Smart Grid Energy Management Staff Exchange

D2.1 Webinars in smart and zero energy buildings:

WP2 - SMART GEMS Training Activities

WP Leader: CUT

REPORT

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Karolis Koreiva	EGM	18/01/2016
Gabija Silienė	EGM	18/01/2016
Fabio Montagnino	IDEA	18/01/2016
Filippo Paredes	IDEA	18/01/2016
Silvana Di Bono	IDEA	18/01/2016

Dr. Siew Eang	NUS	18/01/2016

Table of Contents

1. Introduction

The report for the Deliverable 2.1 concerns the webinars in smart and zero energy buildings, which are under the task 2.1 of Work Package 2 (SMART GEMS Training Activities). The webinars for the task 2.1. commenced on the 21st of October 2015 and were completed on the 16th of December 2015. Five webinars of one hour duration each including the questions and discussion, were organised and presented by UOA, TUC, CUT, CyI, AEA and IDEA, using the Webex Platform. The assigned staff of the Smart Gems partners attended the series of the five webinars with the following topics:

1. The Concept of Smart Buildings and the integrated designed organised by UOA

2. The Concept of ZEB organised by TUC

3. ZEB Case studies organised by CyI/CUT

4. A case study of a smart ZEB: The LEAF House organised by AEA

5. The ZEB buildings technology market organised by IDEA

The summaries of the five webinars were distributed by CUT (WP leader) to all partners well before the beginning of the first webinar.

2 The webinars

2.1 Webinar 1 - The Concept of Smart Buildings and the integrated design organised by UOA

2.1.1. General Information

The first webinar was organised by UOA with the topic "The Concept of Smart Buildings and the Integrated Design". It was performed on the 21st of October 2015 and had a total duration of 51 minutes. The webinar started at 14:09 CET and finished at 15:00 CET. Twenty one members of Smart Gems Project participated the webinar, the names of them are below:

1. Theoni Karlessi (UOA) – Presenter
2. Mat Santamouris (UOA)
3. Kostas Gompakis (TUC) – Host
4. Nikos Kampelis (TUC)
5. Christina Georgatou (TUC)
6. Vagias Vagias (TUC)
7. Denia Kolokotsa (TUC)
8. Despina Serghides (CUT)
9. Chryso Chatzinikola (CUT)
10. Marina Kyprianu Dracou (CyI)
11. George Artopoulos (CyI)
12. Alaric Montenon (CyI)
13. Ian Chilvers (SPS)
14. Laura Standardi (AEA)
15. Cristina Cristalli (AEA)

16. Filippo Paredes (IDEA)

17. Fabio Montagnino (IDEA)

18. Luca Venezia (IDEA)

19. Riccardo Di Paola (IDEA)

20. Sergio Milone (IDEA)

21. Calogero Serporta (ISSIA-CNR invited by IDEA)

2.1.2. Summary of the first webinar

The main objective of the Concept of Smart Buildings and the Integrated Design Webinar**,** presented by UoA was to underline the principles of ID procedure and link the process with smart building technologies.

The methodology applied in this webinar is summarized in the steps described below:

- The Integrated Design step by step process from initial concept to in-use phase of a building
- Current policy framework in EU to promote ID as supportive tool for NZEB
- Smart building technologies to achieve high energy performance and sustainability
- Development of a collaborative methodology to incorporate energy management and smart building technologies to the ID concept
- Conclusions

2.2 Webinar 2 - The Concept of ZEB organised by TUC

2.2.1. General Information

The second webinar was organised by TUC with the topic "The Concept of ZEB". It was performed on the 11th of November 2015 and had a total duration of 44 minutes and 15 seconds. The webinar started at 14:06 CET and finished at 14:50 CET. Thirty one members of Smart Gems Project participated the webinar, the names of them are below:

1. Nikolaos Kambelis (TUC) - Presenter
2. Kostas Gobakis (TUC) - Host
3. Professor Denia Kolokotsa (TUC)
4. Kostas Kalaitzakis (TUC)
5. Christina Georgatou (TUC)
6. Vagias Vagias (TUC)
7. Georgios Chalkiadakis (TUC)
8. Professor Despina Serghides (CUT)
9. Chryso Chatzinikola (CUT)
10. Dr. Martha Katafygiotou (CUT)
11. Stella Dimitriou (CUT)
12. Marilena Michaelidou (CUT)
13. Michalis Christophi (CUT)
14. Konstantinos Erodotou (CUT)
15. Galatia Dracou (CUT)
16. Fytoula Andreou (CUT)
17. Andriana Georgiou (CUT)
18. Marina Magidou (CUT)

19. Antonia Loizou (CUT)
20. Konstantina Vasilakopoulou (UOA)
21. Marina Kyprianu Dracou (CyI)
22. Nestor Fylaktos (CyI)
23. Andri Pyrgou (CyI)
24. Alaric Montenon (CyI)
25. Laura Standardi (AEA)
26. Filippo Paredes (IDEA)
27. Fabio Montagnino (IDEA)
28. Riccardo Di Paola (IDEA)
29. Luca Venezia (IDEA)
30. Sergio Milone (IDEA)
31. Pietro Muratore (IDEA)

2.2.2. Summary of the second webinar

The main objective of the Concept of ZEB Webinar**,** presented by TUC was to underline the main definitions of Zero Energy Buildings, Net Zero Energy, Zero Cost Energy and Zero Carbon Emissions. The methodology applied in this webinar is summarized in the steps described below:

- The ZERO Energy Buildings Definitions. Various approaches and methodologies.
- EU and International legislation, trends and perspectives concerning the zero energy concept.
- Energy efficiency methodologies to achieve the zero energy concept at building level.
- Climatic diversities and the zero energy perspective.

- The role of energy management, smart metering and demand response in the zero energy buildings' framework.
- The concept of ZEB and the role of the building users.
- Conclusions

2.3 Webinar 3 - ZEB Case studies organised by CyI/CUT

2.3.1. General Information

The third webinar was organised by CyI and CUT with the topic "ZEB Case studies". It was performed on the 2nd of December 2015 and had a total duration of 47 minutes and 14 seconds. The webinar started at 14:04 CET and finished at 14:51 CET. Twenty seven members of Smart Gems Project participated the webinar, the names of them are below:

1. Professor Despina Serghides (CUT) - Presenter
2. Chryso Chatzinikola (CUT)
3. Stella Dimitriou (CUT)
4. Marilena Michaelidou (CUT)
5. Konstantinos Erodotou (CUT)
6. Galatia Dracou (CUT)
7. Andreas Chrysanthou (CUT)
8. Giorgos Panagi (CUT)
9. Marina Kyprianu Dracou (CyI) - Presenter
10. Alaric Montenon (CyI) - Presenter
11. Professor Denia Kolokotsa (TUC)
12. Kostas Gobakis (TUC) - Host
13. Nikolaos Kambelis (TUC)
14. Kostas Kalaitzakis (TUC)

15. Christina Georgatou (TUC)
16. Vagias Vagias (TUC)
17. Georgios Chalkiadakis (TUC)
18. Theoni Karlesi (UOA)
19. Daniela Isidori (AEA)
20. Laura Standardi (AEA)
21. Filippo Paredes (IDEA)
22. Fabio Montagnino (IDEA)
23. Riccardo Di Paola (IDEA)
24. Luca Venezia (IDEA)
25. Sergio Milone (IDEA)
26. Calogero Serporta (ISSIA-CNR invited by IDEA)
27. Gegiminas Valevičius (Elgama)

2.3.2. Summaries of the third webinar

2.3.2.1. Summary of the webinar organised by CUT

The main aim of the case studies of nearly Zero Energy Buildings presented by CUT was to illustrate various refurbishment scenarios of the old building stock in Cyprus, aiming at the highest and most cost-effective reduction of the conventional energy consumption and consequently the CO_2 emissions by 90% from those of 1990. Thus, offering new paradigms of building construction, which are sustainable and could be adapted to different climates. The methodology applied in this webinar is summarized in the steps described below:

- The selection of the case studies was based on the national building matrix.

- At least one representative dwelling per typology (Single Family House, Terrace House and Multi Family House) and chronological period presented.
- For each building:

1. The energy performance of each house presented initially the existing state. (For the energy performance simulation iSBEM-Cy was used (the governmental software for the issuance of Energy Performance Certificates).
2. A standard nZEB refurbishment scenario, based on the Directive 366/2014.
3. Assessment of the energy efficiency and the cost viability for each refurbishment measure related to the building envelope elements thermal performance.
4. Energy and cost optimized nZEB scenario.
5. Comparisons between the 2 Scenarios (the standard and the optimized) and the existing state.
6. Conclusions.

2.3.2.2. Summary of the webinar organised by TUC

The main focus of the nearly Zero Energy case studies Webinar presented by the CyI was to illustrate the near zero energy consumption building of the CyI called the "New Technologies Laboratory Building", which is a prototype near zero energy building with advanced controls and management systems. The New Technologies Laboratory (NTL) aims at the highest and most cost-effective reduction of the conventional energy consumption and consequently the CO_2 emissions, thus offering new paradigms of near zero-energy building construction. The methodology applied in this webinar is summarized in the steps described below:

- The aforementioned nZEB case study was selected to be examined and presented as it is a state-of-the-art infrastructure and among the very few available in the wider area of the Eastern Mediterranean.
- The laboratories and research facilities relevant to SMART GEMS presented:
  - Measuring and control equipment.
  - Solar thermal power system (Linear Fresnel collector): developed to provide heat in winter and cooling in summer to the NTL thanks to solar energy (direct radiation). Instead of cooling thanks to heat-pump or mechanical chillers, a 35 kW cooling power absorption chiller cools the building. In winter, the heat produced is directly sent to the HVAC system. The heat produced by the Fresnel collector can be stored up to 2 hours in pressurized water tank vessel. This solar cooling system was integrated on a previously implemented HVAC system.
- The results of a recent Energy Audit reports for the building presented.
- Conclusions.

2.4 Webinar 4 - A case study of a smart ZEB: The LEAF House organised by AEA

2.4.1. General Information

The fourth webinar was organised by AEA with the topic "A case study of a smart ZEB: The LEAF House". It was performed on the 16th of December 2015 and had a total duration of 24 minutes. The webinar started at 14:04 CET and finished at 14:28 CET. Twenty seven members of Smart Gems Project participated the webinar, the names of them are below:

1. Laura Standardi (AEA) - Presenter
2. Daniela Isidori (AEA)

3. Cristina Cristalli (AEA)
4. Professor Despina Serghides (CUT)
5. Chryso Chatzinikola (CUT)
6. Stella Dimitriou (CUT)
7. Marilena Michaelidou (CUT)
8. Konstantinos Erodotou (CUT)
9. Michalis Christophi
10. Marina Kyprianu Dracou (Cyl)
11. Professor Denia Kolokotsa (TUC)
12. Kostas Gobakis (TUC) - Host
13. Nikolaos Kambelis (TUC)
14. Kostas Kalaitzakis (TUC)
15. Christina Georgatou (TUC)
16. Vagias Vagias (TUC)
17. Georgios Chalkiadakis (TUC)
18. Konstantina Vassilakopoulou (UOA)
19. Margarita Niki Assimakopoulos (UOA)
20. Filippo Paredes (IDEA)
21. Fabio Montagnino (IDEA)
22. Riccardo Di Paola (IDEA)
23. Luca Venezia (IDEA)
24. Sergio Milone (IDEA)
25. Calogero Serporta (ISSIA-CNR invited by IDEA)
26. Gegiminas Valevičius (Elgama)
27. Lukas Samulevičius (Elgama)

2.4.2. Summary of the fourth webinar

In this webinar, AEA (Loccioni group) introduced and described two real cases of ZEB realized by the company: the LEAF House and the LEAF Lab. The aim of this webinar was to make Smart GEMS partners aware of the potentialities of such ZEBs that could be exploited within the project.

In the view of providing a complete description of the LEAF house and the LEAF Lab which matches all partners' areas of expertise, the following topics addressed during the webinar:

- LEAF House concept: an introduction on the motivations and the idea that caused the construction of this ZEB back in 2008 by the Loccioni Group,
- Construction high-energy-efficiency-oriented: the focus was on the design and the materials used,
- Thermal and electrical equipment: the thermal control room and the electrical equipment shown including the changes and the replacements done over the years,
- Sensors Data and Building Energy Management System: the LEAF house has about 1000 sensors, thus, the connected monitoring and control activities done by the BEMS explained,
- Performances: this part addressed the energy consumption and production,
- Start-of-the-art research on the LEAF house: this ZEB has attracted much attention and the related research works done over the years introduced,
- The LEAF LAB concept: an A+ energy efficiency industrial building in addition it is also connective by exchanging electrical energy with the grid.
- Construction high-energy-efficiency-oriented,
- Thermal and electrical equipment,

- Sensor Data and Building Energy Management System,
- Performances,
- Conclusions.

2.5 Webinar 5 - The ZEB buildings technology market organised by IDEA

2.5.1. General Information

The fifth webinar was organised by IDEA with the topic "The ZEB buildings technology market". It was performed on the 16th of December 2015, right after the end of the fourth webinar and had a total duration of 54 minutes. The webinar started at 14:30 CET and finished at 15:24 CET. Twenty seven members of Smart Gems Project participated the webinar, the names of them are below:

1. Fabio Montagnino (IDEA) - Presenter
2. Filippo Paredes (IDEA)
3. Riccardo Di Paola (IDEA)
4. Luca Venezia (IDEA)
5. Sergio Milone (IDEA)
6. Calogero Serporta (ISSIA-CNR invited by IDEA)
7. Professor Despina Serghides (CUT)
8. Chryso Chatzinikola (CUT)
9. Stella Dimitriou (CUT)
10. Marilena Michaelidou (CUT)
11. Konstantinos Erodotou (CUT)
12. Michalis Christophi (CUT)
13. Marina Kyprianu Dracou (CyI)
14. Professor Denia Kolokotsa (TUC)

15. Kostas Gobakis (TUC) - Host
16. Nikolaos Kambelis (TUC)
17. Kostas Kalaitzakis (TUC)
18. Christina Georgatou (TUC)
19. Vagias Vagias (TUC)
20. Georgios Chalkiadakis (TUC)
21. Konstantina Vassilakopoulou (UOA)
22. Margarita Niki Assimakopoulos (UOA)
23. Laura Standardi (AEA)
24. Daniela Isidori (AEA)
25. Cristina Cristalli (AEA)
26. Gegiminas Valevičius (Elgama)
27. Lukas Samulevičius (Elgama)

2.5.2. Summary of the fifth webinar

At the webinar with the topic "The ZEB buildings technology market", IDEA introduced the main technologies for energy harvesting, storage and conversion in ZEB together with their maturity level and market perspective. The methodology applied in this webinar is summarized in the steps described below:

- Holistic overview of the ZEB technologies
- Energy harvesting technologies at a ZEB scale
- Building integrated energy storage, electrical and thermal solutions
- Energy mix for a ZEB: suitable energy conversion devices
- TRL of ZEB technologies, industrial and market trends.
- Conclusions

3. Conclusions

In this report the five webinars for the task 2.1 - Smart and Zero Energy Buildings of Work Package 2 (WP2 - SMART GEMS Training Activities) were summarised and presented. The video recordings of the five webinars have been delivered with this report and they are uploaded to the following link:

https://www.dropbox.com/sh/4ykvqwcjauenadt/AADOZiW5FMrHd4Bv5YWT-TWBa?dl=0

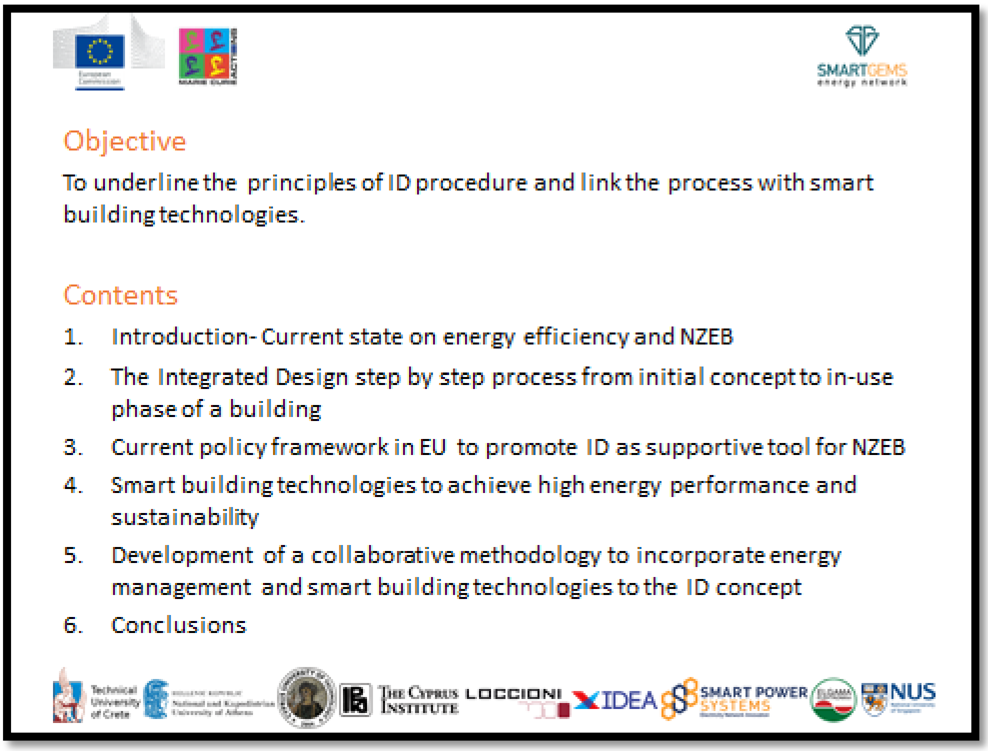
In addition the video recordings of the webinars are available at the YouTube channel of the Energy Management in the Built Environment Laboratory (EMBER) of Technical University of Crete in the following URL:

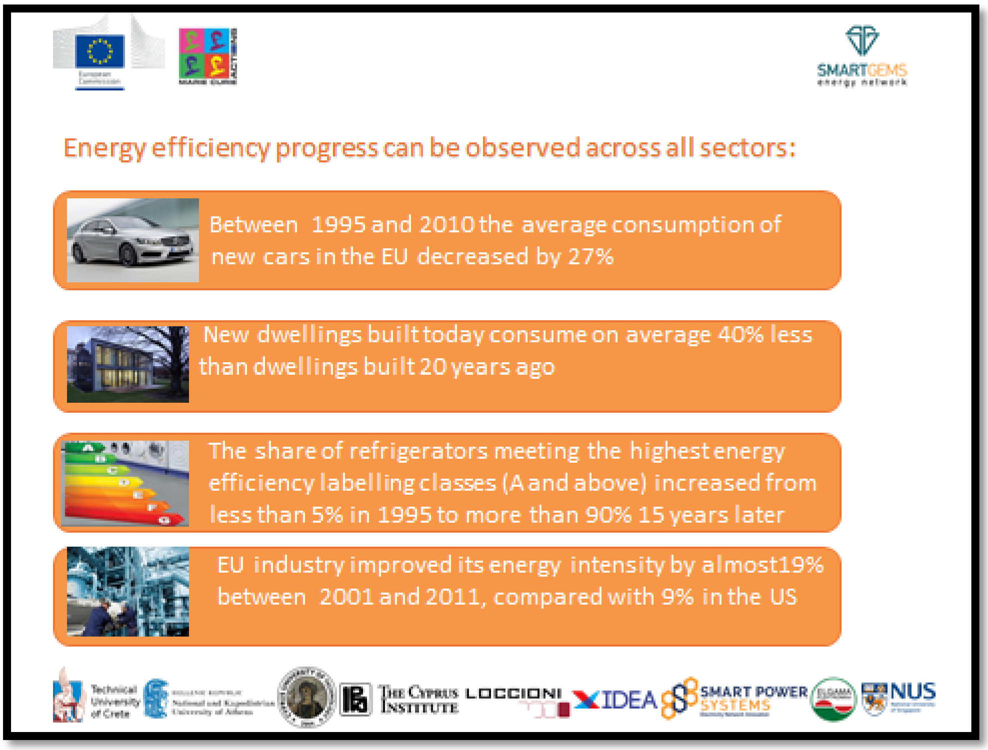
https://www.youtube.com/user/EmberTUC

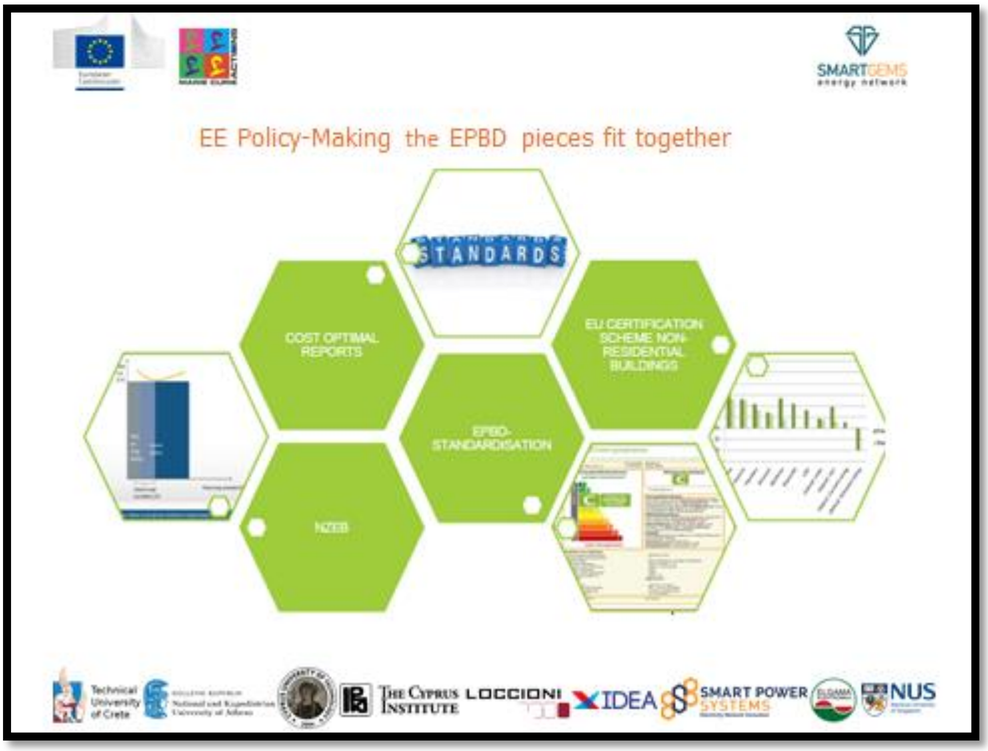
Finally, the above link to the webinars' videos will become available in the Smart GEMS website shortly. As a next step, the webinars for the task 2.2 - Training in Smart Grids and Smart Communities of Work Package 2 will be organised and they will be presented as already scheduled.

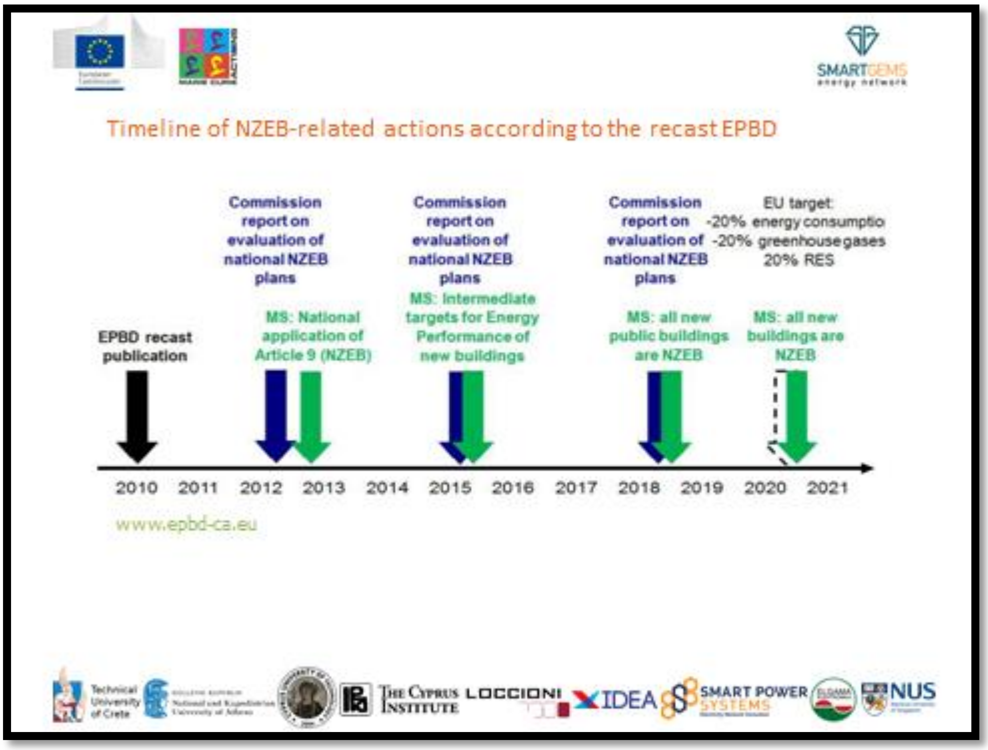
4. Annexes

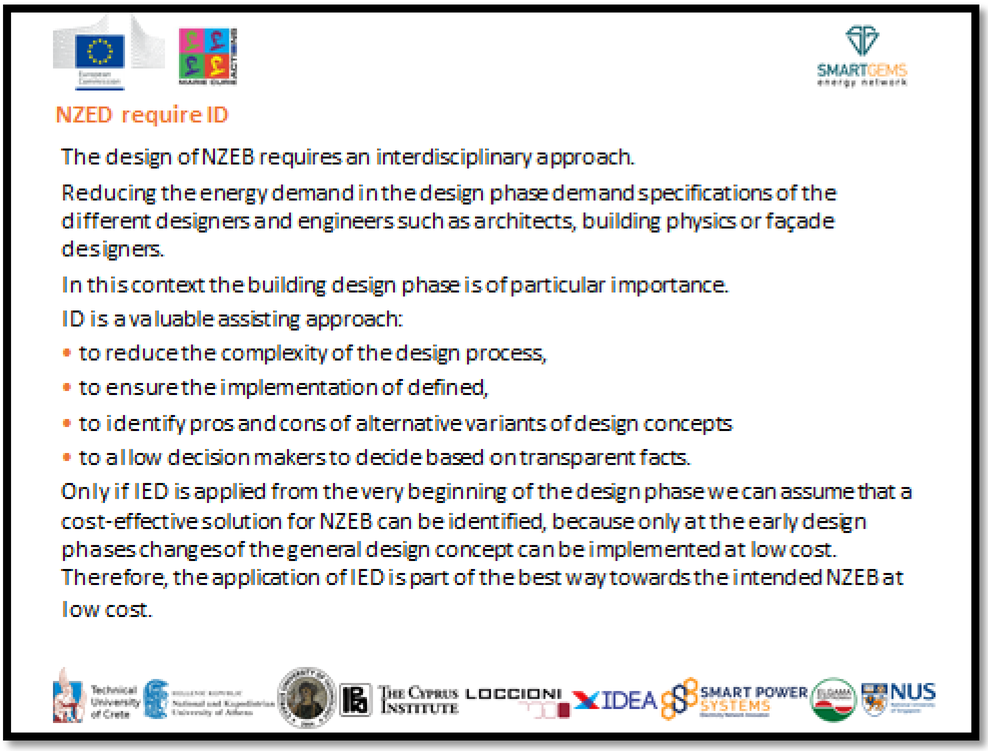
Annex I: Slides of the 1st Webinar - The Concept of Smart Buildings and the integrated design organised by UOA.

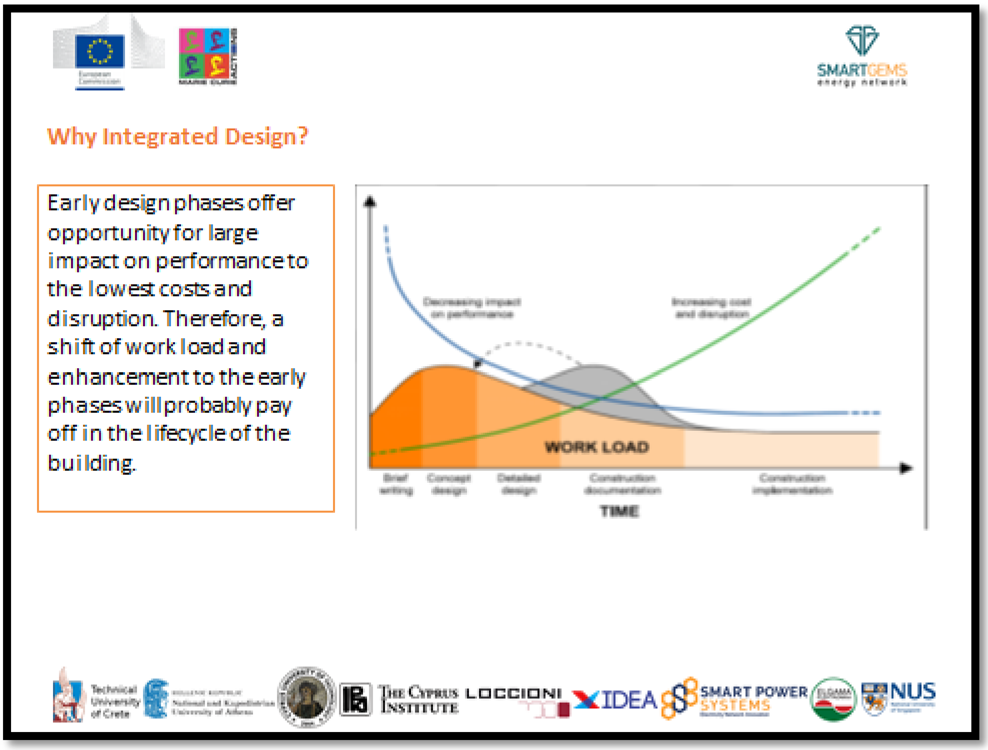


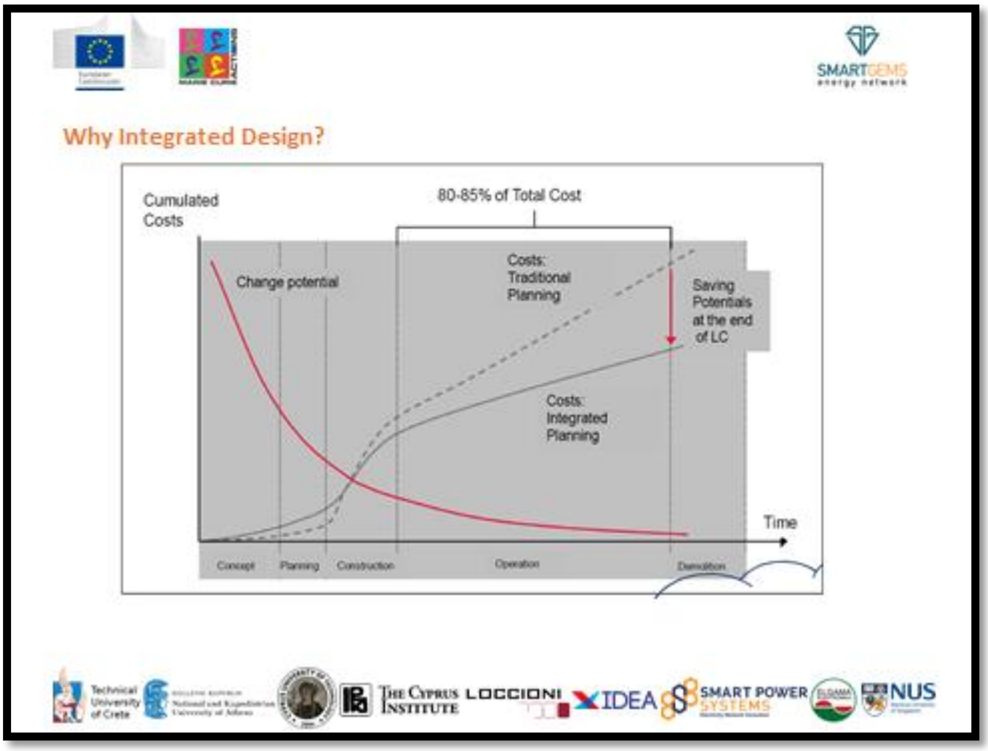

Energy efficiency progress can be observed across all sectors:
Between 1995 and 2010 the average consumption of new cars in the EU decreased by 27%
New dwellings built today consume on average 40% less than dwellings built 20 years ago
The share of refrigerators meeting the highest energy efficiency labelling classes (A and above) increased from less than 5% in 1995 to more than 90% 15 years later
EU industry improved its energy intensity by almost19% between 2001 and 2011, compared with 9% in the US

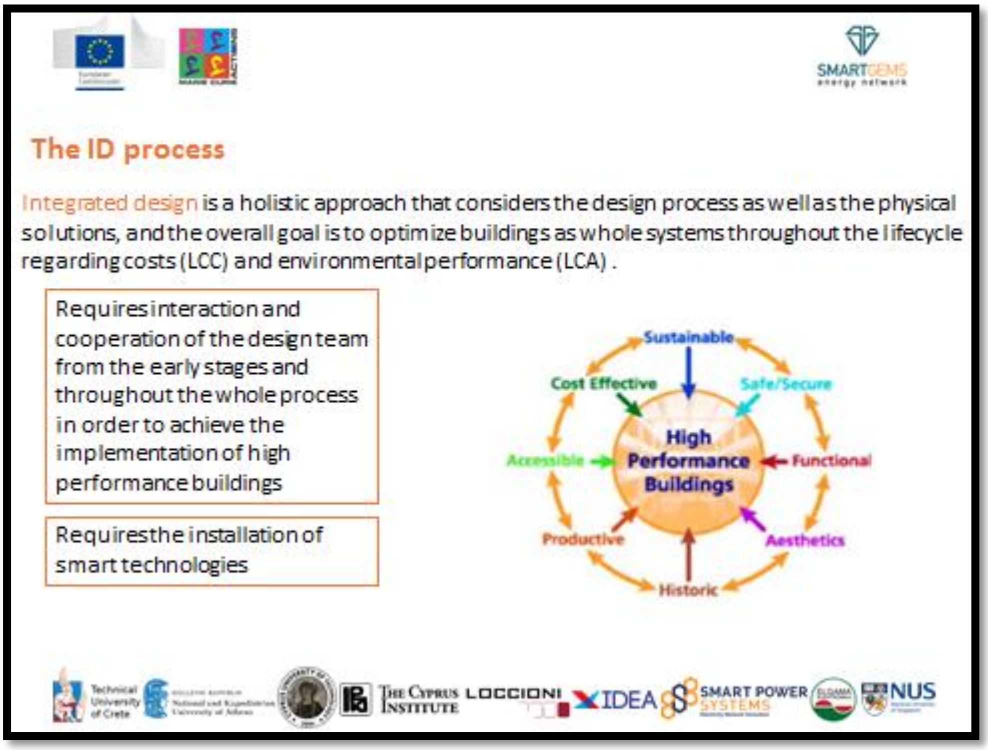

EE Policy-Making the EPBD pieces fit together
STANDARDS
COST OPTIMAL REPORTS
EU CERTIFICATION SCHEME NON-RESIDENTIAL BUILDINGS
EPBD-STANDARDISATION
NZEB

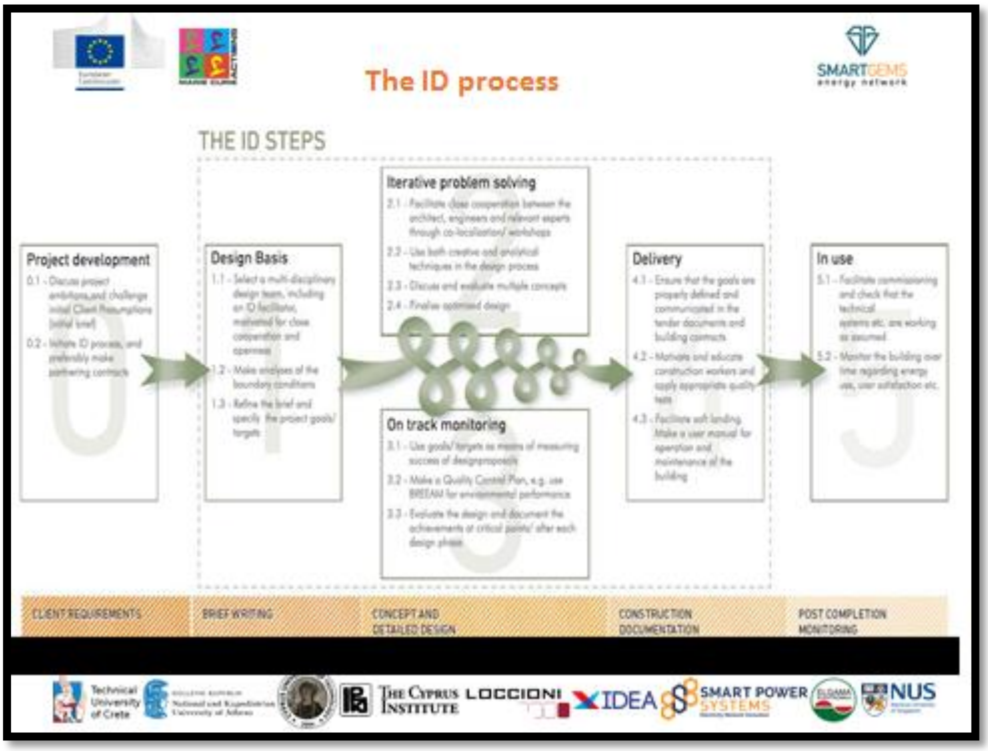

Timeline of NZEB-related actions according to the recast EPBD
Commission report on evaluation of national NZEB plans
Commission report on evaluation of national NZEB plans
Commission report on evaluation of national NZEB plans
EU target: -20% energy consumptio -20% greenhouse gases 20% RES
EPBD recast publication
MS: National application of Article 9 (NZEB)
MS: Intermediate targets for Energy Performance of new buildings
MS: all new public buildings are NZEB
MS: all new buildings are NZEB
2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
www.epbd-ca.eu


NZED require ID
The design of NZEB requires an interdisciplinary approach.
Reducing the energy demand in the design phase demand specifications of the different designers and engineers such as architects, building physics or façade designers.
In this context the building design phase is of particular importance.
ID is a valuable assisting approach:
• to reduce the complexity of the design process,
• to ensure the implementation of defined,
• to identify pros and cons of alternative variants of design concepts
• to allow decision makers to decide based on transparent facts.
Only if IED is applied from the very beginning of the design phase we can assume that a cost-effective solution for NZEB can be identified, because only at the early design phases changes of the general design concept can be implemented at low cost. Therefore, the application of IED is part of the best way towards the intended NZEB at low cost.


Why Integrated Design?
Early design phases offer opportunity for large impact on performance to the lowest costs and disruption. Therefore, a shift of work load and enhancement to the early phases will probably pay off in the lifecycle of the building.
Decreasing impact on performance
Increasing cost and disruption
WORK LOAD
Brief writing
Concept design
Detailed design
Construction documentation
Construction implementation
TIME


Why Integrated Design?
Cumulated Costs
80-85% of Total Cost
Change potential
Costs: Traditional Planning
Saving Potentials at the end of LC
Costs: Integrated Planning
Time
Concept
Planning
Construction
Operation
Demolition


The ID process
Integrated design is a holistic approach that considers the design process as well as the physical solutions, and the overall goal is to optimize buildings as whole systems throughout the lifecycle regarding costs (LCC) and environmental performance (LCA) .
Requires interaction and cooperation of the design team from the early stages and throughout the whole process in order to achieve the implementation of high performance buildings
Requires the installation of smart technologies
Sustainable
Cost Effective
Safe/Secure
Accessible
High Performance Buildings
Functional
Productive
Aesthetics
Historic


The ID process
THE ID STEPS
Project development
Design Basis
Iterative problem solving
On track monitoring
Delivery
In use
CLIENT REQUIREMENTS
BRIEF WRITING
CONCEPT AND DETAILED DESIGN
CONSTRUCTION DOCUMENTATION
POST COMPLETION MONITORING

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Current policy framework in EU to promote ID as supportive tool for NZEB

Country	Building Codes	Environment assessment schemes	Public subsidy schemes	Building programs and regional initiatives	Rules for design competitions	Policies adopted by professional associations	Other policy supporting framework conditions
Greece	'Regulation of Energy Performance of Buildings' (KENAK) has been issued in April 2010 (Ministerial decision D6/B/5825 National Gazette 407). Directive 2010/31/EU (EPBD recast) has been adapted by the greek legislation Energy Performance of Buildings-Harmonization with the Directive 2010/31/EU (Law Number 4122, National Gazette 42) of February 2013. ID not included	LEED, BREEAM etc	The new building's regulation (Law Number 4067, National Gazette 79) of April 2012 gives incentive as it provides an increase of 5% of the building coefficient for buildings rated A+ according to KENAK and 10% at nearly zero energy buildings certified by a recognized environmental assessment method such as LEED, BREEAM etc. No direct link to ID	The Covenant of Mayors is the mainstream European movement involving local and regional authorities, voluntarily committing to increasing energy efficiency and use of renewable energy sources on their territories. More than 60 municipalities in Greece participate in the Covenant promoting sustainability.	In Greece, the last years there have been several design competitions focusing on energy and environmental performance, but integrated design is not a prerequisite for the competition.	Directive T.O.T.E.E. 20701/2010 national standards energy performance The directive doesn't include ID references	No other policy frameworks identified.

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Current policy framework in EU to promote ID as supportive tool for NZEB

Country	Building Codes	Environment assessment schemes	Public subsidy schemes	Building programs and regional initiatives	Rules for design competitions	Policies adopted by professional associations	Other policy supporting framework conditions
Cyprus	Directive 2010/31/EU (EPBD recast) has been adapted by the Cypriot legislation Energy Performance of Buildings-Harmonization with the Directive 2010/31/EU. However, ID is not included in the energy and construction regulating Directives.	The National tool for energy performance assessment of the buildings (iSBEM_cy) does not take into consideration the ID.	The "save, upgrade" public funding scheme for energy refurbishments (2014-2020) is not linked to ID.	There are some local and regional authorities, which voluntarily commit to increasing energy efficiency and use of renewable energy sources on their territories (eg Aglantzias municipality) promoting sustainability).	The national architectural competitions do not include the ID as part of the guidelines. However, there are some international architectural competitions for bigger/public buildings that do emphasis energy and environmental performance, but ID is still not a prerequisite for those competitions.	Not applicable	Not applicable

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Current policy framework in EU to promote ID as supportive tool for NZEB

Country	Building Codes	Environment assessment schemes	Public subsidy schemes	Building programs and regional initiatives	Rules for design competitions	Policies adopted by professional associations	Other policy supporting framework conditions
Italy	Regulations about technical aspects, building process but not ID	The Italian environmental assessment scheme, called Protocollo Itaca is used in 13 of 20 regions, but does not include an explicit ID-addressed criterion. Other environmental assessment schemes are also used such as EU GreenBuilding, BREEAM, LEED	Italian subsidiary schemes (e.g., Detrazione IRPEF 55% and Piano Casa) directly or indirectly are linked to the energy efficiency performance of buildings. No subsidies schemes are linked to ID.	The Itaca Protocol has beem adopted by 13 out of 20 Italian Regions, plus the autonomous Province of Trento. It is used to verify the fulfilment of the specific requirements of Building Regulations or to participate in incentive programs, such as the Piano Casa.	In recent years, design contests are increasingly demanding high environmental ambitions, but an explicit adoption of ID is not required.	Not applicable	Considering a requirement of data exchange among designers a first step towards an ID practice, the national law Legge 10/1991 and the Decreto legislativo 192/2005 are policy frameworks that fostered the energy amelioration of the building sector in Italy.

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SMARTGEMS energy network

Current policy framework in EU to promote ID as supportive tool for NZEB

Country	Building Codes	Environment assessment schemes	Public subsidy schemes	Building programs and regional initiatives	Rules for design competitions	Policies adopted by professional associations	Other policy supporting framework conditions
UK	Some indirect support for ID through Planning system, but Building Regulations primarily focus on technical performance of built environment rather than design processes. Strong drive for energy efficiency may consequentially influence design approach, however.	BREEAM (non domestic) and Code for Sustainable Homes (domestic). Neither explicitly supports ID, but BREEAM AP is perhaps the closest existing role to the ID Facilitator	Publicly funded schemes have greater obligations than regulatory minimums, including the drive for collaborative or partnering working practices and the increasing requirement for "Soft Landings", both sympathetic to the integrated Design processes.	Education, Justice & Defence show signs of collaborative working, although not full ID. Health spending shows less sign of this currently. Other building programmes and regional initiatives largely driven by Home Nation or county/city policies	Design Competitions are comparatively rare and not a requirement of public procurement	Most institutions are supportive of collaborative working practices, although none have specific reference to Integrated Design at this point	Not applicable

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Current policy framework in EU to promote ID as supportive tool for NZEB

Although Integrated Design is not generally a requirement, a set of policy framework conditions contribute to push ID forward. Type and extent of these frameworks vary from country to country. Policies adopted in e.g. environmental assessment schemes and in rules for design competitions support the ideas of ID, and also professional associations generally recommend collaborative working practices.

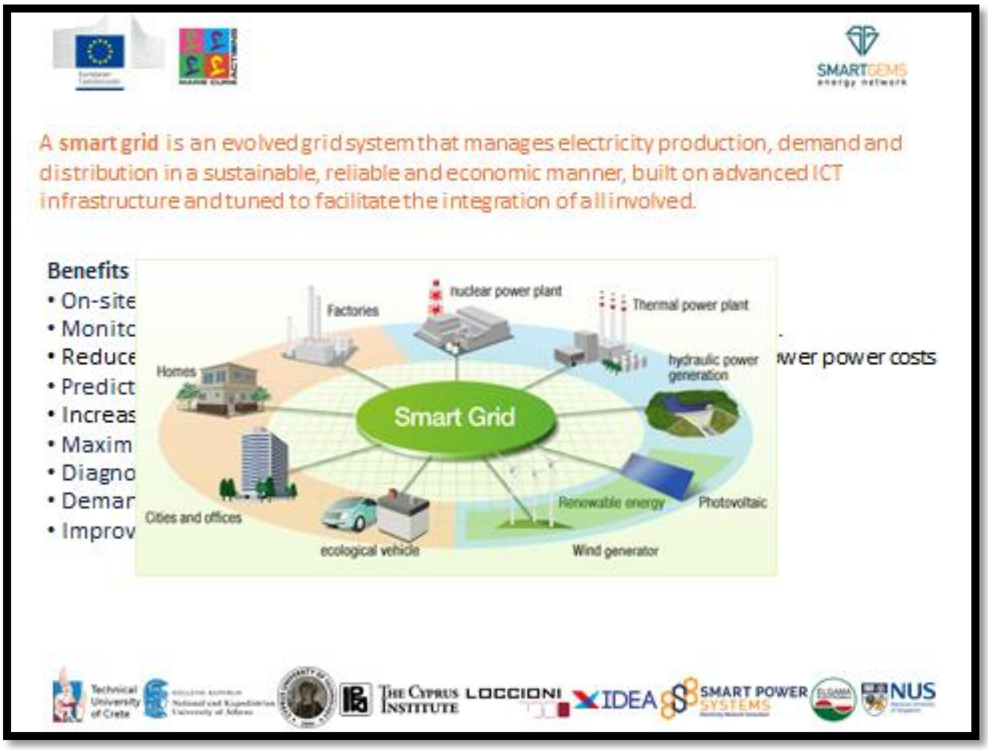
Furthermore, educational institutions are usually supportive of collaborative and cross-disciplinary work. ID is taught in most European countries at various architectural schools and is thus adopted by future decision makers. As such, education is a supporting policy in the broadest sense, and could probably turn out as the most promising framework for promoting ID.

Smart electricity - efficient power for a sustainable world

Electricity is the most versatile and widely used form of energy and global demand is growing continuously. Generation of electrical energy, however, is currently the largest single source of carbon dioxide emissions, making a significant contribution to climate change. To mitigate the consequences of climate change, the current electrical system needs to undergo significant adjustments.

Most of today's generation capacity relies on fossil fuels and contributes significantly to the increase of carbon dioxide in the world's atmosphere, with negative consequences for the climate and society in general.

To satisfy both the increasing demand for power and the need to reduce carbon dioxide emissions, we need an electric system that can handle these challenges in a sustainable, reliable and economic way.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energy network
A smart grid is an evolved grid system that manages electricity production, demand and distribution in a sustainable, reliable and economic manner, built on advanced ICT infrastructure and tuned to facilitate the integration of all involved.
Benefits
• On-site
• Monitc
• Reduce
• Predict
• Increas
• Maxim
• Diagno
• Demar
• Improv
wer power costs
Smart Grid
Factories
nuclear power plant
Thermal power plant
hydraulic power generation
Homes
Cities and offices
ecological vehicle
Renewable energy
Photovoltaic
Wind generator
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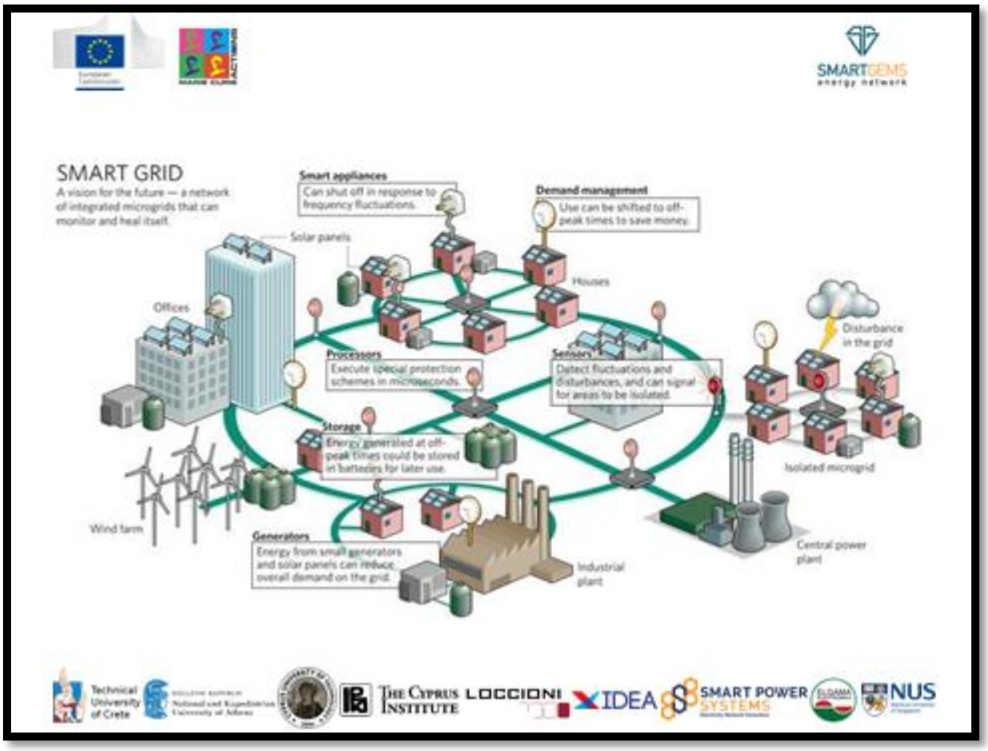
SMARTGEMS
energy network
SMART GRID
A vision for the future — a network of integrated microgrids that can monitor and heal itself.
Smart appliances
Can shut off in response to frequency fluctuations.
Demand management
Use can be shifted to off-peak times to save money.
Solar panels
Houses
Offices
Disturbance in the grid
Processors
Execute special protection schemes in microseconds.
Sensors
Detect fluctuations and disturbances, and can signal for areas to be isolated.
Storage
Energy generated at off-peak times could be stored in batteries for later use.
Isolated microgrid
Wind farm
Generators
Energy from small generators and solar panels can reduce overall demand on the grid.
Industrial plant
Central power plant
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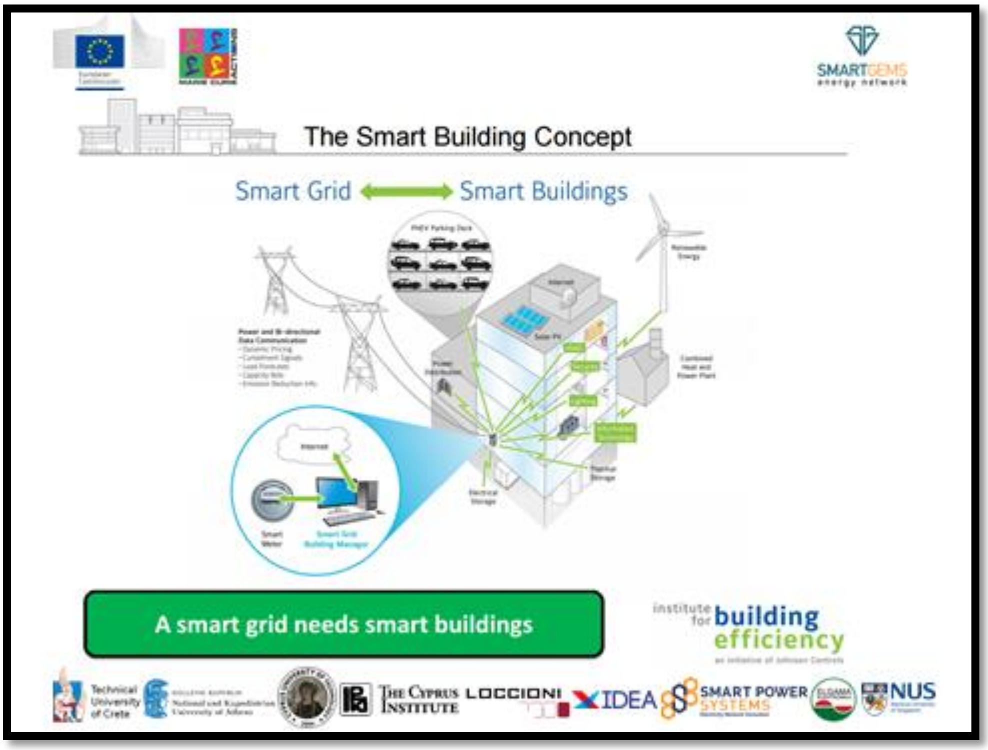
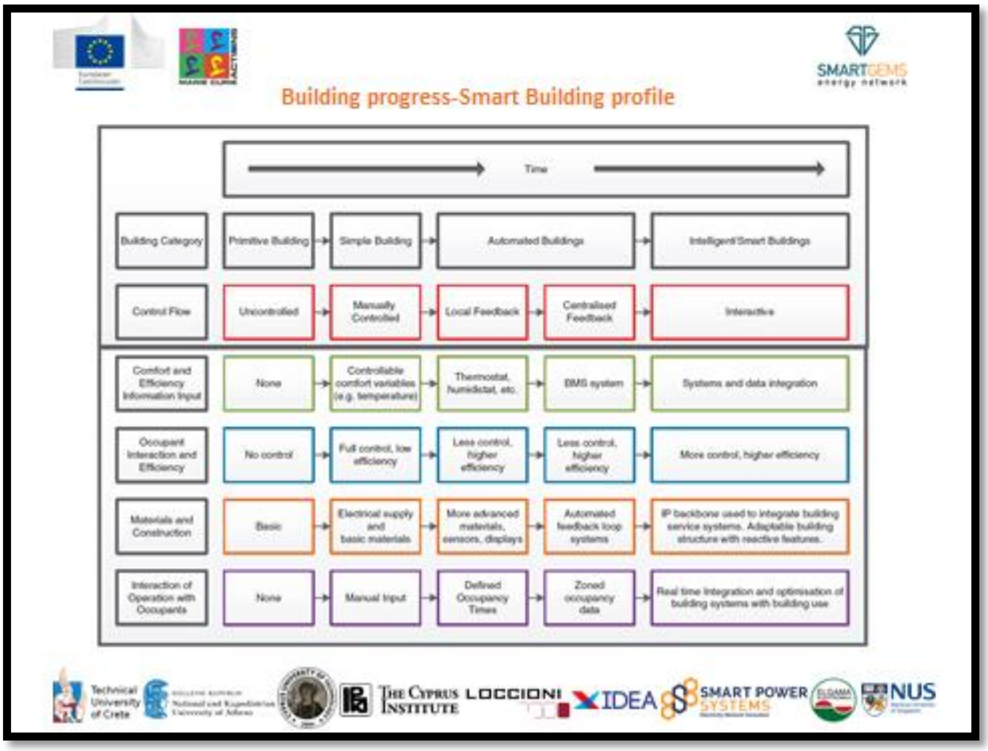

The Smart Building Concept
Smart Grid
Smart Buildings
A smart grid needs smart buildings
institute for building efficiency
Technical University of Crete
The Cyprus Institute
LOCCIONI
IDEA
SMART POWER SYSTEMS
NUS


Building progress-Smart Building profile
Time
Building Category
Primitive Building
Simple Building
Automated Buildings
Intelligent/Smart Buildings
Control Flow
Uncontrolled
Manually Controlled
Local Feedback
Centralised Feedback
Interactive
Comfort and Efficiency Information Input
None
Controllable comfort variables (e.g. temperature)
Thermostat, humidistat, etc.
BMS system
Systems and data integration
Occupant Interaction and Efficiency
No control
Full control, low efficiency
Less control, higher efficiency
Less control, higher efficiency
More control, higher efficiency
Materials and Construction
Basic
Electrical supply and basic materials
More advanced materials, sensors, displays
Automated feedback loop systems
IP backbone used to integrate building service systems. Adaptable building structure with reactive features.
Interaction of Operation with Occupants
None
Manual Input
Defined Occupancy Times
Zoned occupancy data
Real time integration and optimisation of building systems with building use
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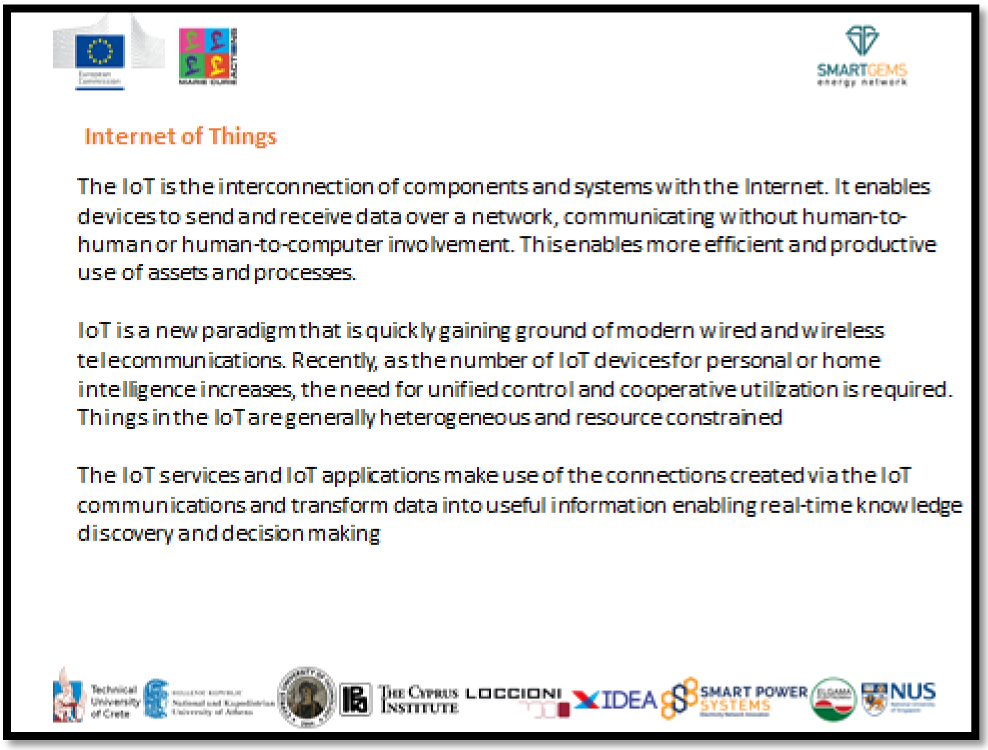
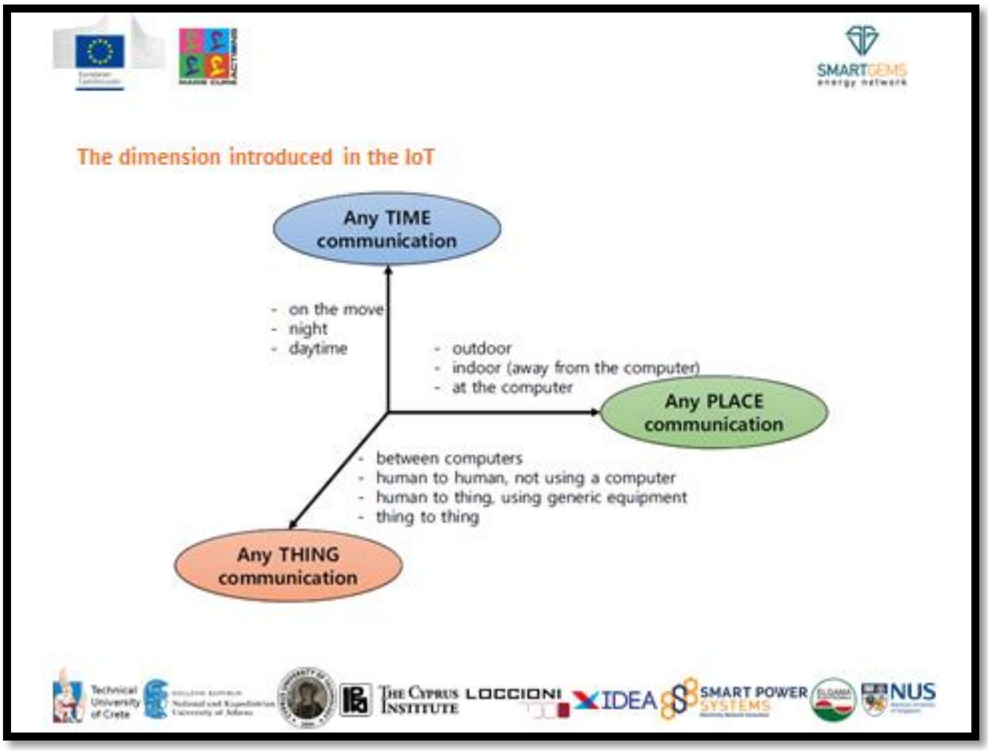
A building should not simply contain the systems that provide comfort, light and safety.
Buildings of the future must connect the various pieces in an integrated, dynamic and functional way. This vision is a building that seamlessly fulfills its mission while minimizing energy cost, supporting a robust electric grid and mitigating environmental impact.
Smart buildings deliver useful building services that make occupants productive (e.g. illumination, thermal comfort) at the lowest cost and environmental impact over the building lifecycle.
Reaching this vision requires adding intelligence from the beginning of design phase through to the end of the building's useful life. Smart buildings use information technology during operation to connect a variety of subsystems, which typically operate independently, so that these systems can share information to optimize total building performance.
Enabled by technology, this smart building connects the structure itself to the functions it exists to fulfill:
Connecting to building systems, people and technology, the global environment, the smart power grid
Connecting to an intelligent future


Smart Building
1. Provides actionable information regarding the performance of building systems and facilities;
2. Proactively monitors and detects errors or deficiencies in building systems;
3. Integrates systems to an enterprise business level for real-time reporting and management utilisation of operations, energy and occupant comfort;
4. Incorporates the tools, technologies, resources and practices to contribute to energy conservation and environmental sustainability


SMARTGEMS energy network
Internet of Things
The IoT is the interconnection of components and systems with the Internet. It enables devices to send and receive data over a network, communicating without human-to-human or human-to-computer involvement. This enables more efficient and productive use of assets and processes.
IoT is a new paradigm that is quickly gaining ground of modern wired and wireless telecommunications. Recently, as the number of IoT devices for personal or home intelligence increases, the need for unified control and cooperative utilization is required. Things in the IoT are generally heterogeneous and resource constrained
The IoT services and IoT applications make use of the connections created via the IoT communications and transform data into useful information enabling real-time knowledge discovery and decision making


SMARTGEMS energy network
The dimension introduced in the IoT
Any TIME communication
- on the move
- night
- daytime
- outdoor
- indoor (away from the computer)
- at the computer
Any PLACE communication
- between computers
- human to human, not using a computer
- human to thing, using generic equipment
- thing to thing
Any THING communication


SMARTGEMS energy network
Cloud computing and IoT concept
Cloud computing with the IoT concept is a new tendency for efficient managing and processing of energy sensing data for smart building. Cloud computing is a new method that refers to centralized storage, shared data processing tasks and online access to computer services using remote servers hosted on the Internet
The major challenge in the building management system design for such a building is to minimize the energy consumption without compromising the user's comfort.
A smart building on IoT and cloud-based technology that can perform collaboration and efficient operation with various sensing devices in building and facilities. Also, applications of the IoT and cloud computing, smart building for the real-time building monitoring and management system for the building energy forecasting.
The proposed system selects an optimum device feature subset from the computing resources and storages by our cloud-based building management system (BMS).
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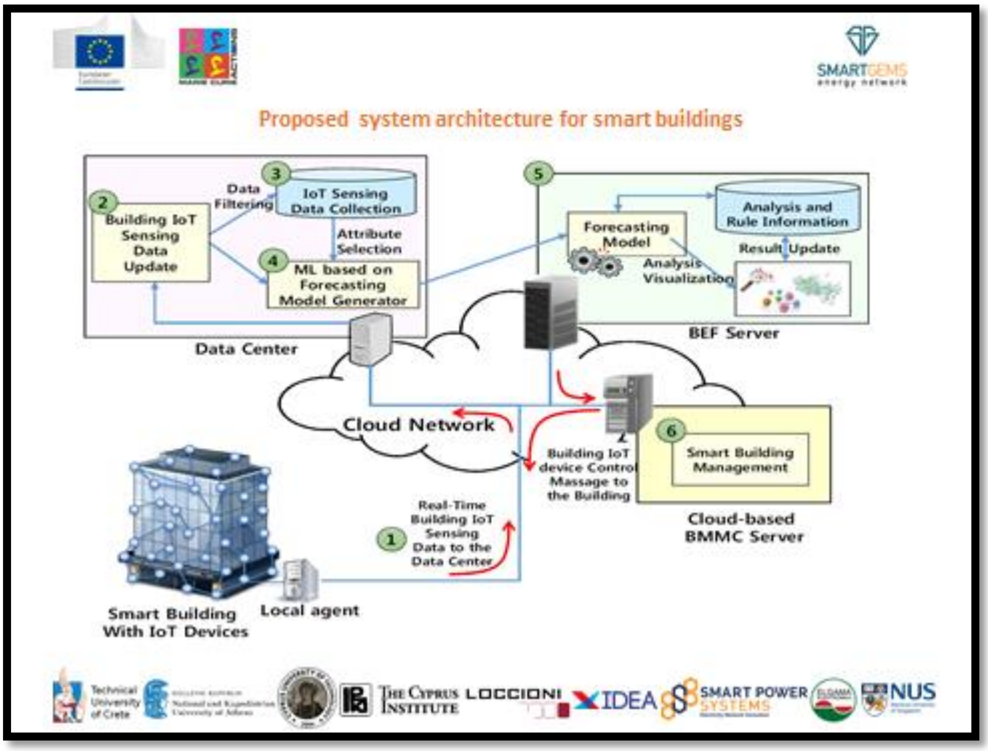
SMARTGEMS energy network
Proposed system architecture for smart buildings
Data Filtering
IoT Sensing Data Collection
Building IoT Sensing Data Update
Attribute Selection
ML based on Forecasting Model Generator
Data Center
Forecasting Model
Analysis and Rule Information
Result Update
Analysis Visualization
BEF Server
Cloud Network
Building IoT device Control Massage to the Building
Smart Building Management
Cloud-based BMMC Server
Real-Time Building IoT Sensing Data to the Data Center
Smart Building With IoT Devices
Local agent
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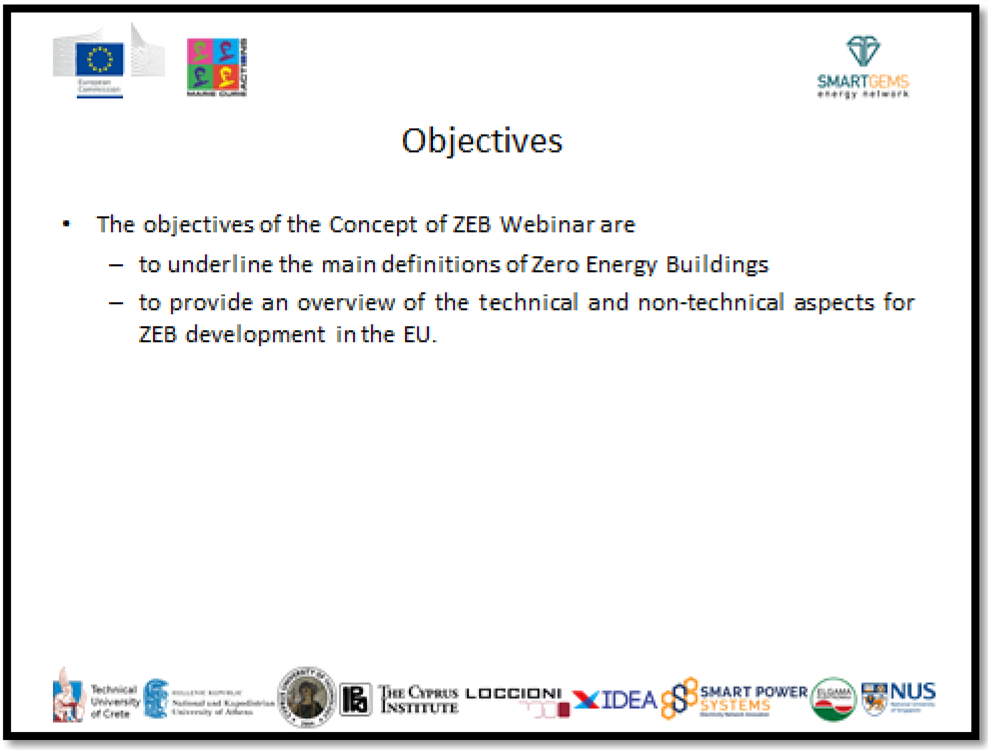
Conclusions
Smart buildings are buildings empowered by ICT (information and communication technologies) in the context of the merging advanced technologies as the Internet of Things.
The installation and function of these technologies in order to be cost-effective and to have high energy and environmental performance demand the incorporation at the building concept from the early design phases through the interdisciplinary procedure of Integrated Design.

Annex II: Slides of the 2nd Webinar - The Concept of ZEB organised by TUC.


SMARTGEMS
energy network
Objectives
• The objectives of the Concept of ZEB Webinar are
– to underline the main definitions of Zero Energy Buildings
– to provide an overview of the technical and non-technical aspects for ZEB development in the EU.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Introduction
Buildings are expected to meet higher and complex levels of performance:
– Be sustainable
– Use zero-net energy
– be healthy and comfortable
– Grid-friendly
– economical to build and maintain
– Meet energy requirements from low-cost, locally available, non-polluting sources
– Generate renewable energy to equal annual energy use

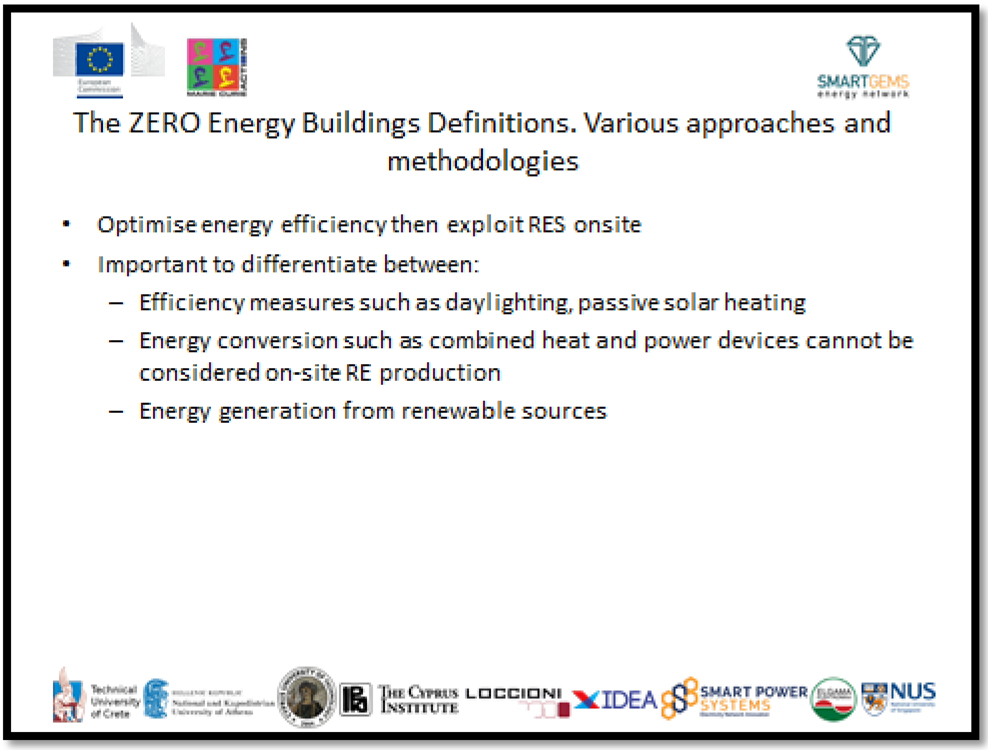
The ZERO Energy Buildings Definitions. Various approaches and methodologies

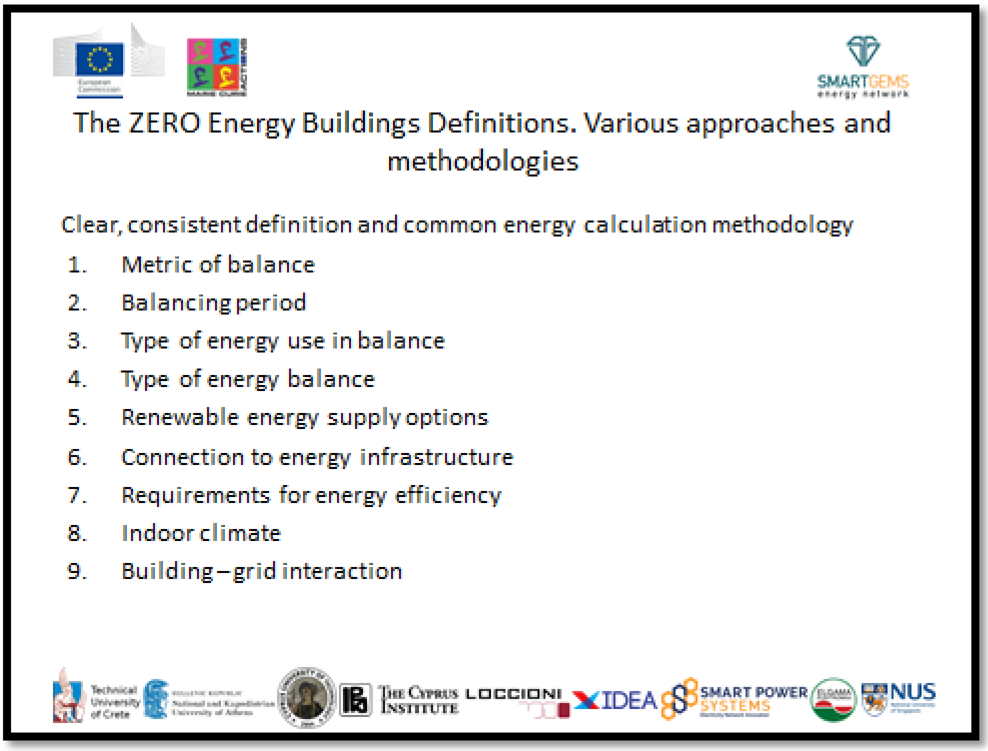
A net zero-energy building (ZEB) is any residential or commercial building of greatly reduced energy needs supplied by renewable technologies.

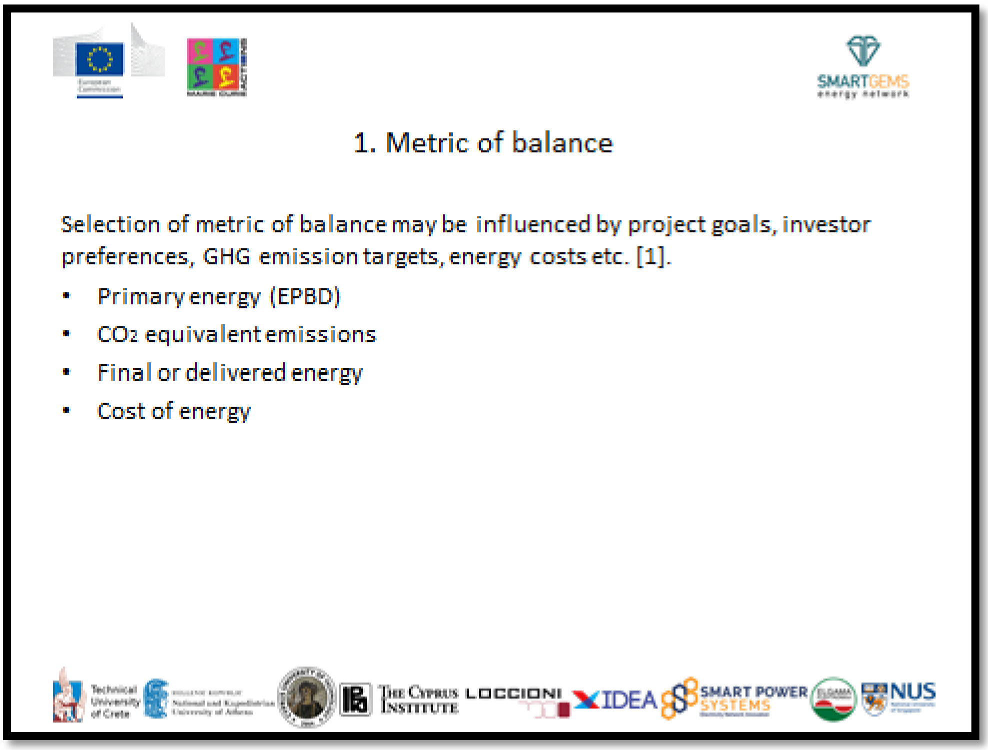
- ZEB concept takes designing low-energy buildings into the real sustainable energy endpoint.
- ZEB targets and a common calculating methodology are critical to the design process

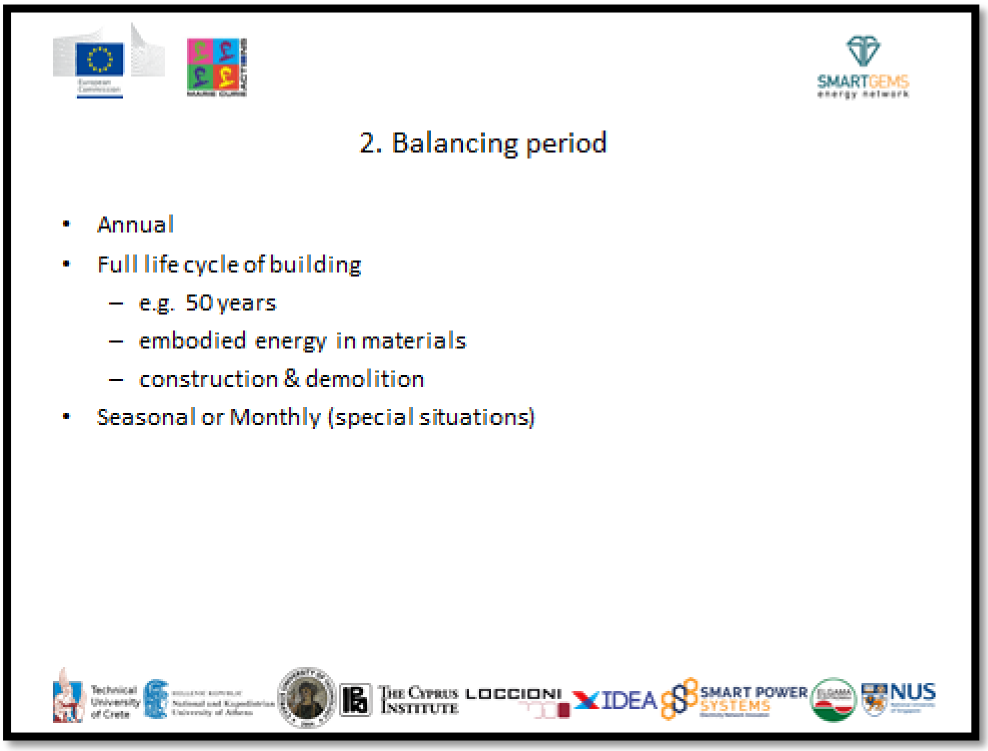
The ZERO Energy Buildings Definitions. Various approaches and methodologies

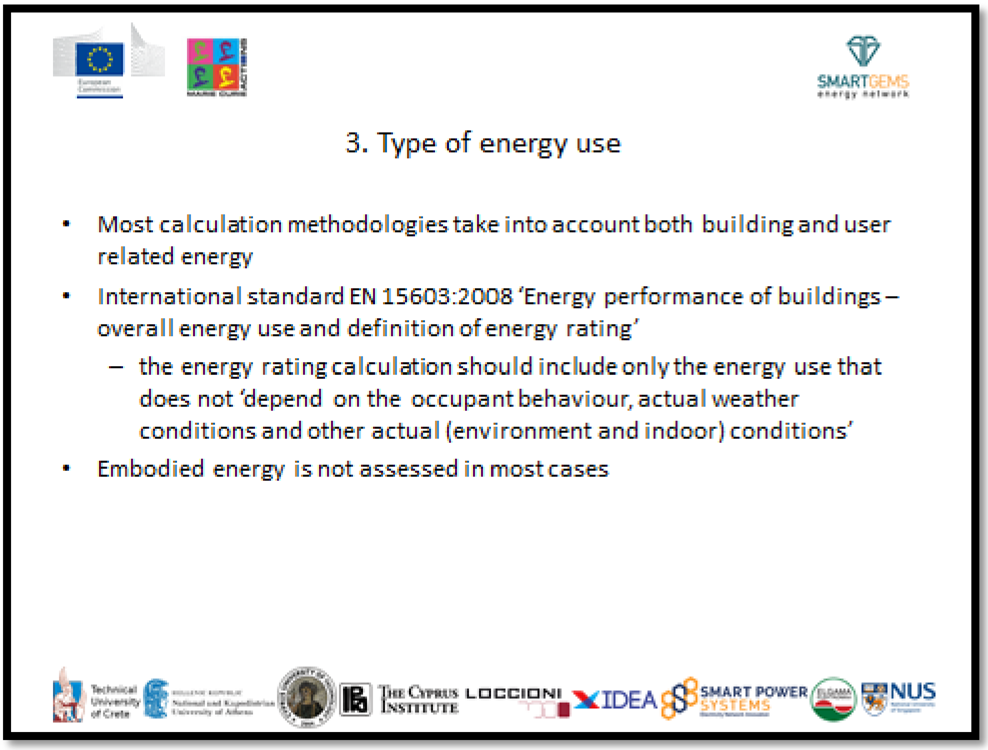
- A ZEB makes use of conventional energy sources when on-site generation cannot meet load
- When on-site generation exceeds building's loads, excess power is exported to the main power grid.
- The grid is used for energy and power balance
- Excess production offsets later energy use.
- The ZE target in off-grid buildings is limited by constraints in generation or storage technologies.

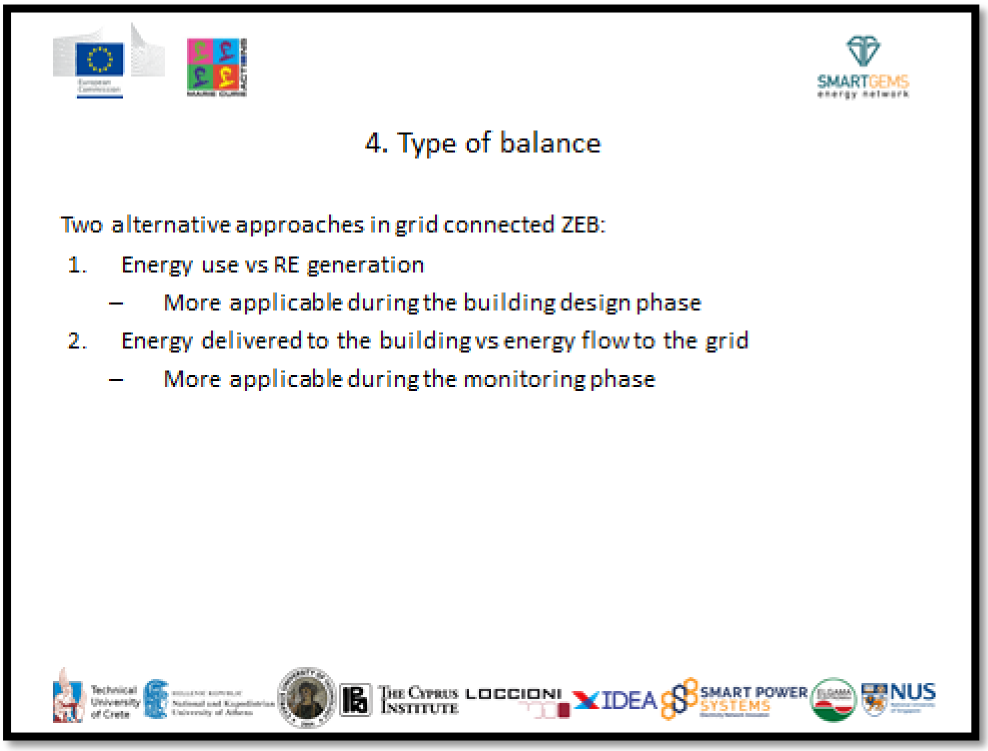

The ZERO Energy Buildings Definitions. Various approaches and methodologies
• Optimise energy efficiency then exploit RES onsite
• Important to differentiate between:
– Efficiency measures such as daylighting, passive solar heating
– Energy conversion such as combined heat and power devices cannot be considered on-site RE production
– Energy generation from renewable sources


The ZERO Energy Buildings Definitions. Various approaches and methodologies
Clear, consistent definition and common energy calculation methodology
1. Metric of balance
2. Balancing period
3. Type of energy use in balance
4. Type of energy balance
5. Renewable energy supply options
6. Connection to energy infrastructure
7. Requirements for energy efficiency
8. Indoor climate
9. Building–grid interaction

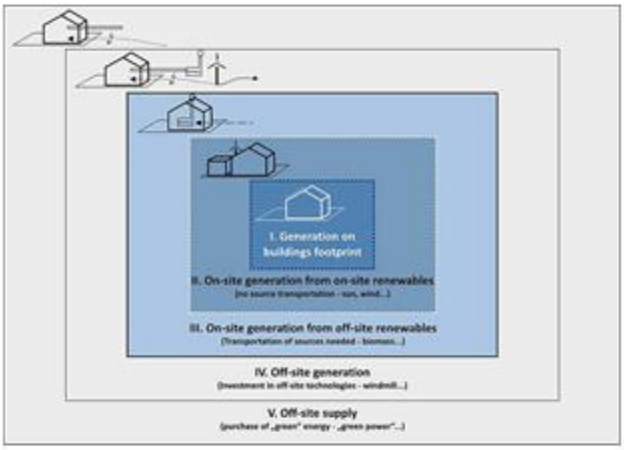

1. Metric of balance
Selection of metric of balance may be influenced by project goals, investor preferences, GHG emission targets, energy costs etc. [1].
• Primary energy (EPBD)
• CO2 equivalent emissions
• Final or delivered energy
• Cost of energy


2. Balancing period
• Annual
• Full life cycle of building
– e.g. 50 years
– embodied energy in materials
– construction & demolition
• Seasonal or Monthly (special situations)


SMARTGEMS energy network
3. Type of energy use
Most calculation methodologies take into account both building and user related energy
International standard EN 15603:2008 'Energy performance of buildings – overall energy use and definition of energy rating'
the energy rating calculation should include only the energy use that does not 'depend on the occupant behaviour, actual weather conditions and other actual (environment and indoor) conditions'
Embodied energy is not assessed in most cases


SMARTGEMS energy network
4. Type of balance
Two alternative approaches in grid connected ZEB:
1. Energy use vs RE generation
– More applicable during the building design phase
2. Energy delivered to the building vs energy flow to the grid
– More applicable during the monitoring phase

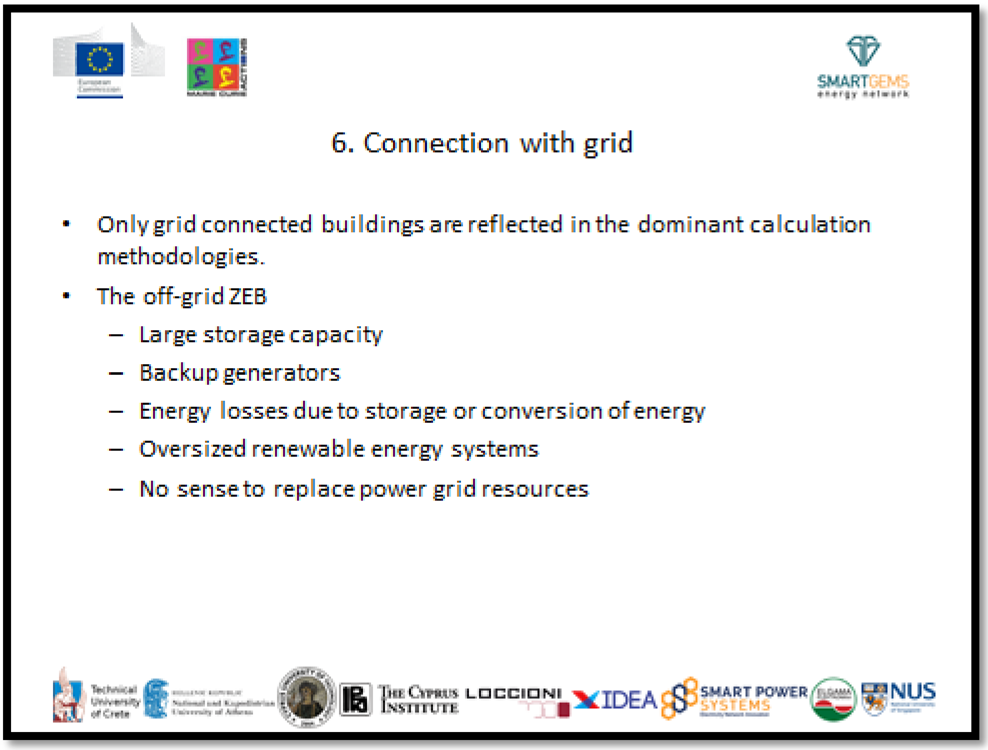
5. Renewable energy supply options

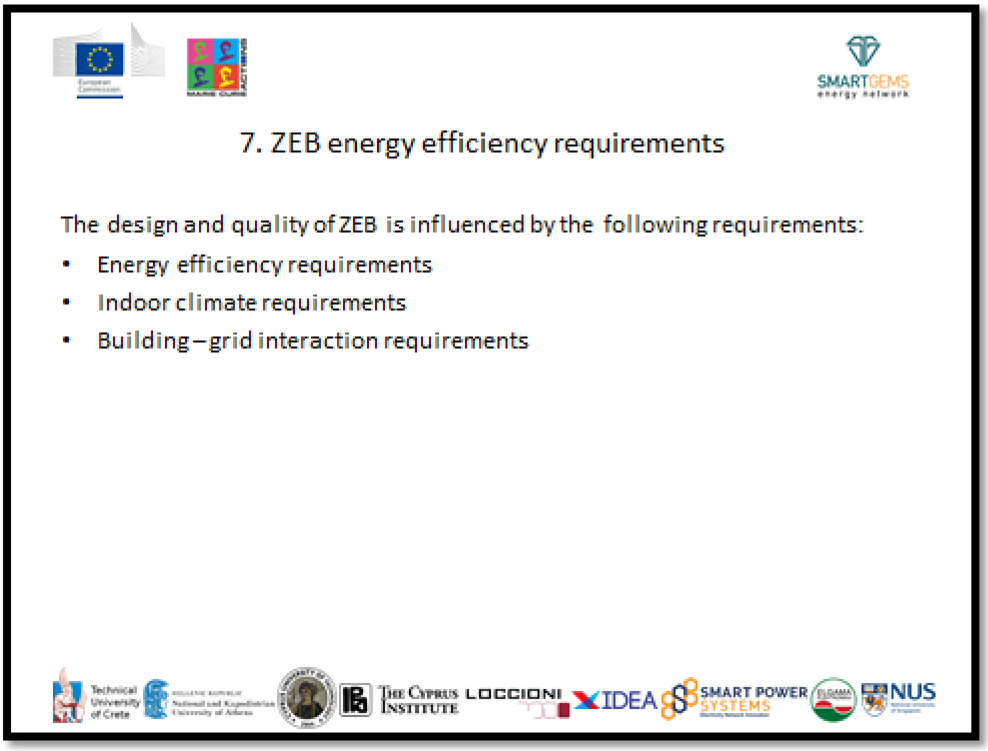


[2]

5. Renewable energy supply options

ZEB Renewable Energy Supply-Side Options [1]	Examples
Reduce site energy use through low-energy building technologies	Daylighting, high-efficiency HVAC equipment, natural ventilation, evaporative cooling, etc.
On-Site Supply Options	
Use renewable energy sources available within the building's footprint	PV, solar hot water, and wind located on the building.
Use renewable energy sources available at the site	PV, solar hot water, low-impact hydro, and wind located on-site, but not on the building.
Off-Site Supply Options	
Use renewable energy sources available off site to generate energy on site	Biomass, wood pellets, ethanol, or biodiesel that can be imported from off site, or waste streams from on-site processes that can be used on-site to generate electricity and heat.
Purchase off-site renewable energy sources	Utility-based wind, PV, emissions credits, or other "green" purchasing options. Hydroelectric is sometimes considered.


6. Connection with grid
• Only grid connected buildings are reflected in the dominant calculation methodologies.
• The off-grid ZEB
– Large storage capacity
– Backup generators
– Energy losses due to storage or conversion of energy
– Oversized renewable energy systems
– No sense to replace power grid resources


7. ZEB energy efficiency requirements
The design and quality of ZEB is influenced by the following requirements:
• Energy efficiency requirements
• Indoor climate requirements
• Building – grid interaction requirements

8. Indoor climate

- Not well developed within the ZEB definitions
- Considered mostly in terms of the energy consumption
- Associated with:
  - Daylight and artificial lighting control
  - Fresh air and sufficient atmospheric environment
  - Temperature, humidity and air quality (i.e. CO_2 concentration)
  - Healthy materials
  - Acoustics and sound

9. Building grid interaction

- ZEB definitions overlook this issue
- Differences in quality of energy imported / exported by the ZEB
- Requirement for quality of energy fed back to the grid

Climatic diversity and the zero energy perspective

Climatic diversity is a major factor when considering the design of a ZEB:

- Energy efficiency measures i.e. insulation, passive measures etc.
- Energy influencing technologies i.e. selection of heat pump
- RES technology i.e. variations in RES potential
- Variations in energy demand profiles i.e. cooling load higher than heating loads in various areas and vice verca.

Zero Energy Building Definitions

- Net zero site energy
- Net zero source energy
- Net zero energy costs
- Net zero energy emissions

Definitions: Net zero site energy building

- At least as much energy as it is consumed in a year, needs to be produced by RES when accounted for at the site.

Advantages	Disadvantages
Easy to implement & understand	Does not consider energy costs
Verifiable through on-site measurements	Does not account for non-energy differences between fuel types (supply availability, pollution)
No externalities affect performance	
Encourages energy-efficient building designs	

Definitions: Net zero source energy building

- At least as much energy as it is consumed in a year, needs to be produced by RES when accounted for at the source (primary energy).

Advantages	Disadvantages
Able to equate energy value of fuel types used at the site	Does not account for non-energy differences between fuel types (supply availability, pollution).
Better models impact of national energy system.	Source calculations are too broad to account for regional variations in power generation.
Easier to reach	Source energy use accounting and fuel switching may have a larger impact than efficiency technologies.
	Does not consider all energy costs

Definitions: Net zero energy costs building

- Utility payment per annum to the building owner for the energy exported to the grid is at least equal to the owner's payment to the utility for the energy and services.

Advantages	Disadvantages
Easy to implement and measure	May not reflect impact to national grid for demand.
Allows for demand-responsive control	Requires net-metering agreements.
Verifiable through utility bills	Highly volatile energy rates make tracking difficult over time.
	Offsetting monthly service and infrastructure charges require going beyond ZEB.

Net zero energy emissions building

- At least as much emissions-free renewable energy as it is consumed based on emission producing energy sources.

Advantages	Disadvantages
Better model for green power	Requires appropriate emission factors.
Accounts for non-energy differences between fuel types (pollution, greenhouse gases)	
Relatively easy to reach.	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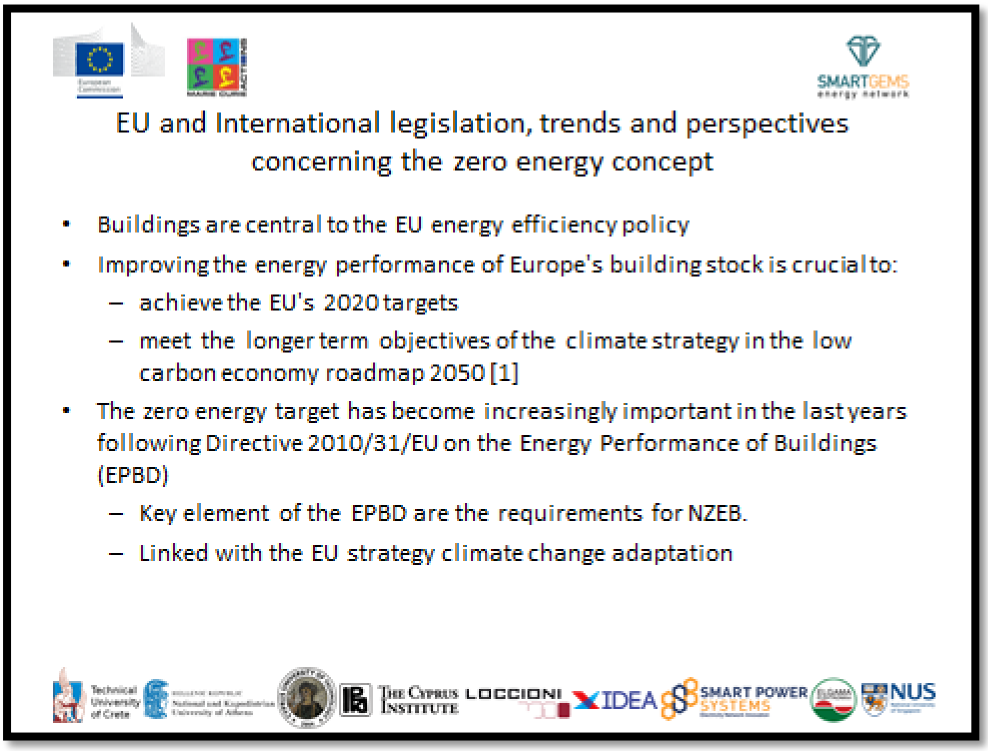
ZEB non technological challenges
• High quality vocational training programs for ZEB professionals and stakeholders
• Reliable channels of information on new and upcoming regulations
• Clearly defined strategies offering perspectives for industrial development in new-built and retrofit
• Lack of market demand (inertia) and slow uptake of innovative solutions
• No "one size fits all"
• Fight "cultural" resistance to change
• Know-how exchange among professionals of different disciplines
• High quality demonstration projects for all types of buildings, all climates and regions. [4]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energy network
EU and International legislation, trends and perspectives concerning the zero energy concept
• Buildings are central to the EU energy efficiency policy
• Improving the energy performance of Europe's building stock is crucial to:
– achieve the EU's 2020 targets
– meet the longer term objectives of the climate strategy in the low carbon economy roadmap 2050 [1]
• The zero energy target has become increasingly important in the last years following Directive 2010/31/EU on the Energy Performance of Buildings (EPBD)
– Key element of the EPBD are the requirements for NZEB.
– Linked with the EU strategy climate change adaptation

EU and International legislation, trends and perspectives concerning the zero energy concept

- EPBD sets NZEB target from 2018 for all public owned or occupied by public authorities buildings and from 2020 for all new buildings.
- Primary energy is used as the metric for energy balance.
- Member States are responsible to report on the detailed application of ZEB in practice (reflecting national, regional or local conditions)
- For residential ZEB buildings the maximum primary energy consumption range between 33 $kWh/m^2/y$ for Croatia and **95 $kWh/m^2/y$ for Latvia**, with a majority of the countries (BE, EE, FR, IE) aiming at **45- 50 $kWh/m^2/y$.**

Energy efficiency methodologies to achieve the zero energy concept at building level

- Additional initial investment costs for residential buildings range from **€200-700/m^2** [10].
- Efforts to quantify and bridge the energy, financial and environmental gaps that exist between the cost optimal combinations of energy technologies and NZEB
  - Successful and optimal integration is still missing
  - One of the main shortcomings of NZE buildings is that they generally rely on customisable technologies difficult to integrate.

Integration, standards & technologies

- Standardized interfaces to ensure that different components can be interchanged or adjusted.
- Innovative Technologies
  - Building envelope solutions for reduced energy consumption
  - Advanced HVAC systems
  - PV building façade components
  - Integrated wind and PV solutions
  - Solar energy and thermal storage
  - Building Energy Management Systems

Building envelope solutions for reduced energy consumption

Advanced insulation and envelope components to minimise energy demand for heating and cooling.

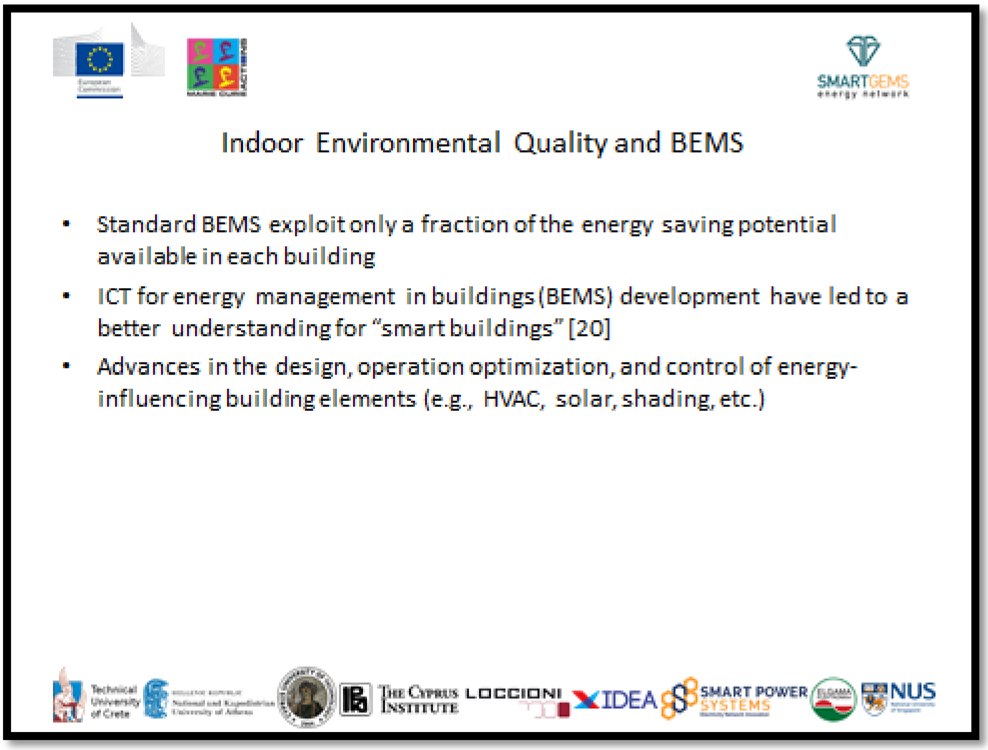
- Cool thermal insulating materials based on new generation XPS
- Vacuum insulation panels [10]–[12]
- Nano-insulation materials
- Cool materials & surfaces
- Green facades & roofs [13]–[17]
- Smart windows [18]

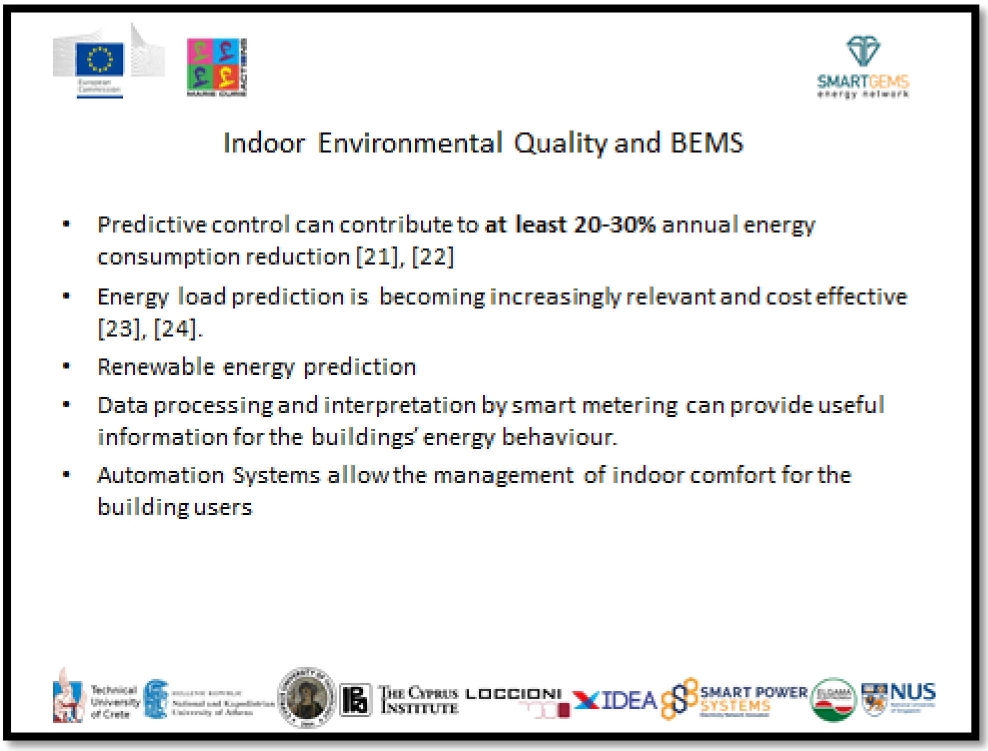
Advanced technologies

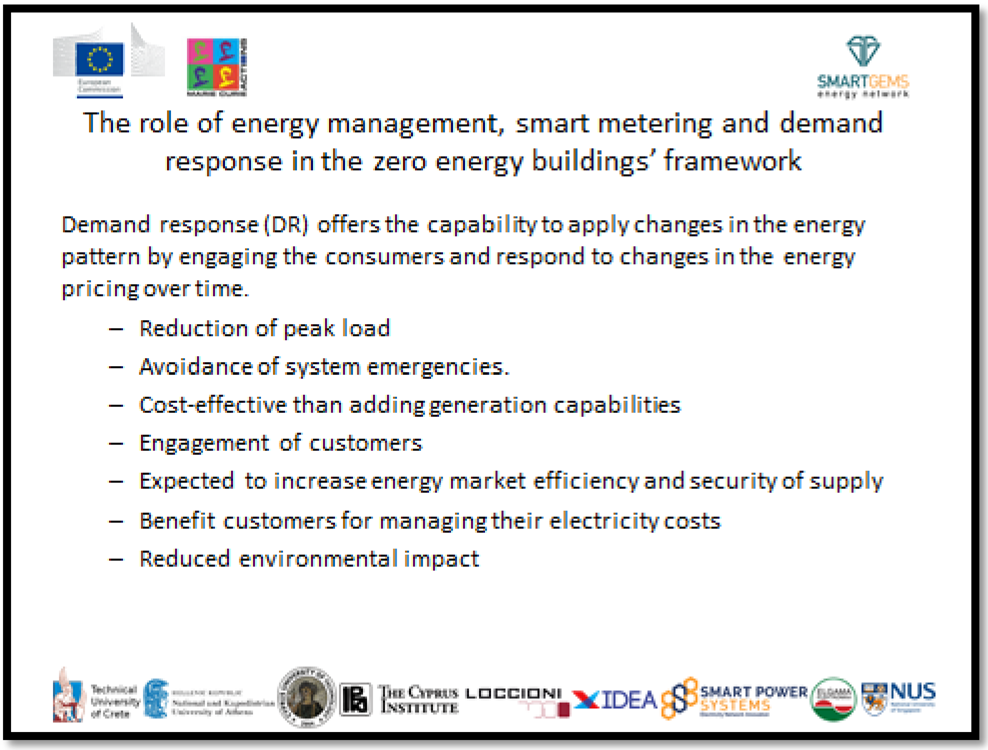
- Solar thermal technologies
  - Can be exploited to meet energy demand [19].
  - Replace electricity used for hot water production and space heating
  - Strong correlation between the supply of the solar resource and demand for cooling during day time.
- Innovative Building Integrated Photovoltaic (BiPV) Systems
  - great potential for architectural use and increase of share of renewable energies
  - improve energy efficiency of the building envelope
- Integrated solar inverter and storage system
  - Maximum Power Tracking and storage control
  - Significant research on storage systems such as batteries with limited lifetime
  - Integrated solar inverter & storage medium allows high self-consumption capabilities

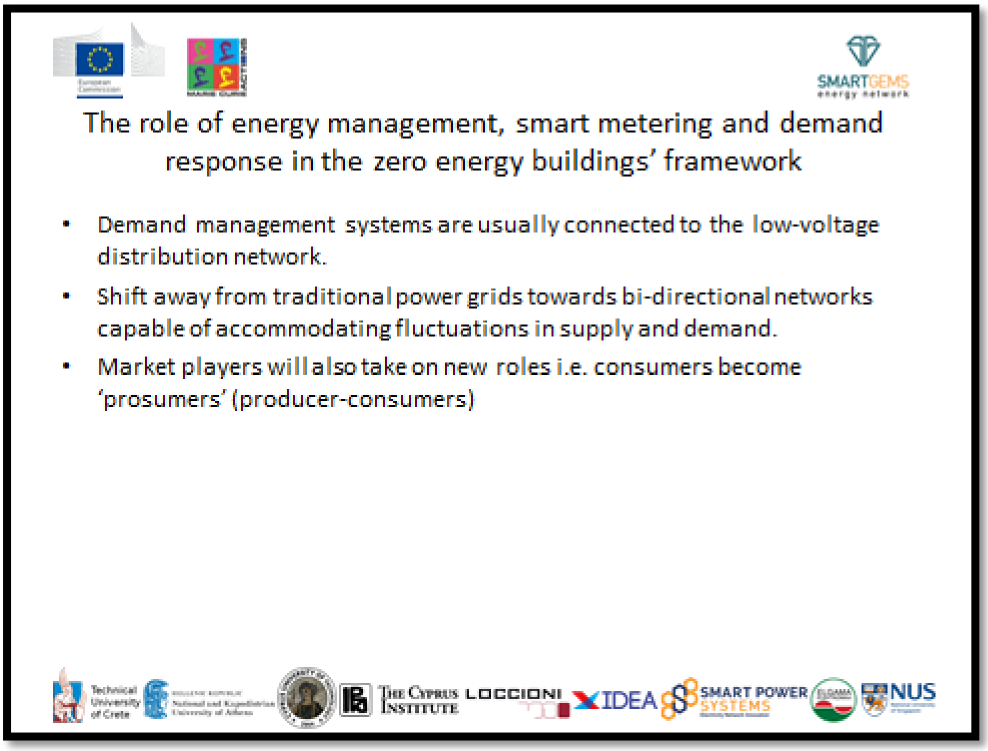
Combined Solar and Wind driven energy systems

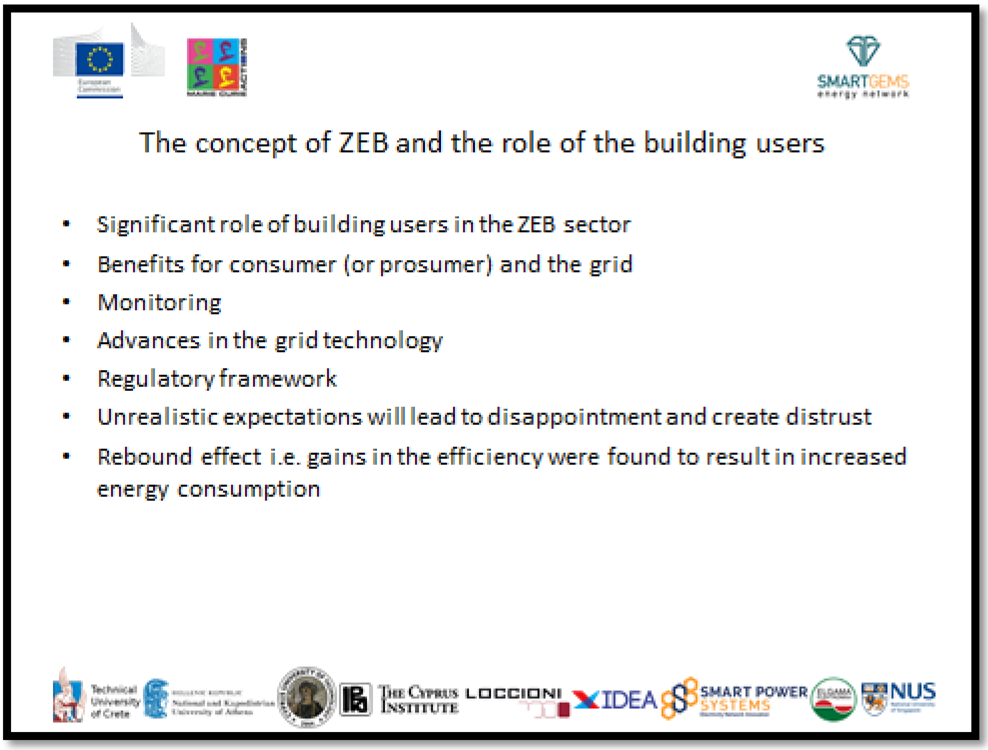
- RES on buildings currently focus on solar radiation usage by PV (electricity) and solar thermal (heat) stand-alone applications.
- Wind as resource is rarely used, and pressure differences around the building are not at all exploited as additional available resources
- Building-based modular system available in the market exploiting pressure differences around the building and solar radiation to generate electricity.

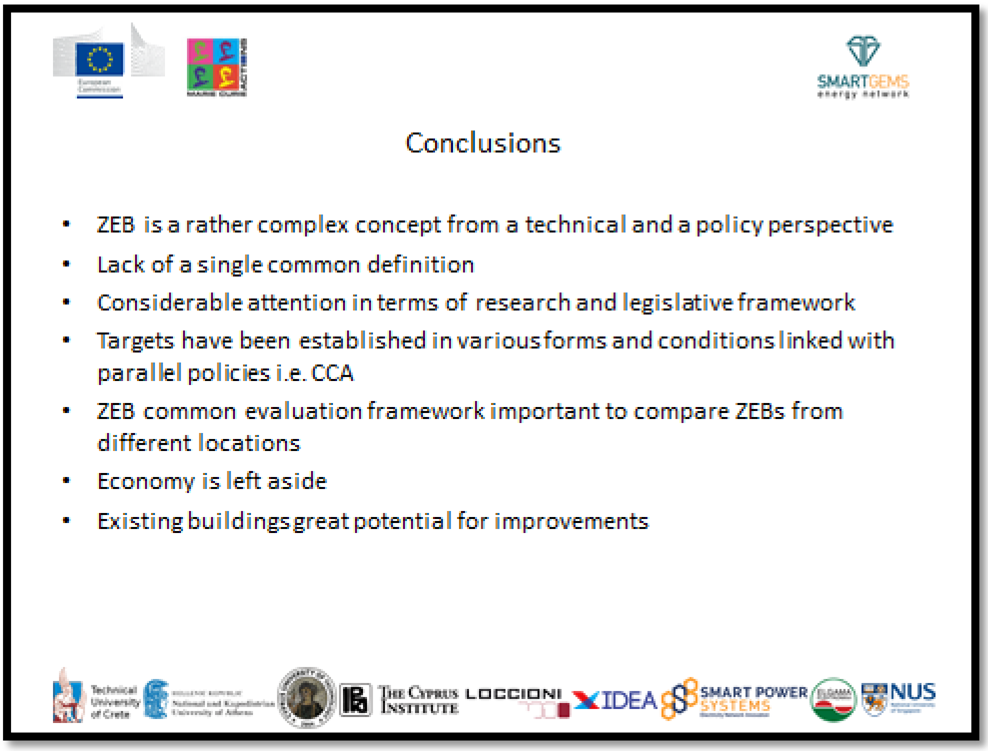

Indoor Environmental Quality and BEMS
• Standard BEMS exploit only a fraction of the energy saving potential available in each building
• ICT for energy management in buildings (BEMS) development have led to a better understanding for "smart buildings" [20]
• Advances in the design, operation optimization, and control of energy-influencing building elements (e.g., HVAC, solar, shading, etc.)

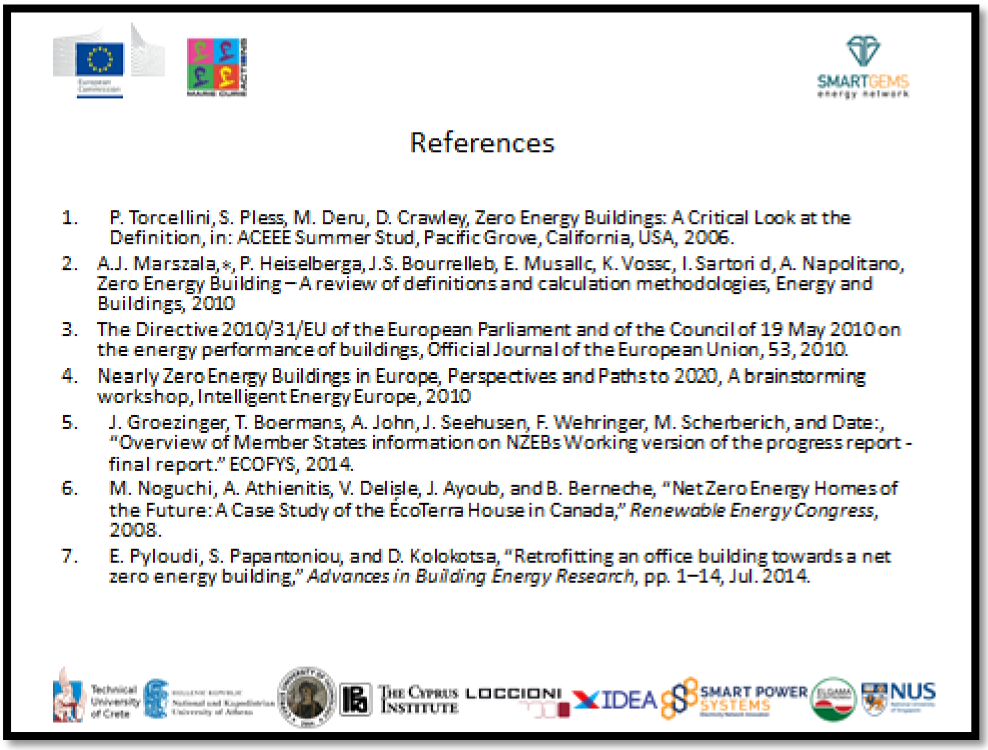

Indoor Environmental Quality and BEMS
• Predictive control can contribute to at least 20-30% annual energy consumption reduction [21], [22]
• Energy load prediction is becoming increasingly relevant and cost effective [23], [24].
• Renewable energy prediction
• Data processing and interpretation by smart metering can provide useful information for the buildings' energy behaviour.
• Automation Systems allow the management of indoor comfort for the building users


The role of energy management, smart metering and demand response in the zero energy buildings' framework
Demand response (DR) offers the capability to apply changes in the energy pattern by engaging the consumers and respond to changes in the energy pricing over time.
– Reduction of peak load
– Avoidance of system emergencies.
– Cost-effective than adding generation capabilities
– Engagement of customers
– Expected to increase energy market efficiency and security of supply
– Benefit customers for managing their electricity costs
– Reduced environmental impact


The role of energy management, smart metering and demand response in the zero energy buildings' framework
• Demand management systems are usually connected to the low-voltage distribution network.
• Shift away from traditional power grids towards bi-directional networks capable of accommodating fluctuations in supply and demand.
• Market players will also take on new roles i.e. consumers become 'prosumers' (producer-consumers)


The concept of ZEB and the role of the building users
Significant role of building users in the ZEB sector
Benefits for consumer (or prosumer) and the grid
Monitoring
Advances in the grid technology
Regulatory framework
Unrealistic expectations will lead to disappointment and create distrust
Rebound effect i.e. gains in the efficiency were found to result in increased energy consumption


Conclusions
ZEB is a rather complex concept from a technical and a policy perspective
Lack of a single common definition
Considerable attention in terms of research and legislative framework
Targets have been established in various forms and conditions linked with parallel policies i.e. CCA
ZEB common evaluation framework important to compare ZEBs from different locations
Economy is left aside
Existing buildings great potential for improvements


SMARTGEMS energy network
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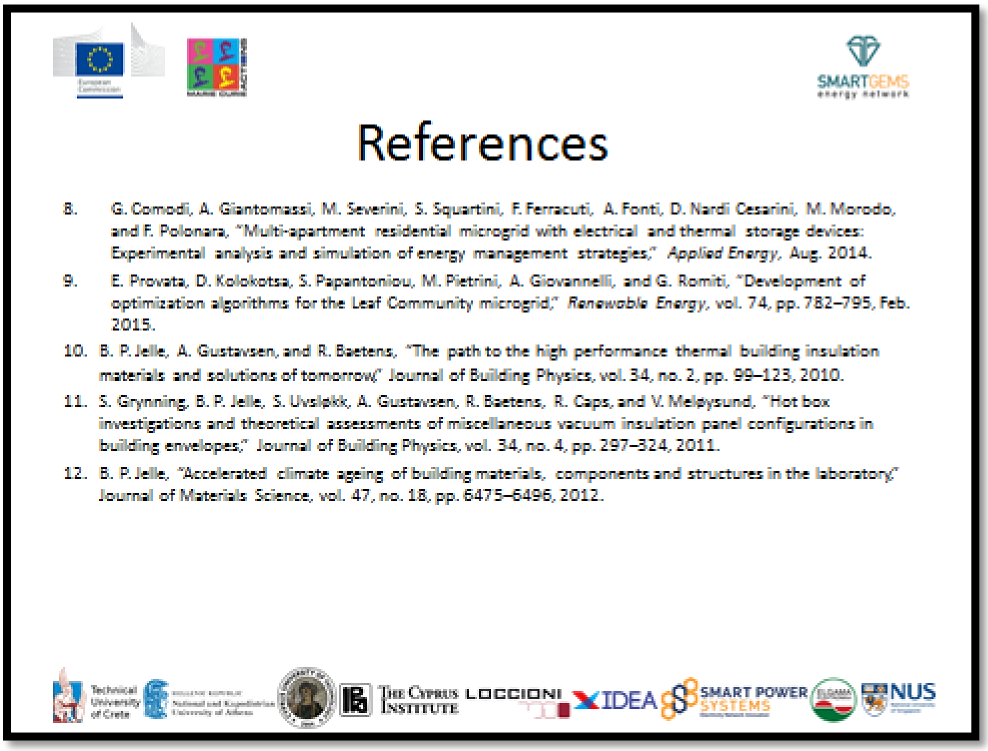
SMARTGEMS energy network
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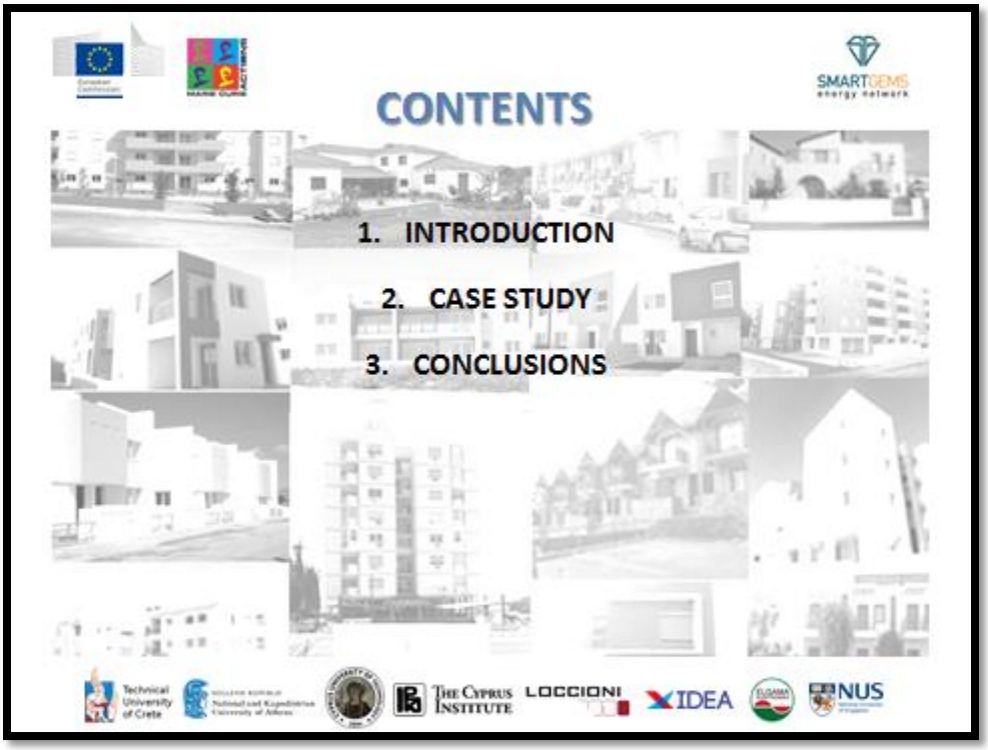
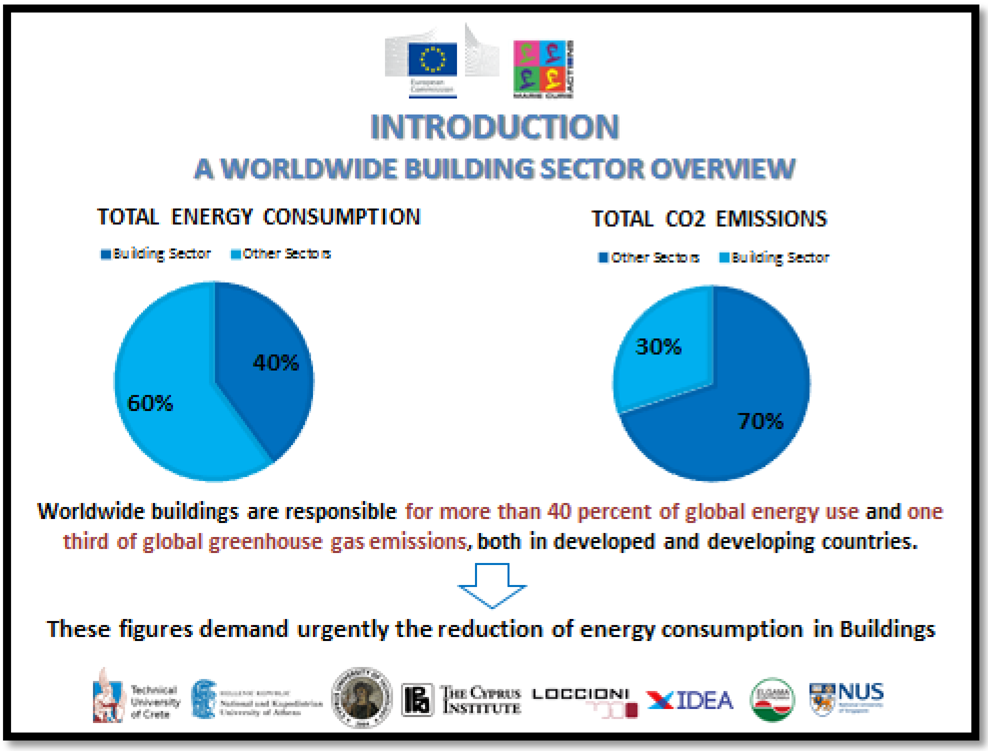
Annex III: Slides of the 3rd Webinar - ZEB Case studies organised by CyI/CUT.

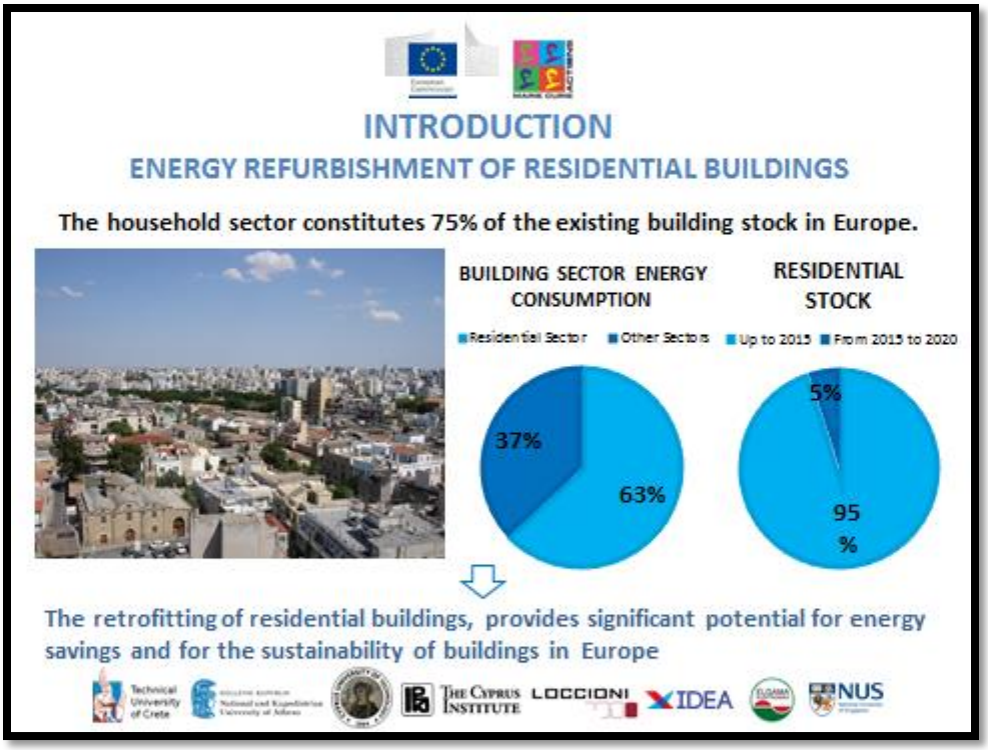
Slides of the Webinar organised by CUT

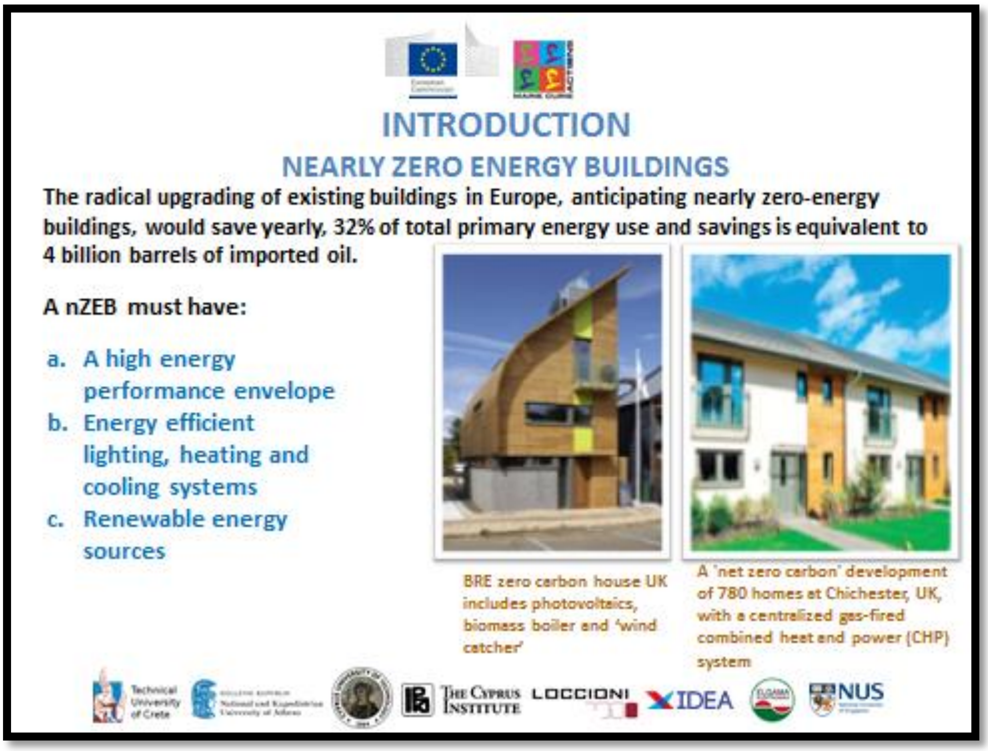

CONTENTS
1. INTRODUCTION
2. CASE STUDY
3. CONCLUSIONS

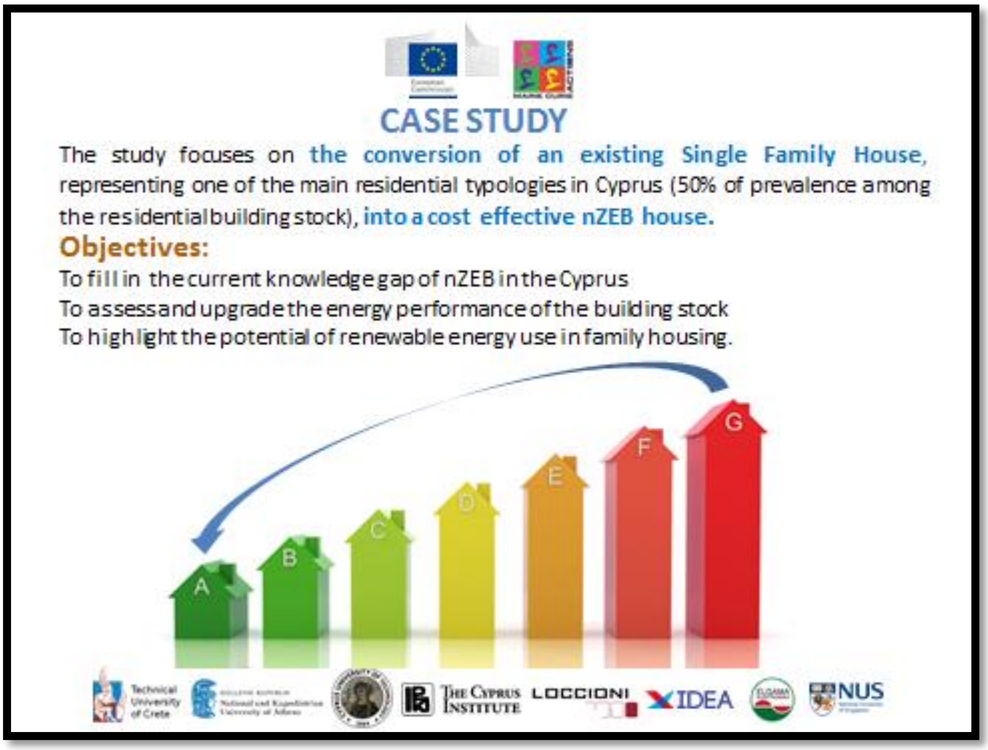

INTRODUCTION
A WORLDWIDE BUILDING SECTOR OVERVIEW
TOTAL ENERGY CONSUMPTION
Building Sector
Other Sectors
40%
60%
TOTAL CO2 EMISSIONS
Other Sectors
Building Sector
30%
70%
Worldwide buildings are responsible for more than 40 percent of global energy use and one third of global greenhouse gas emissions, both in developed and developing countries.
These figures demand urgently the reduction of energy consumption in Buildings


INTRODUCTION
EUROPE 2020 GOALS
The EU 2020 climate and energy package
Reduction in greenhouse gas emissions
20%
Raise the share of the European energy consumption produced from renewable resources
20%
Improve energy efficiency towards nZEB
20%
By 2050 all existing buildings should be net zero energy buildings.

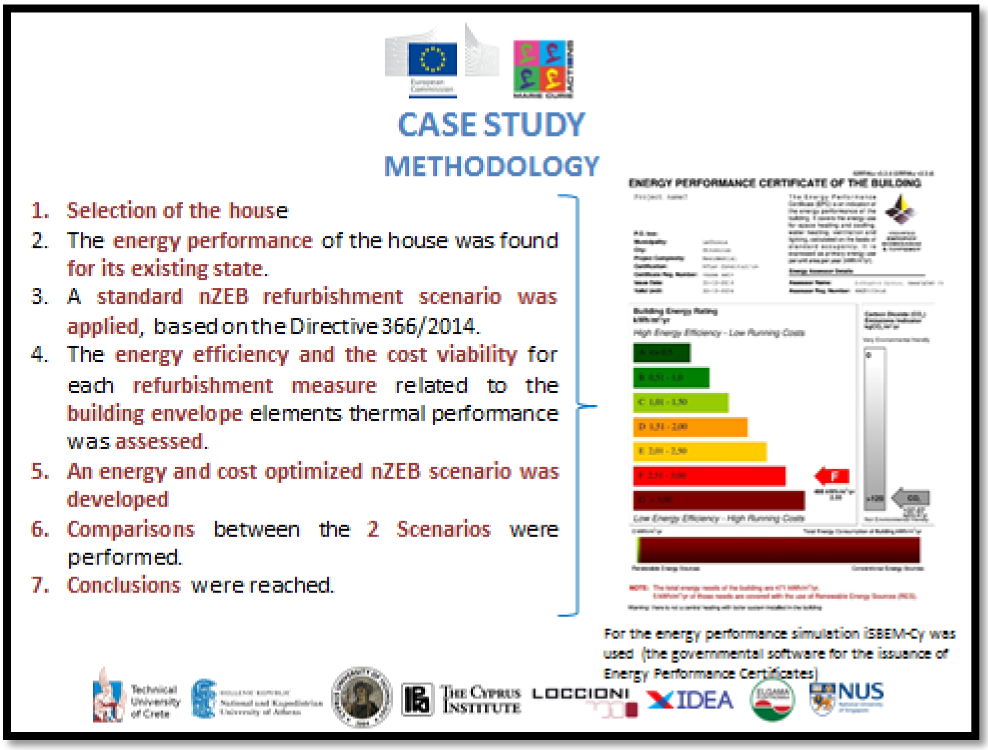

INTRODUCTION
EUROPE'S BUILDING SECTOR
The average annual rate of new construction in Europe amounts to 1%.
The improvement of the energy performance of the old building stock is a high priority in the research agenda of the European Union.


INTRODUCTION
ENERGY REFURBISHMENT OF RESIDENTIAL BUILDINGS
The household sector constitutes 75% of the existing building stock in Europe.
BUILDING SECTOR ENERGY CONSUMPTION
Residential Sector
Other Sectors
37%
63%
RESIDENTIAL STOCK
Up to 2015
From 2015 to 2020
5%
95 %
The retrofitting of residential buildings, provides significant potential for energy savings and for the sustainability of buildings in Europe


INTRODUCTION
NEARLY ZERO ENERGY BUILDINGS
The radical upgrading of existing buildings in Europe, anticipating nearly zero-energy buildings, would save yearly, 32% of total primary energy use and savings is equivalent to 4 billion barrels of imported oil.
A nZEB must have:
a. A high energy performance envelope
b. Energy efficient lighting, heating and cooling systems
c. Renewable energy sources
BRE zero carbon house UK includes photovoltaics, biomass boiler and 'wind catcher'
A 'net zero carbon' development of 780 homes at Chichester, UK, with a centralized gas-fired combined heat and power (CHP) system


CASE STUDY
The study focuses on the conversion of an existing Single Family House, representing one of the main residential typologies in Cyprus (50% of prevalence among the residential building stock), into a cost effective nZEB house.
Objectives:
To fill in the current knowledge gap of nZEB in the Cyprus
To assess and upgrade the energy performance of the building stock
To highlight the potential of renewable energy use in family housing.
A
B
C
D
E
F
G


CASE STUDY
BACKGROUND
NATIONAL BUILDING STOCK
EPISCOPE – EU, IEE Project (http://episcope.eu)
Building Type Matrix
Cyprus
Region
Construction Year Class
Additional Classification
SFH Single Family House
TH Terraced House
MFH Multi Family House
national (Cyprus) ... 1980 generic
CY.N.SFH.01.Gen CY.N.TH.01.Gen CY.N.MFH.01.Gen
national (Cyprus) 1981 ... 2006 generic
CY.N.SFH.02.Gen CY.N.TH.02.Gen CY.N.MFH.02.Gen
national (Cyprus) 2007 ... 2013 generic
CY.N.SFH.03.Gen CY.N.TH.03.Gen CY.N.MFH.03.Gen
national (Cyprus) 2014 ... generic
CY.N.SFH.04.Gen CY.N.TH.04.Gen CY.N.MFH.04.Gen
Older generation construction
Construction Boom in Cyprus
First Minimum Energy requirements 2007
New minimum energy requirements 2014


CASE STUDY
METHODOLOGY
1. Selection of the house
2. The energy performance of the house was found for its existing state.
3. A standard nZEB refurbishment scenario was applied, based on the Directive 366/2014.
4. The energy efficiency and the cost viability for each refurbishment measure related to the building envelope elements thermal performance was assessed.
5. An energy and cost optimized nZEB scenario was developed
6. Comparisons between the 2 Scenarios were performed.
7. Conclusions were reached.
ENERGY PERFORMANCE CERTIFICATE OF THE BUILDING
For the energy performance simulation iSBEM-Cy was used (the governmental software for the issuance of Energy Performance Certificates)
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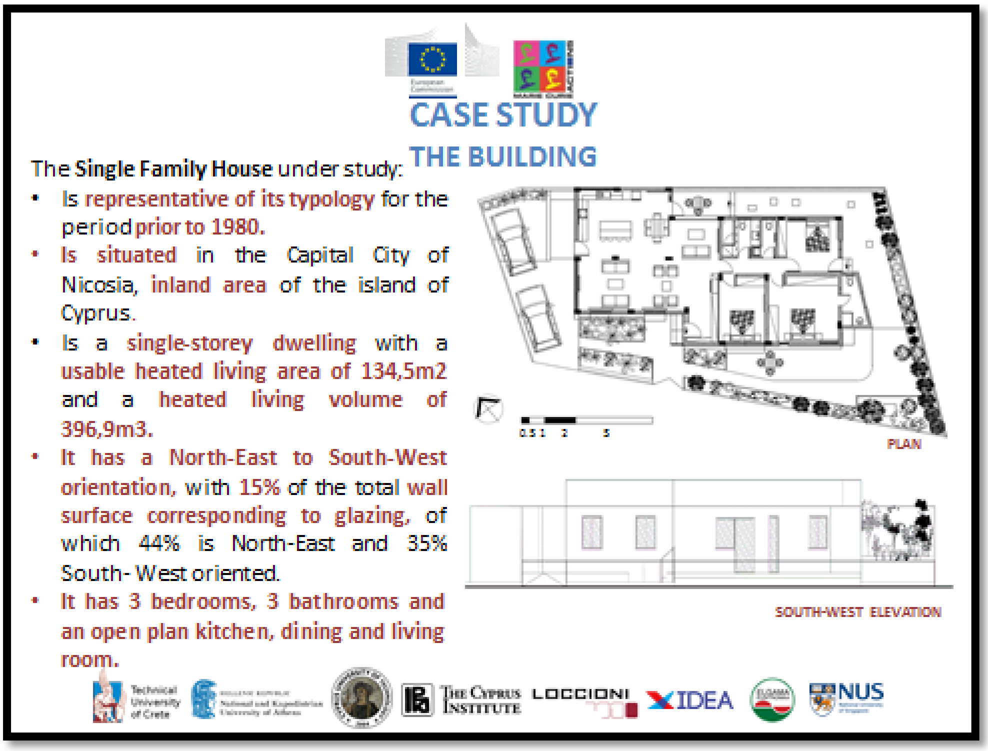
CASE STUDY
THE BUILDING
The Single Family House under study:
• Is representative of its typology for the period prior to 1980.
• Is situated in the Capital City of Nicosia, inland area of the island of Cyprus.
• Is a single-storey dwelling with a usable heated living area of 134,5m2 and a heated living volume of 396,9m3.
• It has a North-East to South-West orientation, with 15% of the total wall surface corresponding to glazing, of which 44% is North-East and 35% South- West oriented.
• It has 3 bedrooms, 3 bathrooms and an open plan kitchen, dining and living room.
PLAN
SOUTH-WEST ELEVATION
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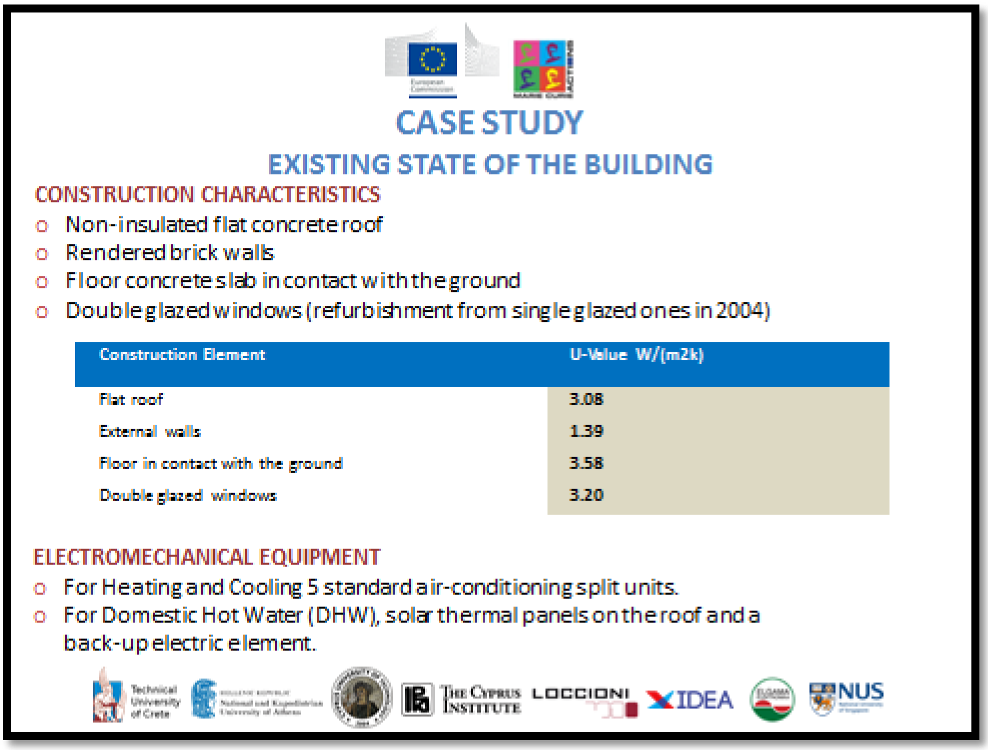
CASE STUDY
EXISTING STATE OF THE BUILDING
CONSTRUCTION CHARACTERISTICS
Non-insulated flat concrete roof
Rendered brick walls
Floor concrete slab in contact with the ground
Double glazed windows (refurbishment from single glazed ones in 2004)
Construction Element | U-Value W/(m2k)
Flat roof | 3.08
External walls | 1.39
Floor in contact with the ground | 3.58
Double glazed windows | 3.20
ELECTROMECHANICAL EQUIPMENT
For Heating and Cooling 5 standard air-conditioning split units.
For Domestic Hot Water (DHW), solar thermal panels on the roof and a back-up electric element.
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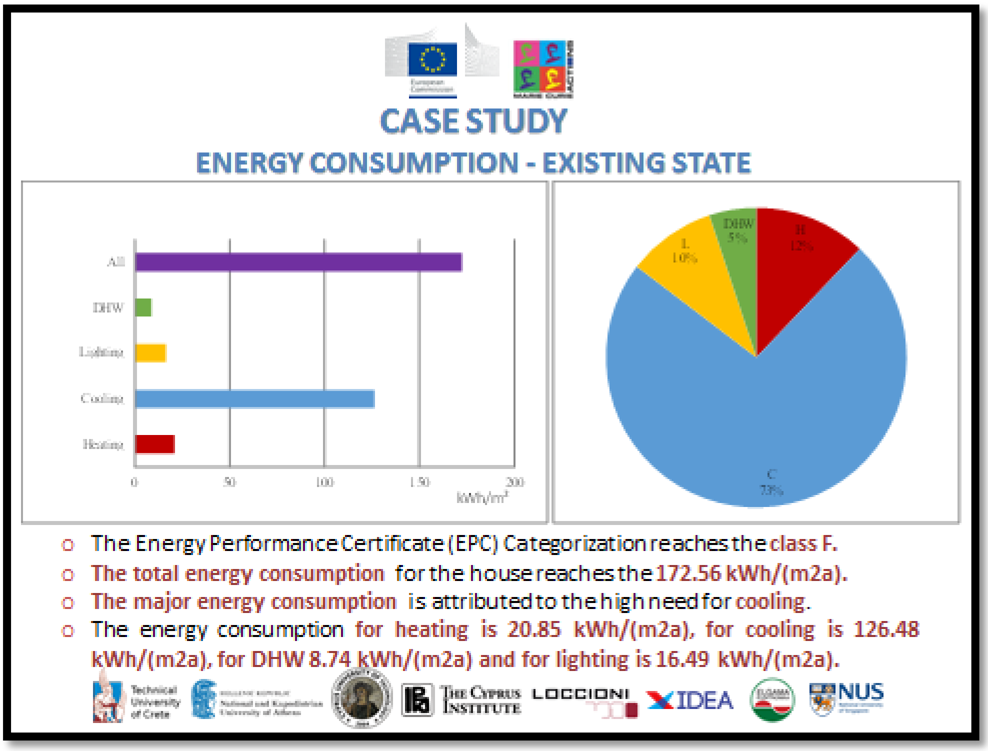
CASE STUDY
ENERGY CONSUMPTION - EXISTING STATE
All
DHW
Lighting
Cooling
Heating
0
50
100
150
200
kWh/m²
DHW 5%
H 12%
L 10%
C 73%
The Energy Performance Certificate (EPC) Categorization reaches the class F.
The total energy consumption for the house reaches the 172.56 kWh/(m2a).
The major energy consumption is attributed to the high need for cooling.
The energy consumption for heating is 20.85 kWh/(m2a), for cooling is 126.48 kWh/(m2a), for DHW 8.74 kWh/(m2a) and for lighting is 16.49 kWh/(m2a).
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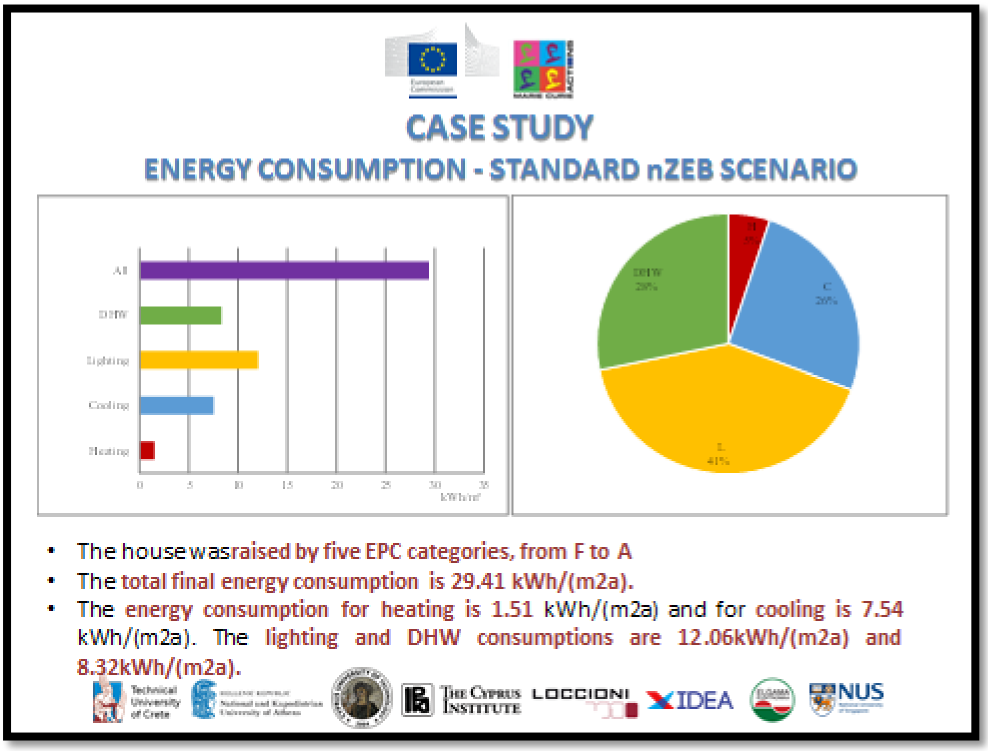
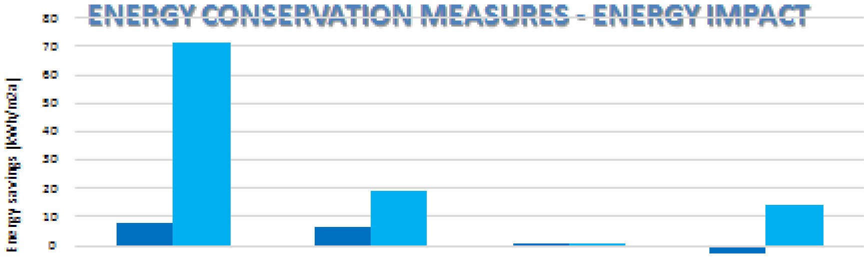
CASE STUDY
STANDARD nZEB REFURBISHMENT SCENARIO
The Standard nZEB Scenario is based on the existing Directive 366/2014:
NZEB REQUIREMENTS FOR HOUSES
Technical specifications - Construction Element | U-Value W/(m²K)
Flat roof | 0.40
External walls | 0.40
Double glazed windows | 2.25
Energy Performance specifications | Minimum requirements
Energy Performance Certificate | A
Total Primary Energy consumption | 100 kWh/(m²a)
Energy Demand for heating | 15 kWh/(m²a)
Renewable energy percentage of the total primary energy consumption | 25%
REFURBISHMENT MEASURES
Addition of 90mm thermal insulation externally on the roof.
Addition of 80mm of thermal insulation (expanded polystyrene) externally on the walls
Replacement of the windows with new, thermally improved ones.
Addition of horizontal overhang shades (aluminium frame and fabric) above the south-facing windows.
Placement of 3 photovoltaic panels of total area of 4.8m2 on the roof with an inclination of 30°
Substitution of the existing AC units with ones of A+++ class.


CASE STUDY
ENERGY CONSUMPTION - STANDARD nZEB SCENARIO
All
DHW
Lighting
Cooling
Heating
0 5 10 15 20 25 30 35
kWh/m²
H 5%
C 26%
L 41%
DHW 28%
The house was raised by five EPC categories, from F to A
The total final energy consumption is 29.41 kWh/(m2a).
The energy consumption for heating is 1.51 kWh/(m2a) and for cooling is 7.54 kWh/(m2a). The lighting and DHW consumptions are 12.06kWh/(m2a) and 8.32kWh/(m2a).

CASE STUDY

ENERGY CONSERVATION MEASURES - ENERGY IMPACT

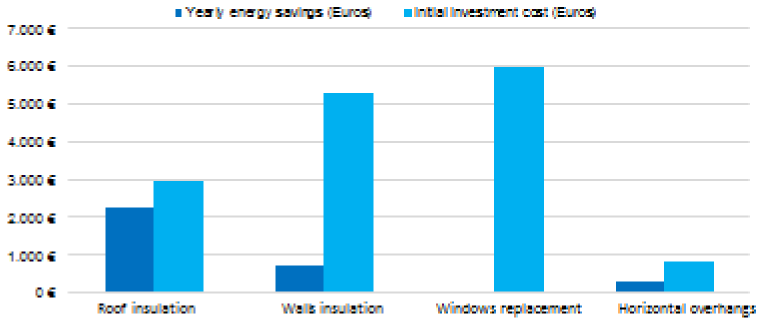


	Refurbishment - Roof	Refurbishment - Wall	Refurbishment - Windows	Exterior shading - Horizontal overhang
Heating	7,97	6,05	0,59	-2,57
Cooling	71,18	18,95	1,05	14,07

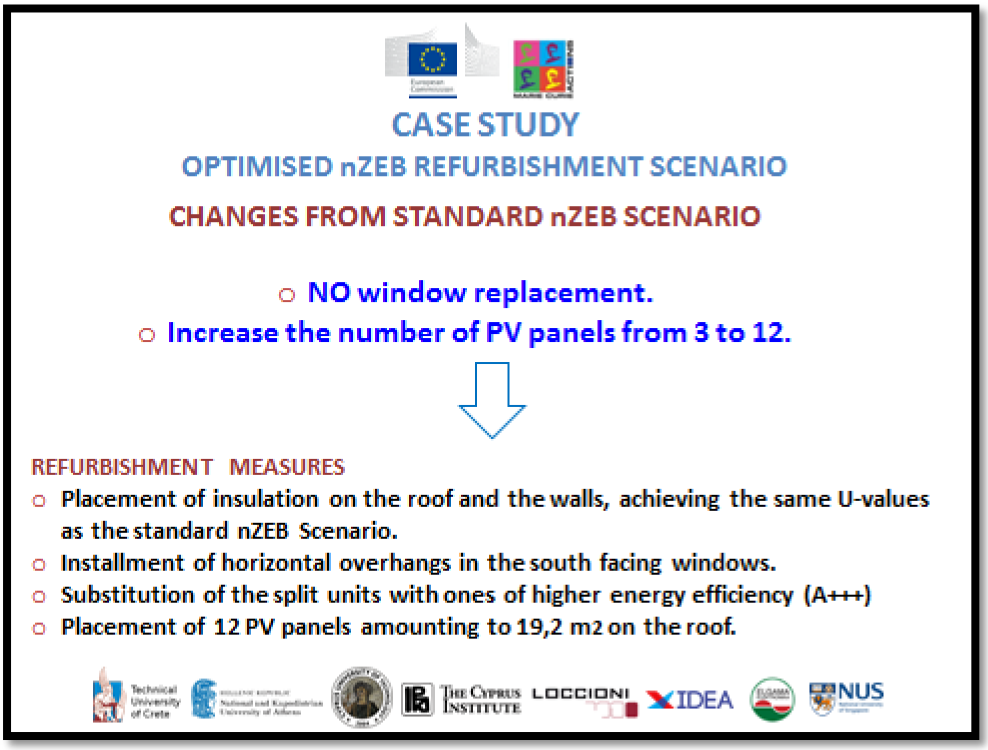
- The placement of thermal insulation on the roof is the most effective measure.
- The cooling savings after insulating the roof are more than 3 times higher than the ones incurring from the placement of insulation on the walls.
- The replacement of the existing double glazed windows with new ones, of lower U-value, results to minimal energy savings.
- The placement of the 1m length overhangs above the windows is energy efficient only for Cooling.

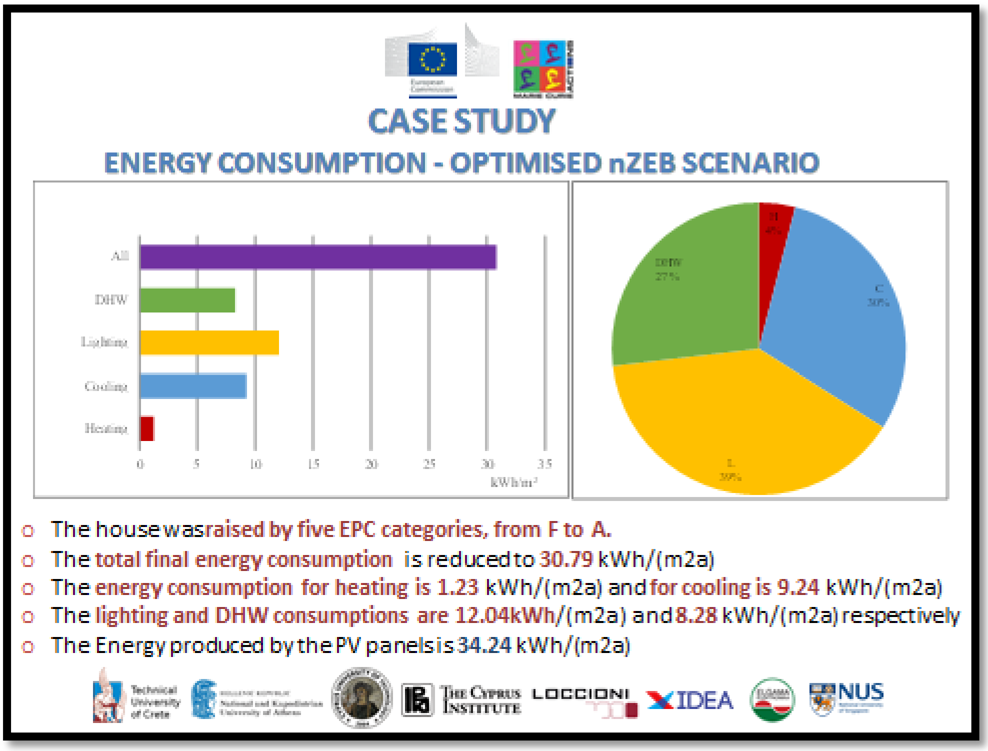
CASE STUDY

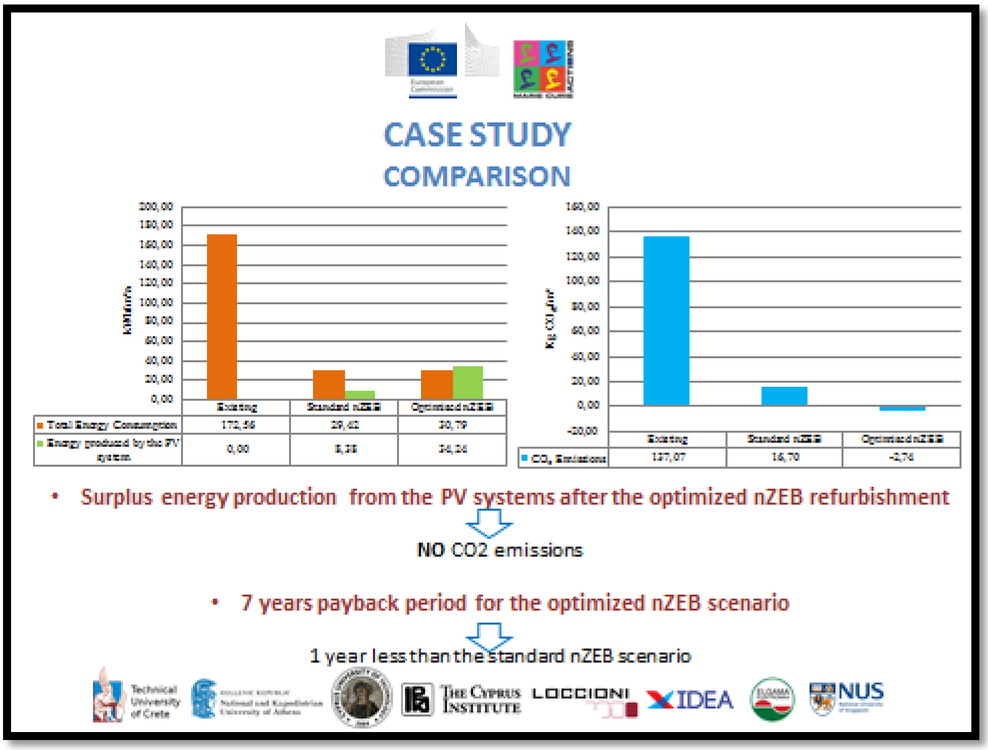
ENERGY CONSERVATION MEASURES - COST-EFFECTIVENESS

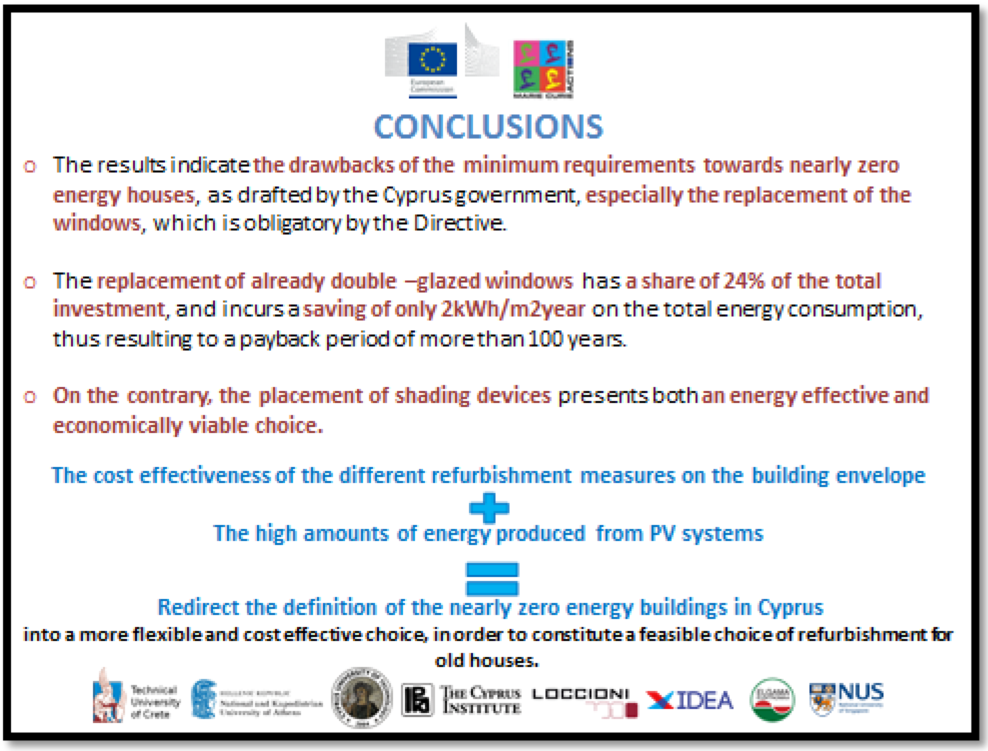


- The most cost - effective measure is the addition of insulation on the roof, with a payback period of less than 2 years.
- The horizontal overhangs have a 3 years payback time and the insulation of the walls 7 years.
- The replacement of the double-glazed windows with ones of better energy performance is the least effective measure with more than a century to amortize its initial investment cost.


CASE STUDY
OPTIMISED nZEB REFURBISHMENT SCENARIO
CHANGES FROM STANDARD nZEB SCENARIO
NO window replacement.
Increase the number of PV panels from 3 to 12.
REFURBISHMENT MEASURES
Placement of insulation on the roof and the walls, achieving the same U-values as the standard nZEB Scenario.
Installment of horizontal overhangs in the south facing windows.
Substitution of the split units with ones of higher energy efficiency (A+++)
Placement of 12 PV panels amounting to 19,2 m2 on the roof.


CASE STUDY
ENERGY CONSUMPTION - OPTIMISED nZEB SCENARIO
All
DHW
Lighting
Cooling
Heating
0 5 10 15 20 25 30 35
kWh/m²
The house was raised by five EPC categories, from F to A.
The total final energy consumption is reduced to 30.79 kWh/(m2a)
The energy consumption for heating is 1.23 kWh/(m2a) and for cooling is 9.24 kWh/(m2a)
The lighting and DHW consumptions are 12.04kWh/(m2a) and 8.28 kWh/(m2a) respectively
The Energy produced by the PV panels is 34.24 kWh/(m2a)


CASE STUDY
COMPARISON
kWh/m²a
Kg CO2/m²
Existing
Standard nZEB
Optimized nZEB
Total Energy Consumption 172,56 29,62 30,79
Energy produced by the PV system 0,00 8,38 34,26
CO2 Emissions 137,07 16,70 -2,74
Surplus energy production from the PV systems after the optimized nZEB refurbishment
NO CO2 emissions
7 years payback period for the optimized nZEB scenario
1 year less than the standard nZEB scenario


CONCLUSIONS
The results indicate the drawbacks of the minimum requirements towards nearly zero energy houses, as drafted by the Cyprus government, especially the replacement of the windows, which is obligatory by the Directive.
The replacement of already double –glazed windows has a share of 24% of the total investment, and incurs a saving of only 2kWh/m2year on the total energy consumption, thus resulting to a payback period of more than 100 years.
On the contrary, the placement of shading devices presents both an energy effective and economically viable choice.
The cost effectiveness of the different refurbishment measures on the building envelope
The high amounts of energy produced from PV systems
Redirect the definition of the nearly zero energy buildings in Cyprus
into a more flexible and cost effective choice, in order to constitute a feasible choice of refurbishment for old houses.


THANK YOU!
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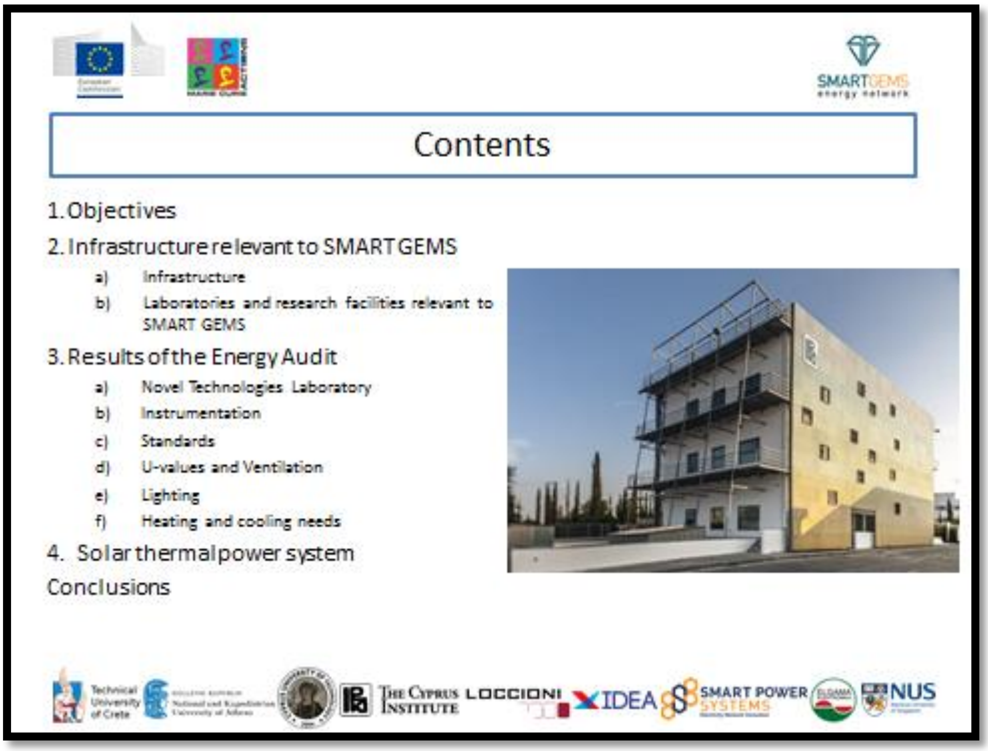
Slides of the Webinar organised by CyI



Objectives

The main focus of the nearly Zero Energy case studies Webinar to be presented by the Cyprus Institute (CyI) is to illustrate the near zero energy consumption building which belongs to the CyI and is called the "Novel Technologies Laboratory Building" (NTL). The particular building was selected to be examined and presented as it is a state-of-the-art infrastructure and among the very few available in the wider area of the Eastern Mediterranean.

The building hosts laboratories, administration spaces, and seminar rooms of the Energy, Environment and Water Research Center (EEWRC) and is located at the outskirts of Nicosia, the capital of Cyprus. It has a total floor space of 2130m2 and consists of a basement, ground floor, 1st floor and 2nd floor.

Meeting nzeb criteria

The building is designed to meet near-zero energy consumption criteria using advanced energy conservation measures, smart energy management and solar thermal and photovoltaic systems to cover the remaining energy load. The energy conservation techniques which are used result in reduced energy consumption of the building by almost 70% compared with a conventional building, while almost 27% of the remaining heating-cooling- and lighting load is covered by photovoltaics. A concentrating solar thermal system for cooling and heating is being installed to cover the remainder of the load.

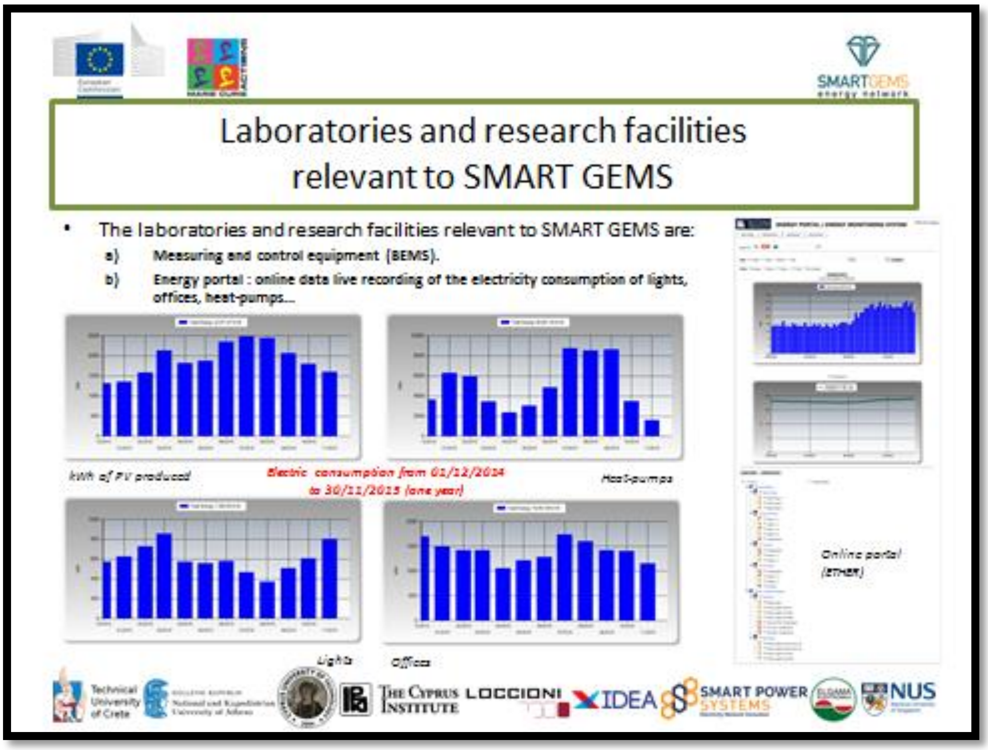
Meeting nzeb criteria

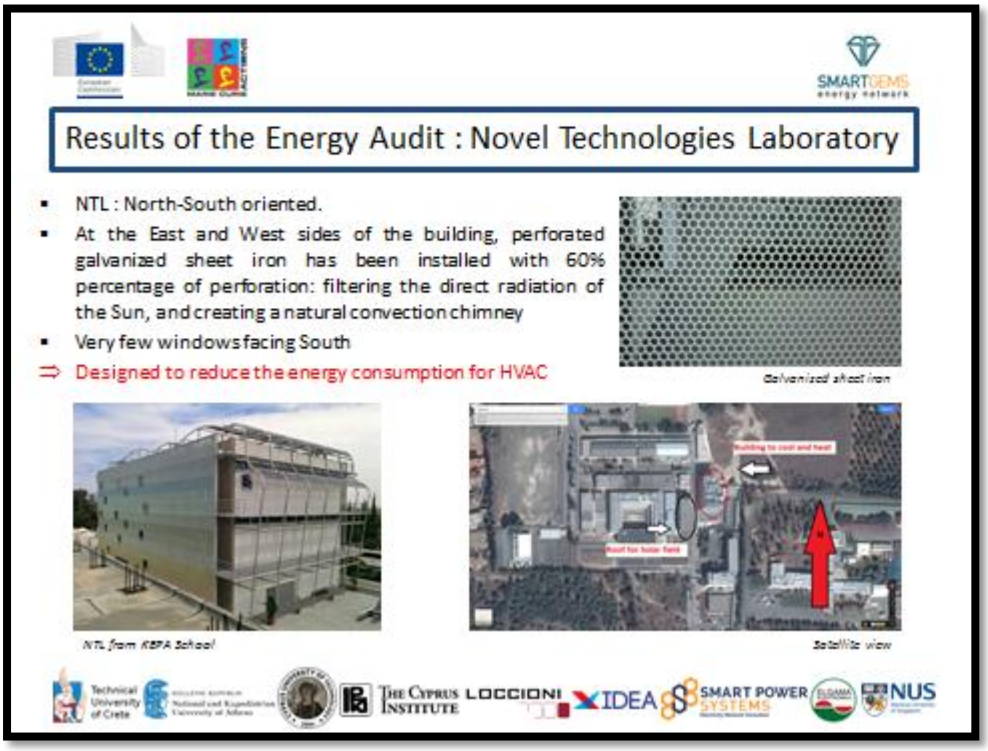
The main orientation of the building is south, which is completely unshaded by other surrounding buildings. The building has no openings in the southfacing wall, while the western and eastern facades are protected by an external metal cover.

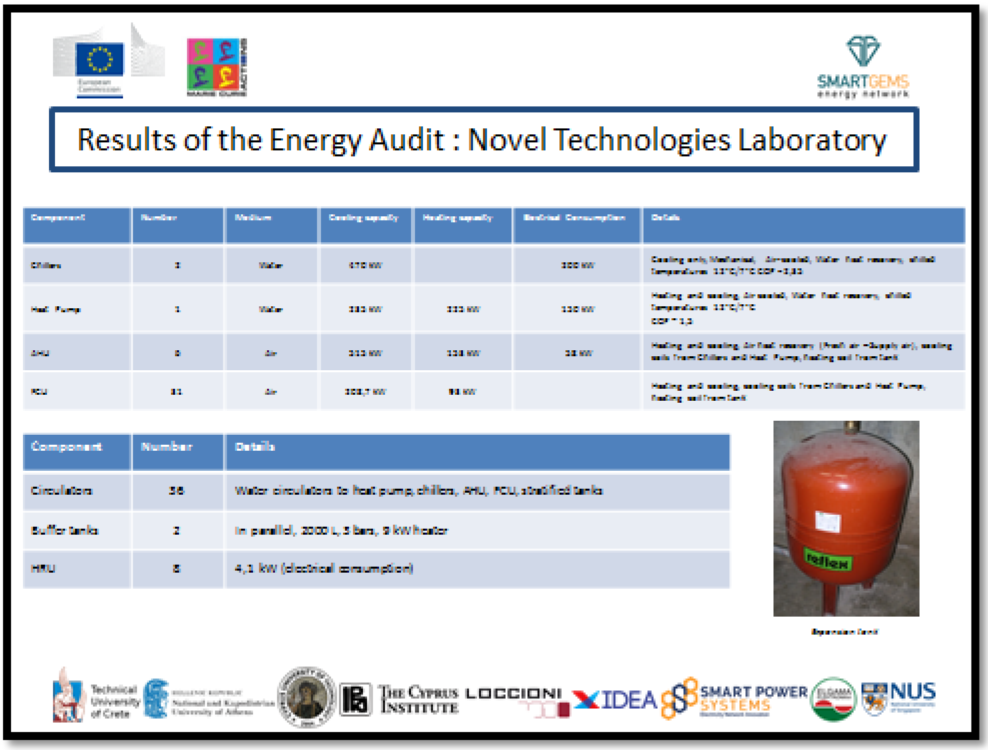
Energy design and characteristics

Main objectives of the design were:

- Usage of sustainable energy sources
- Reduction of the concentration of the emitted pollutants.
- Provision of thermal and visual comfort while staying indoors.
- Improvement of the outdoor microclimate.
- Provision of the best possible indoor air quality.
- Usage of renewable energy sources.
- Usage of intelligent metering and control systems in the building.
- Usage of environmentally friendly materials for the construction and maintenance of the spaces, in order to avoid pollution.


Laboratories and research facilities relevant to SMART GEMS
The laboratories and research facilities relevant to SMART GEMS are:
a) Measuring and control equipment (BEMS).
b) Energy portal : online data live recording of the electricity consumption of lights, offices, heat-pumps...
kWh of PV produced
Electric consumption from 01/12/2014 to 30/11/2015 (one year)
Heat-pumps
Lights
Offices
Online portal (ETHER)


Results of the Energy Audit : Novel Technologies Laboratory
NTL : North-South oriented.
At the East and West sides of the building, perforated galvanized sheet iron has been installed with 60% percentage of perforation: filtering the direct radiation of the Sun, and creating a natural convection chimney
Very few windows facing South
⇒ Designed to reduce the energy consumption for HVAC
Galvanized sheet iron
NTL from KEPA School
Satellite view


SMARTGEMS energy network
Results of the Energy Audit : Novel Technologies Laboratory
Component | Number | Details
Circulators | 56 | Water circulators to heat pump, chillers, AHU, FCU, stratified tanks
Buffer tanks | 2 | In parallel, 2000 L, 5 bars, 9 kW heater
HRU | 8 | 4,1 kW (electrical consumption)
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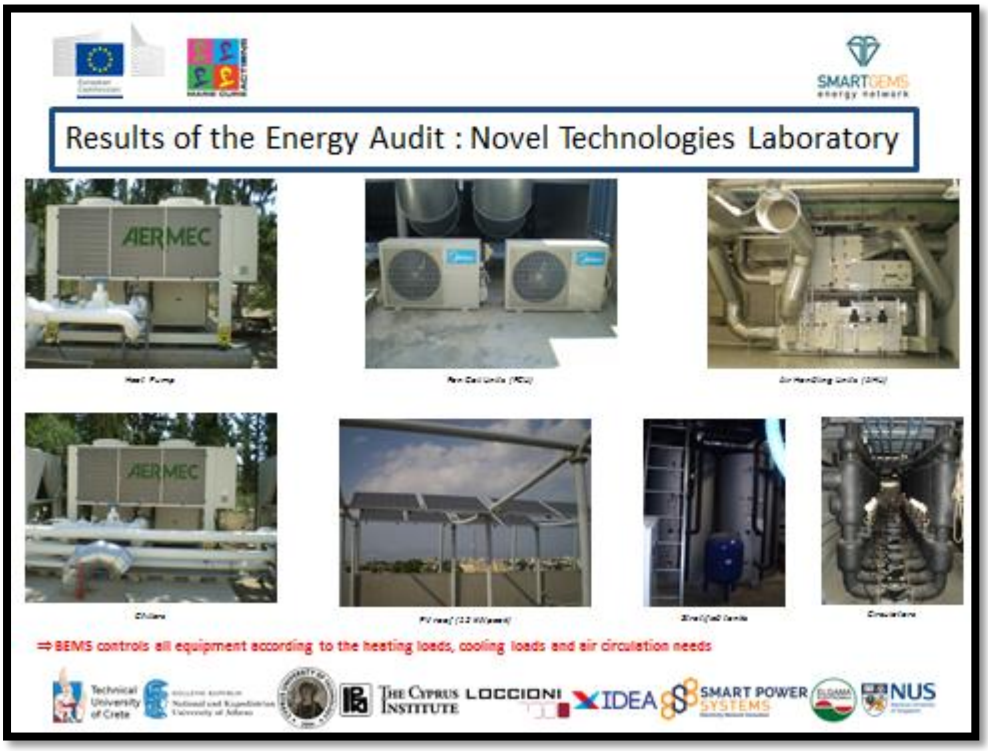
SMARTGEMS energy network
Results of the Energy Audit : Novel Technologies Laboratory
AERMEC
⇒ BEMS controls all equipment according to the heating loads, cooling loads and air circulation needs
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Results of the Energy Audit : Instrumentation

Floor	Area [m²]	Height [m]	Volume [m³]
Basement	930.0	5.5	5115.0
Ground	420.0	5.0	2100.0
First	420.0	4.75	1995.0
Second	420.0	4.75	1995.0
Total	2190.0		11205

Rooms of the NTL

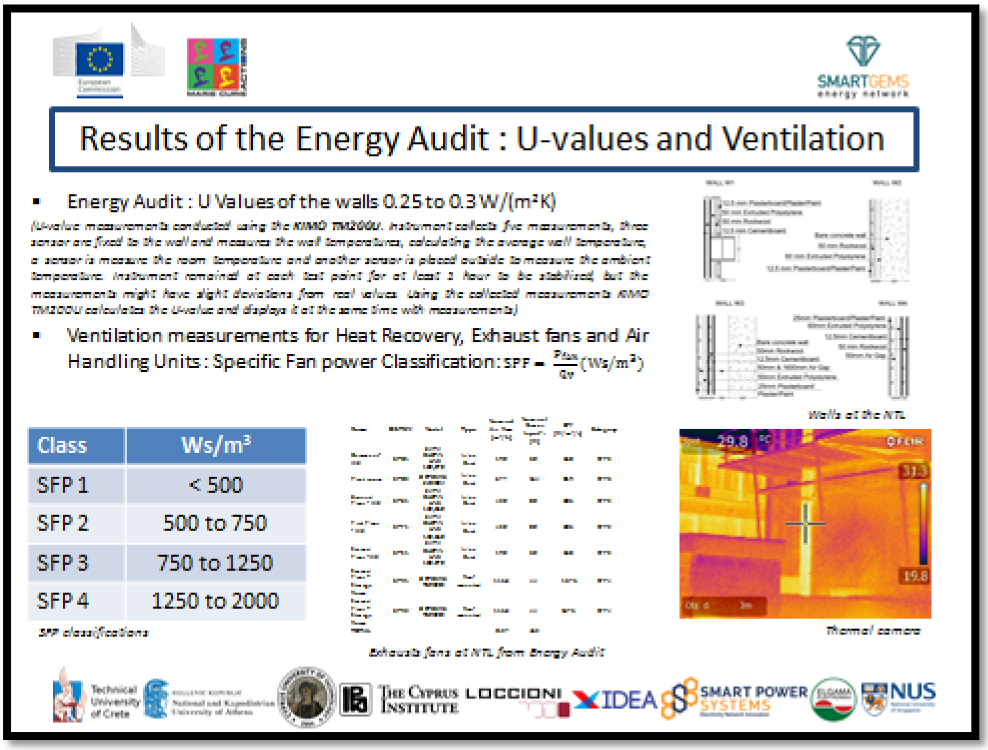
Instruments	Description	Calibration Certificate
KIMO TM200U	Portable instrument. Measures and records three surface temperatures, indoor and outdoor temperatures. It also calculates the U-value.	YES
EXTEXH HD450	Measures the lighting intense (Lux & Fc)	NO (Calibration before the measurement)
FLIR E30	Thermal image camera. Suitable for surveying building, mechanical and electrical applications	YES
ESIS CENTRE 313	Measures environment temperature and humidity	YES
EXTECH AN100	Anemometer. Measures air velocity and air flow	NO (Calibration before the measurement)

Instruments used for the Audit

Results of the Energy Audit : Standards

The energy audit was performed in September 2014 according to the following standards:

Standard	Description
EN 16247-1:2012	Energy audits – Part 1: General requirements
EN 15239:2007	Ventilation for buildings – Energy performance of buildings – Guidelines for inspection of ventilation systems
EN 15240	Ventilation for buildings – Energy performance of buildings – Guidelines for inspection of air-conditioning systems
K.Π.Α. 171/2012	Technical Guide of Energy Audits
EN15251:2007	Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.
EN 15193	Energy performance of buildings – Energy requirements for lighting
EN 15251	Indoor environmental input parameters for design and assessment of energy performance of buildings – addressing indoor air quality, thermal environment, lighting and acoustics
C.I.B.S GUIDE B	Heating, Ventilating, Air Conditioning and Refrigeration
EN 13779	Ventilation for non-residential building – Performance requirements for ventilation and room-conditioning systems
EN 15459	Energy efficiency for buildings – standard economic evaluation procedure for energy systems in buildings
EN 12464-1	Light and lighting – Lighting of work places – Part 1: Indoor work places
ISO 7730:2005	Ergonomics of thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort
ASHRAE 90.1-2007	Energy Standard for Buildings Except Low-Rise Residential Buildings


SMARTGEMS energy network
Results of the Energy Audit : U-values and Ventilation
Energy Audit : U Values of the walls 0.25 to 0.3 W/(m²K)
(U-value measurements conducted using the KIMO TM200U. Instrument collects five measurements, three sensor are fixed to the wall and measures the wall temperatures, calculating the average wall temperature, a sensor is measure the room temperature and another sensor is placed outside to measure the ambient temperature. Instrument remained at each test point for at least 1 hour to be stabilized, but the measurements might have slight deviations from real values. Using the collected measurements KIMO TM200U calculates the U-value and displays it at the same time with measurements)
Ventilation measurements for Heat Recovery, Exhaust fans and Air Handling Units : Specific Fan power Classification: SPF = Pfan/qv (Ws/m³)
Class | Ws/m³
SFP 1 | < 500
SFP 2 | 500 to 750
SFP 3 | 750 to 1250
SFP 4 | 1250 to 2000
SFP classifications
Exhausts fans at NTL from Energy Audit
Walls at the NTL
Thermal camera
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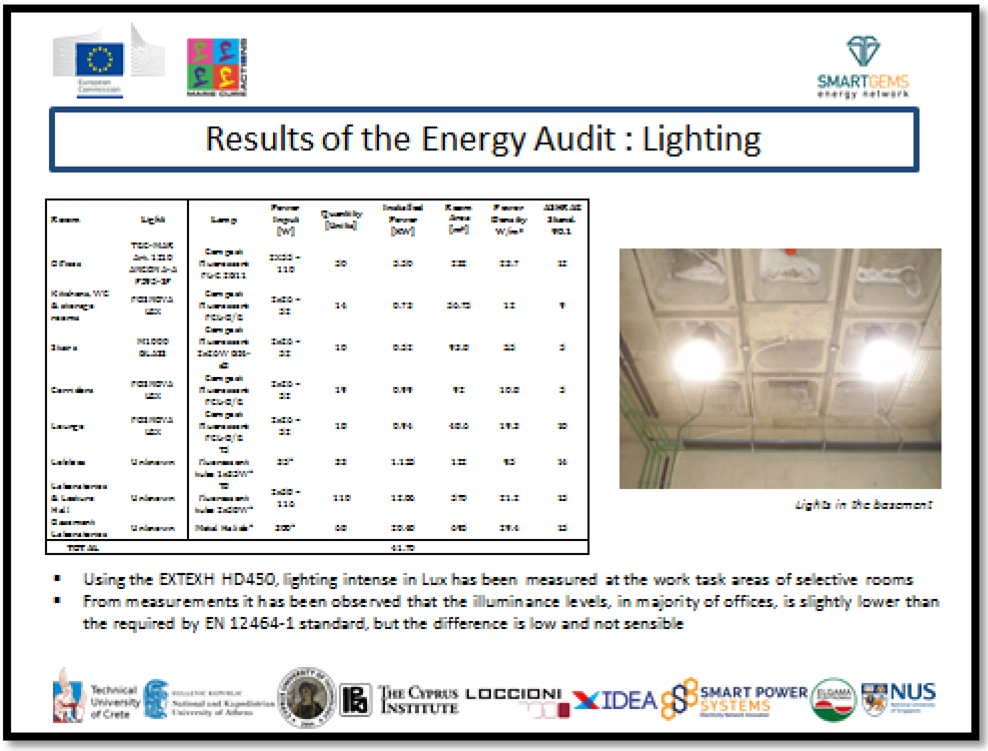
SMARTGEMS energy network
Results of the Energy Audit : Lighting
Lights in the basement
Using the EXTEXH HD450, lighting intense in Lux has been measured at the work task areas of selective rooms
From measurements it has been observed that the illuminance levels, in majority of offices, is slightly lower than the required by EN 12464-1 standard, but the difference is low and not sensible
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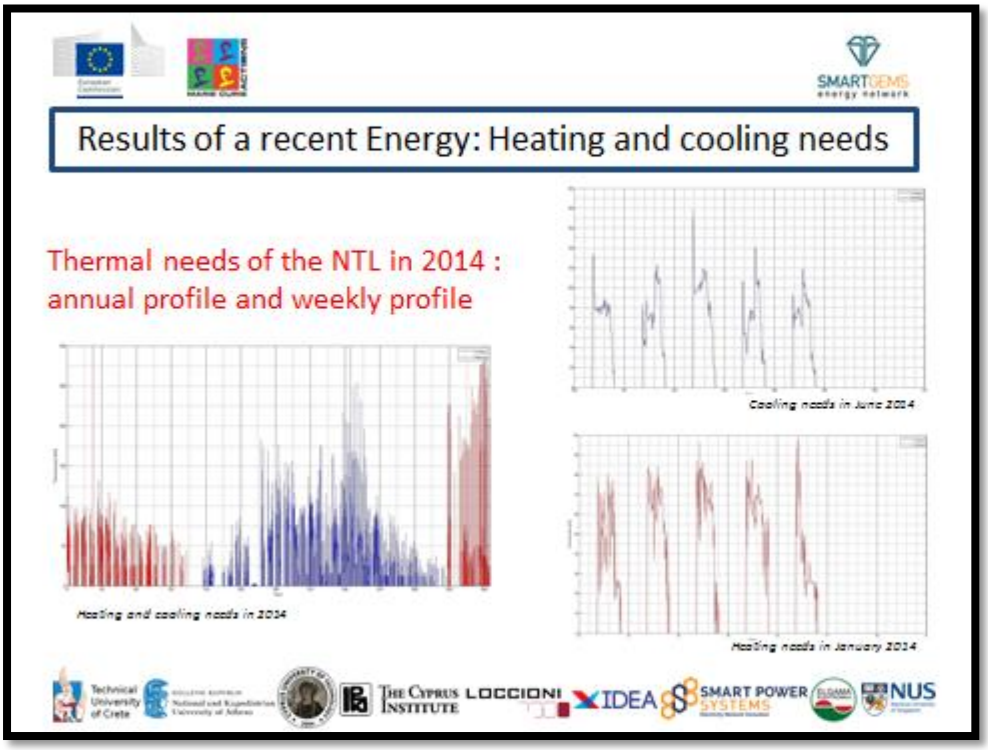
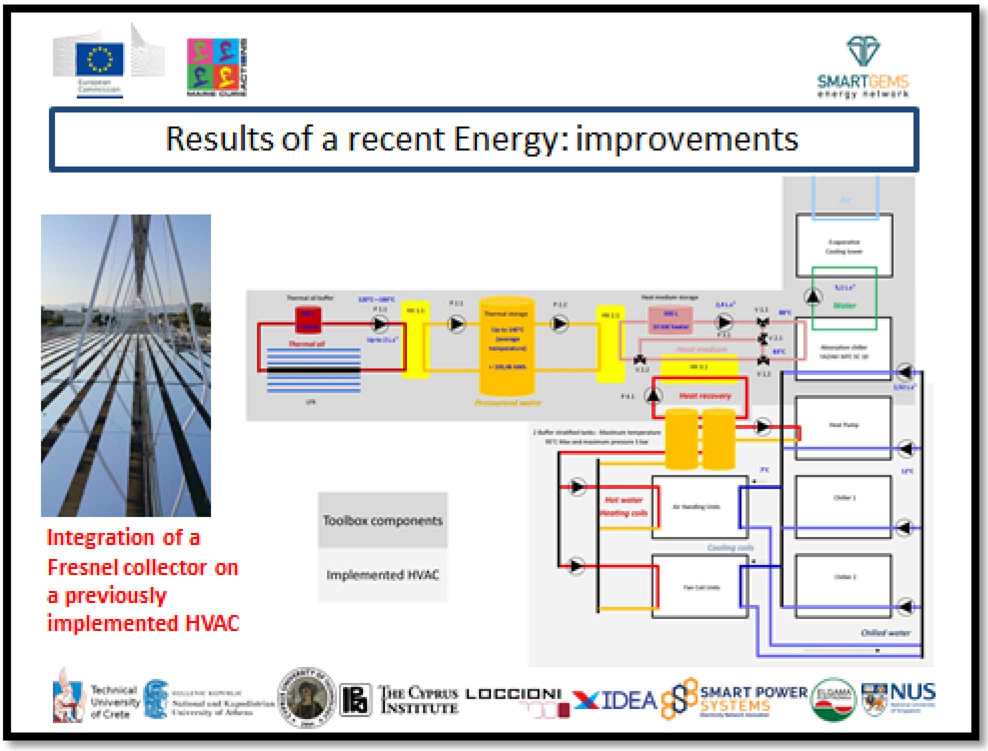

Results of a recent Energy: Heating and cooling needs
Thermal needs of the NTL in 2014 :
annual profile and weekly profile
Cooling needs in June 2014
Heating and cooling needs in 2014
Heating needs in January 2014


Results of a recent Energy: improvements
Integration of a
Fresnel collector on
a previously
implemented HVAC
Toolbox components
Implemented HVAC


SMARTGEMS energy network
Solar thermal power system (Linear Fresnel collector)
Flat mirrors (18 rows, 32 meters long)
Low area density (≈ 25 kg/m²)
Low wind load
Fixed on the roof (beams and pads)
8 Collectors in series (one receiver)
North-South orientation (KEPA School)
Thermal oil (180°C) as heat fluid
Power: Up to 75 thermal KW
End of installation in July 2015, first installation in Cyprus
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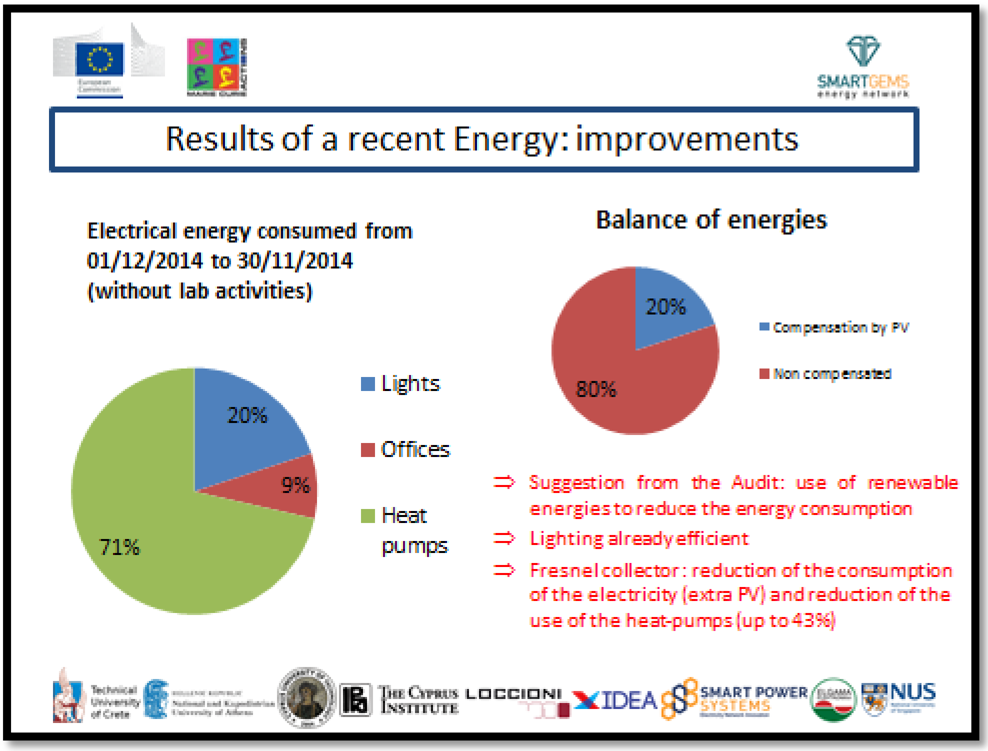
SMARTGEMS energy network
Results of a recent Energy: improvements
Electrical energy consumed from 01/12/2014 to 30/11/2014 (without lab activities)
20%
9%
71%
Lights
Offices
Heat pumps
Balance of energies
20%
80%
Compensation by PV
Non compensated
Suggestion from the Audit: use of renewable energies to reduce the energy consumption
Lighting already efficient
Fresnel collector: reduction of the consumption of the electricity (extra PV) and reduction of the use of the heat-pumps (up to 43%)
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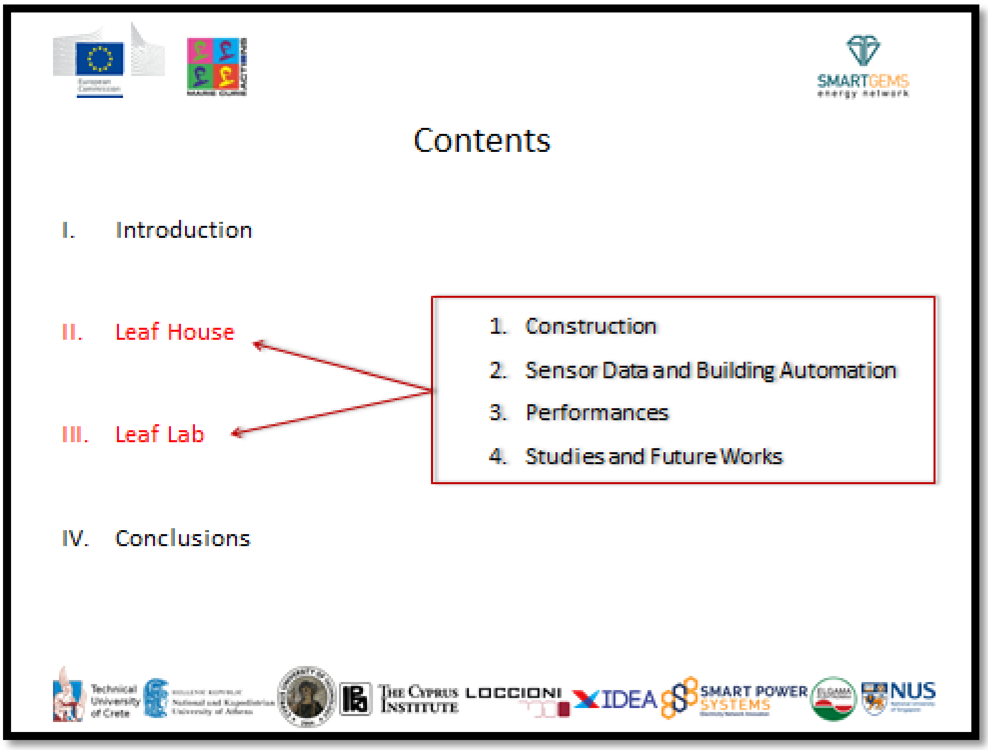
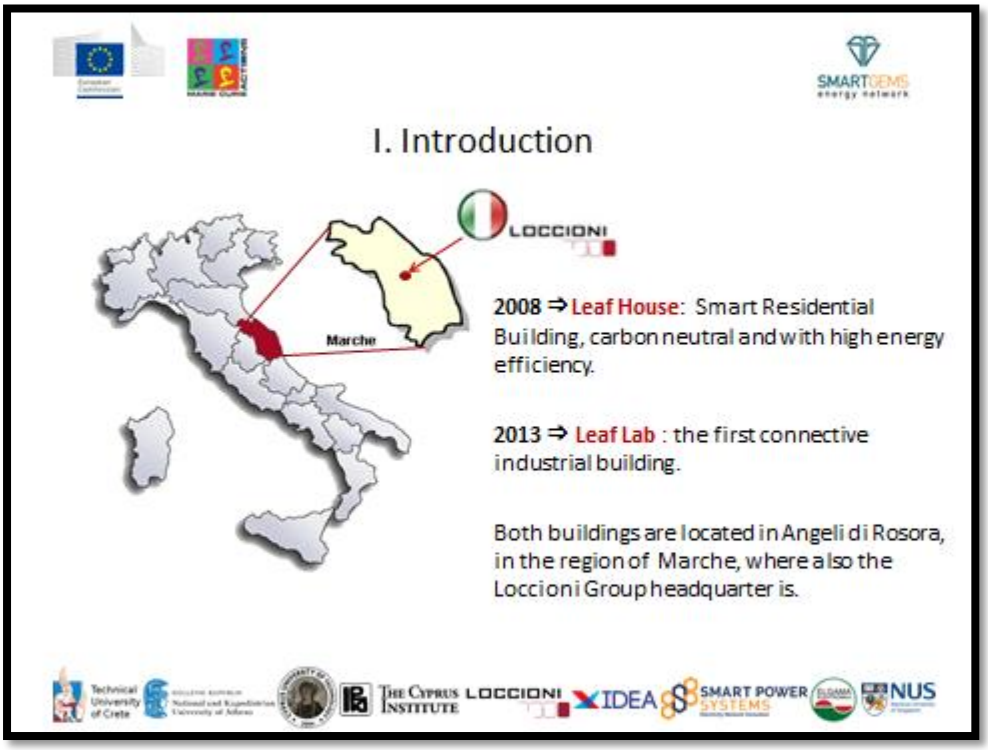
Conclusions

- The preliminary design of the NTL (South orientation, windows, grids, PV panels) permits to reduce avoidable energy consumption by the end-user
- The energy Audit identified the points to be improved : insulation and use of renewable energies
- Cooling and Heating needs are responsible of a great part of the electric consumption in Cyprus
- Using a Fresnel collector permits to reduce the electricity consumption, using less heat-pumps

Thank you for your attention

Annex IV: Slides of the 4th Webinar - A case study of a smart ZEB: The LEAF House organised by AEA




I. Introduction
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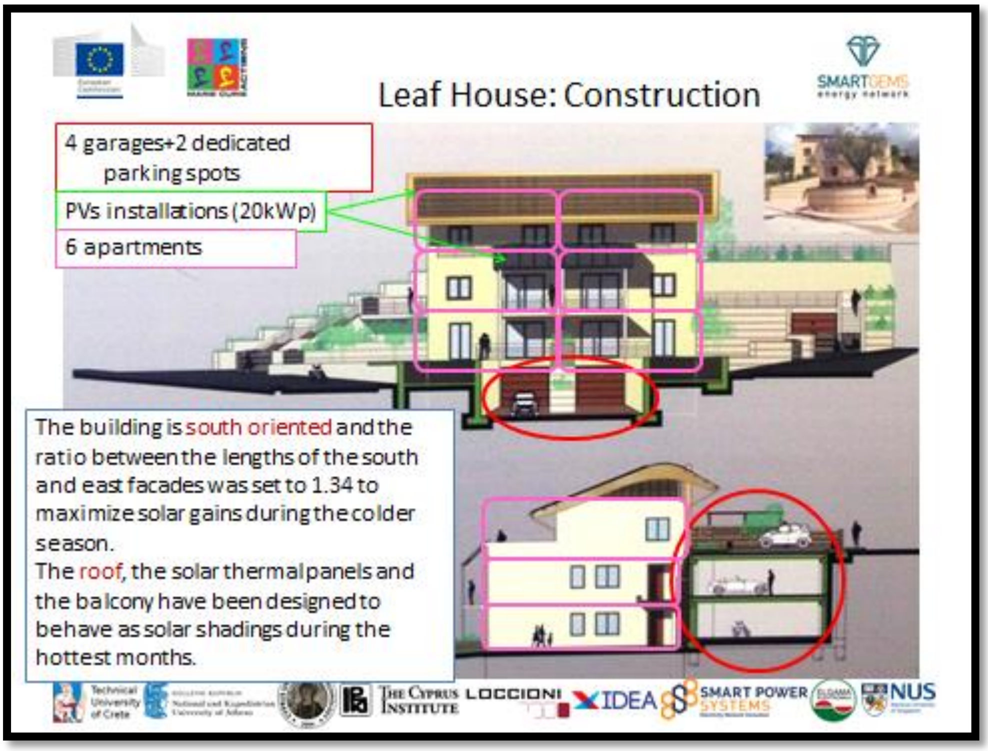
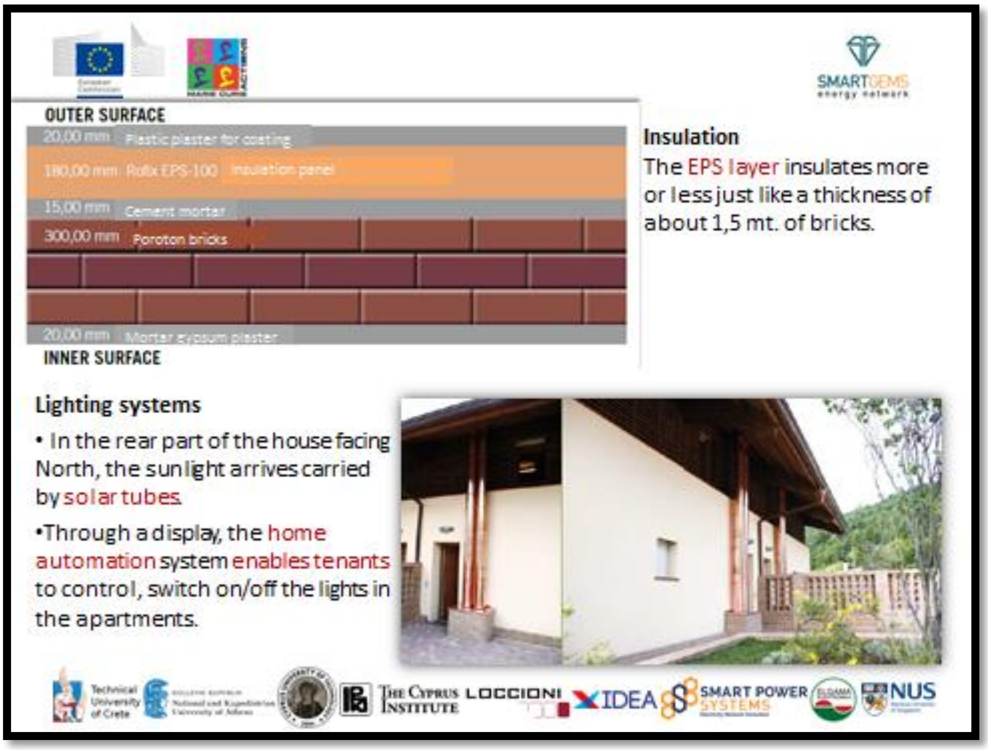
Marche
2008 ⇒ Leaf House: Smart Residential Building, carbon neutral and with high energy efficiency.
2013 ⇒ Leaf Lab : the first connective industrial building.
Both buildings are located in Angeli di Rosora, in the region of Marche, where also the Loccioni Group headquarter is.


II. Leaf House
From the typical farmhouse in Marche seen as an autonomous and sustainable microcosm where every resource was exploited and nothing wasted...
..to the Leaf House.


The Leaf House is a residential building designed and constructed in the view of minimizing energy consumption and emissions.
It comprises:
• 6 apartments,
• 8 persons regularly living in 4 of these apartments,
• 2 guest apartments.
The Leaf House is seen as an open laboratory:
✓ many researchers have been working on it,
✓ changes and upgrades have been often made.
This project was supported by the Loccioni Group and sponsored by many partners, both industrial and academic.


Leaf House: Construction
4 garages+2 dedicated parking spots
PVs installations (20kWp)
6 apartments
The building is south oriented and the ratio between the lengths of the south and east facades was set to 1.34 to maximize solar gains during the colder season.
The roof, the solar thermal panels and the balcony have been designed to behave as solar shadings during the hottest months.


OUTER SURFACE
20,00 mm Plastic plaster for coating
180,00 mm Rofix EPS-100 Insulation panel
15,00 mm Cement mortar
300,00 mm Poroton bricks
20,00 mm Mortar gypsum plaster
INNER SURFACE
Insulation
The EPS layer insulates more or less just like a thickness of about 1,5 mt. of bricks.
Lighting systems
• In the rear part of the house facing North, the sunlight arrives carried by solar tubes.
•Through a display, the home automation system enables tenants to control, switch on/off the lights in the apartments.


Water Collecting System and Treatment
• The rain water is collected in a tank dug under the garden and reused for domestic purposes and for irrigation.
• The water is also pre-treated in the kitchens to make it completely pure and drinkable (sink with three-way valve: hot, cold, drinkable).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energy network
Leaf House: Thermal & Electrical Equipment
Geothermal Heat Pump
Control area
Hot water boiler
Air Handling Unit
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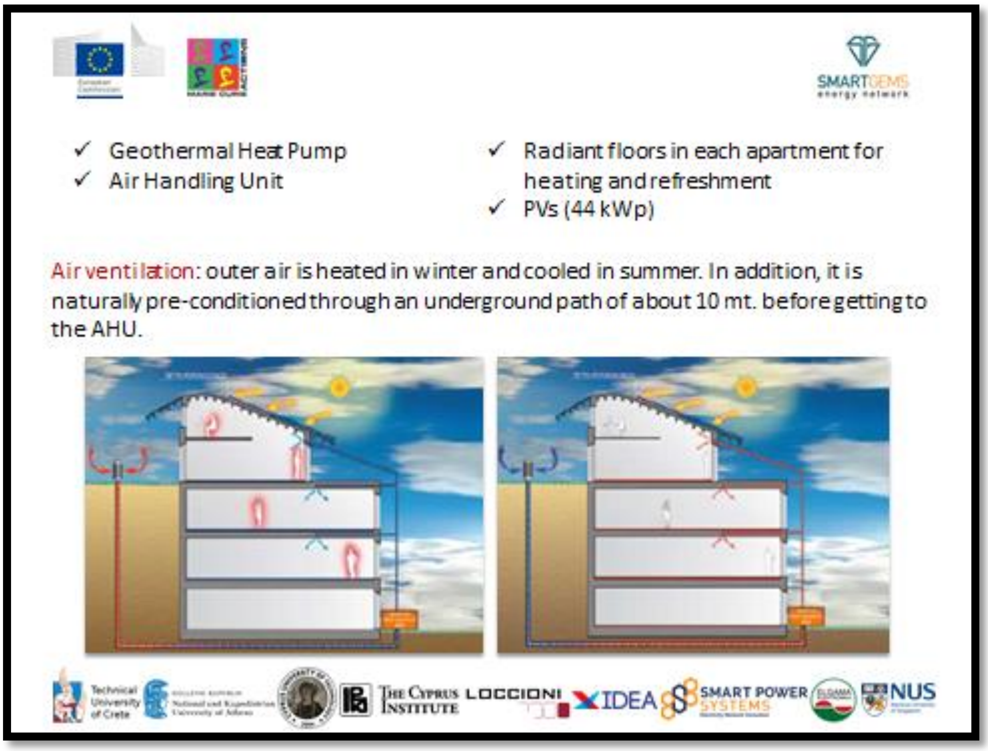
SMARTGEMS
energy network
Geothermal Heat Pump
Air Handling Unit
Radiant floors in each apartment for heating and refreshment
PVs (44 kWp)
Air ventilation: outer air is heated in winter and cooled in summer. In addition, it is naturally pre-conditioned through an underground path of about 10 mt. before getting to the AHU.
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SMARTGEMS
energy network
Leaf House: Sensor Data & Building Automation
About 1000 sensors installed:
• indoor comfort (temperature, humidity, CO2)
• thermal and electrical measures,
• energy consumption,
• rain water level.
Building Automation: each apartment has a display that enables tenants to:
▪ set the desired temperature in the apartment,
▪ monitor lights,
▪ check windows/doors open,
▪ see energy consumptions.
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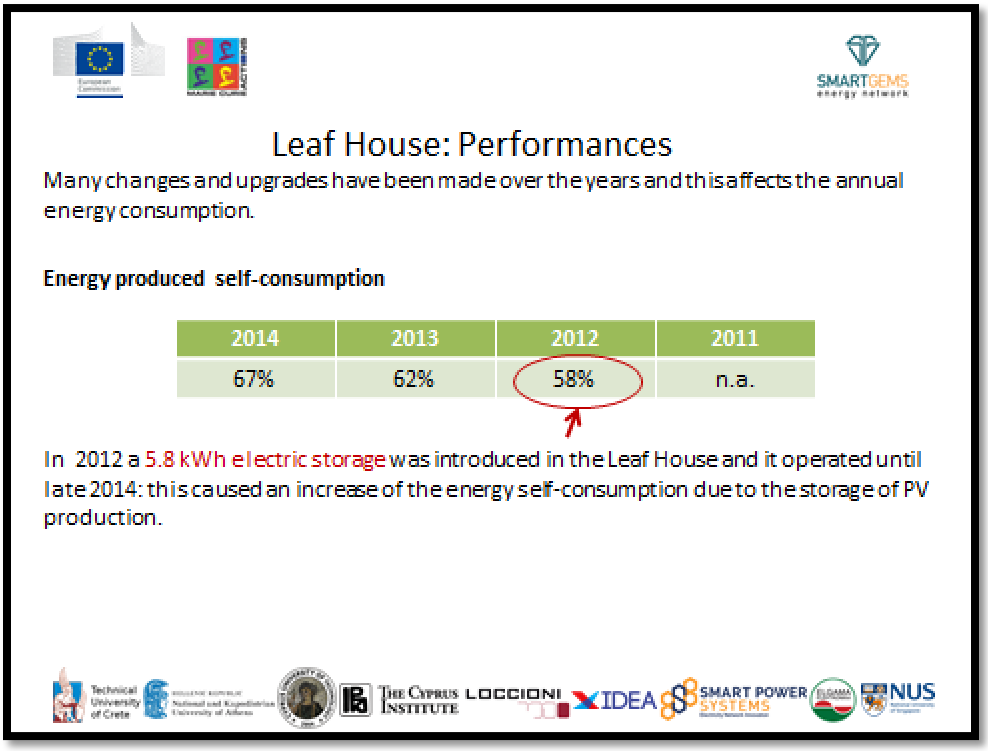
SMARTGEMS
energy network
Leaf House: Performances
Many changes and upgrades have been made over the years and this affects the annual energy consumption.
Energy produced self-consumption
2014 2013 2012 2011
67% 62% 58% n.a.
In 2012 a 5.8 kWh electric storage was introduced in the Leaf House and it operated until late 2014: this caused an increase of the energy self-consumption due to the storage of PV production.
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Water consumption

The annual water consumption for a family, consisting of three people, in Italy is about 130m3.

The Leaf house has 8 people regularly living there + 2 guests apartments for 4 people and the water consumptions are:

2014	2013	2012	2011
227 m3	183 m3	229 m3	n.a.

- Italy: 1 Family with 3 persons = 130m3/year
- Leaf House: 6 persons +2/4 occasional guests = about 220 m3/year.

Studies

The Leaf House has attracted much interest:

- journal and conference papers, MSc and PhD thesis regarding modeling and advanced control techniques applied to both one single apartment and the overall building,
- participation at Task 40 'Net Zero Energy Buildings' joint project SHC Task 40 /ECBCS Annex 52 by International Energy Agency.


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III. Leaf Lab
The Leaf Lab is a high-performance productive building that has been built to live in symbiosis with the surrounding environment.
Architectural and engineering choices allow to ensure:
• comfort of people while working
• low management costs
• investment costs comparable with traditional buildings (about 20 % more)
• 6.000 m²
• A + Energy efficiency ratio
• 4 kWh/m³ annual energy consumption
• Natural gas independence


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Leaf Lab: Construction
The rooftop PV installation of 235 kWp allows energy production from renewable sources.
The electric and thermal energy storage systems enable energy fluxes optimization:
- Peak shaving
- Time shifting

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Leaf Lab: Thermal and Electrical Equipments

Free cooling: during the night, when external temperature is lower than the internal one, air exchange is activated:

- mechanical exchange: office area
- natural exchange: production area, through automatic shed opening

This allows consumption savings for cooling up to 10%.

Natural cooling: during summer, the energy demand for conditioning in the office area is satisfied by directly utilizing the terminals of ground water.

Accordingly, heat pumps are not used and energy savings increase up to 20% for cooling.

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3 ground water heat pumps generate the energy necessary for the building heating and cooling.

Lighting system comprises led dimmable lights, presence detector, and illuminance sensors.

- Artificial lights are regulating according to external daylight,
- Lights are switched on/off if a presence is detected in the room,
- Energy consumption reduced up to 66%

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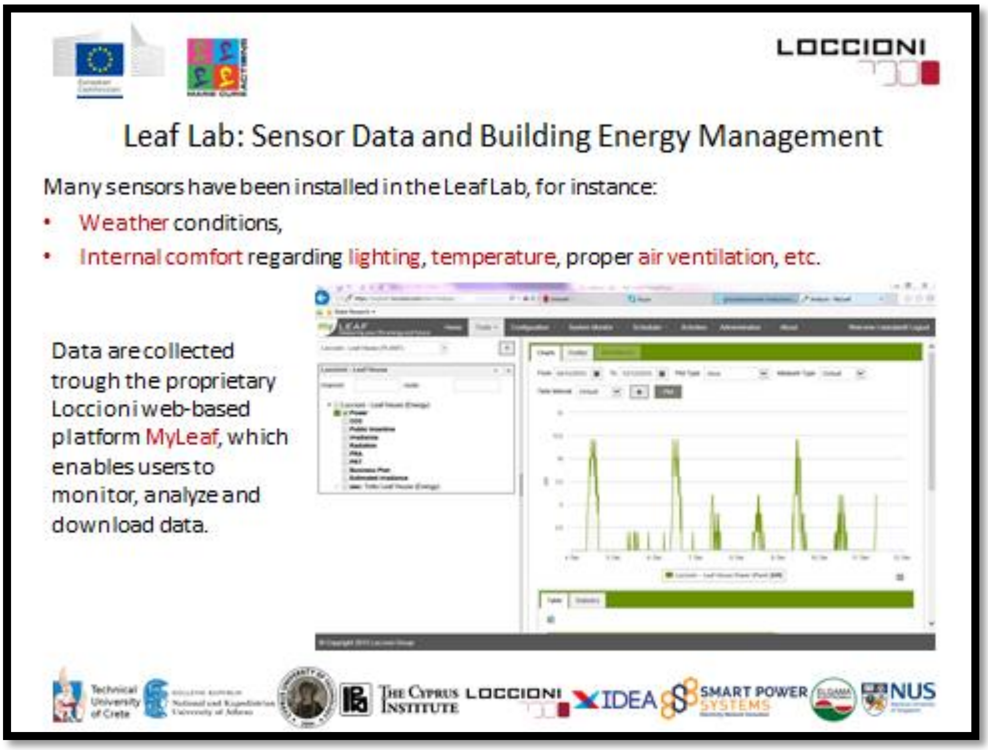
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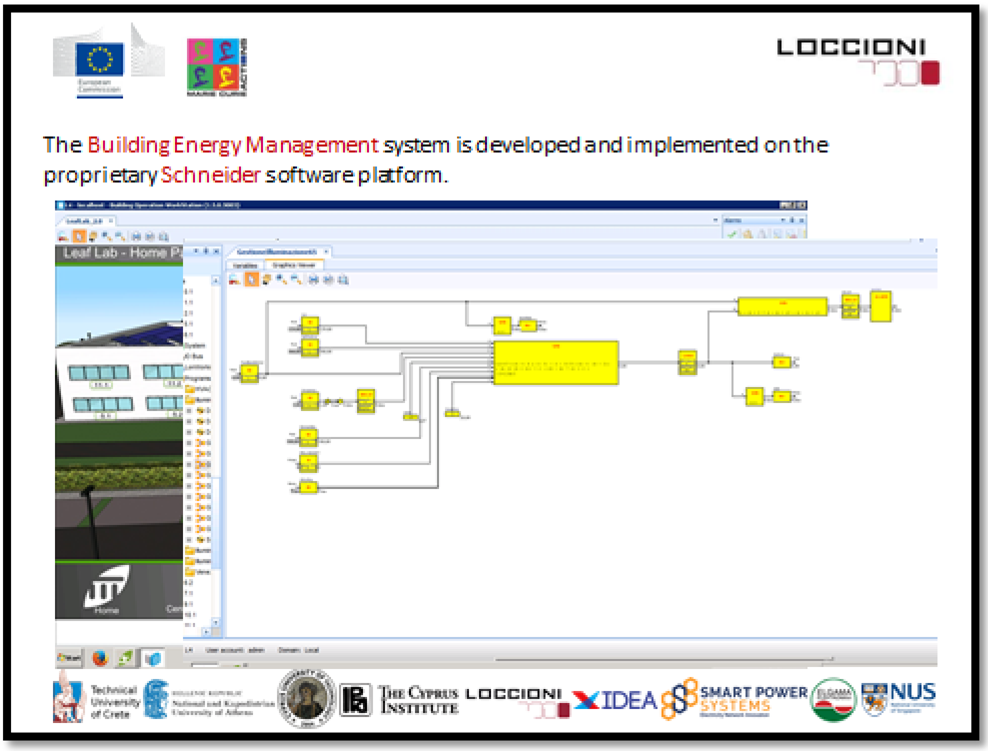
Leaf Lab: Sensor Data and Building Energy Management
Many sensors have been installed in the Leaf Lab, for instance:
• Weather conditions,
• Internal comfort regarding lighting, temperature, proper air ventilation, etc.
Data are collected trough the proprietary Loccioni web-based platform MyLeaf, which enables users to monitor, analyze and download data.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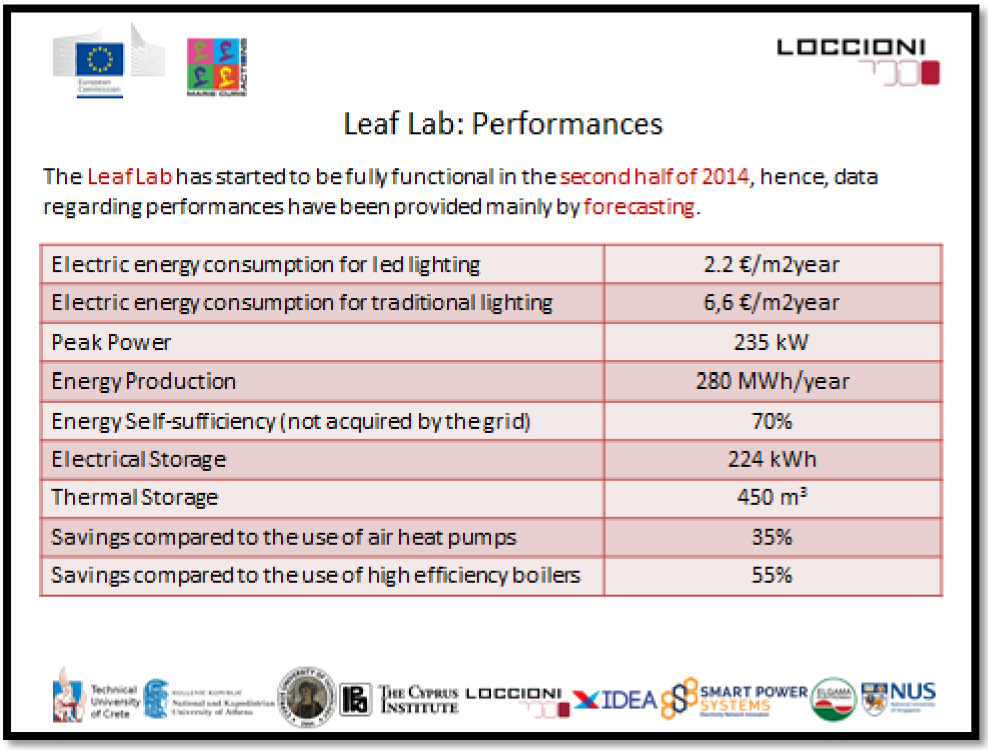
The Building Energy Management system is developed and implemented on the proprietary Schneider software platform.
Leaf Lab - Home P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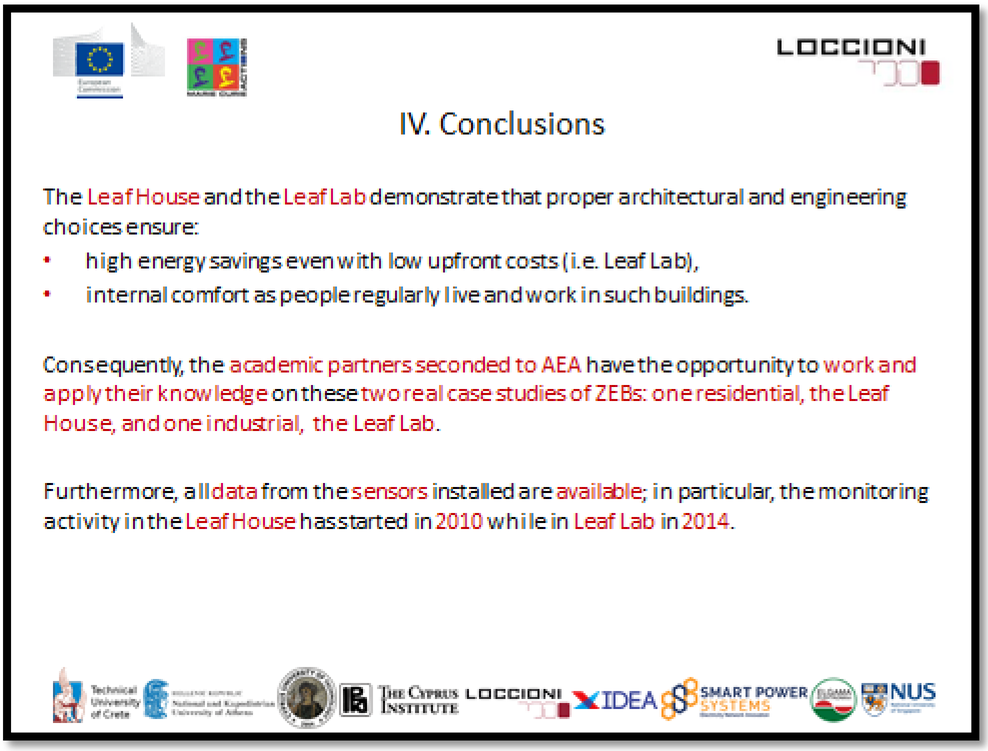
Leaf Lab: Performances
The Leaf Lab has started to be fully functional in the second half of 2014, hence, data regarding performances have been provided mainly by forecasting.
Electric energy consumption for led lighting | 2.2 €/m2year
Electric energy consumption for traditional lighting | 6,6 €/m2year
Peak Power | 235 kW
Energy Production | 280 MWh/year
Energy Self-sufficiency (not acquired by the grid) | 70%
Electrical Storage | 224 kWh
Thermal Storage | 450 m³
Savings compared to the use of air heat pumps | 35%
Savings compared to the use of high efficiency boilers | 55%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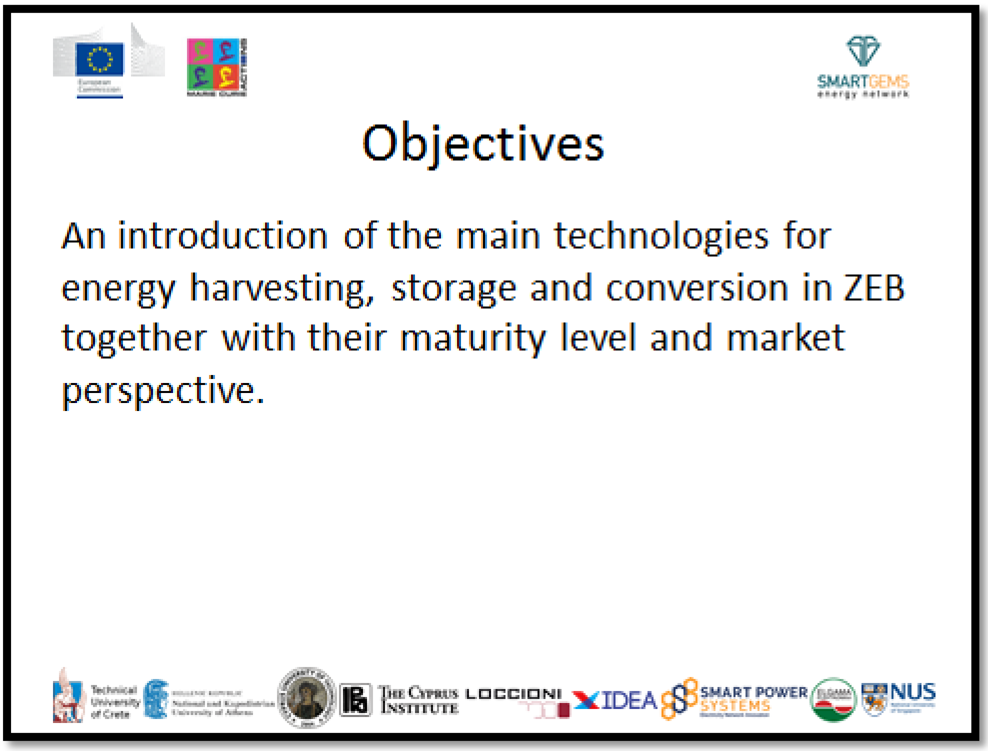
IV. Conclusions
The Leaf House and the Leaf Lab demonstrate that proper architectural and engineering choices ensure:
• high energy savings even with low upfront costs (i.e. Leaf Lab),
• internal comfort as people regularly live and work in such buildings.
Consequently, the academic partners seconded to AEA have the opportunity to work and apply their knowledge on these two real case studies of ZEBs: one residential, the Leaf House, and one industrial, the Leaf Lab.
Furthermore, all data from the sensors installed are available; in particular, the monitoring activity in the Leaf House has started in 2010 while in Leaf Lab in 2014.


2016
Happy New Year
Merry Christmas

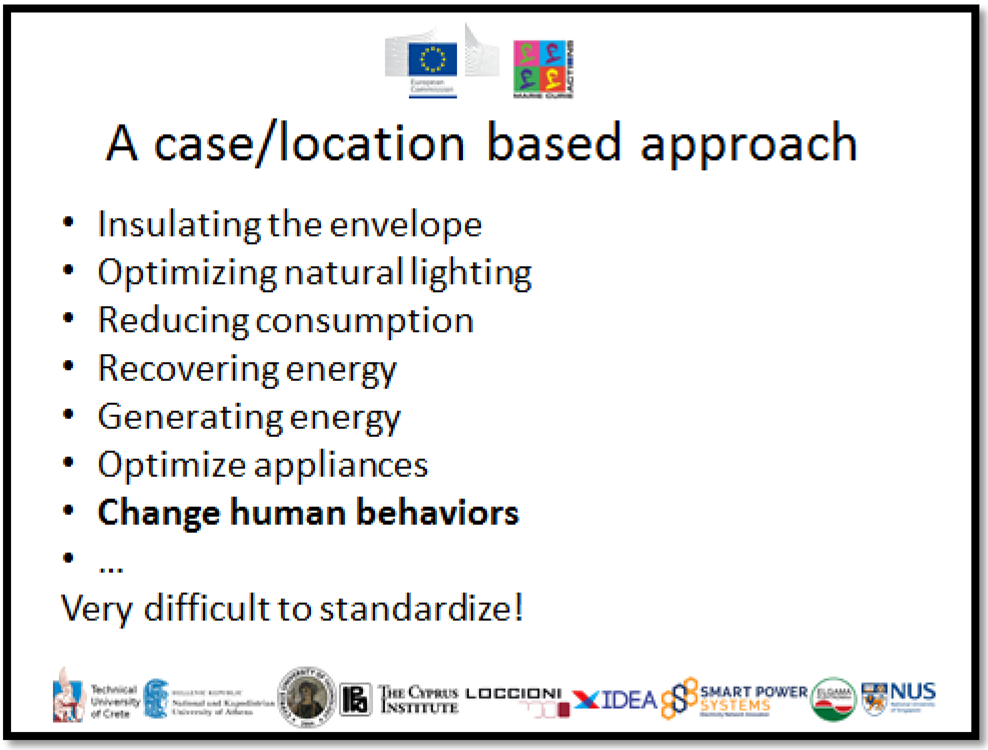
Annex V: Slides of the 5th Webinar - The ZEB buildings technology market organised by IDEA.

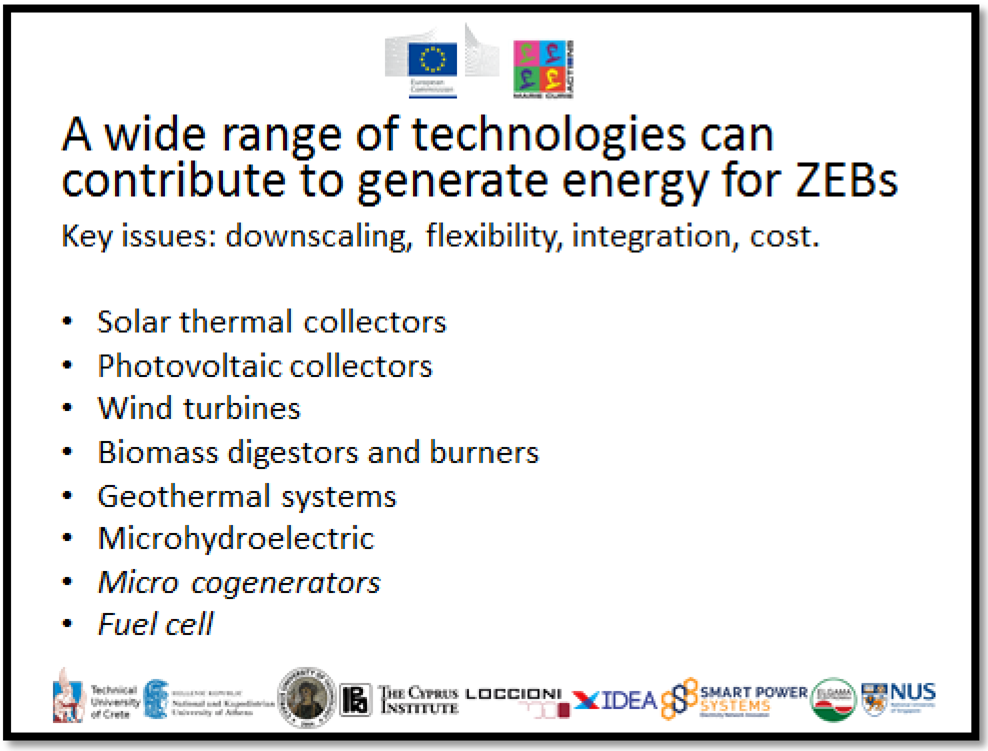


Methodology

- Introduction: an holistic overview of the ZEB technologies.
- Energy harvesting technologies at a ZEB scale.
- Building integrated energy storage: electrical and thermal solutions.
- Energy mix for a ZEB: suitable energy conversion devices.
- Role of control systems and smart appliances.
- TRL of ZEB technologies, industrial and market trends.

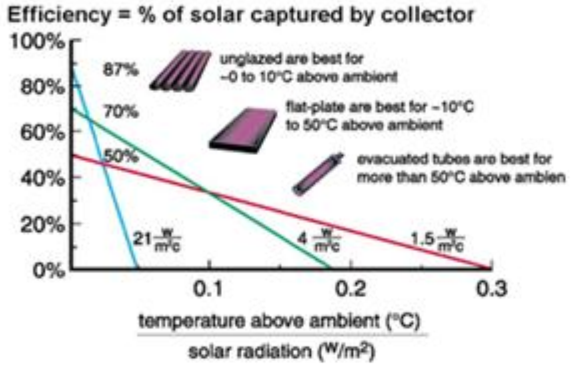
An holistic overview


A case/location based approach
• Insulating the envelope
• Optimizing natural lighting
• Reducing consumption
• Recovering energy
• Generating energy
• Optimize appliances
• **Change human behaviors**
• ...
Very difficult to standardize!


A wide range of technologies can contribute to generate energy for ZEBs
Key issues: downscaling, flexibility, integration, cost.
• Solar thermal collectors
• Photovoltaic collectors
• Wind turbines
• Biomass digestors and burners
• Geothermal systems
• Microhydroelectric
• *Micro cogenerators*
• *Fuel cell*

Solar thermal collectors

Range of applications/solution for water heating



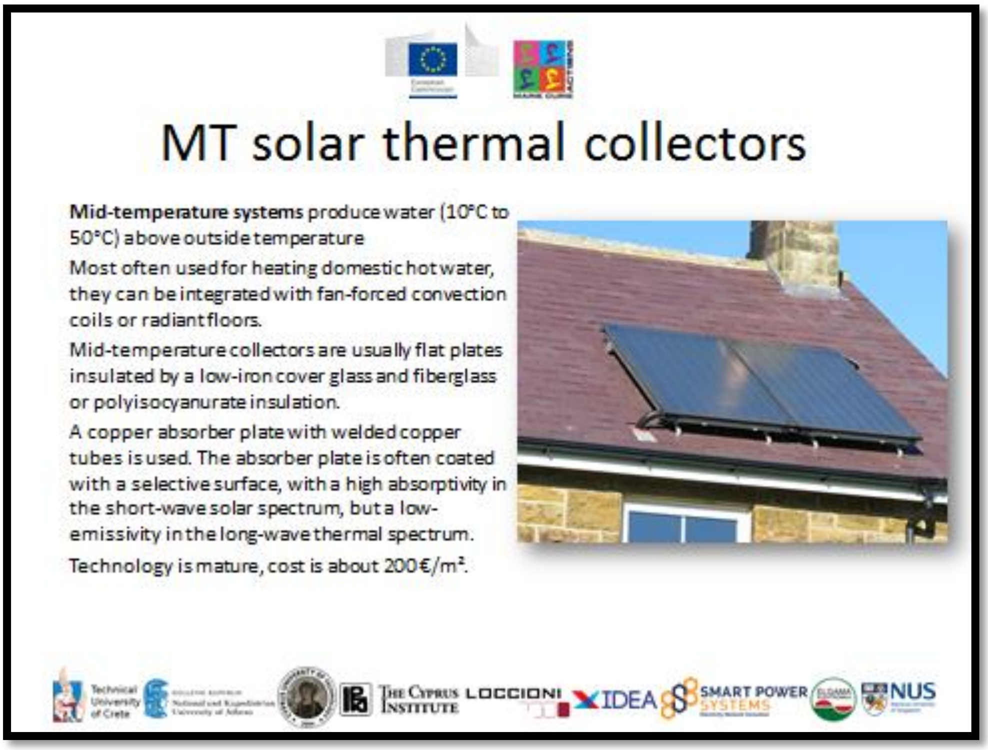
LT solar thermal collectors

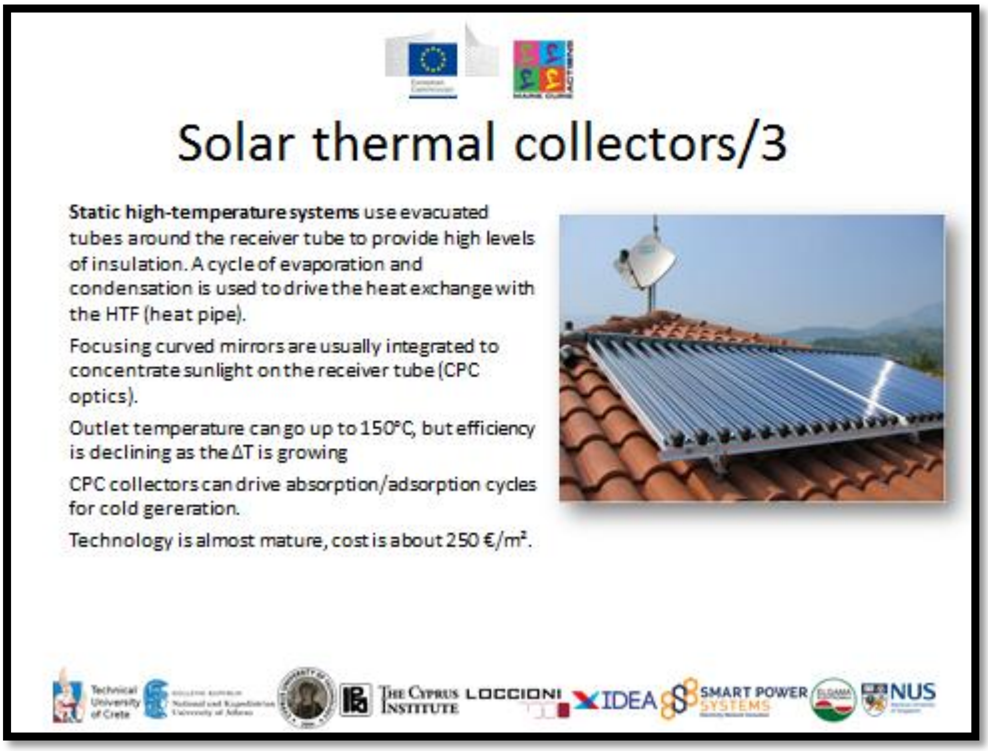
Low-temperature systems are extruded from polypropylene or other polymers with ultraviolet stabilizer.

They usually operate at low temperature, up to 10°C above ambient temperature.

Suitable if large surfaces are available for water pre-heating.

Technology is mature, cost is about 150 €/m².


MT solar thermal collectors
Mid-temperature systems produce water (10°C to 50°C) above outside temperature
Most often used for heating domestic hot water, they can be integrated with fan-forced convection coils or radiant floors.
Mid-temperature collectors are usually flat plates insulated by a low-iron cover glass and fiberglass or polyisocyanurate insulation.
A copper absorber plate with welded copper tubes is used. The absorber plate is often coated with a selective surface, with a high absorptivity in the short-wave solar spectrum, but a low-emissivity in the long-wave thermal spectrum.
Technology is mature, cost is about 200€/m².


Solar thermal collectors/3
Static high-temperature systems use evacuated tubes around the receiver tube to provide high levels of insulation. A cycle of evaporation and condensation is used to drive the heat exchange with the HTF (heat pipe).
Focusing curved mirrors are usually integrated to concentrate sunlight on the receiver tube (CPC optics).
Outlet temperature can go up to 150°C, but efficiency is declining as the ΔT is growing
CPC collectors can drive absorption/adsorption cycles for cold gereration.
Technology is almost mature, cost is about 250 €/m².

HT solar thermal collectors

Solar tracking high-temperature systems are required for absorption cooling or electricity generation, but are also used for industrial heating and mid-temperature applications such as water heating.

Due to the tracking mechanism required to keep the focusing mirrors facing the sun, high-temperature systems are usually large and mounted on suitable rooftops or on the ground adjacent to a facility.

Systems may have PTC, LFC or dish based optics.

Outlet temperature can be high (even 300°C) if an appropriate HTF is used (i.e. diathermic oil).

Technology is still under development, some demonstrative early commercial sites are available.

Cost is about 300 €/m² of collecting surface.

Photovoltaic collectors - PV modules

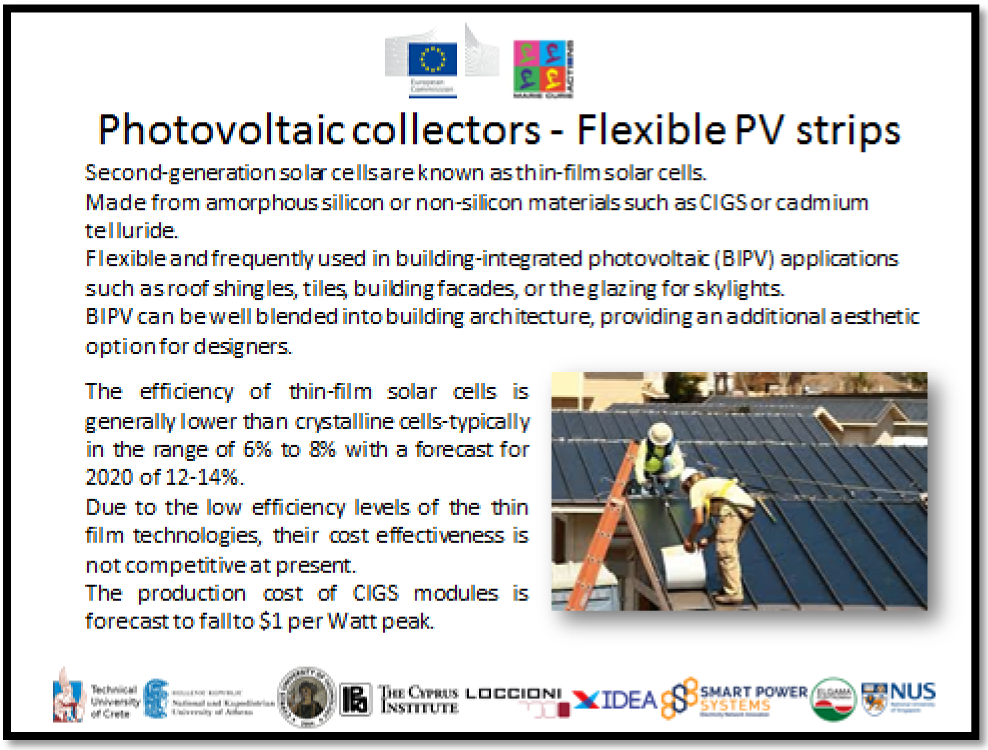
Traditional photovoltaic cells are made from mono and poly crystaline silicon combined and wired together into flat-plate panel modules.

Although photovoltaic modules degrade over time, crystalline-type modules are typically guaranteed through warranties to produce at least 80% of their original power after 20 to 25 years.

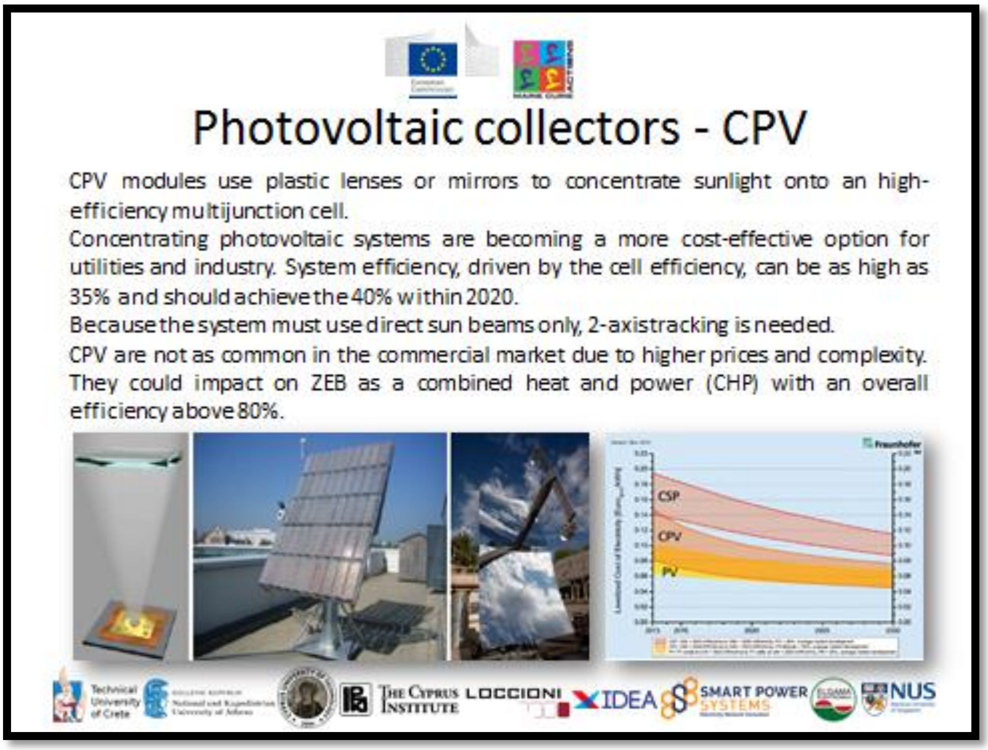
Typical overall electric efficiency of crystalline solar panels is about 15% (up to 20% for double sided panels)

Installation is flexible and it can range from few kW to MW

Costs have dramatically dropped down:
a typical rooftop installation price is 2€/Wep


Photovoltaic collectors - Flexible PV strips
Second-generation solar cells are known as thin-film solar cells.
Made from amorphous silicon or non-silicon materials such as CIGS or cadmium telluride.
Flexible and frequently used in building-integrated photovoltaic (BIPV) applications such as roof shingles, tiles, building facades, or the glazing for skylights.
BIPV can be well blended into building architecture, providing an additional aesthetic option for designers.
The efficiency of thin-film solar cells is generally lower than crystalline cells-typically in the range of 6% to 8% with a forecast for 2020 of 12-14%.
Due to the low efficiency levels of the thin film technologies, their cost effectiveness is not competitive at present.
The production cost of CIGS modules is forecast to fall to $1 per Watt peak.


Photovoltaic collectors – architectural BIPV
An architectural BIPV system consists of solar cells or modules that are integrated in building elements or material as part of the building structure.
They replace a conventional building element, rather than attaching to one.
BIPV modules not only generate electricity, they can also provide added functionality to the building as sun protection, thermal insulation, noise protection or safety.
For example photovoltaic integrated into insulating glass block with third generation solar cells (DSCs) can be applied for outside installations (roofs and façades).
Maturity level is mostly pre-commercial with relevant demo installations.


Photovoltaic collectors - CPV
CPV modules use plastic lenses or mirrors to concentrate sunlight onto an high-efficiency multijunction cell.
Concentrating photovoltaic systems are becoming a more cost-effective option for utilities and industry. System efficiency, driven by the cell efficiency, can be as high as 35% and should achieve the 40% within 2020.
Because the system must use direct sun beams only, 2-axis tracking is needed.
CPV are not as common in the commercial market due to higher prices and complexity.
They could impact on ZEB as a combined heat and power (CHP) with an overall efficiency above 80%.
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CPV
PV
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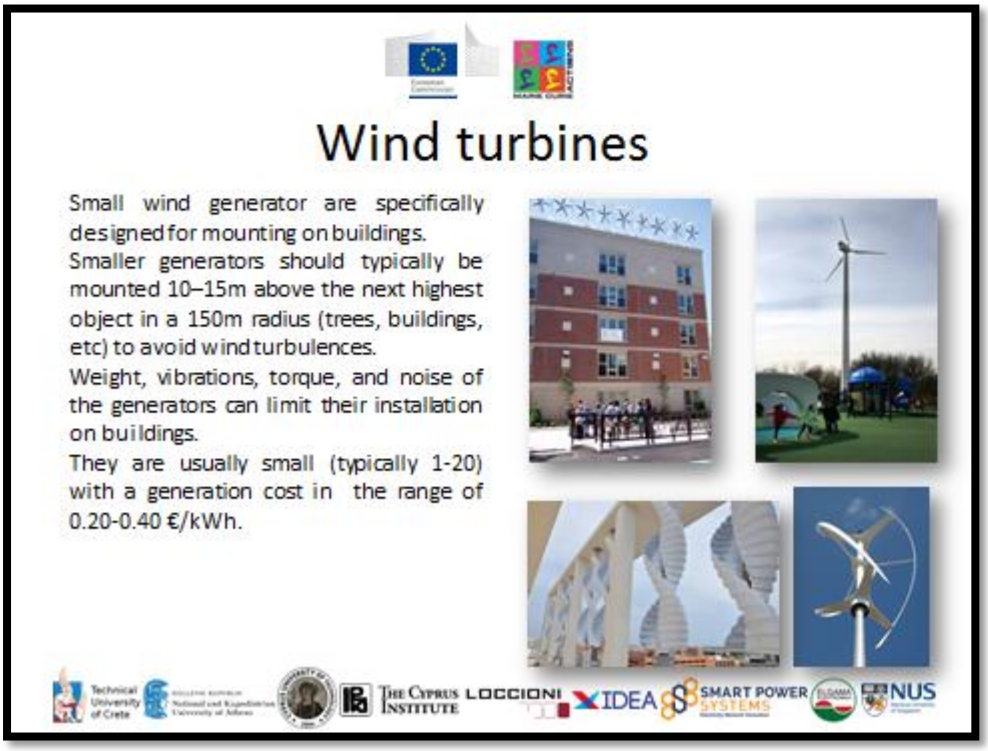
Wind turbines
Small wind generator are specifically designed for mounting on buildings.
Smaller generators should typically be mounted 10–15m above the next highest object in a 150m radius (trees, buildings, etc) to avoid wind turbulences.
Weight, vibrations, torque, and noise of the generators can limit their installation on buildings.
They are usually small (typically 1-20) with a generation cost in the range of 0.20-0.40 €/kWh.
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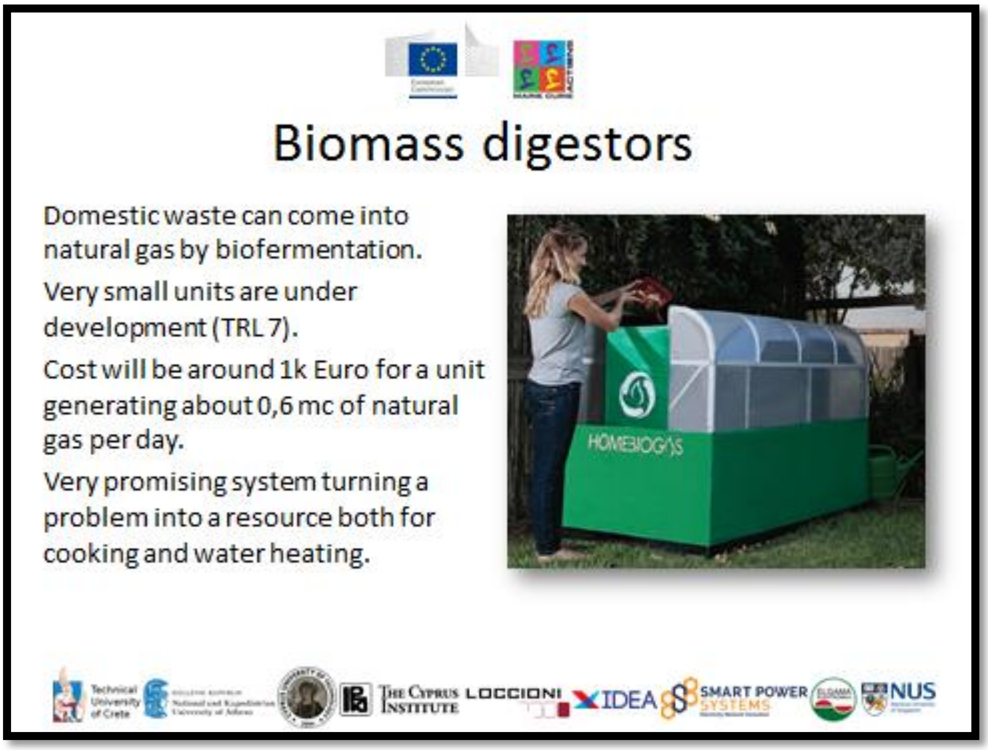
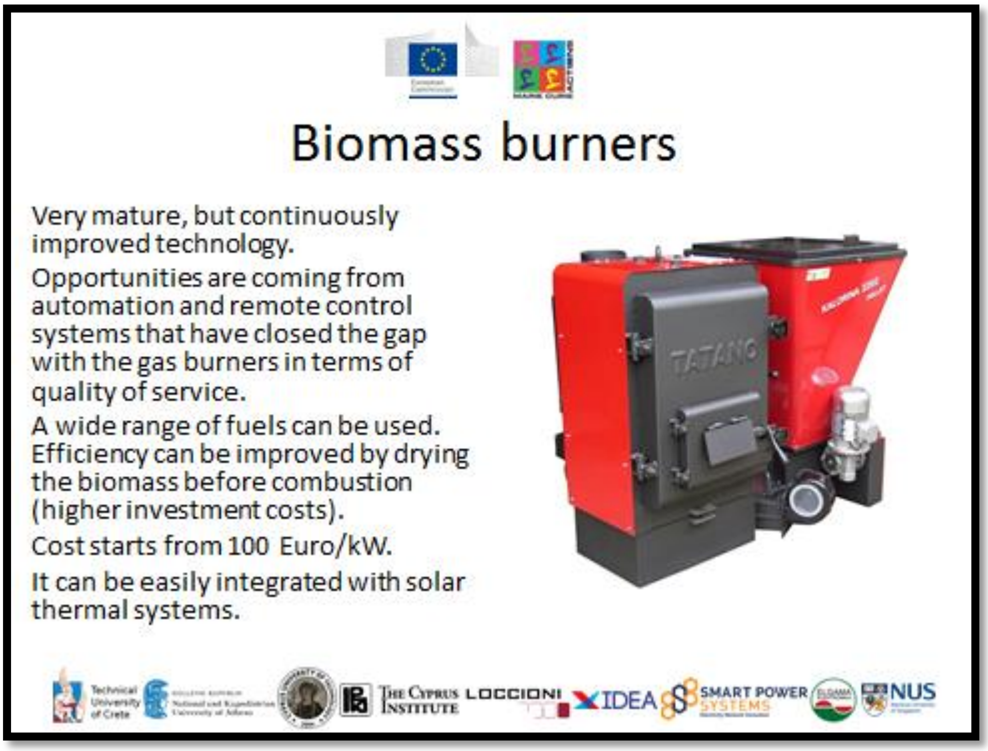
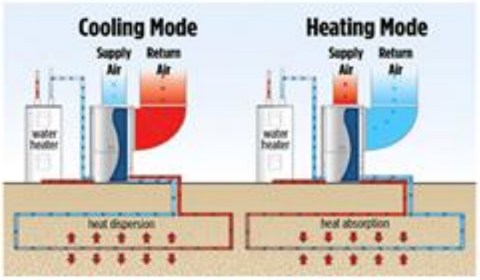

Biomass digestors
Domestic waste can come into natural gas by biofermentation.
Very small units are under development (TRL 7).
Cost will be around 1k Euro for a unit generating about 0,6 mc of natural gas per day.
Very promising system turning a problem into a resource both for cooking and water heating.
HOMEBIOGAS


Biomass burners
Very mature, but continuously improved technology.
Opportunities are coming from automation and remote control systems that have closed the gap with the gas burners in terms of quality of service.
A wide range of fuels can be used. Efficiency can be improved by drying the biomass before combustion (higher investment costs).
Cost starts from 100 Euro/kW.
It can be easily integrated with solar thermal systems.
TATANO

Geothermal systems

Direct or non-electric use of geothermal energy refers to the immediate use of the energy for both heating and cooling applications.

Geothermal projects are usually limited by the high capital cost (>500 Euro/kW).



Good opportunities are coming from the combination with heat pumps (for winter heating in cold regions and summer cooling in hot regions).

Microhydroelectric

A variety of small hydrogenerators are coming into the market.

Technology is almost mature, improvements can be introduced on the electricity conversion side (intelligent inverters) and for the insertion into water ducts for energy recovery.

Prices are ranging from 1.000 Euro/kWe.
Installation is very easy.

Microturbine cogenerators

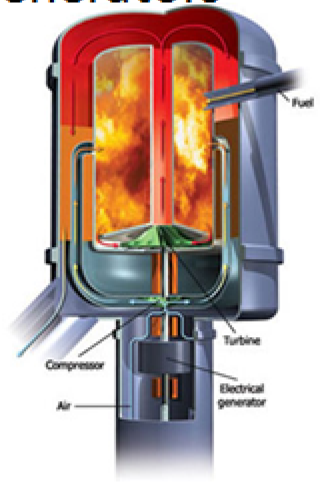
Small combustion turbines can produce, in integration with buildings and settlements, in the range of 10-100 kWe.

Technology is derived from trucks turbocharger and turbines in aircraft auxiliary power units.

Advantages are the small number of moving parts, compact size, lightweight, greater efficiency, lower emissions, lower electricity costs, and opportunities to utilize waste fuels.

Electric efficiency is about 25%, if waste heat can be used, total efficiency goes above 80%.

Cost is moving from down from about 1.000 Euro/kW and it can reach 500 Euro. Plus installation (30 – 50 %).



Other cogenerators

Integrated gas boiler CHP (TRL 9, prices are reducing).

Small scale steam expander engines (already commercial installations available).

Combustion engines (Otto, Stirling, ...). Many products derived from automotive industry.

Small ORC units (TRL 7-9, low efficiency (6-10%) at a small scale, better efficiency above 50 kW (16-20%).

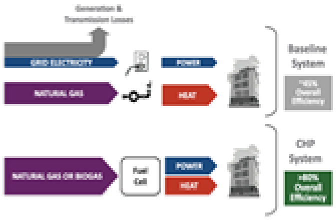
Abilitating new business models for utilities. Most of the developments are related to regulations.

Fuel cell - FP

Fuel cells use the chemical energy of hydrogen or another fuel to cleanly and efficiently produce electricity. If hydrogen is the fuel, electricity, water, and heat are the only products.

Fuel cells can operate at higher efficiencies than combustion engines, and convert the fuel chemical energy to electrical energy (60% and more than 80% for CHP applications).

These systems are not at an high maturity level. Depending on size and application, stationary fuel cells are estimated to cost from € 3.000/kW to €7.000/kW.



Energy conversion devices – HVAC

Absorption chiller

Absorption chillers are heat-operated devices that produce chilled water via an absorption cycle. Absorption chillers can be direct-fired, using natural gas or fuel oil, or indirect-fired as hot water or steam generated by waste heat or solar source.

H_2O/LiBr solution is used for chilling water above 0°C while H_2O/LiCl or NH_3/H_2O produce water below 0 °C.

Double effect chillers are more efficient and require higher temperature inlet (above 160°C). Triple effect chillers are unde development for small units.

COP (coefficient of performance) is in a range of 0.4-0.6 for single-effect, and 0.8-1.2 for double-effect chillers.

Costs are about 0,7K€ per KWc for small units.

Energy conversion devices – HVAC

Adsorption Chiller

Adsorption chillers use solid water sorption materials (i.e. Silica gel and Zeolith).

Under typical operation conditions with a driving temperature of 80 °C, the systems achieve a COP of about 0.6, but operation is possible even with temperatures of approx. 60 °C.
The capacity of the chillers ranges from 5.5 kW to 500 kW chilling power.

Commercial units are available but due to the small number of produced items, price is currently still high.
Silica Gel based DEC systems are the most mature in terms of price and reliability.

Intelligent lighting

Integrated natural/artificial lighting in windows, building integrated light pipes.

Technology is almost mature, high cost have limited the full deployment of this solutions.

New ESCO based business models are coming out.

Electric storage

Very fast developments towards home solutions due to the wide diffusion of distributed generation.

Lithium technology is dominating. Concerns have been raised for the environmental impact and temperature management issues.

Cost is still high. The Orison plug & play systems (in the picture) will start at around $1.600 for two kilowatt-hours of power. Tesla Power Wall starts at $3.000 for 7 kWh and $3.500 for 10 kWh.

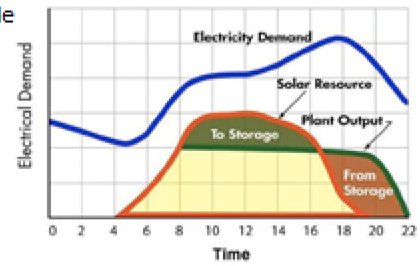
The key performance issues are still the lifespan and the number of charge/discharge cycles.

Thermal storage

Thermal storage is needed to link renewable thermal sources to the users demand.

There are three kinds of TES systems:

1) sensible heat storage based on storing thermal energy by heating or cooling a liquid or solid storage medium (e.g. water, sand, molten salts, rocks), with an HTF.
2) latent heat storage using phase change materials or PCMs (e.g. from a solid state into a liquid state).
3) thermo-chemical storage (TCS) using chemical reactions to store and release thermal energy.



a) buffering during variable sunshine periods,
b) time shifting in using available radiation,
c) increment in the annual Capacity Factor reducing the cost of energy,
d) more regular production of energy0

liquid thermal storage

Hot water storage systems used as a buffer storage for DHW (domestic hot water) supply are usually in the range of 500lt to several m^3.
This technology is also used in solar thermal installations for DHW combined with building heating systems (Solar-Combi-Systems).
Large hot water tanks are used for seasonal storage of solar thermal heat in combination with small district heating systems. Charging temperatures are in the range of 80-90°C.

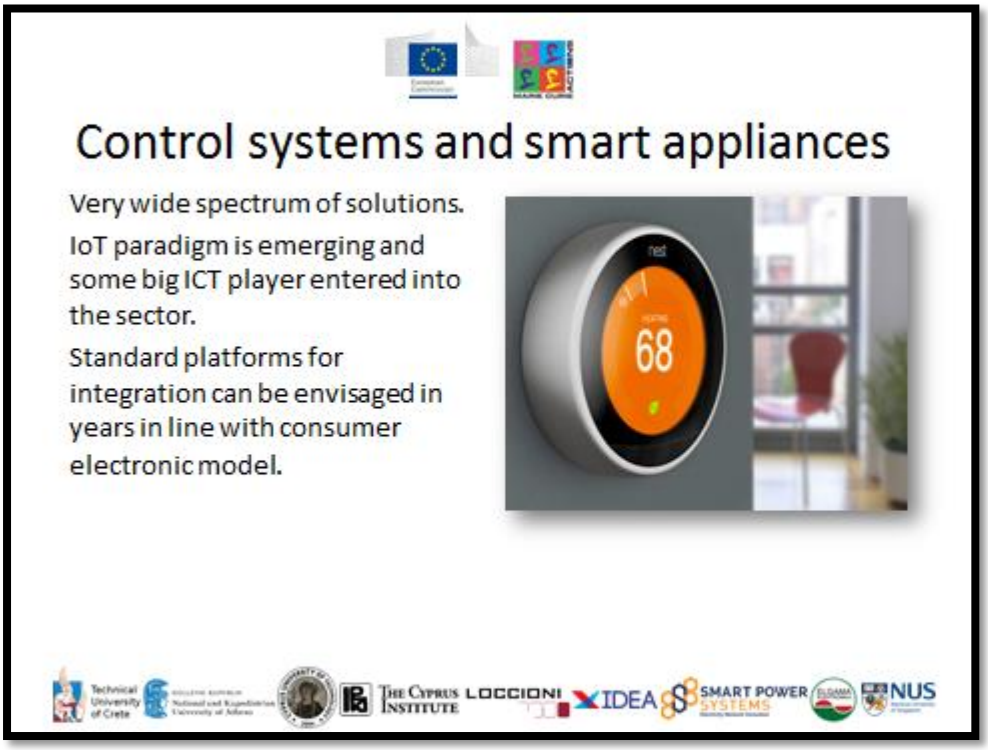
To improve the energy density and the temperature, downscaling of industrial storage systems, as oil and molten salts, are under development.

Solid thermal storage

Concrete is the most common option to transfer sensible heat with low price 2500 kJ/m^3K.
The storage module requires an heat exchanger with pipes embedded in the concrete mass.
Thermal conductivity (<1.5 W/mK) and mechanical strength are the main issues.
A very interesting system but only in development stage.

Phase change materials (PCM)-based TES enables higher storage capacities and target oriented discharging temperatures. PCMs can be incorporated into buidings elements, enabling both both hot and cold storage.

Melting processes involve energy densities on the order of 100 kWh/m^3 (e.g. ice) compared to a typical 25 kWh/m^3 for sensible heat storage options.


Control systems and smart appliances
Very wide spectrum of solutions.
IoT paradigm is emerging and some big ICT player entered into the sector.
Standard platforms for integration can be envisaged in years in line with consumer electronic model.
nest
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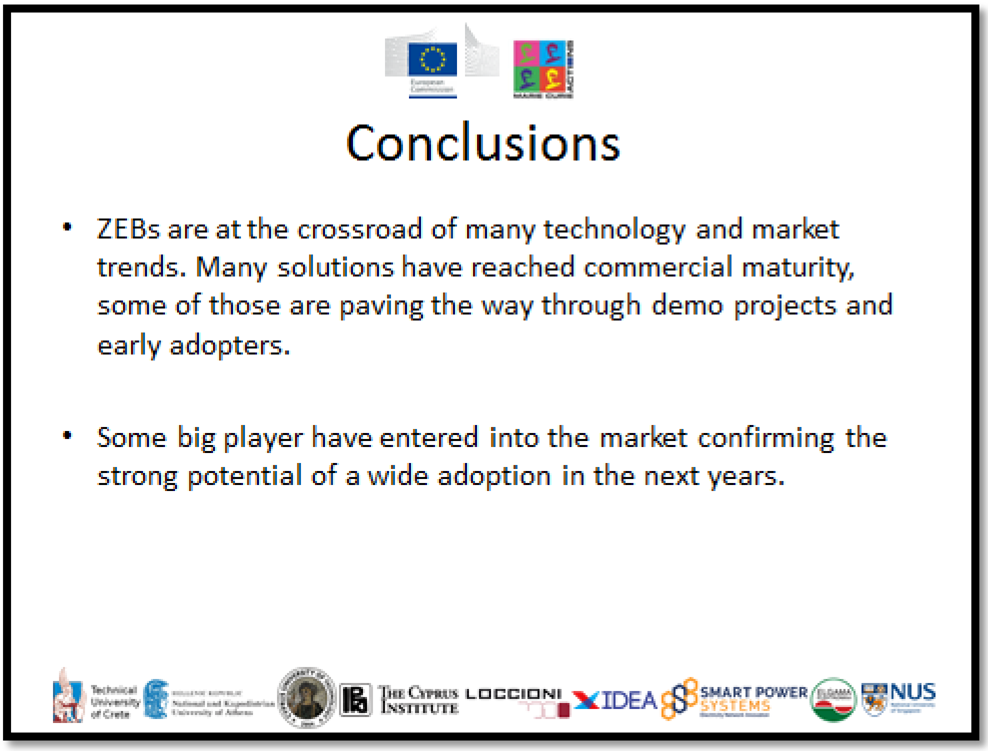
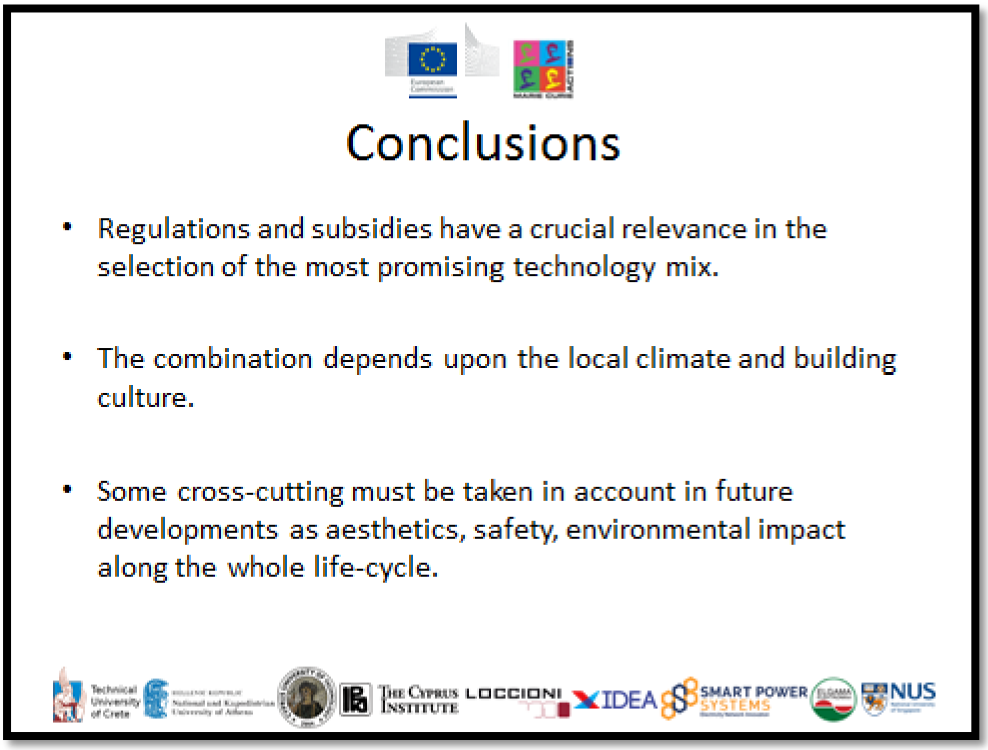

Conclusions
• ZEBs are at the crossroad of many technology and market trends. Many solutions have reached commercial maturity, some of those are paving the way through demo projects and early adopters.
• Some big player have entered into the market confirming the strong potential of a wide adoption in the next years.


Conclusions
• Regulations and subsidies have a crucial relevance in the selection of the most promising technology mix.
• The combination depends upon the local climate and building culture.
• Some cross-cutting must be taken in account in future developments as aesthetics, safety, environmental impact along the whole life-cycle.


Thank you