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D 2.8. European roadmap BIM applied to energy performance improvement report

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Revision and history chart

Version	Date	Editors	Comment Description
V0.1	22 April	Anna Moreno	First draft with table format for partners contribute
V0.2	23 June	Anna Moreno	Second contribute with some partner filling the tables
V1.0	24 July	Anna Moreno	New version with contribute of all partners and conclusion added
V 1.1	25 July	Anna Moreno	Integration of comments by Emanuele Mignone and Larissa De Rosso
V1.2	28 July	Anna Moreno	Integration of Dijana Likar comments and final revision

Publishable executive summary

This report provides inputs to develop a roadmap to get a workforce ready for the challenges of climate changes. The report starts recalling the requirements already defined in the European directives dealing with energy performance, the renewable energy sources, and the digitalization. Then, starting from the outputs of the previous deliverables, the roadmap briefly identifies the knowledge, the skills and the competences needed both on the demand side and the offer side to reach the goal of having our buildings more resilient to climate change and with less use of natural resources. In the second part the partners have provided the perception of the maturity level reached in their country for all the technologies considered important to improve the energy performance of the buildings.

Finally, some conclusions with the suggestions to “fill the gap” of competences are given.

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1. Introduction

Within WP2, a strategic plan has been developed to ensure that current and future stakeholders, interested in increasing the competences in the energy and digital domain can guarantee that current and future training materials are adequate to the continuous changes. The roadmaps start from an in-depth analysis of the status quo in the participating countries.

Not all the partners could gather the information on the national competences in the energy and digital domains in the building sector because there does not exist a national register to consult. Nevertheless, we had the opportunity to understand what is necessary to improve the capacity of the workforce to make buildings more resilient to climate changes. The roadmaps here described can be only considered as a “brainstorming” useful to identify the gap to be filled. The roadmap should allow any company, public administration, or individual to understand the gap of competences and take the advantages of all innovative energy and digital technologies.

The roadmaps are prepared considering, as input, the outcome of the previous deliverables:

- D2.2 First overview of EU directives implementation. This deliverable has provided the legislation framework confirming the need to have a qualified workforce to increase the number of renewable energy installations and improve the energy performance of buildings. Not all the countries, however, have yet the obligation of requiring digital competences while they are more prepared for RES and EPBD directives implementations.

- D2.3 First overview of the national and regional qualification framework. This deliverable has shown the heterogenous development of qualification systems covering the needs of the competences in the energy domain in the above-mentioned directives. The national qualification framework is usually not updated with the latest technology and even for the traditional ones not all the countries have implemented them.

- D2.4 First overview of other EU wide certification schemes. There are very few and heterogeneous certification systems in the examined countries in the energy domain while, for the digital competences, the buildingSMART International qualification system is widely accepted in Europe and internationally, even if not yet very well known and implemented.

- D2.5 Overview of pathways of integration of previous EU project resources. This deliverable has demonstrated how, through the EC funded projects, the majority of competences have already been identified, and they are even published as a CEN Workshop Agreement. These competences could cover most of the needs listed in the European directives but there is the lack of a national and European strategy to push all the stakeholders in the same direction. The digital competences have been associated to the energy competence to underline the fact that digitalization is an instrument to facilitate communication among the different actors and should be taught in any course related to the energy domain.

- D2.6 Overview of Industry technical input. This deliverable confirms that the training of workers, in the construction sector, is divided into a thousand streams because it is carried out by different subjects for different classes of workers and, sometimes, carried out at the provincial level. This makes it impossible both to monitor the different actions and to have the same, or at least comparable, competence development objectives. Furthermore, the educational system does not easily adapt to technological innovation which advances rapidly, and which is carried out mainly by the producers of technologies.

2. The roadmap development

In all the partner countries there is legislation supporting both the use of renewable energy sources and the improvement of the energy performance. The digitalization is not always compulsory, but there are many initiatives to increase the competences in this domain starting from the public tenders where the use of BIM is becoming compulsory in many countries. Consequently, we expect in the future a huge increase in the demand of digital competences that are needed in all the supply chain.

To provide the basis for the development of national roadmaps we have considered a matrix where we suggest the level of knowledge/competence of the different targets for each technology. The digitalization, being considered an instrument and not an objective, is considered for each technology and each target.

The level of knowledge/competence is marked with the following letters:

K: foresees the **knowledge** of the advantages and the limits of the technology

R: foresees the competences needed to **read instructions** for the maintenance

I: foresees the competences needed for a correct **installation**

De: foresees the competences needed for the correct **design of the plant** and the integration in new and existing buildings

C: foresees the **capacity** to integrate the proposed technologies in the construction of new buildings or in the refurbishment of existing ones.

P: foresees the capacity to **promote** the innovative technologies by training designers and workers

DiK: foresees the **knowledge** of the advantages and the uses of open standards applied to the **digitalization**

DiR: foresees the competences needed to **read a digital model** and integrate with information deriving for maintenance

DiI: foresees the competences needed to **read a digital model and integrate with information** needed to install and maintain an equipment

DiDe: foresees the competences needed to produce a **digital model of the plant and the evaluation of interferences** with the architectonic or structural model in new and existing buildings

DiC: foresees the **capacity to integrate the digital model** with all the information needed to manage and maintain the buildings

DiP: foresees the capacity to **provide the proposed technologies with any digital information** needed to design and to install, by using open standards.

Table 1

Technologies	Public adm.	Owners	Design companies	Construction Companies	Produ -cers	Worker s
Solar power systems for electricity generation	K DiK	K DiK R DiR	De DiDe	C DiC	P DiP	I Di
Solar thermal energy	K DiK	K DiK	De	C DiC	P DiP	I Di
Heat pump	K DiK	R DiR	DiDe	C DiC	P DiP	I Di
Geothermal pumps	K	K DiK	De	C DiC	P DiP	I Di
Biomass stove and boiler	DiK	R DiR	DiDe	C DiC	P DiP	I Di
Smart grid	K	K DiK	De	C DiC	P DiP	I Di
Domotic systems	DiK	R DiR	DiDe	C DiC	P DiP	I Di
Building Management systems BMS	K	K DiK	De	C DiC	P DiP	I Di

(utility buildings						
Heating and cooling	DiK	R DiR	DiDe	C DiC	P DiP	I Di
District heating and cooling	DiK	R DiR	De	C DiC	P DiP	I Di
Solar absorption cooling	K	K DiK	DiDe	C DiC	P DiP	I Di
Mini wind power generation	DiK	R DiR	De	C DiC	P DiP	I Di
Combined heat and power (CHP) generation	K	K DiK	DiDe	C DiC	P DiP	I Di
Thermal Insulation and envelope	DiK	R DiR	De	C DiC	P DiP	I Di
Building air tightness	K	K DiK	DiDe	C DiC	P DiP	I Di
Micro-climates	DiK	R DiR	De	C DiC	P DiP	I Di
Hot water	K	K DiK	DiDe	C DiC	P DiP	I Di
Window and/or glazing	DiK	R DiR	De	C DiC	P DiP	I Di
Heating and cooling emission	K	K DiK	DiDe	C DiC	P DiP	I Di

Electric heating	DiK	R DiR	De	C DiC	P DiP	I Di
Artificial lightning	K	K DiK	DiDe	C DiC	P DiP	I Di
Ventilation	DiK	R DiR	De	C DiC	P DiP	I Di

3. The different maturity level in the countries

To develop the roadmap to reach the above levels of knowledge/competence, it is necessary to start from the current situation. In the following tables each partner has provided the level of implementation of the European directives in their country.

Denmark

Table 2 EU directive on RES

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Solar power systems for electricity generation				X	
Solar thermal energy installation				X	
Heat pump installation				X	
Low enthalpy Geothermal heat pumps				X	
Biomass stoves and boiler installation				X	

Table 3 Energy performance directives

Technology	Not used	Theory known	Rarely applied	Most used	Full impl.
Smart grid			X		
Building automation systems			X		
Building Management systems BMS			X		
Heating and cooling GENERAL			X		
Biogas energy production			X		
District heating and cooling					X
Solar absorption cooling			X		
Mini wind power generation			X		
Combined heat and power generation			X		
Thermal Insulation and envelope systems					X
Building air tightness				X	
Micro-climates			X		

Hot water systems			X		
Window and/or glazing systems					X
Heating and cooling emission systems				X	
Electric heating systems			X		
Artificial lightning systems				X	
Ventilation systems				X	

Table 4 Digitalization implementing BIM

Stakeholders	Not used	Theory known	Rarely applied	Most used	Fully impl.
Public authority					X
Public owner					X
Private owner					X
Designers					X
Constructors				X	
Installers				X	

Ireland

Table 5 EU directive on RES

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Solar power systems for electricity generation					X
Solar thermal energy installation					X
Heat pump installation					X
Low enthalpy Geothermal heat pumps			X		
Biomass stoves and boiler installation			X		

Table 6 Energy performance directives

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Smart grid			X		
Building automation systems			X		
Building Management systems BMS					X
Heating and cooling GENERAL					X
Biogas energy production			X		
District heating and cooling		X			
Solar absorption cooling	X				
Mini wind power generation			X		
Combined heat and power generation				X	
Thermal Insulation and envelope systems					X
Building air tightness					X

Micro-climates		X			
Hot water systems					X
Window and/or glazing systems					X
Heating and cooling emission systems				X	
Electric heating systems			X		
Artificial lightning systems				X	
Ventilation systems					X

Table 7 Digitalization implementing BIM

Stakeholders	Not used	Theory known	Rarely applied	Most used	Fully impl.
Public authority		X			
Public owner		X			
Private owner			X		
Designers				X	
Constructors				X	
Installers				X	

Italy

Table 8 EU directive on RES

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Solar power systems for electricity generation				X	
Solar thermal energy installation				X	
Heat pump installation			X		
Low enthalpy Geothermal heat pumps			X		
Biomass stoves and boiler installation			X		

Table 9 Energy performance directives

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Smart grid			X		
Building automation systems			X		
Building Management systems BMS			X		
Heating and cooling GENERAL				X	
Biogas energy production			X		
District heating and cooling					
Solar absorption cooling			X		
Mini wind power generation	X				
Combined heat and power generation			X		
Thermal Insulation and envelope systems				X	

Building air tightness			X		
Micro-climates	X				
Hot water systems					X
Window and/or glazing systems				X	
Heating and cooling emission systems		X			
Electric heating systems			X		
Artificial lightning systems				X	
Ventilation systems				X	

Table 10 Digitalization implementing BIM

Stakeholders	Not used	Theory known	Rarely applied	Most used	Fully impl.
Public authority				X	
Public owner			X		
Private owner		X			
Designers			X		
Constructors		X			
Installers	X				

Netherland

Table 11 EU directive on RES

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Solar power systems for electricity generation					X
Solar thermal energy installation				X	
Heat pump installation				X	
Low enthalpy Geothermal heat pumps					X
Biomass stoves and boiler installation					X

Table 12 Energy performance directives

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Smart grid			X	X	
Building automation systems				X	
Building Management systems BMS				X	
Heating and cooling GENERAL				X	
Biogas energy production					X
District heating and cooling					X
Solar absorption cooling		X			
Mini wind power generation			X		
Combined heat and power generation				X	

Thermal Insulation and envelope systems				X	
Building air tightness					X
Micro-climates				X	
Hot water systems					X
Window and/or glazing systems					X
Heating and cooling emission systems					X
Electric heating systems			X		
Artificial lightning systems					X
Ventilation systems				X	

Table 13 Digitalization implementing BIM

Stakeholders	Not used	Theory known	Rarely applied	Most used	Fully impl.
Public authority				X	
Public owner			X		
Private owner		X			
Designers				X	
Constructors			X		
Installers			X		
Designers					
Constructors					
Installers					

North Macedonia

Table 14 EU directive on RES

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Solar power systems for electricity generation					X
Solar thermal energy installation					X
Heat pump installation					X
Low enthalpy Geothermal heat pumps			X		
Biomass stoves and boiler installation			X		

Table 15 Energy performance directives

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Smart grid	X				
Building automation systems			X		
Building Management systems BMS			X		
Heating and cooling GENERAL					
Biogas energy production			X		

District heating and cooling				X	
Solar absorption cooling			X		
Mini wind power generation					
Combined heat and power generation				X	
Thermal Insulation and envelope systems					X
Building air tightness					X
Micro-climates					X
Hot water systems				X	
Window and/or glazing systems					X
Heating and cooling emission systems			X		
Electric heating systems				X	
Artificial lightning systems				X	
Ventilation systems					X

Table 16 Digitalization implementing BIM

Stakeholders	Not used	Theory known	Rarely applied	Most used	Fully impl.
Public authority	X				
Public owner	X				
Private owner	X				
Designers		X			
Constructors		X			
Installers		X			

UK

Table 17 EU directive on RES

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Solar power systems for electricity generation				X	
Solar thermal energy installation				X	
Heat pump installation				X	
Low enthalpy Geothermal heat pumps			X		
Biomass stoves and boiler installation			X		

Table 18 Energy performance directives

Technology	Not used	Theory known	Rarely applied	Most used	Fully impl.
Smart grid			X		
Building automation systems			X		

Building Management systems BMS				X	
Heating and cooling GENERAL					X
Biogas energy production			X		
District heating and cooling		X			
Solar absorption cooling	X				
Mini wind power generation			X		
Combined heat and power generation				X	
Thermal Insulation and envelope systems					X
Building air tightness					X
Micro-climates		X			
Hot water systems					X
Window and/or glazing systems					X
Heating and cooling emission systems				X	
Electric heating systems				X	
Artificial lightning systems				X	
Ventilation systems					X

Table 19 Digitalization implementing BIM

Stakeholders	Not used	Theory known	Rarely applied	Most used	Fully impl.
Public authority		X			
Public owner		X			
Private owner			X		
Designers				X	
Constructors			X		
Installers				X	

4. Some general considerations

The situation in the different countries is heterogeneous and, for sure, there are some technologies that are well known in all the countries, while others are less known and applied. Therefore, the directives do not seem to have contributed to speed up the use of new technologies. This depends also on the demand for these new technologies that is not yet mature. By analysing the above tables from a more “general” point of view, we can make some interesting assumptions.

To analyse the data from a general point of view, we have given a different “mark” depending on the maturity level going from one, the lowest, to five, the highest. These values are attributed to each technology mentioned. In the case of RES there are only 5 technologies mentioned, in the case of technologies for energy efficiency there are 16 technologies mentioned and finally for the digitalization there are 7 different targets considered. So, for each country we have summed up the grades and compared them with the mark of the full implementation.

The analysis of the renewable energy sources implementation provides evidence that the Netherlands, that has the best training system, according to the CEDEFOP report (deliverable 2.6), has also the highest implementation level while Italy that has one of the worst systems has also a lower level of implementation. The following figures provide the comparison among the different countries. We can also conclude that there is a room for improvement in aspect of increase of RES participation and introduction of new technologies, even on countries with high level of RES implementation.

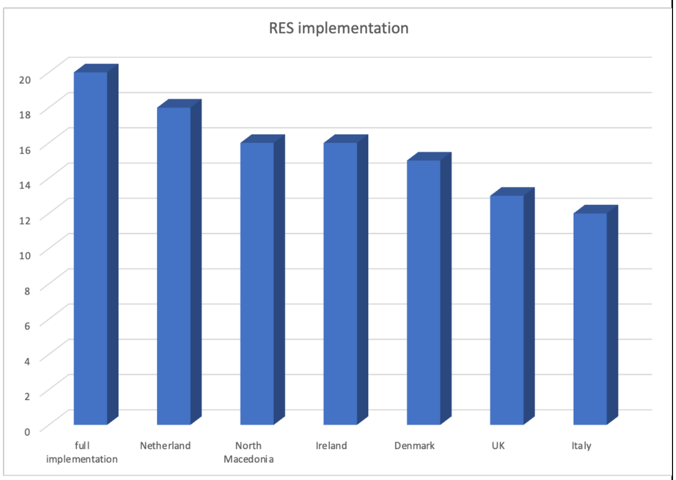

Fig.1 The implementation of the RES plants is diffused in all the countries. The Netherlands has the higher implementation level and Italy the lowest.

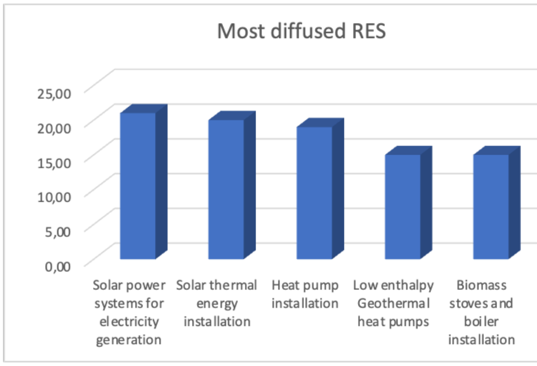

Fig.2 The most widespread plants are photovoltaic and solar thermal then heat pumps, geothermal pumps and biomass follow.

Analogously the analysis of the EPBD implementation provides the comparison reported in the following diagrams.

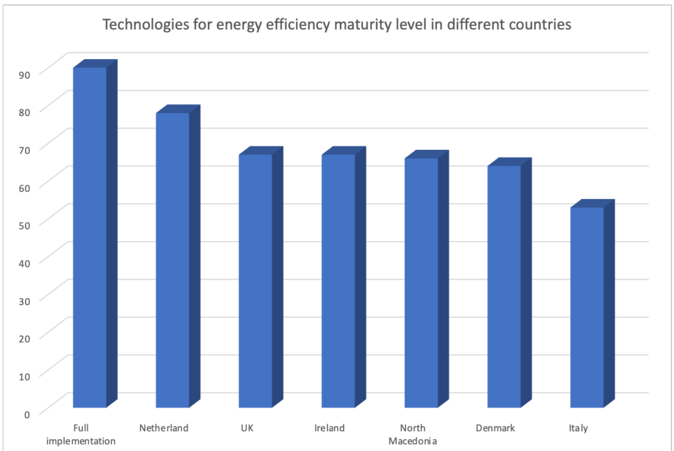

Fig.3 As shown in the diagram, the implementation of the energy efficiency technologies as well has a higher level of maturity in the Netherlands and the lowest level in Italy.

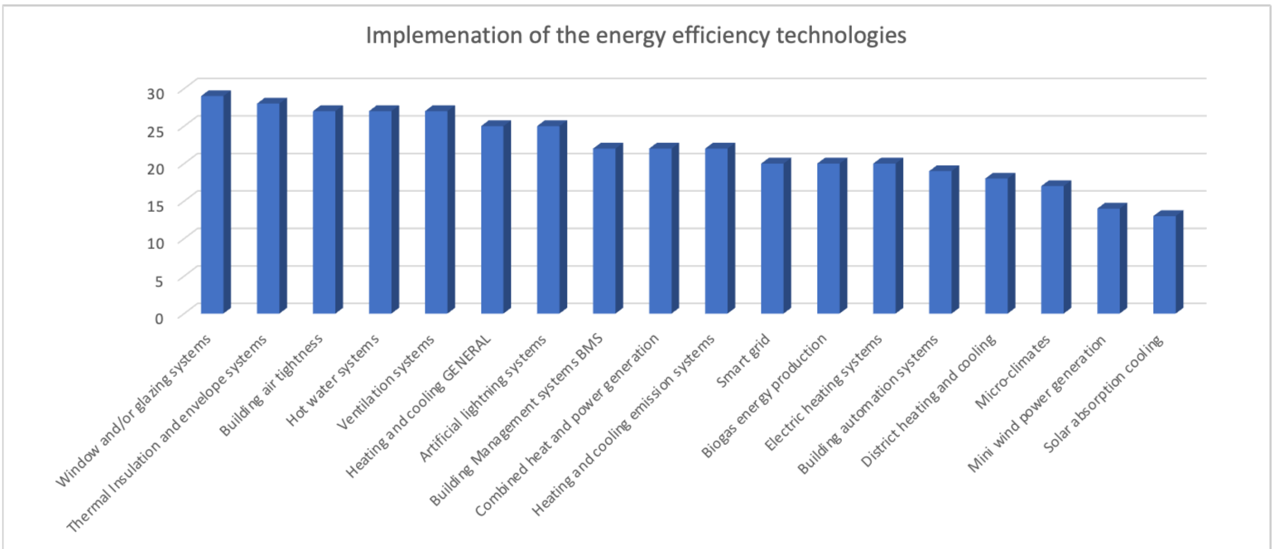

Fig. 4 From the above diagram we can see that the most mature technologies are the ones related to insulation, heating and cooling etc. while the new technologies related to the energy district and mini wind power are the least used. The lack of specific training courses is for sure an obstacle to the dissemination of innovative technologies increasing the energy performance of the buildings. Besides, the adoption and implementation of all these technologies are highly related to the climatic conditions and cultural environment. Therefore, it is natural a difference on the level of implementation in the different countries.

The last two diagrams are related to the implementation of Building Information Modelling (BIM). We can see that the demand is not yet in a "mature stage" and, as a consequence, it is rarely required.

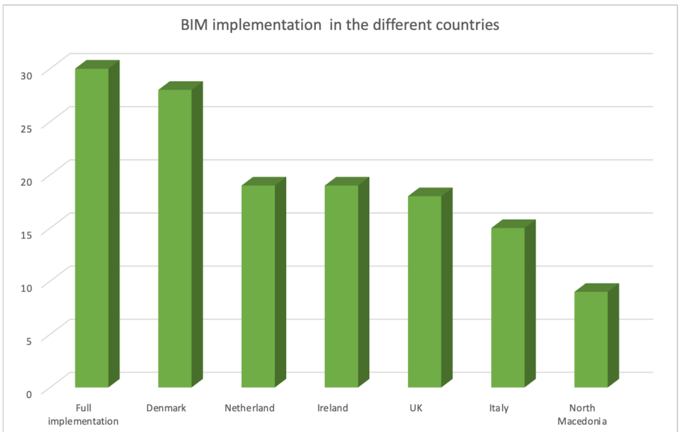

Fig.5 In Denmark BIM is mostly fully implemented while in North Macedonia BIM is only rarely used.

Fig. 6 It is important to notice that the full implementation is more related to the designers while both public and private owners are not yet at the same stage.

5. Conclusions

There is a strong correlation between the quality of the national systems for training and Life Long Learning (LLL) and the use of technologies related to energy performance of the buildings. The north European countries have a more reliable training system in place and, therefore, they also make better use of RES and technologies for energy efficiency. Still there is the need, in all the countries, to facilitate the use of more innovative technologies that are rarely taught in the formal training.

Each country can be aware of the steps necessary to reach the highest maturity level in their country as suggested in table 1 starting from the current situation described in the tables 2-19. They can also take suggestions and good practices from countries that have a higher maturity level to reach the desired level faster.

The ARISE platform can provide the support to achieve higher maturity level in any sector and for any target as it is based on micro-competences. New technologies can also be introduced by the producers that can use the platform to provide training materials to design, install and maintain new equipment and/or materials that can improve the energy performance of a building.

The implementation of the digitalization shows that the problem is more related to the lack of a full maturity on the demand side. The designers are usually ready to use the digitalization as this facilitates their work, but, if the demand of public administration and both public and private owners does not increase, the digitalization cannot be fully implemented in the supply chain. Therefore, the owners could not get any benefit that should allow them to manage any information of their assets to decrease the cost of management and maintenance. If the constructors do not implement the model received by the designers with the information of the products and equipment used and installed, the owner gets only marginal benefit from the BIM model produced by the designer. Therefore, there is a strong need to increase the comprehension of the benefits introduced by the full implementation of BIM in the supply chain. This analysis and roadmap is also useful for training program developers and providers, to give them directions how to profile their programs.

In this case too, the ARISE platform can be beneficial as the European chapters of buildingSMART international are working for an agreement aimed at increasing the awareness of the benefit of BIM along all the supply chain using the training materials developed for the individual qualification free available for any individual.

6. References

Deliverables 2.2 – 2.7