand valve and 3/4&quot; thread. Installed</td>
</tr>
<tr>
<td>1.7.2 U</td>
<td>Strainer filter PN-16, 3/4&quot;, brass made. Max temp=120ºC. Installed</td>
</tr>
</tbody>
</table>

### SOLAR CIRCUIT

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8.1 m</td>
<td>Pipe of rigid copper, 20/22 mm of diameter for primary circuit of the thermal solar systems, put superficially, with isolation through glass whole</td>
</tr>
</tbody>
</table>
protected with asphalt emulsion covered with aluminium.

1.8.2 U Straight copper, tube fittings and accessories, 20/22 mm (inlet and outlet diameter), superficially installed, without insulation, painted 7,0

1.8.3 u Prefabricated Concret block (40x20x20cm) used to hold piping on the deck, every two meters of length. Installed. 25,0

2.1.- GENERAL

2.1.1 U Water tank for Sanitary Hot Water (SHW), 500l of capacity, with internal heat exchanger for a solar circuit, Exchange power=14.5kW, at 550l/h solar circuit flow. Available connections according the hydraulic layouts. Insulation with polyurethane foam 100mm thick, or equivalent; magnesium anode, Maximum operational temperature=90ºC. Max. operational pressure=10bar. Manhole. Installed. 1,0

2.1.2 U Brass ball valve, 3/4". Max pressure 25bar, temperature range -10/+150ºC. Installed. 2,0

2.1.3 U Thermometer with copper T fitting, 3/8", 0-120ºC. Installed. 3,0

2.1.4 U Safety valve with manometer, 3/4". Installed 1,0

2.1.5 U Automatic brass water bleeder, suitable for SHW, with hand valve and T fitting, 3/4". Installed. 6,0

2.1.6 U Expansion Tank, 50l capacity, suitable for SHW, aprox. dimensions 360x620mm (Diameter x height). Installed 1,0

2.1.7 U Brass ball valve, 1 1/4". Installed 5,0

2.1.8 U Non-return brass valve, 1 1/4". Installed. 2,0

2.2.- CURRENT SHW TANK

2.2.1 U Transportation and assembly of the current water tank, from the kitchen on the ground floor to the deck. 1,0

2.2.2 U Automatic brass water bleeder, suitable for SHW, with hand valve and T fitting, 3/4". Installed. 1,0

2.2.3 U Safety valve with manometer, 3/4". Installed 1,0

2.2.4 U 3 way-motorized valve, 1", suitable for SHW. Installed 1,0
2.2.5 U Pressure balance valve, with two pressure measuring points, 1". Installed 1,0

2.2.6 U Brass ball valve, 1 1/4". Installed 1,0

2.3.- RECIRCULATION BETWEEN SHW TANKS

2.3.1 U SHW pump, working point close to: Q=0.689 l/s, Pressure=0.11 bar. Installed 1,0

2.3.2 U Manometer, pressure measuring range 0-4bar. Installed 1,0

2.3.3 U Non-return brass valve, 1 1/4". Installed 1,0

2.3.4 U Brass ball valve, 1 1/4". Installed 2,0

2.3.5 U Strainer filter PN-16, 1 1/4", brass made. Installed 1,0

2.3.6 U Angle seat brass valve, 1 1/4", manual operation. Installed 1,0

2.4.- ENLARGEMENT OF BOILER HEAT EXCHANGER LOOP

2.4.1 m circuit pipe, welding black steel, 1" DN 25 diameter, for outdoor SHW transportation, mineral fiber insulation, and aluminum sheet. Installed. 21,0

2.4.2 m circuit pipe, welding black steel, 1" DN 25 diameter, for underground SHW transportation, Elastomeric insulation foam cover. Installed 23,4

3.1.- OVERALL

3.1.1 U Control switchboard for solar systems, with four PT500 temperature sensors and its sheaths. Installed and programmed. 1,0

3.1.2 U Safety thermostat with stainless steel sheath. Installed 1,0

3.1.3 U Overall electrical installation 1,0

3.1.4 U Pressure switch for solar systems. Installed 1,0

3.2.- LEGIONELLA PREVENTION

3.2.1 U 3-Way hand brass valve, 1 1/4". Installed 1,0

3.2.2 U Digital Thermometer, with a register for maximum and minimum temperatures, 0-100°C, with surface probe and stainless steel 1,0
3.3.- ENERGY METER

3.3.1 U Energy meter with flow meter and two temperature probes, working flow 3.5m³/h, 1" conection threads. Tmax=95°C. Installed. 1,0

4.1.- TEMPERATURE CONTROL

4.1.1 U Temperature control valve, 1 1/4". Installed 1,0
4.1.2 U Non-return brass valve, 1 1/4". Installed. 2,0
4.1.3 U Thermometer with copper T fitting, 3/8", 0-120ºC. Installed. 1,0

4.2.- SHW RECIRCULATION

4.2.1 U SHW pump, working point close to: Q=1100 l/h, Pressure=0.25 bar. Installed. 1,0
4.2.2 U Manometer, pressure measuring range 0-4bar. Installed. 2,0
4.2.3 U Brass ball valve, 1 1/4". Installed 3,0
4.2.4 U Non-return brass valve, 1 1/4". Installed. 2,0
4.2.5 U Thermometer with copper T fitting, 3/8", 0-120ºC. Installed. 1,0
4.2.6 U Safety thermostat with brass sheath. Installed. 1,0
4.2.7 U Daily scheduler. Installed 1,0
4.2.8 U Angle seat brass valve, 1 1/4", manual operation. Installed 1,0

4.3.- SHW RECIRCULATION PIPING

4.3.1 m Circuit pipe, galvanized steel, 1 1/4" DN 32 diameter, for outdoor SHW transportation, insultated and installed. Mineral fiber insulation covered by asphaltic emulsion and aluminum sheet. Installed. 10,5
4.3.2 m Circuit pipe, galvanized steel, 1 1/4" DN 32 diameter, for underground SHW transportation, insultated and installed. 24,0
4.3.3 U Circuit pipe, galvanized steel, 1 1/4" DN 32 diameter, for indoors SHW transportation, insultated and installed. 12,0
### 5.1. OVERALL

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1.1</td>
<td>Non-return brass valve, 1 1/4&quot;. Installed.</td>
<td></td>
<td>U</td>
<td>1.0</td>
</tr>
<tr>
<td>5.1.2</td>
<td>Brass ball valve, 1 1/4&quot;. Installed</td>
<td></td>
<td>U</td>
<td>2.0</td>
</tr>
<tr>
<td>5.1.3</td>
<td>Strainer filter PN-16, 1 1/4&quot;, brass made. Installed.</td>
<td></td>
<td>U</td>
<td>1.0</td>
</tr>
<tr>
<td>5.1.4</td>
<td>Circuit pipe, galvanized steel, 1 1/4&quot; DN 32 diameter, for sanitary water transportation, installed.</td>
<td></td>
<td>m</td>
<td>22.0</td>
</tr>
</tbody>
</table>

### 6.1. BUILDING WORKS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1.1</td>
<td>Drainage Channel Excavation Machinery works</td>
<td></td>
<td>m³</td>
<td>8.5</td>
</tr>
<tr>
<td>6.1.2</td>
<td>Excavation of the level of the pavement (inside and outsider)</td>
<td></td>
<td>U</td>
<td>1.0</td>
</tr>
<tr>
<td>6.1.3</td>
<td>Tiling</td>
<td></td>
<td>M2</td>
<td>6.0</td>
</tr>
<tr>
<td>6.1.4</td>
<td>Filling trench for installation with Earth, sand and concrete</td>
<td></td>
<td>M3</td>
<td>8.5</td>
</tr>
<tr>
<td>6.1.5</td>
<td>Collection box, Polystyrene, or equivalent 80x80x80 (internal measures), with frame and ductile cast iron lid. Installed.</td>
<td></td>
<td>U</td>
<td>2.0</td>
</tr>
<tr>
<td>6.1.6</td>
<td>Piping cover, galvanized steel sheet, according to the drawings. Installed.</td>
<td></td>
<td>U</td>
<td>1.0</td>
</tr>
</tbody>
</table>

### 6.2. BUILDING WORKS IN SHW STORE ROOM

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2.1</td>
<td>Sloping deck Window, polyurethane cover, 134x98cm or similar, with fence sealing. Installed</td>
<td></td>
<td>U</td>
<td>1.0</td>
</tr>
<tr>
<td>6.2.2</td>
<td>Sandwich type cover dimensions 450x300cm with thermal insulation. Installed according to drawings.</td>
<td></td>
<td>U</td>
<td>1.0</td>
</tr>
<tr>
<td>6.2.3</td>
<td>Other Building works in SHW store room: Level the ground with a thin layer of concrete, (areas with equipment to be installed), and inclination of the side walls to allow the installation of the deck</td>
<td></td>
<td>U</td>
<td>1.0</td>
</tr>
<tr>
<td>6.2.4</td>
<td>Iron structure, sizes 130x130cm to evenly convey to the ground a load of 700kg, from a flat-bottomed accumulator (75cm diameter). Installed.</td>
<td></td>
<td>U</td>
<td>1.0</td>
</tr>
</tbody>
</table>
V – Drawings
Trama TecnoAmbiental

Deliverable 8-C: Technical Project description – Solar Thermal installation in Trebinje

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

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Project Director
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Barcelona, July the 29th, 2008
I – Purpose
1

II – General Description
1. Data of the site
2. Standards
3. Architectonic description of the building
4. Occupation and hours
5. Method used for calculation of the sanitary hot water (SHW)
6. Detailed description

   6.1. Heat production plants
   6.2. Tanks
   6.3. Piping network
   6.4. Design of the expansion system
   6.5. Detailed description of the adopted control sub-systems

7. Treatment against legionalla disease
8. Location of the solar installation
9. Commissioning tests

III – Calculation
1. Calculation of the SHW demand
2. Determination of the number of solar thermal collectors
3. Weight of the solar field structure
4. Expansion system

IV - Bill of material

V – Drawings
I – Purpose

The objective of this project is to define the characteristics of the installation of thermal solar energy to heat the sanitary hot water of the Geriatric Facility for in Trebinje, Bosnia Herzegovina, for its implementation.

As an additional objective, it is intended to analyze the existing system that controls the sanitary hot water (SHW) heating installation, and implement some improvements, if necessary. In order to reduce heat losses, it will also be evaluated the possibility to improve piping insulation.

The execution of the installation will be carried out by qualified personnel according to the country’s regulations. The installer will be responsible for the correct operation of the installation and the fulfillment of the applicable regulations, standards and instructions.

The installation will have a collection field with the following surface:

<table>
<thead>
<tr>
<th>Field of thermal solar energy panels</th>
<th>Opening surface (m2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>91 m2</td>
</tr>
</tbody>
</table>

II – General Description

1. Data of the site
The building is located in:
   DOM PENZIONERA
   GRADINA bb
   89101 TREBINJE
   BOSNIA I HERCEGOVINA

2. Standards
This project will be implemented according to the regulation in force in Spain, considering it adequate and sufficient in terms of quality, safety and energetic efficiency. In any case, it should be highlighted that this project will make reference only to the modifications and extensions that will be performed to the current thermal installations and that the installer will be responsible for executing the installation in compliance with the local standards.

- Spanish Royal Decree 1027/2007, of 20 July, that approves the Building Regulation of Thermal Installations, and its subsequent modifications.


- UNE standards of application.

Other standards to consider:
- Spanish Royal Decree 865/2003, of 4 July, that establishes the hygienic-sanitary criteria for the prevention and control of legionnaire’s disease.
- Spanish Decree 152/2002, of 28 May, that establishes the hygienic-sanitary conditions for the prevention and the control of legionnaire’s disease.
- Spanish Royal Decree 1627/1997, of 24 October, that establishes the minimum safety and health dispositions in the construction work.

3. **Architectonic description of the building**

The Geriatric facility has one floor and a deck. On the ground floor there is the engine room, with the boilers and the SHW tanks.

4. **Occupation and hours**

The building can attend up to 150 of elderly people, with rooms, kitchen, common rooms, hall, saloon, sanitary services, etc. It currently attends 104 persons.

5. **Method used for calculation of the sanitary hot water (SHW)**

It is not an objective of this project to calculate the volume of neither SHW build-up necessary nor the estimated consumption amount, given that we assume the current installation is correctly sized.

6. **Detailed description**

The sanitary hot water will be produced through three energetic sources; the principal generation source will be solar energy, and auxiliary sources include the existing generation methods: the diesel boiler, and electrical resistance. The auxiliary sources will be connected in series with the solar installation, and will guarantee that the temperature of the SHW at the collection deposit exit will be the pre-defined, including during periods of little solar radiation. In regards to the order of priorities, when the diesel boiler is operating, the electrical resistance will not, just as in the past.

6.1. **Heat production plants**

Do not proceed, because it will not be modified.

6.2. **Tanks**

Prior to use the heat exchanger of the 3000l tank to heat the SHW with solar energy, it is necessary to verify that it is in proper conditions, by means of an inspection. It is also necessary to know of which metal is made of analyzing its compatibility with copper. If the tank fails the inspection, it will be necessary to install a new on, which is already covered in the measurements. The tank may be inspected once the potable water supply pipe has been connected to the 5000l tank

6.3. **Piping network**

**SHW piping**

After the inspection performed during the third week of July in the Center, it was verified that the SHW piping was properly insulated and it was installed underground, therefore avoiding any options to improve its insulation.

**Solar energy piping**

The distribution piping of the SHW will be made of galvanized steel, just as it is now. The primary circuit of solar energy piping will be copper.
The indoor piping that is installed and brings thermally treated water will also be duly insulated according to the regulation in force.

The outdoor piping will be thermally insulated and protected from the UV radiation with aluminum sheeting.

To compensate the dilatations of the piping, dilators will be installed in compliance with the UNE 100.156 standard. If plastic piping is to be used, the codes of good practices UNE 53.394, UNE 53.399 and UNE 53.495/2 will be taken into account.

- Thermal insulation.

The characteristics and materials used for the thermal insulation and as a barrier against the vapor and its placement will comply with that specified in the instruction UNE 100.171.

6.4. Design of the expansion system

It will have an expansion system for the primary circuit of the solar installation, and another for the SHW circuit, in accordance with the increase of SHW volume caused by the installation of a new SHW deposit.

The calculation annexes describe the method of calculation used and the volumes obtained.

6.5. Detailed description of the adopted control sub-systems

**Control of boiler and electric resistances**

Currently, the control system to produce SHW by means of the boiler and the electrical resistance is out of service. Therefore, when the boiler is producing SHW, the SHW set temperature is also the set temperature of the heat system. In order to control separately the set temperature for the SHW, the new solar control system will also control the pump of the heat exchanger.

**Control of the solar thermal installation**

The installation of thermal solar energy will have its own control system. The functions are defined in the plan of the hydraulic layout of the attached installation.

Principal functions of the control system to highlight:

- Heating of the two SHW deposits with solar energy
- Treatment against legionnaire’s disease: every day, if the system has not reached the predetermined temperature, the recirculation will start up so that all the water in the collectors reaches the predetermined temperature.
- Protection of the solar panels: the start-up of the unit heater will avoid the solar panels reaching more than 105°C.
- Control of the resistance: the resistance is controlled in such a way that it gives preference to the generation of solar energy, whenever possible.
- Control of the SHW temperature through the control of the pump of the boiler heat exchanger.
- Measurement solar energy consumed: with a flow meter and two temperature probes, the solar control will measure the solar contribution in the heating of SHW.

7. Treatment against legionella disease

A complete fulfilment of the standard related to legionnaire’s disease is not anticipated. Frequent 70°C thermal treatments are forecasted, but not a continuous 60°C SHW output of the tank.
8. Location of the solar installation

As shown in the attached plans, installation of the solar panels is planned for the deck. According to the existing drawings and project, the maximum overload of the area where the panels will be installed is 330kp/m².

9. Commissioning tests

According to the instruction nº IT-2 of the new Building Regulation of Thermal Installations, pressure and mechanical tests will be performed before commissioning the installation.

III – Calculation

1. Calculation of the SHW demand

According to the Technical Building Code, an estimation of the demand has been carried out and is summed up in the following table:

<table>
<thead>
<tr>
<th>Demand Criteria</th>
<th>SHW Liters/day at 60°C</th>
<th>Number units full occupancy</th>
<th>liters/ day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing (old age, students, etc)</td>
<td>55 per bed</td>
<td>150</td>
<td>8250</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>8250</strong></td>
</tr>
</tbody>
</table>

2. Determination of the number of solar thermal collectors

The following table shows the sizing of the solar facility that contributes to the SHW heating:
### SHW Fraction Covered by Means of Solar Energy

<table>
<thead>
<tr>
<th>MONTH</th>
<th>JANUARY</th>
<th>FEBRUARY</th>
<th>MARCH</th>
<th>APRIL</th>
<th>MAY</th>
<th>JUNE</th>
<th>JULY</th>
<th>AUGUST</th>
<th>SEPTEMBER</th>
<th>OCTOBER</th>
<th>NOVEMBER</th>
<th>DECEMBER</th>
<th>Yearly total</th>
<th>Daily average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>dias/mes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>28</td>
<td>31</td>
<td>38</td>
<td>31</td>
<td>30</td>
<td>31</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td><strong>SHW Demand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.00%</td>
<td></td>
</tr>
<tr>
<td><strong>Occupancy</strong></td>
<td>%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td><strong>persons/day</strong></td>
<td></td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td><strong>SHW/Tg</strong></td>
<td>°C</td>
<td>59</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td><strong>Average Tc cold water Trebinje</strong></td>
<td>°C</td>
<td>15</td>
<td>13</td>
<td>13</td>
<td>14</td>
<td>18</td>
<td>19</td>
<td>18</td>
<td>21</td>
<td>21</td>
<td>22</td>
<td>15</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total thermal energy demand for SHW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>kw/day</td>
<td>457.46</td>
<td>450.87</td>
<td>414.27</td>
<td>422.09</td>
<td>393.31</td>
<td>374.12</td>
<td>364.83</td>
<td>393.31</td>
<td>412.50</td>
<td>431.68</td>
<td>450.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>kWh/month</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mj/month</strong></td>
<td></td>
<td>51387.34</td>
<td>47070.52</td>
<td>49246.20</td>
<td>45585.84</td>
<td>43893.35</td>
<td>40405.37</td>
<td>41752.21</td>
<td>40861.64</td>
<td>42477.44</td>
<td>46834.49</td>
<td>46821.58</td>
<td>50316.77</td>
<td>545472</td>
</tr>
</tbody>
</table>

### SOLAR ENERGY AVAILABLE

<table>
<thead>
<tr>
<th><strong>RENDIMIENTO</strong></th>
<th><strong>INSTALACION</strong></th>
<th>45º inclination, south</th>
<th>45º inclination, south</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mj/day</strong></td>
<td>13.20</td>
<td>14.00</td>
<td>17.83</td>
</tr>
<tr>
<td><strong>MJ/month</strong></td>
<td>51387.34</td>
<td>47070.52</td>
<td>49246.20</td>
</tr>
</tbody>
</table>

### AVAILABLE ENERGY

<table>
<thead>
<tr>
<th><strong>AVAILABLE ENERGY</strong></th>
<th><strong>Energy available</strong></th>
<th><strong>Mj/day</strong></th>
<th><strong>Mj/month</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mj/day</strong></td>
<td>8.29</td>
<td>9.10</td>
<td>10.74</td>
</tr>
<tr>
<td><strong>Solar coverage system</strong></td>
<td></td>
<td>572.02</td>
<td>656.01</td>
</tr>
<tr>
<td><strong>% coverage</strong></td>
<td>35%</td>
<td>41%</td>
<td>52%</td>
</tr>
</tbody>
</table>

Study on the possibilities use and development of solar energy in BiH - D8

6
For the calculations in the previous table, it was assumed that the solar panels are oriented towards the south, with an inclination of 45°. Considering panels with specific performances, we obtain the following panel surface necessary:

| PANEL DATA | Optical performance | 0,782 | 91 |
|           |                     | SUP. PANELS (M²) |   |
| LBM 100 HF | k1 (W/(m²·K))      | 3,191 | 1  |
|           | number of concurrent rows | 1     |   |
|           | number of concurrent panels by row | 10    |   |

According to the building standard of Thermal Facilities and the Technical Building Code, the collection volume can be found between these two values:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. volume collection</td>
<td>4550</td>
</tr>
<tr>
<td>Max. volume collection</td>
<td>16380</td>
</tr>
</tbody>
</table>

3. **Weight of the solar field structure**

The calculation of the weight required according to NBE-AE-88 necessary to avoid slippage and lifting of the solar field is shown in the following table:

<table>
<thead>
<tr>
<th>Calculation of the rack load according to the NBE-AE-88</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel longitude (m)</td>
<td>5,94</td>
</tr>
<tr>
<td>Panel width (m)</td>
<td>1,7</td>
</tr>
<tr>
<td>Weight of the full panel (kg)</td>
<td>180</td>
</tr>
<tr>
<td>Inclination of the panel</td>
<td>45º</td>
</tr>
<tr>
<td>Number of panels per structure</td>
<td>1</td>
</tr>
<tr>
<td>Height placement panels in regards to the ground (m)</td>
<td>5</td>
</tr>
<tr>
<td>Maximum wind speed (m/s)</td>
<td>40</td>
</tr>
<tr>
<td>Load to place to insure no lifting and slippage (kg)</td>
<td>1989</td>
</tr>
<tr>
<td>kg/m²</td>
<td>196,9697</td>
</tr>
</tbody>
</table>

*Note: to calculate the total action on the ground of the surface, it is necessary to consider the maximum snow load possible according to the area*
The sizing of the concrete blocks is shown in the following table:

<table>
<thead>
<tr>
<th>Sizing concrete blocks</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Density of concrete (kg/m³)</td>
<td>2350</td>
</tr>
<tr>
<td>Block length (cm)</td>
<td>190</td>
</tr>
<tr>
<td>Block width (cm)</td>
<td>40</td>
</tr>
<tr>
<td>Block height (cm)</td>
<td>20</td>
</tr>
<tr>
<td>Block volume (m³)</td>
<td>0,152</td>
</tr>
<tr>
<td>Block weight (kg)</td>
<td>357,2</td>
</tr>
<tr>
<td>Number blocks</td>
<td>5</td>
</tr>
<tr>
<td>Total weight (kg)</td>
<td>1786</td>
</tr>
<tr>
<td>Solar panel weight (kg)</td>
<td>180</td>
</tr>
<tr>
<td>Solar panel Structure weight (kg)</td>
<td>168</td>
</tr>
<tr>
<td>Total weight (kg)</td>
<td>2134</td>
</tr>
<tr>
<td>Load (kg/m² area collector)</td>
<td>211,329</td>
</tr>
</tbody>
</table>

4. Expansion system

The expansion system of the networks has been calculated according to the UNE 100.155 instruction. Below is the table of results:

<table>
<thead>
<tr>
<th>SIZING ATS EXPANSION BASIN FOR THE NEW BUILD-UP DEPOSIT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume water installation</td>
<td></td>
</tr>
<tr>
<td>Volume SHW recirculation</td>
<td>0</td>
</tr>
<tr>
<td>Volume inertia deposits</td>
<td>80001</td>
</tr>
<tr>
<td>Additional volume</td>
<td>20,4282541</td>
</tr>
<tr>
<td>Total volume</td>
<td>8020,431</td>
</tr>
<tr>
<td>System operating temperature</td>
<td></td>
</tr>
<tr>
<td>Ta discharge</td>
<td>70°C</td>
</tr>
<tr>
<td>Ta return</td>
<td>65°C</td>
</tr>
<tr>
<td>Average Ta (max. operation)</td>
<td>67,5°C</td>
</tr>
<tr>
<td>Expansion coefficient</td>
<td>0.0189592</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Increase installation volume of 4°C up to max operating Ta</td>
<td>152.060903l</td>
</tr>
<tr>
<td>Calculation work pressure</td>
<td></td>
</tr>
<tr>
<td>Ptarred safety valve (absolute)</td>
<td>3bar</td>
</tr>
<tr>
<td>Maximum Pabsolute installation work</td>
<td>2.65bar</td>
</tr>
<tr>
<td>Geometric height installation (in relation to expansion basin)</td>
<td>6m</td>
</tr>
<tr>
<td>Minimum Pabsolute to avoid cavitation</td>
<td>1.8bar</td>
</tr>
<tr>
<td>Calculation pressure coefficient</td>
<td></td>
</tr>
<tr>
<td>Cp expansion basin closed with diaphragm</td>
<td>3.11764706</td>
</tr>
<tr>
<td>Volume expansion basin</td>
<td>474.07l</td>
</tr>
<tr>
<td>Exchange power</td>
<td>72.00kW</td>
</tr>
<tr>
<td>Diameter minimum connection</td>
<td>27.73mm</td>
</tr>
</tbody>
</table>

**SIZING EXPANSION BASIN PRIMARY CIRCUIT**

<table>
<thead>
<tr>
<th>Volume water installation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Recirculation volume</td>
<td>64.7735088</td>
</tr>
<tr>
<td>Collectors volume</td>
<td>75l</td>
</tr>
<tr>
<td>Heat exchangers volume</td>
<td>105l</td>
</tr>
<tr>
<td>Total volume</td>
<td>244.77l</td>
</tr>
<tr>
<td>Sizing expansion basin</td>
<td></td>
</tr>
<tr>
<td>Volume hydraulic interceptor</td>
<td>3l</td>
</tr>
<tr>
<td>Pressure tarred safety valve</td>
<td>5.5bar</td>
</tr>
<tr>
<td>Max. Ta safety valve</td>
<td>120°C</td>
</tr>
<tr>
<td>Height static installation</td>
<td>5.5m</td>
</tr>
<tr>
<td>Minimum volume expansion basin</td>
<td>272l</td>
</tr>
<tr>
<td>Cold pressure primary circuit (to avoid formation of vapour)</td>
<td>1.5bar</td>
</tr>
<tr>
<td>Initial expansion basin pressure</td>
<td>2.05bar</td>
</tr>
<tr>
<td>Exchange power</td>
<td>72.00kW</td>
</tr>
<tr>
<td>Diameter minimum connection</td>
<td>27.73mm</td>
</tr>
</tbody>
</table>
## IV - Bill of material

<table>
<thead>
<tr>
<th>Num.</th>
<th>Ut</th>
<th>Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.</td>
<td>L</td>
<td>Antifreeze propylyenglycol based or similar, specially used for solar systems (protection against frozen and corrosion), unharfillf for man and environment. Antifreeze mixed up to 60% with water. Freeze protection guaranteed un to -19°C. Installed</td>
<td>275,</td>
</tr>
<tr>
<td>1.2.1</td>
<td>U</td>
<td>Automatic bleeder for solar systems with brass elbow and hand valve, 3/4&quot; thread size. Installed</td>
<td>10,0</td>
</tr>
<tr>
<td>1.2.2</td>
<td>U</td>
<td>Roof ground aluminium made mount system for solar panel (5940x1700x120), adjustable tilt from 30°C to 50°C, installed on concrete blocks. Included mounting screws and accessories.</td>
<td>10,0</td>
</tr>
<tr>
<td>1.2.3</td>
<td>U</td>
<td>Concrete block of 357kg weight, and dimensions: 190x40x20cm, used to hold roof ground mount for solar panel. Installed.</td>
<td>50,0</td>
</tr>
<tr>
<td>1.2.4</td>
<td>U</td>
<td>Flat-plate, horizontally mounted type collector, aprox size 5940x1700x120mm, absorbing surface 9,1m2 according to DIN 4757, anodized aluminium case, mineral fibre insulation with 60mm thickness. Solar safety glass cover, 4mm thick (minimum transmissivity 91%). Minimum optical efficiency Ro=78,2%, max heat losses k1=3,19W/(m2 K). Maximum operational pressure 10bar, copper absorber. Connection 1/2&quot;. Installed.</td>
<td>10,0</td>
</tr>
<tr>
<td>1.2.5</td>
<td>U</td>
<td>Brass Flow regulator for solar systems, 0.6-2.4 l/min, 3/4&quot;, Installed.</td>
<td>10,0</td>
</tr>
<tr>
<td>1.2.6</td>
<td>U</td>
<td>Safety brass valve (2-6 bar), suitable for solar energy systems (antifreeze flux, max temp=160°) Size 3/4&quot;. Installed.</td>
<td>1,0</td>
</tr>
<tr>
<td>1.3.1</td>
<td>U</td>
<td>Heat sink fan-type 72kW cooling pipe, at the operating temperature of 85°C, suitable for solar systems. 1-phase electric motor 220V. Installed.</td>
<td>1,0</td>
</tr>
<tr>
<td>1.3.2</td>
<td>U</td>
<td>3 way-motorized valve, 1&quot;, suitable for solar systems, installed.</td>
<td>2,0</td>
</tr>
<tr>
<td>1.3.3</td>
<td>U</td>
<td>Brass ball valve, 1&quot;. Max pressure 25bar, temperature range -10/+150°C. Installed.</td>
<td>2,0</td>
</tr>
<tr>
<td>1.3.4</td>
<td>U</td>
<td>Dampening sleeve, 1&quot;, brass made, suitable for solar systems. Installed.</td>
<td>2,0</td>
</tr>
<tr>
<td>1.4.</td>
<td></td>
<td>EXPANSION TANK</td>
<td></td>
</tr>
</tbody>
</table>
### 1.4.1 U Brass ball valve, 1". Max pressure 25bar, temperature range \(-10/\pm150^\circ\text{C}\). Installed. 1,0

### 1.4.2 U Expansion Tank, 300l capacity, suitable for solar systems, approx. dimensions 485x1965mm (Diameter x height). Tmax=130^\circ\text{C}, Preload=2.5bar. Installed 1,0

### 1.5.- PUMPING AND SAFETY

#### 1.5.1 U Double Solar circulation unit (antifreeze, two pumps), working point at flow=1365 l/h, Pressure= 0.63bar. The solar circulation unit has three different speeds available, two thermometers, one flow regulator, a non return valve, safety valve set at 6bar according to standard EN 12977, manometer. Connections with 3/4" thread. 1,0

#### 1.5.2 U Brass ball valve, 1". Max pressure 25bar, temperature range \(-10/\pm150^\circ\text{C}\). Installed. 2,0

#### 1.5.3 U Strainer filter PN-16, 1", brass made. Max temp=120^\circ\text{C}. Installed. 1,0

#### 1.5.4 U 2-Way solenoid valve, 1", suitable for solar systems. Installed. 1,0

### 1.6.- FILLING/EMPTY

#### 1.6.1 U Non-return brass valve, 1 ". Installed. 1,0

#### 1.6.2 U Filling pump, suitable for solar systems. Fluid operational range: 0\degree\text{C} - 40\degree\text{C}. P_{\text{min}}=1,2bar. Flow 1000 l/h. Installed 1,0

#### 1.6.3 U Tank of 100l capacity, suitable for antifreeze. Installed. 1,0

#### 1.6.4 U Assembly of Filling and empty ball valves, for a solar circuit, 1". Installed. 1,0

### 1.7.- AIR SEPARATOR

#### 1.7.1 U Air separator for solar systems, with air bleeder, hand valve and 1" thread. Installed. 1,0

#### 1.7.2 U Strainer filter PN-16, 1", brass made. Max temp=120\degree\text{C}. Installed. 1,0

#### 1.7.3 U Brass ball valve, 1". Max pressure 25bar, temperature range \(-10/\pm150^\circ\text{C}\). Installed. 2,0

### 1.8.- SOLAR CIRCUIT

#### 1.8.1 m Pipe of rigid copper, 26/28 mm of diameter for primary circuit of the thermal solar systems, put superficially, with isolation through glass whole protected with asphalt emulsion covered with aluminium. 155,0

#### 1.8.2 U Straight copper, tube fittings and accessories, 26/28 mm (inlet and outlet 47,0
diameter), superficially installed, without insulation, painted

1.8.3  u  Prefabricated Concret block (40x20x20cm) used to hold piping on the deck, every two meters of length. Installed. 45,0

2.1.- GENERAL

2.1.1  U  Thermometer with copper T fitting, 3/8", 0-120°C. Installed. 3,0

2.1.2  U  Automatic brass water bleeder, suitable for SHW, with hand valve and T fitting, 3/4". Installed. 1,0

2.1.3  U  Expansion Tank, 500l capacity, suitable for SHW, aprox. dimensions 600x2065mm (Diameter x height). Installed 1,0

2.1.4  U  Brass ball valve, 1". Max pressure 25bar, temperature range -10/+150°C. Installed. 2,0

2.1.5  U  Brass ball valve, DN-2 1 1/2". Installed 3,0

2.1.6  U  Non-return brass valve, 2 1/2". Installed. 1,0

2.1.7  U  Safety brass valve, set to 3 bar, 3/4". Installed. 1,0

2.1.8  U  Manometer, pressure measuring range 0-4bar. Installed 1,0

2.2.- RECIRCULATION BETWEEN SHW TANKS

2.2.1  m  Circuit pipe, galvanized steel, 2 1/2" diameter, for indoor SHW transportation, insulated and installed.

Mineral fibre insulation covered by asphaltic emulsion and aluminium sheet. Installed. 9,0

2.3.- CURRENT SHW TANK

2.3.1  U  Brass ball valve, 1". Max pressure 25bar, temperature range -10/+150°C. Installed. 1,0

2.3.2  U  Inspection of the existing heat exchanger of the 3000l tank, according to Project Memory description (chapter 8.3). 1,0

2.3.3  U  Water tank for Sanitary Hot Water (SHW), 300l of capacity, with internal heat exchanger for a solar circuit, 5m2 of exchange surface. Available connections according the hydraulic layouts. Insulation with polyurethane foam 80mm thick, or equivalent; magnesium anode, Maximum operational temperature=90°C. Max. operational pressure=10bar. Manhole. Installed. 1,0
3.1.- OVERAL

3.1.1 U Control switchboard for solar systems, with four PT500 temperature sensors and its sheaths. Installed and programmed.

3.1.2 U Safety thermostat with stainless steel sheath. Installed.

3.1.3 U Overall electrical installation

3.1.4 U Pressure switch for solar systems. Installed.

3.2.- LEGIONELLA PREVENTION

3.2.1 U Digital Thermometer, with a register for maximum and minimum temperatures, 0-100°C, with surface probe and stainless steel sheath. Installed.

3.2.2 U 3-Way seat hand valve, DN-65, installed.

3.3.- ENERGY METER

3.3.1 U Energy meter, working flow 15 m3/h, flanges, DN 50. Installed.

4.1.- MIXTURE

4.1.1 U Temperature control valve, DN 50. Installed 1,0

4.1.2 U Non-return brass valve, 2 1/2". Installed. 1,0

4.1.3 U Non-return brass valve, 1/2". Installed. 1,0

4.1.4 U Thermometer with copper T fitting, 3/8", 0-120°C. Installed. 2,0

4.1.5 m Circuit pipe, galvanized steel, 2 1/2" diameter, for indoor SHW transportation, insulated and installed. 6,0

4.2.- SHW RECIRCULATION

4.2.1 U Thermometer with copper T fitting, 3/8", 0-120°C. Installed. 1,0

4.2.2 U Daily scheduler. Installed 1,0

4.2.3 U Safety thermostat with brass sheath. Installed. 1,0

4.2.4 U Angle seat brass valve, 1 1/2", manual operation. Installed 1,0

4.2.5 U Non-return brass valve, 1 1/2". Installed. 2,0
4.2.6 U Automatic brass water bleeder, suitable for SHW, with hand valve and T fitting, 3/4". Installed. 1,0

4.2.7 U Brass ball valve, 1 1/2". Installed 1,0

4.2.8 U SHW pump, working point close to: Q=0.51 l/s, Pressure=0.35 bar. Installed 2,0

4.2.9 U Manometer, pressure measuring range 0-4bar. Installed 2,0

5.1 U Destroy existing concrete chimney, and replace it with a new one with insulation and stainless steel. Withdraw existing out of service equipment from the deck, like a cooling machine. 1,0
V – Drawings
Deliverable 8-D: Tender for individual PV system

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

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Barcelona, November the 7th, 2008
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I – General Description of the system

The present document aims to define the conditions and technical specifications for the supply only of an individual autonomous Photovoltaic system, also known as Solar Home System.

The aim of the application is to use this installation in a technical center (university, research center, etc) in order to study the behaviour of the whole system. That is the reason why the monitoring and data logging are critical issues.

The general description is defined at the end of the document in table of System Characteristics.

II – Photovoltaic modules

1. Introduction

The photovoltaic modules shall provide the rated output for a minimum of twenty years. The modules shall be labelled with the minimum guaranteed output in Watt peak (Wp) at STC.

The modules are intended to be used to charge 12V lead acid batteries which will be cycled an average of 20% of their capacity each day. Reliability of service is an important criterion and preference will be given for photovoltaic modules which have a proven capability.

The 150-170Wp arrays can be made from two 75Wp (or 85) units or one 150Wp (170 Wp) unit. The evaluation of offers will take into account the whole configuration PV module-mounting rack and the least cost option will be given preference.

2. Photovoltaic cells

The standards applicable for the general electric connections are the general Spanish code for low voltage connected PV installation (R.D. 842/2002. Reglamento Electrotécnico de Baja Tensión) or any other similar European standards.

3. Electrical performance at STC

The standard system will be made of 1 or 2 PV modules. PV modules shall have a rated power of at least 75Wp and no more than 170Wp. The nominal voltage shall be 12V (36 cells). (STC are: radiation of 1000W/m2, ambient temperature of 25ºC, air mass of 1.5).

4. Connection

The modules shall have a separate connection box on the rear part with protection class IP 65. The terminals must be clearly marked with + and – for the corresponding
connections. Connections shall be of a screw type with a capacity of at least two 4 mm² wires.

5. **Module construction**
Framed modules should be used with marine grade aluminium or stainless steel.

6. **Certification**
The modules must in all respects comply with either IEC 61215-2 and that compliance must be certified by ESTI or other laboratory internationally recognized as competent to make that certification.

7. **Lifetime and warranties**
The modules must have an expected lifetime of a minimum 20 years and the Tenderer has to provide a warranty of at least 15 years which should include a statement of the modules minimum output, or greater for the 15 year period.

8. **Labelling**
On each module the following information has to be provided:
- Manufacturer’s name, if the supplier is not the manufacturer the address of the supplier must be indicated
- Module serial nº
- Type of module
- Nominal power at STC
- Date of manufacture

9. **Information required from the tenderer**

9.1. **Technical required information**

Full technical specification shall be provided by the Tenderer. These must include:
- Voc, Isc, Wp at STC, current/voltage curves for at least 4 radiation levels (250, 500, 750, 1000 W/m²)
- Relationship between temperature and module output for at least 4 module temperatures (30°C, 40°C, 50°C, 60°C)
- Physical size and weight
- Details of all the construction material
- Test certificates

9.2. **Warranty**

Tenderers must include a statement of warranties, in effect including what specifically constitutes warranty failure and all requirements and procedures for obtaining compensation for modules which have failed under warranty.
III–Battery

1. Introduction
The 100 Ah (C10) lead acid batteries provided shall power lighting systems after charging by photovoltaic modules. The design is based on a load of 20 Ah per day at 12V. Automotive or starting type batteries have performed poorly and are not acceptable under this tender. Reliability of service is a very important criterion and preference will be given for batteries which have a proven capability for high cycling capabilities and high depth of discharge.

2. Type of battery
The battery shall be of the lead-acid, deep discharge, vented and with high cycling number.

3. Transport
Batteries shall be shipped dry charged with sufficient electrolyte supplied separately for filling at the time of installation.

4. Construction
The batteries preferably shall be of the open “vented” type. Preference is given to batteries with handles for easy transportation and transparent body for easy inspection of electrolytes level. Preference is given to tubular construction of the positive plates.

5. Electrolyte
The electrolyte shall be of good purity according to VDE S10 or similar with a density of about 1.25kg/l.

6. Manufacture
The batteries must be manufactured according DIN 40736-1 or IEC 61427.

7. Rating of batteries
   - The battery shall have a 12V nominal operating voltage. The 12V battery may be made up of series connected 2V, 4V or 6V units but the price quoted shall be for a 12V configuration. Parallel connection of batteries is not acceptable.
   - The battery shall have at least 100 Ah capacity at C10 discharge rate at 20°C with an end voltage of 1.85 V per cell according to DIN 43539.

8. Battery Performance
   - The battery shall have a self-discharge when new of less than 5% per month (at 25°C and fully charged) of its nominal capacity. The battery shall have a Coulombic efficiency of at least 85% and energy conversion efficiency of at least 85% when new and charged to more than 50% of capacity.
9. Lifetime and warranties

The design lifetime of the batteries shall be of at least 7 years without losing more than 20% of the nominal C10 capacity. The Tenderer has to provide a replacement warranty of at least 3 years.

10. Labelling

On each battery the following information has to be provided:
- Manufacturer
- Serial number
- Nominal capacity C10
- Manufacturing date
- Clear indication of the positive and negative pole
- Clear indication of maximum and minimum electrolyte level
- Safety warnings as needed

11. Information required from Tenderers

11.1. Battery performance

Tenders must include details or the results of any tests carried out on the batteries by independent laboratories particularly regarding performance in conditions equivalent to solar equipment located in moist, equatorial coastal locations shall be included.

11.2. Full technical specifications shall be provided by the Tenderer.

These must include:
- Curves showing rated Ah capacity at several discharge rates from C10-C240
- Cycle life versus depth of discharge
- Self-discharge characteristics
- Physical size and weight
- Details of the materials used in construction.

11.3. Additional documentation to be provided with the tender

- Safety warning and advice how to handle batteries
- Maintenance and replacement procedure
- Range of operating temperature and storage temperature

11.4. Warranty

Tenderers must include a statement of warranties in effect including what specifically is covered under warranty and requirements for obtaining compensation for batteries which have failed under warranty.
IV – Charge controller

1. Introduction

The charge controller is a key part of the system since it regulates the charge and the discharge of the battery. It prevents overcharging and may prevent against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It may also prevent completely draining (“deep discharging”) a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. It assures a proper running of the battery and also of the whole system.

2. Type of charge controller

The charge controller should have a ‘Series’ regulation with 3 steps during the battery charging (bulk charge, equalization and floating). Also, it should control the battery discharge based on the ‘state of charge’ calculation or any other advanced adaptative algorithms and not only based on battery voltage.

3. Manufacture

The charge controller must in all respects comply with international standards. At least it is requested to fulfil those two certificates: EN60730-1, EN60730-2-11.

4. Lifetime and warranties

The design lifetime of the charge controller shall be of at least 5 years. The Tenderer has to provide a replacement warranty of at least 2 years.

5. Labelling

On the charge controller the following information has to be provided:
- Manufacturer
- Serial number
- Nominal or maximum load/charge current
- Safety warnings as needed

6. Information required from the Tenderer

6.1. Performance of the equipment

Tenders must include details or the results of any tests of the charge controller from any independent and/or qualified recognised laboratory.

6.2. Technical required information

Full technical specification shall be provided by the Tenderer. These must include:
- Brand and model
- Efficiency at different temperatures
- Allowed and max load current
- Self consumption
- Full certification
- Description of indicators and displays
- Physical size and weight
6.3. Warranty

Tenderers must include a statement of warranties in effect including what specifically is covered under warranty and requirements for obtaining compensation for batteries which have failed under warranty.

V – Inverter

1. Introduction

An inverter is an electrical or electro-mechanical device that converts direct current (DC) to alternating current (AC); the resulting AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits. In our case, the output current should have characteristics of standard current (230 V AC and 50 Hz).

2. Type of inverter

The inverter must be a pure sine-wave inverter.

3. Manufacture

The inverter must in all respects comply with international standards. At least it is requested to fulfil those certificates/homologations: 61000-6-1, EN 61000-6-3, EN 55014, EN 55022.

4. Lifetime and warranties

The lifetime expectancy of the inverter shall be of at least 5 years. The Tenderer has to provide a replacement warranty of at least 2 years.

5. Labelling

On the inverter the following information has to be provided:
- Manufacturer
- Serial number
- Nominal power
- Safety warnings as needed

6. Information required from the Tenderer

6.1. Performance of the equipment

Tenders must include details or the results of any tests of the inverter from any independent and/or qualified recognised laboratory.

6.2. Technical required information

Full technical specification shall be provided by the Tenderer. These must include:
- Brand and model
- Efficiency at different temperatures
- Input and output ranges of voltage
- Self consumption
- Full certification
- Description of indicators and displays
- Physical size and weight

6.3. Warranty

Tenderers must include a statement of warranties in effect including what specifically is covered under warranty.

VI - Data Logging

The characteristics of the data logger must fulfil the following specifications:

<table>
<thead>
<tr>
<th>DATA LOGGING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Data logging</td>
<td>Yes</td>
</tr>
<tr>
<td>Monitorized parameters</td>
<td></td>
</tr>
<tr>
<td><strong>Mandatory:</strong></td>
<td></td>
</tr>
<tr>
<td>- Battery voltage</td>
<td></td>
</tr>
<tr>
<td>- Battery state of charge</td>
<td></td>
</tr>
<tr>
<td>- Relevant energy flows</td>
<td></td>
</tr>
<tr>
<td><strong>Optional:</strong></td>
<td></td>
</tr>
<tr>
<td>- Solar irradiation</td>
<td></td>
</tr>
<tr>
<td>Frequency of logging</td>
<td>Minimum one hour</td>
</tr>
<tr>
<td>Maximum period of data storage</td>
<td>minimum 1 year for hourly data</td>
</tr>
</tbody>
</table>

The data logger could be integrated in the charge controller or put additionally as an external device.

VII - System characteristics

<table>
<thead>
<tr>
<th>PV ARRAY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PV power</td>
<td>From 150 Wp until 170 Wp</td>
</tr>
<tr>
<td>Type of modules</td>
<td>Crystalline from 75 Wp to 85 Wp -12V</td>
</tr>
<tr>
<td>N° PV modules</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BATTERY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N° elements</td>
<td>1</td>
</tr>
<tr>
<td>Type of battery</td>
<td>Lead acid vented 100 Ah - 12V</td>
</tr>
<tr>
<td>Capacity (C100)</td>
<td>120 Ah</td>
</tr>
<tr>
<td>Days of autonomy</td>
<td>3 days</td>
</tr>
</tbody>
</table>
### REGULATION AND CHARGE CONTROL

<table>
<thead>
<tr>
<th>Type of charge control</th>
<th>Serie</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max load current</td>
<td>15 A</td>
</tr>
<tr>
<td>Nominal battery voltage Ucc.N</td>
<td>12</td>
</tr>
<tr>
<td>Equalization charge voltage (25º)</td>
<td>Adjustable, factor of correction of temperature</td>
</tr>
<tr>
<td>Period of full charge</td>
<td>11 ... 176</td>
</tr>
<tr>
<td>Floating voltage (25º) UF</td>
<td>Adjustable, factor of correction of temperature</td>
</tr>
</tbody>
</table>
| Indicators             | LEDs for various visible parameters (in real time):  
  - Battery voltage  
  - Relevant energy flows  
  - Battery index of charge  
  - Energy measurements |

### INVERTER

<table>
<thead>
<tr>
<th>DC input</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal input voltage Udc.N</td>
<td>12</td>
</tr>
<tr>
<td>Input voltage range Udc</td>
<td>10-16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AC output</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal output voltage Uac.N</td>
<td>230 ± 5%</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 ± 0,05%</td>
</tr>
<tr>
<td>Harmonic distorsion</td>
<td>&lt;5%</td>
</tr>
<tr>
<td>Potencia nominal PN</td>
<td>200</td>
</tr>
<tr>
<td>Maximum nominal power during 30 min</td>
<td>&gt;120%*PN</td>
</tr>
<tr>
<td>Allowed power factor</td>
<td>0,5 – 1</td>
</tr>
<tr>
<td>Efficiency a PN</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>Efficiency at 10% of PN</td>
<td>&gt;85%</td>
</tr>
<tr>
<td>Self-consumption</td>
<td>≤ 2 W</td>
</tr>
</tbody>
</table>
| Indicators      | - Acoustic alarm before battery disconnection  
  - Operation status  
  - Fault message |
Trama TecnoAmbiental

Deliverable 10: Results of tender evaluation

Study on the possibilities use and development of solar energy in BiH

EDU/0724/07

Prepared for: IMG

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Project Manager
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Barcelona, November the 6th, 2008
INDEX

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II – Evaluation of PV system in Mostar ................................................................. 1
III – Evaluation of Solar Thermal system in Mostar ............................................ 4
IV – Evaluation of Solar Thermal system in Trebinje........................................... 7
V – Conclusions............................................................................................................. 10
I – Introduction

After having identified the different pilot projects in both entities of Bosnia and Herzegovina using both technologies (PV and solar Thermal), the tender has been launched in September based on a short list of companies in Spain and Bosnia and Herzegovina.

The offers received at the deadline date were the following:

<table>
<thead>
<tr>
<th>Pilot projects</th>
<th>ITM</th>
<th>Technoplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Mostar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar Thermal Mostar</td>
<td>ITM</td>
<td>Diasolar</td>
</tr>
<tr>
<td>Solar Thermal Trebinje</td>
<td>ITM</td>
<td>Diasolar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bankom-Inzinjering</td>
</tr>
</tbody>
</table>

The present deliverable describes the evaluation of all the offers received. At the end of the document, recommendations are written in order to the final selection of the companies.

II – Evaluation of PV system in Mostar

The technical proposal is evaluated on the basis of its responsiveness to the Tender Documents in accordance with the following technical evaluation criteria:

A: ITM
B: Technoplus

<table>
<thead>
<tr>
<th>Summary of Technical Proposal Evaluation Forms</th>
<th>Score Weight</th>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Expertise of Firm / Organization submitting Proposal</td>
<td>20%</td>
<td>200</td>
<td>A 100 / B 0</td>
</tr>
<tr>
<td>2. Proposed Work Plan and Approach</td>
<td>20%</td>
<td>200</td>
<td>A 145 / B 0</td>
</tr>
<tr>
<td>3. Proposed Equipment &amp; Services Specifications</td>
<td>50%</td>
<td>500</td>
<td>A 410 / B 0</td>
</tr>
<tr>
<td>4. Personnel</td>
<td>10%</td>
<td>100</td>
<td>A 50 / B 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1000</strong></td>
<td><strong>705</strong></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

Evaluation forms for technical proposals are indicated here below. The obtainable number of points specified for each evaluation criterion indicates the relative significance or weight of the item in the overall evaluation process. The Technical Proposal Evaluation Forms are:

Form 1: Expertise of Firm / Organization Submitting Proposal
Form 2: Proposed Work Plan and Approach
Form 3: Proposed Equipment & Services Specifications
Form 4: Personnel
# Technical Proposal Evaluation

<table>
<thead>
<tr>
<th>Form 1</th>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td><strong>Expertise of firm / organization submitting proposal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Reputation of Organization</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>1.2 Experience on similar projects in the Mediterranean Region</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>1.3 General Organizational Capability which is likely to affect implementation (i.e. loose consortium, holding company or one firm, size of the firm / organization, strength of project management support e.g. project financing capacity and project management controls)</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>1.4 Quality Certification (ISO 9001/2000) &amp; Quality assurance procedures</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Form 1</strong></td>
<td><strong>200</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Form 2</th>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td><strong>Proposed Work Plan and Approach</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 To what degree does the Bidder understand the task?</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2.2 Have the important aspects of the task been addressed in sufficient detail?</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>2.3 Is the proposal based on a survey of the project environment and was this data input properly used in the preparation of the proposal?</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>2.4 Is the conceptual framework adopted appropriate for the task?</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>2.5 Is the scope of task well defined and does it correspond to the TOR?</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>2.6 Is the presentation clear and is the sequence of activities and the planning logical, realistic and promise efficient implementation to the project?</td>
<td>100</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total Form 2</strong></td>
<td><strong>200</strong></td>
<td><strong>145</strong></td>
</tr>
</tbody>
</table>
### Technical Proposal Evaluation

#### Points Obtainable

<table>
<thead>
<tr>
<th>Proposed Equipment &amp; Services Specifications</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>3.1 To what degree does the Bidder's Equipment &amp; Services meet the technical requirements of requested material (Individual and Collective)</td>
<td>80</td>
</tr>
<tr>
<td>3.2 Equipment design and performance in accordance to International Standards (EN or ISO) accompanied with Test Report/Certificate by an Independent Laboratory</td>
<td>120</td>
</tr>
<tr>
<td>3.3 Level of Deviation from the Technical Specifications</td>
<td>50</td>
</tr>
<tr>
<td>3.4 Level of warranty, spare parts and after sales services</td>
<td>100</td>
</tr>
<tr>
<td>3.5 Previous individual / collective solar systems installations in the Balkan countries supported by Owners reference letters</td>
<td>50</td>
</tr>
<tr>
<td>3.6 Level of local presence and after sales services in B&amp;H</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total Form 3</strong></td>
<td><strong>500</strong></td>
</tr>
</tbody>
</table>

#### Personnel

<table>
<thead>
<tr>
<th>Technical Proposal Evaluation</th>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 4</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Personnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1 Project Manager</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>4.2 Installation Team</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total Form 4</strong></td>
<td><strong>100</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

Only one company out of the two has passed the threshold for the Technical evaluation. ITM reaches 71%.

The other company did not give any information about the company itself, the methodology and technical specifications.

The financial evaluation reveals that the price for the installation is: **25,472.83 €**.

This price does not include VAT or any other customs tax. Due to the nature of the project, there won’t be any taxes that IMG has to take into account and add to the present.

As ITM is the only company for technical aspects and the only one which has been evaluated from a financial point of view:

\[
St (ITM) = 1 \quad \text{and} \quad Sf (ITM) = 1
\]

\[
TS = St \times 0.4 + Sf \times 0.6
\]

\[
TS = 0.4 + 0.6 = 1
\]
This result is not very representative as ITM is the only company. This tool for evaluation is normally done for the comparison of different offers.

Nevertheless, the evaluation is satisfactory. The technical proposal is good. ITM has lost point in the parts 1 and 4 about the key personal and the organization, because the information is missing.

Concerning the financial offer, the price announced is in the range of the expected prices. Indeed, the evaluation is positive on that point too.

As a conclusion, ITM has sent the best offer and should be contracted for the realization of the PV pilot project in “Los Rosales” located in Mostar, Bosnia & Herzegovina.

III – Evaluation of Solar Thermal system in Mostar

The technical proposal is evaluated on the basis of its responsiveness to the Tender Documents in accordance with the following technical evaluation criteria:

A: ITM
B: DIASOLAR
C: Technoplus

<table>
<thead>
<tr>
<th>Summary of Technical Proposal Evaluation Forms</th>
<th>Score</th>
<th>Weight</th>
<th>Points Obtainable</th>
<th>Company /Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form 1: Expertise of Firm / Organization Submitting Proposal</td>
<td>Score</td>
<td>Weight</td>
<td>Points Obtainable</td>
<td>Company /Other Entity</td>
</tr>
<tr>
<td>1. Expertise of Firm / Organization submitting Proposal</td>
<td>20%</td>
<td>200</td>
<td>100</td>
<td>A = 0 B = 0 C = 0</td>
</tr>
<tr>
<td>Form 2: Proposed Work Plan and Approach</td>
<td>20%</td>
<td>200</td>
<td>180</td>
<td>A = 0 B = 0 C = 0</td>
</tr>
<tr>
<td>Form 3: Proposed Equipment &amp; Services Specifications</td>
<td>50%</td>
<td>500</td>
<td>390</td>
<td>A = 50 B = 0 C = 0</td>
</tr>
<tr>
<td>Form 4: Personnel</td>
<td>10%</td>
<td>100</td>
<td>50</td>
<td>A = 0 B = 0 C = 0</td>
</tr>
<tr>
<td>Total</td>
<td>1000</td>
<td>720</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

Evaluation forms for technical proposals are indicated here below. The obtainable number of points specified for each evaluation criterion indicates the relative significance or weight of the item in the overall evaluation process. The Technical Proposal Evaluation Forms are:

Form 1: Expertise of Firm / Organization Submitting Proposal
Form 2: Proposed Work Plan and Approach
Form 3: Proposed Equipment & Services Specifications
Form 4: Personnel
## Technical Proposal Evaluation

### Form 1

<table>
<thead>
<tr>
<th>Expertise of firm / organization submitting proposal</th>
<th>Points obtainable</th>
<th>Company/ Other Entity</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Reputation of Organization</td>
<td>50</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1.2 Experience on similar projects in the Mediterranean Region</td>
<td>50</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1.3 General Organizational Capability which is likely to affect implementation (i.e. loose consortium, holding company or one firm, size of the firm / organization, strength of project management support e.g. project financing capacity and project management controls)</td>
<td>50</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1.4 Quality Certification (ISO 9001/2000) &amp; Quality assurance procedures</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Form 1</strong></td>
<td><strong>200</strong></td>
<td><strong>100</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Form 2

<table>
<thead>
<tr>
<th>Proposed Work Plan and Approach</th>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 To what degree does the Bidder understand the task?</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.2 Have the important aspects of the task been addressed in sufficient detail?</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.3 Is the proposal based on a survey of the project environment and was this data input properly used in the preparation of the proposal?</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.4 Is the conceptual framework adopted appropriate for the task?</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.5 Is the scope of task well defined and does it correspond to the TOR?</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.6 Is the presentation clear and is the sequence of activities and the planning logical, realistic and promise efficient implementation to the project?</td>
<td>100</td>
<td>80</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total Form 2</strong></td>
<td><strong>200</strong></td>
<td><strong>180</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Proposed Equipment &amp; Services Specifications</td>
<td>Points Obtainable</td>
<td>Company / Other Entity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>-------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 To what degree does the Bidder's Equipment &amp; Services meet the technical requirements of requested material (Individual and Collective)</td>
<td>80 80 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 Equipment design and performance in accordance to International Standards (EN or ISO) accompanied with Test Report/Certificate by an Independent Laboratory</td>
<td>120 100 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3 Level of Deviation from the Technical Specifications</td>
<td>50 50 50 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4 Level of warranty, spare parts and after sales service</td>
<td>100 80 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5 Previous individual / collective solar systems installations in the Balkan countries supported by Owners reference letters</td>
<td>50 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6 Level of local presence and after sales services in B&amp;H</td>
<td>100 60 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Form 3</strong></td>
<td>500 390 50 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Personnel</th>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Project Manager</td>
<td>50 25 0 0</td>
<td></td>
</tr>
<tr>
<td>4.2 Installation Team</td>
<td>50 25 0 0</td>
<td></td>
</tr>
<tr>
<td><strong>Total Form 4</strong></td>
<td>100 50 0 0</td>
<td></td>
</tr>
</tbody>
</table>

Only one company out of the two has passed the threshold for the Technical evaluation. ITM reaches 72%.

The other companies did not give any information about the company itself, the methodology and technical specifications.

The financial evaluation reveals that the price for the installation is: **23,577,19 €**.

This price does not include VAT or any other customs tax. Due to the nature of the project, there won’t be any taxes that IMG has to take into account and add to the present.

As ITM is the only company for technical aspects and the only one which has been evaluated from a financial point of view:

\[ St (ITM) = 1 \quad \text{and} \quad Sf (ITM) = 1 \]

\[ TS = St \times 0.4 + Sf \times 0.6 \]

\[ TS = 0.4 + 0.6 \]

\[ TS = 1 \]
This result is not very representative as ITM is the only company. This tool for evaluation is normally done for the comparison of different offers.

Nevertheless, the evaluation is satisfactory. The technical proposal is good. ITM has lost point in the parts 1 and 4 about the key personal and the organization, because the information is missing.

Concerning the financial offer, the price announced is in the range of the expected prices. Indeed, the evaluation is positive on that point too.

**According to the evaluation, ITM seems to be the most suitable company for the realization of the solar thermal pilot project in “Los Rosales” located in Mostar, Bosnia & Herzegovina.**

### IV – Evaluation of Solar Thermal system in Trebinje

The technical proposal is evaluated on the basis of its responsiveness to the Tender Documents in accordance with the following technical evaluation criteria:

A: ITM  
B: DIA SOLAR  
C: Bankom-Inzinjering

<table>
<thead>
<tr>
<th>Summary of Technical Proposal Evaluation Forms</th>
<th>Score Weight</th>
<th>Points Obtainable</th>
<th>Company /Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Expertise of Firm / Organization submitting Proposal</td>
<td>20%</td>
<td>200</td>
<td>A: 100 B: 0 C: 190</td>
</tr>
<tr>
<td>2. Proposed Work Plan and Approach</td>
<td>20%</td>
<td>200</td>
<td>A: 40 B: 170 C: 180</td>
</tr>
<tr>
<td>3. Proposed Equipment &amp; Services Specifications</td>
<td>50%</td>
<td>500</td>
<td>A: 80 B: 50 C: 310</td>
</tr>
<tr>
<td>4. Personnel</td>
<td>10%</td>
<td>100</td>
<td>A: 50 B: 0 C: 80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1000</strong></td>
<td><strong>270 220 760</strong></td>
<td></td>
</tr>
</tbody>
</table>

Evaluation forms for technical proposals are indicated here below. The obtainable number of points specified for each evaluation criterion indicates the relative significance or weight of the item in the overall evaluation process. The Technical Proposal Evaluation Forms are:

Form 1: Expertise of Firm / Organization Submitting Proposal  
Form 2: Proposed Work Plan and Approach  
Form 3: Proposed Equipment & Services Specifications  
Form 4: Personnel
### Technical Proposal Evaluation Form 1

<table>
<thead>
<tr>
<th>Expertise of firm / organization submitting proposal</th>
<th>Points obtainable</th>
<th>Company/ Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>1.1 Reputation of Organization</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>1.2 Experience on similar projects in the Mediterranean Region</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>1.3 General Organizational Capability which is likely to affect implementation (i.e. loose consortium, holding company or one firm, size of the firm / organization, strength of project management support e.g. project financing capacity and project management controls)</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>1.4 Quality Certification (ISO 9001/2000) &amp; Quality assurance procedure.</td>
<td>50</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Form 1**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>190</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Technical Proposal Evaluation Form 2

<table>
<thead>
<tr>
<th>Proposed Work Plan and Approach</th>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>2.1 To what degree does the Bidder understand the task?</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2.2 Have the important aspects of the task been addressed in sufficient detail?</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>2.3 Is the proposal based on a survey of the project environment and was this data input properly used in the preparation of the proposal?</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2.4 Is the conceptual framework adopted appropriate for the task?</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>2.5 Is the scope of task well defined and does it correspond to the TOR?</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>2.6 Is the presentation clear and is the sequence of activities and the planning logical, realistic and promise efficient implementation to the project?</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Form 2**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>40</td>
<td>170</td>
</tr>
<tr>
<td>180</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Proposed Equipment & Services Specifications

<table>
<thead>
<tr>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

#### 3.1 To what degree does the Bidder's Equipment & Services meet the technical requirements of requested material (Individual and Collective)

|                  | \(80\) | \(0\) | \(0\) | \(80\) |

#### 3.2 Equipment design and performance in accordance to International Standards (EN or ISO) accompanied with Test Report/Certificate by an Independent Laboratory

|                  | \(120\) | \(0\) | \(0\) | \(100\) |

#### 3.3 Level of Deviation from the Technical Specifications

|                  | \(50\) | \(0\) | \(50\) | \(50\) |

#### 3.4 Level of warranty, spare parts and after sales services

|                  | \(100\) | \(80\) | \(0\) | \(0\) |

#### 3.5 Previous individual / collective solar systems installations in the Balkan countries supported by Owners reference letters

|                  | \(50\) | \(0\) | \(0\) | \(0\) |

#### 3.6 Level of local presence and after sales services in B&H

|                  | \(100\) | \(0\) | \(0\) | \(80\) |

**Total Form 3**

|                  | \(500\) | \(80\) | \(50\) | \(310\) |

---

### Personnel

<table>
<thead>
<tr>
<th>Points Obtainable</th>
<th>Company / Other Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
</tbody>
</table>

#### 4.1 Project Manager

|                  | \(50\) | \(25\) | \(0\) | \(40\) |

#### 4.2 Installation Team

|                  | \(50\) | \(25\) | \(0\) | \(40\) |

**Total Form 4**

|                  | \(100\) | \(50\) | \(0\) | \(80\) |

Only one company out of the two has passed the threshold for the Technical evaluation. Bankom-Inzinjering reaches 76%.

The other company did not give enough information about the company itself, the methodology and technical specifications.

The financial evaluation of the offer of Bankom-Inzinjering reveals that the price for the installation is: **56,522,70 €**.

This price does not include VAT or any other customs tax. Due to the nature of the project, there won’t be any taxes that IMG has to take into account and add to the present.

As Bankom-Inzinjering is the only company for technical aspects and the only one which has been evaluated from a financial point of view:

\[
\text{St (Bankom-Inzinjering)} = 1 \quad \text{and} \quad \text{Sf (Bankom-Inzinjering)} = 1
\]

\[
\text{TS} = \text{St} \times 0.4 + \text{Sf} \times 0.6
\]

\[
\text{TS} = 0.4 + 0.6
\]

\[
\text{TS} = 1
\]
This result is not very representative as Bankom-Inzinjering is the only company. This tool for evaluation is normally done for the comparison of different offers.

Nevertheless, the evaluation is satisfactory. The technical proposal is good. Bankom-Inzinjering has lost point in the parts 3 mainly about the certification (reference letter, level of warranty), because the information is missing.

Concerning the financial offer, the price announced is in the range of the expected prices. Indeed, the evaluation is positive on that point too.

**Bankom-Inzinjering has proposed an acceptable technical and financial offer which leads us to recommend it for the realization of the solar thermal pilot project located in Trebinje, Bosnia & Herzegovina.**

**V – Conclusions**

Finally, after the evaluation of the several offers, we have found acceptable candidates for the three pilot projects in Mostar and Trebinje. In each part, we can see the name of the chosen subcontracted entities and the justification of the evaluation.

In the case that the contract is signed with each entity for the implementation of the installation, the total budget for the three projects will be as it follows in the table:

<table>
<thead>
<tr>
<th>Available budget</th>
<th>Federation of BiH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Republika Srpska</td>
<td>50.000,00</td>
</tr>
<tr>
<td>Solar Thermal Trebinje</td>
<td>56.522,70</td>
</tr>
<tr>
<td>Solar Home System R.S.</td>
<td>~ 4.000,00</td>
</tr>
<tr>
<td>Total budget</td>
<td>~ 60.000,00</td>
</tr>
<tr>
<td>Solar Thermal Mostar</td>
<td>-</td>
</tr>
<tr>
<td>PV Mostar</td>
<td>-</td>
</tr>
</tbody>
</table>

It is important to note that another part of the pilot projects is the supply of a Solar Home System (small individual PV system). The discussions are still open in order to define the location and the beneficiary of this system, in the Republika Srpska.

Another element that we will have to take into account and which has been discussed already is the complementary funds that we have to find for the pilot projects in Republika Srpska. At the beginning of the project the director of the institution in Trebinje assured that they were willing to complement on their own budget the expenses of the project.

During the next months, those aspects will be considered by all the actors of the project (Spanish Cooperation, IMG, TTA, both Ministries in each entity and subcontracted companies).
Trama TecnoAmbiental

Deliverable 12-13-14: Report on Assessment, Definition and Strategy for a Programme of Diffusion and Training in solar technologies

Study on the possibilities use and development of solar energy in B&H

EDU/0724/07

Prepared for: IMG

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Ivana Cankara 8
71000 Sarajevo, Bosnia and Herzegovina

Barcelona, March the 4th, 2009

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Report on Definition of a Program of Diffusion and Training in solar technologies

The availability of qualified human resources is essential for the development of the solar energy market in B&H. Education is the better way to start scientific vocations and also capable of professionalize a determinate sector. It is evident that the development of this market assumes the availability of specialists at different levels for designing and installing the energy systems and keeping in good condition the equipment supplied and installed.

1 – Analysis of existing training in B&H in the area of renewable energies

A first step towards the integration of the training programmes in solar energy technologies for B&H is to know what the current offer in training is. The main objective of the present chapter is an effort to fulfill this need.

Based on the results of the present survey and on experience in training courses in solar technologies in other countries the programmes will be established.

1. Sustainable energy engineering training in specialized centres

1.1. Center for Ecology and Energy in Tuzla

➢ About the centre
The Center for Ecology and Energy Tuzla is a non-governmental organization that encourages sustainable development in the field of environmental protection, utilizing a combination of educational and practical work with cooperation at all levels of society.

➢ Activities

Energy efficiency activities
They have insulated the doors and windows of about 12 buildings (mainly schools) and are now working on a pilot project to measure the energy savings of 10 houses in BiH with wall insulation

Solar energy activities
Through a series of workshops, exhibitions and seminars they have showed citizens coming from different parts of the country that anyone can take advantage of the awesome power of the sun.

➢ Three-part workshop series from August – September 2006, guiding participants through:
  - The background theory of energy issues (09.08.2006)
  - Actual construction of two panels (16-18.08.2006) and
  - Theory and practice of installing a solar collector (22-23.09.2006).
• Public exhibitions in Tuzla, in addition to the Annual Gradačac Plum Fair and at 10 different schools around the Canton (about 2550 visitors).

• Public seminar for other participants to explain the theory behind energy issues, RES, solar panel construction and installation (01.12.2006).

• Training course: DIY (Do It Yourself) solar thermal collectors. Target public: electro-technical high school students, teachers and custodial staff. The training took place over the course of two months, though the entire project was about six months long. (2008).

• Currently future trainings for potential solar thermal business-owners and an installation of PV panels at a school is being planned.

Additionally, they tried to spread the message of the importance of solar energy, RES and the problems of fossil fuels and nuclear energy through means of various publications and media work.

• Completion and printing of 1000 leaflets: about the project and solar energy.

• Completion of instructional handbooks and printing of 250 copies: in-depth look into energy issues, RES, and DIY solar construction and installation. This handbook was especially designed to be translated into other languages and spread around; contact us to obtain the pictures and/or text in an easier-to-edit format.

• Completion of a study “The Contemporary Energy Situation of Bosnia and Herzegovina”

• Press releases and media work for nearly all events, as well as articles on three websites.

➢ Website

http://www.ekologija.ba/

1.2. Regional Environmental Centre (REC) in B&H

➢ About the centre

There is a REC in Sarajevo and a REC Field Office in Banja Luka. It was established in 1997 being a part of an international organization.

The country office provides a full range of services to NGOs in terms of financial support, capacity building and information in the environmental field.

The centre develops capacity building programs and awareness activities on natural resources and sustainability.

➢ Activities

Some of the Projects related to these topics in 2008 were:

• Local Environmental Action Planning for Sustainability in the South-eastern Europe (SEE)

• Cross-border LEAPs’: Environmental Planning for Peace and Stability

• Development of Local Environmental Action Plan (LEAP) for the Municipality of Sokolac

• Neretva Delta Forum for the sustainable use of shared natural resources in Bosnia and Herzegovina
• Support to the Public Regional Communal Service Company and four B&H municipalities
• Supporting Environmental Civil Society Organisations (CSO) in South Eastern Europe – SECTOR

➤ Website
http://www.rec.org.ba/

2. Sustainable energy engineering training in University

2.1. Master
There is a Master of Technical Science, carried out by three universities in B&H, where a course on Renewable Energy Technology is provided.

The program of the master consists of a core and elective modules, comprising general courses from two major fields: Power Generation and Energy Utilization, dealing with the corresponding basic issues. Successful completion of the program leads to obtaining the degree of Master of Technical Science.

➤ Duration
Total duration of the courses is 9 months corresponding to 60 ECTS credits.

➤ Target group
The program is offered to applicants from all over the world with a suitable academic background that include mechanical engineering, applied physics, and areas of electrical/chemical engineering relevant to power generation/distribution, and/or energy utilization.

➤ Partners
• University of Sarajevo
• University of Banja Luka
• University of Mostar
• The Royal Institute of Technology KTH
• City University London
• University College of Dublin

➤ Detailed program

<table>
<thead>
<tr>
<th>FIRST SEMESTER</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CORE MODULES</strong></td>
<td></td>
</tr>
<tr>
<td>1. Basics of Energy Technology</td>
<td></td>
</tr>
<tr>
<td>2. Sustainable Energy Generation</td>
<td></td>
</tr>
<tr>
<td>3. Modern Energy Utilization</td>
<td></td>
</tr>
<tr>
<td>4. Advanced and Renewable Energy Sources</td>
<td></td>
</tr>
<tr>
<td><strong>ELECTIVE MODULES</strong></td>
<td></td>
</tr>
<tr>
<td>1. Applied Refrigeration and Heat Pump Technology</td>
<td></td>
</tr>
<tr>
<td>2. Machines and Equipment in Power and Process Engineering</td>
<td></td>
</tr>
</tbody>
</table>
**SECOND SEMESTER**

**CORE MODULES**
1. Applied Energy Technology
2. Energy Management

**ELECTIVE MODULES**
1. Climate Comfort
2. Selected Topics in Nuclear Power Engineering
3. Clean Coal Technology
4. Measurements in Power and Process Technology
5. Computer Simulation and Modelling of Processes
6. Energy and Environment
7. Applied Heat and Power Technology

**THESIS PROJECT**

► Detailed program of the Advanced and Renewable Energy Sources

The aim of this course is to introduce students to:
- Potential renewable energy resources and possibilities for their application.
- Main principles of energy transformation and technologies applied.
- Simple and complex systems powered by renewable energy.

At the end of the course the students should be able to analyze and design energy systems to supply electricity, heat and the cooling requirements using renewable sources.

The purpose of the course is to give an overview of the most significant renewable energy sources and the state of art of the technologies and their applications. The use of geothermal, hydrogen, waves, tidal energy is discussed. Special review is given to solar, biomass, wind and hydro energy. Project work is focused on designing combined systems based on renewable energy technologies for various purpose and possibilities for their application instead of conventional ones. This course includes a study visit to built facilities and laboratory installations.

The course consists of 52 h lecture (the theoretical part of course lessons and tutorials) and a study visit that will be distributed as follows:
- Introduction to renewable sources (4h)
- Wind Energy (12h)
- Biomass (12h)
- Solar Energy (12h)
- Hydro Energy (12h)
- Study visit (8h)

The solar module includes the following lessons:
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Solar radiation</td>
</tr>
<tr>
<td>1.1</td>
<td>The Sun</td>
</tr>
<tr>
<td>1.2</td>
<td>Definitions</td>
</tr>
<tr>
<td>1.3</td>
<td>Direction of Beam Radiation</td>
</tr>
<tr>
<td>1.4</td>
<td>Ratio of Beam Radiation on Tilted Surface to that on Horizontal Surface</td>
</tr>
<tr>
<td>1.5</td>
<td>ET Radiation on Horizontal Surface, GO</td>
</tr>
<tr>
<td>1.6</td>
<td>Atmospheric Attenuation of Solar Radiation</td>
</tr>
<tr>
<td>1.7</td>
<td>Estimation of Clear Sky Radiation</td>
</tr>
<tr>
<td>1.8</td>
<td>Beam and Diffuse Components of Monthly Radiation</td>
</tr>
<tr>
<td>1.9</td>
<td>Radiation on Sloped Surface – Isotropic Sky</td>
</tr>
<tr>
<td>2.</td>
<td>Selected heat transfer topics</td>
</tr>
<tr>
<td>3.</td>
<td>Radiation characteristics for opaque metals</td>
</tr>
<tr>
<td>3.1</td>
<td>Absorptance, Emittance and Reflectance</td>
</tr>
<tr>
<td>3.2</td>
<td>Selective Surfaces</td>
</tr>
<tr>
<td>4.</td>
<td>Radiation transmission through glazing; absorbed radiation</td>
</tr>
<tr>
<td>4.1</td>
<td>Reflection of Radiation</td>
</tr>
<tr>
<td>4.2</td>
<td>Optical Properties of Cover Systems</td>
</tr>
<tr>
<td>4.3</td>
<td>Absorbed Solar Radiation</td>
</tr>
<tr>
<td>4.4</td>
<td>Monthly Average Absorbed Radiation</td>
</tr>
<tr>
<td>5.</td>
<td>Flat – plate collectors</td>
</tr>
<tr>
<td>5.1</td>
<td>Basic Flat – Plate Energy Balance Equation</td>
</tr>
<tr>
<td>5.2</td>
<td>Temperature Distributions in Flat – Plate Collectors</td>
</tr>
<tr>
<td>5.3</td>
<td>Collector Overall Heat Loss Coefficient</td>
</tr>
<tr>
<td>5.4</td>
<td>Collector Heat Removal Factor FR</td>
</tr>
<tr>
<td>5.5</td>
<td>Collector Tests</td>
</tr>
<tr>
<td>5.6</td>
<td>Energy Storage: Water Tanks</td>
</tr>
<tr>
<td>6.</td>
<td>Semiconductors and P-N junctions</td>
</tr>
<tr>
<td>6.1</td>
<td>Semiconductors</td>
</tr>
<tr>
<td>6.2</td>
<td>P-N Junctions</td>
</tr>
<tr>
<td>7.</td>
<td>The behaviour of solar cells</td>
</tr>
<tr>
<td>7.1</td>
<td>Absorption of light</td>
</tr>
<tr>
<td>7.2</td>
<td>Effect of light</td>
</tr>
<tr>
<td>7.3</td>
<td>One-diode model pf PV cell</td>
</tr>
<tr>
<td>7.4</td>
<td>Cell Properties</td>
</tr>
<tr>
<td>8.</td>
<td>Stand-alone photovoltaic systems</td>
</tr>
<tr>
<td>8.1</td>
<td>Design and modules</td>
</tr>
<tr>
<td>8.2</td>
<td>Batteries</td>
</tr>
<tr>
<td>8.3</td>
<td>Household power systems</td>
</tr>
<tr>
<td>9.</td>
<td>Grid connected photovoltaic systems</td>
</tr>
<tr>
<td>9.1</td>
<td>Photovoltaic systems in buildings</td>
</tr>
<tr>
<td>9.2</td>
<td>Photovoltaic power plants</td>
</tr>
</tbody>
</table>
2.2. Existing Subjects and courses about solar energy in Universities

UNIVERSITY SARAJEVO

Subject: RES Technology

Professor: Faik Begić

ECTS credits: 5

Aims and objective: The objective of this subject is to learn the best possible use of RES. This includes the knowledge for the future development of this technology until it reaches maximum benefit for the environment.

Preconditions: Knowledge from Thermodynamic engineering I, Fluid mechanics and Mechanical elements.

Program:

RES Technology

1. Wind Energy
   1.1 Evaluation of commercial wind technology (present development, goals, design, styles, architecture of modern turbines, montage etc)
   1.2 Trends in Wind Energy (present and future development and research)
   1.3 Protection of environment and wind energy economy

2. Solar Energy
   2.1 Sun’s radiation, measuring sun radiation, calculation of radiation.
   2.2 Solar collectors, solar heating and cooling, photovoltaic system

3. Biomass
   3.1 Definition of Biomass, conversion of biomass
   3.2 Combustion of coal and biomass in different proportion
   3.3 Conversation of combustion system and stabilization of fire from liquid to biomass in industrial and energy tanks
   3.4 Protection of environment and Biomass economy

4. Geothermal systems
   4.1 General about geothermal systems
   4.2 Conversion of geothermal energy to heat and electricity
   4.3 Protection of environment and geothermal system economy
Course title: Renewable Energy Sources

ECTS credits: 4

Professors: A. Knežević, F. Begić

Status of the course in the study programme: Optional subject in the Department for Energy, Process and Environment Engineering.

Aims and objectives of the course: Introduction of basic potential for RES

Program: Historical rate, efficiency and type of used energy sources; reason for reducing use of carbon types of energy (climate change); characteristics and development of technologies for energy conversion based on energy of wind, solar irradiation, hydro potential, waste, as well as bio-mass; accumulation and regulation of energy production and needs, specially intermittent; environmental impact and costs of life cycle these energy types; methods of assessment of economy, specially money back period at conversion of fossil fuel burnt facility by non-carbon fuel; procedure of getting of environmental permits for wind- and hydro power plants, international and national financial mechanisms for enhancement of use of non-carbon energy sources.

UNIVERSITY BANJA LUKA

Subject: Renewable Energy Sources

Department: Power Engineering

Professor: Mico Gacanovic

ECTS credits: 5

Cycle degree: I

Aims and objective: Present the importance of renewable energy sources, their technical and economical status and their impact to the environment. Provide the student with the ability to understand complex problems in the triangle: energy- economy-environment.

Program:

- Importance of renewable energy sources
- Sustainable development in connection with growing energy needs environmental protection and limited resources. Energy efficiency and renewable energy sources.
- Wind power: potential, technologies, best practices.
- Solar power: potential, technologies, best practices
- Biogas and biomass, small hydro, fuel cells, geothermal energy, cogeneration and other possibilities of energy production: potential, technologies, best practices.
- Integration of renewable energy sources in power systems.
- Energy efficiency technologies in production, transmission, distribution and consumption of electricity.

3. Study of needs
Through questionnaires, several teachers of various faculties of engineering in BiH were asked about the training in the field of Renewable Energy and especially on Solar Energy. The questions dealt not only with the existing training but also the needs to be covered in the solar energy subjects from their point of view.

Some of the requirements and needs contained in the questionnaires were:

Some of the topics of the energy solar that should offer the subjects
- Basics of solar energy generation
- Possibilities of energy efficiency in B&H
- Economic or financial payback of solar thermal and photovoltaic energy systems
- Law regulation, possibility of financing
- Training on how to make high- and mid-quality solar thermal panels.

Strategic guidelines for development of solar energy in BiH
As well as to provide training solar energy in the university and the school, there needs to be an emphasis made in awareness of two target groups: authorities and entrepreneurs. Authorities should see first hand how important, practical and affordable solar energy is, so that they can use the experience to create supportive legislation. Entrepreneurs need to see that there is possibility for profit in this sector, as currently there are few companies in BiH offering such services and therefore less competition.

Then, once government enacts good support mechanisms for both companies and customers, consumer demand will rise and the technology will be really developed.

The few existing companies in BiH that offer solar thermal panels focus on high-quality ones unaffordable to most citizens, while NGOs only know the DIY, low-to-mid-quality designs that aren’t always sufficient for home central-heating needs.

4. Potential target groups
The potential target group for the introduction of solar energy engineering training in B&H would be the following universities and faculties:

- UNIVERSITY OF SARAJEVO
  Members:
  - Faculty of architecture
  - Faculty of electrical engineering
  - Faculty of physical education
  - Faculty of mechanical engineering
- UNIVERSITY OF BANJA LUKA
  Members:
  - Faculty of architecture
  - Faculty of electrical engineering
  - Faculty of mechanical engineering
  - Faculty of Electrical Engineering

- UNIVERSITY OF MOSTAR
  Members:
  - Faculty of Mechanical Engineering and Computer Engineering
  - Institute of Mechanical Engineering

- UNIVERSITY OF TUZLA
  Members:
  - Faculty of Electrical Engineering
  - Faculty of Mechanical Engineering
  - Faculty of Mining, Geology and Civil Engineering
II- Design of a training strategy in diverse professional fields and dissemination in schools

The training in the solar energy field has to be guaranteed through three different axes:

- The level of decision: engineers and architects, economists and personal of the administration.
- The local technicians of assembly and maintenance.
- The public or the potential users, including the education in the schools.

Once analysed the training necessities of B&H in solar thermal and photovoltaic energy and the current situation of this training and other courses related to university field, it is important to focus in the design of training plans for the different professional collectives and agents involved in the development of the solar market:

- Installers
- Architects
- Engineers
- Researchers
- Public administration
- Schools
- Public in general

It is worth highlighting that, despite being relevant the training in the professional categories above mentioned, the training for installers is essential in order to guarantee the success in emergency and future consolidation of the solar market. This has been a common approximation in all the countries where the solar energy sector has achieved a certain degree of development: the responsibility of the installers in quality execution, maintenance, and even, commercial promotion for final customers is much more direct than any other professional sector.

Obviously this does not mean that the installers should face alone the challenge of picking up the market. The support of trained superior technicians, or the existence of a researchers network with specific training, will allow to solve complex designs or solutions of specific integration in projects non standardized. Also the development of supporting policies by the administration will result in a very important aspect to activate the sector in B&H.

In any case, the central role of the installer as key agent in the market progress keeps being very important. The objective would be the use of this training to set up an specific accreditation that guarantees the aptitude of the professional in thermal solar installation to users or customers.

Education in other professional fields, at schools and the dissemination for the general public have considered important to set out the training in thermal and photovoltaic solar energy in a more extensive training frame in renewable energy and/or energy efficiency, including aspects related with the bioclimatic architecture, approaching energy, environment and economy together and finally highlighting the importance of the legal framework into the solar market development.
1. Training in solar energy for professionals: Engineers and Architects

Since a few years ago engineers and architects have the challenge of improving the thermal behaviour of buildings by applying bioclimatic design solutions and by integrating solar collection systems in buildings, mainly in new construction ones.

The role of engineers is very important for the development of technically complex projects as collective installations and the role of architects has to consider two basic aspects in the design of buildings: the normative related with the thermal demand in buildings and the architectural integration of solar technologies. The legislation and norms related to the use and integration of solar technologies: both thermal and PV has become a very important aspect for the development of these technologies in countries like Spain.

The architectural integration of some components as the solar collectors is a very important responsibility of the architects. Collectors have to be outside the building and its visibility is an important parameter to be considered mainly in demonstration projects.

1.1. Evaluation of need

For the integral preparation of the future specialists at university degree level it will be important to develop programmes at a certain theoretical level. Also the practical aspects have to be dominated and oriented towards the study of technology applications and available products. In this sense, they should be known, the real possibilities of the use of solar energy in all the sectors, the installation design and all the implementation phases. Although some modules are similar to the installers training process, others would need a greater level of depth and detail.

The specialized education and training in solar energy with the objective of obtaining a postgraduate degree are also very important and the programmes should be adapted to this aim.

Continuous education is other important aspect to be considered in the engineers training. This process allows that specialized engineers in other disciplines may acquire in a short time the required knowledge to work in a new field. Short courses and summer schools are adequate for this purpose.

In the case of architects is important to be considered that although normally they have a sufficient basic knowledge in thermodynamics, hydraulic systems, etc., it is necessary a change of habits in the way of applying these knowledge making them extensive to solar thermal technologies. In this sense, they are used to working with standardize systems that may be used in any part and under any environmental condition (conventional fuel or electricity systems). Although for convenience, they are reluctant to introduce ideas or concepts involving a radical change in its design process.
1.2. Design programs of training

1.2.1. Solar Thermal Technology

<table>
<thead>
<tr>
<th>TRAINING COURSE IN SOLAR THERMAL ENERGY FOR ENGINEERS</th>
</tr>
</thead>
</table>

**Objectives:**
The main objective of this training is to provide education and training in solar thermal energy in two different levels:

At first level, the aim is to understand, analyze and judge the relevance of any contribution in this field in relation to their social environment, energy and scientific-technical.

At the second level, it is necessary to assure specialized training to provide skills in the following aspects:
- Design, analysis, characterization, planning and installation of thermal systems
- Energy efficiency in buildings

**Target Group:**
This training course is focused on engineers with high electrical skills and knowledge in thermodynamics, hydraulic systems, etc.

**Programme:**
The competencies that follow are divided into 5 modules:

**MODULE 1: RENEWABLE ENERGY TECHNOLOGY**
- Session 1.1  World energy scenario
- Session 1.2  Demand and potential for solar thermal energy in B&H
- Session 1.3  Solar radiation and shading

**MODULE 2: SOLAR THERMAL SYSTEMS: TYPOLOGY AND COMPONENTS**
- Session 2.1  Solar thermal systems introduction
- Session 2.2  Solar thermal systems components
- Session 2.3  Regulation of the solar installations

**MODULE 3: SOLAR THERMAL DESIGN AND MAINTENANCE**
- Session 3.1  Design of solar installations
- Session 3.2  Specific applications
- Session 3.3  Execution and maintenance of a solar installations

**MODULE 4: SOLAR ENERGY MANAGEMENT**
- Session 4.1  Study of the feasibility of the project
- Session 4.2  Project formalities
### Session 4.3 The solar energy market in B&H

### Session 4.4 New solar thermal technologies in development

**MODULE 5: VISITS OF SOLAR THERMAL INSTALLATIONS AND MANUFACTURING INDUSTRIES OF SOLAR THERMAL COMPONENTS**

**Forms of Study:**
- Lectures, exercises, laboratory work, assignment, study visits.

**Literature:**

---

**Detailed programme**

**MODULE 1: RENEWABLE ENERGY TECHNOLOGY**

This module includes: energy technology, renewable energy in a sustainable future, the physics and science behind climate change, and why renewable energy is necessary for the future. Students will understand different types and characteristics of renewable energy technology, especially solar thermal technology: how it work, its advantages, disadvantages, and limitations.

<table>
<thead>
<tr>
<th>SESSION 1.1 WORLD ENERGY SCENARIO</th>
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<tbody>
<tr>
<td>- Knowledge about the energy situation worldwide/relevant state, energy consumption, emissions, climate change, carbon dioxide and greenhouse effect.</td>
</tr>
<tr>
<td>- The thermal energy in the EU and B&amp;H</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>SESSION 1.2. DEMAND AND POTENTIAL FOR THERMAL ENERGY IN B&amp;H</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Solar radiation atlas in B&amp;H</td>
</tr>
<tr>
<td>- Possibilities use and development of solar energy in B&amp;H</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 1.3 SOLAR RADIATION AND SHADING</th>
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</thead>
<tbody>
<tr>
<td>- Basic terms: mechanics, radiation, thermodynamics, heat transfer, etc</td>
</tr>
<tr>
<td>- Nature of the solar radiation: Spectral distribution and Direct, diffuse radiation and albedo</td>
</tr>
<tr>
<td>- Movement Sun-Earth: Reference systems, Sun position, Solar hour, Solar</td>
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</tbody>
</table>
**MODULE 2: SOLAR THERMAL SYSTEMS: TYPOLOGY AND COMPONENTS**

The physics of solar thermal systems, especially collectors, properties of suitable materials for collectors, and different types of heat storage. Students will develop models that describe the radiation-heat conversion mathematically. Different types of collectors are compared. The most important technologies in hot climates are extensively studied such as: solar cooking, solar thermosiphon heating systems, and crop drying. Solar air conditioning is also given a special place.

<table>
<thead>
<tr>
<th>SESSION 2.1 SOLAR THERMAL SYSTEMS INTRODUCTION</th>
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<tbody>
<tr>
<td>• The flat solar collector: characteristics, functioning and yield of different market models</td>
</tr>
<tr>
<td>• The vacuum tube solar collector: characteristics, functioning and yield of different market models</td>
</tr>
<tr>
<td>• Collector mounting methods suitable for roof types and selected mounting structural attachments</td>
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<tr>
<td>• Collectors selection</td>
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<tr>
<td>• System configurations of hot water solar systems: thermosiphonic, pumped, open-loop (direct), closed loop (indirect)</td>
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<tr>
<td>• System configurations of heating systems: emission radiant floor systems, swimming pool heating.</td>
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<table>
<thead>
<tr>
<th>SESSION 2.2 SOLAR THERMAL SYSTEMS COMPONENTS</th>
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<tbody>
<tr>
<td>• Heat transfer fluids: Protection against freezing and boiling</td>
</tr>
<tr>
<td>• Piping</td>
</tr>
<tr>
<td>• Storage tanks</td>
</tr>
<tr>
<td>• Thermal insulation</td>
</tr>
<tr>
<td>• Heat exchangers</td>
</tr>
<tr>
<td>• Pumps</td>
</tr>
<tr>
<td>• Other installation elements</td>
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</table>

<table>
<thead>
<tr>
<th>SESSION 2.3 REGULATION OF SOLAR INSTALLATIONS</th>
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<tbody>
<tr>
<td>• System regulation</td>
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<tr>
<td>• Regulation by thermostats</td>
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<tr>
<td>• Regulation by means of temperature difference.</td>
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<tr>
<td>• Regulation and assembly of solar collectors in series and parallel</td>
</tr>
<tr>
<td>• Monitoring of the installation</td>
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</tbody>
</table>
MODULE 3: SOLAR THERMAL DESIGN AND MAINTENANCE

The function and characteristics of different types of solar thermal systems are studied including: small scale, hot water systems, combi-systems, pool systems, collector fields, short term storage, and seasonal storage. Control and operational strategies are studied as well as calculation of heat loads. Simulation programs are used to evaluate a real case study. The case studies come from local housing agencies or other local groups that are interested in installing solar thermal systems. The situation is evaluated, and then the simulations are run to find the most economic system design and size for the given case study.

<table>
<thead>
<tr>
<th>SESSION 3.1 DESIGN OF SOLAR INSTALLATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Basic principles for the optimum use of energy</td>
</tr>
<tr>
<td>• Energy needs study</td>
</tr>
<tr>
<td>• Selection criteria of the solar system type</td>
</tr>
<tr>
<td>• Selection criteria of the auxiliary system type</td>
</tr>
<tr>
<td>• Calculation of the collector area and the solar fraction (introduction to a dimensioning informatics programme)</td>
</tr>
<tr>
<td>• Calculation of the installation elements: heat transport fluid, piping, circulation pumas, expansion vessel, heat exchanger, drain valves and storage tanks</td>
</tr>
<tr>
<td>• Selection of the regulation system</td>
</tr>
<tr>
<td>• Most frequent design errors</td>
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<tr>
<th>SESSION 3.2 SPECIFIC APPLICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Solar hot water production in single family household</td>
</tr>
<tr>
<td>• Solar hot water production in multifamily household.</td>
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<tr>
<td>• Solar hot water production in the service sector buildings: hotels, hospitals, sportive centres, etc.</td>
</tr>
<tr>
<td>• Heated Swimming pool</td>
</tr>
<tr>
<td>• Space heating applications in dwellings</td>
</tr>
<tr>
<td>• Calculation examples of different applications</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>SESSION 3.3 EXECUTION AND MAINTENANCE OF A SOLAR INSTALLATION</th>
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<tbody>
<tr>
<td>• Planning the execution of the installation</td>
</tr>
<tr>
<td>• Phases in the process assembly</td>
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<tr>
<td>• Commissioning the installation</td>
</tr>
<tr>
<td>• Installation delivery</td>
</tr>
<tr>
<td>• Preventive maintenance</td>
</tr>
<tr>
<td>• Corrective maintenance</td>
</tr>
<tr>
<td>• Installation monitoring</td>
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</tbody>
</table>
**MODULE 4: SOLAR ENERGY MANAGEMENT**

This course includes: different measures of financial and economic performance and their relative merits and limitations specifically for solar energy projects, the time value of money and derivation of relevant formulas including but not limited to, B/C ratios, discount rate, IRR, standard and discount payback period, depreciation, and net present benefit. Also studied are approaches for considering uncertainty, financial incentives, and various financing methods of solar systems. Lastly, regulations, legislation, cultural aspects, insurance issues, and subsidy programs are also studied.

### SESSION 4.1 STUDY OF THE FEASIBILITY OF THE PROJECT
- Definitions and process calculation
- General aspects affecting the budget
- Budget calculation, savings, financing and possible subsidies, investment return time
- Budget elaboration and presentation of offers
- Document preparation for permits, administrative approval and possible incentives

### SESSION 4.2 PROJECT FORMALITIES
- Existing legislation and norms: the relevant safety regulations, equipment accreditation
- Project legalization
- Document preparation for permits, administrative approval and possible incentives

### SESSION 4.3 NEW SOLAR THERMAL TECHNOLOGIES IN DEVELOPMENT
- Solar heat for industrial processes
- Solar Cooling
- Water desalination
- Solar drying
- New materials used in the components of a solar installation

### SESSION 4.4 THE SOLAR ENERGY MARKET IN B&H
- Current situation
- Companies directory
- Public support programmes
- Economic or financial payback of solar thermal systems
- References of interest
MODULE 5: VISITS OF SOLAR THERMAL INSTALLATIONS AND MANUFACTURING INDUSTRIES OF SOLAR THERMAL COMPONENTS

This course includes practices and external training activities such as visits to manufacturing industry of solar thermal components (mainly collector) and visits of solar thermal installations.

TRAINING COURSE IN SOLAR THERMAL ENERGY FOR ARCHITECTS

Objectives:
The main objective of this training is to provide education and training in solar thermal energy in two different levels:

At first level understand, analyze and judge the relevance of any contribution in this field in relation to their social environment, energy and scientific-technical.

At the second level, specialized training to provide skills in the following aspects and topics:
- Design, analysis, characterization, planning and installation of thermal systems
- Natural architecture and new energy techniques
- Integration of energy systems in architecture, according to aesthetic and functional criteria
- Energy efficiency in buildings

Target Group:
This training course is focused on architects with knowledge in thermal energy, heating, etc

Programme:
The competencies that follow are divided into 5 modules:

MODULE 1: RENEWABLE ENERGY TECHNOLOGY
- Session 1.1 World energy scenario
- Session 1.2 Demand and potential for solar thermal energy in B&H
- Session 1.3 Solar radiation and shading

MODULE 2: PASSIVE SOLAR ENERGY TECHNOLOGY
- Session 2.1 Natural architecture and new energy techniques

MODULE 3: SOLAR THERMAL SYSTEMS: TYPOLOGY AND APPLICATIONS
- Session 3.1 Solar thermal systems introduction
- Session 3.2 Specific applications
- Session 3.3 Calculation and dimensioning of solar thermal systems

MODULE 4: ARCHITECTURAL INTEGRATION
- Session 4.1 Architectural integration of solar thermal installation
Detailed programme

MODULE 1: RENEWABLE ENERGY TECHNOLOGY

This module includes: energy technology, renewable energy in a sustainable future, the physics and science behind climate change, and why renewable energy is necessary for the future. Students will understand different types and characteristics of renewable energy technology, especially solar thermal technology: how it work, its advantages, disadvantages, and limitations.

SESSION 1.1 WORLD ENERGY SCENARIO

- Knowledge about the energy situation worldwide/relevant state, energy consumption, emissions, climate change, carbon dioxide and greenhouse effect.
- The thermal energy in the EU and B&H

SESSION 1.2. DEMAND AND POTENTIAL FOR THERMAL ENERGY IN B&H

- Solar radiation atlas in B&H
- Possibilities use and development of solar energy in B&H

SESSION 1.3 SOLAR RADIATION AND SHADING

- Basic terms: mechanics, radiation, thermodynamics, heat transfer, etc
### MODULE 2: PASSIVE SOLAR ENERGY TECHNOLOGY

The aim is to understanding of the energy use and thermal energy balance of different types of buildings and the potential for energy savings. Also, the MODULE will deal with passive solar techniques for both heating and cooling, the roll of building design and orientation, daylighting, microclimate, natural ventilation and the integration of active elements for thermal applications.

#### SESSION 2.1 NATURAL ARCHITECTURE AND NEW ENERGY TECHNIQUES

- Energy exchangers. Energetic units. Principles of energy in architecture
- The environmental comfort and energy-environment.
- Passive solar energy techniques
- Energy consumption: building energy balance (gains, losses), hot water consumption, etc.
- Energy saving in buildings

### MODULE 3: SOLAR THERMAL SYSTEMS: TYPOLOGY AND APPLICATIONS

This part will tackle the physics of solar thermal systems, especially collectors, properties of suitable materials for collectors, and different types of heat storage. Students will develop models that describe the radiation-heat conversion mathematically. Different types of collectors are compared. The most important technologies in hot climates are extensively studied such as: solar cooking, solar thermosyphon heating systems, and crop drying. Solar air conditioning is also given a special place.

#### SESSION 3.1 SOLAR THERMAL SYSTEMS INTRODUCTION

- The flat solar collector: characteristics, functioning and yield of different market models
- The vacuum tube solar collector: characteristics, functioning and yield of different market models
- Collector mounting methods suitable for roof types and selected mounting structural attachments
- Collectors selection
- System configurations of hot water solar systems: thermosiphonic, pumped, open-loop (direct), closed loop (indirect)
- System configurations of heating systems: emission radiant floor systems, swimming pool heating.
SESSION 3.2 SPECIFIC APPLICATIONS

- Solar hot water production in single family household
- Solar hot water production in multifamily household.
- Solar hot water production in the service sector buildings: hotels, hospitals, sportive centres, etc.
- Heated Swimming pool
- Space heating applications in dwellings

SESSION 3.3 CALCULATION AND DIMENSIONING OF SOLAR THERMAL SYSTEMS

- Previous data: Demand calculation, climatic zones
- General conditions of the installation: working fluid
- General calculation criteria: Basic dimensioning, collection system (support structure), storage system, etc
- System components
- Calculation of losses: orientation, tilt, shadings
- Calculation examples of different applications

MODULE 4: ARQUITECTURAL INTEGRATION

It is intended that participants gain the skills necessary for integration of energy systems in architecture, according to aesthetic and functional criteria.

SESSION 4.1 ARQUITECTURAL INTEGRATION

- The three levels of integration: social, of management and physical
- The physical integration: Available space, support structure, legal aspects (administrative, of property), relative aspects to roof water proofing and support weight of tank
- Typologies of collective installations for hot water production: Centralize, decentralize systems
- Examples of architectural integration

MODULE 5: LEGAL FRAMEWORK AND FINANCING MECHANISMS

This module includes: regulations, legislation, financing mechanisms, insurance issues, and subsidy programs are analyzed. Lastly, the current solar market in B&H is studied.

SESSION 5.1 LEGAL FRAMEWORK

- Existing legislation and norms : the relevant safety regulations, equipment accreditation
Thermal regulation in B&H: Current situation and predicted evolution. Other international references in the thermal regulation of buildings and in solar energy in particular.

Project legalization

Document preparation for permits, administrative approval and possible incentives

SESSION 5. THE SOLAR ENERGY MARKET IN B&H

- Current situation
- Companies directory
- Public support programmes
- References of interest

MODULE 6: VISITS OF SOLAR THERMAL INSTALLATIONS AND MANUFACTURING INDUSTRIES OF SOLAR THERMAL COMPONENTS

This module includes practices and external training activities such as visits to manufacturing industry of solar thermal components (mainly collector) and visits of solar thermal installations.

1.2.2. Photovoltaic Technology

TRAINING COURSE IN PHOTOVOLTAIC ENGINEERING

Objectives:
The main objective of this training is to provide education and training in solar photovoltaic energy in two different levels:

At first level understand, analyze and judge the relevance of any contribution in this field in relation to their social environment, energy and scientific-technical.

At the second level, specialized training to provide skills in the following aspects:
- Design, analysis, characterization, planning and installation of stand-alone as well grid-connected solar electricity systems and choose components for optimum system performance
- Production, development and innovation of technological processes for the manufacture of photovoltaic devices
- Choose and evaluate computer system simulation programs for photovoltaic systems
- The legal framework and financing mechanism of Photovoltaic energy

Target Group:

ENGINEERS
This training MODULE is addressed to the training of the new-graduated students in technical-scientific subjects (engineers) and the aimed updating technician already operating in private business and public administrations.

**Programme:**
The competencies that follow are divided into 6 modules:

**MODULE 1: RENEWABLE ENERGY AND SOLAR ENERGY TECHNOLOGY**
- **Session 1.1** World energy scenario
- **Session 1.2** Demand and potential for PV energy in B&H
- **Session 1.3** Solar radiation and shading

**MODULE 2: PHYSICS FOR PHOTOVOLTAIC**
- **Session 2.1** Solar cells basis
- **Session 2.2** Physics of photovoltaic materials
- **Session 2.3** Optical design engineering
- **Session 2.4** Applied mathematics to solar energy
- **Session 2.5** Simulation laboratory

**MODULE 3: SOLAR ELECTRICITY**
- **Session 3.1** Basic electronic
- **Session 3.2** Electronic instrumentation
- **Session 3.3** Electrical engineering and power electronics

**MODULE 4: PV AND HYBRID SYSTEM: TYPOLOGIES AND DESIGN**
- **Session 4.1** Stand-alone solar systems
- **Session 4.2** Grid-connected solar electricity
- **Session 4.3** Design of solar installations
- **Session 4.4** Execution and maintenance of a solar installation

**MODULE 5: ECONOMIC AND PROJECT FINANCING OF PHOTOVOLTAIC**
- **Session 5.1** Study of the feasibility of the project
- **Session 5.2** Project formalities
- **Session 5.3** Innovative photovoltaic technologies
- **Session 5.4** The solar energy market in B&H

**MODULE 6: VISITS OF SOLAR PV INSTALLATIONS AND MANUFACTURING INDUSTRIES OF SOLAR PV COMPONENTS**

**Forms of Study:**
- Lectures, exercises, operative work in laboratory supported by teachers and tutors, operative work in laboratory supported by teachers and tutors
- Simulations tools that simplifies the task of evaluating design options for both
off-grid and grid-connected power systems for remote, stand-alone and distributed generation (DG) applications. (i.e. HOMER, TRNSYS,..)

Literature:
- UNESCO energy engineering series. Energy engineering learning package, ISSN

Detailed programme

MODULE 1: RENEWABLE ENERGY AND SOLAR ENERGY TECHNOLOGY

This module includes: energy technology, renewable energy in a sustainable future, the physics and science behind climate change, and why renewable energy is necessary for the future. Students will understand different types and characteristics of renewable energy technology, especially solar PV technology: how it work, its advantages, disadvantages, and limitations.

<table>
<thead>
<tr>
<th>SESSION 1.1 WORLD ENERGY SCENARIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Knowledge about the energy situation worldwide/relevant state, energy consumption, emissions, climate change, carbon dioxide and greenhouse effect.</td>
</tr>
<tr>
<td>• The PV energy in the EU and B&amp;H</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 1.2. DEMAND AND POTENTIAL FOR PV ENERGY IN B&amp;H</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Solar radiation atlas in B&amp;H</td>
</tr>
<tr>
<td>• Possibilities use and development of solar energy in B&amp;H</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SESSION 1.3 SOLAR RADIATION AND SHADING</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nature of the solar radiation: Spectral distribution and Direct, diffuse radiation and albedo</td>
</tr>
<tr>
<td>• Movement Sun-Earth: Reference systems, Sun position, Solar hour, Solar trajectory and incidence angle</td>
</tr>
<tr>
<td>• Components of the solar radiation: Brightness index and diffuse fraction, Calculation of irradiation average, Shading analysis</td>
</tr>
</tbody>
</table>

MODULE 2: PHYSICS FOR PHOTOVOLTAIC
In this module the basics of solar engineering are studied: the basic properties of solar radiation and its measurements, and the effect of orientation and slope of receiving surfaces, optical properties of materials are reviewed and discussed, the physics of photovoltaic devices and how they can be modelled mathematically, how these devices are manufactured, how the devices are tested, and how they need to be connected and packaged to provide practical power producing modules. Electrical energy storage and control is also studied. Simulation programs are used to evaluate a real case study.

### SESSION 2.1 SOLAR CELLS BASIS
- Principles of Physics semiconductors  Physics
- P-N junction. From P-N junction to solar cell
- Characteristic equations  and electric y circuital parameters
- Types of solar cells
- Structures and concepts for high efficiency

### SESSION 2.2. PHYSICS OF PHOTOVOLTAIC MATERIALS
- Conductors and semiconductors materials, crystalline and amorphous.
- Crystalline structure. Electronic structure.
- Principles of statistical physics of electrons, photons and phonons.
- Balance, weak excitance, transport phenomenon and strong fields.
- Mechanisms and statistics of generation-recombination.
- Photonic absorption, optical properties and parameters.
- Basic semiconductor equations

### SESSION 2.3. OPTICAL DESIGN ENGINEERING
- The optical engineering
- Geometrical optics.
- Radiometry and photometry
- Characterization of optical materials: mirrors, glass, plastics.
- Using software tools
- Photovoltaic concentrator
- Lighting with LEDs

### SESSION 2.4 APPLIED MATHEMATICS TO SOLAR ENERGY
- Spherical trigonometry. Applications to the calculation of solar paths,
- Directions of incidence of lightning, shadows, etc..

- Differential equations. Spatial and temporal response of physical systems.
- Curve fitting. Implicit and nonlinear models

### SESSION 2.5 SIMULATION LABORATORY
- Solar cells Characterization
- Modules and photovoltaic systems

### MODULE 3: SOLAR ELECTRICITY

#### SESSION 3.1 BASIC ELECTRONIC
- Electronic introduction
- Junction diode
- Bipolar transistors
- Field effect transistors
- Basic amplifier circuits.
- Basic integrated circuit.
- Circuit Switching

#### SESSION 3.2 ELECTRONIC INSTRUMENTATION
- General principles of instrumentation
- Electronic circuits in instrumentation
- Noise and interference in instrumentation
- Collectors Information
- Measurement of physical quantities
- Advanced sensors
- Electronic Advanced instrumentation

#### SESSION 3.3 ELECTRICAL ENGINEERING AND POWER ELECTRONICS
- Three-phase system. Generation, transmission and distribution
- Electrical systems. Protections
- Electromechanical and electronic converters
- Transformers
Machines a.c and electronic monitoring. Asynchronous and synchronous

Machines c.c and electronic monitoring.

MODULE 4: PV AND HYBRID SYSTEM: TYPOLOGIES AND DESIGN

The module includes detailed designs for PV and hybrid systems, both for standalone and grid-connected applications. Also it tackles combined heat and power generation from the sun, real case studies under supervision, the understanding of system types, general design concepts, and the components required in them as well as the economic analysis of the system.

Control and operational strategies are studied as well as calculation of heat loads. Simulation programs are used to evaluate a real case study. The situation is evaluated, and then the simulations are run to find the most economic system design and size for the given case study.

SESSION 4.1 STAND-ALONE SOLAR SYSTEMS

- Basic stand-alone PV installations typologies
- Specifications for the components: International standards for the stand-alone PV systems and Universal technical regulations
- System of measurement, checking and certification
- Energy dispenser-counter
- Examples of different applications

SESSION 4.2 GRID-CONNECTED SOLAR ELECTRICITY

- Grid-connected typologies
- Specifications for the components: International standards for the stand-alone PV systems and Universal technical regulations
- System of measurement, checking and certification
- Energy dispenser-counter
- Examples of different applications

SESSION 4.3 DESIGN OF SOLAR INSTALLATIONS

- Basic principles for the optimum use of energy
- Energy needs study
- Selection criteria of the solar system type
- Selection criteria of the auxiliary system type
- Calculation of the size of photovoltaic array and the solar fraction (introduction to a dimensioning informatics programme)
- Calculation of the installation elements: Accumulator capacity, PV charge controller, Inverter, data logging
- Most frequent design errors

### SESSION 4.4 EXECUTION AND MAINTENANCE OF A SOLAR INSTALLATION
- Planning the execution of the installation
- Phases in the process assembly
- Commissioning the installation
- Installation delivery
- Preventive maintenance
- Corrective maintenance
- Installation monitoring

### MODULE 5: ECONOMIC AND PROJECT FINANCING OF PHOTOVOLTAIC
This module includes: different measures of financial and economic performance and their relative merits and limitations specifically for solar energy projects, the time value of money and derivation of relevant formulas including but not limited to, B/C ratios, discount rate, IRR, standard and discount payback period, depreciation, and net present benefit. Also studied are approaches for considering uncertainty, financial incentives, and various financing methods of solar systems. Lastly, regulations, legislation, cultural aspects, insurance issues, and subsidy programs are also studied.

### SESSION 5.1 STUDY OF THE FEASIBILITY OF THE PROJECT
- Definitions and process calculation
- General aspects affecting the budget
- Budget calculation, savings, financing and possible subsidies, investment return time
- Budget elaboration and presentation of offers
- Document preparation for permits, administrative approval and possible incentives

### SESSION 5.2 PROJECT FORMALITIES
- Existing legislation and norms: the relevant safety regulations, equipment accreditation
- Project legalization
- Document preparation for permits, administrative approval and possible incentives
SESSION 5.3 INNOVATIVE PHOTOVOLTAIC TECHNOLOGIES

- Semiconductor III-V
- Thin-film crystalline silicon photovoltaic devices
- Third generation photovoltaic

SESSION 5.4 THE SOLAR ENERGY MARKET IN B&H

- Current situation
- Companies directory
- Public support programmes
- Economic or financial payback of solar PV systems
- References of interest

MODULE 6: VISITS OF SOLAR PV INSTALLATIONS AND MANUFACTURING INDUSTRIES OF SOLAR PV COMPONENTS

This module includes practices and external training activities such as visits to manufacturing industry of solar PV components and visits of solar PV installations.

TRAINING COURSE IN PHOTOVOLTAIC ENERGY FOR ARCHITECTS

**Objectives:**

The main objective of this training is to provide education and training in photovoltaic energy in two different levels:

At first level understand, analyze and judge the relevance of any contribution in this field in relation to their social environment, energy and scientific-technical.

At the second level, specialized training to provide skills in the following aspects and topics:

- Design, analysis, characterization, planning and installation of PV systems
- Natural architecture and new energy techniques
- Integration of PV systems in architecture, according to aesthetic and functional criteria
- Energy saving in buildings

**Target Group:**

This training course is addressed to the training of the new-graduated architects and the aimed updating technician already operating in private business and public administrations.

**Programme:**

28 of 53
The competencies that follow are divided into 4 modules:

**MODULE 1: RENEWABLE ENERGY AND SOLAR ENERGY TECHNOLOGY**

- **Session 1.1** World Energy Scenario
- **Session 1.2** Demand and potential for PV energy in B&H
- **Session 1.3** Solar radiation and shading

**MODULE 2: PV SYSTEM: TYPOLOGIES AND DESIGN**

- **Session 2.1** Stand-alone solar systems
- **Session 2.2** Grid-connected solar electricity
- **Session 2.3** Calculation and dimensioning of solar thermal systems

**MODULE 3: ARCHITECTURAL INTEGRATION**

- **Session 3.1** Architectural integration of solar PV installation

**MODULE 4: LEGAL FRAMEWORK AND FINANCING MECHANISMS**

- **Session 4.1** Legal framework
- **Session 4.2** The solar energy market in B&H

**MODULE 5: VISITS OF SOLAR PV INSTALLATIONS**

**Forms of Study:**
- Lectures, exercises, laboratory work, assignment, study visits.

**Literature:**

**Detailed programme**

**MODULE 1: RENEWABLE ENERGY AND SOLAR ENERGY TECHNOLOGY**

This module includes: energy technology, renewable energy in a sustainable future, the physics and science behind climate change, and why renewable energy is necessary for the future. Students will understand different types and characteristics of renewable energy technology, especially solar PV technology: how it work, its advantages, disadvantages, and limitations.
### SESSION 1.1 WORLD ENERGY SCENARIO
- Knowledge about the energy situation worldwide/relevant state, energy consumption, emissions, climate change, carbon dioxide and greenhouse effect.
- The PV energy in the EU and B&H

### SESSION 1.2 DEMAND AND POTENTIAL FOR PV ENERGY IN B&H
- Solar radiation atlas in B&H
- Possibilities use and development of solar energy in B&H

### SESSION 1.3 SOLAR RADIATION AND SHADING
- Nature of the solar radiation: Spectral distribution and Direct, diffuse radiation and albedo
- Movement Sun-Earth: Reference systems, Sun position, Solar hour, Solar trajectory and incidence angle
- Components of the solar radiation: Brightness index and diffuse fraction, Calculation of irradiation average, Shading analysis

### MODULE 2: PV SYSTEM: TYPOLOGIES AND DESIGN
Detailed designs for PV systems, both for standalone and grid-connected applications. Real case studies under supervision. Understanding of system types and general design concepts, the components required in them as well as the economic analysis of the system.

### SESSION 2.1 STAND-ALONE SOLAR SYSTEMS
- Basic stand-alone PV installations typologies
- Specifications for the components: International standards for the stand-alone PV systems and Universal technical regulations
- System of measurement, checking and certification
- Energy dispenser-counter
- Examples of different applications

### SESSION 2.2 GRID-CONNECTED SOLAR ELECTRICITY
- Grid-connected typologies
- Specifications for the components: International standards for the stand-alone PV systems and Universal technical regulations
- System of measurement, checking and certification
- Energy dispenser-counter
MODULE 3: ARQUITECTURAL INTEGRATION

It is intended that participants gain the skills necessary for integration of energy systems in architecture, according to aesthetic and functional criteria.

SESSION 3.1 ARQUITECTURAL INTEGRATION

- The three levels of integration: social, of management and physical
- The physical integration: Available space, support structure, legal aspects (administrative, of property), relative aspects to roof water proofing and support weight of installation
- Integration of PV systems in architecture, according to aesthetic and functional criteria
- Examples of architectural integration

MODULE 4: LEGAL FRAMEWORK AND FINANCING MECHANISMS

This module includes: regulations, legislation, financing mechanisms, insurance issues, and subsidy programs are analyzed. Lastly, the current solar market in B&H is studied.

SESSION 4.1 LEGAL FRAMEWORK

- Existing legislation and norms : the relevant safety regulations, equipment accreditation
- Thermal regulation in B&H: Current situation and predicted evolution. Other international references in the thermal regulation of buildings and in solar energy in particular.
- Project legalization
- Document preparation for permits, administrative approval and possible incentives

SESSION 4.2 THE SOLAR ENERGY MARKET IN B&H

- Current situation
- Companies directory
- Public support programmes
- References of interest

MODULE 5: VISITS OF SOLAR PV INSTALLATIONS

This module includes practices and external training activities such as visits of solar thermal installations.
2. Training in solar energy for installers

2.1. Evaluation of need

The Role for installers

Knowledgeable and motivated installers are a key condition for the success of solar installations mainly solar thermal. In this sense, installers are the first to be asked about heating systems by private households. On the one hand, motivated craftsmen take over an active role in marketing solar thermal systems. On the other hand, installers, who lack experience with this technology, tend to discourage potential buyers from solar thermal.

Additionally, the lack of specific skill needed to install solar thermal and PV components can lead to faulty installations. In several countries, bad installations have damaged the otherwise good reputation of these technologies in the past. The quality of the hardware is an important issue. As has been mentioned in the strategic guidelines drawn in deliverable 7, with the Solar Keymark, the European Solar Thermal Industry Federation (ESTIF) has established a quality label, which helps the consumer to choose good quality products, which satisfy the European EN standards.

The Need for Training

Quality installations need not only good hardware, but also skilled installers. Knowledge and motivation can best be improved through training. Ideally, training in solar thermal is integrated in the standard training of installers. But to-day, training in renewable energies is still seen as an add-on, and installers have to pay extra money for it.

In the more dynamic markets installers see solar thermal as an opportunity to expand their business and are more willing to invest this extra costs. But others stay with conventional heating products. This has proven to be a barrier for the growth of solar thermal and solar PV.

Courses typologies

In countries with consolidated markets there exists a great variety of courses with different timing lengths from one day till several months and with diverse contents and quality.

Some of these courses are for attendance, others are on-line or distant and others are mix with a combination of both types of sessions. Although all of them can be valid for different content explanation, practical sessions are very important for installers training.

2.2. Design programs of training

In this chapter are described the key competencies for the installation of solar water heating systems and of PV solar systems covering in the first case all aspects of domestic solar water heating installation and their various system configurations. It provides a list of tasks which installers must be able to undertake to be classified as competent installers. These tasks are applicable to the installation contractor, not to the system designer and in the case of solar water heating systems this task list assumes that the installation contractor starts with a reputable solar water heating system package, complete with major components, manufacturer's installation manual, system schematics, and assembly and troubleshooting instructions.
While the installation contractor may not design the system, in many cases they must be knowledgeable about many aspects of system design. It may be necessary for the installer to adapt designs to fit a particular application or customer need.

It is indispensable that seminars covering these Key Competencies include at least one day practical training with solar thermal installations being fully workable.

2.2.1. Solar Thermal Technology

<table>
<thead>
<tr>
<th>TRAINING COURSE OF INSTALLATION AND MAINTENANCE OF SOLAR WATER HEATING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objectives:</strong></td>
</tr>
<tr>
<td>The main objective of the training is provide installers with the skills required to install a solar water heating system that meets the performance and reliability needs of the customer, incorporates quality craftsmanship, and complies with all applicable codes and standards, with the help of basic instructions, manufacturer installation manual, specifications of major components, schematics and drawings. The installer must be able to demonstrate the key competencies detailed in this document.</td>
</tr>
<tr>
<td><strong>Target Group:</strong></td>
</tr>
<tr>
<td>As a result each student is expected to have plumbing and basic electrical skills before starting a course in the installation of solar water heating system. For plumbing these skills include cutting pipe, soldering pipe joints, gluing pipe joints, lagging, sealing fittings, testing for leaks and installation of vented and unvented heating systems. With regards to electrical aspects, the installer should be familiar with basic electrical concepts and terms. They should have the ability to understand wiring diagrams and be able to do electrical wiring and create weatherproof connections.</td>
</tr>
<tr>
<td><strong>Programme:</strong></td>
</tr>
<tr>
<td>The competencies that follow are divided into the following modules and topics:</td>
</tr>
<tr>
<td><strong>MODULE 1: RENEWABLE ENERGY AND SOLAR ENERGY TECHNOLOGY</strong></td>
</tr>
<tr>
<td>Session 1.1 World Energy Scenario</td>
</tr>
<tr>
<td>Session 1.2 Demand and potential for solar energy in B&amp;H</td>
</tr>
<tr>
<td>Session 1.3 About Environment and Ecology</td>
</tr>
<tr>
<td><strong>MODULE 2: SOLAR RADIATION</strong></td>
</tr>
<tr>
<td>Session 2.1 Solar Energy Introduction</td>
</tr>
<tr>
<td><strong>MODULE 3: THERMAL SYSTEMS COMPONENTS</strong></td>
</tr>
<tr>
<td>Session 3.1 Introduction to Solar water heating systems</td>
</tr>
<tr>
<td>Session 3.2 Identifying and sizing system components</td>
</tr>
<tr>
<td>Session 3.3 Conducting a site assessment</td>
</tr>
<tr>
<td>Session 3.4 Determining system layout and planning installation</td>
</tr>
</tbody>
</table>
Session 3.5 Roofing techniques

MODULE 4: PRACTICAL CASES: HOT WATER HEATING SYSTEMS INSTALLATION

- Session 4.1 Installing solar collectors
- Session 4.2 Installing hot water storage tank(s)
- Session 4.3 Installation of auxiliary components
- Session 4.4 Installing electrical control systems
- Session 4.5 Installing components of close-loop (indirect) systems
- Session 4.6 Operation and identification tags and labels
- Session 4.7 Health & Safety and Legislation

MODULE 5: OPERATION AND MAINTENANCE

- Session 5.1 Performing a system check
- Session 5.2 Maintaining a solar water heating system

MODULE 6: CUSTOMER EDUCATION

- Session 6.1 Basic training to the user about the installation

**Results:**

- Make the users aware of the worldwide energy problems and benefits of using renewable energies.
- Technicians trained for installation and maintenance works of solar thermal systems of SHW.
- Design of preventive and corrective maintenance protocols in order to systematize these tasks and assure the quality of service given to users.

**Support documentation:**

- Regulations on installations solar thermal systems.
- Model cards for the preventive and corrective maintenance follow up of solar thermal installations and maintenance protocol.

**Detailed programme**

**Tasks and skills**

The tasks given below could be categorised according to their priority using three levels; *must*, *important* and *additional*. *Must* tasks are those involving safety and as such are considered to be essential. The second level, *important*, relate to tasks that if not carried out correctly would result in system failure. The third level, additional, relates to tasks which should be carried out as part of good working practice.
## MODULE 1: RENEWABLE ENERGY AND SOLAR ENERGY TECHNOLOGY

### SESSION 1.1 WORLD ENERGY SCENARIO

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
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<tbody>
<tr>
<td>Knowledge about the energy situation worldwide/relevant state, energy consumption, emissions, climate change, carbon dioxide and greenhouse effect.</td>
<td>Additional</td>
</tr>
<tr>
<td>The renewable energies in the world and B&amp;H</td>
<td>Additional</td>
</tr>
</tbody>
</table>

### SESSION 1.2 DEMAND AND POTENTIAL FOR SOLAR ENERGY IN B&amp;H

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar resources in B&amp;H</td>
<td>Important</td>
</tr>
<tr>
<td>Possibilities use and development of solar energy in B&amp;H</td>
<td>Important</td>
</tr>
</tbody>
</table>

### SESSION 1.3 ABOUT ENVIRONMENT AND ECOLOGY

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about the energy demand and the percentage of different consumer groups in dwellings (heating, hot water preparation, …)</td>
<td>Additional</td>
</tr>
</tbody>
</table>

## MODULE 2: SOLAR RADIATION

### SESSION 2.1 SOLAR ENERGY INTRODUCTION

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic terms of solar energy</td>
<td>Important</td>
</tr>
<tr>
<td>Solar radiation, ambient data</td>
<td>Additional</td>
</tr>
<tr>
<td>Physical basics, global radiation, strength of irradiation, annual/daily regime</td>
<td>Additional</td>
</tr>
</tbody>
</table>

## MODULE 3: THERMAL SYSTEMS COMPONENTS

### SESSION 3.1 INTRODUCTION TO SOLAR WATER HEATING SYSTEMS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>The different collector types and system configurations</td>
<td>Additional</td>
</tr>
<tr>
<td>All possible other components (installation, dimensioning, maintenance, …)</td>
<td>Important</td>
</tr>
<tr>
<td>The pros and cons of solar water heating systems and specific system components and system configurations</td>
<td>Additional</td>
</tr>
</tbody>
</table>
- Industry codes of practice for the operation of a reputable installation business and why these are additional: **Important**
- How to market solar water heating systems, incentives, factories, economy: **Additional**
- The typical energy savings that can be made by a typical domestic solar water heating system and how to convert this into a meaningful value that a customer can understand: **Additional**

### SESSION 3.2 IDENTIFYING AND SIZING SYSTEM COMPONENTS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate the daily hot water request, selection of a proper hydraulic system</td>
<td>Important</td>
</tr>
<tr>
<td>Identify and size components specific to a pumped open-loop (direct) solar system (For example: collector, tank, pump, controller, sensors, isolation and drain valves, pressure and temperature relief valves, air vent, piping, insulation, flashing)</td>
<td>Important</td>
</tr>
<tr>
<td>Identify and size components specific to a pumped closed-loop (indirect) solar system</td>
<td>Important</td>
</tr>
<tr>
<td>Identify and size components specific to a thermosiphonic open-loop (direct) solar system</td>
<td>Additional</td>
</tr>
<tr>
<td>Identify and size components specific to a thermosiphonic closed-loop (indirect) solar system</td>
<td>Additional</td>
</tr>
</tbody>
</table>

### SESSION 3.3 CONDUCTING A SITE ASSESSMENT

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine the required roof surface area and understand the required orientation and tilt for proposed collector installation.</td>
<td>Important</td>
</tr>
<tr>
<td>Establish whether there is a suitable roof area or other location with unobstructed solar gain for installing the collector</td>
<td>Important</td>
</tr>
<tr>
<td>Determine the extent of shading for any proposed collector location using typical sun path calculators or similar methods</td>
<td>Important</td>
</tr>
<tr>
<td>Assess roof construction, truss spacing, age and structural integrity for suitability of collector(s) installation</td>
<td>Must</td>
</tr>
<tr>
<td>Determine suitable locations for installing all subsystem components (this includes piping, water heater, valves, and ancillary equipment required for complete system installation)</td>
<td>Important</td>
</tr>
<tr>
<td>Identify and assess any site-specific safety hazards or other issues associated with the installation of the solar system</td>
<td>Must</td>
</tr>
<tr>
<td>Identify any other constraints and options for the installation including local and state code requirements</td>
<td>Additional</td>
</tr>
<tr>
<td>Verify with the homeowner the proposed location of the collector and other major components</td>
<td>Important</td>
</tr>
</tbody>
</table>
### SESSION 3.4 DETERMINING SYSTEM LAYOUT AND PLANNING INSTALLATION

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine a pumped open-loop (direct) solar system components’ location and system layout and configuration</td>
<td>Important</td>
</tr>
<tr>
<td>Determine a pumped closed-loop (indirect) solar system components’ location and system layout and configuration</td>
<td>Important</td>
</tr>
<tr>
<td>Determine a thermosyphon open-loop (direct) solar system components’ location and system layout and configuration</td>
<td>Important</td>
</tr>
<tr>
<td>Determine a thermosyphon closed-loop (indirect) solar system components’ location and system layout and configuration</td>
<td>Important</td>
</tr>
<tr>
<td>Apply for building permits</td>
<td>Additional</td>
</tr>
<tr>
<td>Estimate time, materials, tools and labour required for installation</td>
<td>Important</td>
</tr>
<tr>
<td>Inspect all provided system components for damage and completion prior to installation</td>
<td>Must</td>
</tr>
<tr>
<td>Determine the installation sequence to optimise use of time and materials</td>
<td>Important</td>
</tr>
</tbody>
</table>

### SESSION 3.5 ROOFING TECHNIQUES

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate the roof warranty to ensure that the work is performed in such a manner that it does not void the warranty</td>
<td>Important</td>
</tr>
<tr>
<td>Install roofing battens</td>
<td>Important</td>
</tr>
<tr>
<td>Lay roofing tiles and materials</td>
<td>Important</td>
</tr>
<tr>
<td>Cut and drill roofing materials</td>
<td>Important</td>
</tr>
<tr>
<td>Install flashing and maintain a weatherproof seal where the roof has been penetrated.</td>
<td>Important</td>
</tr>
<tr>
<td>Use proper protective equipment and techniques to ensure installer and public safety when working at heights and on roofs</td>
<td>Must</td>
</tr>
</tbody>
</table>

### MODULE 4: PRACTICAL CASES: HOT WATER HEATING SYSTEMS INSTALLATION

### SESSION 4.1 INSTALLING SOLAR COLLECTORS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify different collector mounting methods suitable for roof types</td>
<td>Important</td>
</tr>
<tr>
<td>Identify locations for roof penetrations and structural attachments</td>
<td>Important</td>
</tr>
<tr>
<td>Assess the suitability of selected mounting structural attachments and compliance with applicable local codes</td>
<td>Important</td>
</tr>
<tr>
<td>Determine multi-collector piping layout</td>
<td>Important</td>
</tr>
<tr>
<td>Install collector mounting components on the roof</td>
<td>Important</td>
</tr>
</tbody>
</table>
- Weather seal roof and other structural devices with flashing and sealants  | Important
- Safely lift collectors to the roof  | Must
- Safely work at height and on roofs  | Must
- Attach mounting bracket and struts (if required) to collector  | Important
- Secure collector to collector mounting device  | Must
- Connect collector to piping  | Important

### SESSION 4.2. INSTALLING HOT WATER STORAGE TANK(S)

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine location for a the storage tank and if floor construction can hold the weight of the full tank</td>
<td>Important</td>
</tr>
<tr>
<td>Prepare the area for storage tank installation and auxiliary heat source connection (example electricity or gas)</td>
<td>Important</td>
</tr>
<tr>
<td>Determine the correct tank connections</td>
<td>Important</td>
</tr>
<tr>
<td>Determine plumbing retrofit method to be used when integrating with existing water heating systems.</td>
<td>Important</td>
</tr>
<tr>
<td>Install drain plug as per local codes</td>
<td>Important</td>
</tr>
<tr>
<td>Remove the old conventional water heater tank, if required</td>
<td>Additional</td>
</tr>
<tr>
<td>Connect fittings to the water heater and storage tank</td>
<td>Important</td>
</tr>
<tr>
<td>Install tank valves (for example drain, pressure and temperature relief)</td>
<td>Important</td>
</tr>
<tr>
<td>Connect plumbing and valves between primary tank and secondary tank (if required)</td>
<td>Important</td>
</tr>
<tr>
<td>Connect water heater and/or storage tank to water source</td>
<td>Important</td>
</tr>
<tr>
<td>Fill tank with water</td>
<td>Important</td>
</tr>
<tr>
<td>Connect the water heater and/or storage tank to solar circuit and back up energy source</td>
<td>Important</td>
</tr>
<tr>
<td>Determine that water heater and storage tanks are installed per manufacturers’ recommendations and codes</td>
<td>Important</td>
</tr>
<tr>
<td>Determine that installed tank and fittings have no leaks</td>
<td>Important</td>
</tr>
<tr>
<td>Install exterior tank insulation blanket if required</td>
<td>Important</td>
</tr>
</tbody>
</table>

### SESSION 4.3 INSTALLATION OF AUXILIARY COMPONENTS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine additional components required for a solar water heating system. (This includes the following; air vents, check valves, drain valve, auto drain down, flow control, isolation valves, diverting valves, solenoid operated valves, mixing valves, pressure relief valves, as well as flow meters, temperature sensors, pressure gauges, monitoring systems)</td>
<td>Important</td>
</tr>
<tr>
<td>Determine location of auxiliary components</td>
<td>Important</td>
</tr>
</tbody>
</table>
- Install typical auxiliary and monitoring components as specified in manufacturers’ installation manual and system schematic
- Determine pump location
- Install the pump according to the manufacturers installation manual

### MODULE 4.4 INSTALLING ELECTRICAL CONTROL SYSTEMS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine the location of the controller</td>
<td>Important</td>
</tr>
<tr>
<td>Install a differential controller and sensors, including electrical connections</td>
<td>Important</td>
</tr>
<tr>
<td>Install a timer controller, including electrical connections</td>
<td>Important</td>
</tr>
<tr>
<td>Select and install ultraviolet radiation protective method for external sensor wiring</td>
<td>Important</td>
</tr>
<tr>
<td>Test operation of controller</td>
<td>Important</td>
</tr>
<tr>
<td>Understand and be able to change control settings</td>
<td>Important</td>
</tr>
</tbody>
</table>

### MODULE 4.5 INSTALLING COMPONENTS OF CLOSE-LOOP (INDIRECT) SYSTEMS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install an expansion tank</td>
<td>Important</td>
</tr>
<tr>
<td>Install an external heat exchanger</td>
<td>Important</td>
</tr>
<tr>
<td>Install a low-pressure relief valve</td>
<td>Important</td>
</tr>
<tr>
<td>Install a pressure gauge</td>
<td>Important</td>
</tr>
<tr>
<td>Select appropriate heat transfer fluid</td>
<td>Important</td>
</tr>
<tr>
<td>Fill collector heat transfer loop with heat transfer fluid</td>
<td>Important</td>
</tr>
</tbody>
</table>

### MODULE 4.6 INSTALLING OPERATION AND IDENTIFICATION TAGS AND LABELS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine components that require identification tag and/or label</td>
<td>Additional</td>
</tr>
<tr>
<td>Install identification tags and/or label</td>
<td>Additional</td>
</tr>
</tbody>
</table>

### MODULE 4.7 HEALTH & SAFETY AND LEGISLATION

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhere to the relevant safety regulations and conduct works in a safe and proper manner</td>
<td>Must</td>
</tr>
<tr>
<td>Work safely with tools</td>
<td>Must</td>
</tr>
<tr>
<td>Work safely at height</td>
<td>Must</td>
</tr>
</tbody>
</table>
• Work safely with electricity
• Maintain a work site in such a manner that it is safe for workers, visitors and the public
• Adhere to relevant state and European legislation that may well apply to any part of the installation

MODULE 5: OPERATION AND MAINTENANCE

SESSION 5.1 PERFORMING A SYSTEM CHECK

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify any deficiencies in materials, workmanship, function or appearance by visually inspecting entire installation</td>
<td>Important</td>
</tr>
<tr>
<td>Determine that the system mechanical installation has structural integrity and is weather sealed</td>
<td>Must</td>
</tr>
<tr>
<td>Determine that the system plumbing installation is correctly installed and free from leaks.</td>
<td>Important</td>
</tr>
<tr>
<td>Determine that the electrical installation is correctly installed</td>
<td>Must</td>
</tr>
<tr>
<td>Verify system start-up and shut-down functionality</td>
<td>Important</td>
</tr>
<tr>
<td>Verify overall system operation and functionality</td>
<td>Important</td>
</tr>
</tbody>
</table>

SESSION 5.2 MAINTAINING A SOLAR WATER HEATING SYSTEM

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify system components that pose safety hazards</td>
<td>Must</td>
</tr>
<tr>
<td>Demonstrate proficiency in the proper and safe use of tools and materials required for maintenance and troubleshooting</td>
<td>Must</td>
</tr>
<tr>
<td>Interpret installation manual, wiring diagrams, drawings, and other specifications to plan maintenance or repair work</td>
<td>Important</td>
</tr>
<tr>
<td>Determine evaluation points for system monitoring, maintenance and troubleshooting</td>
<td>Important</td>
</tr>
<tr>
<td>Identify cause of problems based on evaluation results</td>
<td>Important</td>
</tr>
<tr>
<td>Determine regular maintenance interval depending on manufacturers manual</td>
<td>Important</td>
</tr>
<tr>
<td>Maintain a system (database) of information from all installed systems</td>
<td>Additional</td>
</tr>
</tbody>
</table>

MODULE 6: CUSTOMER EDUCATION

SESSION 6.1 CUSTOMER EDUCATION

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate to the owner operation and functionality of system</td>
<td>Important</td>
</tr>
<tr>
<td>Demonstrate to the owner start-up and shut-down procedures for system</td>
<td>Important</td>
</tr>
</tbody>
</table>
Demonstrate to owner simple maintenance and diagnostic procedures
Identify for owner all markings and labels for system service and owner interaction
Identify for owner safety issues associated with operation and maintenance of system
Complete and transfer documentation package to system owner/operators
Review system/component warranties and requirements with owner

2.2.2. Photovoltaic Technology

2.2.2. TRAINING COURSE OF INSTALLATION AND MAINTENANCE OF PHOTOVOLTAIC SYSTEMS

Objectives:
The main objective of the training is to provide installers with the skills required to install a photovoltaic system that meets the performance and reliability needs of the customer, incorporates quality craftsmanship, and complies with all applicable codes and standards, with the help of basic instructions, manufacturer installation manual, specifications of major components, schematics and drawings. The installer must be able to demonstrate the key competencies detailed in this document.

Target Group:
As a result each student is expected to have electrical skills before starting a MODULE in the installation of solar photovoltaic system. The installer should be familiar with basic electrical concepts and terms. They should have the ability to understand wiring diagrams and be able to do electrical wiring.

Programme:
The competencies that follow are divided into the following modules and topics:

MODULE 1: RENEWABLE ENERGY AND SOLAR ENERGY TECHNOLOGY

  Session 1.1 World Energy Scenario
  Session 1.2 Demand and potential for solar energy in B&H
  Session 1.3 About Environment and Ecology

MODULE 2: SOLAR RADIATION

  Session 2.1 Solar Energy Introduction

MODULE 3: PHOTOVOLTAIC COMPONENTS

  Session 3.1 Introduction to Solar Photovoltaic systems

MODULE 4: PV SYSTEM: TYPOLOGIES AND BASIC DESIGN
Results:

- Make the users aware of the worldwide energy problems and benefits of using renewable energies.
- Technicians trained for installation and maintenance works of solar thermal systems of SHW.
- Design of preventive and corrective maintenance protocols in order to systematize these tasks and assure the quality of service given to users.

Support documentation:

- Regulations on installations photovoltaic systems.
- Model cards for the preventive and corrective maintenance follow up of solar photovoltaic installations and maintenance protocol.

Detailed programme

Tasks and skills

The tasks given below could be categorised according to their priority using three levels; must, important and additional. Must tasks are those involving safety and as such are considered to be essential. The second level, important, relate to tasks that if not carried out correctly would result in system failure. The third level, additional, relates to tasks which should be carried out as part of good working practice.
## MODULE 1: RENEWABLE ENERGY AND SOLAR ENERGY TECHNOLOGY

### SESSION 1.1 WORLD ENERGY SCENARIO

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about the energy situation worldwide/relevant state, energy consumption, emissions, climate change, carbon dioxide and greenhouse effect.</td>
<td>Additional</td>
</tr>
<tr>
<td>The renewable energies in the world and B&amp;H</td>
<td>Additional</td>
</tr>
</tbody>
</table>

### SESSION 1.2 DEMAND AND POTENTIAL FOR SOLAR ENERGY IN B&H

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar resources in B&amp;H</td>
<td>Important</td>
</tr>
<tr>
<td>Possibilities use and development of solar energy in B&amp;H</td>
<td>Important</td>
</tr>
</tbody>
</table>

### SESSION 1.3 ABOUT ENVIRONMENT AND ECOLOGY

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about the energy demand and the percentage of different consumer groups in dwellings (heating, hot water preparation, ...)</td>
<td>Additional</td>
</tr>
</tbody>
</table>

## MODULE 2: SOLAR RADIATION

### SESSION 2.1 SOLAR ENERGY INTRODUCTION

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic terms of solar energy</td>
<td>Important</td>
</tr>
<tr>
<td>Solar radiation, ambient data</td>
<td>Additional</td>
</tr>
<tr>
<td>Physical basics, global radiation, strength of irradiation, annual/daily regime</td>
<td>Additional</td>
</tr>
</tbody>
</table>

## MODULE 3: SOLAR PHOTOVOLTAIC SYSTEMS

### SESSION 3.1 COMPONENTS OF A PV INSTALLATION

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>The solar cells</td>
<td>Must</td>
</tr>
<tr>
<td>PV modules</td>
<td>Must</td>
</tr>
<tr>
<td>Connection of the PV modules</td>
<td>Must</td>
</tr>
</tbody>
</table>
- Supporting structures and fixation elements of the PV modules \(\text{Must}\)
- Regulation of the charge process of electrochemical accumulators \(\text{Must}\)
- Inverter \(\text{Must}\)
- Efficient lighting \(\text{Important}\)

**MODULE 4: PV SYSTEM: TYPOLOGIES AND BASIC DESIGN**

**SESSION 4.1 STAND-ALONE SOLAR SYSTEMS**

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Basic stand-alone PV installations typologies</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• Specifications for the components: International standards for the stand-alone PV systems and Universal technical regulations</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• System of measurement, checking and certification</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• Energy dispenser-counter</td>
<td>(\text{Important})</td>
</tr>
<tr>
<td>• Examples of different applications</td>
<td>(\text{Additional})</td>
</tr>
</tbody>
</table>

**SESSION 4.2 GRID-CONNECTED SOLAR ELECTRICITY**

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Grid-connected typologies</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• Specifications for the components: International standards for the stand-alone PV systems and Universal technical regulations</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• System of measurement, checking and certification</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• Energy dispenser-counter</td>
<td>(\text{Important})</td>
</tr>
<tr>
<td>• Examples of different applications</td>
<td>(\text{Additional})</td>
</tr>
</tbody>
</table>

**SESSION 4.3 BASIC DESIGN OF SOLAR INSTALLATIONS**

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Basic principles for the optimum use of energy</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• Energy needs study</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• Selection criteria of the solar system type</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• Selection criteria of the auxiliary system type</td>
<td>(\text{Must})</td>
</tr>
<tr>
<td>• Calculation of the size of photovoltaic array and the solar fraction</td>
<td>(\text{Important})</td>
</tr>
<tr>
<td>• Calculation of the installation elements: Accumulator capacity, PV charge controller, Inverter, data logging</td>
<td>(\text{Important})</td>
</tr>
<tr>
<td>• Most frequent design errors</td>
<td>(\text{Important})</td>
</tr>
</tbody>
</table>
### MODULE 5 PRACTICAL CASES: PHOTOVOLTAIC SYSTEMS INSTALLATION

#### SESSION 5.1 HEALTH & SAFETY AND LEGISLATION

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Adhere to the relevant safety regulations and conduct works in a safe and proper manner</td>
<td>Must</td>
</tr>
<tr>
<td>• Work safely with tools</td>
<td>Must</td>
</tr>
<tr>
<td>• Work safely at height</td>
<td>Must</td>
</tr>
<tr>
<td>• Work safely with electricity</td>
<td>Must</td>
</tr>
<tr>
<td>• Maintain a work site in such a manner that it is safe for workers, visitors and the public</td>
<td>Must</td>
</tr>
<tr>
<td>• Adhere to relevant state and European legislation that may well apply to any part of the installation</td>
<td>Additional</td>
</tr>
</tbody>
</table>

#### SESSION 5.2 INSTALLING SOLAR PHOTOVOLTAIC SYSTEMS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Identify different solar cells panels mounting methods suitable for roof types</td>
<td>Important</td>
</tr>
<tr>
<td>• Identify locations for roof penetrations and structural attachments</td>
<td>Important</td>
</tr>
<tr>
<td>• Assess the suitability of selected mounting structural attachments and compliance with applicable local codes</td>
<td>Important</td>
</tr>
<tr>
<td>• Locate and mark position of panels, on structure, according to specifications and blueprints.</td>
<td>Important</td>
</tr>
<tr>
<td>• Cuts roof and roof membrane and installs flashing.</td>
<td>Important</td>
</tr>
<tr>
<td>• Cuts holes in roof, walls, and ceiling to install equipment and electrical, using power saws and drills, level, square, tape measure, sledge hammer and ladders.</td>
<td>Important</td>
</tr>
<tr>
<td>• Installs supports and brackets to anchor solar panels, using carpenter’s hand tools.</td>
<td>Important</td>
</tr>
<tr>
<td>• Runs conduit and pulls wire.</td>
<td>Important</td>
</tr>
<tr>
<td>• Mounts pipe hangers, and cuts and attaches insulating material.</td>
<td>Important</td>
</tr>
<tr>
<td>• Lays out and connects electrical wiring between controls and panels according to wiring diagram and knowledge of standard industry practice, using electrician’s hand tools.</td>
<td>Must</td>
</tr>
<tr>
<td>• Tests electrical circuits and components for continuity, using electrical test equipment.</td>
<td>Must</td>
</tr>
<tr>
<td>• Pushes control buttons to activate system and observes system to detect malfunctions.</td>
<td>Must</td>
</tr>
</tbody>
</table>
### SESSION 5.3 INSTALLING OPERATION AND IDENTIFICATION TAGS AND LABELS

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine components that require identification tag and/or label</td>
<td>Additional</td>
</tr>
<tr>
<td>Install identification tags and/or label</td>
<td>Additional</td>
</tr>
</tbody>
</table>

### MODULE 6: OPERATION AND MAINTENANCE

### SESSION 6.1 PERFORMING A SYSTEM CHECK

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify any deficiencies in materials, workmanship, function or appearance by visually inspecting entire installation</td>
<td>Important</td>
</tr>
<tr>
<td>Determine that the system mechanical installation has structural integrity and is weather sealed</td>
<td>Must</td>
</tr>
<tr>
<td>Determine that the electrical installation is correctly installed</td>
<td>Must</td>
</tr>
<tr>
<td>Verify system start-up and shut-down functionality</td>
<td>Important</td>
</tr>
<tr>
<td>Verify overall system operation and functionality</td>
<td>Important</td>
</tr>
</tbody>
</table>

### SESSION 6.2 MAINTAINING A PHOTOVOLTAIC SYSTEM

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify system components that pose safety hazards</td>
<td>Must</td>
</tr>
<tr>
<td>Demonstrate proficiency in the proper and safe use of tools and materials required for maintenance and troubleshooting</td>
<td>Must</td>
</tr>
<tr>
<td>Interpret installation manual, wiring diagrams, drawings, and other specifications to plan maintenance or repair work</td>
<td>Important</td>
</tr>
<tr>
<td>Determine evaluation points for system monitoring, maintenance and troubleshooting</td>
<td>Important</td>
</tr>
<tr>
<td>Identify cause of problems based on evaluation results</td>
<td>Important</td>
</tr>
<tr>
<td>Determine regular maintenance interval depending on manufacturers manual</td>
<td>Important</td>
</tr>
<tr>
<td>Maintain a system (database) of information from all installed systems</td>
<td>Additional</td>
</tr>
</tbody>
</table>

### MODULE 7: CUSTOMER EDUCATION

### SESSION 7.1 CUSTOMER EDUCATION

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate to the owner operation and functionality of system</td>
<td>Important</td>
</tr>
<tr>
<td>Demonstrate to the owner start-up and shut-down procedures for system</td>
<td>Important</td>
</tr>
<tr>
<td>Demonstrate to owner simple maintenance and diagnostic procedures</td>
<td>Important</td>
</tr>
<tr>
<td>• Identify for owner all markings and labels for system service and owner interaction</td>
<td>Important</td>
</tr>
<tr>
<td>• Identify for owner safety issues associated with operation and maintenance of system</td>
<td>Must</td>
</tr>
<tr>
<td>• Complete and transfer documentation package to system owner/operators</td>
<td>Important</td>
</tr>
<tr>
<td>• Review system/component warranties and requirements with owner</td>
<td>Additional</td>
</tr>
</tbody>
</table>
3. Training at schools

Introduction

The use of schools initiatives to promote energy awareness and to inspire changes in the behaviour is linked to diverse aspects of the formal education programme. It can be included to human, social, physics sciences courses, aspects of the ethic and also adapted to practical studies and theoretical calculations. It has an outstanding historical aspect and gives a wide margin for artistic, cultural and scientific interpretation.

Moreover, it can inspire young people and have influence on its social community thorough family and friends.

Energy, its production, conversion and use, has yet a significant impact in the studies about environment. The energy education should approach together energy, environment and economy, giving a rational base for the decision making.

Many educational courses about environmental aspects also include energy studies, but usually limited into aspects related to sustainable development. However, it is still necessary to develop specific programmes of education about energy that could set up the base of permanent changes in the users’ behaviour of today and tomorrow. These courses should focus not only in prejudice derived of the energy use, but also in the value of these limited resources.

The educational initiatives should clearly demonstrate the positive consequences of the behaviour change, that is, to choose the energy awareness. Saving energy means saving money. Simple measures can result in a significant annual saving. The personal benefit is a fundamental human motivation, but the personal benefit together with the positive and demonstrable social benefit is an element still more lasting and motivating.

It can be demonstrated that the reduction of the global use of energy, combined with the increasing use of a cleaner energy, as solar thermal and photovoltaic, reduces the general pollution, resulting in benefits for the health. The inclusion of new energy technologies which have being currently developed in many countries of the world, constitutes positive news from different point of views, amongst them the consideration of that a reduction in the greenhouse gases will attenuate the effects of the climate change.

3.1. The role of the different actors of the education process

Any educational initiative about the use of energy should draw attention to the various roles taken by the different agents of the society. It is very important to be aware about the energy we use as particulars, families, households, students or organizations – and the benefit that can be obtained taking profit of energy at individual and collective level.

Population is key agents to assure the rational and appropriate use of energy. Education can give a base for the understanding and a channel of information that citizens need to take rational decisions and be aware of consumption. All they have to perform their role when choosing the most efficient technologies at work and at home, assuring themselves that their houses, work places and vehicles have the highest possible energy efficiency. So, it will be good to encourage students to make their own strategy proposals to solve the energy problems of the society.
There are many diverse agents involved in the energy education field that perform different key roles. However every agent has to understand the role of the others and make a team work to achieve common objectives.

Learning process is complex, and in the case of the energy education there are various factors to bear in mind, included the pre-existent level of energy consciousness and age, gender and cultural situation of the students. Consequently, it is useful to consider how to classify this audience in segments, develop appropriate educational programmes and resume the role of the diverse agents. Four classification criteria can be used: beneficiary group, education level, training level and learning mode. In this strategy design of education for the schools of B&H, the beneficiary group and the level of training have been considered as principal classification criteria.

The beneficiary list can be defined as: students (of different ages), professionals and public in general. In terms of education level four classifications can be used: primary, secondary, student, university student and graduate. The levels of training foreseen are: researcher, engineer, technician, mechanic and elemental, the learning model can be formal or informal.

Learning is organized for young people in two principal locations: at the school and outside school. Obviously the school is a formal training place where students attend, pay attention and (hopefully) are willing to learn. At school, children hope to receive educational messages.

There are four principal agents that can be recognised as formal educational environment at school:

- Children and teenagers, who are the most important agents,
- Teachers, the principal channel of information and inspiration. The experience shows that the quality of education is superior when teachers adjust and improve the material received.
- The education politician responsible. Their work is to develop the appropriate framework that allows and promotes education projects about energy saving and awareness development.
- The energy regional and local agencies, together with other local agents, develop diverse initiatives that are intended to different levels of education.

In external environments, diverse messages and methods are needed to give similar information with effectiveness. Messages should be channel in a more ludic way, involvement of external agents from the education environment is essential (parents, people working with young people, mass media, above all television, etc…).

In order to produce a good informal initiative of energy education, as a television programme, it is important to combine energy knowledge, beneficiary groups, experience in presentation and communication and also count on educational experts.

The energy education, as developed in this report, apart from primary and secondary education, should be also directed to other groups of the society. So, a second group is “professional people in action” where the principal agents are energy specialists and beneficiaries are energy professionals.

Finally, adult people education in general should be taken into account. This will require that all levels of energy organizations become principal agents and together with communication specialists perform programmes intended to the public in general. This should include approach in local and national communication, insisting on the responsibilities of individuals, respect and social behaviour favourable for all the parts.
with the information about individual options of investment and its potential benefit in terms of efficiency and energy saving and profit of renewable resources.

3.2. Educational necessities: increase of awareness

The students’ awareness increase about the role of the energy today is essential. Also how it is produced, transformed and used, apart from the consequences of this processes. This includes the development of awareness in the origins and the causes of the energy past and present crisis.

Understanding the capacities, costs and effects of the diverse sources of energy (renewable and not renewable) which are at present or in a near future available, and the consequences of choosing amongst them, could develop valuable capacities in young students. All that in many aspects (socio-cultural, economic, environmental, etc.), but also the local availability, the requirements about energy and the local climatic and cultural characteristics should be reflected. At the same time the educational contain should keep consistency with national and international priorities, in accordance to the value “think globally, act locally”.

Through the appreciation of consequences of the measures established by the current energy policy, students should be able to identify global solutions – adapted to their own local situation – that is viable, practical and affordable. Older students could also propose strategies of alternative policies.

The educational programme should give a balance between theory and practical aspects, including conferences, demonstration, practical training of capacities, design and manufacturing, depending on the resources and local requirements.

3.3. Typology of activities: Methodology and examples

An excellent example of this approach is a project developed in nine European regions, in which eleven primary schools participated. Its objective was to promote ecological behaviours amongst children of nine and ten years old. The behaviour class promoted, for instance, was to take showers instead of baths, do not let the tap open when brushing teeth, etc. The purpose was also to commit families, through their children and make them aware of energy saving, for example, switching off the television instead of let it in stand by. The project showed a general increase of the awareness about energy efficiency and protection of the environment.

Another useful tool in the education process that can help to change the behaviours is humour. Humour can commit children in their own field, using competences, games and team work in order to find answers and avoiding a direct education work. A wide range of activities, at school and clubs, Internet and TV programs dedicated to energy, have been undertaken.

The large number of experiences developed in diverse counties as Brazil, Belgium, Spain, Italy, etc. confirm the fact that energy education is, at long term, the most profitable method to save energy and promote the energy efficiency and the use of renewable energy.

There are also examples of projects of thermal and photovoltaic energy performed at schools. In rural field, these are the only option (rural solar schools) or in urban field as demonstrative installations. Some of these projects are included into programs and are part of virtual communities as the case of XESCA (Xarxa d’escoles solars de Catalunya – Solar school network of Catalonia). This is a network of solar schools of Catalonia.
(nurseries, primary and secondary schools, agrarian training schools) that have photovoltaic installations and also some thermal installations. Also there is the Solar Schools Network promoted by Greenpeace.

Next the Internet addresses of some energy initiatives and educational resources for the energy efficiency:

- ManagEnergy: http://www.managenergy.net/
- Campaign Sustainable Energy for Europe: http://www.sustenergy.org/
- European program Greenlight: http://www.eu-greenlight.org/
- Energy Star program of the EU: http://www.eu-energystar.org/enl
- Energie Cités: http://www.energie-cites.org/
- Educational European Forum for Energy Feasibility (ESEEF): http://www.school4energy.net/
- Kids for Energy: http://www.kids4energy.net/
- British Centre for the Feasibility Energy: http://www.cse.org.uk/
- Alliance for the Energy Saving: http://www.ase.org/greenschools/

Educational resources for the energy efficiency:

- Guidebook for Teachers: This Guidebook was one of the deliverables of the Grasping of Climate EU project. It includes inspirational ideas and activities from different partner countries: ie Sweden, France and the UK http://www.graspingclimate.net/Grasping_eng_low.pdf
- Predac Project. Library with more than 200 publications http://www.cler.org/predac/library.php3
- Create http://www.create.org.uk/schools/teachers_default.asp
- Practical school cases http://www.est.org.uk/schools/casestudies/
- BP educational resources http://www.bpes.com/
- Energy Education Academy (managed by Utah University) http://www.academyofenergy.org/links.html
- Internet web site with questions about energy of the California Energy Commission http://www.energyquest.ca.gov/teachers_resources/
- Social Energy Aids of Colorado http://www.energyhog.org/
- Network of solar schools of Catalonia (Spain) www.xesca.net

**3.4. Formative modules in Solar Energy**

For training at schools it is proposed that the modules of solar energy be integrated in a wider energy programme aimed to students of secondary education (12 to 15 years old).

This plan is based on the education experience performed in different regions of Spain (“the Energy Tour”. At present it is being established in other European countries thanks
to the support of the programme Intelligent Energy, funded by the European Commission.

The material produced can be used by the teachers and consulted by students. It has the following sections:

- Collection of thematic unities
- Itineraries of installations to be visited
- Laboratory experiences
- Murals collection
- Interactive CD-ROM

The content of educational unities is the following:

- The Energy
- Biomass
- The good use of energy
- The natural gas
- The electricity
- The Oil
- The solar energy
- Mini-hydro
- Wind energy
- Itineraries

The objective of these thematic units is that students acquire basic knowledge of the energy resources and technologies used to take profit of them, and also to awaken interest and increase the rational use of energy and application of renewable energy.

In this point there is only the description of the modules related solar energy that should be included in the thematic unit “the solar energy”. It should be included in the programme of the thematic units mentioned in order that the students previously acquire a global version of the energy world.

**MODULE 1: CURRENT ENERGY SCENARIO**

This course deals with basic general notions like knowledge about the energy situation worldwide/relevant state, energy consumption, emissions, climate change, carbon dioxide and greenhouse effect.

<table>
<thead>
<tr>
<th>SESSION 1.1 CURRENT ENERGY SCENARIO</th>
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<tbody>
<tr>
<td>▪ Current situation of energy in the world</td>
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<tr>
<td>▪ Current situation of energy in B&amp;H</td>
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<tr>
<td>▪ The solar energy in B&amp;H</td>
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<tr>
<td>▪ Energy efficiency</td>
</tr>
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<td>▪ Low consumption devices</td>
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</table>
MODULE 2: THE SUN

As a second module, it is proposed to enter in the statement of the solar radiation principle and history of its first uses.

<table>
<thead>
<tr>
<th>SESSION 2.1 FOUNDATIONS OF THE SOLAR ENERGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Sun as energy resource. The solar radiation passing by the atmosphere.</td>
</tr>
<tr>
<td>▪ The solar radiation. Values of the solar radiation in B&amp;H</td>
</tr>
<tr>
<td>▪ History of the solar energy: Archimedes legend, firsts steps, development of the current technology</td>
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</tbody>
</table>

MODULE 3: DESCRIPTION OF THE TECHNOLOGY

The next module deals with the presentation of the different systems and technologies which take profit of the solar energy.

<table>
<thead>
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<th>SESSION 3.1 SOLAR THERMAL ENERGY</th>
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<tbody>
<tr>
<td>▪ Thermal solar collector</td>
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<tr>
<td>▪ Hot water tank</td>
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<td>▪ Heat distribution system</td>
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<td>▪ Auxiliary system</td>
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<tr>
<th>LESSON 3.2 SOLAR PHOTOVOLTAIC ENERGY</th>
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<tbody>
<tr>
<td>▪ Solar Cell</td>
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<tr>
<td>▪ Electric accumulator</td>
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<tr>
<td>▪ Regulation of the charge process</td>
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<tr>
<td>▪ Inverter</td>
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<td>▪ Efficient lighting</td>
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</table>

MODULE 4: APPLICATIONS OF THE SOLAR ENERGY

Finally, the last module will present the principal solar applications.

<table>
<thead>
<tr>
<th>SESSION 4.1 APPLICATIONS OF THE SOLAR THERMAL ENERGY</th>
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<tbody>
<tr>
<td>▪ Domestic hot water</td>
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<tr>
<td>▪ Production of hot water: systems with primary open (thermosyphon) and close circuit, systems with secondary circuit.</td>
</tr>
<tr>
<td>▪ Solar heating: Heating with radiant floor, fan-coils heating, heating with oversized radiators.</td>
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<tr>
<td>▪ Swimming pools water heating.</td>
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<tr>
<td>SESSION 4.2 APPLICATIONS OF THE SOLAR PHOTOVOLTAIC ENERGY</td>
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<tr>
<td>----------------------------------------------------------</td>
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<tr>
<td>▪ Stand-alone solar systems</td>
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<tr>
<td>▪ Grid-connected solar electricity</td>
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