EUROPEAN COMMISSION
Employment, Social Affairs and Inclusion DG

Europe 2020: Employment Policies
New Skills for New Jobs, Adaptation to Change, CSR, EGF

GEOTHERMAL & SOLAR SKILLS

VP/2012/009/0065

WP2 - Research on skills needed in geothermal and solar thermal installations

CHANIA CHAMBER OF COMMERCE & INDUSTRY

ECTE EUROPEAN CENTER IN TRAINING FOR EMPLOYMENT

Debegesa Debabarreneko Garapen Ekonomikorako Elkartea
Sociedad para el Desarrollo Económico de Debabarrena

LES COMPAGNONS DU DEVOIR et du Tour de France

Co-funded by the European Commission

Mutual learning in the field of skills and employment EU Sector Skills Councils Restructuring

This book is a result of the surveys realised within the project GSSkills, Geothermal and Solar Skills, promoted by CCIC – Chania Chamber Industry and Commerce – Crete, Greece in the framework of EU Programme PROGRESS: Employment, Social Affairs and Inclusion DG, Action: Employment Policies, New Skills for New Jobs, Adaptation to Change CSR, EGF.

Research and analysis has been conducted by ECTE – European Centre in Training for Employment – Greece, partner of the project and responsible for analysing and summarising the data collected by all the members of the consortium.

Thanks to all people who gave a precious contribution to the realisation of this research, especially to all partners and all people and stakeholders involved for filling in the questionnaires.

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Programme of the European Union

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Foreword

The research action described in this volume is a substantial part of the project "GSSkills – Geothermal and Solar Skills", funded by the European Commission within the context of the EU PROGRESS programme: Employment, Social Affairs and Inclusion DG, Action: Employment Policies, New Skills for New Jobs, Adaptation to Change CSR, EGF. The project, which was approved in 2013 for an overall duration of 15 months, terminating on 01 March 2015, involves 3 EU countries and 4 partners: CCIC – Chania Chamber Industry and Commerce (EL), ECTE - European Centre in Training for Employment Rethymno (EL), AOCDTF - Les Compagnons du Devoir et du Tour de France (FR), and DEBEGESA - Sociedad para el Desarrollo Económico de Debabarrena (ES).

The main aim of this survey is to specify what skills and competencies are required to work in specific jobs (plumbers and electricians) in green installations sector. The overall aim of the project is to promote training for low-skilled workers in geothermal and solar installations. As a result of the available resources, was done a comparative analysis in order to identify the qualifications and skills required in geothermal and solar installations for the professions of plumbers and electricians, as well as, to identify the geographical characteristics of each participating country.

The aims of this report is to specify which theoretical and practical skills are required for the implementation of geothermal and solar installations in consortium countries and it also aim to qualify the actual educational needs of low-skilled workers for updating their professional skills according to new technologies that are being applied in their sector, and specific in green installations.

Companies and employers involved in green plants, specifically in geothermal and solar installations in each participating country have been contacted and filled the questionnaires of GSSkills research in order to enrich the existing data for qualifications

and skills required for the successful implementation of geothermal and solar installations.

As envisaged during the design phase, the survey and analysis activity was carried out by the ECTE – European Centre in Training for Employment, leader of the WP2 – Needs analyses in skills for geothermal & solar installations – in collaboration with all the partners in the project. The scope of this activity was to meet the partnership need to carry out an analysis and mapping the green skills need in all partner countries, with special focus on geothermal and solar installations.

In order to adequately support the performing of all the activities foreseen by the project, within the context of this WP2, integrated survey and analysis actions have therefore been implemented, primarily by availing of a Participating Research-Action method and consequently carrying out "on field" analysis activities via the administration of questionnaires, supported by on-going narrative and statistical press reports of the data collected.

The GSSkills research, as was an "on field survey" via the administration of questionnaires in all the partner countries, has made it possible to compare and integrate the testimonies of the stakeholders in the field with the answers to the questionnaires given by employers in green companies, thereby generating the on-going updating of the data and thus ensuring greater compliance of the same.

The "on field" survey has enabled the participatory involvement hoped for by the entire partnership. The exploratory activity has therefore been directed towards making areas emerge where there are criticalities and professional and training needs as reported and perceived by the people in charge in relation to the target pinpointed and the respective needs/requirements expressed. The aim of the survey was therefore to detect both qualitative and quantitative data, and thanks to the use of various technical devices, it

has also allowed for detecting the subjective experiences that the professionals structure throughout their professional activities.

Therefore, by adopting the operating strategies described above, this work has made it possible to detect an amount of useful data for the purposes established during the design stage.

The following pages are filled with contents and indications for the future realisation of design activities that represent a good source for those who, even in the future, wish to learn more about needed skills for low-skilled workers in green installations sector as a tool for training purposes.

Chapter I

Methodology

1. Quantitative research methodology

Research methods in education (and in the other social sciences) are often divided into two main types: quantitative and qualitative methods. According to Aliaga and Gunderson (2000) quantitative research seeks to explain phenomena by collecting numerical data that are being analyzed using mathematical methods, particularly statistics. Quantitative research methods look for empirical generalizations and attempts in order to control causal theoretical assumptions (Kyriazi, 2002). The quantitative methods are based on figures and statistical comparisons, the measurement of theoretical concepts through tools such as standardized questionnaire in order to extract causal relations. The main objective of quantitative research is to classify features in categories to be measured and built statistical models in order to explain what is observed. In other words, the quantitative method include the measurement and quantification of social phenomena. Quantitative surveys follow mostly a strict and predetermined research design, which means that most important decisions are taken by the researcher before the survey, and the research topic is being in advance clear. The basic objective of quantitative research is to empirically test the pre-assumptions of the research, which reached through productive and deductive methodologies from specific theoretical frameworks (Kyriazi, 2006).

The questionnaire is the communication medium (interface) between the researcher and the respondents, directly or indirectly, depending on the data collection method. The preparation of the questionnaire, due to the properties it has, is the most critical and delicate, crucial to the success of a statistical survey. Is argued that none survey could be better than the questionnaire used in this survey (Paraskevopoulos, 1993). This phrase emphasizes the fact that in a survey, even if is applied an effective sampling plan or the most appropriate data analysis, is not

possible to derive correct conclusions if will not collect answers that could be comparable from a reliable questionnaire with explicit questions.

For the implementation of GSSkills research were designed and used questionnaires with open and semi-structured questions. The questionnaires with open and the semi-structured questions allow the researcher to identify elements of the context, personal, cultural and social implications that have guided the subject in responders professional activities, thus enabling access to the structure of interviewees professional experience.

As demonstrated by the results of the research, the attempt to integrate data with the quantitative analysis of this survey has helped reveal the subjective experiences that professionals build up during the implementation of green installations activities in their specific areas of competence.

1.1 Timetable and procedures: questionnaires and data analysis

In all three partner countries the research was structured in three phases:

The first phase which was of an exploratory nature, aimed at building up a databank and was based on the following initial objectives:

1. Mapping of the public and private companies in green installation sector that are implementing geothermal and solar installations and could potentially be interested as end-users in the results of GSSkills research and “Skills Catalogue” that aims to produce.
2. Identification of potential users among employers and green installation companies to whom the questionnaire could be administered.

The second phase concerns the preparation of the questionnaire to be administered to employers and green installation companies.

In structuring the questionnaire, focus was placed on the following objectives:

1. The collection of personal data, qualifications and professional experience of the employers and green companies directors to whom the questionnaire was administered;
2. Encoding of any knowledge and basic technical, professional skills that plumbers and electricians should have in order to be able to carry out a geothermal or a solar thermal installations;

The third phase coincided with the quantitative analysis of the data collected and with the drafting of the research report and the results obtained from the survey conducted.

After the quantitative analysis of the data contained in the questionnaires, fully reproduced in graphs with relative comments to the tables in the following chapters, an analysis was conducted with a description of everything emerging in a narrative form the answers to the questions contained in the questionnaires.

It was finally possible to draft a conclusive initial outcome through the GSSkills research report; the "Skills Catalogue" containing summarised information on the results obtained from the research on needed professional skills in geothermal and solar thermal installations.

Chapter II

Results of Survey and Analysis

2. Analysis of the Questionnaires for Geothermal Installations

Data Analysis

The survey's results reported in this chapter derive from the analysis of 33 questionnaires administered in the 3 partner counties of the GSSkills project: Greece, France and Spain.

Out of the 33 questionnaires, 10 were filled out by Greek green installation companies, 10 by French green installation companies, and 13 by Spanish green installation companies.

The data analysis is divided into paragraphs that match the information and the questions asked to the responders of the questionnaires. The quantitative analyses and graphs were created in Microsoft Excel.

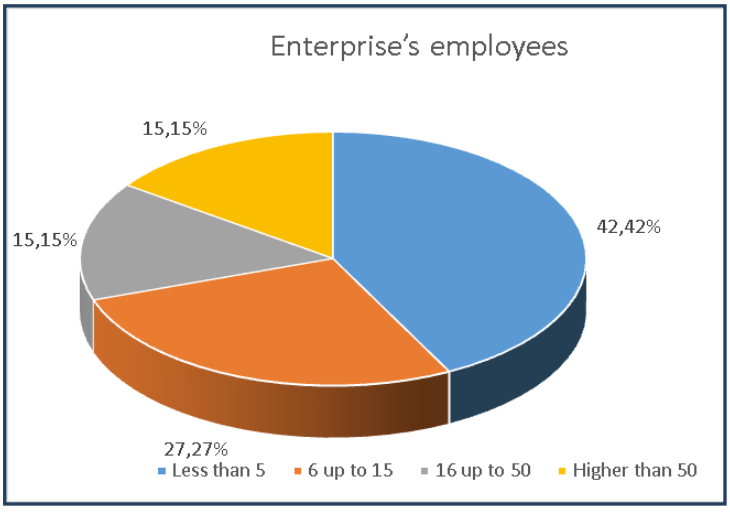
2.1 General Information

In this section of the questionnaire focus was placed on the collection of personal data, qualifications and professional experience of the employers and green companies directors to whom the questionnaire was administered.

Size of the company: employees in enterprise

Summative statistics for all countries

The size of the green installation companies involved in drafting the questionnaires was divided into 4 groups: Group 1 included all the companies that have "Less than 5" employees, Group 2 companies that have "From 6 to 15" employees, Group 3 companies that have "From 16 to 50", Group 4 companies that have "More than 50 employees".



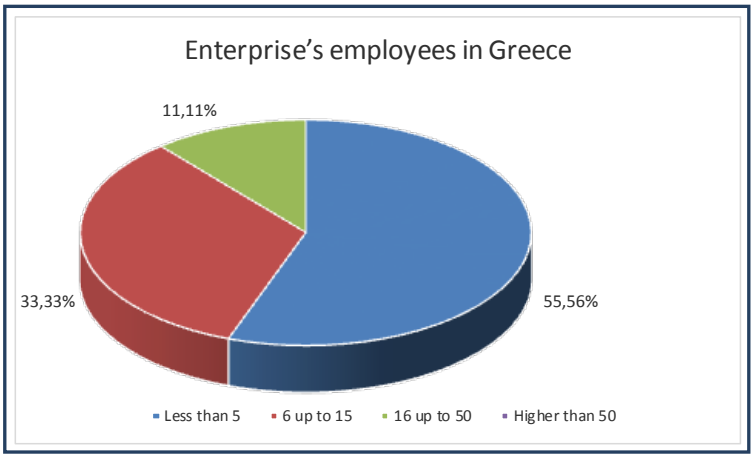
As we can see through the graph the 42,42% of the total interviewees from all participating countries are working in companies with “Less than 5” employees, the 27,27% in companies “From 6 to 15” employees, the 15,15% in companies “From 16 to 50” employees and the 15,15% in companies with “More than 50” employees.

The case of each participating country

There are differences between the countries that took part in the research.

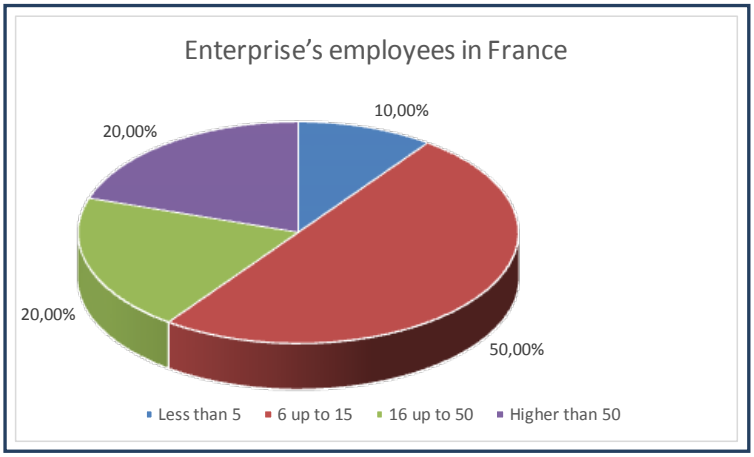
The case of Greece:

In Greece the 55,56% of the enterprise’s employ “Less than 5” workers, the 33,33% employ “From 6 up to 15” workers, and the 11,11% employ “From 16 up to 50” workers.



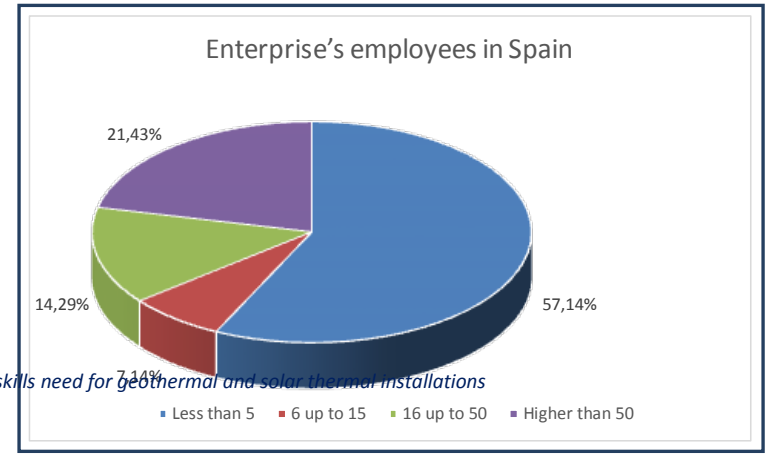
The case of France:

In France the 50% of the enterprise’s employ “From 6 up to 15” workers, the 20% employ “From 16 up to 50” workers, the 20% employ “More than 50” workers, and the 10% employ “Less than 5” workers.



The case of Spain:

In Spain the 57,14% of the enterprise’s employ “Less than 5” workers, the 21,43% employ “More than 50” workers,



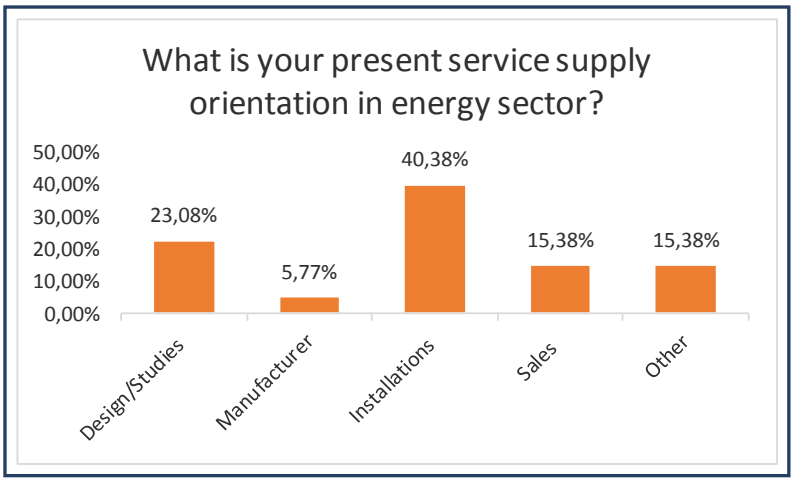
the 14,29% “From 16 up to 50” workers, and the 7,14% employ “From 6 up to 15” workers.

What is your present service supply orientation in energy sector?

Summative statistics for all countries

This question concerns the professional position that the interviewees in all countries have in the green installations companies that took part in the research.

In the questionnaire five options were given: 1)Design/Studies, 2)Manufacturer, 3)Installations, 4)Sales, and 5) Other/ what.

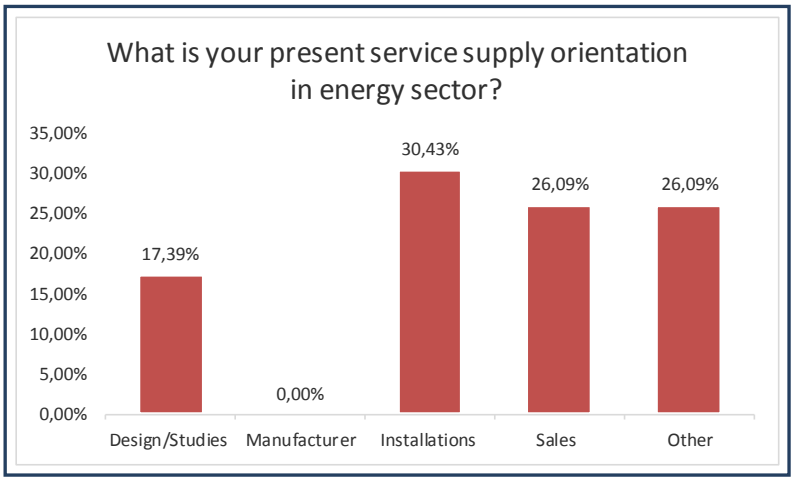


The higher number of interviewees, 40,38%, are working in the implementation of geothermal installations, the 23,08% are working in “Design/ studies” of geothermal plants, the 15,38% in “Sales” department, the 15,38% in “Other” professional positions related with geothermal installations, and the 5,77% as “manufactures” of geothermal installations.

The case of each participating country

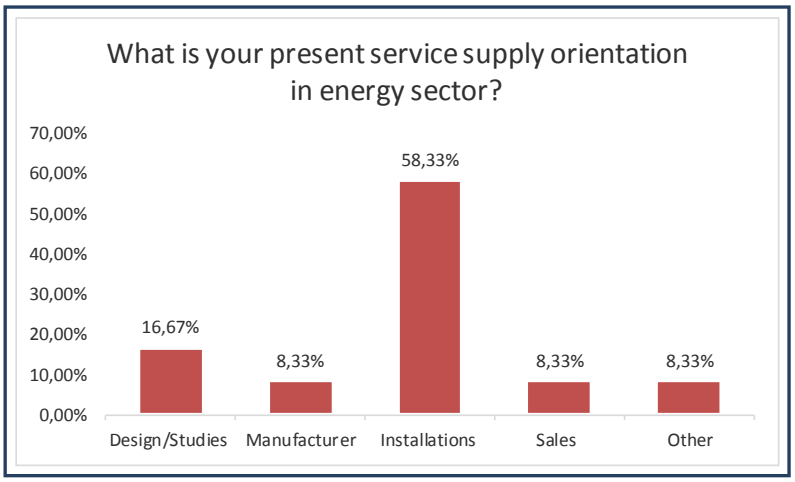
This question concerns the professional position that the interviewees from each participating country have in the green installations companies that took part in the research.

The case of Greece:



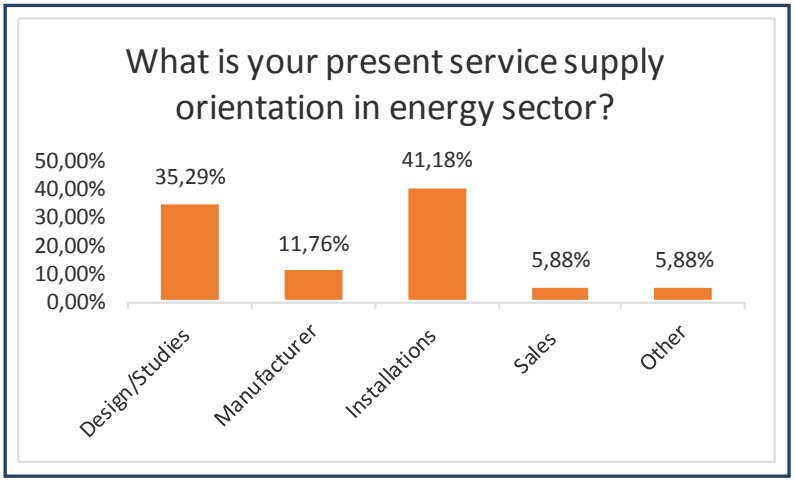
The higher number of interviewees, 30,43%, are working in the implementation of geothermal installations, the 26,09% are working in "Other" professional positions related with installations, the 26,09% in "Sales" department, and the 17,9% in "Design/ studies" of geothermal plants.

The case of France:



The higher number of interviewees, 58,33%, are working in the implementation of geothermal installations, the 16,67% are working in "Design/, studies" of geothermal plants, the 8,33% in "Other" professional positions related with geothermal installations, the 8,33% in "Sales" department, and the 8,33% are working as "Manufacturers" in geothermal installations.

The case of Spain:



The higher number of interviewees, 41,18%, are working in the implementation of geothermal installations, the 35,29% are working in "Design/,

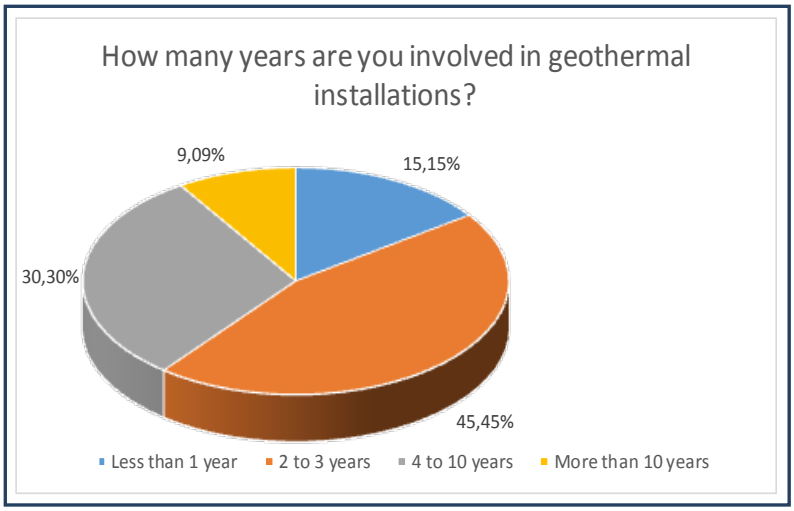
studies" of geothermal plants, the 11,76% are working as "Manufacturers" in geothermal installations, the 5,88% in "Other" professional positions related with geothermal installations, and the 5,88% in "Sales" department.

How many years are you involved in geothermal installations?

Summative statistics for all countries

This question concerns the years of involvement that the interviewees in all countries have in green installations.

In the questionnaire four options were given: 1)"Less than 1 year", 2)"From 2 to 3 years", 3)"From 4 to 10 years, and 4)"More than 10 years".

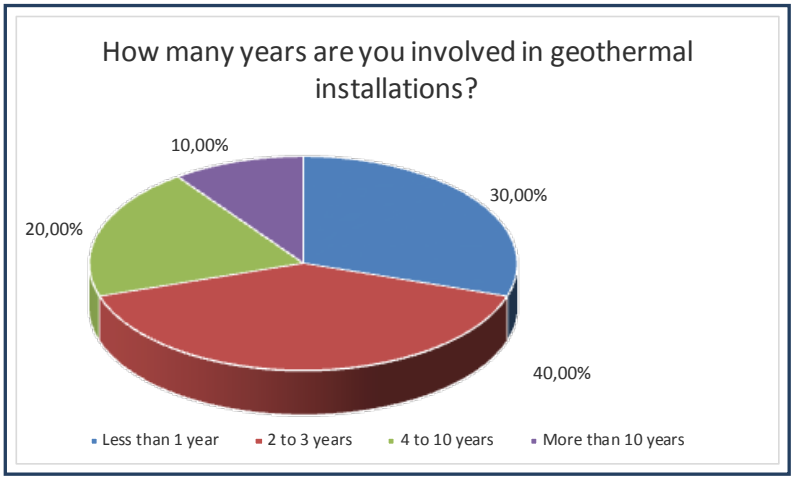


The higher number of interviewees, 45,45%, are working in the implementation of geothermal installations "From 2 to 3 years", the 30,30% "From 4 to 10 years", the 15,15% "Less than 1 year", and the 9,09% "More than 10 years".

The case of each participating country

The case of France:

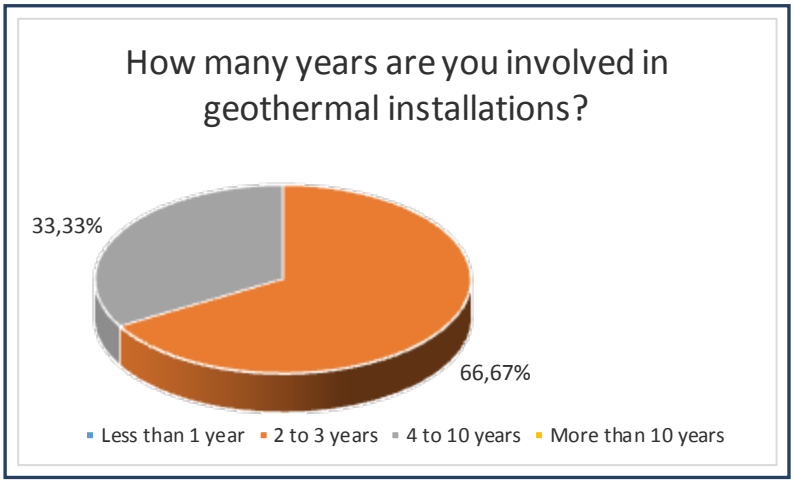
The higher number of interviewees, 40%, are working in the implementation of geothermal installations "From 2 to 3 years", the 30% "Less than 1 year", the 20% "From 4 to 10 years", and the



10% “More than 10 years”.

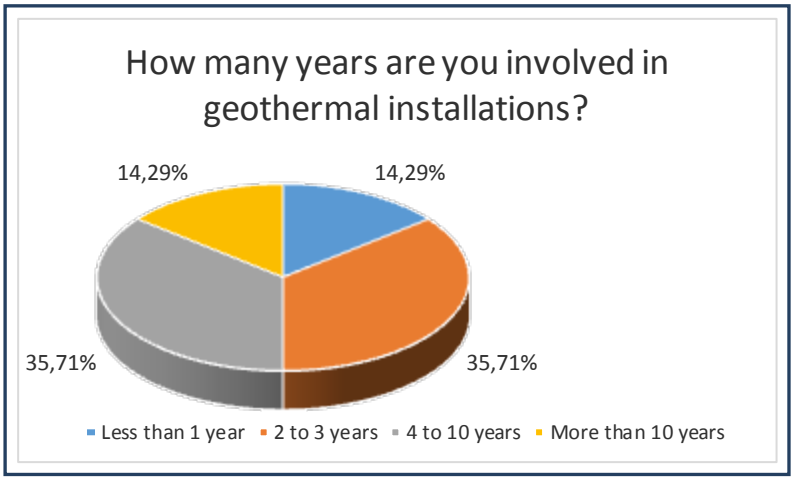
The case of Greece:

The higher number of interviewees, 66,67%, are working in the implementation of geothermal installations “From 2 to 3 years” and the 33,33% “From 4 to 10 years”.



The case of Spain:

The 35,71% of interviewees are working in the implementation of geothermal installations “From 4 to 10 years”, the 35,71% “From 2 to 3 years”, the 14,29% “Less than 1 year” and the 14,29% “More than 10 years”.

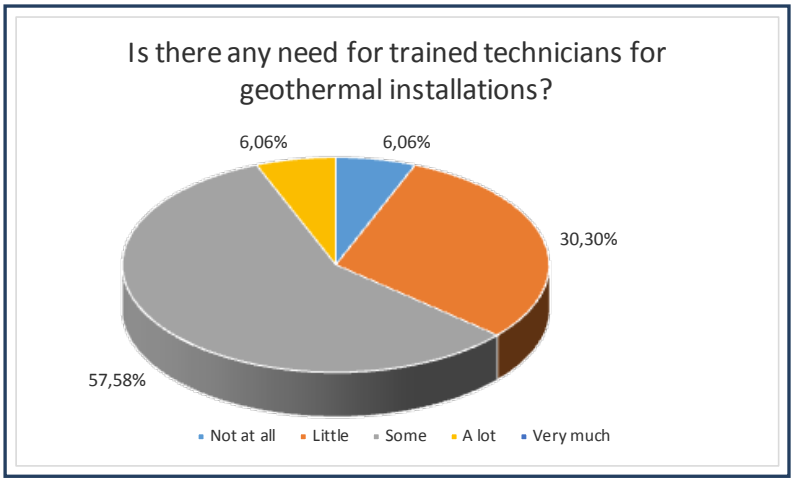


Is there any need for trained technicians for geothermal installations?

Summative statistics for all countries

This question concerns the need for trained technicians in green installations that all countries have.

In the questionnaire five options were given: 1)”Not at all”, 2)” Little”, 3)“Some”, 4)”A lot”, 5) “Very much”.



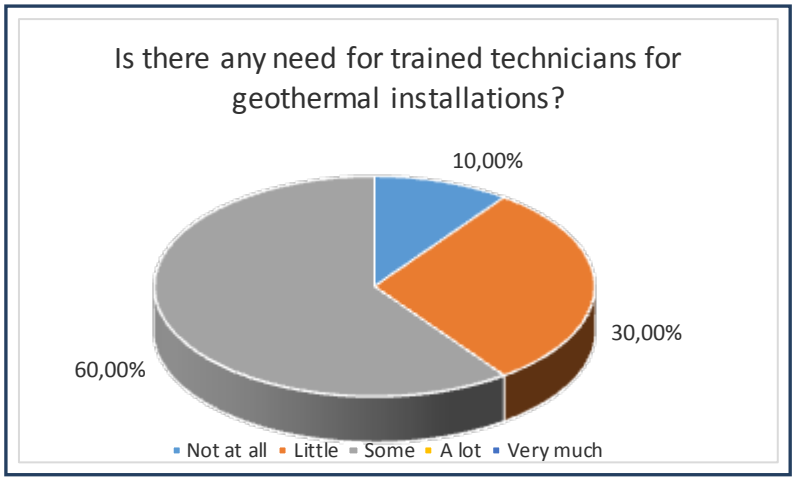
The higher number of interviewees, 57,58%, answered that there is “Some” need for

trained technicians in geothermal installations, the 30,30% that there is a "Little" need, the 6,06% that there is "A lot" of need and the 6,06% that there is "Not at all" need for trained technicians in geothermal installations.

The case of each participating country

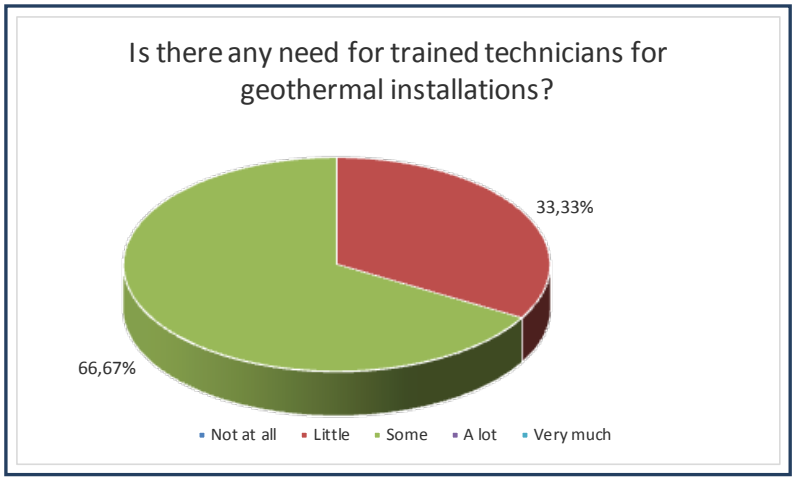
The case of France:

The higher number of interviewees, 60%, answered that there is "Some" need for trained technicians in geothermal installations, the 30% answered that there is a "Little" need for trained technicians, and the 10% answered that there is "Not at all" need for trained technicians in geothermal installations.



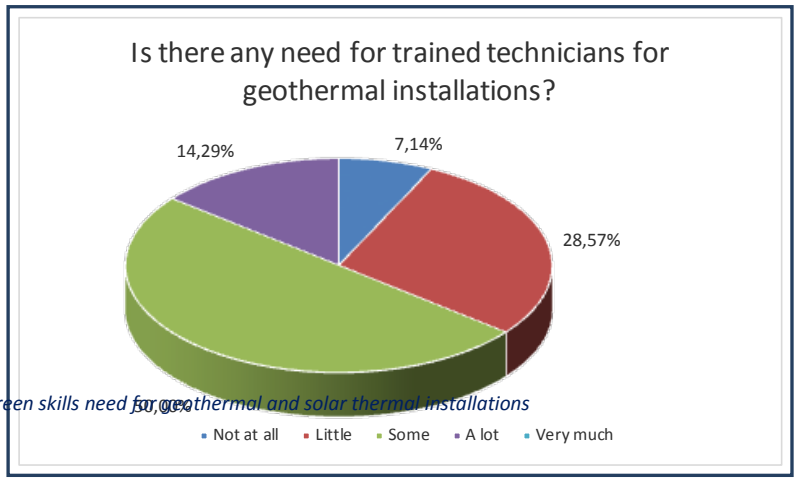
The case of Greece:

The higher number of interviewees, 66,67%, answered that there is "Some" need for trained technicians in geothermal installations, and the 33,33% answered that there is a "Little" need for trained technicians in geothermal installations.



The case of Spain:

The higher number of interviewees, 50%, answered that there is "Some" need for trained technicians in geothermal installations, the 28,57% answered that there is a "Little"



need for trained technicians, the 14,29% that there is “A lot” of need, and the 7,14% that there is “Not at all” need for trained technicians in geothermal installations.

2.2 Theoretical knowledge needs

In this section of the questionnaire focus was placed on the encoding of any theoretical knowledge that plumbers and electricians should have in order to be able to carry out geothermal installations.

Summative statistics for all countries

In question (B1) the interviewees were asked to evaluate a list of theoretical abilities that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered important.

The following 13 theoretical abilities were suggested:

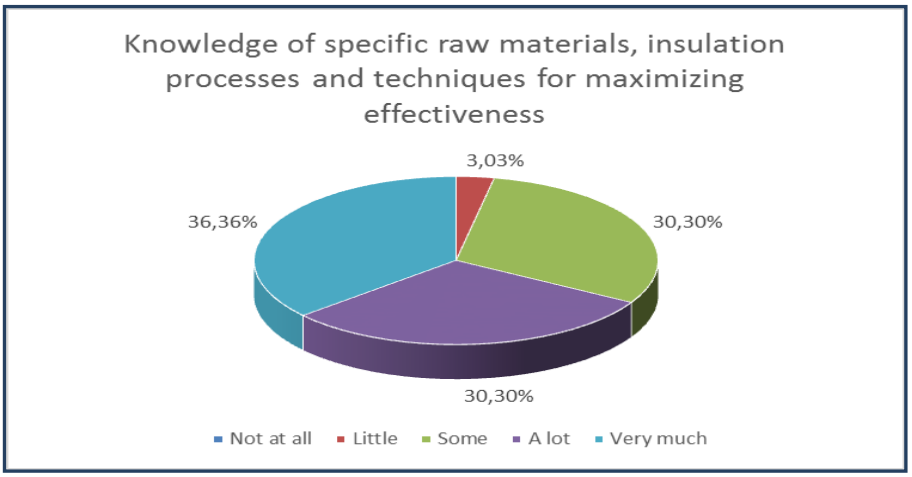
1. (B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness,
2. (B1.2) Knowledge of HVAC relevant costs and quality control,
3. (B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics),
4. (B1.4) Knowledge of accompaniment circuit boards, and electronic equipment,
5. (B1.5) Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods,
6. (B1.6) Knowledge of building thermal distribution systems and relevant equipment operation,
7. (B1.7) Knowledge of seasonal thermal energy storage and thermal efficiency techniques,
8. (B1.8) Knowledge of low surface geological principles and earth heat

exchange basics,

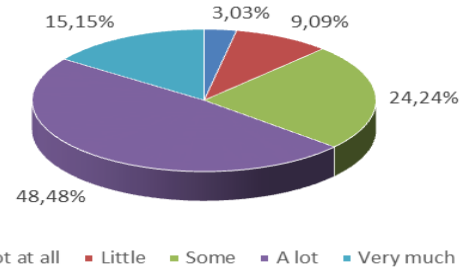
9. (B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints,
10. (B1.10) Knowledge of switching, control, and operation of electrical part of the systems,
11. (B1.11) Knowledge of the worldwide state of the art in geothermal applications,
12. (B1.12) Knowledge of the contemporary development and future trends of geothermal energy,
13. (B1.13) Knowledge of HVAC systems basic structure and operation principles and obstacles.

The interviewees evaluate each single theoretical ability by choosing a value among the five being proposed in the questionnaire. The proposed values were corresponding to the importance of each theoretical knowledge and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much.

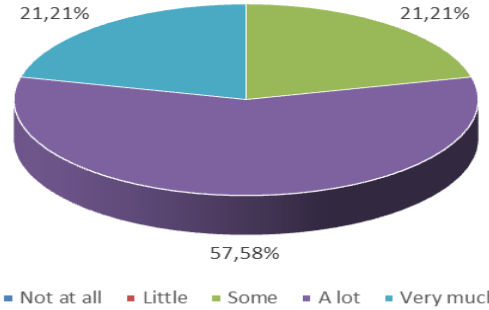
The graphs show the results for each ability:



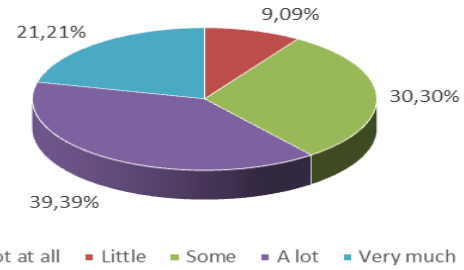
Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods



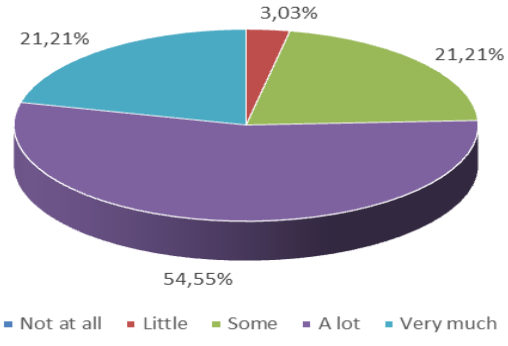
Knowledge of HVAC relevant costs and quality control



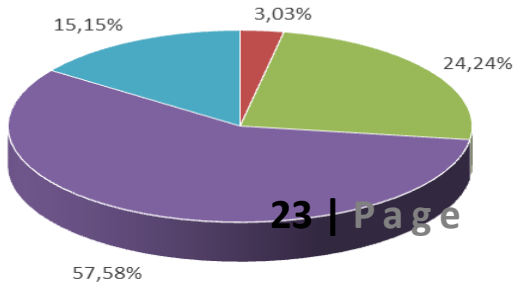
Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)



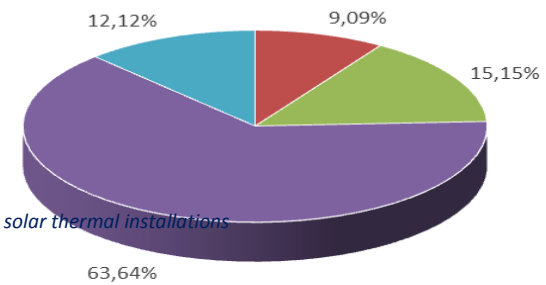
Knowledge of accompaniment circuit boards, and electronic equipment

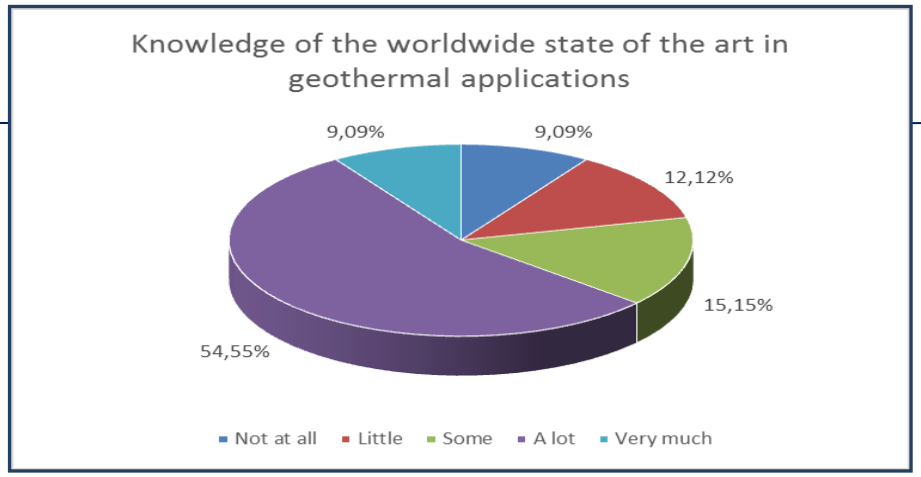


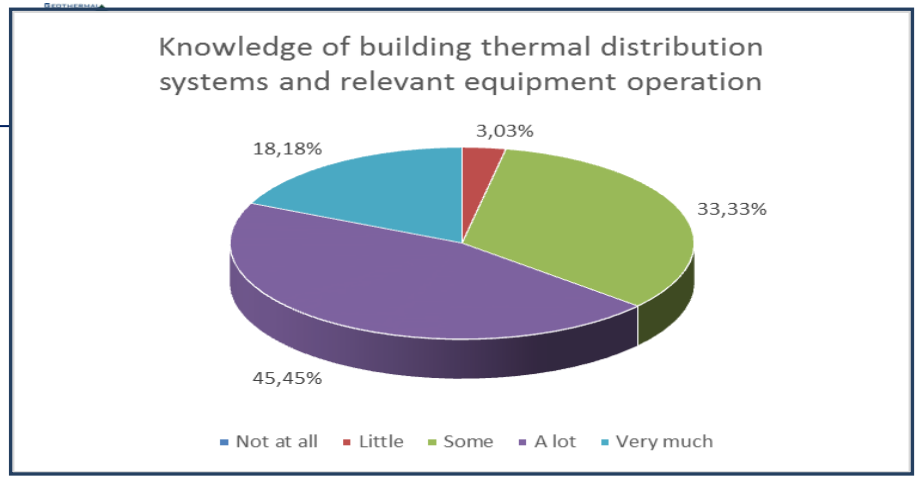
Knowledge of HVAC systems basic structure and operation principles and obstacles

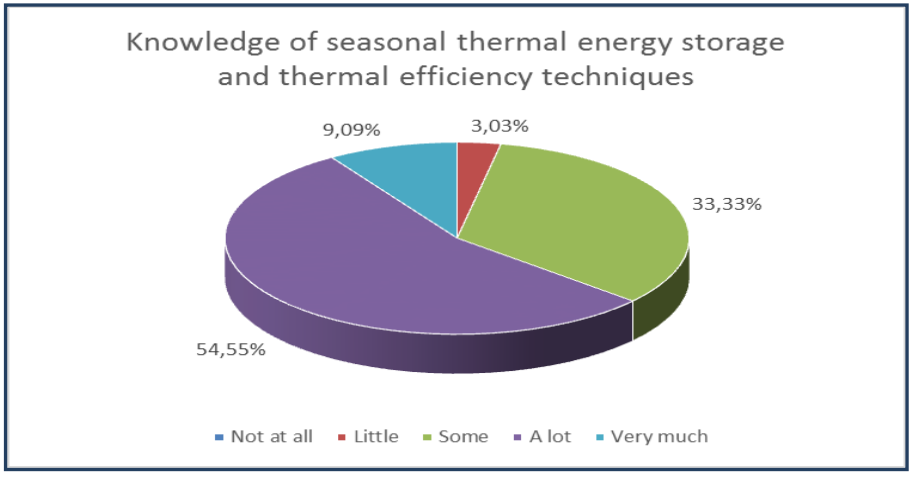


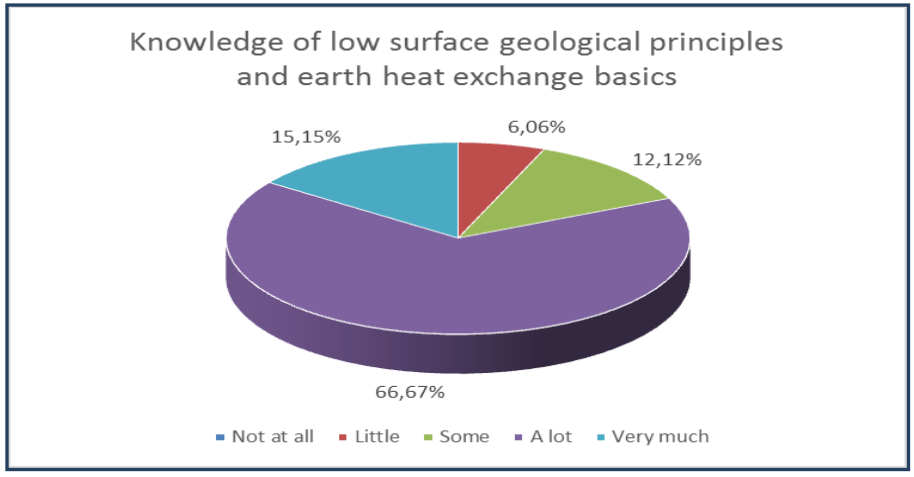
Knowledge of the contemporary development and future trends of geothermal energy

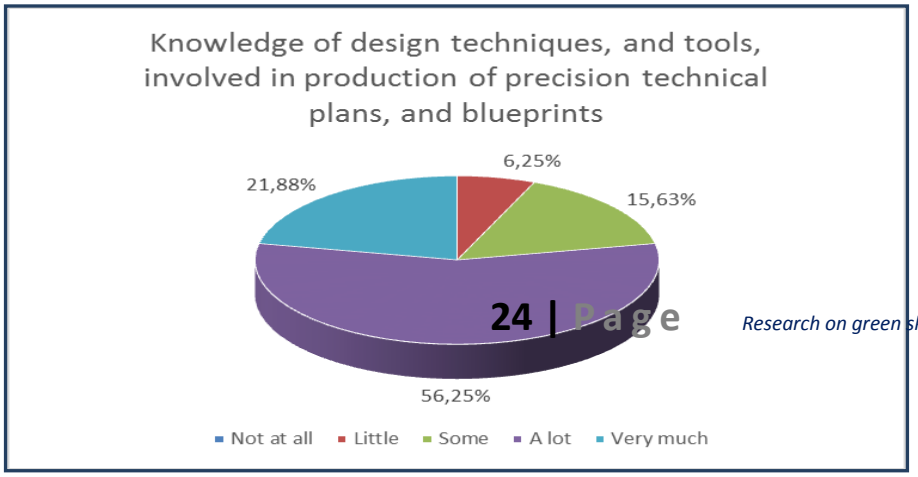


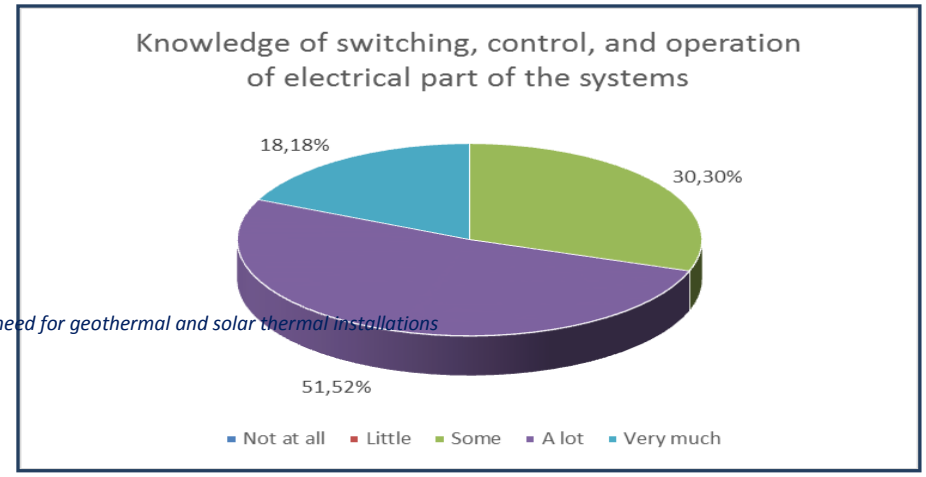

Knowledge of the worldwide state of the art in geothermal applications
9,09%
9,09%
12,12%
15,15%
54,55%
Not at all
Little
Some
A lot
Very much


Knowledge of building thermal distribution systems and relevant equipment operation
3,03%
18,18%
33,33%
45,45%
Not at all
Little
Some
A lot
Very much


Knowledge of seasonal thermal energy storage and thermal efficiency techniques
9,09%
3,03%
33,33%
54,55%
Not at all
Little
Some
A lot
Very much


Knowledge of low surface geological principles and earth heat exchange basics
15,15%
6,06%
12,12%
66,67%
Not at all
Little
Some
A lot
Very much


Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
6,25%
21,88%
15,63%
56,25%
Not at all
Little
Some
A lot
Very much


Knowledge of switching, control, and operation of electrical part of the systems
18,18%
30,30%
51,52%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the theoretical most needed knowledge that a technician should have in order to be able to carry out a geothermal installation.

The following classified abilities are considered very important and correspond from 70% and up of the interviewees' choices:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**81,82%**	(B1.8)Knowledge of low surface geological principles and earth heat exchange basics,
2	**78,79%**	(B1.2) Knowledge of HVAC relevant costs and quality control
3	**78,13%**	(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints,
4	**75,76%**	(B1.4) Knowledge of accompaniment circuit boards, and electronic equipment
5	**75,76%**	(B1.12) Knowledge of the contemporary development and future trends of geothermal energy,
6	**72,72%**	(B1.13) Knowledge of HVAC systems basic structure and operation principles and obstacles.

The following listed abilities are considered as less important and correspond less than 70% of the interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**69,70%**	(B1.10) Knowledge of switching, control, and operation of electrical part of the systems,
2	**66,66%**	(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
3	**63,63%**	(B1.5) Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods
4	**63,63%**	(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation

5	**63,64%**	(B1.7) Knowledge of seasonal thermal energy storage and thermal efficiency techniques,
6	**63,64%**	(B1.11) Knowledge of the worldwide state of the art in geothermal applications,
7	**60,60%**	(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)

In question (B2) the interviewees were asked to indicate any theoretical knowledge they consider as essential for technician of geothermal installations. Besides the abilities listed in the questionnaire, 8 of the 33 interviewees filled out the open question (B2) of the questionnaire - field named as “Other”, with relevant and important abilities not listed in the questionnaire. The proposed essential knowledge by interviewees from all countries is the following:

1 **Spain:** Knowledge of process’s environmental impact.

2 **Spain:** Knowledge in geotechnical and foundation of adjoining buildings.

3 **Spain:** Knowledge of the field (drilling capacity, carrying capacity without shoring, thermal capacity).

4 **Greece:** Cycle cooling, Plumbing, Data conditioning, Heat pump

5 **Spain:** Knowing not only anything that geothermal installations invove; but also about facilities, design, control, etc.).

6 **Spain:** Materials, assemblies, systems and all the plumbing and electrical element.

7 **France:** Professional intrusion of renewable energies field; must be formed, creating a degree of FPII.

8 **Spain:** Feasibility of geothermal exchange systems,

Environmental aspects and risk assessment,

Operation and management IG systems

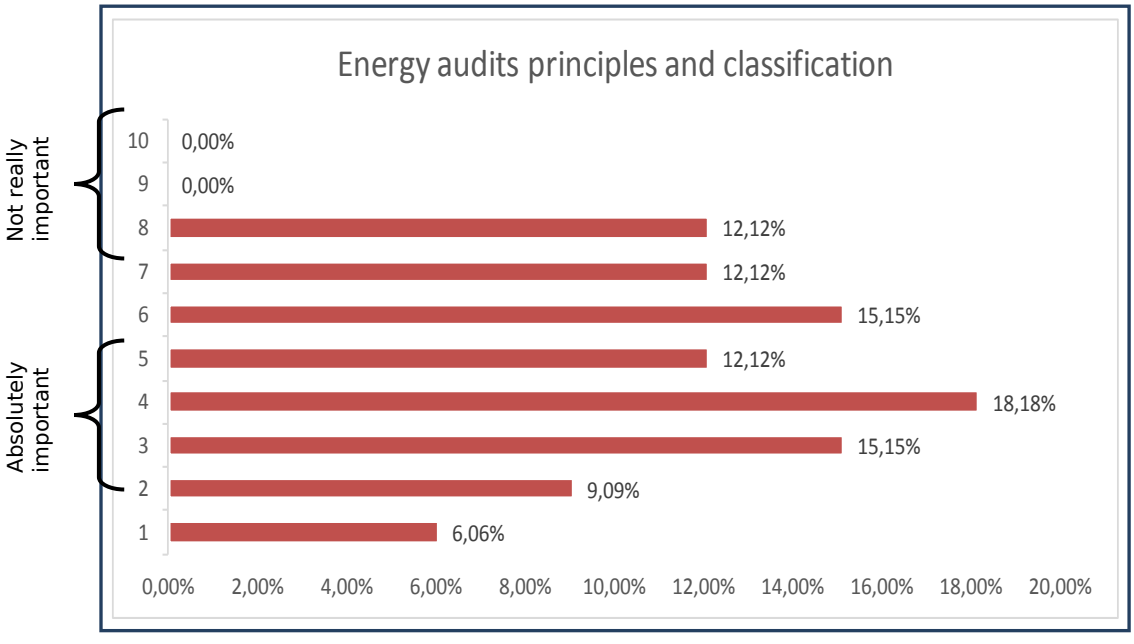
In question (B3) the interviewees from all participating countries in the research were asked to rate a list with proposed theoretical knowledge that a technician should possess in order to perform his/her profession and to be able to carry out a geothermal installation.

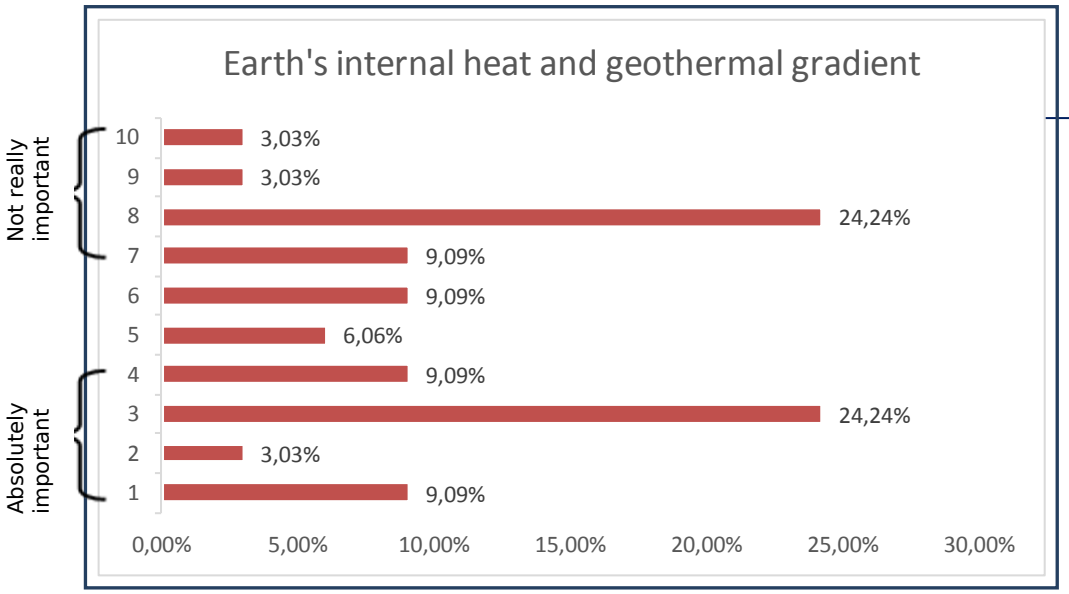
<u>The following 8 abilities were suggested:</u>

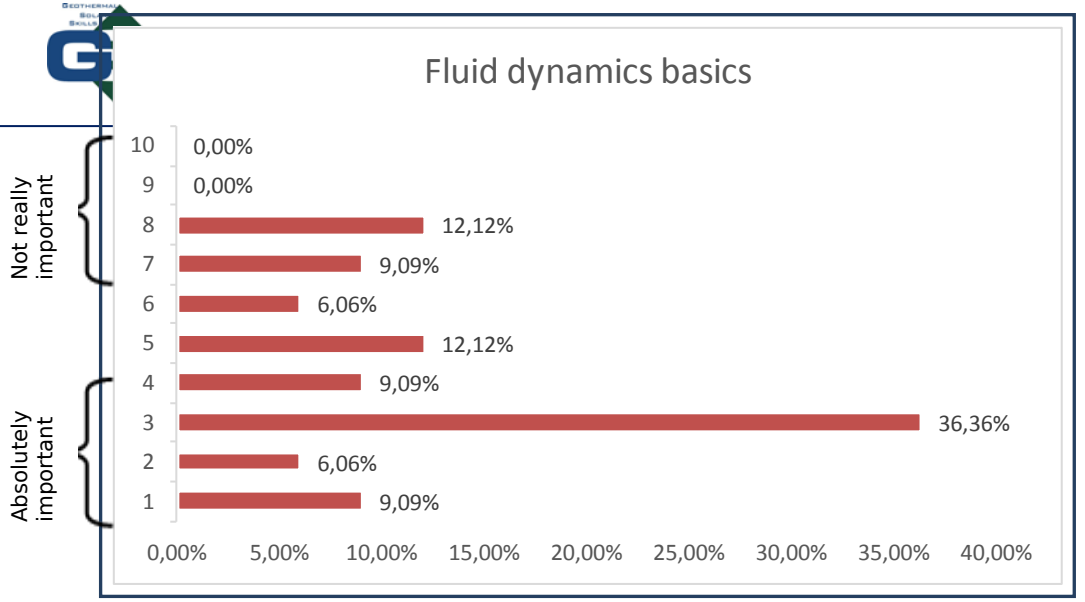
1. Energy audits principles and classification
2. Earth's internal heat and geothermal gradient
3. Fluid dynamics basics
4. Geothermal heating
5. Heat pump's structure and operation
6. Types of geothermal heat pump
7. Building distribution systems
8. Thermal storage techniques

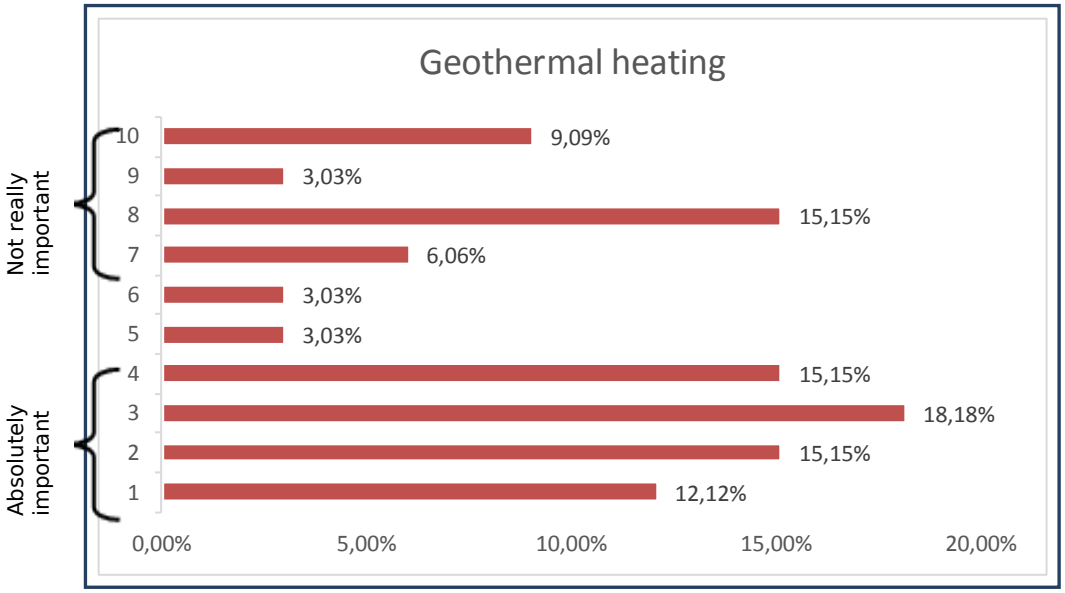
The interviewees evaluated each single ability by choosing a value from 1 to 10, where 1 corresponds to "Absolutely important" and 10 to "Not really important".

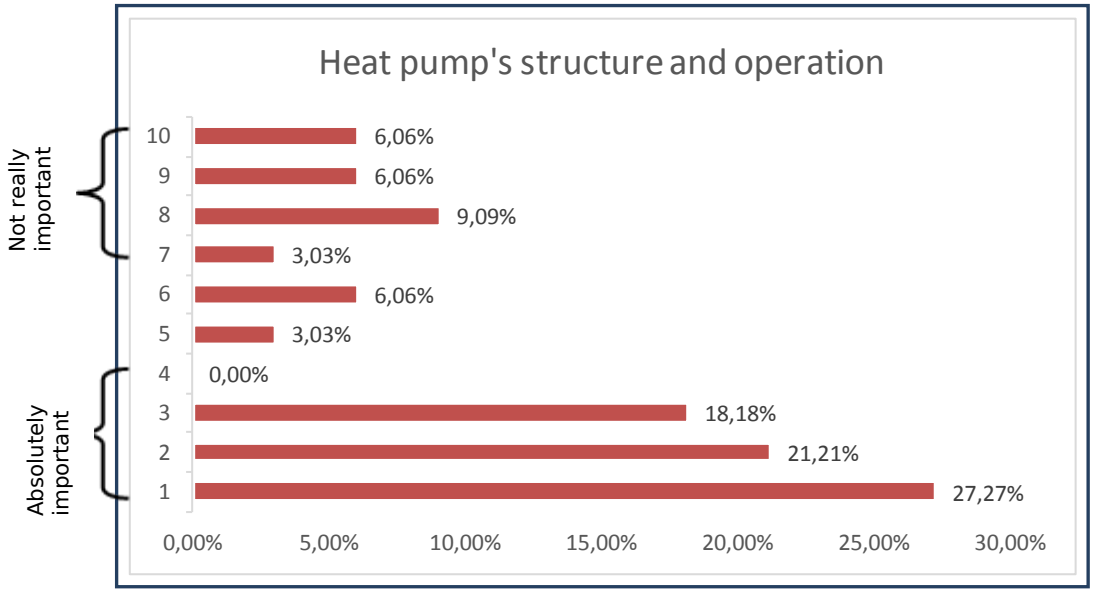
The graphs show the results for each ability:

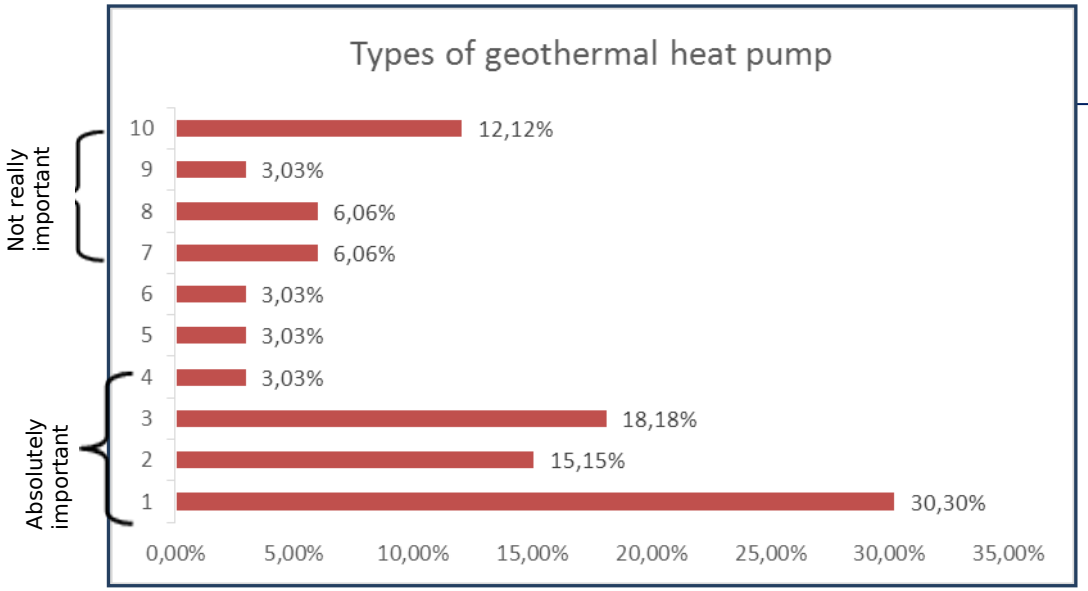


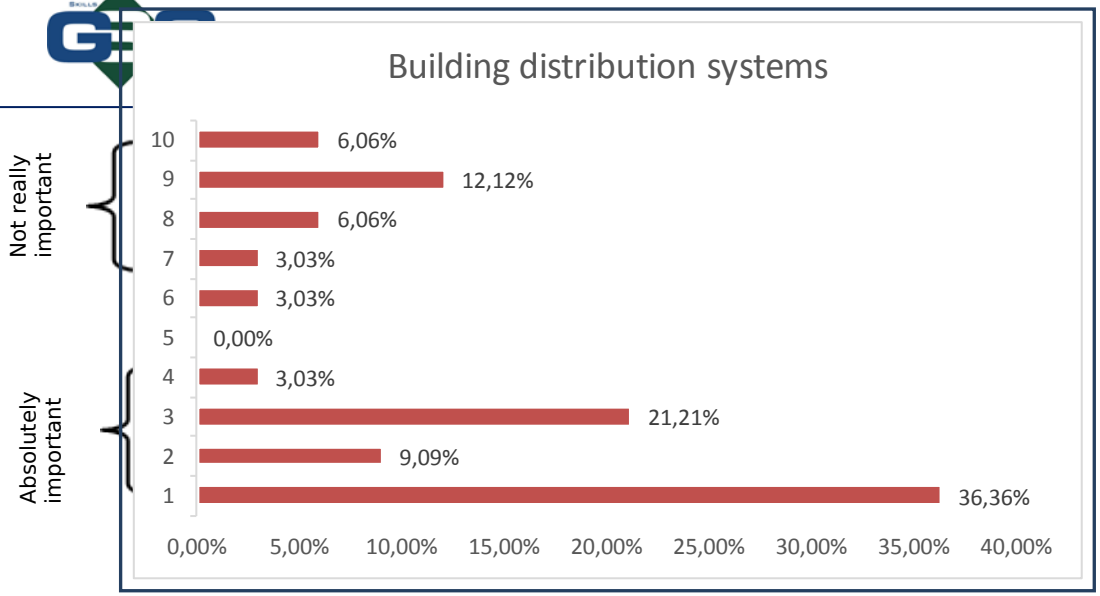

Earth's internal heat and geothermal gradient
Not really important
Absolutely important
10 3,03%
9 3,03%
8 24,24%
7 9,09%
6 9,09%
5 6,06%
4 9,09%
3 24,24%
2 3,03%
1 9,09%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%

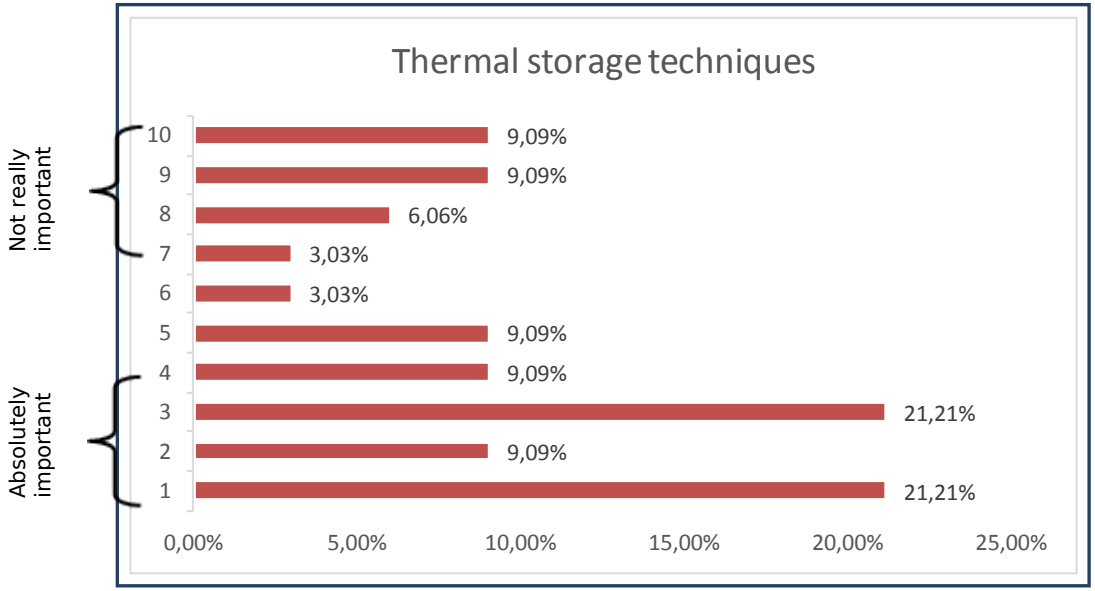

Fluid dynamics basics
Not really important
Absolutely important
10 0,00%
9 0,00%
8 12,12%
7 9,09%
6 6,06%
5 12,12%
4 9,09%
3 36,36%
2 6,06%
1 9,09%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00% 40,00%


Geothermal heating
Not really important
Absolutely important
10 9,09%
9 3,03%
8 15,15%
7 6,06%
6 3,03%
5 3,03%
4 15,15%
3 18,18%
2 15,15%
1 12,12%
0,00% 5,00% 10,00% 15,00% 20,00%


Heat pump's structure and operation
Not really important
Absolutely important
10 6,06%
9 6,06%
8 9,09%
7 3,03%
6 6,06%
5 3,03%
4 0,00%
3 18,18%
2 21,21%
1 27,27%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%


Types of geothermal heat pump
Not really important
Absolutely important
10 12,12%
9 3,03%
8 6,06%
7 6,06%
6 3,03%
5 3,03%
4 3,03%
3 18,18%
2 15,15%
1 30,30%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00%


Building distribution systems
Not really important
Absolutely important
10 6,06%
9 12,12%
8 6,06%
7 3,03%
6 3,03%
5 0,00%
4 3,03%
3 21,21%
2 9,09%
1 36,36%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00% 40,00%


Thermal storage techniques
Not really important
Absolutely important
10 9,09%
9 9,09%
8 6,06%
7 3,03%
6 3,03%
5 9,09%
4 9,09%
3 21,21%
2 9,09%
1 21,21%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00%

According to the answers that interviewees from all participating countries filled out regarding the theoretical abilities that were listed under the question (B3), the above mentioned knowledge is classified as following:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**69,70%**	Building distribution systems
2	**66,67%**	Heat pump's structure and operation
3	**66,67%**	Types of geothermal heat pump
4	**60,61%**	Fluid dynamics basics
5	**60,61%**	Geothermal heating
6	**60,61%**	Thermal storage techniques
7	**48,48%**	Energy audits principles and classification
8	**45,45%**	Earth's internal heat and geothermal gradient

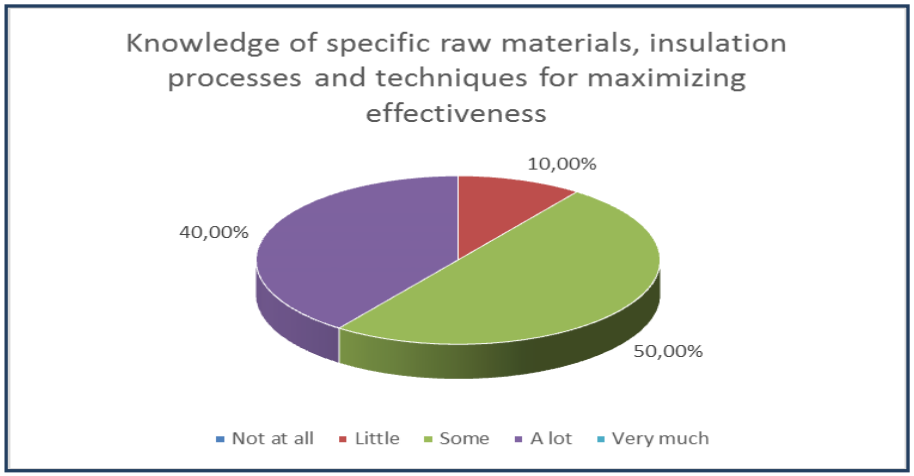
The case of each participating country

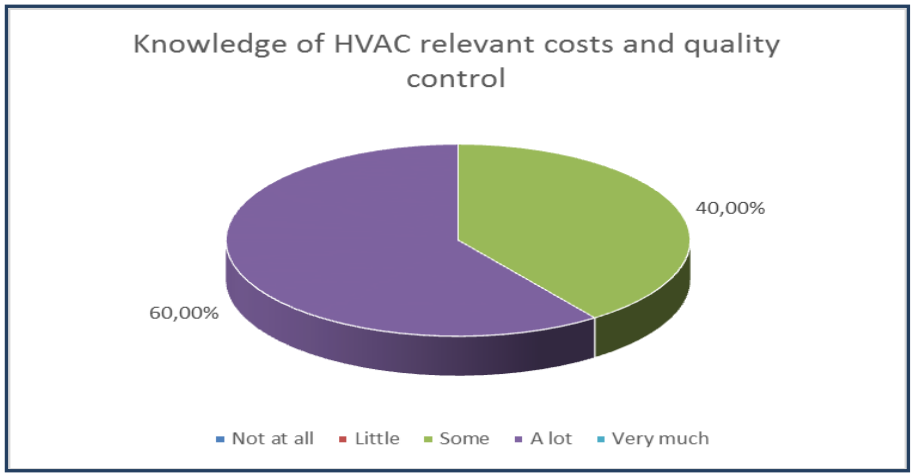
The case of France:

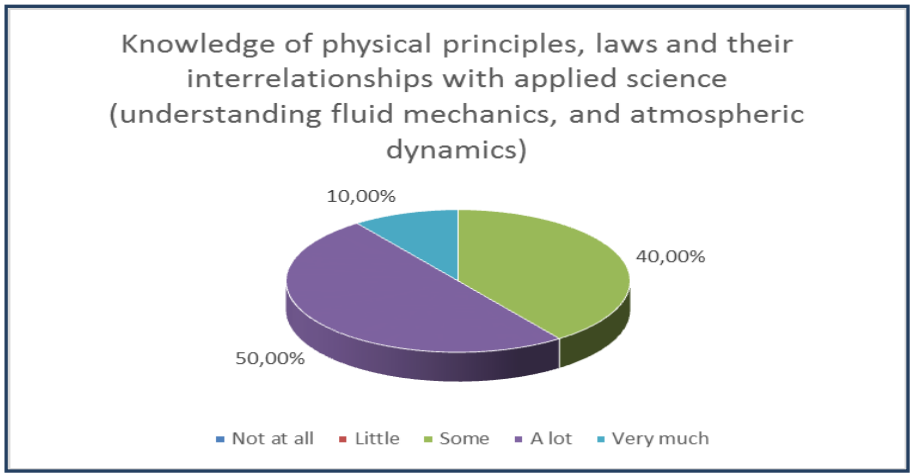
In question (B1) the French interviewees were asked to evaluate a list of theoretical abilities that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered important.

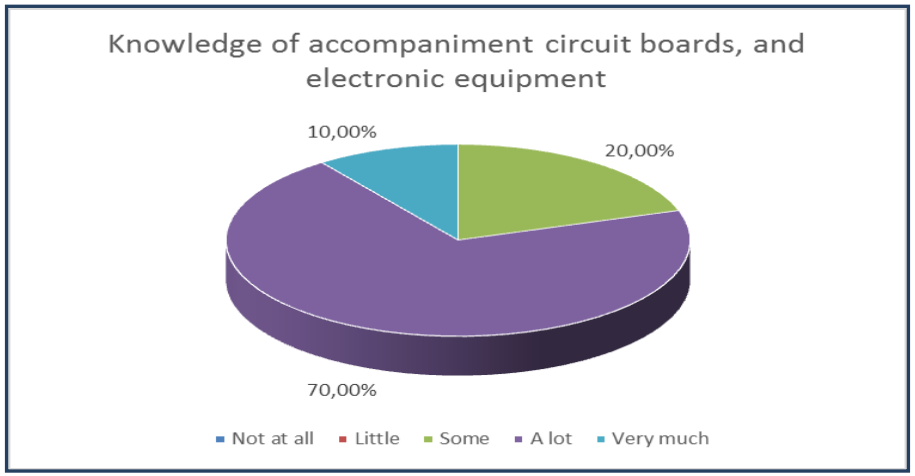
The interviewees evaluate each single theoretical ability listed on the questionnaire by choosing a value among the five being proposed. The proposed values were corresponding to the importance of each theoretical knowledge and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much.

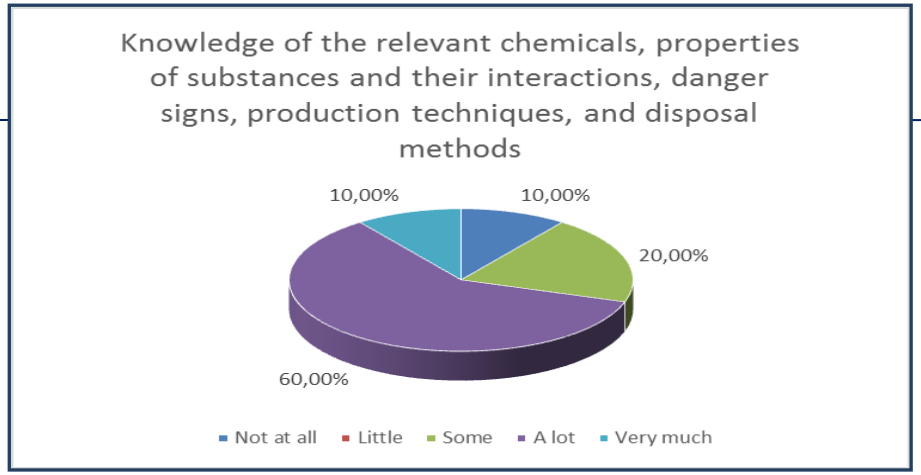
The graphs show the results for each ability:

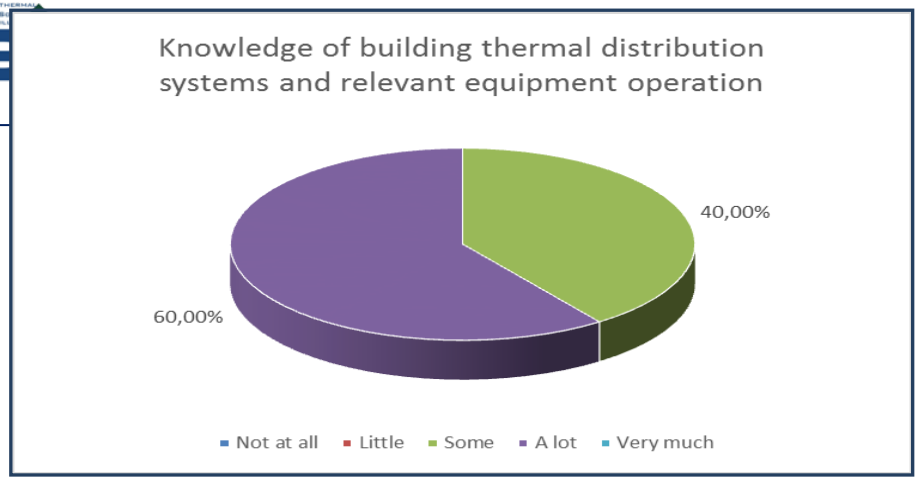

Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
10,00%
40,00%
50,00%
Not at all
Little
Some
A lot
Very much

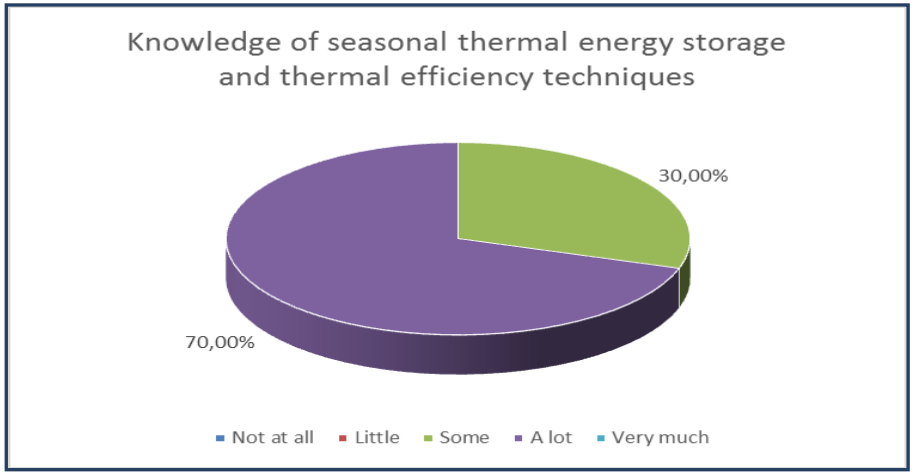

Knowledge of HVAC relevant costs and quality control
40,00%
60,00%
Not at all
Little
Some
A lot
Very much

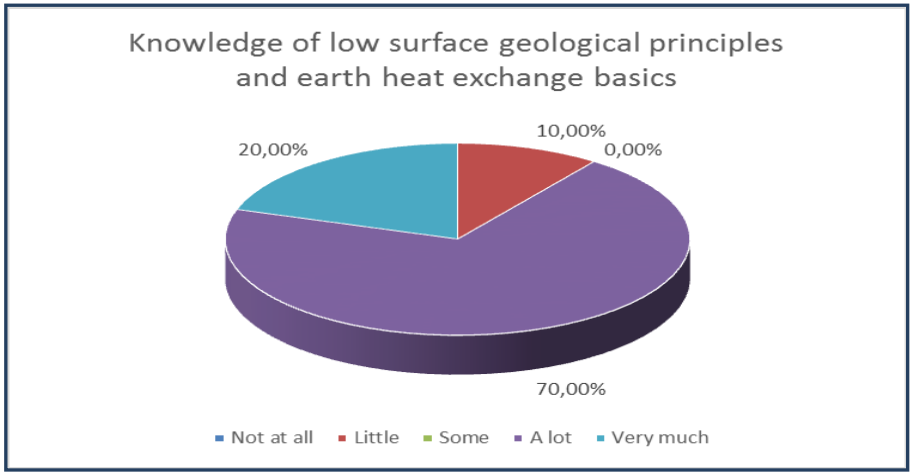

Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)
10,00%
40,00%
50,00%
Not at all
Little
Some
A lot
Very much

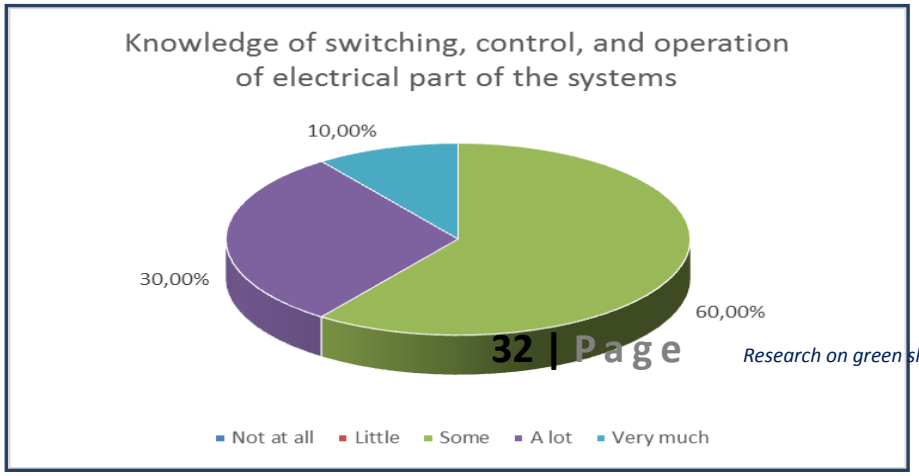

Knowledge of accompaniment circuit boards, and electronic equipment
10,00%
20,00%
70,00%
Not at all
Little
Some
A lot
Very much

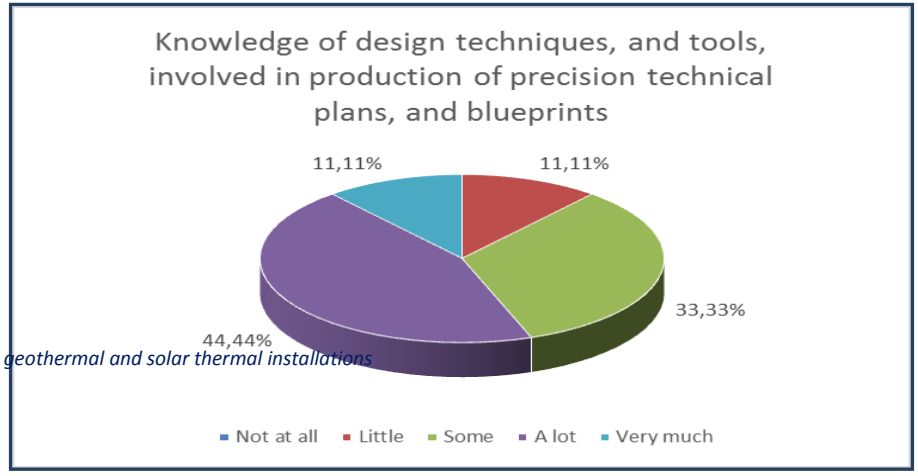

Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods
10,00%
10,00%
20,00%
60,00%
Not at all
Little
Some
A lot
Very much

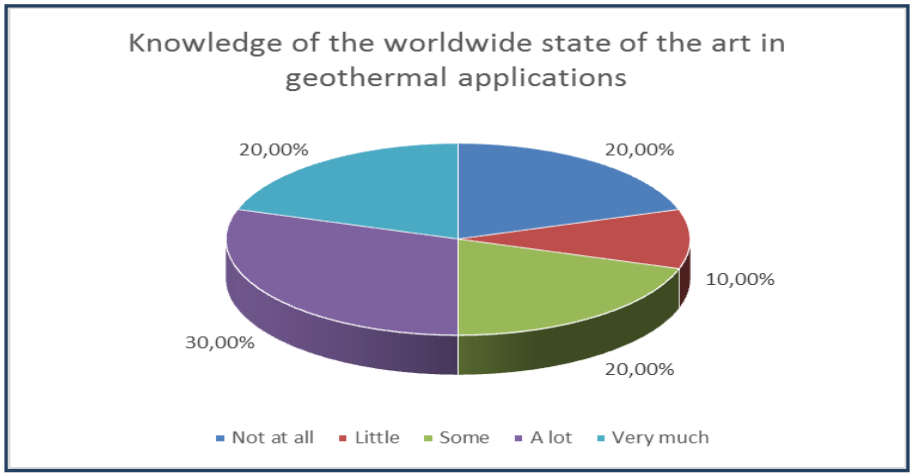

Knowledge of building thermal distribution systems and relevant equipment operation
40,00%
60,00%
Not at all
Little
Some
A lot
Very much

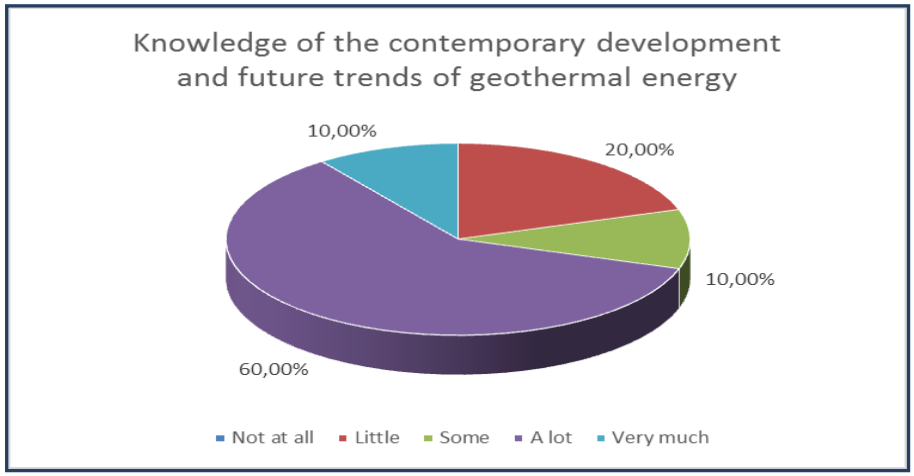

Knowledge of seasonal thermal energy storage and thermal efficiency techniques
30,00%
70,00%
Not at all
Little
Some
A lot
Very much

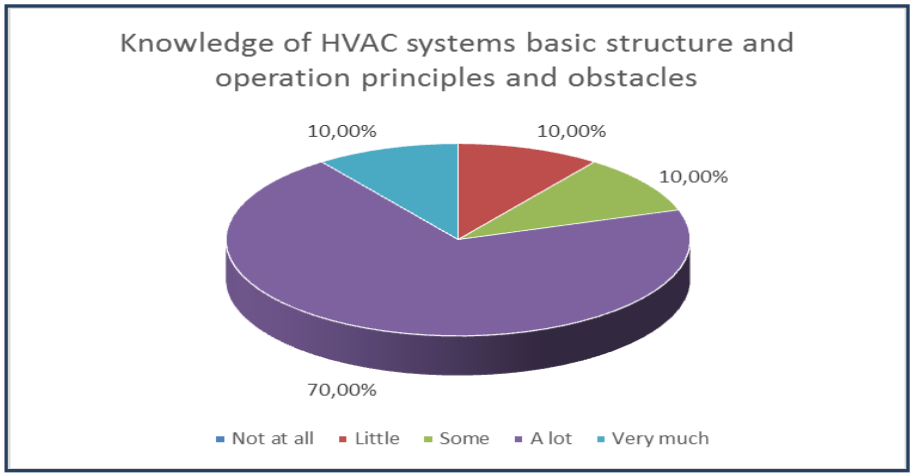

Knowledge of low surface geological principles and earth heat exchange basics
10,00%
0,00%
20,00%
70,00%
Not at all
Little
Some
A lot
Very much


Knowledge of switching, control, and operation of electrical part of the systems
10,00%
30,00%
60,00%
Not at all
Little
Some
A lot
Very much


Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
11,11%
11,11%
33,33%
44,44%
Not at all
Little
Some
A lot
Very much


Knowledge of the worldwide state of the art in geothermal applications
20,00%
20,00%
10,00%
30,00%
20,00%
Not at all
Little
Some
A lot
Very much


Knowledge of the contemporary development and future trends of geothermal energy
10,00%
20,00%
10,00%
60,00%
Not at all
Little
Some
A lot
Very much


Knowledge of HVAC systems basic structure and operation principles and obstacles
10,00%
10,00%
10,00%
70,00%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the theoretical most needed knowledge that a technician should have in order to be able to carry out a geothermal installation in France.

The following classified abilities are considered very important and correspond from 70% and up of the French interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**90%**	(B1.8)Knowledge of low surface geological principles and earth heat exchange basics,
2	**80%**	(B1.13) Knowledge of HVAC systems basic structure and operation principles and obstacles.
3	**80%**	(B1.4) Knowledge of accompaniment circuit boards, and electronic equipment
4	**70%**	(B1.12) Knowledge of the contemporary development and future trends of geothermal energy,
5	**70%**	(B1.5) Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods
6	**70%**	(B1.7) Knowledge of seasonal thermal energy storage and thermal efficiency techniques

The following listed abilities correspond to less than 70% of the French interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**60%**	(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)
2	**60%**	(B1.2) Knowledge of HVAC relevant costs and quality control
3	**60%**	(B1.6) Knowledge of building thermal distribution systems and relevant

		equipment operation
4	**50%**	(B1.11) Knowledge of the worldwide state of the art in geothermal applications
5	**55,56%**	(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
6	**40%**	(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
7	**40%**	(B1.10) Knowledge of switching, control, and operation of electrical part of the systems

In question (B2) the French interviewees were asked to indicate any theoretical knowledge they consider as essential for technicians of geothermal installations. Besides the abilities listed in the questionnaire, one of the ten French interviewees filled out the (B2) open question - field named as “Other”, with abilities not listed in the questionnaire.

France:

The essential knowledge that he/she proposed is the following:

Professional intrusion of renewable energies field; must be formed, creating a degree of FPII.

In question (B3) the French interviewees were asked to rate a list with proposed theoretical knowledge that a technician should possess in order to perform his/her profession and to be able to carry out a geothermal installation.

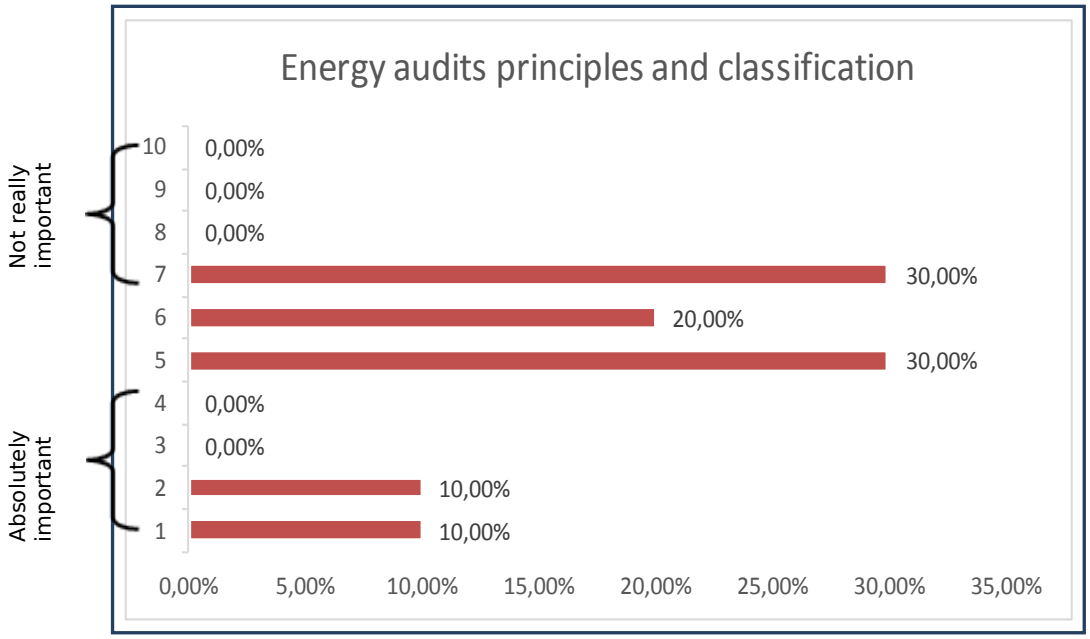
<u>The following 8 abilities were suggested:</u>

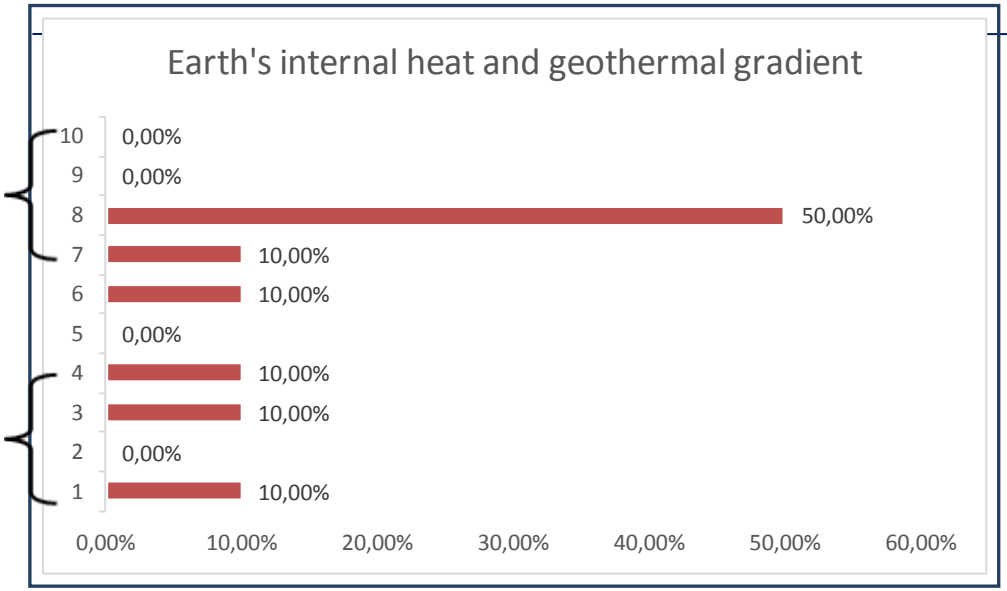
1. Energy audits principles and classification
2. Earth's internal heat and geothermal gradient

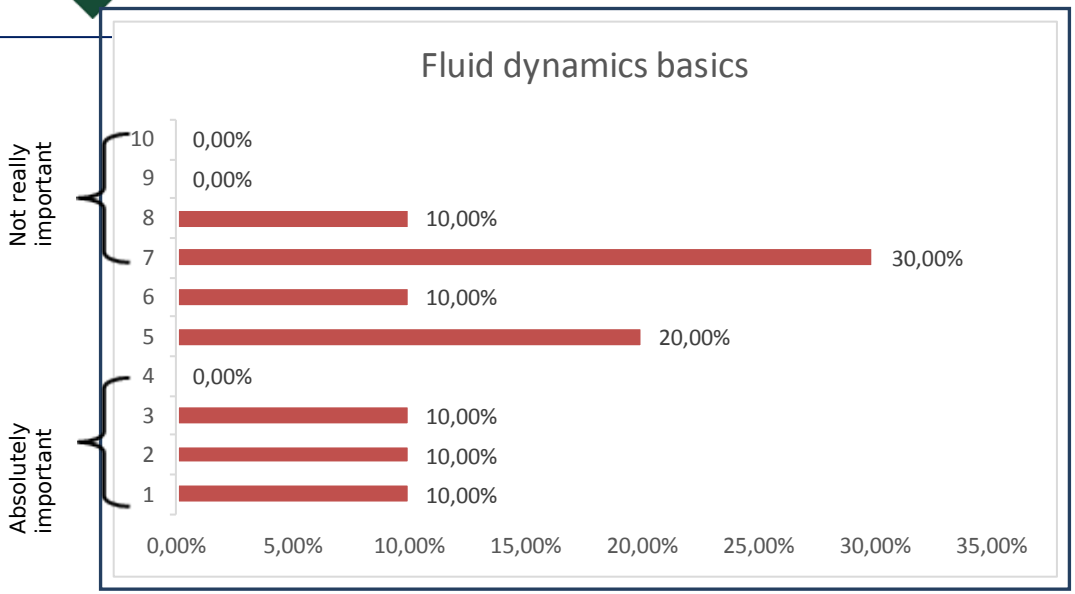
3. Fluid dynamics basics
4. Geothermal heating
5. Heat pump's structure and operation
6. Types of geothermal heat pump
7. Building distribution systems
8. Thermal storage techniques

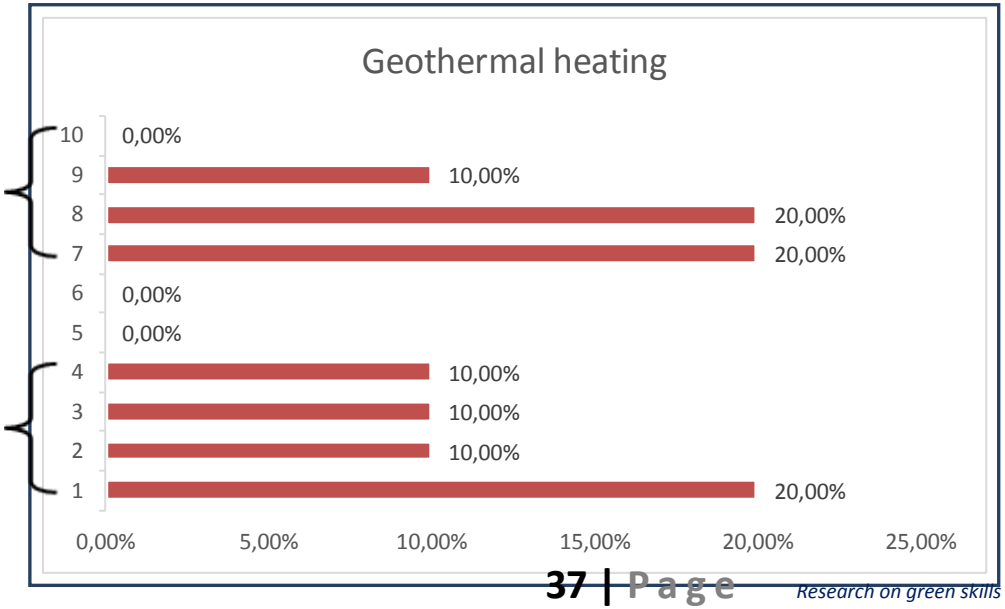
The French interviewees evaluated each single ability by choosing a value from 1 to 10, where 1 corresponds to "Absolutely important" and 10 to "Not really important".

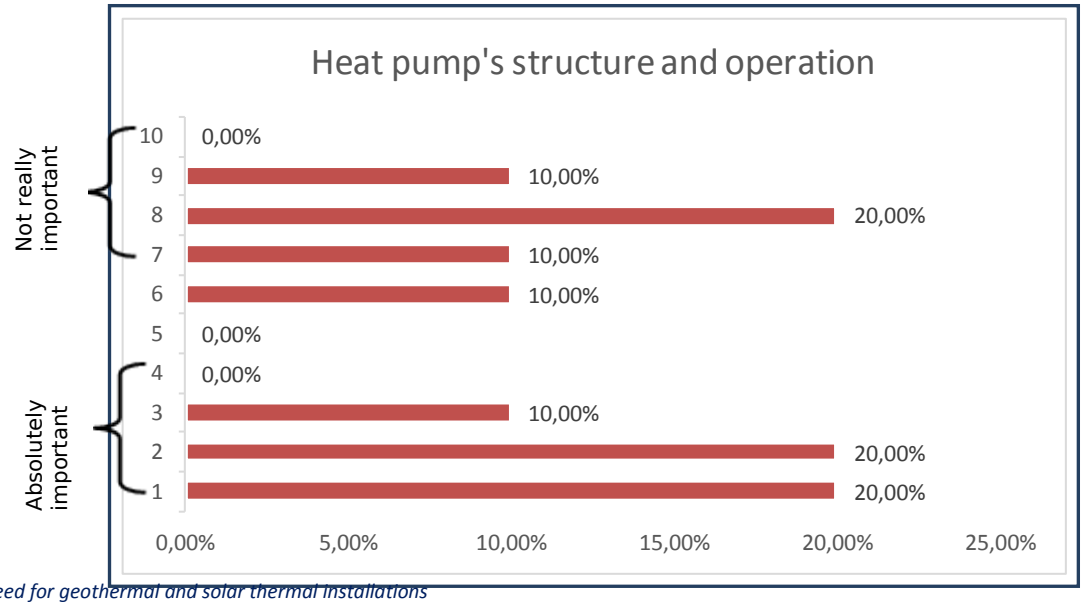
The graphs show the results for each ability:

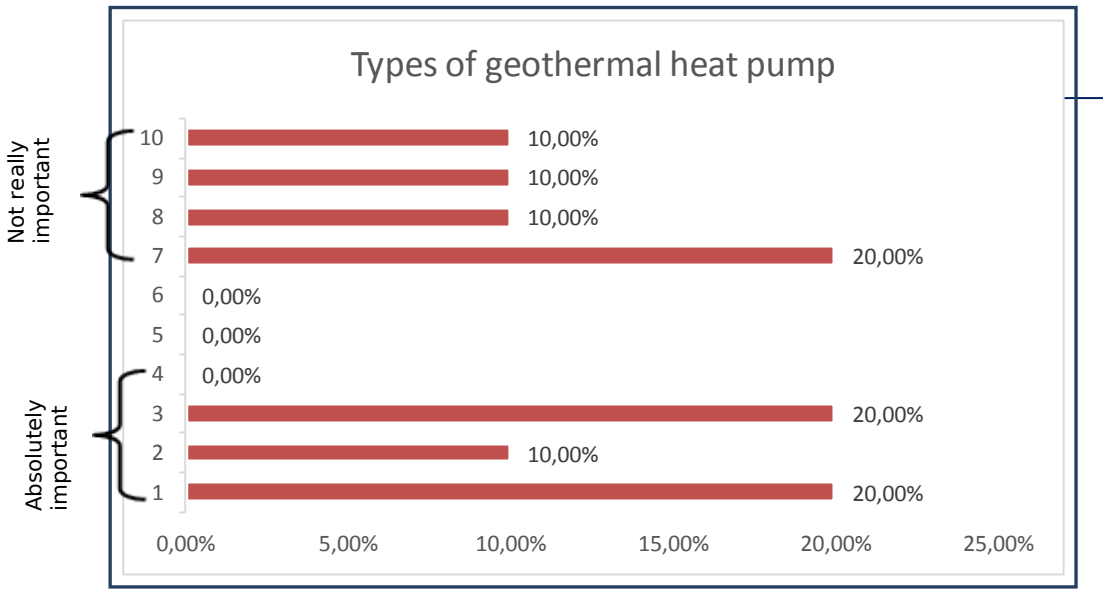


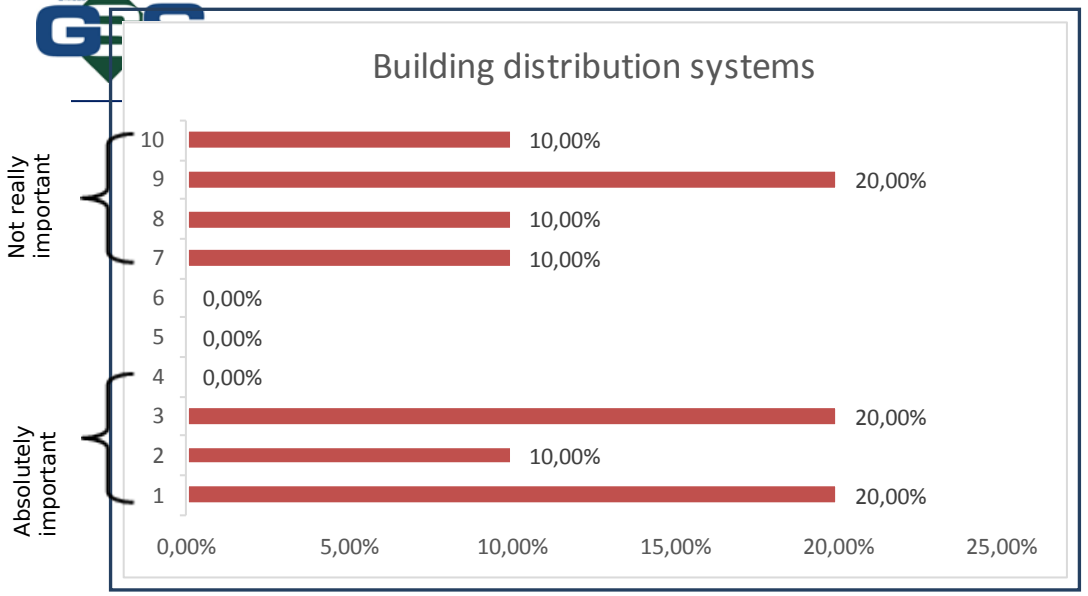

Earth's internal heat and geothermal gradient
Not really important
Absolutely important
10 0,00%
9 0,00%
8 50,00%
7 10,00%
6 10,00%
5 0,00%
4 10,00%
3 10,00%
2 0,00%
1 10,00%
0,00% 10,00% 20,00% 30,00% 40,00% 50,00% 60,00%

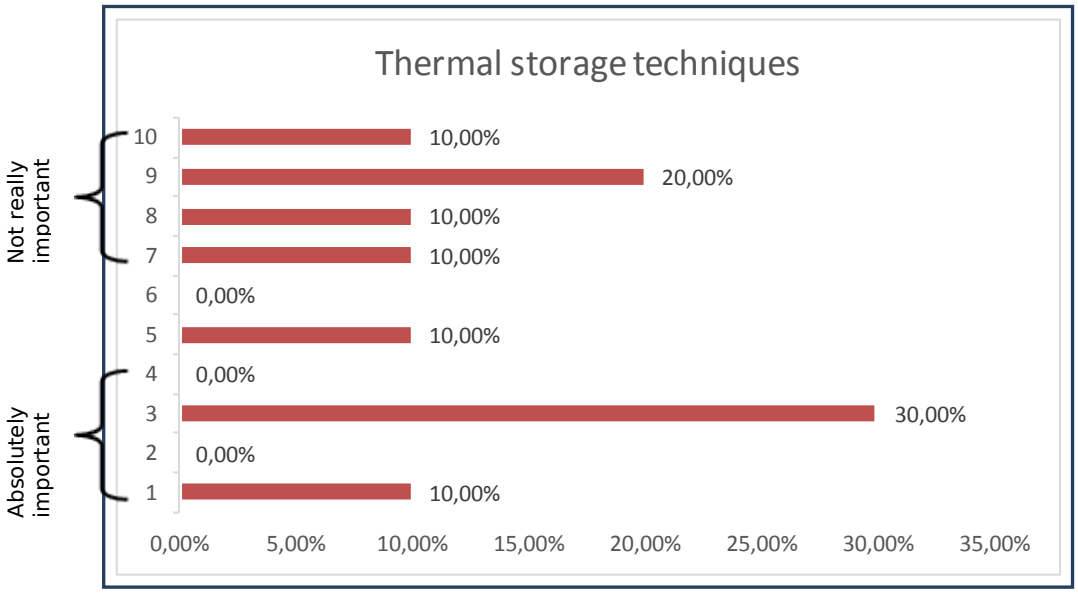

Fluid dynamics basics
Not really important
Absolutely important
10 0,00%
9 0,00%
8 10,00%
7 30,00%
6 10,00%
5 20,00%
4 0,00%
3 10,00%
2 10,00%
1 10,00%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00%


Geothermal heating
Not really important
Absolutely important
10 0,00%
9 10,00%
8 20,00%
7 20,00%
6 0,00%
5 0,00%
4 10,00%
3 10,00%
2 10,00%
1 20,00%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00%


Heat pump's structure and operation
Not really important
Absolutely important
10 0,00%
9 10,00%
8 20,00%
7 10,00%
6 10,00%
5 0,00%
4 0,00%
3 10,00%
2 20,00%
1 20,00%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00%


Types of geothermal heat pump
Not really important
Absolutely important
10
9
8
7
6
5
4
3
2
1
10,00%
10,00%
10,00%
20,00%
0,00%
0,00%
0,00%
20,00%
10,00%
20,00%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%


Building distribution systems
Not really important
Absolutely important
10
9
8
7
6
5
4
3
2
1
10,00%
20,00%
10,00%
10,00%
0,00%
0,00%
0,00%
20,00%
10,00%
20,00%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%


Thermal storage techniques
Not really important
Absolutely important
10
9
8
7
6
5
4
3
2
1
10,00%
20,00%
10,00%
10,00%
0,00%
10,00%
0,00%
30,00%
0,00%
10,00%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%
30,00%
35,00%

According to the answers that French interviewees filled out regarding the theoretical abilities that were listed under the question (B3) the above mentioned knowledge is classified as following:

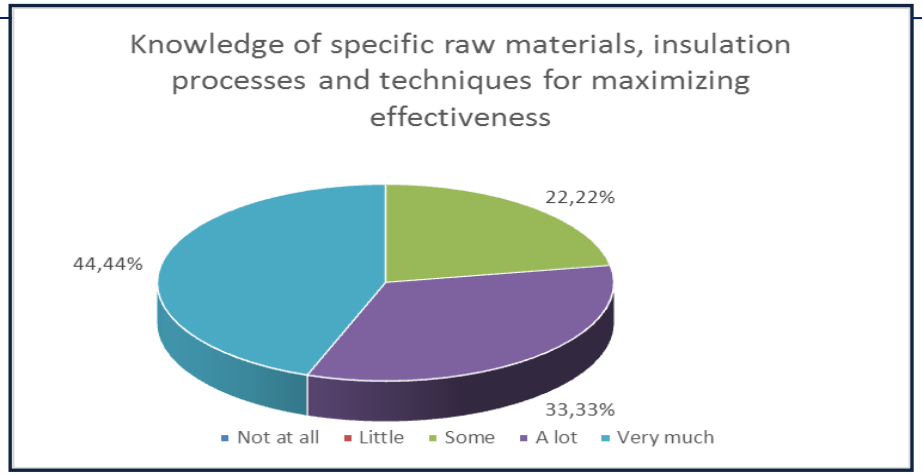
	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**50%**	Building distribution systems
2	**50%**	Heat pump's structure and operation
3	**50%**	Types of geothermal heat pump
4	**50%**	Geothermal heating
5	**40%**	Thermal storage techniques
6	**30%**	Fluid dynamics basics
7	**30%**	Earth's internal heat and geothermal gradient
8	**20%**	Energy audits principles and classification

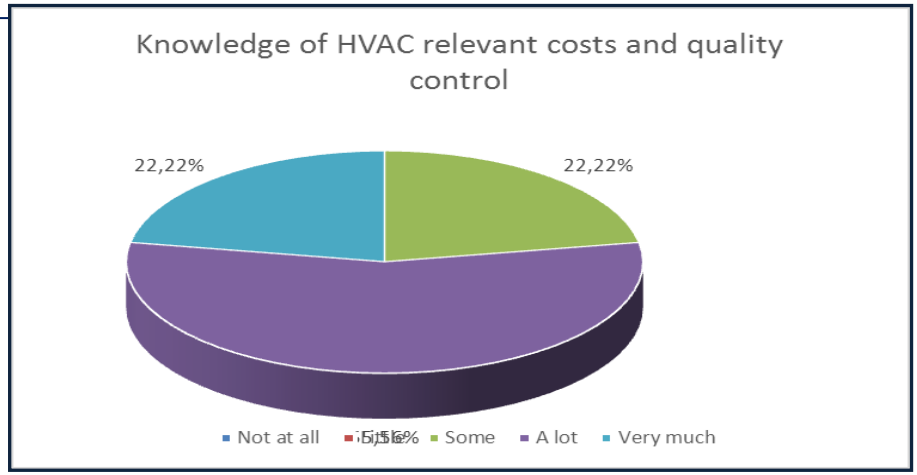
The case of Greece:

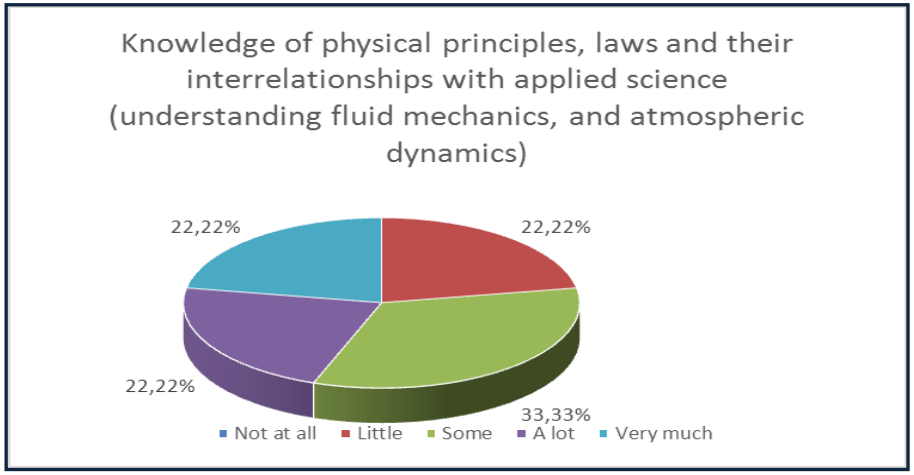
In question (B1) the Greek interviewees were asked to evaluate a list of theoretical abilities that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to propose other theoretical knowledge they considered as important.

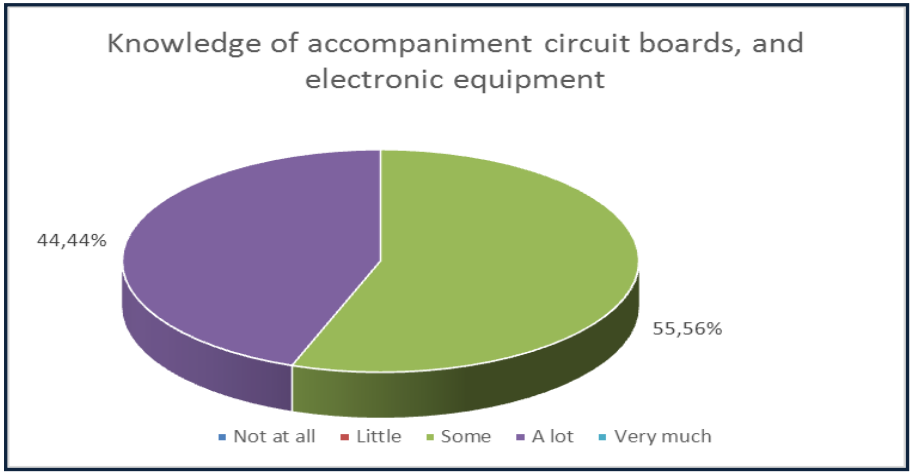
The interviewees evaluate each single theoretical ability listed on the questionnaire by choosing a value among the five being proposed. The proposed values were corresponding to the importance of each theoretical knowledge and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much.

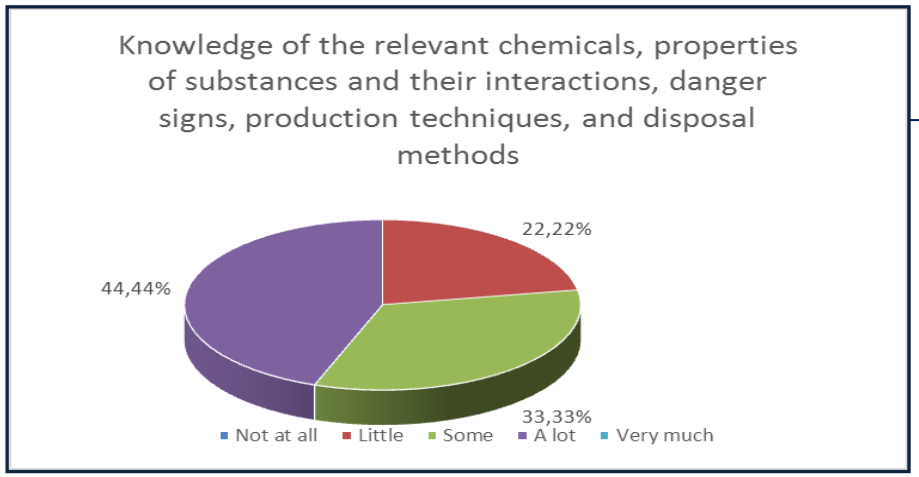
The graphs show the results for each ability:

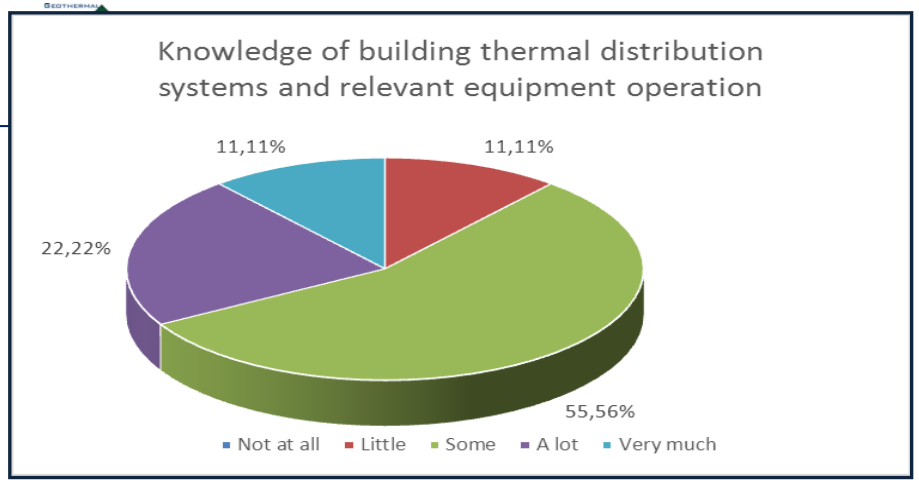

Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
22,22%
44,44%
33,33%
Not at all
Little
Some
A lot
Very much

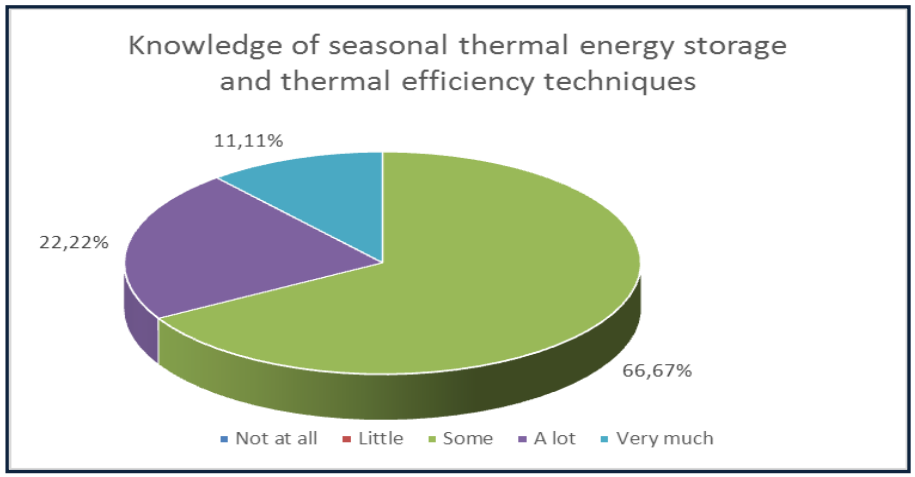

Knowledge of HVAC relevant costs and quality control
22,22%
22,22%
Not at all
Some
A lot
Very much

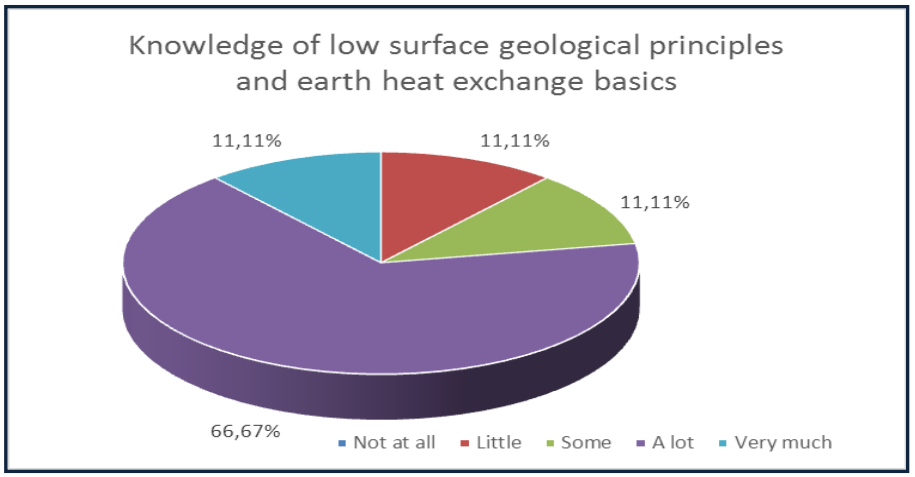

Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)
22,22%
22,22%
22,22%
33,33%
Not at all
Little
Some
A lot
Very much

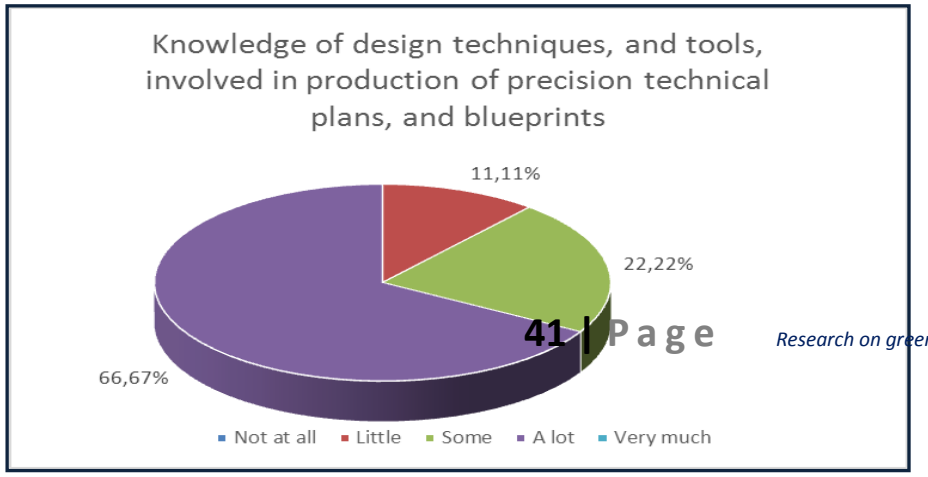

Knowledge of accompaniment circuit boards, and electronic equipment
44,44%
55,56%
Not at all
Little
Some
A lot
Very much

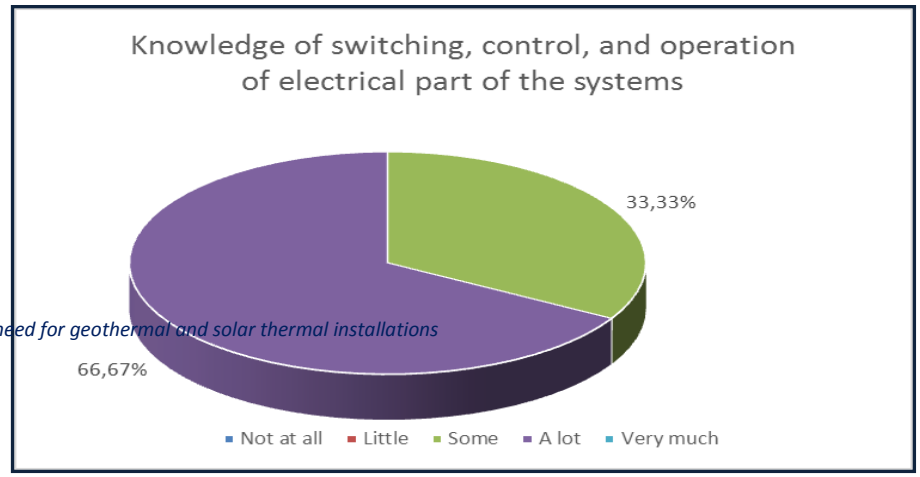

Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods
22,22%
44,44%
33,33%
Not at all
Little
Some
A lot
Very much

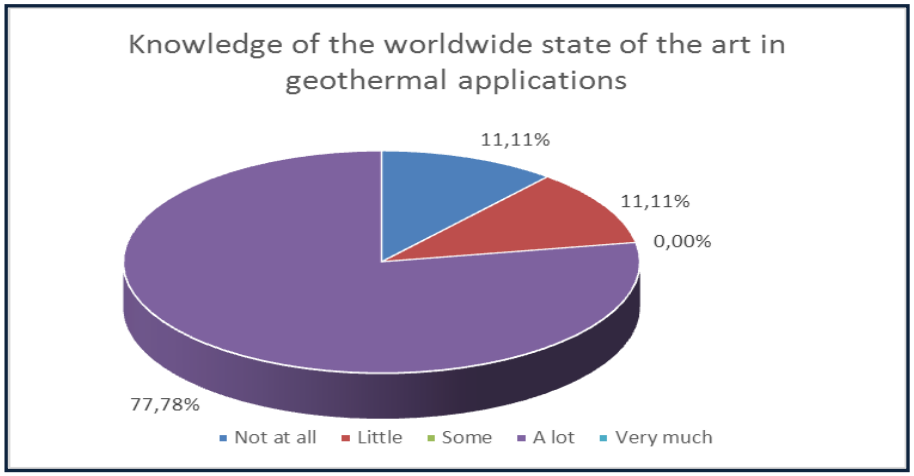

Knowledge of building thermal distribution systems and relevant equipment operation
11,11%
11,11%
22,22%
55,56%
Not at all
Little
Some
A lot
Very much

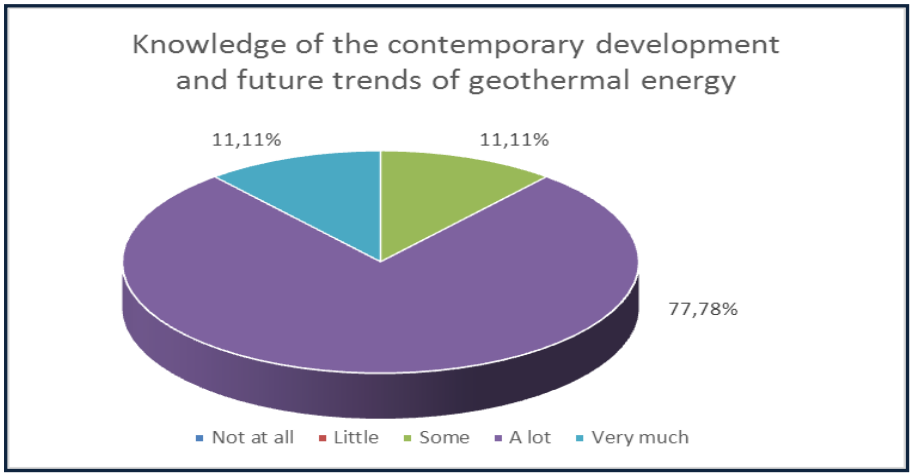

Knowledge of seasonal thermal energy storage and thermal efficiency techniques
11,11%
22,22%
66,67%
Not at all
Little
Some
A lot
Very much

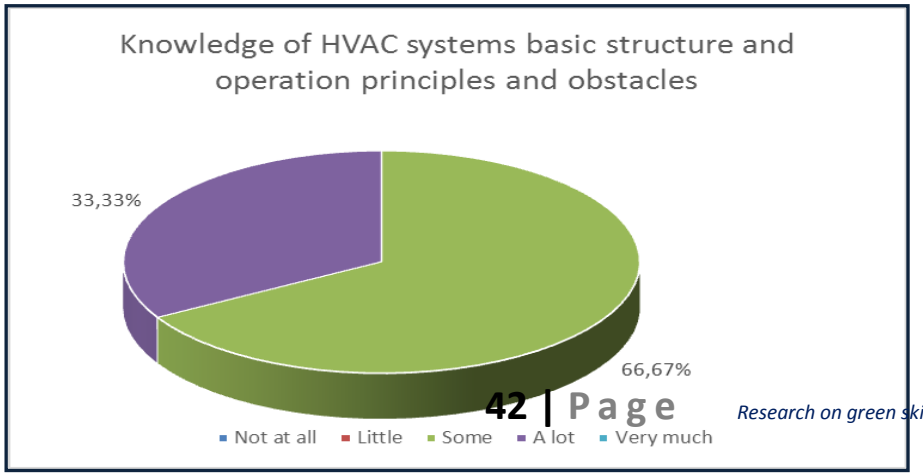

Knowledge of low surface geological principles and earth heat exchange basics
11,11%
11,11%
11,11%
66,67%
Not at all
Little
Some
A lot
Very much


Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
11,11%
22,22%
66,67%
Not at all
Little
Some
A lot
Very much


Knowledge of switching, control, and operation of electrical part of the systems
33,33%
66,67%
Not at all
Little
Some
A lot
Very much


Knowledge of the worldwide state of the art in geothermal applications
11,11%
11,11%
0,00%
77,78%
Not at all
Little
Some
A lot
Very much


Knowledge of the contemporary development and future trends of geothermal energy
11,11%
11,11%
77,78%
Not at all
Little
Some
A lot
Very much


Knowledge of HVAC systems basic structure and operation principles and obstacles
33,33%
66,67%
Not at all
Little
Some
A lot
Very much

From the results obtained through the analysis of the questionnaires it is possible to prepare a list with the theoretical most needed knowledge that a technician should have in order to be able to carry out a geothermal installation in Greece.

The following classified abilities are considered very important as correspond from 70% and up of the Greek interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**88,89%**	(B1.12) Knowledge of the contemporary development and future trends of geothermal energy,
2	**77,78%**	(B1.8) Knowledge of low surface geological principles and earth heat exchange basics
3	**77,78%**	(B1.2) Knowledge of HVAC relevant costs and quality control
4	**77,78%**	(B1.11) Knowledge of the worldwide state of the art in geothermal applications
5	**77,78%**	(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness

The following listed abilities are considered less important as correspond to less than 70% of the Greek interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**66,67%**	(B1.10) Knowledge of switching, control, and operation of electrical part of the systems
2	**66,67%**	(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
3	**44,44%**	(B1.4) Knowledge of accompaniment circuit boards, and electronic equipment
4	**44,44%**	(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)

5	**44,44%**	(B1.5) Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods
6	**33,33%**	(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation
7	**33,33%**	(B1.7) Knowledge of seasonal thermal energy storage and thermal efficiency techniques
8	**33,33%**	(B1.13) Knowledge of HVAC systems basic structure and operation principles and obstacles.

In question (B2) the Greek interviewees were asked to indicate any theoretical knowledge they consider as essential for technicians of geothermal installations. Besides the abilities listed in the questionnaire, one of the ten Greek interviewees filled out the (B2) open question - field named as "Other", with abilities not listed in the questionnaire. The essential knowledge that he/she proposed is the following:

Greece:

Cycle cooling, Plumbing, Data conditioning, Heat pump

In question (B3) the Greek interviewees were asked to rate a list with proposed theoretical knowledge that a technician should possess in order to perform his/her profession and to be able to carry out a geothermal installation.

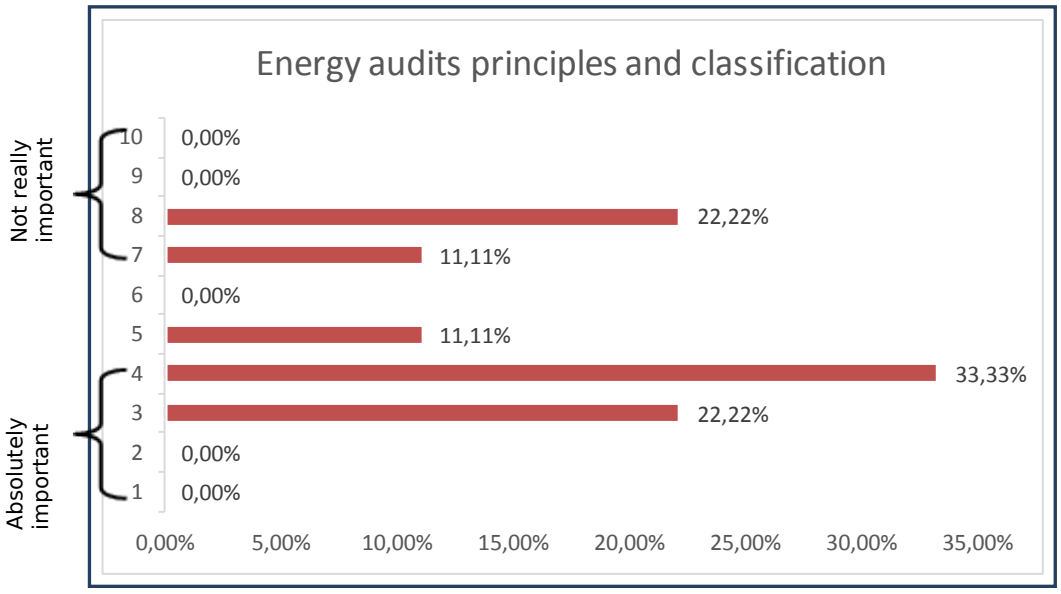
<u>The following 8 abilities were suggested:</u>

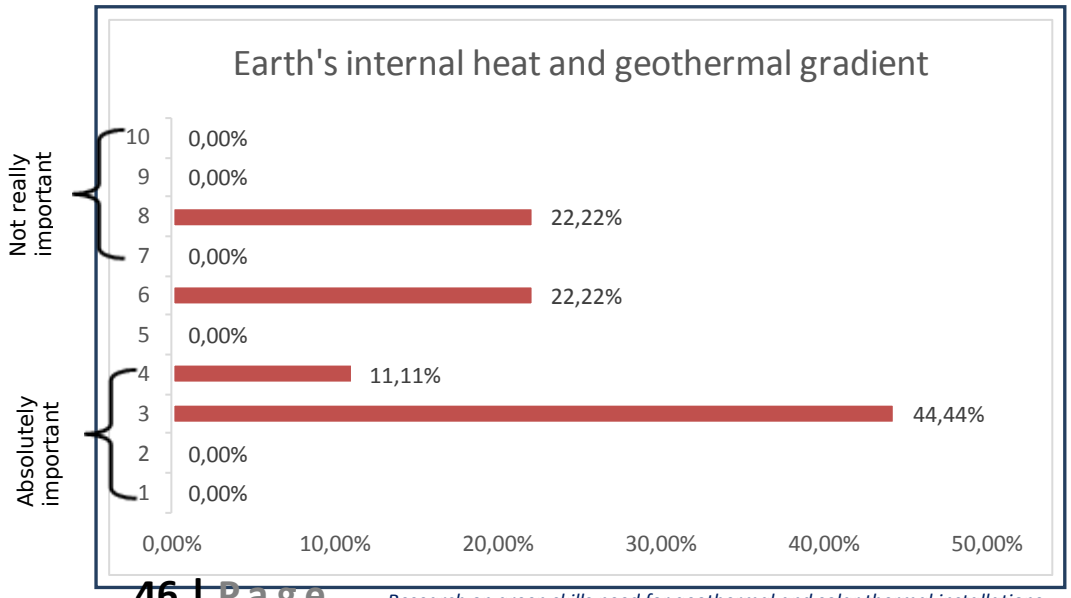
1. Energy audits principles and classification
2. Earth's internal heat and geothermal gradient
3. Fluid dynamics basics
4. Geothermal heating

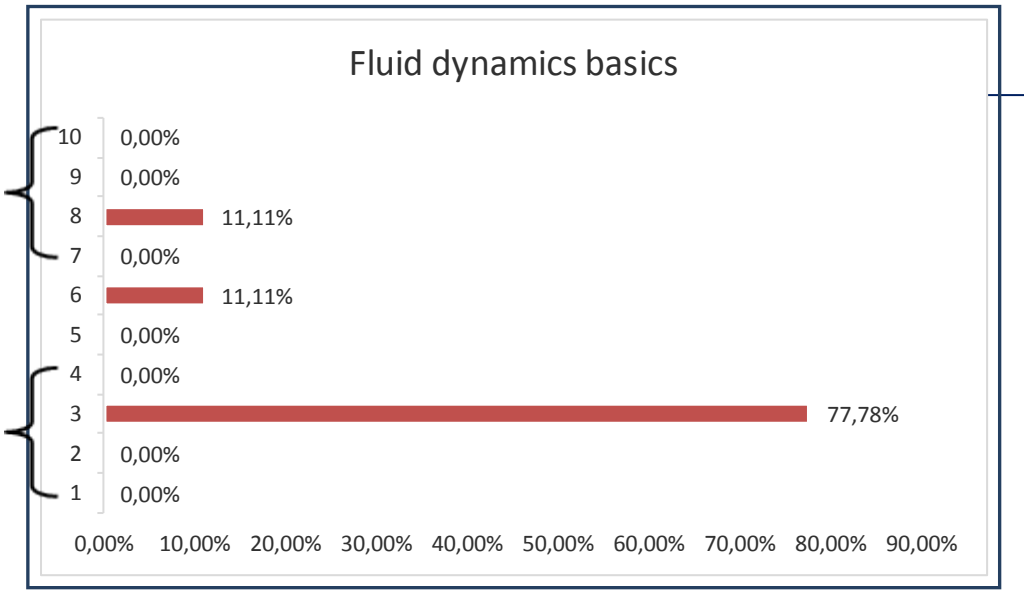
5. Heat pump's structure and operation
6. Types of geothermal heat pump
7. Building distribution systems
8. Thermal storage techniques

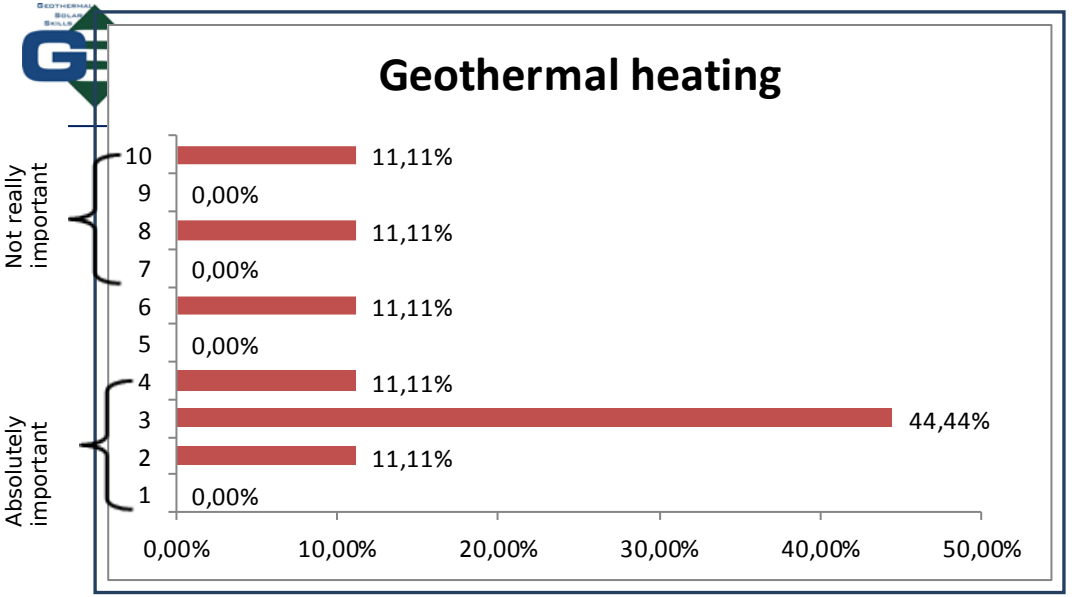
The Greek interviewees evaluated each single ability by choosing a value from 1 to 10, where 1 corresponds to "Absolutely important" and 10 to "Not really important".

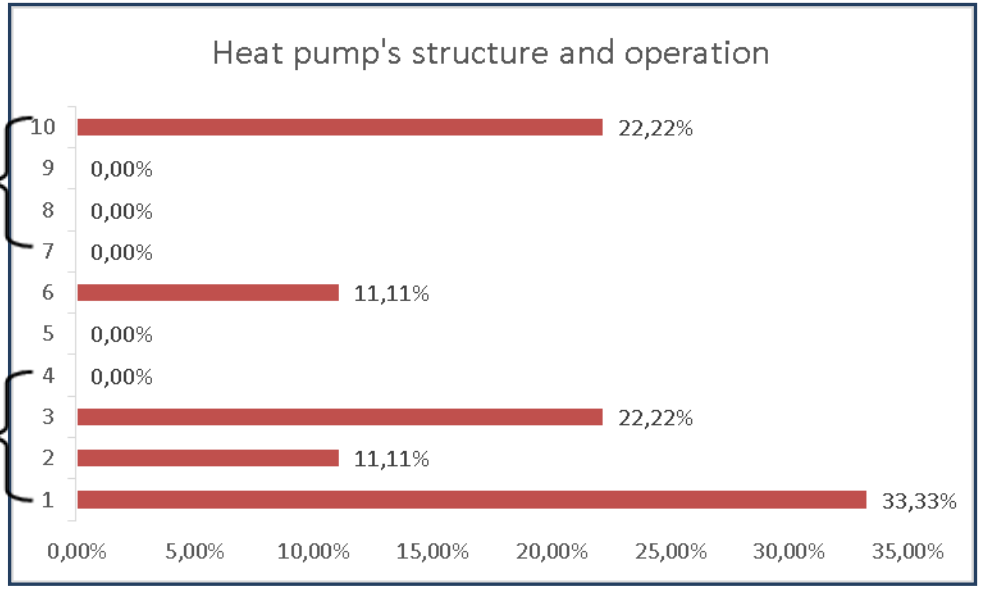
The graphs show the results for each ability:

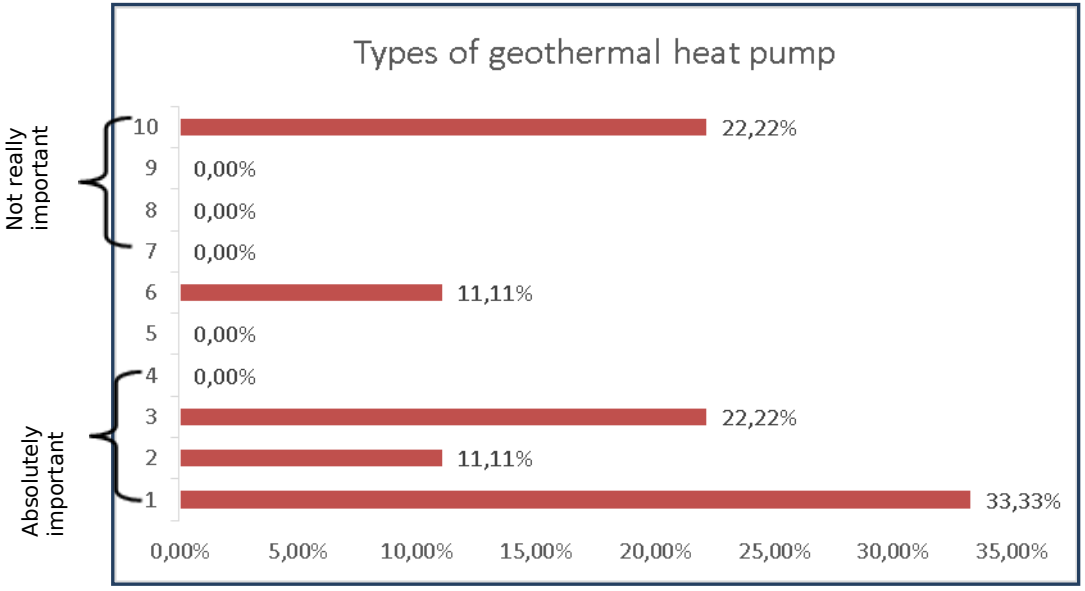


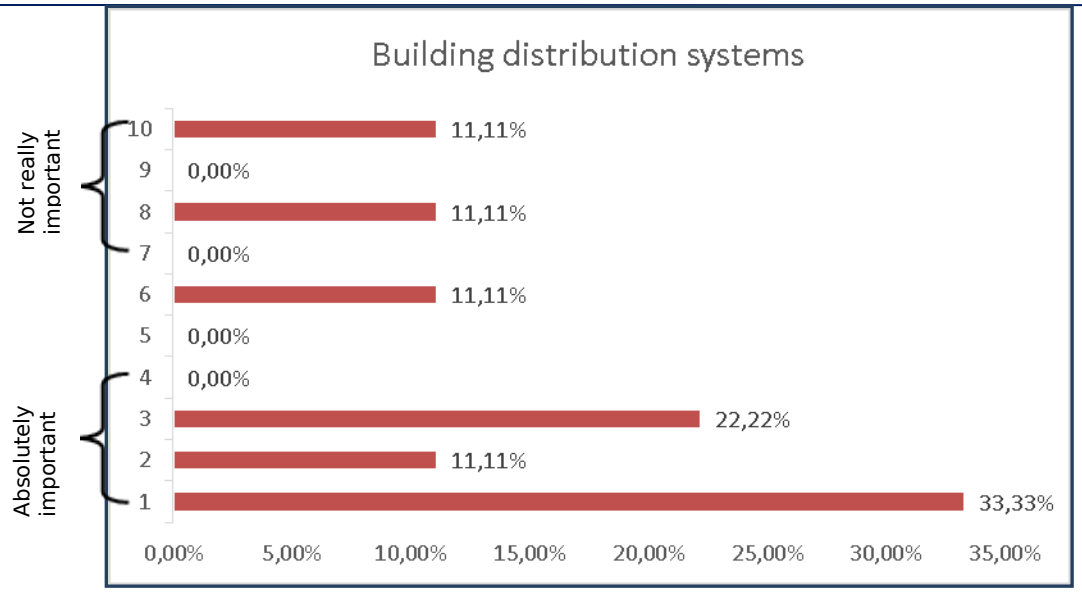


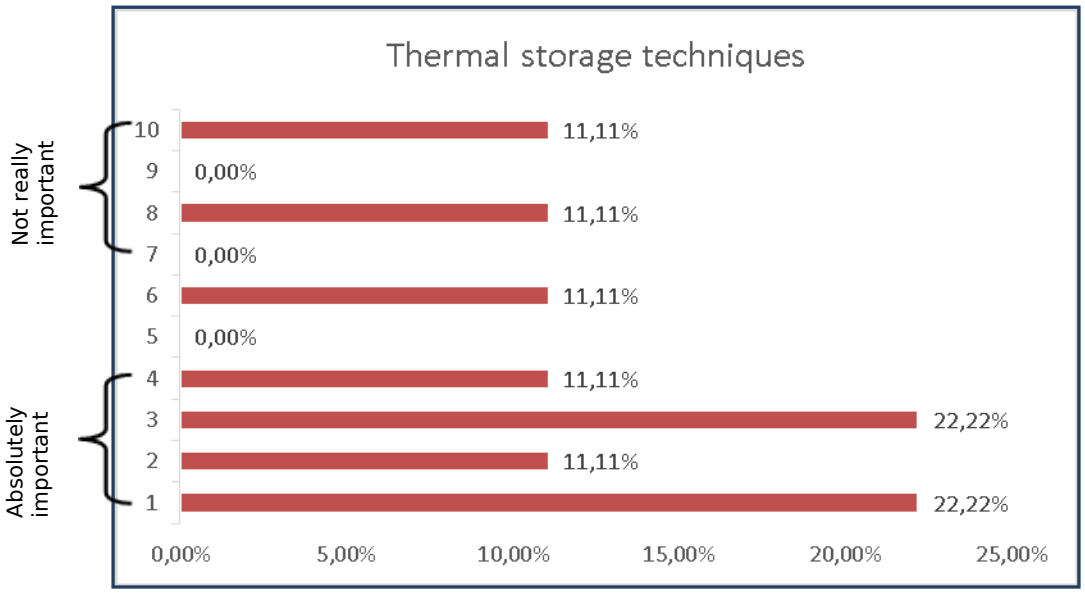

Fluid dynamics basics
Not really important
Absolutely important
10 0,00%
9 0,00%
8 11,11%
7 0,00%
6 11,11%
5 0,00%
4 0,00%
3 77,78%
2 0,00%
1 0,00%
0,00% 10,00% 20,00% 30,00% 40,00% 50,00% 60,00% 70,00% 80,00% 90,00%


Geothermal heating
Not really important
Absolutely important
10 11,11%
9 0,00%
8 11,11%
7 0,00%
6 11,11%
5 0,00%
4 11,11%
3 44,44%
2 11,11%
1 0,00%
0,00% 10,00% 20,00% 30,00% 40,00% 50,00%


Heat pump's structure and operation
Not really important
Absolutely important
10 22,22%
9 0,00%
8 0,00%
7 0,00%
6 11,11%
5 0,00%
4 0,00%
3 22,22%
2 11,11%
1 33,33%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00%


Types of geothermal heat pump
Not really important
Absolutely important
10 22,22%
9 0,00%
8 0,00%
7 0,00%
6 11,11%
5 0,00%
4 0,00%
3 22,22%
2 11,11%
1 33,33%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00%





According to the answers that Greek interviewees filled out regarding the theoretical abilities that were listed under the question (B3) the above mentioned knowledge is classified as in the table below:

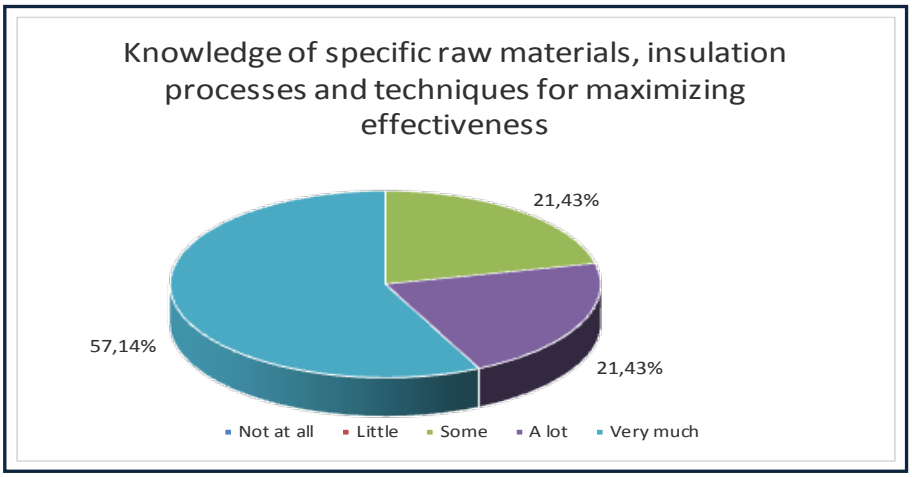
	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**77,78%**	Fluid dynamics basics
2	**66,67%**	Building distribution systems
3	**66,67%**	Heat pump's structure and operation
4	**66,67%**	Types of geothermal heat pump
5	**66,67%**	Geothermal heating
6	**66,67%**	Thermal storage techniques
7	**55,56%**	Earth's internal heat and geothermal gradient
8	**55,56%**	Energy audits principles and classification

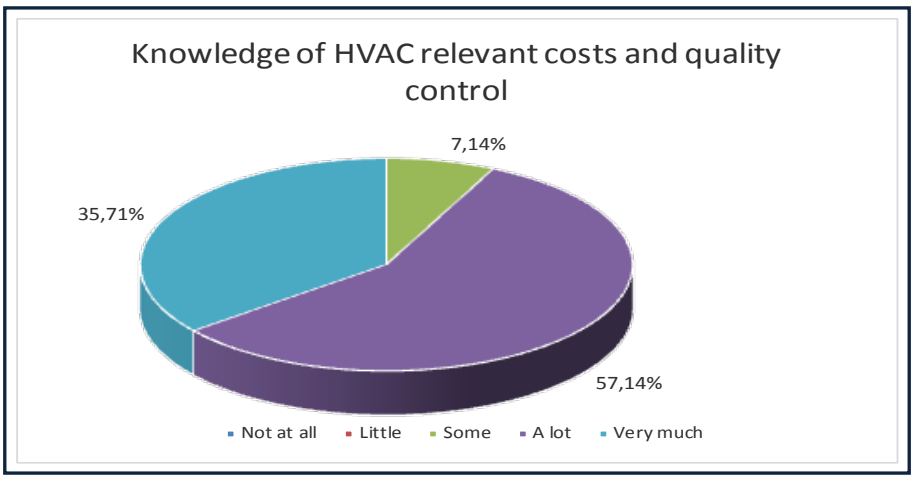
The case of Spain:

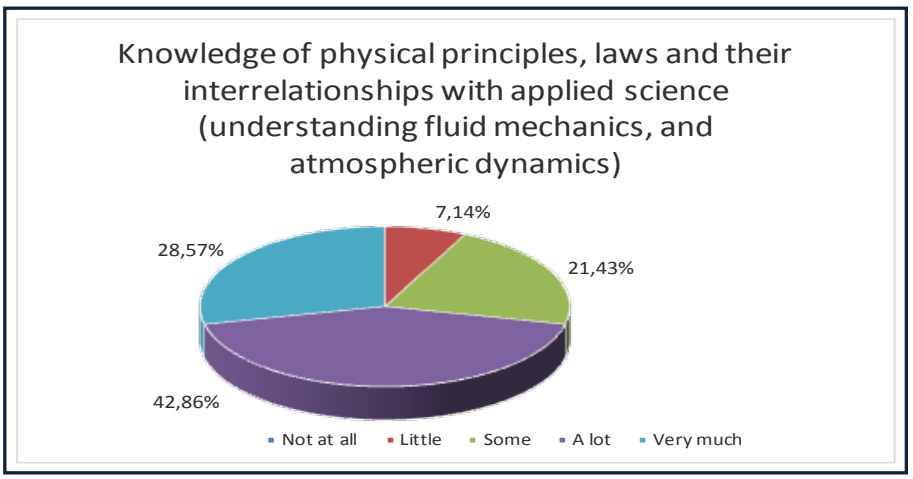
In question (B1) the Spanish interviewees were asked to evaluate a list of theoretical abilities that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered important.

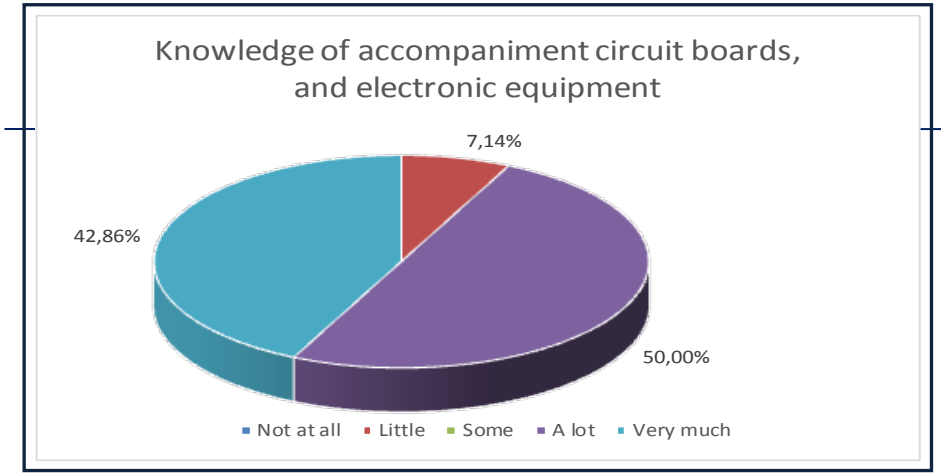
The interviewees evaluate each single theoretical ability listed on the questionnaire by choosing a value among the five being proposed. The proposed values were corresponding to the importance of each theoretical knowledge and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much.

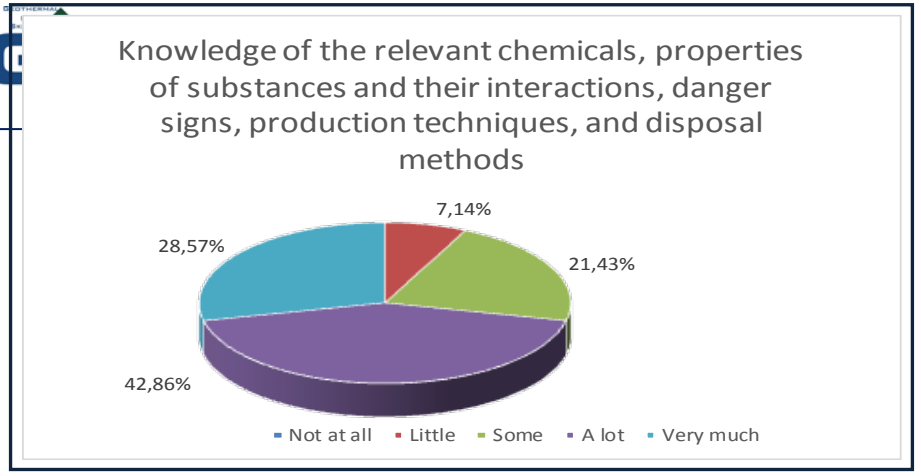
The graphs show the results for each ability:

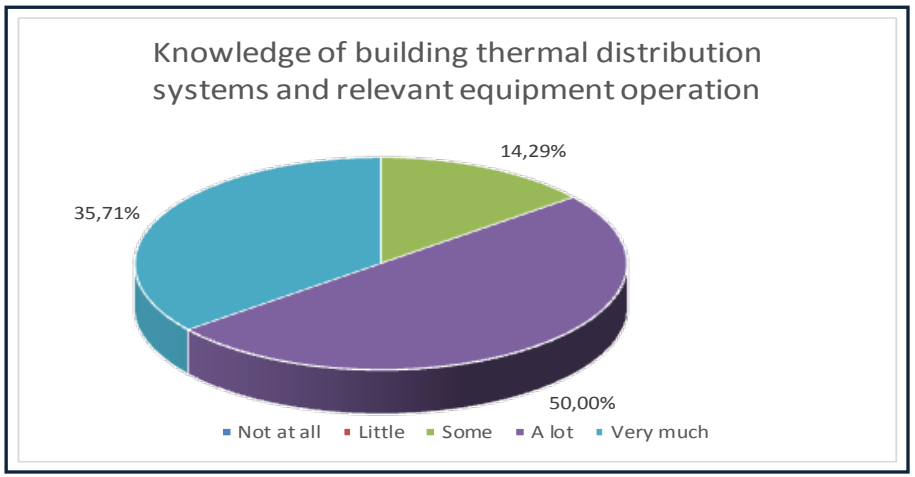

Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
21,43%
57,14%
21,43%
Not at all
Little
Some
A lot
Very much

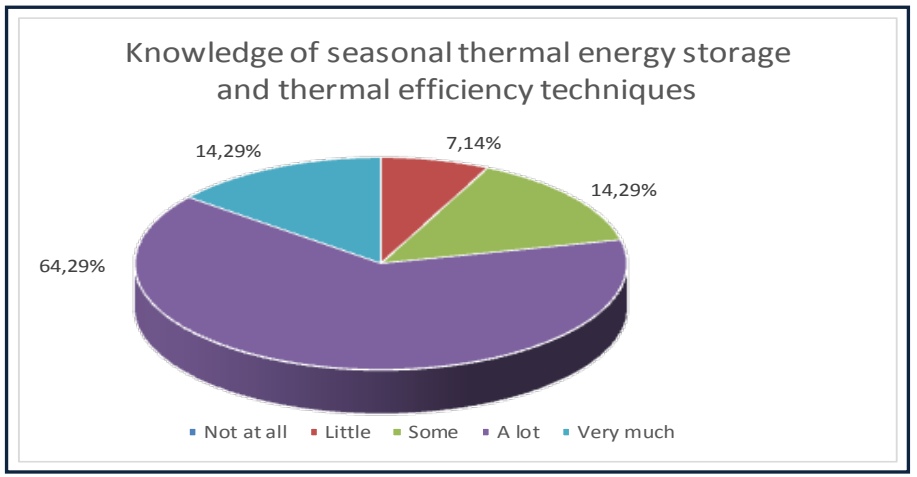

Knowledge of HVAC relevant costs and quality control
7,14%
35,71%
57,14%
Not at all
Little
Some
A lot
Very much

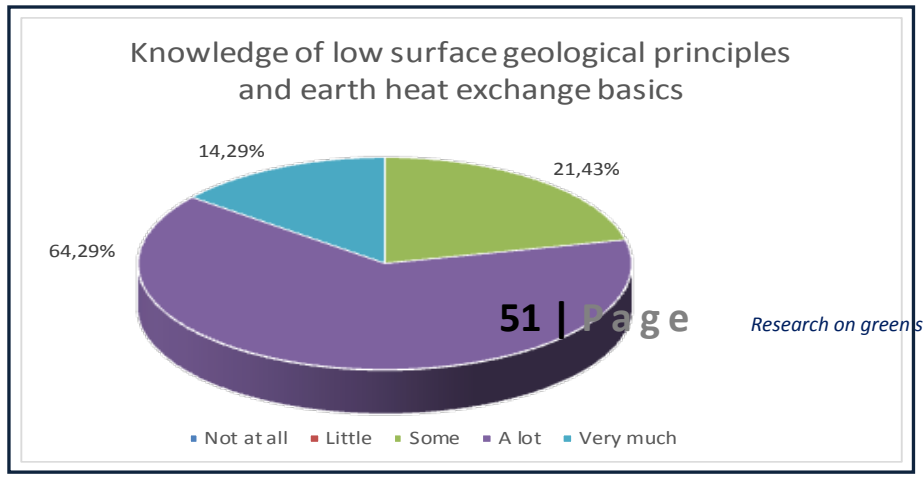

Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)
7,14%
28,57%
21,43%
42,86%
Not at all
Little
Some
A lot
Very much

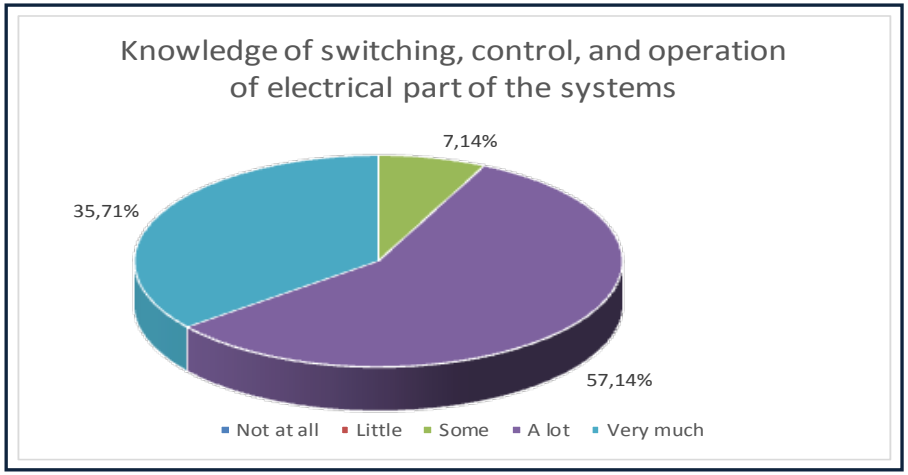

Knowledge of accompaniment circuit boards, and electronic equipment
7,14%
42,86%
50,00%
Not at all
Little
Some
A lot
Very much

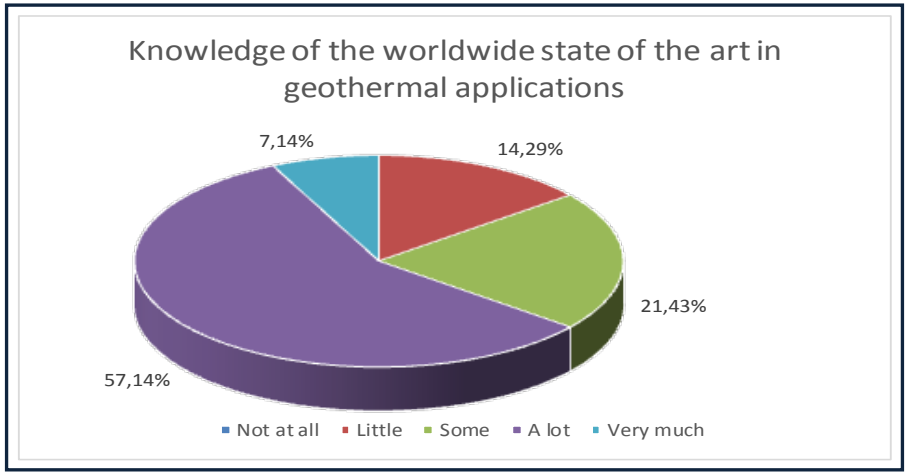

Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods
7,14%
28,57%
21,43%
42,86%
Not at all
Little
Some
A lot
Very much

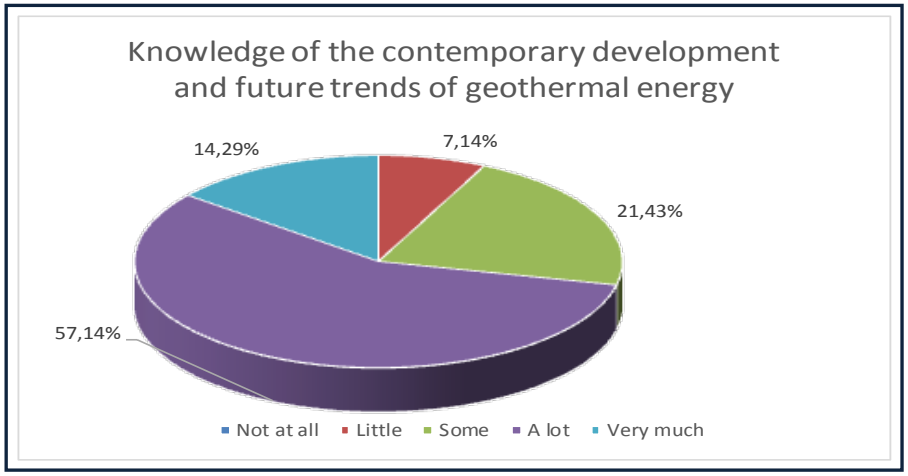

Knowledge of building thermal distribution systems and relevant equipment operation
14,29%
35,71%
50,00%
Not at all
Little
Some
A lot
Very much

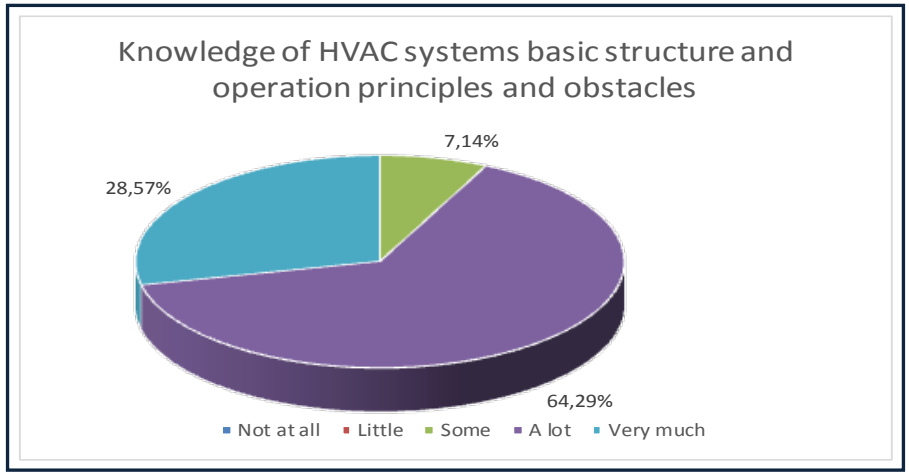

Knowledge of seasonal thermal energy storage and thermal efficiency techniques
14,29%
7,14%
14,29%
64,29%
Not at all
Little
Some
A lot
Very much


Knowledge of low surface geological principles and earth heat exchange basics
14,29%
21,43%
64,29%
Not at all
Little
Some
A lot
Very much


Knowledge of switching, control, and operation of electrical part of the systems
7,14%
35,71%
57,14%
Not at all
Little
Some
A lot
Very much


Knowledge of the worldwide state of the art in geothermal applications
7,14%
14,29%
21,43%
57,14%
Not at all
Little
Some
A lot
Very much


Knowledge of the contemporary development and future trends of geothermal energy
14,29%
7,14%
21,43%
57,14%
Not at all
Little
Some
A lot
Very much


Knowledge of HVAC systems basic structure and operation principles and obstacles
7,14%
28,57%
64,29%
Not at all
Little
Some
A lot
Very much

From the results obtained through the analysis of the questionnaires it is possible to prepare a list with the theoretical most needed knowledge that a technician should have in order to be able to carry out a geothermal installation in Spain.

The following classified abilities are considered very important and correspond from 70% and up of the Spanish interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**100%**	(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
2	**92,86%**	(B1.2) Knowledge of HVAC relevant costs and quality control
3	**92,86%**	(B1.13) Knowledge of HVAC systems basic structure and operation principles and obstacles.
4	**92,86%**	(B1.4) Knowledge of accompaniment circuit boards, and electronic equipment
5	**92,86%**	(B1.10) Knowledge of switching, control, and operation of electrical part of the systems
6	**85,71%**	(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation
7	**78,57%**	(B1.7) Knowledge of seasonal thermal energy storage and thermal efficiency techniques
8	**78,57%**	(B1.8) Knowledge of low surface geological principles and earth heat exchange basics
9	**77,57%**	(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
10	**71,43%**	(B1.12) Knowledge of the contemporary development and future trends of geothermal energy,
11	**71,43%**	(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)
12	**71,43%**	(B1.5) Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods

The following listed ability is considered less important as correspond to less than 70% of the interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**64,29%**	(B1.11) Knowledge of the worldwide state of the art in geothermal applications

In question (B2) the Spanish interviewees were asked to indicate any theoretical knowledge they think that is essential for technicians of geothermal installations. Besides the abilities listed in the questionnaire, eight of the thirteen Spanish interviewees filled out the B.2 “open question” of the questionnaire - field named as “other”, with abilities not listed in the questionnaire and that they considered as relevant and important.

Spain:

The essential knowledge that he/she proposed is the following:

1 *Spain: Knowledge of process’s environmental impact.*

2 *Spain: Knowledge in geotechnical and foundation of adjoining buildings.*

3 *Spain: Knowledge of the field (drilling capacity, carrying capacity without shoring, thermal capacity).*

5 *Spain: Knowing not only anything that geothermal installations invove; but also about facilities, design, control, etc.).*

6 *Spain: Materials, assemblies, systems and all the plumbing and electrical element.*

8 *Spain: Feasibility of geothermal exchange systems,*

Environmental aspects and risk assessment,

Operation and management IG systems

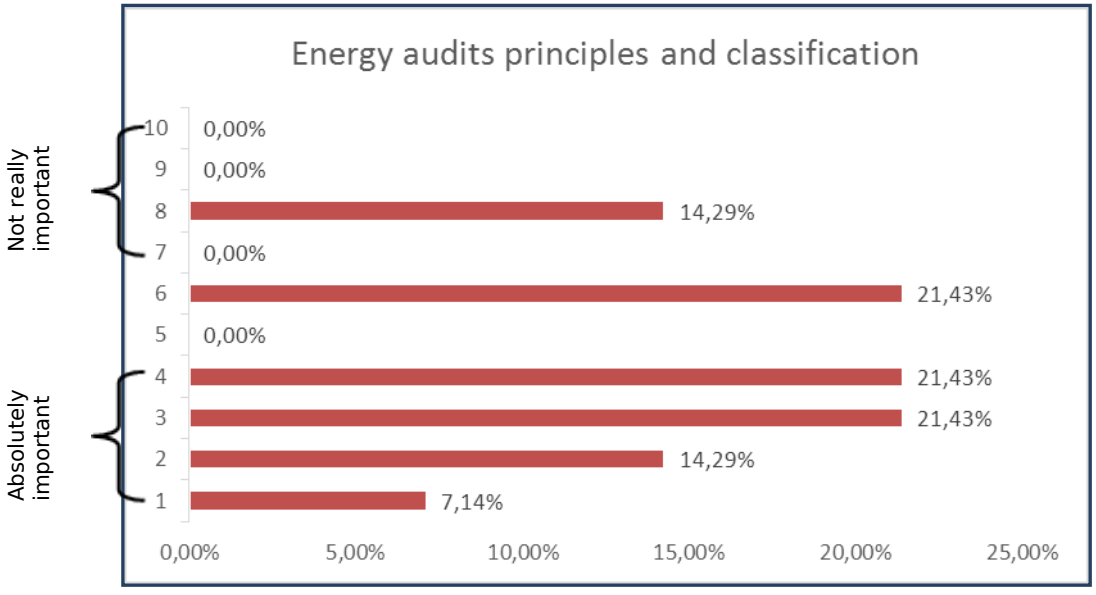
In question (B3) the Spanish interviewees were asked to rate a list with proposed theoretical knowledge that a technician should possess in order to perform his/her profession and to be able to carry out a geothermal installation.

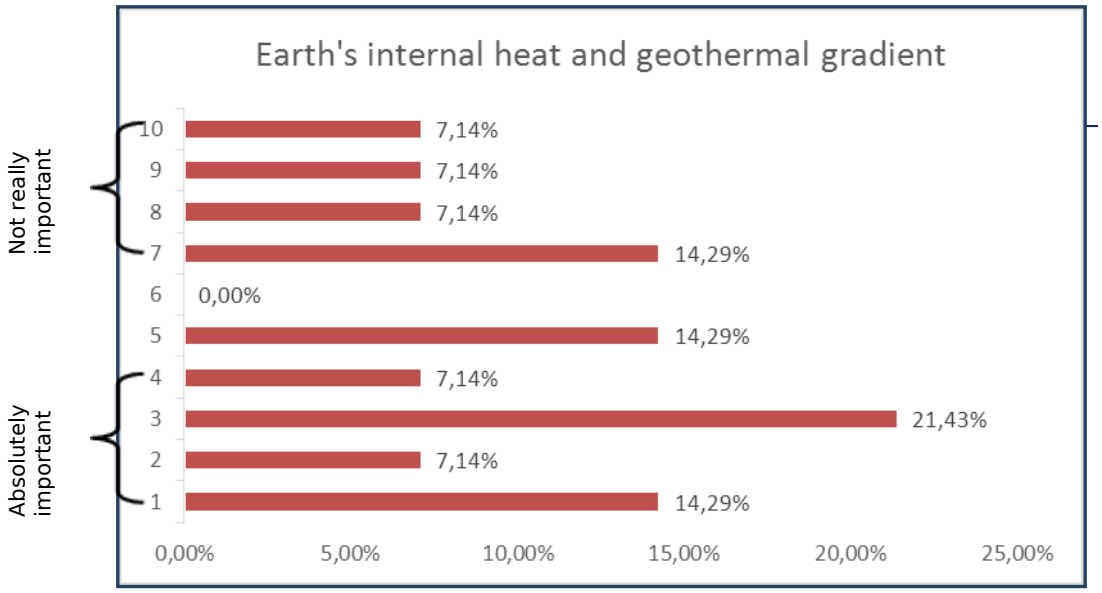
The following 8 abilities were suggested:

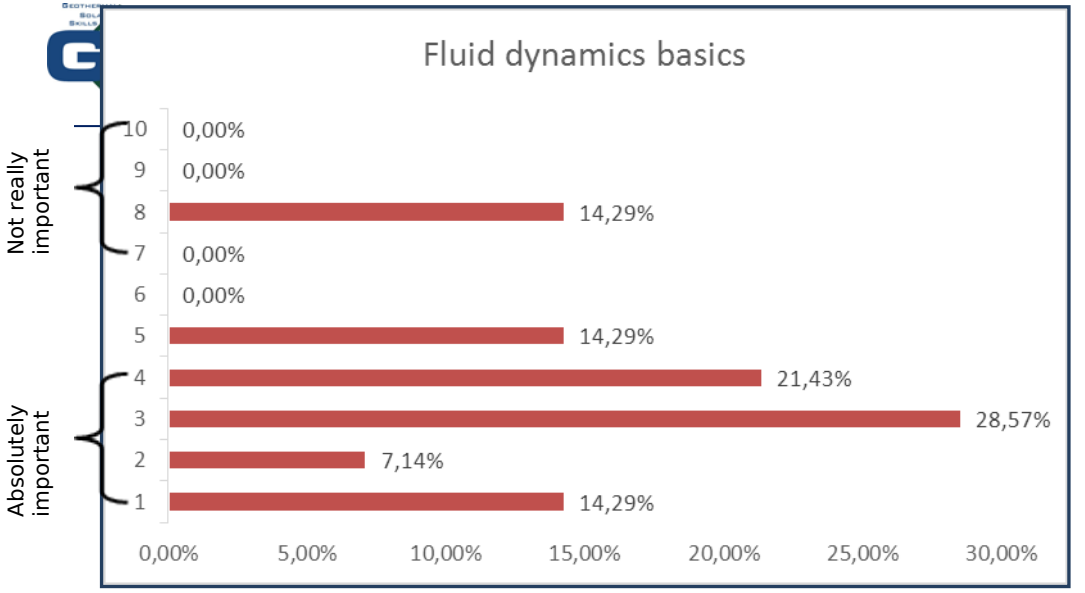
1. Energy audits principles and classification
2. Earth's internal heat and geothermal gradient
3. Fluid dynamics basics
4. Geothermal heating
5. Heat pump's structure and operation
6. Types of geothermal heat pump
7. Building distribution systems
8. Thermal storage techniques

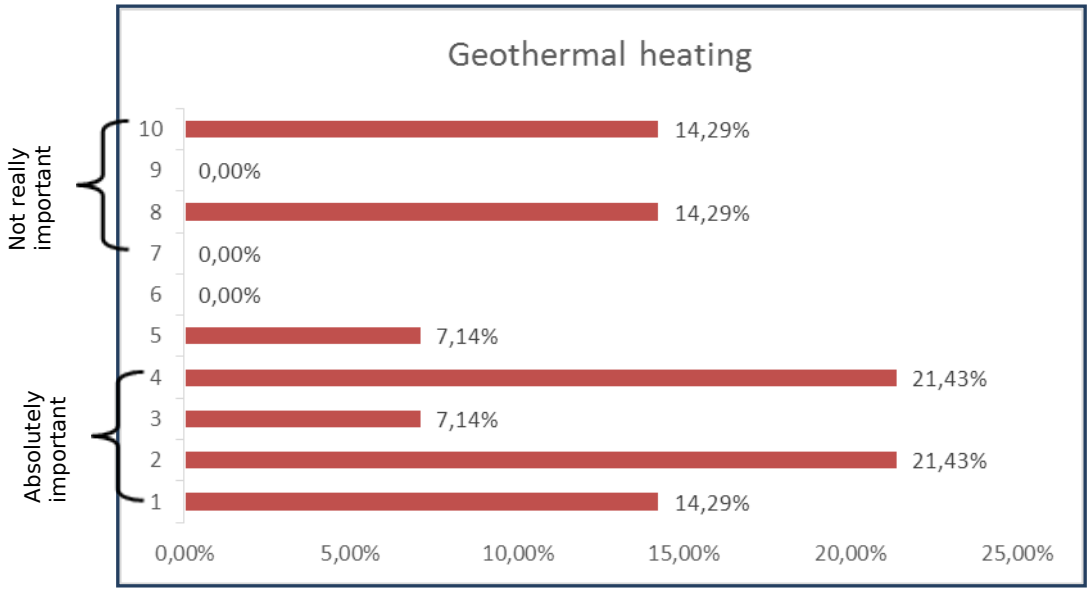
The Spanish interviewees evaluated each single ability by choosing a value from 1 to 10, where 1 corresponds to "absolutely important" and 10 to "not really important".

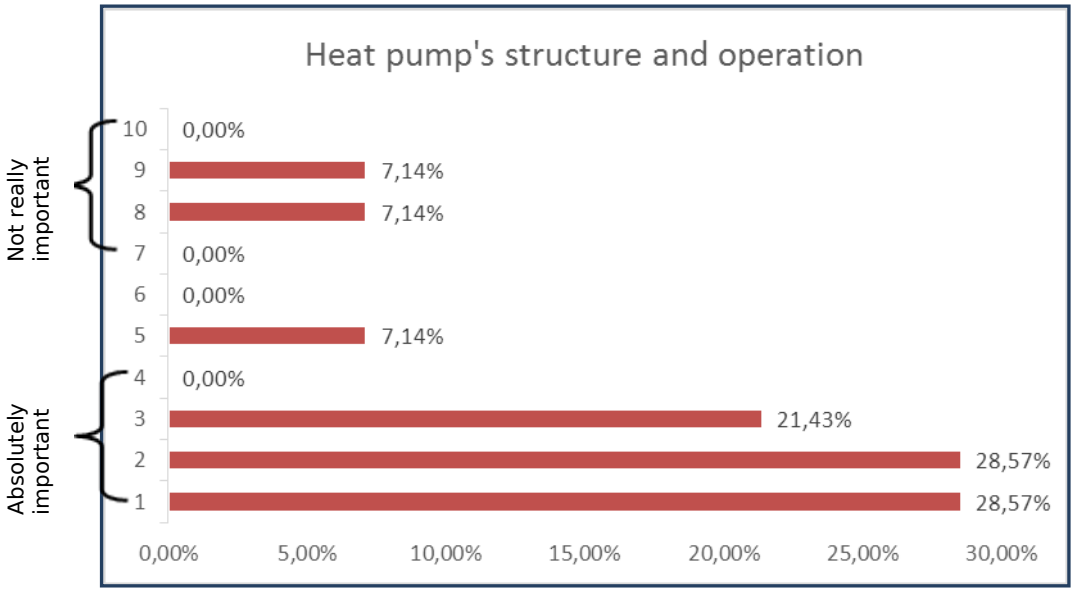
The graphs show the results for each ability:

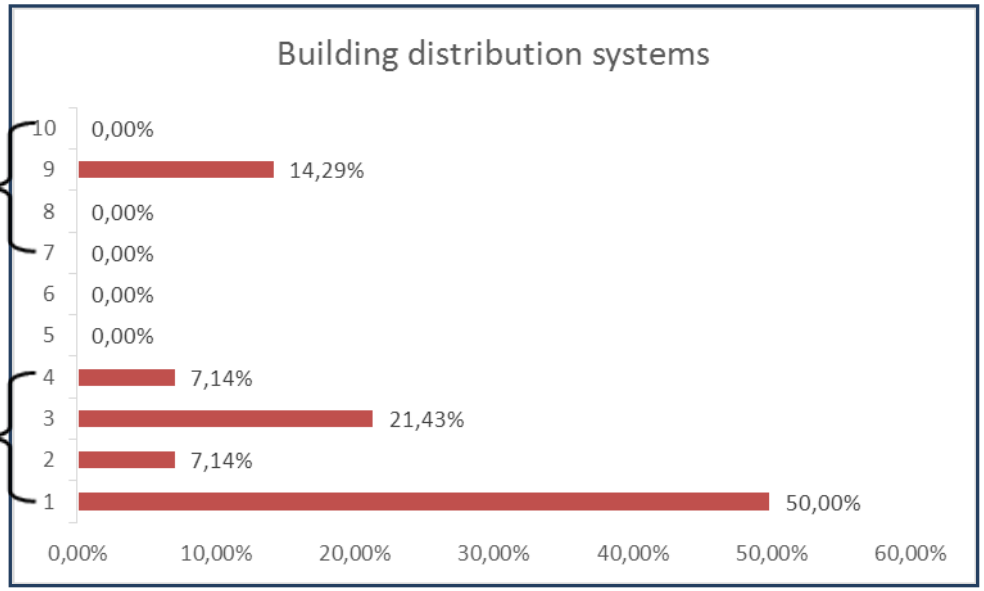


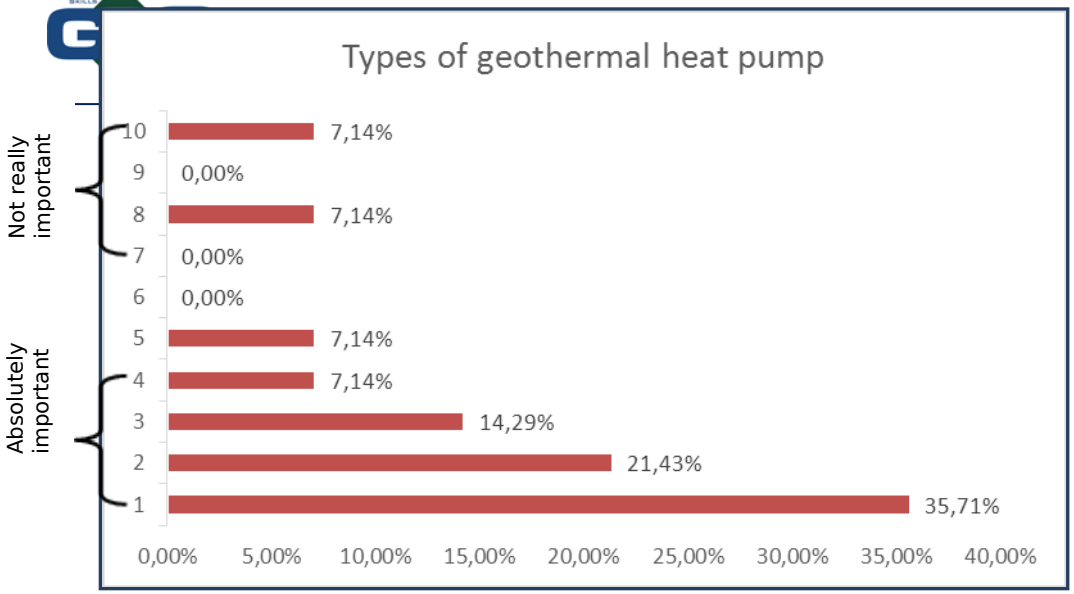

Earth's internal heat and geothermal gradient
Not really important
Absolutely important
10 7,14%
9 7,14%
8 7,14%
7 14,29%
6 0,00%
5 14,29%
4 7,14%
3 21,43%
2 7,14%
1 14,29%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00%

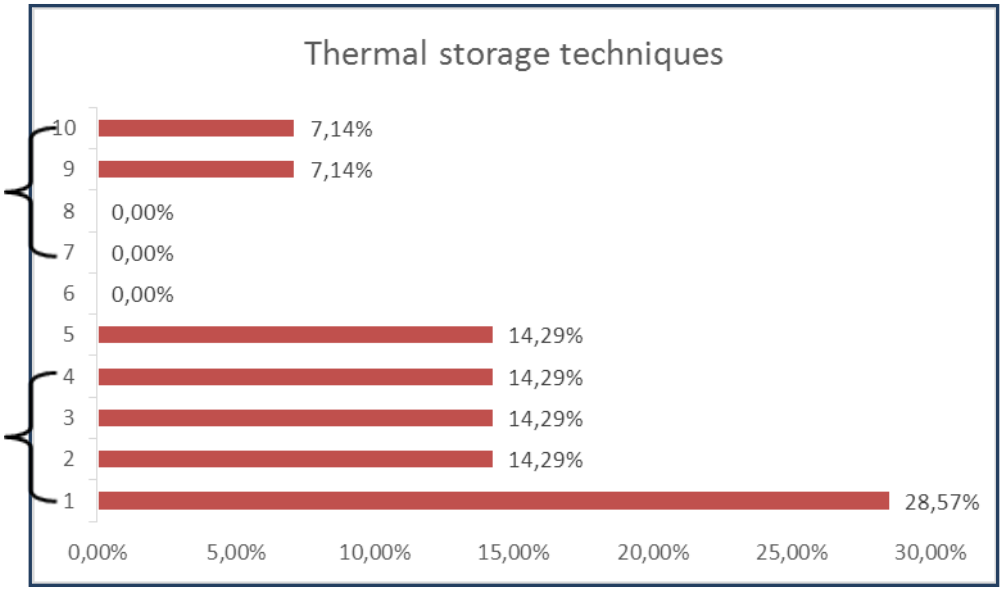

Fluid dynamics basics
Not really important
Absolutely important
10 0,00%
9 0,00%
8 14,29%
7 0,00%
6 0,00%
5 14,29%
4 21,43%
3 28,57%
2 7,14%
1 14,29%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%


Geothermal heating
Not really important
Absolutely important
10 14,29%
9 0,00%
8 14,29%
7 0,00%
6 0,00%
5 7,14%
4 21,43%
3 7,14%
2 21,43%
1 14,29%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00%


Heat pump's structure and operation
Not really important
Absolutely important
10 0,00%
9 7,14%
8 7,14%
7 0,00%
6 0,00%
5 7,14%
4 0,00%
3 21,43%
2 28,57%
1 28,57%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%


Building distribution systems
Not really important
Absolutely important
10 0,00%
9 14,29%
8 0,00%
7 0,00%
6 0,00%
5 0,00%
4 7,14%
3 21,43%
2 7,14%
1 50,00%
0,00% 10,00% 20,00% 30,00% 40,00% 50,00% 60,00%


Types of geothermal heat pump
Not really important
Absolutely important
10 7,14%
9 0,00%
8 7,14%
7 0,00%
6 0,00%
5 7,14%
4 7,14%
3 14,29%
2 21,43%
1 35,71%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00% 40,00%


Thermal storage techniques
Not really important
Absolutely important
10 7,14%
9 7,14%
8 0,00%
7 0,00%
6 0,00%
5 14,29%
4 14,29%
3 14,29%
2 14,29%
1 28,57%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%

According to the answers that Spanish interviewees gave regarding the theoretical abilities that were listed under the question (B3) the above mentioned knowledge is classified as following:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**85,71%**	Building distribution systems
2	**78,57%**	Heat pump's structure and operation
3	**78,57%**	Types of geothermal heat pump
4	**71,43%**	Fluid dynamics basics
5	**71,43%**	Thermal storage techniques
6	**64,29%**	Energy audits principles and classification
7	**64,29%**	Geothermal heating
8	**50%**	Earth's internal heat and geothermal gradient

2.3 Labor Skills

In this section of the questionnaire focus was placed on the encoding of labour skills that plumbers and electricians should have in order to be able to carry out geothermal installations.

Summative statistics for all countries

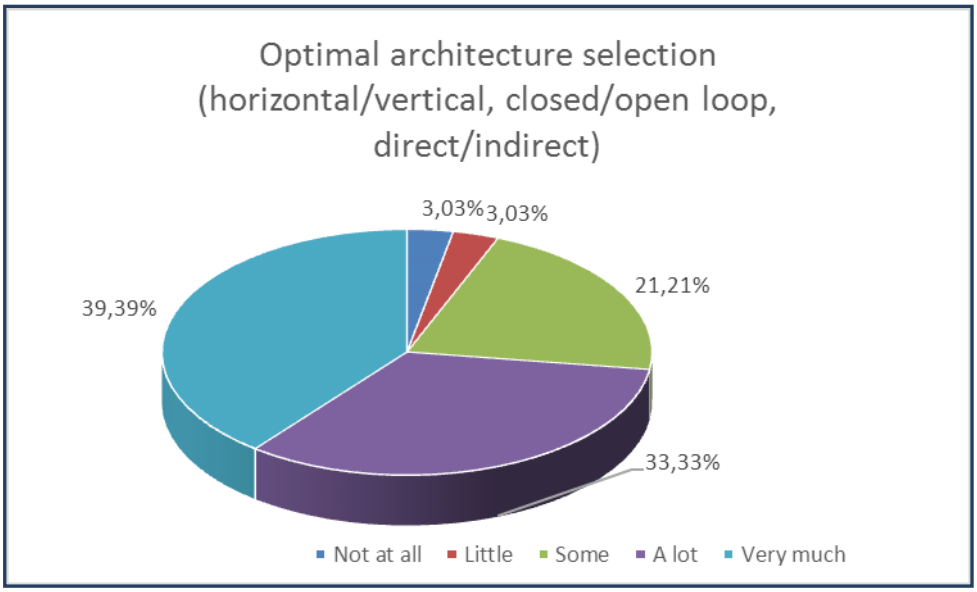
In question (C1) the interviewees were asked to evaluate a list of labour skills that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered as important.

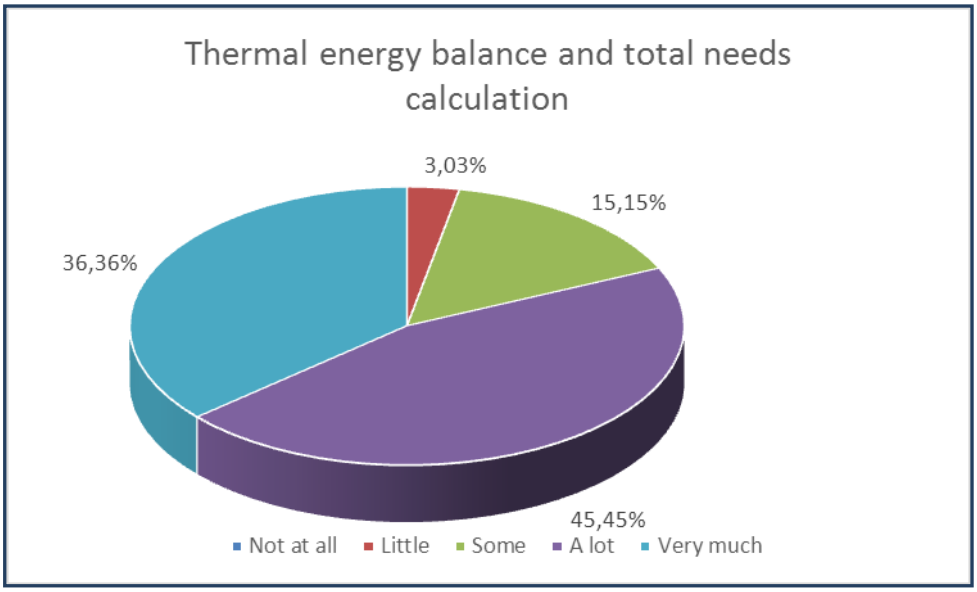
The following 13 labour skills were suggested:

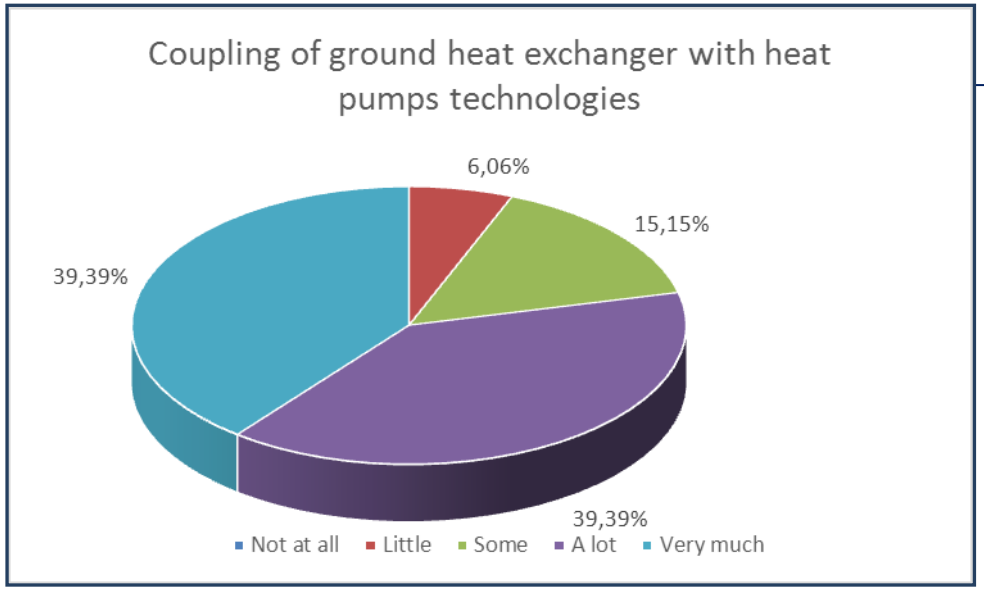
1. (C1.1) Optimal architecture selection (horizontal/vertical, closed/open loop, direct/indirect),
2. (C1.2) Thermal energy balance and total needs calculation,
3. (C1.3) Coupling of ground heat exchanger with heat pumps technologies,
4. (C1.4) Heat exchanger dimensioning and positioning,
5. (C1.5) Insulation and sealing techniques,
6. (C1.6) Building distribution system installation (*fun coils, etc.*),
7. (C1.7) Efficient heat exchanger-heat pump-distribution coupling and mounting,
8. (C1.8) Installation techniques and handling of different type of tubes,
9. (C1.9) Technical plans and blueprints understanding,
10. (C1.10) Formulated malfunction investigation and repair,
11. (C1.11) Formulated and reliable maintenance,
12. (C1.12) Drilling techniques, reliable and effective restoration,
13. (C1.13) Electric water pumps and relevant equipment supervision.

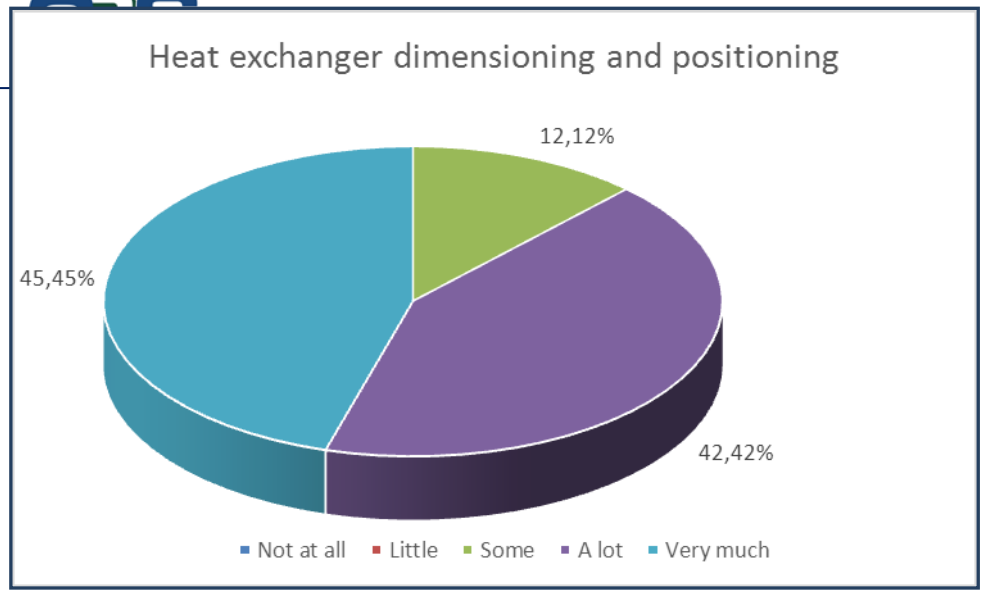
The interviewees evaluate each listed labour skill by choosing a value among the five being proposed in the questionnaire. The proposed values were corresponding to the

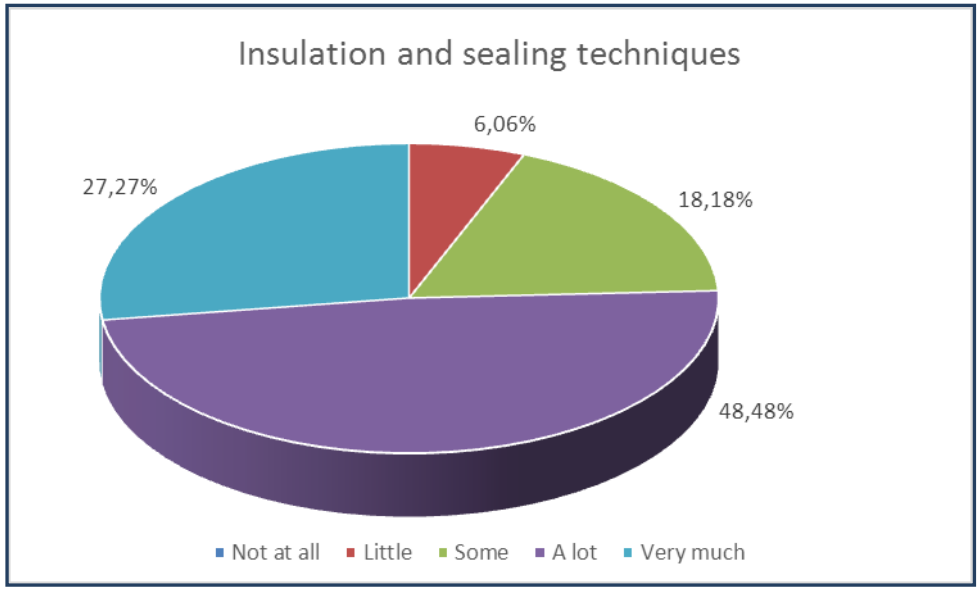
importance of each labour skill and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much. The graphs show the results for each labour skill:

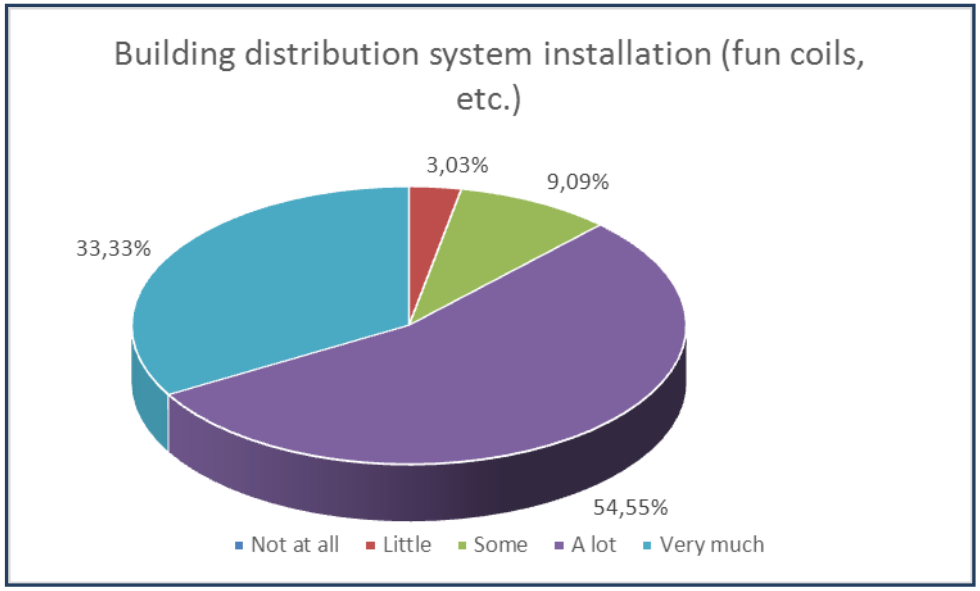


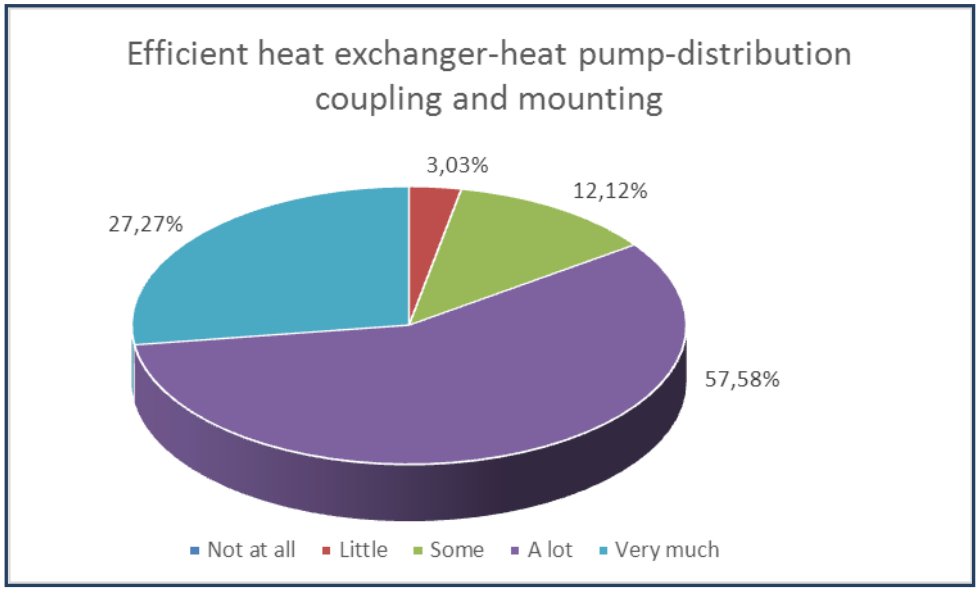


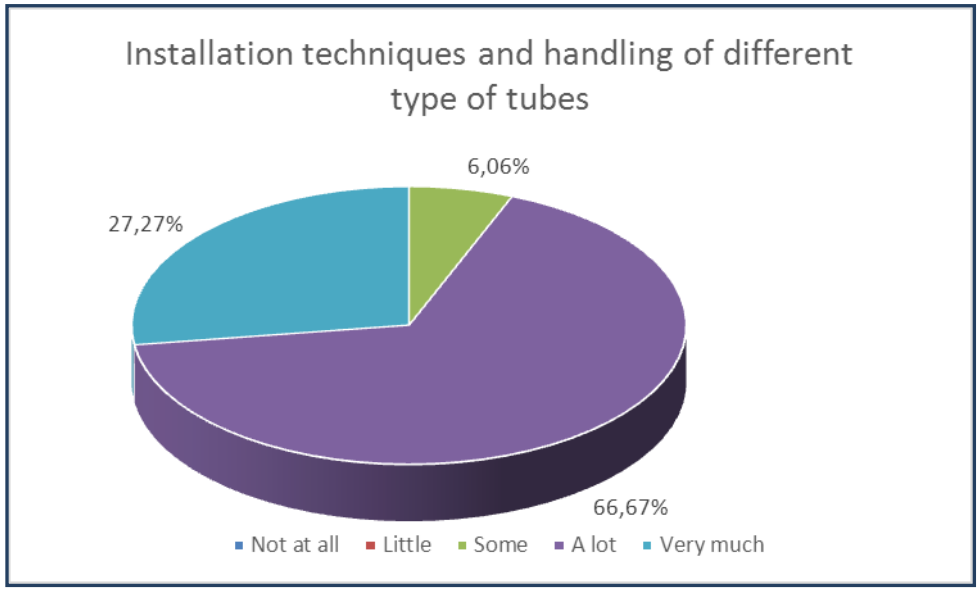

Coupling of ground heat exchanger with heat pumps technologies
6,06%
15,15%
39,39%
39,39%
Not at all
Little
Some
A lot
Very much

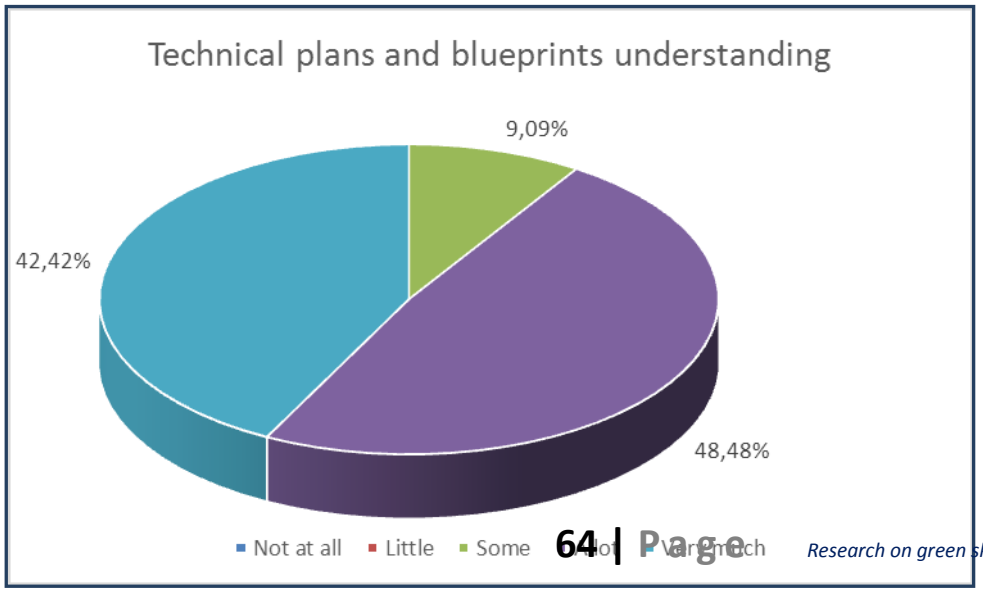

Heat exchanger dimensioning and positioning
12,12%
45,45%
42,42%
Not at all
Little
Some
A lot
Very much

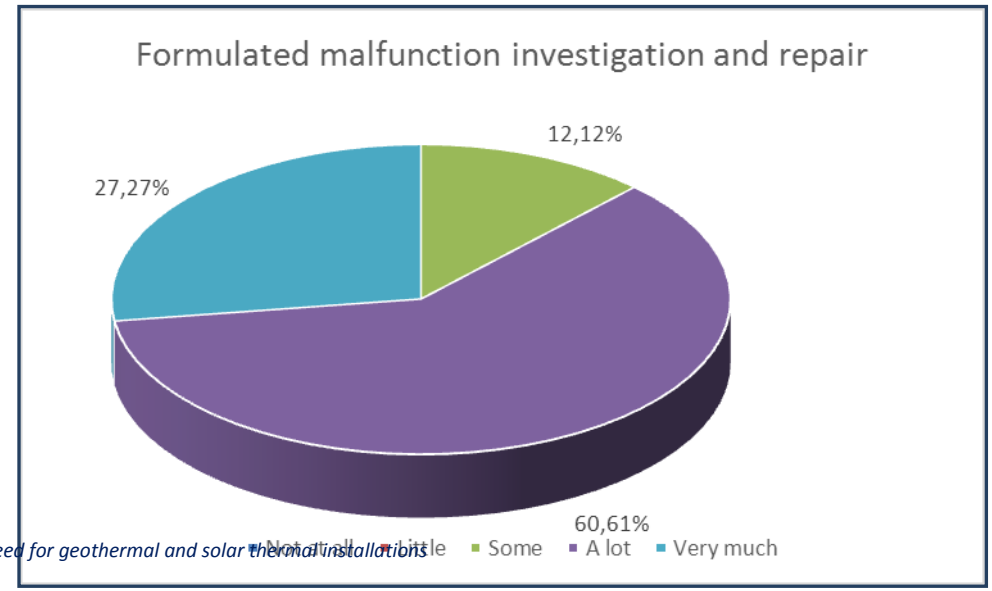

Insulation and sealing techniques
6,06%
27,27%
18,18%
48,48%
Not at all
Little
Some
A lot
Very much

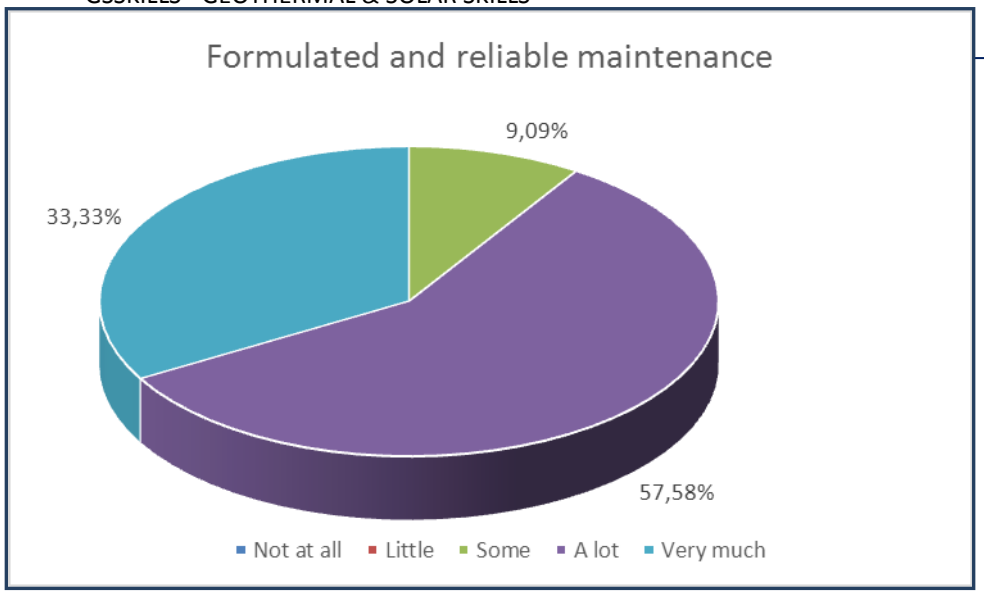

Building distribution system installation (fun coils, etc.)
3,03%
9,09%
33,33%
54,55%
Not at all
Little
Some
A lot
Very much

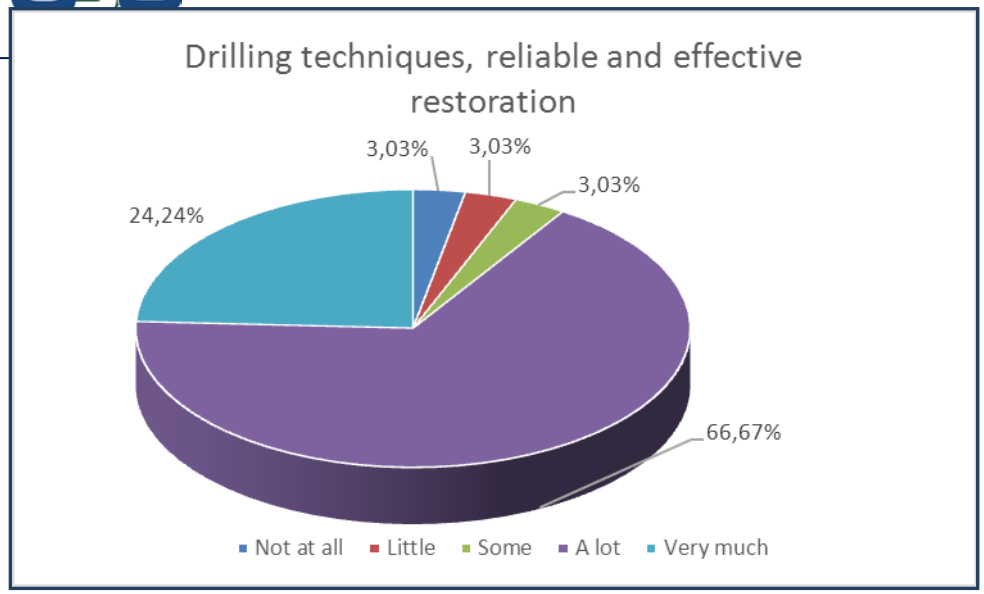

Efficient heat exchanger-heat pump-distribution coupling and mounting
3,03%
12,12%
27,27%
57,58%
Not at all
Little
Some
A lot
Very much

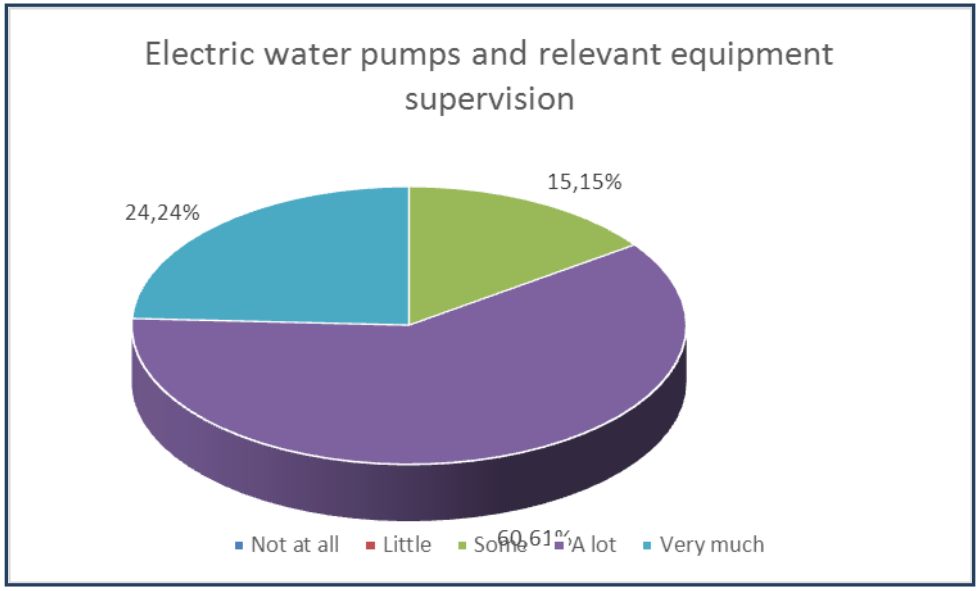

Installation techniques and handling of different type of tubes
6,06%
27,27%
66,67%
Not at all
Little
Some
A lot
Very much


Technical plans and blueprints understanding
9,09%
42,42%
48,48%
Not at all
Little
Some
Very much


Formulated malfunction investigation and repair
12,12%
27,27%
60,61%
Not at all
Little
Some
A lot
Very much


Formulated and reliable maintenance
9,09%
33,33%
57,58%
Not at all
Little
Some
A lot
Very much


Drilling techniques, reliable and effective restoration
3,03%
3,03%
3,03%
24,24%
66,67%
Not at all
Little
Some
A lot
Very much


Electric water pumps and relevant equipment supervision
15,15%
24,24%
60,61%
Not at all
Little
Some
A lot
Very much

From the answers collected through the analysis of the questionnaires it was possible to prepare a list with the most needed labour skills that a technician should have in order to be able to carry out a geothermal installation.

It is necessary to note that all of the thirteen proposed labour skills of the questionnaire were considered very important as correspond from 70% and up of the interviewees' choices:

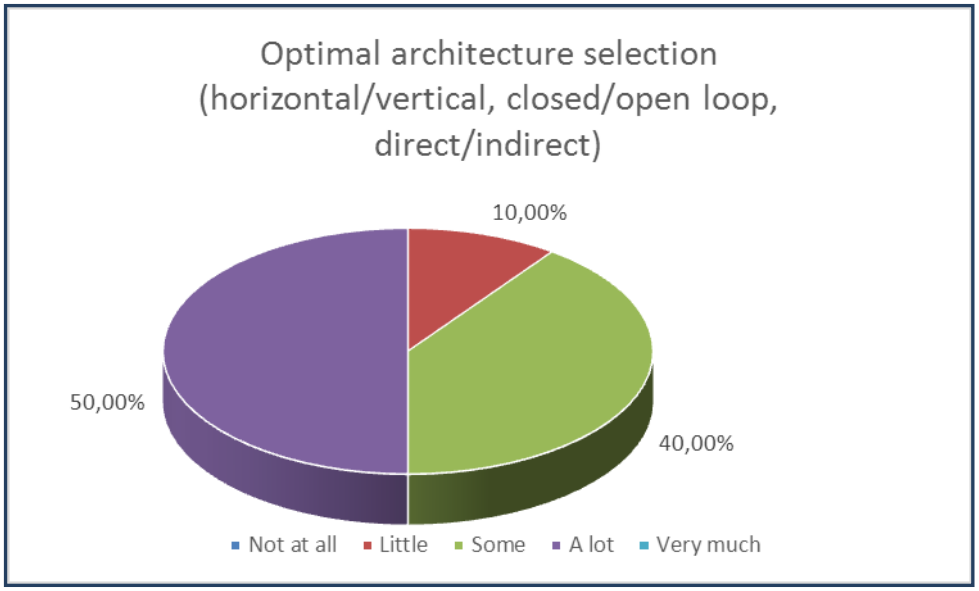
	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**93,94%**	(C1.8) Installation techniques and handling of different type of tubes,
2	**90,91%**	(C1.9) Technical plans and blueprints understanding,
3	**90,91%**	(C1.11) Formulated and reliable maintenance,
4	**90,91%**	(C1.12) Drilling techniques, reliable and effective restoration,
5	**87,88%**	(C1.4) Heat exchanger dimensioning and positioning,
6	**87,88%**	(C1.6) Building distribution system installation (*fun coils, etc.*),
7	**87,88%**	(C1.10) Formulated malfunction investigation and repair,
8	**84,85%**	(C1.13) Electric water pumps and relevant equipment supervision.
9	**84,85%**	(C1.7) Efficient heat exchanger-heat pump-distribution coupling and mounting,
10	**81,82%**	(C1.2) Thermal energy balance and total needs calculation,
11	**78,79%**	(C1.3) Coupling of ground heat exchanger with heat pumps technologies,
12	**75,76%**	(C1.5) Insulation and sealing techniques,
13	**72,73%**	(C1.1) Optimal architecture selection (horizontal/vertical, closed/open loop, direct/indirect),

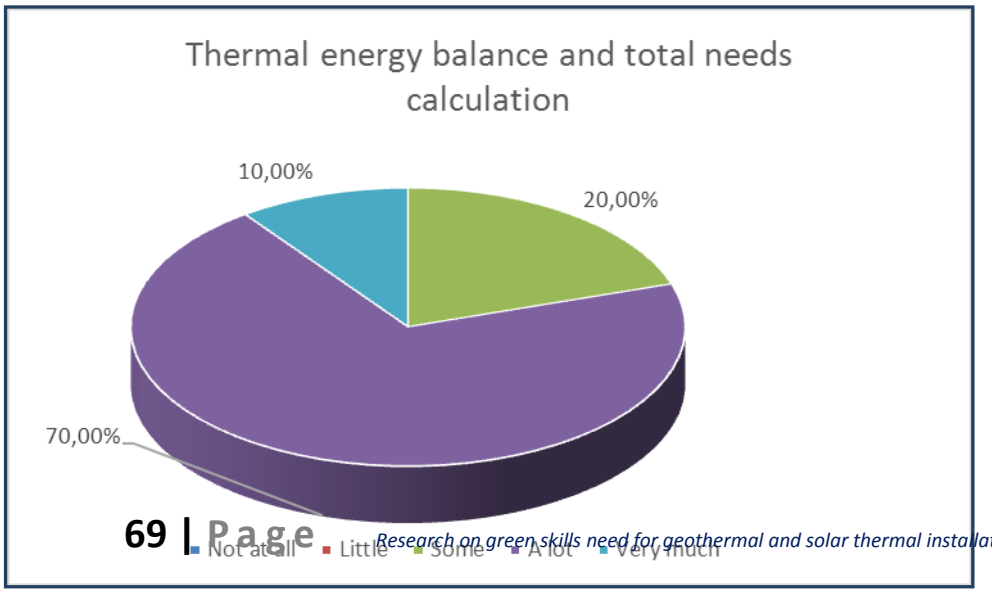
The case of France:

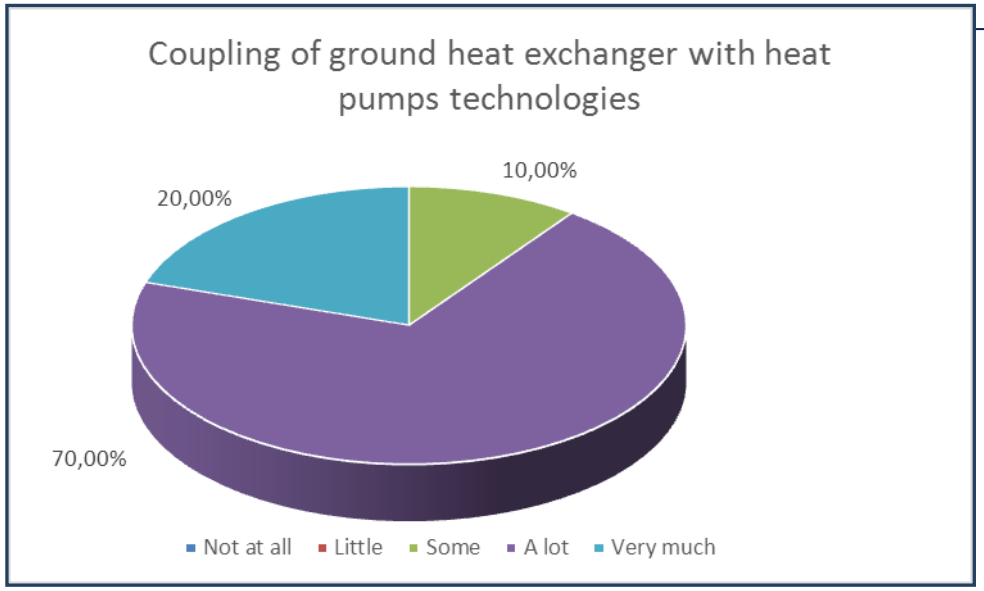
In question (C1) the interviewees were asked to evaluate a list of labour skills that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered as important.

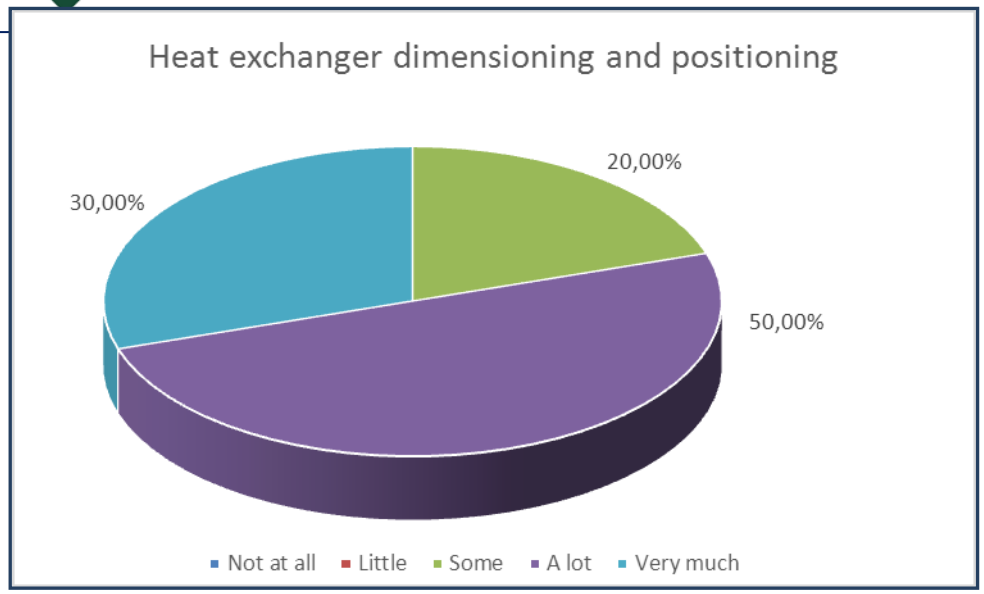
Below are presented the answers that the French interviewers gave in (C1) question.

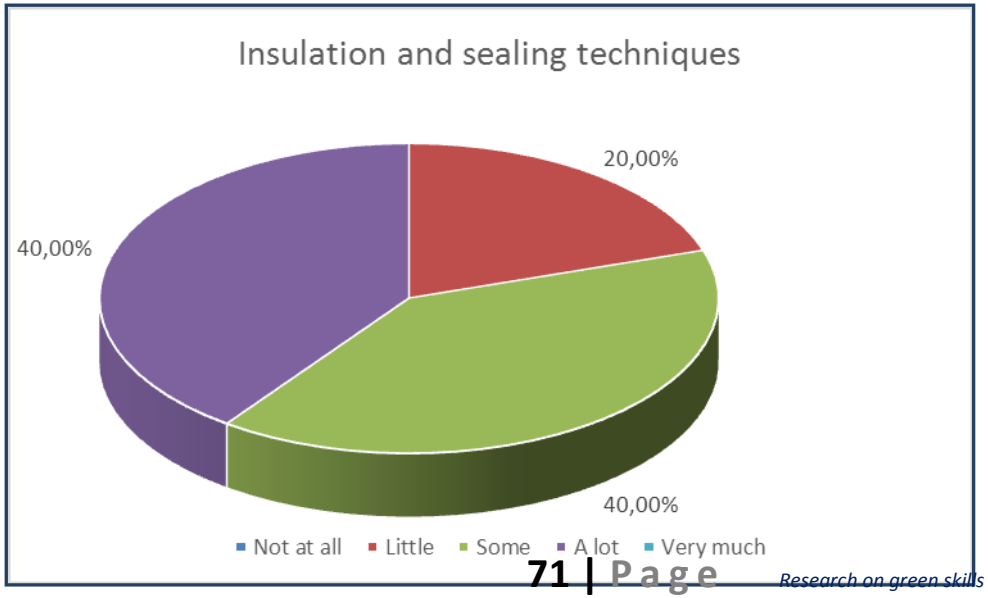
The graphs show the results for each labour skill:

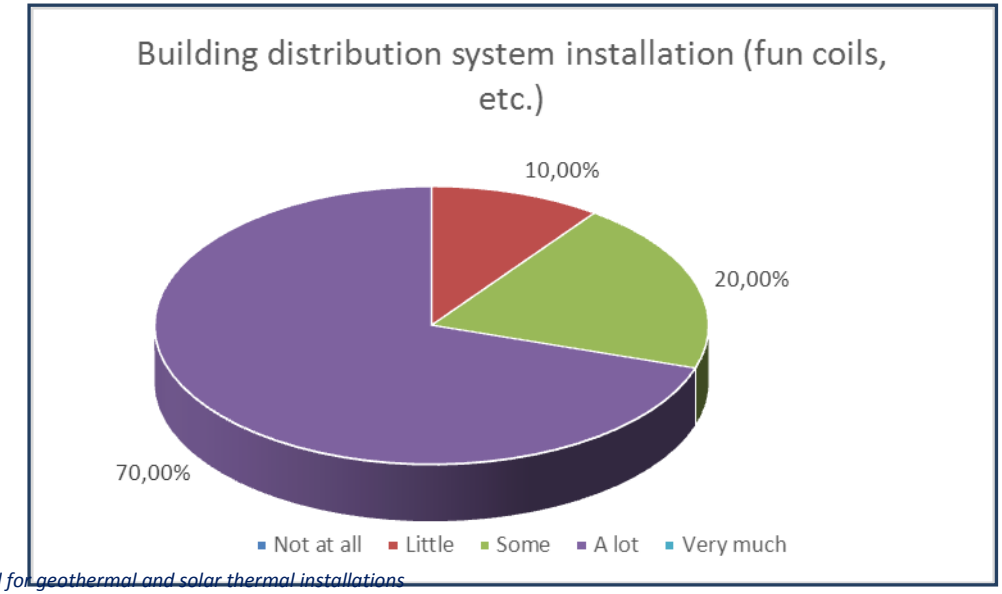


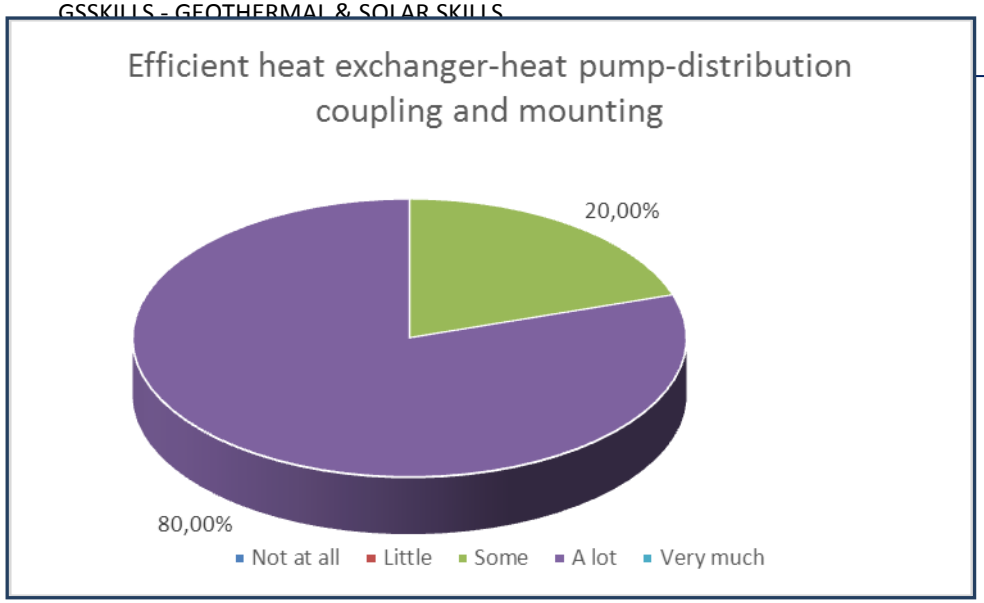


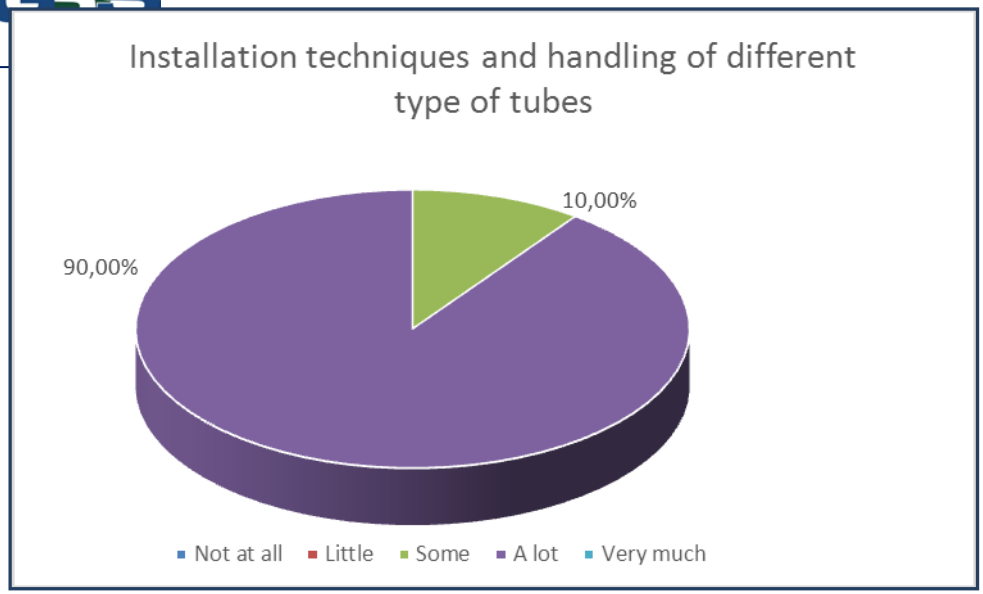

Coupling of ground heat exchanger with heat pumps technologies
10,00%
20,00%
70,00%
Not at all
Little
Some
A lot
Very much

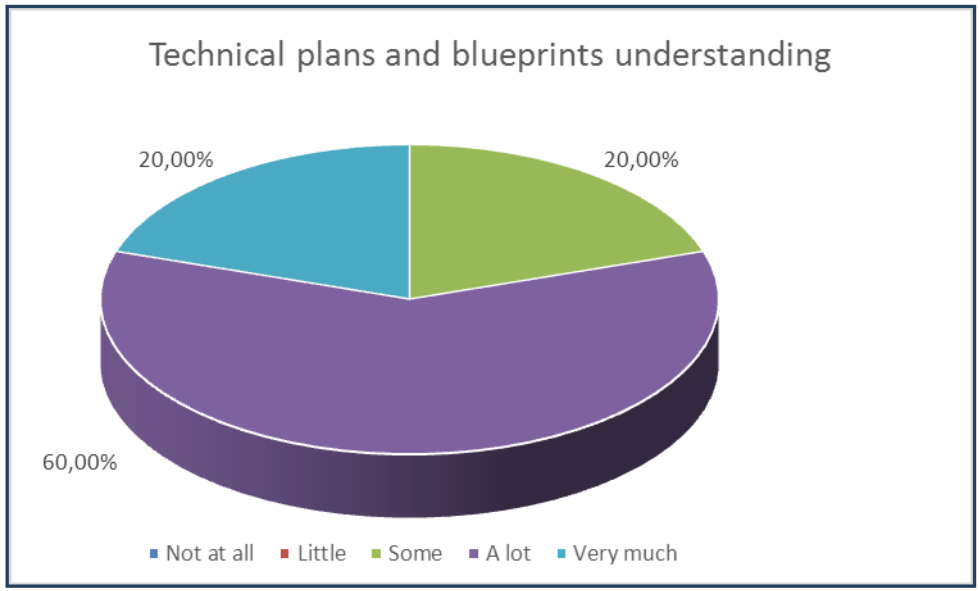

Heat exchanger dimensioning and positioning
20,00%
30,00%
50,00%
Not at all
Little
Some
A lot
Very much

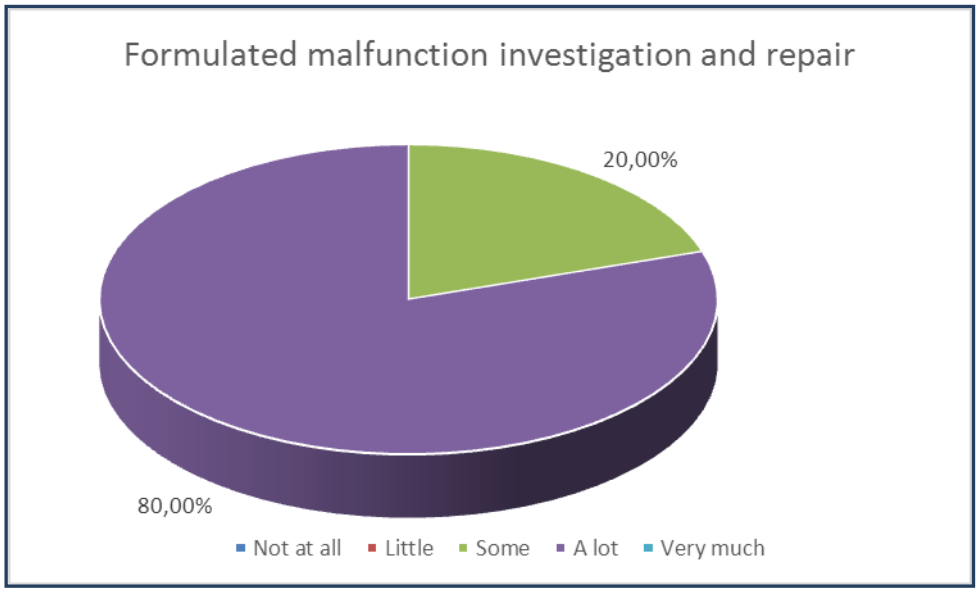

Insulation and sealing techniques
20,00%
40,00%
40,00%
Not at all
Little
Some
A lot
Very much

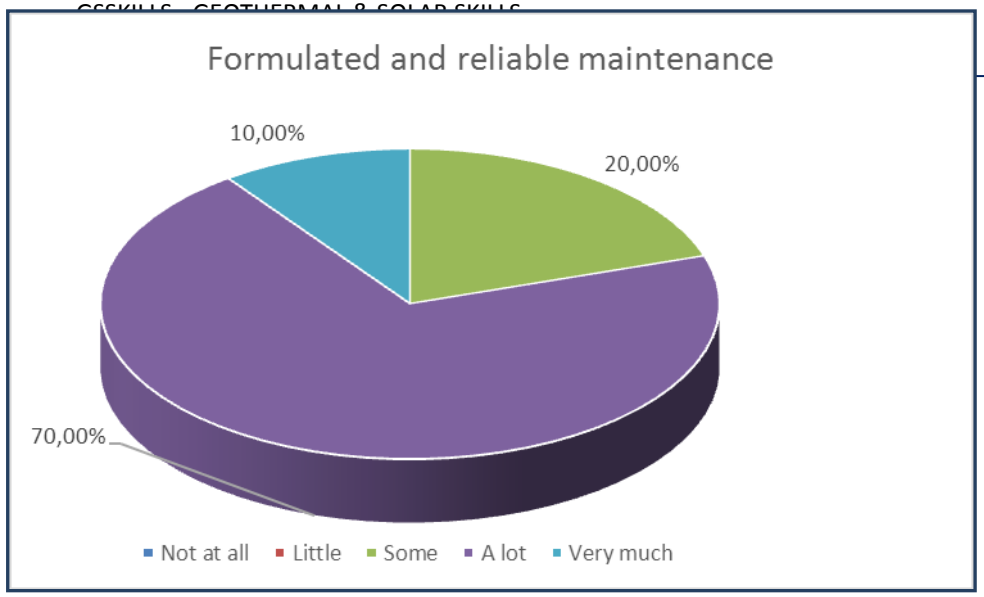

Building distribution system installation (fun coils, etc.)
10,00%
20,00%
70,00%
Not at all
Little
Some
A lot
Very much

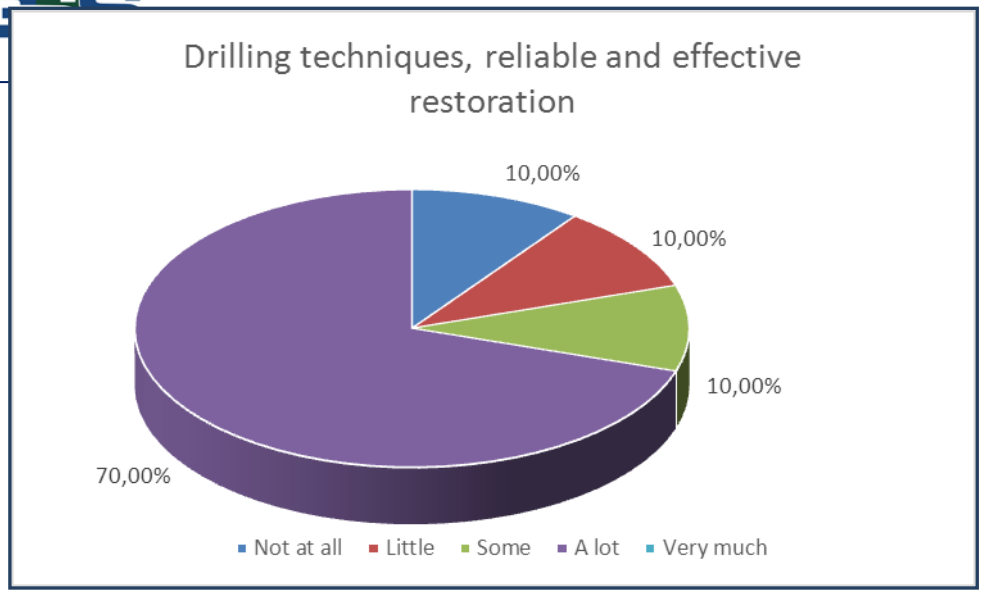

Efficient heat exchanger-heat pump-distribution coupling and mounting
20,00%
80,00%
Not at all
Little
Some
A lot
Very much

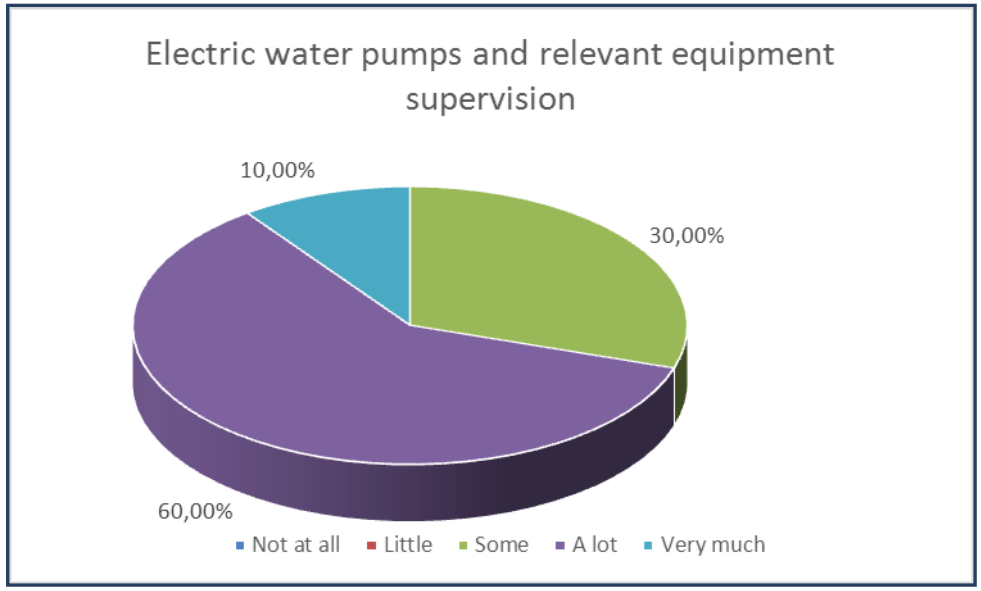

Installation techniques and handling of different type of tubes
10,00%
90,00%
Not at all
Little
Some
A lot
Very much


Technical plans and blueprints understanding
20,00%
20,00%
60,00%
Not at all
Little
Some
A lot
Very much


Formulated malfunction investigation and repair
20,00%
80,00%
Not at all
Little
Some
A lot
Very much


Formulated and reliable maintenance
10,00%
20,00%
70,00%
Not at all
Little
Some
A lot
Very much


Drilling techniques, reliable and effective restoration
10,00%
10,00%
10,00%
70,00%
Not at all
Little
Some
A lot
Very much


Electric water pumps and relevant equipment supervision
10,00%
30,00%
60,00%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the most needed labour skills that a technician should have in order to be able to carry out a geothermal installation in France.

The following classified labour skills are considered very important and, correspond from 70% and up of the French interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**90%**	(C1.8) Installation techniques and handling of different type of tubes,
2	**90%**	(C1.3) Coupling of ground heat exchanger with heat pumps technologies,
3	**80%**	(C1.9) Technical plans and blueprints understanding,
4	**80%**	(C1.11) Formulated and reliable maintenance,
5	**80%**	(C1.4) Heat exchanger dimensioning and positioning,
6	**80%**	(C1.7) Efficient heat exchanger-heat pump-distribution coupling and mounting,
7	**80%**	(C1.2) Thermal energy balance and total needs calculation,
8	**70%**	(C1.6) Building distribution system installation (*fun coils, etc.*),
9	**70%**	(C1.12) Drilling techniques, reliable and effective restoration,
10	**70%**	(C1.13) Electric water pumps and relevant equipment supervision.

The following listed labour skills are considered as less important as correspond to less than 70% of respondent’s choices:

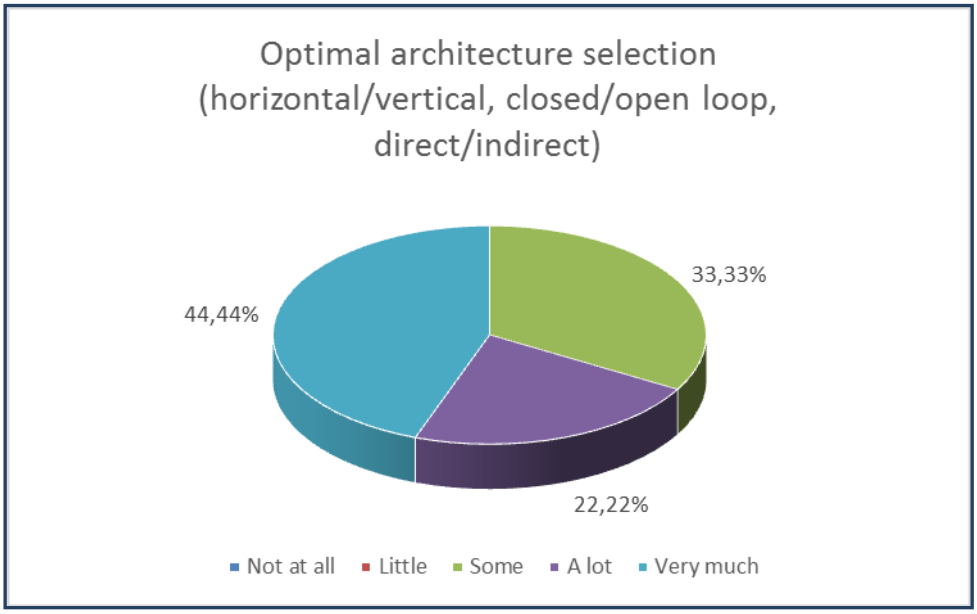
	PERCENTAGE	THEORETICAL KNOWLEDGE
1	**50%**	(C1.1) Optimal architecture selection (horizontal/vertical, closed/open loop, direct/indirect),
2	**40%**	(C1.5) Insulation and sealing techniques,

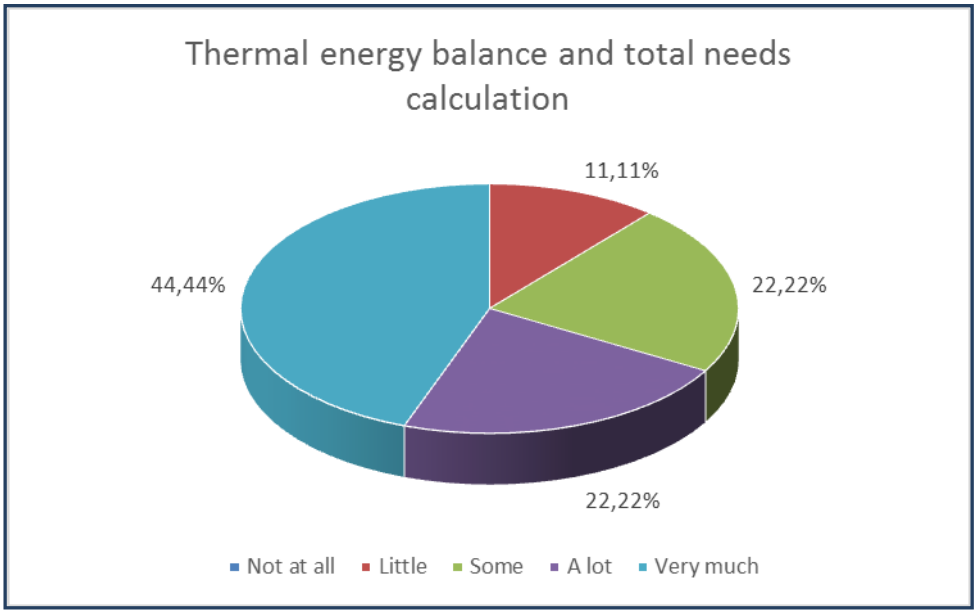
The case of Greece:

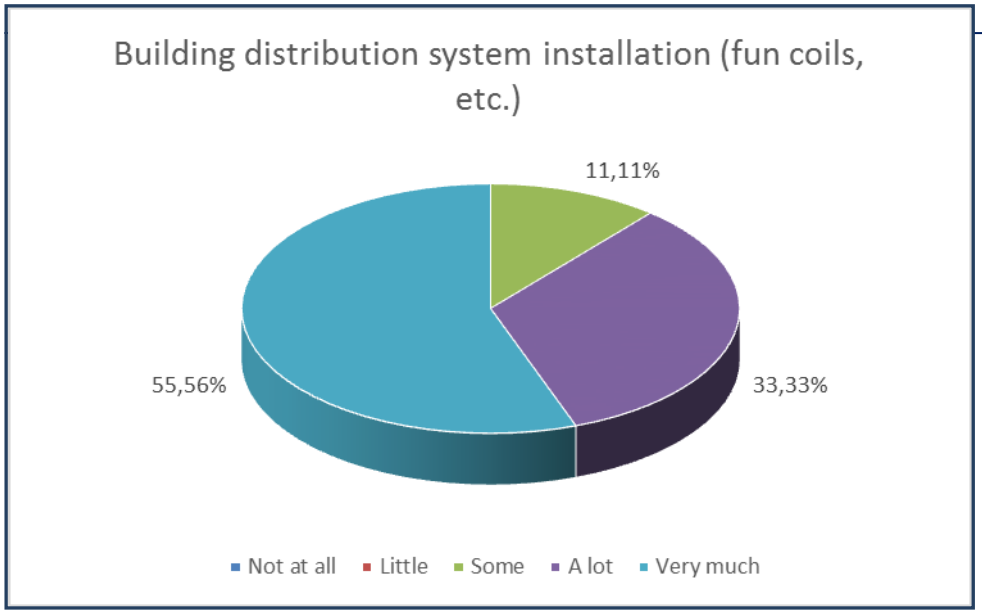
In question (C1) the interviewees were asked to evaluate a list of labour skills that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered as important.

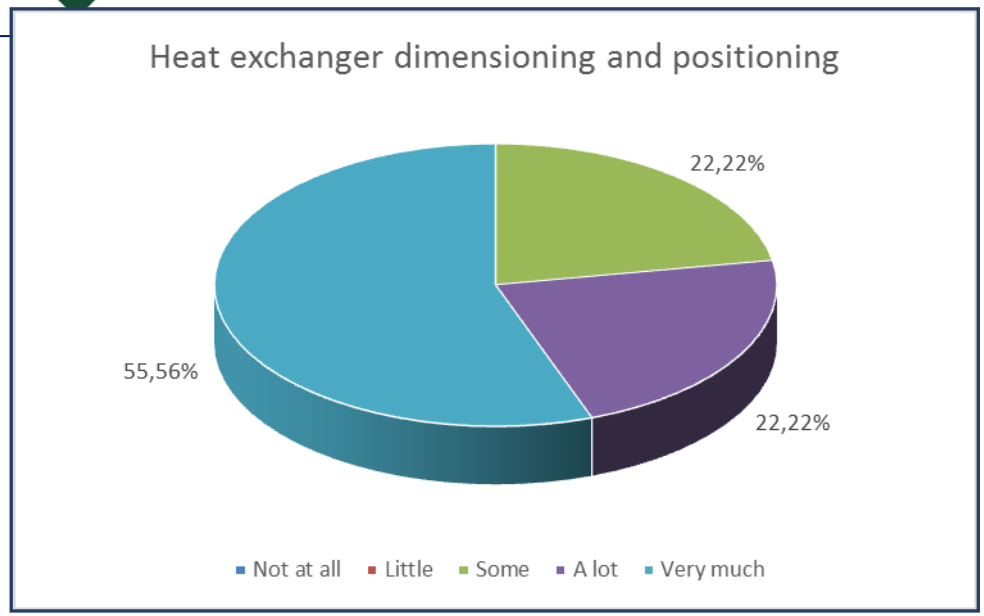
Below are presented the answers that the Greek interviewers gave in (C1) question.

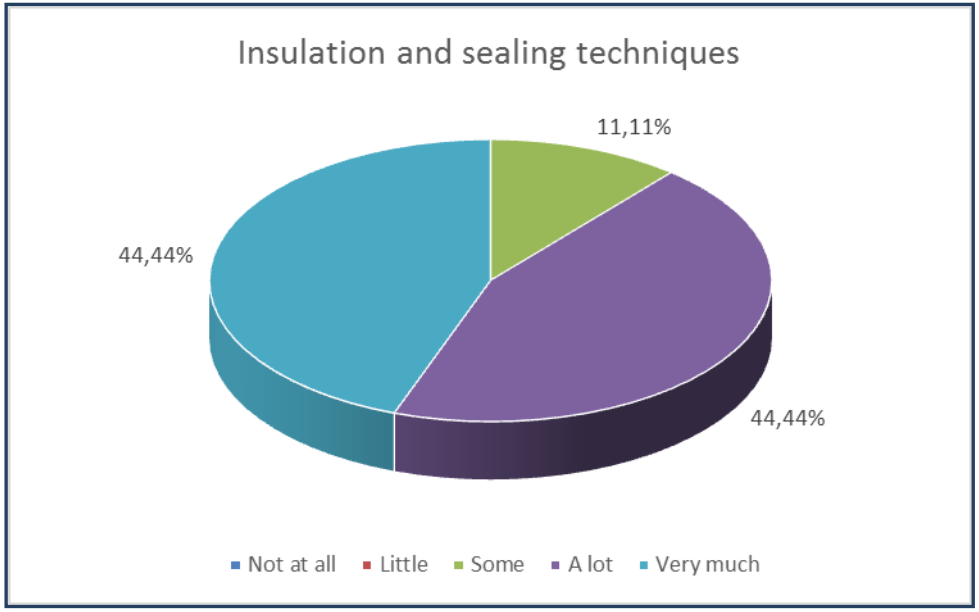
The graphs show the results for each labour skill:

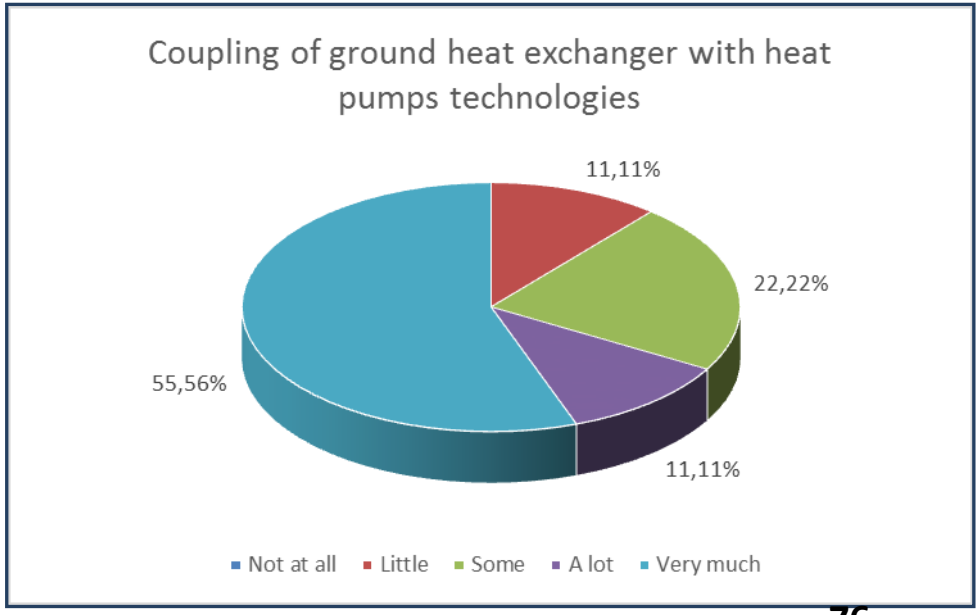


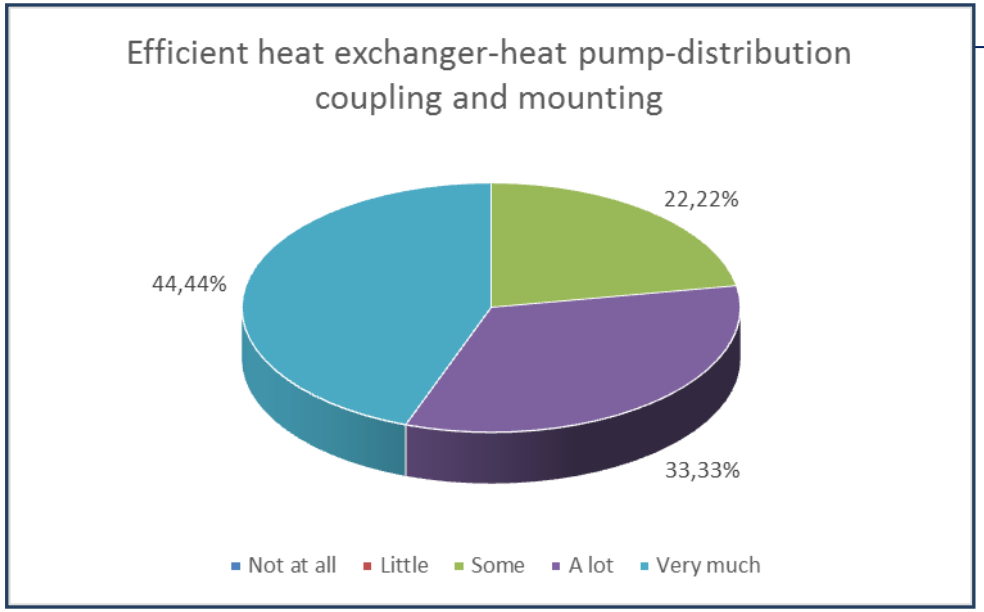


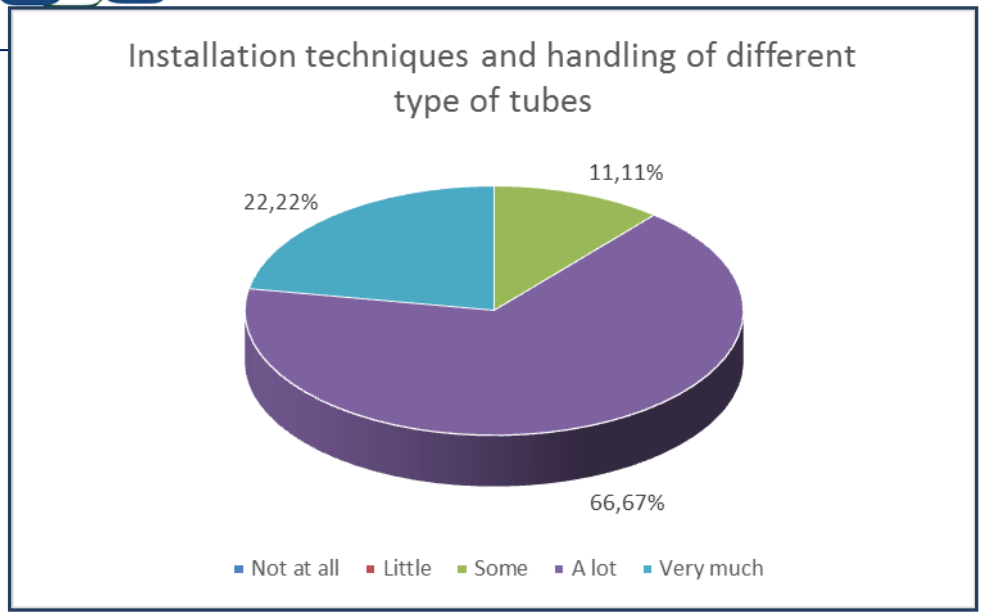

Building distribution system installation (fun coils, etc.)
11,11%
55,56%
33,33%
Not at all
Little
Some
A lot
Very much

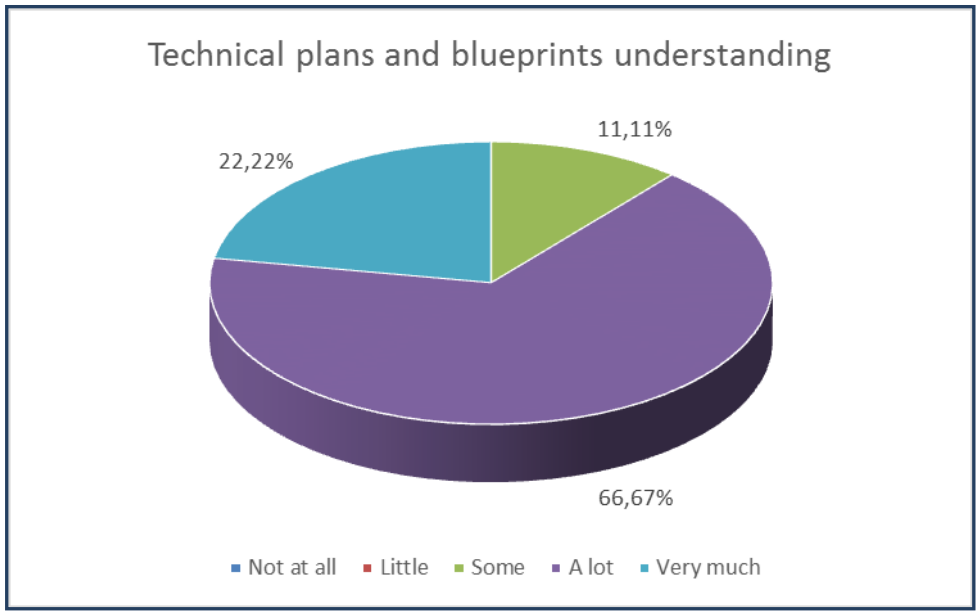

Heat exchanger dimensioning and positioning
22,22%
55,56%
22,22%
Not at all
Little
Some
A lot
Very much

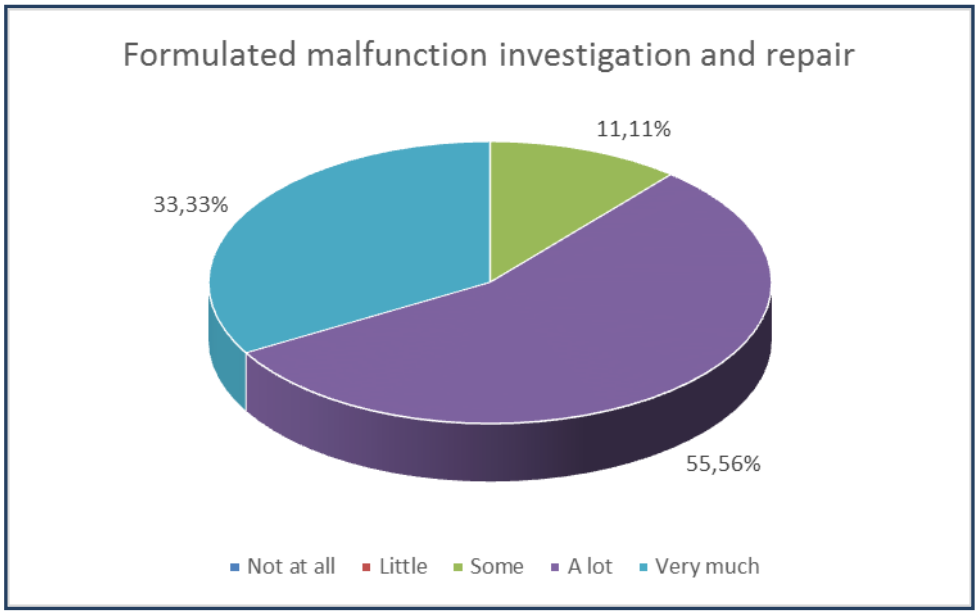

Insulation and sealing techniques
11,11%
44,44%
44,44%
Not at all
Little
Some
A lot
Very much

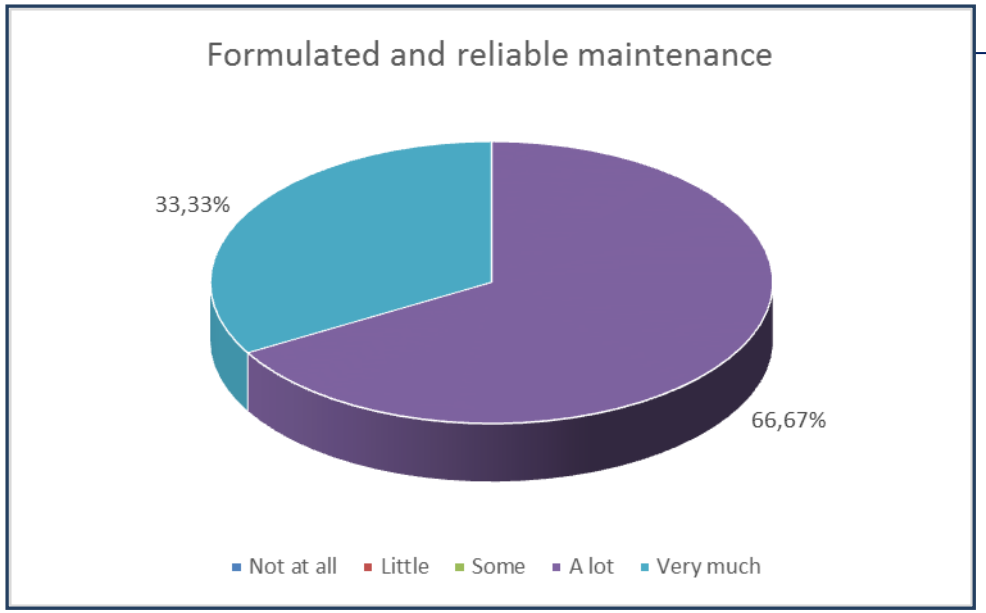

Coupling of ground heat exchanger with heat pumps technologies
11,11%
22,22%
55,56%
11,11%
Not at all
Little
Some
A lot
Very much

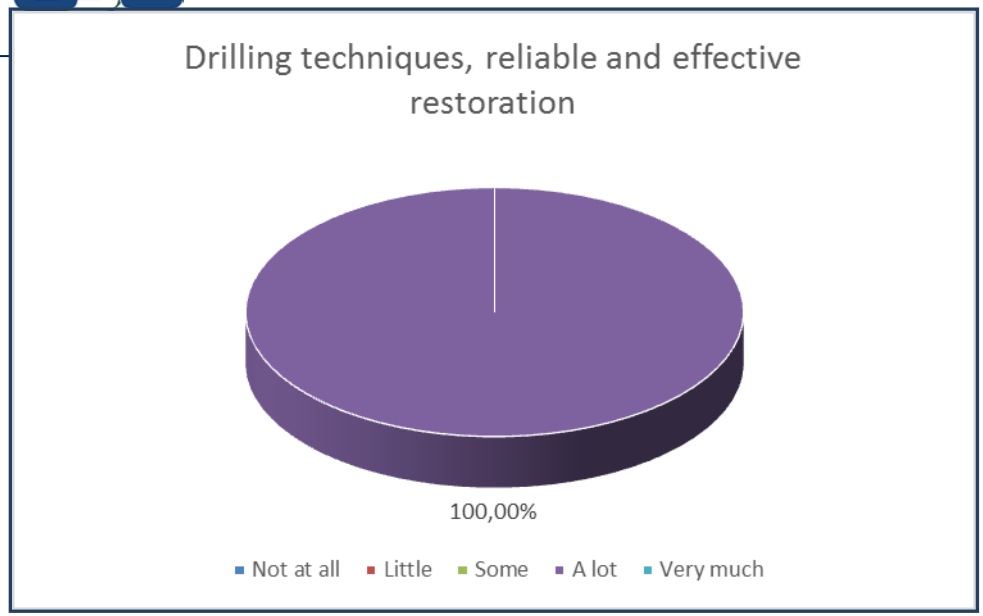

Efficient heat exchanger-heat pump-distribution coupling and mounting
22,22%
44,44%
33,33%
Not at all
Little
Some
A lot
Very much

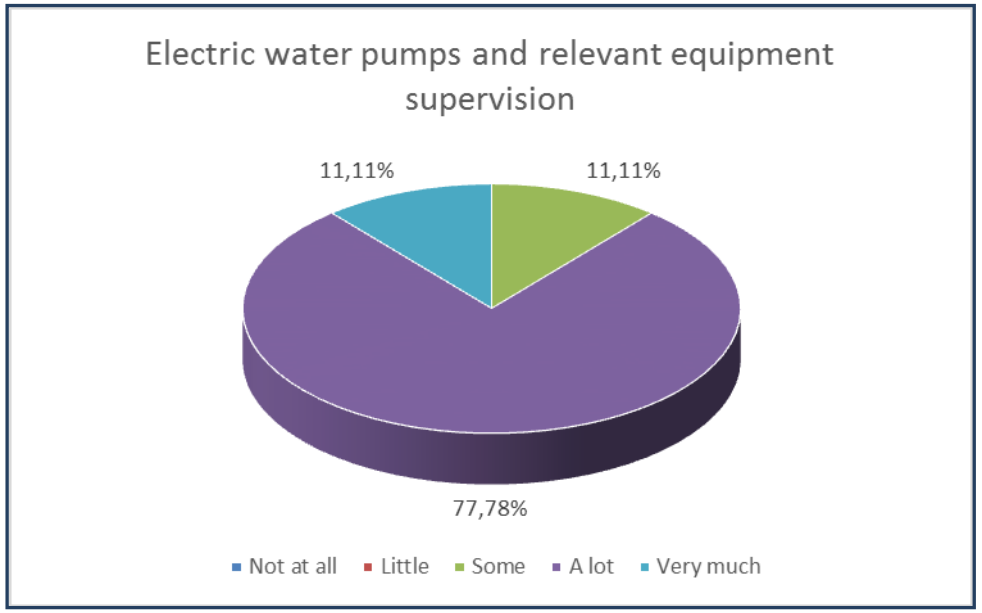

Installation techniques and handling of different type of tubes
11,11%
22,22%
66,67%
Not at all
Little
Some
A lot
Very much


Technical plans and blueprints understanding
11,11%
22,22%
66,67%
Not at all
Little
Some
A lot
Very much


Formulated malfunction investigation and repair
11,11%
33,33%
55,56%
Not at all
Little
Some
A lot
Very much


Formulated and reliable maintenance
33,33%
66,67%
Not at all
Little
Some
A lot
Very much


Drilling techniques, reliable and effective restoration
100,00%
Not at all
Little
Some
A lot
Very much


Electric water pumps and relevant equipment supervision
11,11%
11,11%
77,78%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the most needed labour skills that a technician should have in order to be able to carry out a geothermal installation in Greece.

The following classified labour skills are considered very important as correspond from 70% and up of the Greeks interviewees' choice:

	PERCENTANCE	LABOUR SKILLS
1	100%	**Formulated and reliable maintenance**
2	100%	**Drilling techniques, reliable and effective restoration**
3	88,89%	**Insulation and sealing techniques**
4	88,89%	**Building distribution system installation (*fun coils, etc.*):**
5	88,89%	**Installation techniques and handling of different type of tubes**
6	88,89%	**Technical plans and blueprints understanding**
7	88,89%	**Formulated malfunction investigation and repair**
8	88,89%	**Electric water pumps and relevant equipment supervision**
9	77,78%	**Heat exchanger dimensioning and positioning:**
10	77,78%	**Efficient heat exchanger-heat pump-distribution coupling and mounting**

The following listed labour skills are considered as less important as correspond to less than 70% of respondent's choices:

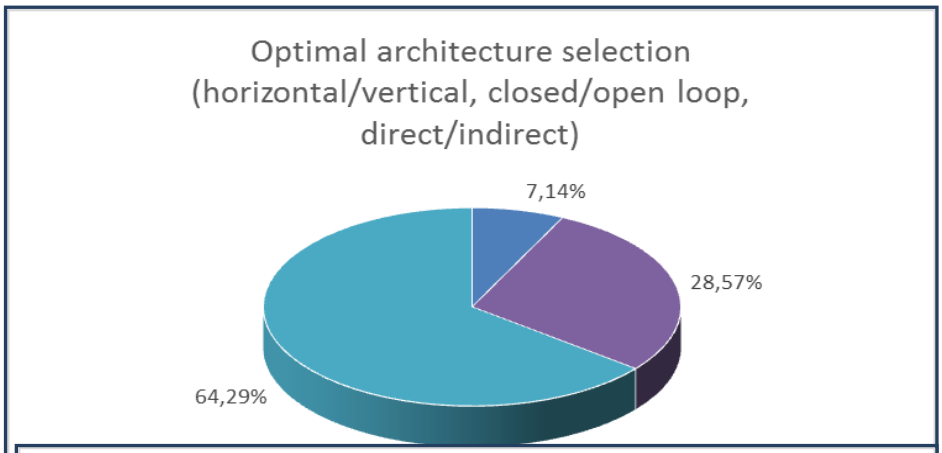
	PERCENTANCE	LABOUR SKILLS
1	66,67%	**Optimal architecture selection (*horizontal/vertical, closed/open loop, direct/indirect*)**
2	66,67%	**Thermal energy balance and total needs calculation**
3	66,67%	**Coupling of ground heat exchanger with heat pumps technologies:**

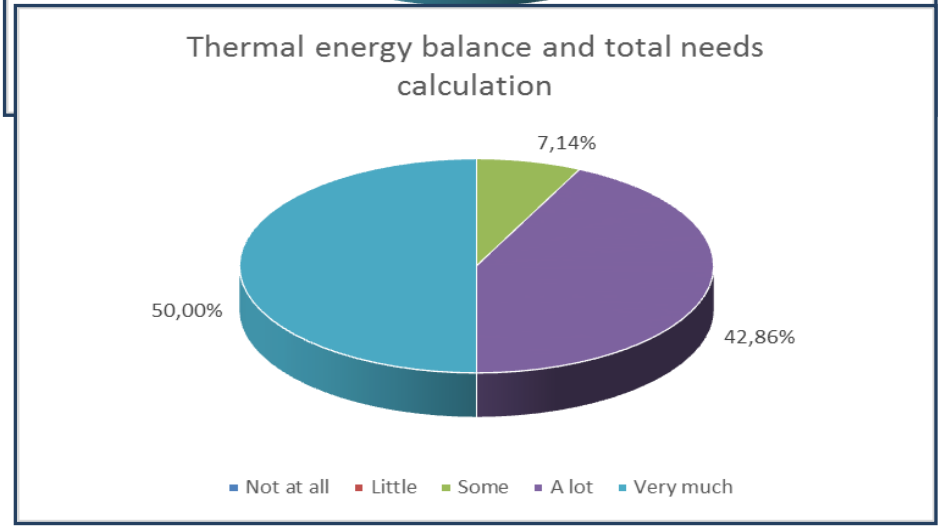
The case of Spain:

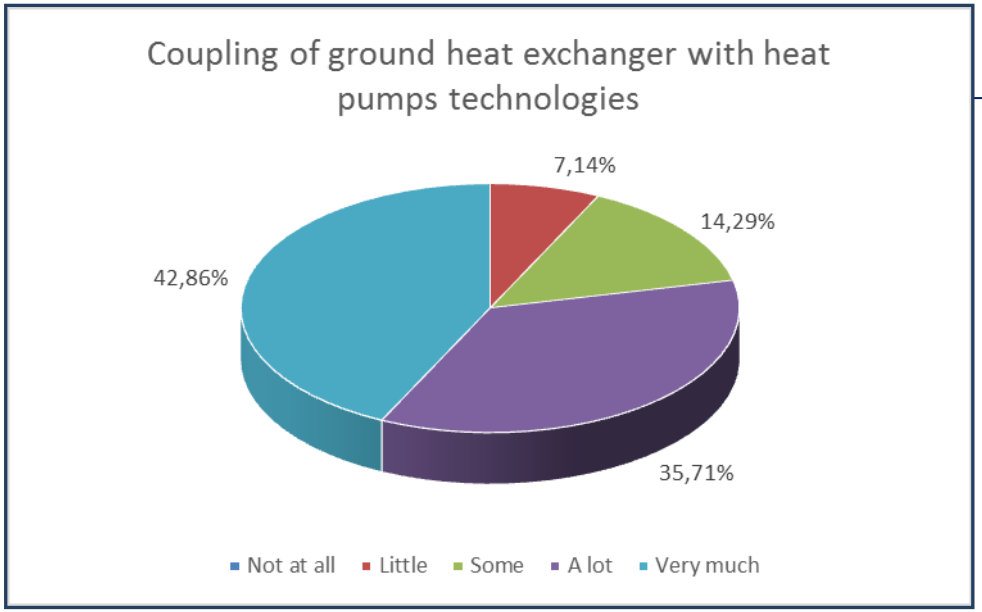
In question (C1) the interviewees were asked to evaluate a list of labour skills that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered as important.

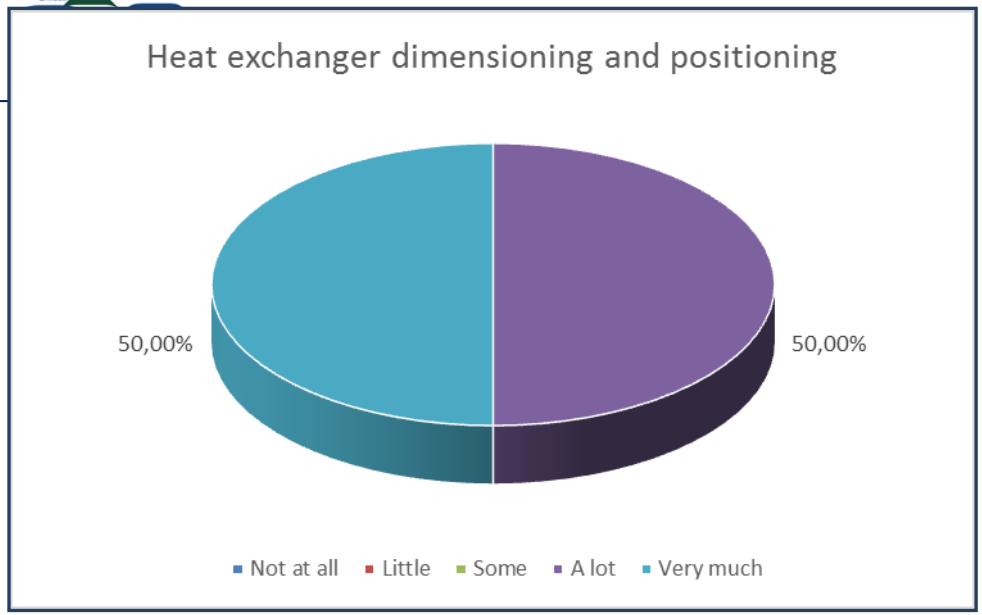
Below are presented the answers that the Spanish interviewers gave in (C1) question.

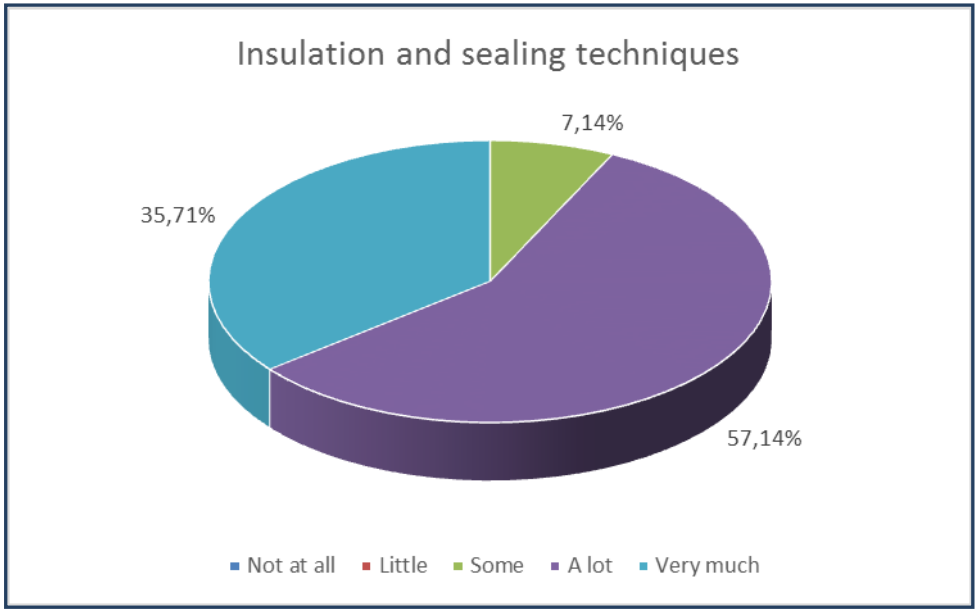
The graphs show the results for each labour skill:

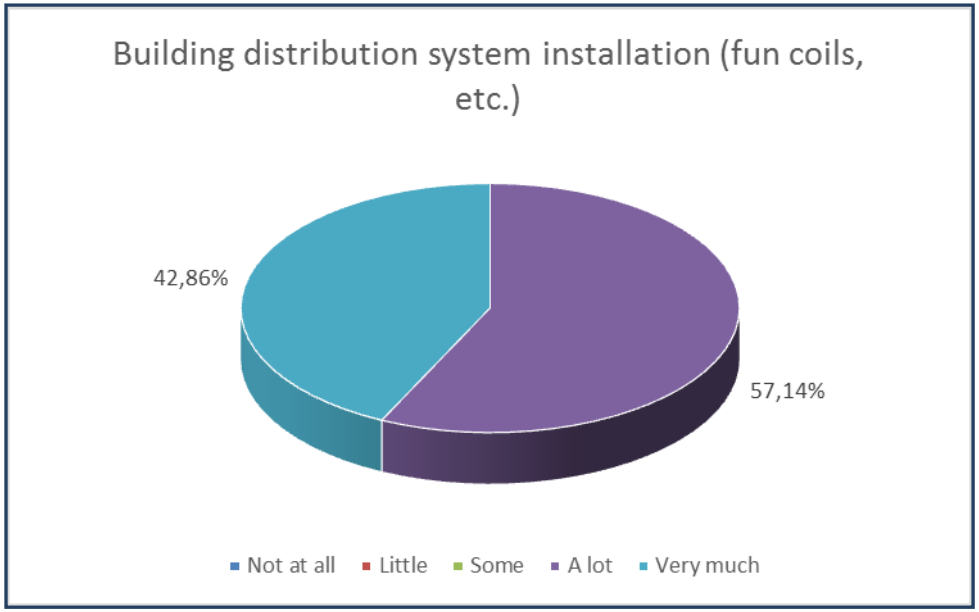


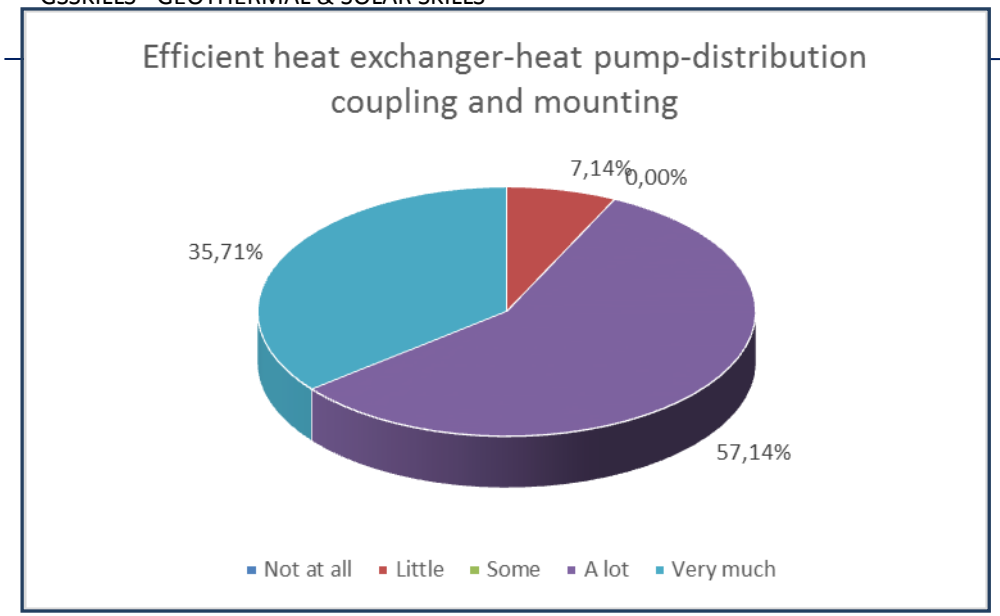


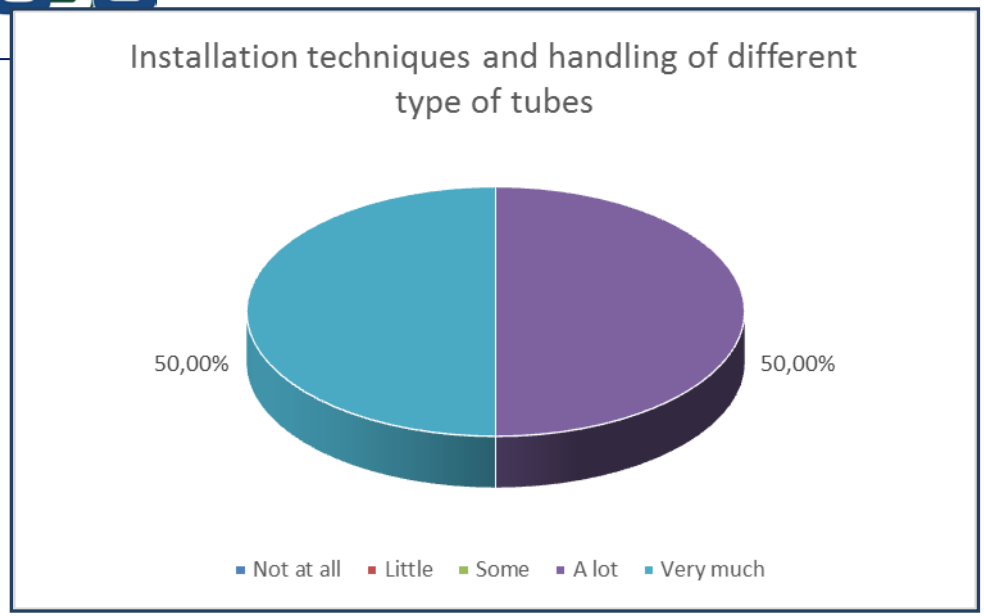

Coupling of ground heat exchanger with heat pumps technologies
7,14%
14,29%
42,86%
35,71%
Not at all
Little
Some
A lot
Very much

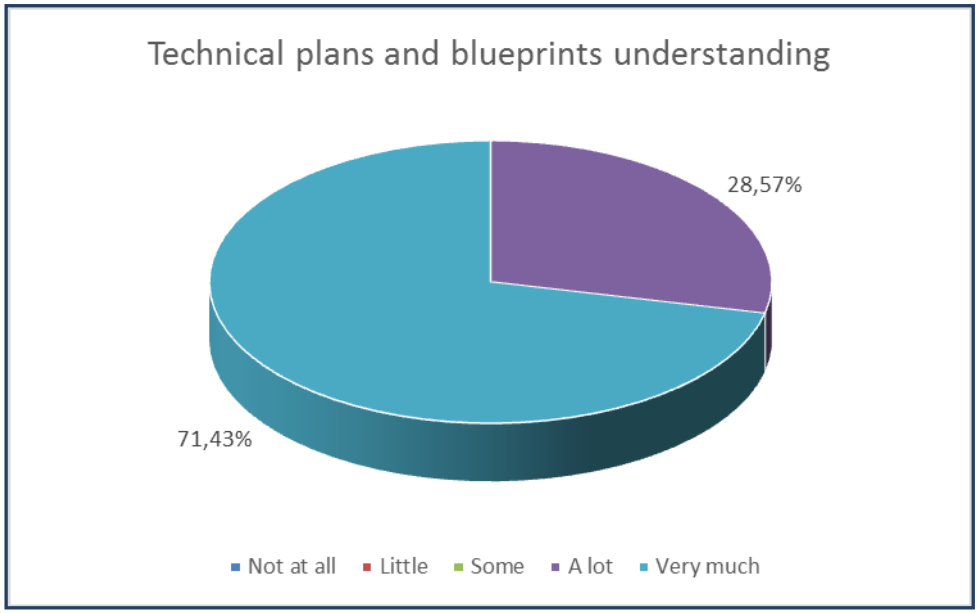

Heat exchanger dimensioning and positioning
50,00%
50,00%
Not at all
Little
Some
A lot
Very much

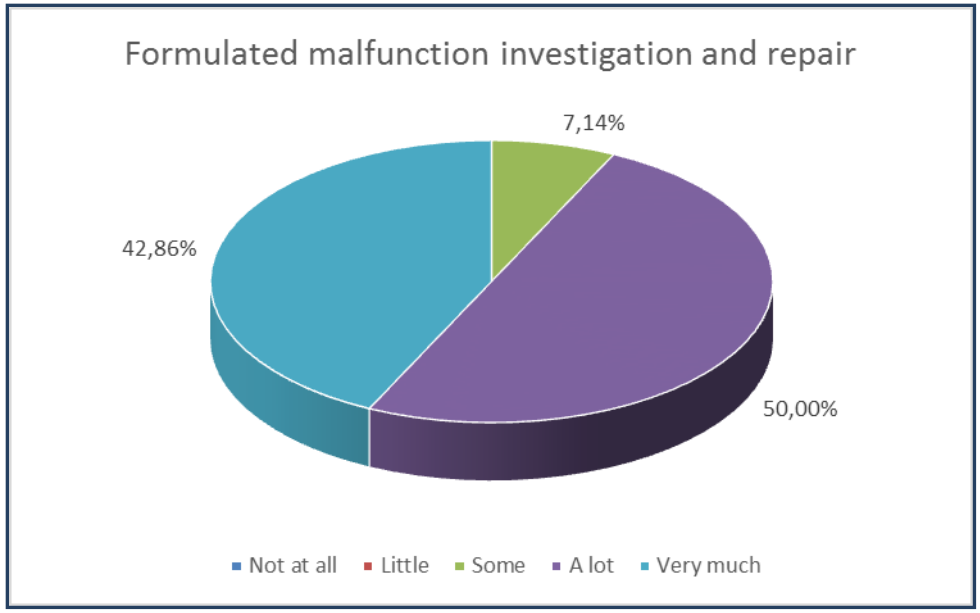

Insulation and sealing techniques
7,14%
35,71%
57,14%
Not at all
Little
Some
A lot
Very much

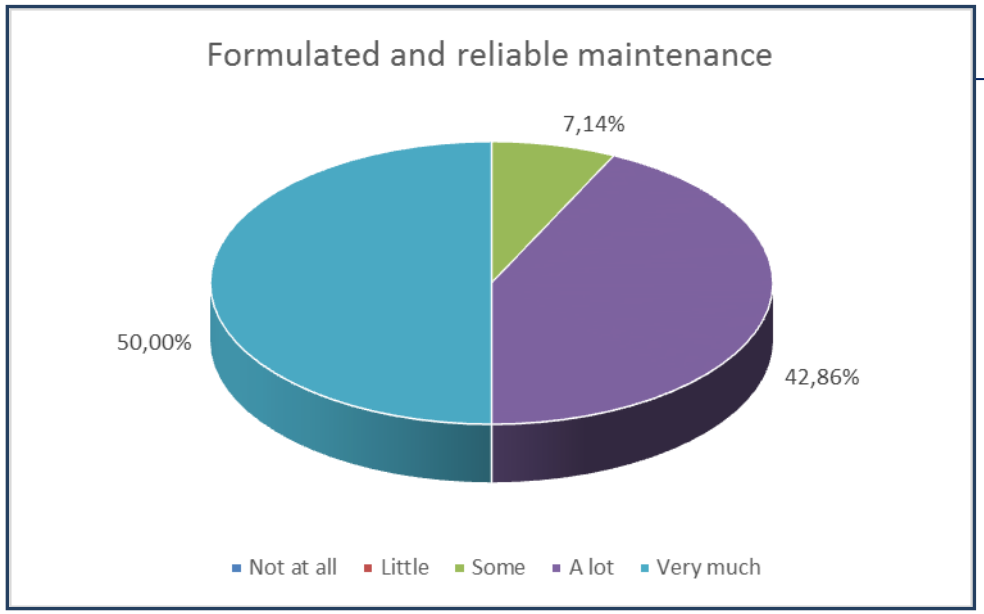

Building distribution system installation (fun coils, etc.)
42,86%
57,14%
Not at all
Little
Some
A lot
Very much

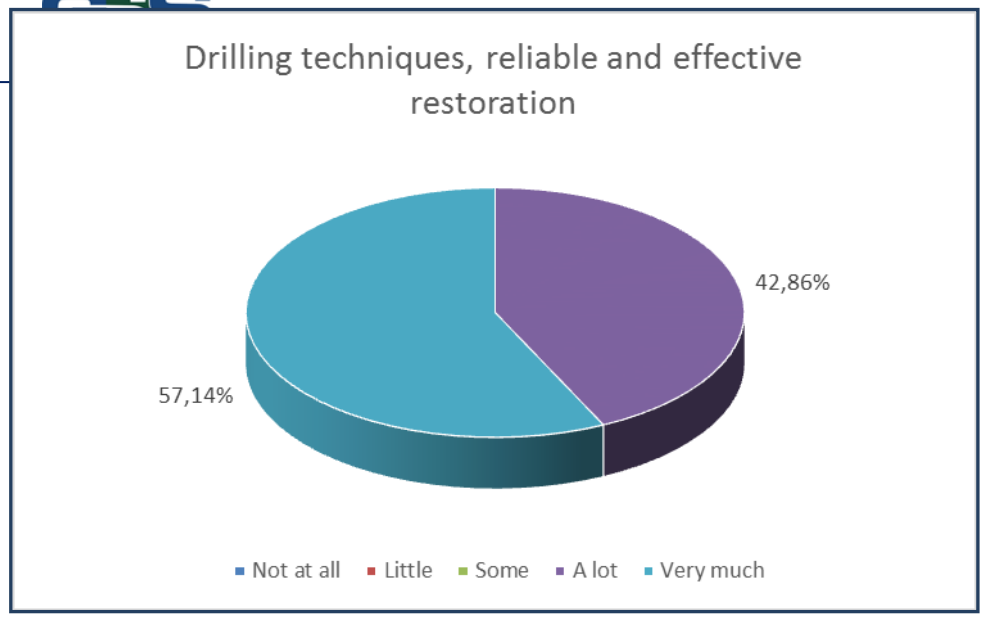

Efficient heat exchanger-heat pump-distribution coupling and mounting
7,14%
0,00%
35,71%
57,14%
Not at all
Little
Some
A lot
Very much

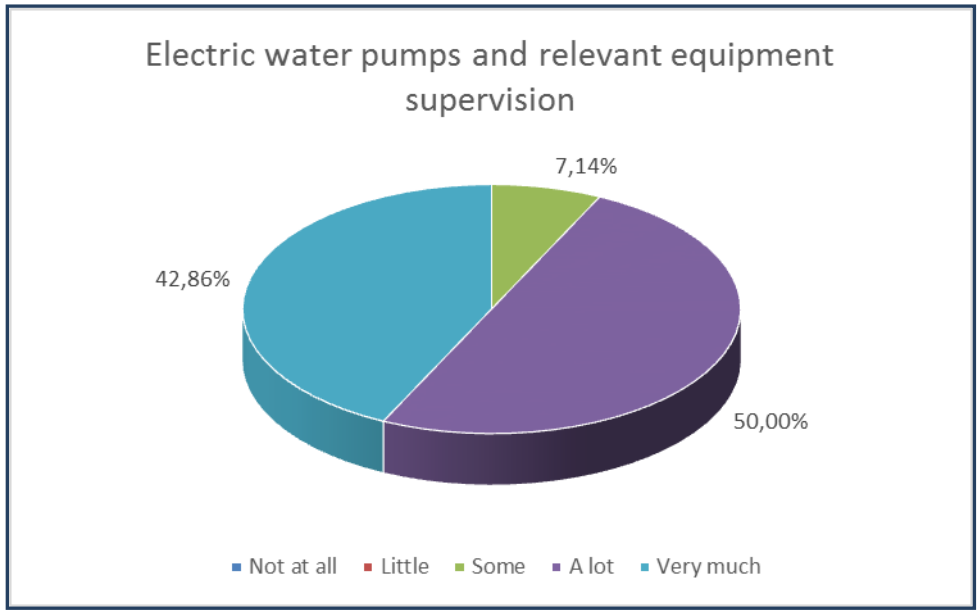

Installation techniques and handling of different type of tubes
50,00%
50,00%
Not at all
Little
Some
A lot
Very much


Technical plans and blueprints understanding
28,57%
71,43%
Not at all
Little
Some
A lot
Very much


Formulated malfunction investigation and repair
7,14%
42,86%
50,00%
Not at all
Little
Some
A lot
Very much


Formulated and reliable maintenance
7,14%
50,00%
42,86%
Not at all
Little
Some
A lot
Very much


Drilling techniques, reliable and effective restoration
42,86%
57,14%
Not at all
Little
Some
A lot
Very much


Electric water pumps and relevant equipment supervision
7,14%
42,86%
50,00%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the most needed labour skills that a technician should have in order to be able to carry out a geothermal installation in Spain.

The Spanish interviewers evaluated all the listed labour skills really important for a technician, as all the proposed skills correspond up to 70% of the interviewees' choice:

	PERCENTANCE	LABOUR SKILLS
1	100%	**Heat exchanger dimensioning and positioning:**
2	100%	**Building distribution system installation (*fun coils, etc.*):**
3	100%	**Installation techniques and handling of different type of tubes:**
4	100%	**Technical plans and blueprints understanding:**
5	100%	**Drilling techniques, reliable and effective restoration:**
6	92,86%	**Electric water pumps and relevant equipment supervision:**
17	92,86%	**Optimal architecture selection (*horizontal/vertical, closed/open loop, direct/indirect*):**
28	92,86%	**Thermal energy balance and total needs calculation:**
9	92,86%	**Insulation and sealing techniques:**
10	92,86%	**Efficient heat exchanger-heat pump-distribution coupling and mounting:**
11	92,86%	**Formulated malfunction investigation and repair:**

12	92,86%	**Formulated and reliable maintenance:**
13	78,57%	**Coupling of ground heat exchanger with heat pumps technologies:**

3. Analysis of the Questionnaires for Solar Installations

Data Analysis

The survey's results reported in this chapter derive from the analysis of 34 questionnaires administered in the 3 partner counties of the GSSkills project: Greece, France and Spain.

Out of the 34 questionnaires, 12 were filled out by French green installation companies, 11 by Greek green installation companies, and 11 by Spanish green installation companies.

The data analysis is divided into paragraphs that match the information and the questions asked to the responders of the questionnaires. The quantitative analyses and graphs were created in Microsoft Excel.

3.1 General Information

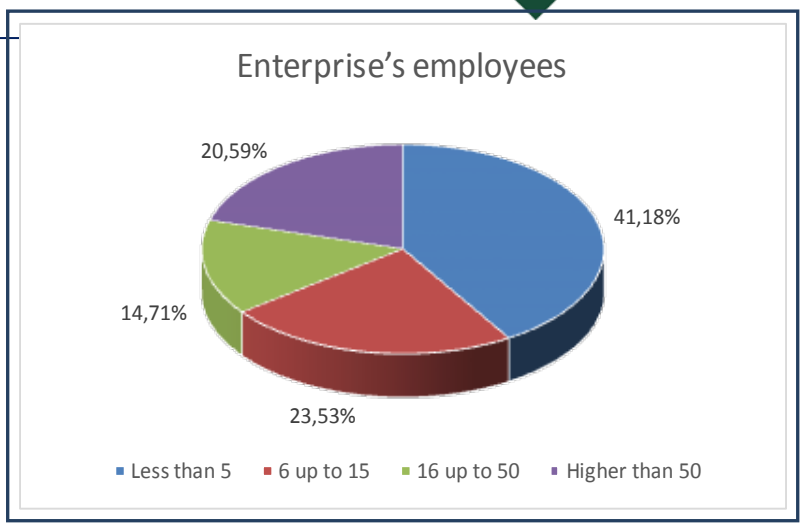
In this section of the questionnaire focus was placed on the collection of personal data, qualifications and professional experience of the employers and green companies directors to whom the questionnaire was administered.

Size of the company: employees in enterprise

Summative statistics for all countries

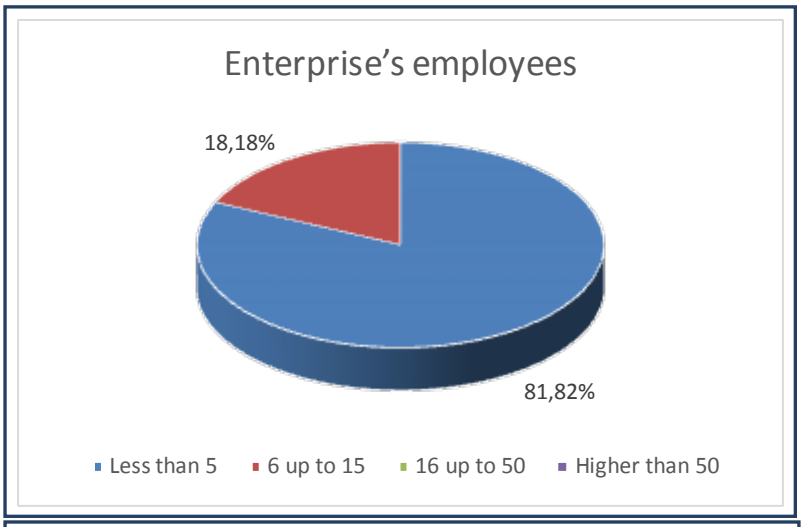
The size of the green installation companies involved in drafting the questionnaires was divided into 4 groups: Group 1 included all the companies that have "Less than 5" employees, Group 2 companies that have "From 6 to 15" employees, Group 3 companies that have "From 16 to 50", Group 4 companies that have "More than 50 employees".

The summary statistics represent the answers collected by the total number of the questionnaires distributed in all countries and shows that the 41,18% of the enterprise's employ "Less than 5" workers, the 23,53% employ "From 6 up to 15" workers, the 20,59% employ "More than 50" workers, and the 14,71% employ "From 16 up to 50" workers



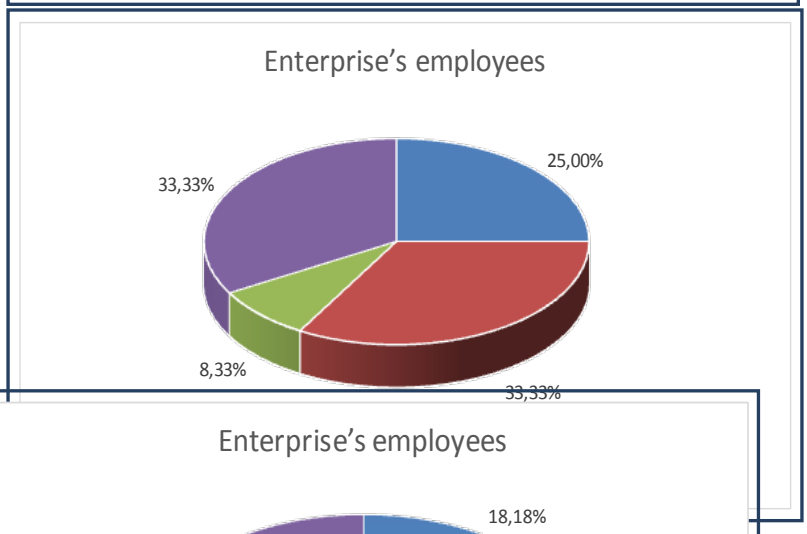
Size of the company: employees in enterprise

The case of each participating country



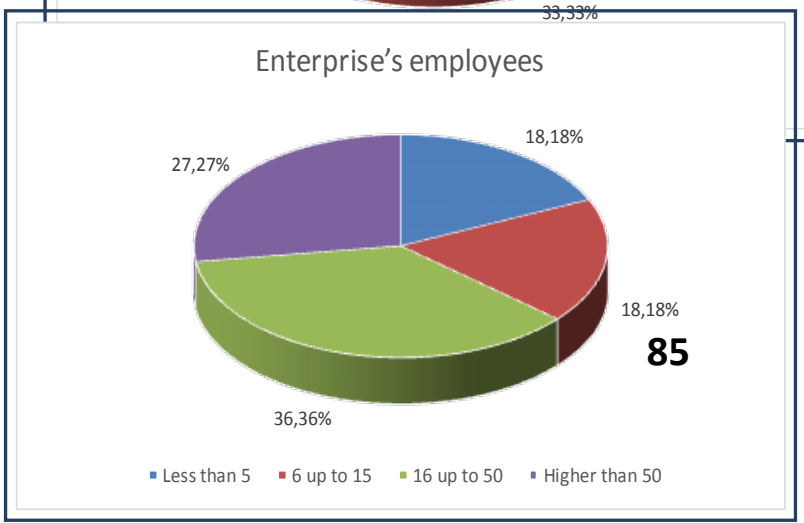
The case of Greece:

In Greece the 81,82% of the enterprise's employ "Less than 5" workers, and the 18,18% employ "From 6 up to 15" workers.



The case of France:

In France the 33,33% of the enterprise's employ "More than 50" workers, the 33,33% employ from "From 6 up to 15" workers, the 25% employ "Less than 5" workers, and the 8,33% employ " From 16 up to 50" workers



The case of Spain:

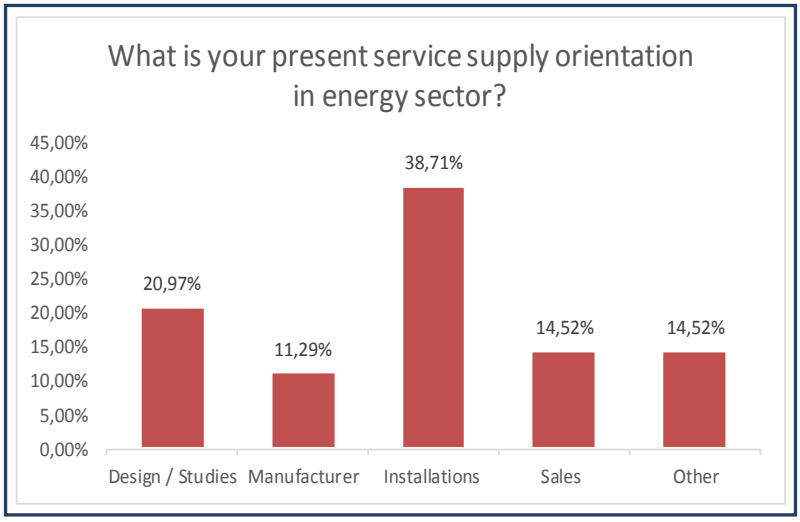
In Spain the 36,36% of the enterprise's employ "From 16 up to 50" workers, the 27,27% employ "More than 50" workers, the 18,18% "Less than 5" workers, and the 18,18% employ "From 6 to 15" workers.

What is your present service supply orientation in energy sector

Summative statistics for all countries

This question concerns the professional position that the interviewees in all countries have in the green installations companies that took part in the research.

In the questionnaire five options were given: 1)Design/Studies, 2)Manufacturer, 3) Installations, 4) Sales, 5) Other/ what



The higher number of interviewees, 38,71%, are working in the implementation of solar thermal installations, the 20,97% are working in "Design/ studies" of solar thermal plants, the 14,52% in "Sales" department, the 14,52% in "Other" professional positions related with solar thermal installations, and the 11,29% as "Manufactures" of solar thermal installations.

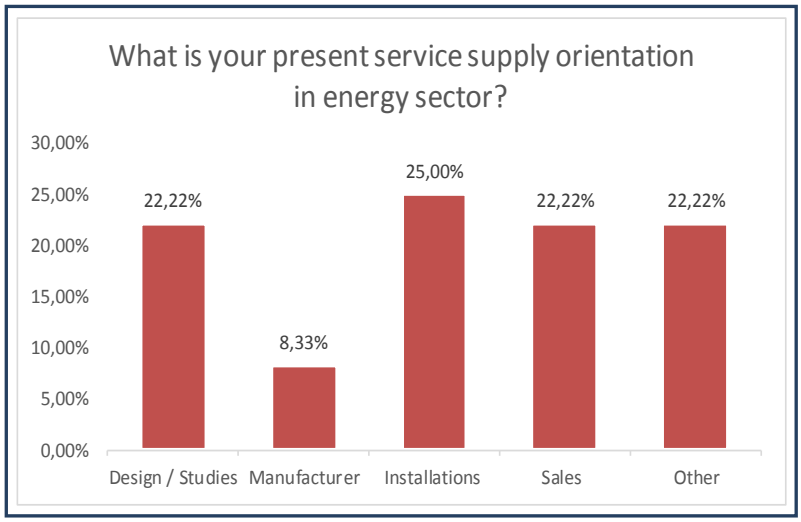
What is your present service supply orientation in energy sector

The case of each participating country

This question concerns the professional position that the interviewees from each participating country have in the green installations companies that took part in the research.

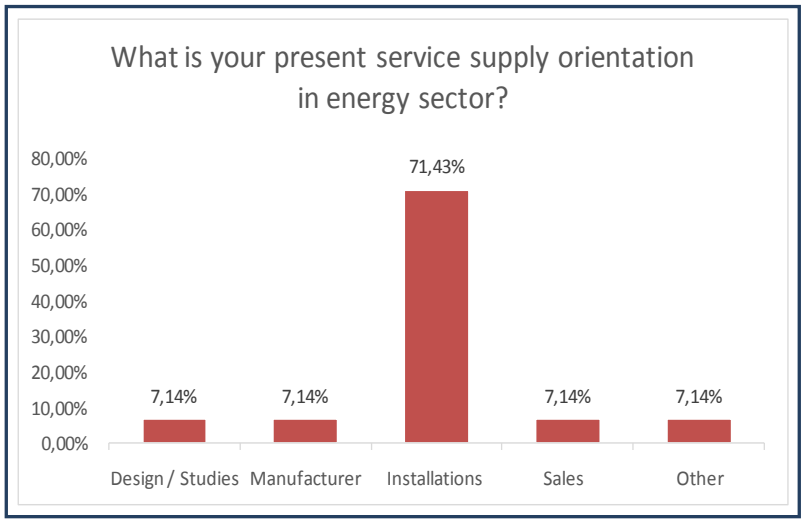
The case of Greece:

The higher number of interviewees, 25%, are working in the implementation of solar thermal installations, the 22,22% are working in "Other" professional positions related with installations, the 22,22% in "Sales" department, the 22,22% in "Design/ studies" and the 8,33% as "Manufactures" of solar thermal installations.



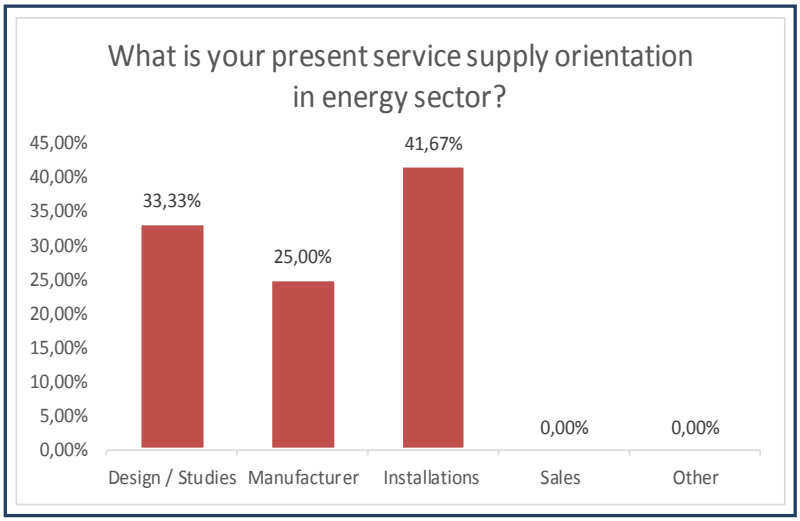
The case of France:

The higher number of interviewees, 71,43%, are working in the implementation of solar thermal installations, the 7,14% are working in "Other" professional positions related with installations, the 7,14% in "Sales" department, the 7,14% in "Design/ studies" and the 7,14% as "Manufactures" of solar thermal installations.



The case of Spain:

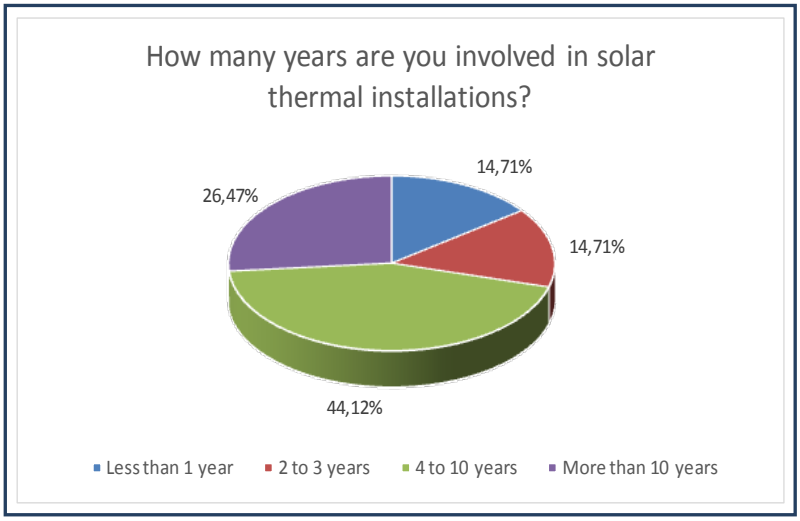
The higher number of interviewees, 41,67%, are working in the implementation of solar thermal installations, the 33,33% are working in in "Design/ studies", and the 25% as "Manufactures" of solar thermal installations.



How many years are you involved in solar thermal installations

Summative statistics for all countries

This question concerns the years of involvement that the interviewees in all countries have in green installations.



In the questionnaire four options were given: 1) "Less than 1 year", 2) "From 2 to 3 years", 3) "From 4 to 10 years, 4) "More than 10 years".

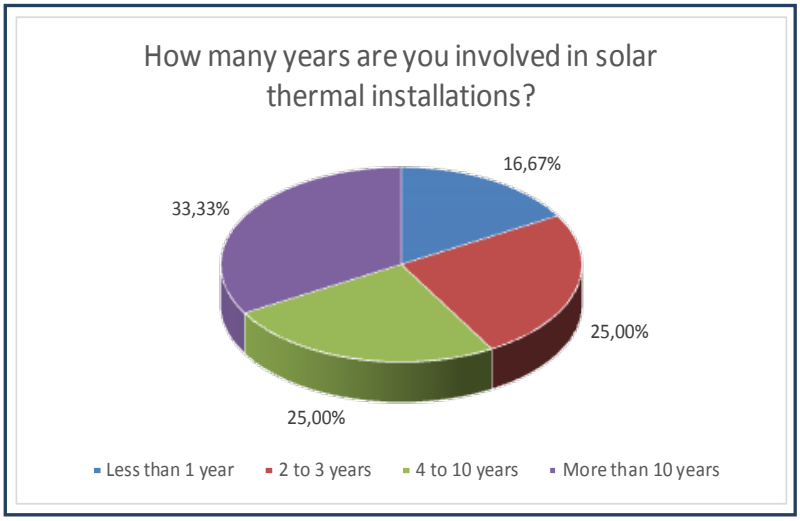
The higher number of interviewees, 44,12%, are working in the implementation of solar thermal installations "From 4 to 10 years", the 26,47% "More than 10 years", the 14,71% "Less than 1 year", and the 14,71% "From 2 to 3 years".

How many years are you involved in solar thermal installations

The case of each participating country

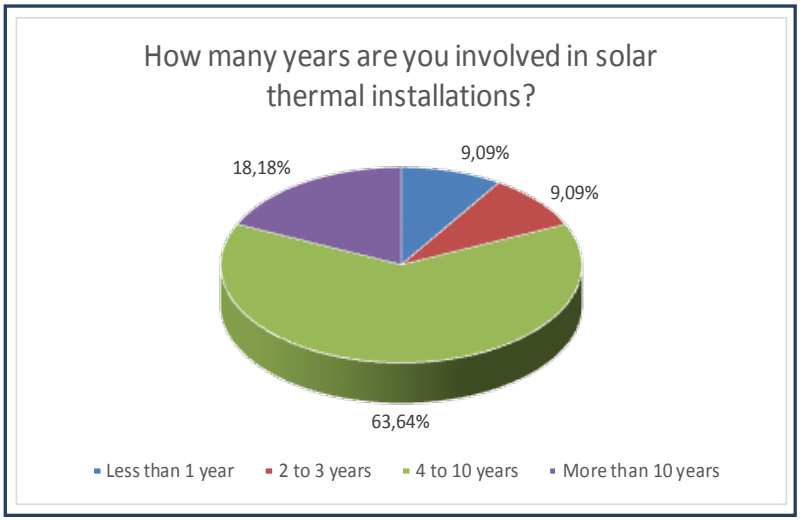
The case of France:

The higher number of interviewees, the 33,33%, are working in the implementation of solar thermal installations "More than 10 years", the 25% "From 2 to 3 years", the 25% "From 4 to 10 years", and the 16,67% "Less than 1 year".



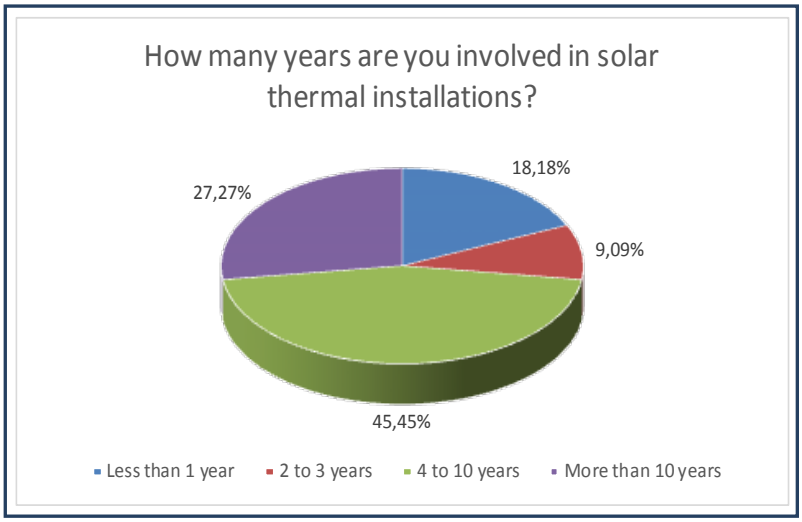
The case of Greece:

The higher number of interviewees, the 63,64%, are working in the implementation of solar thermal installations "From 4 to 10 years", the 18,18% "More than 10 years", the 9,09% "From 2 to 3 years", and the 9,09% "Less than 1 year".



SPAIN:

The higher number of interviewees, the 45,45%, are working in the implementation of solar thermal installations "From 4 to 10 years", the 27,27% "More than 10 years", the 18,18% "Less than 1 year", and the 9,09%. "From 2 to 3 years".

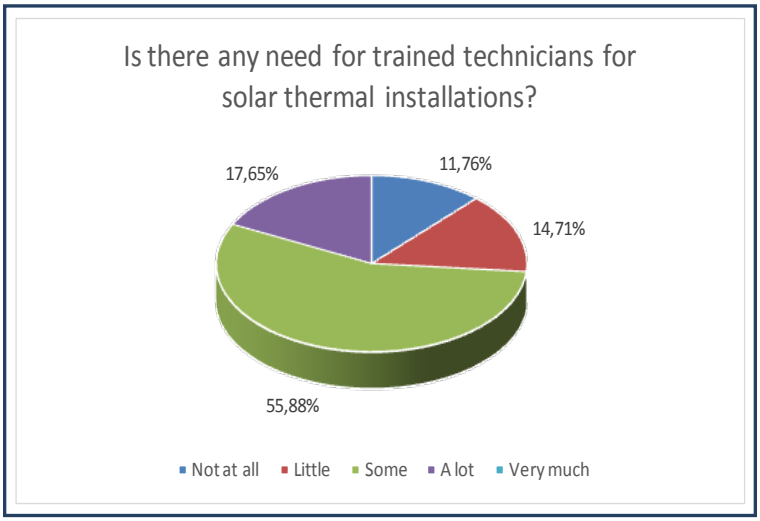


Is there any need for trained technicians for solar thermal installations

Summative statistics for all countries

This question concerns the need for trained technicians in green installations that all countries have.

In the questionnaire five options were given: 1)"Not at all", 2)" Little", 3)"Some", 4)"A lot", 5) "Very much".



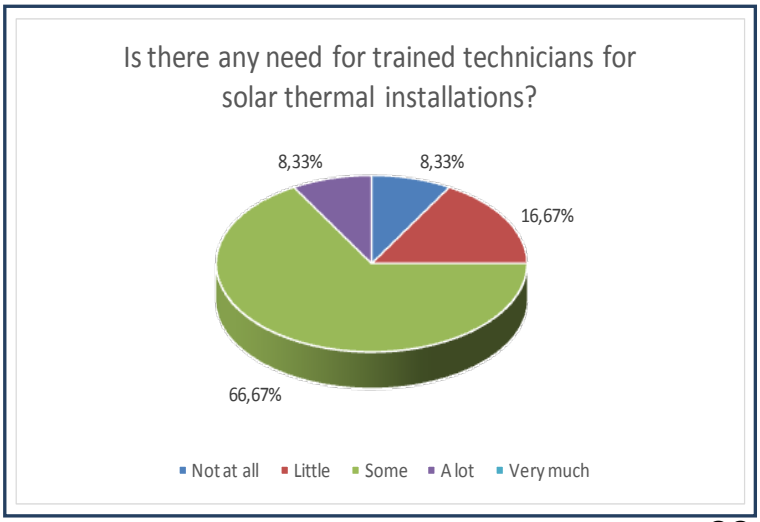
The higher number of interviewees, 55,88%, answered that there is "Some" need for trained technicians in solar thermal installations, the 17,65% that there is "A lot" of need, the 14,71% that there is a "Little" need, and the 11,76% that there is "Not at all" need for trained technicians in solar thermal installations.

Is there any need for trained technicians for solar thermal installations

The case of each country

The case of France:

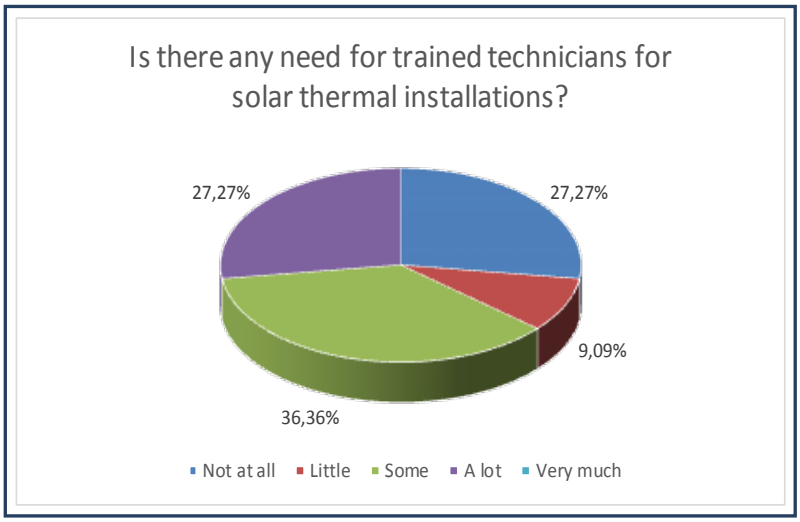
The higher number of interviewees, 66,67%, answered that there is "Some" need for trained technicians in solar thermal installations, the 16,67% answered that there is a "Little" need, the 8,33% answered that there is "A lot"



of need, and the 8,33% answered that there is "Not at all" need for trained technicians in solar thermal installations.

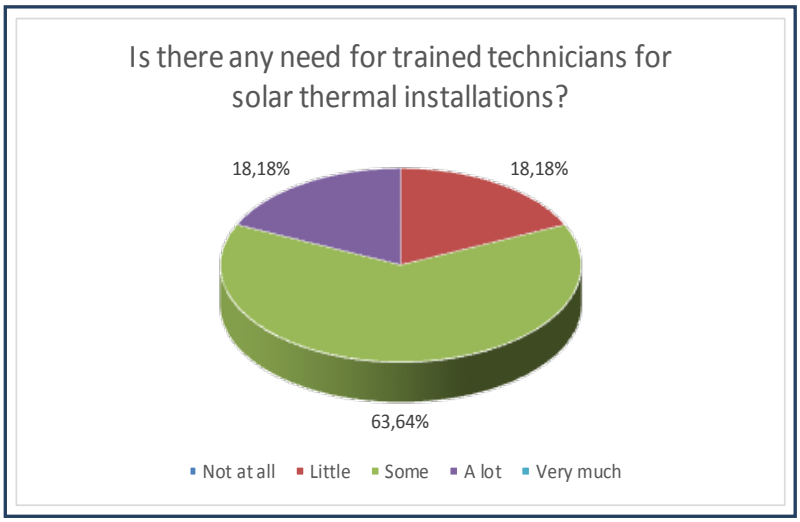
The case of Greece:

The higher number of interviewees, 36,36%, answered that there is "Some" need for trained technicians in solar thermal installations, the 27,27% answered that there is a "A lot" of need, the 27,27% that there is "Not at all" need, and the 9,09% that there is a "Little" need for trained technicians in solar thermal installations.



The case of Spain:

The higher number of interviewees, 63,64%, answered that there is "Some" need for trained technicians in solar thermal installations, the 18,18% answered that there is a "A lot" of need, and the 18,18% that there is a "Little" need for trained technicians in solar thermal installations.



3.2 Theoretical knowledge needs

In this section of the questionnaire focus was placed on the encoding of any theoretical knowledge that plumbers and electricians should have in order to be able to carry out solar thermal installations.

Summative statistics for all countries:

In question (B1) the interviewees were asked to evaluate a list of theoretical abilities that a technician should possess in order to perform his/her profession. In the case that the list is not being complete interviewees were asked to add other theoretical knowledge they considered important for the implementation of solar thermal installations.

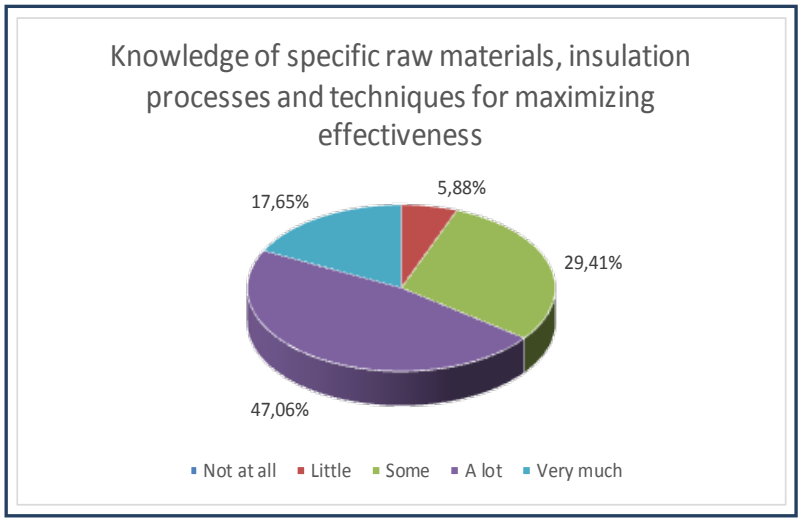
The following 13 theoretical abilities were suggested:

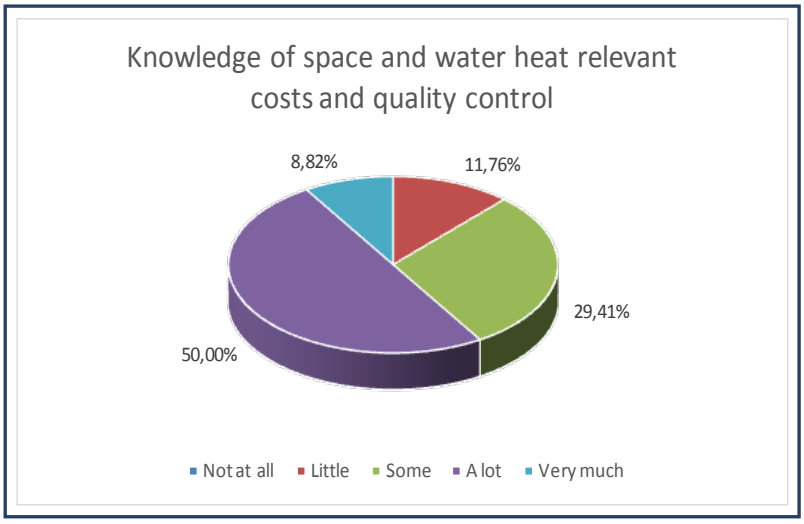
1. **(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**
2. **(B1.2) Knowledge of space and water heat relevant costs and quality control**
3. **(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)**
4. **(B1.4) Knowledge of accompaniment electric pumps, and ventilators**
5. **(B1.5) Knowledge of hot water uses and space heating calculations**
6. **(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**
7. **(B1.7) Knowledge of hot water storage technologies and thermal efficiency techniques**
8. **(B1.8) Knowledge of thermodynamics principles and heat exchange basics**
9. **(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints**

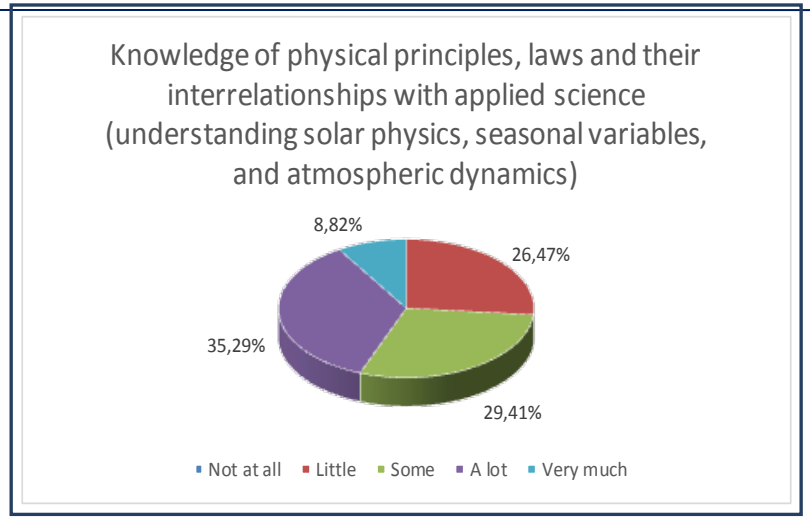
10. **(B1.10) Knowledge of switching, control, and operation of electrical part of the systems**
11. **(B1.11) Knowledge of the worldwide state of the art in solar thermal applications**
12. **(B1.12) Knowledge of the contemporary development and future trends of solar thermal**
13. **(B1.13) Knowledge of panel types basic structure and operation principles and obstacles**

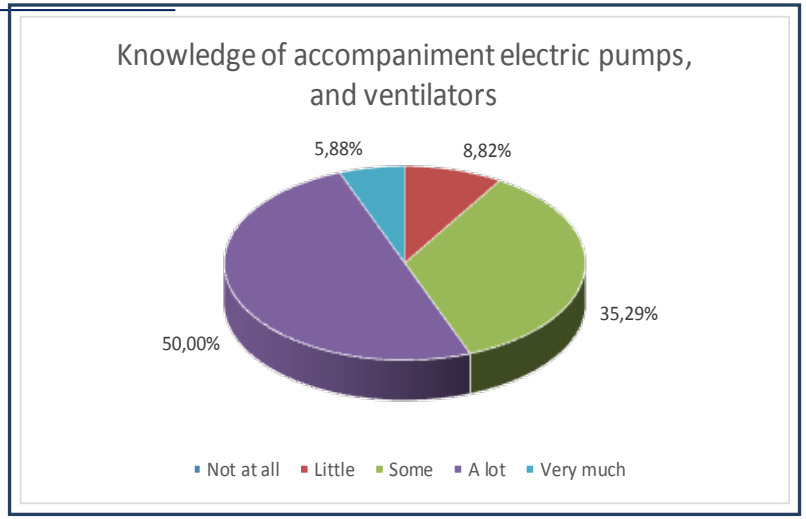
The interviewees evaluate each theoretical ability by choosing a value among the five being proposed in the questionnaire. The proposed values were corresponding to the importance of each theoretical knowledge and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much.

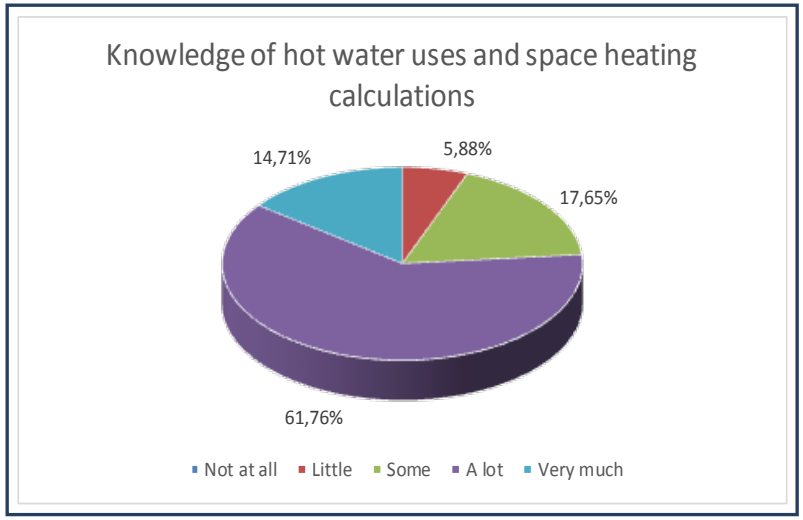
The graphs show the results for each ability:

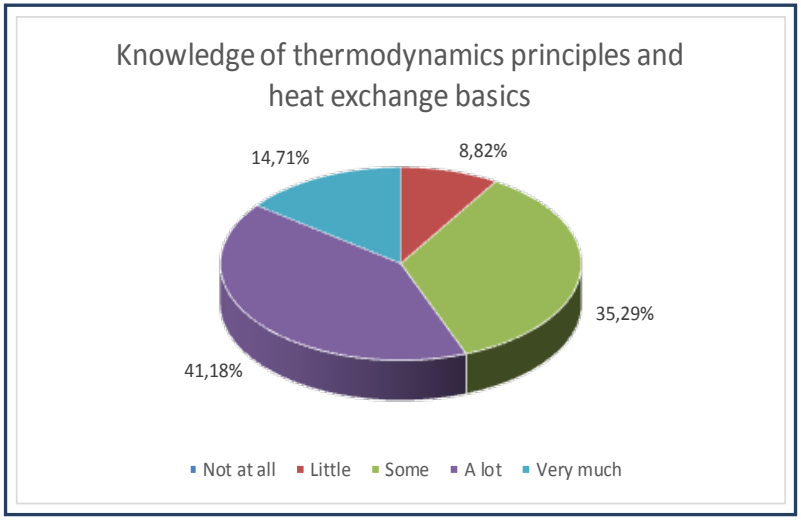


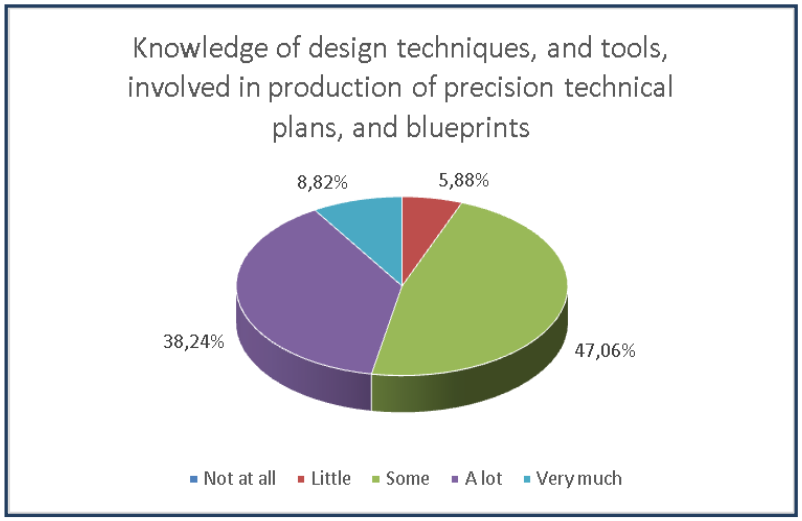


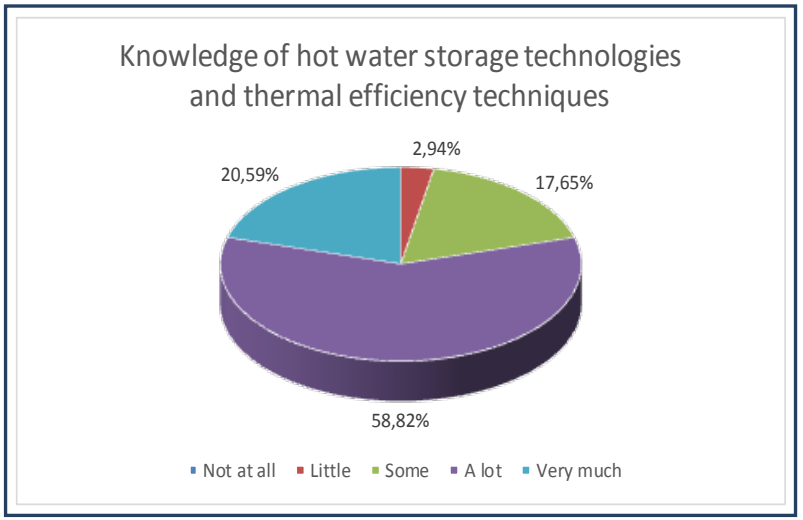

Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)
8,82%
26,47%
35,29%
29,41%
Not at all
Little
Some
A lot
Very much

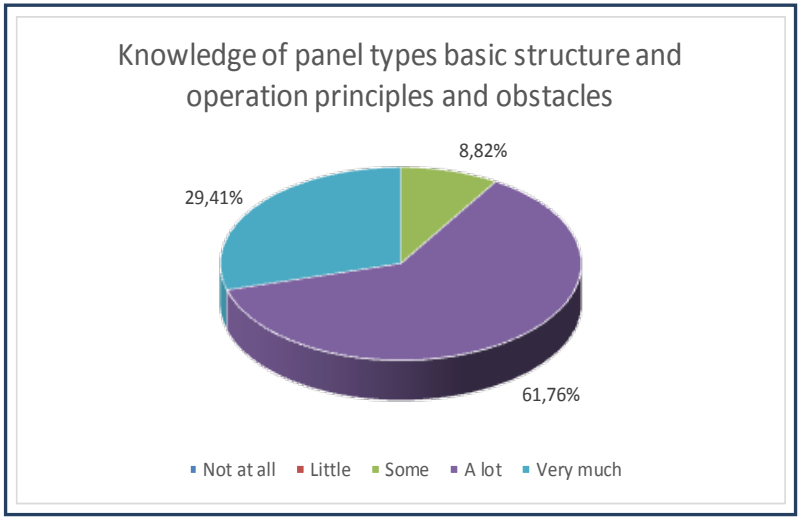

Knowledge of accompaniment electric pumps, and ventilators
5,88%
8,82%
35,29%
50,00%
Not at all
Little
Some
A lot
Very much

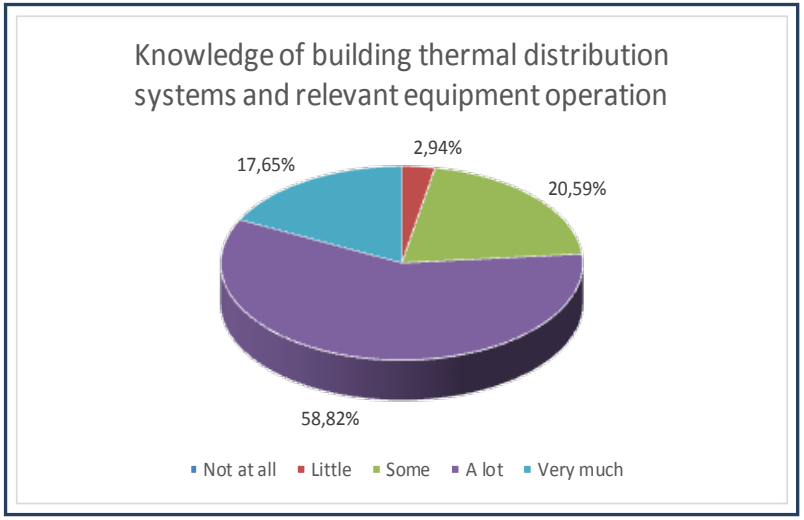

Knowledge of hot water uses and space heating calculations
14,71%
5,88%
17,65%
61,76%
Not at all
Little
Some
A lot
Very much

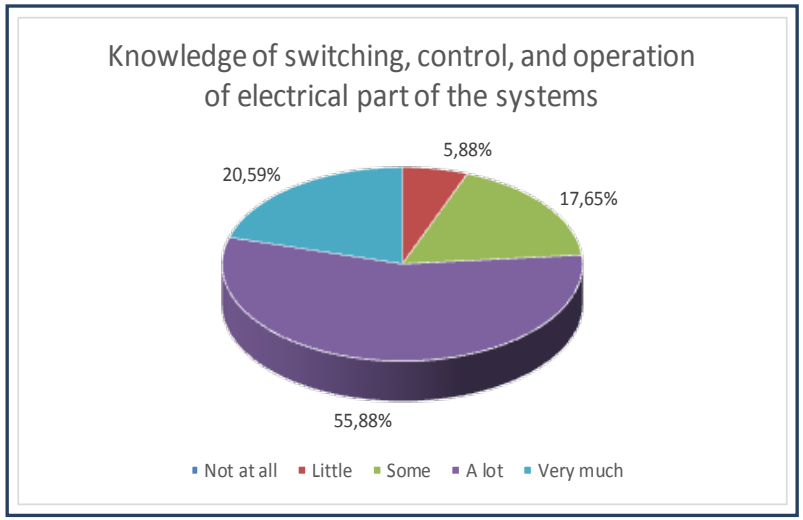

Knowledge of thermodynamics principles and heat exchange basics
14,71%
8,82%
35,29%
41,18%
Not at all
Little
Some
A lot
Very much

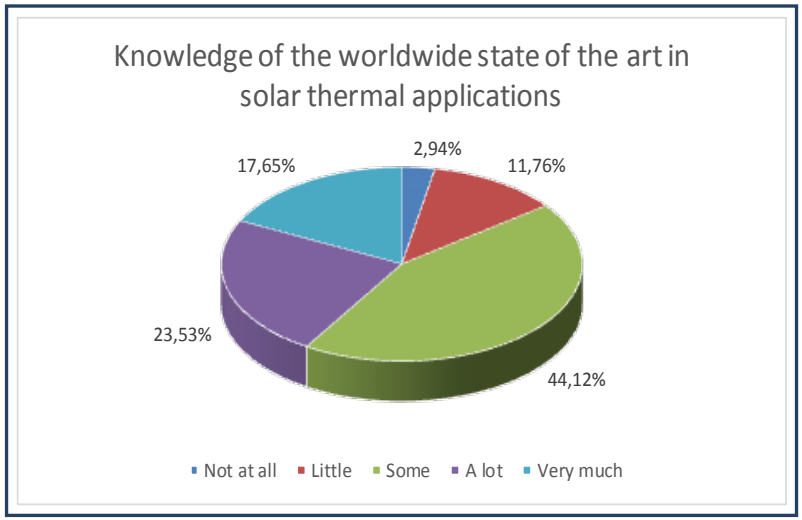

Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
8,82%
5,88%
38,24%
47,06%
Not at all
Little
Some
A lot
Very much

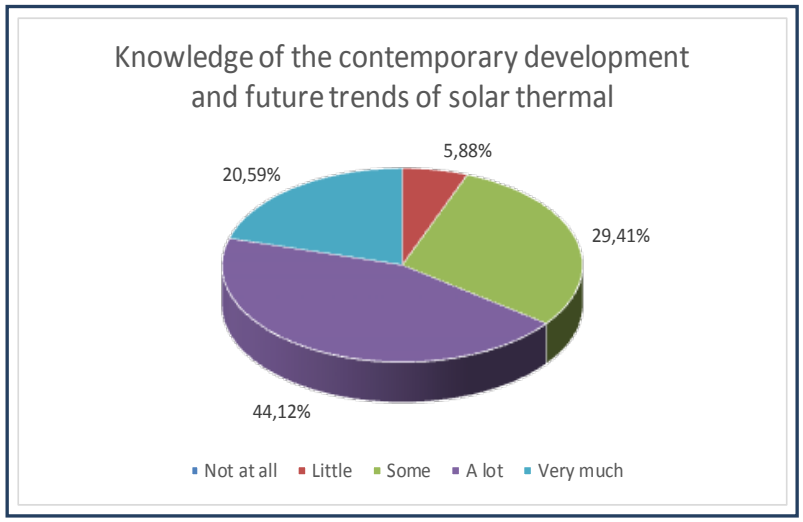

Knowledge of hot water storage technologies and thermal efficiency techniques
2,94%
20,59%
17,65%
58,82%
Not at all
Little
Some
A lot
Very much


Knowledge of panel types basic structure and operation principles and obstacles
8,82%
29,41%
61,76%
Not at all
Little
Some
A lot
Very much


Knowledge of building thermal distribution systems and relevant equipment operation
2,94%
17,65%
20,59%
58,82%
Not at all
Little
Some
A lot
Very much


Knowledge of switching, control, and operation of electrical part of the systems
5,88%
17,65%
55,88%
20,59%
Not at all
Little
Some
A lot
Very much


Knowledge of the worldwide state of the art in solar thermal applications
2,94%
11,76%
44,12%
23,53%
17,65%
Not at all
Little
Some
A lot
Very much


Knowledge of the contemporary development and future trends of solar thermal
5,88%
29,41%
44,12%
20,59%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires collected by all countries, it is possible to prepare a list with the theoretical most needed knowledge that a technician should have in order to be able to carry out a solar thermal installation.

The following classified abilities are considered very important as correspond from 70% and up of the interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	91,18%	**(B1.13) Knowledge of panel types basic structure and operation principles and obstacles**
2	79,41%	**(B1.7) Knowledge of hot water storage technologies and thermal efficiency techniques**
3	76,47%	**(B1.5) Knowledge of hot water uses and space heating calculations**
4	76,47%	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**
5	76,47%	**(B1.10) Knowledge of switching, control, and operation of electrical part of the systems**

The following listed theoretical knowledge are considered as less important as correspond to less than 70% of respondent's choices:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	64,71%	**(B1.1) Knowledge of specific raw materials,**

		insulation processes and techniques for maximizing effectiveness
2	64,71%	**(B1.12) Knowledge of the contemporary development and future trends of solar thermal**
3	58,82%	**(B1.2) Knowledge of space and water heat relevant costs and quality control**
4	55,88%	**(B1.4) Knowledge of accompaniment electric pumps, and ventilators**
5	55,88%	**(B1.8) Knowledge of thermodynamics principles and heat exchange basics**
6	47,06%	**(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints**
7	44,12%	**(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)**
8	41,18%	**(B1.11) Knowledge of the worldwide state of the art in solar thermal applications**

In question (B2) the interviewees were asked to indicate any theoretical knowledge they consider as essential for technician of solar thermal installations. Besides the abilities listed in the questionnaire, eight of the interviewees filled out the (B2) "open question" -

field named as "other", with abilities not listed in and that they considered as relevant and important.

The essential theoretical knowledge proposed by the interviewees is the following:

1. Spain: **Sunshine Orientation, Knowledge of the area to be installed.**
2. Spain: **Comparative studies on heating costs with GAS**
3. Spain: **Knowledge of the different types of facilities**
4. Spain: **The definition of new models of self-supply power management (smart grips). New active-passive solar systems (BIPV).**
5. Greece: **Conditions safety and health at work**
6. France: **Basic knowledge of hydraulic, Knowledge of working height risks**
7. Greece: **Collectors items, hot water reservoirs, tanks equipment expansion, circulators, differential thermostat, piping, safety facilities**
8. Spain: **Mounting systems to cover.**

In question (B3) the interviewees from all participating countries in the research were asked to rate a list with proposed theoretical knowledge that a technician should possess in order to perform his/her profession and to be able to carry out a solar thermal installation.

<u>The following 8 abilities were suggested through the list:</u>

1. **Energy audits principles and classification**
2. **Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
3. **Solar radiation and heat exchange basics**
4. **Solar panel structure and operation**
5. **Insulation material, types and techniques**

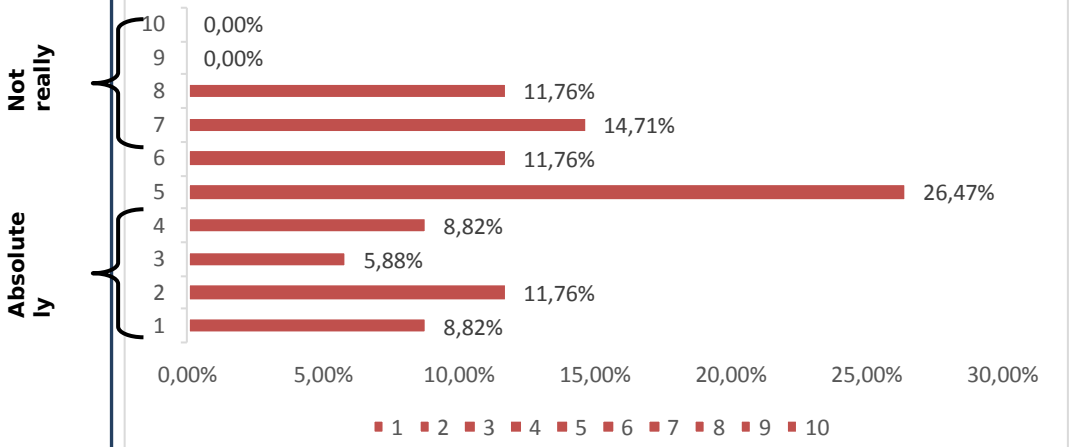
6 **Types of solar thermal water circulation**

7 **Building distribution systems**

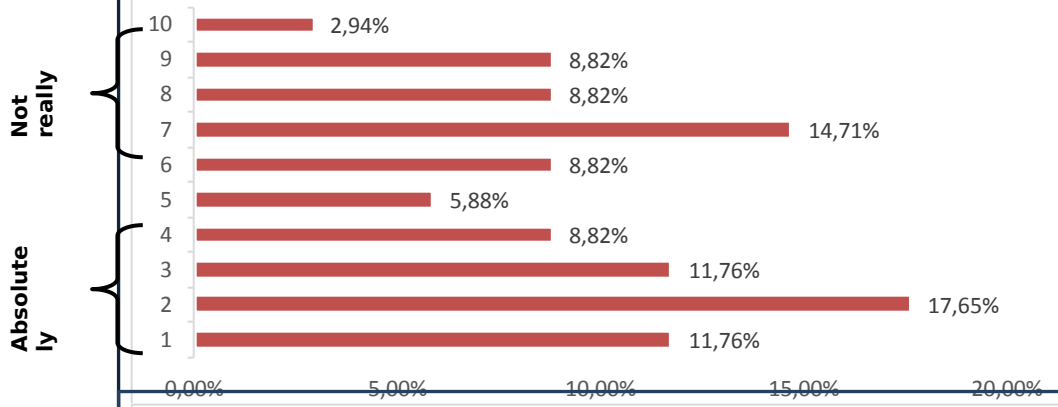
8 **Thermal storage systems**

The interviewees evaluated each single ability by choosing a value from 1 to 10 where 1 corresponds to “Absolutely important” and 10 to “Not really important”. The graphs show the results for each ability:

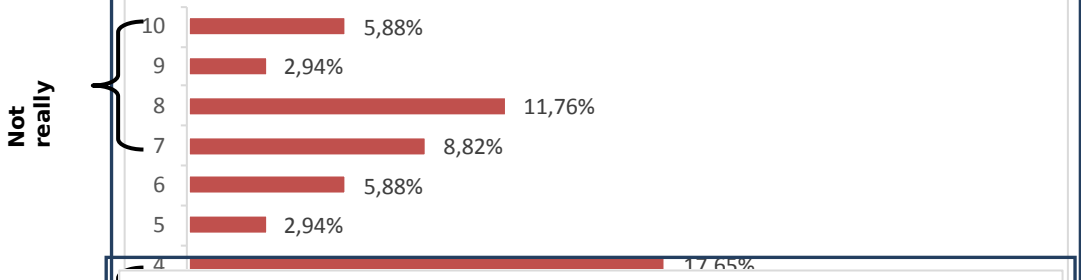
Energy audits principles and classification



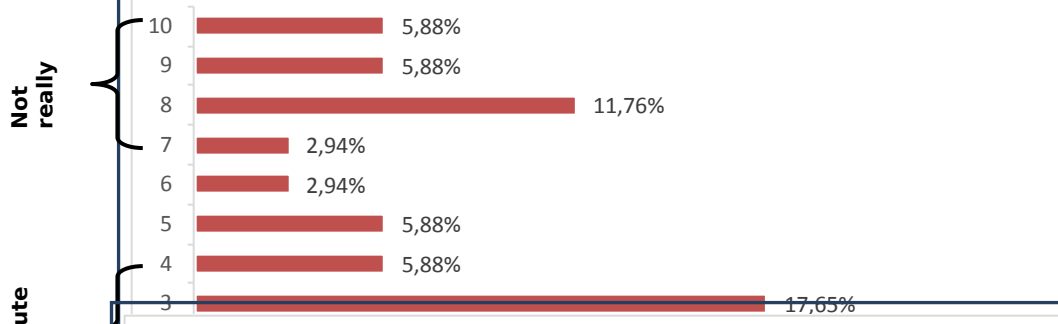
Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)



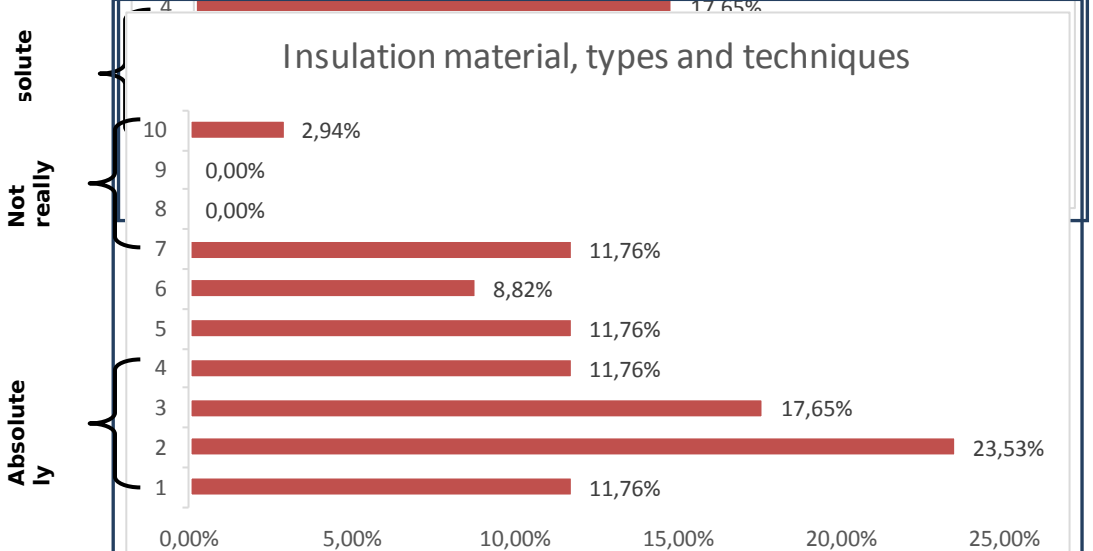
Solar radiation and heat exchange basics



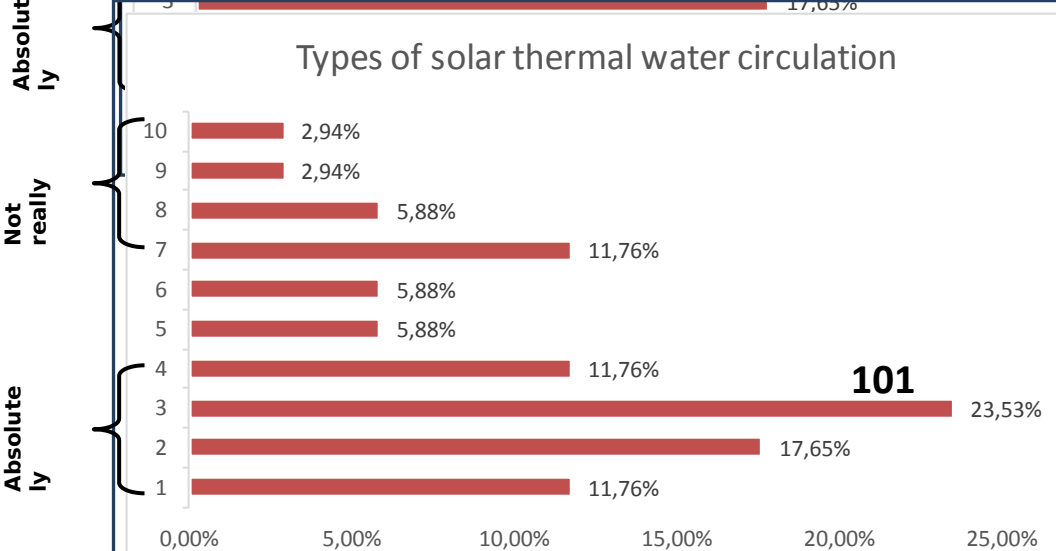
Solar panel structure and operation

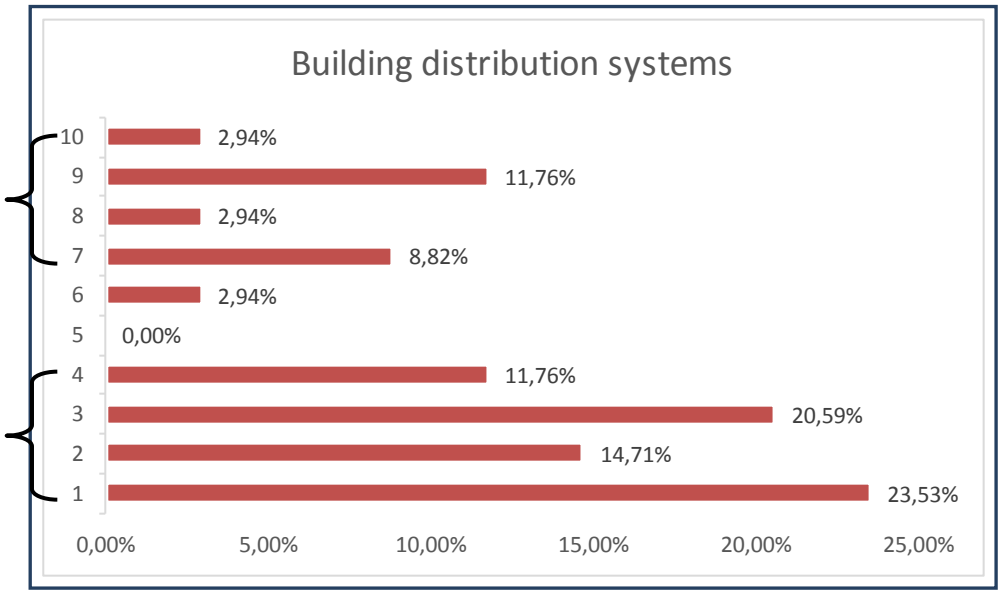


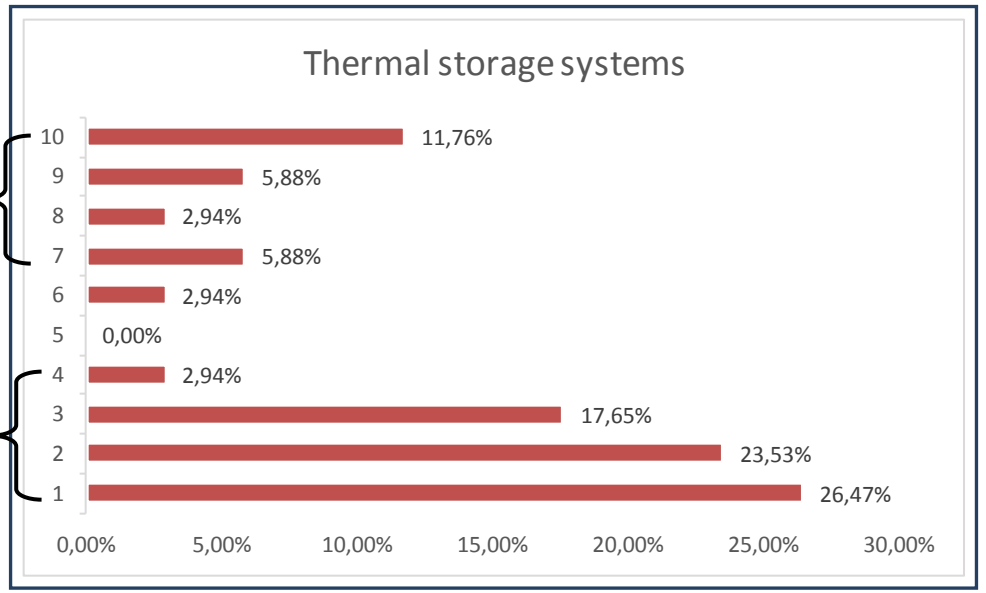
Insulation material, types and techniques



Types of solar thermal water circulation




Building distribution systems
Not really
Absolutely
10
9
8
7
6
5
4
3
2
1
2,94%
11,76%
2,94%
8,82%
2,94%
0,00%
11,76%
20,59%
14,71%
23,53%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%


Thermal storage systems
Not really
Absolutely
10
9
8
7
6
5
4
3
2
1
11,76%
5,88%
2,94%
5,88%
2,94%
0,00%
2,94%
17,65%
23,53%
26,47%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%
30,00%

According to the answers that interviewees from all participating countries filled out regarding the theoretical abilities that were listed under the question (B3) the above mentioned knowledge is classified as following:

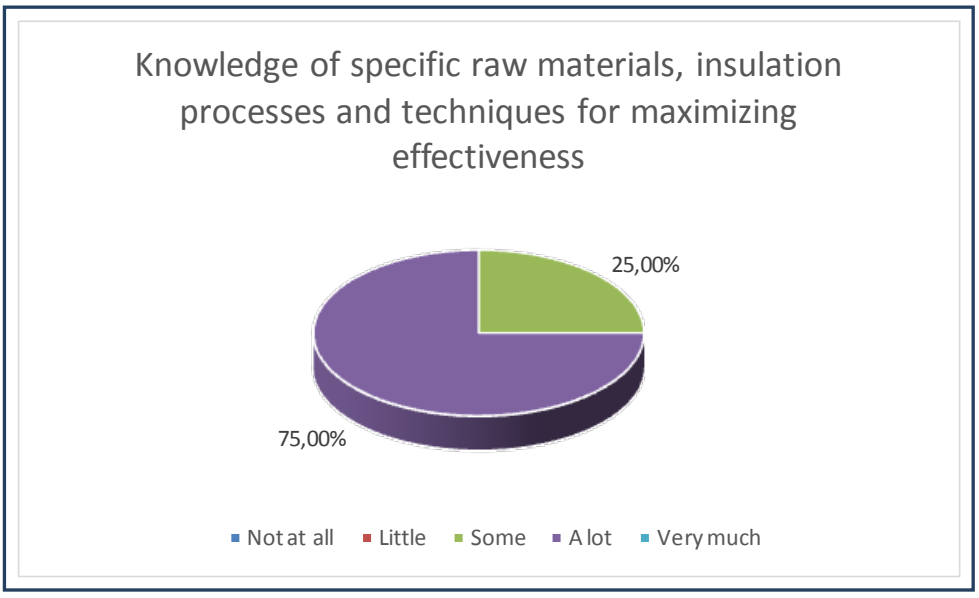
	PERCENTAGE	THEORETICAL KNOWLEDGE
1	35,29%	**Energy audits principles and classification**
2	50%	**Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
3	61,76%	**Solar radiation and heat exchange basics**
4	64,71%	**Solar panel structure and operation**
5	64,71%	**Insulation material, types and techniques**
6	64,71%	**Types of solar thermal water circulation**
7	70,59%	**Building distribution systems**
8	70,59%	**Thermal storage systems**

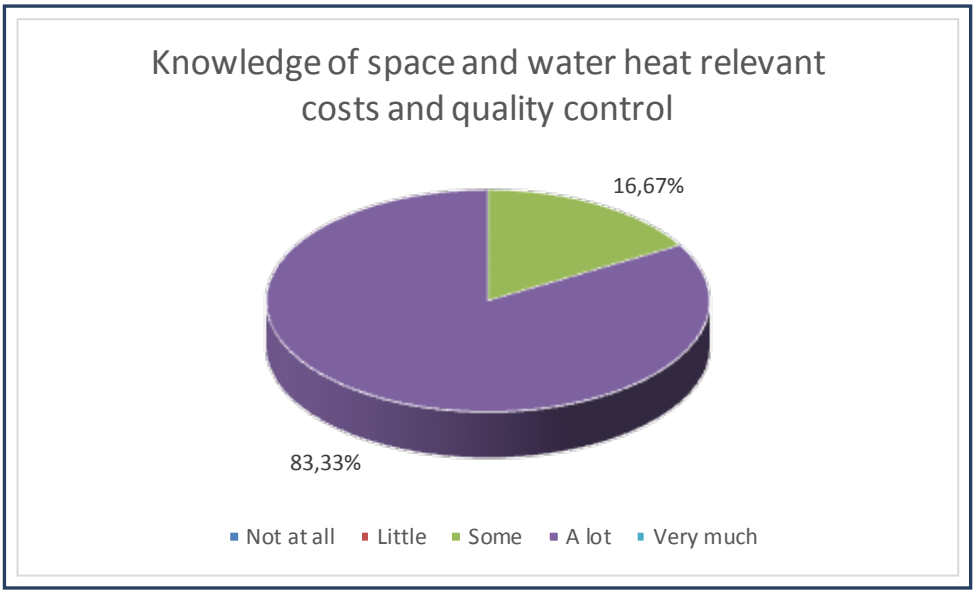
The case of France:

In question (B1) the French interviewees were asked to evaluate a list of theoretical abilities that a technician should possess in order to perform his/her profession and, in case that the list is not being complete interviewees were asked to add others they considered important.

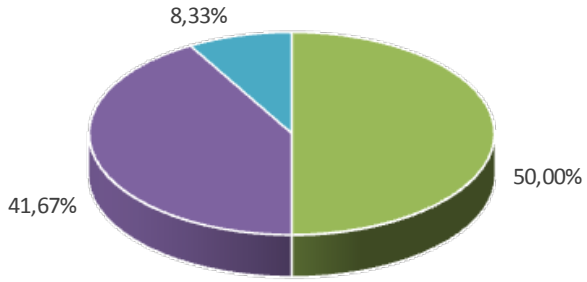
The interviewees evaluate each single theoretical ability listed on the questionnaire by choosing a value among the five being proposed. The proposed values were corresponding to the importance of each theoretical knowledge and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much.

The graphs show the results for each ability:

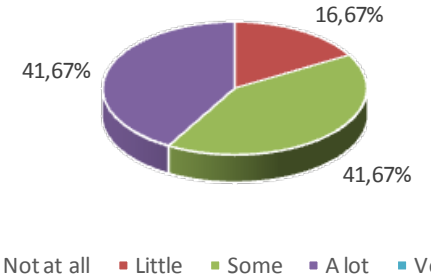




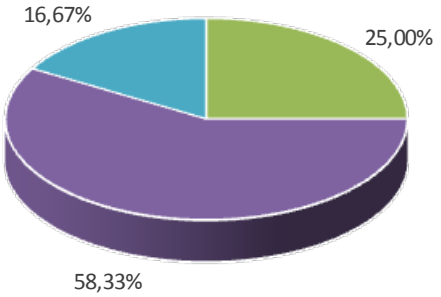
Knowledge of accompaniment electric pumps, and ventilators



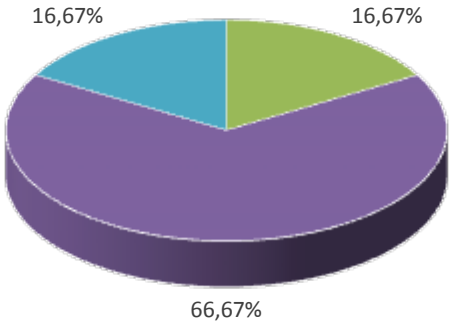
Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)



Knowledge of hot water uses and space heating calculations



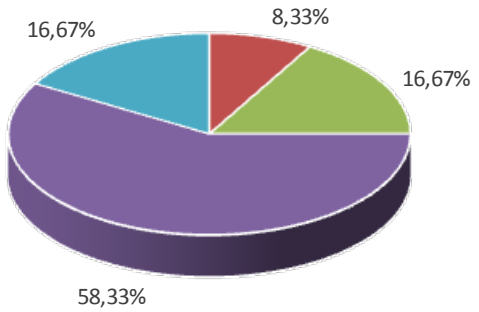
Knowledge of thermodynamics principles and heat exchange basics



Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints

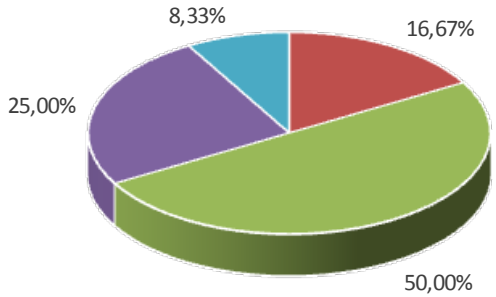
Not at all Little Some A lot Very much

Knowledge of switching, control, and operation of electrical part of the systems



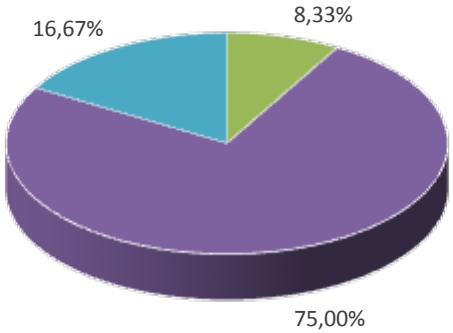
Not at all Little Some A lot Very much

Knowledge of the worldwide state of the art in solar thermal applications

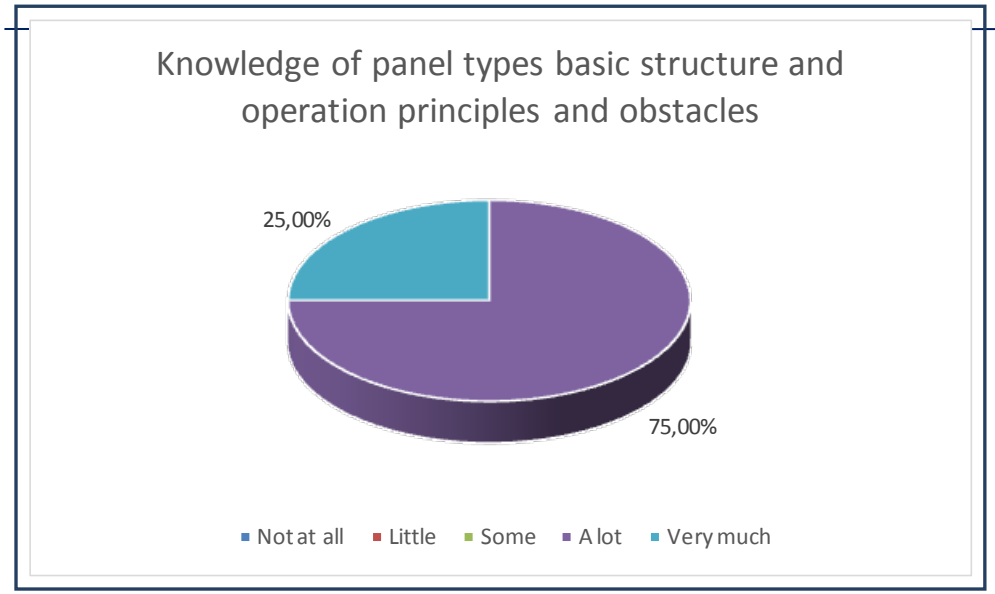


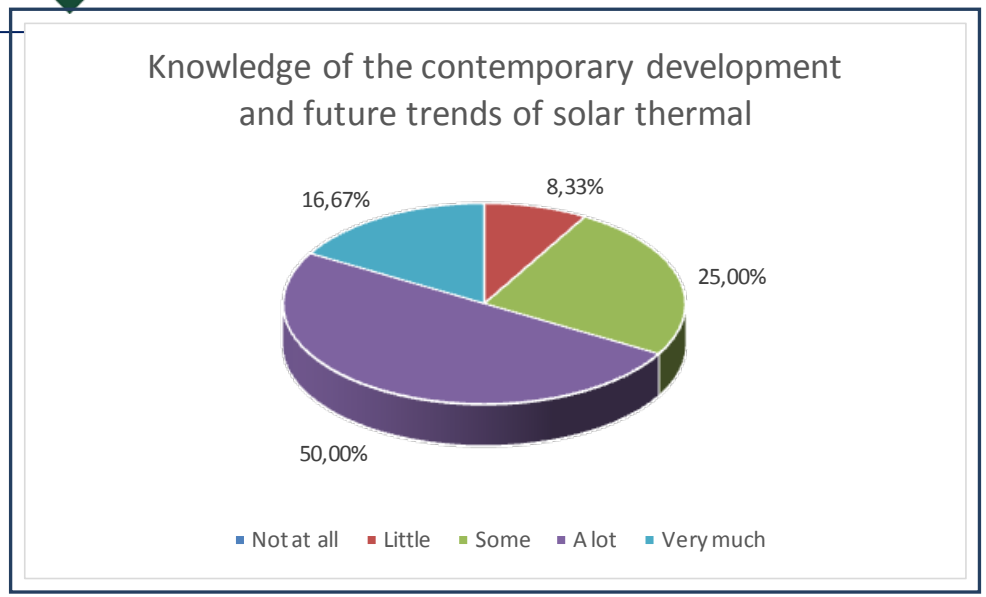
Not at all Little Some A lot Very much

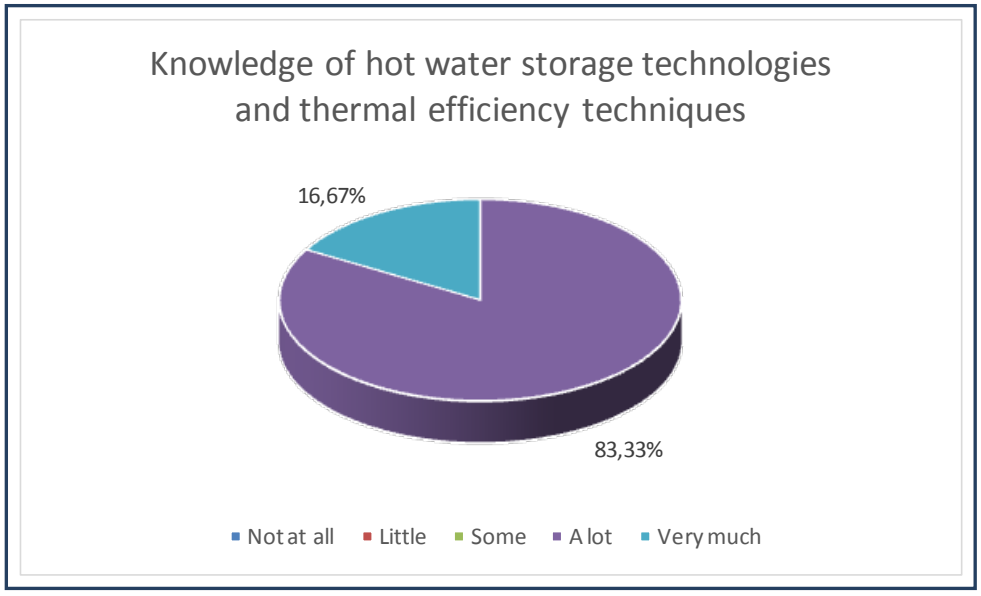
Knowledge of building thermal distribution systems and relevant equipment operation



Not at all Little Some A lot Very much


Knowledge of panel types basic structure and operation principles and obstacles
25,00%
75,00%
Not at all
Little
Some
A lot
Very much


Knowledge of the contemporary development and future trends of solar thermal
16,67%
8,33%
25,00%
50,00%
Not at all
Little
Some
A lot
Very much


Knowledge of hot water storage technologies and thermal efficiency techniques
16,67%
83,33%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the theoretical most needed knowledge that a technician should have in order to be able to carry out a solar thermal installation in France.

The following classified abilities are considered very important as correspond from 70% and up of the interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	100%	**(B1.7) Knowledge of hot water storage technologies and thermal efficiency techniques**
2	100%	**(B1.13) Knowledge of panel types basic structure and operation principles and obstacles**
3	91,67%	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**
4	83,33%	**(B1.2) Knowledge of space and water heat relevant costs and quality control**
5	83,33%	**(B1.8) Knowledge of thermodynamics principles and heat exchange basics**
6	75%	**(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**
7	75%	**(B1.5) Knowledge of hot water uses and space**

		heating calculations
8	75%	**(B1.10) Knowledge of switching, control, and operation of electrical part of the systems**

The following listed abilities are considered less important as correspond to less than 70% of the interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	33,33%	**(B1.11) Knowledge of the worldwide state of the art in solar thermal applications**
2	41,67%	**(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)**
3	50%	**(B1.4) Knowledge of accompaniment electric pumps, and ventilators**
4	66,67%	**(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints**

5	66,67%	**(B1.12) Knowledge of the contemporary development and future trends of solar thermal**

In question (B2) the French interviewees were asked to indicate any theoretical knowledge they consider as essential for a technician of solar thermal installations. Besides the abilities listed in the questionnaire, one of the French interviewees filled out the (B2) open question of the questionnaire - field named as "other", with abilities not listed in the questionnaire and that he/she considered as relevant and important.

The essential knowledge that was proposed is the following:

France:

France: Basic knowledge of hydraulic, Knowledge of working height risks

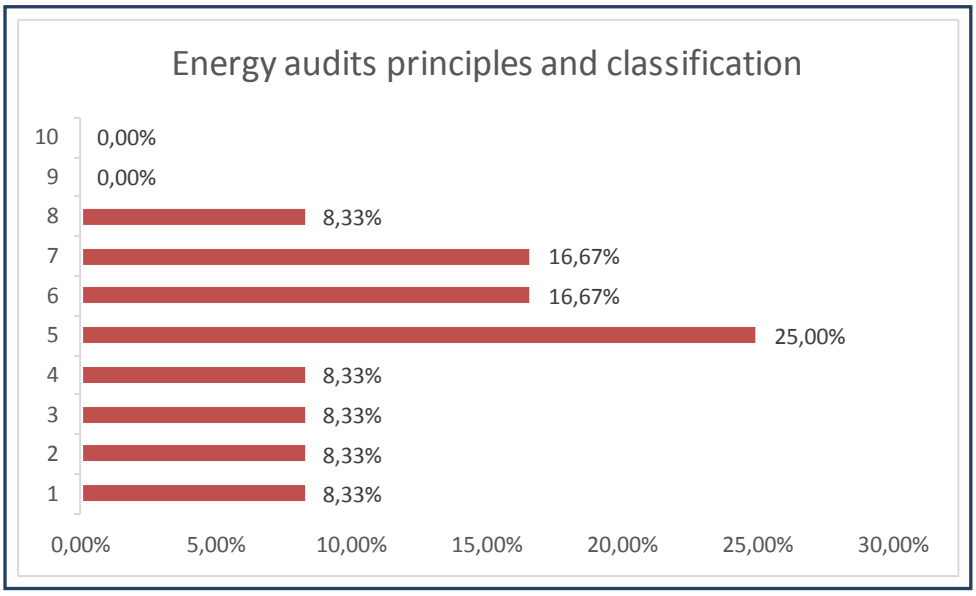
In question (B3) the French interviewees were asked to rate a list with proposed theoretical knowledge that a technician should possess in order to perform his/her profession and to be able to carry out a solar thermal installation.

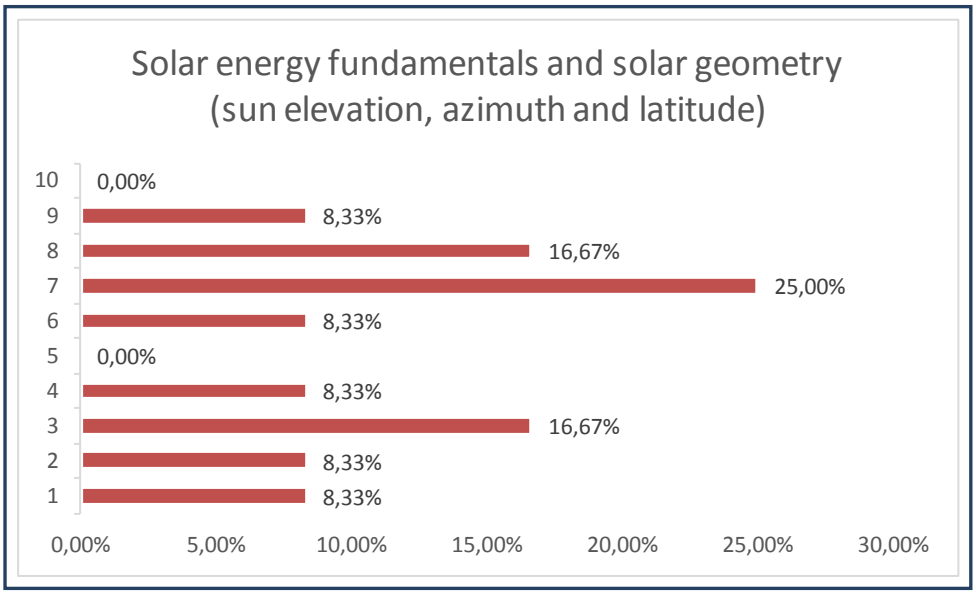
The following 8 abilities were suggested:

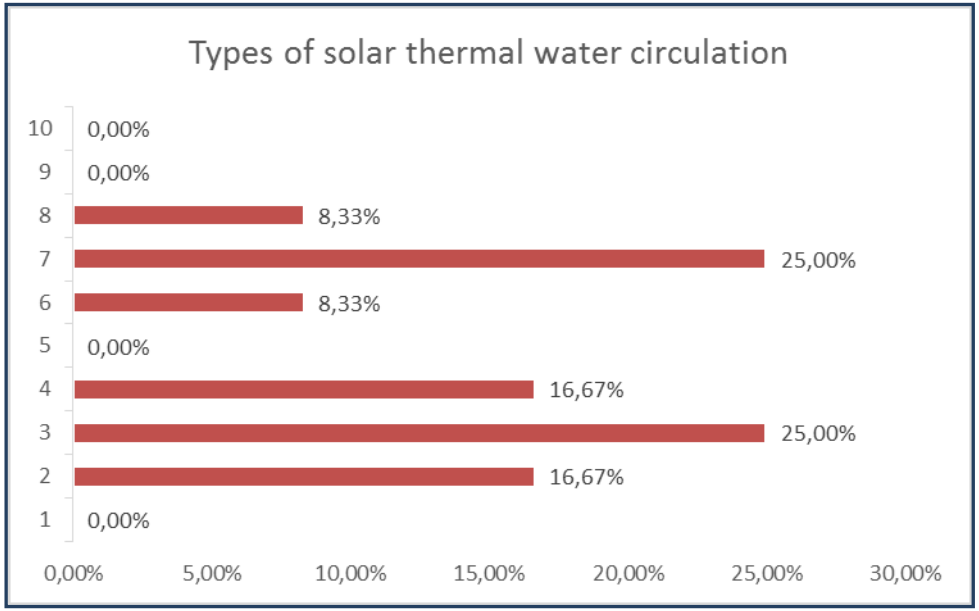
1. **Energy audits principles and classification**
2. **Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
3. **Solar radiation and heat exchange basics**
4. **Solar panel structure and operation**
5. **Insulation material, types and techniques**
6. **Types of solar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

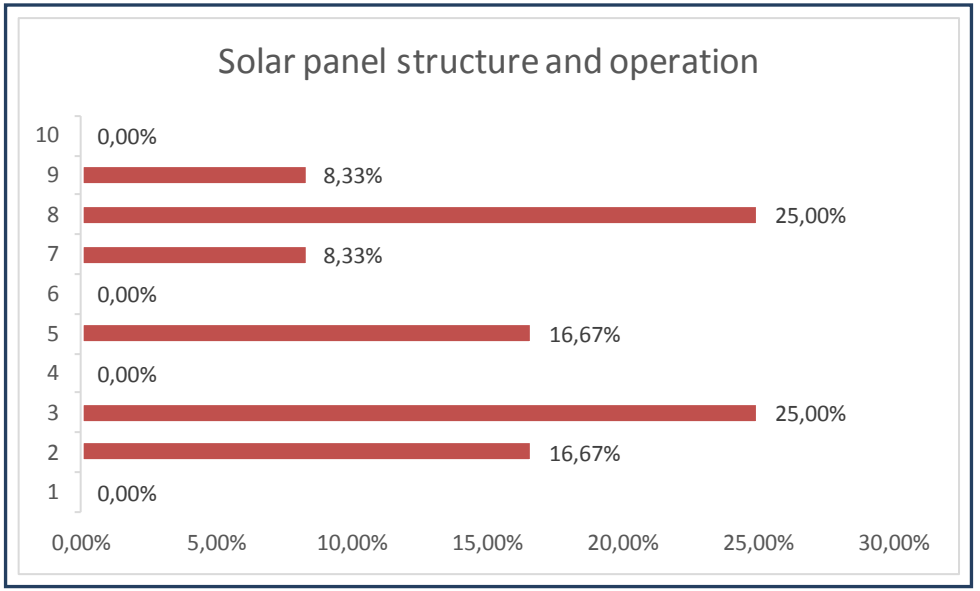
The interviewees evaluated each proposed ability by choosing a value from 1 to 10, where 1 corresponds to "Absolutely important" and 10 to "Not really important".

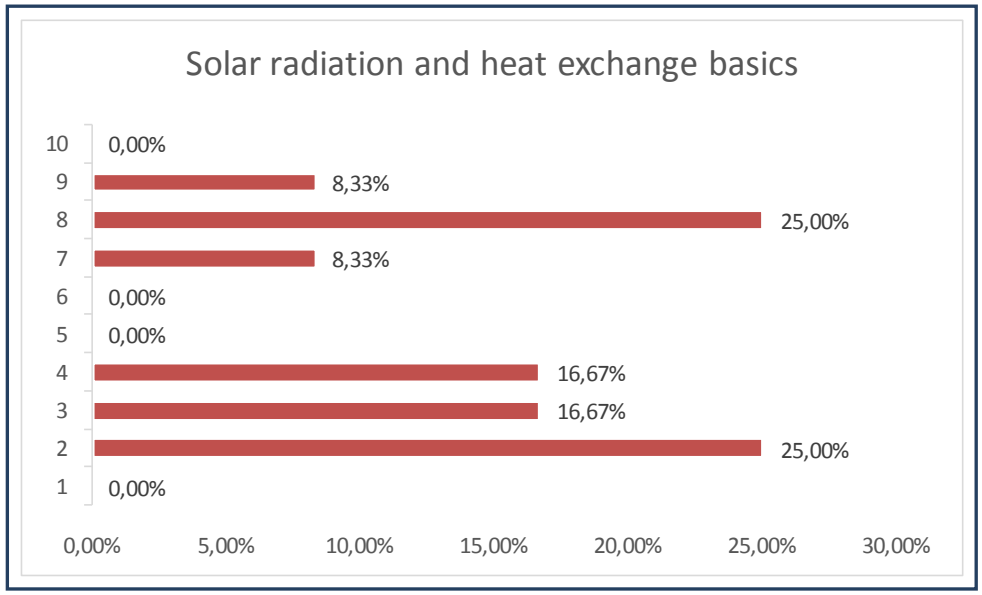
The graphs show the results for each ability:

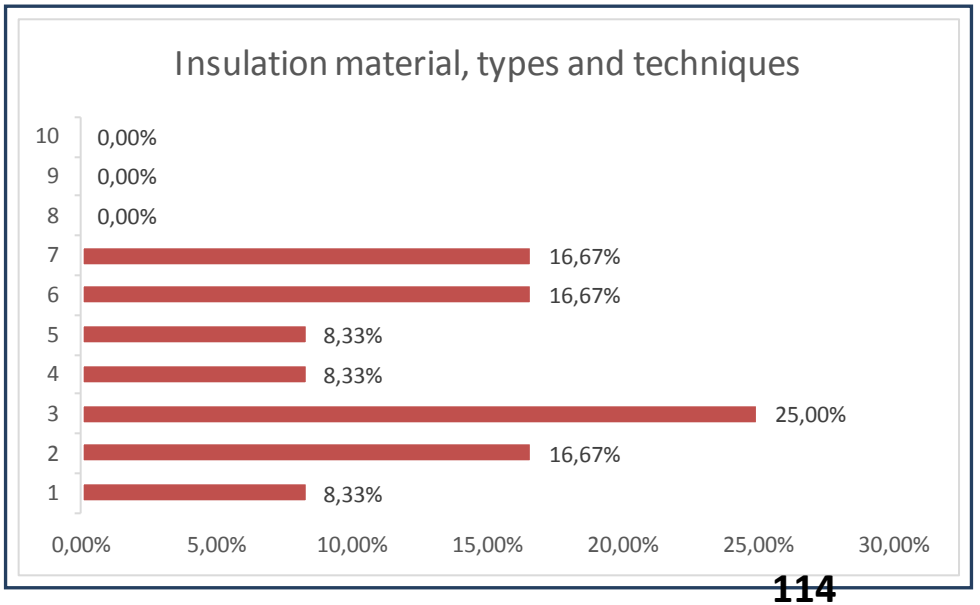


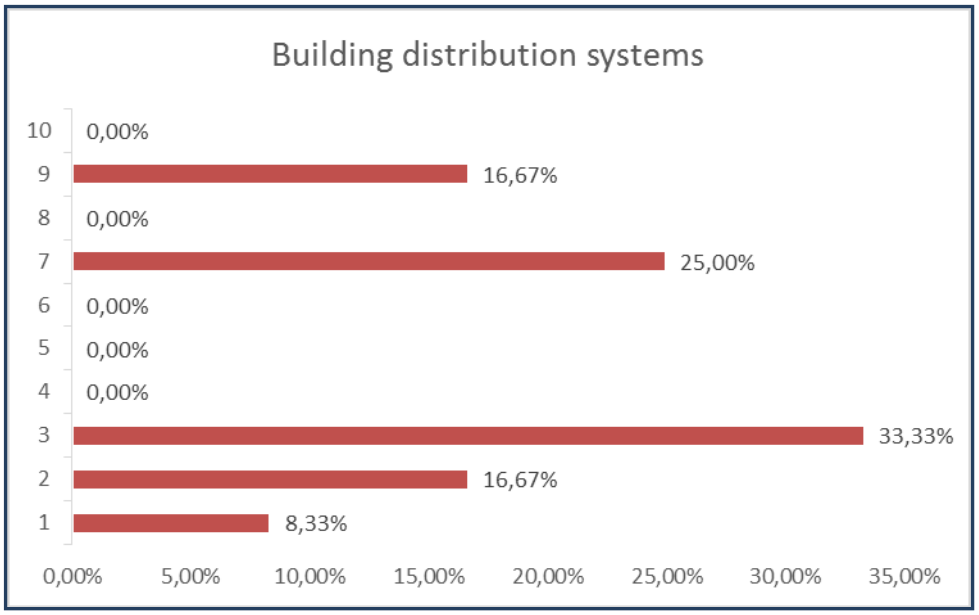


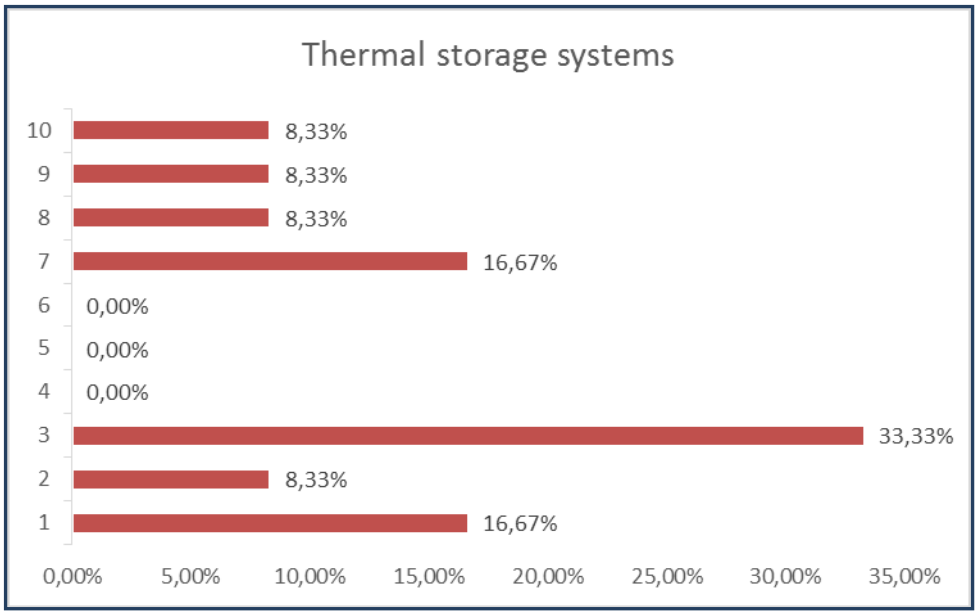

Types of solar thermal water circulation
10 0,00%
9 0,00%
8 8,33%
7 25,00%
6 8,33%
5 0,00%
4 16,67%
3 25,00%
2 16,67%
1 0,00%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%


Solar panel structure and operation
10 0,00%
9 8,33%
8 25,00%
7 8,33%
6 0,00%
5 16,67%
4 0,00%
3 25,00%
2 16,67%
1 0,00%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%


Solar radiation and heat exchange basics
10 0,00%
9 8,33%
8 25,00%
7 8,33%
6 0,00%
5 0,00%
4 16,67%
3 16,67%
2 25,00%
1 0,00%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%


Insulation material, types and techniques
10 0,00%
9 0,00%
8 0,00%
7 16,67%
6 16,67%
5 8,33%
4 8,33%
3 25,00%
2 16,67%
1 8,33%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%





According to the answers that French interviewees filled out regarding the theoretical abilities that were listed under the question (B3) the above mentioned knowledge is classified as following:

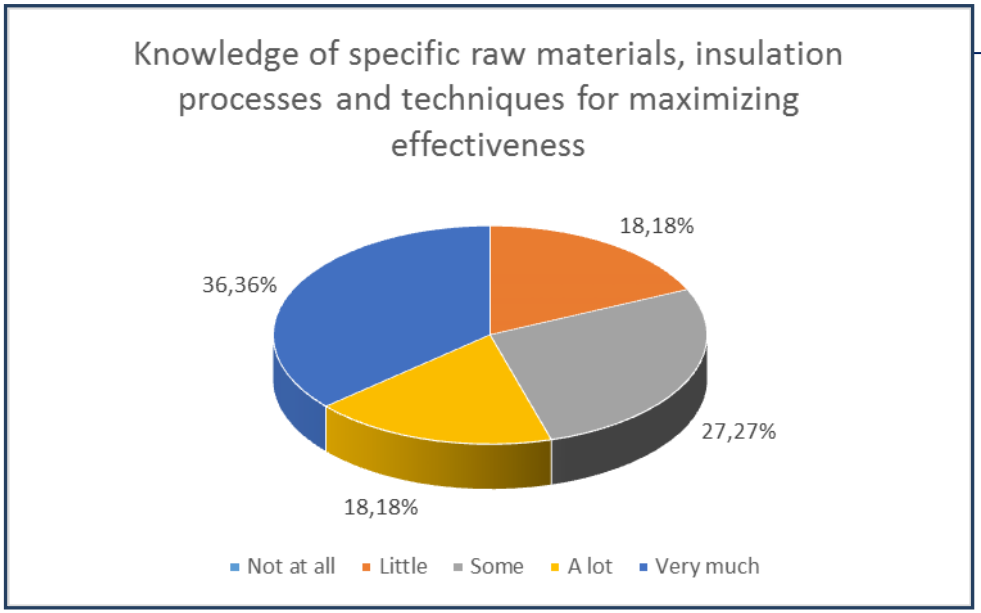
	PERCENTAGE	THEORETICAL KNOWLEDGE
1	33,33%	**Energy audits principles and classification**

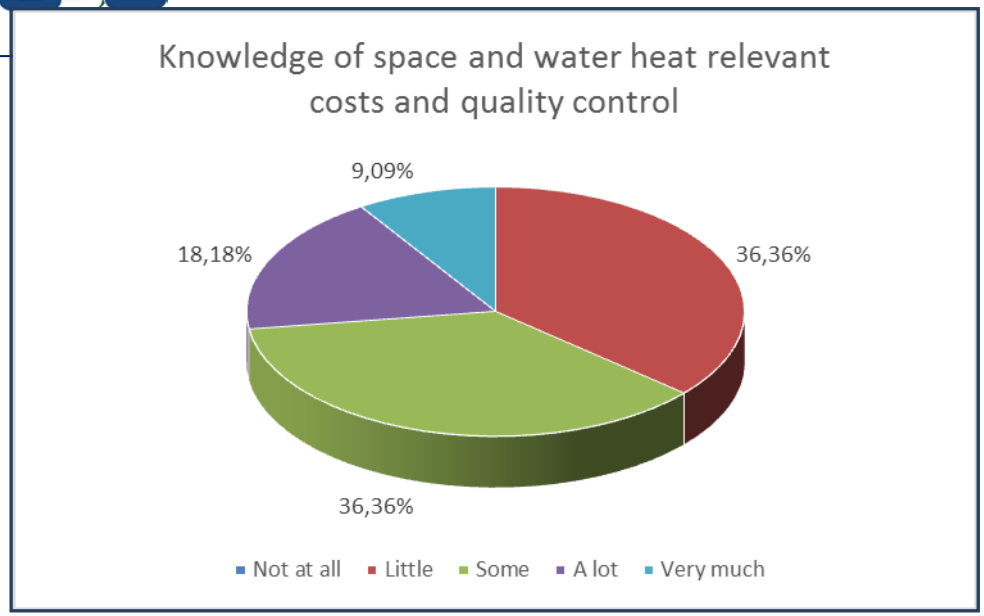
2	41,67%	**Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
3	58,33%	**Solar radiation and heat exchange basics**
4	41,67%	**Solar panel structure and operation**
5	58,33%	**Insulation material, types and techniques**
6	58,33%	**Types of solar thermal water circulation**
7	58,33%	**Building distribution systems**
8	58,33%	**Thermal storage systems**

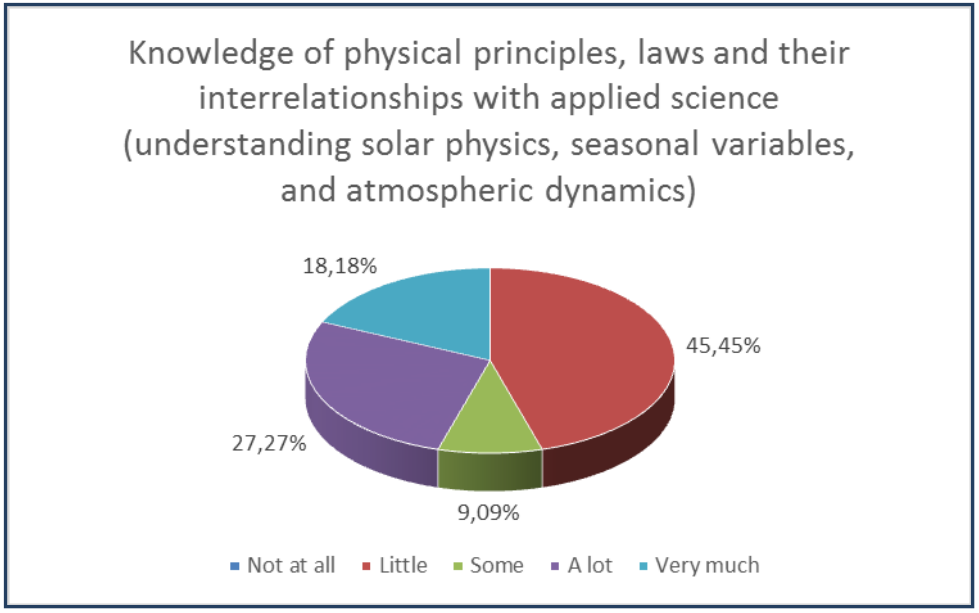
The case of Greece:

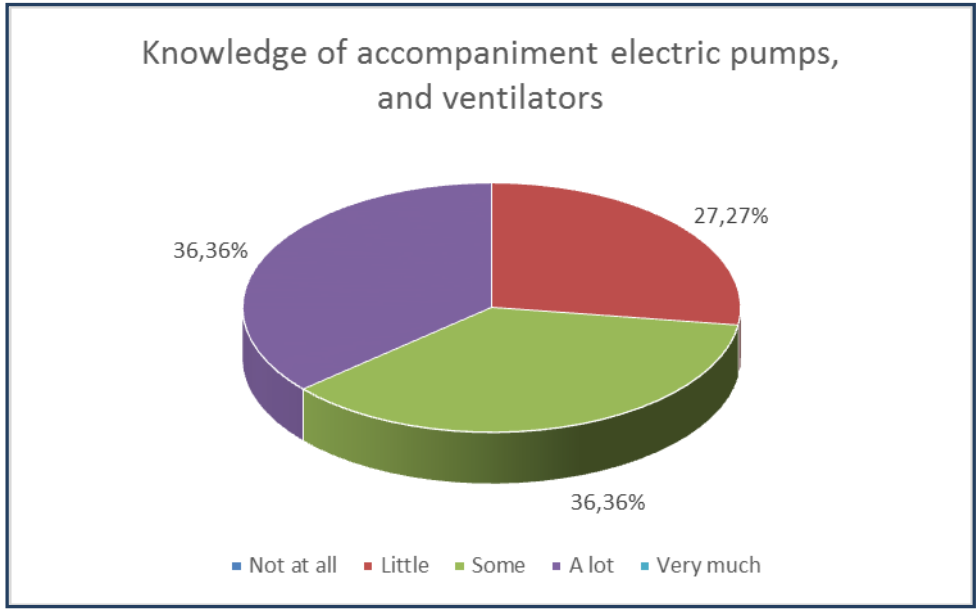
In question (B1) the Greek interviewees were asked to evaluate a list of theoretical abilities that a technician should possess in order to perform his/her profession and, in the case of the list is not being complete interviewees were asked to add others they considered important.

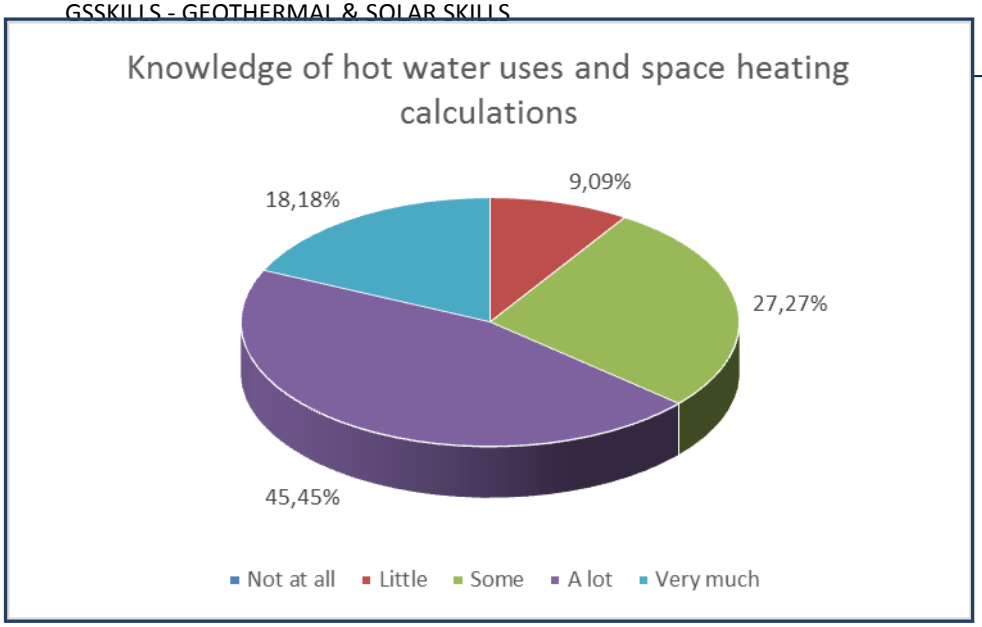
The interviewees evaluate each single theoretical ability listed on the questionnaire by choosing a value among the five being proposed. The proposed values were corresponding to the importance of each theoretical knowledge and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much. The graphs show the results for each ability:

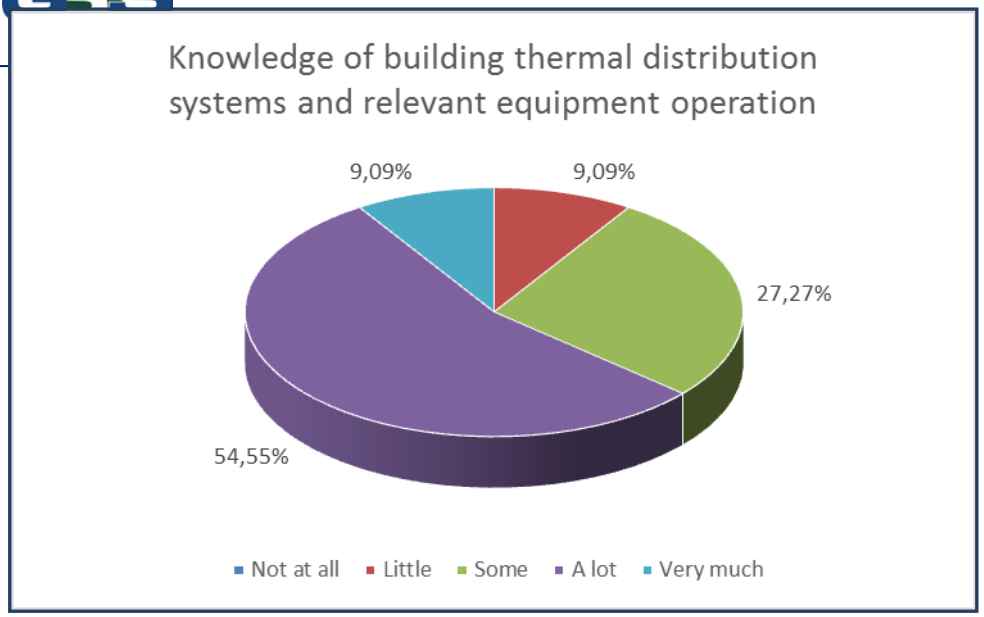

Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
18,18%
36,36%
27,27%
18,18%
Not at all
Little
Some
A lot
Very much

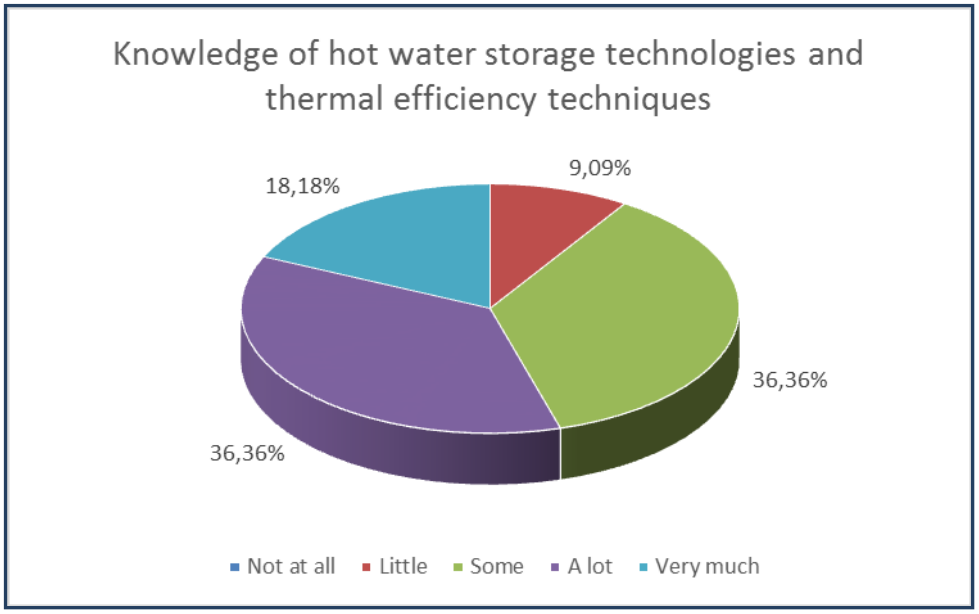

Knowledge of space and water heat relevant costs and quality control
9,09%
18,18%
36,36%
36,36%
Not at all
Little
Some
A lot
Very much

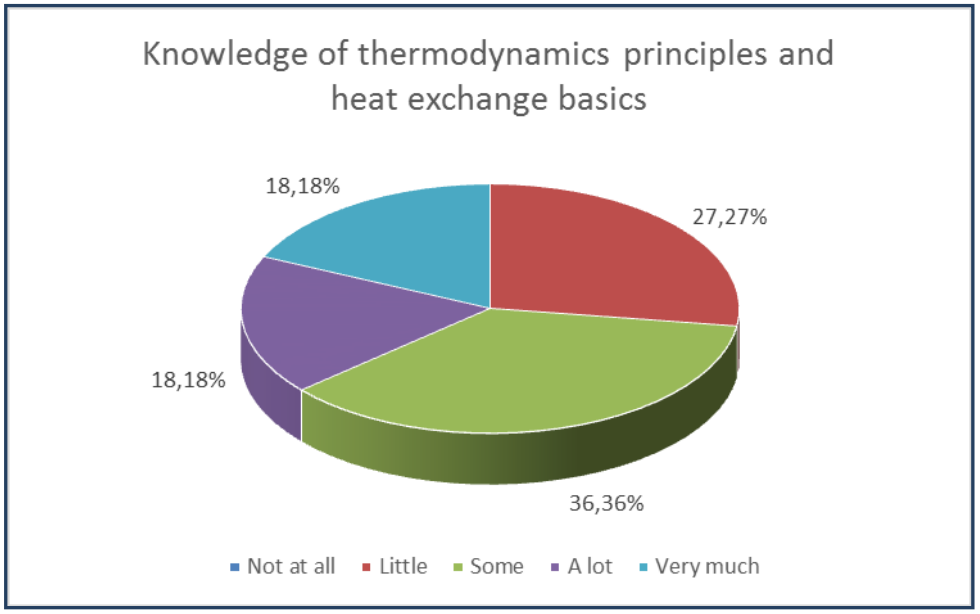

Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)
18,18%
45,45%
27,27%
9,09%
Not at all
Little
Some
A lot
Very much

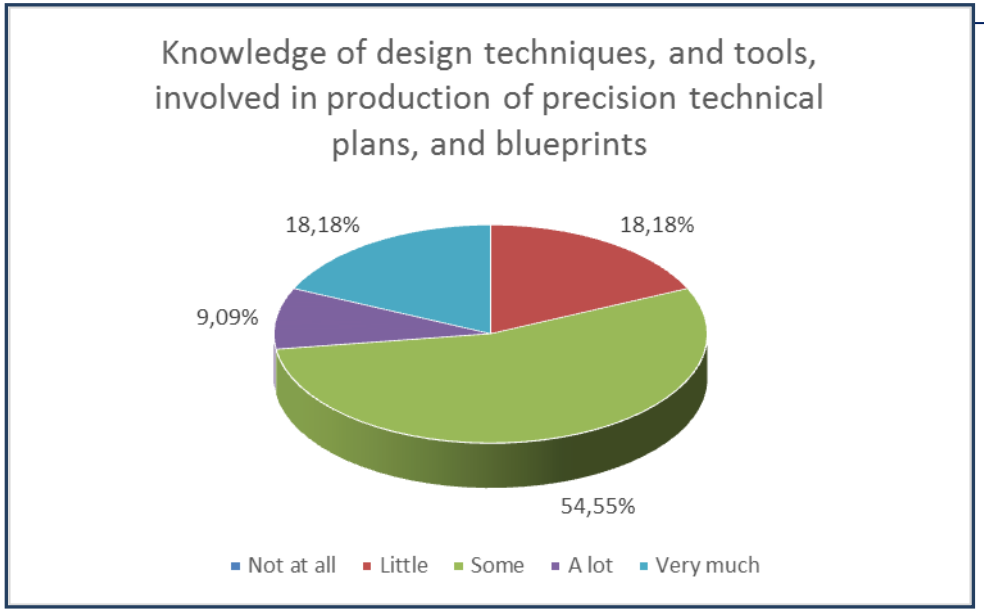

Knowledge of accompaniment electric pumps, and ventilators
27,27%
36,36%
36,36%
Not at all
Little
Some
A lot
Very much

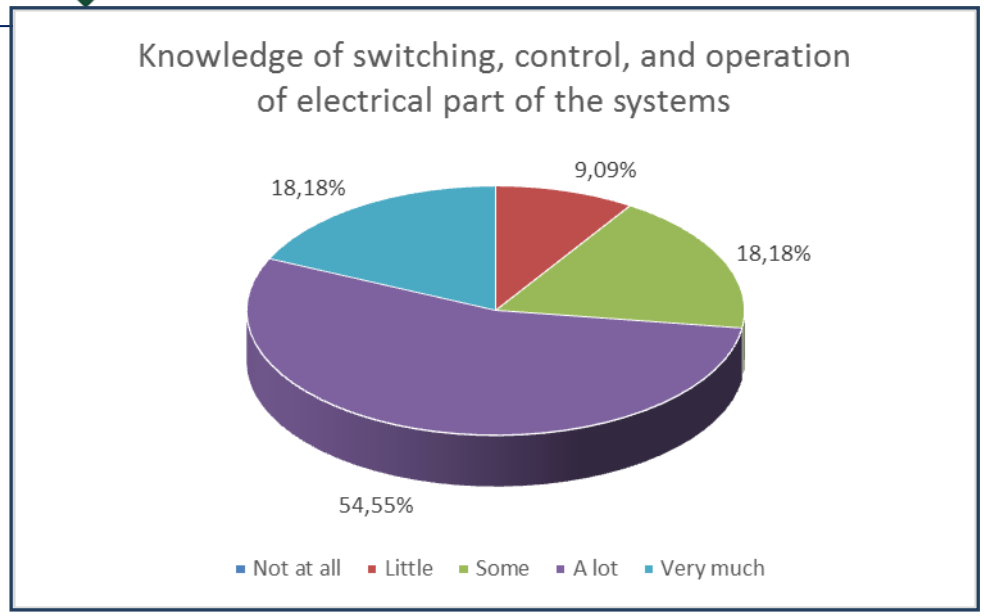

Knowledge of hot water uses and space heating calculations
9,09%
18,18%
27,27%
45,45%
Not at all
Little
Some
A lot
Very much

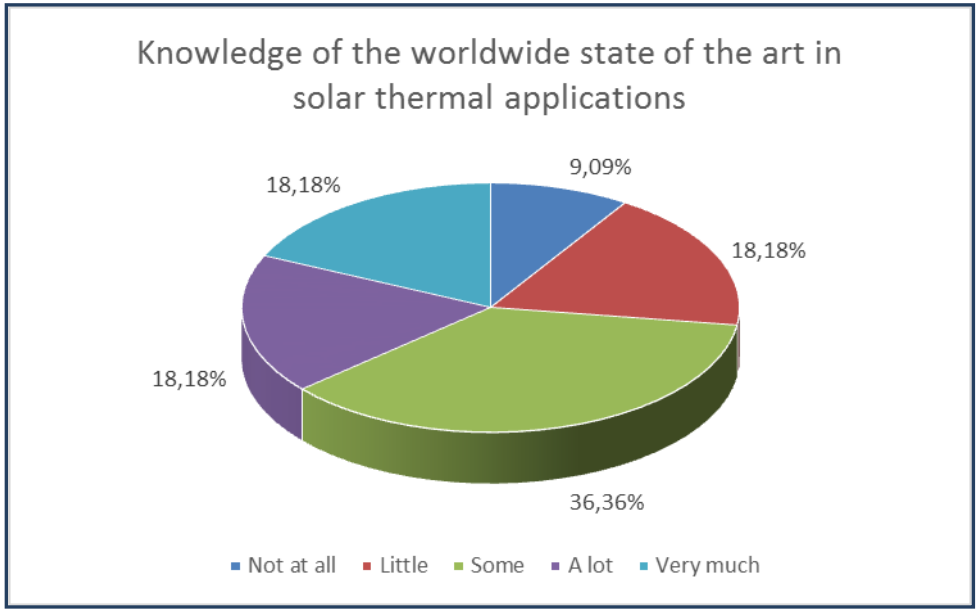

Knowledge of building thermal distribution systems and relevant equipment operation
9,09%
9,09%
27,27%
54,55%
Not at all
Little
Some
A lot
Very much

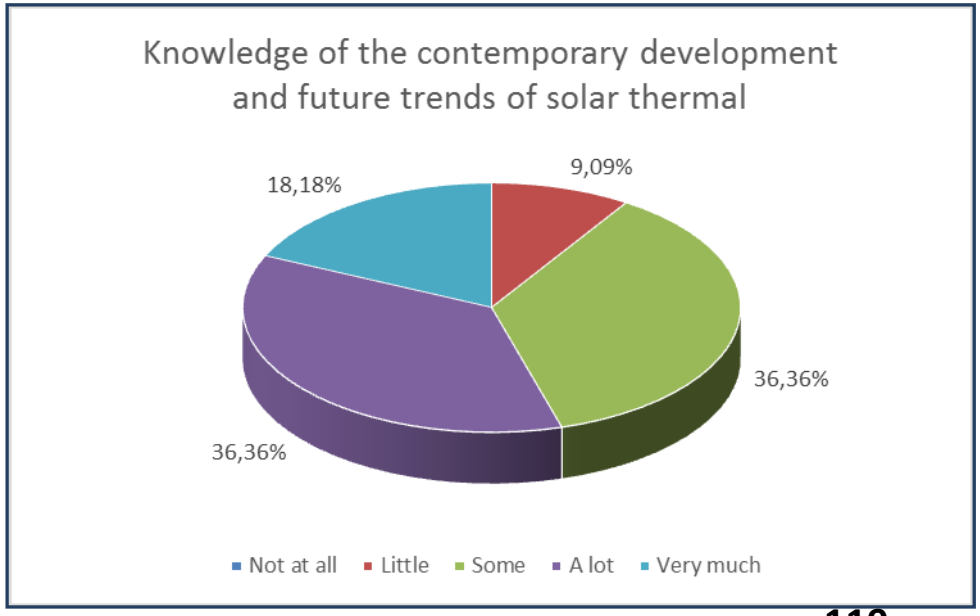

Knowledge of hot water storage technologies and thermal efficiency techniques
9,09%
18,18%
36,36%
36,36%
Not at all
Little
Some
A lot
Very much

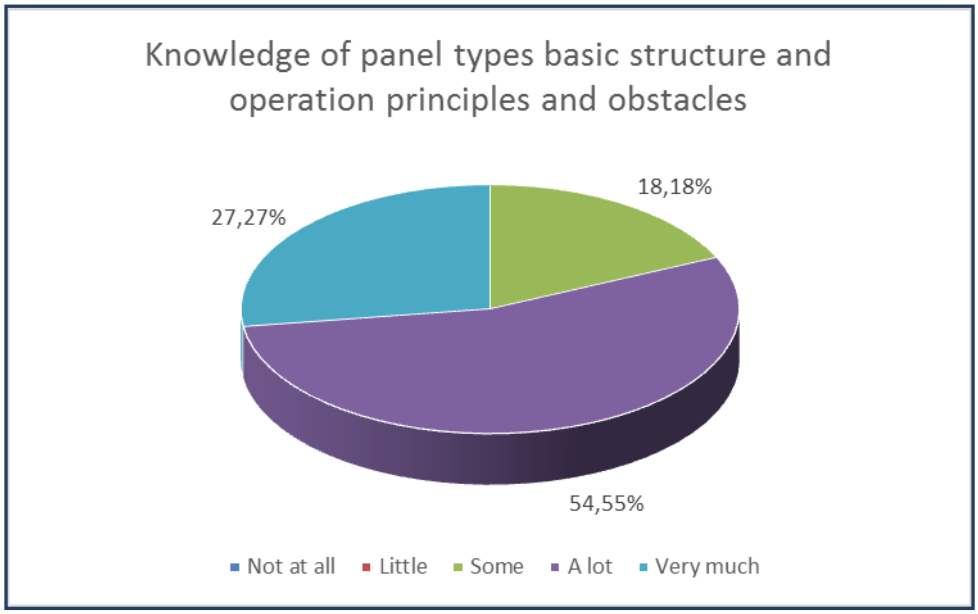

Knowledge of thermodynamics principles and heat exchange basics
18,18%
27,27%
18,18%
36,36%
Not at all
Little
Some
A lot
Very much


Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
18,18%
18,18%
9,09%
54,55%
Not at all
Little
Some
A lot
Very much


Knowledge of switching, control, and operation of electrical part of the systems
9,09%
18,18%
18,18%
54,55%
Not at all
Little
Some
A lot
Very much


Knowledge of the worldwide state of the art in solar thermal applications
9,09%
18,18%
18,18%
18,18%
36,36%
Not at all
Little
Some
A lot
Very much


Knowledge of the contemporary development and future trends of solar thermal
9,09%
18,18%
36,36%
36,36%
Not at all
Little
Some
A lot
Very much



From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the theoretical most needed knowledge that a technician should have in order to be able to carry out a solar thermal installation in Greece.

The following classified abilities are considered very important and, correspond from 70% and up of interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	81,92%	**(B1.13) Knowledge of panel types basic structure and operation principles and obstacles**
2	72,73%	**(B1.10) Knowledge of switching, control, and operation of electrical part of the systems**

The following listed abilities are considered less important and, correspond to less than 70% of interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	27,27%	**(B1.2) Knowledge of space and water heat relevant costs and quality control**
2	27,27%	**(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints**
3	36,36%	**(B1.11) Knowledge of the worldwide state of the art in solar thermal applications**
4	36,36%	**(B1.4) Knowledge of accompaniment electric pumps, and ventilators**
5	36,36%	**(B1.8) Knowledge of thermodynamics principles and heat exchange basics**
6	45,45%	**(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)**
7	54,55%	**(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**

8	54,55%	**(B1.7) Knowledge of hot water storage technologies and thermal efficiency techniques**
9	54,55%	**(B1.12) Knowledge of the contemporary development and future trends of solar thermal**
10	63,64%	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**

Greece:

1. **Conditions safety and health at work**
2. **Collectors' items, hot water reservoirs, tanks equipment expansion, circulators, differential thermostat, piping, safety facilities**

11	63,64%	**(B1.5) Knowledge of hot water uses and space heating calculations**

In question (B2) the Greek interviewees were asked to indicate any theoretical knowledge they consider that is essential for a technician of solar thermal installations. Besides the abilities listed in the questionnaire, 2 of 10 the interviewees filled out the B.2 "open question" of the questionnaire - field named as "other", with abilities not listed in the questionnaire and that they considered as relevant and important.

The essential knowledge that was proposed is the following:

In question (B3) the Greek interviewees in the research were asked to rate a list with proposed theoretical knowledge that a technician should possess in order to perform his/her profession and to be able to carry out a solar thermal installation.

The following 8 abilities were suggested:

1 **Energy audits principles and classification**

2 **Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**

3 **Solar radiation and heat exchange basics**

4 **Solar panel structure and operation**

5 **Insulation material, types and techniques**

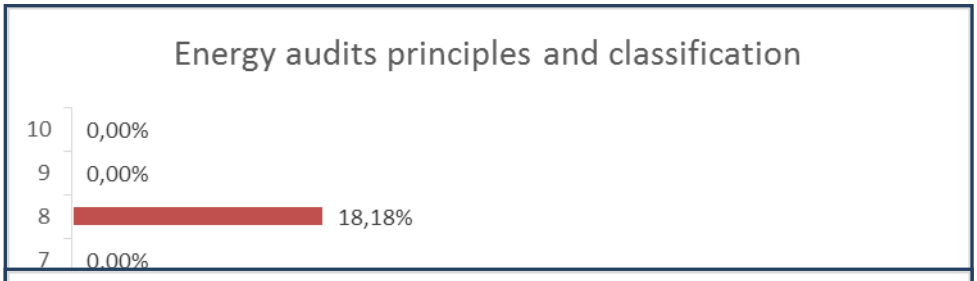
6 **Types of solar thermal water circulation**

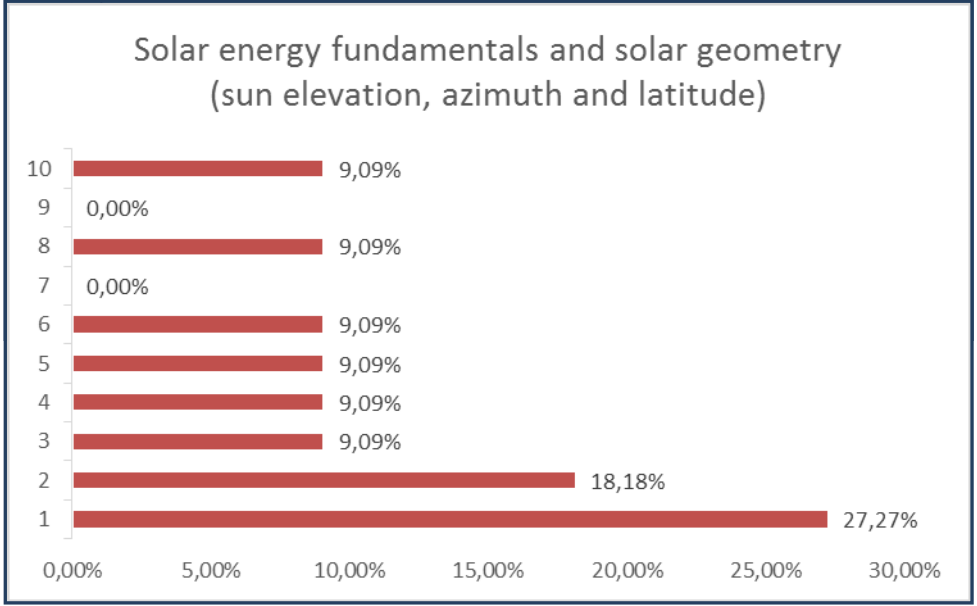
7 **Building distribution systems**

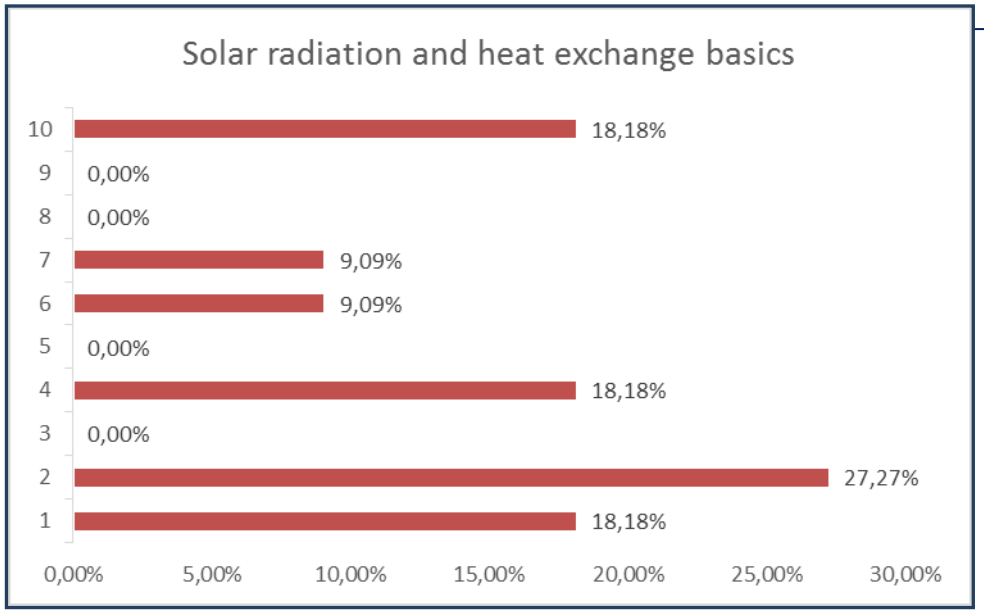
8 **Thermal storage systems**

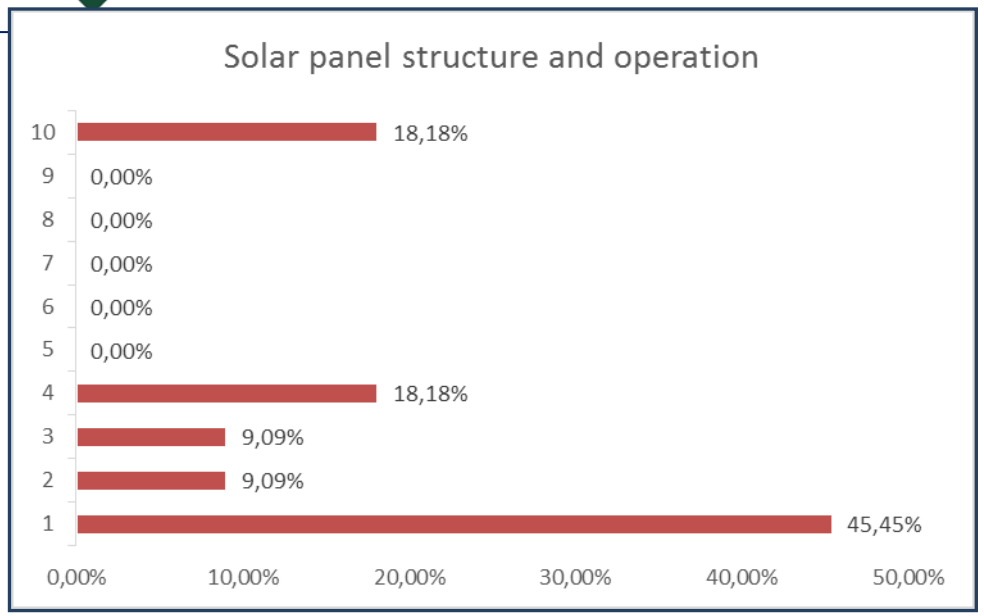
The interviewees evaluated each single ability by choosing a value from 1 to 10 where, 1 corresponds to "Absolutely important" and 10 to "Not really important".

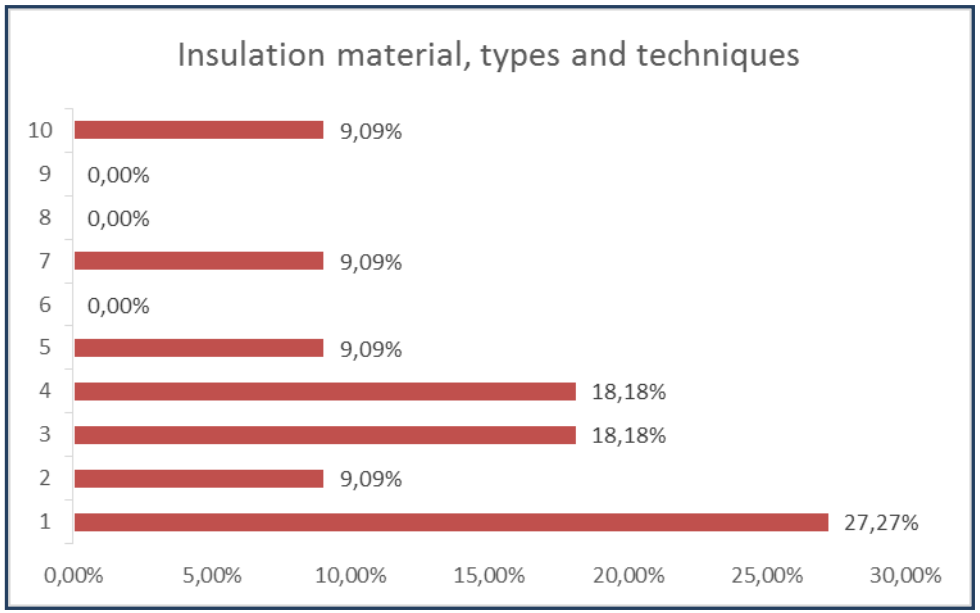
The graphs show the results for each ability:

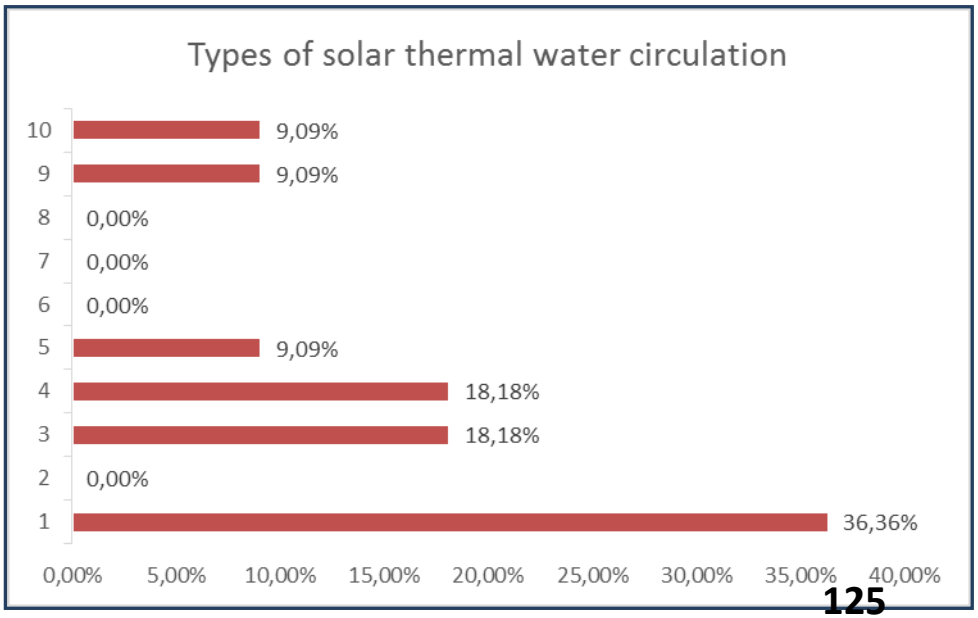


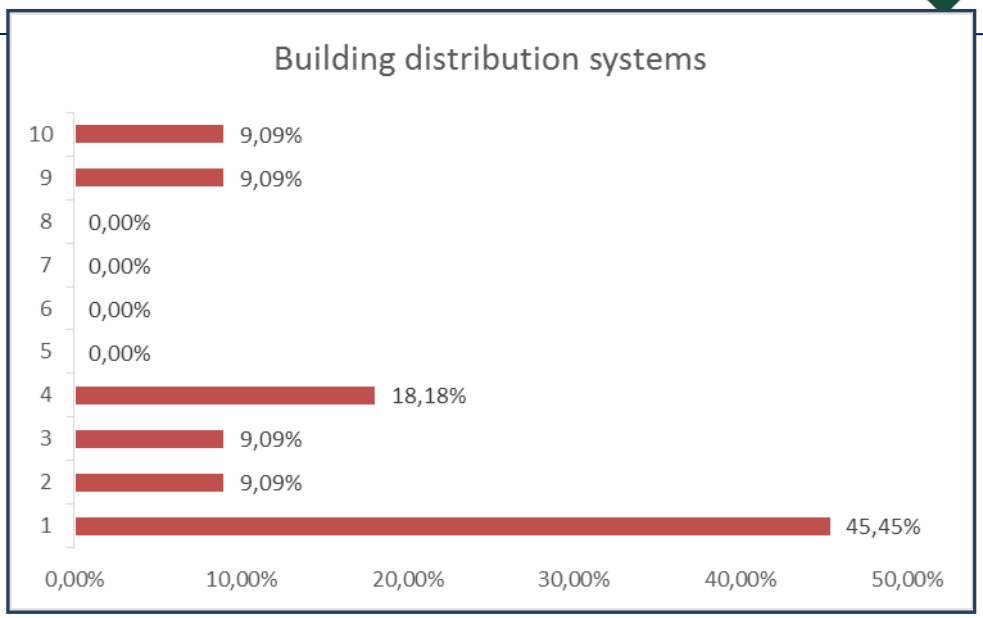


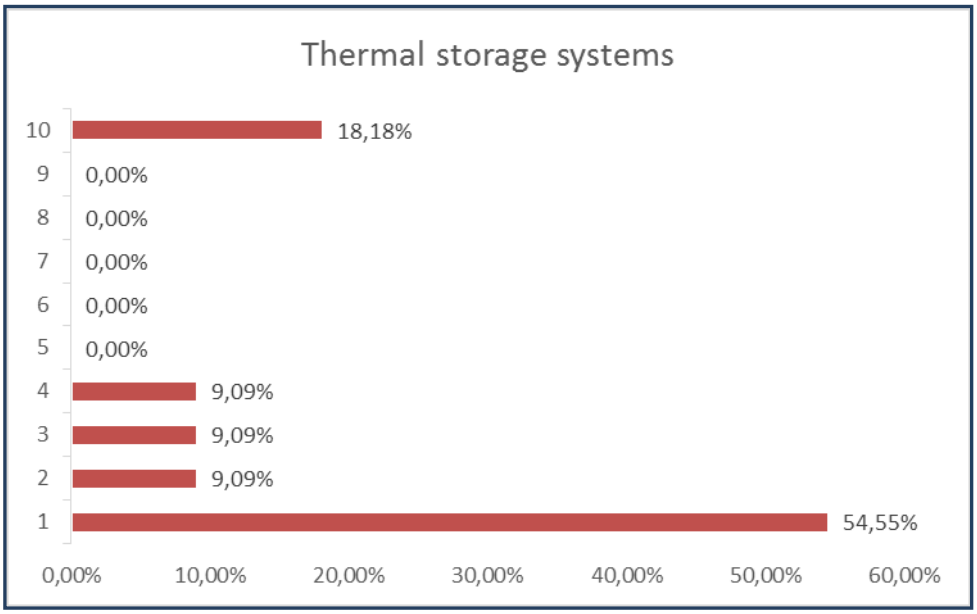

Solar radiation and heat exchange basics
10
9
8
7
6
5
4
3
2
1
18,18%
0,00%
0,00%
9,09%
9,09%
0,00%
18,18%
0,00%
27,27%
18,18%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%
30,00%


Solar panel structure and operation
10
9
8
7
6
5
4
3
2
1
18,18%
0,00%
0,00%
0,00%
0,00%
0,00%
18,18%
9,09%
9,09%
45,45%
0,00%
10,00%
20,00%
30,00%
40,00%
50,00%


Insulation material, types and techniques
10
9
8
7
6
5
4
3
2
1
9,09%
0,00%
0,00%
9,09%
0,00%
9,09%
18,18%
18,18%
9,09%
27,27%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%
30,00%


Types of solar thermal water circulation
10
9
8
7
6
5
4
3
2
1
9,09%
9,09%
0,00%
0,00%
0,00%
9,09%
18,18%
18,18%
0,00%
36,36%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%
30,00%
35,00%
40,00%





According to the answers that Greek interviewees filled out regarding the theoretical abilities that were listed under the question (B3) the above mentioned knowledge is classified as following:

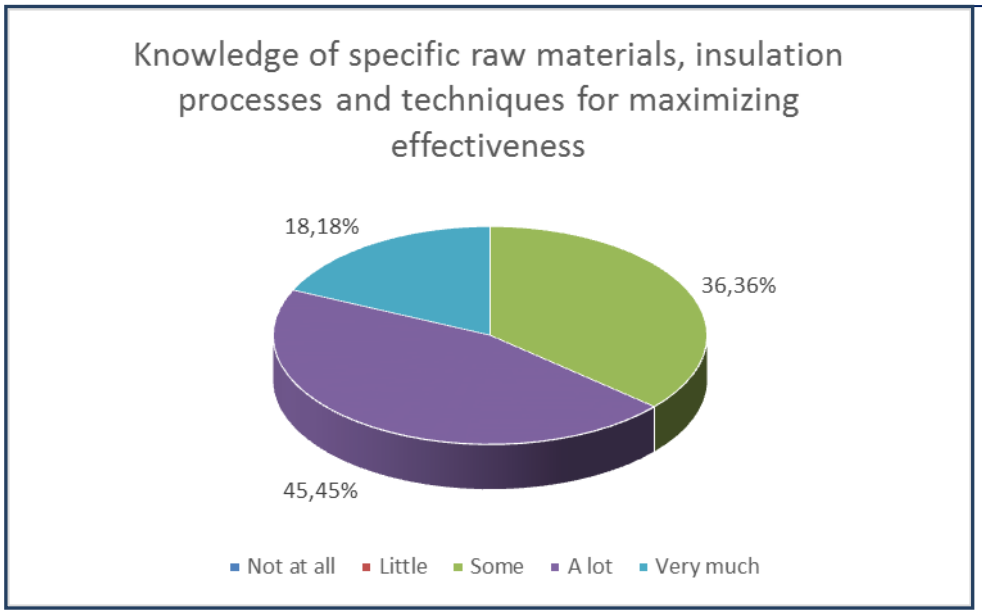
	PERCENTAGE	THEORETICAL KNOWLEDGE
1	27,27%	**Energy audits principles and classification**

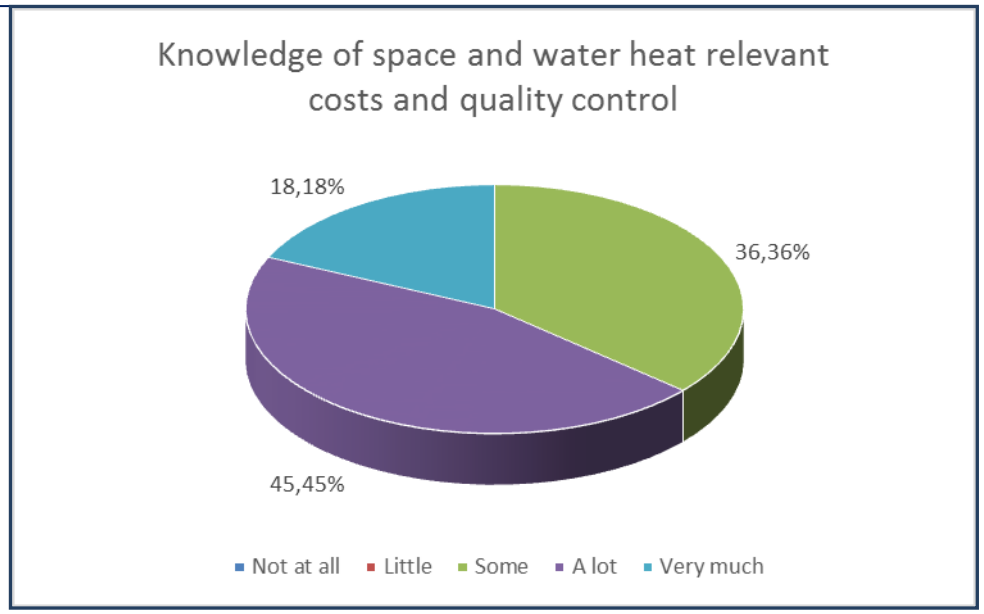
2	63,64%	**Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
3	63,64%	**Solar radiation and heat exchange basics**
4	72,73%	**Insulation material, types and techniques**
5	72,73	**Types of solar thermal water circulation**
6	81,82%	**Solar panel structure and operation**
7	81,82%	**Building distribution systems**
8	81,82%	**Thermal storage systems**

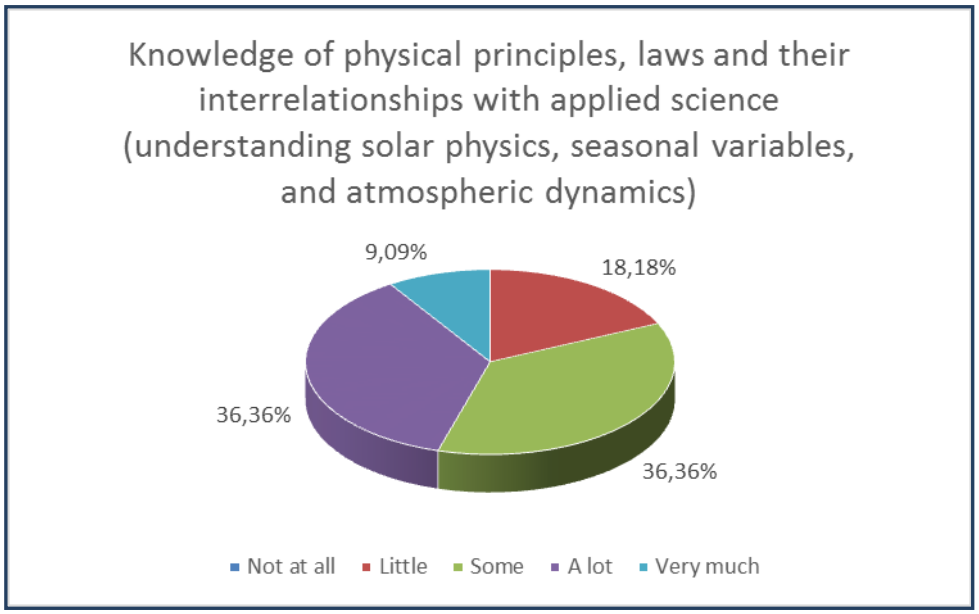
The case of Spain:

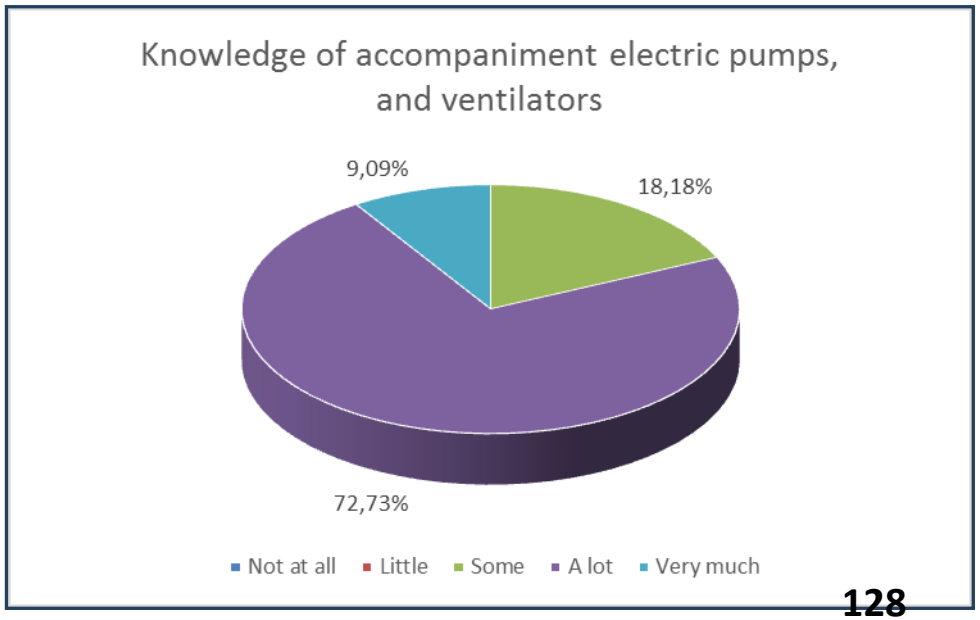
In question (B1) the Spanish interviewees were asked to evaluate a list of theoretical abilities that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered important.

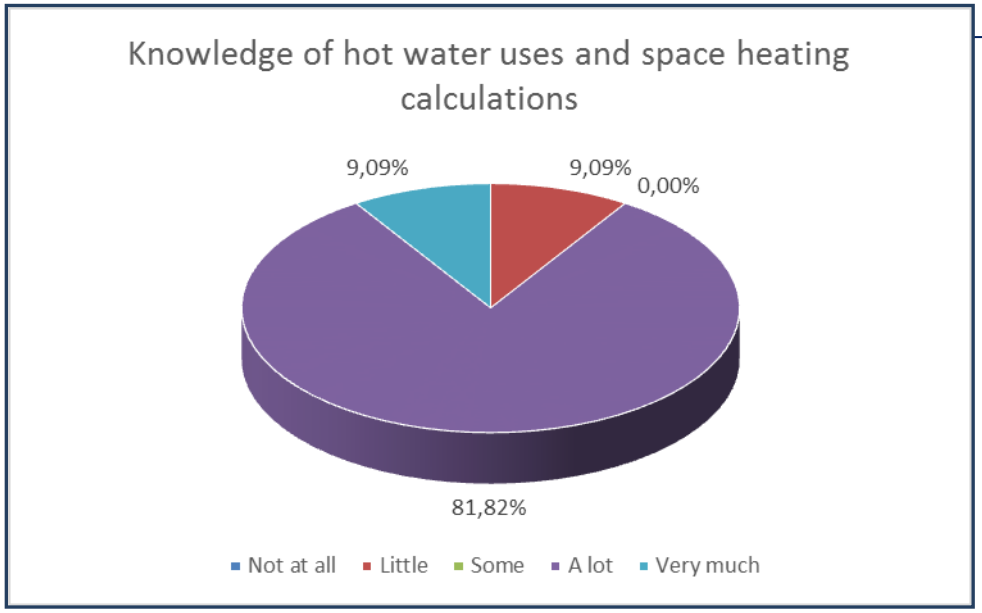
The interviewees evaluate each single theoretical ability listed on the questionnaire by choosing a value among the five being proposed. The proposed values were corresponding to the importance of each theoretical knowledge and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much. The graphs show the results for each ability:

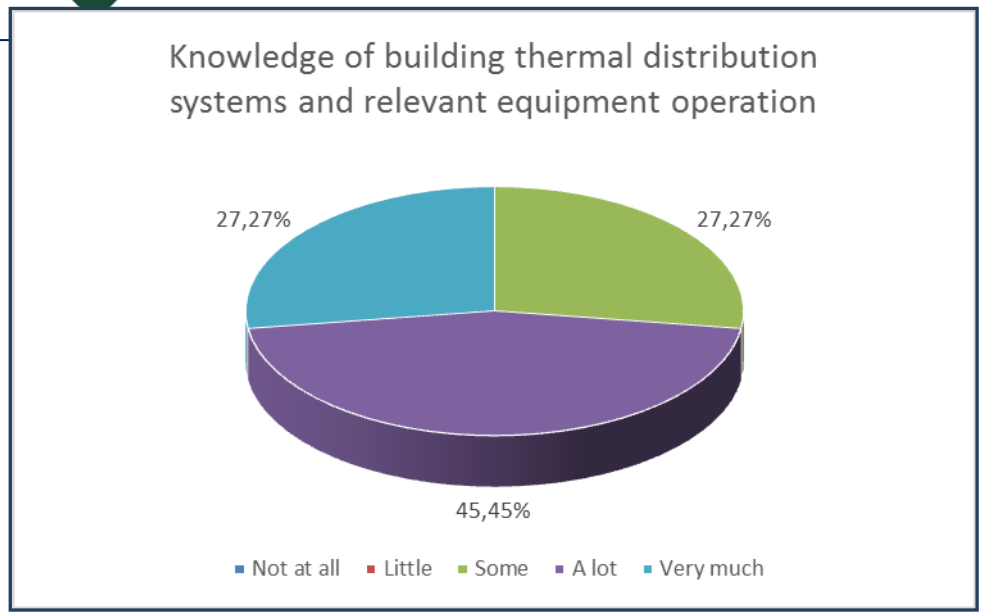

Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
18,18%
36,36%
45,45%
Not at all
Little
Some
A lot
Very much

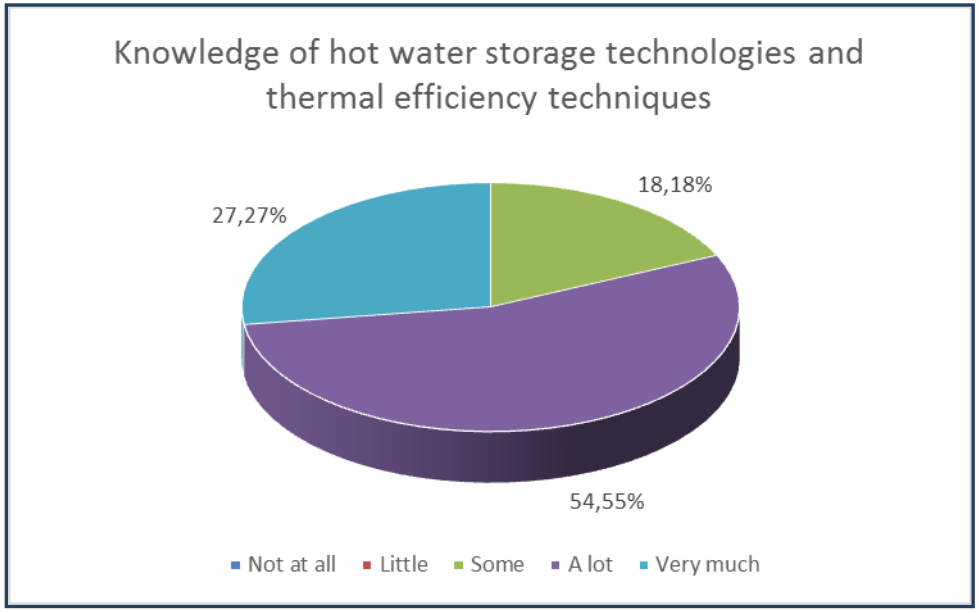

Knowledge of space and water heat relevant costs and quality control
18,18%
36,36%
45,45%
Not at all
Little
Some
A lot
Very much

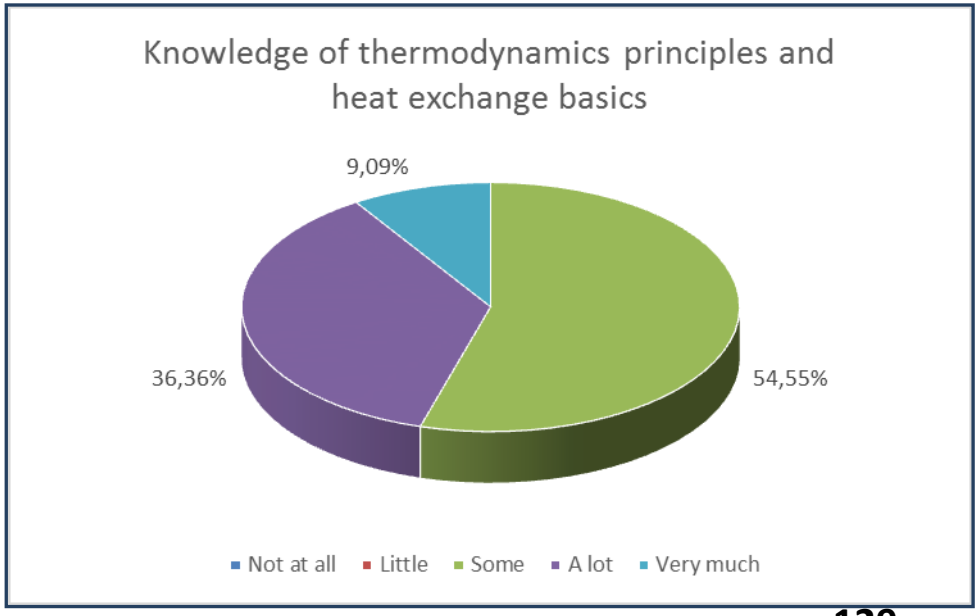

Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)
9,09%
18,18%
36,36%
36,36%
Not at all
Little
Some
A lot
Very much

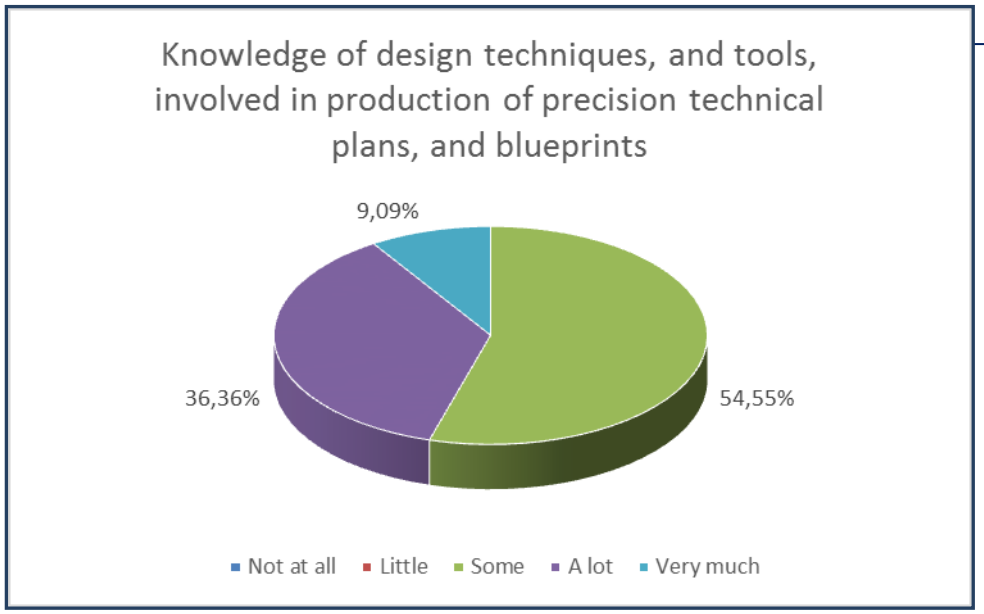

Knowledge of accompaniment electric pumps, and ventilators
9,09%
18,18%
72,73%
Not at all
Little
Some
A lot
Very much

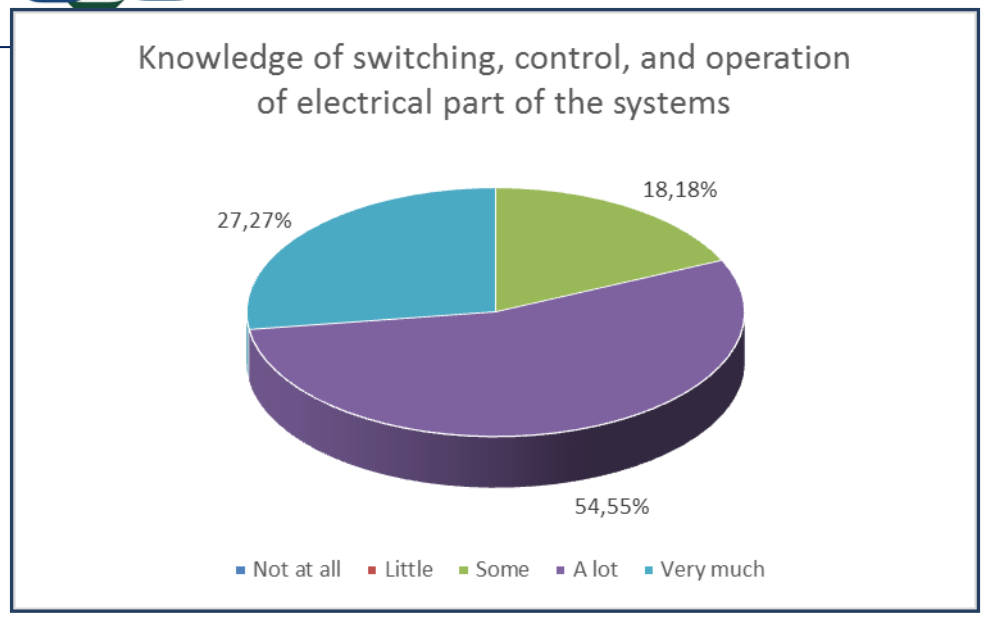

Knowledge of hot water uses and space heating calculations
9,09%
9,09%
0,00%
81,82%
Not at all
Little
Some
A lot
Very much

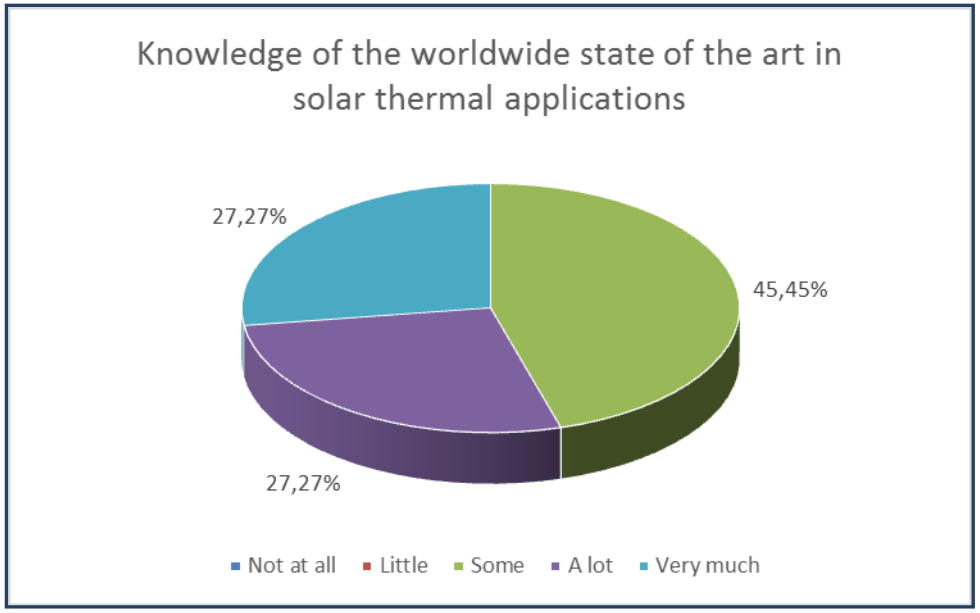

Knowledge of building thermal distribution systems and relevant equipment operation
27,27%
27,27%
45,45%
Not at all
Little
Some
A lot
Very much

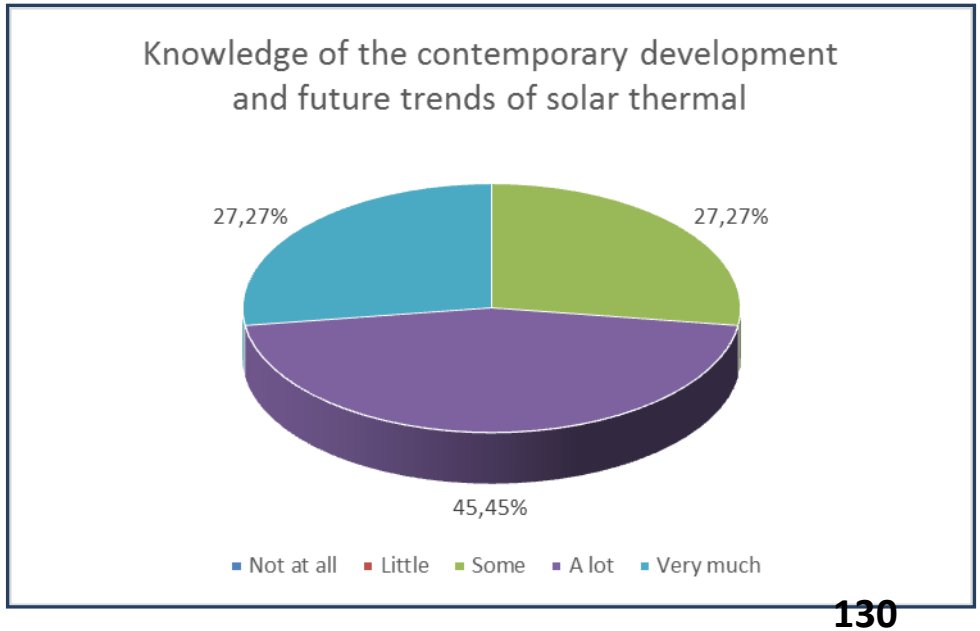

Knowledge of hot water storage technologies and thermal efficiency techniques
27,27%
18,18%
54,55%
Not at all
Little
Some
A lot
Very much

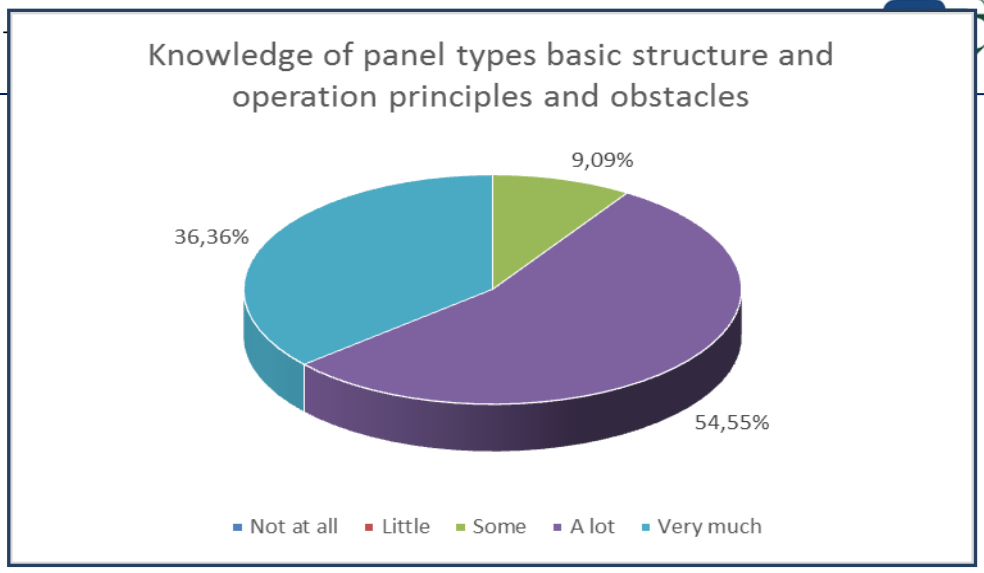

Knowledge of thermodynamics principles and heat exchange basics
9,09%
36,36%
54,55%
Not at all
Little
Some
A lot
Very much


Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
9,09%
36,36%
54,55%
Not at all
Little
Some
A lot
Very much


Knowledge of switching, control, and operation of electrical part of the systems
18,18%
27,27%
54,55%
Not at all
Little
Some
A lot
Very much


Knowledge of the worldwide state of the art in solar thermal applications
27,27%
45,45%
27,27%
Not at all
Little
Some
A lot
Very much


Knowledge of the contemporary development and future trends of solar thermal
27,27%
27,27%
45,45%
Not at all
Little
Some
A lot
Very much



From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the theoretical most needed knowledge that a technician should have in order to be able to carry out a solar thermal installation in Spain.

The following classified abilities are considered very important and correspond from 70% and up of the Spanish interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	90,91%	**(B1.5) Knowledge of hot water uses and space heating calculations**
2	90,91%	**(B1.13) Knowledge of panel types basic structure and operation principles and obstacles**
3	81,82%	**(B1.10) Knowledge of switching, control, and operation of electrical part of the systems**
4	81,82%	**(B1.4) Knowledge of accompaniment electric pumps, and ventilators**
5	81,82%	**(B1.7) Knowledge of hot water storage**

		technologies and thermal efficiency techniques
6	72,73%	**(B1.12) Knowledge of the contemporary development and future trends of solar thermal**
7	72,73%	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**

The following listed abilities are considered less important and correspond to less than 70% of the Spanish interviewees' choice:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	45,45%	**(B1.8) Knowledge of thermodynamics principles and heat exchange basics**
2	45,45%	**(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints**
3	45,45%	**(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)**
4	54,55%	**(B1.11) Knowledge of the worldwide state of the art in solar thermal applications**

5	63,64%	**(B1.2) Knowledge of space and water heat relevant costs and quality control**

Spain:

1. **Sunshine Orientation, Knowledge of the area to be installed.**
2. **Comparative studies on heating costs with GAS**
3. **Knowledge of the different types of facilities**
4. **The definition of new models of self-supply power management (smart grips). New active-passive solar systems (BIPV).**
5. **Mounting systems to cover.**

6	63,64%	**(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**

In question (B2) the Spanish interviewees were asked to indicate any theoretical knowledge they consider that is essential for a technician of solar thermal installations. Besides the abilities listed in the questionnaire, one of the interviewees filled out the (B2) open question - field named as "other", with abilities not listed in the questionnaire and that he/she considered as relevant and important.

The essential knowledge that was proposed is the following:

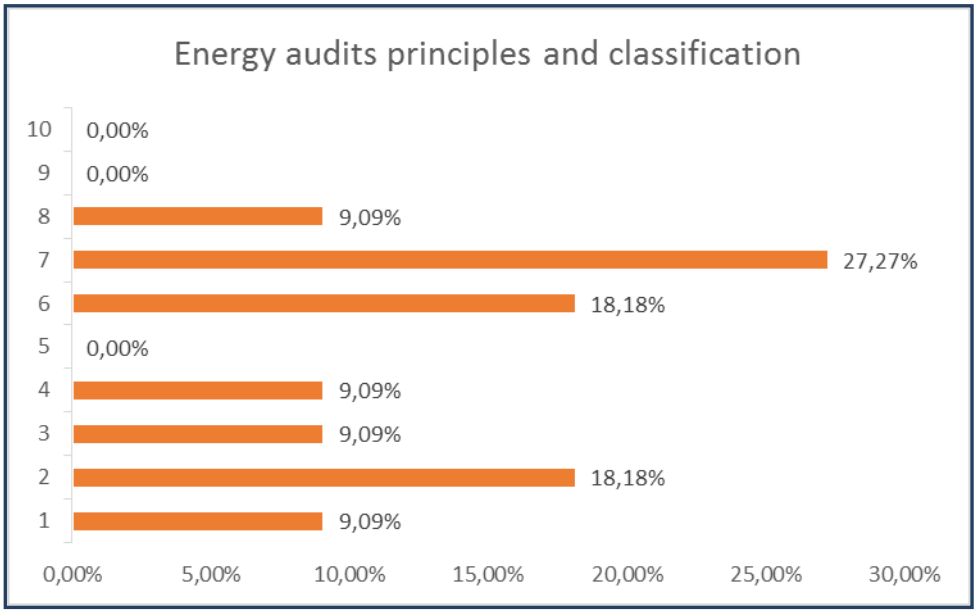
In question (B3) the Spanish interviewees in the research were asked to rate a list with proposed theoretical knowledge that a technician should possess in order to perform his/her profession and to be able to carry out a solar thermal installation.

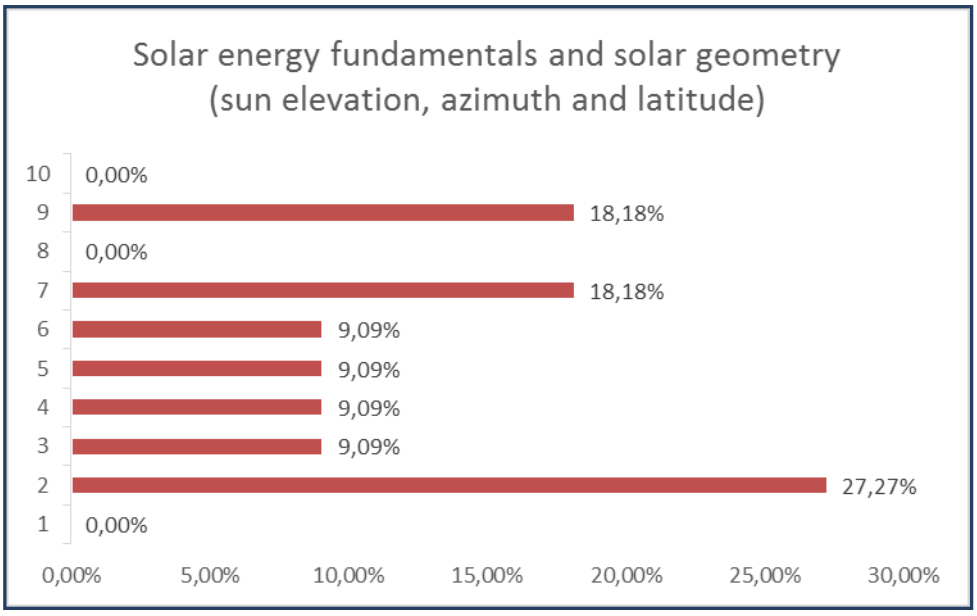
<u>The following 8 abilities were suggested:</u>

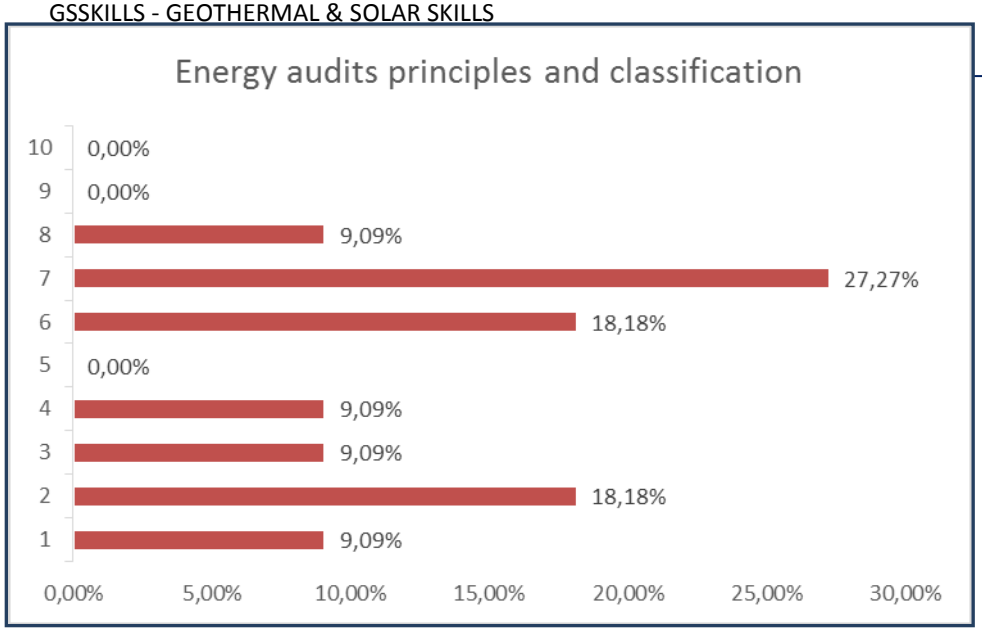
1. **Energy audits principles and classification**
2. **Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
3. **Solar radiation and heat exchange basics**
4. **Solar panel structure and operation**
5. **Insulation material, types and techniques**
6. **Types of solar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

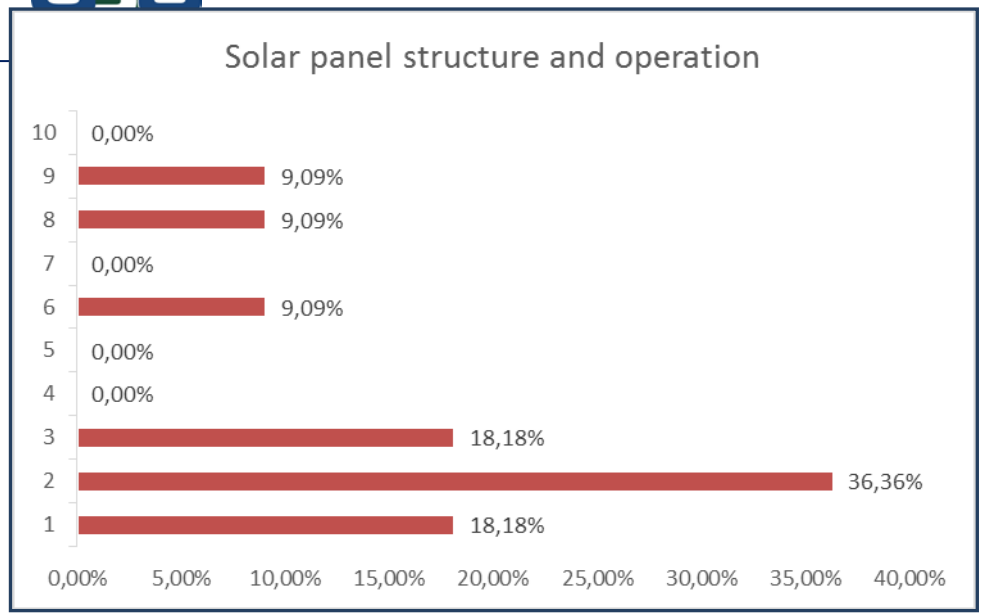
The interviewees evaluated each single ability by choosing a value from 1 to 10, where 1 corresponds to “Absolutely important” and 10 to “Not really important”.

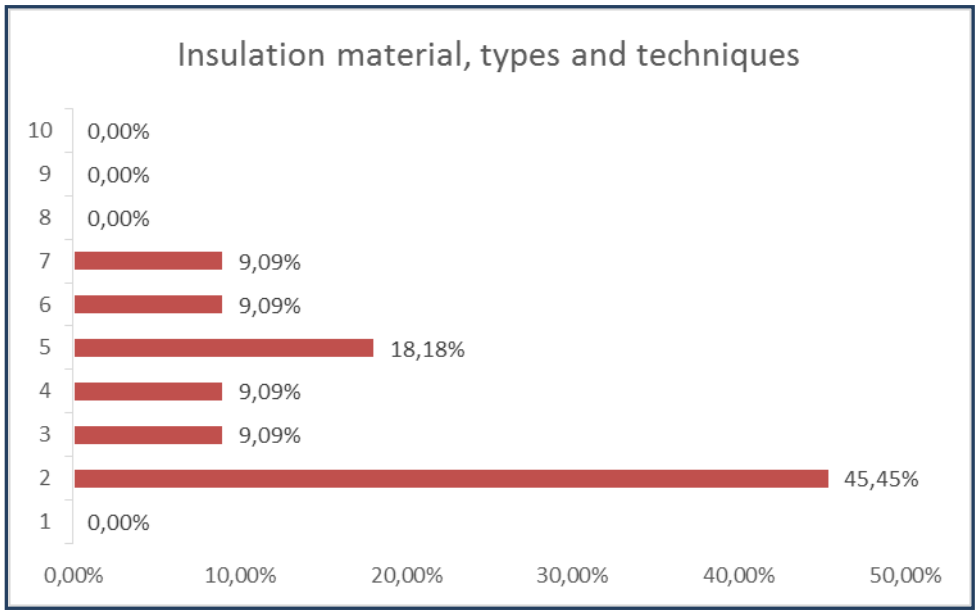
The graphs show the results for each ability:

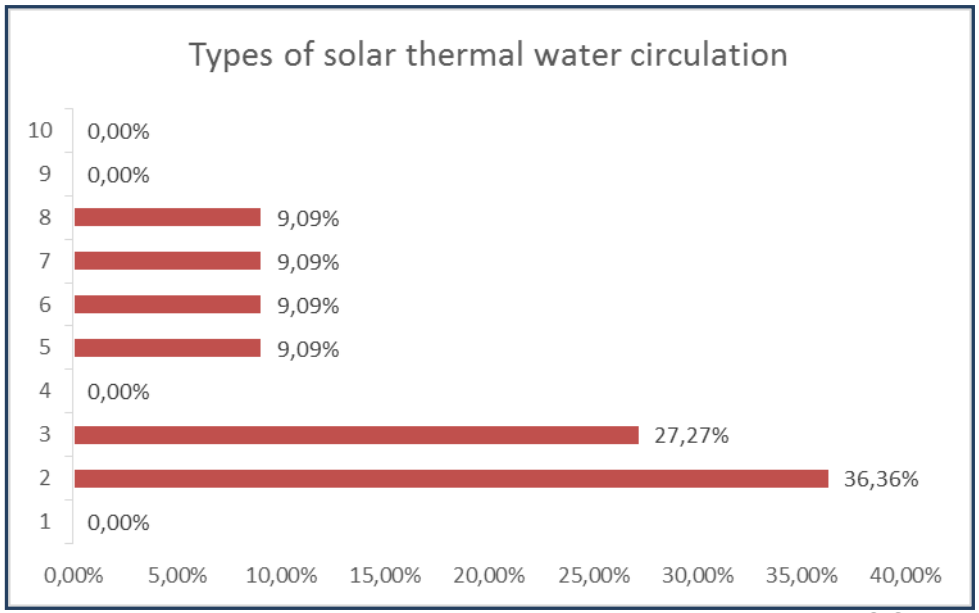

Energy audits principles and classification
10
9
8
7
6
5
4
3
2
1
0,00%
0,00%
9,09%
27,27%
18,18%
0,00%
9,09%
9,09%
18,18%
9,09%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%
30,00%

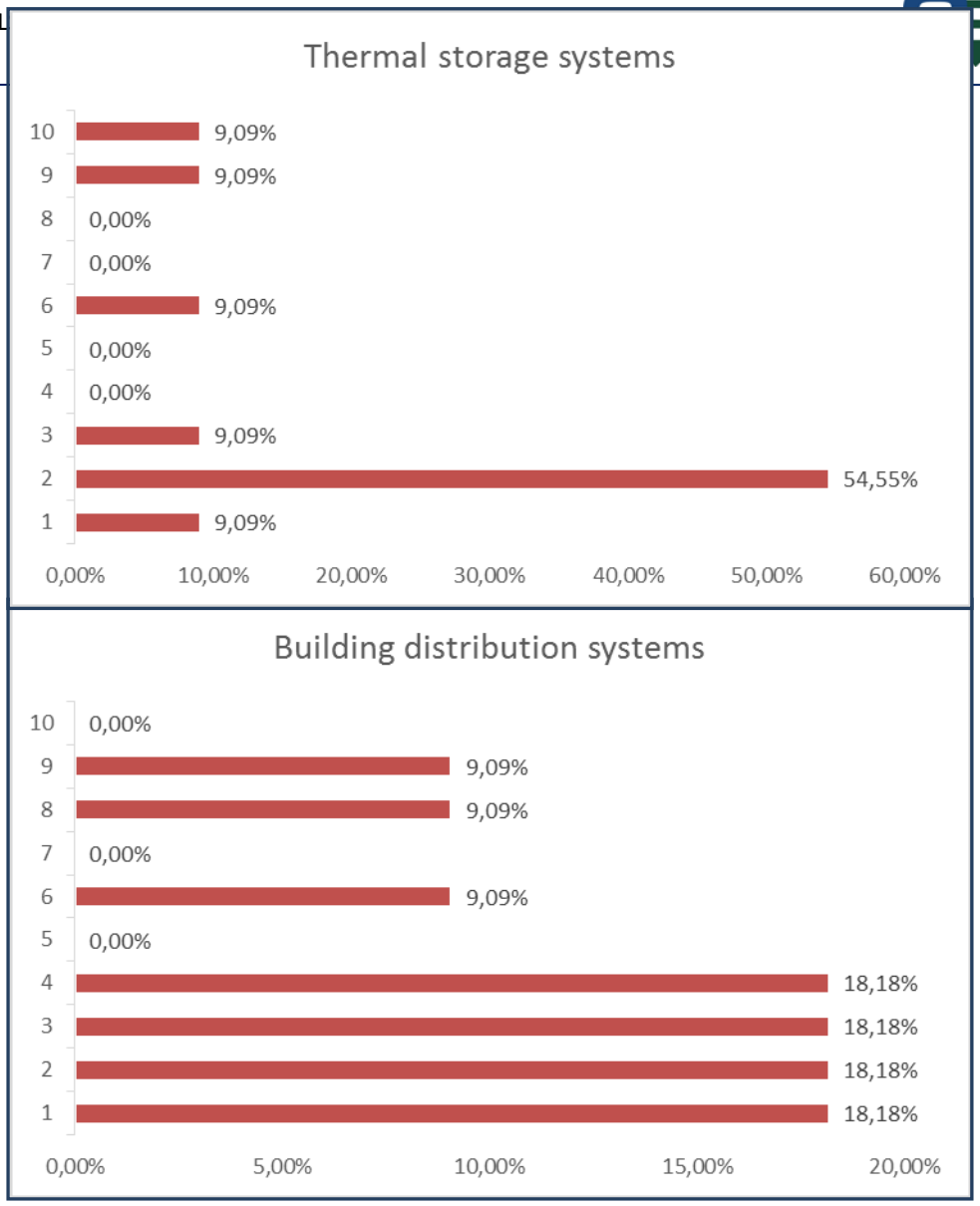

Solar energy fundamentals and solar geometry
(sun elevation, azimuth and latitude)
10
9
8
7
6
5
4
3
2
1
0,00%
18,18%
0,00%
18,18%
9,09%
9,09%
9,09%
9,09%
27,27%
0,00%
0,00%
5,00%
10,00%
15,00%
20,00%
25,00%
30,00%


Energy audits principles and classification
10 0,00%
9 0,00%
8 9,09%
7 27,27%
6 18,18%
5 0,00%
4 9,09%
3 9,09%
2 18,18%
1 9,09%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00%


Solar panel structure and operation
10 0,00%
9 9,09%
8 9,09%
7 0,00%
6 9,09%
5 0,00%
4 0,00%
3 18,18%
2 36,36%
1 18,18%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00% 40,00%


Insulation material, types and techniques
10 0,00%
9 0,00%
8 0,00%
7 9,09%
6 9,09%
5 18,18%
4 9,09%
3 9,09%
2 45,45%
1 0,00%
0,00% 10,00% 20,00% 30,00% 40,00% 50,00%


Types of solar thermal water circulation
10 0,00%
9 0,00%
8 9,09%
7 9,09%
6 9,09%
5 9,09%
4 0,00%
3 27,27%
2 36,36%
1 0,00%
0,00% 5,00% 10,00% 15,00% 20,00% 25,00% 30,00% 35,00% 40,00%



According to the answers that Spanish interviewees gave regarding the theoretical abilities that were listed under the question (B3) the above mentioned knowledge is classified as following:

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	45,45%	**Energy audits principles and classification**
2	45,45%	**Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
3	63,64%	**Solar radiation and heat exchange basics**

4	63,64%	**Insulation material, types and techniques**
5	63,64	**Types of solar thermal water circulation**
6	72,73%	**Solar panel structure and operation**
7	72,73%	**Building distribution systems**
8	72,73%	**Thermal storage systems**

3.3 Labor Skills

In this section of the questionnaire focus was placed on the encoding of labour skills that plumbers and electricians should have in order to be able to carry out solar thermal installations.

Summative statistics for all countries

In question (C1) the interviewees were asked to evaluate a list of labour skills that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered as important.

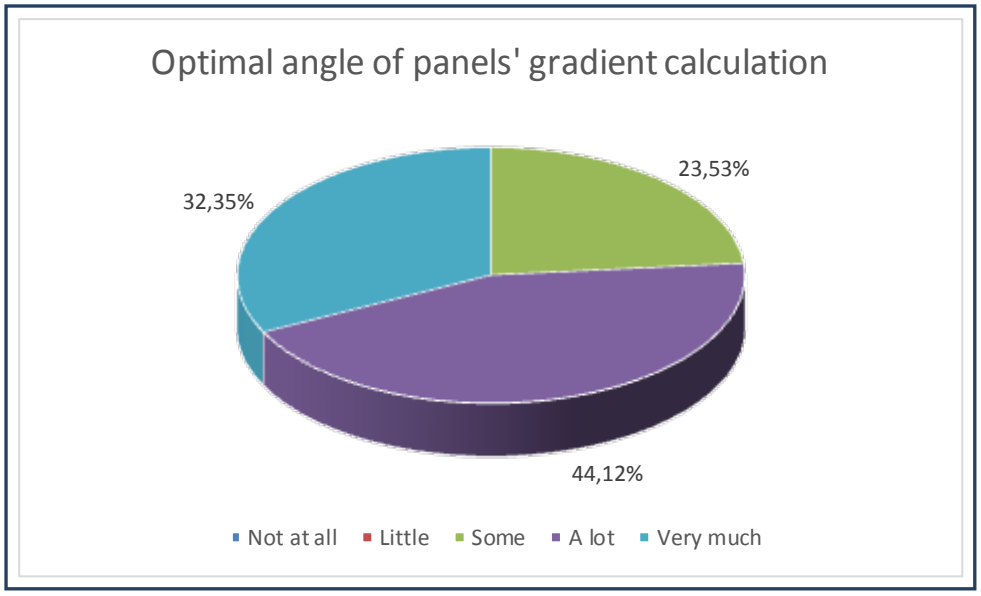
The following 13 labour skills were suggested:

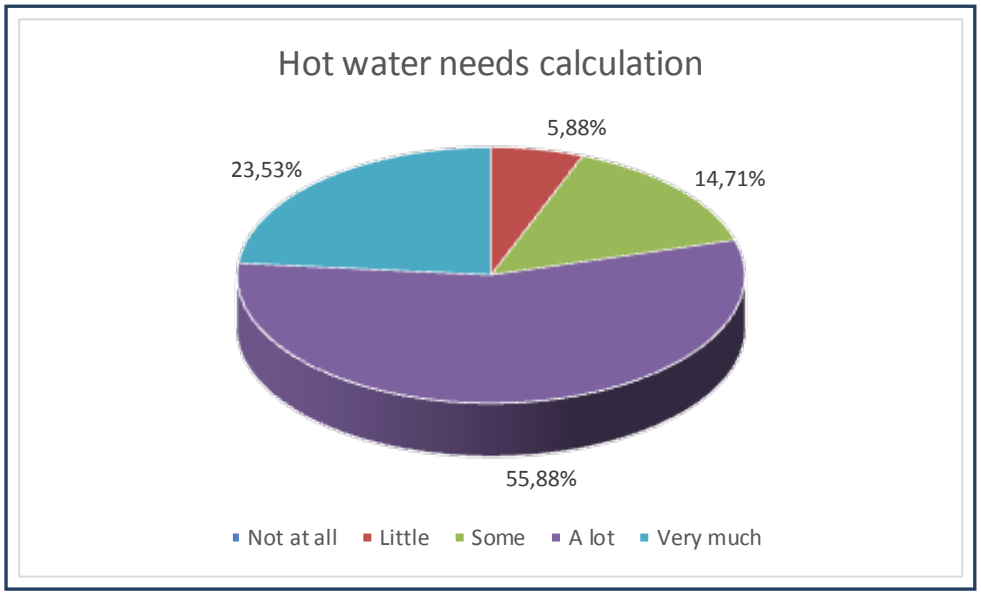
1. **(C1.1) Optimal angle of panels' gradient calculation**
2. **(C1.2) Hot water needs calculation**
3. **(C1.3) Coupling of solar thermal with space heating technologies**
4. **(C1.4) Boiler dimensioning and efficient positioning**
5. **(C1.5) Insulation and sealing techniques**
6. **(C1.6) Optimal architecture selection (Active/passive, closed/open loop, hybrid)**
7. **(C1.7) Efficient panels-boiler-distribution coupling and mounting**
8. **(C1.8) Installation techniques of different type of panels (collectors)**
9. **(C1.9) Technical plans and blueprints understanding**
10. **(C1.10) Formulated malfunction investigation and repair**
11. **(C1.11) Formulated and reliable maintenance**
12. **(C1.12) Antifreeze protection techniques**
13. **(C1.13) Electric water pumps and relevant equipment supervision**

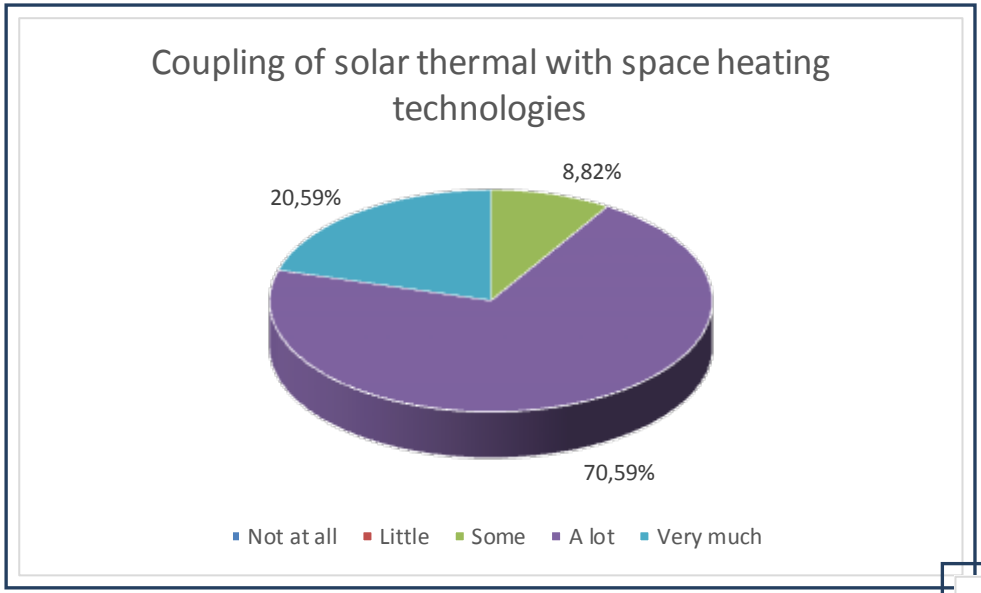
The interviewees evaluate each listed labour skill by choosing a value among the five being proposed in the questionnaire. The proposed values were corresponding to the

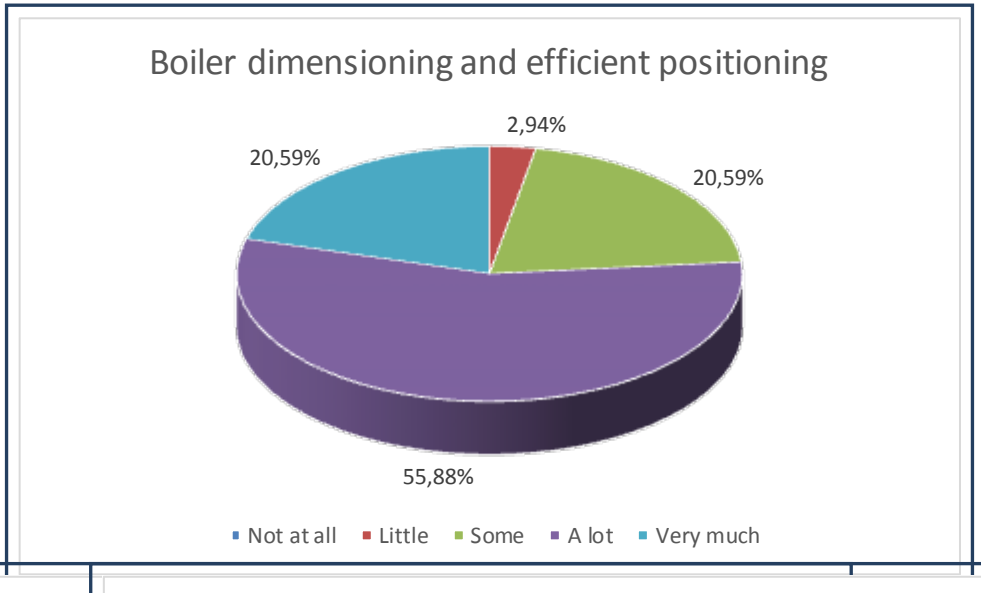
importance of each labour skill and were the following: 1) Not at all, 2) Little, 3) Some, 4) A lot, 5) Very much.

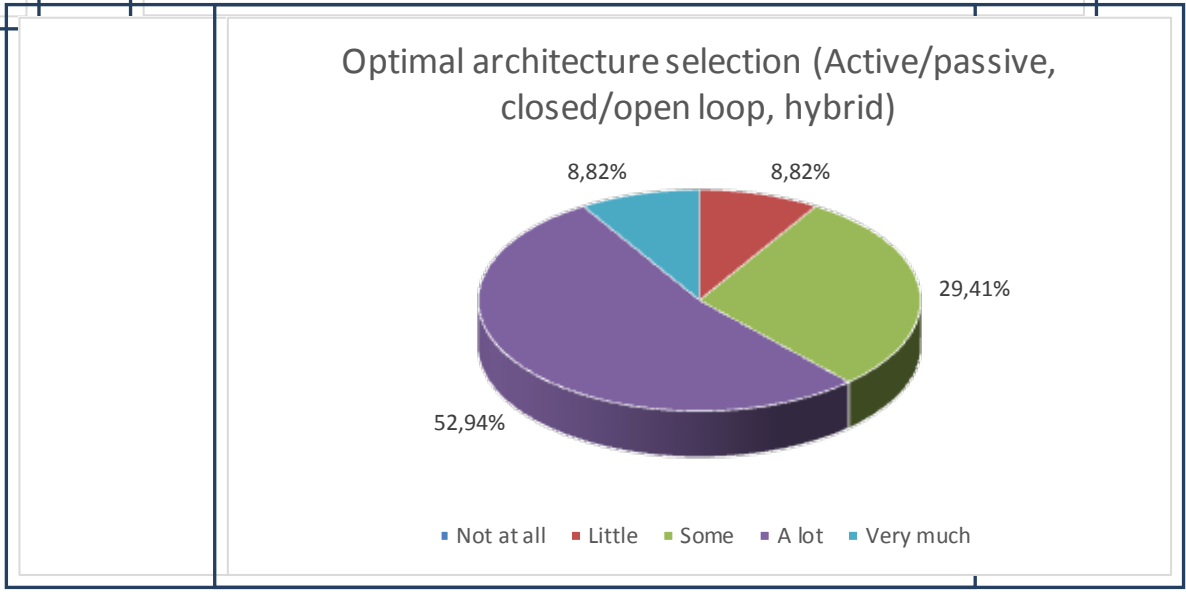
The graphs show the results for each labour skill:

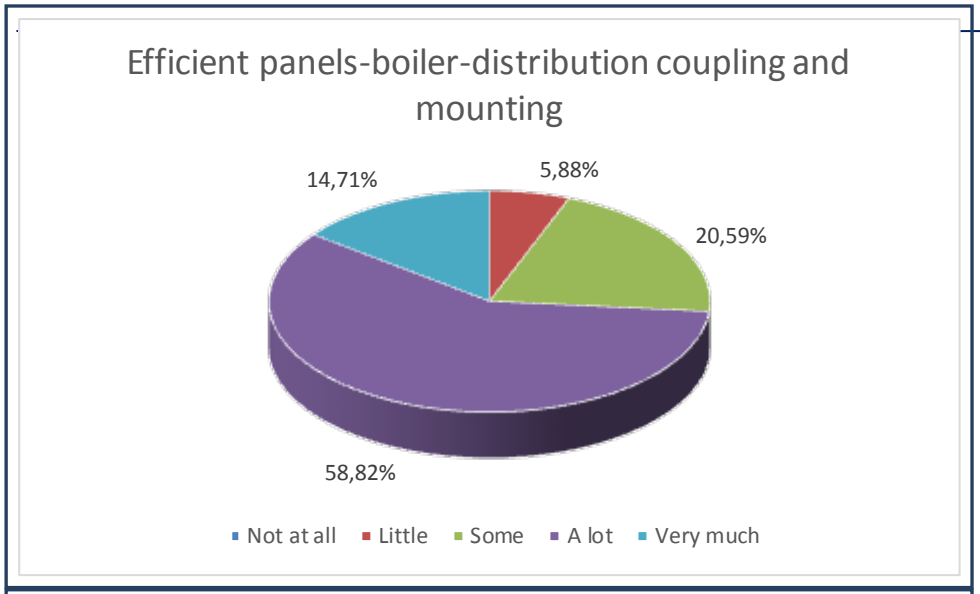


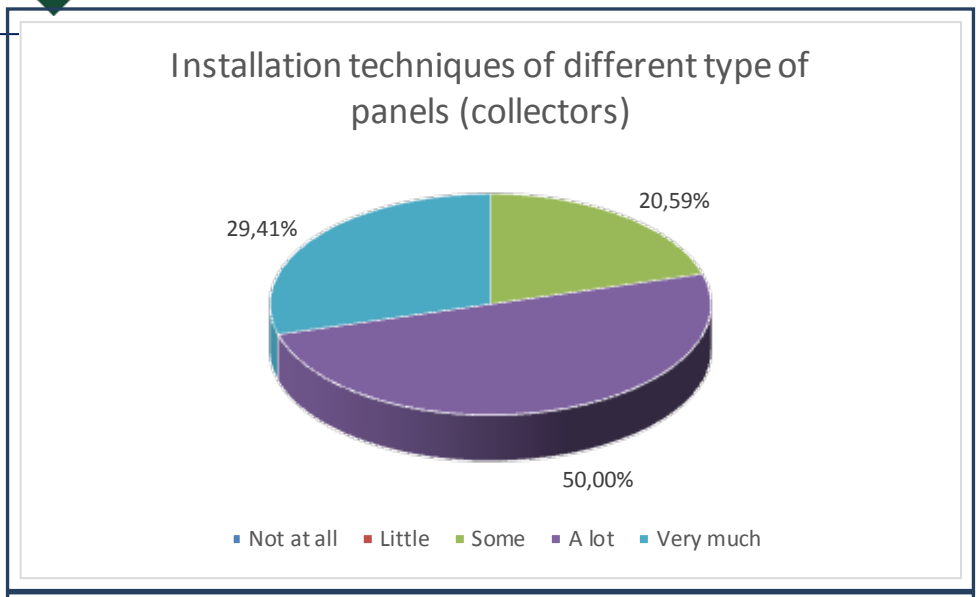


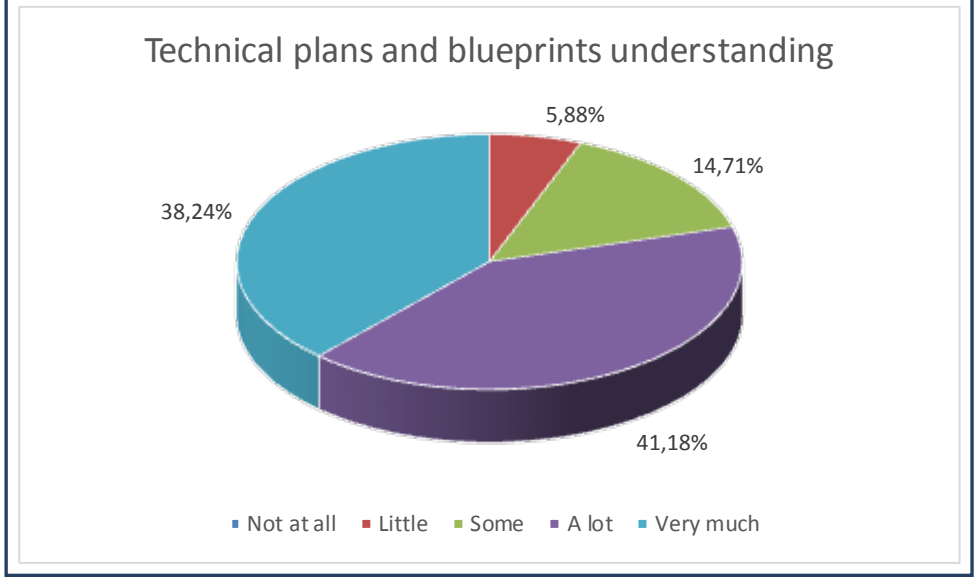

Coupling of solar thermal with space heating technologies
8,82%
20,59%
70,59%
Not at all
Little
Some
A lot
Very much

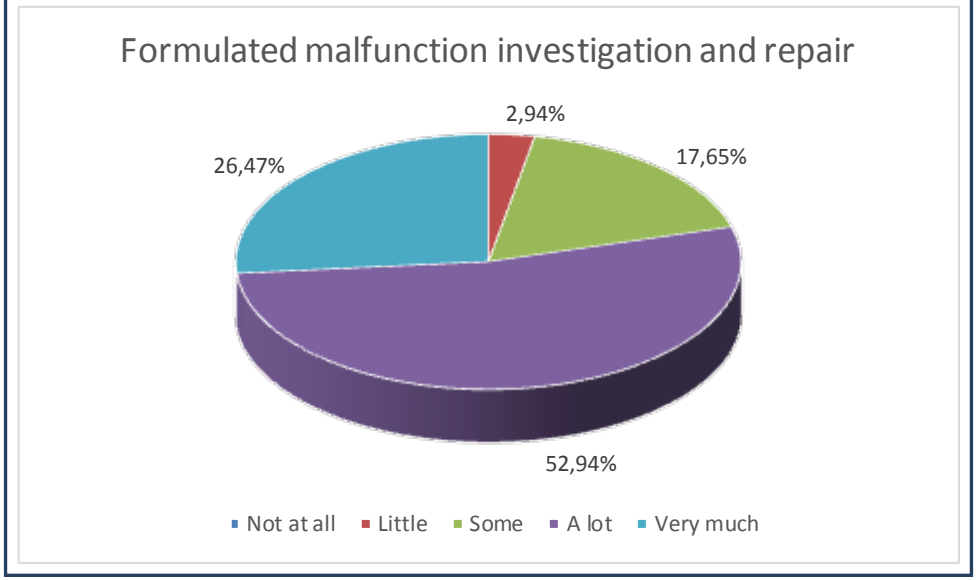

Boiler dimensioning and efficient positioning
2,94%
20,59%
20,59%
55,88%
Not at all
Little
Some
A lot
Very much

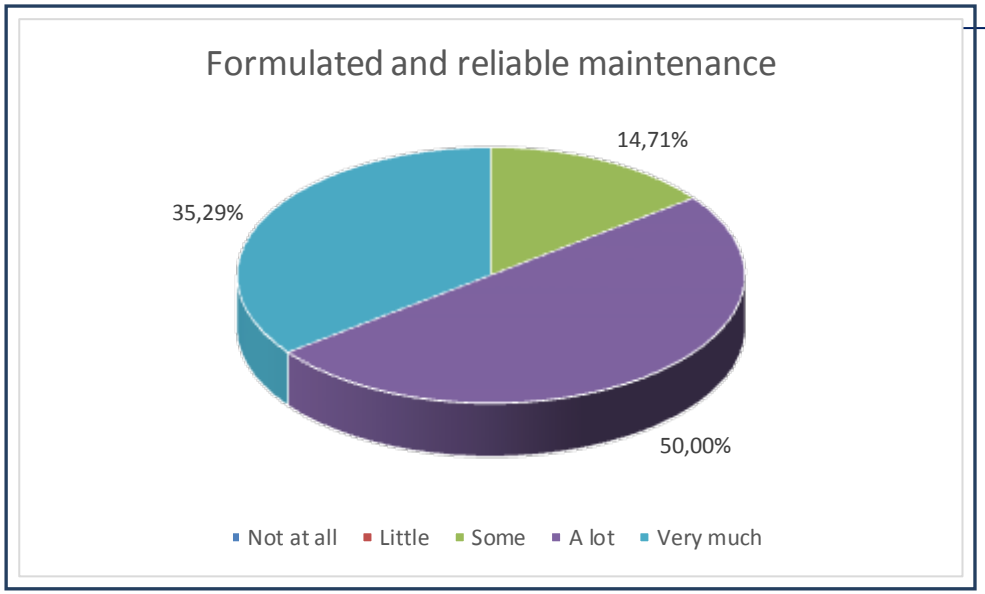

Optimal architecture selection (Active/passive, closed/open loop, hybrid)
8,82%
8,82%
29,41%
52,94%
Not at all
Little
Some
A lot
Very much

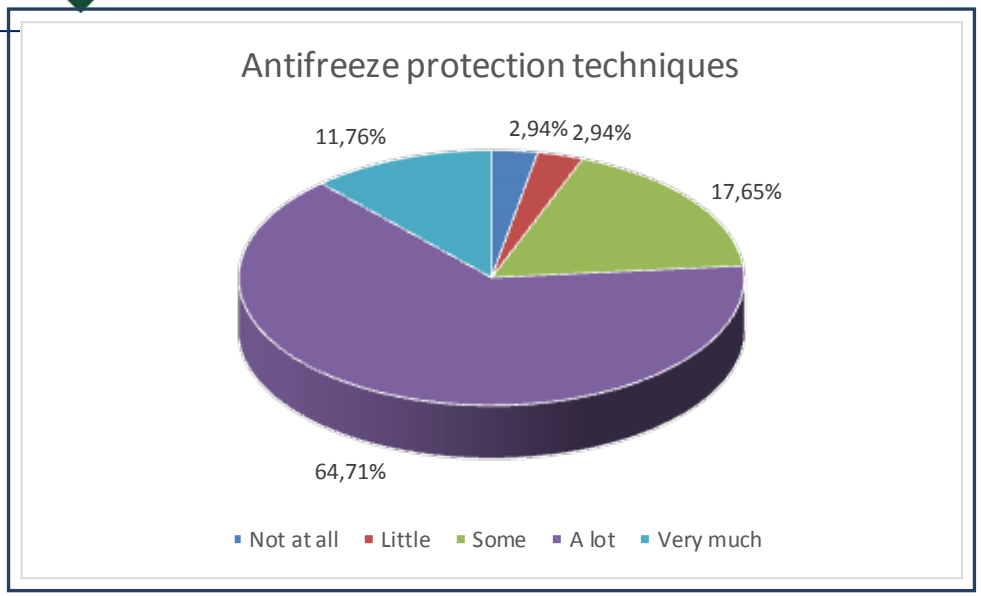

Efficient panels-boiler-distribution coupling and mounting
14,71%
5,88%
20,59%
58,82%
Not at all
Little
Some
A lot
Very much

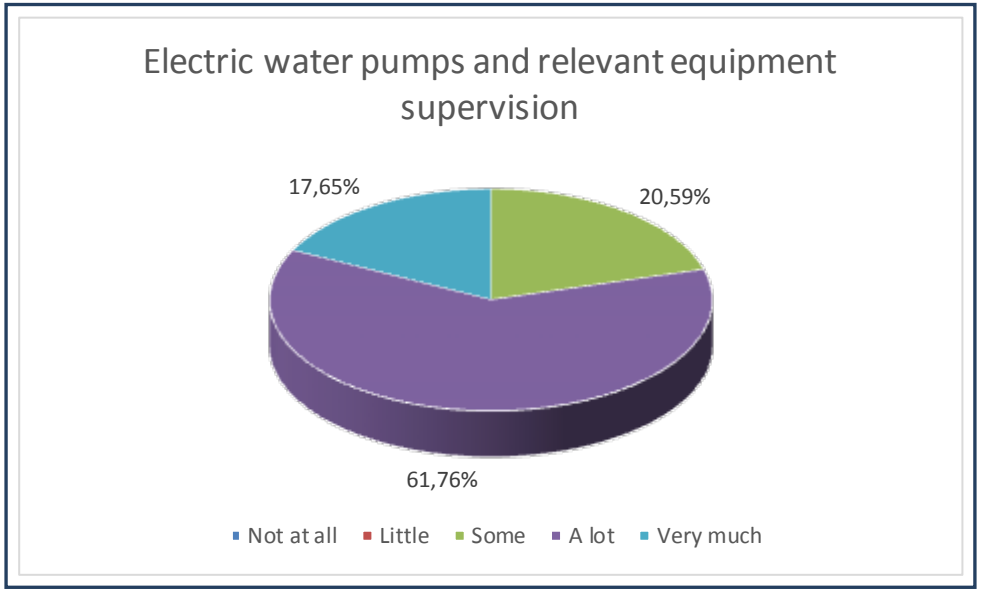

Installation techniques of different type of panels (collectors)
29,41%
20,59%
50,00%
Not at all
Little
Some
A lot
Very much


Technical plans and blueprints understanding
5,88%
14,71%
38,24%
41,18%
Not at all
Little
Some
A lot
Very much


Formulated malfunction investigation and repair
2,94%
17,65%
26,47%
52,94%
Not at all
Little
Some
A lot
Very much


Formulated and reliable maintenance
14,71%
35,29%
50,00%
Not at all
Little
Some
A lot
Very much


Antifreeze protection techniques
11,76%
2,94%
2,94%
17,65%
64,71%
Not at all
Little
Some
A lot
Very much


Electric water pumps and relevant equipment supervision
17,65%
20,59%
61,76%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the most needed labour skills that a technician should have in order to be able to carry out a solar thermal installation.

The following classified labour skills are considered very important and correspond from 70% and up of the all countries interviewees' choice:

	PERCENTAGE	LABOUR SKILLS
1	91,18%	**(C1.3) Coupling of solar thermal with space heating technologies**
2	85,29%	**(C1.11) Formulated and reliable maintenance**
3	79,41%	**(C1.8) Installation techniques of different type of panels (collectors)**
4	79,41%	**(C1.2) Hot water needs calculation**
5	79,41%	**(C1.9) Technical plans and blueprints understanding**
6	79,41%	**(C1.13) Electric water pumps and relevant equipment supervision**
7	79,41%	**(C1.10) Formulated malfunction investigation and repair**
8	76,47%	**(C1.12) Antifreeze protection techniques**
9	76,47%	**(C1.4) Boiler dimensioning and efficient positioning**
1	76,47%	**(C1.1) Optimal angle of panels' gradient**

0		**calculation**
1 1	73,73%	**(C1.7) Efficient panels-boiler-distribution coupling and mounting**

The following listed labour skills are considered as less important as correspond to less than 70% of respondent's choices:

	PERCENTAGE	LABOUR SKILLS
1	61,76%	**(C1.5) Insulation and sealing techniques**
2	61,76%	**(C1.6) Optimal architecture selection (Active/passive, closed/open loop, hybrid)**

In question (C2) the interviewees were asked to indicate any labour skill they consider that is essential for technician of solar thermal installations. Besides the skills listed in the questionnaire, four of the thirty interviewees filled out the (C2) open question of the questionnaire - field named as "other", with skills not listed in the questionnaire and that he/she considered as relevant and important.

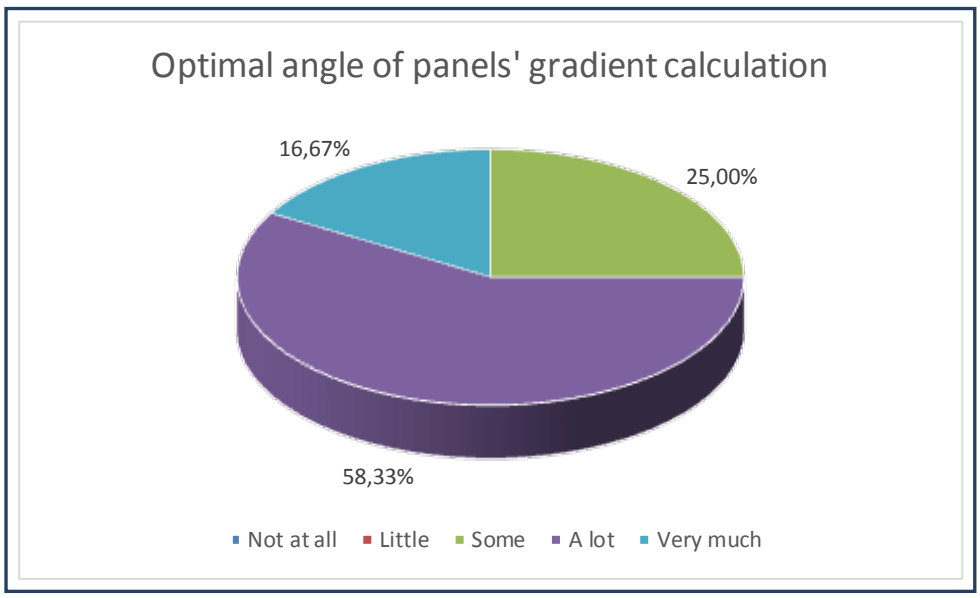
The essential skills that were proposed are the following:

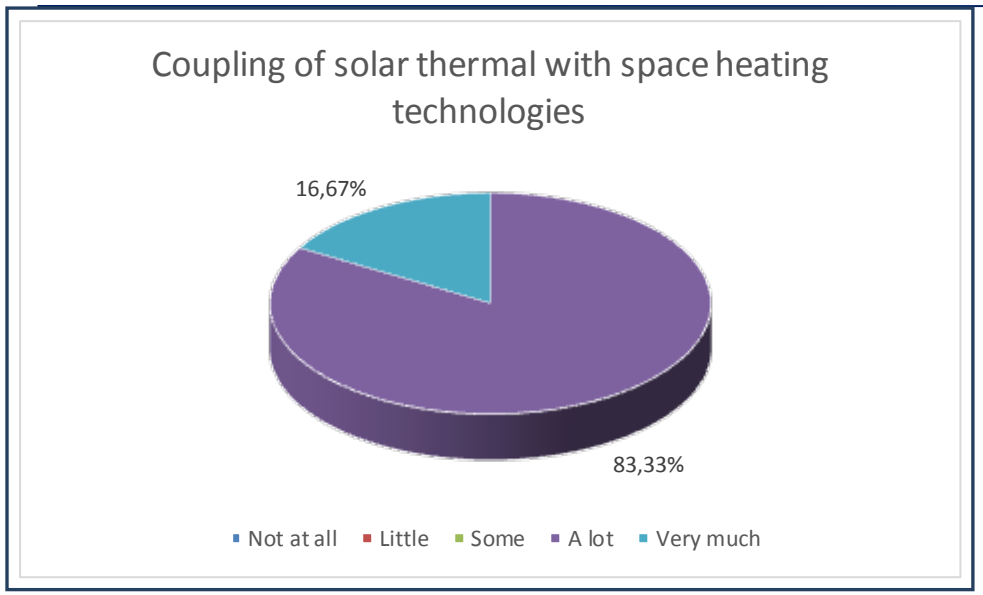
1. Spain: **inspire consumer confidence**
2. Spain: **Provide assurance system**
3. Greece: **Mass calculation of hot water, floor heating**
4. Spain: **Anchoring systems**

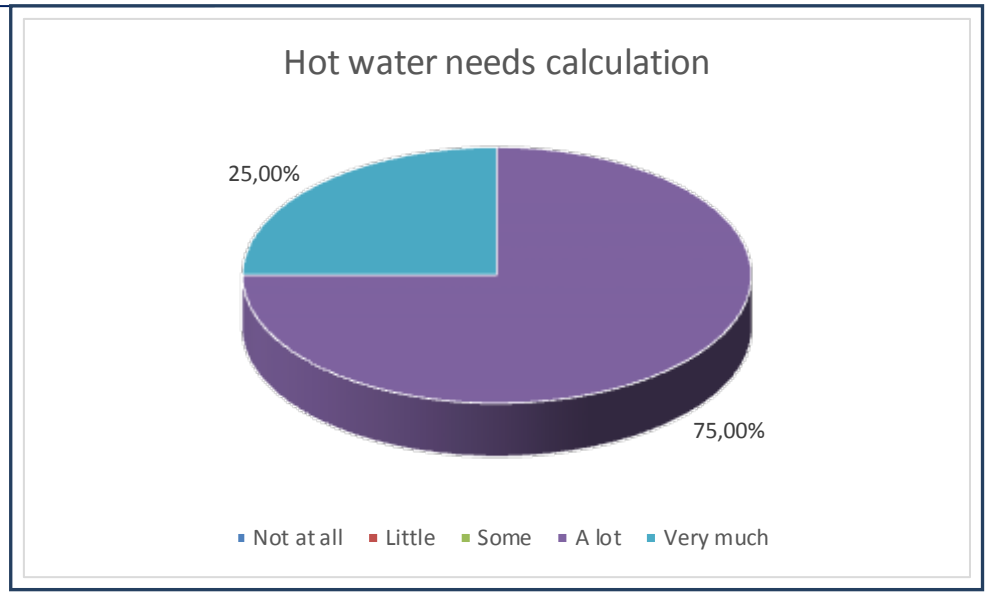
<u>The case of France:</u>

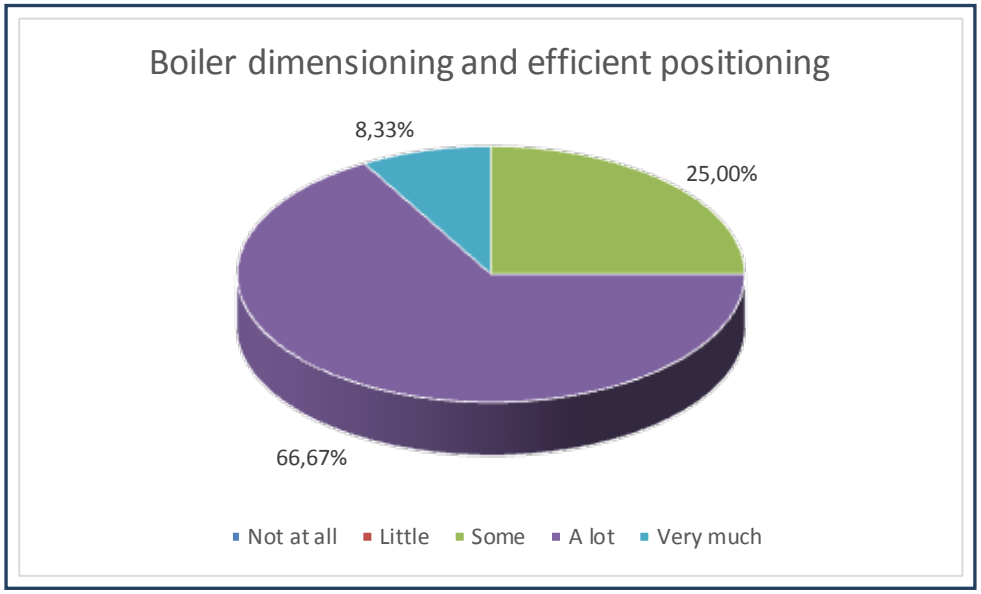
In question (C1) the interviewees were asked to evaluate a list of labour skills that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered as important.

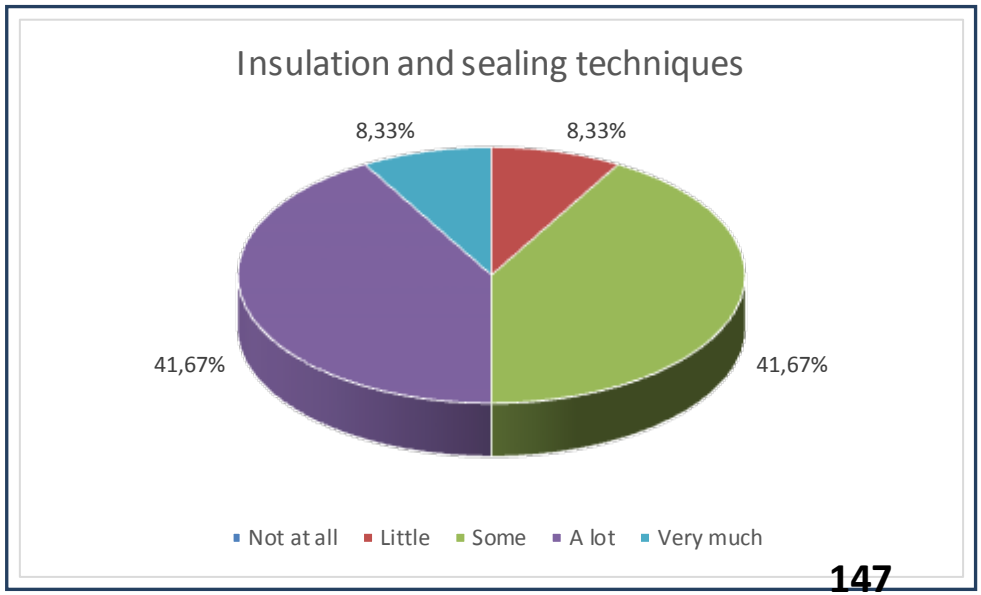
Below are presented the answers that the French interviewers gave in (C1) question. The graphs show the results for each labour skill:



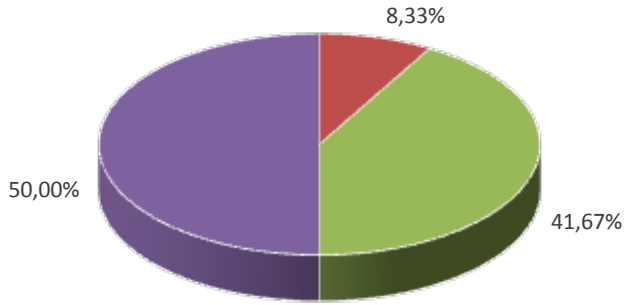

Coupling of solar thermal with space heating technologies
16,67%
83,33%
Not at all
Little
Some
A lot
Very much


Hot water needs calculation
25,00%
75,00%
Not at all
Little
Some
A lot
Very much

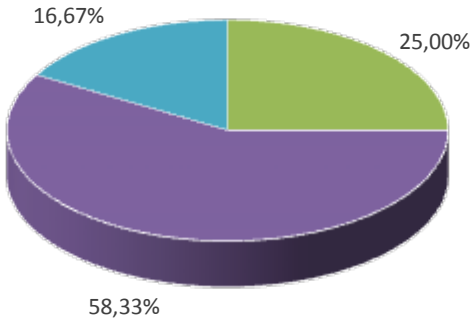

Boiler dimensioning and efficient positioning
8,33%
25,00%
66,67%
Not at all
Little
Some
A lot
Very much


Insulation and sealing techniques
8,33%
8,33%
41,67%
41,67%
Not at all
Little
Some
A lot
Very much

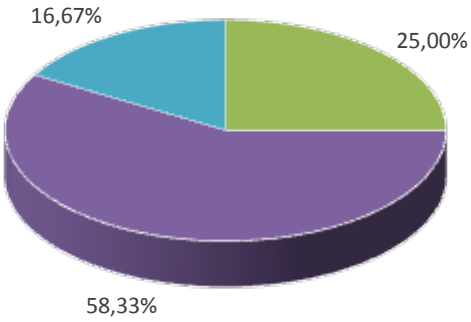
Optimal architecture selection (Active/passive, closed/open loop, hybrid)



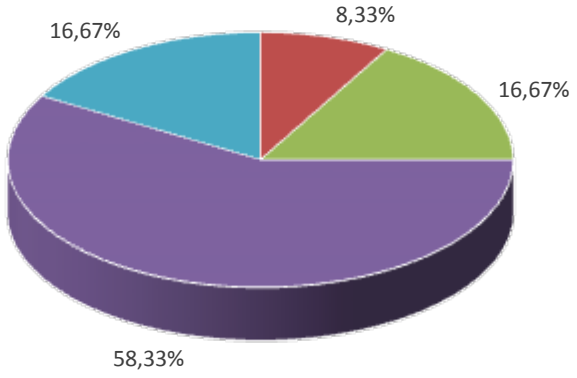
Efficient panels-boiler-distribution coupling and mounting

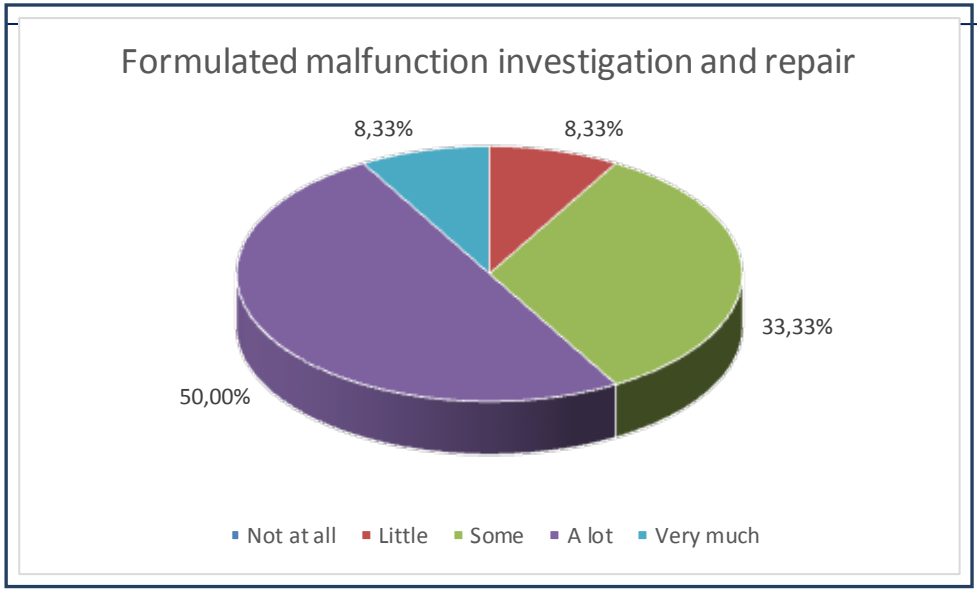


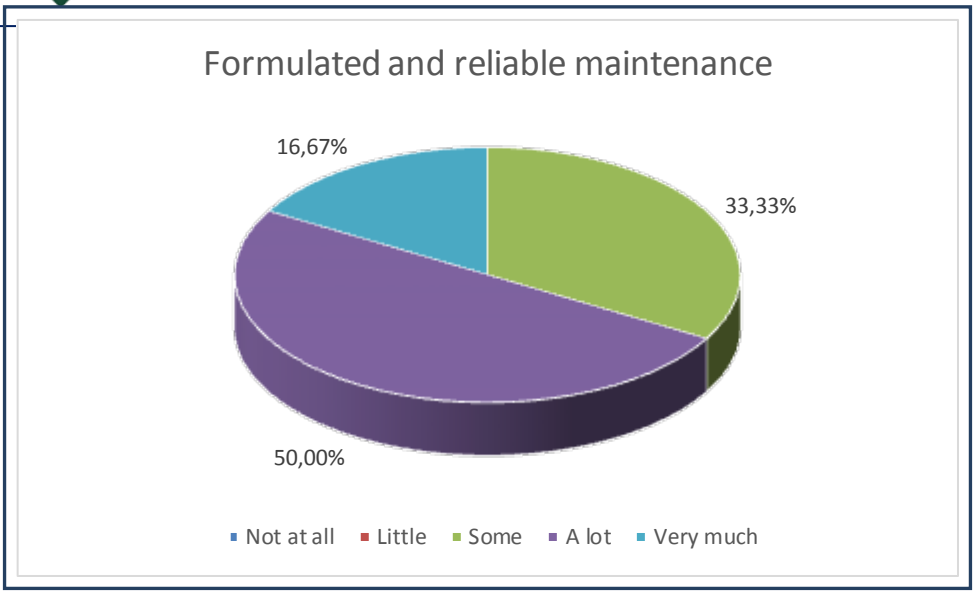
Installation techniques of different type of panels (collectors)

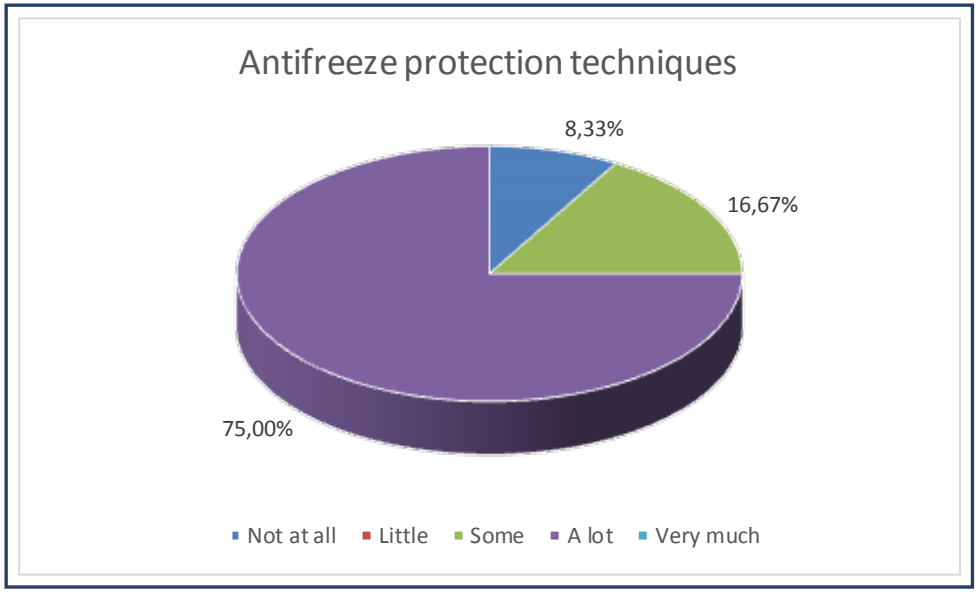


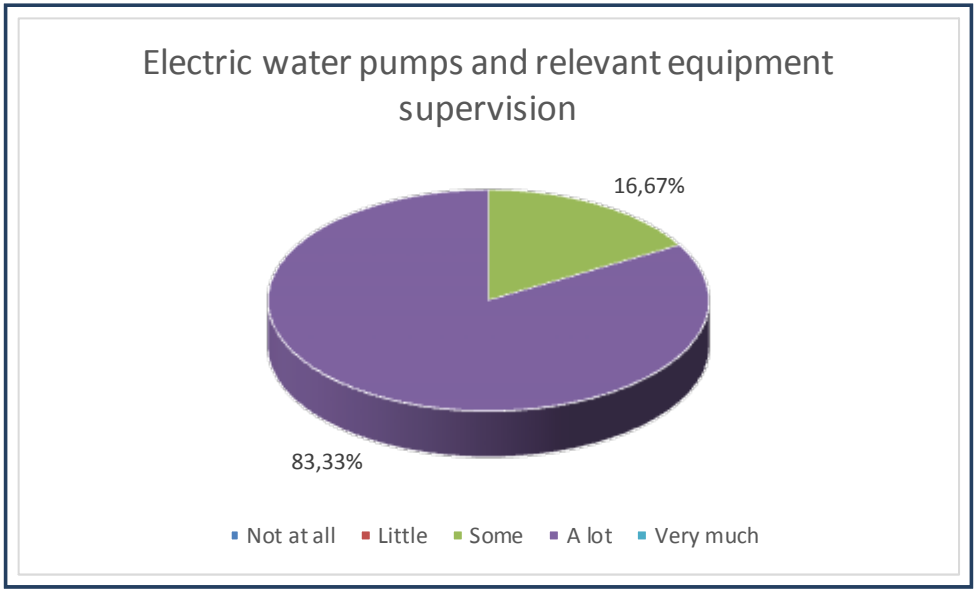
Technical plans and blueprints understanding




Formulated malfunction investigation and repair
8,33%
8,33%
33,33%
50,00%
Not at all
Little
Some
A lot
Very much


Formulated and reliable maintenance
16,67%
33,33%
50,00%
Not at all
Little
Some
A lot
Very much


Antifreeze protection techniques
8,33%
16,67%
75,00%
Not at all
Little
Some
A lot
Very much


Electric water pumps and relevant equipment supervision
16,67%
83,33%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the most needed labour skills that a technician should have in order to be able to carry out a solar thermal installation in France.

The following classified labour skills are considered very important and correspond from 70% and up of the French interviewees' choice:

	PERCENTAGE	LABOUR SKILLS
1	100%	**(C1.3) Coupling of solar thermal with space heating technologies**
2	100%	**(C1.2) Hot water needs calculation**
3	83,33%	**(C1.13) Electric water pumps and relevant equipment supervision**
4	75%	**(C1.8) Installation techniques of different type of panels (collectors)**
5	75%	**(C1.9) Technical plans and blueprints understanding**
6	75%	**(C1.12) Antifreeze protection techniques**
7	75%	**(C1.4) Boiler dimensioning and efficient positioning**
8	75%	**(C1.1) Optimal angle of panels' gradient calculation**
9	75%	**(C1.7) Efficient panels-boiler-distribution coupling and mounting**

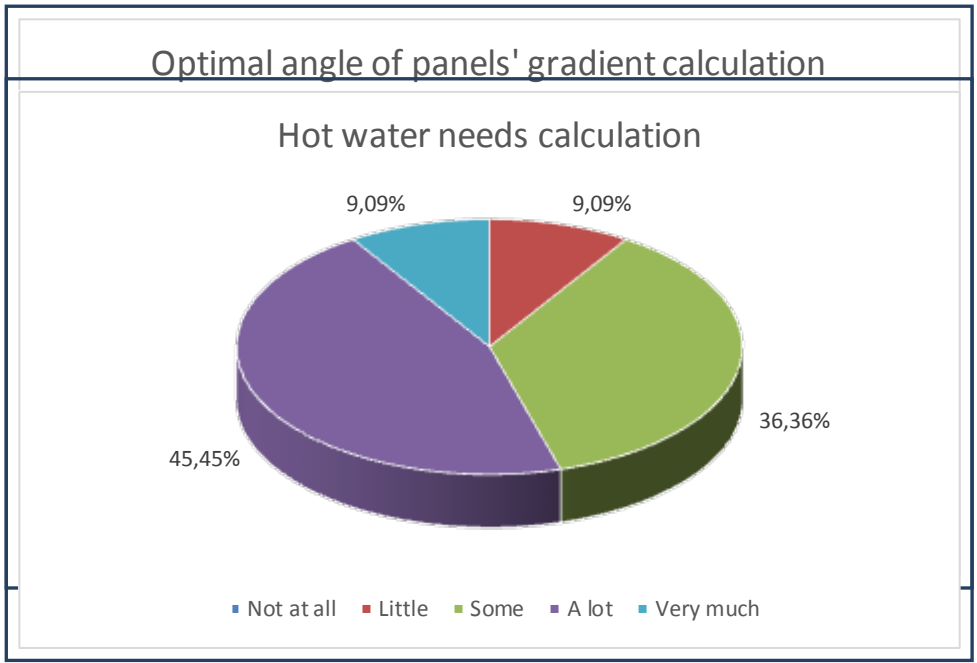
The following listed labour skills are considered as less important as correspond to less than 70% of French respondent's choices:

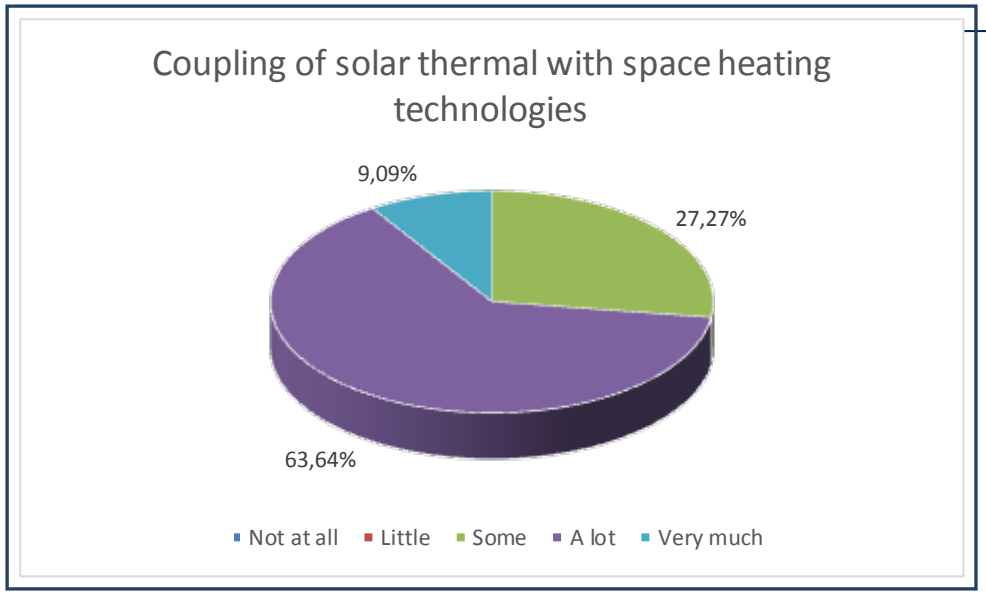
	PERCENTAGE	LABOUR SKILLS
1	66,67%	**(C1.11) Formulated and reliable maintenance**
2	58,33%	**(C1.10) Formulated malfunction investigation and repair**
3	50%	**(C1.5) Insulation and sealing techniques**
4	50%	**(C1.6) Optimal architecture selection (Active/passive, closed/open loop, hybrid)**

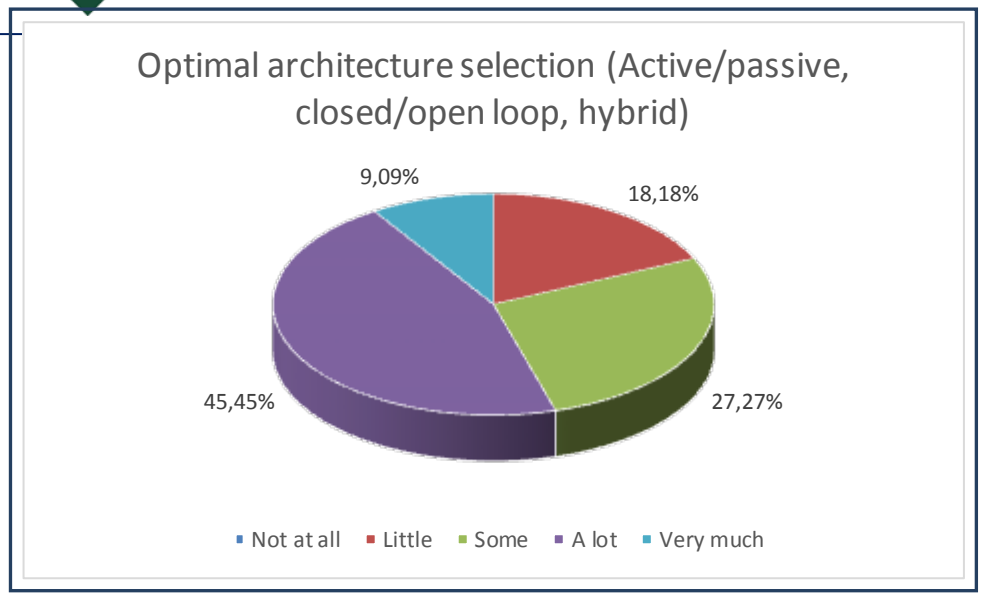
The case of Greece:

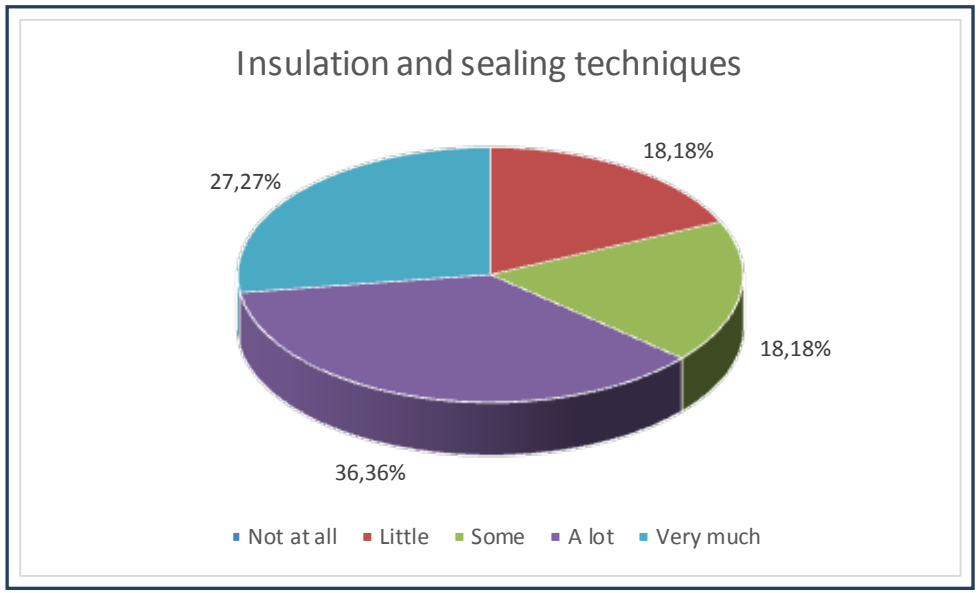
In question (C1) the interviewees were asked to evaluate a list of labour skills that a technician should possess in order to perform his/her profession and, in the case that the list is not being complete interviewees were asked to add others they considered as important.

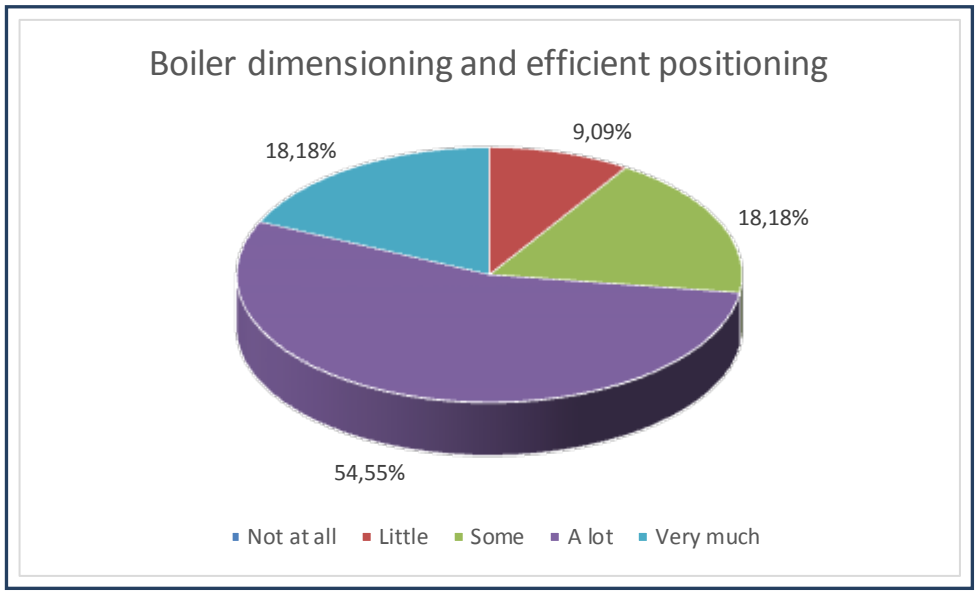
Below are presented the answers that the Greek interviewers gave in (C1) question. The graphs show the results for each labour skill:

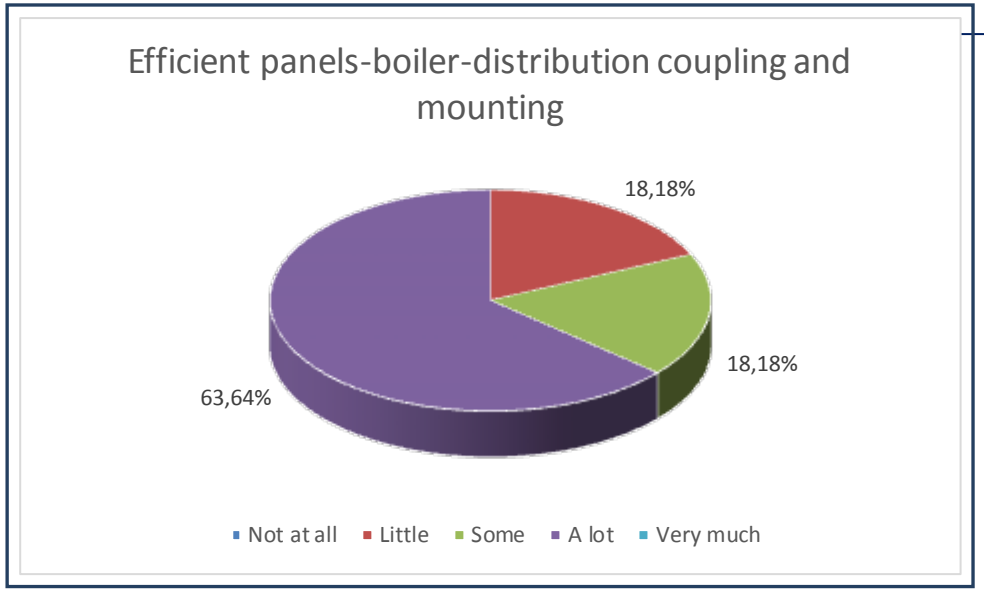


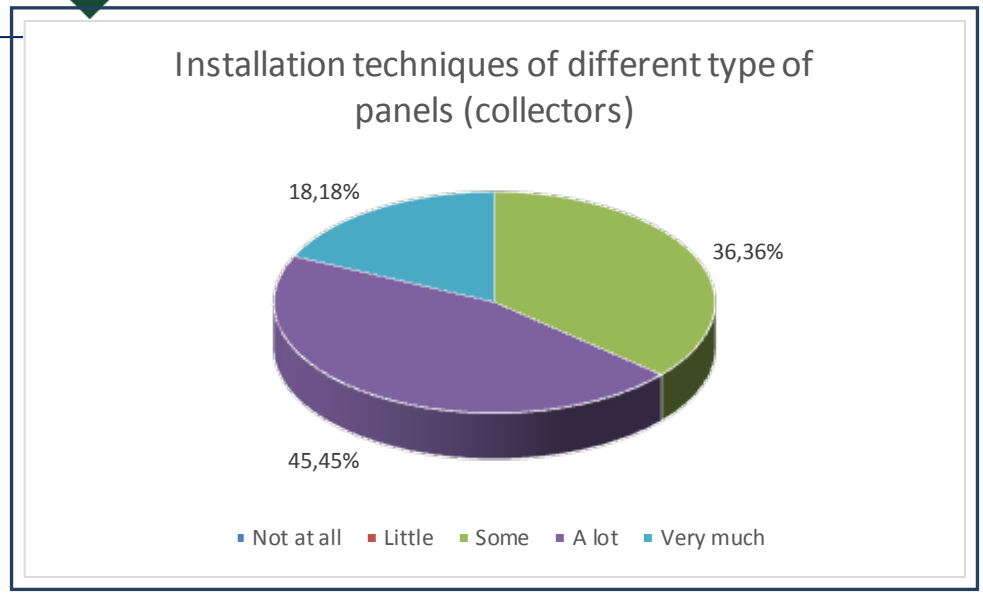

Coupling of solar thermal with space heating technologies
9,09%
27,27%
63,64%
Not at all
Little
Some
A lot
Very much

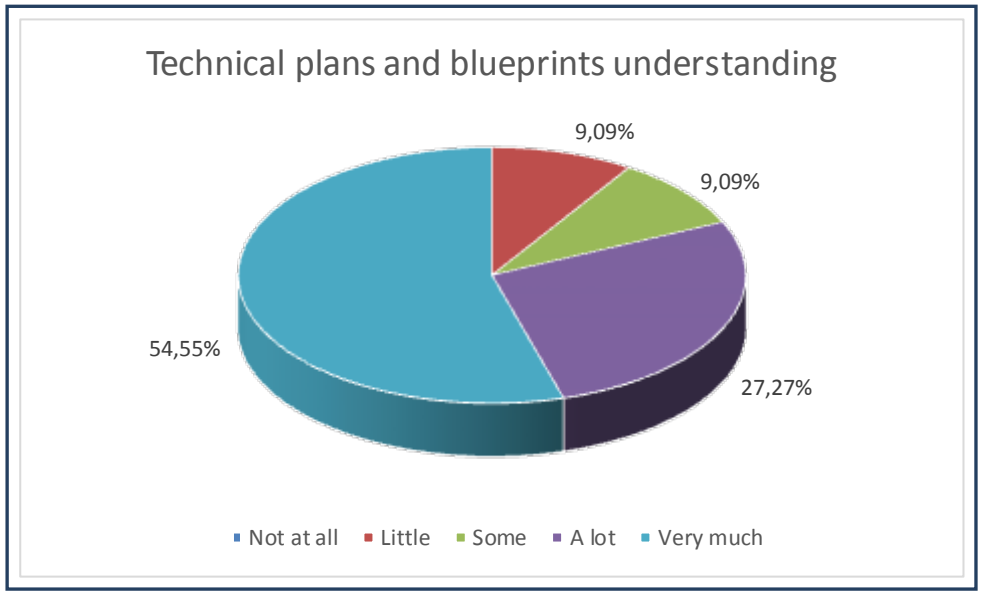

Optimal architecture selection (Active/passive, closed/open loop, hybrid)
9,09%
18,18%
45,45%
27,27%
Not at all
Little
Some
A lot
Very much

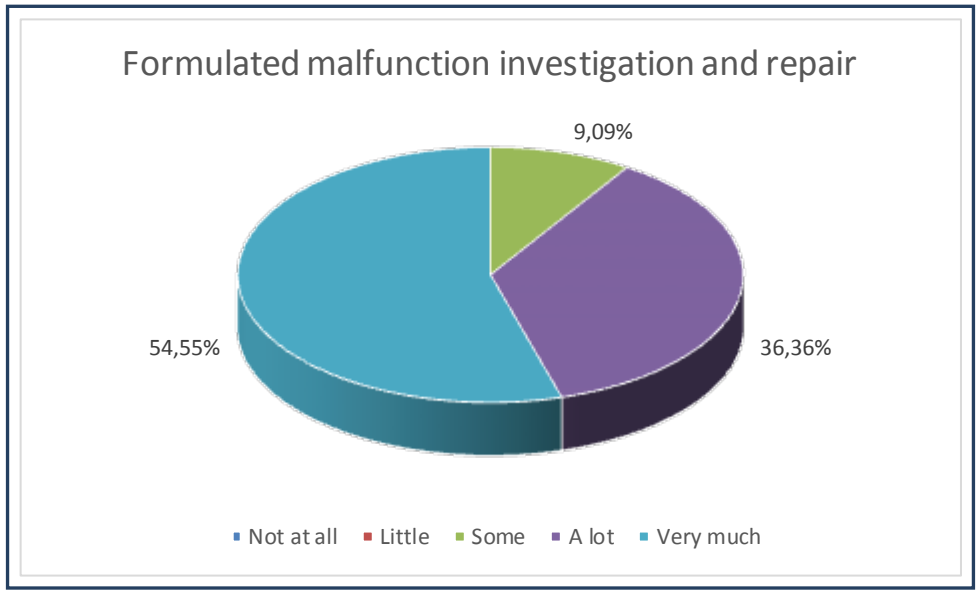

Insulation and sealing techniques
18,18%
27,27%
18,18%
36,36%
Not at all
Little
Some
A lot
Very much

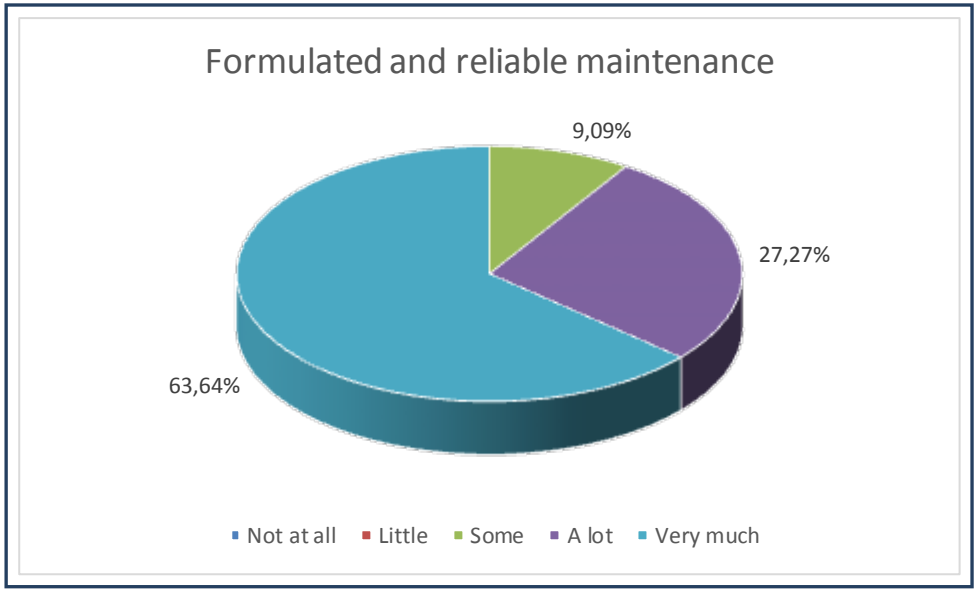

Boiler dimensioning and efficient positioning
9,09%
18,18%
18,18%
54,55%
Not at all
Little
Some
A lot
Very much

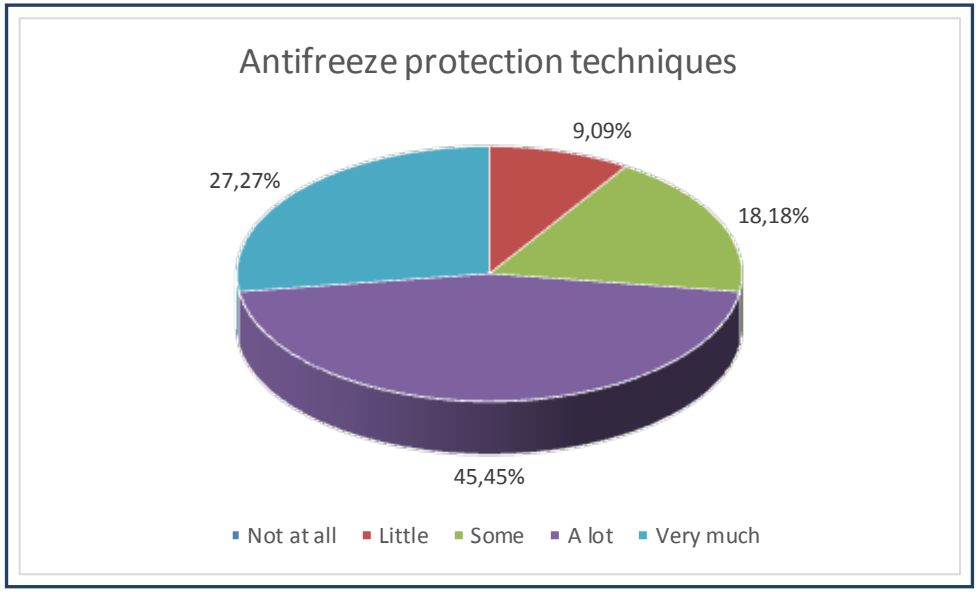

Efficient panels-boiler-distribution coupling and mounting
18,18%
18,18%
63,64%
Not at all
Little
Some
A lot
Very much

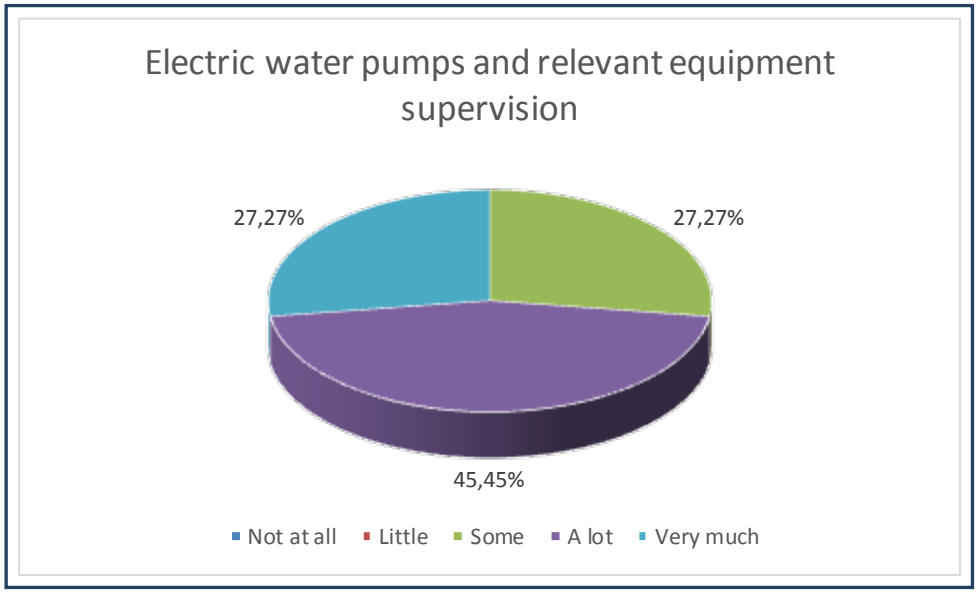

Installation techniques of different type of panels (collectors)
18,18%
36,36%
45,45%
Not at all
Little
Some
A lot
Very much


Technical plans and blueprints understanding
9,09%
9,09%
54,55%
27,27%
Not at all
Little
Some
A lot
Very much


Formulated malfunction investigation and repair
9,09%
54,55%
36,36%
Not at all
Little
Some
A lot
Very much


Formulated and reliable maintenance
9,09%
27,27%
63,64%
Not at all
Little
Some
A lot
Very much


Antifreeze protection techniques
9,09%
27,27%
18,18%
45,45%
Not at all
Little
Some
A lot
Very much


Electric water pumps and relevant equipment supervision
27,27%
27,27%
45,45%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the most needed labour skills that a technician should have in order to be able to carry out a solar thermal installation in Greece.

The following classified labour skills are considered very important and correspond from 70% and up of the Greek interviewees' choice:

	PERCENTAGE	LABOUR SKILLS
1	90,91%	**(C1.11) Formulated and reliable maintenance**
2	90,91%	**(C1.10) Formulated malfunction investigation and repair**
3	81,82%	**(C1.9) Technical plans and blueprints understanding**
4	72,73%	**(C1.3) Coupling of solar thermal with space heating technologies**
5	72,73%	**(C1.13) Electric water pumps and relevant equipment supervision**
6	72,73%	**(C1.12) Antifreeze protection techniques**
7	72,73%	**(C1.4) Boiler dimensioning and efficient positioning**
8	72,73%	**(C1.1) Optimal angle of panels' gradient calculation**

The following listed labour skills are considered as less important as correspond to less than 70% of Greek respondent's choices:

	PERCENTAGE	LABOUR SKILLS
1	54,55%	**(C1.2) Hot water needs calculation**
2	54,55%	**(C1.6) Optimal architecture selection (Active/passive, closed/open loop, hybrid)**
3	63,64%	**(C1.5) Insulation and sealing techniques**
4	63,64%	**(C1.8) Installation techniques of different type of panels (collectors)**

Greece:

Mass calculation of hot water, floor heating

5	63,64%	**(C1.7) Efficient panels-boiler-distribution coupling and mounting**

In question (C2) the Greek interviewees were asked to indicate any labour skill they consider that is essential for technician of solar thermal installations. Besides the skills listed in the questionnaire, one of the ten Greek interviewees filled out the (C2) open question of the questionnaire - field named as "other", with skills not listed in the questionnaire and that he/she considered as relevant and important.

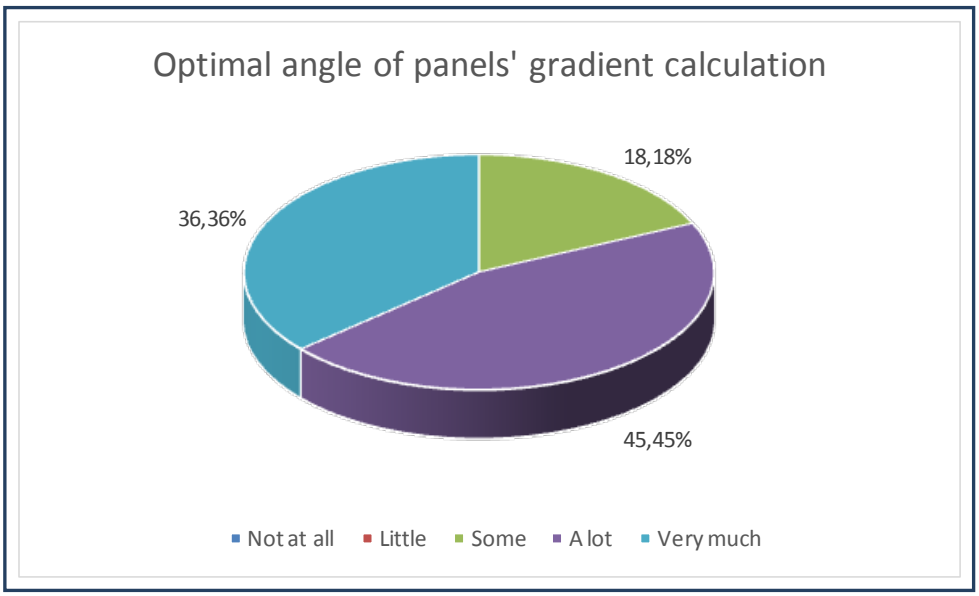
The essential skills that were proposed are the following:

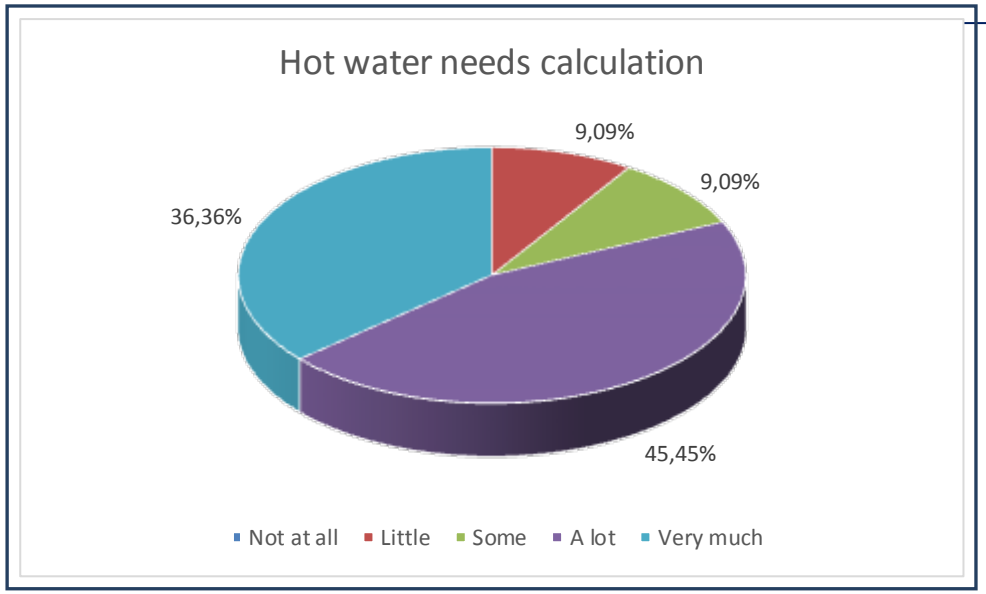
The case of Spain:

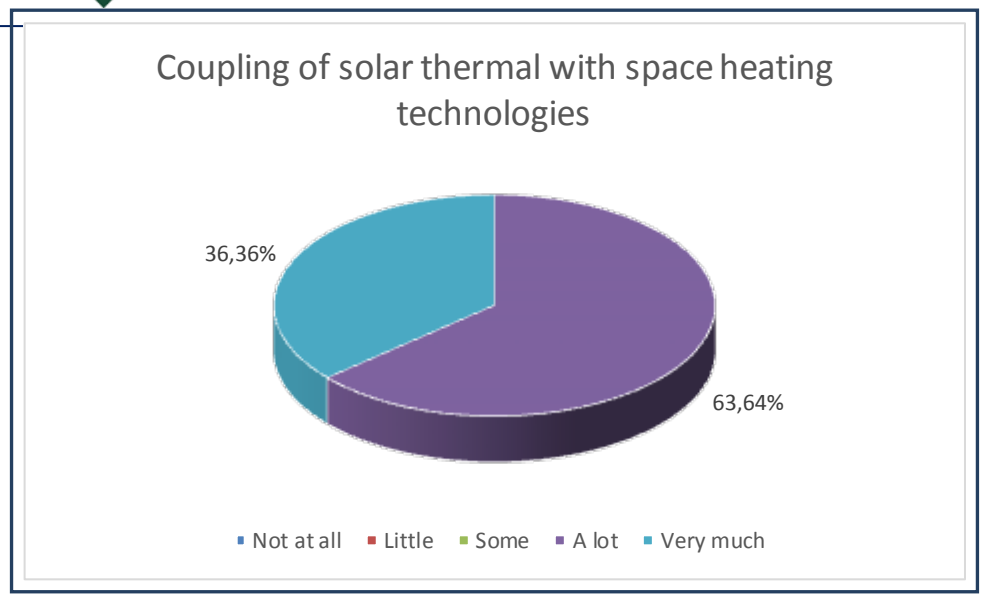
In question (C1) the interviewees were asked to evaluate a list of labour skills that a technician should possess in order to perform his/her profession and, in the case that the

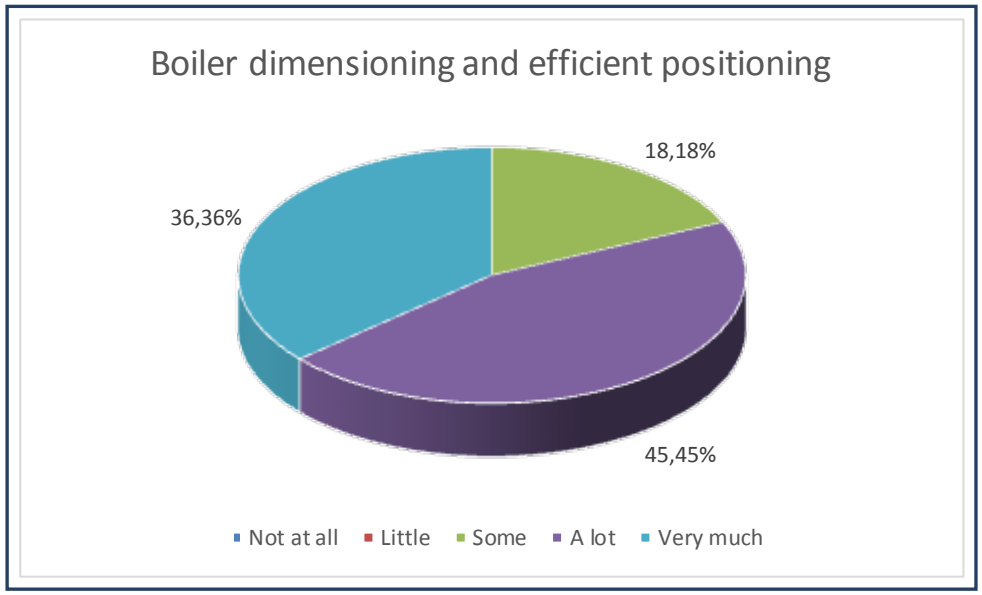
list is not being complete interviewees were asked to add others they considered as important.

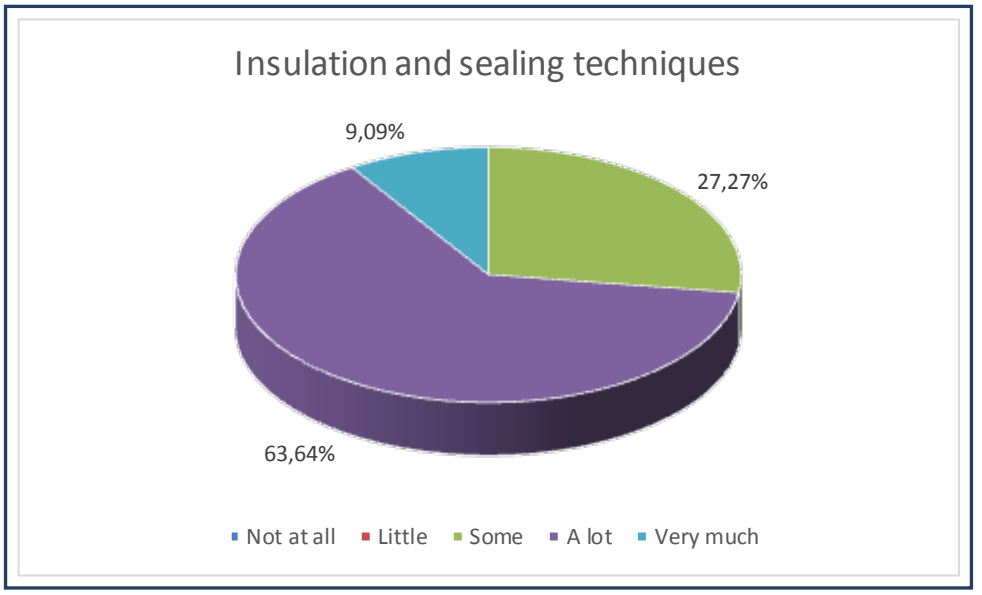
Below are presented the answers that the Spanish interviewers gave in (C1) question. The graphs show the results for each labour skill:

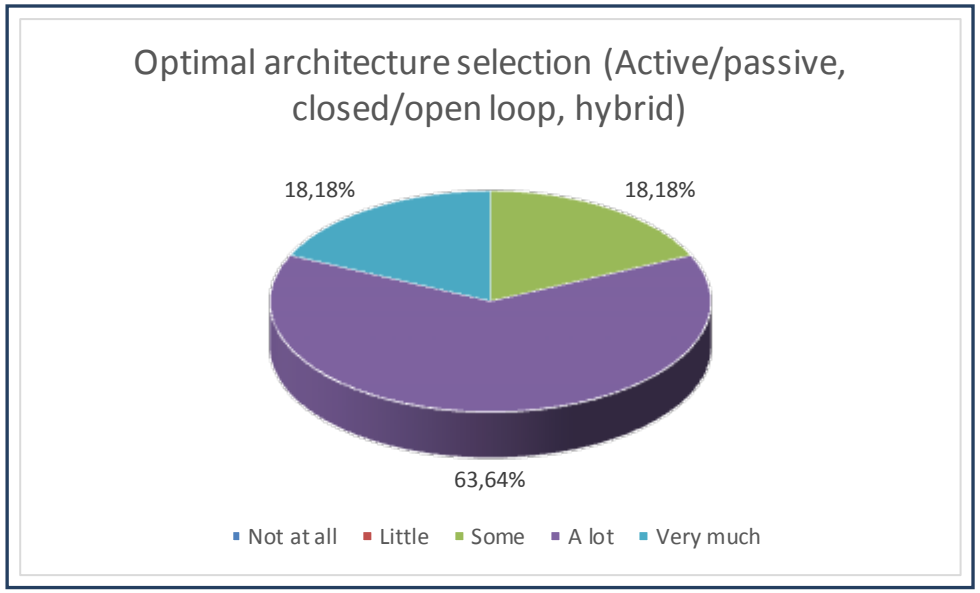


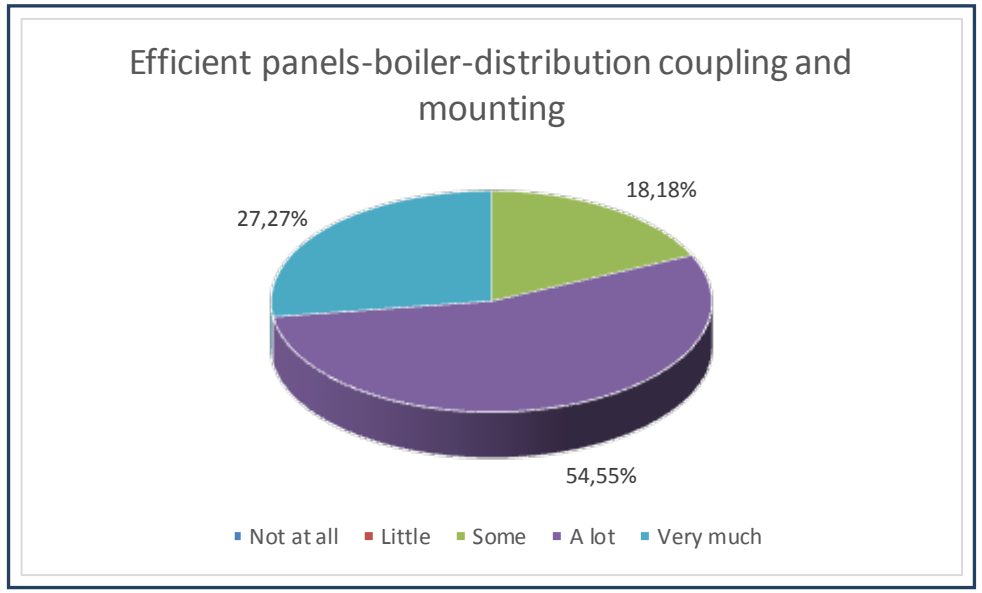

Hot water needs calculation
9,09%
9,09%
36,36%
45,45%
Not at all
Little
Some
A lot
Very much

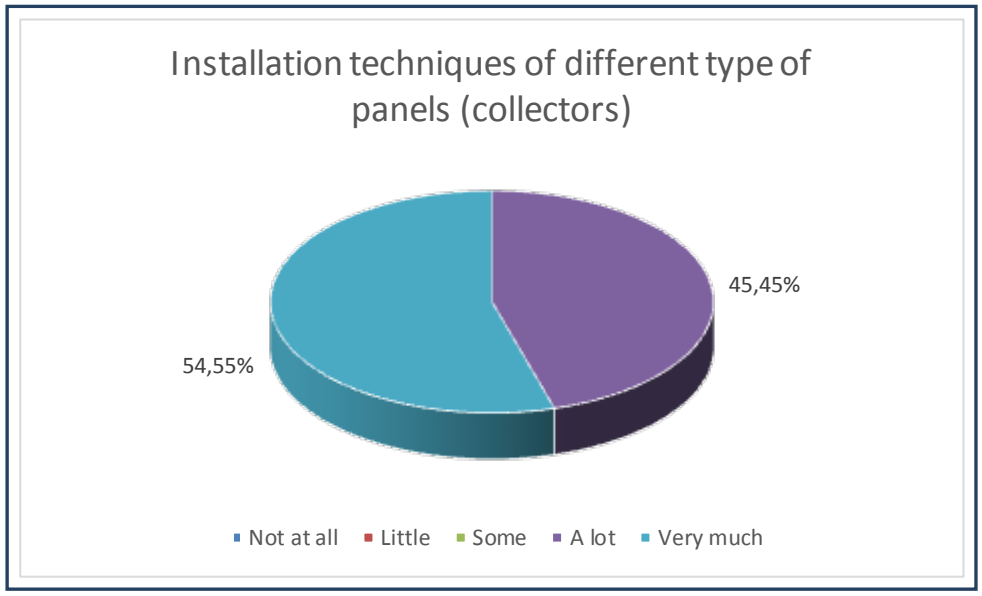

Coupling of solar thermal with space heating technologies
36,36%
63,64%
Not at all
Little
Some
A lot
Very much

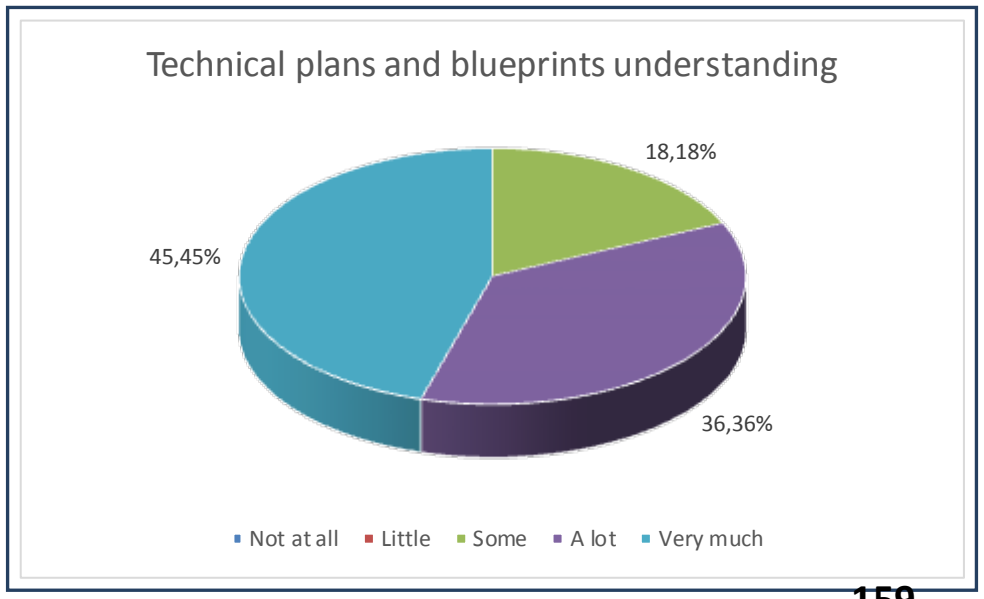

Boiler dimensioning and efficient positioning
18,18%
36,36%
45,45%
Not at all
Little
Some
A lot
Very much

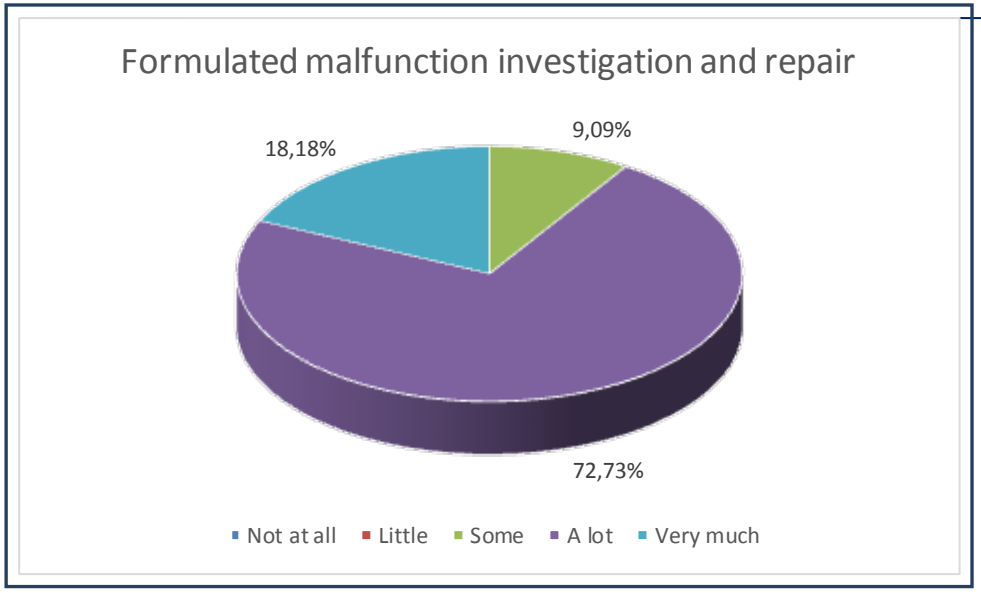

Insulation and sealing techniques
9,09%
27,27%
63,64%
Not at all
Little
Some
A lot
Very much

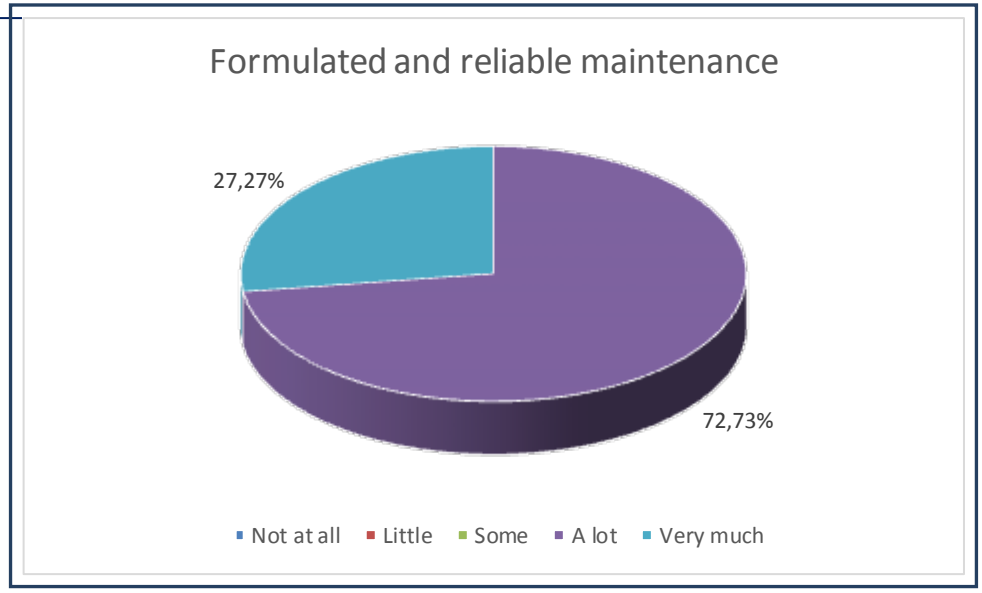

Optimal architecture selection (Active/passive, closed/open loop, hybrid)
18,18%
18,18%
63,64%
Not at all
Little
Some
A lot
Very much

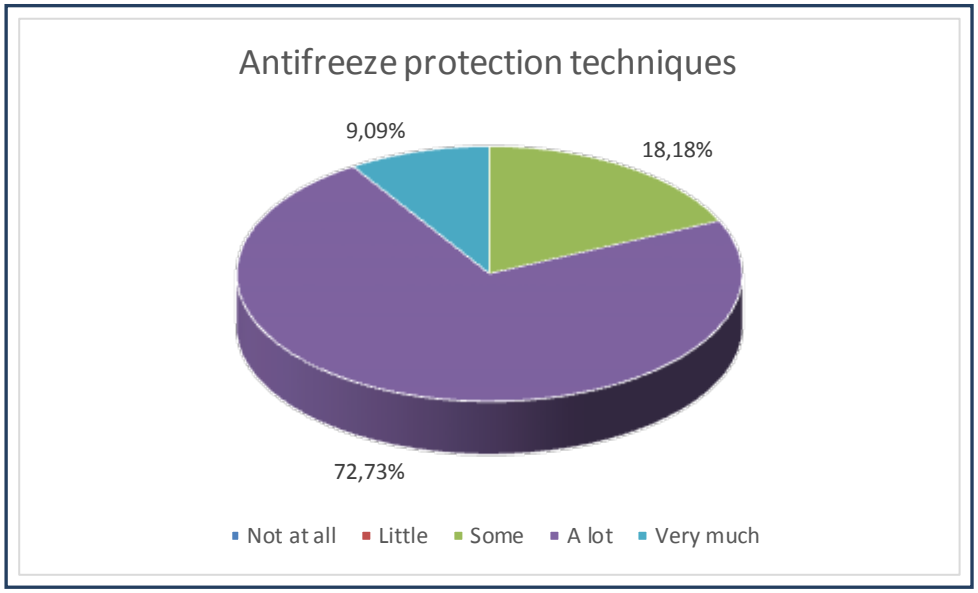

Efficient panels-boiler-distribution coupling and mounting
27,27%
18,18%
54,55%
Not at all
Little
Some
A lot
Very much

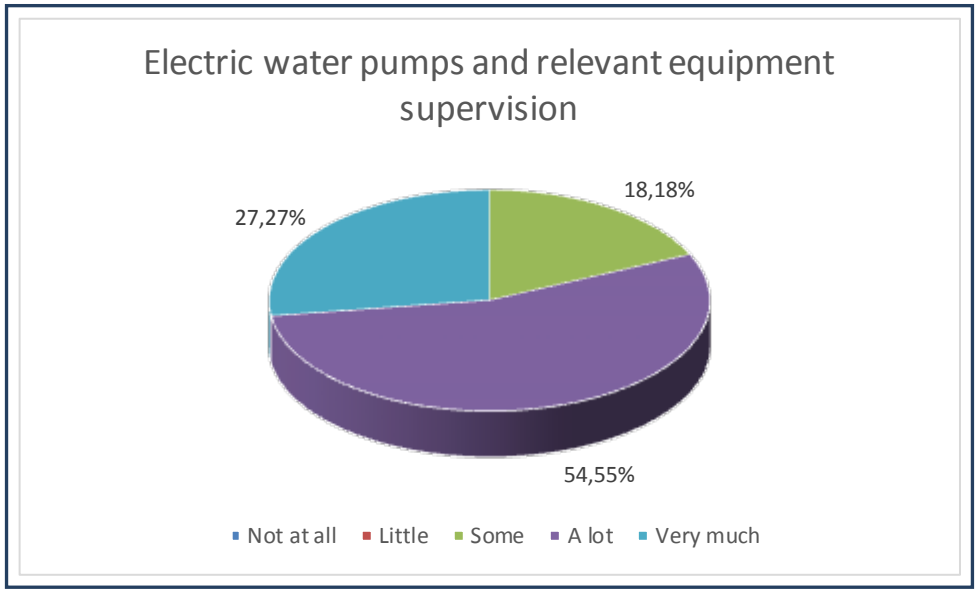

Installation techniques of different type of panels (collectors)
45,45%
54,55%
Not at all
Little
Some
A lot
Very much


Technical plans and blueprints understanding
18,18%
45,45%
36,36%
Not at all
Little
Some
A lot
Very much


Formulated malfunction investigation and repair
9,09%
18,18%
72,73%
Not at all
Little
Some
A lot
Very much


Formulated and reliable maintenance
27,27%
72,73%
Not at all
Little
Some
A lot
Very much


Antifreeze protection techniques
9,09%
18,18%
72,73%
Not at all
Little
Some
A lot
Very much


Electric water pumps and relevant equipment supervision
18,18%
27,27%
54,55%
Not at all
Little
Some
A lot
Very much

From the results obtained by the analysis of the questionnaires it is possible to prepare a list with the most needed labour skills that a technician should have in order to be able to carry out a solar thermal installation in Spain.

The interviewees from Spain evaluated all the listed labour skills in the questionnaire really important for a technician, as all of the proposed skills correspond from 70% and up of the interviewees' choice:

	PERCENTAGE	LABOUR SKILLS
1	100%	**(C1.10) Formulated malfunction investigation and repair**
2	100%	**(C1.3) Coupling of solar thermal with space heating technologies**
3	100%	**(C1.8) Installation techniques of different type of panels (collectors)**
4	90,91%	**(C1.11) Formulated and reliable maintenance**
5	81,82%	**(C1.2) Hot water needs calculation**
6	81,82%	**(C1.9) Technical plans and blueprints understanding**
7	81,82%	**(C1.6) Optimal architecture selection (Active/passive, closed/open loop, hybrid)**
8	81,82%	**(C1.13) Electric water pumps and relevant equipment supervision**
9	81,82%	**(C1.12) Antifreeze protection techniques**

10	81,82%	**(C1.7) Efficient panels-boiler-distribution coupling and mounting**
11	81,82%	**(C1.4) Boiler dimensioning and efficient positioning**
12	81,82%	**(C1.1) Optimal angle of panels' gradient calculation**
13	71,73%	**(C1.5) Insulation and sealing techniques**

Chapter III

Concluding remarks

Conclusions

The main aim of this survey was to specify what skills and competencies are required to work in specific jobs (plumbers and electricians) in green installations sector. As a result of the available resources, was done a comparative analysis in order to identify the qualifications required for the professions of plumbers and electricians in geothermal and solar – thermal installations, as well as, to identify the geographical characteristics of each participating country.

The aims of this report is to specify which theoretical and practical skills are required for the implementation of geothermal and solar installations in consortium countries and it also aim to qualify the actual educational needs of low-skilled workers for updating their professional skills according to new technologies that are being applied in their sector, and specific in green installations.

Companies and employers involved in green plants, specifically in geothermal and solar installations in each participating country have been contacted and filled the questionnaires of GSSkills research in order to enrich the existing data for qualifications and skills required for the successful implementation of geothermal and solar installations.

According to the GSSkills research results reported in the chapter II of this report we classified below the theoretical and practical skills that are required for the implementation of geothermal and solar installations in consortium countries.

4.Geothermal Installations

4.1.Theoretical competences for geothermal installations in France

From the results obtained by the analysis of the questionnaires below is presented a list with the theoretical knowledge that a technician should have in order to be able to carry out a geothermal installation in France.

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	90,00%	(B1.8)Knowledge of low surface geological principles and earth heat exchange basics,
2	80,00%	(B1.4) Knowledge of accompaniment circuit boards, and electronic equipment
3	80,00%	(B1.13) Knowledge of HVAC systems basic structure and operation principles and obstacles.
4	70,00%	(B1.5) Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods
5	70,00%	(B1.7) Knowledge of seasonal thermal energy storage and thermal efficiency techniques
6	70,00%	(B1.12) Knowledge of the contemporary development and future trends of geothermal energy,
7	63,64%	(B1.11) Knowledge of the worldwide state of the art in geothermal applications,
8	60,00%	(B1.2) Knowledge of HVAC relevant costs and quality control
9	60,00%	(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric

		dynamics)
10	**60,00%**	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**
11	**55,56%**	**(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints**
12	**50,00%**	**(B3.7) Building distribution systems**
13	**50,00%**	**(B3.5) Heat pump's structure and operation**
14	**50,00%**	**(B3.6) Types of geothermal heat pump**
15	**50,00%**	**(B3.4) Geothermal heating**
16	**40,00%**	**(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**
17	**40,00%**	**(B1.10) Knowledge of switching, control, and operation of electrical part of the systems,**
18	**40,00%**	**(B3.8) Thermal storage techniques**
19	**30,00%**	**(B3.3) Fluid dynamics basics**

20	**30,00%**	**(B3.2) Earth's internal heat and geothermal gradient**
21	**20,00%**	**(B3.1) Energy audits principles and classification**

4.2 Theoretical competences for geothermal installations in Greece

From the results obtained by the analysis of the questionnaires below is presented a list with the theoretical knowledge that a technician should have in order to be able to carry out a geothermal installation in Greece.

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	88,89%	(B1.12) Knowledge of the contemporary development and future trends of geothermal energy,
2	77,78%	(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness
3	77,78%	(B1.2) Knowledge of HVAC relevant costs and quality control
4	77,78%	(B1.8)Knowledge of low surface geological principles and earth heat exchange basics,
5	77,78%	(B1.11) Knowledge of the worldwide state of the art in geothermal applications,
6	77,78%	(B3.3) Fluid dynamics basics
7	66,67%	(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
8	66,67%	(B1.10) Knowledge of switching, control, and operation of electrical part of the systems,
9	66,67%	(B3.7) Building distribution systems
10	66,67%	(B3.5) Heat pump's structure and operation

11	**66,67%**	**(B3.6) Types of geothermal heat pump**
12	**66,67%**	**(B3.4) Geothermal heating**
13	**66,67%**	**(B3.8) Thermal storage techniques**
14	**55,56%**	**(B3.2) Earth's internal heat and geothermal gradient**
15	**55,56%**	**(B3.1) Energy audits principles and classification**
16	**44,44%**	**(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)**
17	**44,44%**	**(B1.4) Knowledge of accompaniment circuit boards, and electronic equipment**
18	**44,44%**	**(B1.5) Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods**
19	**33,33%**	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**
20	**33,33%**	**(B1.7) Knowledge of seasonal thermal energy storage and thermal efficiency techniques**

2 1	**33,33%**	**(B1.13) Knowledge of HVAC systems basic structure and operation principles and obstacles.**

4.3 Theoretical competences for geothermal installations in Spain

From the results obtained by the analysis of the questionnaires below is presented a list with the theoretical knowledge that a technician should have in order to be able to carry out a geothermal installation in Spain.

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	100,00%	(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints
2	92,86%	(B1.4) Knowledge of accompaniment circuit boards, and electronic equipment
3	92,86%	(B1.13) Knowledge of HVAC systems basic structure and operation principles and obstacles.
4	92,86%	(B1.2) Knowledge of HVAC relevant costs and quality control
5	92,86%	(B1.10) Knowledge of switching, control, and operation of electrical part of the systems,
6	85,71%	(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation
7	85,71%	(B3.7) Building distribution systems
8	78,57%	(B1.8)Knowledge of low surface geological principles and earth heat exchange basics,
9	78,57%	(B1.7) Knowledge of seasonal thermal energy storage and thermal efficiency techniques
10	78,57%	(B3.5) Heat pump's structure and operation
1	78,57%	(B3.6) Types of geothermal heat pump

1		
12	**77,57%**	**(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**
13	**71,43%**	**(B1.5) Knowledge of the relevant chemicals, properties of substances and their interactions, danger signs, production techniques, and disposal methods**
14	**71,43%**	**(B1.12) Knowledge of the contemporary development and future trends of geothermal energy,**
15	**71,43%**	**(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding fluid mechanics, and atmospheric dynamics)**
16	**71,43%**	**(B3.8) Thermal storage techniques**
17	**71,43%**	**(B3.3) Fluid dynamics basics**
18	**64,29%**	**(B1.11) Knowledge of the worldwide state of the art in geothermal applications,**
19	**64,29%**	**(B3.4) Geothermal heating**
20	**64,29%**	**(B3.1) Energy audits principles and classification**
2	**50,00%**	**(B3.2) Earth's internal heat and geothermal**

1		**gradient**

4.4 Labour skills for geothermal installations in France

From the results obtained by the analysis of the questionnaires it was prepared a list with the labour skills that a technician should have in order to be able to carry out a geothermal installation in France.

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	90%	**(C1.8) Installation techniques and handling of different type of tubes,**
2	90%	**(C1.3) Coupling of ground heat exchanger with heat pumps technologies,**
3	80%	**(C1.9) Technical plans and blueprints understanding,**
4	80%	**(C1.11) Formulated and reliable maintenance,**
5	80%	**(C1.4) Heat exchanger dimensioning and positioning,**
6	80%	**(C1.7) Efficient heat exchanger-heat pump-distribution coupling and mounting,**
7	80%	**(C1.2) Thermal energy balance and total needs calculation,**
8	70%	**(C1.6) Building distribution system installation (*fun coils, etc.*),**
9	70%	**(C1.12) Drilling techniques, reliable and effective restoration,**
10	70%	**(C1.13) Electric water pumps and relevant equipment supervision.**

11	50%	**(C1.1) Optimal architecture selection (horizontal/vertical, closed/open loop, direct/indirect),**
12	40%	**(C1.5) Insulation and sealing techniques,**

4.5 Labour skills for geothermal installations in Greece

From the results obtained by the analysis of the questionnaires it was prepared a list with the labour skills that a technician should have in order to be able to carry out a geothermal installation in Greece.

	PERCENTANCE	LABOUR SKILLS
1	100%	**Formulated and reliable maintenance**
2	100%	**Drilling techniques, reliable and effective restoration**
3	88,89%	**Insulation and sealing techniques**
4	88,89%	**Building distribution system installation (*fun coils, etc.*):**
5	88,89%	**Installation techniques and handling of different type of tubes**
6	88,89%	**Technical plans and blueprints understanding**
7	88,89%	**Formulated malfunction investigation and repair**
8	88,89%	**Electric water pumps and relevant equipment supervision**
9	77,78%	**Heat exchanger dimensioning and positioning:**
10	77,78%	**Efficient heat exchanger-heat pump-distribution coupling and mounting**
11	66,67%	**Optimal architecture selection (*horizontal/vertical, closed/open loop, direct/indirect*)**
12	66,67%	**Thermal energy balance and total needs calculation**

13	66,67%	**Coupling of ground heat exchanger with heat pumps technologies:**

4.6 Labour skills for geothermal installations in Spain

From the results obtained by the analysis of the questionnaires it was prepared a list with the labour skills that a technician should have in order to be able to carry out a geothermal installation in Spain.

	PERCENTANCE	LABOUR SKILLS
1	100%	**Heat exchanger dimensioning and positioning:**
2	100%	**Building distribution system installation (*fun coils, etc.*):**
3	100%	**Installation techniques and handling of different type of tubes:**
4	100%	**Technical plans and blueprints understanding:**
5	100%	**Drilling techniques, reliable and effective restoration:**
6	92,86%	**Electric water pumps and relevant equipment supervision:**
17	92,86%	**Optimal architecture selection (*horizontal/vertical, closed/open loop, direct/indirect*):**
28	92,86%	**Thermal energy balance and total needs calculation:**
9	92,86%	**Insulation and sealing techniques:**
10	92,86%	**Efficient heat exchanger-heat pump-distribution coupling and mounting:**
11	92,86%	**Formulated malfunction investigation and repair:**
12	92,86%	**Formulated and reliable maintenance:**

13	78,57%	**Coupling of ground heat exchanger with heat pumps technologies:**

5 Solar - thermal Installations

5.1 Theoretical competences for solar - thermal installations in France

From the results obtained by the analysis of the questionnaires below is presented a list with the theoretical knowledge that a technician should have in order to be able to carry out a solar thermal installation in France.

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	100%	**(B1.7) Knowledge of hot water storage technologies and thermal efficiency techniques**
2	100%	**(B1.13) Knowledge of panel types basic structure and operation principles and obstacles**
3	91,67%	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**
4	83,33%	**(B1.2) Knowledge of space and water heat relevant costs and quality control**
5	83,33%	**(B1.8) Knowledge of thermodynamics principles and heat exchange basics**
6	75%	**(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**
7	75%	**(B1.5) Knowledge of hot water uses and space**

		heating calculations
8	75%	**(B1.10) Knowledge of switching, control, and operation of electrical part of the systems**
9	66,67%	**(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints**
10	66,67%	**(B1.12) Knowledge of the contemporary development and future trends of solar thermal**
11	58,33%	**Insulation material, types and techniques**
12	58,33%	**Types of solar thermal water circulation**
13	58,33%	**Building distribution systems**
14	58,33%	**Thermal storage systems**
15	58,33%	**Solar radiation and heat exchange basics**
16	50%	**(B1.4) Knowledge of accompaniment electric pumps, and ventilators**
1	41,67%	**(B1.3) Knowledge of physical principles, laws and**

7		**their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)**
18	41,67%	**Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
19	41,67%	**Solar panel structure and operation**
20	33,33%	**(B1.11) Knowledge of the worldwide state of the art in solar thermal applications**
21	33,33%	**Energy audits principles and classification**

5.2 Theoretical competences for solar - thermal installations in Greece

From the results obtained by the analysis of the questionnaires below is presented a list with the theoretical knowledge that a technician should have in order to be able to carry out a solar thermal installation in Greece.

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	81,92%	**(B1.13) Knowledge of panel types basic structure and operation principles and obstacles**
2	81,82%	**Solar panel structure and operation**
3	81,82%	**Building distribution systems**
4	81,82%	**Thermal storage systems**
5	72,73%	**Types of solar thermal water circulation**
6	72,73%	**Insulation material, types and techniques**
7	72,73%	**(B1.10) Knowledge of switching, control, and operation of electrical part of the systems**
8	63,64%	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**
9	63,64%	**(B1.5) Knowledge of hot water uses and space heating calculations**
10	63,64%	**Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**
1	63,64%	**Solar radiation and heat exchange basics**

1		
12	54,55%	**(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**
13	54,55%	**(B1.7) Knowledge of hot water storage technologies and thermal efficiency techniques**
14	54,55%	**(B1.12) Knowledge of the contemporary development and future trends of solar thermal**
15	45,45%	**(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)**
16	36,36%	**(B1.11) Knowledge of the worldwide state of the art in solar thermal applications**
17	36,36%	**(B1.4) Knowledge of accompaniment electric pumps, and ventilators**
18	36,36%	**(B1.8) Knowledge of thermodynamics principles and heat exchange basics**
19	27,27%	**(B1.2) Knowledge of space and water heat relevant costs and quality control**
2	27,27%	**(B1.9) Knowledge of design techniques, and**

0		**tools, involved in production of precision technical plans, and blueprints**
2 1	27,27%	**Energy audits principles and classification**

5.3 Theoretical competences for solar - thermal installations in Spain

From the results obtained by the analysis of the questionnaires below is presented a list with the theoretical knowledge that a technician should have in order to be able to carry out a solar thermal installation in Spain.

	PERCENTAGE	THEORETICAL KNOWLEDGE
1	90,91%	**(B1.5) Knowledge of hot water uses and space heating calculations**
2	90,91%	**(B1.13) Knowledge of panel types basic structure and operation principles and obstacles**
3	81,82%	**(B1.10) Knowledge of switching, control, and operation of electrical part of the systems**
4	81,82%	**(B1.4) Knowledge of accompaniment electric pumps, and ventilators**
5	81,82%	**(B1.7) Knowledge of hot water storage technologies and thermal efficiency techniques**
6	72,73%	**(B1.12) Knowledge of the contemporary development and future trends of solar thermal**
7	72,73%	**(B1.6) Knowledge of building thermal distribution systems and relevant equipment operation**
8	72,73%	**Solar panel structure and operation**

9	72,73%	**Building distribution systems**
10	72,73%	**Thermal storage systems**
11	63,64%	**(B1.2) Knowledge of space and water heat relevant costs and quality control**
12	63,64%	**(B1.1) Knowledge of specific raw materials, insulation processes and techniques for maximizing effectiveness**
13	63,64%	**Solar radiation and heat exchange basics**
14	63,64%	**Insulation material, types and techniques**
15	63,64	**Types of solar thermal water circulation**
16	54,55%	**(B1.11) Knowledge of the worldwide state of the art in solar thermal applications**
17	45,45%	**(B1.8) Knowledge of thermodynamics principles and heat exchange basics**
18	45,45%	**(B1.9) Knowledge of design techniques, and tools, involved in production of precision technical plans, and blueprints**

19	45,45%	**(B1.3) Knowledge of physical principles, laws and their interrelationships with applied science (understanding solar physics, seasonal variables, and atmospheric dynamics)**
20	45,45%	**Energy audits principles and classification**
21	45,45%	**Solar energy fundamentals and solar geometry (sun elevation, azimuth and latitude)**

5.4 Labour skills for solar - thermal installations in France

From the results obtained by the analysis of the questionnaires it was prepared a list with the labour skills that a technician should have in order to be able to carry out a solar - thermal installation in France.

	PERCENTAGE	LABOUR SKILLS
1	100%	**(C1.3) Coupling of solar thermal with space heating technologies**
2	100%	**(C1.2) Hot water needs calculation**
3	83,33%	**(C1.13) Electric water pumps and relevant equipment supervision**
4	75%	**(C1.8) Installation techniques of different type of panels (collectors)**
5	75%	**(C1.9) Technical plans and blueprints understanding**
6	75%	**(C1.12) Antifreeze protection techniques**
7	75%	**(C1.4) Boiler dimensioning and efficient positioning**
8	75%	**(C1.1) Optimal angle of panels' gradient calculation**
9	75%	**(C1.7) Efficient panels-boiler-distribution coupling and mounting**
1	66,67%	**(C1.11) Formulated and reliable maintenance**

0		
11	58,33%	**(C1.10) Formulated malfunction investigation and repair**
12	50%	**(C1.5) Insulation and sealing techniques**
13	50%	**(C1.6) Optimal architecture selection (Active/passive, closed/open loop, hybrid)**

5.5 Labour skills for solar - thermal installations in Greece

From the results obtained by the analysis of the questionnaires it was prepared a list with the labour skills that a technician should have in order to be able to carry out a solar - thermal installation in Greece.

	PERCENTAGE	LABOUR SKILLS
1	90,91%	**(C1.11) Formulated and reliable maintenance**
2	90,91%	**(C1.10) Formulated malfunction investigation and repair**
3	81,82%	**(C1.9) Technical plans and blueprints understanding**
4	72,73%	**(C1.3) Coupling of solar thermal with space heating technologies**
5	72,73%	**(C1.13) Electric water pumps and relevant equipment supervision**
6	72,73%	**(C1.12) Antifreeze protection techniques**
7	72,73%	**(C1.4) Boiler dimensioning and efficient positioning**
8	72,73%	**(C1.1) Optimal angle of panels' gradient calculation**
9	63,64%	**(C1.5) Insulation and sealing techniques**
10	63,64%	**(C1.8) Installation techniques of different type of panels (collectors)**

11	63,64%	**(C1.7) Efficient panels-boiler-distribution coupling and mounting**
12	54,55%	**(C1.2) Hot water needs calculation**
13	54,55%	**(C1.6) Optimal architecture selection (Active/passive, closed/open loop, hybrid)**

5.6 Labour skills for solar - thermal installations in Spain

From the results obtained by the analysis of the questionnaires it was prepared a list with the labour skills that a technician should have in order to be able to carry out a solar - thermal installation in Spain.

	PERCENTAGE	LABOUR SKILLS
1	100%	**(C1.10) Formulated malfunction investigation and repair**
2	100%	**(C1.3) Coupling of solar thermal with space heating technologies**
3	100%	**(C1.8) Installation techniques of different type of panels (collectors)**
4	90,91%	**(C1.11) Formulated and reliable maintenance**
5	81,82%	**(C1.2) Hot water needs calculation**
6	81,82%	**(C1.9) Technical plans and blueprints understanding**
7	81,82%	**(C1.6) Optimal architecture selection (Active/passive, closed/open loop, hybrid)**
8	81,82%	**(C1.13) Electric water pumps and relevant equipment supervision**
9	81,82%	**(C1.12) Antifreeze protection techniques**
10	81,82%	**(C1.7) Efficient panels-boiler-distribution coupling and mounting**

11	81,82%	**(C1.4) Boiler dimensioning and efficient positioning**
12	81,82%	**(C1.1) Optimal angle of panels' gradient calculation**
13	71,73%	**(C1.5) Insulation and sealing techniques**

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