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Interreg Balkan-Mediterranean PRO-ENERGY

PROJECT

PRO-ENERGY – PROMOTING ENERGY EFFICIENCY IN PUBLIC BUILDINGS OF THE BALKAN MEDITERRANEAN TERRITORY

Work Package:	*WP4: Capacity Building for Energy Managers*
Activity:	*4.2. Capacity Building for Energy Managers - Training Curricula*
Activity Leader:	Department of Electrical and Mechanical Services – Ministry of Transport, Communications and Works
Deliverable:	*D4.4.2 Training Curricula*

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Editor:	*Frederick University*		


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EUROPEAN UNION
Balkan-Mediterranean
PRO-ENERGY
Cyprus Energy Agency
Department of Electrical and Mechanical Services
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DISCLAIMER:

CONTENTS

IDENTIFICATION SHEET

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INTRODUCTION

PRO-ENERGY is a transnational cooperation project, co-financed by the Cooperation Programme "Interreg V-B Balkan Mediterranean 2014-2020", under Priority Axis 2, Specific Objective 2.2 Sustainable Territories. The project aims at promoting Energy Efficiency in public buildings in the Balkan Mediterranean territory and to create a practical framework of modelling and implementing energy investments interventions, through specific ICT monitoring and control systems, as well as through energy performance contracting (EPC). The specific objective of PRO-ENERGY is to reduce by more than 20% the energy spending in public buildings of the participating entities in one year after the implementation of pilot actions.

Based on the above, Work Package 4 (WP 4) "Capacity Building for Energy Managers" capitalizes on knowledge & results of WP3 & includes the identification/selection of trainees (energy managers), the assessment of their training needs, the design & development of training curricula on topics such as energy management process, monitoring, targeting, energy auditing, solution development, regulations& standards, development& management of energy projects, financial tools & techniques with emphasis on energy performance contracting etc., the organisation of training sessions (eLearning, study visits, seminars etc.) & the evaluation of training sessions.

More specifically, Activity 4.2. "Training Curricula" aims at developing training curricula on energy related topics on the basis of the thematic areas that were identified following the assessment of the training needs. Such training material will be addressed to the trainees (energy managers) that were identified and selected at previous stage.

SECTION 1

1. Scope

As mentioned above, the project aims at promoting Energy Efficiency in public buildings in the Balkan Mediterranean territory and to create a practical framework of modelling and implementing energy investments interventions, through specific ICT monitoring and control systems, as well as through energy performance contracting (EPC). The specific objective of PRO-ENERGY is to reduce by more than 20% the energy spending in public buildings of the participating entities in one year after the implementation of pilot actions.

Against this background, the project addresses the policy & institutional level (Joint Strategy & Action Plan), human resources level (Capacity Building for Energy Managers) & the managerial systems level (open-source ICT Platform & CBA Modeller & Energy Performance Contracting-EPC).

In the frame of the human resources level, this action aims at developing the training curricula on energy related topics on the basis of the thematic areas that were identified following the assessment of the training needs. Such training material will be addressed to the trainees (energy managers) that were identified and selected at previous stage.

Through this activity the project will achieve enhanced capacity of participating territories and other stakeholders and deliver the following results:

- 15 training sessions
- 200 civil servants trained
- 500 stakeholders from all territories trained

2. Methodology for the implementation of the activity

The methodology for the implementation of the action was set by PB4, EMS that is the lead partner for this activity, in collaboration with all other partners. The methodology is common to all project partners. More specifically, on the basis of the results that came up from the web-survey for the identification of trainees and training needs, the coordinator has developed a study guide presenting the main thematic categories for the material that will need to be developed by the partners. Each partner will be contributing to a different thematic as per table that is being presented below.

The Study Guide aims to increase the knowledge, skills, and competencies of trainees on EU-related technical aspects in public buildings, with a particular emphasis on integrating different solutions,

selecting the best scenarios, and ensuring effective monitoring and trainee involvement in the proceedings. It is structured in Units and includes a brief introduction, purpose and expected learning outcomes, keywords/key concepts, annotated bibliography, aiming at a more meaningful understanding of the content, terms and concepts of each Unit.

The Study Guide is divided into 6 educational modules presented in the following table:

Units	Topics
Section 1	Legislative framework for energy efficiency
Section 2	Energy efficiency of buildings
Section 3	Energy-saving - Shell thermal insulation - RES
Section 4	Energy behavior
Section 5	Ways to save energy
Section 6	Good practices of energy saving in public buildings

For each module, there is a comprehensive theoretical introduction. For supporting the trainers in the preparation of the respective training sessions, further suggestions are also included regarding:

- list of reference material that helps to address specific issues in more detail.

What is very important for the Study Guide of the PRO ENERGY project is that it provides not only knowledge but also real aspects related to the implementation of energy efficiency improvements in public buildings, such as the selection of best performance scenarios, overcoming the most typical obstacles or incorporating different types of synergies.

Against this background, it was decided among the partners that the contribution of each under each topic will be as follows:

	Thematic Areas	Partners				
		LB-RE-RUT	PB2-DEA	PB3 - CEA	PB4 - EMS	PB5 - RDA
1	Legislative Framework for energy efficiency		*			*
2	Energy Efficiency of buildings	*				
3	Energy Saving			*		
4	Energy Behaviour	*	*			
5	Ways to save energy					*
6	Good practices			*		

3. Legislative Framework for energy efficiency

3.1 Legislative framework for energy efficiency at EU level

Legislative framework for energy efficiency at EU level

Module 1.a

Module Aim

- Raise awareness on the basic legal framework for the energy efficiency of buildings at **EU level**
- Better understanding of the **practices, guidelines, and regulations** in force in the European Union

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Learning outcomes and keywords (1/2)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy efficiency
- Energy certification of buildings

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Learning outcomes and keywords (2/2)

Energy efficiency	Energy saving
Legislative framework	Green certificates
European directives	

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Energy efficiency directive (Directive 2012/27/EU)

- Binding measures → 20% energy efficiency target by 2020
- EU energy consumption → no more than 1483 million tonnes of oil equivalent (Mtoe) of primary energy or 1086 Mtoe of final energy
- EU countries → use energy more efficiently at all stages of the energy chain

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Measures adopted under Energy Efficiency Directive (1/3)

Policy measures to achieve *energy savings* equivalent to annual reduction of 1.5% in national energy sales
EU countries making *energy efficient renovations* to at least 3% per year of buildings owned and occupied by central governments
National long-term renovation strategies for the *building stock* in each EU country

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Measures adopted under Energy Efficiency Directive (2/3)

Mandatory *energy efficiency certificates* accompanying the sale and rental of buildings
The preparation of *National Energy Efficiency Action Plans (NEEAPs)* every three years
Minimum *energy efficiency standards and labelling* for a variety of products such as boilers, household appliances, lighting and televisions (energy label and eco design)
The planned rollout of close to 200 million *smart meters* for electricity and 45 million for *gas* by 2020

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Measures adopted under Energy Efficiency Directive (3/3)

Obligation schemes for energy companies to achieve yearly energy savings of 1.5% of annual sales to final consumers
Large companies conducting *energy audits* at least every four years
Protecting the *rights of consumers* to receive easy and free access to data on real-time and historical energy consumption

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Clean energy for all Europeans package (2018/2002)

Energy efficiency target for 2030

↓

at least **32.5%**

EU energy consumption → no more than 1273 Mtoe (million tonnes of equivalent) of primary energy and/or no more than 956 Mtoe of final energy

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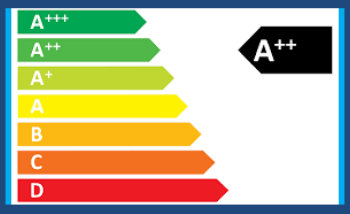
Directive 2008/28/EC (1/2)

Eco-design standards for energy-consuming goods

Electrical and mechanical appliances or heating systems



New Energy Label

- Energy efficiency information of the product (color code of seven categories)
- Energy and water consumption
- Performance (intensity, fulfillment, volume level)

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Directive 2008/28/EC (2/2)

Ecological design → Improve a product's environmental efficiency (remain its functional properties)

Directive → Establishes terms and conditions for establishing requirements for environmental features of products

Energy-consuming products and those that need to be considered for energy savings are indicated by the label and standard product information on energy consumption → Directive 2010/30/EU

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EU energy production grade (1/2)

- Scale of A++ (most energy efficient) to G (least efficient) – Colour coding
- Other information ⟹ energy consumption, water consumption, or noise generation
- Directive 2018/844/EU ⟹ label for buildings

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EU energy production grade (2/2)

Rescaling in 2021

Fridges and freezers

Dishwashers

Washing machines

Lamps

Televisions

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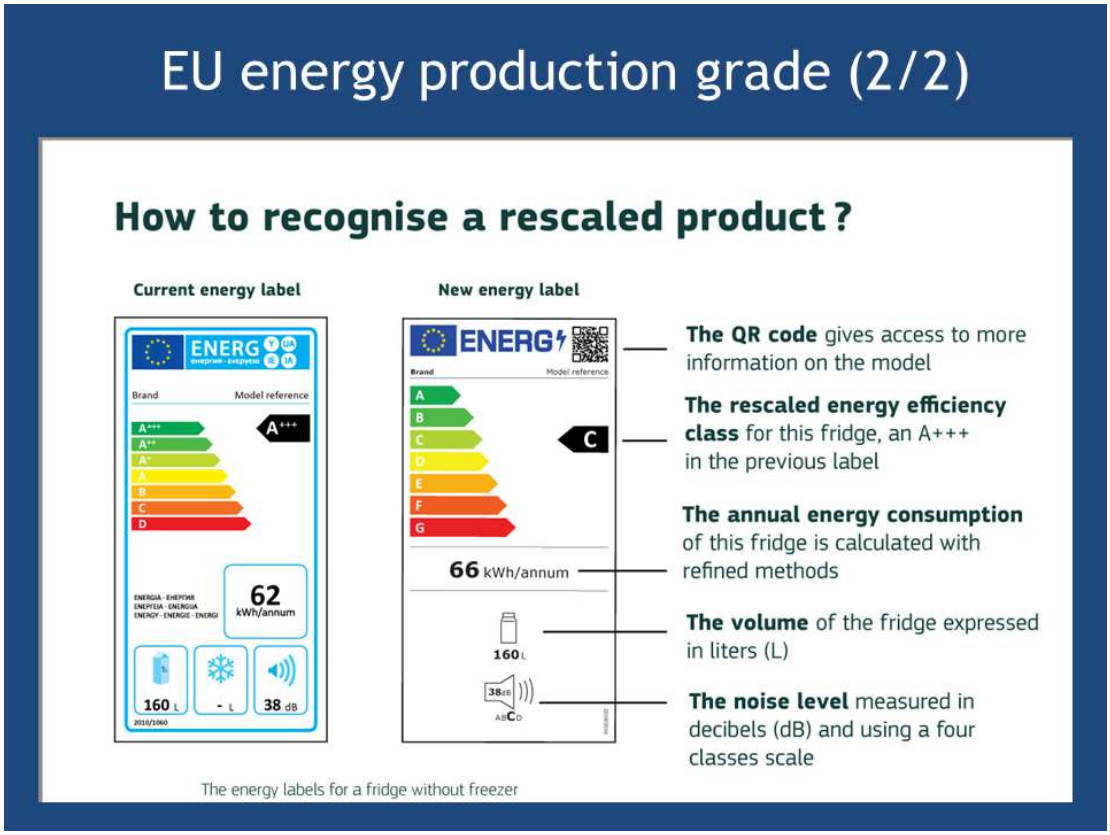

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3.2 Legislative framework for energy efficiency at national level

3.2.1 Greece

Legislative framework for energy efficiency at national level (Greece)

Module 1.b

Module Aim

- Raise awareness on the basic legal framework for the energy efficiency of buildings at **national and regional level (Greece, Thesprotia-Evia)**
- Better understanding of the **practices, guidelines, and regulations** in force in the Greek territory and participating areas

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Learning outcomes and keywords (1/2)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy efficiency
- Energy certification of buildings

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Learning outcomes and keywords (2/2)

Energy efficiency	Energy saving
Legislative framework	Green certificates
European directives	

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Introduction (1/2)

Greek local authorities

Central government's legislation

No issue separate laws or regulations regarding energy efficiency

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Introduction (1/2)

Calculation of Energy Efficiency in buildings

Methodology defined in the Energy Efficiency Regulation of Buildings (KENAK)

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Energy Efficiency Regulation of Buildings (KENAK) - (1/2)

Methodology defined in the Energy Efficiency Regulation of Buildings (**KENAK**)

- Thermal insulation characteristics of the structural elements of the building's shell
- HVAC installations
- Renewable energy sources
- Passive heating and cooling elements
- Shading, indoor air quality
- Adequate natural light and building design

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Energy Efficiency Regulation of Buildings (KENAK) - (2/2)

Methodology defined in the Energy Efficiency Regulation of Buildings (**KENAK**)

- Covers the annual energy efficiency of the building
- In accordance with the relevant European standards
- Defines the minimum requirements for the energy efficiency of buildings and structural elements

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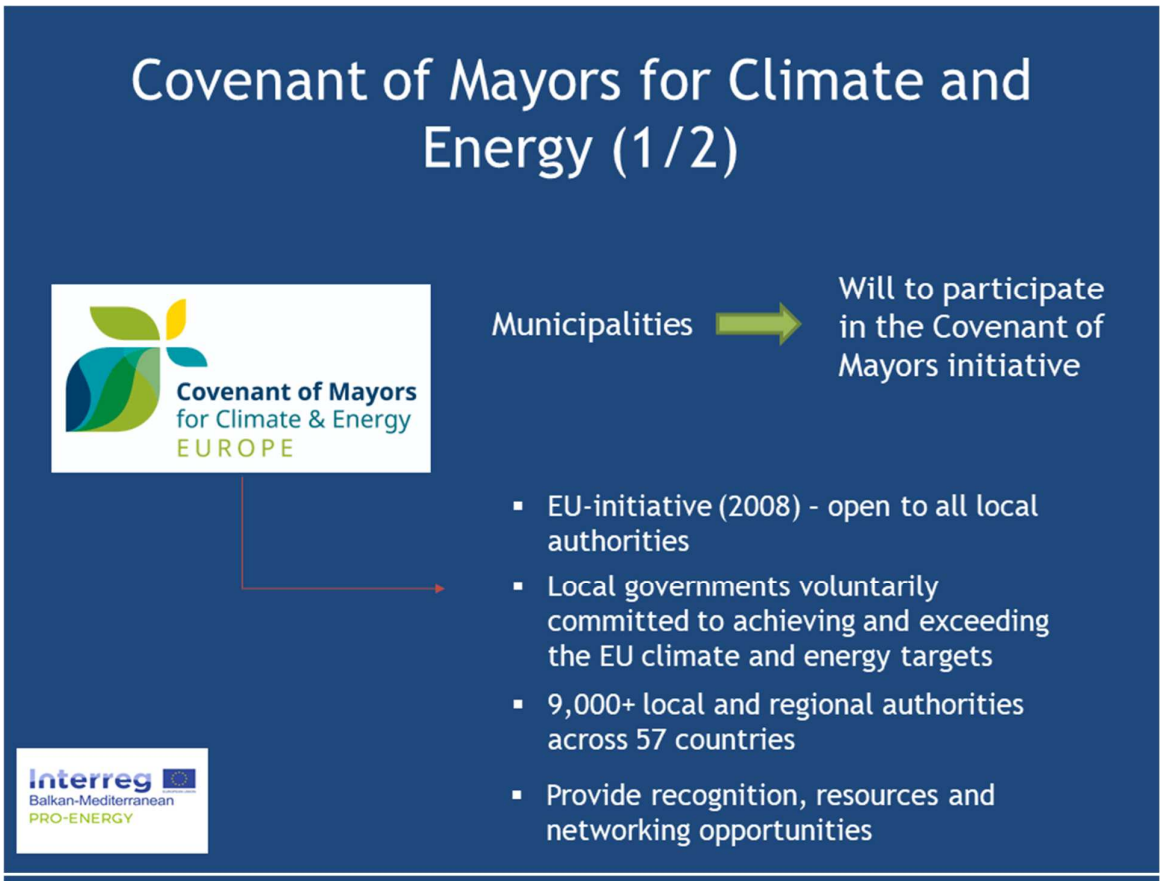
Energy efficiency policy-making trends


Covenant of Mayors for Climate and Energy (1/2)
Covenant of Mayors for Climate & Energy EUROPE
Municipalities
Will to participate in the Covenant of Mayors initiative
EU-initiative (2008) - open to all local authorities
Local governments voluntarily committed to achieving and exceeding the EU climate and energy targets
9,000+ local and regional authorities across 57 countries
Provide recognition, resources and networking opportunities
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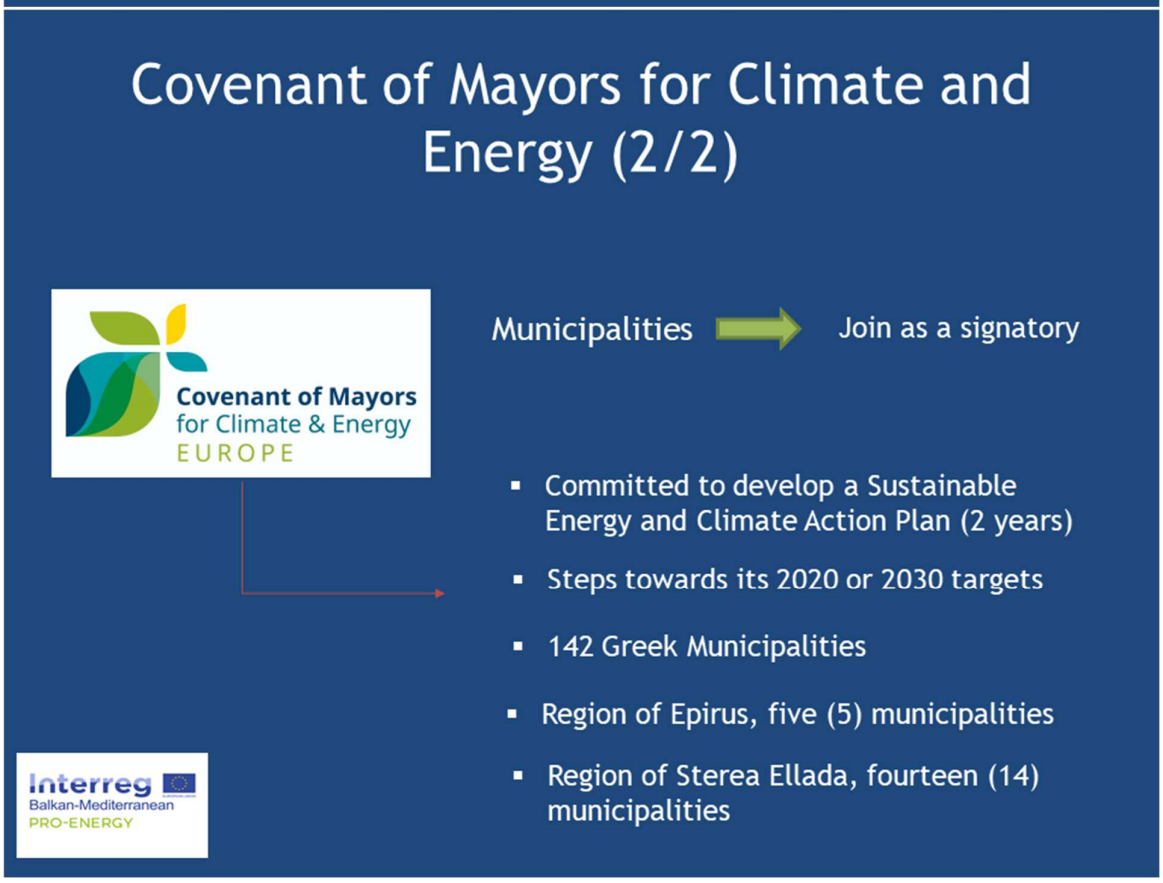
Covenant of Mayors for Climate and Energy (2/2)
Covenant of Mayors for Climate & Energy EUROPE
Municipalities
Join as a signatory
Committed to develop a Sustainable Energy and Climate Action Plan (2 years)
Steps towards its 2020 or 2030 targets
142 Greek Municipalities
Region of Epirus, five (5) municipalities
Region of Sterea Ellada, fourteen (14) municipalities
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Energy Communities Framework

Establishment and operation of the Energy Communities (Law 4513/2018)

A new and integrated institutional intervention, supporting social economy in the energy sector

- Several energy communities
- Significant number of energy projects
- Strengthen the decentralized growth model
- Successful technological examples of self- sufficient and energy autonomous schemes

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3.2.2 Cyprus

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Legislative framework for energy efficiency at national level (Cyprus)

Module 1.c

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Module Aim

- Raise awareness on the basic legal framework for the energy efficiency of buildings at **national level (Cyprus)**
- Better understanding of the **practices, guidelines, and regulations** in force in Cyprus

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Learning outcomes and keywords (1/2)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy efficiency
- Energy certification of buildings

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Learning outcomes and keywords (2/2)

Energy efficiency	Energy saving
Legislative framework	Green certificates
European directives	

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Introduction (1/2)

Cypriot local authorities

- Central government's legislation
  - No issue separate laws or regulations regarding energy efficiency
  - Difficulties in implementing, or securing funds for, actions intended for residential and public buildings

Introduction (2/2)

- Real market of investment loans is limited to the buildings of local authorities
- Rest of the public building stock belongs to the central government (Ministry of Transport, Communication & Works)

  - 55 buildings (mainly town halls) belong to municipalities/local authorities with an average floor area of 1.735 m2 (a cost for EE renovation works at approximately € 125/m2)

→ relevant investments needed for EE measures conducted by local authorities amounts to € 12 million

Energy Communities (Directive 2018/2001/EU) (1/2)

Energy Communities

- **Voluntary** and **open** participation
- Under the **substantial control** of partners or members who are natural persons, local authorities, including municipalities, or small businesses
- Provide environmental, economic and **social benefits** at the community level

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Energy Communities (Directive 2018/2001/EU) (2/2)

Energy Communities

Involved in the production

- Cumulative representation
- Energy storage
- Electric vehicle charging services
- Consumption services
- Distribution, and supply of electricity
- Production from renewable sources
- Energy efficiency services
- Provision of other energy services like energy renovations (2019/944/EU)

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Covenant of Mayors for Climate and Energy (1/2)

Covenant of Mayors for Climate & Energy EUROPE

Local authorities → Endorsed the Covenant of Mayors initiative or the Covenant of Islands

- EU-initiative (2008) - open to all local authorities
- Local governments voluntarily committed to achieving and exceeding the EU climate and energy targets
- 9,000+ local and regional authorities across 57 countries
- Provide recognition, resources and networking opportunities

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Covenant of Mayors for Climate and Energy (2/2)

Covenant of Mayors for Climate & Energy EUROPE

- Development of local Sustainable Energy Action Plans (SEAPs)
- Actions for improving the energy efficiency of buildings used by local authorities
- Actions for promoting measures relating to the energy upgrading of existing buildings / construction of new
- 23 sustainable energy action plans
- Reduction of approximately 600.000 tons of carbon dioxide
- Increase in the amount of RES energy to 90.000 MWh/year

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'Smart Islands' initiative

Aims to stress the specificities of insular areas and mobilize targeted financing for:

- RES
- Energy efficiency and
- Sustainable transport projects on the islands

National Strategy for the Development of the Troodos Mountain Communities (2019)

Description of the current energy situation of the specific area and measures to improve it

Other initiatives

Municipalities of Nicosia, Paphos, and Aradippou

Initiatives for their transformation into smart cities

Development of applications and infrastructure through a package of advanced digital services that can be used in the future by energy communities as well

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https://energy.gov.cy/secondary-menu/%CE%BD%CE%BF%CE%BC%CE%BF%CE%B8%CE%B5%CF%83%CE%AF%CE%B1/%CE%B4%CE%B9%CE%B1%CF%84%CE%AC%CE%B3%CE%BC%CE%B1%CF%84%CE%B1/%CE%B5%CE%BD%CE%B5%CF%81%CE%B3%CE%B5%CE%B9%CE%B1%CE%BA%CE%AE-%CE%B1%CF%80%CF%8C%CE%B4%CE%BF%CF%83%CE%B7-%CE%BA%CF%84%CE%B9%CF%81%CE%AF%CF%89%CE%BD/

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3.2.2 Bulgaria

Section 1
Bulgarian legislative framework for energy efficiency

WP4: D4.2 Training curricula and material on energy related topics

Date: 01/06/2021

Where: Plovdiv, Bulgaria

Bulgarian legislation in the field of energy efficiency

The Bulgarian government is actively working to improve energy efficiency and promote the use of renewable energy sources in the country. This will have a positive effect on economic growth and increase the competitiveness of the construction sector. Bulgaria seeks to support the construction of new low-energy buildings and to achieve the same energy performance when renovating or renovating existing buildings.

Bulgarian legislation in the field of energy efficiency

The institutions responsible for the implementation of national policies regarding energy efficiency in buildings and for the development of national strategies, programs and plans, including national plans for increasing the number of buildings with almost zero energy consumption are the Ministry of Economy, Ministry of Energy and the Ministry of Regional Development and Public Works, as well as the Agency for Sustainable Energy Development.

Bulgarian legislation in the field of energy efficiency

In addition, the Bulgarian government will focus on:

- Improving the efficiency of electricity and heat production
- Reducing transmission and distribution losses
- Improving the energy performance of existing buildings and introducing even stricter energy standards for new buildings, including energy-independent buildings.

Bulgarian legislation in the field of energy efficiency

In fulfillment of the commitments of the Republic of Bulgaria to achieve the goals of the European energy policy for the establishment of the Energy Union, the Sustainable Energy Development Strategy towards 2030, with a horizon until 2050, sets the following main priorities:

1. Ensuring energy security and sustainable energy development
2. Development of an integrated and competitive energy market and consumer protection by ensuring transparent, competitive and non-discriminatory conditions for the use of energy services
3. Increasing energy efficiency in the processes from production to final energy consumption
4. Sustainable energy development for clean energy and decarbonisation of the economy
5. Implementation of innovative technologies for sustainable energy development

Bulgarian legislation in the field of energy efficiency

In connection with the implementation of these national energy priorities by 2030, with a horizon to 2050, and to ensure the contribution of Bulgaria to the implementation of the common European energy policy, the following goals are set by 2030:

- Reduction of primary energy consumption compared to the baseline forecast PRIMES 2007 - 27.89%;
- Reduction of final energy consumption compared to the base forecast PRIMES 2007 - 31.67%;
- 27.09% share of renewable energy in gross final energy consumption;
- At least 15% interconnection of electricity

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Energy Efficiency Act

This law regulates the public relations related to the conduct of government policy to increase energy efficiency. The law aims to increase energy efficiency as part of the country's sustainable development policy by:

1. Using a system of activities and measures to increase energy efficiency in production, transmission and distribution, as well as in final energy consumption
2. Introduction of energy saving obligation schemes
3. Developing the market for energy efficient services and promoting the provision of energy efficient services
4. introduction of financial mechanisms and schemes supporting the implementation of the national energy efficiency target.

Energy Efficiency Act

The energy efficiency requirements provided for in this Act and in the Spatial Planning Act shall apply to each investment project for:

1. Construction of a building;
2. Reconstruction of a building, which changes its energy performances;
3. Reconstruction, major renovation or deep renovation of a building, when more than 25 per cent of the area of the external enclosing structures and elements of the building are covered and its energy characteristics change

Energy Efficiency Act

The additional provisions of the Act define basic concepts of energy efficiency:

- "Energy efficiency in buildings" is the provision and maintenance of regulations parameters of the microclimate in the buildings, their heat storage and the saving of energy resources for the needs of the buildings with minimal financial costs.
- "Energy efficiency" is the ratio between the initial amount produced goods, services or energy and the amount of energy invested.
- "Energy efficiency audit" is a process based on a systematic method for determination and valuation of energy flows and costs in buildings, enterprises, industrial systems and systems for outdoor artificial lighting, determining the scope of the technical and economic parameters of the measures for increasing the energy efficiency.

ORDINANCE № 7 OF 2004 ON ENERGY EFFICIENCY OF BUILDINGS

The ordinance determines:

1. The minimum requirements for energy efficiency of residential buildings and of buildings for public service and the ways for expressing the technical requirements to the energy characteristics of the buildings;
2. The methodology for calculation of the indicators for energy consumption and of the energy characteristics of the buildings;
3. The limit values of the integrated energy indicator "specific annual consumption of primary energy" in kWh / m2, determined by the scale of the energy consumption classes;

ORDINANCE № 7 OF 2004 ON ENERGY EFFICIENCY OF BUILDINGS

4. The reference values of the heat transfer coefficient through the building enclosing constructions and elements;

5. The requirements for moisture resistance, air permeability, water impermeability and sun protection during the summer period;

6. The technical requirements regarding the efficiency of the heat / cold generators in the buildings, including the decentralized systems for utilization of the energy from renewable sources;

7. The requirements to the investment projects in the assessment of the energy consumption.

ORDINANCE № 7 OF 2004 ON ENERGY EFFICIENCY OF BUILDINGS

The requirements of the ordinance apply to:

1. Design, implementation and maintenance of new residential buildings and public buildings, as well as in case of reconstruction, renovation, overhaul, reconstruction, upgrading and extension of existing residential and non-residential public service buildings.

2. Assessment of the conformity of the investment projects of the buildings under item 1;

3. Assessment of the total and specific annual energy consumption when performing a energy efficiency audit of existing buildings; the assessment is performed by combined application of the calculation methodology determined by the ordinance and the necessary technical measurements in the buildings;

ORDINANCE № 7 OF 2004 ON ENERGY EFFICIENCY OF BUILDINGS

4. Design of industrial buildings, as well as for inspection for energy efficiency of this type of buildings as part of an industrial system, which are not subject to certification by the order of the Energy Efficiency Act, but for which the conditions under Art. 2 of the ordinance;

5. Inspection for energy efficiency and design of buildings - cultural values, included in the scope of the Cultural Heritage Act, insofar as the improvement of the energy characteristics of the enclosing elements and / or the technical systems in these buildings does not lead to violation of the architectural and / or artistic characteristics of the buildings.


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ORDINANCE № 7 OF 2004 ON ENERGY EFFICIENCY OF BUILDINGS

Compliance with the energy performance requirements of buildings is considered to be met when the value of the integrated indicator - specific annual primary energy consumption in kWh / m2, corresponds at least to the following class of energy performance:

1. "B" - for new buildings, which are put into operation for the first time, and for existing buildings, which are put into operation after February 1, 2010;
2. "C" - for existing buildings that have been put into operation by February 1, 2010 inclusive;
3. "A" - for buildings with near zero energy consumption when fulfilling the condition for minimum share of energy from renewable sources according to the definition in 1, item 31 of the additional provisions of the ordinance.

The ordinance also determines reference values of the heat transfer coefficient (U-value) for the enclosing structures and elements in the design of new buildings and after reconstruction, major renovation, overhaul or reconstruction of existing buildings.

ORDINANCE № E-РД-04-1 OF 22.01.2016 FOR ENERGY EFFICIENCY AUDITING, CERTIFICATION AND EVALUATION OF ENERGY SAVINGS OF BUILDINGS

This ordinance determines the conditions and the order for:

1. Issuance of certificates for design energy characteristics for new buildings;
2. Carrying out an audits (inspection) for energy efficiency of buildings and parts of buildings in operation, including preparation of inspection reports;
3. Issuance of certificates for energy characteristics of buildings and parts of buildings in operation;
4. preparation of an assessment of the energy savings of buildings.

ORDINANCE № E-РД-04-1 OF 22.01.2016 FOR ENERGY EFFICIENCY AUDITING, CERTIFICATION AND EVALUATION OF ENERGY SAVINGS OF BUILDINGS

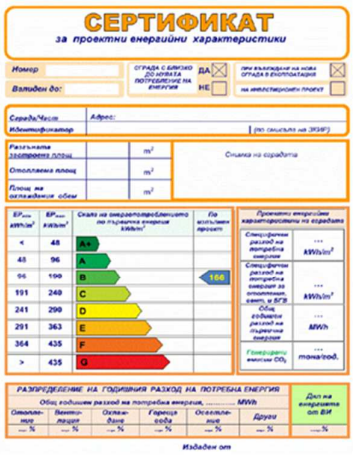
The certificate for energy performance of a building in operation certifies the energy performance in case of normalized energy consumption in the existing condition of the building at the time of the inspection, the expected level of energy consumption after application of a selected package of energy saving measures and its corresponding energy consumption class on the scale of energy consumption classes of the ordinance under Art. 31, para. 3 EEL.

A new certificate shall be issued not earlier than one calendar year after the implementation of energy saving measures or the performance of construction and installation works, for which there is a registered energy consumption by type of fuels and energy used in the building.

ORDINANCE № Е-РД-04-1 OF 22.01.2016 FOR ENERGY EFFICIENCY AUDITING, CERTIFICATION AND EVALUATION OF ENERGY SAVINGS OF BUILDINGS

The front page of the certificate reflects representative data that will be placed in a prominent place in the building and shows results for:

1. The existing condition of the building, including its current energy performance class at the time of the inspection;
2. The expected class of energy consumption, which is expected to be achieved after the implementation of a package of energy saving measures, chosen to be implemented in the building.



ORDINANCE № Е-РД-04-2 OF 22.01.2016 ON INDICATORS FOR ENERGY CONSUMPTION AND THE ENERGY CHARACTERISTICS OF THE BUILDINGS

This ordinance regulates:

1. The conditions for determining the indicators for energy consumption and the energy characteristics of buildings;

2. The unified methodology for calculation of indicators for energy consumption and energy characteristics of buildings;

3. The parameters of the scale of the classes of energy consumption for different purpose categories of buildings;

4. The limit numerical values of the integrated energy indicator "specific annual primary energy consumption" in kWh / m2, determined by the scale of the energy consumption classes for different categories of buildings.

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ORDINANCE № Е-РД-04-2 OF 22.01.2016 ON INDICATORS FOR ENERGY CONSUMPTION AND THE ENERGY CHARACTERISTICS OF THE BUILDINGS

The calculation of the energy characteristics shall be performed for the purpose of:

1. Determination of the annual energy consumption in buildings;
2. Determination of the level of energy efficiency in the buildings according to the scale of the energy performance classes;
3. Assessment of the compliance of investment projects of buildings with the requirements for energy efficiency
4. Issuance of certificates for energy performance of buildings.

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ORDINANCE № Е-РД-04-2 OF 22.01.2016 ON INDICATORS FOR ENERGY CONSUMPTION AND THE ENERGY CHARACTERISTICS OF THE BUILDINGS

For the calculation of the indicators for energy consumption and the energy characteristics the classification of the categories of buildings according to their purpose shall be accepted, as follows:

1. Residential buildings:
    a) single-family houses;
    b) multi-family residential buildings (blocks) with low, medium and high construction;
    c) mixed-use buildings;
    d) buildings for social services - residential type;

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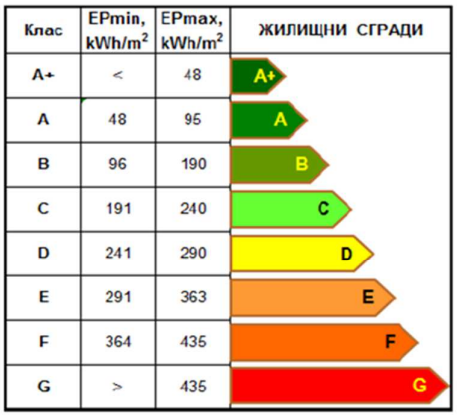
ORDINANCE № Е-РД-04-2 OF 22.01.2016 ON INDICATORS FOR ENERGY CONSUMPTION AND THE ENERGY CHARACTERISTICS OF THE BUILDINGS

2. Buildings for public service:

a) Buildings for administrative service;
b) Buildings for education and science;
c) Buildings in the field of healthcare;
d) Buildings in the field of hospitality;
e) Buildings in the field of trade, public catering, services;
f) Sports buildings;
g) Buildings in the field of culture and art;
h) Other public service buildings.



Клас	EPmin, kWh/m²	EPmax, kWh/m²	ЖИЛИЩНИ СГРАДИ
A+	<	48	A+
A	48	95	A
B	96	190	B
C	191	240	C
D	241	290	D
E	291	363	E
F	364	435	F
G	>	435	G

ORDINANCE № Е-RD-04-1 3.01.2018 BY THE CIRCUMSTANCES ON THE SUBJECT OF ENTRY REGISTRIES IN THE ENERGY EFFICIENCY ACT, LISTING AND OBTAINING INFORMATION FROM THESE REGISTRIES, TERMS AND CONDITIONS FOR ACQUISITION OF QUALIFICATION OF CONSULTANTS IN ENERGY EFFICIENCY

This ordinance determines:

1. The circumstances subject to entry in the registers under Art. 44 and 60 of the Energy Efficiency Act (EEA);

2. The procedure for entry, including entry of changes in the circumstances, and deletion of entries in the registers;

3. The procedure for receiving information from the registers;

4. The conditions and the order for acquiring qualification of the consultants on energy efficiency.

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ORDINANCE № E-RD-04-1 3.01.2018 BY THE CIRCUMSTANCES ON THE SUBJECT OF ENTRY REGISTRIES IN THE ENERGY EFFICIENCY ACT, LISTING AND OBTAINING INFORMATION FROM THESE REGISTRIES, TERMS AND CONDITIONS FOR ACQUISITION OF QUALIFICATION OF CONSULTANTS IN ENERGY EFFICIENCY

The Agency (SEDA – Sustainable Energy Development Agency) shall enter in the register under Art. 2, para. 1, item 1 the persons, who carry out inspection (audits) for energy efficiency and certification of buildings, inspections for energy efficiency of heating installations with hot water boilers and of air-conditioning installations in buildings, shall prepare assessments for compliance of the investment projects of buildings with the requirements for energy efficiency and estimates of energy savings in buildings, as well as the circumstances related to these persons.

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LONG-TERM STRATEGY TO SUPPORT THE RENOVATION OF THE NATIONAL BUILDING FUND OF RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS UNTIL 2050

The long-term strategy to support the renewal of the national building stock of residential and non-residential buildings until 2050 contains:

1. Review of the national building stock of residential and non-residential buildings (national building stock) on the basis of statistical samples and expected share of the renovated buildings in 2020;

2. The determination of cost-effective approaches for renovation, taking into account the type of buildings and the climatic zone, taking into account the appropriate moments for intervention, if any, in the life cycle of the building;

3. Policies and actions for promotion of economically efficient major renovation of buildings, including gradual major renovation;

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LONG-TERM STRATEGY TO SUPPORT THE RENOVATION OF THE NATIONAL BUILDING FUND OF RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS UNTIL 2050

4. Reviewing policies and actions targeting the worst-performing buildings, barriers to the allocation of market incentives and weaknesses, and identifying appropriate actions at national level that contribute to reducing energy poverty;

5. Policies and actions aimed at all public service buildings;

6. A review of national initiatives to promote smart technologies in buildings and communities, as well as the acquisition of skills and education in the construction and energy efficiency sectors;

7. Expected energy savings and their benefits, including health, safety and air quality benefits;

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LONG-TERM STRATEGY TO SUPPORT THE RENOVATION OF THE NATIONAL BUILDING FUND OF RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS UNTIL 2050

8. Opportunities for creating conditions for investors' access to package solutions through grouping of projects, including through investment platforms or groups, and through consortia of small and medium enterprises;

9. Mechanisms for reducing the perceived risk for investors and individuals in the implementation of energy efficiency measures;

10. Opportunities to use public funding to attract additional private sector investment or to address specific market weaknesses;

11. Opportunities for directing investments to achieve energy efficient public building stock;

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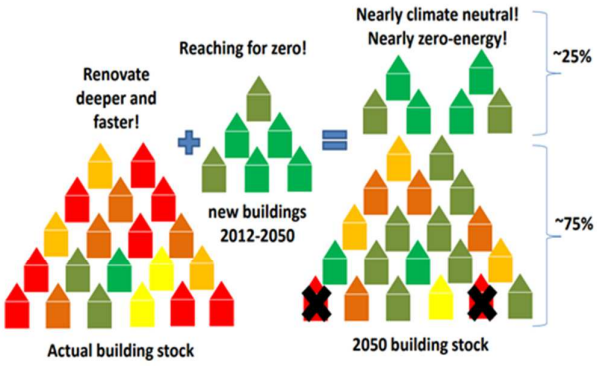
LONG-TERM STRATEGY TO SUPPORT THE RENOVATION OF THE NATIONAL BUILDING FUND OF RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS UNTIL 2050

12. Creation of accessible and transparent tools for providing consultations, such as one-stop shop and advice on energy issues related to appropriate energy efficiency measures and financing instruments;

13. Roadmap with measures contributing to the achievement of a decarbonised national building stock and facilitating the cost-effective transformation of existing buildings into near-zero energy buildings, measurable progress indicators and indicative milestones for 2030, 2040 and 2050.

NATIONAL PLAN FOR NZEB BUILDINGS

The National NZEB Plan 2015 - 2020 (NPSBNPE) has been developed on the basis of Art. 9, para 1 of Directive 2010/31 / EU on the energy performance of buildings. It aims to turn the concept of buildings with near zero energy consumption into a practical alternative to the future construction of new buildings in Bulgaria after 2018, and with proven cost-effectiveness - and the renovation of existing buildings for different sub-categories of buildings.



NATIONAL PLAN FOR NZEB BUILDINGS

The plan contains:

1. The national definition and the technical indicators for NZEB, which reflects the national conditions;
2. The national goals for increasing the number of the buildings with near zero energy consumption depending on the classification of the types of buildings according to the ordinance of art. 31, para. 4;
3. Policies and mechanisms, incl. financial, to encourage the construction of buildings with near zero energy consumption;
4. The period of validity of the plan.

NATIONAL PLAN FOR NZEB BUILDINGS

Definition of a building with near to zero energy consumption at national level
According to the plan:

"A building with near zero energy consumption" is a building that simultaneously meets the following conditions:

(a) The energy consumption of the building, defined as primary energy, corresponds to class A of the scale of energy classes for the type of building concerned.
(b) Not less than 55 per cent of the consumed (supplied) energy for heating, cooling, ventilation, hot water for household needs and lighting is energy from renewable sources located on site at the building level or near the building.

NATIONAL PLAN FOR IMPROVING THE ENERGY CHARACTERISTICS OF HEATING AND / OR COOLING BUILDINGS

The plan contains:

1. Review of the national building stock;
2. Determination of economically efficient approaches for improvement of the energy characteristics of buildings, compliant with the type of buildings and the climatic zone;
3. Policies and measures for promotion of economically efficient basic improvement of the energy characteristics of buildings, including phased ones;
4. List of the buildings, which as of January 1 of the respective year do not correspond to the minimum requirements for the energy characteristics, determined by the ordinance of art. 31, para. 4, arranged in priority, with the buildings with the worst energy characteristics having the highest priority in relation to the minimum requirements for the energy characteristics;
5. The period of validity of the plan

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NATIONAL LONG-TERM PROGRAM FOR PROMOTION OF INVESTMENTS FOR IMPLEMENTATION OF MEASURES FOR IMPROVING THE ENERGY CHARACTERISTICS OF THE BUILDING FROM THE COMMON

The program contains:

1. Review of the national building stock, based on statistical samples;
2. Determination of economically efficient approaches for improvement of the energy performances of the buildings, compliant with the type of buildings and the climatic zone;
3. Policies and measures for promotion of economically efficient basic improvement of the energy characteristics of buildings, including step by step implemented;
4. Establishment of a financial framework for directing the investment decisions of investors, the construction industry and financial intermediaries;
5. Forecast for the expected energy saving

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THE STANDARD "PASSIVE HOUSE"

A passive house is a building in which a comfortable room temperature of about 20 ° C can be achieved without conventional heating and cooling systems. Such buildings are called 'passive' because most of their heat demand is provided by 'passive' sources, such as sun exposure and exhaust heat from people and technology. The required heat can be delivered to the premises through a controlled ventilation system with heat recovery. The annual heat consumption for the passive house is very low - the average for Europe is about 15 kWh / m2 / year. The need for total primary energy consumption should not exceed 120 kWh / m2 / year, including heating and cooling energy, domestic hot water and household electricity.

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THE STANDARD "PASSIVE HOUSE"

The main characteristics that distinguish the construction of the passive building: compact shape and good insulation; southern orientation and shading considerations; good air tightness of the surrounding structures of the building; passive heating of fresh air; highly efficient recovery of heat from the exhaust air through recuperation; use of air-to-air heat exchanger; hot water supply using renewable energy sources; use of energy saving household appliances. The design of passive houses is a complete process of planning and implementation. It can be used for the design of new buildings or for energy renovation of existing buildings.

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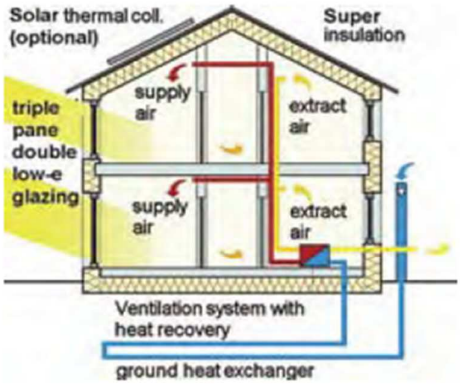
THE STANDARD "PASSIVE HOUSE"

The main part of energy saving in passive houses is achieved by reducing heat losses from heat transfer (through the enclosing elements) and ventilation. This is achieved by very good thermal insulation of all surrounding surfaces (roof, basement walls, foundation, windows), a largely dense envelope of the house and controlled ventilation of the premises with recovery of heat contained in the exhaust air. Thermal bridges and unsealed connections are not permitted.



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Sources:

- ANALYSIS OF THE REGULATORY REGULATION with a focus on energy efficiency in industry (Authors: Dr. Eng. Kamen Kolev, Assoc. Prof. Dr. Eng. Dimitar Baev, Dr. Eng. Zdravko Georgiev, Eng. Silvia Todorova.)
- NATIONAL PLAN FOR BUILDINGS WITH NEAR ZERO ENERGY CONSUMPTION 2015-2020, Sofia, 2015
- Energy Roadmap 2050. Brussels, 15.12.2011
- LABEL 2020 project https://bg.label2020.eu
- Website of the European Commission https://ec.europa.eu/
- SEDA website https://www.seea.government.bg/

4. Energy Efficiency of Buildings

4.1 Objectives of the European Union

Energy Efficiency of buildings:

Objectives of the European Union

Module 2.a

Module Aim

- Familiarize with key energy concepts and energy-efficient technologies and behaviors
- Better understanding of the energy efficiency benefits, the energy management process, its stages and activities, and how energy efficiency can be applied to buildings

Interreg Balkan-Mediterranean PRO-ENERGY

Learning outcomes and keywords (1/3)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy efficiency
- Energy certification of buildings
- EU energy labels
- Co-production
- Ecological design
- Energy efficiency measures (EEMs)
- Energy efficiency action plan
- Project implementation

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Learning outcomes and keywords (2/3)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy transformation
- Energy supply
- Energy cost

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Learning outcomes and keywords (3/3)

Energy efficiency	Energy consumption
Energy monitoring systems	Energy use
Energy management	Renewable sources

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Energy Efficiency in buildings (1/3)

Energy use in daily needs

Heat (thermal), light (radiant), motion (kinetic), electrical, chemical, nuclear, and gravitational energy

Energy transformation → converting one form of energy into another (fuel into electricity)

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Energy Efficiency in buildings (2/3)

Negative effects on the environment

Climate change, pollution, depletion of resources, and the destruction of ecosystems

Energy efficiency

mitigates external energy dependence, reduces energy imports and energy costs

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Energy Efficiency in buildings (3/3)

Improved energy efficiency

Efficient technologies/behaviour /economic change

Benefits environment

Improves air quality and public health, reduces greenhouse gas emissions

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Objectives of the European Union

European Union

Carbon and energy efficiency targets to be achieved by 2020, 2030, and 2050

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Objectives of the European Union - Target 2020

Energy efficiency Directive (2012/27/EU)

20% improvement in energy efficiency - which will lead to a reduction of primary energy by 368 Mtoe

Objectives of the European Union – Target 2030

Energy efficiency Directive (2018/2002/EU)

At least 32.5% improvement in energy efficiency which will lead to a reduction of 1 273 Mtoe of primary energy and 956 Mtoe of final energy

Objectives of the European Union - Target 2050

A clean planet for all (COM (2018) 773)

Make the EU a "Neutral Climate" - which means reducing greenhouse gas emissions by 80-95%

#EU2050

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Objectives of the European Union - Energy efficiency of buildings

Energy efficiency of buildings → buildings' evaluation according to their energy efficiency

- Construction industry, is boosted by investing in energy efficiency (40% of energy demand and around 36% of CO2 emissions in the EU)
- Allows building owners to know how well their buildings perform and what measures are needed to improve energy efficiency

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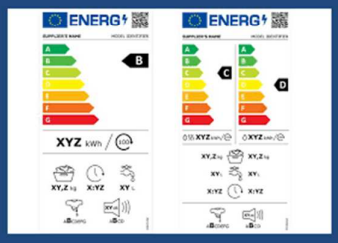
Objectives of the European Union - EU energy labels

Energy labels → Direct and easy indicator of a product's energy quality at the point of sales, enabling consumers to shop for more reliable devices

EU eco-design regulation

Important mechanism for enhancing commodity environmental sustainability by establishing uniform minimum energy efficiency requirements



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Directive 2008/28/EC (1/2)

Eco-design standards for energy-consuming goods

Electrical and mechanical appliances or heating systems

New Energy Label

- Energy efficiency information of the product (color code of seven categories)
- Energy and water consumption
- Performance (intensity, fulfillment, volume level)

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Directive 2008/28/EC (2/2)

Ecological design → Improve a product's environmental efficiency (remain its functional properties)

Directive → Establishes terms and conditions for establishing requirements for environmental features of products

Energy-consuming products and those that need to be considered for energy savings are indicated by the label and standard product information on energy consumption → Directive 2010/30/EU

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10. Clean Energy for Islands Initiative- European Commission

THANK YOU!!

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4.2 Energy control

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Energy Efficiency of buildings:

Energy control

Module 2.b

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Module Aim

- Familiarize with key energy concepts and energy-efficient technologies and behaviors
- Better understanding of the energy efficiency benefits, the energy management process, its stages and activities, and how energy efficiency can be applied to buildings

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Learning outcomes and keywords (1/3)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy efficiency
- Energy certification of buildings
- EU energy labels
- Ecological design
- Energy efficiency measures (EEMs)
- Energy efficiency action plan
- Project implementation

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Learning outcomes and keywords (2/3)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy Performance Certificate (EPC)
- Energy Services Company (ESCO)
- Energy cost

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Learning outcomes and keywords (3/3)

Energy efficiency	Energy consumption
Energy monitoring systems	Energy use
Energy management	Renewable sources

Energy Efficiency (1/2)

Energy use in daily needs

Heat (thermal), light (radiant), motion (kinetic), electrical, chemical, nuclear, and gravitational energy

Energy transformation → converting one form of energy into another (fuel into electricity)

Energy Efficiency (2/2)

Negative effects on the environment

Climate change, pollution, depletion of resources, and the destruction of ecosystems

Energy management

Ensures that less energy is used to maintain or improve the quality of services energy dependence, reduces energy imports and energy costs

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Energy Management (1/3)

Energy Audit

Identified and quantified energy flows

Existing energy systems are analyzed

- Definition of an energy base
- Opportunities for improving energy use are identified
- Set of energy efficiency measures are proposed, analyzed, and compared

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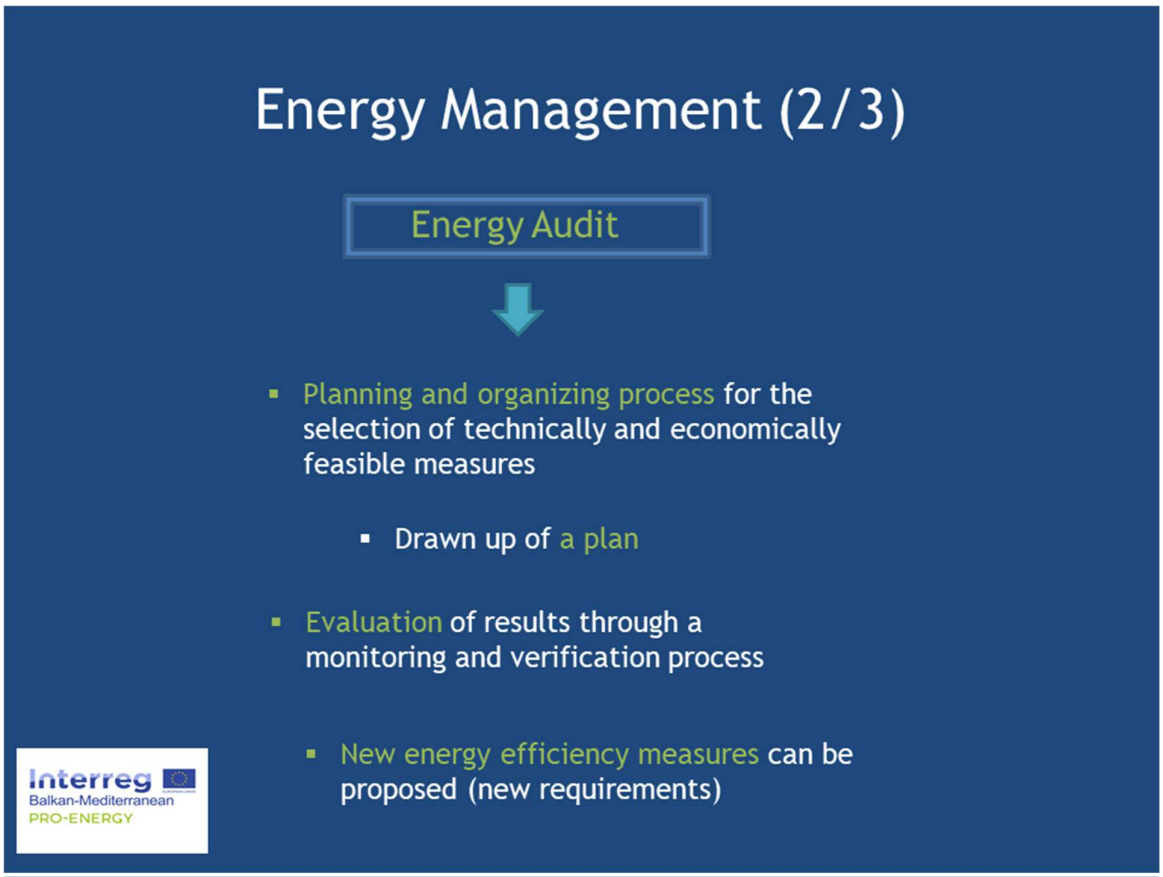
Energy Management (2/3)
Energy Audit
Planning and organizing process for the selection of technically and economically feasible measures
Drawn up of a plan
Evaluation of results through a monitoring and verification process
New energy efficiency measures can be proposed (new requirements)
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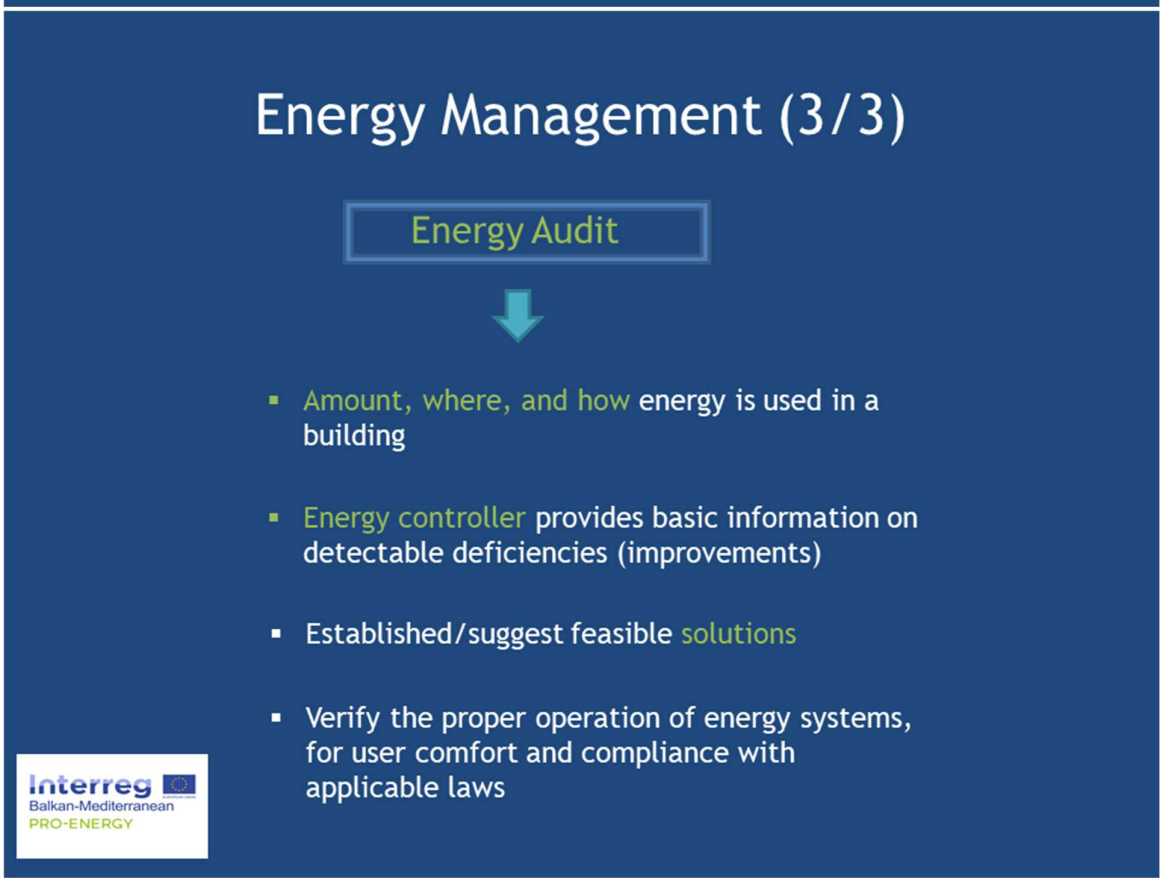
Energy Management (3/3)
Energy Audit
Amount, where, and how energy is used in a building
Energy controller provides basic information on detectable deficiencies (improvements)
Established/suggest feasible solutions
Verify the proper operation of energy systems, for user comfort and compliance with applicable laws
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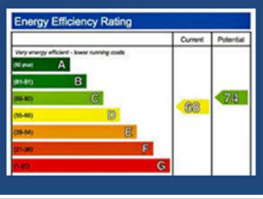
Energy Performance Certificate (EPC)

- Registers are the **primary source of information** regarding certified buildings. The share of buildings registers in the EPC database varies across Europe
- Important **instrument** that should contribute to the enhancement of the energy performance of buildings
- Shall include the **energy performance of a building** and the reference values, as well as the recommendations for the cost-optimal or cost-effective improvements of the energy performance of a building or building unit



Energy Service Companies (ESCOs)

Offer energy services which may include implementing energy-efficiency projects (and also renewable energy projects)

- Guarantee energy savings and/or provision of the same level of energy service at lower cost
- The remuneration of ESCOs is directly tied to the energy savings achieved
- Can finance, or assist in arranging financing for the operation of an energy system by providing a savings guarantee

ESCO
Energy Service Company

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4.3 Energy efficiency measures

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Energy Efficiency of buildings:

Energy efficiency measures

Module 2.c

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Module Aim

- Familiarize with key energy concepts and energy-efficient technologies and behaviors
- Better understanding of the energy efficiency benefits, the energy management process, its stages and activities, and how energy efficiency can be applied to buildings

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Learning outcomes and keywords (1/3)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy efficiency
- Energy certification of buildings
- EU energy labels
- Co-production
- Ecological design
- Energy efficiency measures (EEMs)
- Energy efficiency action plan
- Project implementation

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Learning outcomes and keywords (2/3)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy Performance Certificate (EPC)
- Energy Services Company (ESCO)
- Energy transformation
- Energy supply
- Energy cost

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Learning outcomes and keywords (3/3)

Energy efficiency	Energy consumption
Energy monitoring systems	Energy use
Energy management	Renewable sources

Energy Efficiency measures

Energy efficiency measures

reduce energy use without affecting the overall performance of a building or the comfort of its trainee

behavior-based

Reduce energy waste through changes in behavior and better planning of equipment operation

equipment-based

Involves the installation of higher energy efficiency equipment

Behaviour based

Connectivity and commitment

- Knowledge and advancement
- Education
- Responsibility
- Personal advice
- Performance metrics
- Action planning
- Modeling and feedback
- Demonstrations
- Personal Commitment

Behaviour based - Social dynamics

Energy consumption activities → Social activities (heat homes, workplace and public spaces)

Social interactions → When, why and how people consume energy

Energy behaviour in the form of peer-effects → Adopt peer-group energy saving behaviours

- Direct interpersonal communication
- Shifting social norms

Community-based initiatives (1/2)

- Could lead to long-term behaviour change
- Groups sharing information
- Part of a wider programme that has clear objectives

Reducing the environmental footprint

Delivering energy savings

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Pre-existing relationship between the participants

Share pro-environmental views

Community-based initiatives (2/2)

- Group size → less than 10 people to more than 100 (1,000 in some cases)
- Regular meetings
- Access to reliable information through written material and/or access to a trained expert
- People from the same neighborhood, workplace or community of interest such as a faith or a voluntary group → Successful in long-term due to social norms and behaviours

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Equipment based

Measures

Appropriate reporting framework

- Direct feedback – smart meters and in-home displays
- Indirect feedback – enhanced billing; personal goal setting and feedback;
- Energy audits

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Direct feedback

Immediate, from the meter or an associated display monitor

Savings range from 5-15%

- The meter provides a clearly-understood point of reference for **improved billing and for display**
- **Free-standing display**
- **Clearly visible**, within the building

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Indirect feedback

Feedback that has been processed in some way before reaching the energy user, normally via billing

Savings have ranged from 0-10%, but they vary

- Usually more suitable for demonstrating any effect on consumption of changes in space heating
- Historic feedback (comparing with previous recorded periods of consumption) → more effective than comparative or normative (other buildings)

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Energy Audits

- Useful tool to provide the information needed to implement energy efficiency measures in a specific environment
- Strengthen the link between energy audits and consumption practices → Be part of a longer-term programme to improve energy management and not just a one-off activity
- Provide information tailored to a specific context and actual consumption
- Delivered by independent experts
- Successful in raising awareness about energy issues

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ENERGY AUDITS

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5. Energy Savings

PRO-ENERGY

Promoting Energy Efficiency in Public Buildings of the

WP4: Training Material

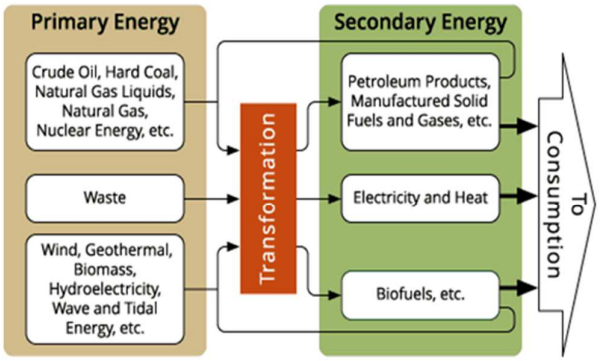
Subject: Energy Savings

Author: Cyprus Energy Agency
28 May 2021

1. Introduction to Energy

Energy concept

- Energy, in physics, the capacity for doing work.
- It may exist in potential, kinetic, thermal, electrical, chemical, nuclear, or other various forms.
- Energy is the food of human activity. It's the one who moves our bodies, cooks our food, gives heat and light to our houses and propels our vehicles.
- Man's dependence on energy is total.
- Energy is neither created nor destroyed, only transformed (First Principle of Thermodynamics).
- The transformation processes are not reversible, due to problems derived from heat transfer (Second Principle of Thermodynamics).



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Non-Renewable Energy

- Energy resources that are exhaustible relative to the human life span, such as gas, coal, or petroleum.
- Non - renewable resources are limited in supply and cannot be used sustainably.
- Major types of non-renewable resources: oil, natural gas, coal, and nuclear energy.
- Oil, natural gas, and coal are collectively called fossil fuels. Fossil fuels were formed within the Earth from dead plants and animals over millions of years—hence the name "fossil" fuels.
- They are found in underground layers of rock and sediment. Pressure and heat worked together to transform the plant and animal remains into crude oil (also known as petroleum), coal, and natural gas.

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Renewable Energy

- Energy obtained from sources that are virtually inexhaustible and replenish naturally over small time scales relative to the human life span.

- Renewable resources include biomass energy hydropower, geothermal power, wind energy, and solar energy.

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Renewable Energy

Solar energy: the use of direct solar energy.

There are two types depending on whether solar heat (solar thermal energy) or the electromagnetic radiation emitted by it (photovoltaic solar energy) is used.

Wind energy: Wind energy is a manifestation of indirect solar energy. The Sun heats the Earth's surface to different temperatures, producing air pressure differences, and consequently causing the air to move. It is therefore present all over the Earth, but with different intensity and regularity.

The machines that collect wind energy, popularly known as windmills, are among the oldest artefacts built by man.

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Renewable Energy

Hidraulic energy: produced by the water when is stored in reservoirs and lakes at a high altitude (so that it has gravitational potential energy).

If at a given moment it falls to a lower level, this energy is transformed into kinetic energy and afterwards into electrical energy in the hydroelectric plant.

Geothermal energy: is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. The geothermal energy of the Earth's crust originates from the original formation of the planet and from radioactive decay of materials; not have its immediate origin in solar radiation

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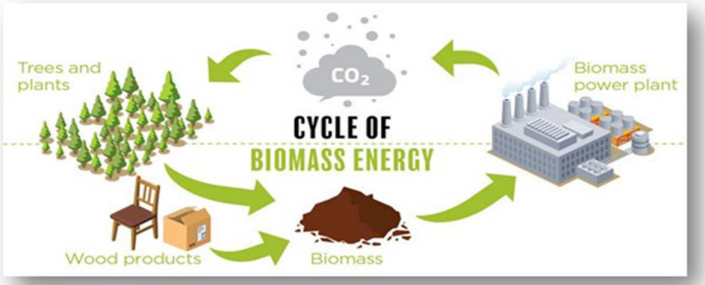
Renewable Energy

Biomass energy: energy of the Sun is used by plants to synthesize organic (photosynthesis).

- This organic matter is incorporated and transformed by the animal kingdom.
- This also transforms it by artificial procedures to obtain consumer goods.
- This whole process gives rise to directly usable elements, but also to by-products that have the possibility of finding application in the energy field, mainly through the combustion process.



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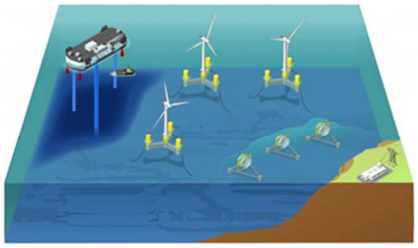
Renewable Energy

Ocean energy: energy use of the sea can be done by a mechanical and a thermal way.

The mechanical way consists of using the wind, the movement of the waves and the changes in height that the tides have. The thermal consists in taking advantage of the existing thermal gradient between different depths.



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2. Solar Energy

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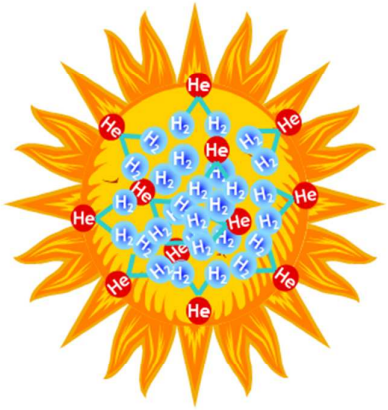
Solar energy - General aspects

- The origin of the energy that the Sun produces and radiates is due to the nuclear reactions that are continuously carried out inside.
- The Sun emits electromagnetic waves in a manner similar to an ideal black body that emits with an effective temperature of 5777K.
- This emission is described by a spectrum of radiant intensity that establishes the proportion in which the different wavelengths of which the radiation is composed participate.



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Characteristics of solar radiation

Solar radiation	Generic term. Electromagnetic waves carry energy that is transformed into heat or electricity.
Irradiation (H)	Incident energy on a surface per unit area and over a certain period of time (hourly irradiation, daily irradiation, etc.). Is measured in Wh/m^2 (o J/m^2).
Irradiance (G)	Incident power density on a surface, or the incident energy on a surface per unit of time. Is measured in W/m^2.

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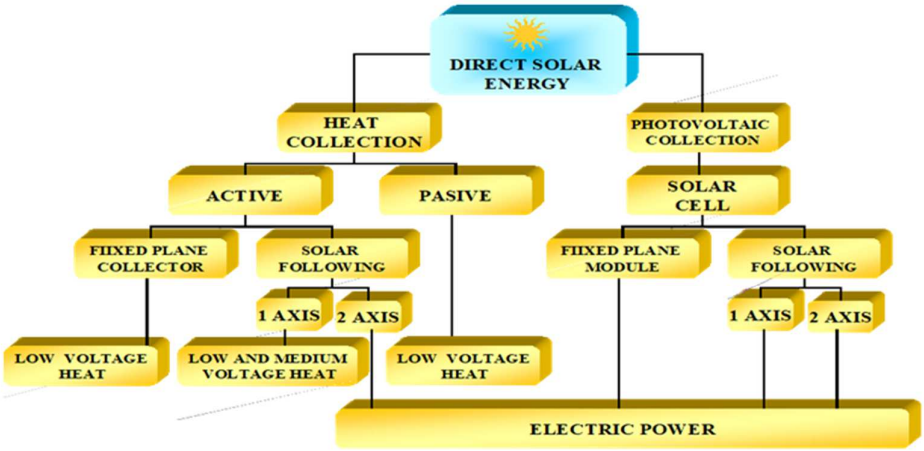
Transformation of solar energy



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Design criteria of solar systems

Orientation

- The collector system has to be positioned in such a way to use as much as possible of the solar radiation available during the year.
- An attempt is made for the solar radiation to reach as perpendicularly as possible on the collector's surface.
- It always has to be oriented towards the equator.
- This rule is valid both in the northern and southern hemispheres.

Inclination

Normal inclinations applied to solar collectors:

Use	Angle of inclination
All year round (d. hot water)	Latitude
Winter (heating)	Latitude + 10°
Summer (outdoor swimming pools/hotel)	Latitude - 10°
All year around photovoltaic	Latitude + 10°
Connection to photovoltaic grid	Latitude - 10°

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Classification of solar thermal energy

- Passive solar space heating happens when the sun shines through the windows of a building and warms the interior. Building designs that optimize passive solar heating (in the northern hemisphere) usually have south-facing windows that allow the sun to shine on solar heat-absorbing walls or floors in the building during the winter. The solar energy is absorbed by the building materials and heats the interior of buildings by natural radiation and convection.
- Active solar heating systems have collectors for heating a fluid (air or a liquid) and fans or pumps to move the fluid through the collectors, where it is heated, to the interior of a building or to a heat storage system, where the heat is released, and back to the collector to be reheated. Active solar water heating systems usually have a tank for storing solar heated water.

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Classification of solar thermal energy

Solar thermal energy	Operation temperature	Applications	Technology
Low temperature	T<90°C	Domestic Hot Water (DHW) and support for domestic heating, DHW in sports centers, water heating of swimming pools, etc.	• Flat plate collectors
Medium temperature	90°C<T<250°C	Production of thermal fluids for industrial processes, desalination of seawater and cooling by solar energy.	• Vacuum solar collectors • Parabolic trough concentrators collectors
High temperature	T>250°C	Steam generation for large-scale electricity production.	Installations of: • Dish-Stirling • Solar Tower

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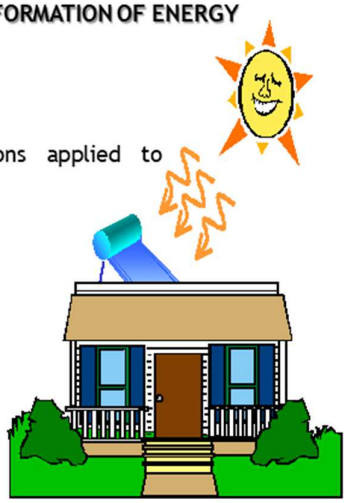
Low temperature solar thermal energy

DIRECT TRANSFORMATION OF ENERGY

Normal inclinations applied to solar collectors:



USEFUL ENERGY REQUIRED BY THE USER

DHW

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Low temperature solar thermal energy PRO-ENERGY

Advantages of STE (Solar thermal Energy)

- High energy quality
- Renewable and inexhaustible energy source
- No Pollution and Global Warming Effects
- No Fuel Cost: Solar energy is free and abundant
- Predictable, 24/7 Power
- Don't need transport and distribution systems
- It can be used with relatively simple systems (low temperature)

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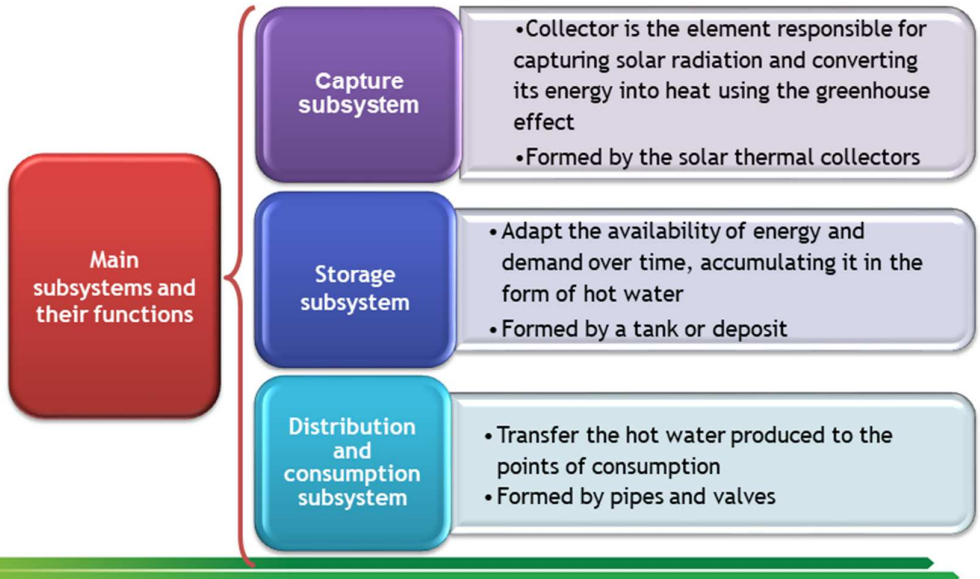
Description of low temperature STE system PRO-ENERGY



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Description of capture subsystem

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Capture subsystem:

- It is formed by thermal solar collectors.
- The collector is the element responsible for capturing solar radiation and converting its energy into heat using the greenhouse effect.
- In solar thermal collectors, the area that receives the solar radiation is roughly the same as the absorber area (i.e., the area absorbing the radiation).

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Description of storage subsystem

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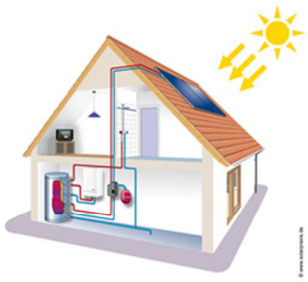
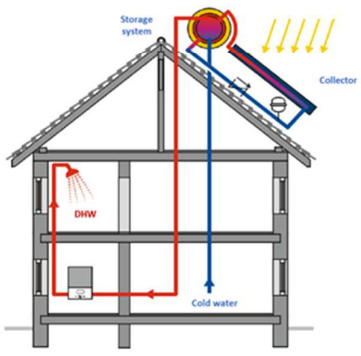
Storage subsystem:

- It is formed by by a tank or deposit.
- The storage subsystem is the element that adapt the availability of energy and demand over time, accumulating it in the form of hot water.
- The hot water can be offered at any time it is requested.





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3. Photovoltaic Solar Energy

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Introduction to photovoltaic energy

- Photovoltaic (PV) solar energy is the direct collection of solar energy to obtain electric power.
- This process is based on the application of the photovoltaic effect produced when light is incident on materials called semi-conductors. This generates a flow of electrons inside the material which can be used to obtain electric power.

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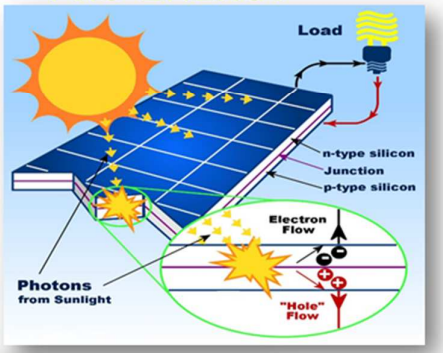
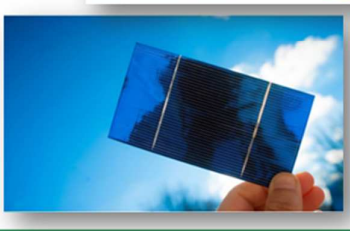
Solar cells

- Solar cells directly transform part of the solar energy that they receive into electric power.
- The photovoltaic effect occurs when solar radiation enters into contact with a crystalline semi-conductor material.
- The light transports energy in the form of photons.
- When they are incident on certain materials (for example, silicon doped with phosphorous and boron, and thus transformed into a semi-conductor), this makes the electrons move inside them to produce a power differential at the ends of the materials, turning them into small batteries or electric generators.





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Description of PV systems

Main subsystems and their functions

Capture subsystem
- Collector is the element responsible for capturing solar radiation and converting its energy into electricity
- Formed by photovoltaics interconnected modules

Storage subsystem
- Adapt the availability of energy and demand over time, accumulating it
- Formed by batteries

Regulation subsystem
- Regulate the current absorbed by the battery to prevent dangerous overloads, but making sure that the best possible use is made of the energy collected by the panels.
- Formed by a regulator/inverter

Distribution and consumption subsystem
- Transfer the electricity produced to the points of consumption
- Formed by cables and electrical equipment

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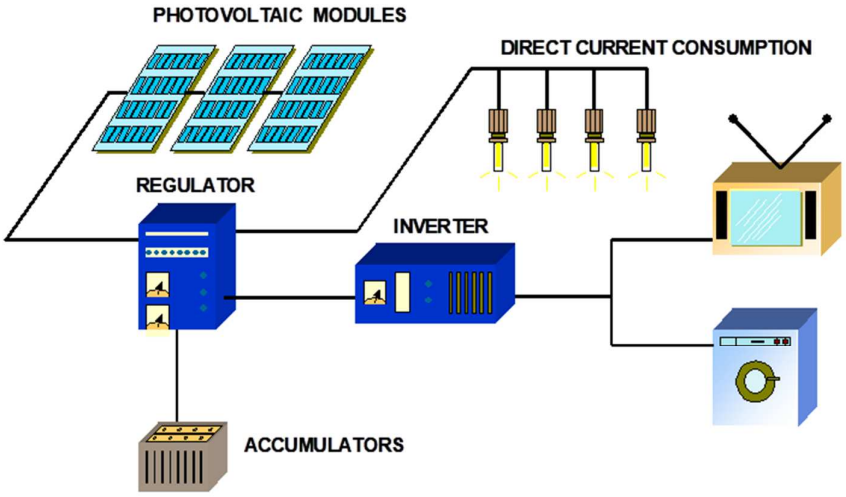
Description of PV systems



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Description of PV systems

4. Wind Energy

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Wind Energy - Introduction

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- Wind power is the conversion of wind energy into useful form, such as electricity, using wind turbines.
- In windmills, wind energy is directly used to crush grain or to pump water.
- Wind power is produced in large scale wind farms connected to electrical grids, as well as in individual turbines for providing electricity to isolated locations.
- Accurate evaluation of available wind is so important that differences of about 10% can lead to differences of 30% in the power output received. This evaluation and characterization process aims to identify the air available for use at a specific location, or in other words, the wind with the necessary characteristics to be used by a particular collection system. This evaluation is a complex process that is subject to a large number of relevant factors.

Wind energy is:

- Plentiful
- Renewable
- Widely distributed
- Clean
- Reduces greenhouse gas emissions

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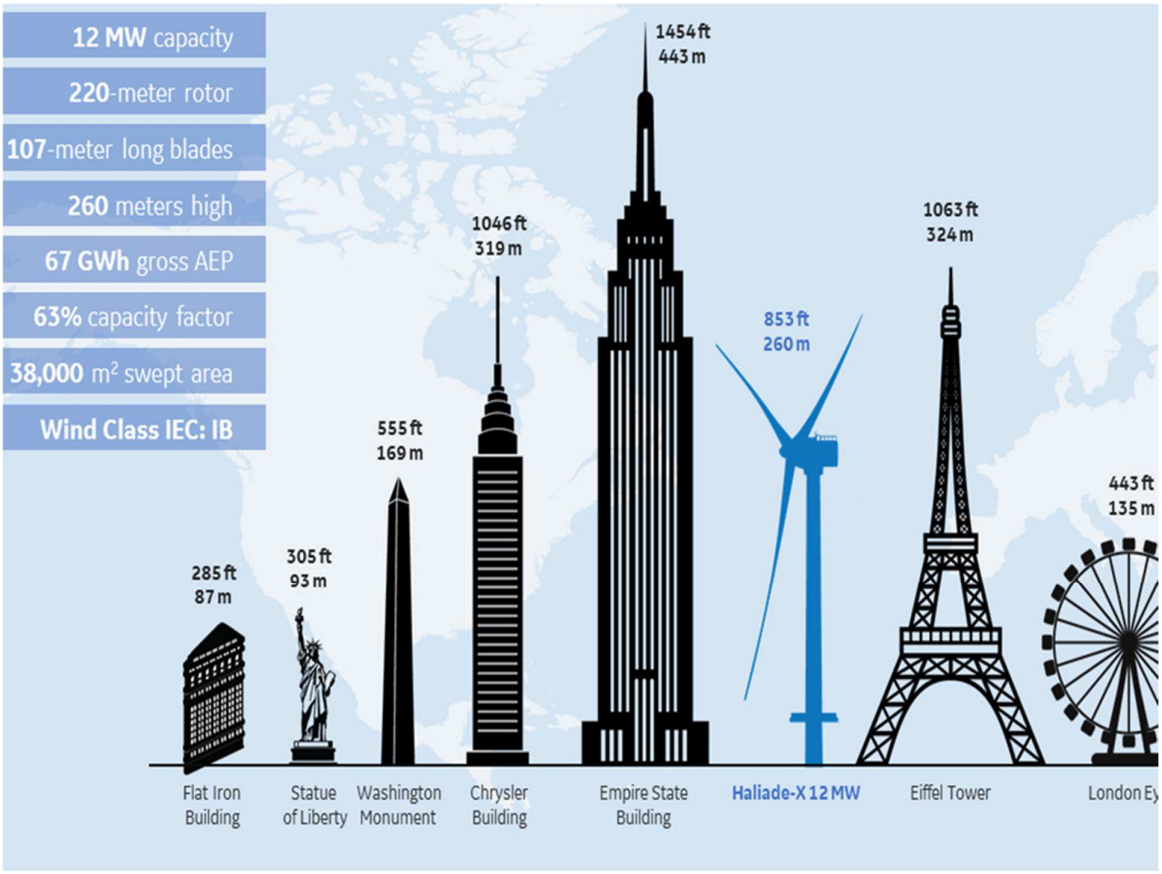
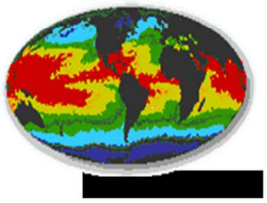
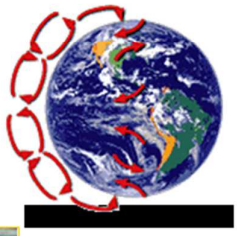


Wind Energy - Introduction

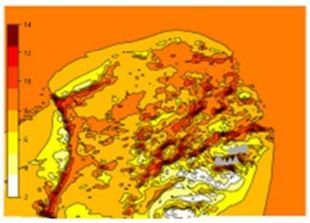
- Wind energy is a manifestation of indirect solar energy.
- It is therefore present all over the Earth, but with different intensity and regularity.





Producing air pressure differences, and consequently causing the air to move

Transforming wind energy into electric power



Wind

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General characteristics of the wind

DIFFERENT TYPES OF WIND CAN BE DEFINED:

- General winds derived from the circulation of the air over the planet: heat differentials and topographical terrain differences.
- Local winds: are more clearly manifest when general winds are weak, and there are areas where they are so important that they are the stronger of the two.

  - Wind speed vary with height.
  - Close to the surface, the wind's path is modified, and it is slowed down by its interaction with the terrain.
  - Different roughness factors on the terrain causes variable turbulences ⇒ more difficult use the wind close to the surface of the terrain where the installation is mounted.

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Classification of wind machines

RATED POWER

Small (≤10 kW)
- Homes
- Farms
- Remote Applications

(e.g. water pumping, telecom sites, icemaking)

Intermediate (10-250 kW)
- Village Power
- Hybrid Systems
- Distributed Power

Large (250 kW - 2+MW)
- Central Station Wind Farms
- Distributed Power

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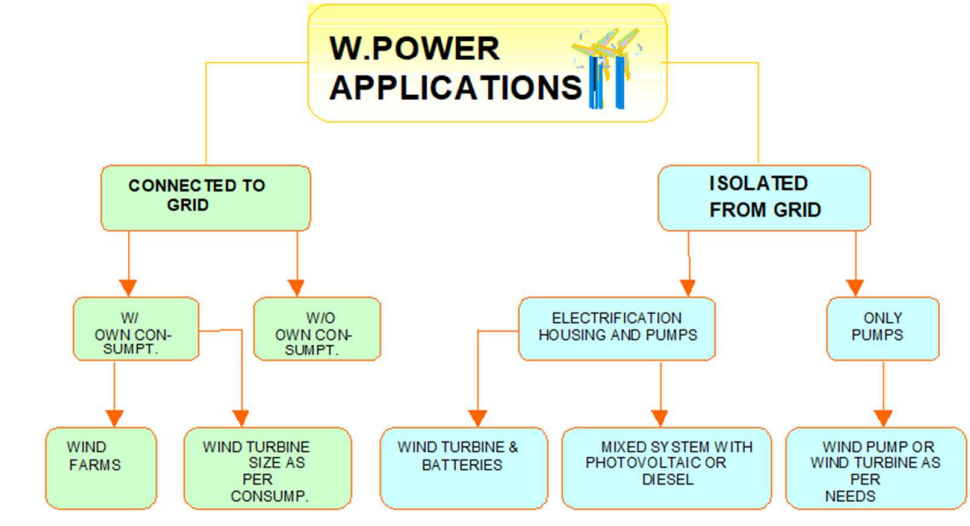
Wind power applications



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5. Biomass

Introduction to biomass

Biomass is plant or animal material used for energy production (electricity or heat), or in various industrial processes as raw material for a range of products.

Biomass energy

- Grown energy crops (e.g., miscanthus, switchgrass)
- Wood or forest residues
- Waste from food crops (wheat straw, bagasse)
- Horticulture (yard waste)
- Food processing (corn cobs)
- Animal farming (manure, rich in nitrogen and phosphorus)
- Human waste from sewage plants.

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Biofuel

Biofuels are a durable solution to the energy problem, due it is a renewable resource (it is solar energy stored in chemical form), economical (its final price is similar to that of commercially priced fossil fuels) and very abundant.

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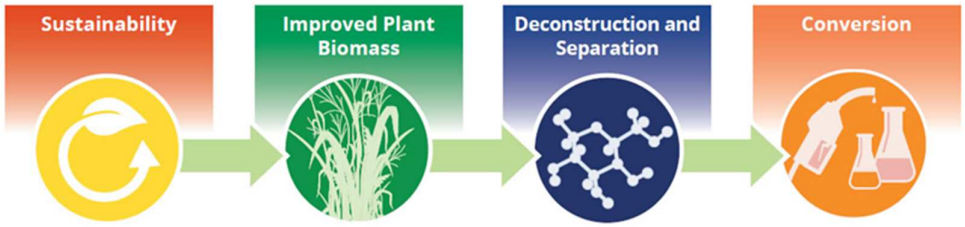
From biomass to advanced biofuels and bioproducts



Sustainability
Produce biomass for biofuels and bioproducts with minimal to positive impacts on the environment.

Biomass Development
Develop crops with cell walls optimized for deconstruction and conversion to biofuels and bioproducts.

Biomass Breakdown
Improve enzymes and microbes that break down biomass into sugars and lignin.

Biofuel and Bioproduct Synthesis
Engineer metabolic pathways in microbes to produce biofuels and bioproducts.

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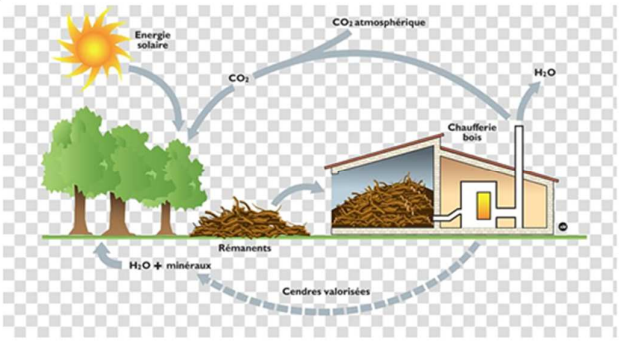
The biomass and energy vector

- During photosynthesis, plants generate carbohydrates: sugars and starches. Carbohydrates are organic compounds from carbon and hydrogen. These compounds store energy in the bonds that hold them together.
- This stored energy is released when plants are eaten or, more importantly, when they are burned.

Combustion: The oxygen in the air combines with the carbon of the plants and releases energy, water and carbon dioxide (CO_2).

Fermentation: another process to release energy from plants. The fermentation process converts plant sugars into alcohol. Then that alcohol, in the form of liquid or gas, can be burned to release energy. The biomass fuel obtained in this way is called biofuel.



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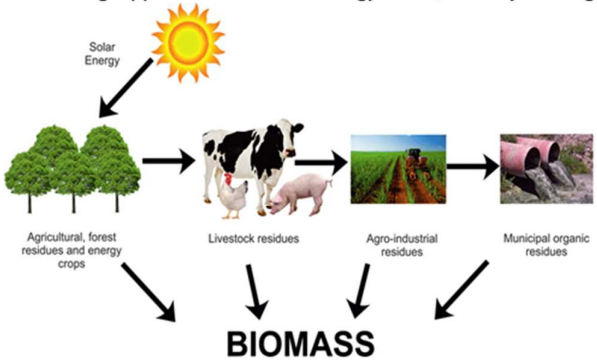
Waste used by biomass

The energy of the Sun is used by plants to synthesize organic matter through the process of photosynthesis. This organic matter is incorporated and transformed by the animal kingdom (including the human being). This also transforms it by artificial procedures to obtain consumer goods. This whole process gives rise to directly usable elements, but also to by-products that have the possibility of finding application in the energy field, mainly through the combustion process.



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Energy efficiency of biofuels

The energy efficiency of ethanol production is the ratio between the calories that the obtained biofuel has, and those consumed in the process.

There is widespread controversy regarding the efficiency of the process of converting corn into ethanol, while some claim that it is greater than 1.77 others argue that it is less than one.

In a study developed by the United States Department of Agriculture, a detailed energy balance of obtaining ethanol from corn is carried out, which determined that for the most technologically efficient processes, the production of fertilizers and chemicals uses an amount of energy equal to 10% of the total calories contained in the ethanol produced.

Crop	(Input/Output)
Corn	3.84
Switchgrass	14.52
Soy	2.56
Sunflower	0.76
Rape	4.47
Wheat	5.91

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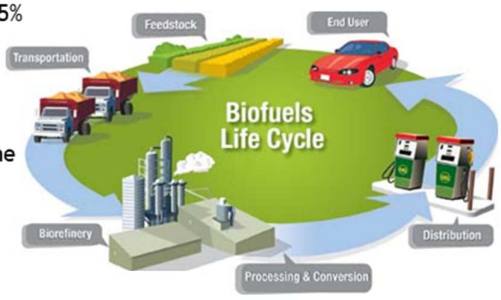
Advantages of biofuels

- Exhaust gases of ethanol are much cleaner.
- Greenhouse gases reduce
- Ethanol - blended fuels such as E85 (85% ethanol and 15% gasoline) reduce up to 37,1 % of GHGs
- Positive energy balance, depending on the type of raw stock.
- Output of energy during the production is more than the input.
- Any plant can be use for production of bioethanol
- It only has to contain sugar an starch.
- Carbon neutral
- The CO_2 released in the bioethanol production process is the same amount as the one the crops previously absorbed during photosynthesis.



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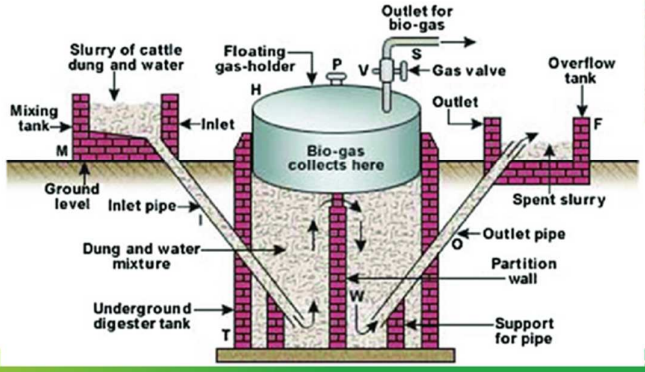
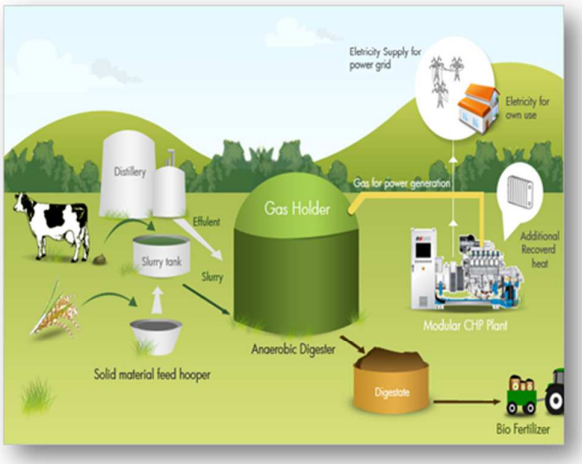
Anaerobic digestion processes and biodigesters

Biodigesters are simple equipment, designed so that the anaerobic digestion process can be developed in a controlled way. They convert the organic fraction of waste into usable by-products, such as methane gas and fertilizer.



Biogas

The term biogas refers to the mixture of gases resulting from the decomposition of organic matter by bacterial action under anaerobic conditions. Biogas can be considered a renewable and clean fuel, especially if it is the result of the use of organic waste from full landfills and is used to move vehicles and generate electricity and heat with local resources.



Characteristics of biogas

Biogas is a fuel with a high caloric value of 4700 to 5500 kcal/m³ (the caloric power of biogas is 22260 kJ/l, compared to diesel estimated at 39000 kJ/l) and can be used to cook food, for the lighting of ships and homes, as well as to power the internal combustion engine power.

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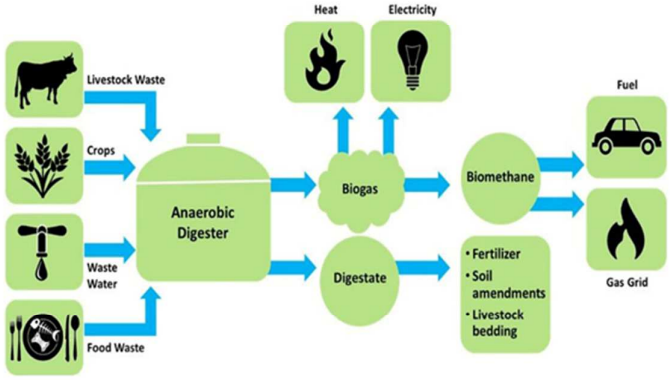
Biogas uses

Biogas can be used as fuel for internal combustion engines, both diesel and gasoline, later a generator can produced electrical energy.

- Domestic fuel
- For street lighting
- Generation of electricity
- If compressed, it can replace compressed natural gas for use in vehicles.



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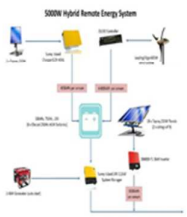
6. Hybrid Systems: Grid-connected and off grid isolated power supply

Introduction to hybrid system

Hybrid plants can be an integration of diesel generators with renewable energy resources such as photovoltaic and wind. In addition, integrating a battery energy storage system (BESS) with the hybrid plant provides significant dynamic operation benefits such as higher stability and reliability of power supply. Hybrid plants are outlined as an optimum approach for off grid power supply options for remote areas applications..



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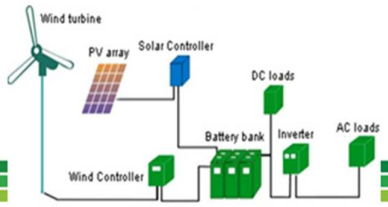
Introduction to hybrid system

- Stand-alone power grids can be gradually expanded into large-scale systems as a result of the parallel connectability of all energy suppliers and consumers. They are particularly well suited for the supply of grid-isolated areas such as remote villages. The autonomous energy system can easily be expanded by further power generators when the power demand rises. One further advantage of the stand-alone power system: Thanks to the storage batteries, energy not needed during the day will be available at night, e.g., for street lighting.
- Highly reliable and efficient Hybrid RAPS – Remote Area Power Supply solution combine PV and small wind turbine, with reliable diesel generator, for a stable power supply. RES reduces the consumption of diesel fuel and the costs of generator maintenance; the increased capital cost of solar panels and batteries is quickly repaid by the substantial savings in operating costs. That not only lowers electricity bills and improves the competitive position of the operator, but also protects the environment and reduces carbon emissions.



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Introduction to hybrid system

Microgrid projects are driven by factors that can be very different from one deployment to another. Some key drivers include:

- Need for electrification in remote locations and developing countries.
- Customer need for more reliable, resilient, and sustainable service.
- In remote areas, reduce the dependence on expensive and dirty diesel fuel by substituting with RES.
- Grid security and survivability concerns.
- Utility needs for grid optimization, investment deferral, congestion relief, and ancillary services.
- Demand for lower-cost energy supplies than are locally available (especially at remote sites, such as islands, military or mineral/resource installations, and isolated communities relying on expensive, high-polluting fuels).
- Environmental, efficiency, and renewable energy benefits.

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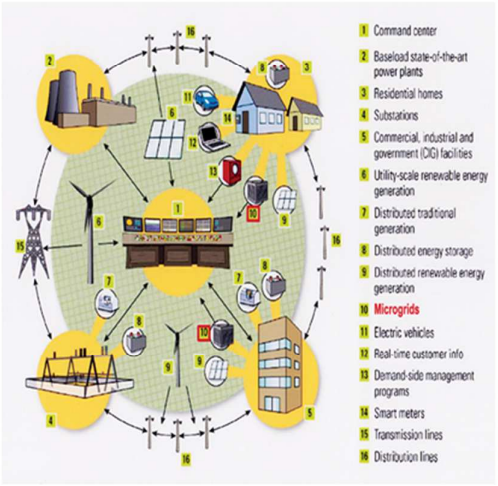
Introduction to hybrid system

Microgrids presently cover roughly 1% of US power systems (most of them are military), but in Europe the percentage is even lower. The number of installed microgrids is small, but it's growing in many regions around the world. The International Energy Agency (IEA) estimates that to achieve its goal of universal access to electricity, "70% of the rural areas that currently lack access will need to be connected using mini-grid or off-grid solutions."

Combining res with diesel generators in hybrid microgrids

A microgrid is a localized small-scale integrated power delivery system consisting of a group of small-interconnected controllable and not controllable customer loads. Multiple types of small dispatchable and non-dispatchable distributed energy generation units that include RES (PV, wind, biomass) and conventional fossil generation (diesel ICE, micro-turbines). Energy storage systems (flywheels, batteries), that operates as a coherent system within clearly defined electrical boundaries, and that acts as a single controllable entity that can operate either connected to a wider power grid as a single point load, or operate autonomously disconnected from the grid (known as "islanding" mode).



Combining res with diesel generators in hybrid microgrids

DERs and technologies available to make microgrids work:

- Gas or diesel cogeneration / CHP
- Fuel cells and microturbines
- Photovoltaic (PV) modules
- Wind, biomass, small hydro
- Storage capacity
- Energy management and automation systems

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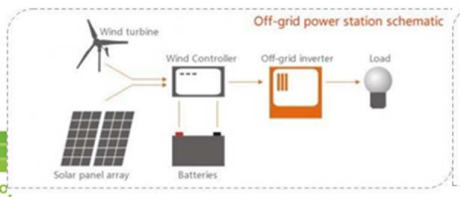
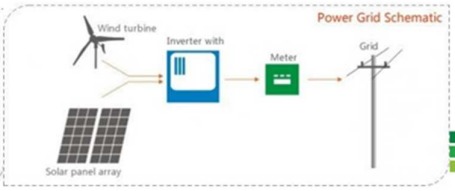
Off-grid microgrids

When operating off-grid, a microgrid itself provides a high quality distributed power generation solution. In grid-connected operation, a microgrid provides valuable energy resources to the main grid with valuable contribution such as supplying peak load supply and reactive power correction, etc.

- An off-grid RES microgrid system are designed to cover the needs of good power quality service for users who have no access to an electrical grid or prefer to be completely independent of grid power. Those who choose to live off-grid often need to adjust when and how they use electricity, so they can live within the limitations of the system's design
- Stand-alone off-grid microgrids are designed to operate independent of the electric utility grid and sized to supply certain DC and/or AC electrical loads. These types of systems may be powered by PV array only, or may use wind, an engine-generator for back-up power. Typically the off-grid microgrid system is identical to the hybrid grid-connected system, but with a larger battery bank and a generator for backup power. These systems represent a considerable investment, but for many users, for example an island resort or remote business site that is fully dependent on a generator for power, they remain cost-effective and economical.





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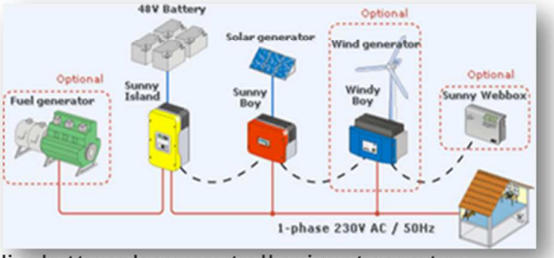
Off-grid microgrids

Typical off-grid microgrid system requires the following extra components:



- RES systems, which generates DC power
- Battery Bank that stores the DC power
- Backup Generator (optional)
- Balance of system (BOS) equipment—including battery charge controller, inverter, system wiring
  - Charge Controller (protecting the battery during charging)
  - Off-Grid Inverter. The intelligence center of a renewable system, seamlessly converting DC power to clean and reliable AC electricity to supply the loads

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Off-grid microgrids

7. Energy storage systems

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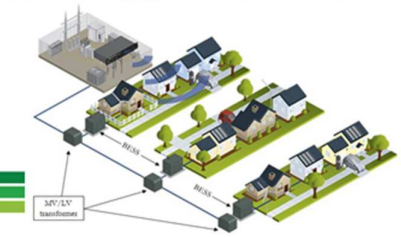
Energy storage systems

- Grid energy storage is a collection of methods used to energy storage on a large scale within an electrical power grid.
- Electrical energy is stored during times when electricity is plentiful and inexpensive (especially from intermittent power plants such as renewable electricity sources such as wind power, tidal power, solar power) or when demand is low, and later returned to the grid when demand is high, and electricity prices tend to be higher.
- Energy storage is the capture of energy produced at one time for use later.



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Types of energy storage

1. Fossil fuel storage: It is stored in the form of the chemical energy generated from its own heat of combustion. It is the most concentrated form of storage that exists, of the order of 10,000 kWh per m^3.

2. Mechanical storage: Energy can be stored in water pumped to a higher elevation using pumped storage methods or by moving solid matter to higher locations (gravity batteries). Other commercial mechanical methods include compressing air and flywheels that convert electric energy into kinetic energy and then back again when electrical demand peaks. In summary, the forms of mechanical energy storage are:

a. Compressed air energy storage (CAES
b. Flywheel energy storage
c. Solid Mass Gravitational Energy Storage
d. Pumped-storage hydroelectricity

3. Thermal storage: Thermal energy storage (TES) is the temporary storage or removal of heat. Basically, there are two different types:

a) Seasonal thermal energy storage (STES).
b) Latent heat thermal energy storage systems.

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Types of energy storage

4. Electrochemical (Battery Energy Storage System, BESS): The most important electrochemical systems for storage are the following:

a) Rechargeable battery
b) Flow battery
c) Supercapacitor

5. Electrical methods: the way to store energy with electrical methods is through the use of the following elements:

a) Capacitor
b) Superconducting magnetics

6. Other Chemical: Among these storage methods are Power to gas, Power to liquid, Biofuels, Hydrogen, etc. Biofuel and Hydrogen could be the energy storage medium of the future. Although currently the overall performance of the chain is very low, with very high thermal losses.

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Battery technologies

The battery energy storage system consists of two main parts; the electrochemical storage part and the rectifier/inverter, which transform the voltage from DC to AC and vice versa.

Any battery has two terminals. One terminal is marked (+), or positive, while the other is marked (-), or negative.

The internal workings of a battery are typically housed within a metal or plastic case. Inside this case are a cathode, which connects to the positive terminal, and an anode, which connects to the negative terminal.

These components, more generally known as electrodes, occupy most of the space in a battery and are the place where the chemical reactions occur. A separator creates a barrier between the cathode and anode, preventing the electrodes from touching while allowing electrical charge to flow freely between them. The medium that allows the electric charge to flow between the cathode and anode is known as the electrolyte. Finally, the collector conducts the charge to the outside of the battery and through the load.

When a device is connected to a battery, a reaction occurs that produces electrical energy. This is known as an electrochemical reaction. When a load closes the circuit between the two terminals, the battery produces electricity through a series of electromagnetic reactions between the anode, cathode and electrolyte.

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Types of batteries

There are two types of batteries: non-rechargeable batteries, or primary cells, and rechargeable batteries, or secondary cells. When electrical energy from an outside source is applied to a secondary cell, the negative-to-positive electron flow that occurs during discharge is reversed, and the cell's charge is restored.

- **Zinc-carbon battery:** The zinc-carbon chemistry is common in many inexpensive AAA, AA, C and D dry cell batteries. The anode is zinc, the cathode is manganese dioxide, and the electrolyte is ammonium chloride or zinc chloride.
- **Alkaline battery:** This chemistry is also common in AA, C and D dry cell batteries. The cathode is composed of a manganese dioxide mixture, while the anode is a zinc powder. It gets its name from the potassium hydroxide electrolyte, which is an alkaline substance.
- **Lead-acid battery (rechargeable):** This is the chemistry used in a typical car battery. The electrodes are usually made of lead dioxide and metallic lead, while the electrolyte is a sulfuric acid solution.
- **Lithium-ion battery (rechargeable):** Lithium chemistry is often used in high-performance devices, such as cell phones, digital cameras and even electric cars. A variety of substances are used in lithium batteries, but a common combination is a lithium cobalt oxide cathode and a carbon anode.
- **Flow Battery:** are normally considered for relatively large (1 kWh - 10 MWh) stationary applications. Various types of flow cells (batteries) have been developed, including redox, hybrid and membraneless (Vanadium Redox; Zinc Bromine; Iron-chromium; Zinc-nickel Oxide). The fundamental difference between conventional batteries and flow cells is that energy is stored in the electrode material in conventional batteries, while in flow cells it is stored in the electrolyte.

The most common rechargeable batteries on the market today are lithium-ion (LiOn), though nickel-metal hydride (NiMH) and nickel-cadmium (NiCd) batteries.

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8. Shell thermal insulation

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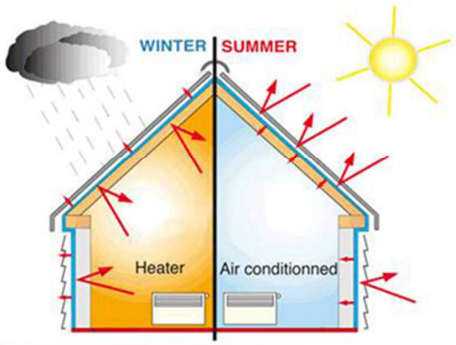
Introduction to thermal Insulation PRO-ENERGY

Thermal Insulation

▪Heat Transfer

The heat is transfer from high temperature environment to the low temperature environment.



In the summer we have heat (unwanted) from the external environment to the interior.

→ high energy consumption for building air conditioning

In the winter we have an undesirable heat loss from the interior to the external environment.

→ high energy consumption for building heating

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Introduction to thermal Insulation PRO-ENERGY

Thermal Insulation

▪Heat Loss in a building depends on:

(1) The climate of the area
(2) The location of the building
(3) Structural characteristics of the building

- Thermal Insulation of a construction material, is a process to reduce the heat losses occurring during winter and heat gain occurring during summer.
- Therma insulation is an important technology to reduce energy consumption in buildings by preventing heat gain/loss through the building.
- Thermal transmittance or U-value, is the rate of transfer of heat through a structure.
- Thermal conductivity (λ), is the measure of how easily heat flows through a specific type of material. The lower the thermal conductivity of a material, the better the thermal performance.

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Introduction to thermal Insulation

Thermal Insulation

▪Application of thermal insulations

Masonry : (walls, beams and columns)

Ceilings : (flat roofs and roofs)

Floors: (exposed floors or floors in contact with non-conditioned spaces)

Openings :(windows and exterior doors)

- Reducing the heat loss from building elements such as walls and floors is imperative for designing an energy efficient building.
- A good design of these composite components minimizes the u-Value, which provides a passive and long lasting benefit to the buildings' lifetime costs.

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Thermal Insulation Materials

Mineral - Wool

Rock - Wool

XPS Polystyrene

Glass - Wool

Polyurethane foam

EPS Polystyrene

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Thermal Insulation Materials

Thermal Bricks

Foam concrete

Thermal Insulating Plasters

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Double Glazing Windows

- Frames fitted with two panes of glass that have a space between them, usually 12mm to 16mm.
- The gap between the two glass panes is filled with normal air.
- The air between the panes glass leads to dramatic reductions of heat and noise transmissions.

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Lighting

- Switching to energy -efficient lighting is one of the fastest ways to cut your energy bills
- CFL Lighting : Last 10 times longer and use about one-fourth the energy of traditional incandescent bulbs
- LED Lighting: Use only about 20%-25% of the energy and last up to 25 times longer than traditional incandescent bulbs

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External Shading

- Contribute a lot in solar radiation penetration and reflectance.
- The use of suitable external shades, blinds, window sills, can save up to 15%.

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Green Roofs

- A green roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane.
- Reducing waste and conserving energy.
- Manage Rainwater and purify it. Green roofs filter it out themselves.
- Improve air quality.

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6. Energy Behavior

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Energy behavior

Module 4.a

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Module Aim

- Identify **energy behavior** via the presentation of relevant **measures**, ways to be improved to contribute to workplace's best possible energy efficiency
- Civil servants will learn how they could help/encourage their colleagues towards this **energy-saving logic**

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Learning outcomes and keywords (1/2)

Trainees are expected to understand, know and apply the following terms and definitions:

- Energy Efficiency
- Energy behaviour
- Energy Efficiency measures

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Learning outcomes and keywords (2/2)

Energy behavior	Energy consumption level
Energy security	Employee incentive measures

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Introduction

Energy-efficient policies

People's changing actions + Technical solutions

Behavioral models

- Energy management
- Static behavior improvement

→ Dynamic Interactions

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Energy efficiency measures – Types of interventions

Connectivity and commitment

Connectivity and commitment

- Knowledge and advancement
- Education
- Responsibility
- Personal advice
- Performance metrics
- Action planning
- Modeling and feedback
- Demonstrations
- Personal Commitment

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Social dynamics of Energy Behaviour

Energy consumption activities → Social activities (heat homes, workplace and public spaces)

Social interactions → When, why and how people consume energy

Energy behaviour in the form of peer-effects → Adopt peer-group energy saving behaviours

- Direct interpersonal communication
- Shifting social norms

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Feedback measures (1/2)

Feedback measures

Appropriate reporting framework

- Direct feedback – smart meters and in-home displays
- Indirect feedback – enhanced billing; personal goal setting and feedback;
- Energy audits
- Community-based initiatives

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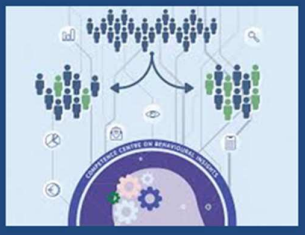
Feedback measures (2/2)

Feedback measures (other)

- Building certification and labelling;
- Public engagement campaigns;
- Financing schemes and subsidies;
- Eco-design



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Financial incentives and disincentives

Financial incentives and disincentives

- Contributions
- Incentives
- Charges
- Taxes, Bonus schemes, tax disputes, tax refunds,
- Investment funds such as interest-free loans, rewards
- Penalties are examples of financial incentives and disincentives

Economic instruments to mobilise investment in energy efficiency in buildings

Goal →
- Scale-up private investment in low-energy buildings
- Realise the full, economically-efficient energy saving potential as soon as possible

Incentives → encourage potential investors to take action

Deterrents → increase the cost of doing nothing (consumption subsidies/taxes)

Enablers → Facilitate access to finance to invest in energy efficiency

Regulatory Interventions

Regulatory

- General legislation and regulations, special exceptions and
- Agreements
- Adjustable agreements against dynamic energy pricing

Energy efficiency directive (Directive 2012/27/EU)

- Binding measures → 20% energy efficiency target by 2020
- EU energy consumption → no more than 1483 million tonnes of oil equivalent (Mtoe) of primary energy or 1086 Mtoe of final energy
- EU countries → use energy more efficiently at all stages of the energy chain

Measures adopted under Energy Efficiency Directive (1/3)

Policy measures to achieve *energy savings* equivalent to annual reduction of 1.5% in national energy sales
EU countries making *energy efficient renovations* to at least 3% per year of buildings owned and occupied by central governments
National long-term renovation strategies for the *building stock* in each EU country

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Measures adopted under Energy Efficiency Directive (2/3)

Mandatory *energy efficiency certificates* accompanying the sale and rental of buildings
The preparation of *National Energy Efficiency Action Plans (NEEAPs)* every three years
Minimum *energy efficiency standards and labelling* for a variety of products such as boilers, household appliances, lighting and televisions (energy label and eco design)
The planned rollout of close to 200 million *smart meters* for electricity and 45 million for *gas* by 2020

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Measures adopted under Energy Efficiency Directive (3/3)

Obligation schemes for energy companies to achieve yearly energy savings of 1.5% of annual sales to final consumers
Large companies conducting *energy audits* at least every four years
Protecting the *rights of consumers* to receive easy and free access to data on real-time and historical energy consumption

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THANK YOU!!
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6.1 Feedback measures

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Energy behavior

Feedback measures

Module 4.b

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Module Aim

- Identify **energy behavior** via the presentation of the **feedback** and **feedback measures**, ways to be improved to contribute to workplace's best possible energy efficiency
- Civil servants will learn how they could help/encourage their colleagues towards this **energy-saving logic**

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Learning outcomes and keywords (1/2)

Trainees are expected to understand, know and apply the following terms and definitions:

- Feedback
- Feedback measures
- Indirect and immediate feedback

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Learning outcomes and keywords (2/2)

Energy behavior	Energy consumption level
Energy security	Employee incentive measures

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Introduction

Energy-efficient policies

People's changing actions + Technical solutions

Behavioral models

- Energy management
- Static behavior improvement

→ Dynamic Interactions

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Types of Feedback

Feedback types (1/3)

- Direct feedback

- Self-meter-reading
- Direct displays
- Interactive feedback via a PC
- Pay-as-you-go/keypad meters
- 'Ambient' devices
- Meter reading with an adviser, as part of energy advice
- Cost plugs or similar devices on appliances

- Indirect feedback

- More frequent bills
- Frequent bills based on readings plus historical feedback
- Frequent bills based on readings plus comparative/normative feedback
- Frequent bills plus disaggregated feedback Frequent bills plus detailed annual or quarterly energy reports

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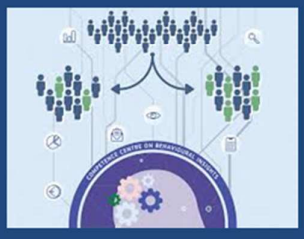
Feedback types (2/3)

- Inadvertent feedback - learning by association

- With the advent of microgeneration, the home becomes a site for generation as well as consumption of power
- Community energy conservation projects such as the Dutch 'Eco-teams'



- Utility-controlled feedback - learning about the customer

- Utility-controlled feedback via smart meters, with a view to better load management.

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Feedback types (3/3)

- Energy audits - learning about the 'energy capital' of a building
- Audits may be

• undertaken by a surveyor on the client's initiative
• undertaken as part of a survey for the Home Information Pack
• carried out on an informal basis by the consumer using freely available software, eg carbon calculators

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Direct feedback

Immediate, from the meter or an associated display monitor

Savings range from 5-15%

- The meter provides a clearly-understood point of reference for **improved billing and for display**
- **Free-standing display**
- **Clearly visible**, within the building

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Indirect feedback

Feedback that has been processed in some way before reaching the energy user, normally via billing

Savings have ranged from 0-10%, but they vary

- Usually more suitable for demonstrating any effect on consumption of changes in space heating
- Historic feedback (comparing with previous recorded periods of consumption)

more effective than comparative or normative (other buildings)

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Disaggregated by end-use (electricity meter) feedback

- Relatively expensive and complicated to supply
- Give the consumer adequate information on different end-uses
- Savings of 10-20% are quoted (North America)

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Energy behavior

Feedback measures

Module 4.c

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Module Aim

- Identify **energy behavior** via the presentation of the **feedback measures**, ways to be improved to contribute to workplace's best possible energy efficiency
- Civil servants will learn how they could help/encourage their colleagues towards this **energy-saving logic**

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Learning outcomes and keywords (1/2)

Trainees are expected to understand, know and apply the following terms and definitions:

- Indirect and immediate feedback
- Energy Audits
- Community-based initiatives

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Learning outcomes and keywords (2/2)

Energy behavior	Energy consumption level
Energy security	Employee incentive measures

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Introduction

Energy-efficient policies

People's changing actions + Technical solutions

Behavioral models

- Energy management
- Static behavior improvement

→ Dynamic Interactions

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Social dynamics of Energy Behaviour

Energy consumption activities → Social activities (heat homes, workplace and public spaces)

Social interactions → When, why and how people consume energy

Energy behaviour in the form of peer-effects → Adopt peer-group energy saving behaviours

- Direct interpersonal communication
- Shifting social norms

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Feedback measures (1/2)

Feedback measures

Appropriate reporting framework

- Direct feedback – smart meters and in-home displays
- Indirect feedback – enhanced billing; personal goal setting and feedback;
- Energy audits
- Community-based initiatives

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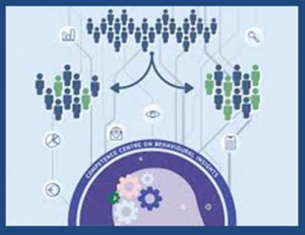
Feedback measures (2/2)

Feedback measures (other)

- Building certification and labelling;
- Public engagement campaigns;
- Financing schemes and subsidies;
- Eco-design



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Direct feedback

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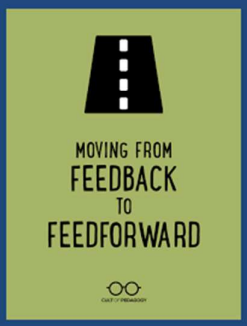
Direct feedback – Learning by looking or paying

- Direct displays
- Interactive feedback via a PC
- Smart meters
  - operated by smart cards
  - two-way (automatic) metering
- Trigger devices/consumption limiters
- Prepayment meters
- Self-meter-reading
- Meter reading with an adviser
- Cost plugs



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Direct feedback (EEA, 2013)

- The most promising single intervention type → almost all of the projects that involved direct feedback producing savings of 5 % or more
- Direct feedback in conjunction with some form of advice or information → Savings in the region of 10 % in 4 programmes aimed at low-income households

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Indirect feedback

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Indirect feedback- Learning by reading and reflecting

- More frequent bills based on meter readings

Frequent bills

- based on readings plus historical feedback
- based on readings plus normative feedback (comparison with similar households)
- plus disaggregated feedback
- plus offers of audits or discounts on efficiency measures
- plus detailed annual or quarterly energy reports

Indirect feedback

- Via **better billing** can have a part to play in bringing about energy awareness and conservation
- Energy savings from indirect feedback can reach 10 %
- Combination of measures (Direct feedback)

Increase the consumer's **awareness** on energy consumption and maintain the **motivation** to actively engage in energy efficiency actions

Energy Audits

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Energy Audits (1/3)

- Useful tool to provide the information needed to implement energy efficiency measures in a specific environment
- Strengthen the link between energy audits and consumption practices → Be part of a longer-term programme to improve energy management and not just a one-off activity
- Provide information tailored to a specific context and actual consumption
- Delivered by independent experts
- Successful in raising awareness about energy issues

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ENERGY AUDITS

Energy Audits (2/3)

- Seen as part of the solution to upgrade the quality of the building

- Energy efficiency being more a consequence of conducting such audits than a driver for doing so

Energy audits carried out (Poland) - raising Managers' awareness of

- Energy efficiency benefits,
- Importance of properly monitored energy consumption,
- Setting energy efficiency goals, and
- Adequately planning for energy efficiency investments

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Energy Audits (3/3)

Types of Feedback

- Undertaken as part of a house sale/purchase or other mandatory survey
- Undertaken by a surveyor on the client's initiative
- Carried out on an informal basis by the consumer

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Community-based initiatives

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Community-based initiatives (1/3)

- Could lead to long-term behaviour change
- Groups sharing information
- Part of a wider programme that has clear objectives

Reducing the environmental footprint

Delivering energy savings

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Pre-existing relationship between the participants

Share pro-environmental views

Community-based initiatives (2/3)

- Group size → less than 10 people to more than 100 (1,000 in some cases)
- Regular meetings
- Access to reliable information through written material and/or access to a trained expert
- People from the same neighborhood, workplace or community of interest such as a faith or a voluntary group → Successful in long-term due to social norms and behaviours

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Community-based initiatives (3/3)

Table 2.5 European group- or community-based projects

Project	Description
EcoTeams (United Kingdom and the Netherlands)	The EcoTeams programme is run by Global Action Plan (GAP) both in the Netherlands and in the United Kingdom. British EcoTeams met once a month for five months with set monthly topics. Meetings were facilitated either by GAP employees or by trained volunteers, and attendants were provided with information packs and workbooks, and encouraged to explore, discuss and share information. By 2008, a total of 3 602 British households had participated in EcoTeams, and household consumption data were available for 1 096 households (GAP United Kingdom, 2006 and 2008). The Dutch EcoTeams programme has been extensively assessed in a longitudinal report (where people are studied and restudied over a long period of time) of 153 households through questionnaires and measurement of energy, waste and water use (Staats and Harland, 1995; Staats et al., 2004).
Carbon Rationing/ Reduction Groups (CRAGs)	The CRAG movement is a loose-knit community of people who meet in groups to reduce their carbon emissions. Unlike EcoTeams, there is no specific model for how CRAGs function. Members agreed how to record changes in energy use and emissions, recorded their own meter and odometer readings and shared information at regular meetings. Individual CRAGs chose how often to meet (usually monthly) and participants valued the opportunity to discuss changes and share ideas. CRAGs used an annual accounting system and had no trained facilitators, but groups were supported by information on the CRAG website (Howell, 2009; Seyfang et al., 2007).
Green Streets	A slightly different group-based intervention was conducted by British Gas as part of its Green Streets programme. Eight households were recruited in each of eight streets to form neighbourhood teams with the aim of reducing the emissions of all the households in the team. The team that made the largest reductions won a cash prize. Green Streets households were supported by a dedicated energy advisor and the teams met to discuss and share information. British Gas also provided each group with GBP 30 000 of funding to make improvements to the households, including a mandatory element of renewable energy generation. Green Streets participants were provided with feedback through handheld meters and monitoring of energy consumption through monthly meter readings (Lockwood and Platt, 2009).

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6.2 Feedback and goal setting

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Energy behavior

Feedback and goal setting

Module 4.d

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Module Aim

- Identify **energy behavior** via the presentation of the **feedback and goal setting**, in order to contribute to workplace's best possible energy efficiency
- Civil servants will learn how they could help/encourage their colleagues towards this **energy-saving logic via goal setting**

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Learning outcomes and keywords (1/2)

Trainees are expected to understand, know and apply the following terms and definitions:

- Feedback
- Goal seeting – Smart goals
- Self-selective basis

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Learning outcomes and keywords (2/2)

Energy behavior	Energy consumption level
Energy security	Employee incentive measures

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Introduction

Energy-efficient policies

People's changing actions + Technical solutions

Behavioral models

- Energy management
- Static behavior improvement

→ Dynamic Interactions

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Feedback measures (1/2)

Feedback measures → **Appropriate reporting framework**

- Direct feedback – smart meters and in-home displays
- Indirect feedback – enhanced billing; personal goal setting and feedback;
- Energy audits
- Community-based initiatives

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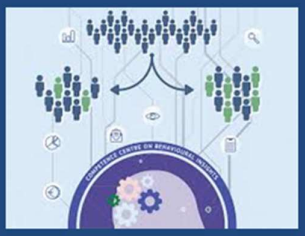
Feedback measures (2/2)

Feedback measures (other)

- Building certification and labelling;
- Public engagement campaigns;
- Financing schemes and subsidies;
- Eco-design



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Feedback and goal setting (1/2)

- Used on a **self-selective basis**
- Workers set and adhere to a particular **energy-saving target**
- Efficient form of dedication
- Substantial and persistent **energy savings of 11%** for informed customers who set realistic goals and approximately 4.4% on average for all customers (Harding and Hsiaw, 2012)

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Feedback and goal setting (2/2)

Programme Northern Illinois - Case Study (Harding and Hsiaw, 2012)

- Consumers are asked to choose an **energy savings goal**
- Provided with **information** and feedback designed to help them implement a series of energy efficiency and conservation actions
- Consumers achieve substantial savings
- Realistic goals → higher savings
- Energy-saving programs are driven by consumers' recognition of their present bias

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SMART goals method (1/2)

- Used to help people define and implement intentions
- Used in healthcare settings, but they are also used successfully in **business** and educational settings
- Help to create increase a **sense of ownership** and personal importance (Nelis SM, Thom JM, Jones IR, Hindle JV, Clare L., 2018)

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SMART goals method (2/2)

Specific - Clearly defines who or what the focus is and what change is expected

Measurable - includes an amount or proportion of change that is expected

Achievable - a change that the individual is capable of making given their needs and preferences, as well as the social norms and expectations.

Realistic (Relevant) - important to your organization and its resources, and what it is trying to achieve

Timely (Time-bound) - states the time period for achieving the behavioral changes.

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7. Ways to save energy

Section 5
Ways to save energy

WP4: D4.2 Training curricula and material on energy related topics

Date: 01/06/2021

Where: Plovdiv, Bulgaria

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Ways to save energy

Current energy consumption patterns are unsustainable: the world is using excessive amounts of energy, and non-renewable energy sources are rapidly dwindling. Energy can be conserved in many ways, and choosing energy-efficient goods is one of them. Consumers need to be able to make educated decisions when buying electrical appliances. Information about the energy certificate and labelling systems of the European Union can be helpful when making these choices. It is also important for households to know how much energy is actually used by their appliances. There are many readily available tools to help you calculate your energy consumption and implement energy-saving solutions.

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Ways to save energy in the office

European companies are expected to increase their competitive potential by achieving rational and correct use of energy, recognizing the importance of energy efficiency and implementing at least one of the following measures:

- Introduction of requirements for energy efficiency of the used equipment;
- Technological modernization of production;
- Reduction of energy losses in buildings;
- Renovation of existing buildings in order to improve their energy performance (insulation, coatings and layout);
- "Green energy" (from renewable energy sources)

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Ways to save energy in the office

Worldwide, 40% of raw materials and resources are consumed by the offices of enterprises.

One of the most effective ways to reduce this consumption is the introduction of green, environmentally friendly practices, as well as the implementation of energy efficiency measures.

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Ways to save energy in the office

Organizations have fewer resources and less motivation, which is why they feel a greater need for tools to create an environmentally friendly, energy efficient and pleasant working environment in the office. Energy efficiency and energy saving are important for the competitiveness of enterprises in national and global markets.

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Ways to save energy in the office

For improving the energy efficiency in the offices - it is necessary to define measures for energy savings:

- Reducing the consumption of natural resources and office materials;
- Waste reduction and recycling;
- Green public procurement - development of criteria for green purchases and procedures for deliveries of certain goods and services for the office;
- Sustainable transport and mobility - measures to reduce the impact of transport and sustainable mobility;

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Ways to save energy in the office

- Creating a healthy office environment - measures for a healthy and socially responsible work environment, which include regular risk assessment at work.
- Inspection and energy audit of the office. Analysis of the premises. Identification of measures for energy saving
- Distribution of offices according to exposure (north, east, west, south)
- Purpose of the premises.

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Lighting systems in the office

Questions about lighting that every organization should ask themselves:

- Is there enough sunlight?
- Are the blinds / curtains fully drawn?
- Are the walls and ceilings light enough to reflect light?
- Are the windows big enough?
- Have the lamps been replaced with energy-saving one

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Lighting systems in the office

Energy saving tips for lighting

Good lighting in the workplace is recommended to be provided with direct sunlight. According to the requirements of the work performed at the workplace, the luminous flux measured in lumens (lm) is provided.

• The most common type of lighting in old office buildings is general purpose lighting for the whole room.

• In different operating modes of individual workplaces, local lighting is used, and the power of the lighting for general purposes is reduced.

• In non-residential / transit areas, the lighting system has motion sensors that turn on the lights when needed.

Lighting systems in the office

Types of lamps and characteristics

Type	Wotking hours, h	Efficiency, lm/W
Incandescent lamp	1000-1500	12-17
Halogen lamps	3000-5000	16-24
Fluorescent lamps	5000-8000	45-75
Compact fluorescent lamps	8000-10000	30-50
LED lamps	30000-50000	30-90

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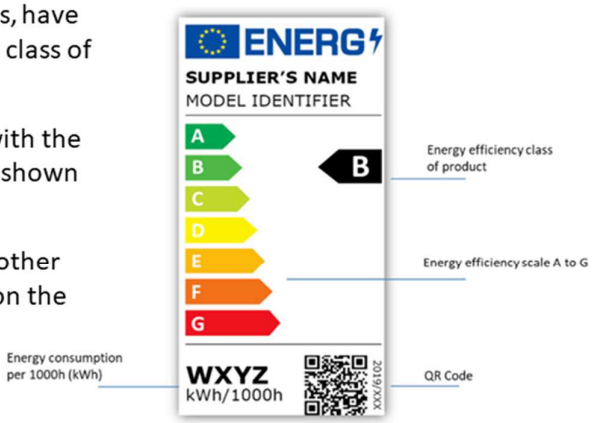
Lighting systems in the office

According to the requirements of the EC, the lamps on the market, like household appliances, have energy labels, which show the efficiency class of the lamp.

- The most efficient lamps are marked with the highest class on the label scale, which is shown below.
- The average energy consumption and other important information must be written on the label.



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Heating and cooling in the office

Questions about heating and cooling that every organization should ask themselves:

- Do the windows close tightly?
- Are blinds and curtains used correctly?
- Are the exterior doors of the building kept open more than nece
- Do the interior doors of the rooms close tightly when heating / c
- Are roofs, ceilings and floors insulated?
- Is there internal and / or external wall insulation?
- Are the heating and / or cooling appliances blocked by furniture
- Are the boilers and water heaters checked and insulated well?

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Heating and cooling in the office

Energy saving tips for heating and cooling in the office

- Reducing the temperature of the premises in winter by 1 degree can reduce the electricity bill by 10%.

- Install a system for optimizing and controlling the heating and cooling processes so that the building operates at a set temperature, depending on the working hours. The control panel includes sensors that monitor the outside and inside air temperature and calculates the time required for the building to heat up or cool down by turning the heating / cooling system on and off at the right time.

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Heating and cooling in the office

Energy saving tips for heating and cooling in the office

- Limit the space used outside the building's working hours: The HVAC system will only be needed to work in a certain part of the building. As a result, a part of the system could be separated to be serviced independently of that part during the stay.

- The use of heat from the condenser can be used to heat domestic water or heat the premises.

- Design the installation so that it operates at full capacity - choosing a higher power than required leads to lower efficiency and bigger energy losses.

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Office equipment in the office

Electricity consumption of office equipment:

About 1/3 of the total consumption of IT equipment in the office is due to the servers. Energy Star servers are 30% more efficient than older ones, which is accompanied by a significant increase in their efficiency.

Office equipment in the office

The following measures are very easy to implement:

- Each device of office equipment left plugged in consumes electricity. By turning off computers at the end of the day and unplugging all printers and monitors and unplugging chargers when not in use, the office's power consumption will be reduced.
- Stand By mode - Reduces power consumption for computers and monitors by 1-3 watts each. Turns on after seconds. This mode can save about 60-120 BGN (30-60 euro) per year for each personal computer.
- "Sleep mode" - reduces power consumption for computers and monitors by 1-3 watts each. Turns on after 20 seconds. Saves labor in case of power failure. It saves 40-120 BGN (20-60 euro) per year.
- "Turn off the monitor" - reduces power consumption by 1-3 watts. Half of the system's savings are due to the "standby" or "sleep" mode - savings about 20-60 BGN (10-30 euro) per year.

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Energy efficiency measures in households

To achieve balancing of energy consumption in a household, it is necessary to perform the following steps:

- ✓ Identifying and analyzing the consumption of appliances;
- ✓ Calculation of energy costs for individual appliances;
- ✓ Taking measures to reduce energy dependence;
- ✓ Monitoring the effect and continuous improvement

Energy efficiency measures in households

General tips for saving energy in households:

• Keep track of your consumption. Check your consumption and your bills regularly: it will ease the planning of your family budget. Witness how changes in your behaviour may affect energy bills.

• Buying a more energy efficient appliance could save you money over time, when compared with similar products.

• Switch off all electrical appliances at the plug instead of using the "standby" mode. Appliances are still using electricity when on "standby" mode, and account for 6% of all electricity usage in home. Turning off your appliances could save up to 5 MWh or …… Euro (BGN, HRK) a year.

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Energy efficiency measures in households

General tips for saving energy in households:

• Close your curtains at dusk to stop heat escaping through the windows and check for draughts around windows and doors.

• Remember to ventilate - Ventilation is needed to get fresh air in and let moisture and smells out. Open the windows daily. Please remember, the shorter, the better: 10 minutes is generally enough! In winter do that during the least cold hours and turn the heating on only when ventilation is finished.

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Energy saving tips for heating and cooling

Heating

• Maintain your radiators properly. Furniture in front of a radiator will block or absorb the heat.

• Reflective radiator panels behind the radiators could reduce your heating bill by up to 20%. When radiators are installed on a poorly insulated wall, most of the heat will dissipate through the wall and to the outside. To avoid heat losses, a thin reflective panel between the wall and the radiator can be installed (they are easily available at stores).

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Energy saving tips for heating and cooling

Heating

- The easiest way to save energy on heating is to keep the recommended indoor temperatures. In winter, 21 ºC during the day and 15 - 18 ºC at night should be enough to make you feel comfortable at home. Turning your thermostat down by 1 degree centigrade could save you 10% on your fuel bill per year.
- Drying your clothes on the radiator makes your boiler work harder than it needs to and costs more.
- Heat-resistant radiator reflectors between exterior walls and the radiators help your heating system work more efficiently.
- Leaving doors open between areas of different temperatures allows warm air to escape.

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Energy saving tips for heating and cooling

Heating

- Keep heat where you need it. Take control of heated spaces by closing doors (or by opening them in case you want to let heat be distributed to other rooms). Leaving the door open in a single room you want to heat will make you waste energy and money.
- In the colder days it is recommended not to switch off the heating during the hours when you are away from home, only to reduce it. When it is turned off, your home will cool down too quickly, which will lead to overheating to reach a favourable temperature.
- If you are away from home during the day or for a longer time, reduce the temperature, but not below 15 degrees, otherwise the air in the room becomes too humid and the risk of mold increases. You should know that the lower the temperature in a room, the more often you need to ventilate the room to reduce the humidity.

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Energy saving tips for heating and cooling

Heating

- Heating with pellet boiler is up to 30% cheaper than heating with damp wood and / or coal. Although the price per tonne of pellets is higher than heating with wood and coal, then if we compare the prices for obtaining the same amount of heating energy, pellet heating is the cheapest. This is due to the fact that the pellets are first of all much more calorific (kWh/tonne) than other fuels (wet wood and / or coal) and secondly because they are burned in boilers with much higher efficiency - up to 90%, compared to 35 ÷ 40% for old stoves.

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Energy saving tips for heating and cooling

Insulation

- Insulate your facade and roof - Choose external wall insulation solutions to gain the best results. Otherwise, opt for interior wall insulation or other insulating technologies.
- As much as a third of your heating costs could be escaping through your roof. Loft insulation is the most cost-effective energy saving measure and the easiest to install.
- Up to a third of the heat produced in your home is lost through your walls.
- Solid walls can also be insulated by internal wall insulation.
- Watch out for air and water infiltration through doors and windows - cover cracks with cheap material as silicone, filler or draught excluders.

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Energy saving tips for heating and cooling

Cooling

• The easiest way to save energy consumed by cooling devices is by keeping the recommended indoor temperatures: in summer 26°C should be enough. Turning up your room thermostat by one degree, can lead you to a 8% saving. If you turn it up by two degrees, you can enjoy a whole day of free cooling, and avoid unnecessary colds.

• Make sure air conditioning works at its highest performance - clean the filters once a month and do preventive maintenance properly. Point adjustable flaps to the ceiling to slowly cool the rooms from the top. Splits must be placed in windows or walls near the centre of the room and in the shadiest space of the house.

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Energy saving tips for heating and cooling

Cooling

• Take advantage on natural ventilation - open north- and south-facing windows to facilitate cross ventilation when it is cooler outside.

• Keep the cold in the space you choose - take control of cold spaces by remembering to keep doors shut (or by opening them, in case you want to let cool be distributed to other rooms). Leaving the door open in a single room you want to cool will make you waste energy and money.

• When buying a new cooling system, pay attention to its energy label - choose a high energy efficiency system.

• Clean fans and filters: dirty or clogged filters and fans or air-conditioning units and desk fans can reduce efficiency by up to 30%. You can make immediate energy savings and increase the cleanliness of your workspace by maintaining them.

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Energy saving tips for lighting

- An energy efficient LED lamps uses up to 80% less electricity than an incandescent bulb and could last up to ten times longer.
- Switching off a typical fluorescent light for one hour in each working day will save 30kg of CO_2 emissions annually.
- Working nearer windows will save turning on lights too often.
- Switching off the light whenever you leave the room is an easy way to save.

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Energy saving tips for household equipment

Washing Machine:

- Washing clothes at 30°C uses around 40% less electricity than at higher temperatures.
- Modern washing powders and detergents work as effectively at lower temperatures, something worth considering.
- New washing machine with high energy class could save up to 100kWh
- A half load wash can use more than half the energy of a full load setting.

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Energy saving tips for household equipment

Dryer:

• Drying your clothes outside on the terrace is free! If you use a dryer, consider its energy efficiency characteristics.

• Drying the same fabrics together speeds up the drying process.

• Drying clothes in the tumble dryer is expensive and makes them harder to iron.

• Dry towels and heavier cottons in a separate load from lighter-weight clothes.

• If your dryer has a "cooling cycle", it allows the clothes to finish drying with the residual heat in the dryer.

• Purchasing a new dryer with class B and A could save up to 420 kWh / year.

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Energy saving tips for household equipment

Dishwasher:

• An energy efficient dishwasher will save you 20% energy and water from an old and inefficient dishwasher or washing dishes by hand

• If you are buying a new dishwasher, look at its energy class. This is your guarantee that you are buying energy efficient equipment. A new dishwasher with class B-A can save 180 kWh / year.

• Use the eco setting when possible.

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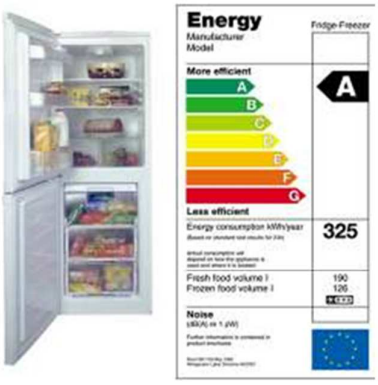
Energy saving tips for household equipment

Refrigeration Equipment:



- Determine how much refrigerator you need: a larger refrigerator uses less energy than two smaller ones;
- Move the refrigerator / freezer away from the stove, heating radiator, solar radiation;
- Refrigerators without freezer consume less energy than refrigerators with freezer;
- Refrigerators that do not need defrosting consume between 10% and 20% more electricity;

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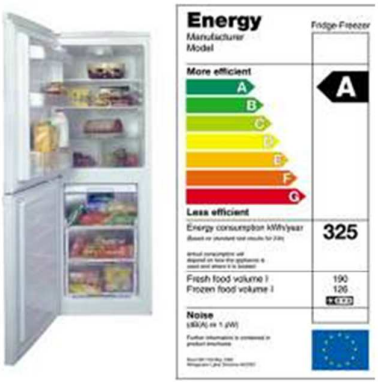
Energy saving tips for household equipment

Refrigeration Equipment:



- Make sure that the heat is removed freely from the refrigerator;
- Check the insulation of the refrigerator;
- Defrost the refrigerator regularly;
- For each minute the freezer door is open, it takes 3 minutes after closing to reach the freezer temperature;

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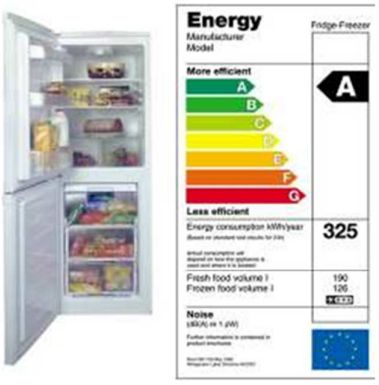
Energy saving tips for household equipment

Refrigeration Equipment:

• If your refrigerator is older than 10 years, consider buying a new one;

• the average temperature inside the old refrigerator is about 2°C when the temperature in the room where the refrigerator is located rises from 20 ° c to 21° C, its consumption increases by about 6%.

• with an old refrigerator, this temperature difference can lead to a greater increase in consumption, so the refrigerator should be placed in a cooler place.



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Energy saving tips for household equipment

Refrigeration Equipment:

Temperature parameters for class A refrigerators

• 8 °C is maintained inside the refrigerator and on the door shelves.

• 0 °C (zero degrees and fresh): special drawer suitable for storing all types of fresh food.

Temperature parameters for the freezer

• -12 °C: Temperature in the freezer compartment to keep open

• packages of frozen food, as well as ice cream.

• -18 °C: optimal conditions for storing large quantities of frozen food

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Energy saving tips for household equipment

Electric kettles:

- Heat the amount of water you need
- A new electric kettle with energy class B-A can save more than 70 kWh / year

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Energy saving tips for household equipment

Computers:

- A monitor left to work overnight uses the energy to laser print 800 pages;
- For a 12-month period, a computer left to run 24 hours a day will consume up to 2,500 kWh of electricity per year
- A computer with energy class B-A can save 2,000 kWh per year
- Activate your power saving devices: Right-click on the desktop> Properties> Screen saver> Power. Your monitor will reactivate within seconds of moving the mouse.

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Energy saving tips for household equipment

Computers:

• Hibernation is energy efficient if you leave your laptop running all night. This option is designed for laptops and may not be available for all computers. Hibernate mode uses less power than Sleep, and when you restart your computer, you return to where you left off (though not as fast as Sleep). Use Hibernation when you know you will not be using your laptop or tablet for an extended period of time and will not be able to charge the battery during this time. First, make sure that this option is available on your computer and turn it on, if available.

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Energy saving tips for household equipment

TV's

• Leaving your TV and all accessories attached to it in standby mode all the time can cost you up to BGN 60 per year. Use standby power strips and turn off during the day.

• The new TV with energy class B-A can save about 160 kWh / year.

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Energy saving tips for household equipment

Cooking

• Household microwave appliances consume on average about 1/2 less energy than the energy consumed by conventional household appliances.

• When you open the oven door during cooking, you lose up to 30% of the oven temperature.

• Preheat the oven only when necessary;

• The diameter of the hob must correspond to the diameter of the pan placed on it - so the heat is transferred optimally;

• Always cover the pot when cooking;

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Energy saving tips for household equipment

Cooking

• Turn off the hobs before the end of the boiling time to use the residual heat;

• Heat portions up to 400 g in the microwave oven - this will save both time and energy;

• When frying meat for a short time, a pan should be used;

• Making coffee in a coffee machine is 50% cheaper than boiling water on the stove;

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Energy saving tips for household equipment

Cooking

• Use a deep fryer instead of an electric stove, so you save up to 25% electricity;

• Baking the slices with a toaster is a more energy-saving method (by about 70%) compared to using the oven;

• When cooking eggs for breakfast, it is better to use an electric egg cooker than a pot, which will save up to 50% of electricity.

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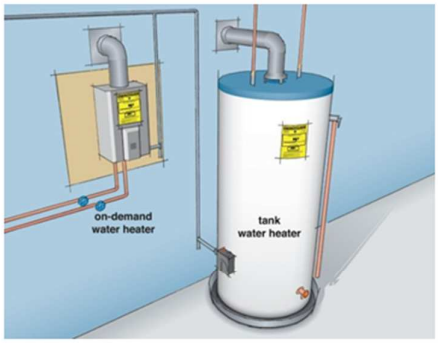
Energy saving tips for household equipment

Domestic water heating

• Reduce the temperature of hot water from the boiler to 40-45ºC;

• Use a night tariff when possible, this will not save electricity, but will reduce the cost (bill);

• Use water-saving shower aerators - this will reduce water flow. The payback period for new efficient showers is less than 1 year;



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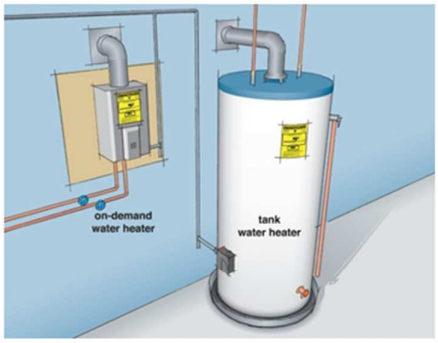
Energy saving tips for household equipment

Domestic water heating

• If your boiler is old, replace it, possibly energy-saving. Due to the presence of scale in the water, it accumulates on the heat exchange surface of the boiler, which leads to a gradual increase in electricity consumption for water heating.
• When heating an electric boiler: During the winter the temperature of the hot water should not be higher than 55 ° C, and in the summer it is recommended that the temperature of the hot water be lower. In order to prevent Legionnaires' disease, it is necessary to heat the temperature of the hot water from the boiler to at least 60 ° C once a month.



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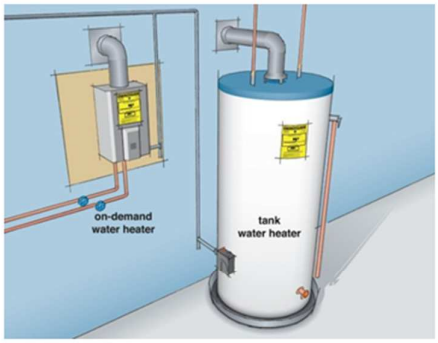
Energy saving tips for household equipment

Domestic water heating

•Hot water from TPP: Hot water leaves the subscriber station with a temperature of 52 to 55 ° C, depending on the setting of the thermostatic valve.

•Check for hidden water losses with water meters! If there is no increase in the water meter reading after two hours when the water taps in the apartment are closed everywhere, then everything is fine. Otherwise, look for leaks;



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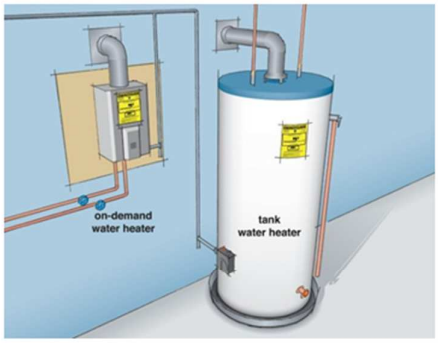
Energy saving tips for household equipment

Domestic water heating



• Check for water losses from the toilet cistern! For this purpose, a water colorant can be used in it. If without dropping the cistern, after 30 minutes there is staining of the water in the toilet bowl, then there is a leak. Replacing defective seals is not a problem for anyone;

• Remember that the biggest consumer of water is the toilet cistern! Place small plastic bottles filled with water and some sand or pebbles at a safe distance from moving parts to sink to the bottom. In this way you can save up to 20 liters per day or replace the old cistern with a new one, with a smaller volume;

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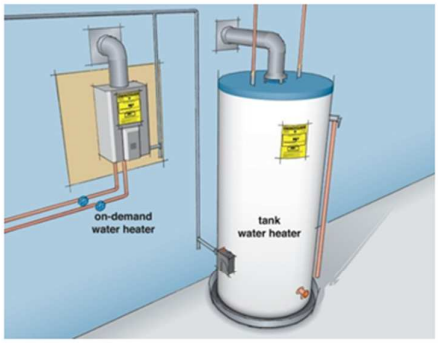
Energy saving tips for household equipment

Domestic water heating



• Stop the water after wetting the toothbrush and while brushing your teeth;

• Use a glass of water to rinse your mouth. Use the washing machine and dishwasher only when fully charged.

• When washing dishes by hand, do not let the rinsing water in the sink run constantly;

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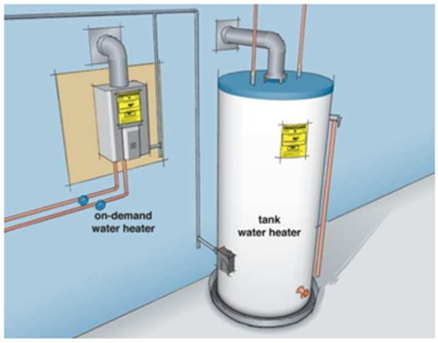
Energy saving tips for household equipment

Domestic water heating



• Do not cool drinks with running tap water, but in the refrigerator. This will save a lot of water;

• Eliminate damage causing leaks or drips immediately;

• When buying a washing machine (the second largest consumer of water), prefer those with a water factor of less than 9.5, which uses 35 - 50% less water and consumes up to 50% less energy per charging.

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Intelligent meters and devices for energy management

There are some good practices for reducing energy consumption in households as analysis of current energy consumption and calculation of costs by compiling a list of electrical appliances (especially energy efficient goods) in the home:

Non-renewable energy resources such as crude oil, natural gas and coal will soon be depleted. Their rising cost is just one of the many reasons why a change in thinking is essential. In general, we consume much more energy than we really need, and thus endanger the energy supply of current and future generations.

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Intelligent meters and devices for energy management

There are many useful tools for measuring energy consumption. While awareness of the problems can help the consumer to save energy, thus reducing the effects of climate change, the analysis and monitoring of energy consumption is crucial to save energy.

Lack of information is an obstacle to saving energy for consumers.

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Intelligent meters and devices for energy management

It is a barrier on two levels:

Consumers do not have information about the energy consumption of their household appliances, as well as how this consumption can be reduced.

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Intelligent meters and devices for energy management

By using intelligent equipment and feedback on the individual consumption patterns of their appliances, consumers will be given a very easy way to learn how much energy their appliances use. Smart energy meters allow consumers to monitor the level of energy savings by changing their energy habits. Seeing this immediate effect is one of the most motivating ways to change habits.

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Intelligent meters and devices for energy management

The thermostat is a device that automatically responds to changes in ambient temperature by turning on or off a heating or cooling system to constantly maintain a set desired temperature indoors.

The biggest benefit of using the thermostat is the ability to set different temperature regimes and schedules. When the operation of the heating or cooling system or appliances is optimized, significantly less energy is used in the long run.

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Intelligent meters and devices for energy management

Temperature control - It is possible to set a lower temperature (heating during the day when you are not at home and at the same time a program) (with digital thermostats) to reach and maintain a comfortable temperature when you get home. Saving energy during our absence and at the same time when we return home, we are waiting for a cozy and warm home.

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8. Good practices

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Promoting Energy Efficiency in Public Buildings of the

WP4: Training Material

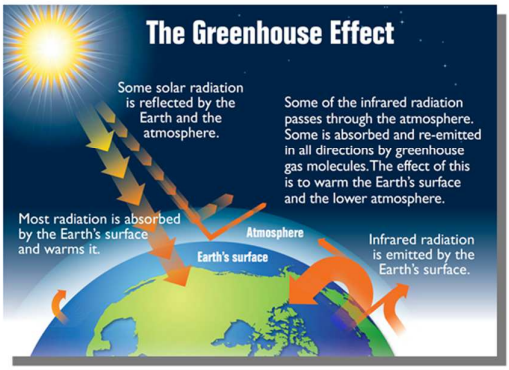
Subject: Good Practices of energy-saving in public buildings

Author: Cyprus Energy Agency
28 May 2021

1.Introduction to Good Practices

Introduction to Good Practices

- Climate change is one of the global environmental challenges - such as biodiversity loss, deforestation, ozone layer depletion, ocean acidification, soil erosion, etc. - we are facing today.
- Climate change also happens naturally; however, "97 percent or more of actively publishing climate scientists agree: Climate warming trends over the past century are very likely due to human activities."
- The main contribution to human made climate change is the accumulation of greenhouses gases (GHGs)2 in the atmosphere. The two main human activities that contribute to this process, and thus to climate change are the burning of fossil fuels to produce energy and to power transport, and deforestation.



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Introduction to Good Practices

- The EU buildings are responsible for 40% of energy consumption and 36% of CO2 emissions.
- Offices do contribute considerably to climate change through:

- using energy for heating, cooling, lighting
- consuming energy to power office equipment
- consuming energy for work-related travel as well as commuting to work
- embodied energy in products and services purchased

→ Good energy use practices in public buildings can potentially influence energy use elsewhere, in other offices as well as in households, especially if these practices are made visible and are communicated well

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2. Re - operation

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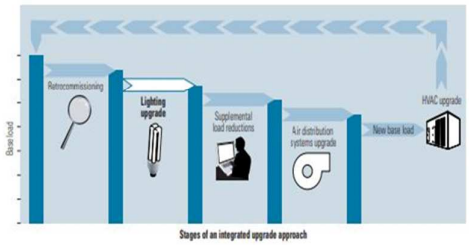
Introduction

- The goal of the re-operation stage in a building upgrade effort is to ensure that the building operates as intended and meets current operational needs.
- A well-planned and -executed re-operation project generally consists of planning and execution phases. In addition, the effort includes plans to ensure that benefits persist and can be added to through such measures as training, preventive operations and maintenance, and performance tracking.
- Plans should also be made for periodic re-operation or ongoing re-operation of the building.
- As part of the re-operation effort, adjustments and fine-tuning may be made to all building systems, including lighting, supplemental loads, building envelope, controls, and all aspects of heating and cooling systems



Stages of an integrated upgrade approach

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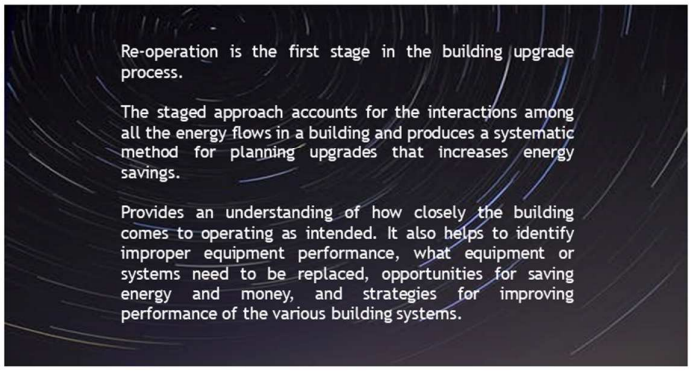
Introduction



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Introduction

- Re-operation is a form of commissioning. Commissioning is the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained according to the owner's operational needs. Retrocommissioning is the same systematic process applied to existing buildings that have never been commissioned to ensure that their systems can be operated and maintained according to the owner's needs.
- For buildings that have already been commissioned or retrocommissioned, it is recommended that the practices of recommissioning or ongoing commissioning be applied. Recommissioning is the term for applying the commissioning process to a building that has been commissioned previously (either during construction or as an existing building); it is normally done every three to five years to maintain top levels of building performance and/or after other stages of the upgrade process to identify new opportunities for improvement.

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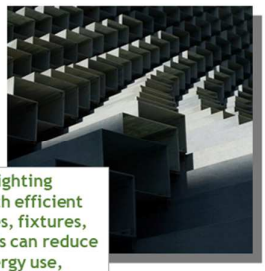
Tune-up Opportunities

- Lighting: A lighting upgrade is the second stage in the building upgrade process. The staged approach accounts for the interactions among all the energy flows in a building and produces a systematic method for planning upgrades that maximize energy savings
- Supplemental Loads: are secondary load contributors to energy consumption in buildings. In the retrocommissioning process, loads can be cut by reducing equipment energy use and sealing the building envelope.
- Distribution Systems: The systems that distribute air and water for space conditioning throughout a facility may need to be balanced and cleaned as part of the retrocommissioning effort.

3.Lighting

Lighting



Upgrading lighting systems with efficient light sources, fixtures, and controls can reduce lighting energy use, improve the visual environment, and affect the sizing of HVAC and electrical systems.

Actions to upgrading lighting systems

- Distribute that light to prevent glare.
- Use daylight whenever possible but avoid direct sunlight, and install controls to reduce the use of electric lights in response to daylight.
- Use the most efficient light source for the application: high-performance fluorescent systems as the primary light source for most commercial spaces; compact fluorescent lamps in place of incandescent bulbs in most cases; and high-intensity discharge lamps where appropriate.
- Use automatic controls to turn lights off or dim lights as appropriate.
- Plan for and carry out the commissioning of all lighting systems to ensure that they are performing as required, and create a schedule to retrocommission systems periodically.
- Design lighting systems with ongoing maintenance in mind, and include a comprehensive plan for group relamping, fixture cleaning, and proper disposal of old lamps and ballasts.

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Lighting – Heating and cooling loads

- Lighting it is the largest cost component of a commercial building's electricity bill and a significant portion of the total energy bill.
- When planning full-building upgrades, a lighting upgrade should come early in the process, because it can affect heating and cooling loads and power quality, which can make a significant difference in the specifications for other building systems.
- Lighting systems produce large amounts of heat as well as light. Lighting is typically the largest source of waste heat, often called "heat gain," inside commercial buildings. This internal heat gain may be useful when the building requires heating, but it is counterproductive when the building requires cooling.
- Energy-efficient lighting adds less heat to a space per unit of light output than inefficient lighting. By reducing internal heat gain, efficient lighting also reduces a building's cooling requirements. Consequently, the existing cooling system may be able to serve future added loads.

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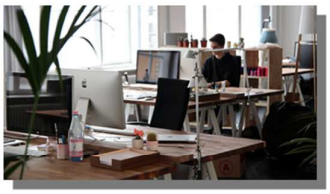
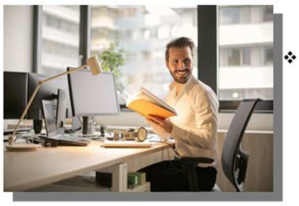
Lighting – People

- A lighting upgrade is an investment not only in reducing electricity consumption but also in improving the way a building supports its occupants. A building's lighting directly affects the comfort, mood, productivity, health, and safety of its occupants.





- Successful lighting upgrades take into account the impact of energy-performance choices on building occupants and seek to marry efficiency with improved lighting quality and architectural aesthetics wherever possible.
- Comfort, mood, productivity, health, safety, and other effects lighting has on people should be considered as part of every lighting upgrade.

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Lighting Design - The Right Quantity

This task-ambient lighting design approach creates flexibility to accommodate individual tasks or worker requirements, creates visual interest, and can save considerable energy in comparison to a uniform ambient-level approach

- Keep in mind that the lighting level targets should be considered average maintained levels for the task
- Lighting levels should be customized through the use of supplemental task lighting in areas requiring higher localized levels
- Target lighting levels should be the sum of the ambient and task lighting levels.

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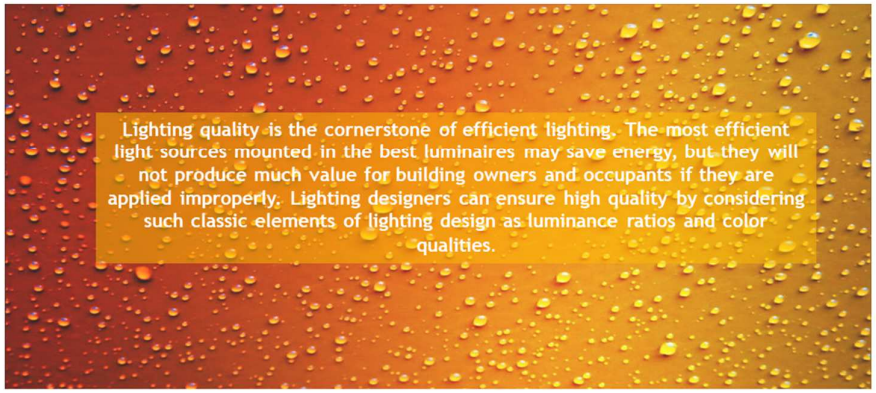
Lighting Design - The Right Quality



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Lighting Design – Outdoor Lighting

- Well-designed outdoor lighting is cost-effective, controls light by directing it where it is needed, reduces glare, distributes illumination evenly, and reduces light trespass.
- The most common lamps used for outdoor lighting are high-intensity discharge (HID) sources—metal halide and high pressure sodium.
- In recent years, compact fluorescent lamps (CFLs) and induction lamps have become viable sources for outdoor lighting as well, offering good color quality and better control options than HID sources.
- As costs come down and performance improves, light-emitting diodes (LEDs) could become a good choice for outdoor lighting as well.

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Lighting Design – Use Efficient Light Sources

- Efficient lighting begins with the use of as much daylight as possible.
  - After that, choose the lamp/ballast/fixture combination that will maximize efficiency while balancing the considerations of lighting quality and quantity described above.
    - There is a wide variety of light sources to choose from including fluorescent (linear and compact), high-intensity discharge (HID), and newer sources such as induction lamps and light-emitting diodes (LEDs).
      - These sources vary widely in their efficacy, color quality, service life, and the applications for which they are best suited.

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Lighting Design – Make use of Daylight

The most efficient source of light is the sun, effectively providing up to 140 lumens (lm) of light for each watt (W) of heat energy, which compares favorably with the 90 lm/W from an efficient electric lighting system.

Four basic principles to produce an effective daylighting system:

- ✓ **Bring in the light.** Light can be brought into a building via conventional glazing, light shelves, skylights, and clerestory windows or with more advanced approaches such as light pipes or specialized reflective materials.
- ✓ **Eliminate glare.** Glare is the number-one killer of daylighting systems—direct sunlight can cause very uneven luminance ratios that are distracting or even painful to occupants. Means for combating glare include using translucent materials and bouncing direct light off surfaces such as painted walls, perforated metal, or fabrics.
- ✓ **Adjust electric lights as appropriate.** Without lighting controls, daylighting will not save any energy. Automatic controls that sense ambient daylight are the best approach, because they ensure that electric lighting will be reduced when enough daylight is available. Figure 6.6 shows how an automatic daylight control system installed at a grocery store cut energy use by 30 percent and decreased demand during peak hours.
- ✓ **Commission the system.** Many daylighting systems fail to deliver the expected benefit because they are not commissioned. Commissioning consists of adjusting photosensors and ensuring proper sensor placement so that the electric lighting system responds properly to the presence of daylight.

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4. Additional Load Reduction

Additional Load Reduction- Reducing Equipment Energy

- Use Electric-powered equipment obviously affects electric loads.
- It is also important to remember that for many types of equipment, much of the electricity used in a space will ultimately end up in that space as heat.
- Reducing the energy use of electric equipment not only reduces electric loads but also reduces cooling loads and, as with lighting, provides an opportunity to replace that heat more efficiently, when needed, with gas heat or electric heat pumps.

- Office equipment and, in many facilities, kitchen equipment, can be cost-effectively upgraded with more efficient products and controls. The best way to ensure that this happens is with a corporate policy that encourages purchasing energy-efficient equipment.
- Employee training programs can also help ensure that equipment is used efficiently.

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Additional Load Reduction- Corporate Purchasing Policies

- By purchasing and specifying energy-efficient products, organizations can cut energy use, achieve enormous cost savings, and help reduce pollution and greenhouse gas emissions.
- To ensure that new equipment purchases favor high-efficiency models, energy management programs should adopt a procurement policy as a key element for their overall strategy.

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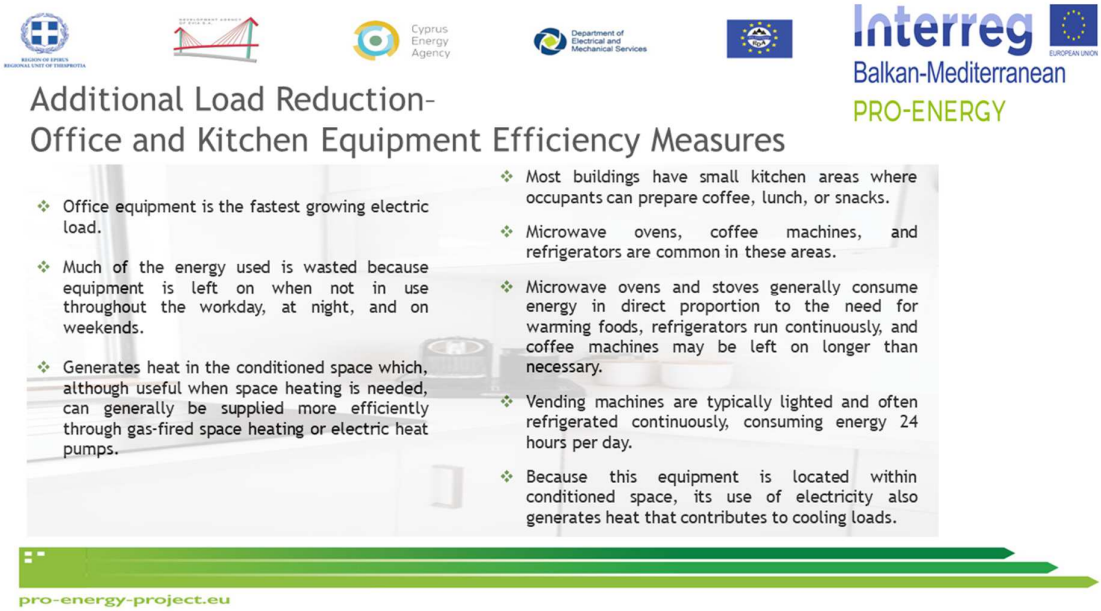
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Department of Electrical and Mechanical Services
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Additional Load Reduction-
Office and Kitchen Equipment Efficiency Measures
Office equipment is the fastest growing electric load.
Much of the energy used is wasted because equipment is left on when not in use throughout the workday, at night, and on weekends.
Generates heat in the conditioned space which, although useful when space heating is needed, can generally be supplied more efficiently through gas-fired space heating or electric heat pumps.
Most buildings have small kitchen areas where occupants can prepare coffee, lunch, or snacks.
Microwave ovens, coffee machines, and refrigerators are common in these areas.
Microwave ovens and stoves generally consume energy in direct proportion to the need for warming foods, refrigerators run continuously, and coffee machines may be left on longer than necessary.
Vending machines are typically lighted and often refrigerated continuously, consuming energy 24 hours per day.
Because this equipment is located within conditioned space, its use of electricity also generates heat that contributes to cooling loads.
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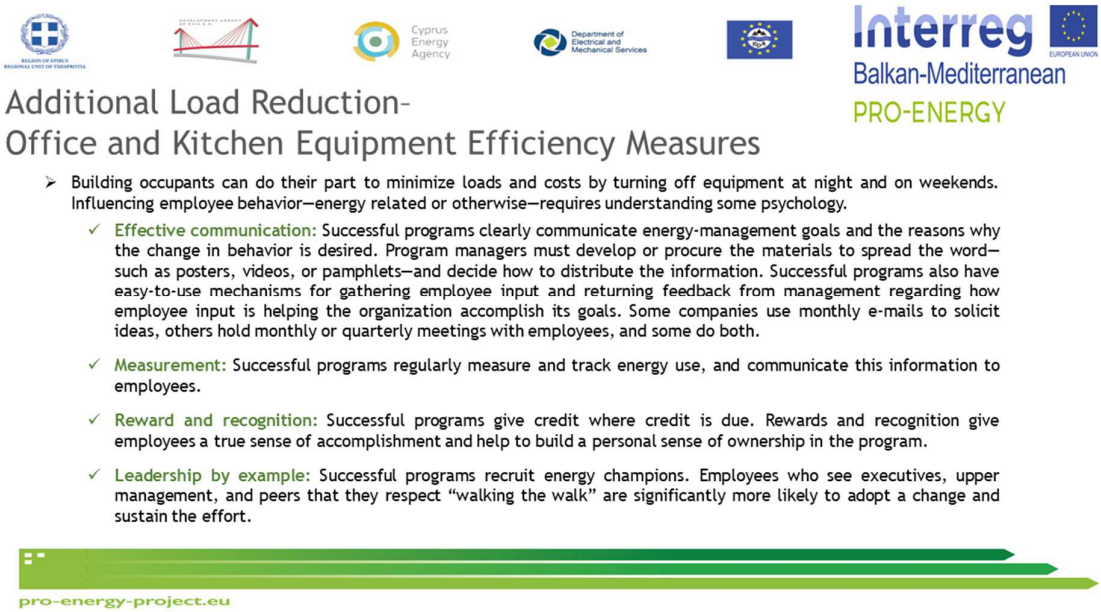
Cyprus Energy Agency
Department of Electrical and Mechanical Services
Interreg
Balkan-Mediterranean
PRO-ENERGY
Additional Load Reduction-
Office and Kitchen Equipment Efficiency Measures
Building occupants can do their part to minimize loads and costs by turning off equipment at night and on weekends. Influencing employee behavior—energy related or otherwise—requires understanding some psychology.
Effective communication: Successful programs clearly communicate energy-management goals and the reasons why the change in behavior is desired. Program managers must develop or procure the materials to spread the word—such as posters, videos, or pamphlets—and decide how to distribute the information. Successful programs also have easy-to-use mechanisms for gathering employee input and returning feedback from management regarding how employee input is helping the organization accomplish its goals. Some companies use monthly e-mails to solicit ideas, others hold monthly or quarterly meetings with employees, and some do both.
Measurement: Successful programs regularly measure and track energy use, and communicate this information to employees.
Reward and recognition: Successful programs give credit where credit is due. Rewards and recognition give employees a true sense of accomplishment and help to build a personal sense of ownership in the program.
Leadership by example: Successful programs recruit energy champions. Employees who see executives, upper management, and peers that they respect "walking the walk" are significantly more likely to adopt a change and sustain the effort.
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Additional Load Reduction- Upgrading the Building Envelope

The building envelope includes:

- Windows
- Doors
- Wall
- Roof
- foundation

Heat always flows from the warmer side of the building shell to the colder side. The most commonly discussed parameters of heat flow through the building envelope, in or out, are conduction, infiltration, and solar radiation. Controlling these heat flows requires insulation, good sealing materials and techniques, and proper maintenance.

Infiltration is a form of convection in which heat flows via air movement. This phenomenon explains why occupants feel cold when the door is open on a winter day.

Conduction is heat flow through a material from hot to cold. This phenomenon explains why the handle on a stove pot becomes hot, and why people insulate walls.

Radiation is heat flow over a distance from hot to cold, the way the Sun's heat reaches Earth. Building occupants use window shades in summer to block radiation.

Conduction (roof, walls, windows). Conductivity depends on the materials used in the building shell. Insulation slows, but does not stop, heat flow through walls and roofs.

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Additional Load Reduction- Upgrading the Building Envelope- Windows

Ways to reduce heat flow through a buildings window:

- ✓ Window films:
  - Thin layers of polyester, metallic coatings, and adhesives that save energy by limiting both the amount of solar radiation passing through the window and the amount of internal heat escaping.
  - Can be retrofitted to existing windows to reduce heat gain from solar radiation and provide low-cost cooling load reduction.
  - They can be applied directly to the interior surfaces of all types of glass and generally last 5 to 15 years.

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Additional Load Reduction- Upgrading the Building Envelope- Windows

Ways to reduce heat flow through a buildings window:

- ✓ Window shading
  - Can also reduce the solar cooling load imposed by windows—exterior and interior shading are among the best ways to keep the Sun's heat out of buildings located in sunny climates.
  - Properly placed shades also make daylighting systems more effective by eliminating glare. Common shading techniques include:
    - Interior shading: Venetian blinds and other operable shades are low-cost and effective solutions for keeping out sunlight. More sophisticated systems, sometimes installed between two panes of window glazing, automatically open and close shades in response to the cooling load imposed by sunlight. Low-emissivity (low-e) coatings. Available with many window systems, low-e coatings insulate better than bare windows, while allowing as much solar heat gain as possible.
    - Exterior shading: Overhangs, awnings, shade screens, roller blinds, and vegetation can provide exterior shading that also reduces the glare from direct sunlight striking glass. Overhangs and awnings can be particularly beneficial because they admit light from the low winter sun (when sunlight is beneficial for heating and lighting) and tend to block the higher summer sun when solar gain is less desirable. Awnings are popular on low-rise commercial buildings.

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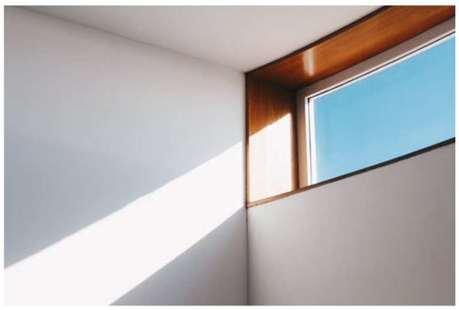
Additional Load Reduction- Upgrading the Building Envelope- Windows

Ways to reduce heat flow through a buildings window:

- ✓ High-performance windows
  - Windows almost always represent the largest source of unwanted heat loss and heat gain in buildings. This is because even the best windows provide less insulation (have lower R-values) than the worst walls or roofs, and because windows represent a common source of air leakage. Windows also admit solar radiation. Although eliminating windows is generally impractical, replacing the complete window can be economically feasible in some situations, particularly as part of an extensive renovation.



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Additional Load Reduction- Upgrading the Building Envelope- Windows

Ways to reduce heat flow through a buildings window:

- ✓ High-performance windows
- o Options for new window products include:
  - Spectrally selective glass. This type of glass can maximize or minimize solar gain and shading depending on the chosen selectivity.
  - Double-glazed, low-e systems. Layers of low-e film are stretched across the interior air space between glass panes, and windows with this feature offer R-values as high as 8.
  - Electrochromic windows. When integrated with a daylighting control system, these windows can preserve the view outside while varying their tint to modulate transmitted light, glare, and solar heat gain. Sensors that adjust tint can automatically balance comfortable lighting with energy efficiency to reduce energy use and peak demand.

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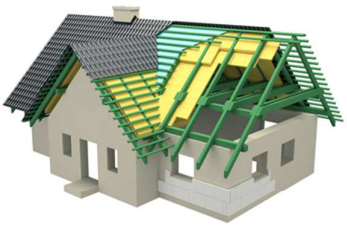
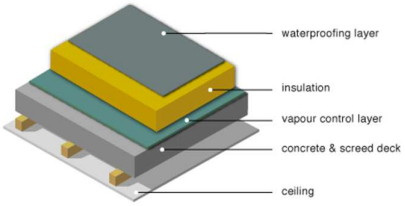
Additional Load Reduction- Upgrading the Building Envelope - Roofs

Roofs Measures include:
- ➢ roof insulation
- ➢ cool roofs
- ➢ green roofs

Roof Insulation:
Much of a building's heat losses and gains occur through the roof, so there are often significant energy-savings opportunities related to roof efficiency. The best way to reduce heat transfer through the roof is to maximize R-value by adding thermal insulation.





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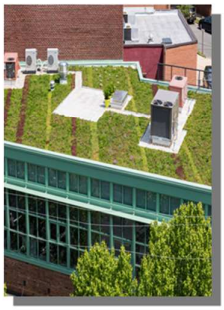
Additional Load Reduction- Upgrading the Building Envelope - Roofs

Roofs Measures include:
- roof insulation
- cool roofs
- green roofs

Green Roofs:

Green roofs and rooftop gardens save energy by mitigating the heat island effect.

Green roofs produce cooling in four ways:
- The soil provides a layer of insulation.
- Transpiration from the plants cools the rooftop just as sweating cools our bodies.
- The trees and other plants shade the roof.
- A green roof surface does not absorb much heat, so it emits less heat back into the surrounding air.



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Additional Load Reduction- Upgrading the Building Envelope - Roofs

Roofs Measures include:
- roof insulation
- cool roofs
- green roofs

Cool Roofs:
- Cool Roofs feature a highly reflective outer surface that reduces the amount of heat conducted through the roof.
  - **Benefits of cool roofs include:**

Downsized air-conditioning equipment: A cool roof can reduce peak cooling demand by up to 40 percent in warm climates, although in cold climates the heating load penalty may offset the cooling energy savings. Typical energy savings run around 20 percent, with simple payback periods of a few years.

Extended roof life: Cool roofs tend to last longer because they are less susceptible to thermal expansion and contraction. Less heat absorption also helps the roof resist degradation by ultraviolet light and water.

Reduced heat island effect: Nonreflective roofs can heat the air around them in a process known as the heat island effect. This phenomenon can raise the cooling demands of buildings and vehicles in a wide area, contributing to smog, elevated ambient temperatures, and associated health problems.

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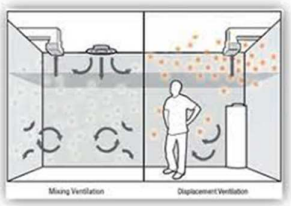
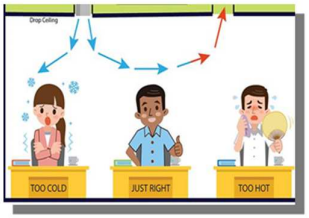
5. Air Distribution Systems

Air Distribution

- When considering options for improving the performance of an air distribution system, it is important to remember that the purpose of having an HVAC system in the first place is to regulate the temperature, humidity, freshness, and movement of air in buildings.





- Accordingly, energy-efficiency retrofit projects should not undermine the system's capability to provide thermal comfort and air quality. The goal of energy retrofit projects should be to improve system efficiency while maintaining or enhancing comfort.

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Air Distribution

Some of the most common opportunities to consider are:

- Recalibrate thermostats: In systems with pneumatic controls, the thermostats periodically require recalibration (typically, every 6 to 12 months) in order to regulate space temperature more accurately. Though thermostat calibration should be checked if a comfort complaint exists, it is preferable to evaluate the thermostats on a regular basis as a proactive maintenance measure.

- Inspect dampers: For systems with zone dampers, periodically inspect the damper, linkage, and actuator for proper operation. In older buildings where maintenance has not been rigorous, it is likely that some of the zone dampers are frozen in position, rendering them ineffective at regulating comfort. Because evaluating and repairing nonfunctional zone dampers can be time-consuming and costly (especially in large buildings that may have hundreds or even thousands of zones), consider allocating a portion of the annual maintenance budget for this purpose to address a certain quantity or percentage of zones.

- Regulate static pressure: Dual-duct systems typically include static balancing dampers for the hot and cold ducts (also called hot and cold "decks"). The purpose of static balancing dampers is to regulate the static pressure in the hot and cold decks in response to zone demands.

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Air Distribution

Some of the most common opportunities to consider are:

- Prevent overcooling: In zone-level reheat systems, performance should be evaluated to keep cooling levels as low as possible. For hot water reheat systems, verify operation of the hot water reheat valve to ensure that it opens and closes in response to control system commands. Check the coil itself to confirm that water is flowing through when it is supposed to and that the coil is not clogged. Confirm the sequence of operation to make sure the reheat coil only operates when it is supposed to. For a single-duct VAV system, the reheat coil typically operates after the VAV damper has reached its minimum airflow position while the zone is calling for heat. If the reheat system is electric, verify proper operation of the coil in response to system commands. Verify the capacity of the electric coil by measuring its input power with an amp probe or true RMS (root-mean-square) power meter. Compare the calculated value with the nameplate value. If the calculated value is much lower than the nameplate value, the coil may have burned-out elements and may require replacement.

- Disable reheat systems in summer months: For CV reheat systems, consider whether the zone-level reheat systems can be disabled during the summer. Some facilities with electric reheat systems have successfully shut off the reheat coils at the breaker during the cooling season, leading to significant energy savings. In conjunction with this change, it may be necessary to adjust the supply-air temperature to avoid overcooling certain spaces, and it may be necessary to leave the reheat coil breakers active in certain spaces (such as interior zones) in order to maintain comfort.

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Air Distribution – Modify Controls

Modifying the way the distribution system operates, not just the system itself or its components, can also save energy.

- ✓ Optimized scheduling: An optimum start-and-stop procedure is a common-sense control philosophy that can result in significant energy savings. Normally, a system is set to automatically turn itself on and off based upon the expected occupant working hours. For example, a building's cooling system might come on at 6:00 a.m. and shut off at 7:00 p.m.

- ✓ Supply-air temperature reset: Most cooling coils are designed to deliver 53° to 55°F air to satisfy cooling requirements on the hottest day of the year. During periods of milder weather, this temperature can be automatically reset upward to improve system efficiency by reducing wasteful reheating of already cooled air. Supply-air temperature reset can be accomplished in a few different ways.

- ✓ Pressure reset: Pressure reset is a method that can yield additional energy savings in systems that have VSDs installed. Pressure and flow are related. Reducing the pressure supplied by fans also reduces the flow supplied, which in turn reduces the power required.

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Air Distribution – Main actions

Some of the actions that are available to optimize constant-volume and variable air volume air distribution systems are:

- Address zone-level opportunities first.
- Consider converting a CV system to VAV.
- Rightsize fan system to match actual loads.
- Install VSDs where practical.
- Consider improved controls to optimize scheduling and to implement temperature or pressure reset, economizer cooling, and demand-controlled ventilation.
- Install rightsized, premium-efficiency motors where possible.
- Install energy-efficient belts.

6. Heating and cooling upgrades

Heating and cooling upgrades

- Although heating and cooling systems provide a useful service by keeping occupants comfortable, they also account for a significant portion of a building's energy use—typically about a quarter. However, it is possible to lessen this impact in both central and unitary systems by increasing their efficiency.
- Cooling systems generally have higher space-conditioning capacities than heating systems because waste heat from people, lighting, and office equipment supplies a large portion of a building's heating requirement. Although their higher capacities often translate into more opportunities for savings from cooling systems, significant savings can still be had from heating systems.
- The conventional approach to upgrading a heating and cooling system is to address each component of the system individually. However, addressing the interactions among components using an integrated-system approach ultimately results in superior efficiency, particularly with central systems. An annual maintenance program is also essential for keeping any heating or cooling system operating efficiently. Clean or replace air filters regularly, verify proper refrigerant levels and airflow, and inspect equipment for obvious malfunctions like stuck dampers. Although heating and cooling upgrades represent the last stage of building upgrades, they do not signal the end of the process. It is important to make sure the changes implemented continue to provide the intended benefits throughout their useful lifetimes—through periodic recommissioning and further upgrades as needed.

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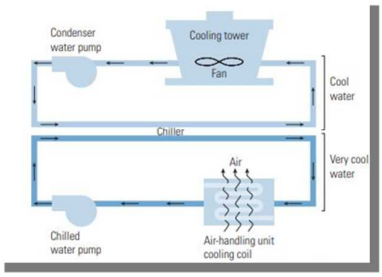
Heating and cooling upgrades

- Central Cooling Systems Chilled-water systems, found mainly in large buildings, feature separate central chillers and air handlers, with a network of pipes and pumps to connect them Chillers use one of four types of compressor: reciprocating, scroll, screw, and centrifugal.
- Reciprocating chillers are the least efficient. Screw and scroll compressors are typically used in applications needing up to 300 tons of cooling capacity. Centrifugal compressors traditionally provide larger capacities, although a new type of centrifugal compressor that employs magnetic bearings breaks this mold to serve the under-300-ton market.



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Heating and cooling upgrades

- Chiller Plant Operations and Maintenance
- The efficiency of a chiller plant can be improved through both operations and maintenance adjustments. Use controls to properly sequence chillers. Monitor the capacity of all chillers in the plant and turn chillers on or off so that each one is loaded enough to keep it in its most efficient zone.
- Monitor outdoor conditions and reset the chilled-water temperature accordingly. This strategy can help match chiller output to the actual load. Note however that this strategy is often disabled by chiller plant operators trying to rectify unrelated plant problems. To help prevent this, show plant operators how to apply and maintain this strategy and explain why it is valuable. Monitor outdoor conditions and reset the condenser-water temperature accordingly. Higher condenser-water temperatures decrease cooling tower fan power but increase chiller power.
- The optimum operating temperature occurs at the point where these two opposing trends combine to produce the lowest total power use. However, this point changes with outdoor conditions, so it needs to be adjusted periodically to maintain efficiency.

Heating and cooling upgrades

- Most chilled-water plants have excess capacity, with one or more cooling towers not operating during low-load periods. To make the most of existing cooling towers, simply run condenser water over as many towers as possible, at the lowest possible fan speed, and as often as possible.
- This strategy is feasible only for chilled-water systems that include multiple chillers and towers plumbed in parallel—and the ability to vary the speed of the fans. For such systems, open all the condenser-water isolation valves at the cooling towers and leave them open. To avoid additional pumping power costs, run only enough condenser-water pumps to maintain adequate flow through the chillers. This retrofit strategy does have one drawback for two-speed fans: It causes additional fan cycling (between half speed and off, and between half speed and full speed).
- This in turn leads to additional wear and tear on motors and gears. Inspect tubes annually and clean as needed, or use automatic tube-cleaning equipment. As a chiller runs, water may leave behind scale, algae, or slime on the inside of the condenser tubes (buildup is typically not a problem in the evaporator tubes because that is a closed system). These deposits can decrease both the efficiency and the capacity of the chiller by reducing heat-transfer efficiency. Periodic chemical or ozone treatments can help keep condenser tubes clear.

Heating and cooling upgrades

- Another option is automatic cleaning equipment that inserts thumb-sized nylon brushes into each condenser tube—catch baskets epoxied to the ends of the tubes collect the brushes. These brushes are slightly larger than the inside diameter of the tubes, so they brush the whole length of the tube as they are propelled by the water flow.
- Energy and maintenance savings depend on the chemical or manual treatment that would otherwise have been used—the more deposits that would have built up, the greater the savings. A condenser fouled to the point that the temperature increases 5 degrees results in a 5 percent decrease in capacity and a 5 percent increase in power requirements.
- In some older machines, refrigerant tubes in the evaporator can become fouled by oil in the refrigerant—oil separators address this problem and are standard equipment on newer systems. Prevent scale formation in cooling towers.
- Scaling, corrosion, and biological growth all impede tower efficiency and increase maintenance costs from the resultant condenser fouling and loss of heat transfer. Chemical treatments typically mitigate these problems, but nonchemical treatment technologies, such as ozone generators and ultraviolet irradiation, are also available.

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Heating and cooling upgrades

- The following list presents efficiency opportunities to consider for chilled-water systems:
- Control chilled-water pumps with variable-speed drives (VSDs)
- Upgrade the chiller compressor
- For chillers without a VSD, use low-voltage soft starters
- Replace an old or oversized standard-efficiency chiller with a properly sized high-efficiency water-cooled unit
- When replacing an existing chiller, select one that will be most efficient under the conditions it is likely to experience
- Install plumbing to connect multiple cooling towers or multicell towers in parallel and VSDs to control cooling tower fans
- Install water-side economizers to allow cooling towers to produce chilled water when weather conditions permit

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Heating and cooling upgrades - Boiler System Operations and Maintenance

The following list of operation and maintenance measures are important parts of the overall boiler system upgrade strategy and can provide significant energy savings:

Establish a total-system water treatment program: This will help prevent the formation of deposits that degrade heat transfer and increase friction.

Periodically check the air-fuel ratio: If it is not cost-effective to install a boiler combustion monitoring system, periodically check and calibrate the stack temperature, excess air, CO, CO2, opacity, and NO using portable monitoring equipment.

Periodically reset the boiler pressure: If temperature/pressure reset controls are not used, periodically assess the temperatures required and reset boilers to the minimum necessary pressure.

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Heating and cooling upgrades - Boiler System Operations and Maintenance

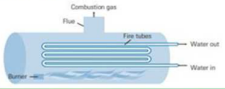
The following list of operation and maintenance measures are important parts of the overall boiler system upgrade strategy and can provide significant energy savings:

Assess feedwater and blowdown rates: Where it is not feasible or economical to install an automatic blowdown control system, establish the feedwater and blowdown rates described in the Boiler and Pressure Vessel Code developed by the American Society of Mechanical Engineers. This will help remove dissolved solids that might otherwise damage equipment and waste energy.

Identify and repair steam leaks: Leaks waste energy and can damage surrounding spaces.

Establish a program for systematically inspecting, testing, and repairing steam traps: Leaking steam traps waste energy by allowing steam to escape into the condensate return line, thus preventing the steam from delivering heat where intended.

Remove scale from boiler heat-exchange surfaces: Scale decreases the heat transfer capability of heat exchangers.



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Heating and cooling upgrades - Boiler System Operations and Maintenance

Several small boilers can also be grouped together in parallel to provide staged heating capacity. This approach is usually more economical and efficient than using a single large boiler because:

- The boilers can be staged to operate at or near their highest efficiency points.
- Small boilers are more efficient than large commercial boilers.
- Multiple boilers provide redundancy, which can reduce system downtime.
- Small boilers can reduce installation costs because each boiler is small enough to be handled without a crane.

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Heating and cooling upgrades - Boiler System Operations and Maintenance

Where boiler replacement is not feasible, there are many retrofit options that will improve the efficiency of an existing boiler system:

- Insulate hot-water distribution lines. Insulation reduces heat loss to unconditioned spaces, thereby optimizing the delivery of heat to the intended portions of the building.
- Install VSD controls on hot-water distribution pump motors. This measure is most effective in large buildings where pumping energy is significant and when used in conjunction with condensing boilers. Be careful with noncondensing boilers because low flow rates can cause flue gas condensation and corrosion in the boiler.
- Install a combustion monitoring and control system. Use the monitoring data to trim boiler excess air and/or install automatic oxygen trim controls.
- Install temperature/pressure reset controls. These provide significant energy savings by matching the supply of steam or hot water with the demand for heat—by resetting the system

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Heating and cooling upgrades - Unitary Systems

- Unitary equipment cools about 70 percent of air-conditioned commercial buildings in the U.S. Unitary equipment is factory assembled, available as single-packaged or split-system units, and may take the form of a heat pump (providing both heating and cooling) or an air conditioner.
- Unitary systems include an evaporator, blower, compressor, and condenser. Some unitary air conditioners also include an electric resistance or gas heater section. The systems are typically cabinetor skid-mounted for easy installation and range in cooling capacity from about 1.5 to 130 tons. Compared to central chiller plants, unitary systems do not last as long (median lifetime of 15 years compared to 20 to 23 years for chillers) and are less efficient.
- Unitary systems are generally used in buildings up to three stories that have small cooling loads, such as retail spaces, small office buildings, and schools. Generally speaking, it is not feasible to convert a building from a unitary to a central chilling system. However, it is not always necessary to replace an old unit with a new one of the same type. For example, a packaged rooftop air conditioner can be replaced with an air-to-air heat pump.
- Commercial buildings typically have unitary systems with cooling capacities greater than 5 tons. These systems are rated by energy-efficiency ratio (EER), which is a measure of full-load efficiency at conditions specified by the Air-Conditioning and Refrigeration Institute. Some buildings use residential-sized unitary systems (under 5 tons, using single-phase power) because of space requirements, physical limitations, or for small additions. Residential-sized systems are rated by seasonal energy-efficiency ratio (SEER), a seasonally-adjusted value. For both EER and 14 SEER, a higher number indicates a higher efficiency.

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Heating and cooling upgrades - Unitary Systems

- Regardless of the equipment chosen, it is important to commission the overall system to ensure its proper operation from the onset as well as to maintain it properly over time (see sidebar).
- Comprehensive testing, adjusting, and balancing the installed unit and its controls will maximize efficiency and comfort.
- Conducting regular tune-ups, correcting refrigerant charge, cleaning and adjusting the system to correct airflow and improve heat transfer, and verifying economizer operation can yield surprising energy savings at low cost.
- Testing, adjusting, and balancing contractors; general HVAC service contractors; and those who use specialized diagnostic products to specifically measure refrigerant charge and airflow levels can perform commissioning and maintenance services.

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