TESSe2B

the smart energy storage

Thermal Energy Storage Systems

for energy efficient building an integrated solution for residential building energy storage by solar and geothermal resources

TESSe2b project

Workshop - The Future of Energy Storage

SP2018

Luís Coelho*, João Garcia*, Amândio Rebola* and Kostas Karytsas**

***Instituto Politécnico de Setúbal (IPS) / CINEA-IPS; **CRES**

European Commission

SUSTAINABLE PLACES 2018 June 27-29, 2018 Aix-les Bains, France

Objectives

- To present the European TESSe2b Project .
- To present some results achieved so far.

Project Title

Thermal Energy Storage Systems for Energy Efficient Buildings. An **integrated** solution for **residential** building **energy storage** by **solar** and **geothermal** resources

- TESSe2b Project –

Project number: 680555

Call identifier: H2020-EeB-2015 **Call for EeB – Energy-efficient Buildings**

EeB 6 – 2015: Integrated solutions of thermal energy storage for building applications

Context of the project

TESSe2b Project

Type of action: **RIA** - Research & Innovation Actions (defined in the call)

Activities expected to focus on Technology Readiness **Levels 4-6**.

- Budget: 4.311.700 euros;
- Number of participants: 10
- Number of countries: 8
- Starting date of the project: 01/10/2015;
- Duration: 48 months

G.Technology readiness levels (TRL)

Where a topic description refers to a TRL, the following definitions apply, unless otherwise specified:

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

General Objectives

- Increasing **energy efficiency** in buildings, enhance **green technologies** and promote advance **thermal energy storage** solutions.

- The target of TESSe2b is to **design**, **develop**, **validate** and **demonstrate** a **modular** and **low cost thermal storage** technology based on **solar collectors** and highly efficient **heat pumps** for **heating**, **cooling** and domestic hot water (**DHW**) production.

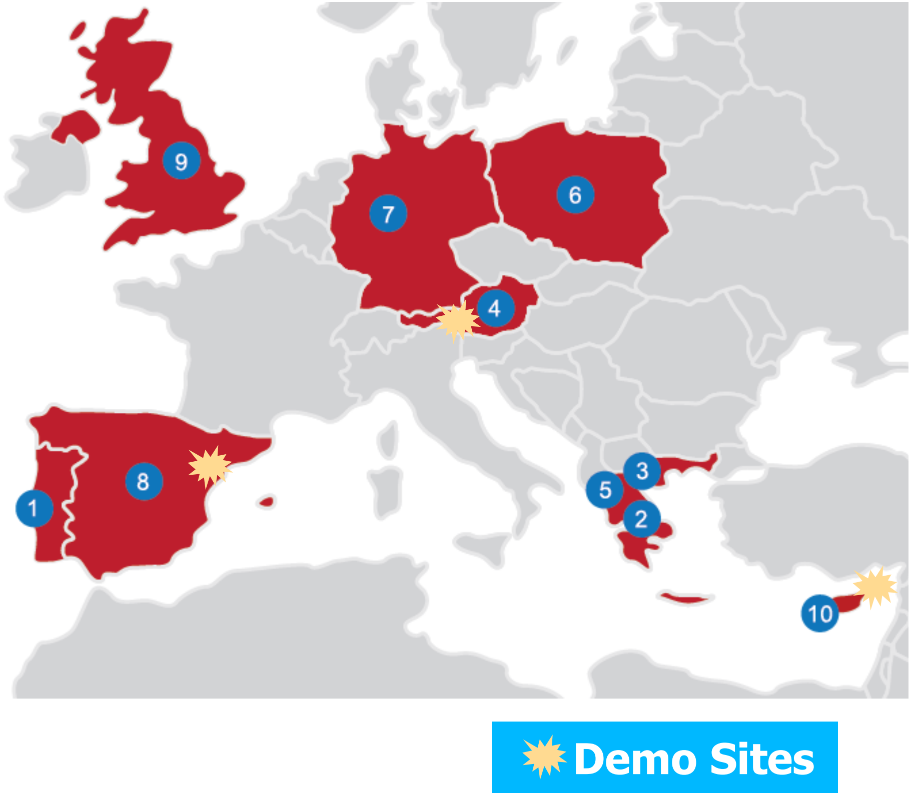
Expected results

- The TESSe2b solution will **reduce the building energy consumption at least 15%,** but it might be possible to reach **25-30% or more** (depending on the application conditions), with a corresponding reduction in operating costs.

- The estimated **payback** period is expected to reach **8-9 years**.

- TESSe2b project and its exploitable products have the **potential** to take advantage of the **market opportunity** in thermal energy storage, contributing at the same time to **enhance the development of TES systems** in the EU market.

Consortium overview and organisation



Name	R&D legal statuses	Country
Instituto Politécnico de Setúbal - IPS	Higher education	Portugal
Centre For Renewable Energy Sources and Saving Fondation - CRES	Research organisation	Greece
Technologiko Ekpedeftiko Idrima Stereas Elladas - TEISTE	Higher education	Greece
Geoteam Technisches Buro Fur Hydrogeologie, Geothermie Und Umwelt Gmbh - GEOTEAM	SME	Austria
Panepistimio Ioanninon - UOI	Higher education	Greece
Szkola Glowna Gospodarstwa Wiejskiego - SGGW	Higher education	Poland
Ruhr-Universitat Bochum - RUB	Higher education	Germany
Asociacion Ecoserveis - ECOSERVEIS	Non-profit org.	Spain
Phase Change Material Products Ltd – PCM Produc	SME	U.K.
Z & X Mechanical Installations Limited – Z&X	SME	Cyprus

Hydraulic scheme

Latent Thermal Energy Storage

Heating, Cooling and DHW Tanks (NEPCM)

Enhanced PCM BHEs

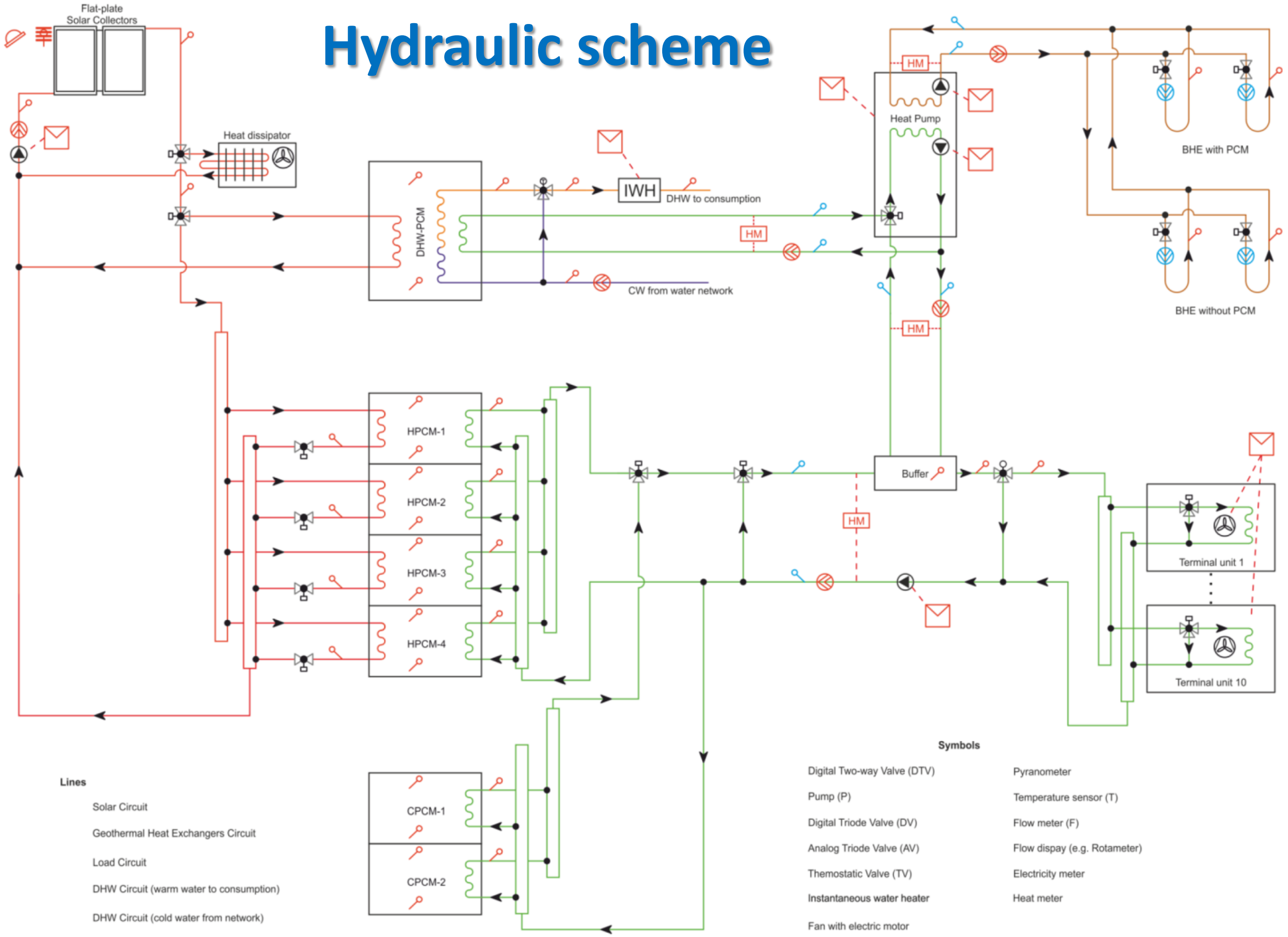
Renewable Energy Sources

Solar (Thermal Collectors)

Heating and DHW

Geothermal - GSHP

Cooling, Heating and DHW



Problems to solve

SOLUTION FOUND

- Select the most **appropriate PCMs** for each application.

PARAFINAS

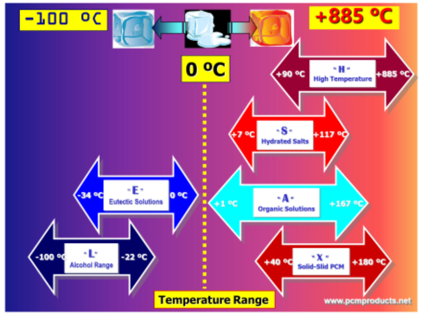
Application	Temperature Range	PCM Selected
Cold PCM Tank	≈10-17 ºC	A9 & A14
Hot PCM Tank	≈38-45 ºC	A44 & A46
DHW Tank	≈50-60 ºC	A53 & A58H

SAIS HIDRATATOS

Application	Temperature Range	PCM Selected
Cold PCM Tank	≈10-17 ºC	S10 & S13
Hot PCM Tank	≈38-45 ºC	S44 & S46
DHW PCM Tank	≈50-60 ºC	S50 & S58

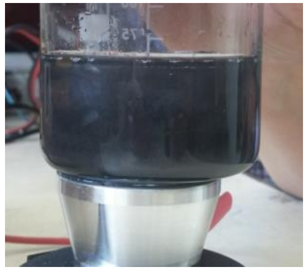
PCMs (PARAFINAS) NOS FUROS GEOTÉRMICOS

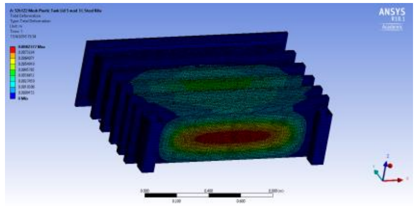
Application	Soil Temperature	Temperature Range	PCM Selected
BHE in Spain	≈17-18 ºC	≈14-15 ºC	A12
BHE in Austria	≈12-13 ºC	≈9-10 ºC	A9
BHE in Cyprus	≈21-22 ºC	≈24-25 ºC	A25

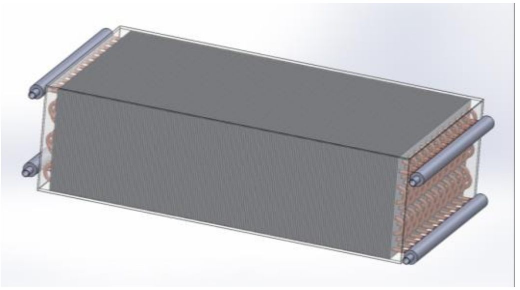


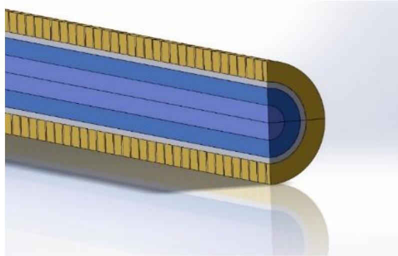
Problems to solve

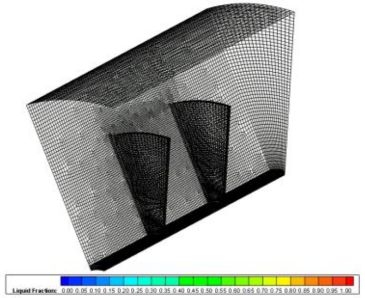
- **Improving the performance of paraffins** (PCM) in heat exchangers immersed in PCM:
  - Addition of **nano-particles** - nano-composite **enhanced** paraffin PCM (**NEPCM**). **– SOLUTION FOUND**
  - Solution based on **tubes and fins** adequately designed. **– SOLUTION FOUND**



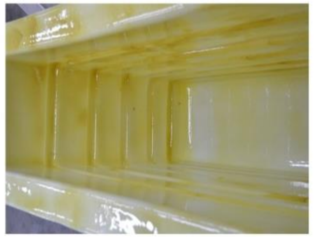


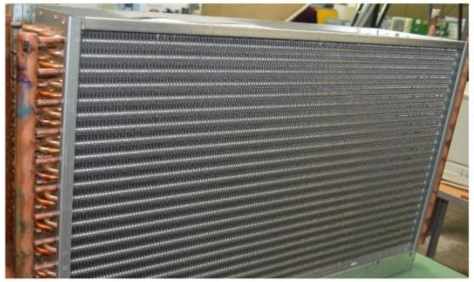


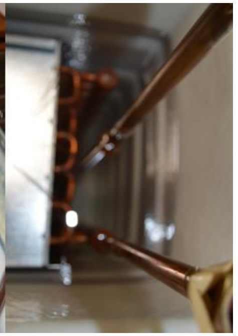


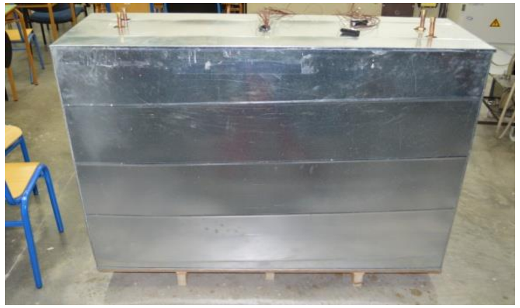


Tesse2b 1st pre-prototype construction procedure







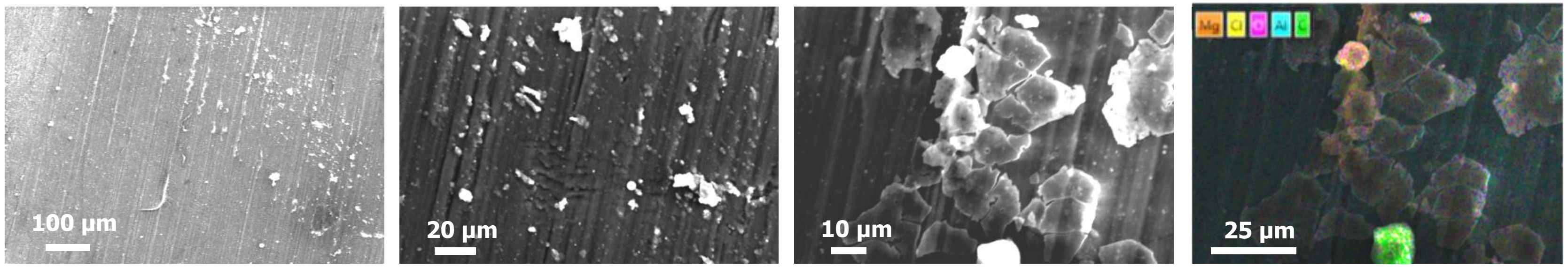


Volume per tank:
180 litros

Problems to solve

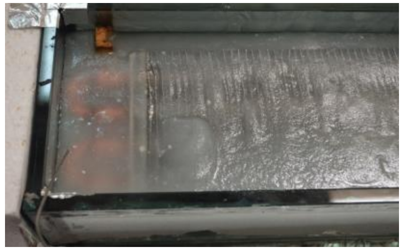
- Develop a **protective thin film** coating against the corrosivity of **salt-hydrates** to the heat exchanger (HE).
  - **Developed** a highly efficient protective thin film. **– SOLUTION FOUND**

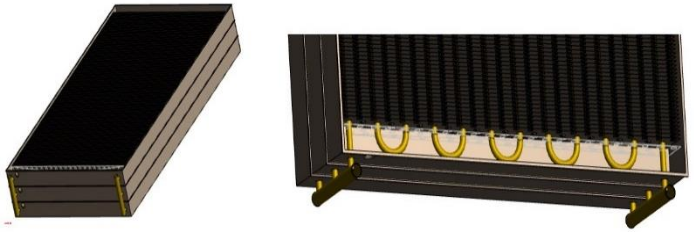
After corrosion test



Problems to solve

- Finding a solution for the **geometry** of the tank and its heat exchanger to ensure the **stability of the hydrated salts**.
    - Developed a **modular geometry** with a limited height, ensuring stability. **– SOLUTION FOUND**

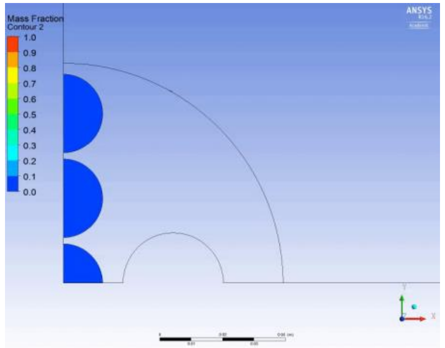


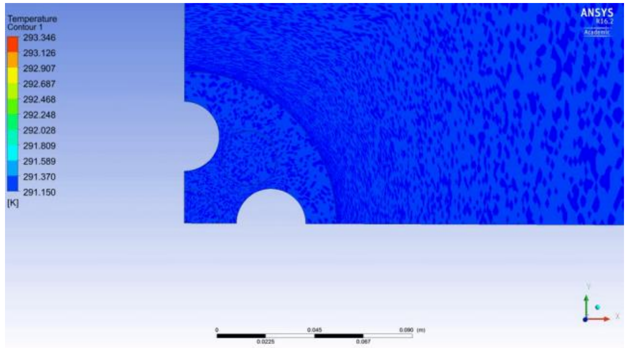


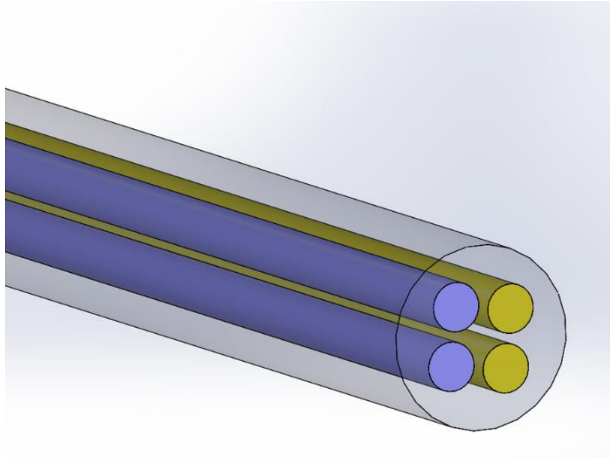
Problems to solve

- Use **PCMs** (paraffins) in **geothermal boreholes (enhanced PCM BHEs)** to help stabilize the temperature in the heat exchanger and thereby increase the efficiency of the heat pump

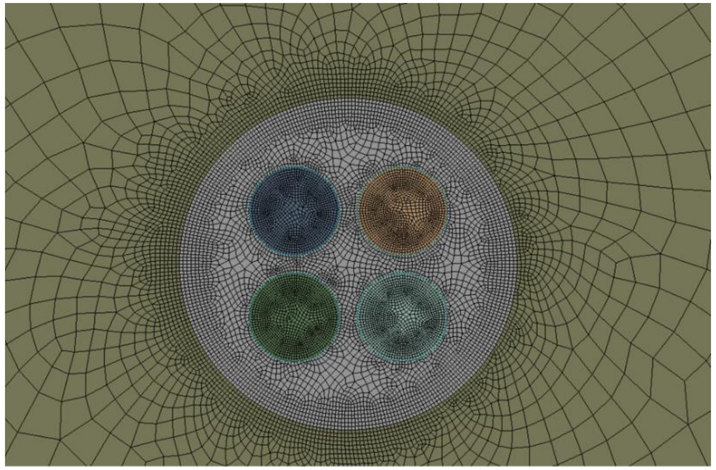
    - **PCMs encapsulated** in **HDPE tubes**. **– SOLUTION FOUND**



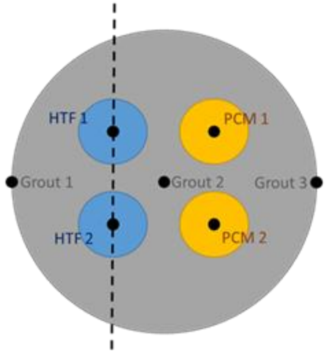




Double U-configuration with PCM inside in one of the U-tubes

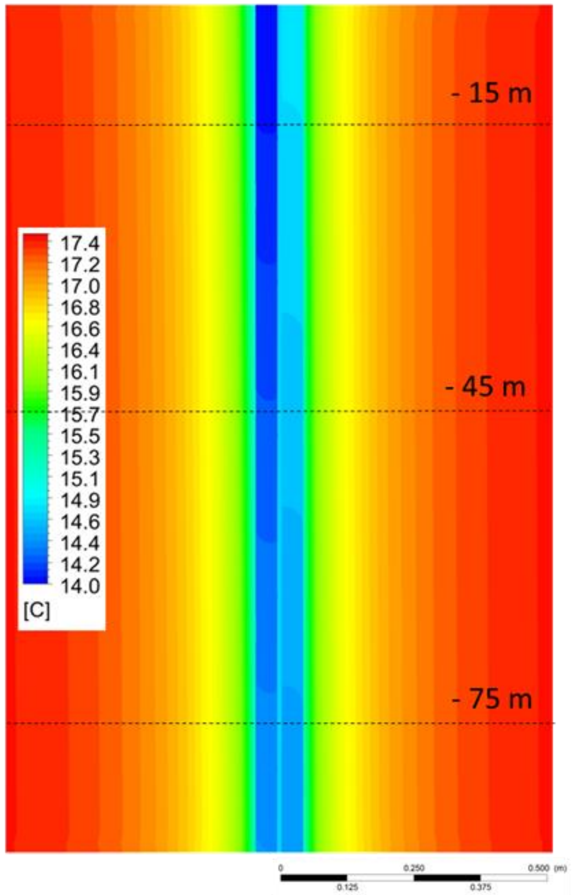


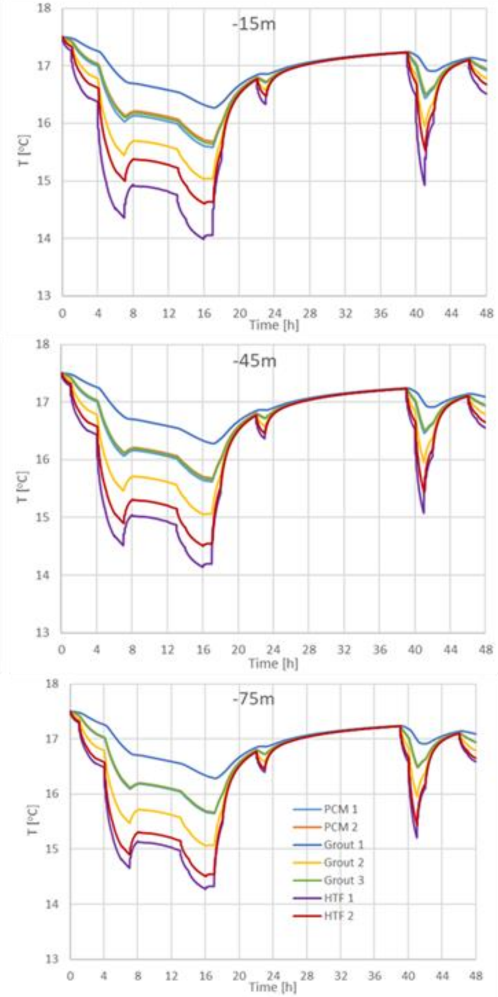
Detail view of the mesh in the borehole region



HTF cross plane

HTF cross plane



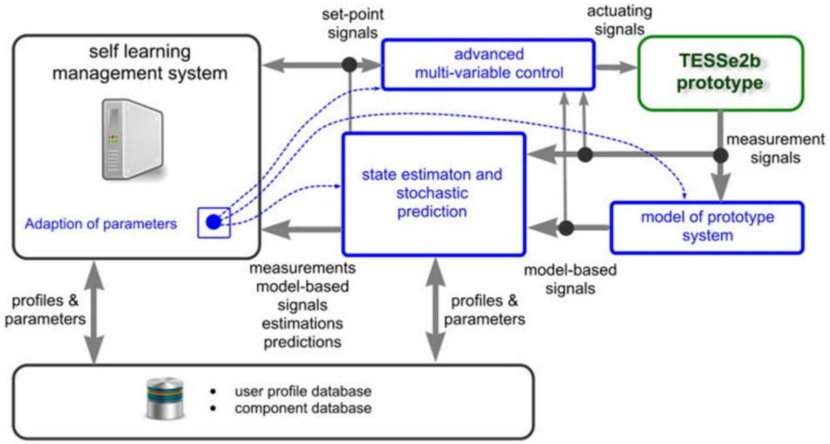


Problems to solve

- Development of a **smart control system** (self-learning) for efficient TESSe2b operation. Several parameters to control in purely dynamic and strongly dependent processes.
  - **Hardware e Software under development**. **– SOLUTION FOUND**

Multi-purpose sensor

Modular Pt1000 Temperature acquisition system



Demo Sites

Location: Village Miliou, Cyprus

Location: Calonge de Segarra, Barcelona, Spain

Location: Kapfenberg, Graz, Austria

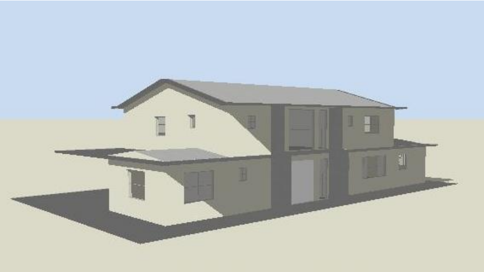
Main results from Energy Building Simulation for each demo site

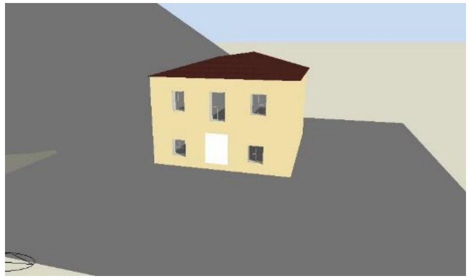
Demo Site	Area (m^2)	Heating Capacity (kW)	Cooling Capacity (kW)	Heating Anual needs (kWh)	Cooling Anual needs (kWh)	Heating Anual needs (kWh/m^2)	Cooling Anual needs (kWh/m^2)	**Solar collectores #**	**Hot PCM tanks**	**Cold PCM tanks**	DHW PCM tanks	Solar Fraction Heating	**Increase of solar fraction due the PCM**	Solar Fraction Heating + DHW	**Heating needs shifted day to night (total - solar)**	**Cooling needs shifted day to night**
Austria	321,1	14,39	4,67	17685,8	2784,0	55,08	8,67	**10,00[a)]**	**4**	*	**1**	11,8%	**8,2%**	20,9%	**43,7%**	*
Cyprus	220,7	17,03	18,56	10006,4	15431,0	45,34	69,92	**10,00[b)]**	**3**	**3**	**1**	30,5%	**27,2%**	42,3%	**44,8%**	**30,3%**
Spain	137,8	12,18	4,92	8802,0	944,0	63,88	6,85	**9,00[b)]**	**4**	**2**	**1**	33,5%	**31%**	47,0%	**0,0%**	**95,3%**

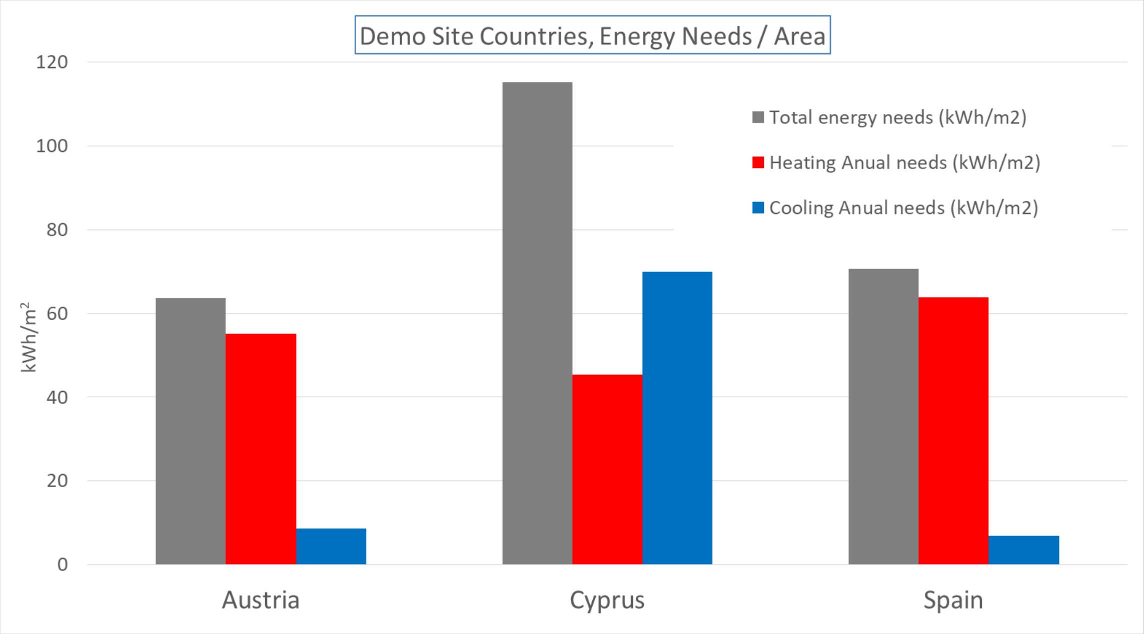
* free-cooling

a) Vacuum; b) Flat plate;

Demo Site	BHE #	BHE depth (m)
Austria	**4**	**75**
Cyprus	**7**	**100**
Spain	**2**	**90**







Results from Energy Building Simulation for 8 countries, Cyprus geometry with reference thermal envelope for each country

Country	City	Heating Capacity (kW)	Cooling Capacity (kW)	Heating Anual needs (kWh/m^2)	Cooling Anual needs (kWh/m^2)	Solar collectores # (Flat)	Hot PCM tanks	Cold PCM tanks	Solar Fraction Heating (%)	DHW PCM tanks	Solar Fraction Heating + DHW (%)	Heating needs shifted day to night (total - solar) (%)	Cooling needs shifted day to night (%)
Poland	Warsaw	**16,4**	**4,5**	**133,7**	**1,8**	**12**	**5**	**1**	11%	**1**	**16%**	40%	59%
Germany	Berlin	15,8	**4,5**	112,8	3,8	**12**	**5**	**1**	**10%**	**1**	17%	**46%**	42%
Austria	Graz	16,4	6,2	94,4	11,0	**10**	**4**	**2**	12%	**1**	20%	41%	59%
U.K.	London	10,2	5,8	77,4	3,8	**12**	**5**	**1**	18%	**1**	26%	**26%**	51%
Spain	Barcelona	12,6	7,1	56,8	13,2	**12**	**4**	**2**	32%	**1**	42%	44%	55%
Greece	Athens	13,3	9,2	34,4	34,6	**12**	**4**	**2**	33%	**1**	46%	45%	**35%**
Portugal	Lisbon	**9,0**	7,4	31,3	12,3	**10**	**3**	**3**	41%	**1**	57%	35%	**75%**
Cyprus	Pafos	10,5	**9,8**	**21,9**	**49,8**	**10**	**3**	**3**	**49%**	**1**	**65%**	36%	41%
						(10 – 12)	(3 – 5)	(1 – 3)		(1)			

Portugal

1st case: TESSe2b vs. HEAT OIL+ASHP

Total annual operation cost savings: 79%

CO_2 savings: 79%

SPBP: 4.5 years

DPBP: 5 years

2nd case: TESSe2b vs. NAT GAS+ASHP

Total annual operation cost savings: 78%

CO_2 savings: 72%

SPBP: 5 years

DPBP: 5.38 years

Cyprus

1st case: TESSe2b vs. HEAT OIL+ASHP

Total annual operation cost savings: 66.7%

CO_2 savings: 53%

SPBP: 5.8 years

DPBP: 6 years

2nd case: TESSe2b vs. ASHP

Total annual operation cost savings: 56%

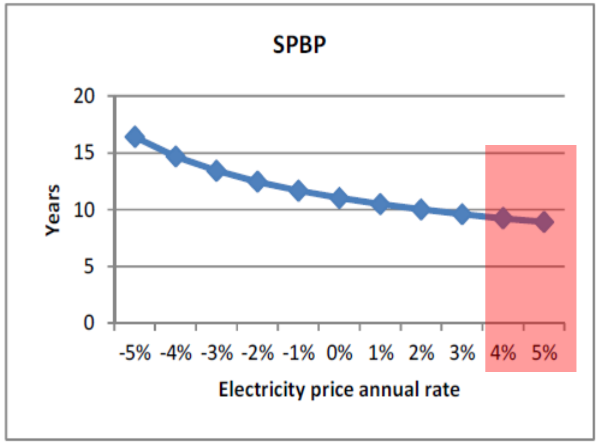
CO_2 savings: 55.5%

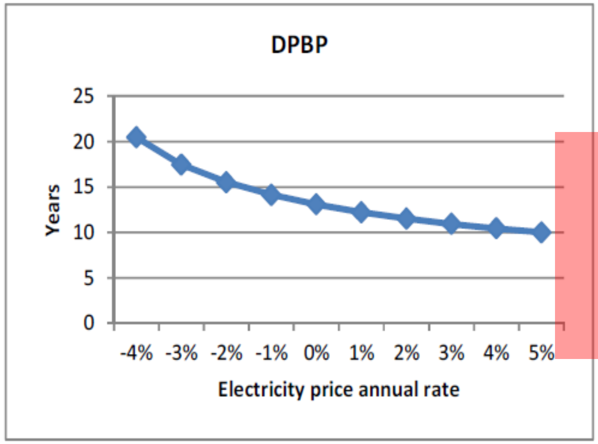
SPBP: 10.5 years

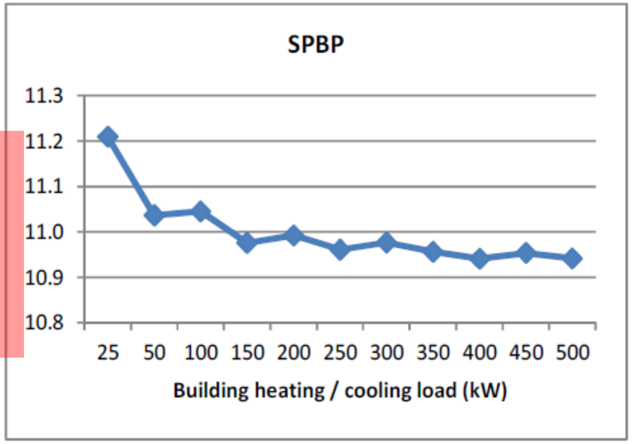
DPBP: 12 years

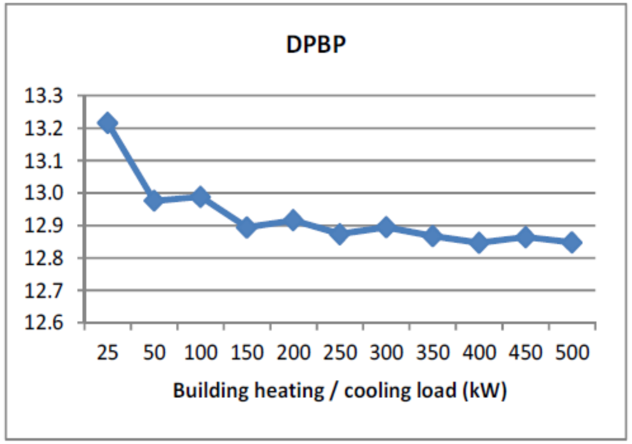
(DPBP - discounted payback period)
(SPBP - simple payback period)

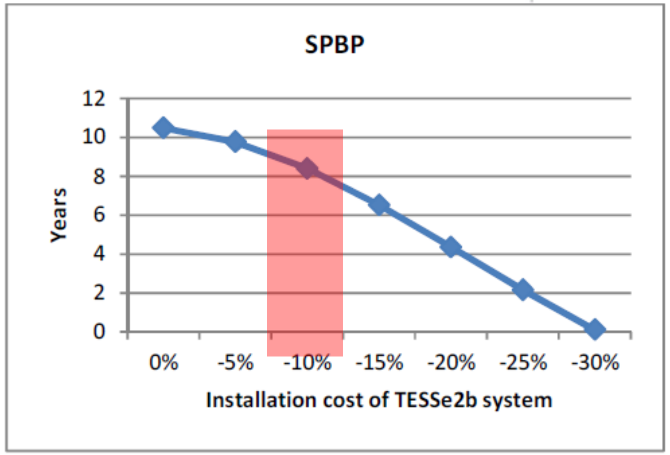
Cyprus
2nd case: TESSe2b vs. ASHP

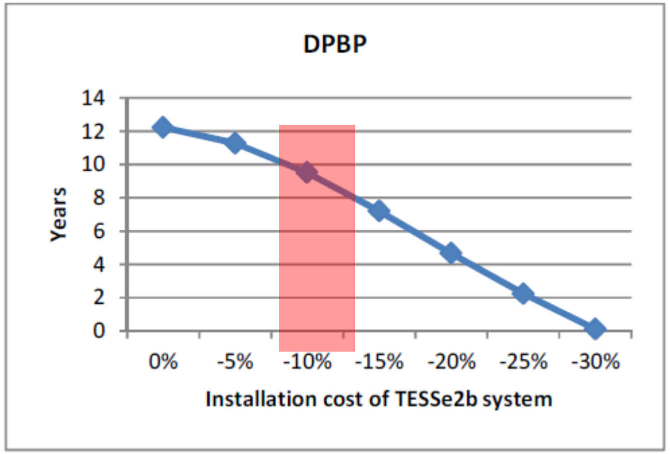






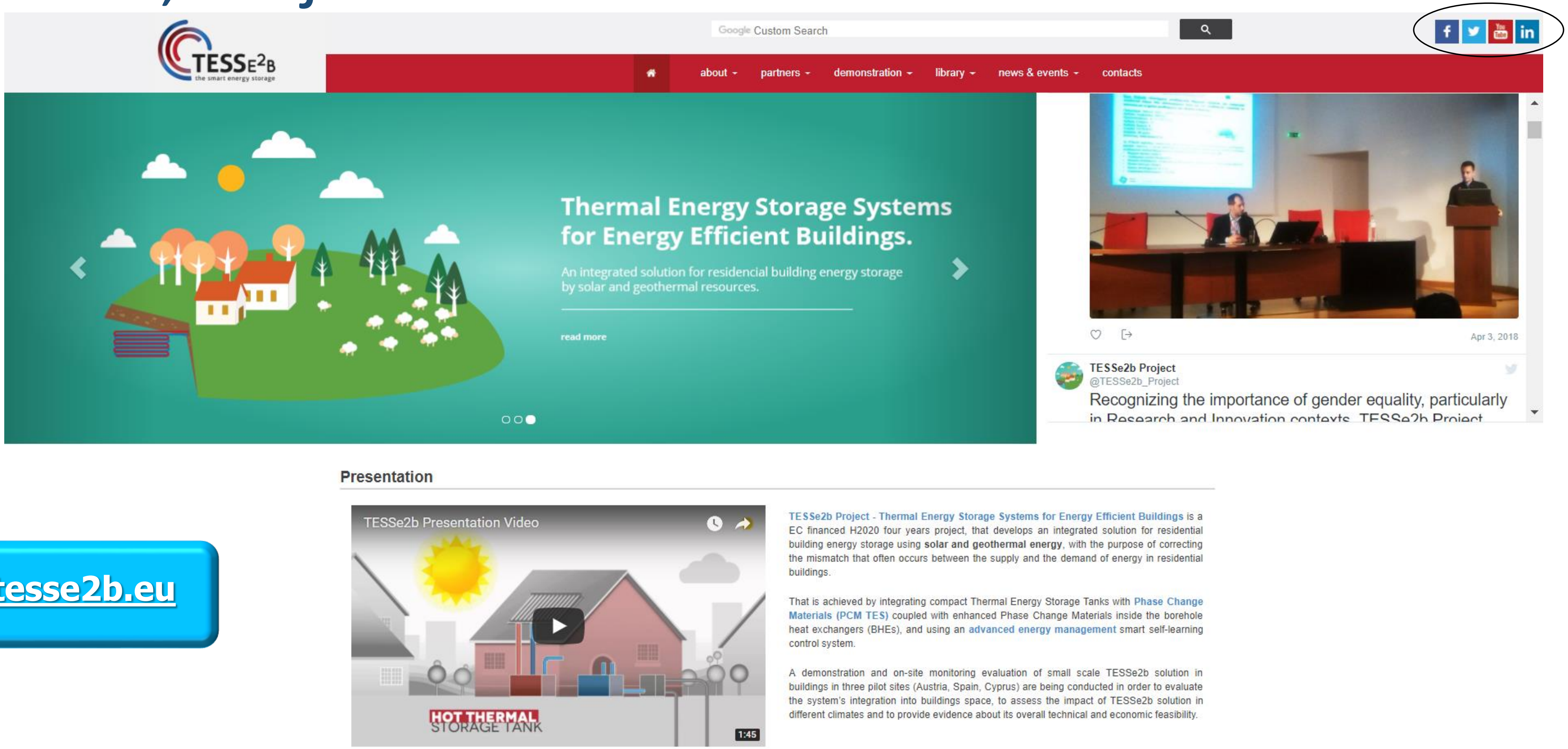






Reduce installation costs in commercial applications is the key point, but this is achievable without major difficulties.

Website, Project Video and Social Media



www.tesse2b.eu

Conclusions

- The project is currently in month 33 of its development.
- At the beginning of October the three demo site will start to operate.
- The development of the project is going well and is meeting the previously proposed objectives.
- Several important results have been achieved so far.
- For better information it is suggested to consult the project website and social media.

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Thank for your attention

luis.coelho@estsetubal.ips.pt

Centro de Investigação em Energia e Ambiente do Instituto Politécnico de Setúbal (CINEA-IPS)

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SUSTAINABLE PLACES 2018 June 27-29,2018 Aix-les Bains, France