

CORE GREEN SKILLS REQUIRED FOR PLUMBERS AND ELECTRICIANS

(D2.1-2.2-2.3-2.4)



GSS-VET

Geothermal and solar systems - Vocational education and training



**CORE GREEN SKILLS REQUIRED
FOR PLUMBERS AND ELECTRICIANS
(D2.1-2.2-2.3-2.4)**

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1 Background and Objectives

Several actions are taken by the European Union to move beyond the economic crisis by creating the conditions for a more competitive economy with higher employment. Its growth strategy aims to be smart, through more effective investments in education, research and innovation; sustainable, thanks to a decisive move towards a low-carbon economy; and inclusive, with a strong emphasis on job creation and poverty reduction. The energy sector is one of the main areas where action is needed to meet these objectives.

Renewable energy, in particular, is a sectors for which new competences are required, this imply that also adequate education and training need to be provided. This Project aims to address innovation chain and work profiles at technician level for geothermal and solar energy sectors in the surveyed countries.

At present, specialists working in the field of geothermal and solar installations and equipment should have the following professional qualification: “Technician of power equipment and installations” or “Installer of power equipment and installations”, and be specialized in “Renewable sources of energy”. This profession can be acquired at some Vocational High Schools (the mode of attendance is mostly full-time, although some of them also offer part-time courses), and at Vocational Training Centres. Vocational high schools and vocational training centres are not harmonized, and certainly do not offer satisfactory preparation for market demand.

The purposes of this report is to summarize results of the surveys/workshops carried out in Spain, Greece, Germany and Bulgaria (according to deliverables 2.1, 2.2, 2.3 and 2.4) in terms of required skills at technician level and to identify differences among these four countries (.



2 Identification of Skills for Geothermal Installations

2.1 Identification of Skills for Geothermal Installations in Spain

2.1.1 Methodology

A Workshop organized by INSTAGI took place in San Sebastian on March 29th 2017 with 5 Spanish companies in order to review the knowledge catalogue of the previous GSSkills Project to which Spain and Greece participated. All these companies are involved in the design, installation, sales and maintenance of solar and geothermal installations. The number of workers for the companies varies between 2 and more than 30. The experience of the participating companies is superior to 5 years. Most of the participants to the workshop also provide training in the areas of solar and geothermal energy installations.

2.1.2 Identified Skills for Geothermal Installations in Spain

Competences and knowledge defined in the previous GSSkills Project were confirmed but reorganized according to the logical process followed in every project, which deals with the phases of design, execution and maintenance of the installation.

The following competencies have been validated and added (in bold) with respect to previous GSSkills Project:

- Competences of design of the installation
 1. Dimensioning and positioning for the heat exchanger.
 2. Thermal energy balance and calculation of total requirements.
 3. Optimal architecture selection (horizontal / vertical, closed / open circuit, direct / indirect).
 4. Insulation and sealing techniques.



5. Design of basic facilities.
 6. Work safety for the workers and the company that realizes the installations.
 7. Needs of machinery, tools and materials.
- Competences of execution of the installation
 1. Installation techniques and handling of different types of pipes.
 2. Drilling techniques, reliable and effective restoration.
 3. Installation of building distribution systems (coils, fun, etc.).
 4. Connection of the ground heat exchanger with heat pump technologies.
 5. Efficient heat exchanger-heat pump-distribution assembly and coupling.
 6. Insulation and sealing techniques.
 7. Interpretation of schemes.
 8. Basic knowledge of refrigeration facilities.
 9. Selection and reception of materials.
 10. Mounting Techniques.
 - Maintenance responsibilities of the installation
 1. Investigation of malfunction performed and repair.
 2. Elaborate and reliable maintenance.
 3. Supervision of pumps of electrical terms and important equipment.
 4. Insulation and sealing techniques.
 5. Knowledge about fluorinated gases.



2.2 Identification of Skills for Geothermal Installations in Greece

2.2.1 Methodology

A Workshop organized by ETAN took place in Chania on April 6th 2017 with 6 Greek companies in order to review the knowledge catalogue of the previous GSSkills Project to which Spain and Greece participated. The companies are small personal companies of plumbers. All of them have been active for more than 15 years, and all of them have been dealing with geothermal installations for at least 4 years.

In order to maximize the impact and the number of stakeholders defining the skills for this sector, the participants presented the results to the General Assembly of the Chania Plumbers Association, whose members are more than 100, and unanimously fully agreed on the proposed skills catalogue (theoretical and practical).

2.2.2 Identified Skills for Geothermal Installations in Greece

Theoretical Skills needed for Geothermal Installations:

1. Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness.
2. Knowledge of HVAC relevant costs and quality control.
3. Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics).
4. Knowledge of accompaniment circuit boards, and electronic equipment.
5. Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods.
6. Knowledge of building thermal distribution systems and relevant equipment operation.
7. Knowledge of seasonal thermal energy storage and thermal efficiency techniques.
8. Knowledge of low surface geological principles and earth heat exchange basics.
9. Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints.
10. Knowledge of switching, control, and operation of electrical part of the systems.



11. Knowledge of the worldwide state of the art in geothermal applications.
12. Knowledge of the contemporary development and future trends of geothermal energy.
13. Knowledge of HVAC systems basic structure and operation principles and obstacles.
14. Energy audits principles and classification.
15. Earth's internal heat and geothermal gradient.
16. Fluid dynamics basics.
17. Geothermal heating.
18. Heat pump's structure and operation.
19. Types of geothermal heat pump.
20. Building distribution systems.
21. Thermal storage techniques.

Practical Skills needed for Geothermal Installations:

1. Optimal architecture selection (horizontal/vertical, closed/open loop, direct/indirect).
2. Thermal energy balance and total needs calculation.
3. Coupling of ground heat exchanger with heat pumps technologies.
4. Heat exchanger dimensioning and positioning.
5. Insulation and sealing techniques.
6. Building distribution system installation (fun coils, etc.).
7. Efficient heat exchanger-heat pump-distribution coupling and mounting.
8. Installation techniques and handling of different type of tubes.
9. Technical plans and blueprints understanding.
10. Formulated malfunction investigation and repair.
11. Formulated and reliable maintenance.
12. Drilling techniques, reliable and effective restoration.
13. Electric water pumps and relevant equipment supervision.



2.3 Identification of Skills for Geothermal Installations in Germany

2.3.1 Methodology

The questionnaire on geothermal installations were slightly adjusted and updated according to the preceding GSS-Skills Project. The survey was included in the online tool SurveyMonkey. 29 questionnaires were filled out by German geothermal companies.

The same method was used for both questionnaires on geothermal and on solar. Most of the interviewed companies have 6 to 15 employees (55,2%) and 3,4% more than 50. Most of them are working in the implementation of geothermal installations with more than 10 years of experience in the geothermal sector.

2.3.2 Identified Skills for Geothermal Installations in Germany

Theoretical Knowledge that technicians should have in order to be able to carry out geothermal installations (in bold those added by respondents beside those suggested within the questionnaire):

1. Accompaniment circuit boards, electronic equipment.
2. HVAC systems basic structure, operation principles, obstacles.
3. Physical principles, laws, their interrelationships with applied science (understanding fluid mechanics, atmospheric dynamics).
4. Heating, Ventilation, Air Conditioning (HVAC) relevant costs, quality control.
5. Building thermal distribution systems, relevant equipment operation.
6. Switching, control, operation of electrical parts of the systems.
7. Contemporary development, future trends of geothermal energy.
8. Seasonal thermal energy storage, thermal efficiency techniques.
9. Low surface geological principles, earth heat exchange basics.
10. Specific raw materials, insulation processes, techniques for maximizing effectiveness
11. Drilling techniques, equipment.
12. Relevant chemicals, properties of substances, their interactions, danger signs, production techniques, disposal methods.
13. Design techniques, tools, involved in production of precise technical plans, blueprints



14. Worldwide state of the art in geothermal applications.
15. Understanding of the complete system (EWS-WP-WV), hydraulic and electrical circuitry.
16. Technical basics for heat pump, influences on the COP at higher temperatures. GWP of heat pumps of the F-gas regulation. Condition and quality of ground water. Heat transfer in case of soil humidity. The confusing legal guidelines in the 'Energieeinsparverordnung' which often does not merge with the applicable regulations in case of low energy.
17. Secondary education.
18. Fluid mechanics.
19. Experience.
20. Construction of heat load of the building.
21. Coldness.

Theoretical Abilities that technicians should have in order to be able to carry out geothermal installations:

1. Heat pump's structure and operation.
2. Types of geothermal heat pump.
3. Building distribution systems.
4. Geothermal heating.
5. Thermal storage techniques.
6. Drilling techniques.
7. Fluid dynamics basics.
8. Energy audits principles and classification.
9. Earth's internal heat and geothermal gradient.

Practical Skills that plumbers and electricians should have in order to be able to carry out geothermal installations (in bold those added by respondents beside those suggested within the questionnaire):

1. Selection of the suitable architecture (horizontal/vertical, closed/open loop, direct/indirect).
2. Thermal energy balance and total needs calculation.



3. Heat exchanger dimensioning and positioning.
4. Formulated malfunction investigation and repair.
5. Formulated and reliable maintenance.
6. Technical plans and blueprints understanding.
7. Coupling of ground heat exchanger with heat pumps technologies.
8. Building distribution system installation.
9. Efficient heat exchanger-heat pump-distribution coupling and mounting.
10. Installation techniques and handling of different type of tubes.
11. Insulation and sealing techniques.
12. Electric water pumps and relevant equipment supervision.
13. Drilling techniques and TRT.
14. Drilling techniques, reliable and effective restoration.
15. Knowledge of operating modes of heating and hydraulic systems of heat pumps and construction of the heat pump system.
16. Duration of regeneration of the heat source. Environmentally compatible coolant. Distance of the different heat sources and the adjacent land. Regeneration of heat sources and use of heat and coldness.
17. None.
18. Good physical basic skills.



2.4 Identification of Skills for Geothermal Installations in Bulgaria

2.4.1 Methodology

The survey was conducted online, on the basis of questionnaires especially developed for the survey, and sent to 26 Bulgarian companies working in the field of geothermal and solar installations. First, the questionnaires were sent to the respective companies. The managers of the companies were afterwards contacted by phone to offer further details of the survey and the aims of the Project as a whole. After the completed questionnaires were returned, a meeting with representatives of the respondent companies was organized to present the results and to identify further needs.

2.4.2 Identified Skills for Geothermal Installations in Bulgaria

Theoretical Knowledge that technicians should have in order to be able to carry out geothermal installations:

1. Constructing thermal distribution systems, operation and maintenance of the respective equipment.
2. The control and operation of the electrical parts of the systems.
3. Controls, circuits and electronic equipment.
4. Specific materials, thermal insulation processes and efficiency optimizing techniques.
5. The main structure, operating principles, operation and technical problems of HVAC systems.
6. The consumption and cost of energy for HVAC and quality control.
7. Main principles of designing, using and drawing precise blueprints and drawings.
8. The physical principles, laws and their interrelation with applied sciences (fluid mechanics, atmospheric dynamics).
9. The global developments in geothermal applications.
10. The geological principles and concepts of earth heat-exchange.
11. The respective chemical properties of substances and their interactions, hazard signs and markings, production methods and disposal methods.
12. The latest developments and future trends in geothermal energy.
13. The seasonal storage of thermal energy and thermal efficiency techniques.



Theoretical Abilities that technicians should have in order to be able to carry out geothermal installations:

1. Heat pump's structure and operation.
2. Types of geothermal heat pump.
3. Designing and building distribution systems.
4. Geothermal heating and characteristics of geothermal waters.
5. Principles and classification of energy audits.
6. Internal heat of the earth, and geothermal gradient.
7. Thermal energy storage techniques.
8. Fundamentals of fluid dynamics.

Practical Skills that plumbers and electricians should have in order to be able to carry out geothermal installations (in bold those added by respondents beside those suggested within the questionnaire):

1. Reading and interpreting technical blueprints and drawings.
2. Investigating and remedying identified faults.
3. Thermal energy balance and calculation of the total needs.
4. Technologies for connecting the ground heat exchanger with the heat pumps.
5. Installation and assembly techniques, and working with different types of pipes.
6. Regulated and reliable maintenance and service.
7. Selecting an optimal architecture (horizontal/vertical, open/closed loop/ direct/indirect).
8. Insulation and sealing techniques.
9. Drilling techniques, reliable and efficient recovery.
10. Electrical water pumps and respective monitoring of the equipment.



3. Identification of Skills for Solar Installations (thermal/ PV)

3.1 Identification of Skills for Solar Thermal Installations in Spain

3.1.1 Methodology

A Workshop organized by INSTAGI took place in San Sebastian on March 29th 2017 with 5 Spanish companies in order to review the knowledge catalogue of the previous GSSkills Project to which Spain and Greece participated. All these companies are involved in the design, installation, sales and maintenance of solar and geothermal installations. The number of workers for the companies varies between 2 and more than 30. The experience of the participating companies is superior to 5 years. Most of the participants also provide training in the areas of solar and geothermal energy installations.

3.1.2 Identified Skills for Solar Thermal Installations in Spain

From the first analysis, it was clear that the competences and defined knowledge refer to solar thermal energy installations and that the issue of the PV solar energy installations was not addressed at the meeting. Competences and knowledge defined in the previous GSSkills Project were confirmed but reorganized according to the logical process followed in every project, which deals with the phases of design, execution and maintenance of the installation.

For solar thermal installations, the following competencies were considered validated and added (in bold) with respect to previous GSSkills Project:

- **Competences of design of the installation**

1. Efficient positioning and boiler dimensioning.
2. Thermal solar coupling with room heating.
3. Calculation of hot water requirements.
4. Anti-freeze protection techniques.
5. Optimal architecture selection (active / passive, closed / open circuit, hybrid).
6. Optimal angle of the gradient calculation panels.
7. Design of basic facilities.



8. Regulation, regulations affecting the installation (CTE - Technical Building Code and RITE - Regulations on Thermal Installations in Buildings) and its legalization for its implementation.
9. Work safety for the workers and the company that realizes the installations
10. Needs of machinery, tools and materials.

- **Competences of execution of the installation**

1. Technical installations of different types of panels (collectors).
2. Coupling and installation of boiler distribution panels.
3. Anti-freeze protection techniques.
4. Insulation and sealing techniques.
5. Interpretation of schemes.
6. Selection and collection of materials.
7. Welding.
8. Insulation / assembly techniques.

- **Maintenance responsibilities of the installation**

1. Adequate and safe maintenance.
2. Investigation and repair of malfunction.
3. Monitoring of electric water pumps.
4. Anti-freeze protection techniques.
5. Regulations affecting the installation.
6. Preventive maintenance and corrective maintenance.

3.2 Identification of Skills for PV Solar Installations in Greece

3.2.1 Methodology

A Workshop organized by HELAPCO took place in Athens on April 6th 2017, with 5 Greek companies working in the PV solar sector, considering that the market is entering a new phase of development. The



profile of the participating companies represents a vast range of enterprises active in the market. The number of workers ranges from small (2-3 employees) to large (over 50 employees). Experience in the field varies from 2-3 years to over 30 years. All companies are involved in the sales, design, installation, and O&M of PV systems. The workshop was thus representative of the current market status. Some of the participants have training experience, mainly through internal company training courses focused mostly on technical skills related to PV solar.

Three major aspects have been considered: (a) theoretical knowledge needs, (b) labour skills and (c) professional ethics and attitude. The questionnaire used was tailor-made for the PV sector, as the relevant questionnaire available (previous GSSkills Project) was not appropriate for the needs of PV companies, especially considering the current situation in the market.

3.2.2 Identified Skills for PV Solar Installations in Greece

Theoretical Skills needed for PV Solar Installations need to be addressed to:

1. Best practices in PV installation
 - A short manual with DOs & DON'Ts coupled with relevant photos and/or graphics would be of most help.
2. Best practices in O&M of PV systems
 - A short manual with DOs & DON'Ts coupled with relevant photos and/or graphics would be of most help.
3. Health and safety issues related to PV installation
 - Although this item does not require extensive coverage, a 1-pager with the most important issues should be prepared both for installers as well as for their customers.
4. PV plus storage (on/off-grid)
 - As this is a relatively new issue (especially the on-grid storage) more extensive technical information including specs should be part of the training.
5. Financing of PV projects and new business models



- Basic business plan skills are needed. A short description of existing and emerging business models would also be welcome
6. Smart grids – smart buildings – Electric vehicles – New technologies
- A general and brief introduction would suffice.
7. Legislative issues related to PV deployment
- A brief and coherent guide is needed with the most important legislative measures influencing the market, preferably in a Q&A format. Long and detailed legislative descriptions should be avoided. As regulation is quite dynamic, such info should be updated twice a year.



3.3 Identification of Skills for Solar Installations in Germany

3.3.1 Methodology

The questionnaire on solar installations was slightly adjusted and updated according to the preceding GSS-Skills Project. The survey was included in the online tool SurveyMonkey. 18 questionnaires were filled out by German companies. The same method was used for both questionnaires on geothermal and on solar.

Most of the interviewed companies have less than 5 employees (47,1%), 11,8% between 16 and 50 and the same amount have more than 50 employees. Most of them are working in the implementation of geothermal installations with more than 10 years of experience in the geothermal sector. Most of the companies are working in the implementation of solar installations and have their focus the sale of solar equipment. The highest number of interviewees have been working in the implementation of solar installations for more than 10 years.

3.3.2 Identified Skills for Solar Installations in Germany Theoretical

Knowledge needed for a technician in solar installations:

1. Hot water uses, space heating calculations.
2. Switching, control, operation of electrical part of the systems.
3. Building thermal distribution systems, relevant equipment operation.
4. Thermodynamics principles, heat exchange basics.
5. Specific raw materials, insulation processes, techniques for maximizing effectiveness.
6. Space and water heat relevant costs and quality control.
7. Physical principles, laws, interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics).
8. Hot water storage technologies, thermal efficiency techniques.
9. Design techniques, tools (involved in production of precision technical plans), blueprints.
10. Panel types basic structure, operation principles, obstacles.
11. Accompaniment electric pumps, ventilators.



12. Worldwide state of the art in solar thermal applications.
13. Contemporary development, future trends of solar thermal.

Theoretical Abilities needed for a technician in solar installations:

1. Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude).
2. Types of solar thermal water circulation.
3. Building distribution systems.
4. Solar panel structure and operation.
5. Solar radiation and heat exchange basics.
6. Insulation material, types and techniques.
7. Thermal storage systems.
8. Energy audits principles and classification.

Practical Skills needed for a technician in solar installations (in bold those added by respondents beside those suggested within the questionnaire):

1. Formulated malfunction investigation and repair.
2. Coupling of solar thermal with space heating technologies.
3. Boiler dimensioning and efficient positioning.
4. Efficient panels-boiler-distribution coupling and mounting.
5. Installation techniques of different type of panels (collectors).
6. Technical plans and blueprints understanding.
7. Formulated and reliable maintenance.

8. Antifreeze protection techniques.
9. Hot water needs calculation.
10. Electric water pumps and relevant equipment supervision.
11. Optimal architecture selection (Active/passive, closed/open loop, hybrid).
12. Optimal angle of panels' gradient calculation.



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13. Insulation and sealing techniques.
14. Effort calculation for tender.



3.4 Identification of Skills for Solar Installations in Bulgaria

3.4.1 Methodology in Bulgaria

The survey was conducted online, on the basis of questionnaires especially developed for the survey, and sent to 26 Bulgarian companies working in the field of geothermal and solar installations. First, the questionnaires were sent to the respective companies. The managers of the companies were afterwards contacted by phone to offer further details of the survey and the aims of the Project as a whole. After the completed questionnaires were returned, a meeting with representatives of the respondent companies was organized to present the results and to identify further needs.

3.4.2 Identified Skills for Solar Installations in Bulgaria

Theoretical Knowledge needed for a technician in solar installations:

1. The respective electrical pumps and fans.
2. The control (switching, control and operation of the electrical part) of the systems.
3. The main types, structure and efficiency of solar collectors: operation, principles and obstacles.
4. The costs for heating space and water, and quality control.
5. How to calculate the power consumption for water and space heating, as well as for other thermal applications.
6. Designing and laying building systems for heat distribution and the respective equipment.
7. The principles of thermodynamics and fundamentals of heat exchange.
8. Basic principles of designing used in preparing precise blueprints and drawings.
9. Specific materials (raw materials), insulation processes and efficiency optimizing techniques.
10. The physical principles, laws and interrelations with applied sciences (understanding of solar physics, seasonal variables, and atmospheric dynamics).
11. The global developments in the sphere of solar thermal applications.
12. The current developments and future trends in solar thermal applications.
13. Hot water storage technologies and thermal efficiency techniques.



Theoretical Abilities needed for a technician in solar installations:

1. Classification and construction of solar systems.
2. Types of circulation in the solar systems.
3. Heat storage systems (accumulation).
4. Insulation materials, types and techniques.
5. Structure and operation of solar collectors.
6. Principles and classifications of energy audits.
7. Fundamentals of solar power and basic astronomical concepts (declination, altitude angle, azimuth, latitude, etc.).
8. Solar radiation and principles of heat exchange.

Practical Skills needed for a technician in solar installations:

1. Techniques for protection from freezing, pressure surges and overheating in the system
2. Investigating and remedying identified faults
3. Reading technical blueprints and drawings
4. Selecting the materials and components of the solar installation. Insulating and sealing techniques
5. Selecting an optimal system (active/passive, open/closed loop, hybrid, etc.)
6. Effectively connecting collector field-boiler-distribution, and assembly
7. Calculating the optimal angle of the collector field: Limiting self-overshadowing
8. Installation techniques for the different types of panels (collectors)
9. Regulated, scheduled and reliable maintenance
10. Calculating the energy needed for water and space heating, drying, etc.
11. Connecting the solar installation with the heating one
12. Determining the optimal dimensions and position of the boiler
13. Electric water pumps and respective monitoring of the equipment



4. Identification of differences among the countries for Geothermal and Solar Installations

This report aims to highlight differences among Spain, Greece, Germany and Bulgaria with respect to skills needed by technicians working in the Geothermal and Solar sectors.

Spain and Greece participated to previous GSSkills Project, so the above data is the outcome of workshops that took place in Spain and Greece to validate previous results and to add new essential skills for technicians working in the sectors of Geothermal and Solar Installations.

Surveys in Germany and Bulgaria were instead carried out for the first time and with online questionnaires that were slightly adjusted and updated according to previous GSSkills Project. Even if a relatively small number of companies for each country participated to these surveys, most of them agreed on needed skills for both geothermal and solar and are in accordance to the general state of the art of other European Countries.

Even if only Spain explicit this partition, most of the skills can be traced to the three macro areas of design, installation/operation and maintenance according to the logical process followed in every project for geothermal and solar.

Addressed skills for geothermal have been grouped in theoretical and practical.

4.1 Geothermal Installations

Essential theoretical skills

1. Specific raw materials, insulation processes and techniques for maximizing effectiveness.
2. HVAC systems.
3. Building distribution systems.
4. Design techniques, and tools, involved in production of precision technical plans, and blueprints.



5. Switching, control, and operation of electrical part of the systems.
6. Geothermal heating. Heat pump's structure and types of geothermal heat pump.
7. Energy audits principles and classification/quality control.
8. Physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics).
9. Relevant chemicals, properties of substances and their interactions, danger signs.
10. Low surface geological principles and earth heat exchange basics.
11. Knowledge of the worldwide state of the art in geothermal applications.
12. Knowledge of the contemporary development and future trends of geothermal energy.

Essential practical skills

14. Optimal architecture selection (horizontal/vertical, closed/open loop, direct/indirect).
15. Thermal energy balance and total needs calculation.
16. Coupling of ground heat exchanger with heat pumps technologies.
17. Heat exchanger dimensioning and positioning.
18. Insulation and sealing techniques.
19. Building distribution system installation (fun coils, etc.).
20. Efficient heat exchanger-heat pump-distribution coupling and mounting.
21. Installation techniques and handling of different type of tubes.
22. Technical plans and blueprints understanding.
23. Formulated malfunction investigation and repair.
24. Formulated and reliable maintenance.
25. Drilling techniques, reliable and effective restoration.
26. Electric water pumps and relevant equipment supervision.

Work safety was specifically addressed by Spain. The knowledge of thermal storage techniques, smart grid-smart buildings and the need of legal framework and regulation guidelines were pointed out by



Greece, Germany and Bulgaria. To be noted that in the German survey is listed as labour skill none, some for the respondent/s no practical skills are essential for a technician in the geothermal sector.

4.2 Solar Installations

Addressed skills for solar have been grouped in theoretical and practical, with the exception of PV Solar in Greece for which the respondents addressed crucial issues and best practices by treating theoretical and practical needs as a whole.

For the solar sector, it is necessary to take into account that resulting skills are referred to Solar Thermal in all countries with the exception of Greece where the skills are divided in two distinct areas, i.e. Solar Thermal and PV.

Essential theoretical skills

1. Hot water uses, space heating calculations.
2. Switching, control, operation of electrical part of the systems.
3. Building thermal distribution systems.
4. Thermodynamics principles, heat exchange basics.
5. Specific raw materials, insulation processes, techniques for maximizing effectiveness.
6. Space and water heat relevant costs and quality control.
7. Physical principles, laws, interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics).
8. Hot water storage technologies, thermal efficiency techniques.
9. Design techniques, tools (involved in production of precision technical plans), blueprints.
10. Panel types basic structure, operation principles, obstacles.
11. Accompaniment electric pumps, ventilators.
12. Worldwide state of the art in solar thermal applications.
13. Contemporary development, future trends of solar thermal.
14. Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude).
15. Types of solar thermal water circulation.



16. Solar panel structure and operation.
17. Solar radiation and heat exchange basics.
18. Insulation material, types and techniques.
19. Thermal storage systems.
20. Energy audits principles, classification and quality control.

Practical Skills needed for a technician in solar installations:

1. Formulated malfunction investigation and repair.
2. Coupling of solar thermal with space heating technologies.
3. Boiler dimensioning and efficient positioning.
4. Efficient panels-boiler-distribution coupling and mounting.
5. Installation techniques of different type of panels (collectors).
6. Technical plans and blueprints understanding.
7. Formulated and reliable maintenance.
8. Antifreeze protection techniques.
9. Hot water needs calculation.
10. Electric water pumps and relevant equipment supervision.
11. Optimal architecture selection (Active/passive, closed/open loop, hybrid).
12. Optimal angle of panels' gradient calculation.
13. Insulation and sealing techniques.
14. Effort calculation for tender.

Work health and safety for workers were specifically addressed by Spain and Greece. The knowledge of financing of PV projects and new business models was specifically highlighted by Greece as also basic knowledge of smart grids – smart buildings – electric vehicles – New technologies. Knowledge of legislative issues related to PV deployment was required by Greece and Bulgaria. In particularly Greece suggested to provide a brief and coherent guide essential for technicians on the most important



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FOR PLUMBERS AND ELECTRICIANS**

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legislative measures influencing the market and, as regulation is quite dynamic, such info should be updated twice a year.

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