

# Green Skills – Energy Efficiency

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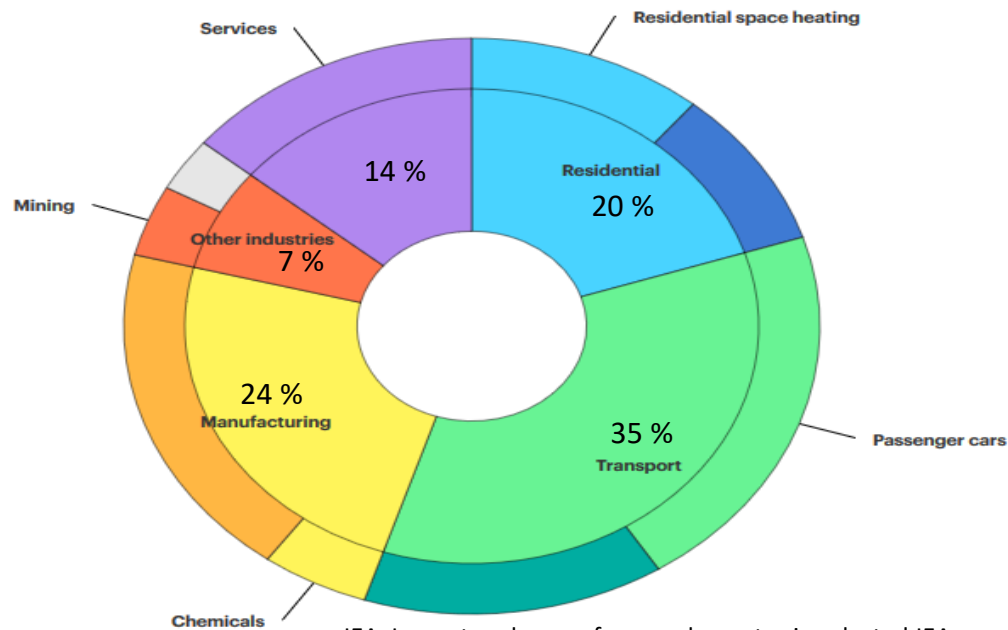
# Energy efficiency – Using less energy to reach the same amount of useful output

- *Securing energy supply & reducing the need for imported energy*
- *Reducing energy costs*
- *Ensuring resource efficiency*
- *Contributes also to increasing the share of renewable energy*
- *Positive image*



# Where the energy is used?

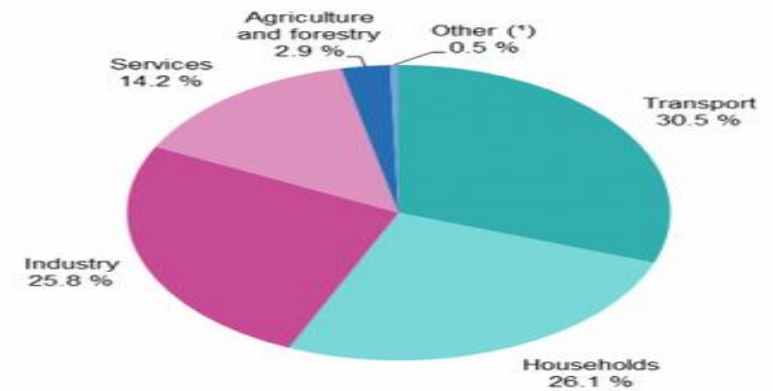
## End-uses of energy by sector (IEA)



IEA, Largest end-uses of energy by sector in selected IEA countries, 2018, IEA, Paris <https://www.iea.org/data-and-statistics/charts/largest-end-uses-of-energy-by-sector-in-selected-iea-countries-2018>

## End-uses of energy by sector (EU)

**Final energy consumption by sector, EU-27, 2018**  
(% of total, based on tonnes of oil equivalent)



(\*) Data on "international aviation" are not included in category Transport and hence are included in the category "Other".

Source: Eurostat (online data code: nrg\_bal\_s)

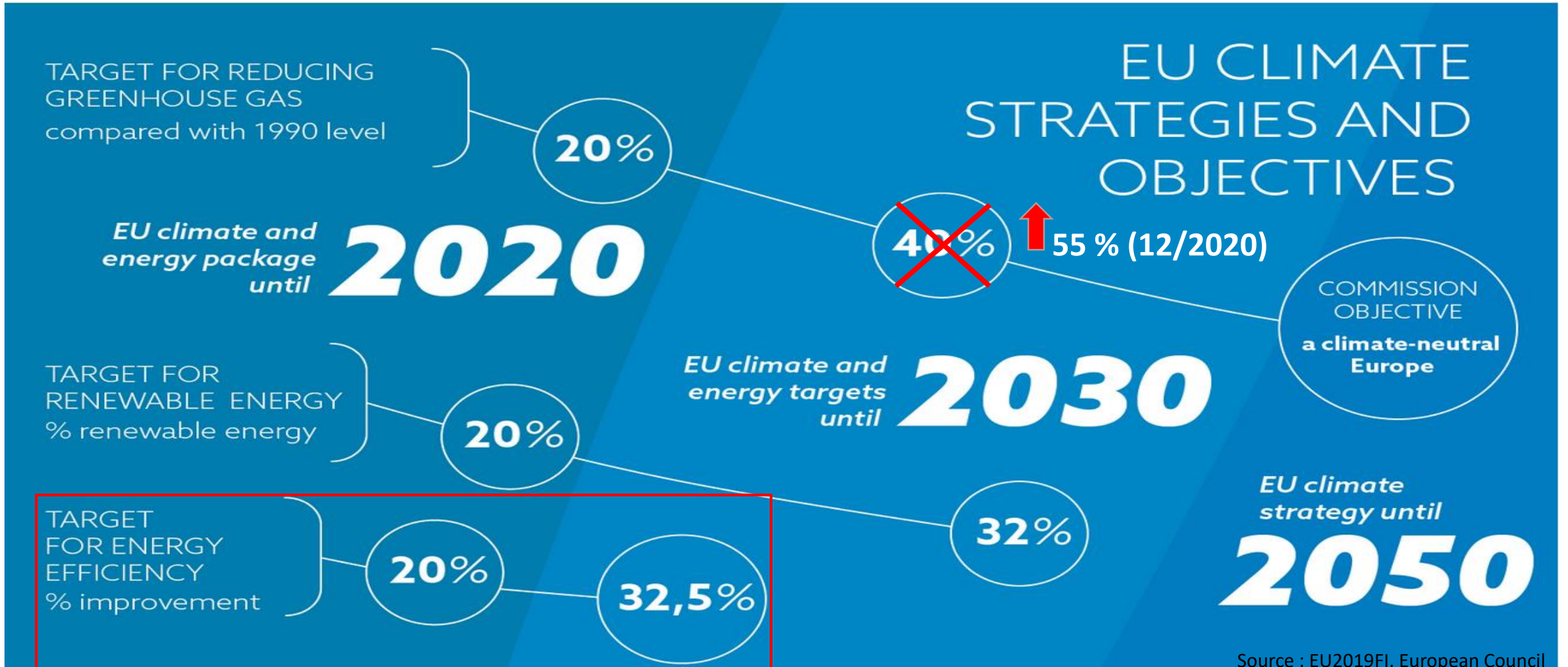
eurostat 

Figure 10: Final energy consumption by sector, EU-27, 2018

(% of total, based on tonnes of oil equivalent)

Source: Eurostat ([nrg\\_bal\\_s](#))

# EU's 2030 and future targets



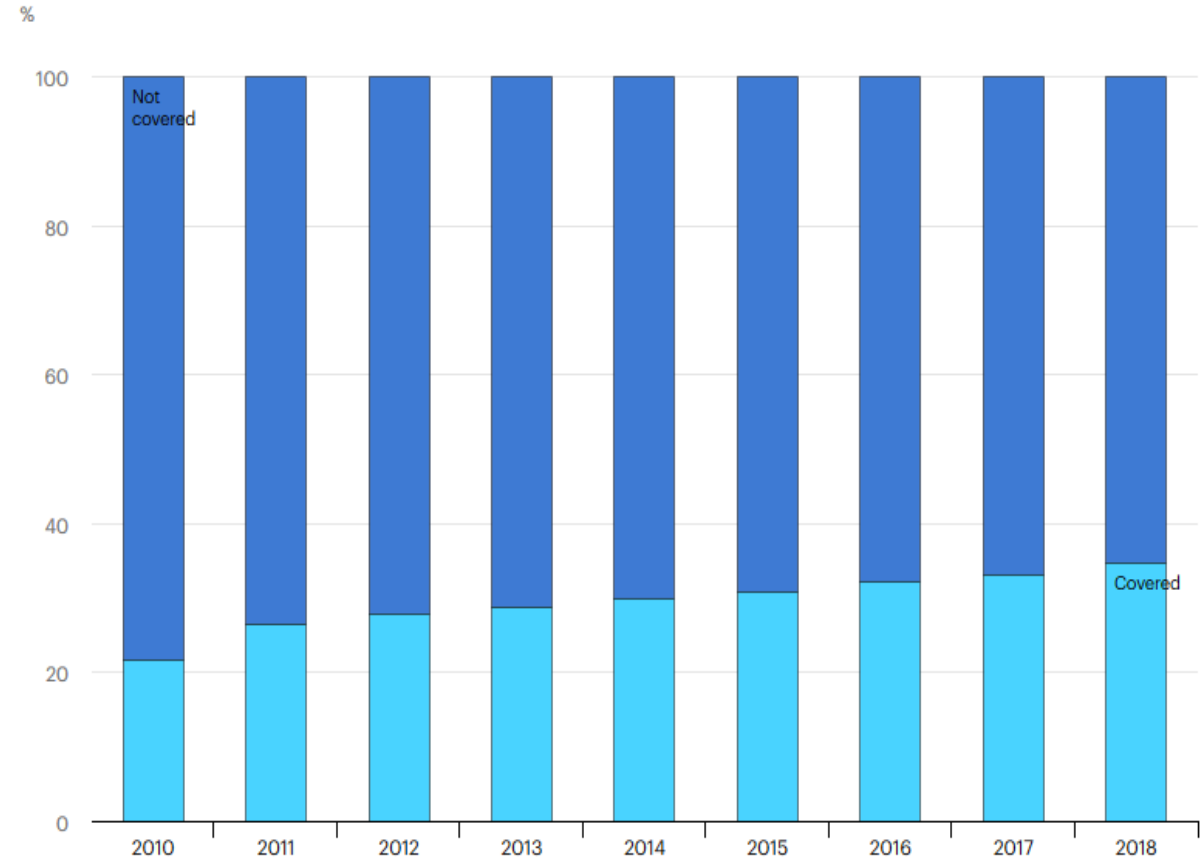
# Rules and regulations or voluntary activities?

## Examples of EU 2012 energy efficiency directive (2012/27/EU) & 2018 amending directive

- 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
- 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
- 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**

Source: European Commission

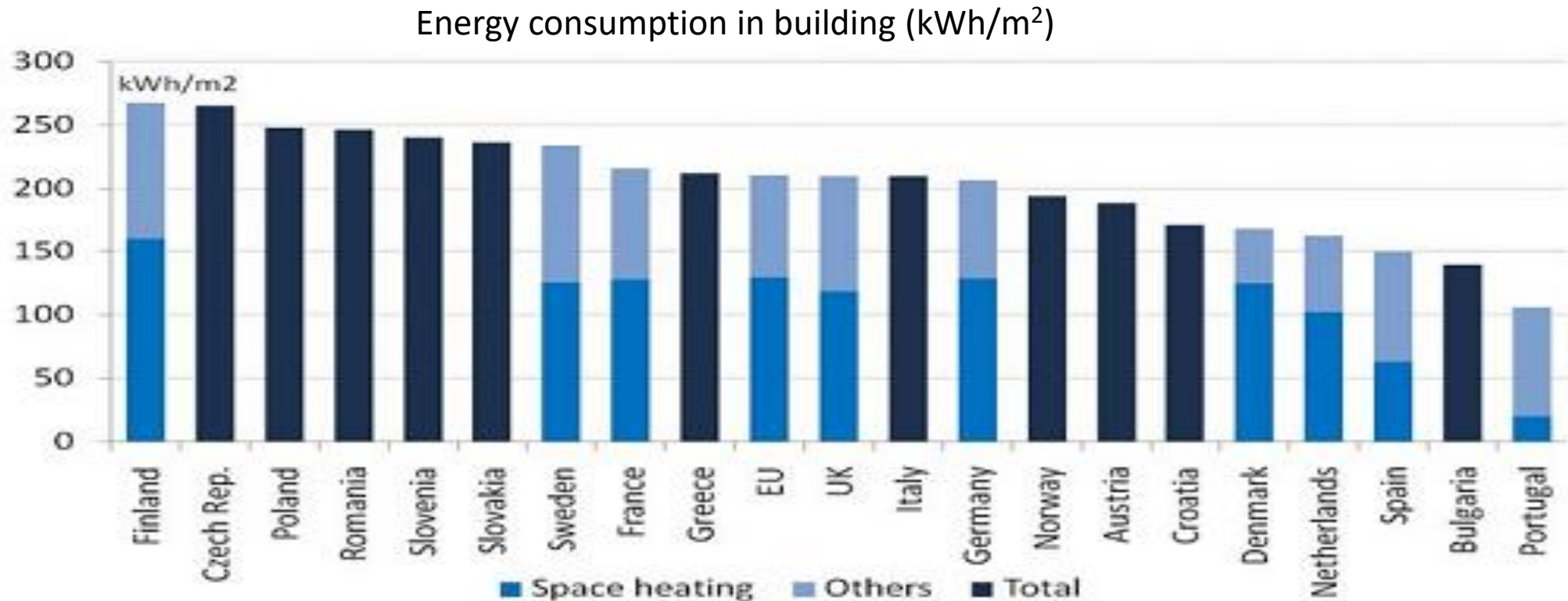
## Share of final energy use covered by mandatory efficiency policies, 2010-2018



IEA, Share of final energy use covered by mandatory efficiency policies, 2010-2018, IEA, Paris  
<https://www.iea.org/data-and-statistics/charts/share-of-final-energy-use-covered-by-mandatory-efficiency-policies-2010-2018>

# Energy performance in buildings

*"Buildings are responsible for approximately 40 % of energy consumption and 36 % of CO<sub>2</sub> emissions in the EU, making them the single largest energy consumer in Europe" – European Commission*



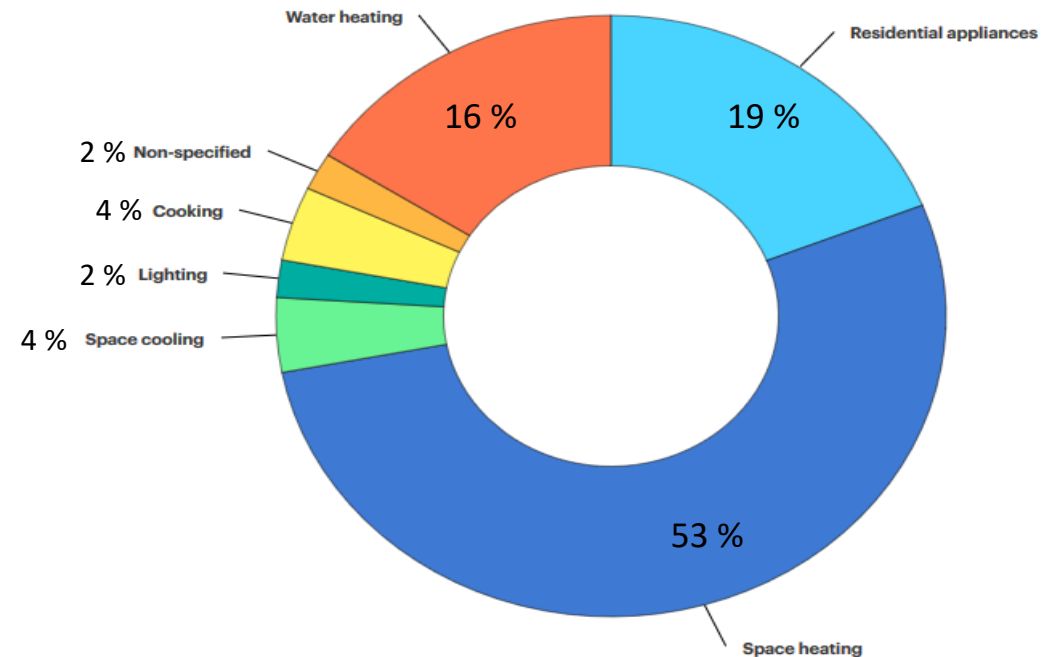
Source: ODYSSEE-MURE-project, 2018

# Energy performance in buildings

## Where the energy is consumed?

- Space and water heating
- Ventilation
- Electricity (appliances, lightning, machinery)
- Cooling
- Processes
- Space heating is typically significant factor in all buildings (residential, commercial/public, industry)
- Ventilation (depending on the system) and lightning are typically significant factors in commercial/public buildings and industry

## Residential energy consumption by end use



Source: IEA, Shares of residential energy consumption by end use in selected IEA countries, 2018, IEA, Paris <https://www.iea.org/data-and-statistics/charts/shares-of-residential-energy-consumption-by-end-use-in-selected-iea-countries-2018>



# Energy audits

- *Energy audits* are comprehensive reports on energy consumption and the potential for energy conservation implemented according to separate instructions
  - analyze the gross energy consumption
  - find potential energy savings
  - present proposed saving measures
  - includes calculations for savings
- *Energy walkthrough* is more lighter option
  - the aim is to find the most potential energy saving methods via visualization, observation and interviews
  - can lead to further actions for example more comprehensive energy audit





# Energy efficiency aspects & improvements – Where and what to look at?

- *Building envelope*
- *Heating systems & heating in general*
- *Water consumption and water heating*
- *Ventilation*
- *Lighting*
- *Appliances/machinery/processes*



# Energy efficiency factors of the building envelope

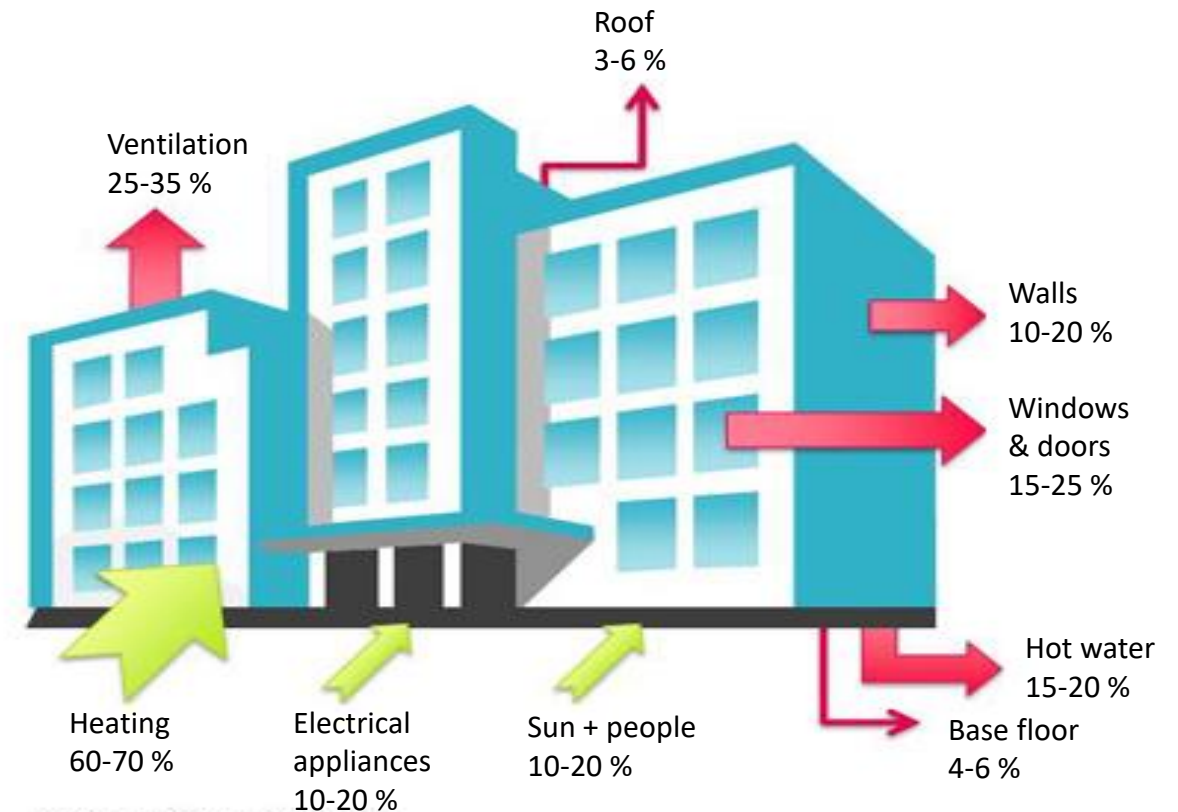
- U-values of the building envelope and temperature difference (outside & inside) determines the heat losses together with air tightness
- Usually it is not economically viable just to improve energy efficiency alone
  - combined with larger renovations

U-value requirements of building elements at different decades in Finland

$W/(K \cdot m^2)$	Building year								
	-1969	1969-	1976-	1978-	1985-	10/2003-	2008-	2010-	2012-
Walls	0,81	0,81	0,40	0,35	0,28	0,25	0,24	0,17	0,17
Ground slab	0,47	0,47	0,40	0,40	0,36	0,25	0,24	0,16	0,16
With crawl space	0,47	0,47	0,40	0,40	0,40	0,20	0,20	0,17	0,17
Roof	0,47	0,47	0,35	0,29	0,22	0,16	0,15	0,09	0,09
Door	2,2	2,2	1,4	1,4	1,4	1,4	1,4	1,0	1,0
Window	2,8	2,8	2,1	2,1	2,1	1,4	1,4	1,0	1,0

Source: Ministry of the Environment

## Typical thermal energy balance in 1970's block of flats (Finland)



Source: Housing association energy book

# Energy efficiency factors of heating systems: Oil

- The efficiency of oil heating system depends on age and maintenance
- Technical life of boiler is ~20 years and burner ~15 years
  - with old boiler + burner the typical efficiency is ~70-80 %
  - new boiler + burner ~90 %
- Energy efficiency is maintained with regular maintenance
  - yearly cleaning of the boiler
  - maintenance of the burner
- Automatic control of the system

*If the boiler efficiency is 70 % and it consumes 5 000 liters oil per year with heating energy content of ~50 000 kWh:*

- 35 000 kWh is used to space/hot water heating
- system losses are 15 000 kWh.



# Energy efficiency factors of heating systems: Pellet

- Pellet boiler is quite similar to oil boiler
  - automatic ignition and power adjustment
- Typical efficiency is ~80-90 %
- Energy efficiency is maintained with regular maintenance
  - regular sweeping of the boiler and ash removal



# Energy efficiency factors of heating systems:

## Wood

- Technical life of wood boiler is 15-20 years
  - typical efficiency of old boiler is ~60-75 %
  - typical efficiency of old boiler is ~70-85 %
- Energy efficiency is maintained with regular maintenance
  - yearly sweeping of the boiler
- Using dry wood as fuel (percentage of moisture 15-20 %)
- With accumulator one can optimize the burning process

Accumulator losses in hot water storage (kWh/a)

Accumulator volume (liter)	40 mm insulation	100 mm insulation
50	440	220
100	640	320
150	830	420
200	1000	500
300	1300	650
500	1700	850
1000	2100	1100
2000	3000	1500
3000	4000	2000





# Energy efficiency factors of heating systems:

## District heating

- Heat is generated in district heating plant so the customers energy efficiency is related to the district heating equipment
- Typical efficiency is  $\sim 95\%$
- Where to look at:
  - control and measure devices are functioning properly
  - heat exchangers are insulated and in good shape (technical life  $\sim 20$  years) and there are no leakages
  - set point values are ok and steady
  - temperature difference between incoming and outgoing DH water/steam is high enough

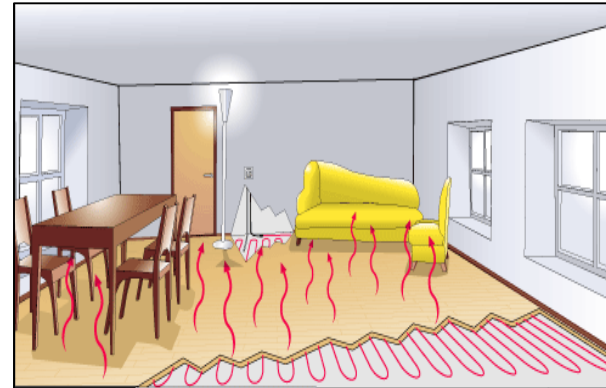




# Energy efficiency factors of heating systems:

## Electric heating

- Electrical heating can be divided to direct *electrical heating* (electric radiator) and *electric storage heating* (electrical cables in floor slab or water circulating floor heating/radiators)
  - typical efficiency in direct electric heating is ~95-99 %
  - typical efficiency in electric storage heating is ~80 %
- Where to look at:
  - electric radiators are in good shape /technical life of electric radiators is ~20 years)
  - room temperature set points are correct and thermostats are working
  - adding automation if possible
  - replacing electric heating with other heating system (has typically the most expensive energy)



# Energy efficiency factors of heating systems:

## Heat pumps

- In terms of energy efficiency heat pumps are the best option available
- Heat pump types
  - air source heat pump
  - air to water heat pump
  - ground source heat pump
  - exhaust air heat pump
- Coefficient of performance (COP, SCOP, SPF) tells what is the heating power compared to the power taken from the grid
  - e.g heat pump with SCOP 3 → takes 1 kW of electricity from the grid and generates 3 kW of heating energy
  - low temperature requirement → higher coefficient of performance
- Can also be used for cooling



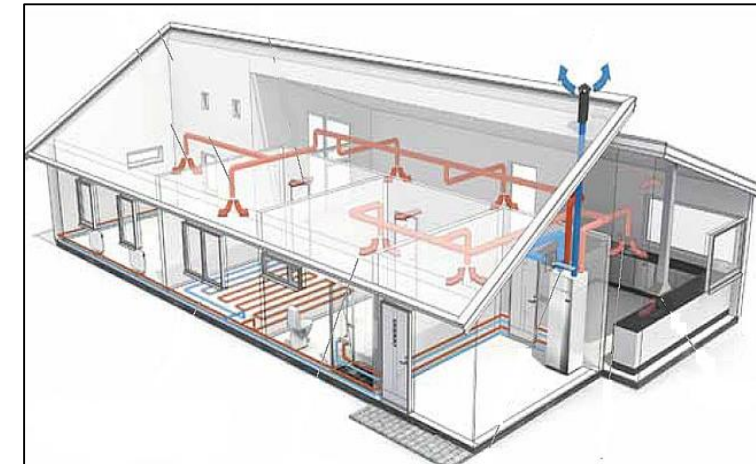
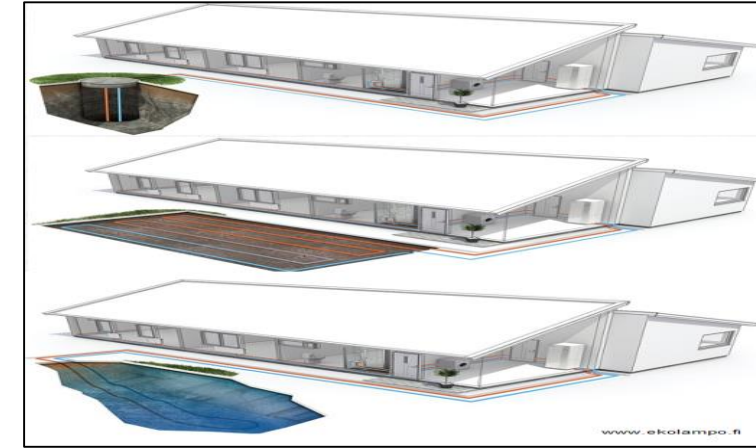
# Energy efficiency factors of heating systems:

## Heat pumps

- Air source heat pumps and air to water heat pumps use outside air as energy source
  - coefficient of performance depends on air temperature
- Air source heat pump is a supportive heating method for example with electricity heating
- Air to water heat pump can be used as primary heating system (space heating and domestic hot water)



- Ground source heat pump has typically the best coefficient of performance
- Suitable for buildings where the demand for heating energy is high
- Exhaust heat pump uses exhaust air from the building as energy source
- Suitable for low-energy houses



# General energy efficiency factors of heating

- Temperature set points in rooms/building are in order
  - typical value for residential spaces is 21 °C
  - secondary spaces can have lower temperatures
- Temperatures are controlled and monitored by building automation
  - outside & inside temperature
  - thermostats
  - heat distribution system is working properly and is in balance



Mechanical



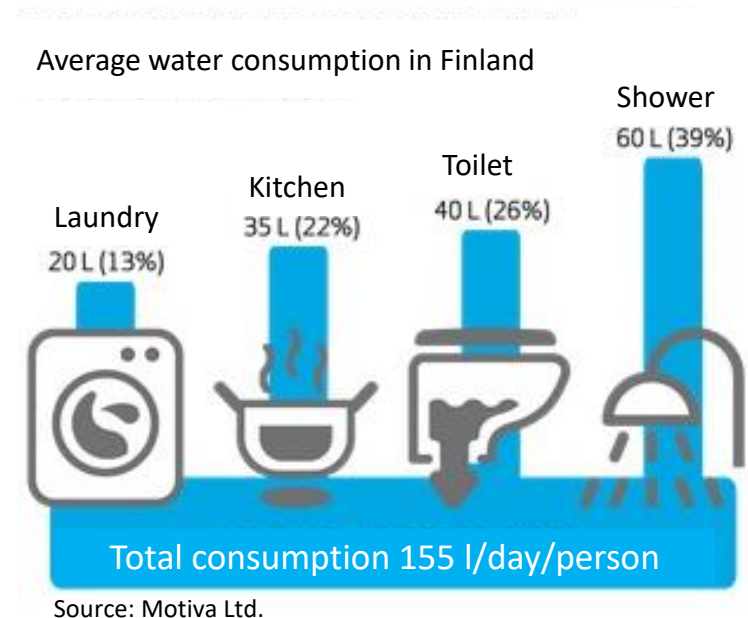
Digital



Smart

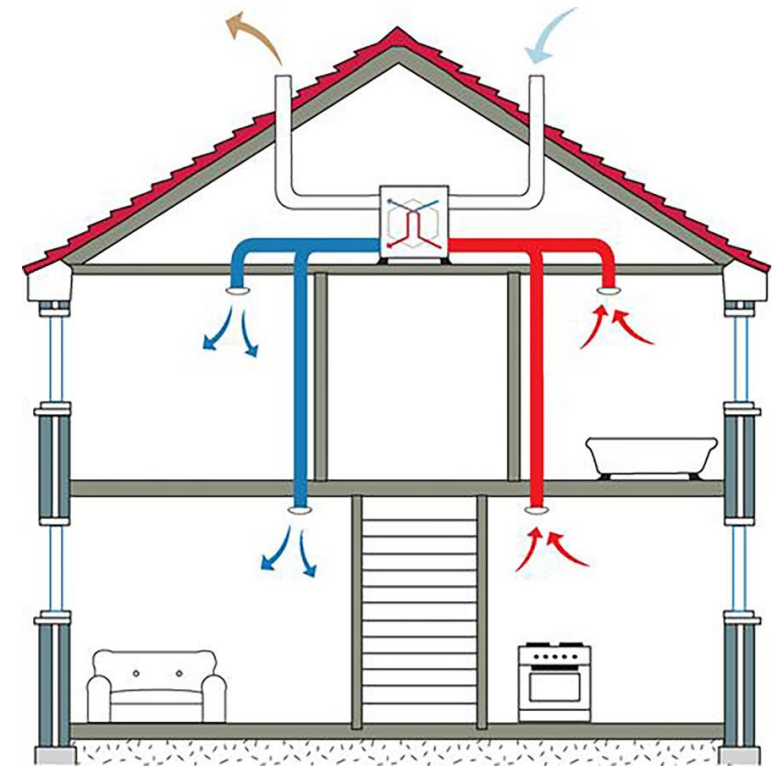
# Energy efficiency factors of water and water heating

- The biggest factor in water consumption is the people/habits
- Where to look at:
  - adjusting the water flow in taps/shower
  - using water saving plumbing fixtures (automated taps etc.)
  - using pressure reducer valve if the water pressure level is too high
  - hot water temperature in accumulator is 55-65 °C
  - hot water system is properly insulated
  - both hot and cold water is measured and billed accordingly
  - regular inspection and maintenance of plumbing fixtures
  - informing/educating people
  - checking all the processes that uses water and possible improvements
  - heat recovery from sewage water



# Energy efficiency factors of mechanical ventilation system

- Ventilation systems: natural ventilation, extract ventilation system, mechanical ventilation system
- In terms of ventilation, mechanical ventilation is the most energy efficient
  - heat recovery system, efficiency varies between 40-80 %
- Where to look at:
  - age of the system
  - using demand controlled ventilation if possible and/or variable air flow system
  - using design air flows, adjusting if needed
  - total air temperature in the system as low as possible
  - regular maintenance is essential
    - filter replacements
    - cleaning the heat recovery system
  - monitoring the system performance





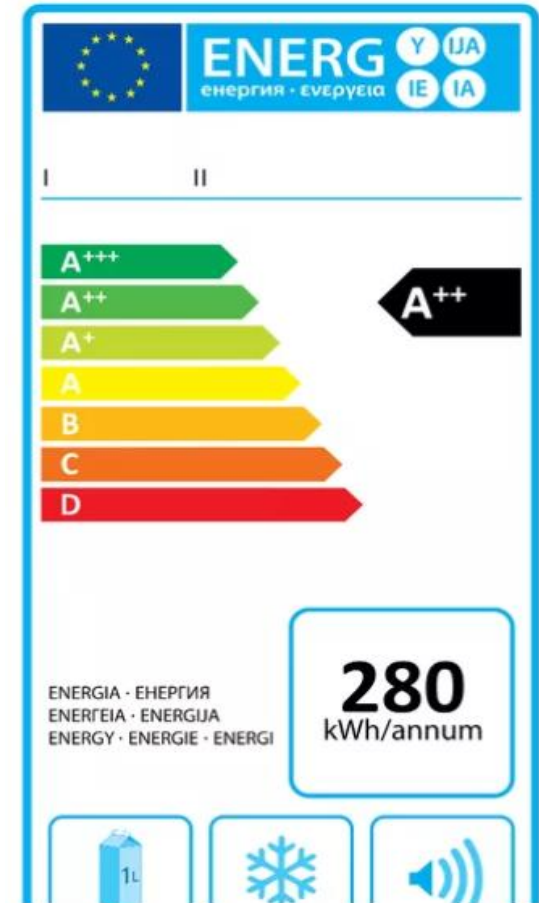
# Energy efficiency factors of lightning

- Lightning is a big electricity consumer in public sector and industry
- Biggest energy efficiency improvement concerning lightning is typically switching from fluorescent bulbs/tubes to LED lightning
- Combining LED with smart light control and motion sensors can generate energy savings of 80 % in lightning, when comparing to the old lightning system
  - short payback time
- Maximizing the use of natural light when available



# Energy efficiency factors of appliances/machinery/processes

- Modern residential appliances are already quite energy efficient due to labelling and eco-design regulations
- Renewing old appliances/machinery helps to improve energy efficiency and reduces consumption
- In the industry and commercial and public sector there are several processes which energy consumption vary a lot
  - key element is to recognize these processes that consumes a lot of energy and try to find improvements or alternative solutions



# Energy efficiency – why it is sometimes difficult?

- In most cases it is the lack of knowledge
- Usually there is no detailed info where the energy is actually consumed
  - most of the times there is only yearly amount of heating energy, electricity and cold water consumption
  - makes it harder to find the best options
- Data/info is scattered and it can take weeks before one gets it
- Expectations for payback times are not always reasonable
- Sometimes energy prices (or subsidies) are just too low encourage energy efficiency improvements



# Energy walkthrough exercise

- In this exercise your task is to choose suitable target (for example your work place) for energy walkthrough
  - try to choose a target where you can get enough information
- The aim is to examine different energy efficiency factors with the help of visualization, observation, interviews and information search and consider how one could improve energy efficiency
  - examine energy efficiency in general level (not too detailed)
- Contents of the energy walkthrough
  - building information
  - energy consumption
  - building envelope
  - heating system
  - water system & consumption
  - ventilation
  - lightning and use of electricity
- It is likely that you can't get all the information for every system presented here but answer the questions as best as you can
- This exercise can be done alone or in pairs
  - exercise is done in Microsoft Forms
  - submit the form 18.3.2021 at the latest
- You can use the Microsoft Teams chat if you have any questions

QR-code and link to Microsoft Forms



<http://bit.ly/3s7PW9s>

# Thank you!

