TEESCHOOLS

Transferring Energy Efficiency in Mediterranean Schools

PRIORITY AXIS: Fostering Low-carbon strategies and energy efficiency in specific MED territories: cities, islands and remote areas

OBJECTIVE: 2.1 To raise capacity for better management of energy in public buildings at transnational level

DELIVERABLE NUMBER: **4.4.2**

TITLE OF DELIVERABLE: **4.4.2 Training package**
WP n. 4: TRANSFERRING

ACTIVITY n. **4.4 TEESCHOOLS TRAININGS**

PARTNER IN CHARGE: CMAR PACA

PARTNERS INVOLVED: ALL PARTNERS

Status:

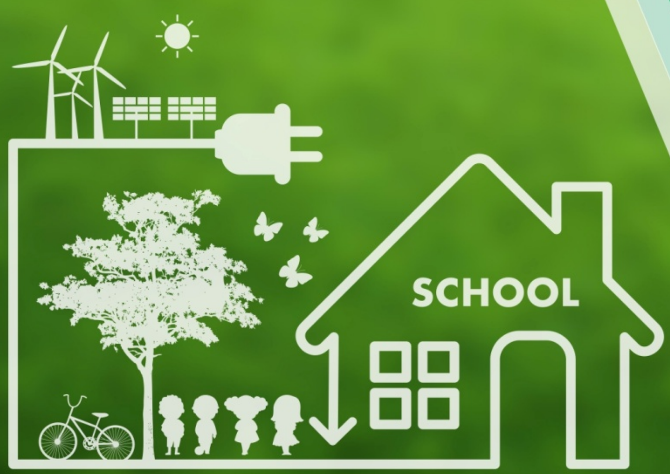
	Final	*Version n. 01*

Date: October 2018

WP4 – 4.4.2.

Regulatory framework -

EU Directive on Energy Efficiency
EU Directive on EPBD



4th project meeting

September 18-20th, 2018, Split

Partner: Ribera Consortium

CONSORCI DE LA RIBERA
àrea d'energia

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1. **Introduction**
2. **EU Directive on Energy Efficiency.**
3. **EU Directive on EPBD** *(Energy Performance Building Directive)*.

   EPB 2002.

   EPB 2010.

   EPB2018.

1. Introduction: Regulatory framework

EUROPE 2020 objectives:

- Employment
  - 75% of people aged 20–64 to be in work
- Research and development (R&D
  - 3% of the EU's GDP to be invested in R&D
- Climate change and energy
  - greenhouse gas emissions 20% lower than 1990 levels
  - 20% of energy coming from renewables
  - 20% increase in energy efficiency
- Education
  - rates of early school leavers below 10%
  - - at least 40% of people aged 30–34 having completed higher education
- Poverty and social exclusion
  - at least 20 million fewer people in – or at risk of – poverty/social exclusion

1. Ensure access to affordable, reliable, sustainable and modern energy for all;
2. Ensure a stable and abundant supply of energy for European citizens and the economy
3. Reducing energy imports dependecy; i;
4. Creating new opportunities on jobs, growth and investment.

1. EU energy umbrella

EU energy strategies

- ✔ 2020 Climate & Energy package
- ✔ 2030 Climate & Energy framework
- ✔ 2050 Low-carbon Economy

Local level

Covenant of Mayors for Climate & Energy

1. What about buildings??

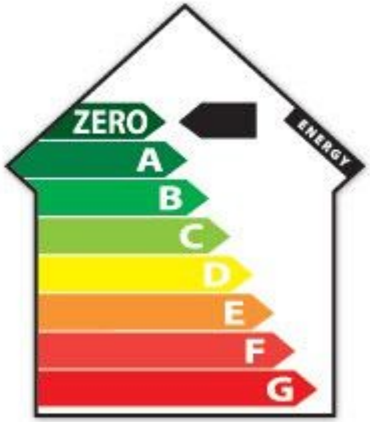
Buildings are responsible for approximately 40% of energy consumption and 36% of CO2 emissions in the EU;

More than 60% of municipal sector energy consumtion (CoM) is due to public buildings & installations.

1. EU challenges and objectives about building sector

EU countries must make energy efficient renovations (since January 2014) to at least 3% of the total floor area of public buildings annually owned and occupied by central government (exemplary Role of Public Bodies).

[Directive 2010/31/EU on the energy performance of buildings (recast) and Directive 2012/27/UE].



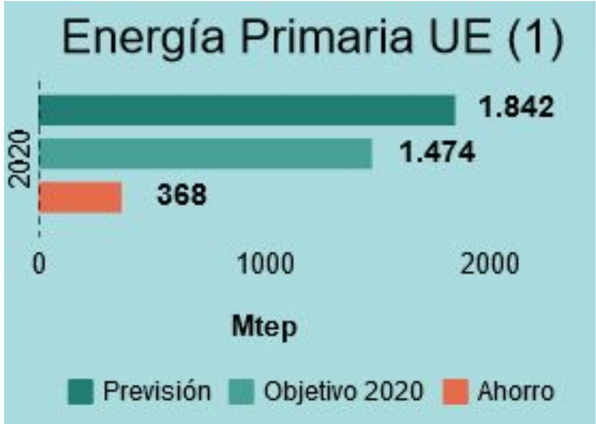
Since 31 December 2018, all new public buildings must be nearly zero-energy NZEB.

[Directive 2010/31/EU on the energy performance of buildings]

2. EU Directive on Energy Efficiency 2012/27/EU.

- Establishes a common framework of measures to promote energy efficeny in the European Union.
- Establishes a set of binding measures to help the EU reach its 20% energy eficiency target by 2020.
- EU countries are required to transpose the Directive’s provisions into their national laws.

EE targets 2020:
1474 Mtep primary energy
368 Mtep savings



2. EU Directive on Energy Efficiency 2012/27/EU.

ISO 50001
ENERGY MANAGEMENT

The **ISO 50001:2011** is the standard for transposing the Directive 2012/27/UE.

Specifies requirements for establishing, implementing, maintaining and improving an energy management system.

2. EU Directive on Energy Efficiency 2012/27/EU.

1. EFFICIENCY IN ENERGY USE

- Building renovation (Article 5)

An exemplary role for public buildings: Public sector required to renovate 3% of buildings by the central government in each country.

Buildings need to have a useful area larger than 500 m2 in order to be covered by this requirement (lowered to 250 m2 as of July 2015).

- **Purchasing by public bodies (Article 6)**

Central administrations should purchase only products, services and buildings with high energy efficiency.

-Energy efficiency obligation schemes (Article 7)

Energy companies are requested to reduce energy sales by 1.5% every year among their customers. This can be achieved via improved heating systems, fitting double-glazed windows or insulating roofs.

2. EU Directive on Energy Efficiency 2012/27/EU.

1. EFFICIENCY IN ENERGY USE

- Energy Audits and Energy Management Systems (Article 8)

MS are obliged to promote the availability to all final customers of high quality energy audits.

The audits must be cost-effective and executed in an independent manner by accredited experts or implemented and supervised by independent authorities under national legislation.

- Metering + Consumer information and empowerment (Article 9-11)

Energy consumers should be empowered to better manage consumption. This includes easy and free access to data on consumption through individual 'smart' metering.

2. EU Directive on Energy Efficiency 2012/27/EU.

2. EFFICIENCY IN ENERGY SUPPLY

- Energy transformation, transmission, and distribution. (Article 15)

MS should shall ensure that national energy regulatory authorities pay due regard to energy efficiency in executing the regulatory tasks specified in Directives 2009/72/EC and 2009/73/EC regarding their decisions on the operation of the gas and electricity infrastructure.

-Promotion of efficiency in heating and cooling (Article 14)

By December 31st 2015, Member states shall carry out and report to the Commission a comprehensive assessment of the potential for the application of high-efficiency cogeneration and efficient district heating and cooling.

MS must take adequate measures for efficient district heating and cooling infrastructure to be developed high-efficiency cogeneration, where the comprehensive assessment identifies a potential whose benefits exceed the costs for the application.

2. EU Directive on Energy Efficiency 2012/27/EU.

3. HORIZONTAL DISPOSITIONS

- Qualification, accreditation, and certification schemes (Article 16)

The Directive also promotes qualification, accreditation and certification schemes for providers of energy services, energy audits, energy managers and installers of energy-related building elements.

- Energy services (Article 16)

Member States must promote the energy services market and access.

It must support the public sector in taking up energy service offers, in particular for building refurbishment by providing model contracts for energy performance contracting.

2. EU Directive on Energy Efficiency 2012/27/EU.

3. HORIZONTAL DISPOSITIONS

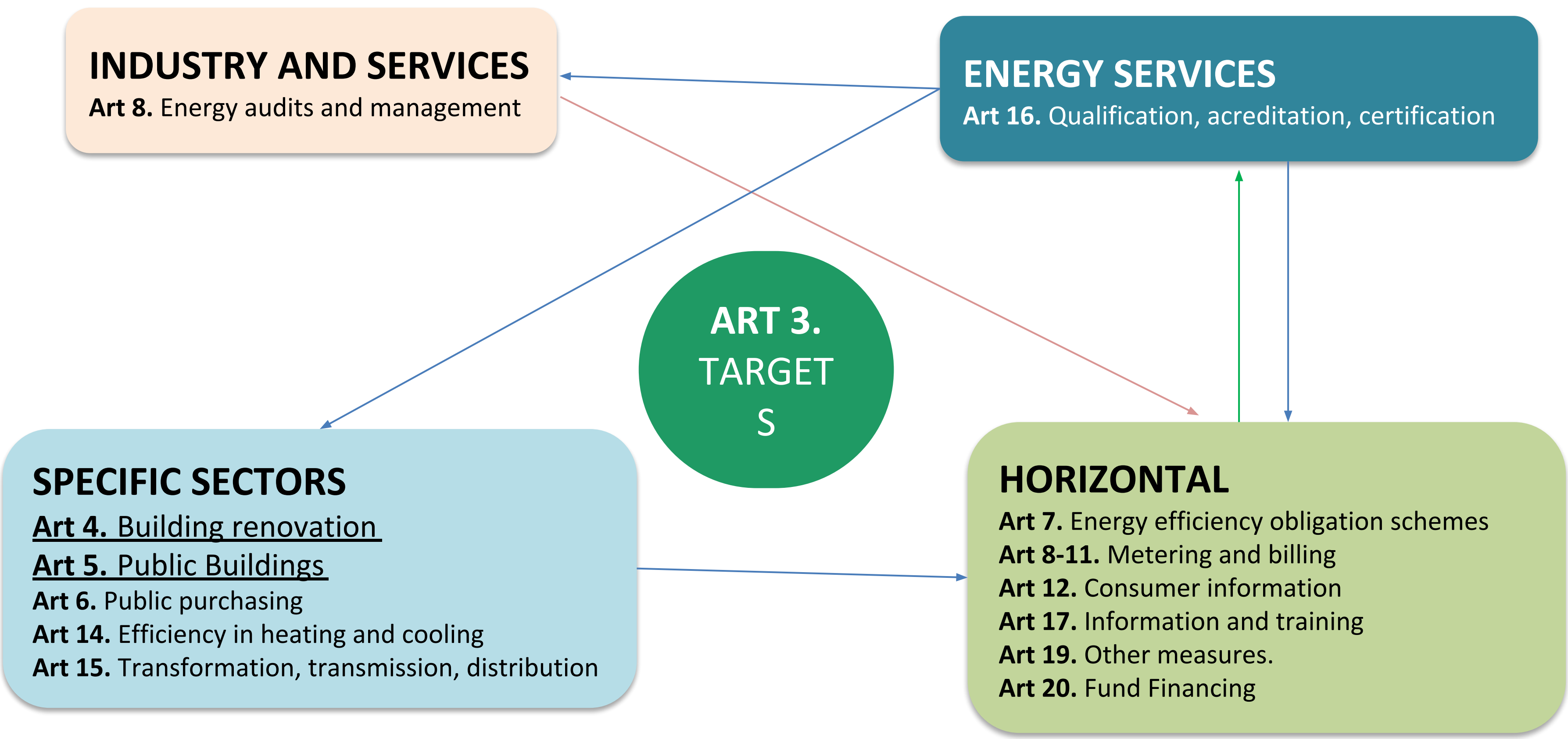
- Information and training. Other measures to promote energy efficiency (Articles 17-19)
Member States must evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy efficiency including the split of incentives between the owner and tenant of a building or among owners.

These measures may include providing incentives, repealing or amending legal or regulatory provisions, adopting guidelines and interpretative communications, or simplifying administrative procedures and may be combined with the provision of education, training and specific information and technical assistance on energy efficiency.

- Energy efficiency national fund, financing, and technical support (Article 20)
Member States will create an Energy Efficiencie National Found.

2. EU Directive on Energy Efficiency 2012/27/EU.

EED Interrelations



3. EU Directive EU Directive on EPBD *Energy Performance of Building Directive*

Background Information – EPBD (2002)

The **EPBD** *(Directive 2002/91/EC)* has been the main European legislative instrument for improving the energy efficiency of Europe's building stock. Under the Directive, the following obligations were introduced in all Member States:

- A methodology to calculate and rate the integrated energy performance of buildings
- A system of energy certification for new and existing buildings, with display requirements for public buildings.
- Regular inspections of heating and air-conditioning systems.
- Minimum energy performance standards for new buildings and for existing buildings that undergo major renovation with a useful floor area over 1 000 m^2.

3. EU Directive EU Directive on EPBD *Energy Performance of Building Directive*

EPBD (2010)

In 2010, the EPBD Recast *(Directive 2010/31/EU)* entered into force with a transposition deadline of July 2012. The updated text clarified, strengthened and extended the scope of the 2002 directive. **Key changes included:**

- Development of a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements
- Mandatory **energy certification** for all properties constructed, sold or rented out.
- **Inspection schemes** must be established for heating and air conditioning.
- All new buildings must be **NZEB** by 31/12/2020 (public buildings by 31/12/2018).
- Extension to all buildings of requirement to set **minimum energy performance** levels when a major renovation takes place
- EU countries have to draw up lists of **national financial measures** to enable the transition towards nearly zero energy levels in buildings.
- Requirement for Member States to establish penalties for non-compliance

3. EU Directive EU Directive on EPBD *Energy Performance of Building Directive*

EPBD (2018)

Revised Energy Performance of Buildings Directive (EU) 2018/844

This is intended to accelerate building renovation, delivering more energy efficient systems and strengthening the energy performance of new buildings, making them smarter. The measures include:

- Creating a clear path towards a **low and zero-emission building stock** in the EU by **2050** underpinned by national roadmaps to decarbonise buildings.
- Encouraging the use of **information and communication technology** (ICT) and smart technologies to ensure buildings operate efficiently, for example by introducing automation and control systems.
- Supporting the rollout of the infrastructure for **e-mobility** in all buildings.

3. EU Directive EU Directive on EPBD *Energy Performance of Building Directive*

EPBD (2018)

Revised Energy Performance of Buildings Directive (EU) 2018/844

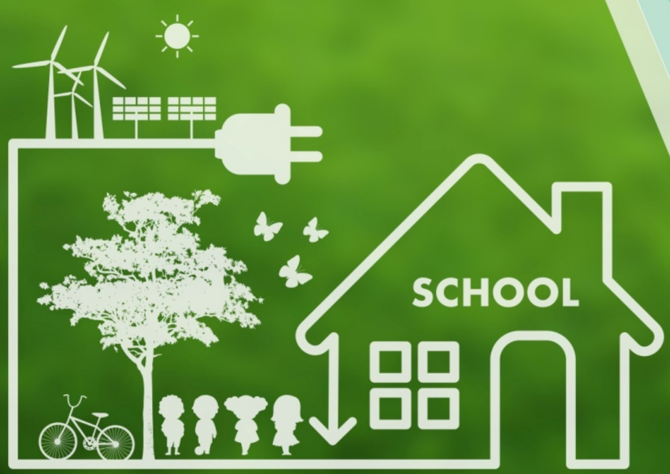
- Introducing a **smart readiness indicator** which will measure buildings' capacity to use new technologies and electronic systems to adapt to the needs of the consumer, optimise its operation and interact with the grid.
- Integrating and substantially strengthening long-term building **renovation strategies**.
- Mobilising public and private **financing and investment**
- **Combatting energy poverty** and reducing household energy bills by renovating older buildings.
- Following formal agreement, Member States will have to transpose the new elements of the Directive into national law **within 20 months**

Circular Economy and related policies

Internal Training Session

Split, 20th September 2018

Rovena Preka PhD, ENEA



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Introduction

- What is Circular Economy (CE)
- Strategies for the transition to CE
- Policies for the CE

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From Linear Economy to Circular Economy

Linear Model: virgin materials are taken from nature, used to make products, which are then used and eventually disposed. This model creates waste and dependence between economic development and inputs of new virgin materials.

The "take-make-dispose" linear models can be improved, optimized, efficient, but as long as waste remains, pollutants and waste, industrial production and consumption will continue to discharge environmentally and socially negative externalities without even seizing the opportunity to increase economic advantages.

Furthermore, the end of-pipe treatment of pollutants and waste, the current remedy for linear production, has now shown clear limits.

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From Linear Economy to Circular Economy

Circular Economy is an economy that is **restorative** and **regenerative** by design and aims to keep *products*, *components*, and *materials* at their highest utility and value at all times, distinguishing between technical and biological cycles.

It is conceived as *a continuous positive development cycle* that preserves and enhances natural capital, optimizes resource yields, and minimizes system risks by managing finite stocks and renewable flows.

It works effectively at every scale.

This economic model seeks to ultimately *decouple global economic development from finite resource consumption*. (Ellen Mc Arthur Foundation)

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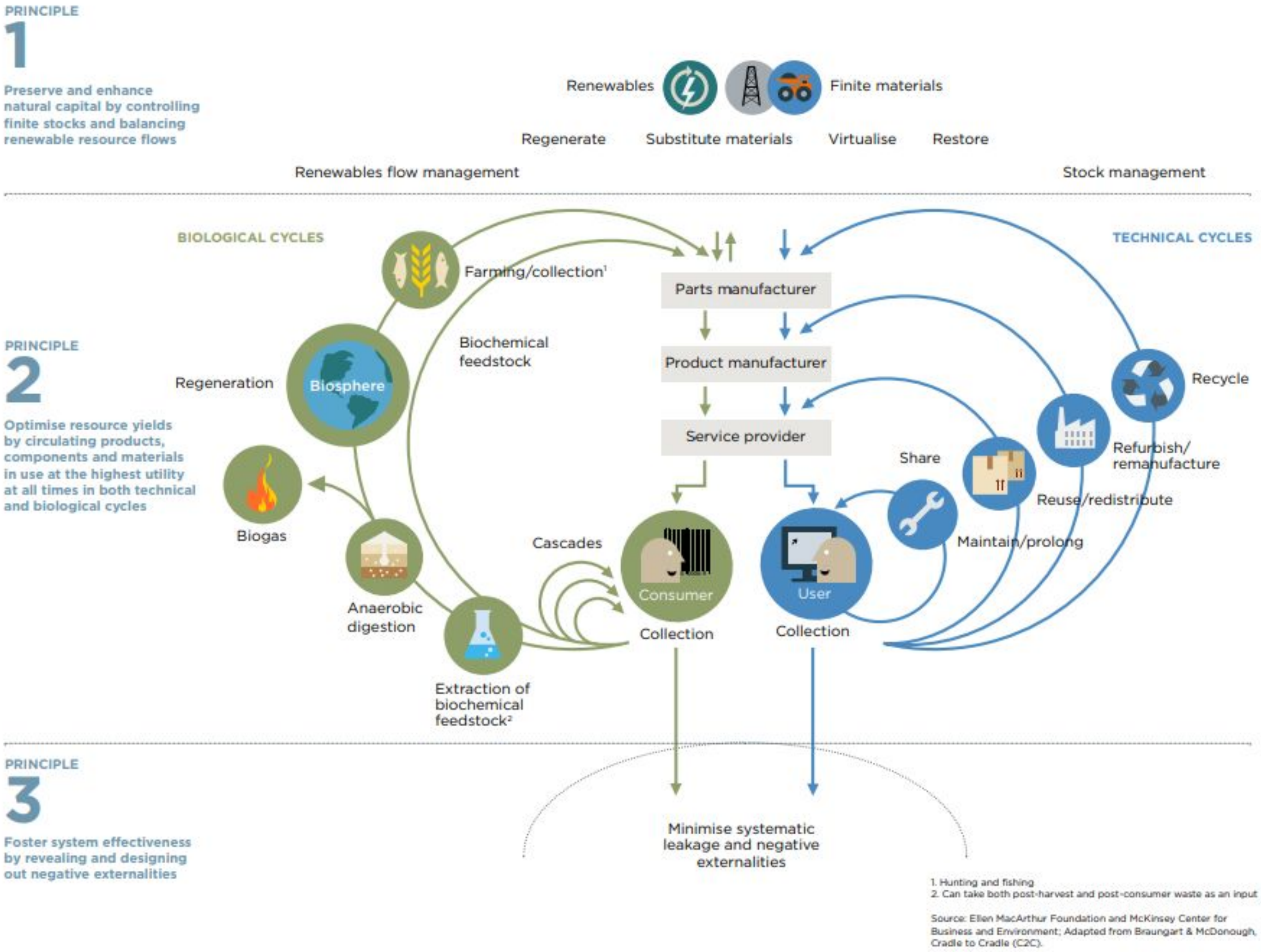
The principles of Circular Economy



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The principles of Circular Economy

A REGENERATIVE AND RESTORATIVE ECONOMY

A circular economy distinguishes between **technical** and **biological** cycles:

The **technical cycle** involves the management of stocks of finite materials. Use replaces consumption. Technical materials are recovered and mostly restored in the technical cycle.

The **biological cycle** encompasses the flows of renewable materials. Consumption only occurs in the biological cycle. Renewable (biological) nutrients are mostly regenerated in the biological cycle.

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The principles of Circular Economy

Principle 1: Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows.

This starts by dematerialising utility – delivering utility virtually, whenever optimal. When resources are needed, the circular system selects them wisely and chooses technologies and processes that use renewable or better-performing resources, where possible. A circular economy also enhances natural capital by encouraging flows of nutrients within the system and creating the conditions for the regeneration of, for example, soil.

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The principles of Circular Economy

Principle 2: Optimise resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles.

Designing for **remanufacturing**, **refurbishing**, and **recycling** to keep technical components and materials circulating in and contributing to the economy. Circular systems use tighter, inner loops (e.g. maintenance, rather than recycling) preserving more embedded energy and other value. These systems also maximise the number of consecutive cycles and/or the time spent in each cycle, by **extending product life** and optimising reuse. **Sharing** in turn increases product utilisation.

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The principles of Circular Economy

Principle 3: Foster system effectiveness by revealing and designing out negative externalities.

This includes reducing damage to systems and areas such as food, mobility, shelter, education, health, and entertainment, and managing externalities, such as land use, air, water and noise pollution, and the release of toxic substances.

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Characteristics of Circular Economy

- **Waste is “designed out”**: waste does not exist, and is designed out by intention.
- **Diversity builds strength:** The larger enterprises bring volume and efficiency, while the smaller ones offer alternative models when crises occur
- Renewable energy sources power the economy: energy required to fuel the circular economy should be renewable by nature, in order to decrease resource dependence

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Characteristics of Circular Economy

- **Waste is "designed out"**: waste does not exist, and is designed out by intention.
- **Diversity builds strength:** The larger enterprises bring volume and efficiency, while the smaller ones offer alternative models when crises occur
- **Renewable energy sources power the economy**: energy required to fuel the circular economy should be renewable by nature, in order to decrease resource dependence
- **Think in systems**: real world elements are part of complex systems where different parts are strongly linked to each other
- **Prices or other feedback mechanisms should reflect real costs**: full costs of negative externalities are revealed and taken into account, and perverse subsidies are removed.

Building blocks of Circular Economy

The success of circular models depends **four key building blocks**:

- **Rethinking product design** facilitates the recovery of components and materials.
- **Innovative business models** enable changes of incentives and the collection of products.
- **New reverse logistics** need to be put in place, recovering products back from consumers or users and into the supply chain, and treatment methods need to be improved.
- **A number of system conditions** can help businesses to make the transition, such as education, policy frameworks, collaboration platforms or metrics.

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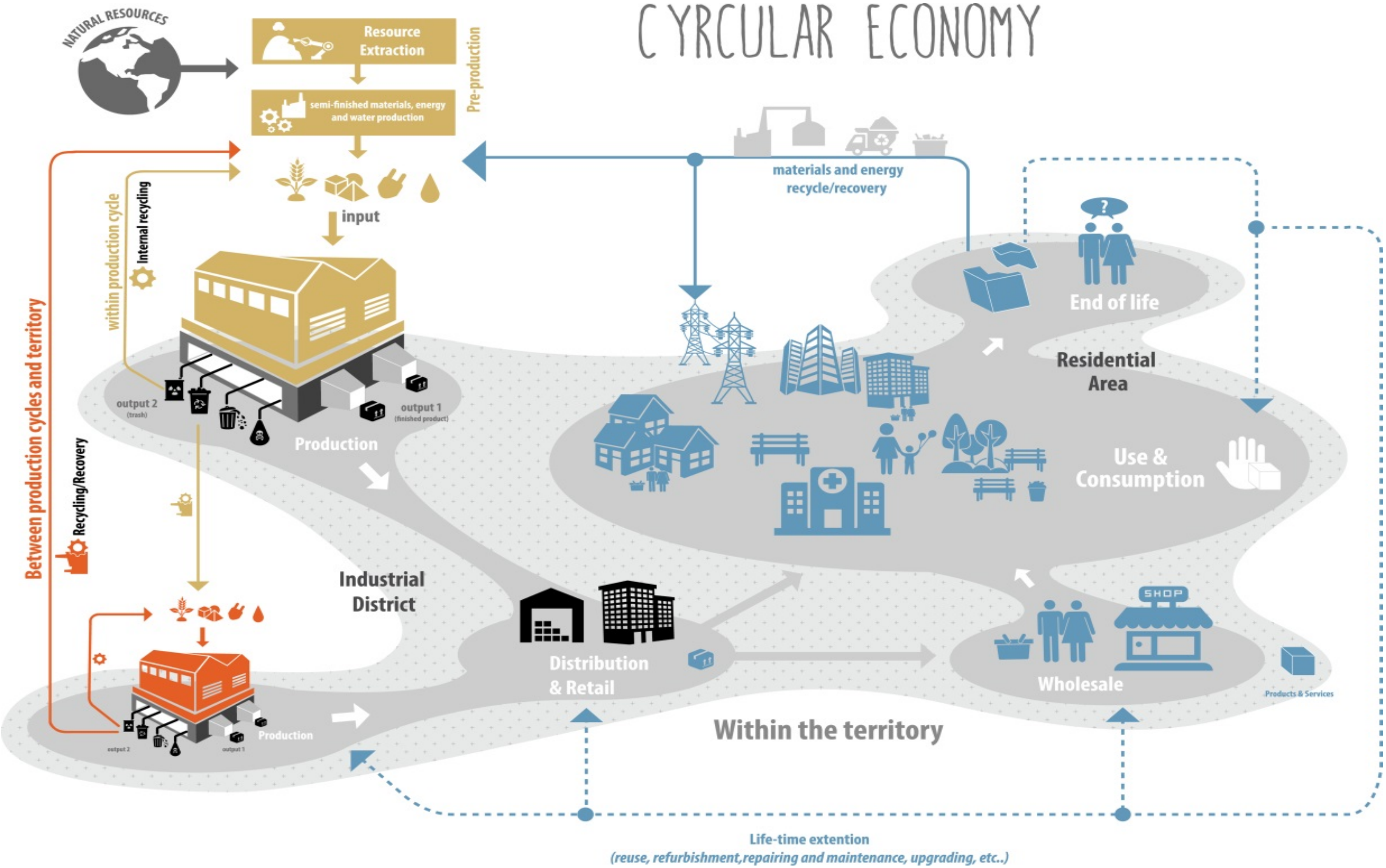
CYRCULAR ECONOMY



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Building sector and Circular Economy

To move away from the linear economic model of ‘take, make, and waste’ to the circular economy and towards resource efficiency, Europe needs a sustainable built environment.

And the buildings sector is one of the most resource consuming sectors in Europe - it accounts for approximately half of all extracted materials, half of total energy consumption, one third of water consumption and one third of waste generation.

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Building sector and Circular Economy

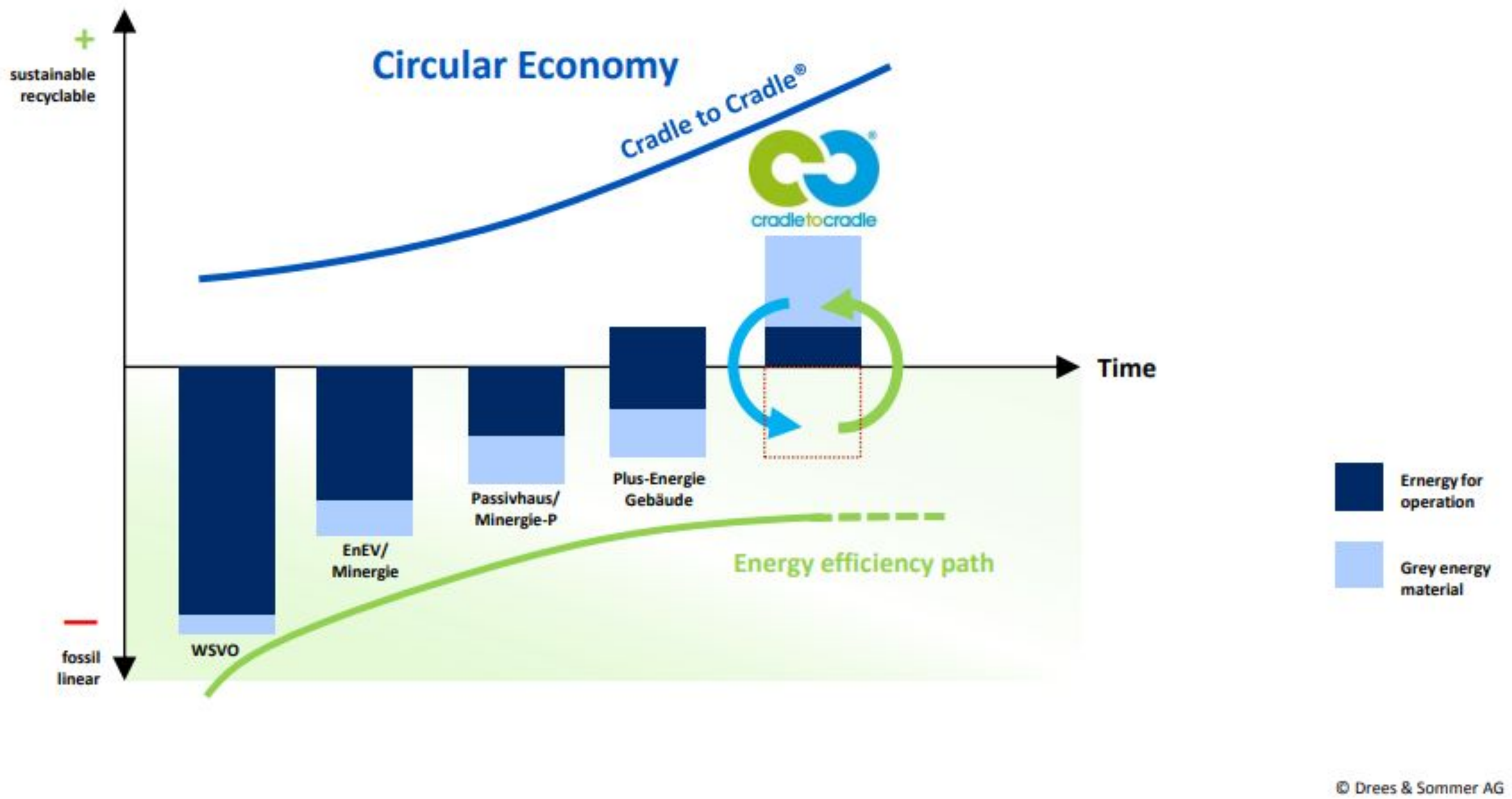

Figure: Drees and Sommer AG

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EU Policies for the Circular Economy

The **European Circular Economy Package** ("CEP") was adopted on June 14, 2018. (An action plan and 4 legislative modifications)

The action plan for the circular economy aims to 'close the loop' by complementing the measures contained in the legislative modifications and to contribute to meeting the United Nations Sustainable Development Goals (SDG) adopted in 2015, in particular Goal 12 on sustainable consumption and production. It highlights several areas for action:

❖Regarding **production**: improve product design by promoting the reparability, durability and possibilities for upgrading and recycling of products

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EU Policies for the Circular Economy

- Regarding **consumption**: better inform consumers about the sustainability of products through labelling, encourage innovative forms of consumption (e.g. sharing products or consuming services rather than products)
- help create **markets for secondary raw materials** by setting quality standards for materials recovered from waste
- promote **innovation for a circular economy** through a series of existing instruments

Five priority sectors: 1) plastics, 2) food waste, 3) critical raw materials, 4) construction and demolition, 5) biomass and bio-based products

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Types of measures:

- legislative measures
- communications and reports
- implementation and enforcement
- guidance and best practices
- Indicators
- Standards
- Support
- Financing instruments

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Thanks for your attention!

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LIVINGPROSPECTS
DEVELOPMENT & ENVIRONMENTAL SERVICES

Meeting in Split

Partner : **Living Prospects (PP14)**

Title of the presentation :

Improvement options: the

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Introduction

The present training material "Improvement options: the innovative approaches" is elaborated in the context of ***WP4 – Transferring*** *& it constitutes part (topic) of the* ***Training package*** *that will be produced under* ***Act. 4.4.2****.*

Contents:

-Purposes

-Innovative approaches (measures)

-Typical approaches

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Objective

- *The present training material presents innovative measures that can be adopted in order to improve the energy performance of school buildings.*
- *These recommendations will be presented to stakeholders: energy auditors, school owners, school principles, building managers, school committees etc. aiming to facilitate the selection & the application of the most suitable ones for the Mediterranean school buildings.*

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Innovative approach 1

1/2

Title: Mechanical Ventilation with Heat Recovery

Introduction:

A ventilation system with heat recovery **integrated in the window frame** is an ideal proposal for school buildings that usually have only natural ventilation. By opening the windows there is no control at all and severe thermal losses occur.

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Innovative approach 1

Advantages:

- ✔ Easy way to **ensure the right amount of fresh air** needed in classrooms.
- ✔ Improve **comfort**, **health** and **well-being** of students and teachers.
- ✔ The **heat recovery** system minimizes the heat losses when indoor warm air is extracted and fresh cold air is provided.
- ✔ **Minimum heat losses due to ventilation** which is a significant part of the buildings total heat loss in the winter – especially in schools where ventilation rates standards are high due to the number of students.

Disadvantages:

- ❑ All windows need to be replaced to reach desirable air flow levels
- ❑ High cost
- ❑ Windows should remain closed during winter in order to achieve savings

Expected Energy Savings: 20% -30% reduction in heating consumption

Indicative Cost: 2.000 € / per classroom

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Innovative approach 2

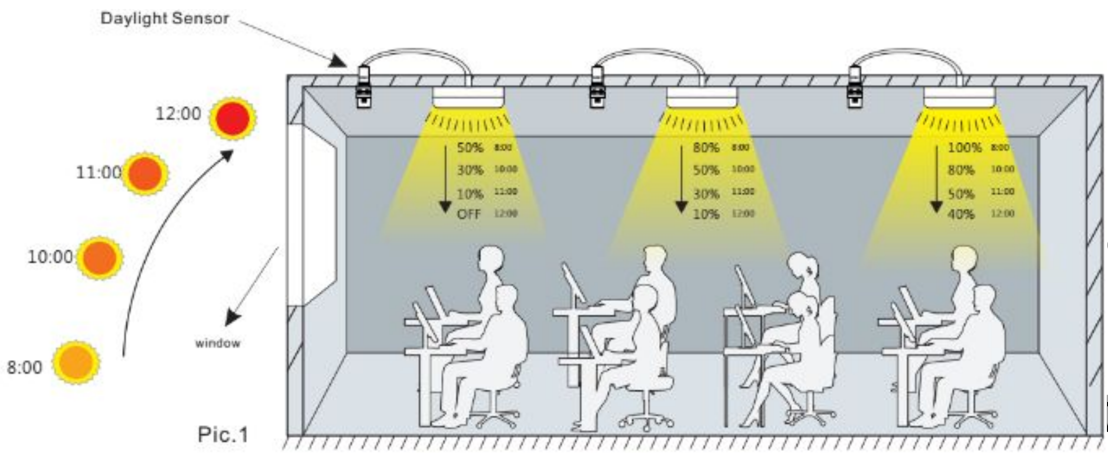
1/2

Title: Lightin

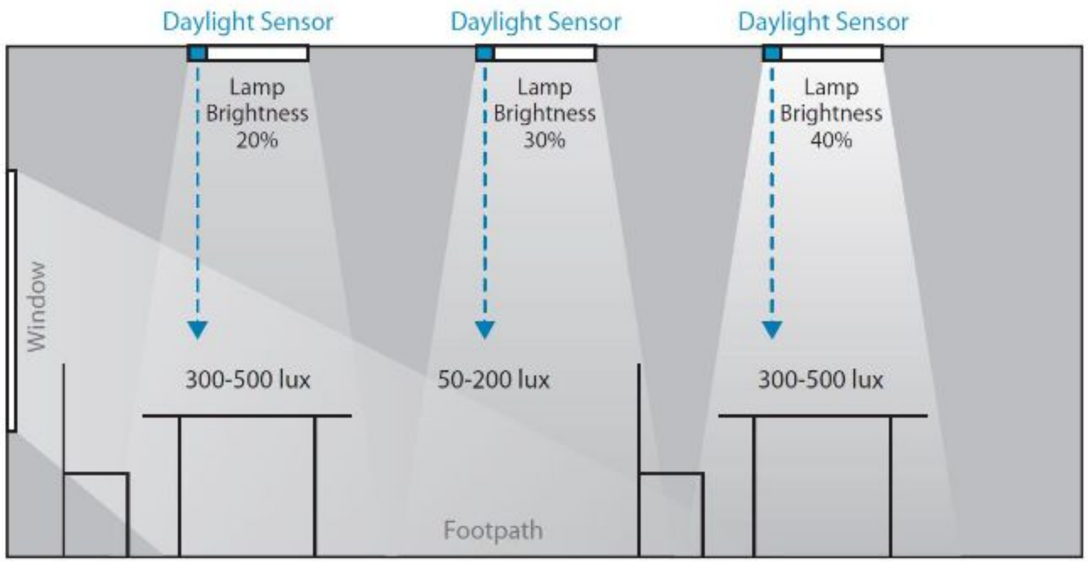
Introduction:

Smart auto ... ous sensors in combinatio ... D).

- ❑ Daylight s ... t luminance either by dimming or by turning off a group or all of the lights
- ❑ Presence s ... neric use spaces that are u



Pic.1



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Innovative approach 2

2/2

Advantages:

- ✔ Due to morning school operation and big openings daylight can be of use
- ✔ Ensure right luminance levels in classrooms and offices
- ✔ Optimum visual conditions automatically
- ✔ Electricity saving

Disadvantages:

- ❑ Calibration and right location of the sensors is crucial for the good performance of the system
- ❑ Cost

Expected Energy Savings: up to 40% decrease in electricity for lighting in educational buildings

Indicative Cost: 150 € / classroom

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Innovative approach 3

1/2

Title: PV with Virtual Net Metering (started in Greece in the summer of 2017 for municipalities & farmers)

Introduction:

Electricity generation with PV systems on school roofs using virtual
r … bui … g.
T … ed … d
e … e N

Wh

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Innovative approach 3

Advantages:

- ✔ School roofs are usually large and suitable for many m2 of PV panels
- ✔ PV yearly energy generation can be quite higher than the school's own needs
- ✔ With Virtual Net Metering other facilities that consume electricity can be benefitted
- ✔ Virtual Net Metering contributes to make the investment more attractive (lower payback time)

Disadvantages:

- ❑ Poor performance on cloudy days

Expected Energy Savings: 60% reduction in final energy consumption

Indicative Cost: 1500 € / kW

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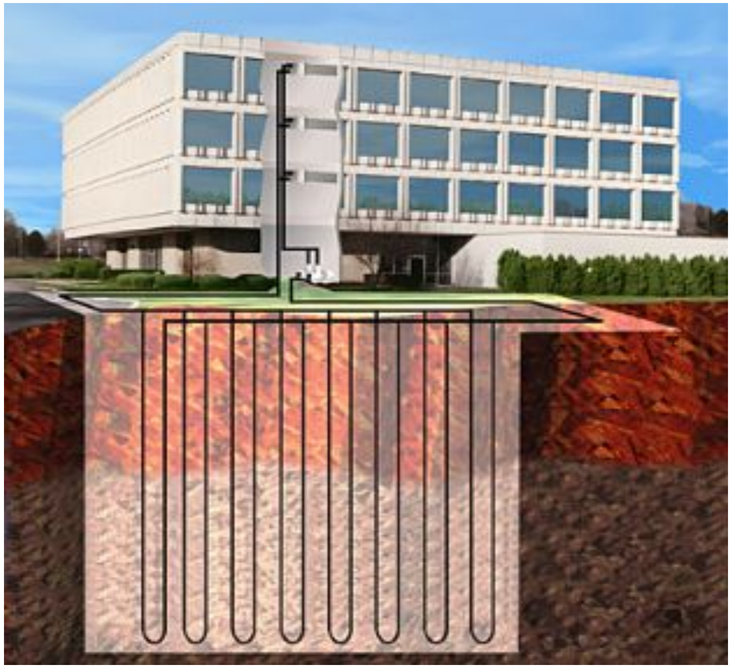
Innovative approach 4

1/2

Title: Geothermal Heat Pumps

Introduction:

A geothermal system in combination with heat pumps for heating & cooling. Vertical or horizontal loops for exploiting grounds stable temperature.



Innovative approach 4

Advantages:

2/2

- ✔ Schools have usually big yards & outdoor areas to install ground loops for the system
- ✔ Multi-purpose halls, gyms & library buildings are suitable candidates that are suitable for having heat pumps for cooling and heating.
- ✔ High efficiency of the overall system means low electricity cost

Disadvantages:

- ❑ Quite expensive because of the ground digging & drilling required

Expected Energy Savings: 25% reduction in heating consumption

Compared to simple air to air heat pumps

Indicative Cost: 1500 € / kW

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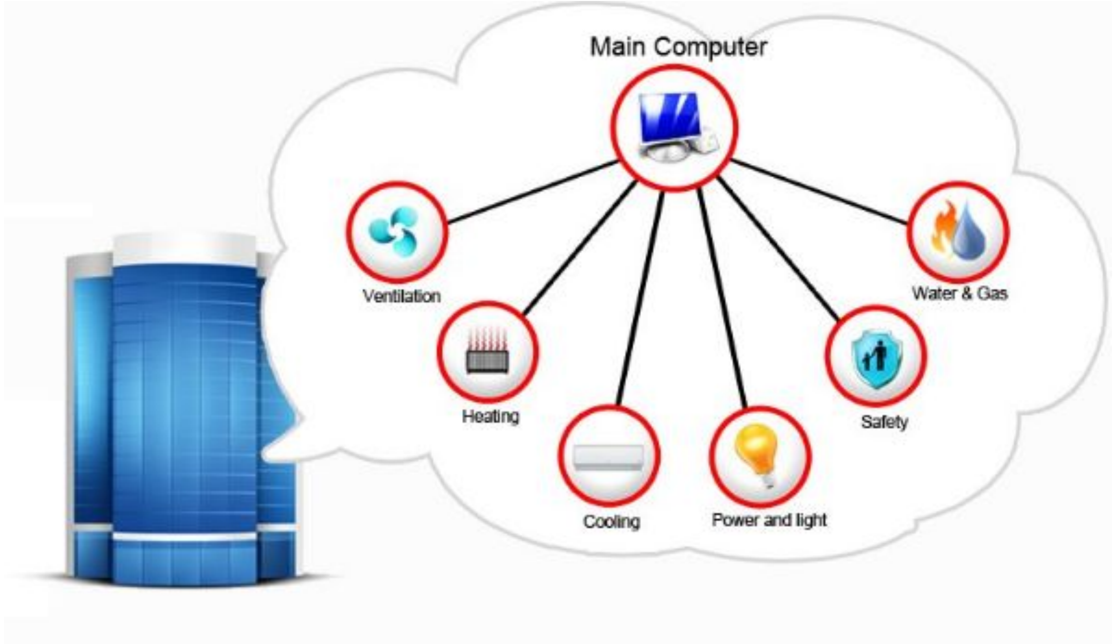
Innovative approach 5

1/2

Title: BEMS (Building energy monitoring system)

Introduction:

An energy management system that allows the monitoring and control of all the building's system (heating, cooling, lighting, ventilation etc.)



Innovative approach 5

Advantages:

- ✔ Very useful in school buildings which are in general big and with many classrooms and spaces
- ✔ Turn of the heating or cooling in empty classrooms or other spaces
- ✔ Ensure lights are not turned on after class
- ✔ Adjust the indoor comfort per classroom for ideal conditions
- ✔ Save energy by running the building smart and efficiently and avoid energy waste
- ✔ When having a BEMS it is then easy to identify energy saving opportunities.

Disadvantages:

- ❑ Unless correctly specified, installed and operated a BEMS system can increase cost and environmental impacts.
- ❑ Need for a skilled operator to ensure maximum efficiency

Expected Energy Savings: 15-20 %

Indicative Cost: 25 – 75 € / m2 depending on the level of automation

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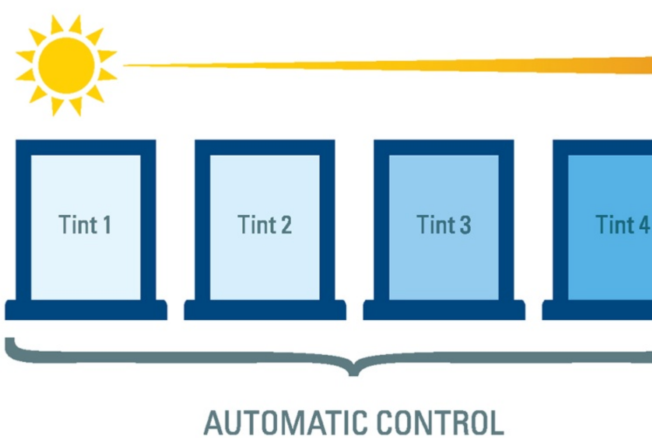
Innovative approach 6

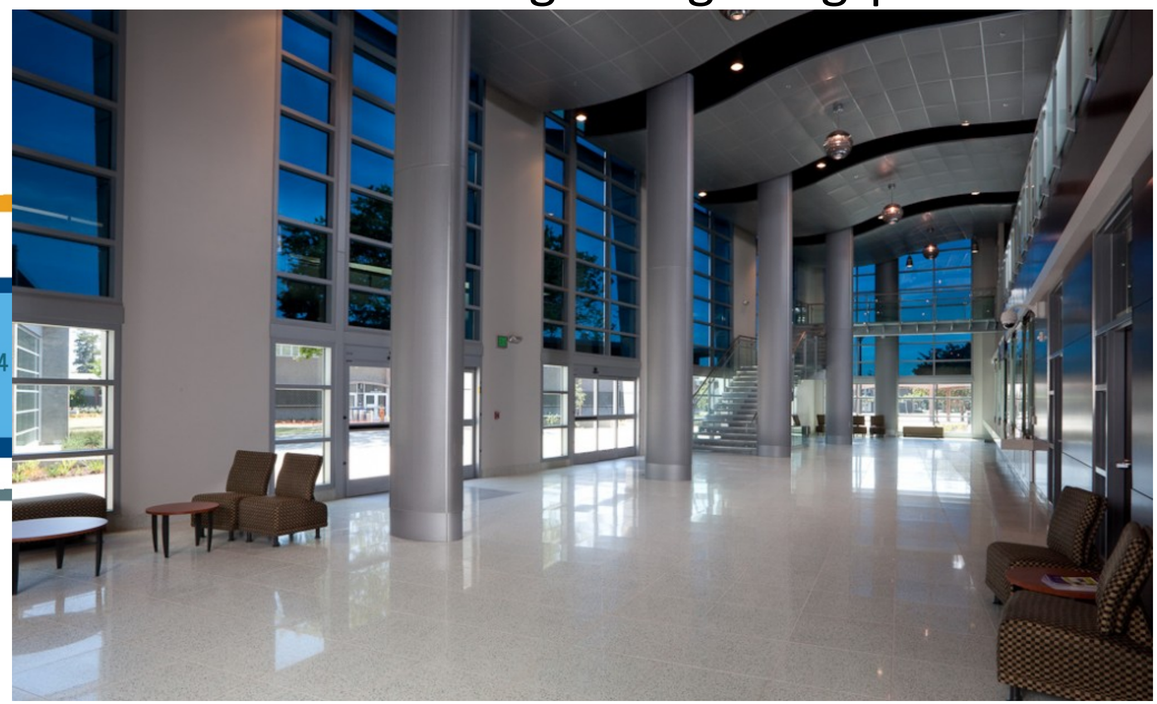
1/2

Title: Electrochromic Windows

Introduction:

Glazing that can change their transparency could be a good solution for school buildings that often encounter overheating and glaring problems in sunny warm days.





Innovative approach 6

Advantages:

- ✔ Improve visual conditions in classrooms and offices
- ✔ Reduce consumption for cooling
- ✔ Avoid overheating problems – improve thermal comfort

Disadvantages:

- ❑ Increase of lighting use and electricity consumption

Expected Energy Savings: N/A

Indicative Cost: 500 – 1000 € / m2

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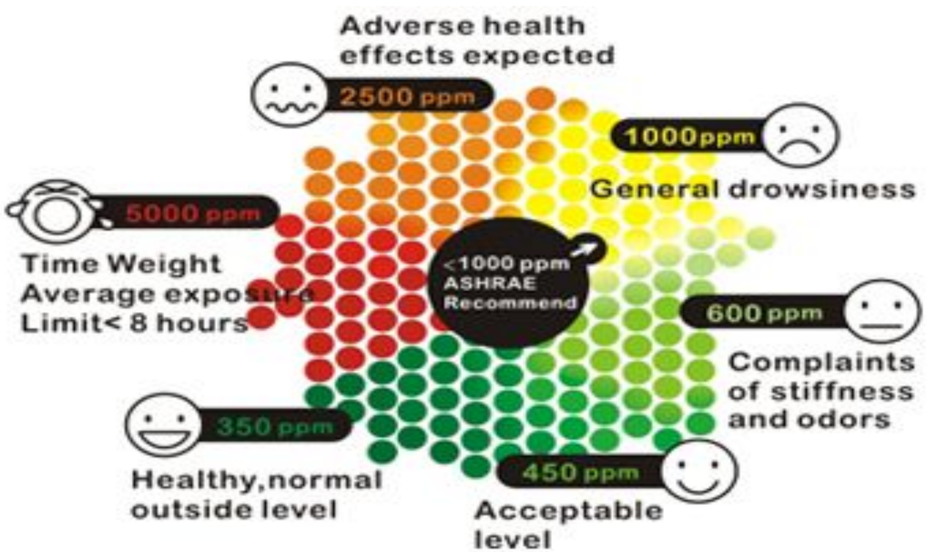
Innovative approach 7

Title: Monitoring CO2 concentration & humidity in classrooms through metering devices

Introduction:

Measuring CO2 concentration & relative humidity levels inside classrooms can better control their natural ventilation & will contribute to energy savings.



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Innovative approach 7

2/2

Advantages:

- ✔ Opening windows only when it is necessary
- ✔ Avoid excessive heat loss during the winter and thus reduce heating consumption
- ✔ Ensure indoor air quality for students
- ✔ Healthier conditions, prevent of disease spread, promote well being and productivity and avoid sleepiness

Disadvantages: -

Expected Energy Savings: 5-10% decrease of heating consumptions

Indicative Cost: 100-150 € / device

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Typical approach 1

Title: Building Shell Insulation/renovation

Introduction:

This approach includes all measures that include adding extra insulation to the building elements (walls, roofs, floors) and replacing old windows (frames & glazing) with new ones with better thermal and optical properties, in order to reduce the thermal loss of a building.

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Typical approach 1

2/2

Advantages:

- ✔ Easy to install – ideal for refurbishment
- ✔ Exploit the thermal mass of the building

Disadvantages:

- ❑ Not ideal for spaces that are used for short time intervals during the day
- ❑ Window replacing is very costly

Expected Energy Savings: 30 % - 50 % reduction in heating

Indicative Cost for Insulation: 45-50 € / m2

For windows: > 300 €/m2

Typical approach 2

1/2

<u>Title</u>: Lighting system replacement with LED

<u>Introduction:</u>

Replacing old fluorescent or incandescent lighting fixtures and bulbs with LED technology systems (LED panels, LED tubes etc.) which are much more energy efficient – consume less electricity for the same result.

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Typical approach 2

2/2

Advantages:

- ✔ Offer all types of light colors
- ✔ Combined easily with dimming and smart controls
- ✔ Last long
- ✔ Free of hazardous materials

Disadvantages: -

Expected Energy Savings: 50 % electricity reduction compared to fluorescent

Indicative Cost: 10 – 20 €/m2

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Typical approach 3

1/2

Title: Heating & Cooling systems replacement

Introduction:

Replacing old boilers or heat pumps with high efficiency condensing gas technology or high efficiency heat pumps energy conversion in the most efficient way. Going from boiler (fossil fuel) to heat pump (electricity) can also be conditionally of benefit.

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Typical approach 3

2/2

Advantages:

- ✔ Efficient systems
- ✔ Integrated automations for more saving
- ✔ Flexibility in heat load operation

Disadvantages:

- ❑ Piping system and terminals needs to be replaced or repaired for optimum energy saving

Expected Energy Savings: 20 – 30 % in heating consumption

Indicative Cost: 30.000 € for 200 kW boiler

150.000 € for 200 kW heat pump

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Thanks for your attention!

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Italian National Agency for New Technologies, Energy and Sustainable Economic Development

Carbon Footprint of renovation actions

Internal Training Session

Split, 20th September 2018

Pier Luigi Porta, ENEA

Interreg Mediterranean TEESCHOOLS

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Index

- Background
- EU Policies
- Carbon Footprint
- Life Cycle Assessment
- Carbon Footprint of renovation actions

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Background

- Buildings are responsible for approximately 40% of energy consumption and 36% of CO_2 emissions in the EU.
- Currently, about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy *in*efficient, while only 0.4-1.2% (depending on the country) of the building stock is renovated each year.
- Therefore, more renovation of existing buildings has the potential to lead to significant energy savings – potentially reducing the EU’s total energy consumption by 5-6% and lowering CO_2 emissions by about 5%.

https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

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EU Policies

The 2010 **Energy Performance of Buildings Directive** and the 2012 **Energy Efficiency Directive** are the EU's main legislative instruments promoting the improvement of the energy performance of buildings within the EU. As Directives, they needed to be transposed by Member States into national legislation.

The 2010 Energy Performance of Buildings Directive has made possible for consumers **to make informed choices** that will help them save energy and money, and has resulted in a positive change of trends in the energy performance of buildings.

Following the introduction of energy efficiency requirements in national building codes in line with the Directive, **new buildings today consume only half as much as typical buildings from the 1980s**.

https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

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EU Policies

On November 2016, as part of the **Clean Energy for All Europeans package**, the Commission proposed an update to the Energy Performance of Buildings Directive **to help promote the use of smart technology in buildings, to streamline existing rules and accelerate building renovation**.

The Commission also published a new buildings database – the **EU Building Stock Observatory** – to track the energy performance of buildings across Europe.

On June 2018 **Directive (2018/844/EU)** amending the Energy Performance of Buildings Directive was published. This revision introduces targeted amendments to the current Directive aimed at **accelerating the cost-effective renovation of existing buildings**, with the vision of **a decarbonised building stock by 2050** and the mobilization of investments.

https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

Carbon Footprint

- What is Carbon Footprint?

Is the sum of greenhouse gas emissions and removals in a product system, expressed as CO_2 equivalents and based on a life cycle assessment using the single impact category of climate change

ISO14067:2013 DEFINITION

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Carbon Footprint Standard

- **Product Carbon Footprint Certification** calculated based on the "PAS 2050, Publicly Available Specification" standard and the "Greenhouse Gas Protocol, Corporate Accounting and Reporting Standard".
- **ISO 14067** specifies principles, requirements and guidelines for the quantification and communication of the carbon footprint of a product (CFP) and on environmental labels and declarations (ISO 14020, ISO 14024 and ISO 14025) for communication.
- **ISO 16745**, Sustainability in buildings and civil engineering works – Carbon metric of an existing building during use stage provide a set of methods for the calculation, reporting, communication and verification of a collection of carbon metrics for **GHG emissions arising from the measured energy use during the activity of an existing building**, the measured user-related energy use, and other relevant GHG emissions and removals.

*Methodologically the **Carbon Footprint** is generally based on International Standards on **Life Cycle Assessment** (ISO 14040 and ISO 14044 series).*

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Life Cycle Assessment (LCA)

"LCA is process of compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle"

Roadmap for the European Platform on Life Cycle Assessment JRC 2013

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Life Cycle Assessment (LCA)

LCA methodology is a holistic procedure for compiling an inventory (inputs and outputs of materials and energy) of the whole life cycle of a product or service system with a specific function and then for assessing the related environmental impacts.

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Life Cycle Assessment (LCA)

The life cycle includes raw-material production, manufacture, distribution, use and disposal including all intervening transportation steps necessary or caused by the product's existence.

LCA allows quantifying the environmental performance of a system/product/process avoiding shifting of burdens on different life cycle phases or locations.

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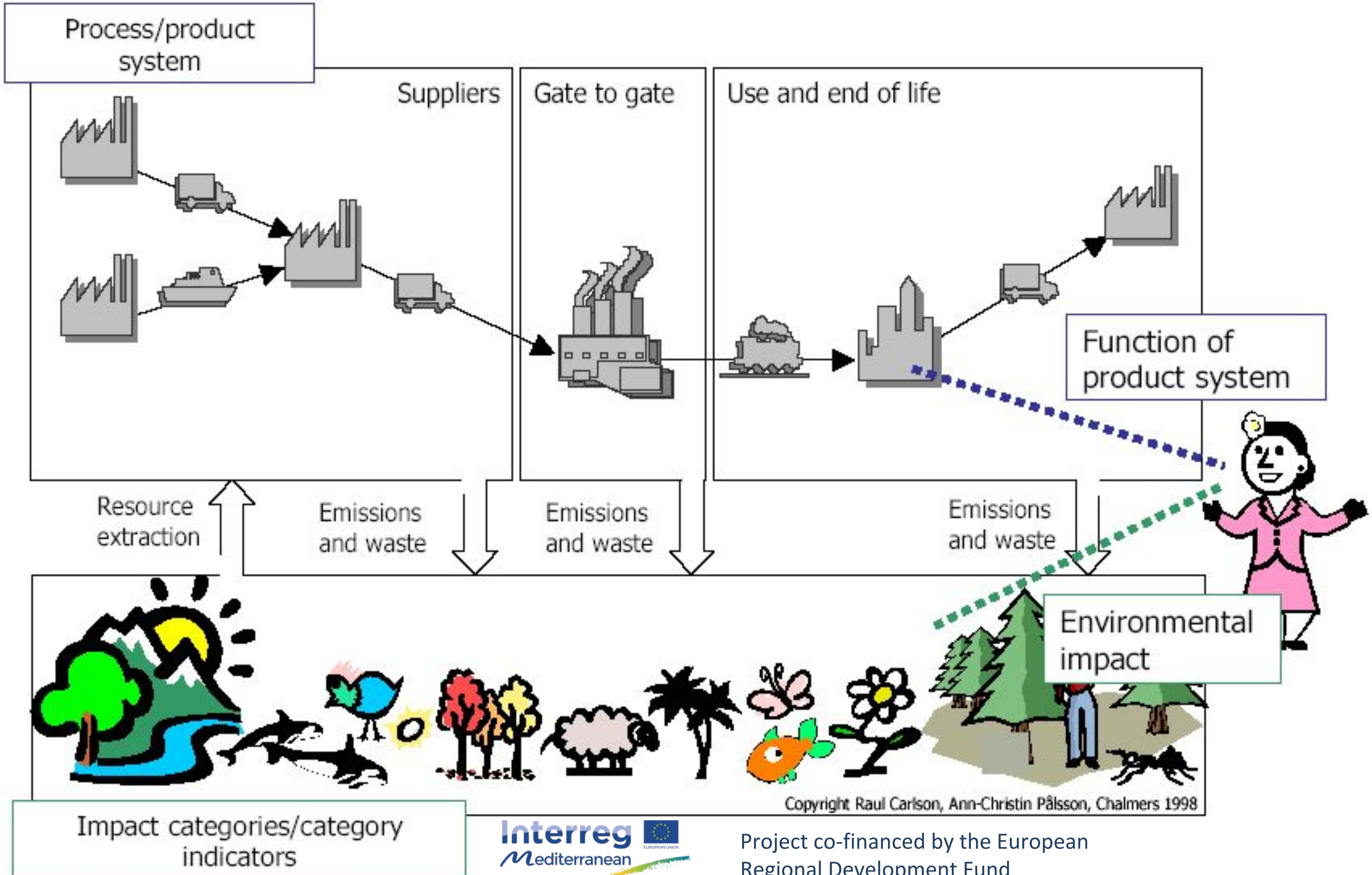
Life Cycle Assessment (LCA)



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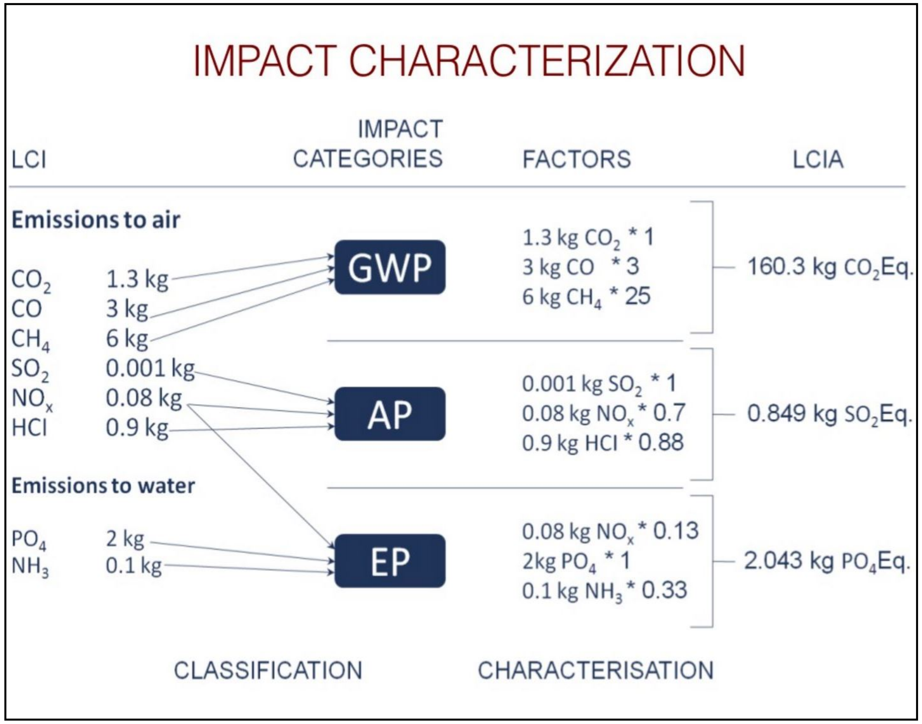
Life Cycle Indicators



Inputs and outputs are converted into impact categories indicators related to some environmental priorities like Climate change; Nature and Biodiversity; Environment, health and quality of life; Natural resources and wastes.

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Life Cycle Indicators

- Some example:
  - **Acidification Potential (AP)** and **Eutrophication Potential (EP)** are chosen to address the priority of nature and biodiversity. The key pollutants relevant for these impact categories are SO_2 and NOX which have been in the past, and in many cases still are, the main sources of damage to forests and soil.
  - The protection of human health and the improvement of the quality of life are amongst other measures addressed by controlling ground level ozone levels. The impact category **Photochemical Ozone Creation Potential (POCP)** addresses the issue of summer smog formation, especially in densely populated urban areas.
  - For describing Climate Change, **Global Warming Potential (GWP),** also addressed as **Carbon Footprint,** is a globally accepted impact category. It generally comes from energy production, transportation, and conversion. To consider the varying greenhouse gas effects, a time horizon of 100 years is chosen, this indicator is also known as "GWP100".

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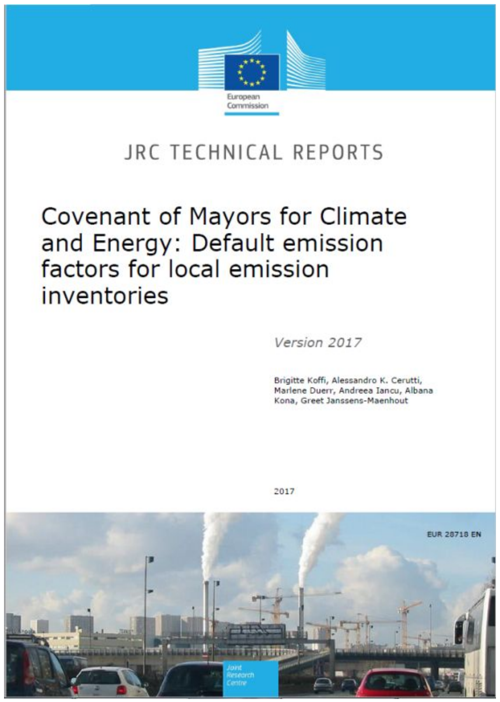
Emission Factors

*An **emissions factor** is a representative value that relates the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.*

www.epa.gov



Annex I - Covenant of Mayors Default Emission Factors - Version 2017

AI.1. CoM default emission factors for fossil fuels and municipal wastes (non-biomass fraction)

Energy carriers[1]		Standard (IPCC, 2006)		LCA[2,4] up to 2007	LCA[3,4] 2008-2015 (current update)
SECAP Template	IPCC denomination	t CO_2 /MWh	t CO_2-eq /MWh	t CO_2-eq /MWh	t CO_2-eq /MWh
Natural gas	Natural gas	0.202	0.202	0.237	0.240
Liquid gas	Liquefied Petroleum Gases	0.227	0.227	n.a.	0.281[a]
	Natural Gas Liquids	0.231	0.231	n.a.	0.272[a]
Heating Oil	Gas/Diesel oil	0.267	0.268	0.305	0.306
Diesel	Gas/Diesel oil	0.267	0.268[b]	0.305	0.306
Gasoline	Motor gasoline	0.249	0.250[b]	0.307	0.314
Lignite	Lignite	0.364	0.365	0.375	0.375
Coal	Anthracite	0.354	0.356	0.393	0.370
	Other Bituminous Coal	0.341	0.342	0.380	0.358
	Sub-Bituminous Coal	0.346	0.348	0.385	0.363
Other non renewable fuels[5]	Peat	0.382	0.383	0.392	0.390[a]
	Municipal Wastes (non-biomass fraction)	0.330	0.337	0.174	0. 295

http://publications.jrc.ec.europa.eu/repository/bitstream/JRC107518/jrc_technical_reports_-_com_default_emission_factors-2017.pdf

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Carbon Footprint of Schools

The target of the EU of reducing by 20% its total emissions within 2020 has activated actions both in private and public sector. Renovation of buildings emerges as an urgent issue, but there is lack of knowledge on performance/cost characteristics of advanced component and systems for efficient renovation of buildings.
TEESCHOOLS project aims at providing new solutions to Local Authorities both in technical and financial terms to implement Nearly Zero Energy Building (NZEB) renovation activities in Mediterranean Schools.

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Carbon Footprint of renovation actions

To evaluate the potential improvements in Carbon Footprint of schools:

- A significative number of schools from different Mediterranean countries have been selected
- Energy Audits including extra information have been conducted
- Data gathered have been used to build models in an LCA software
- Results obtained have been evaluated

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Data source: Energy Audit

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TEESCHOOLS

Transferring Energy Efficiency in Mediterranean Schools

PRIORITY AXIS: Fostering Low-carbon strategies and energy efficiency in specific MED territories: cities, islands and remote areas

OBJECTIVE: 2.1 To raise capacity for better management of energy in public buildings at transnational level

DELIVERABLE NUMBER: 3.3.1

TITLE OF DELIVERABLE: Energy Audits on selected italian schools

WP n. 3: testing

ACTIVITY n. 3.3: Energy Audits and adaptation of the tool

PARTNER IN CHARGE: ENEA

Authors: M.A. Segreto, G. Margareci, M. Piazzi

ANNEX II EVENTS REPORT

Standard data and additional information:

- Energy consumption
- Energy sources
- Area modified
- Materials used and its lifetime

Don Milani Primary School

Don Milani (Primary School - 1950)

Height for each storey	4 m
Heated Volume	3215,946 m^3
Dispersing surface	1783,726 m^2
Shape ratio	0,555 m^{-1}
Total floor surface	658,086 m^2

Type of school	Primary (6-10 years old)
Number of pupils	104
Number of other people that work in it	91
Operational time	30 hours per week
Classrooms	5
Rooms	5 classrooms
	1 kitchen
	1 dining-room
	1 laboratory
	hygienic services
	1 gym

Masonry structure with low insulated walls
PVC windows with double glasses
Concrete pitched roof with shingles and low insulation
All U values are higher respect to law requirements
Heating System with n° 2 methane boilers (h=97,7% - 92,3%) of 109,8 – 26,2 kW with radiators (n.43) and boiler temperature regulation) and not well insulating pipes (h=96,0%)

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Don Milani Primary School

Aim of the renovation plan

- After collecting the preliminary data it is clear that the school building does not meet the minimum requirements of current Italian legislation. It is therefore necessary to conduct an analysis to verify which improvement actions are applicable to achieve the minimum legal requirements or even to reach the nZEB class.

Energy demand reduction

- For Don Milani school the goal to reach is the nZEB classification. Different improvement actions were evaluated and the optimal combination that allows to reach nZEB solution whit the lower costs has been chosen.

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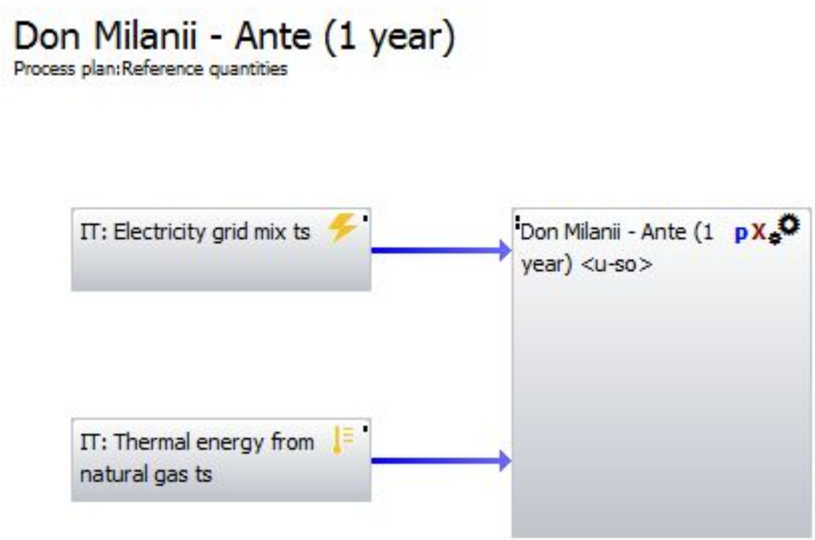
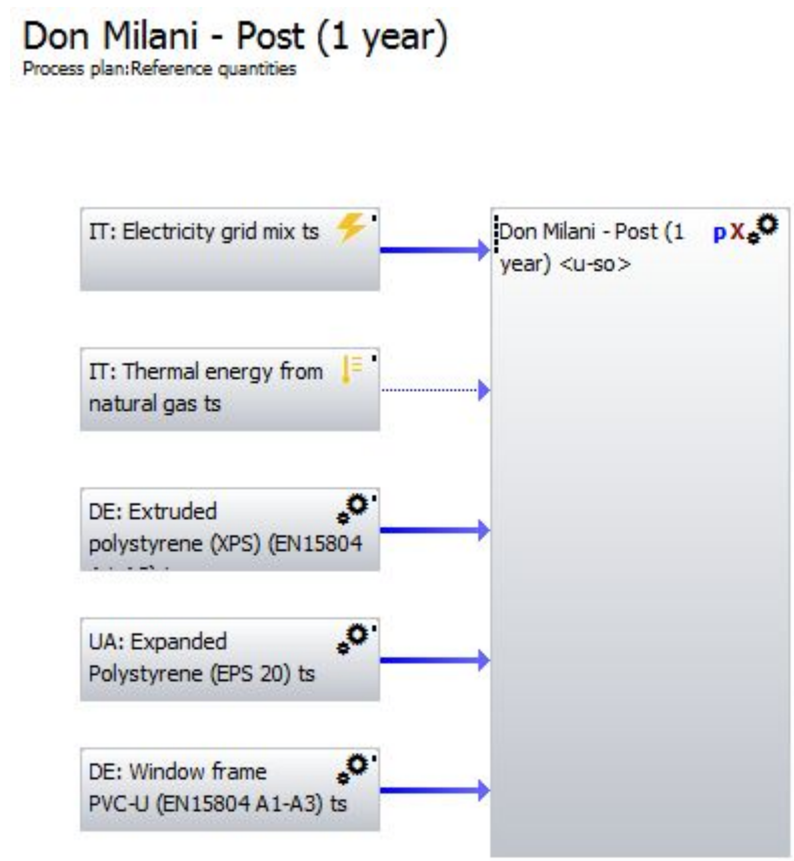
LCA Models





Models built in an LCA software using specific databases allow the calculation of Carbon Footprint deriving from energy and materials used in the renovation

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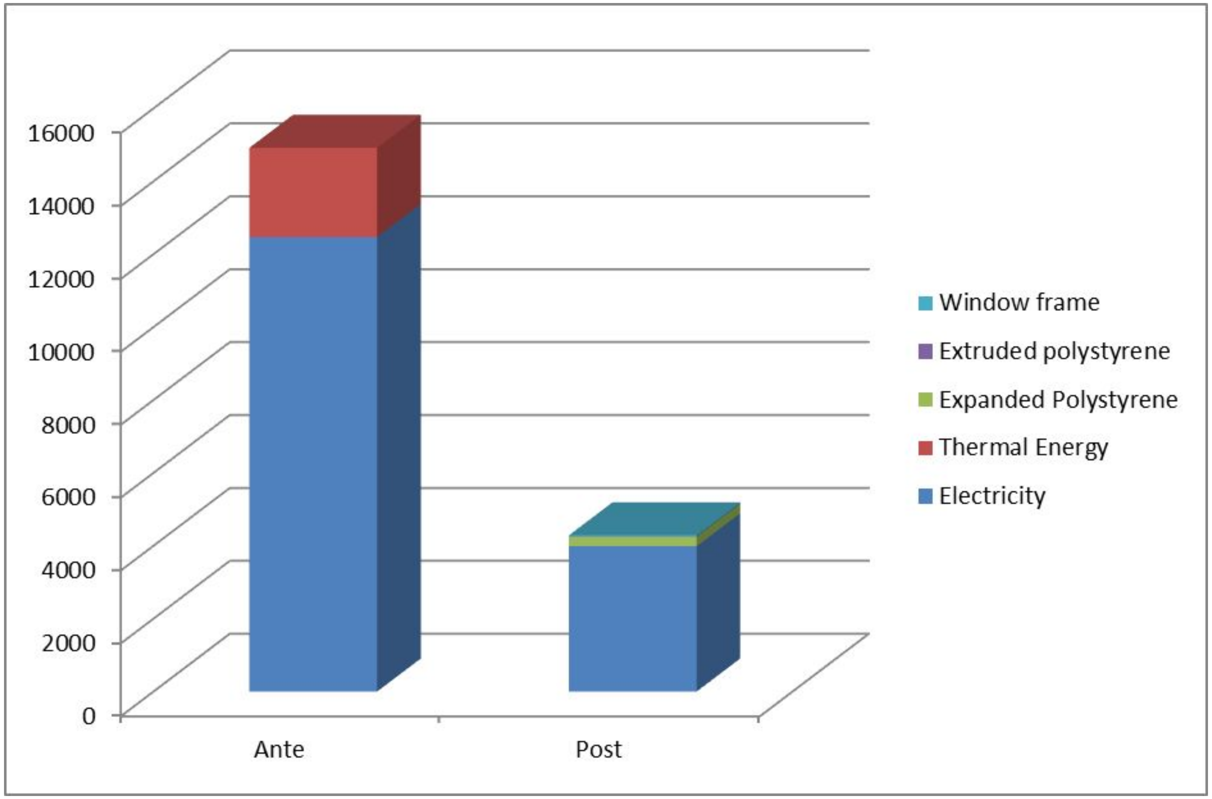
Results



After the proposed renovation, the school overall emissions decreased of around 70% respect the initial conditions considering the avoided impacts of the electricity produced. The impact due to the materials used for the restoration contributes for a 7% of the Post intervention emissions.

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Conclusions

- The improving percentages deeply vary among the analysed schools even if we consider schools from the same nation; in fact results obtained show improving in energy and emission saving from around 20 up to more than 90 percent from the initial conditions.
- In some cases the new design showed low advantages compared to the initial one, this was due to the nZEB guidelines that recommend adopting high efficiency systems that are often electrical and can bring to these results in nations where the electricity mix entail high emissions.
- The solution, also suggested by guidelines, is to cover the electricity needs by energy from renewable sources, including energy produced on-site or nearby.
- In some analysed schools a photovoltaic solar system was already present so that the advantage was already calculated into the initial results.

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Conclusions

- Impact due to the production of materials used into the renovation phase have been considered estimating a lifetime of 20 years, the share of impacts depend on different factors, for example it is important to notice that materials can have an important contribution when the retrofitting is significant and when the emission due the energy used are very low.
- Results obtained deeply depend on the staring condition of analysed schools, improvements are significant when buildings are old or where the construction techniques adopted were not intended for energy saving; while when schools were more recent, where in the design and construction phases energy savings in buildings were adopted, where a solar system was already present, results obtained were lower but still significant.
- Finally, it have been noticed that dimensions and layout of buildings can affect the potential improvements that can be achieved.

Thanks for your attention!

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Optimal financing models for energy efficiency projects in schools

Intenal training

Split, 20th September 2018

Partner: HEP-ESCO

Title of the presentation:

Optimal financing models for energy efficiency projects in schools

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TEESCHOOLS

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Content of presentation

- Aim of TEESCHOOL analysis
- Overview of financing models for EE projects
- Results of analisys per country
- Conclusion

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Aim of TEESCHOOL analysis

- Energy renovation is costly, energy renovation to nZEB standard is even more costly
- Schools have limited budgets and capacities to implement energy renovation projects in schools
- The aim of analysis was to investigate situation in participating countries related to:
  - Availability of financing schemes for EE projects in schools
  - Preferred financing models for EE projects in schools
  - Persisting barriers to implementation of EE projects in schools

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Financing models for EE projects

1. Own (budget) financing
2. Credit (loan) financing
3. ESCO model
4. PPP model
5. Subsidies (grants)

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Own (budget) financing

- Traditional financing of projects in cities and municipalities relies dominantly on the use of own budget.
- One of the financing challenges facing municipalities, more often for smaller municipalities rather than larger ones is the insufficient revenue base with which to fund projects (not only EE projects, but also other development projects as well). An insufficient revenue base, which may be the result of a small number of tax-paying commercial businesses and/or high-income residents, can reduce the availability of adequate funds for capital investments.
- Municipalities depending on revenue transfers from regional or national governments often have limited revenue-raising powers. Such limitations imply that any decision to invest in an EE project either requires the municipality to reallocate funds or convince higher levels of government that the EE project is economically viable. This may often not be a simple task.
- Reliance on transfers from other levels of government also exposes municipalities to the risk that permitted levels and uses of funds may be affected by changes in national budgetary or political priorities. This introduces further uncertainties and makes commitment to multi-year programs of capital expenditures more difficult.

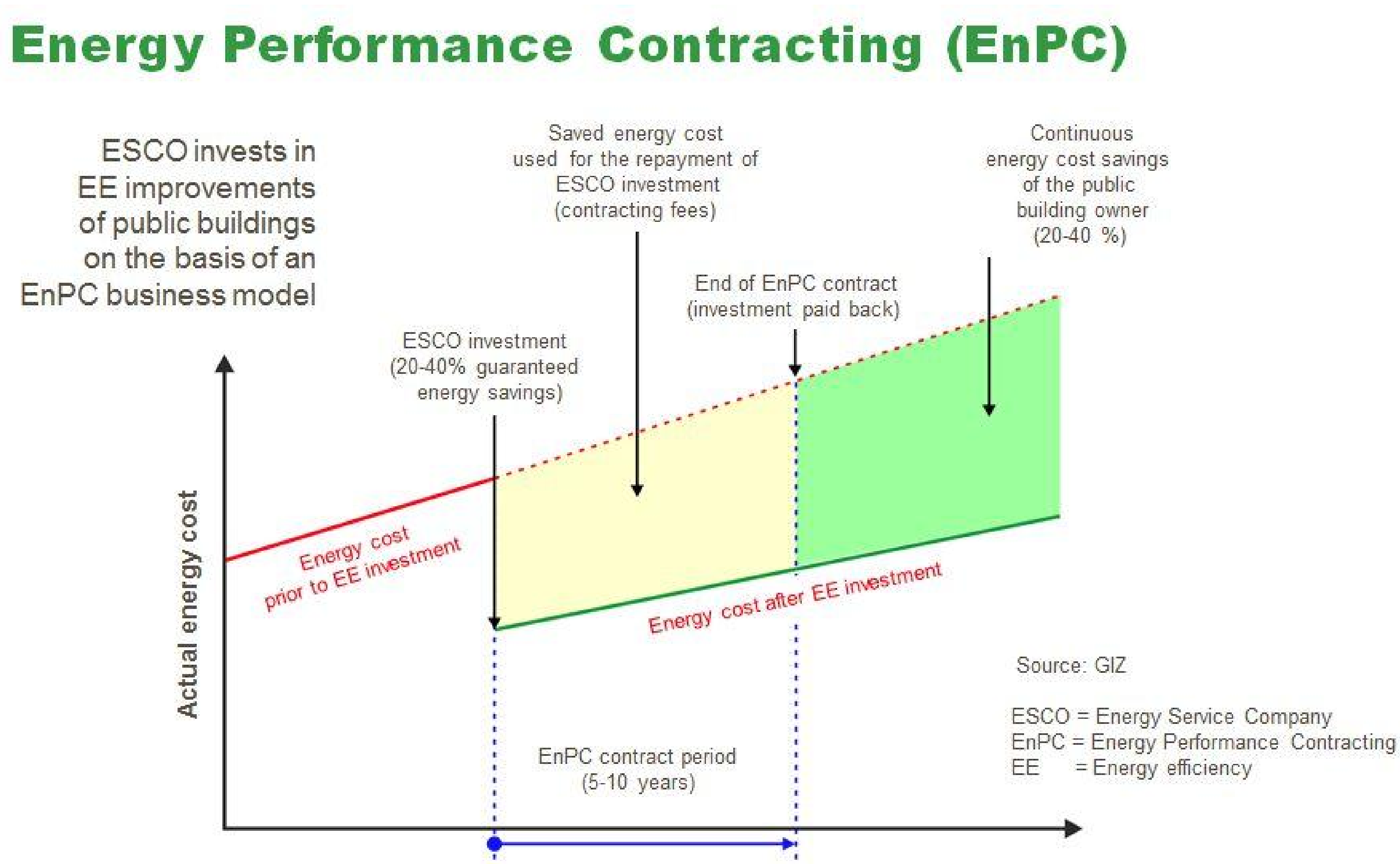
Credit (loan) financing

- National governments often impose limits on borrowing by municipalities to prevent them getting into financial difficulties. These restrictions may take the form of limits on the use of loan funds and/or on the total amount that municipalities may borrow. In both cases, EE projects are likely to lose out, because they are not typical capital expenditure projects that can be readily assessed and approved by higher authorities. In addition, when debt ceilings are in place, EE projects, with relatively low public profiles, are likely to have a lower priority than other pressing or mandated needs.
- Soft loans are dedicated credit lines for EE measures extended to end users at preferential terms in terms of maturity and/or interest rates. Such credit lines are often provided by national or international development banks (such as European Investment Bank (EIB) and European Bank for Reconstruction and Development (EBRD) and are further distributed to designated markets through regional partner retail banks.

ESCO model

- ESCOs are companies that work on a basis of energy performance contracts (EPC). In an energy EPC arrangement, the ESCO is responsible for **optimizing building services systems and system operations in existing buildings across all branches of construction and maintenance.** The main service provided by the ESCO is a guaranteed level of savings over a defined period.
- Before a tender is made, an energy cost baseline is determined for the building (or building pool) or facility. This is usually based on the energy consumption of the calendar year prior to commencement of the EPC, which is often also compared to the two preceding years in order to eliminate extreme climatic influences, usage fluctuations, etc. The evaluated baseline data is climate adjusted on the basis of mild or hot days (annual degree days). Proceeding from the energy cost baseline, the ESCO guarantees an annual energy cost savings (in EUR, calculated on a fixed price basis with the energy prices of the reference year) to the customer over the entire contract period. A fixed proportion of these guaranteed savings is set as the contracting fee, which the ESCO receives from the client to finance the investment, maintain the installations and attain a profit margin. Usually, the fee is set lower that the guaranteed saving in order for client to immediately benefit from savings.

ESCO model



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ESCO model

„Quasi” ESCO	EPC
Delivery of EE project (equipment and works)	Delivery of energy service
After implementation assets are transfered in public partner's books	After implementation assets remain in books of service provider
One invoice, repayment through payouts	Successive periodic (monthly) invoices, increased for VAT
It represents the indebtedness of public partner (investment costs)	Does not represents the indebtedness of public partner (operating costs)
Risks are divided	Risks are on the side of the service provider
Maintenance and insurance are obligation of public partner	Maintenance and insurance are obligation of the service provider
Projected (contracted) savings	Guaranteed (measured and verified) savings
There is no penalties mechanism in case of non-achievement of contracted savings	There is penalties mechanism in case of non-achievement of contracted savings

ESCO model

- In the 5th month of 2018, Eurostat announces a long-awaited guide: A Guide to the Statistical Treatment of Energy Performance Contracts http://www.eib.org/attachments/pj/guide_to_statistical_treatment_of_epcs_en.pdf
- Detailed description of all aspects of the EPC contract and its effects:
  - Legal ownership and access rights
  - Specification, design, construction and installation of the EPC assets
  - Maintenance and operation of the EPC assets
  - The Guaranteed Savings
  - The payment mechanism
  - Compensation, relief and force majeure events
  - Changes to the EPC
  - Changes in law
  - Insurance
  - Warranties and indemnities
  - Early termination of the EPC
  - Compensation on early termination of the EPC
  - Expiry of the EPC
  - Financing arrangements
  - Government influence

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PPP model

- A Public-Private Partnership (PPP) arrangement differs from conventional public procurement in several respects. In a PPP arrangement the public and private sectors collaborate to deliver public infrastructure projects (e.g. roads, railways, hospitals) which typically share the following features:
  - a long-term contract between a public procuring authority (the "Authority") and a private sector company (the "PPP Company") based on the procurement of services, not assets;
  - the transfer of certain project risks to the private sector, notably with regard to designing, building, operating and/or financing the project;
  - a focus on the specification of project outputs rather than project inputs, taking account of the whole life cycle implications for the project;
  - the application of private financing (often "project finance") to underpin the risks transferred to the private sector; and
  - payments to the private sector which reflect the services delivered. The PPP Company may be paid either by users through user charges (e.g. motorway tolls), by the Authority (e.g. availability payments, shadow tolls) or by a combination of both (e.g. low user charges together with public operating subsidies).

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PPP model

- The rationale for using a PPP arrangement instead of conventional public procurement rests on the proposition that optimal risk sharing with the private partner delivers better “value for money” for the public sector and ultimately the end user.
- PPP arrangements are more complex than conventional public procurement. They require detailed project preparation and planning, proper management of the procurement phase to incentivise competition among bidders. They also require careful contract design to set service standards, allocate risks and reach an acceptable balance between commercial risks and returns. These features require skills in the public sector which are not typically called for in conventional procurement.

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Subsidies (grants)

- Most of available grant schemes are based on the use of European Unison structural and investment funds (ESI). EE projects in buildings belong to projects that generate net income after completion, i.e. the energy cost savings of the project are treated as net income.
- Under the preamble (paragraph 13) of the Delegated Regulation 480/2014, as well as under recital (paragraph 58) of Regulation 1303/2013 of the EU, it is necessary to accurately calculate net income to ensure the efficient use of Union funds and to avoid over-financing of projects. Determining the share of co-financing by the Union should reflect the rule of non-profit - grants must not result in earning a profit. If they are profitable, it is necessary to conduct a financial analysis to determine the financing gap, the assessment of the need for grant and the amount of potential grants. Therefore, the purpose of co-financing through grants is to close the financing gap that is generated in energy efficiency projects when the investment in energy efficiency cannot be paid off from savings on energy costs. GUIDANCE FOR BENEFICIARIES of European Structural and Investment Funds and related EU instruments, EC, 2014 (http://ec.europa.eu/regional_policy/sources/docgener/guides/synergy/synergies_beneficiaries.pdf)

Overview of financing models for EE projects

Criteria/ Model	Own financing	Loan financing	Grants	ESCO model	PPP model
Neutral impact on government debt	◫	☹	◫	◫	◫
Administrative procedure complexity	◫	◫	◫	◫	☹
Guarantee of savings / service standard	☹	☹	◫	◫	◫
Capacities and capabilities of the public bodies to implement the model	◫	◫	◫	☹	☹
Estimated multiplier effect	☹	☹	◫	◫	◫
Projects for which the model is appropriate	Simple EE measures with short pay-back periods	Simpler EE measures with shorter pay-back periods	More complex projects, with longer pay-back periods	Highly complex projects, with moderate pay-back periods (up to 10 years)	Highly complex projects, usually with new buildings, long-term

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Questionnaire results per country – available& acceptable financing schemes

Country	Criteria/ Model	Own financing	Loan financing	Grants	ESCO model	PPP model
B&H	Availability	√	√	√	√	-
	Acceptability	√	√	√	√	-
Croatia	Availability	√	√	√	√	-
	Acceptability	√	-	√	√	-
Cyprus	Availability	√	√	√	√	-
	Acceptability	√	√	√ (if grant scheme for public sector is to be established)	√	-
France	Availability	-	√	√	-	-
	Acceptability	√ (only if planned as priority)	√	√ (if available)	-	-
Greece	Availability	-	√	√	√	-
	Acceptability	√	√	√	-	-
Italy	Availability	√	-	√	√	√
	Acceptability	√	-	√	~ (only if model is further developed)	-
Spain	Availability	√	√	√	√	-
	Acceptability	√	-	√	-	-

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Questionnaire results per country – preferred financing models

Criteria/ Model	Own financing	Loan financing		Grants	ESCO model	PPP model
		Interest rate %	Duration year	Grant rate %		
B&H	√	1.25	10	40	20%	
Croatia	√			45	20%	
Cyprus	√	3.00 -5.00	7 - 10	n/a (up to 50% based on similar schemes)		
France	√	< 1.00	5 - 7	n/a		
Greece	√	3.00 -5.00	5 - 7	100		
Italy	√			65	20%	
Spain	√			100		

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Questionnaire results per country – persisting barriers to implementation of EE projects in schools

- <u>Administrative and legal barriers</u>:
  - *lack of **construction permits** and other documents that are required for application for grants as well as **unsolved land registry and ownership issues**; lack of **technical expertise and data**; **complicated procedures** for obtaining grants; many schools are under **architectural heritage protection**; **no specific environmental requirements** for renovation of existing buildings (unlike for construction of new buildings)*
- <u>Financial barriers</u>
  - ***irregular offer of grants**; **insufficient pre-planned budget** for implementation of EE measures; procedures for loans for ESCO model are too **time consuming**; **debt limitations** of local public authorities, which are the owners of schools*
- <u>Accounting barriers</u>
  - ***no system for energy data and bills collection**; the latest **Eurostat guidelines** on accounting if Energy Performance Contracting has not been transferred yet to national legislative framework; **public procurement legislation** does not provide clear guidelines for EE projects based on ESCO model*

Conclusion

- Various financing models available and used for EE projects
- No strict nZEB standards for energy renovation
- Planning of own budget, debt limitations and capacities of schools to implement EE projects are universal problems
- Through TEESCHOOLS project calculation tool to demonstrate pros and cons of each financing model developed and tested based on inputs from energy audits

Thanks for your attention!

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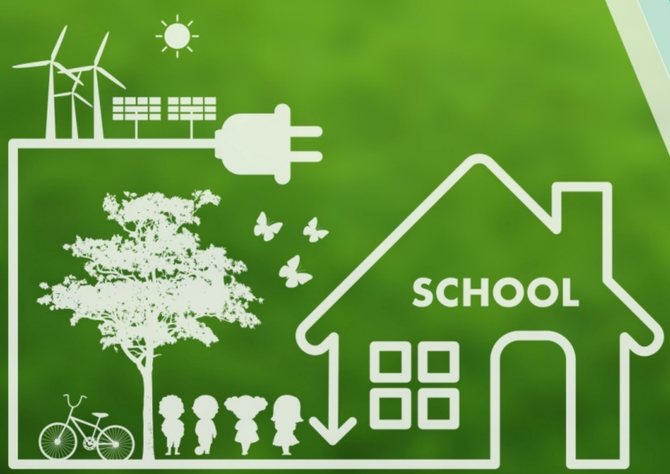
WEB TOOL PRESENTATION AND APPLICATION



TRAININGS

SPLIT 20th SEPTEMBER 2018

Partner: ENEA

Title of the presentation:

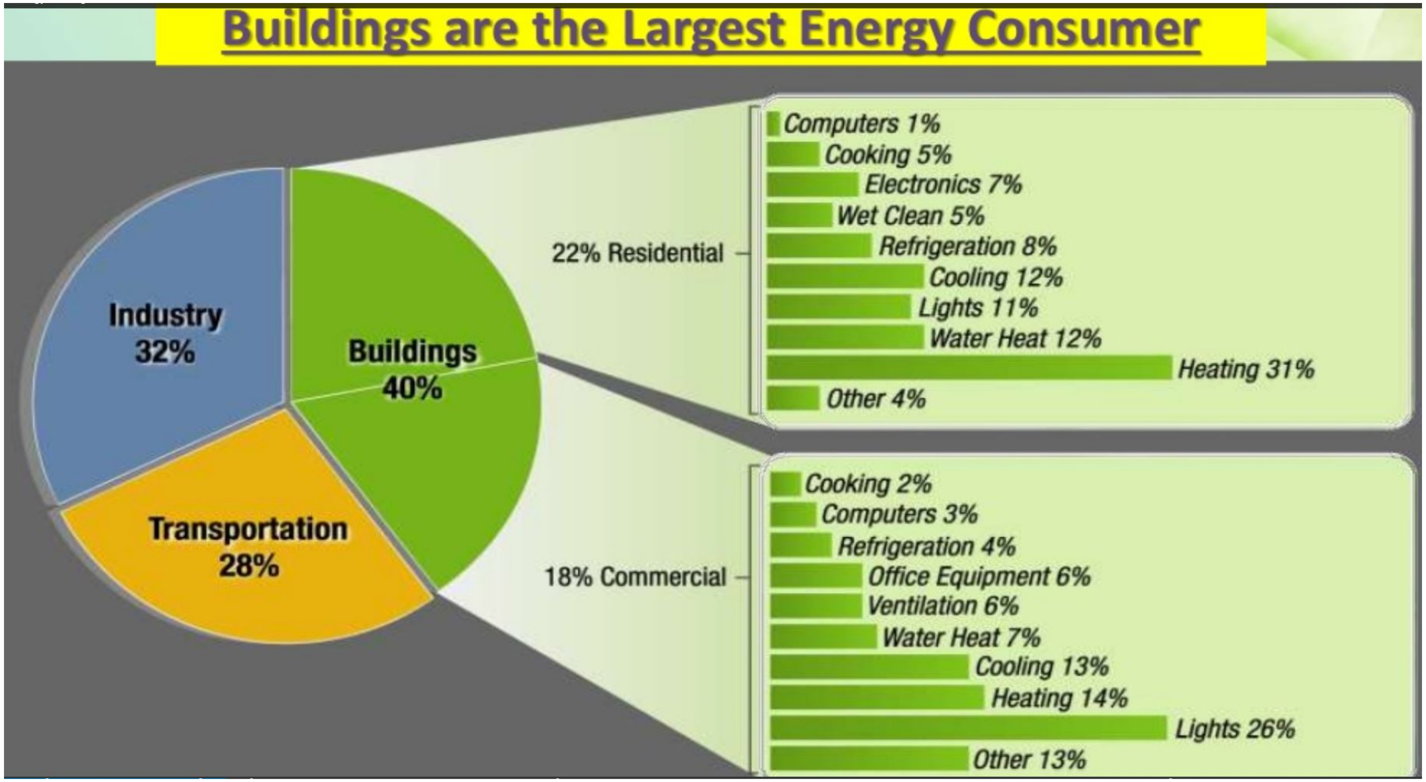
WEB TOOL PRESENTATION AND APPLICATION

M.A. SEGRETO, G. MARGARECI,

Interreg Mediterranean
TEESCHOOLS
Project co-financed by the European Regional Development Fund

INTRODUCTION

The schools buildings, like all the other buildings, have high energy consumption for heating, for the production of hot domestic water, for lighting and for other services (ventilation, cooling, internal transportation…).



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INTRODUCTION

Sometimes energy used isn’t the most appropriate for the final service, in other cases the system for the production and distribution of energy have low performances or the energy use doesn’t take place in the best way (high heat losses in distribution net, overheating, high energy losses through winwows…).

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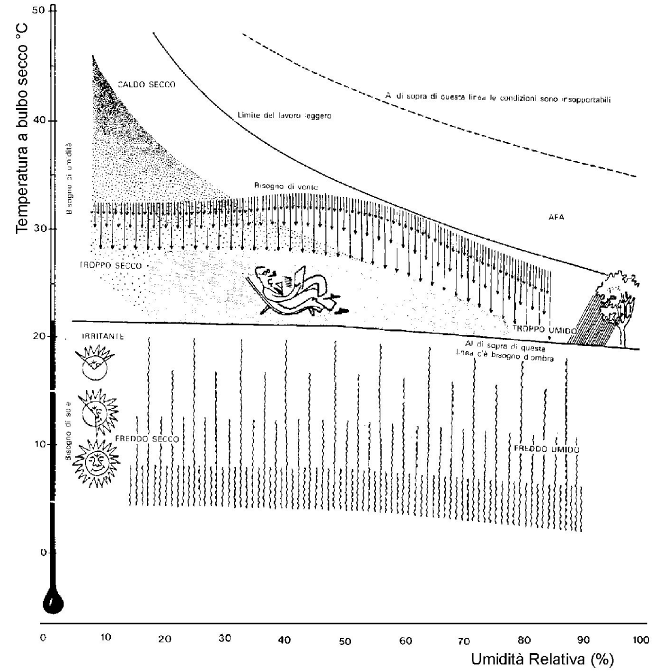
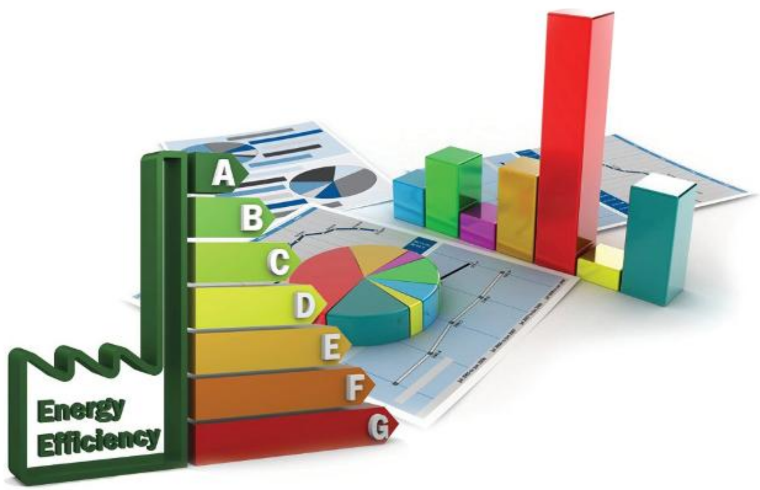
INTRODUCTION

In all these cases there is a greater use of resources than necessary, with negative effects both on the users comfort and on the waste of money.

To help stakeholders interested in school buildings, a web tool has been developed with the aim to simplify the analysis of the actual state of a school building and the implementation of energy improvement actions.





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WEB TOOL

One of the most important aim of TEESCHOOLS Project is developing a simplified web tool to allow stakeholders, involved in school buildings, to make evaluations on the savings achievable through energy improvement actions.

It is important to remember that the tool is not a design tool. The design of improvement actions must be entrusted to professionals (engineers, architects, energy expert…) choose by the school manager.

The tool, however, furnishes the possibility to evaluate if it is the case to proceed with a deepened energy audit and then it allows to evaluate what is the intervention that can give the greatest savings.

In fact the tool allows to appraise the weight of every single action in comparison to the total saving.

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WEB TOOL: STATE OF THE ART

The developed web tool allows knowing the energy quality of the schools building, evaluated with respect to the average value of the national school consumption.

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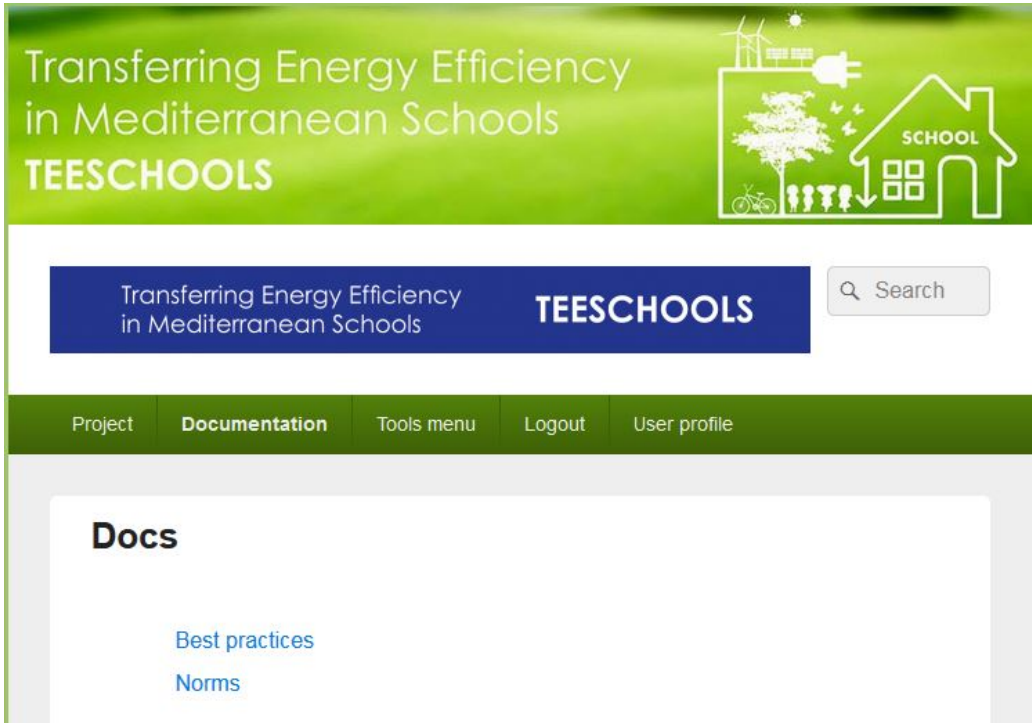
WEB TOOL: IMPROVEMENT ACTIONS



It also allows to identify the simplest interventions to improve the energy quality of the school buildings and to evaluate the opportunity of carrying out, through an energy specialists, more in-depth energy audits.

In the website you can also find other materials:

- Project information
- Norms and local Regulation
- Collection of Best practises

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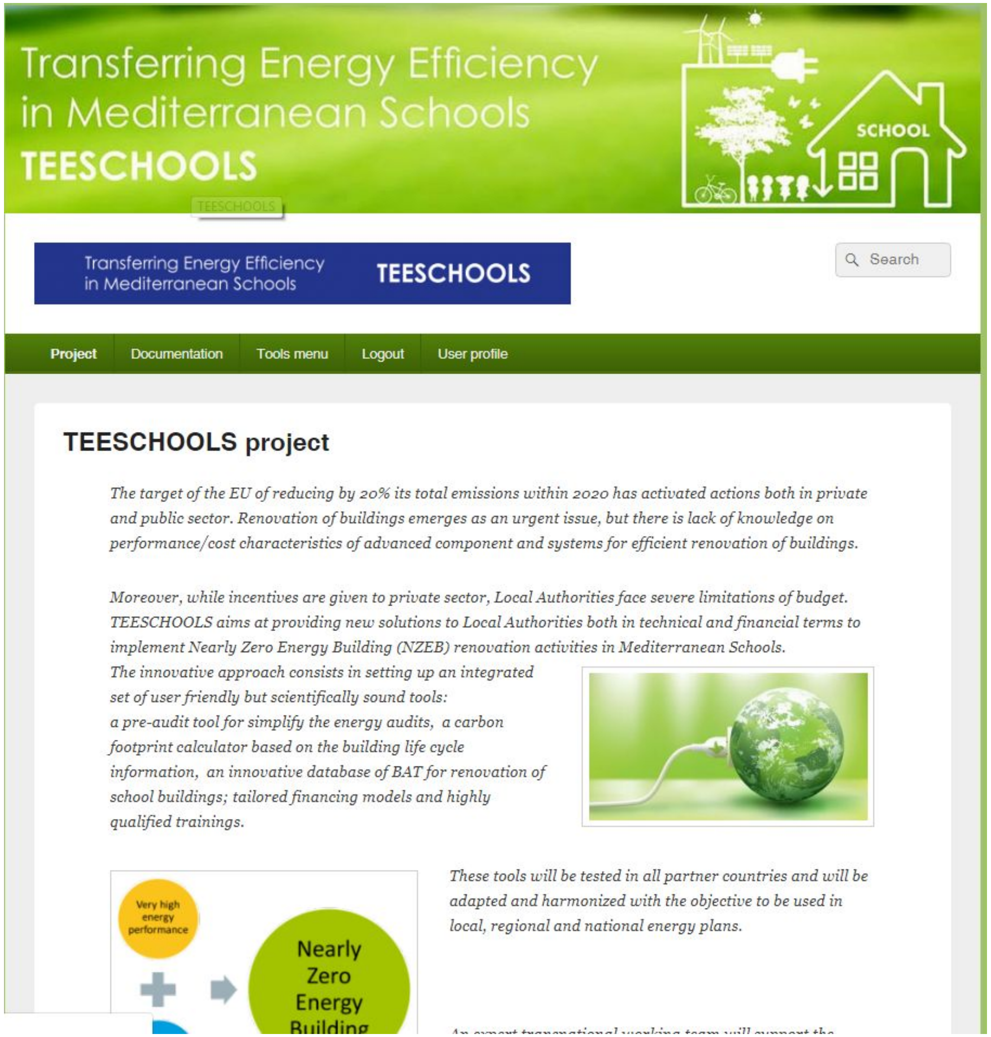
WEB TOOL

The evaluation of energy quality of the school building takes place through the comparison with a representative sample of similar schools. The examples used for the comparison were originate from a series of complex energy audits performed in different European countries (TEESCHOOLS project partners).

In the picture it is shown the home page of the web tool.

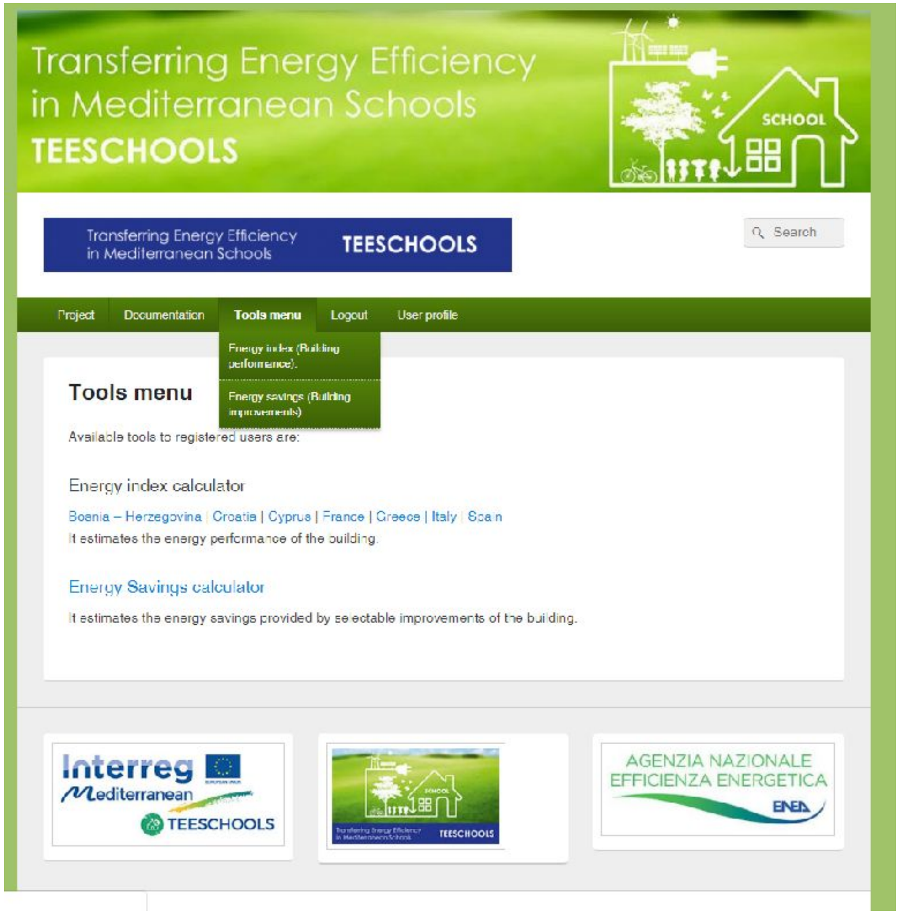


WEB TOOL

In the link bar you can choose the action for your evaluation:

- Building performances (state of art)
- Building improvement

And you can choose your Country.



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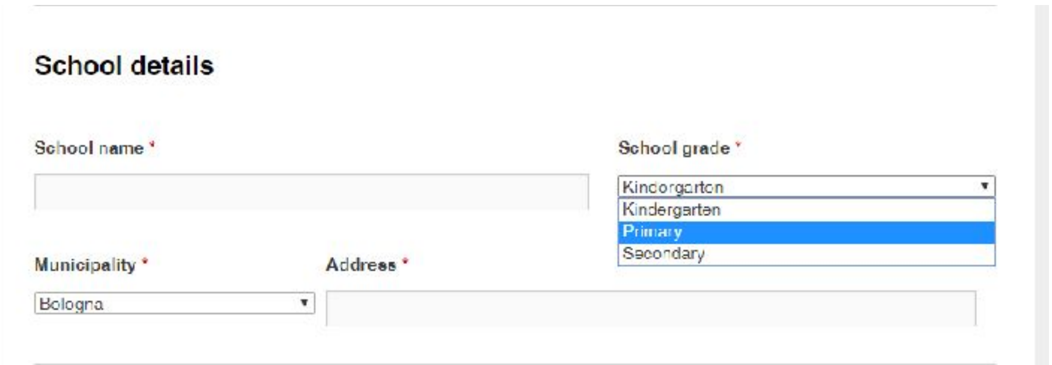
WEB TOOL

Characteristics of schools and areas of application

The web tool evaluation can be applied to different type of school buildings:

- Preschool
- Primary
- Secondary



Other data are:

- School name
- Municipality (this data defines your climatic condition)
- Address

WEB TOOL

Calculation method for specific energy consumption in the schools

To determine the energy indicators the single phases below indicated must be follow:

1. **CONSUMPTION EVALUATION**
2. **GROSS HEATED VOLUME, GROSS AREA OF THE FLOORS AND DISPERSING SURFACE OF BUILDINGS COLLECTION**
3. **DEGREES DAYS (K_D) OF THE CITY IN WHICH IS LOCATED THE SCHOOL**
4. **HEATING CONSUMPTION NORMALIZATION FACTOR, DEPENDING ON THE SHAPE OF THE BUILDINGS**
5. **THE OPERATING TIME NORMALIZATION FACTOR FH**
6. **NORMALIZED ENERGY INDICATORS CALCULATION**

WEB TOOL

Type	Year (0)	Year (-1)	Year (-2)	Average	
Methane gas	0	0	0	0.00 m^3	x 9.59 = 0.00 kWh_t
Diesel fuel	0	0	0	0.00 l	x 11.86 = 0.00 kWh_t
Fuel Oil	0	0	0	0.00 l	x 11.40 = 0.00 kWh_t
L P G	0	0	0	0.00 l	x 12.79 = 0.00 kWh_t
Firewood	0	0	0	0.00 kg	x 4.77 = 0.00 kWh_t
Coal	0	0	0	0.00 kg	x 8.15 = 0.00 kWh_t
Electric Energy	0	0	0	0.00 kWh	kWh_t

STEP 1 – CONSUMPTION EVALUATION

As a firts step, the energy consumption for heating per year detected by the bills relating to the previous 3 years will be collected.

The fuel consumption of three years is added together and divided by 3 obtaining the annual average fuel consumption.

The same will be done for electricity.

The data of annual consumption of fuel and electricity, should be registered in specific tables as shown in the picture.

Contract ID	Year (0)	Year (-1)	Year (-2)	Average
Electric Contra	kWh	kWh	kWh	0.00 kWh
Electric Contra	kWh	kWh	kWh	0.00 kWh
Electric Contra	kWh	kWh	kWh	0.00 kWh

Electricity average total = 0.00 kWh_t

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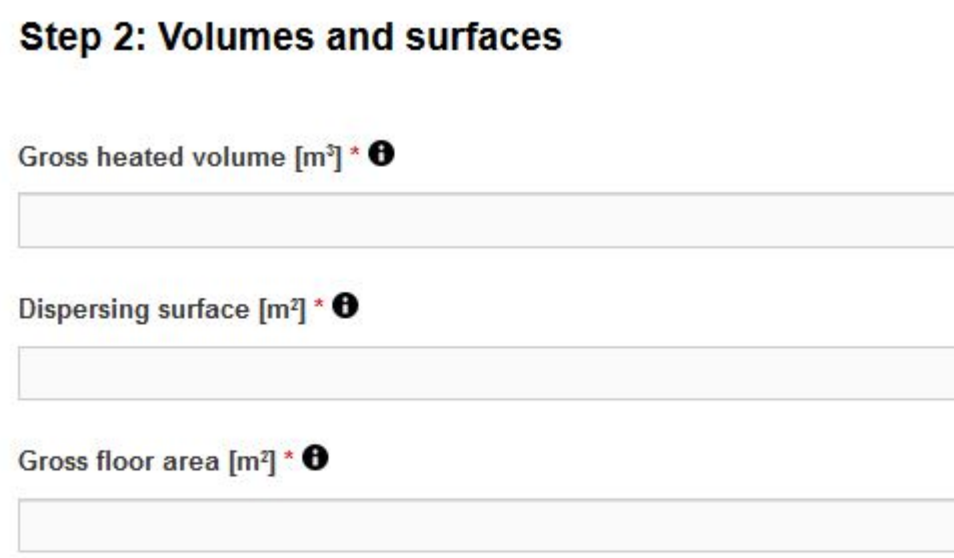
STEP 2 – COMPILATION OF SPECIFIC BUIDING DATA: GROSS HEATED VOLUME, GROSS AREA OF THE FLOORS AND DISPERSING SURFACE

The gross heated volume

It is obtained from the drawings, if they are available, or the building can be measured from the outside. In the gross heated volume, the external walls must be included and the not heated parts of the buildings must be excluded (undergrounds, attics, stores, garage...).

If the school building consists of several buildings, Volume will be the sum of the volumes of the individual building.



WEB TOOL

The gross floor Area

It is obtained from the drawings, if they are available, or the building is measured from the outside. In the gross heated volume, the external walls must be included and the not heated parts of the buildings must be excluded (undergrounds, attics, stores, garage...).

If the school building consists of several buildings, Volume will be the sum of the volumes of the individual building.

Step 2: Volumes and surfaces

Gross heated volume [m^3] *

Dispersing surface [m^2] *

Gross floor area [m^2] *

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WEB TOOL

The dispersing surface

The dispersing surface is obtained from the sum of the individual surface of the gross heated volume V (walls, roofs, ground floor slabs).

Is not considered as a dispersing surface all walls or slabs that are connected to other heated buildings. If the school consists of several buildings S will be the sum of the dispersing surfaces of the individual buildings.

Step 2: Volumes and surfaces

Gross heated volume [m^3] *

Dispersing surface [m^2] *

Gross floor area [m^2] *

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WEB TOOL

STEP 3 - DEGREE DAYS OF THE PLACE IN WHICH IS LOCATED THE SCHOOL

To compare heating consumption, it is necessary to consider the climatic differences in the Country and the Municipality in which the school buildings are located. According to this issue, consumption is released from climatic differences through the use of degrees day (DD). is obtained as the sum of the positive differences between the internal comfort temperature and the outdoor daily average temperature.
The summation is extended to all the heating days of the winter season.

Location ………

DD……………….

Step 3: Degree days (DD)

For the selected municipality Bologna you have 2,259.00 DD

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WEB TOOL

PHASE 4 - HEATING CONSUMPTION NORMALIZATION FACTOR

The specific consumption of schools buildings must be normalized with a factor depending on shape.

It is expressed by the ratio between the buildings dispersing surface and its heated volume (S/V).

The normalization factor Fe is obtained from the following value:

V = ……… m^3
S = ……… m^2
S/V = ……… m^2/m^3

Step 4: Shape normalization factor

Check value:

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WEB TOOL

SHAPE NORMALIZATION FACTOR

Kindergarten

S/V m^2/m^3	Fe
up to 0,25	1,1
0,26 - 0,30	1,0
0,31 - 0,40	0,9
Over 0,40	0,8

Primary

S/V m^2/m^3	Fe
up to 1	1,2
0,41 - 0,50	1,1
0,51 - 0,60	1,0
Over 0,60	0.9

Secondary and High school

S/V m^2/m^3	Fe
up to 0,30	1,2
0,31 - 0,35	1,1
0,36 - 0,40	1,0
0,41 - 0,45	0,9
Over 0,45	0,8

Fe = ……….

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PHASE 5 - THE OPERATING TIME NORMALIZATION FACTOR FH

The normalization factor Fh depends from the operational hours of the school.

The factor Fh will be subsequently multiplied for the specific heating consumption and for the specific electricity consumption.

Step 5: Operating time factor

Time normalizazion factor *

h/day

hours/ days	Fh
Up to 6	1,2
7	1,1
8 – 9	1,0
10 – 11	0,9
Over 11	0,8

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WEB TOOL

STEP 6 - CALCULATE THE NORMALIZED ENERGY INDICATORS

After the insertion of all previous data we can calculate the two normalized indicators NEIh e NEIe and classifying the building energy performances.

NORMALIZED ENERGY INDEX FOR HEATING

NEIh = 7.78 Wht/m³ x DD x year

Heating rating:

GOOD

NORMALIZED ENERGY INDEX FOR ELECTRICITY

NEIe = 33.00 kWhe/m² x year

Electricity rating:

BAD

Click **Next** to send a summary to your e-mail address and go to the "Improvements" tool.

Next

NEI_h= (PHASE 1 x PHASE 4 x PHASE 5 x 1000)/(PHASE 2 x PHASE 3) $\mathbf{Wh_t/m^3*DDx*y}$

NEI_e= (PHASE 1 x PHASE 3)/(PHASE 2) $\mathbf{kWh_e/m^2*y}$

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WEB TOOL

CALCULATE OF SPECIFIC ENERGY CONSUMPTION OF THE SCHOOLS

Reference sample

The evaluation of the specific consumption is carried out by **comparing** the specific consumption data with those from the **reference sample**.

Identification of energy classes

The energy class of the school building is identified according a reference tables that take into account the specific consumption data compared with those from the reference sample. Averge data come from energy audits (pilots of project partner, scientific paper, National studies…)

Evaluation of results

If the NEI value is "sufficient", to the school building is associated an average consumption and it is advisable to propose improvement actions

If the NEI value is "good", the school building has efficient systems and good management than **no improvement actions is obliged** but it is advisable to propose improvement actions to reach the nZEB class.

If the NEI value is "insufficient", it is **necessary identify deep interventions** to improve school building energy efficiency.

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WEB TOOL

INTERVENTIONS OF RATIONAL ENERGY USE OF FOR SCHOOLS

The energy efficiency improvement can be obtained, in general, with several actions:

- Improvement actions on the **building envelope** to reduce heat losses
- Improvement actions on **heat production systems** for heating and hot domestic water
- More conscious **behaviour** on energy management of school buildings.
- Adoption of **innovative technological or management systems**

In the second part of TEESCHOOLS web tool you can choose different improvement actions to evaluate savings.

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WEB TOOL

Elements	U_{old}	U_{new}	Area	Energy Saving	% Saved
Glazing	single glass + woo	Best Insulation	35	7,780.00	3.98 %
Roof	Bricks + concrete r	Best Insulation	350	31,309.74	16.04 %
Walls	Solid masonry wall	Good Insulation	1200	117,757.15	60.31 %
Floor	Bricks + concrete s	Insulation	350	26,565.84	13.61 %

What plants do you want to change?

η_{old} and P_{old} [kW] are the efficiency and the installed power before the renovation, η_{new} and P_{new} [kW] are the efficiency and the installed power after the renovation, while hh are the working hours.

Heat Generator	η_{old}: 0.85	η_{new}: 0.98		1,272.14	0.65 %
Lights	P_{old}: 16	P_{new}: 4	hh: 880	10,560.00	5.41 %

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Thanks for your attention!

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Cyprus Energy Agency

ΕΝΕΡΓΕΙΑΚΟ ΓΡΑΦΕΙΟ
ΚΥΠΡΙΩΝ ΠΟΛΙΤΩΝ

Del. 4.4.2 - Training package

4th Project Meeting

Split, Croatia | 18 – 20 SEP 2018

Partner: Cyprus Energy Agency [M.A.]

Title of the presentation: Behavioural change for energy efficiency at schools

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Behavioural change for EE at schools

1. Background – Introduction
2. Why behavioural change?
3. Challenges for energy-saving through behavioural changes in public/private organisations
4. Overcoming the barriers – Steps to behavioural change
5. How is behavioural change implemented in schools
6. A Successful example
7. Additional info – Tips [Literature Review]

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Introduction

…The fact is, you can build two identical buildings, right next to each other—with the same insulation levels, the same windows, the same appliances, and the same lighting—and the energy bills for those homes can differ by a factor of two, because they are operated differently…

Changing Behavior and Saving Energy (December 20, 2012) – The building green blog post

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Introduction

Raising the environmental awareness of children must begin early at school, where children are socialised, shaping viewpoints and behaviours, setting the foundation for their future life.

The role of the teacher -and of any authority figure- in this effort is paramount. Teachers can influence their students and contribute to more suitable behaviour of the younger generation regarding energy and the environment.

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Behavioural change for EE at schools

Introduction

Every school is **a small community**, in addition to the students and the teachers, we also have the administrative staff, the cleaning staff, the technical staff and people working at the schools' canteens. All these people are also important for the energy efficiency and the environmental approach of a school, therefore when speaking for behavioural change, one should not only focus in students.

An integrated approach should be used.

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Behavioural change for EE at schools

Why behavioural change?

Energy use is an important part of a schools' expenditures. You can always make changes to the infrastructure or improve already existing equipment or to acquire new equipment that is more efficient. Those things end up costing a lot of money to start and then, years later, you most probably run into the same problems.

Changing energy related behaviour can potentially save about

19% (±5%)

of our energy consumption

So why not make a change in an individual person's behaviour?

Doing some small things can make a big difference to the energy consumption and the energy bills. Behavioural change is the basis for important energy savings at school premises.

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Behavioural change for EE at schools

Why behavioural change?

The potential of behavioural change policies

Energy behaviour is either investment or habitual behaviour. The former typically involves the adoption of a new technology, perhaps the purchase of a new appliance. Habitual behaviour is routine behaviour such as turning off the lights when leaving a room. **Changes in this behaviour can lead to important savings in energy use.**

Factors which influence the attitudes of students towards the energy efficiency are **the features of their family environment, their energy education at school and social interaction.** Through the activities of an appropriate educational curriculum the students can revise their personal values, understand the good called energy and learn to use it rationally.

Challenges for energy-saving through behavioural changes in public/private organisations

1. The users are not motivated to use energy more efficiently as possible savings do not benefit themselves but those who pay the bills.
2. There are no direct economic incentives or impact to proceed with energy savings
3. Due to (usually) high number of users, individual effort is less apparent
4. When feedback is at group level the results of once actions can not be evaluated
5. There is not a full or direct control over systems operation / maintenance

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Challenges for energy-saving through behavioural changes in public/private organisations

The design and delivery of behaviour change programmes related to energy efficiency **can differ greatly when comparing domestic to non-domestic consumers**. The potential for savings through behaviour change is thought to be greater in the domestic environment, where there is more direct control over energy consumption.

In the non-domestic sector, initiatives are normally delivered at the organisational or sub-organisational level, and **there is no direct link to personal wealth of the individual employees**. Motivation for users/employees to engage in energy efficiency behaviours is therefore very different. Generally it is believed that **people do not behave rationally with respect to energy usage in places that they are not responsible for energy bills.** This is mainly because they would not benefit directly from initiatives to reduce energy consumption in a commercial setting.

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Behavioural change for EE at schools

Overcoming the barriers - Steps to behavioural change

Energy efficiency/conservation initiatives use several different types of interventions:

1. **Communication and engagement:**

information and promotion, training, personal advice and one-to-one engagement, demonstrations, benchmarking, commitment, goal-setting, labelling, prompts, modelling, feedback;

2. **Economic incentives and disincentives:**

subsidies, levies, surcharges, taxes, bonuses, tax differentiations, tax refunds, financial instruments such as interest free loans, rewards and penalties;

3. **Regulatory:**

general laws and rules, specific exemptions, covenants and agreeme

regulated versus dynamic energy pricing

Behavioural change is connected with all these

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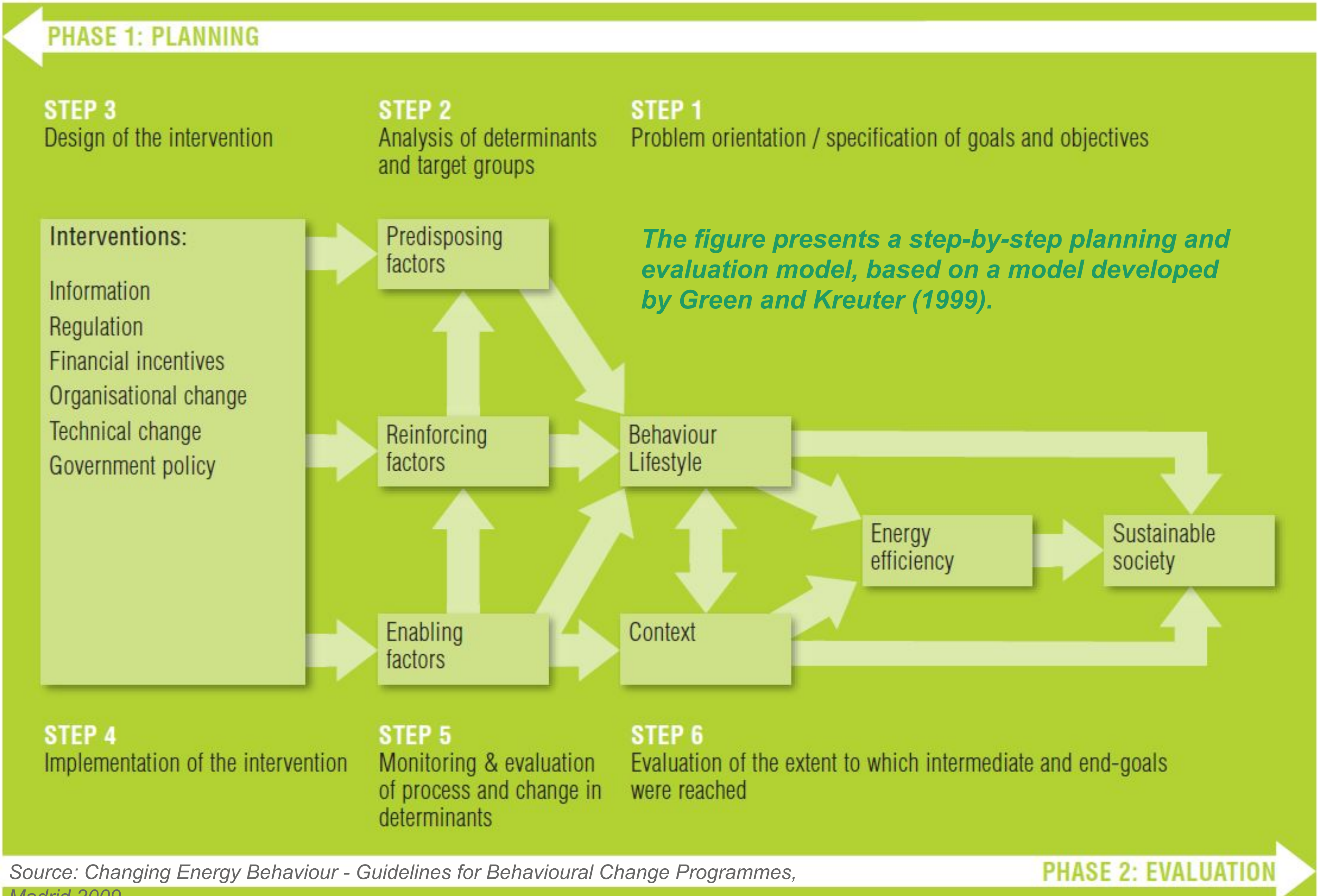
Figure 4. Planning and evaluation model

How all the above come together?



Source: Changing Energy Behaviour - Guidelines for Behavioural Change Programmes, Madrid 2009

Overcoming the barriers - Steps to behavioural change

The change-oriented approach - Keep it Simple!

What motivates people to change their behaviour?

According to (Fishbein and Ajzen 2010), the motivational questions are:

- ***"Do I care?"*** (attitude - motivation);
- ***"Can I do the behaviour?"*** (perceived control - ability);
- ***"What will others think of my behaviour?"*** (perceived norm - trigger).

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Overcoming the barriers - Steps to behavioural change

MOTIVATION

ABILITY

TRIGGER →

BEHAVIOUR

The change-oriented approach assumes that behavioural change occurs if people are **motivated** and enabled to change. It focuses on the factors that motivate people to change their behaviour.

Motivation by itself, however, is not enough; one also has to be **able to perform** the desired behaviour. The change-oriented approach therefore also focuses on "enabling factors". These factors are external to the individual.

Finally, if we want a change in behaviour to be permanent, it **requires reinforcement**. "Reinforcing factors" include feedback. These factors are also external to the individual.

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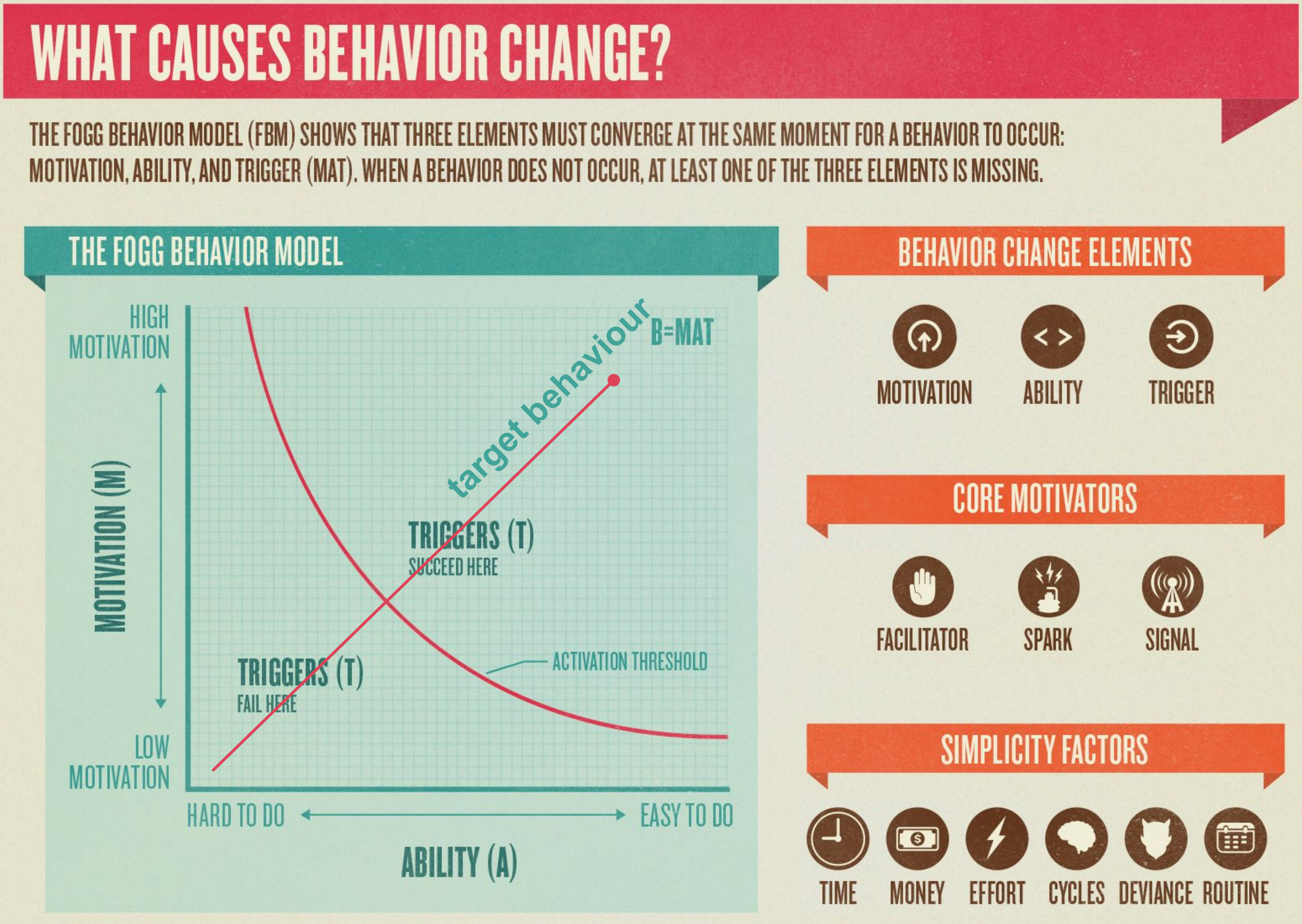


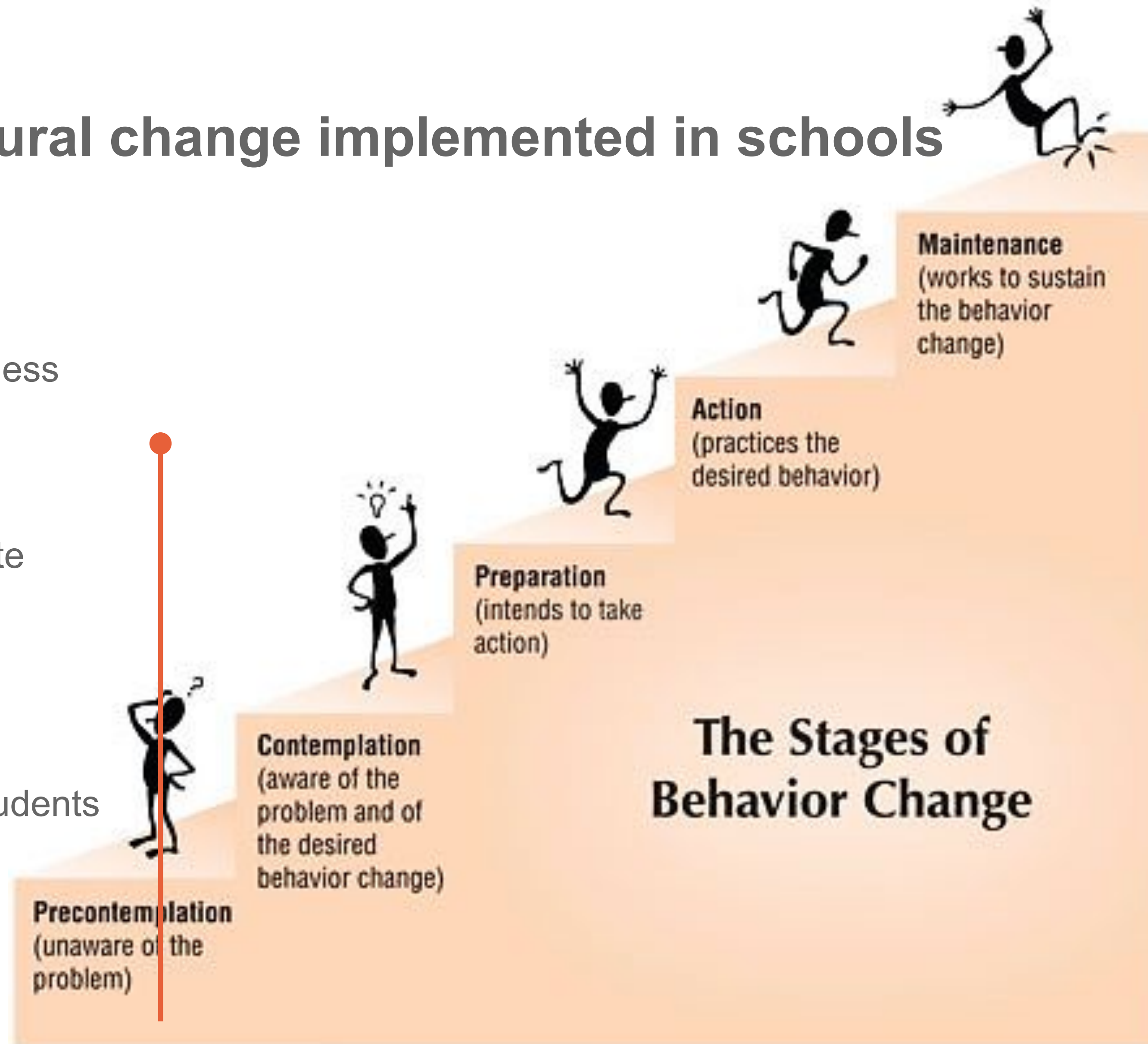
“In general, persuasive design succeeds faster when we focus on making the behaviour simpler instead of trying to pile motivation.”

Behavioural change for EE at schools

How is behavioural change implemented in schools

STEPS:

1. Understand the issue
2. Educate – Raise awareness
3. Prepare - Propose
4. Act! *Soft measures*
5. Maintain and Disseminate



WHO:

1. Educational staff and Students
2. Other staff

So what are the steps for making these types of changes in schools?

How is behavioural change implemented in schools

- First, we want to **see how much energy savings are possible** through some behavioural changes. A good place to start is the **monitoring of the energy use** where feasible and identify where savings can be achieved.
- The next step is to look at **what the best practices are** in order to start programs that will create behaviour changes and save energy on a school setting. Another measure is to **take an expert advice** to assist with the choice of the best possible decision for the school.
- Following, we want to find ways to **put a tangible measurement on the potential savings** from the desired behaviour changes. **Reviewing successful changes** that have been made at other schools would be a good beginning. Another option would be to **conduct our own experiment** on a school and observe those results.

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Behavioural change for EE at schools

How is behavioural change implemented in schools

- **Put together an energy-saving plan** with targets and review it according to monitoring information - build commitment to energy saving across your school.
- Make **people responsible** for the energy-saving plan - Give the users and managers -where applicable-, an important role in proposing ideas and measures to save energy.
- **Raise energy awareness among the users** and employees of the schools going beyond the original targets → changing their own energy-behaviours thereby **influencing families and friends** to do the same.
- Save money that would have been spent on energy and **use it to finance other projects, activities or improvements in the facilities**.

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Behavioural change for EE at schools

How is behavioural change implemented in schools

Educate the students

- Learning the different types of energy
- Learning the greenhouse effect
- Acquiring information on the heating system and how to save energy
- Acquiring information on water heating and how to save energy
- Learning the ideal temperatures for summer and winter in the classrooms
- Acquiring information on the energy consumption of various equipment
- Learning the right use of lighting and acquiring information on the light levels in classes
- Learning about the various types of lighting equipment and how to save energy
- Learning the meaning of recycling and reuse
- Learning how power is related to cost
- Acquiring information on the use of energy in the school
- Learning about the behavioural changes
- Learning how to take action and change behaviours
- Creating stickers and applying them in visible, meaningful areas for the users to see
- Learning how to read the electricity bill

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Behavioural change for EE at schools

Other Examples used in the framework of TEESCHOOLS

- Class rules - A3 poster, 10 rules for energy saving
- The pupil's guide to save energy– Booklet, 12 steps
- Energy management of your own house – Educational Booklet, 36 pages

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Behavioural change for EE at schools

How is behavioural change implemented in schools

Raising energy awareness

Remember! It's essential for school authorities and school managers to show their support for energy efficiency. You can do this by:

- making energy efficiency a priority
- appointing energy 'champions', who are responsible for spotting energy waste and promoting energy efficiency
- seeking input to the energy plan and rewarding feedback
- celebrating achievements
- keeping people informed about new ideas
- making it fun by having activities or competitions around saving energy.

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Behavioural change for EE at schools

How is behavioural change implemented in schools

- Energy training for the cleaning staff
- Day without energy in the schools
- Re-thinking the space uses in order to save electricity
- Research project on energy inspired by the energy team
- Conduct an energy survey
- Exhibition of old electric equipment
- Observe the monthly consumption figures
- Spend a day without shopping
- Sculptures from waste paper
- Transferring awareness from schools to families
- Workshop on energy saving and energy labelling
- Use the public transportation. walk or cycle
- Energy agents in action!
- Let's recycle!
- Recycling for our future
- Cooking with Renewable tastes so good!

Good Practices examples from Europe

Ideas for actions – Good Practises!

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How is behavioural change implemented in schools [summarizing]

1. Education | Awareness
2. Authority Figures [teachers, principle, school labelling]
3. Feedback on progress [individual, comparative, immediate | real-time, visual, consistent, direct, indirect]
4. Rewards | Incentives [field trips, purchase of equipment etc]
5. Built-in routine [on-going process]
6. Gamification [to apply all the above]
7. Individual formal commitment

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A successful example

EURONET 50/50 max **-** [Project's Website]

The purpose of this project was to provide a simple way – the 50/50 methodology – to achieve energy savings without making large investments, basically through behavioural changes in the use of the facilities.

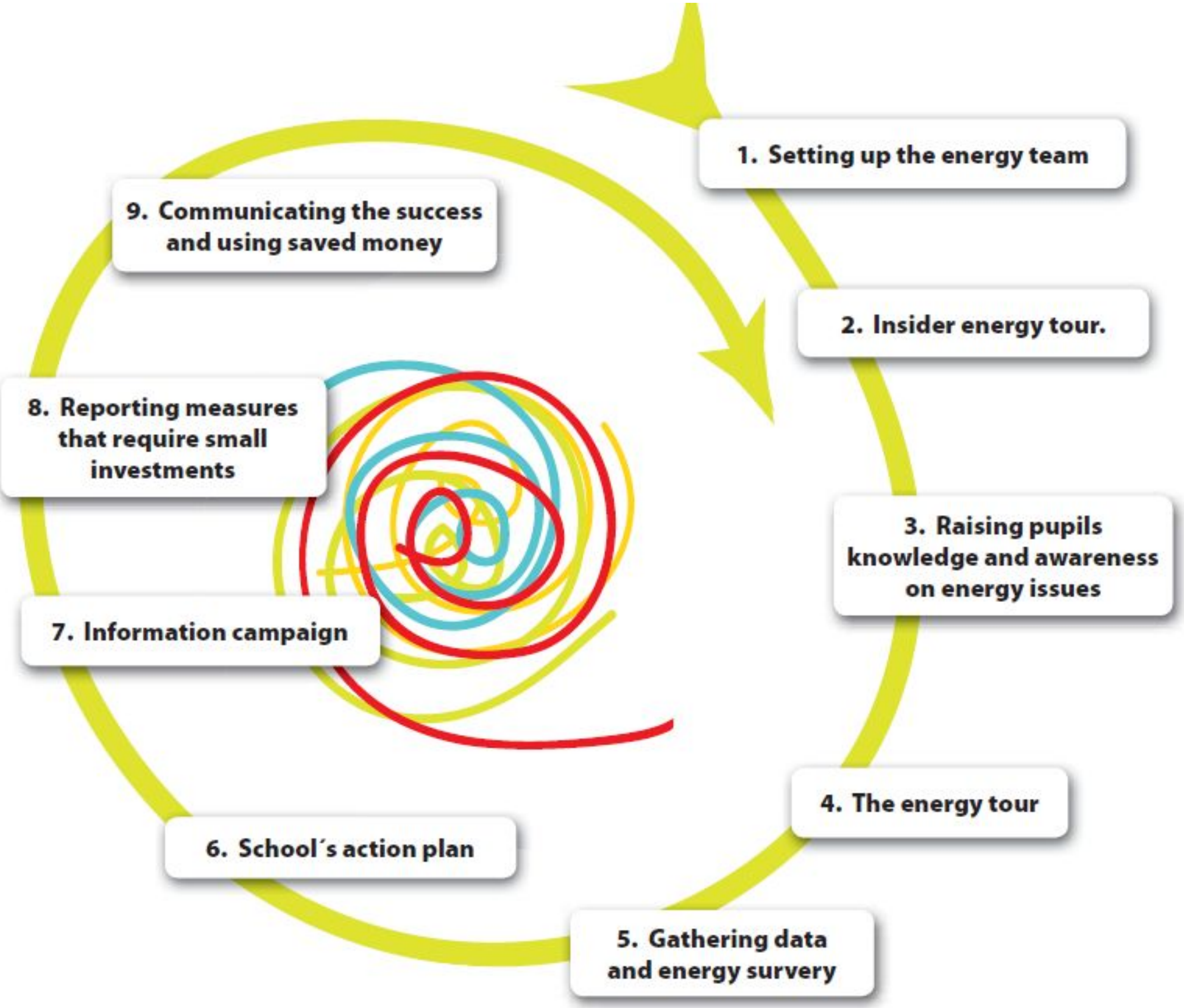
- Guidebook “50/50 step by step. Energy efficiency and saving at school”
- Guidebook “Everything you want to know about 50/50 - Energy saving in schools and other public buildings”
- Guidebook “How to handle the energy team”
- Guidebook “Energy saving at school”
- Guidebook “Energy saving at school: part 2”
- Guidebook “Energy saving in public buildings”
- Guidebook "Benefits of applying 50/50 in public buildings"

Behavioural change for EE at schools

METHODOLOGY

The 50/50 methodology is **a 9-step methodology** aiming at the achievement of energy and financial savings in a building. It actively involves building users in the process of energy management and teaches
them environmentally friendly behaviours through practical actions.

The 9 steps can generally be extended over a whole year. However, each energy team can decide the appropriate speed to develop them, and will arrange the working plan in accordance with its reality.



Behavioural change for EE at schools

Additional info – Tips [Literature review]

Education | Awareness

Built-in routine

Gamification

Many argue that the best way to teach children about energy is through **interactive and educational activities, and gamification** which improves active learning and class engagement.

It's a fact that up to now, educational materials have been mostly in the form of school books and brochures. The design and production of new interactive activities in schools, is an important step to provide the necessary background for **better understanding and creative discussion** between the children on these topics. Also, it will help teachers to organise their lessons on energy better, emphasising the role of energy in everyday life.

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Additional info – Tips [Literature review]

By **educating students** in the classroom about the right decisions, it is making their ability much higher by reducing brain cycles. If the knowledge is on the front of their mind an individual will not have to think as hard about what is right. This reduction in complex thought also saves time. By creating more environmental classes and increasing participation from each student, it p**ushes sustainability into the realm of a social norm**.

Education | Awareness

Built-in routine

Individual formal commitment

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Additional info – Tips [Literature review]

Students must be aware of the importance **of energy efficiency and environmental consequence**, so that they can develop a **positive attitude** and successfully participate in related activities.

Research carried out in schools in Ireland reveals that students of "green schools" participate in high percentage in environmental friendly activities, such as recycling. These students recognize the need to separate garbage, contributing to the reduction of the quantity of garbage and they function as transmitters in their family environment.

Education | Awareness

Authority Figures

Built-in routine

Individual formal commitment

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Additional info – Tips [Literature review]

Change of attitude and behaviour with regard to the sustainable use of energy is necessary. It is important that students understand the significance of rational energy management so that they can create positive attitudes towards the management of natural resources. **Education on energy issues plays a key role in the formation of student behaviour.** The application of initiatives regarding energy saving within school units can only bring benefits and lead towards reduction of energy cost. Students are also given opportunities to appreciate activities regarding energy saving and disseminate what they learnt in their wider social environment

Education | Awareness

Authority Figures

Built-in routine

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Additional info – Tips [Literature review]

An effort to implement a non-routine element would cause some disorientation and civil unrest for a little while, but eventually people would get acclimated especially if this element is more **appealing through comfort, simplicity, and through ease of access**. People do not like being told what to do, in any circumstance. So introducing different lifestyle changes in increments cannot be stressed enough. **Adaptability is a key element of survival for any species.** If we are unable to adapt to small lifestyle changes like using the bus instead of your own car, then our future is bleak in terms of sustainability.

Built-in routine

Individual formal commitment

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Behavioural change for EE at schools

Additional info – Tips [Literature review]

Agreements could be made to ensure that schools **consume a certain percentage of recycled/reusable products** and aim at **purchasing energy star appliances**. Encouraging these, the school's carbon footprint will be significantly reduced and it will be easier for the students to maintain an environmental friendly behaviour.

…There are many small, low-cost things you can do to make efficiencies at your school. For example, one important thing is raising awareness, in particular, **encouraging people to 'switch off'.**

Education | Awareness

Authority Figures

Built-in routine

Individual formal commitment

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steps to remember

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“We shape our buildings, and afterwards they shape us.”

Winston Churchill

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Thank you for your attention!

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ΕΝΕΡΓΕΙΑΚΟ ΓΡΑΦΕΙΟ
ΚΥΠΡΙΩΝ ΠΟΛΙΤΩΝ

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