“Energy transition in the European residential sector: Investigating the saving potential and cost effectiveness of different energy-efficiency measures”

Dr. Vassilis Stavrakas, Dimitra Tzani, Dimitris Papantonis, Danai Sofia Exintaveloni, Prof. Dr. Alexandros Flamos

The SENTINEL project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 837089.

Introduction & Problem statement (1/2)

Buildings are accounting for nearly **40%** of the final **energy consumption** in the EU.

50 million consumers struggle to keep their homes **adequately** warm.

Annual renovation rate of the building stock varying from **0.4** to **1.2%**.

Need for smarter & more energy-efficient buildings

Buildings account for **43%** of the final consumption in the EU, with **residential** consuming **2/3** of this consumption.

85% of the buildings in the EU have been constructed **before 2001**.

85% - 95% of the **current buildings** will continue to **exist up to 2050** with most of them not being energy efficient.

Building sector has significant room for decarbonisation.

Need of immediate action

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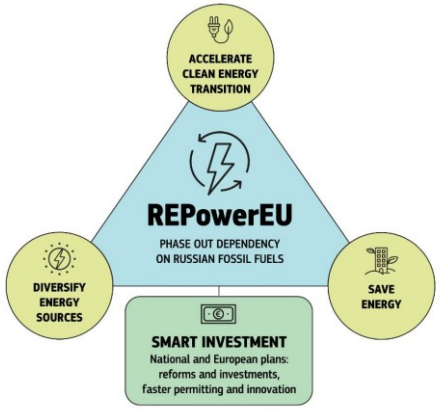
Introduction & Problem statement (2/2)

Towards the decarbonisation of the European residential sector…

- Estimating the **energy saving potential** of **nine (9)** different energy-efficiency measures (**EEMs**),
- in the context of **eight (8) European countries.**
- Performing technoeconomic analysis to assess the **cost-effectiveness** of the different EEMs.



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Model Application

ELSEVIER

Energy Conversion and Management

Volume 205, 1 February 2020, 112339

A modular high-resolution demand-side management model to quantify benefits of demand-flexibility in the residential sector

Vassilis Stavrakas, Alexandros Flamos

DREEM

Dynamic High-Resolution Demand-Side Management Model

Building sector

Energy demand *simulation model*

Benefits *&* ***limitations*** *of demand-flexibility primarily for* ***consumers*** *& other* ***power actors*** *involved*

IAM COMPACT

ENCLUDE

Energy Citizens for Inclusive Decarbonization

DigiBUILD

SENTINEL

SUSTAINABLE ENERGY TRANSITIONS

FORTESIE

TIPPING+

SOCIALWATT

ENSMOV

TOWARDS BETTER ENERGY EFFICIENCY POLICIES

ENPOR

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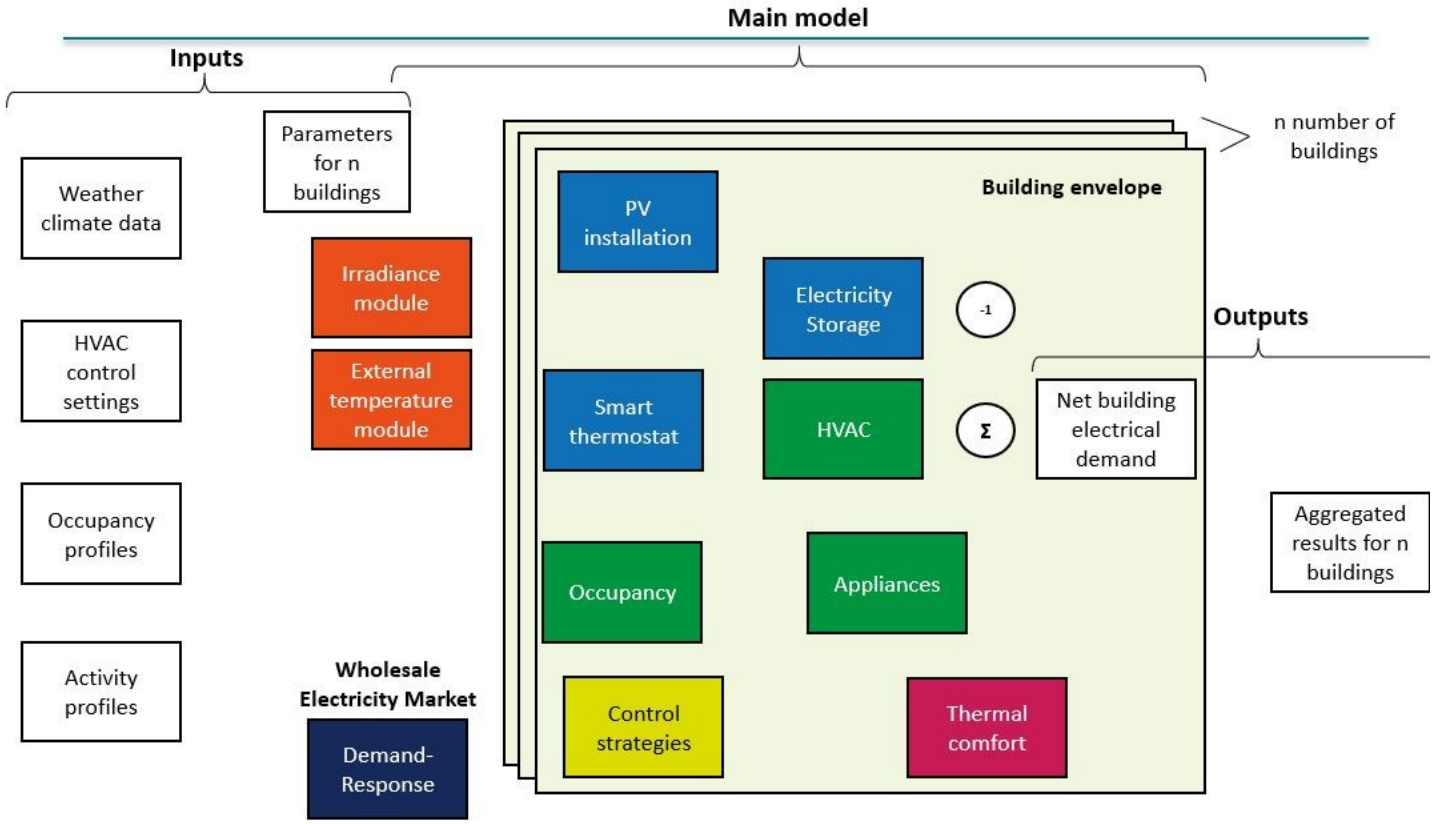
MODEL CHARACTERISTICS (1/2)

Main **principles** of **component-** & **modular**-based system modeling approach

- **interdependence** of decisions **within** modules
- **independence** of decisions **between** modules
- **hierarchical dependence** of modules on components embodying standards & design rules

Modular *structure*



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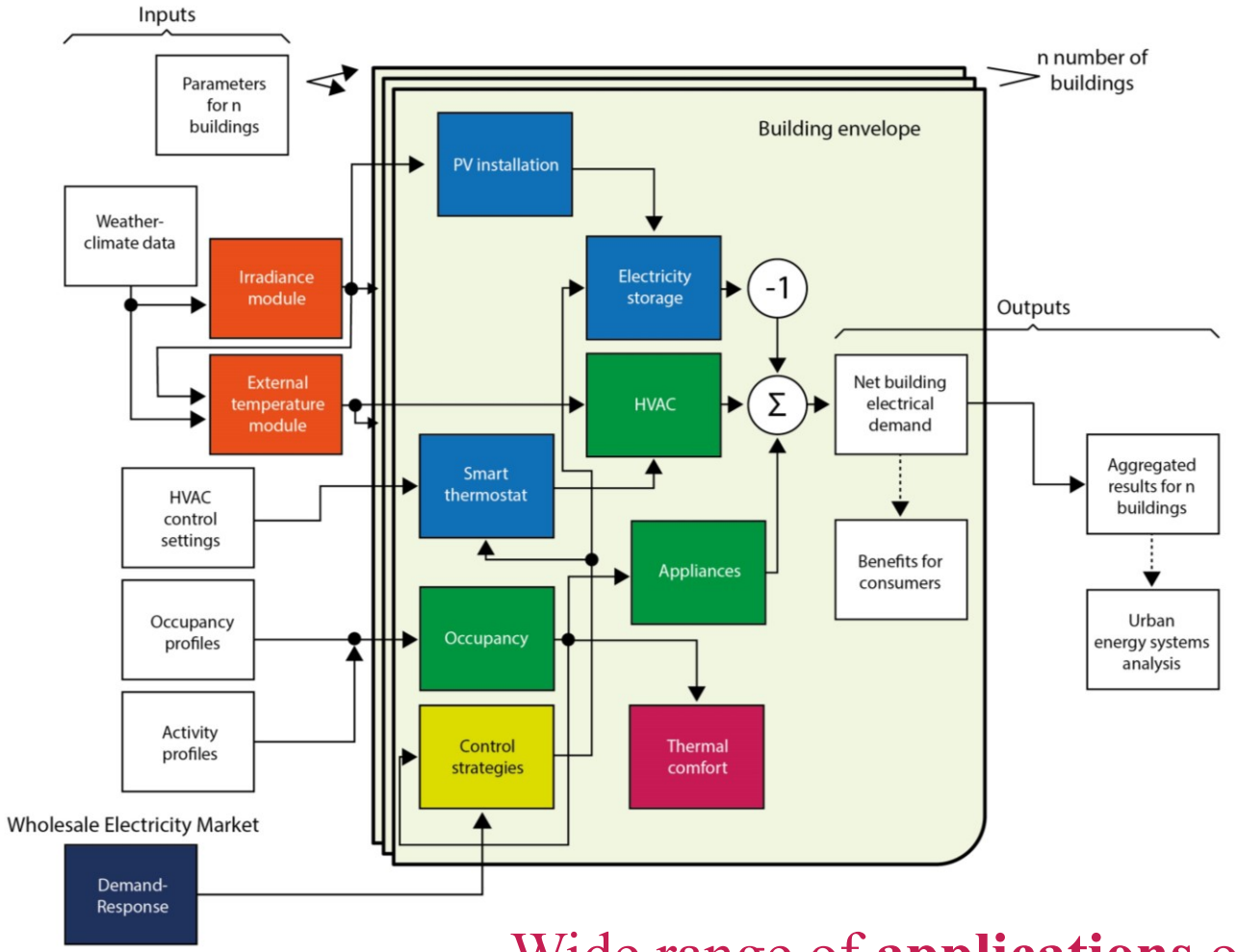
MODEL CHARACTERISTICS (2/2)



- **Incremental** modeling: **sub-models** in multiple levels
- **Control** capabilities: **managing** the **complexity** of large systems
- **Realistic representations** of dynamic systems
- Fast development & simulations: **computational efficiency**

Wide range of **applications** on Europe's energy transition towards **2050**

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Modelling the Energy Performance of European Residential Buildings

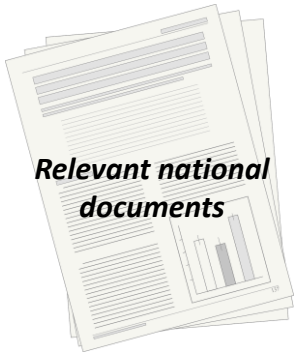
2 categories of residential buildings based on their construction period

- **Category I:** Buildings that have been built **before 1981*** (the requirements for thermal insulation of buildings was set after 1981).
- **Category II:** Buildings that have been built during the period **1981-2006**.

Building specifications

TABULA — Greece, Italy, Spain France & Ireland

ENTRA NZE — Croatia, Romania & Latvia



*How can **different geographical contexts** and **construction periods/building characteristics**, **affect energy-saving potential** and **cost-effectiveness** of different **EEMs?***

*Except for Croatia, where the building under study has been built before 1987

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BUILDING TYPOLOGIES – SOUTH EUROPE (1/2)

Greece

Two reference buildings in the city of **Athens**
(Greek Climate Zone B)

Parameter	Specifications	
Year of construction	<1981 (first class) 	1981-2000 
Type of building	Residential, detached	Residential, detached
No. of floors	1	1
Total floor area	102 m^2	88 m^2
Height	2.50 m	2.50 m
Total roof area	110 m^2	150 m^2
Total walls area	182 m^2	350 m^2
Total windows area	46 m^2	42 m^2

Italy

Two reference buildings in the city of **Rome**
(Italian Climate Zone D)

Parameter	Specifications	
Year of construction	1961 - 1975 	1990 - 2005 
Type of building	Residential, detached	Residential, detached
No. of floors	2	2
Total floor area	156 m^2	172 m^2
Height	2.17 m	2.50 m
Total roof area	156 m^2	172 m^2
Total walls area	475.3 m^2	441.6 m^2
Total windows area	19.5 m^2	21.6 m^2

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Building Typologies – South Europe (2/2)

Spain

Two reference buildings in the city of **Barcelona**

Parameter	Specifications	
Year of construction	1960-1979 	1980 - 2006 
Type of building	Residential, detached	Residential, detached
No. of floors	1	1
Total floor area	90 m^2	107 m^2
Height	2.50 m	2.50 m
Total roof area	64 m^2	132 m^2
Total walls area	312 m^2	234 m^2
Total windows area	13 m^2	66 m^2

Croatia

Two reference buildings in the city of **Zagreb**

Parameter	Specifications	
Year of construction	1971-1987	1988-2005
Type of building	Residential, detached	Residential, detached
No. of floors	1	1
Total floor area	96.32 m^2	96.32 m^2
Height	2.80 m	2.80 m
Total roof area	96.32 m^2	96.32 m^2
Total walls area	118.72 m^2	118.72 m^2
Total windows area	12.48 m^2	12.48 m^2

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BUILDING TYPOLOGIES - EASTERN EUROPE

Romania

One reference building in the city of **Bucharest**

Parameter	Specifications
Year of construction	<1979
Type of building	Residential, detached
No. of floors	1
Total floor area	99.7 m^2
Height	2.50 m
Total roof area	99.7 m^2
Total walls area	93.84 m^2
Total windows area	12 m^2

Latvia

One reference building in the city of **Riga**

Parameter	Specifications
Year of construction	1970-1979
Type of building	Residential, detached
No. of floors	1
Total floor area	96 m^2
Height	3.0 m
Total roof area	96 m^2
Total walls area	117.6 m^2
Total windows area	12 m^2

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BUILDING TYPOLOGIES – WESTERN/NORTH EUROPE

France

Two reference buildings in the city of **Paris**

Parameter	Specifications	
Year of construction	1975 - 1981 	1990 - 1999 
Type of building	Residential, detached	Residential, detached
No. of floors	1	1
Total floor area	97 m^2	107 m^2
Height	2.50 m	2.50 m
Total roof area	113 m^2	107 m^2
Total walls area	174 m^2	133 m^2
Total windows area	38 m^2	15 m^2

Ireland

Two reference buildings in the city of **Dublin**

Parameter	Specifications	
Year of construction	1967 - 1977 	1983-1993 
Type of building	Residential, detached	Residential, detached
No. of floors	1	1
Total floor area	125 m^2	157 m^2
Height	2.50 m	2.50 m
Total roof area	125 m^2	157 m^2
Total walls area	90 m^2	126 m^2
Total windows area	29 m^2	27 m^2

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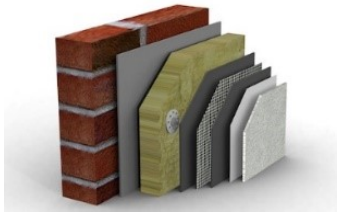
Energy Efficiency Measures (EEMs)

EEM #1



Exterior walls - Improving **insulation** standards of the building envelope

EEM #2

Roof insulation - Thermal retrofit of roofs to reduce the heat load of the buildings under study

EEM #3

Windows - Thermal upgrade of windows through double-glazed windows

EEM #4

Smart thermostat- setback states, without compromising thermal comfort of the occupants

EEM #5

Replacement of an **oil-fired** boiler with a **modern oil condensing** boiler

EEM #6

Replacement of an **oil-fired** boiler with a **natural gas** condensing **boiler**

EEM #7

Replacement of an **oil-fired** boiler with a with a **biomass boiler**

EEM #8

Replacement of an **oil-fired** boiler with a high temperature **heat pump**

EEM #9

Replacement **of traditional incandescent** light bulbs with **LED** bulbs

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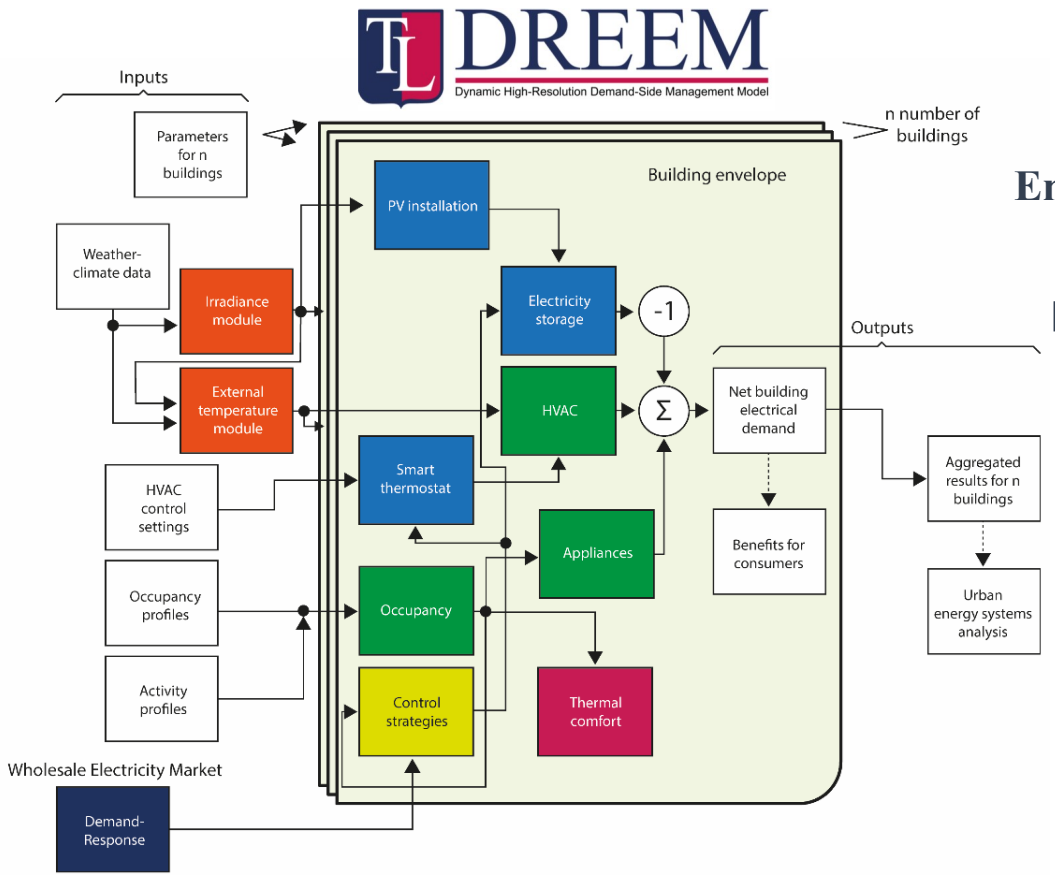
TECHNOECONOMIC ANALYSIS

The **Levelised Cost of Saved Energy (LCSE)** is used to assess the **cost effectiveness** of the different EEMs



Energy Savings for each EEM

€/kWh

$$LCSE = \frac{(CRF * \text{Cost}_{investment}) + \text{Cost}_{O\&M}}{Energy\ Svings\ (kWh)}$$

$$Capital\ Recovery\ Factor\ (CRF) = \frac{r * (1+r)^N}{(1+r)^N - 1}$$

where:

- **r:** discount rate
- **N:** lifetime of measures
- **$\text{Cost}_{investment}$:** total investment cost
- **$\text{Cost}_{O\&M}$:** annual operational and maintenance costs of the energy-saving scenario
- **Energy Savings:** total annual energy savings (kWh/year)

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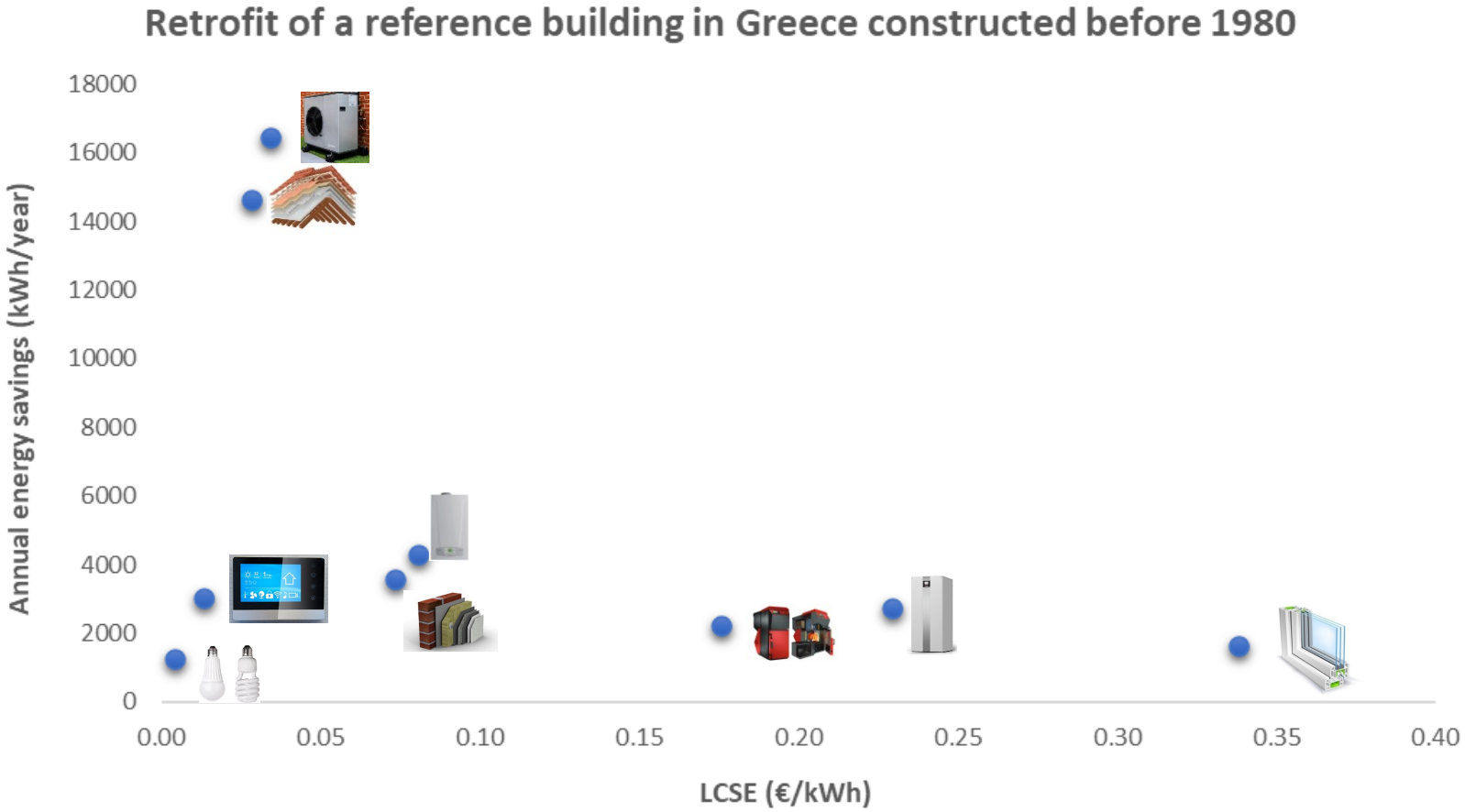
RESULTS (1/21)

Greece (Athens) – Category I

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.0732	3586.9
EEM2	0.0283	14626.2
EEM3	**0.3383**	1617.6
EEM4	0.0134	3009.1
EEM5	0.2292	2727.1
EEM6	0.0804	4275.1
EEM7	0.1759	2243.7
EEM8	0.0344	**16435.5**
EEM9	**0.0041**	1245.8



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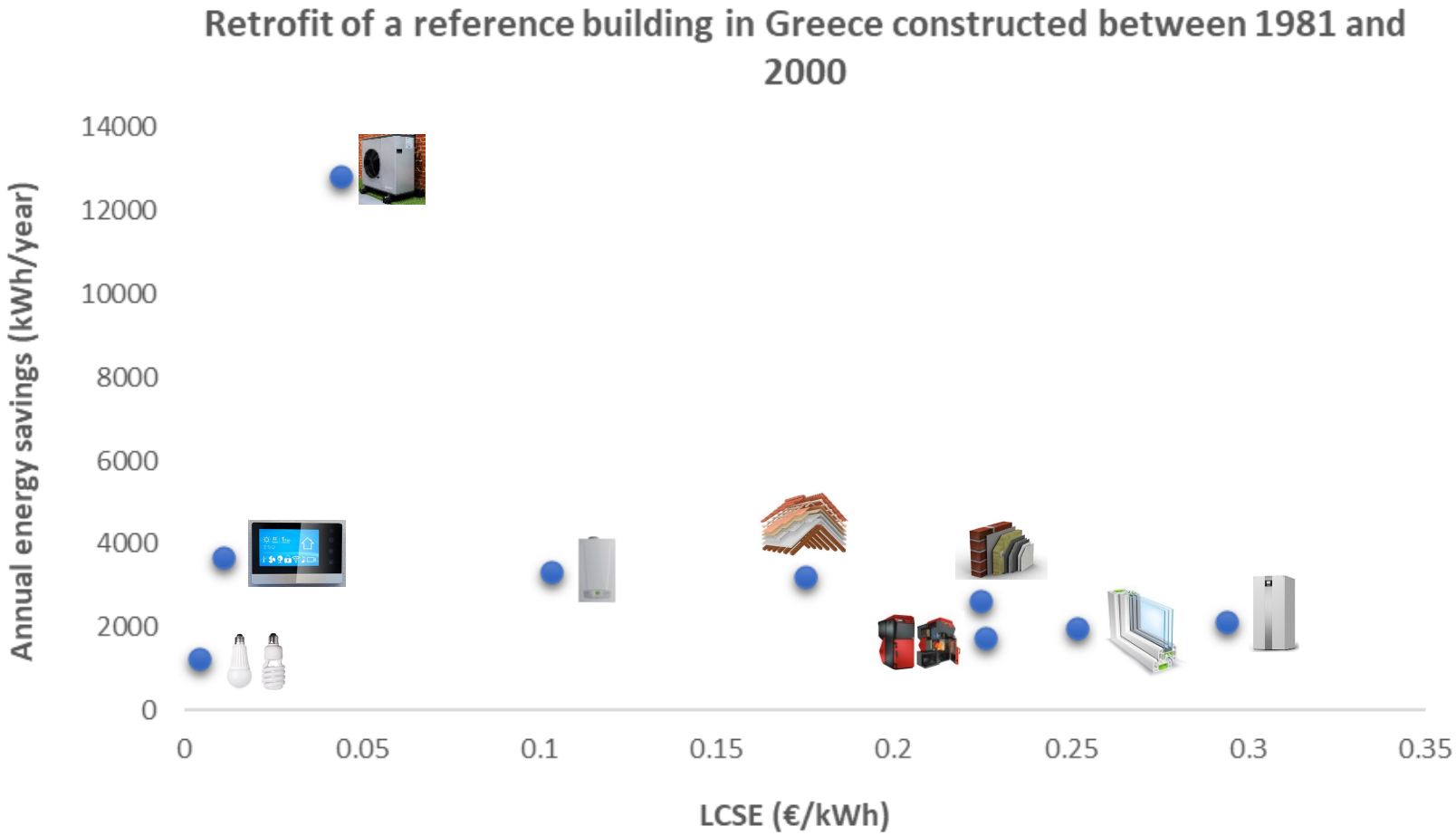
RESULTS (2/21)

Greece (Athens) – Category II

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.2243	2651
EEM2	0.1750	3226
EEM3	0.2515	1987.1
EEM4	0.0109	3680.1
EEM5	**0.2940**	2126.4
EEM6	0.1031	3332.9
EEM7	0.2258	1748.2
EEM8	0.0441	**12813.4**
EEM9	**0.0041**	1247.8



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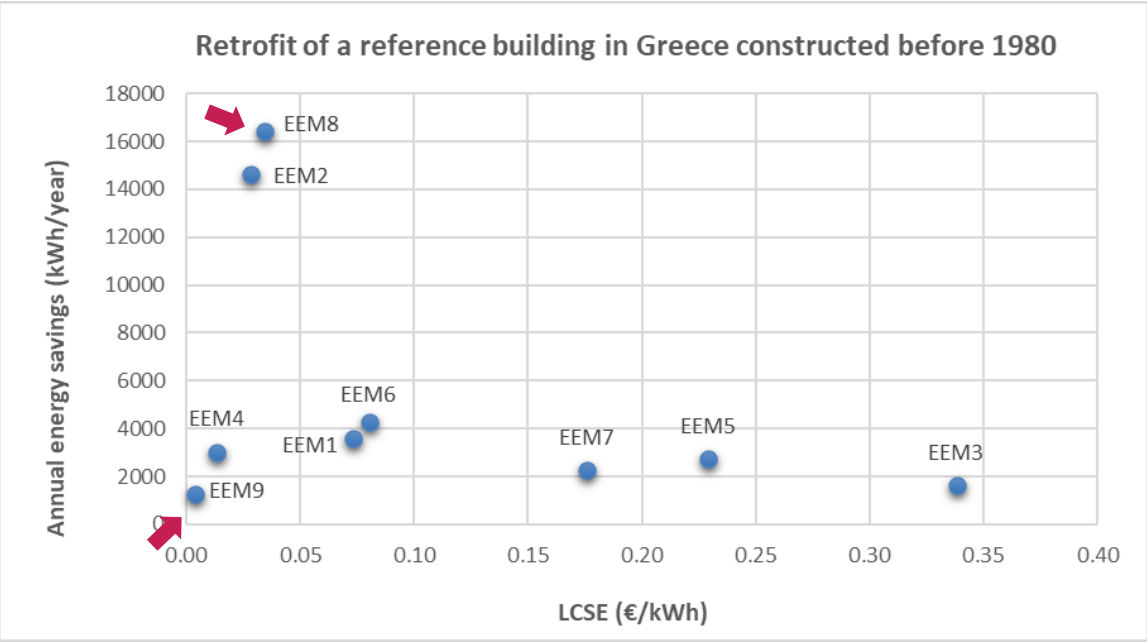
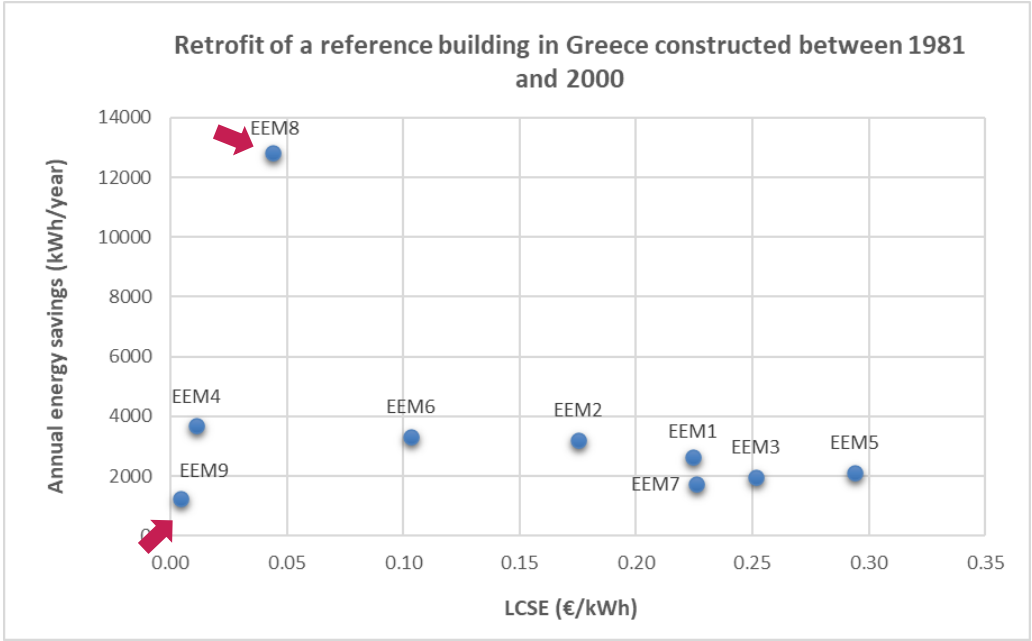
RESULTS (3/21)

Greece





- **LED bulbs (EEM9)** & **smart thermostat (EEM4)** are the **most cost-effective measures** in both building categories.
- **Heat pump (EEM8)** has the highest value of **annual energy savings** in both building categories.
- **Double-glazed windows (EEM3)** & **modern oil condensing boiler (EEM5)** are the **least cost-effective measures**.

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RESULTS (4/21)

Italy (Rome) – Category I

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.2243	2651
EEM2	0.1750	3226
EEM3	0.2515	1987.1
EEM4	0.0109	3680.1
EEM5	**0.2940**	2126.4
EEM6	0.1031	3332.9
EEM7	0.2258	1748.2
EEM8	0.0441	**12813.4**
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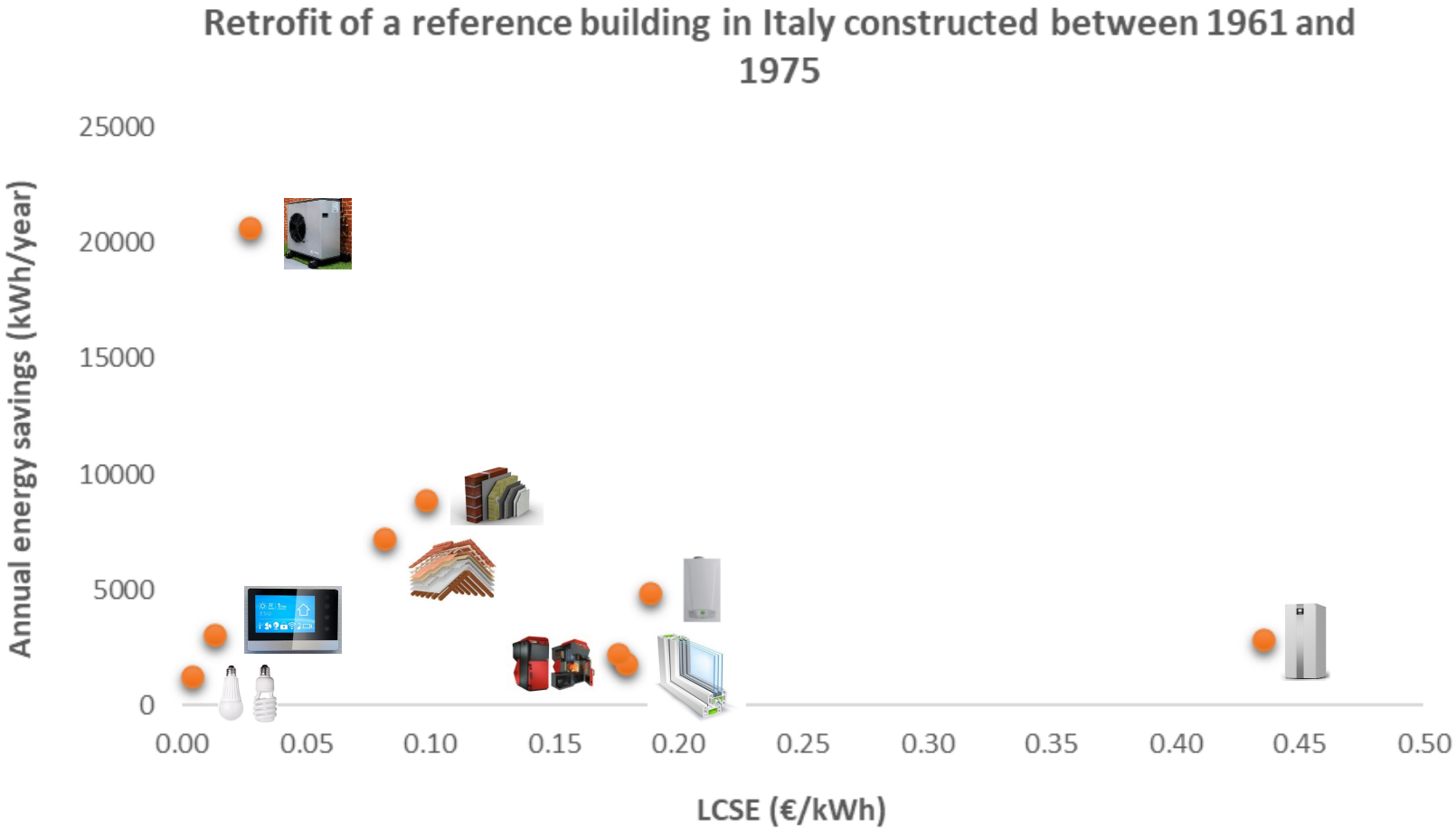

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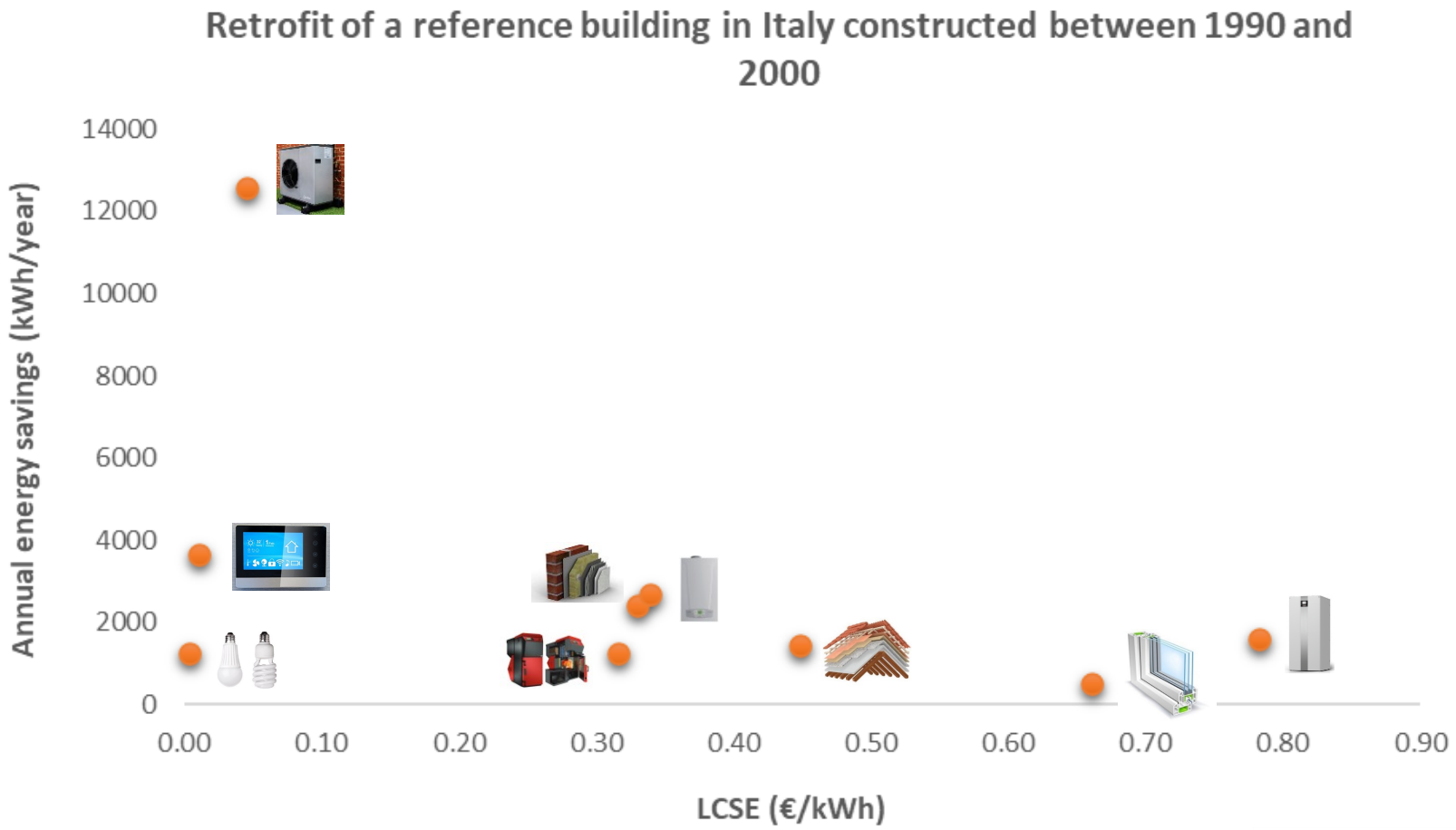
RESULTS (5/21)

Italy (Rome) – Category II

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.3298	2434.8
EEM2	0.4488	1433.7
EEM3	0.6606	540.3
EEM4	0.0110	3644.1
EEM5	**0.7822**	1598.2
EEM6	0.3389	2704.4
EEM7	0.3154	1251.4
EEM8	0.0450	**12570.4**
EEM9	**0.0041**	1245.8



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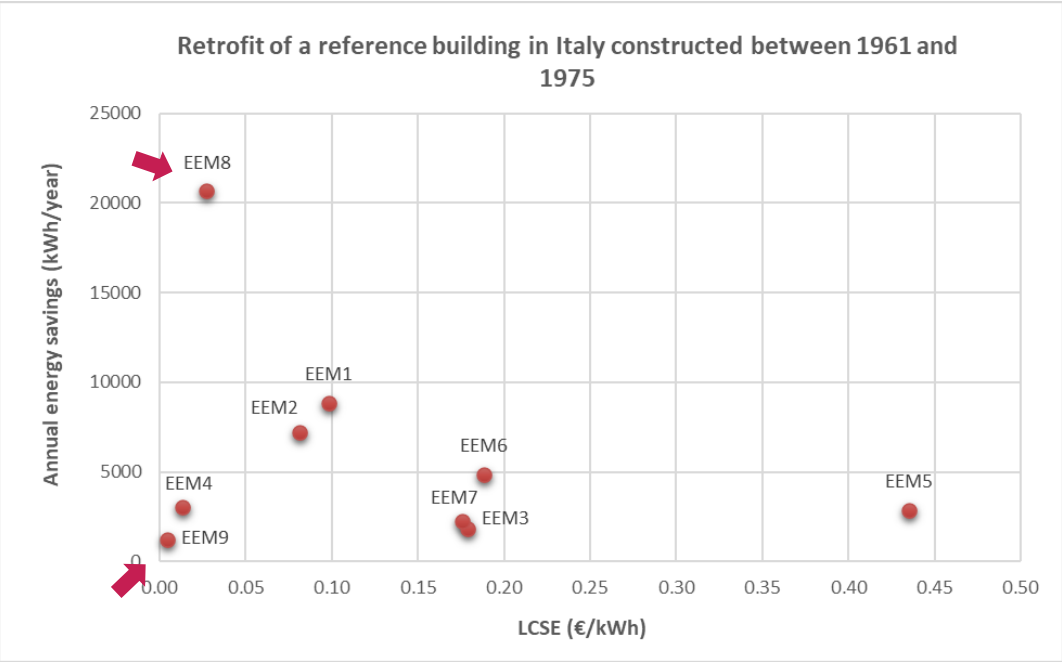
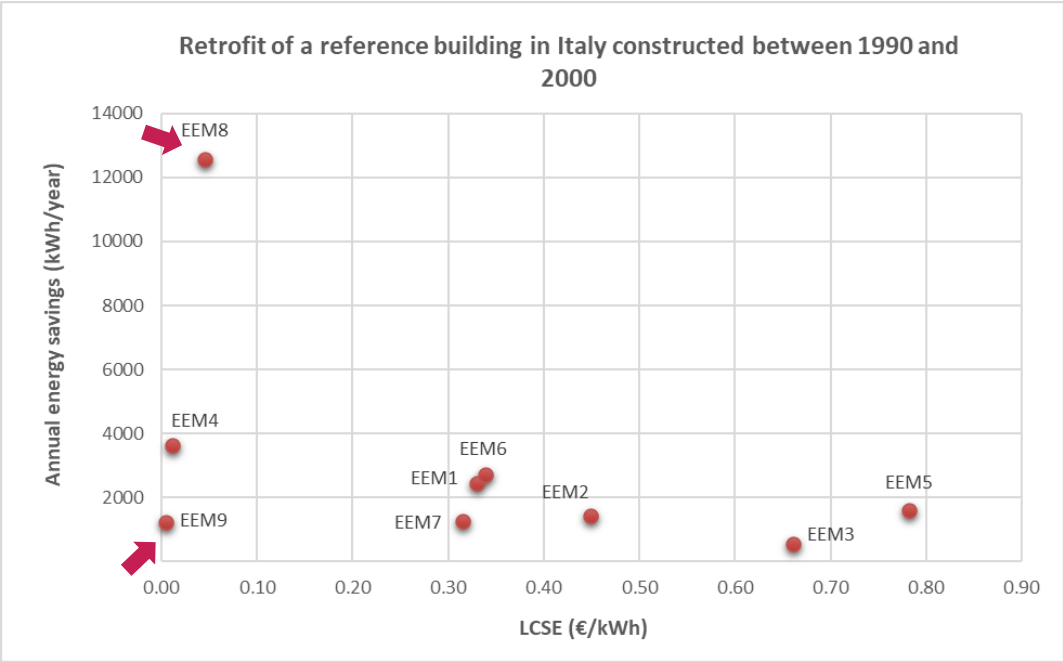
RESULTS (6/21)

Italy (Rome)





- **LED bulbs (EEM9)** & **smart thermostat (EEM4)** are the **most cost-effective measures** in both building categories.
- **Heat pump (EEM8)** has the highest value of **annual energy savings** in both building categories.
- **Modern oil condensing boiler (EEM5)** is the **least cost-effective measure** in both building categories.

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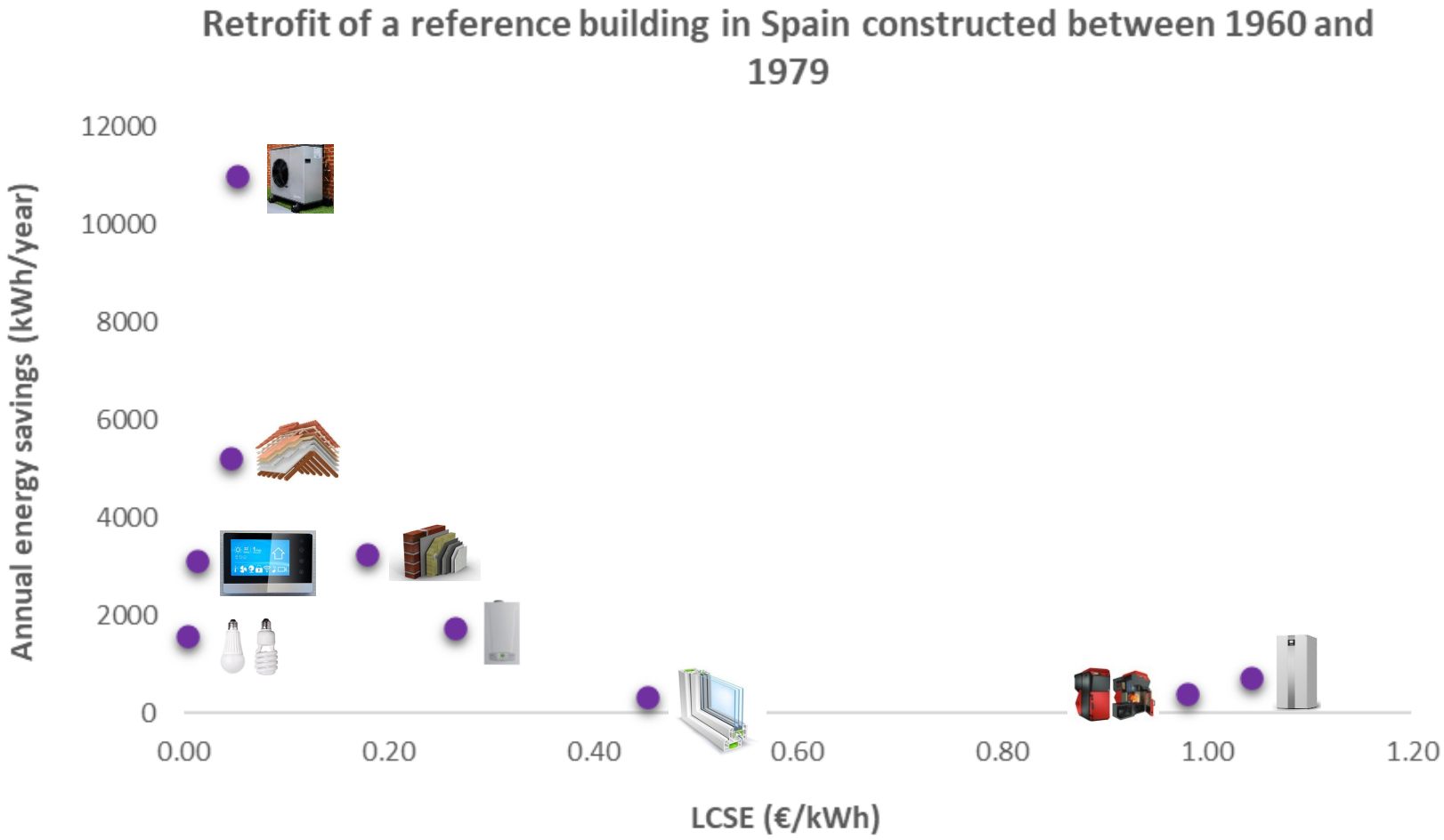
RESULTS (7/21)

Spain (Barcelona) - Category I

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.1791	3243.9
EEM2	0.0461	5226.8
EEM3	0.4521	342.1
EEM4	0.0129	3103.1
EEM5	**1.0431**	719.1
EEM6	0.2647	1731.7
EEM7	0.9801	402.7
EEM8	0.0514	**11003.7**
EEM9	**0.0033**	1579.3



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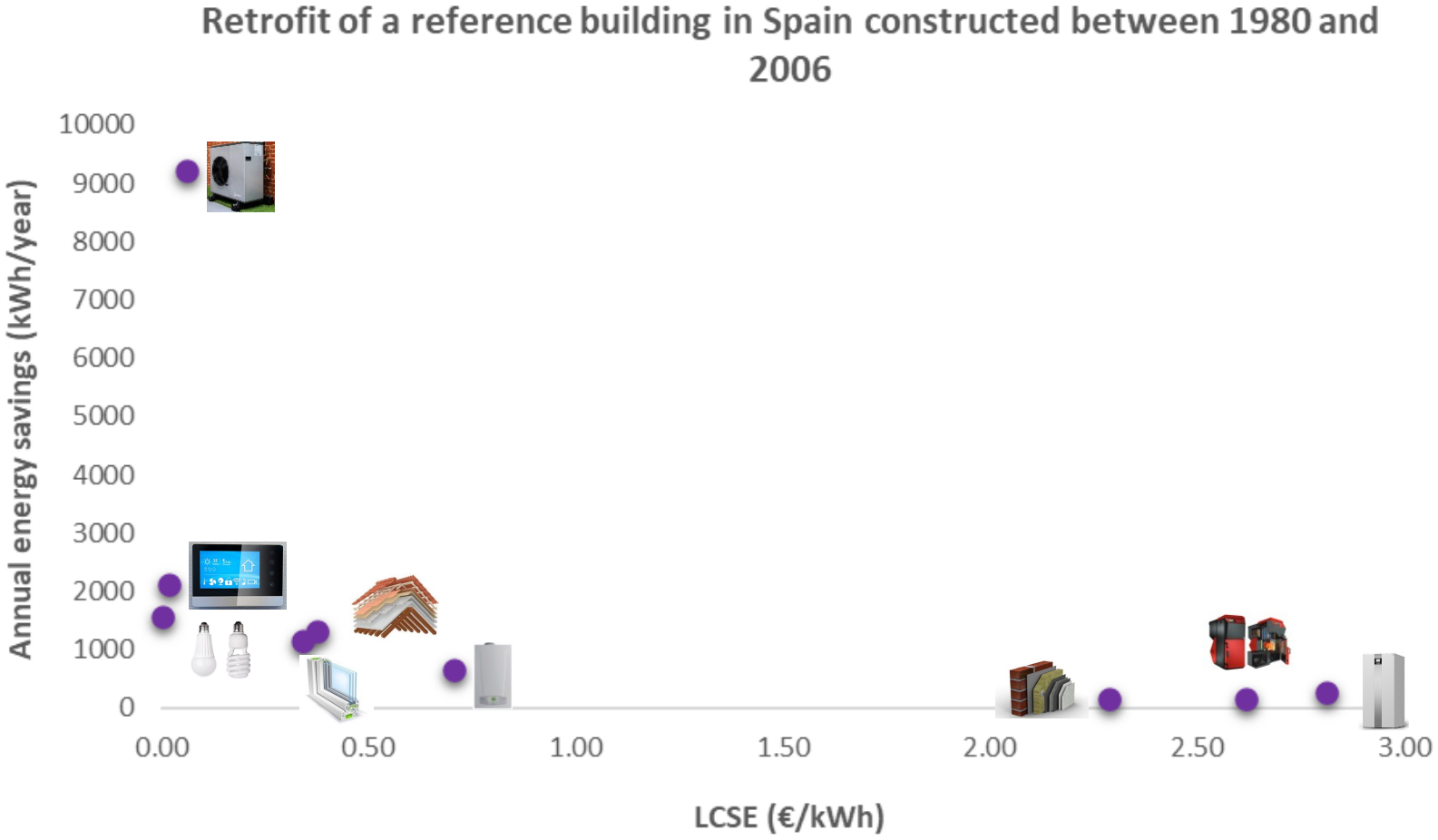
RESULTS (8/21)

Spain (Barcelona) - Category II

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.1791	3243.9
EEM2	0.0461	5226.8
EEM3	0.4521	342.1
EEM4	0.0129	3103.1
EEM5	**1.0431**	719.1
EEM6	0.2647	1731.7
EEM7	0.9801	402.7
EEM8	0.0514	**11003.7**
EEM9	**0.0033**	1579.3



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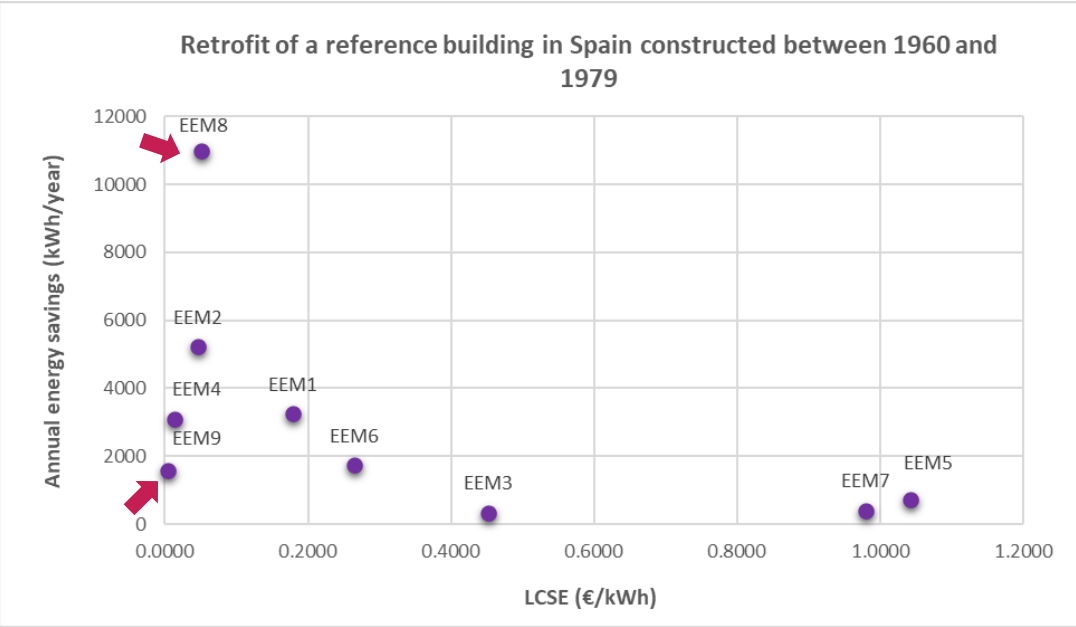
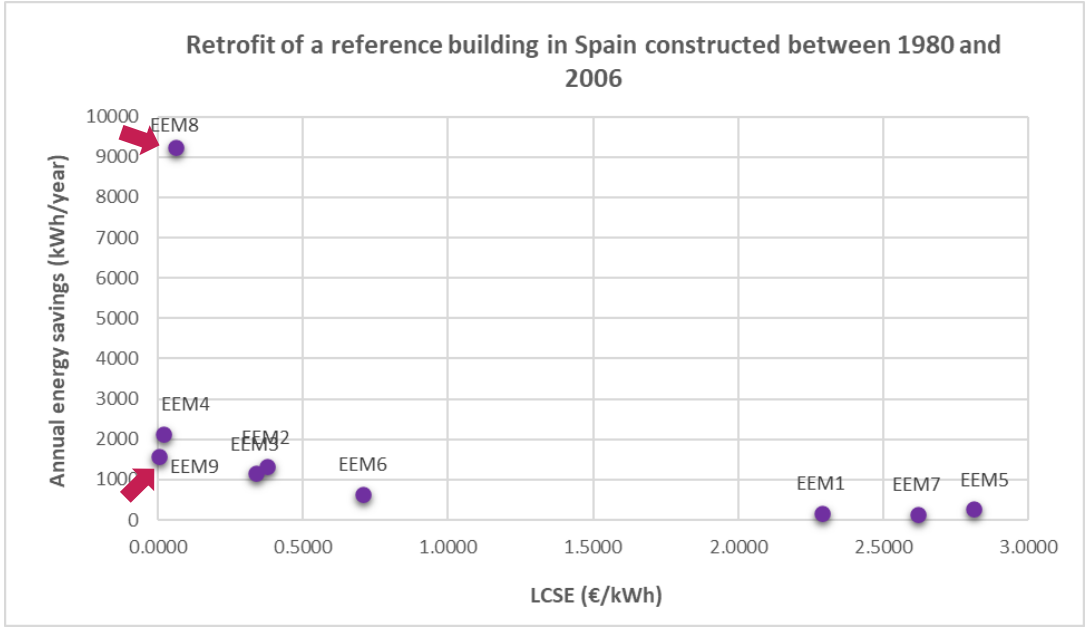
RESULTS (9/21)

Spain (Barcelona)





- **LED bulbs (EEM9)** & **smart thermostat (EEM4)** are the **most cost-effective measures** in both building categories.
- **Heat pump (EEM8)** has the highest value of **annual energy savings** in both building categories.
- **Modern oil condensing boiler (EEM5)** & **biomass boiler (EEM7)** are the **least cost-effective** measures in both building categories.

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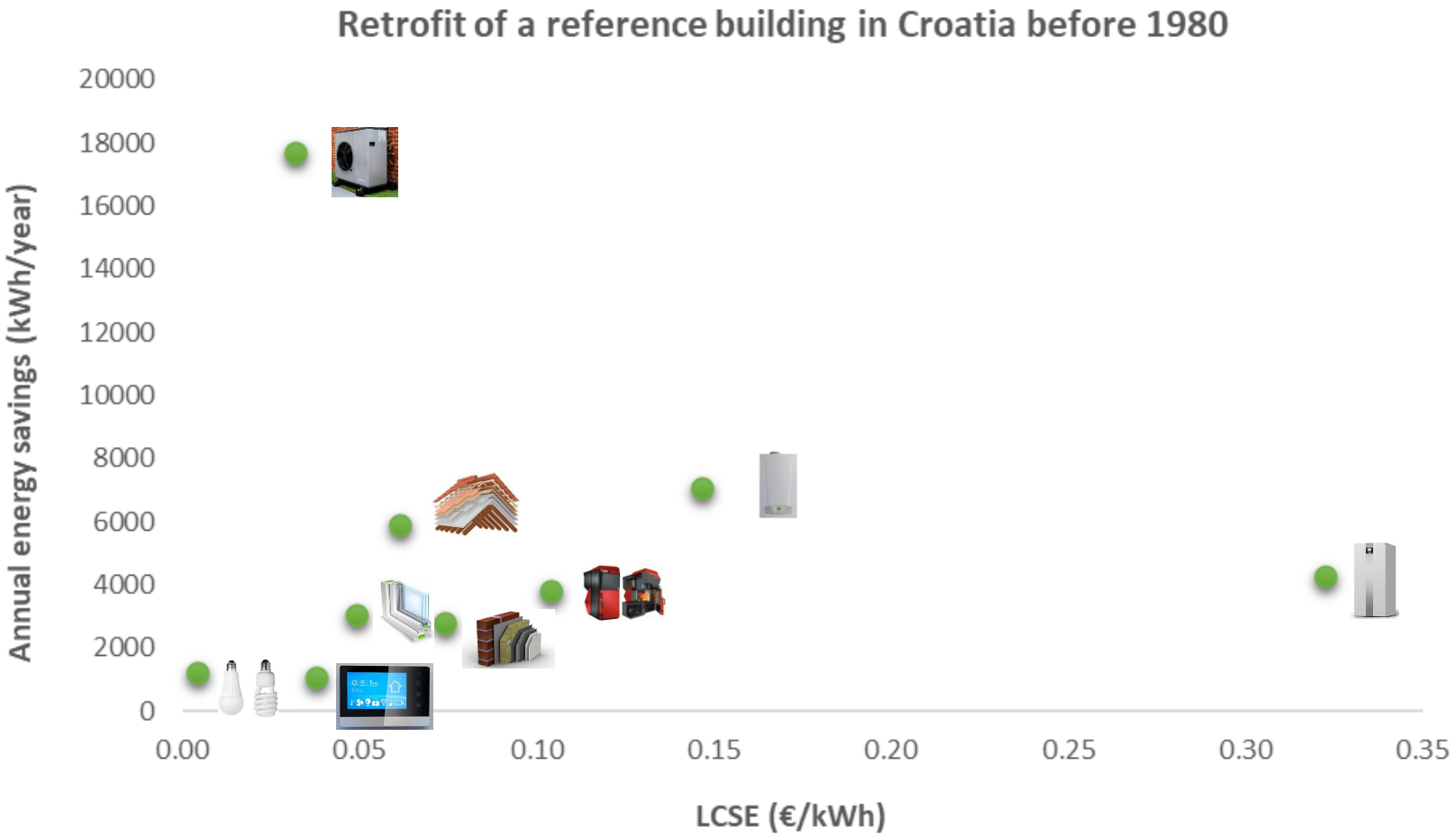
RESULTS (10/21)

Croatia (Zagreb) - Category I

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.0740	2771.8
EEM2	0.0612	5917.5
EEM3	0.0489	3035.6
EEM4	0.0376	1068
EEM5	**0.3223**	4267.1
EEM6	0.1463	7048
EEM7	0.1041	3792.9
EEM8	0.0320	**17673.1**
EEM9	**0.0041**	1242.3



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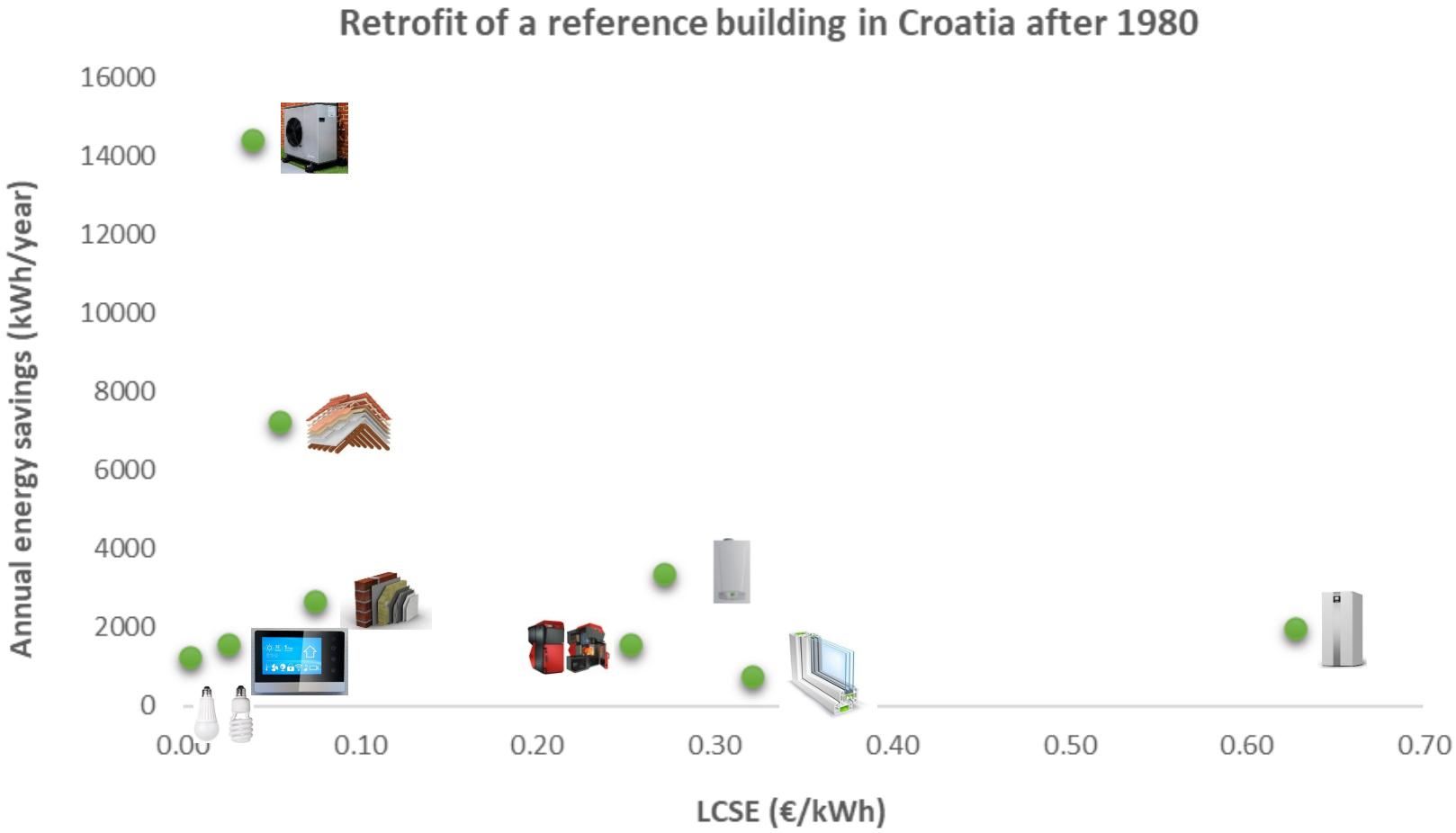
RESULTS (11/21)

Croatia (Zagreb) - Category II

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.0746	2680.2
EEM2	0.0541	7228.4
EEM3	0.3211	770.6
EEM4	0.0252	1594.4
EEM5	**0.6270**	1993.9
EEM6	0.2716	3374.6
EEM7	0.2528	1561.3
EEM8	0.0392	**14419.6**
EEM9	**0.0041**	1246.3



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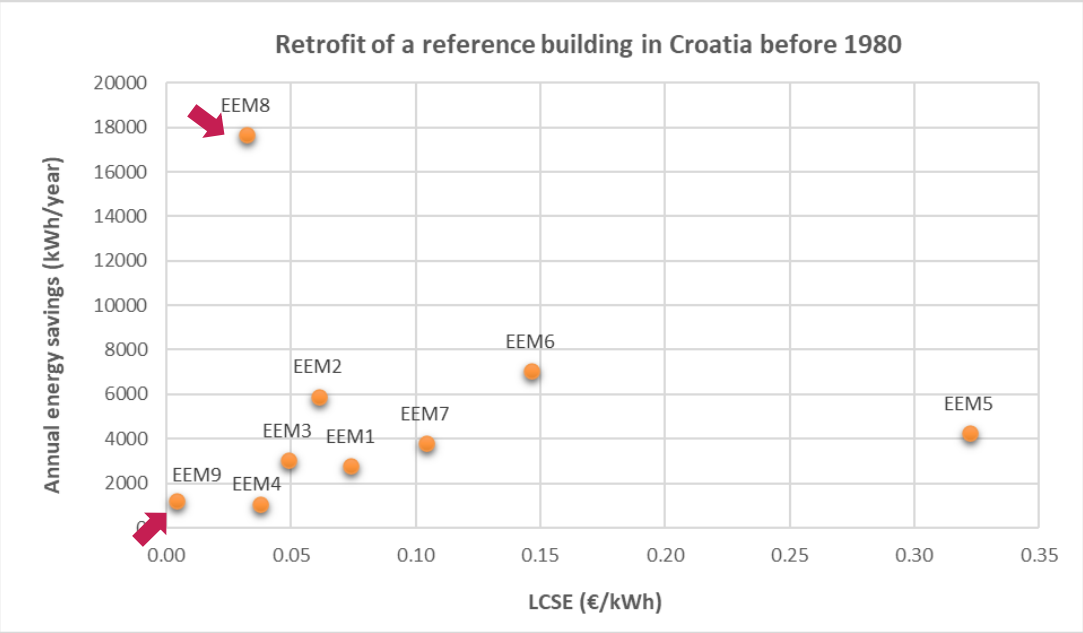
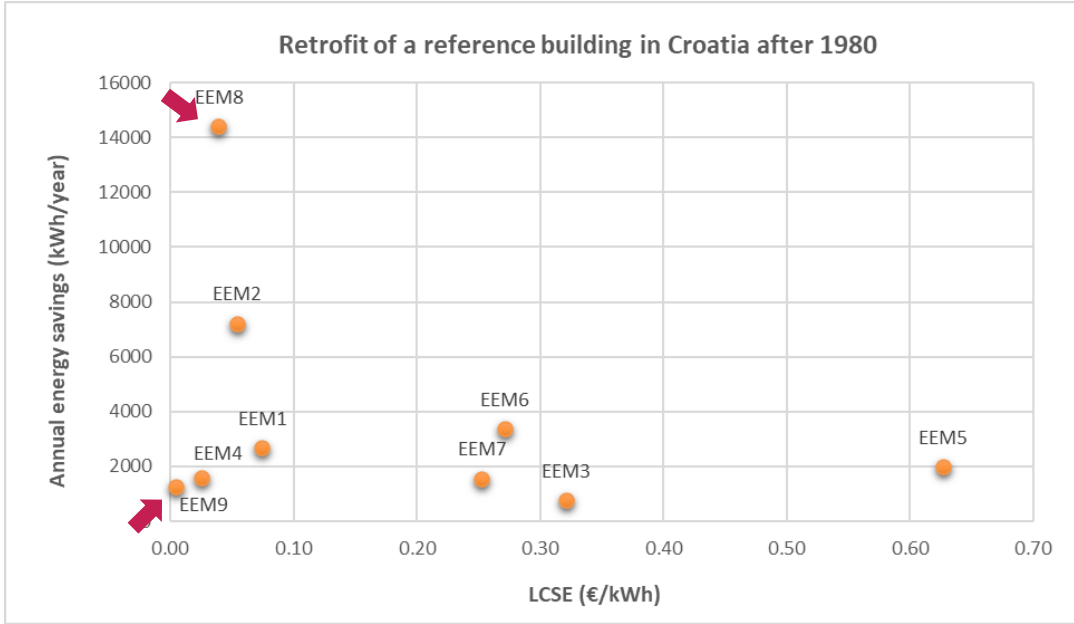
RESULTS (12/21)

Croatia (Zagreb)





- **LED bulbs (EEM9)** & **smart thermostat (EEM4)** are the **most cost-effective measures** in both building categories.
- **Heat pump (EEM8)** has the highest value of **annual energy savings** in both building categories.
- **Modern oil condensing (EEM5)** boiler is the **least cost-effective measure** in both building categories.

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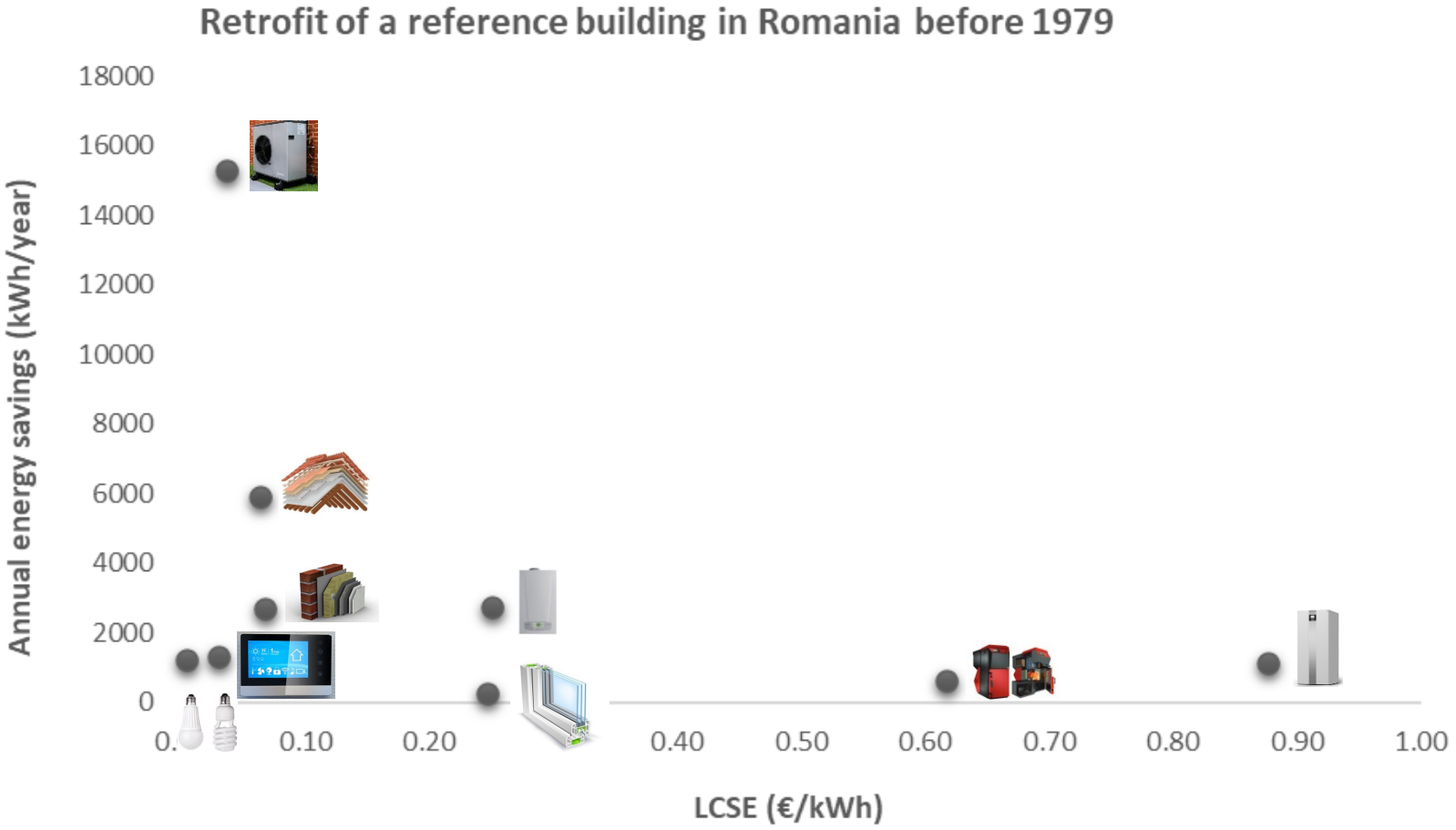
RESULTS (13/21)

Romania (Bucharest) – Category I

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.0675	2688.6
EEM2	0.0631	5948.2
EEM3	0.2470	289.0
EEM4	0.0302	1332.0
EEM5	**0.8758**	1142.0
EEM6	0.2506	2743.4
EEM7	0.6166	640.1
EEM8	0.0369	**15321.1**
EEM9	**0.0041**	1246.0

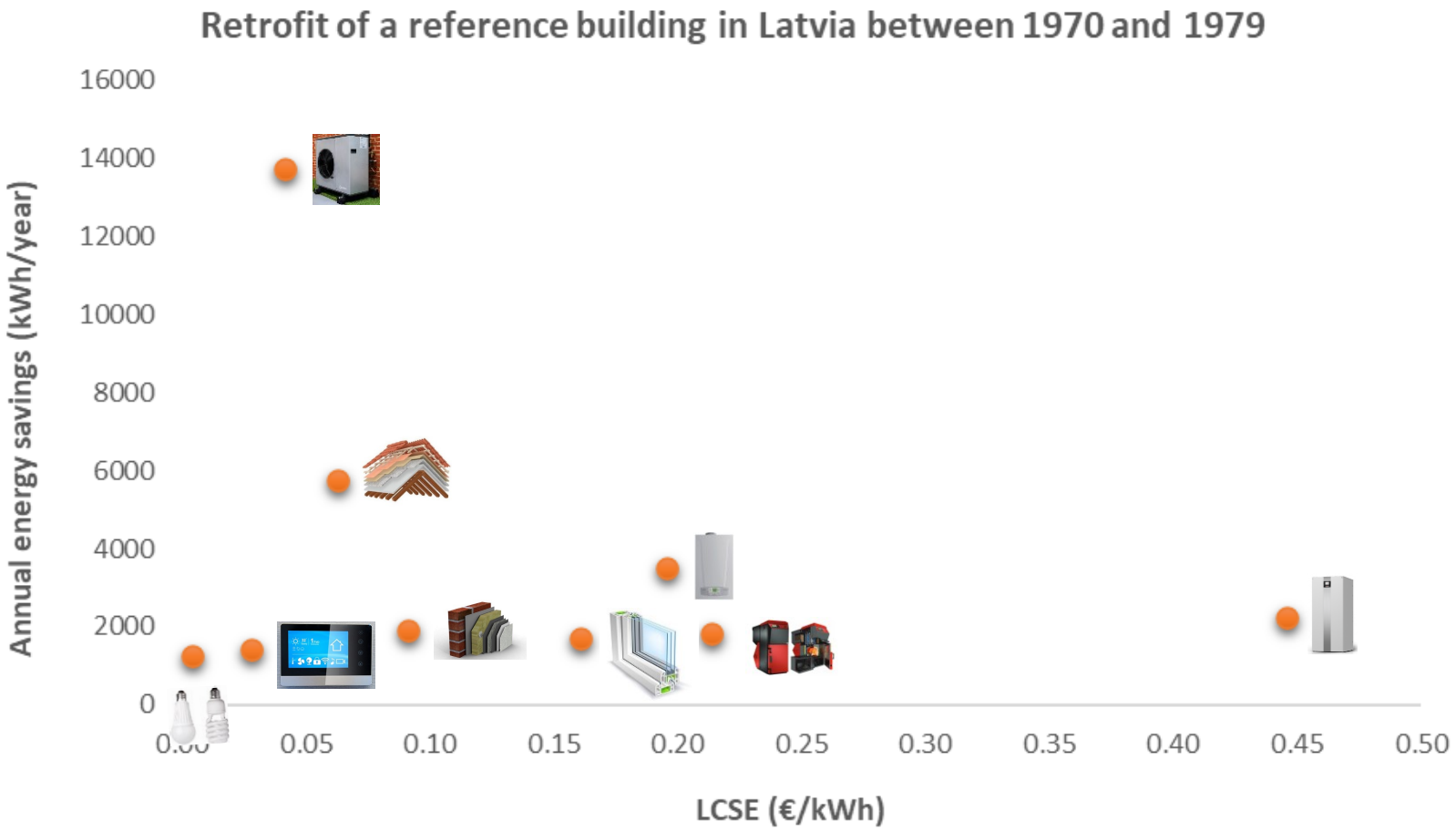


The SENTINEL project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 837089.

RESULTS (14/21)

Latvia (Riga) – Category I

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.0914	1922
EEM2	0.0627	5765
EEM3	0.1607	1702.9
EEM4	0.0282	1423.1
EEM5	**0.4454**	2245.3
EEM6	0.1954	3518.9
EEM7	0.2138	1845.9
EEM8	0.0412	**13724.1**
EEM9	**0.0041**	1245.7



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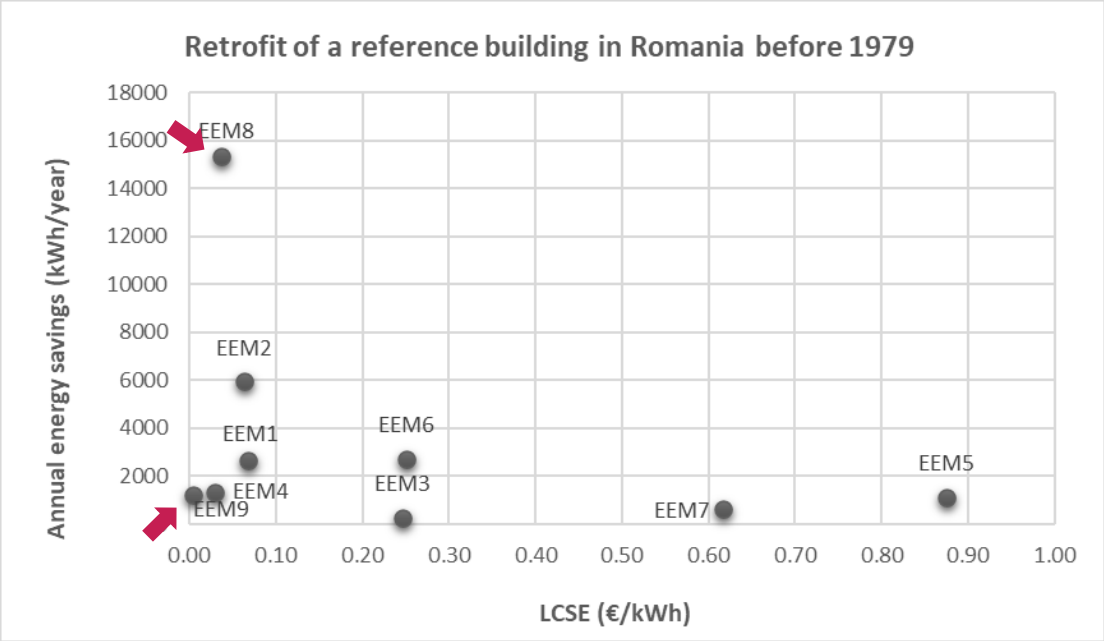
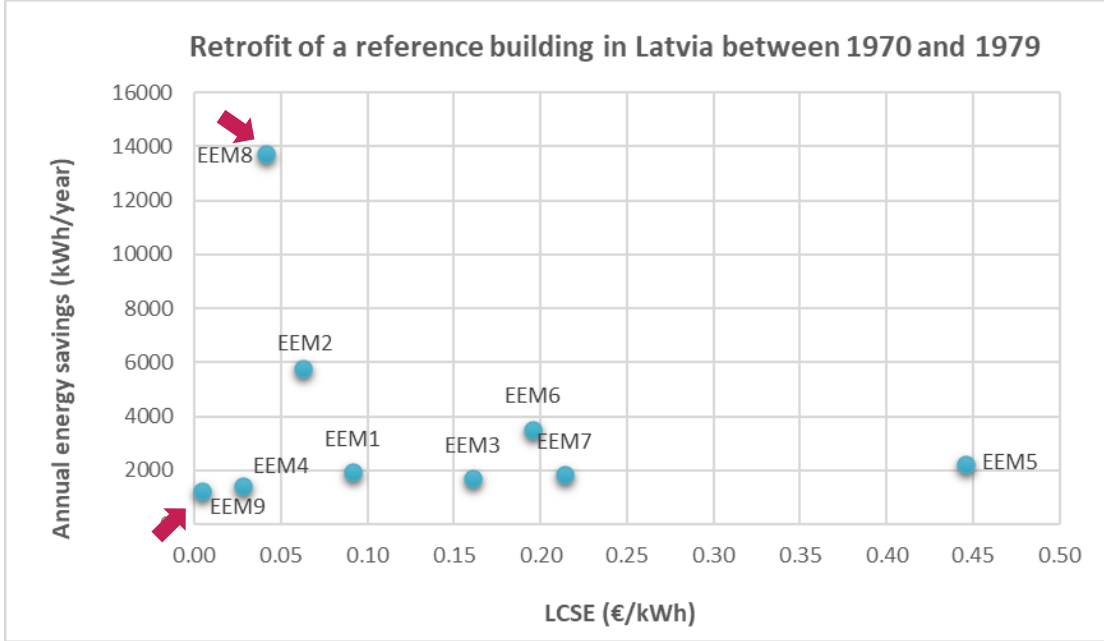
RESULTS (15/21)

Romania (Bucharest)



Latvia (Riga)



- **LED bulbs (EEM9)** & **smart thermostat (EEM4)** are the **most cost-effective measures** in both countries.
- **Heat pump (EEM8)** has the highest value of **annual energy savings** in both building categories.
- **Modern oil condensing (EEM5)** boiler is the **least cost-effective measure** in both countries.

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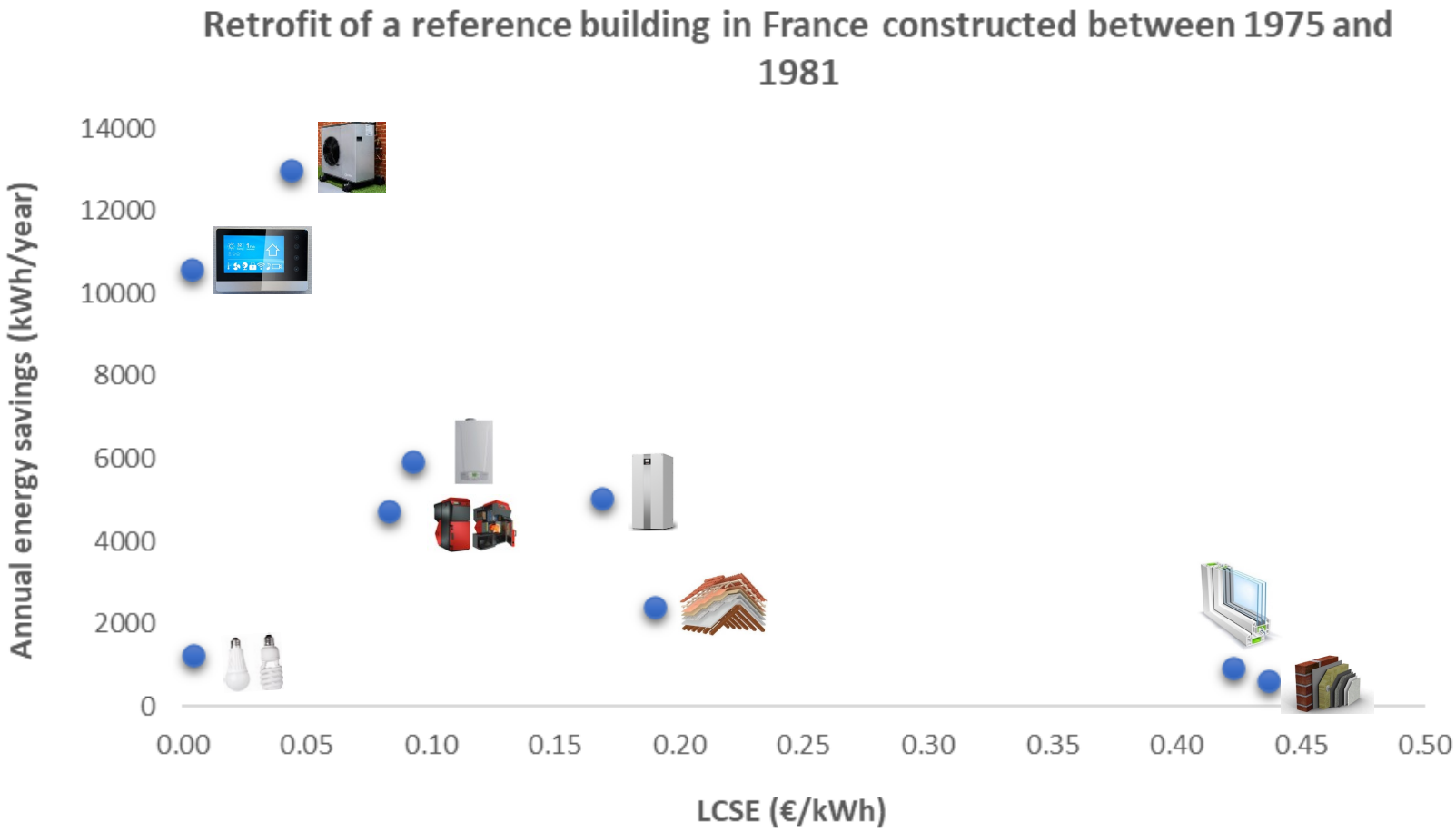
RESULTS (16/21)

France (Paris) – Category I

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.4371	640.4
EEM2	0.1897	2400.2
EEM3	**0.4231**	928
EEM4	0.0038	10593
EEM5	0.1686	5042.7
EEM6	0.0924	5951.6
EEM7	0.0830	4757.9
EEM8	0.0435	**12996.1**
EEM9	**0.0041**	1244.9



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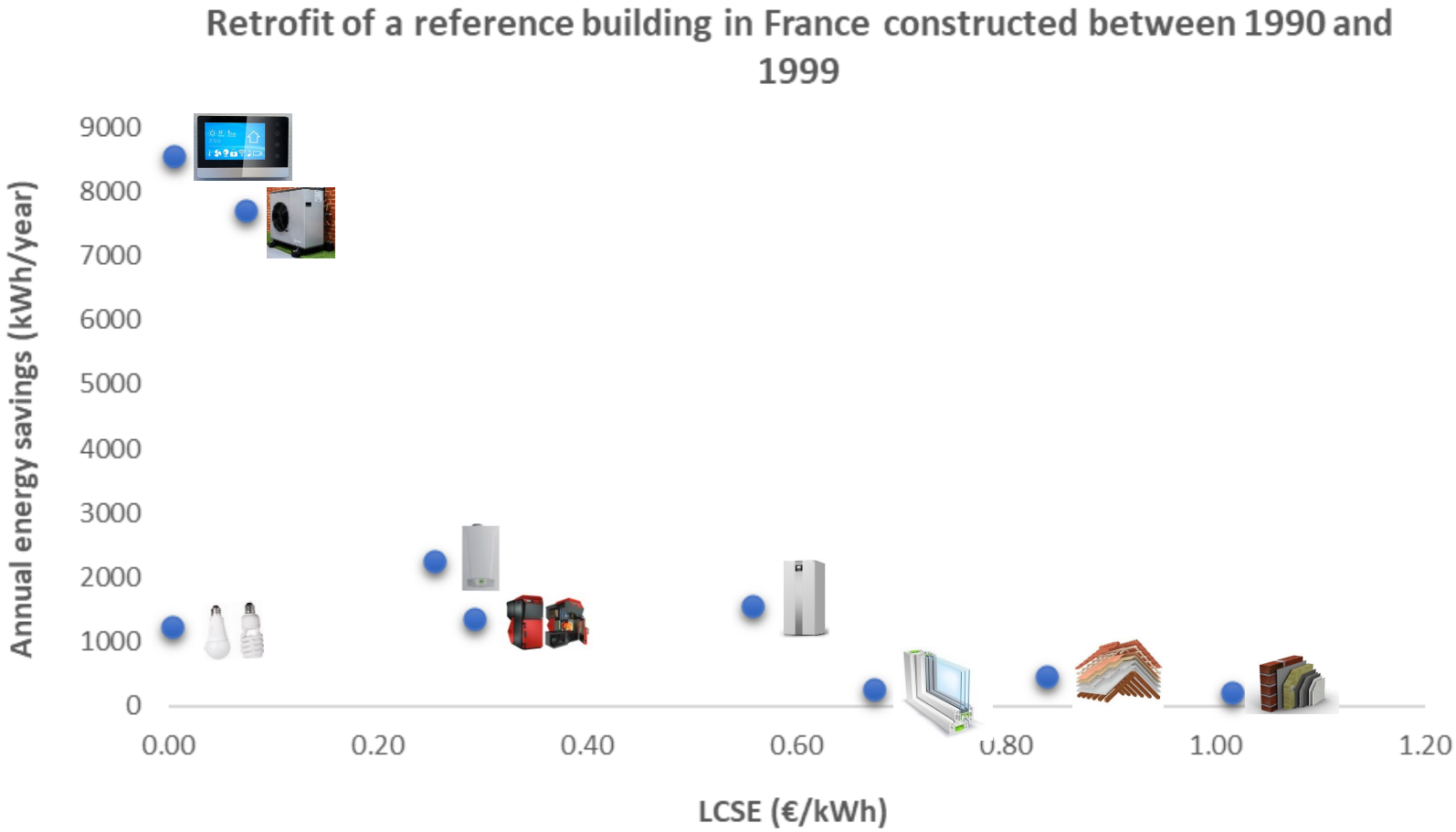
RESULTS (17/21)

France (Paris) – Category II

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	**1.0152**	232
EEM2	0.8384	480.3
EEM3	0.6742	264.7
EEM4	0.0047	**8552**
EEM5	0.5570	1571.2
EEM6	0.2531	2263.2
EEM7	0.2914	1354.4
EEM8	0.0734	7701.1
EEM9	**0.0041**	1246.1



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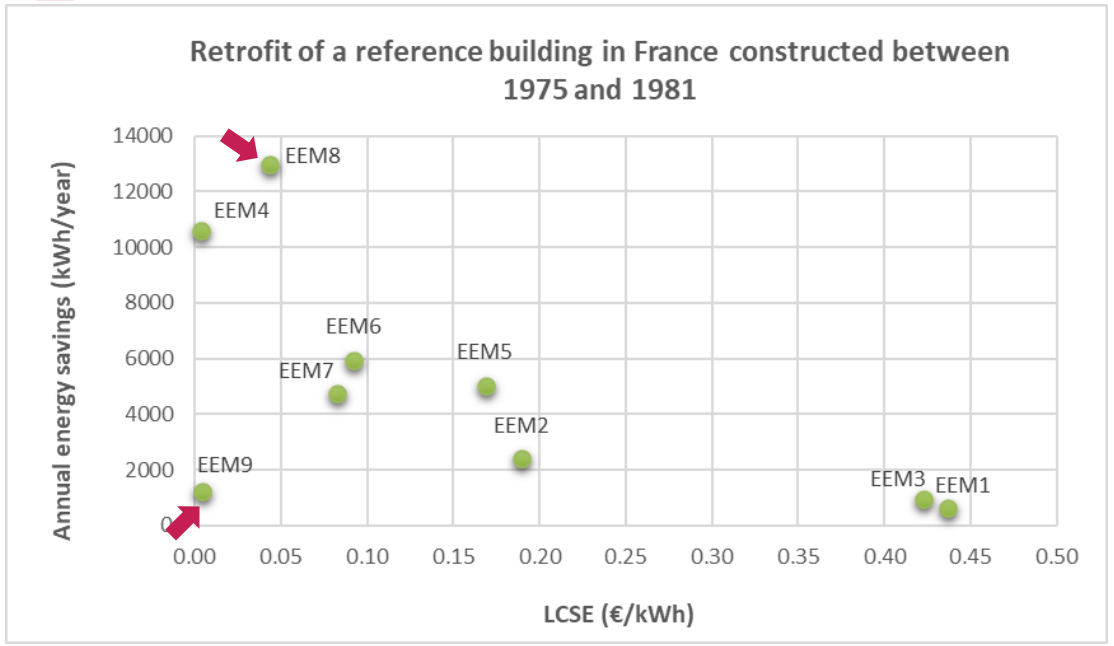
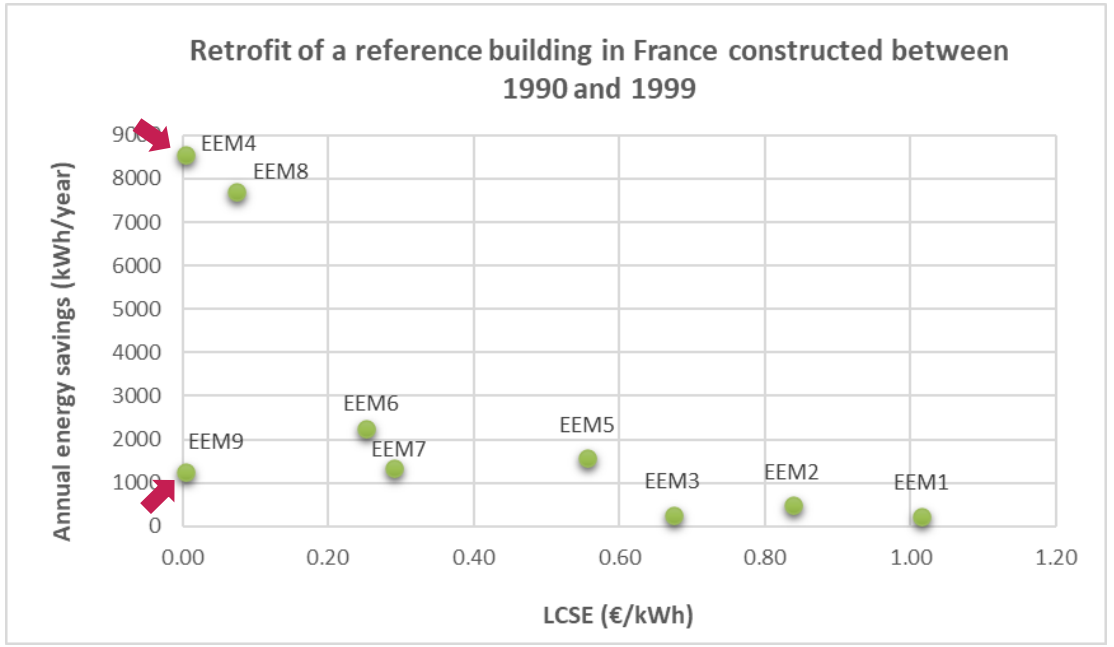
RESULTS (18/21)

France (Paris)





- **LED bulbs (EEM9)** are the **most cost-effective measure** in both building categories.
- **Heat pump (EEM8)** & **smart thermostat (EEM4)** have the highest value of **annual energy savings** in both building categories.
- **Exterior wall insulation (EEM1)** is the **least cost-effective measure** in both building categories.
- **Roof insulation (EEM2)** & **double-glazed windows (EEM3)** also have relatively high LCSE in the second building category.

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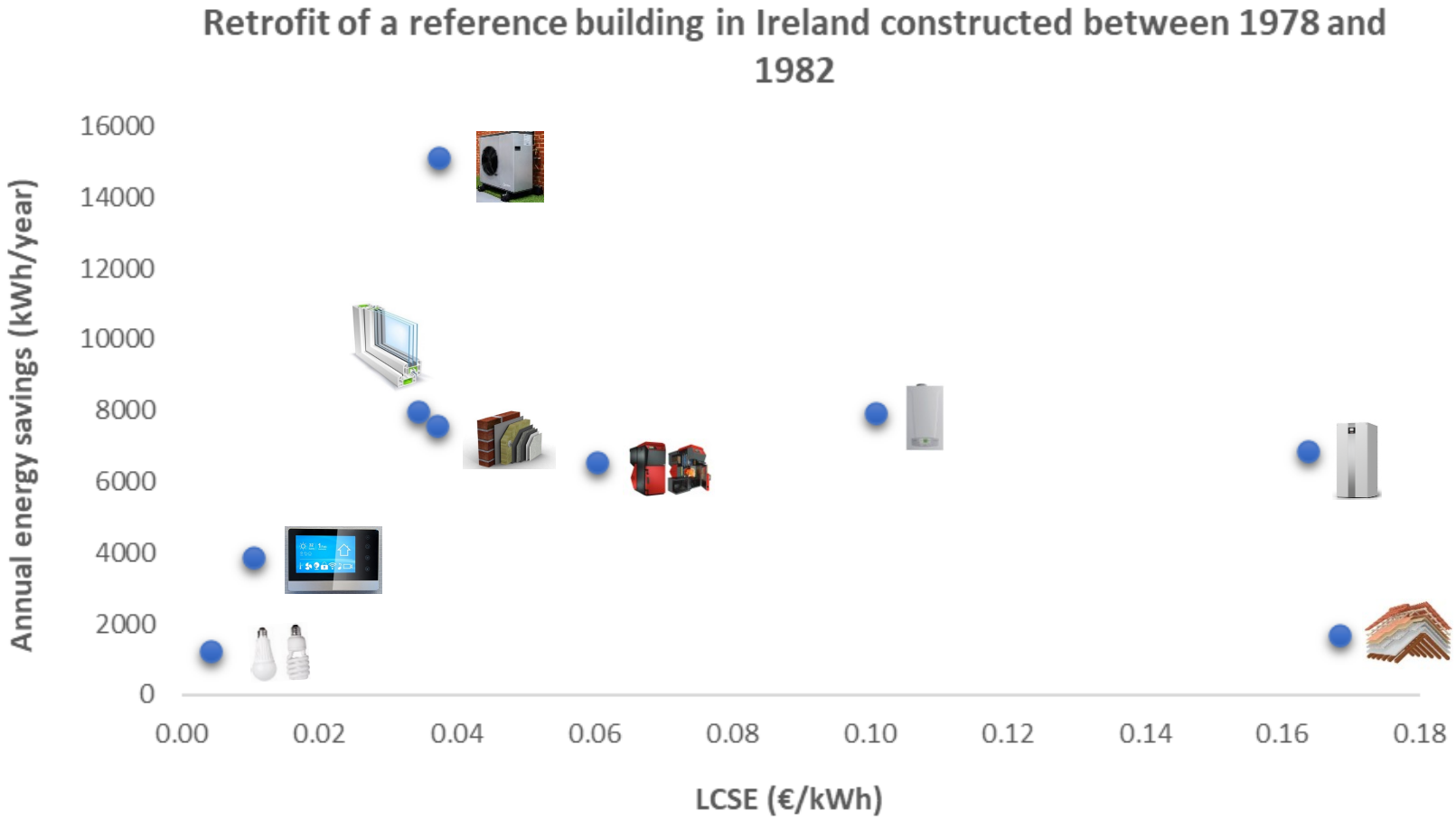
RESULTS (19/21)

Ireland (Dublin) – Category I

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.0371	7599.9
EEM2	**0.1683**	1699.7
EEM3	0.0342	7992.7
EEM4	0.0104	3867.5
EEM5	0.1637	6872.6
EEM6	0.1009	7945.9
EEM7	0.0604	6536.2
EEM8	0.0374	**15129.5**
EEM9	**0.0041**	1246.1



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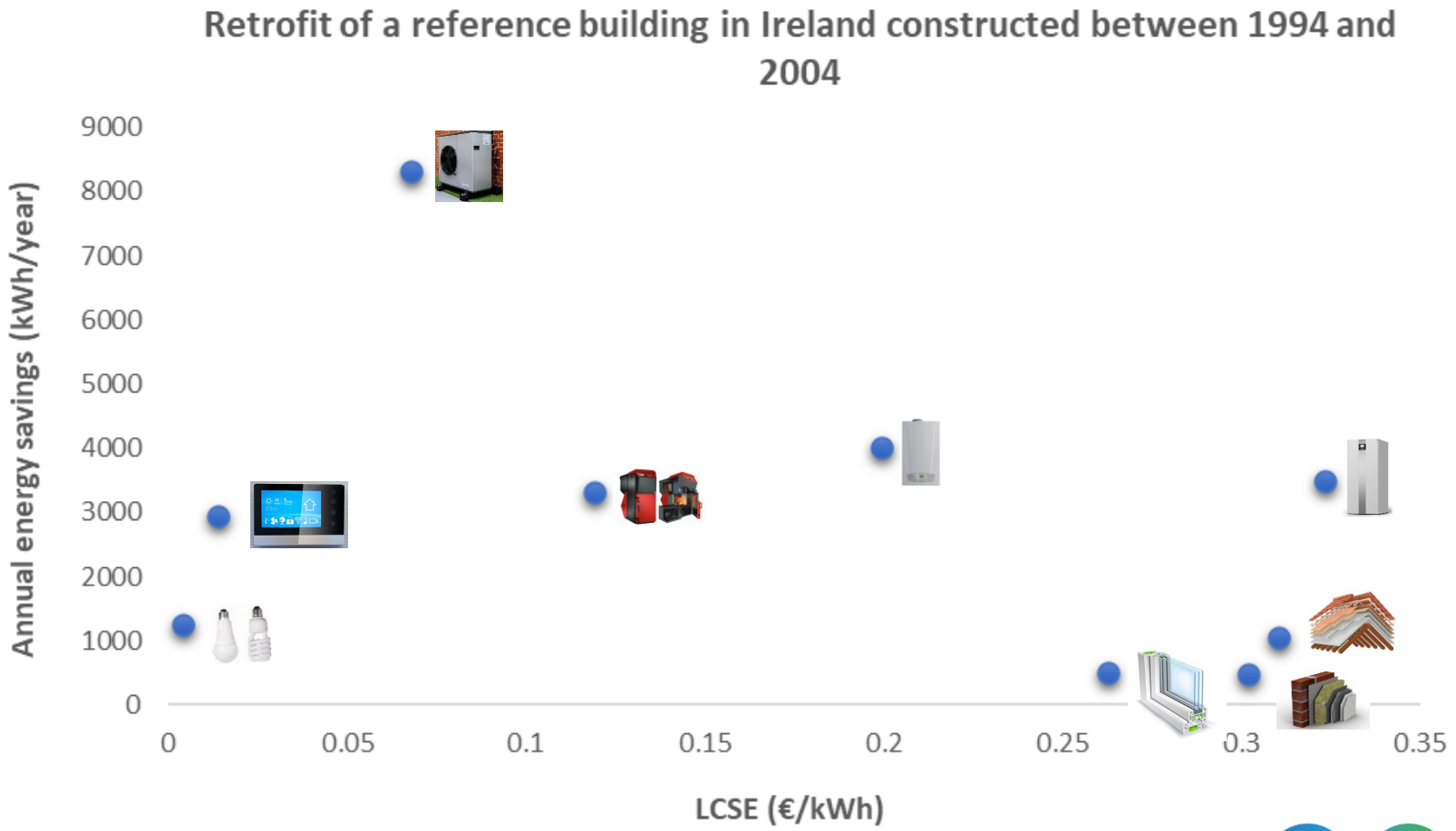
RESULTS (20/21)

Ireland (Dublin) – Category II

Energy Efficiency Measures	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.3017	479.9
EEM2	0.3101	1043.5
EEM3	0.2625	498.6
EEM4	0.0136	2945.8
EEM5	**0.3231**	3482.6
EEM6	0.1992	4026.3
EEM7	0.1192	3312.3
EEM8	0.0679	**8321**
EEM9	**0.0041**	1246.3



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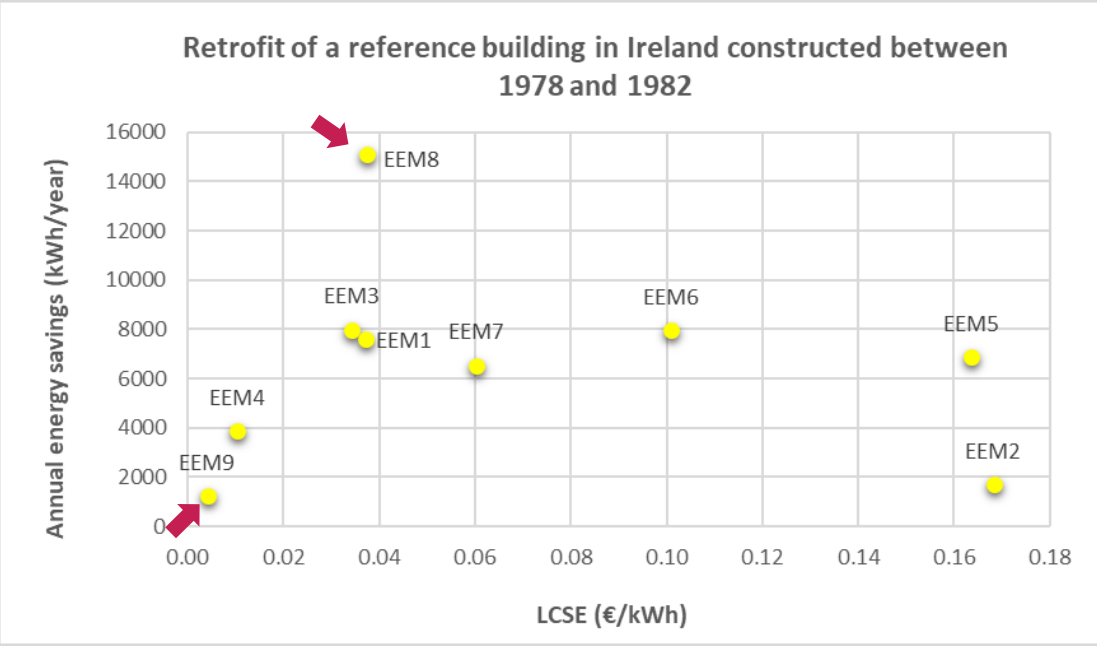
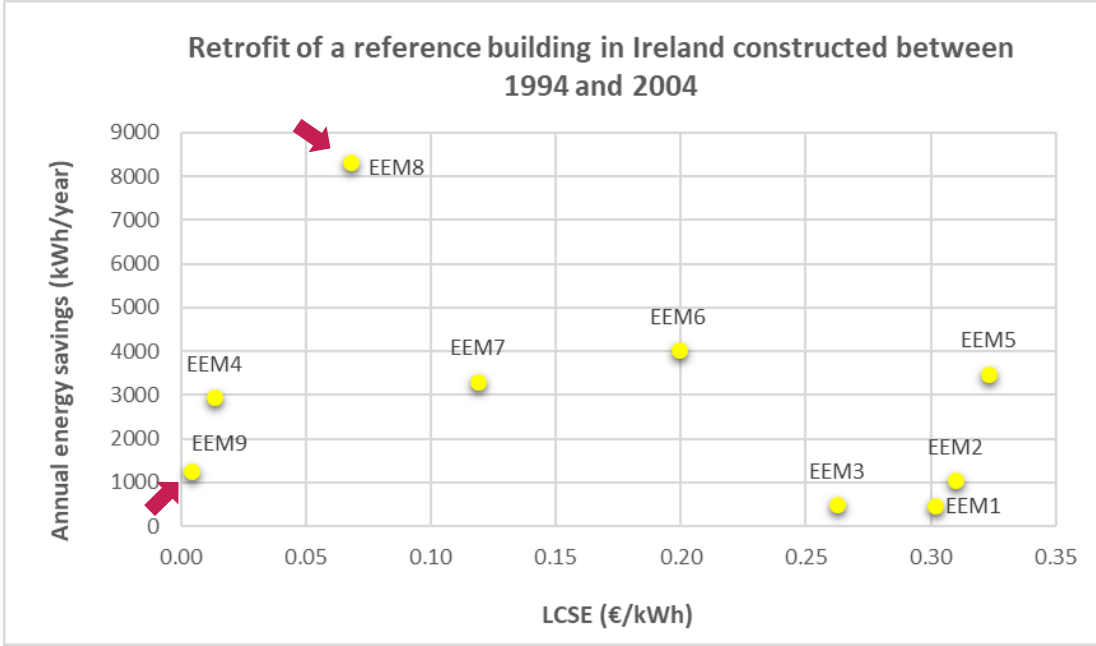
RESULTS (21/21)

Ireland (Dublin)





- **LED bulbs (EEM9)** & **smart thermostat (EEM4)** are the **most cost-effective measures** in both building categories.
- **Heat pump (EEM8)** has the highest value of **annual energy savings** in both building categories.
- **Roof insulation (EEM2)** and **modern oil condensing boiler (EEM5)** are the least cost-effective measures in building **Category I**, while in **Category II** **exterior wall insulation (EEM1)** is also **among the least cost-effective measures**.

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RESULTS – OVERALL (1/2)

- Energy-saving potential of the EEMs is commonly **higher** for buildings in **Category I**.

- The replacement of an old heating system with a **heat pump** system is among the **most cost-effective measures** for all countries, while also illustrates **high energy-saving potential**.

- Replacement of the traditional heating system with a **more energy-efficient diesel boiler** is shown to be the **least cost-effective measure** in most cases.

- **Exterior wall insulation**, **roof insulation**, and **double-glazed windows rank low** in terms of cost-effectiveness in many cases.

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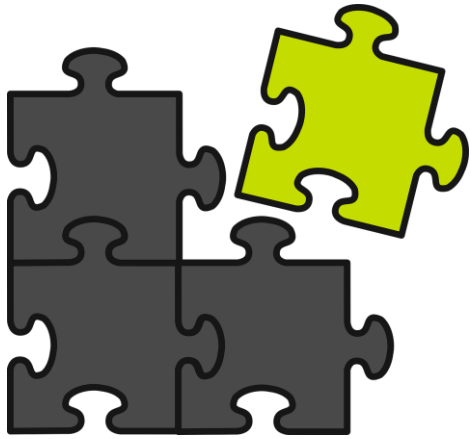
RESULTS – OVERALL (2/2)

- The results of the DREEM model presented in this study can be used to **inform** the development of **financial incentives** for energy-saving actions. Taking into account the **national context**, the study showcases the most and least cost-effective measures per country giving a hint on where the financial resources should be channelled.

- **Scale-up** of DREEM model results can further support policymakers in taking the right pathway that will allow the EU to reach the ambitious **14.5% energy saving goal for 2030***, introduced by the European Parliament this July.

- The DREEM model can also be employed to assess **portfolios of EEMs** and thus provide valuable information to **one-stop-shop** services.



*Compared to the 2020 EU reference scenario

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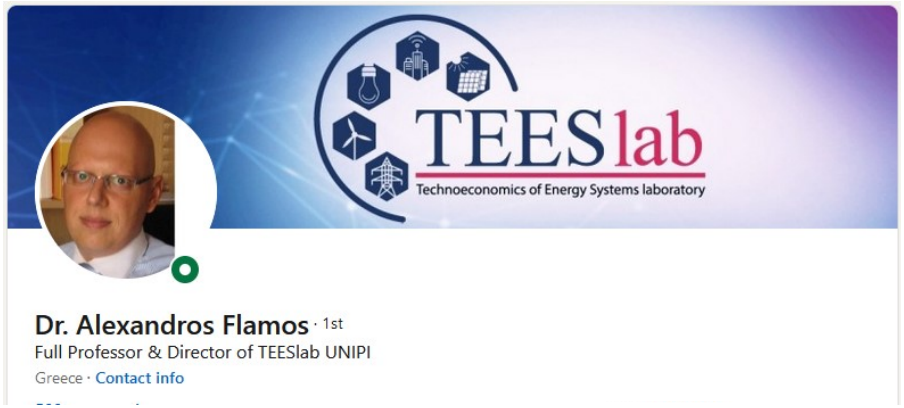

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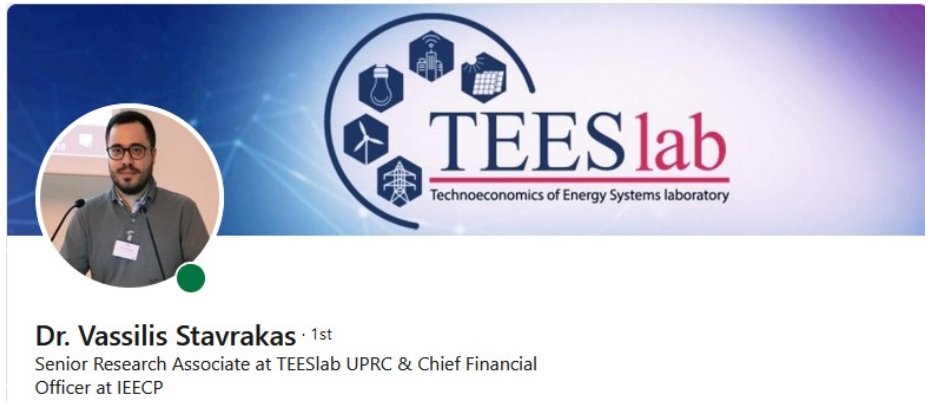

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DEVELOPMENT TEAM

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SUSTAINABLE ENERGY TRANSITIONS

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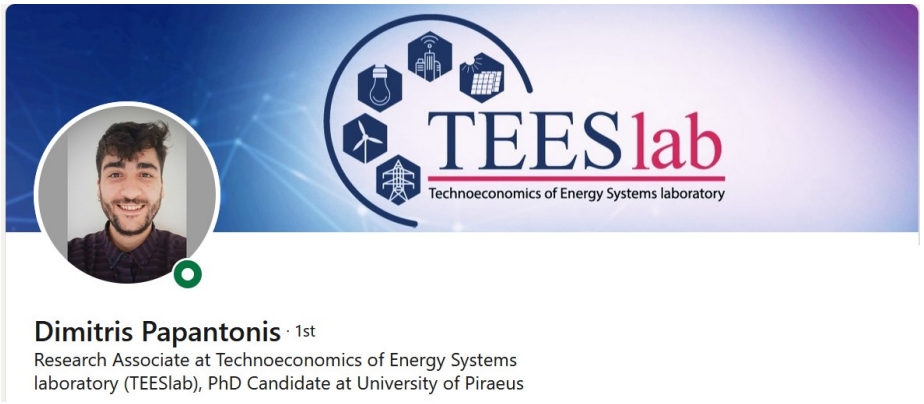

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ANNEX –ANNUAL SAVINGS & LCSE (1/2)

Category I

	Greece		Italy		Spain		Croatia		Romania		Latvia		France		Ireland	
Energy Efficiency Measures explored	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.0732	3586.9	0.0981	8871.5	0.1791	3243.9	0.0740	2771.8	0.0675	2688.6	0.0914	1922	0.4371	640.4	0.0371	7599.9
EEM2	0.0283	14626.2	0.0811	7241.1	0.0461	5226.8	0.0612	5917.5	0.0631	5948.2	0.0627	5765	0.1897	2400.2	**0.1683**	1699.7
EEM3	**0.3383**	1617.6	0.1788	1863.6	0.4521	342.1	0.0489	3035.6	0.2470	289.0	0.1607	1702.9	**0.4231**	928	0.0342	7992.7
EEM4	0.0134	3009.1	0.0132	3042.9	0.0129	3103.1	0.0376	1068	0.0302	1332.0	0.0282	1423.1	0.0038	10593	0.0104	3867.5
EEM5	0.2292	2727.1	**0.4352**	2872.9	**1.0431**	719.1	**0.3223**	4267.1	**0.8758**	1142.0	**0.4454**	2245.3	0.1686	5042.7	0.1637	6872.6
EEM6	0.0804	4275.1	0.1885	4863.1	0.2647	1731.7	0.1463	7048	0.2506	2743.4	0.1954	3518.9	0.0924	5951.6	0.1009	7945.9
EEM7	0.1759	2243.7	0.1754	2250.2	0.9801	402.7	0.1041	3792.9	0.6166	640.1	0.2138	1845.9	0.0830	4757.9	0.0604	6536.2
EEM8	0.0344	**16435.5**	0.0273	**20678.9**	0.0514	**11003.7**	0.0320	**17673.1**	0.0369	**15321.1**	0.0412	**13724.1**	0.0435	**12996.1**	0.0374	**15129.5**
EEM9	**0.0041**	1245.8	**0.0041**	1246	**0.0033**	1579.3	**0.0041**	1242.3	**0.0041**	1246.0	**0.0041**	1245.7	**0.0041**	1244.9	**0.0041**	1246.1

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ANNEX –ANNUAL SAVINGS & LCSE (2/2)

Category II

	Greece		Italy		Spain		Croatia		France		Ireland	
Energy Efficiency Measures explored	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)	LCSE (€/kWh)	Annual energy savings (kWh/year)
EEM1	0.2243	2651	0.3298	2434.8	0.1791	3243.9	0.0746	2680.2	**1.0152**	232	0.3017	479.9
EEM2	0.1750	3226	0.4488	1433.7	0.0461	5226.8	0.0541	7228.4	0.8384	480.3	0.3101	1043.5
EEM3	0.2515	1987.1	0.6606	540.3	0.4521	342.1	0.3211	770.6	0.6742	264.7	0.2625	498.6
EEM4	0.0109	3680.1	0.0110	3644.1	0.0129	3103.1	0.0252	1594.4	0.0047	**8552**	0.0136	2945.8
EEM5	**0.2940**	2126.4	**0.7822**	1598.2	**1.0431**	719.1	**0.6270**	1993.9	0.5570	1571.2	**0.3231**	3482.6
EEM6	0.1031	3332.9	0.3389	2704.4	0.2647	1731.7	0.2716	3374.6	0.2531	2263.2	0.1992	4026.3
EEM7	0.2258	1748.2	0.3154	1251.4	0.9801	402.7	0.2528	1561.3	0.2914	1354.4	0.1192	3312.3
EEM8	0.0441	**12813.4**	0.0450	**12570.4**	0.0514	**11003.7**	0.0392	**14419.6**	0.0734	7701.1	0.0679	**8321**
EEM9	**0.0041**	1247.8	**0.0041**	1245.8	**0.0033**	1579.3	**0.0041**	1246.3	**0.0041**	1246.1	**0.0041**	1246.3

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Thank you for your attention!