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Possibilities of use Renewable Energy Sources for public buildings

Workshop on “Elaboration of active house concept for public buildings”

Ing. Zsolt Čonka, PhD.

17 March 2021

NET4SENERGY

Project HUSKROUA/1702/6.1/0075
“Cross-border network of energy sustainable universities (NET4SENERGY)”

Lead Beneficiary: Ivano-Frankivsk National Technical University of Oil and Gas, project coordinator Prof.Maksym Karpash
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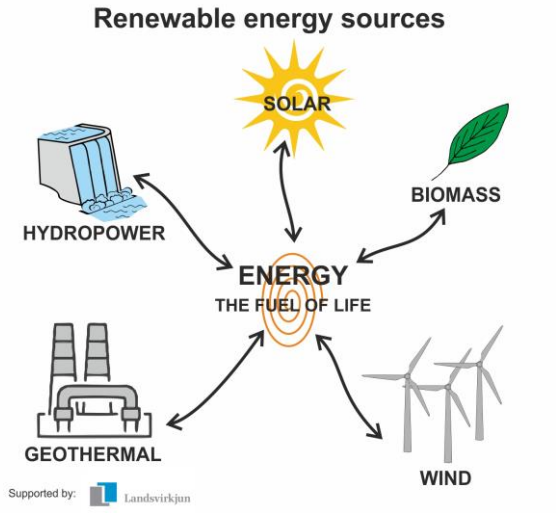
Why we need „Green electricity generation“???



The customer / consumer has little information on the environmental impact of electricity production. Naturally, people are mainly interested in the price of electricity and therefore it is necessary to green the generation of electricity.

Electricity consumption is an irreversible event with permanent negative consequences for the environment :

- oxides related to electricity consumption (carbon, sulfur, nitrogen),
- solid residues related to electricity consumption, (many elements of the Mendelian table)

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Types of renewable energy sources

Photovoltaic

Wind

Water

Biomass

Geotermal

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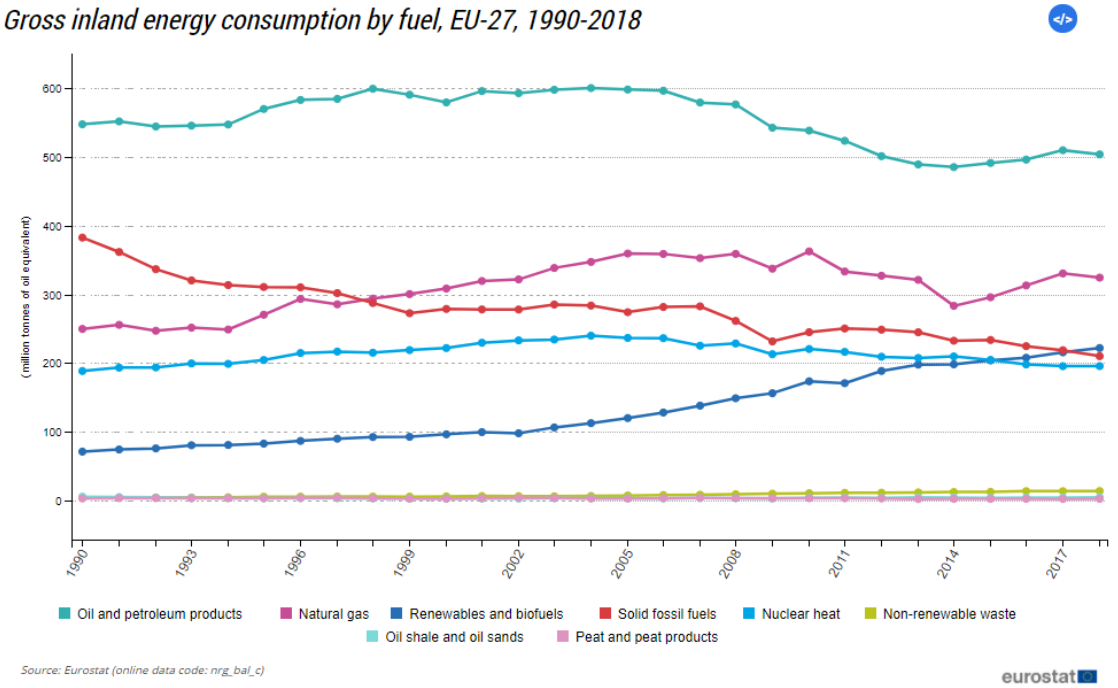
Possibilities of using RES for public buildings

Buildings account for about 40% of total final energy consumption and around 55% of electricity consumption in the EU-28. Buildings are the largest end-use sector, followed by transport (32%), industry (26%) and agriculture (2%). Buildings represent even more than 45% of final energy consumption in countries such as Estonia, Latvia or Hungary



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Photovoltaic systems

Photovoltaic systems are used to convert energy from the sun into electricity. They are a safe and reliable source of solar electricity that produces no on-site pollution or emissions. PV systems incur few operating costs and can be installed on any kind of building, such as:

- Residential;
- Commercial;
- Industrial;
- Institutional;
- Agricultural.

PV systems fall into two main categories — off-grid and on-grid.

Off-Grid systems are typically installed in remote locations where no utility grid is available. These systems usually require storage, such as batteries, to store the excess electricity generated by the PV system. Energy can be withdrawn from the batteries when the demand exceeds the PV system electricity production.

On-Grid systems can also include storage technologies, but they generally feed any excess electrical energy production to the grid.

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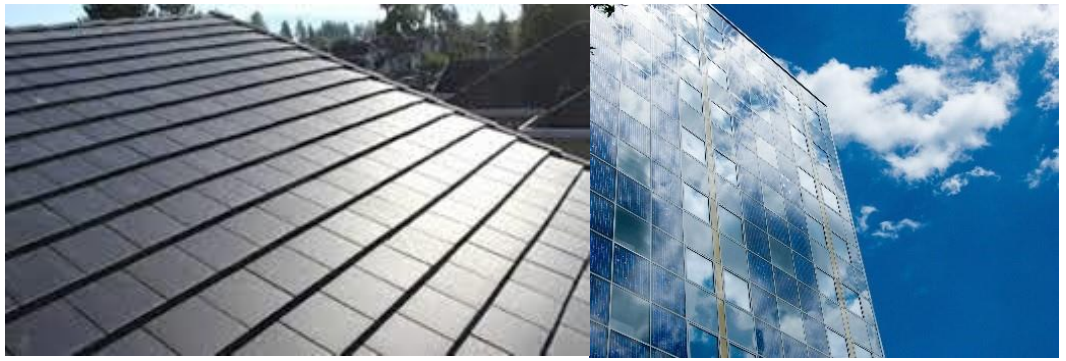
Photovoltaic systems

In the built environment, photovoltaic systems can be split into two market segments:

1. Building-applied photovoltaics (BAPV), where the PV system is added to an existing building (e.g. conventional rooftop applications);

2. Building-integrated photovoltaics (BIPV), where the PV system can be included as part of building components to become an integral part of the building skin.



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Building-applied photovoltaics (BAPV)

In the built environment, building-applied PV (BAPV) are the most common type of installation around the word.
PV modules in a BAPV installation are typically mounted on a racking system.
Two basic variants can be distinguished:

•With orientation of the panels either optimized for solar energy generation (optimal azimuth and tilt angles)

•Flush-mounted in parallel to the [illegible]re attached to (the roof or wall)

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Building-integrated photovoltaics

Building-integrated photovoltaics (BIPV) are solar power generating products or systems that are seamlessly integrated into the building envelope and part of building components such as fasades, roofs or windows.
Serving a dual purpose, a BIPV system is an integral component of the building skin that simultaneously converts solar energy into electricity and provides building envelope functions such as:

•weather protection (water proofing, sun protection);

•thermal insulation;

•noise protection;

•daylight illumination; and/or

•safety.

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Building-integrated photovoltaics

BIPV systems can be installed during the construction phase of a building or deployed during a retrofit of an existing building when one of the envelope components needs to be replaced. The built environment allows for many ways to integrate BIPV. In general, there are three main application areas for BIPV:

•roofs (e.g. shingles, tiles, skylights)

•fasades (e.g. cladding, curtain walls, windows)

•externally integrated systems (e.g. balcony railings, shading systems)

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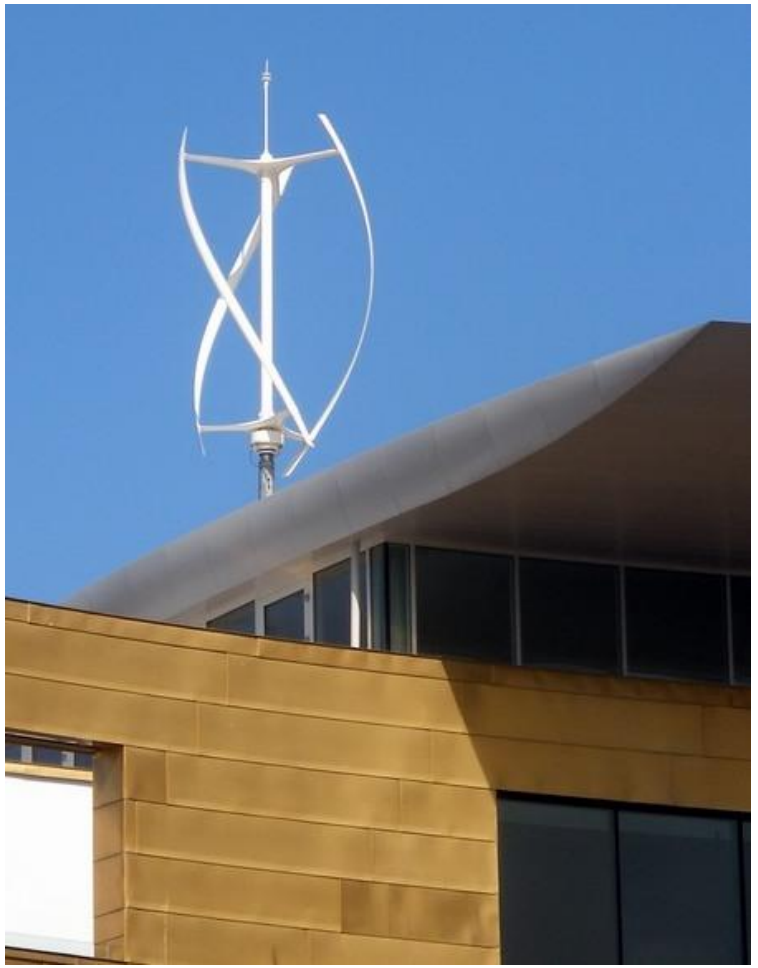
Wind power for buildings

- Small wind turbines have less generating capacity than the huge commercial turbines found on wind farms, but their reduced costs and added versatility allow wind power to be used in a wider set of applications.
- These small turbines are used primarily for distributed generation – generating electricity for use on-site, rather than transmitting energy over the electric grid from central power plants or wind farms.
- Small turbines are a small-scale alternative to solar panels, providing clean renewable energy to rural homes, farms and businesses.
- This reduces reliance on large fossil-fuel power plants and lowers the burden on the electrical transmission grid.



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Wind power for buildings

- Small wind turbines can have a generating capacity of anywhere from 0.3 to 100 kW, though the amount of power they generate depends on wind speed.
- A small turbine will typically need wind speeds of four meters per second at the height of the turbine.
- Because steady wind speed is important, small turbines must be placed away from buildings, trees, and other obstructions that may block the flow of wind.
- This makes them ideal for rural and suburban communities that do not have the space restrictions found in urban centers.

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Wind power for buildings

- Off-grid wind turbines are not connected to the electrical transmission grid. These are generally installed in areas far from the grid, and where connecting to the grid would be expensive.
- The simplest off-grid systems use direct current (DC) and provide power to devices in remote locations, such as telecommunications equipment and water pumps. These simple systems may use battery storage to provide backup power when the wind is not blowing.
- By adding an inverter to an off-grid system, the electricity can be converted to alternating current (AC), which allows the turbine to power AC appliances and makes the system compatible with the electric grid.
- Rural houses and farms located far from population centers can use off-grid wind in combination with solar panels, generators, and/or batteries to provide all of their power needs. The small wind market has seen a shift in recent years away from off-grid systems to more grid-connected systems.

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Wind power for buildings

- On-Grid small wind is now the most common type of small wind system.
- Many new turbine models have an inverter built in, so they are compatible with the AC electric grid upon installation.
- Grid-connected businesses and factories use small turbines for distributed generation to lower their carbon footprint and reduce their electricity bills.
- Homes and farms also use small wind for the same reasons, as small wind is often a cheaper option than solar panels.
- If a grid-connected small turbine has a large enough generating capacity, it may be possible to sell excess electricity back to the utility, in addition to the money saved on monthly electric bills.

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Wind power for buildings

- Small wind turbines operate on the same principles as large utility-scale turbines – air moving past the turbine blades creates aerodynamic lift, causing the blades to rotate.
- A generator inside the turbine converts the mechanical energy of the rotating blades into electricity.
- However, small turbines operate lower to the ground and at lower wind speeds than utility-scale turbines.
- There was 2 types of wind turbines:
    - Horizontal axis wind turbine
    - Vertical axis wind turbine

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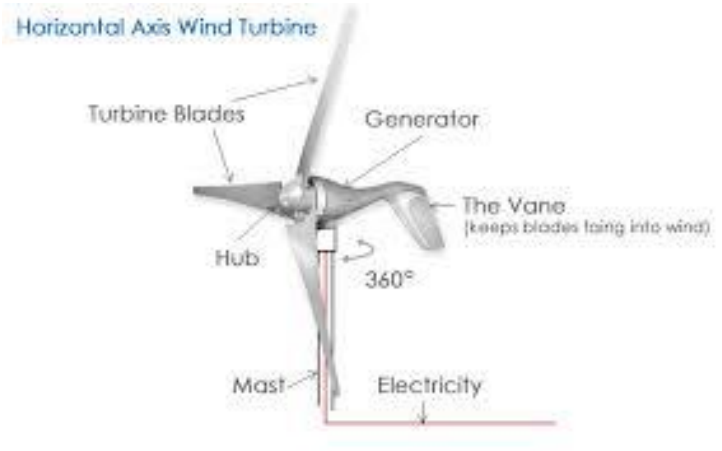
Wind power for buildings

- The most common type of turbine is the horizontal axis wind turbine.
- These turbines must be pointed into the wind to generate power.
- Simpler models do this with a weather vane behind the blades, but more complex models have wind sensors and a motor that will move the turbine to face the wind.



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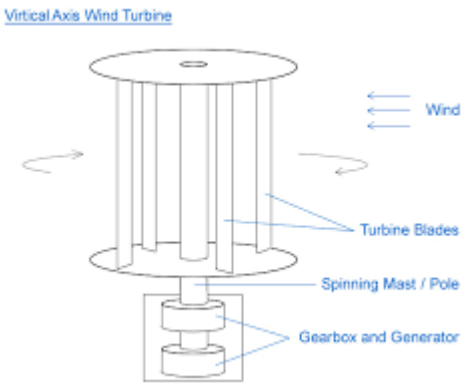
Wind power for buildings

- The vertical axis wind turbine is a radically different turbine design, in which the blades rotate around a vertical shaft.
- These turbines operate at lower wind speeds, and can be placed lower to the ground than HAWTs.
- Because of the shape of the blades, VAWTs can generate power from wind blowing in any direction – even vertically.
- They have smaller space requirements and can be placed closer together than HAWTs.
- The generator is located at the bottom of the shaft – at ground level – making maintenance much easier on these turbines.
- However, because they operate at lower wind speeds, they generate less power than horizontal axis turbines.
- The blades are also more vulnerable to being damaged by high winds than the blades of HAWTs.



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Water power plants in Slovakia

- The total installed capacity of hydro power plants in Slovenské elektrárne's portfolio is 1,653 MWe. This represents about 40% of its total installed capacity, which generates on average around 11% of produced electricity.
- Because of their very variable power output and operational flexibility, hydroelectric plants are capable to satisfy the swiftly changing demands in the daily-load diagram.
- They are suitable to cover the short time load variation in the power system.
- The hydro power plants located at large water reservoirs (e.g. Orava, Liptovská Mara, Nosice, Kráľová) and the pumped storage hydro-plants (e.g. Čierny Váh, Liptovská Mara, Ružín, Dobšiná) help us satisfy the non-uniform electricity consumption during the day.

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Water power plants in Slovakia

- The today's technology enables to utilise at hydroelectric power plants a generation process that is characteristic and specific only for the hydroelectric power plants:

- very effective transformation of primary energy to electricity
- high flexibility and manoeuvrability enabling to provide qualitative services for the power system
- environment friendly technology
- highly reliable operation and safety
- full automation of the whole process, possible operation with no operating staff and with remote control
- long life period of equipment and whole plant at inexhaustible primary energy resource
- low energy consumption
- compensation is possible in addition to the turbine and pumping mode.

The actually utilised potential of hydropower in the Slovak republic is about 57.5%.

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Biomass

- Biomass is one of the key renewable sources of energy that is produced from organic matter. It includes wood, agricultural crops and waste, and other “living” materials that can be used to produce heat and energy.

- Directive 2001/77/EC defines the biomass as a biodegradable fraction of products, waste, and residues from agriculture (including vegetal and animal substances), forestry, and related industries, as well as the biodegradable fraction of industrial and municipal waste.

- In terms of its origin, we can talk about plant biomass (phytomass), animal biomass (zoomass), and municipal and industrial waste. Dendromass is an organic matter of woody and shrubby plants consisting of wood, bark, and green matter.

- Regardless of source, biomass materials can be divided into two broad categories: woody and non-woody. Forests provide only woody materials; agriculture sources provide both woody and non-woody biomass for bioenergy production

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Biomass

- Table presents data representing the development in the dendromass stock specified for energy use.

Year	Forest chips1		Wood fuel and other2		Total	
	(Kt)	(TJ)	(Kt)	(TJ)	(Kt)	TJ
2017	580	5510	845	8028	1425	13,538
2016	610	5795	830	7885	1440	13,680
2015	615	5843	835	7933	1450	13,775
2013	620	5890	820	7790	1440	13,680
2010	250	2375	695	6602	945	8977
2005	120	1140	640	6080	760	7220
2000	5	48	471	4475	476	4522
1990	2	19	368	3496	370	3515

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Geotermal

- Geothermal energy is not really a renewable source of energy because it comes from the hot core of the earth, which has a temperature over 4000 ° C.
- Due to the inexhaustible supply of resources but among those ranks.
- On the surface goes through cracks in the volcanic rocks.
- Inside the ground to accumulate large amounts of energy. Slowly penetrating the surface to form a thermal flow, which make an average of 0.063 W/m2.
- The thermal gradient measured temperature increase per unit of length near the ground surface, the thermal gradient that drives the geothermal heat flux, equal to about 30 ° C / km.
- This means that about 3 km length achieve an average of 100 ° C.

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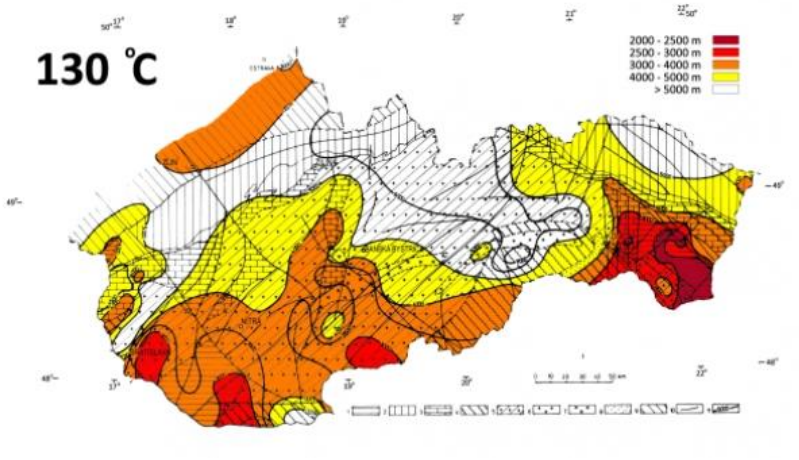
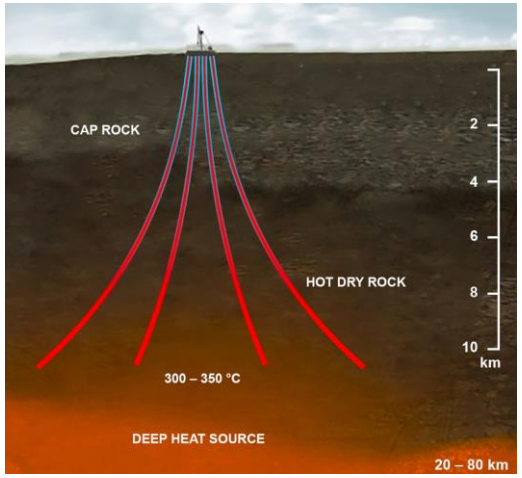
Geotermal

- In Slovakia is located 25 prospective areas of geothermal water temperature to 150 ° C at depths to 5000 m. These springs are used mainly in agriculture.
- Today it is used for heating swimming pools with geothermal water, heating hospitals and residential development.
- Today's use of the SR is limited because of the high financial cost.
- Advantages of geothermal energy are high performance and no production of pollutants and the ability to position anywhere on the mainland.
- The disadvantage is that the use of this energy increases the number of earthquakes, loosing the earth's crust and the risk of leakage of toxic compounds from the well.





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Any Questions?

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