WP 3 – Task 3.2

D3.2. Pilot clusters and main findings

Annex 1 - New developments in the geocluster methodology

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Contents

1. Introduction

In WP3, various sessions (see D3.1) were organized to demonstrate the geocluster methodology and the associated mapping tool. As a general rule, the demonstration of the tool was favorably perceived by the audience and positive feedback was given. From the numerous proposals to improve the methodology and the tool that were received, only few of them have been implemented within the timeframe of the project. The following sections describe the new developments that were performed to meet end-user expectations.

2. Development of a new financial indicator for thermal insulation

Most of potential end-users attending demo sessions stressed out the necessity to match financial data (material cost, labour cost, maintenance cost …) with technical data such as energy performance indicators. A new financial indicator was introduced and implemented in the geocluster methodology for the thermal insulation technology.

The Envelope retrofitting Payback Period ($ERPR$) is defined as the period of time required for the thermal insulation to save enough energy from heating (at present prices) to pay for the initial investment. ERPR can be calculated as follows:

$$ERPR = \frac{ER_{Cost}}{ER_{Benefit}}$$

Where:

$ERPR$: Envelope Retrofitting Payback Period [years]

ER_{Cost}: Envelope Retrofitting investment Cost [€/m²]

$ER_{Cost} = f(Country, Technical\ solution, insulation\ material\ thickness)$

$ER_{Benefit}$: Envelope Retrofitting Benefit [€/(m².year)]

The Envelope Retrofitting Benefit is defined as a function of the climate, the period of construction of the building, the country thermal regulation and the energy cost.

$$ER_{Benefit} = f\left(Climate, Building\ Age\ of\ construction, Country\ \ Thermal\ Regulation, Energy\ cost\right)$$

Envelope Retrofitting investment Cost:

The initial investment cost takes into account the labour cost and the material cost. This cost is defined as follows:

$$ER_{Cost} = C_{labour} + C_{materials}$$

Where :

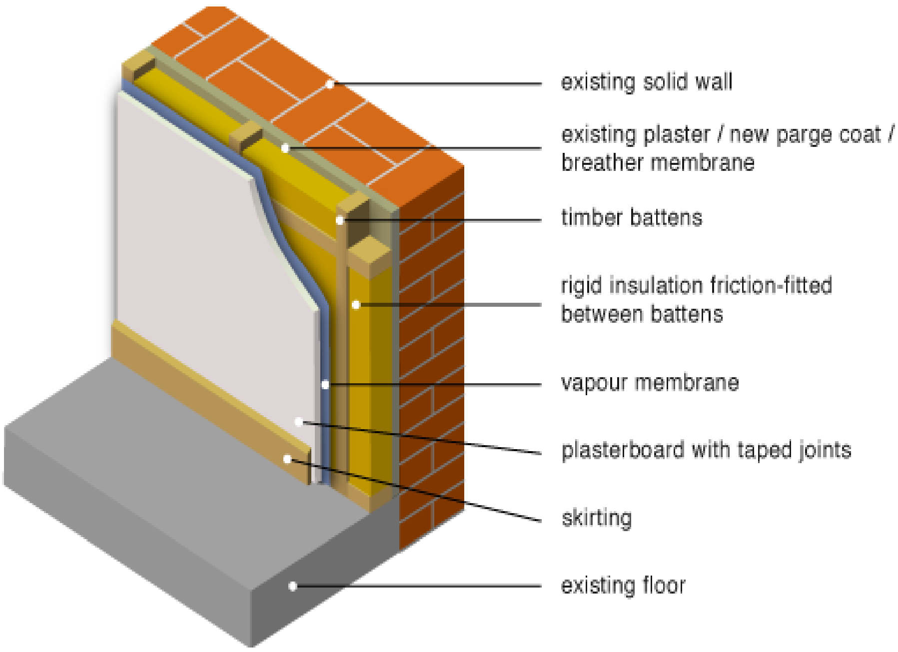
C_{labour}: Envelope retrofitting labour cost per square meter of material installed [€/m²]

The labour cost takes into account the roll out of the thermal insulation material on its support. This cost varies from country to country and even from region to region. In the following, an average labour cost has been considered with the assumption that thermal insulation is applied on a clean support.

$C_{materials}$: Envelope retrofitting materials cost per square meter [€/m²]

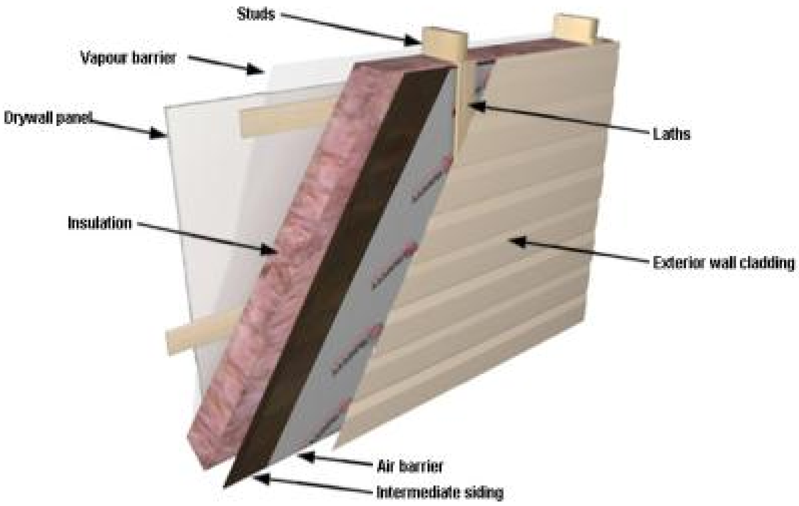
The material cost includes the cost of the thermal insulation layer plus the rendering or the cladding and includes all the fittings necessary to fix the layer on its support. This cost has been identified for different retrofitting solutions. These solutions are different for wall, roof and floor and are listed below:

- **Wall**
  - Internal wall insulation material with plaster board

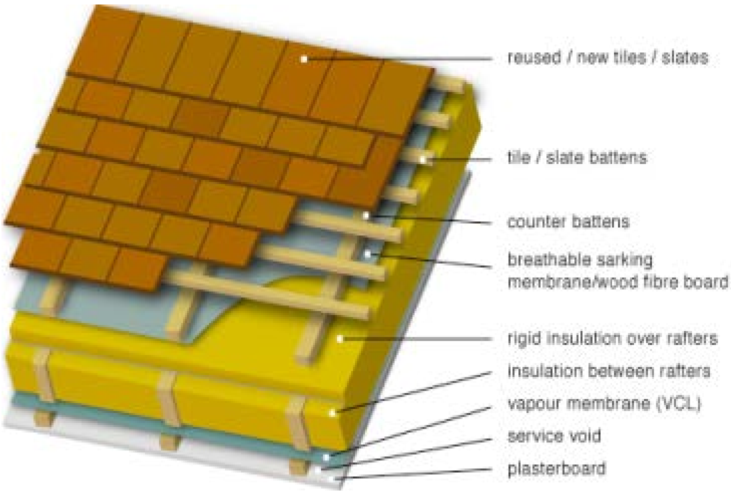


  - External wall insulation material with rendering

- External wall insulation material with cladding (Wood: pine)

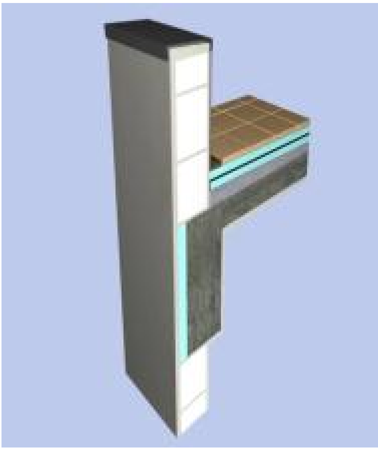


- **Roof**
  - Internal roof insulation: panel / roll under roof space insulation material

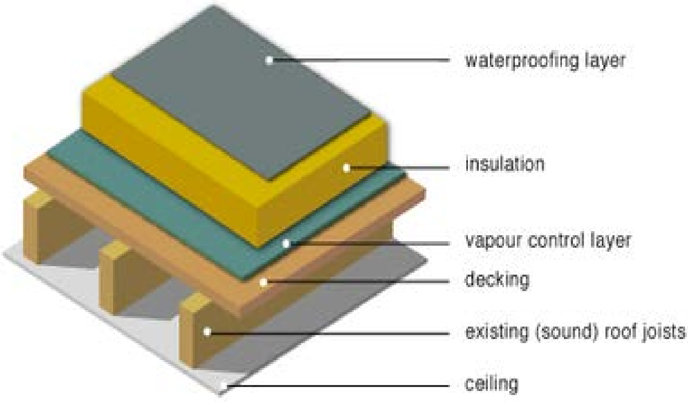


- Internal roof insulation: spray under space insulation material

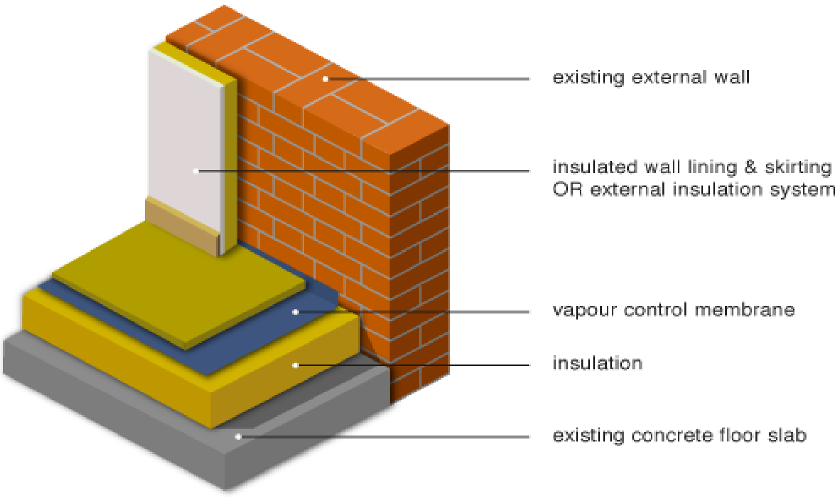
- External roof insulation: built-up roof insulation (under waterproofing)



- **Floor**
    - Internal floor insulation: Spray under floor insulation material



- Internal floor insulation: panels / roll under floor insulation material



Different thermal insulation materials specific to each construction technology have been selected. These materials are listed below:

- Glass Wool
- Rock Wool
- Polyurethane
- Expended Polystyrene
- Extruded polystyrene
- Hemp Wool
- Sheep Wool

Material costs have been collected for typical insulation thicknesses (these typical values vary from country to country and are most of the time related to building energy codes). Table 1 gives an example of Envelope Retrofitting investment Costs for a specific retrofitting solution (external wall insulation: Insulation material with rendering).

External Wall Insulation : Insulation material with rendering				
Insulation Material m²	Thickness [m]	Materials € VAT Excluded	Labour € VAT Excluded	Total € VAT Excluded
Glass wool XX cm	0,00	Not usual		
Rock wool 6 cm	0,06	45	35	80
Rock wool 10 cm	0,10	50	35	85
Rock wool 16 cm	0,16	65	35	100
polyurethane panels xx cm	0,00	Not usual		
Expanded polystyrene (EPS) 6 cm	0,06	50	35	85
Expanded polystyrene (EPS) 10 cm	0,10	55	35	90
Expanded polystyrene (EPS) 16 cm	0,16	70	35	105
Extruded polystyrene (XPS) 6 cm	0,06	55	35	90
Extruded polystyrene (XPS) 10 cm	0,10	60	35	95
Extruded polystyrene (XPS) 16 cm	0,16	75	35	110
Hemp wool xx cm	0,00	Not usual		
Sheep wool xx cm	0,00	Not usual		

Table 1 : Envelope Retrofitting investment Costs for external wall insulation with rendering - France

Data have been collected for different countries:

- Spain
- Slovenia
- Italy
- France

Envelope Retrofitting Benefit:

The envelope retrofitting benefit takes into account the energy saved due to thermal insulation, the type of energy used (through the cost of this energy) and the efficiency of the system used to transform the initial energy (gas, electricity, oil…) into heat. The Envelope Retrofitting Benefit is defined as follows:

$$ER_{Benefit} = \frac{\Delta E_y \times C_E}{\eta_{Sys}} = \frac{\Delta U \times HDD \times 24 \times C_E}{\eta_{Sys}}$$

Where:

ΔE_y: Annual energy saving due to envelope retrofitting [Wh/year]

ΔU: Thermal Flow per square meter saved due to envelope retrofitting [W/(m².K)]

HDD: Heating degree days [K.year]

C_E: Energy cost (This data has been collected at the beginning of the project for different energy sources and countries [€/Wh]

η_{Sys}: System efficiency [-]

In the tool, the system efficiency was fixed to 1 ($\eta_{Sys} = 1$), meaning that we have considered a building or a house heated with an electric heating system such as convector for instance.

This relation gives the possibility to match different layers represented by maps:

- Heating Degree Days

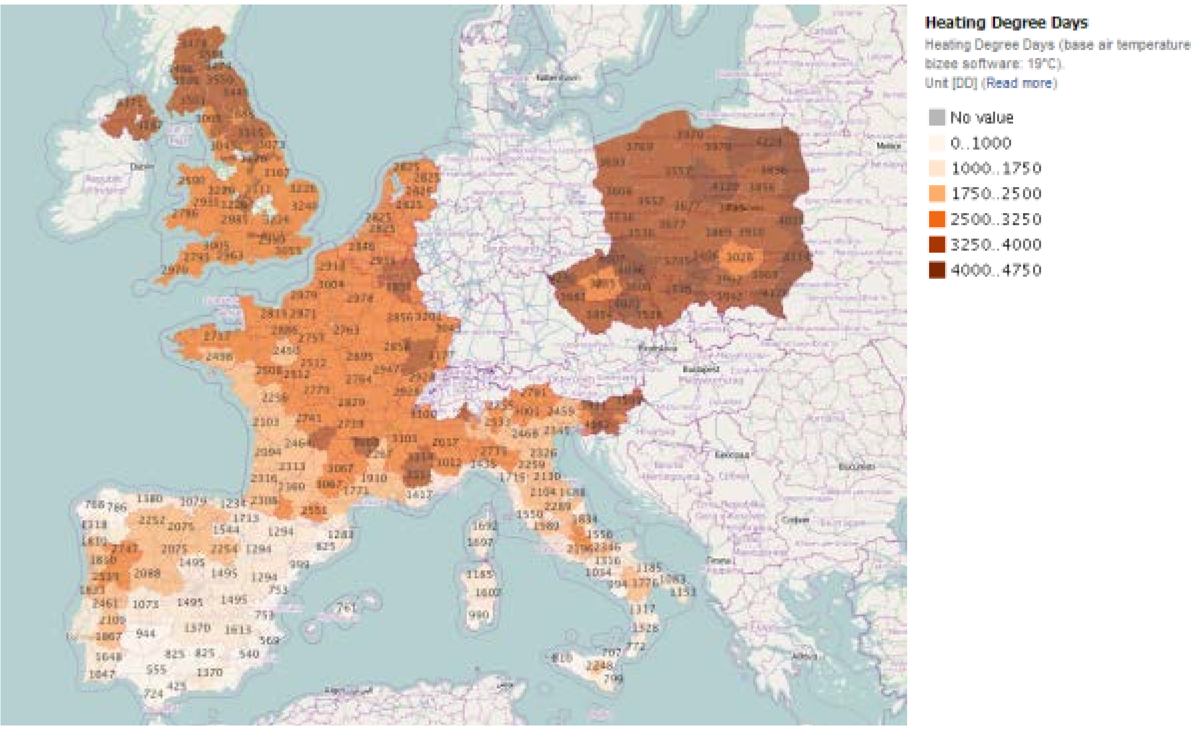


Figure 1 : Heating Degree Days geo-descriptor European Map

- Electricity prices for household consumers

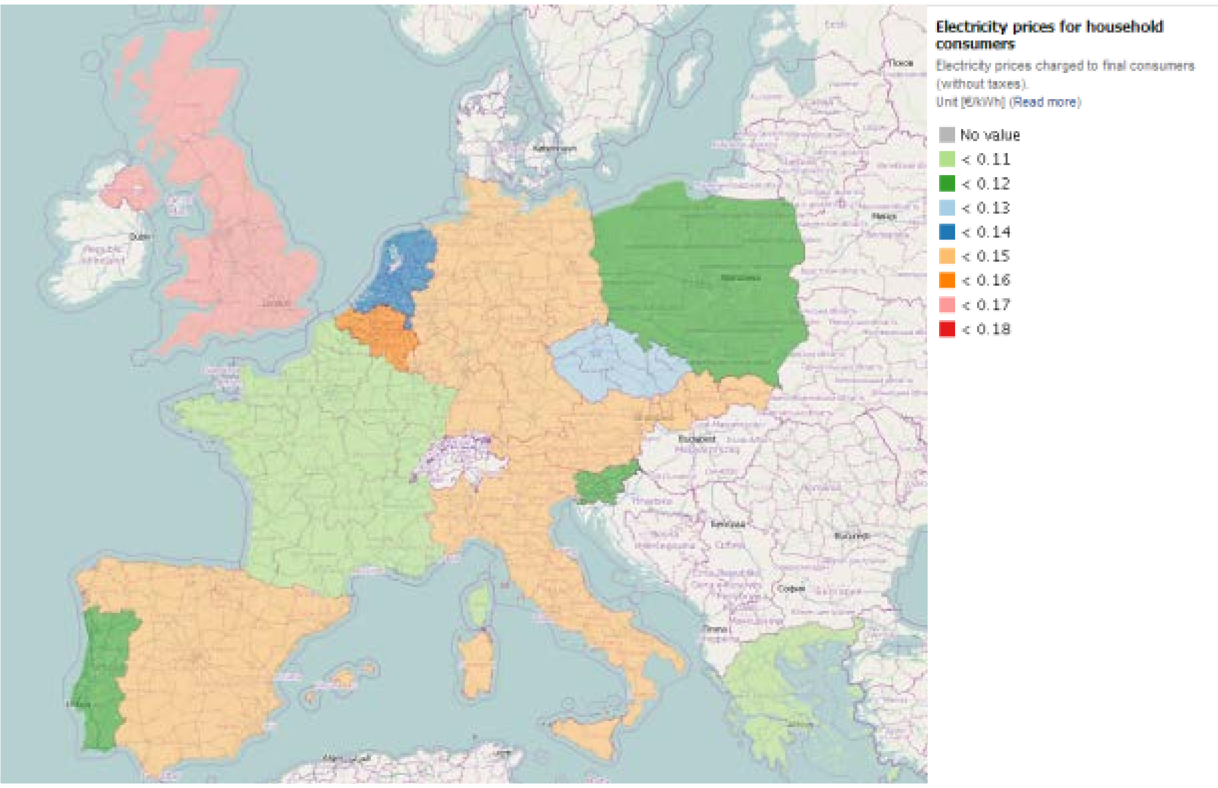


Figure 2 : Electricity prices for Household consumers European Map

- Wall / Roof / Floor U-value of existing building for different age of construction

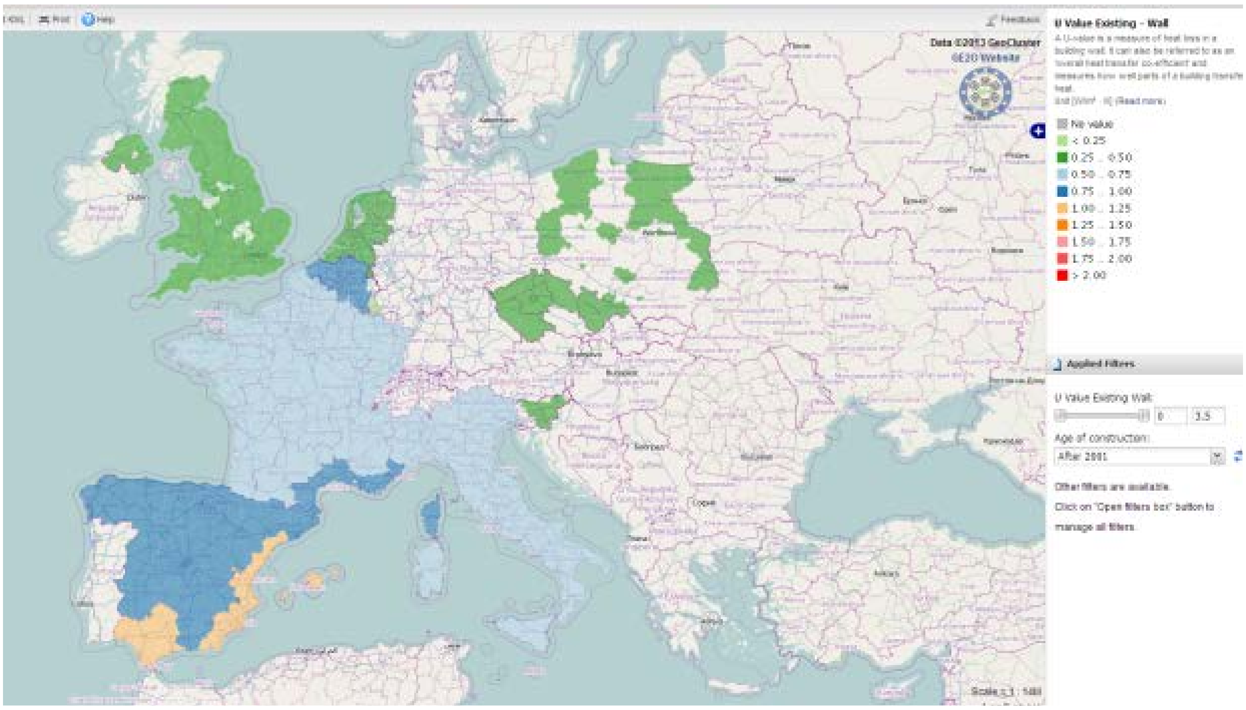


Figure 3 : Wall U-value for existing building built after 2001

- Wall / Roof / Floor U-value target defined by the on-going energy regulation / labels

CODE	NUTS 0	NUTS 1	NUTS 2	NUTS 3	Walls	Roof	Floor
FR	FRANCE						
FR1		ÎLE DE FRANCE					
FR10			Île de France				
FR101				Paris	0,2	0,1	0,3
FR102				Seine-et-Marne	0,2	0,1	0,3
FR103				Yvelines	0,2	0,1	0,3
FR104				Essonne	0,2	0,1	0,3
FR105				Hauts-de-Seine	0,2	0,1	0,3
FR106				Seine-Saint-Denis	0,2	0,1	0,3
FR107				Val-de-Marne	0,2	0,1	0,3
FR108				Val-d'Oise	0,2	0,1	0,3
FR2		BASSIN PARISIEN					
FR21			Champagne-Ardenne				
FR211				Ardennes	0,2	0,1	0,3
FR212				Aube	0,2	0,1	0,3
FR213				Marne	0,2	0,1	0,3
FR214				Haute-Marne	0,2	0,1	0,3
FR22			Picardie				
FR221				Aisne	0,2	0,1	0,3
FR222				Oise	0,2	0,1	0,3
FR223				Somme	0,2	0,1	0,3
FR23			Haute-Normandie				
FR231				Eure	0,2	0,1	0,3
FR232				Seine-Maritime	0,2	0,1	0,3
FR24			Centre				
FR241				Cher	0,2	0,1	0,3
FR242				Eure-et-Loir	0,2	0,1	0,3
FR243				Indre	0,2	0,1	0,3
FR244				Indre-et-Loire	0,2	0,1	0,3
FR245				Loir-et-Cher	0,2	0,1	0,3
FR246				Loiret	0,2	0,1	0,3
FR25			Basse-Normandie				

Input-Output / listes / Existing-U-Value-France / Target-U-Value-France / HDD / DeltaU / ER_Benefits / Insulation_Thickn
Prêt

Table 2 : France U-value target data collected at NUT3 Level

Data and equations have been implemented in an Excel sheet. Figure 4 gives an example of the calculation of the Envelope retrofitting Payback Period. The Excel sheet is available on the drop box under the following name: Return_Investment_Cost_Calculation.xlsx.

	A	B	C	D
1			**INPUT**	
2				
3	**Geodescriptor**			
4		Country	France	
5		NUT3	Corse-du-Sud	
6				
7	**Building typology**			
8		Years of construction	49-74	
9				
10	**Enveloppe Retroffing**			
11		Wall typology	Wall	
12		Technical solution	External wall Insulation: Insulation material with rendering	
13		Insulation material	Expanded polystyrene (EPS)	
14				
15	**Socio Economics**			
16		Electricity cost [€/kwh]	0,0986	(France)
17				
18				
19				
20				
21				
22			**OUTPUT**	
23				
24				
25		ER_Benefits	7,90	[€/m².years]
26		Material Cost	57,95	[€/m²]
27		Labor Cost	35,00	[€/m²]
28				
29				
30		Return on Investment Cost	11,8	[Years]
31				
32				

Figure 4 : Thermal insulation payback time Excel tool screen shot

3. Development of a new indicator for solar cooling market potential

Solar cooling technology is a niche market. So the definition of a market potential indicator for this technology cannot be defined through a quantitative approach. The new indicator detailed below is based on a qualitative approach mixing the energy performance indicator of the solar cooling system (which depends on climatic conditions and system technology), the financial incentive scheme existing (or not) in the different countries and the economical context (through electricity cost).

Solar Cooling market potential indicator

The solar cooling market potential indicator (MP_{SC}) is defined as the product of three coefficients related to technology performance indicator, financial incentives and electricity cost. Weighting factors have been defined through expert rules.

$$MP_{SC} = C_{tpi} \times C_{fi} \times C_{ei}$$

Where:

C_{tpi} : Technology performance indicator coefficient [-]

C_{fi} : Financial inventives coefficient [-]

C_{ei} : Electricity cost coefficient [-]

It was arbitrary decided that these coefficients will range from 0 to 0.8. These coefficients have been built from physical data (for example CSPF) or qualitative data (for example financial incentives). These coefficients are defined as follows:

Technology performance indicator coefficient:

The technology performance indicator coefficient is linearly recalculated from CSPF data base. The best performance (CSPF = 1.2 for vacuum tube in south of Europe) has been associated with a C_{tpi} of 0.8. A linear correction is applied to calculateC_{tpi} for all other CSPF. Figure 5 gives the representation of solar cooling performance indicator for a double stage cooling systems coupled with vacuum tube collectors.

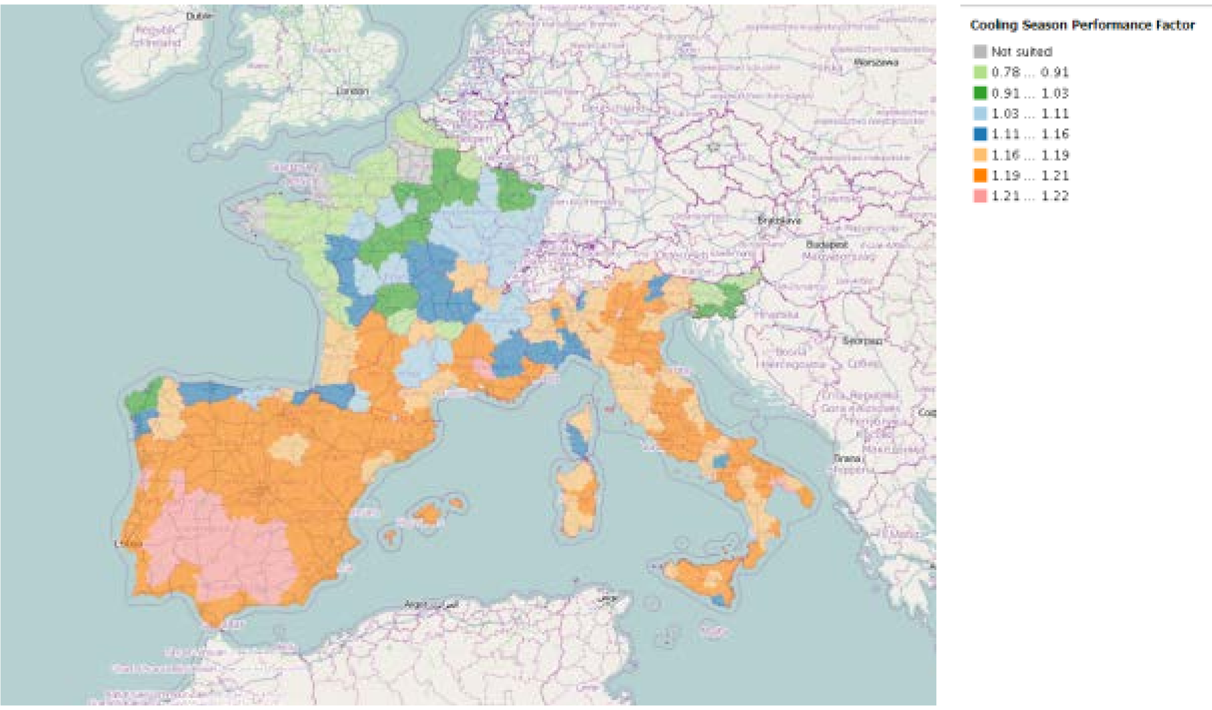


Figure 5 : Double stage / vacuum tube Solar cooling performance indicator European Map

Financial incentive coefficient:

Financial incentive data are collected through qualitative description. Each European country has its own scheme to subsidy (or not) solar cooling systems. To have a homogeneous and quantitative representation, a financial incentive coefficient **(C_{fi})** has been introduced. This coefficient is listed in Table 3 and only relies on the existence (or not) of financial incentive in a country.

Financial incentives	C_{fi}
No financial incentive scheme or not identified	0.3
Financial incentive scheme is existing	0.8

Table 3 : Financial incentive coefficient

Figure 6 maps European countries according to the existence (or not) of financial incentive for solar cooling systems.

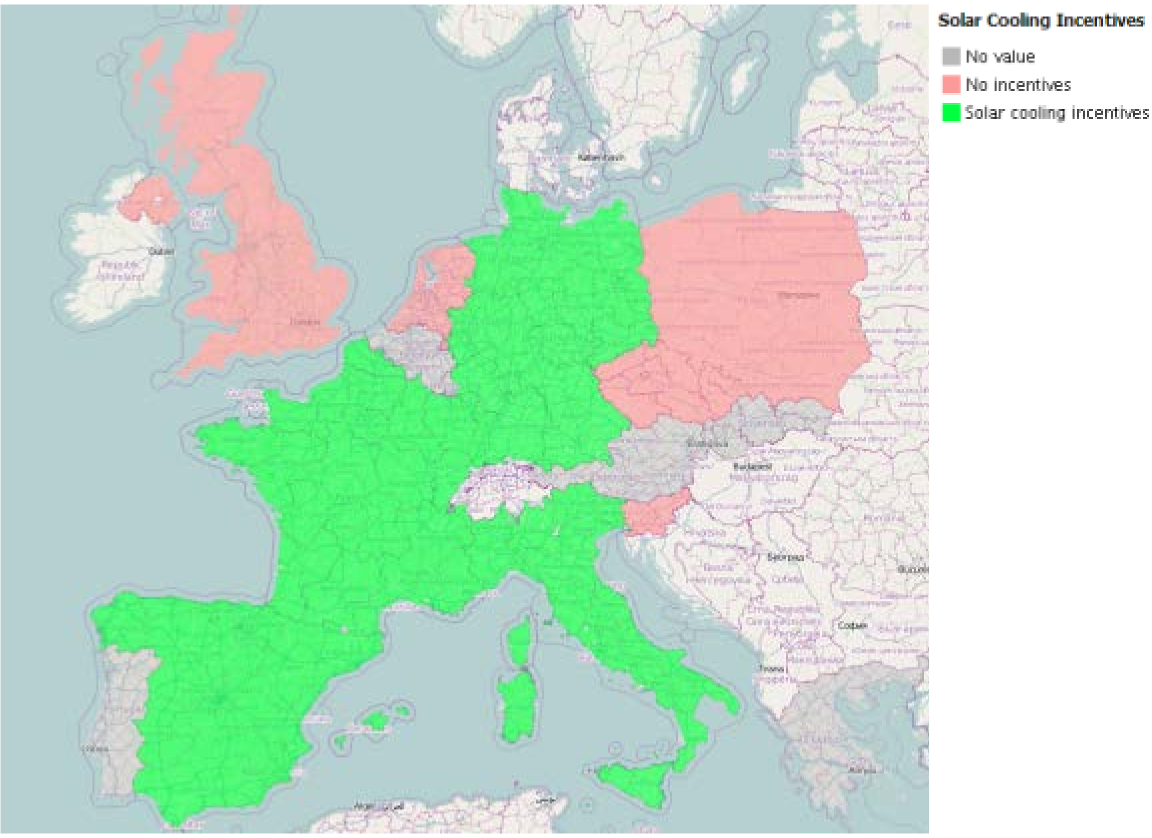


Figure 6 : Solar Cooling financial incentives European Map

Electricity cost coefficient:

The electricity cost coefficient has been defined by the following equation:

$$C_{ei} = 0.3 + \frac{Ce_{country} \times 0.5}{Ce_{max}}$$

Where:

$Ce_{country}$: Electricity cost for a given country [€/kWh]

Ce_{max}: Most expensive electricity cost in Europe [€/kWh]

This approach gives the possibility to update electricity cost data. C_{ei} is equal to 0.8 for the European country where the electricity cost is the highest. For other country, C_{ei} ranges from 0.3 to 0.8. Figure 7 gives the actual European map of electricity prices.

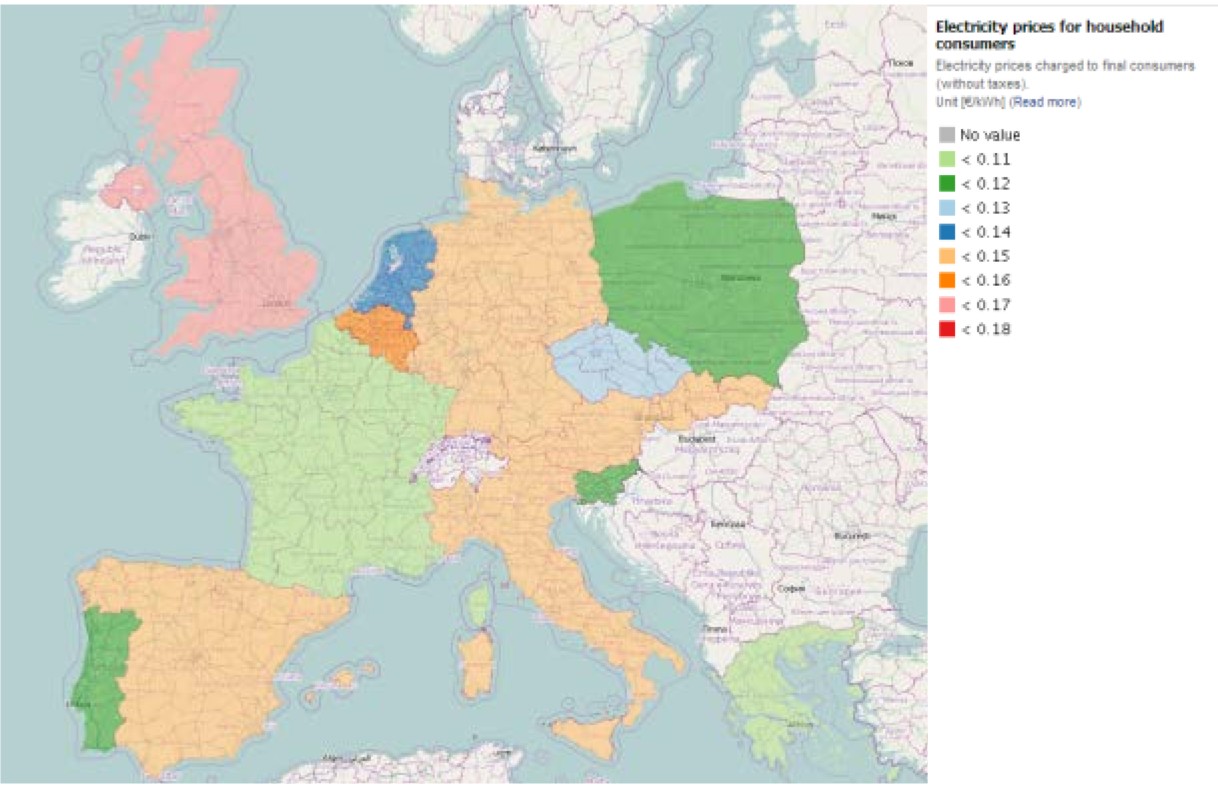


Figure 7 : electricity prices for Household consumers European Map

Solar cooling market potential feasibility Excel tool:

Data and equations have been implemented in an Excel sheet. Figure 8 gives an example of the calculation of the solar cooling potential market indicator. The Excel sheet is available on the drop box.

Solar cooling market potential

This Excel tool is active only for France. The Mapping tool will include the Meditteranean arc countries.

		Code	Technology indicator Coefficient [-]	Financial incentives Coefficient [-]	Electricity cost coefficient [-]		Market potential Indicator
Country	France		0,53	0,80	0,63		0,27
NUT3	Morbihan						
Collectors	Vaccum_tube	7					
Cooling System	Absorption_double_stage	1					

Figure 8 : Solar Cooling Market potential Excel tool screen shot

The mapping colour scale is defined in Table 4.

Min	Max	Colour	Qualitative interpretation
0			Not suitable
0,0001	0,1		Weak potential
0,1	0,2		
0,2	0,3		Medium potential
0,3	0,4		
0,4			Best potential

Table 4 : Solar cooling potential market colour scale definition