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**VSB TECHNICAL
UNIVERSITY
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Visegrad Fund

Coal usage reduction in district heating system of city Žilina as important step towards clean energy in city

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**PAN-EUROPEAN
UNIVERSITY**



UNIVERSITY OF ŽILINA
Faculty of Mechanical
Engineering

No. 22320037

www.visegrad.fund

Forecasting factors influence on climatic changes as a part of Sustainable Development
Goals 2030

Main motivation

- Energy system based on fossil fuels
- Most of the fuels are imported from 3rd countries
- Reduction of energy demand and emissions is needed
- Replacement of technologies with RES is desired
- Model presents the city Zilina

Slovak energy system

- High share of nuclear power
- Relatively high share of installed hydropower
- Heavily dependent on natural gas for electricity production

Installed Capacity of Power plants in Slovakia in the Year 2021

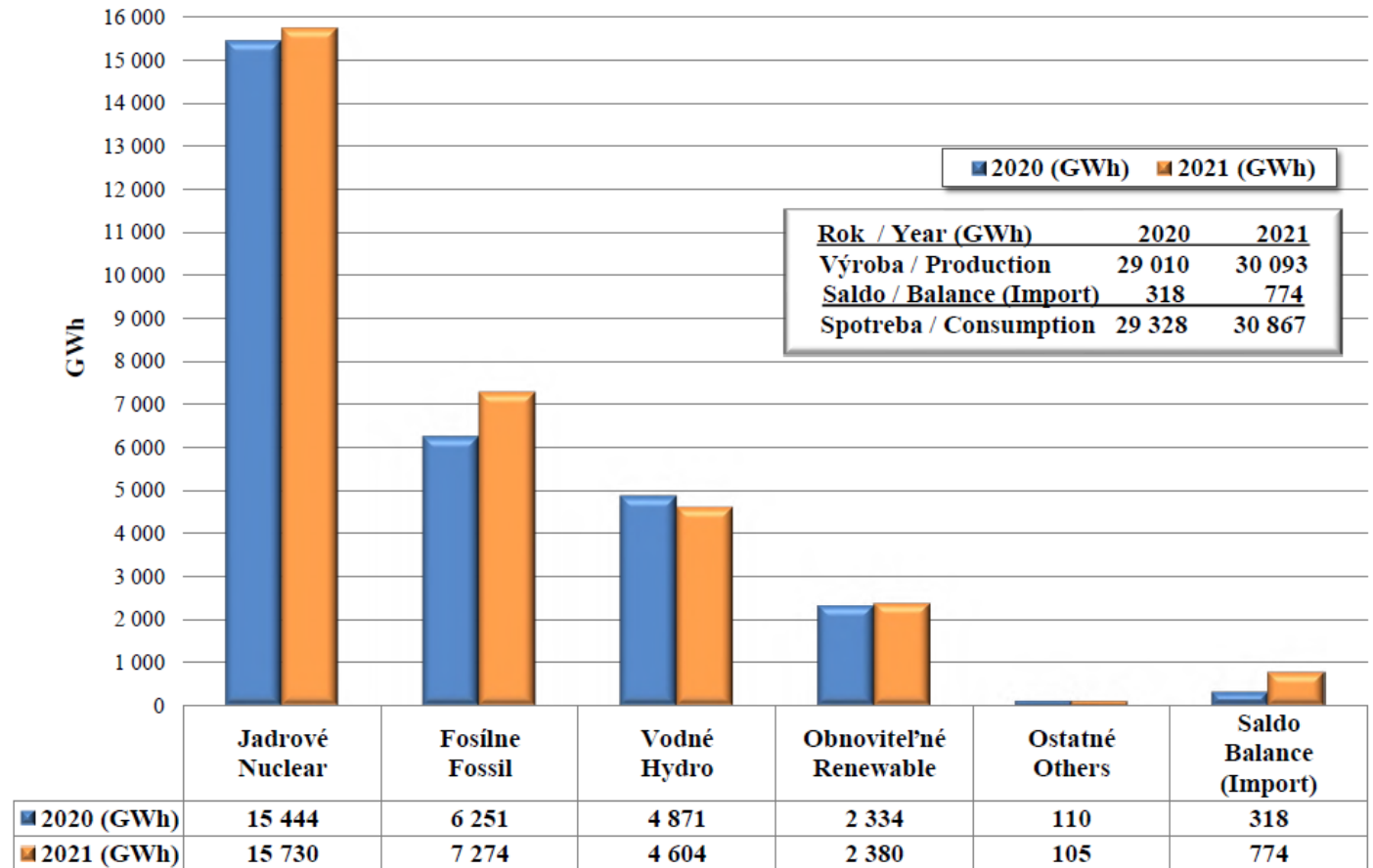
Rozdelenie podľa Palív Shared by Fuels		Výkon (MW) Power (MW)	Podiel (%) Share (%)	
Jadro	Nuclear	2 003	25,7	
Voda	Hydro	2 546	32,7	
Hnedé uhlie	Lignite	276	3,5	Fosilné Fossil
Čierne uhlie	Hard coal	1	--	
Zemný plyn	Natural gas	1 183	15,2	
Ropa	Oil	259	3,3	
Mix palív	Mixed fuels	609	7,8	
Slnko	Solar	532	6,8	Obnoviteľné Renewable
Biomasa	Biomass	234	3,0	
Bioplyn	Biofuel	104	1,3	
Vietor	Wind	3	--	
Iné OZE	Other RES	11	0,1	
Ostatné	Others	18	0,2	
Spolu	Total	7 779		

Source: <https://www.sepsas.sk/pre-partnerov/dispecing/rocnky-sed/>

Slovak energy system

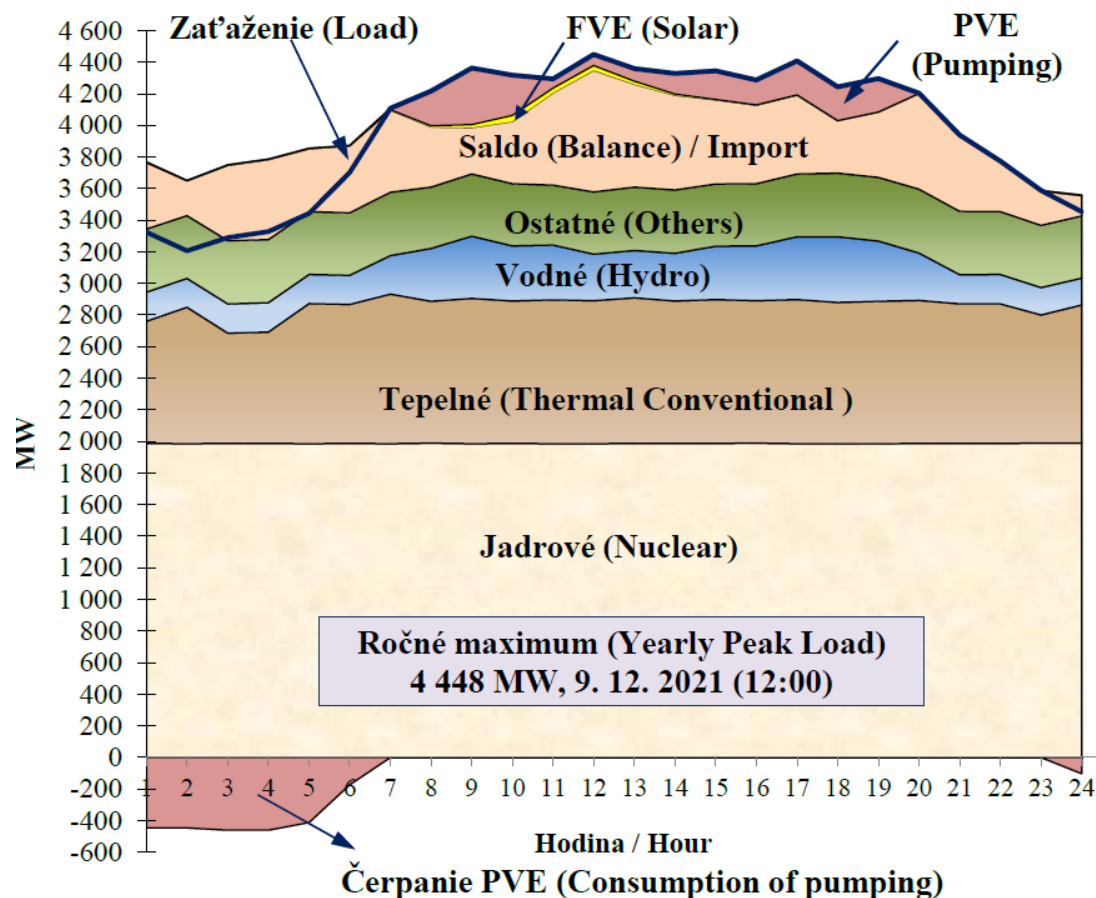
- Most of electricity from nuclear power plants
- Renewables are playing minor role

Share of Sources in the Electricity Production of Years 2020 - 2021

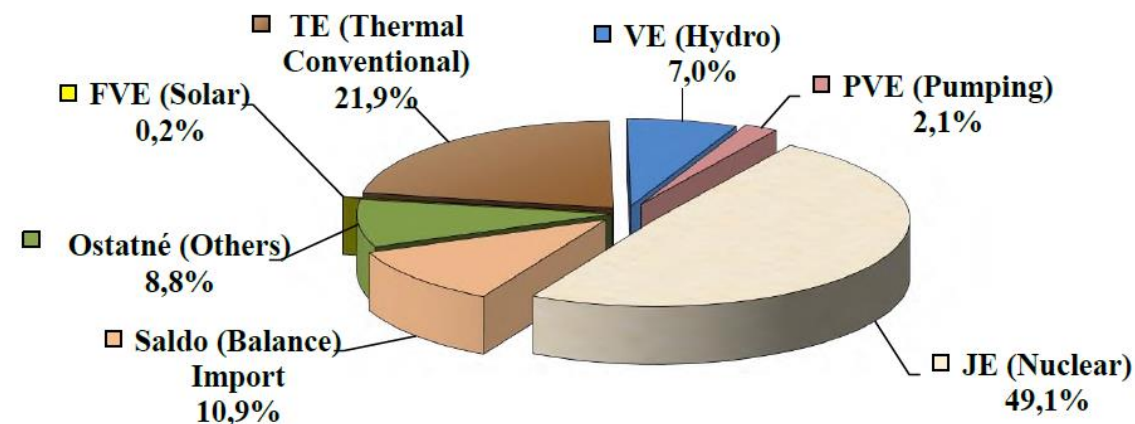


Slovak energy system

POKRYTIE ZAŤAŽENIA V DNI ROČNÉHO MAXIMA 9.12.2021
Load-Curve Coverage on Day of Yearly Peak 9 Dec 2021



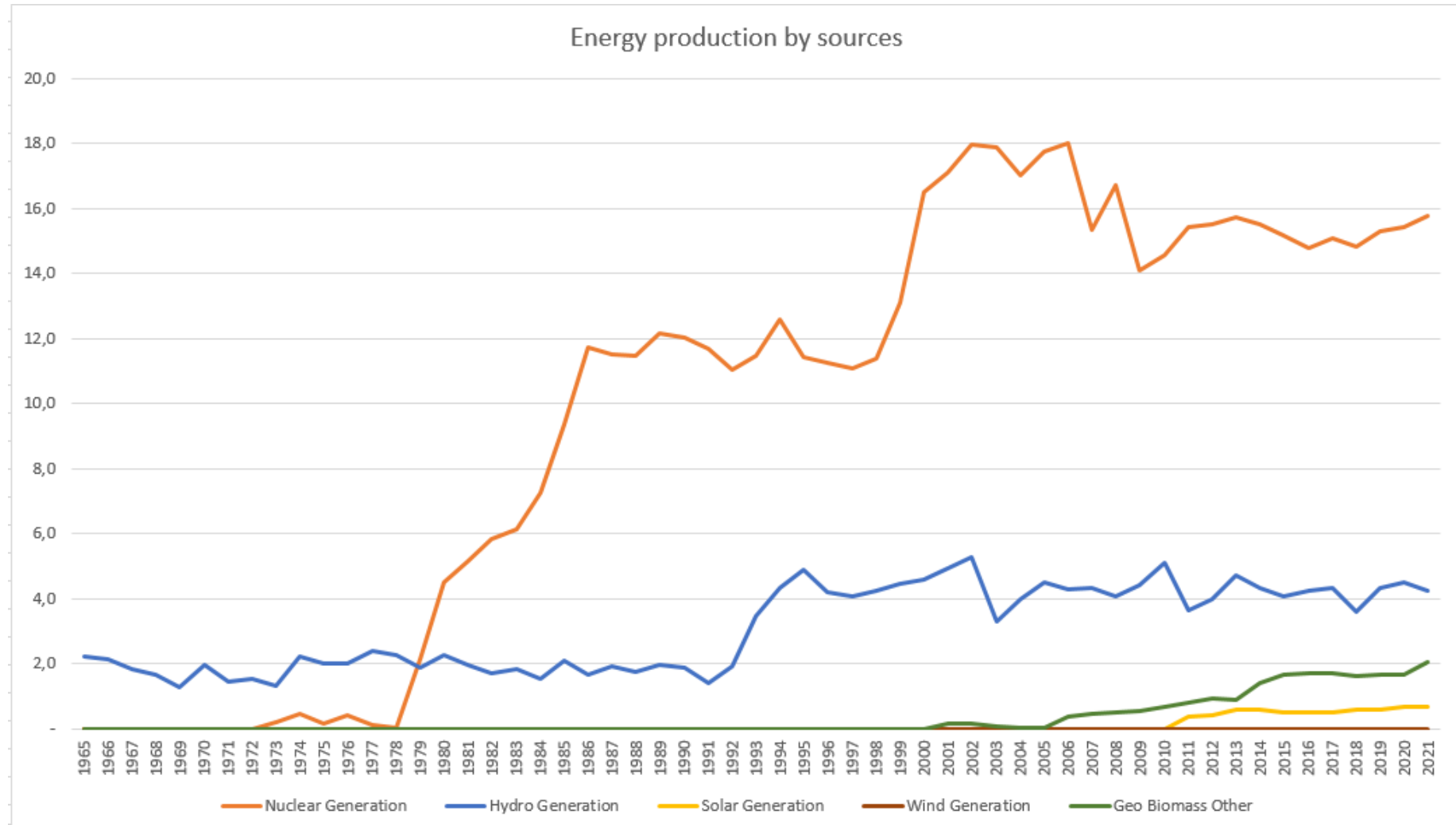
PODIEL ZDROJOV V DNI ROČNÉHO MAXIMA 9.12.2021
Share of Generation on Day of Yearly Peak 9 Dec 2021



9 December 2021

Výroba (Production)	86 729 MWh
Saldo (Balance) Import	10 620 MWh
Spotreba (Consumption)	97 349 MWh

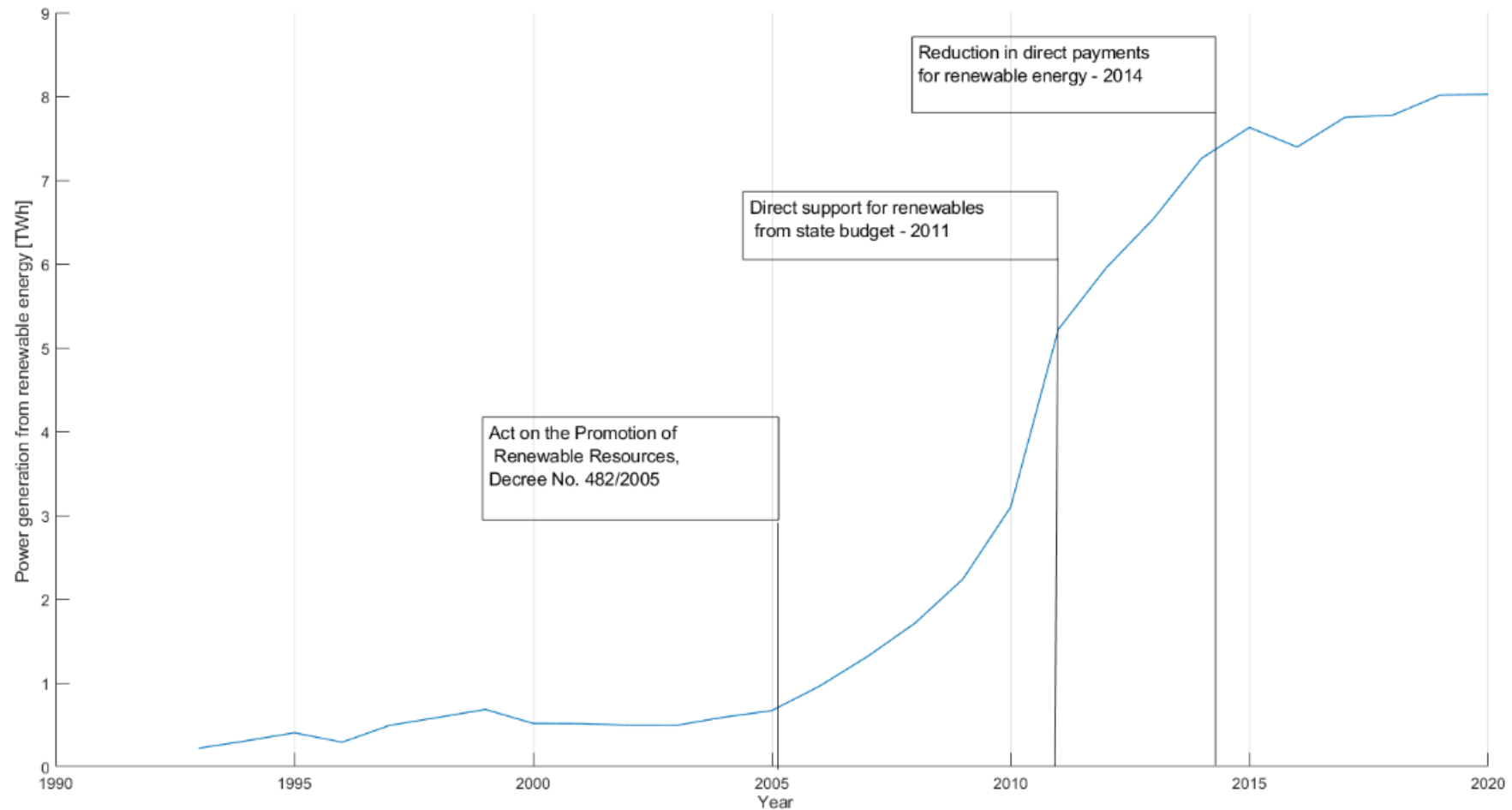
Slovak energy system



Source: <https://iea.org>

Slovak energy system

Evolution of legislative and its effects on installed capacity



Source: adapted according to <https://iea.org>

Zilina city

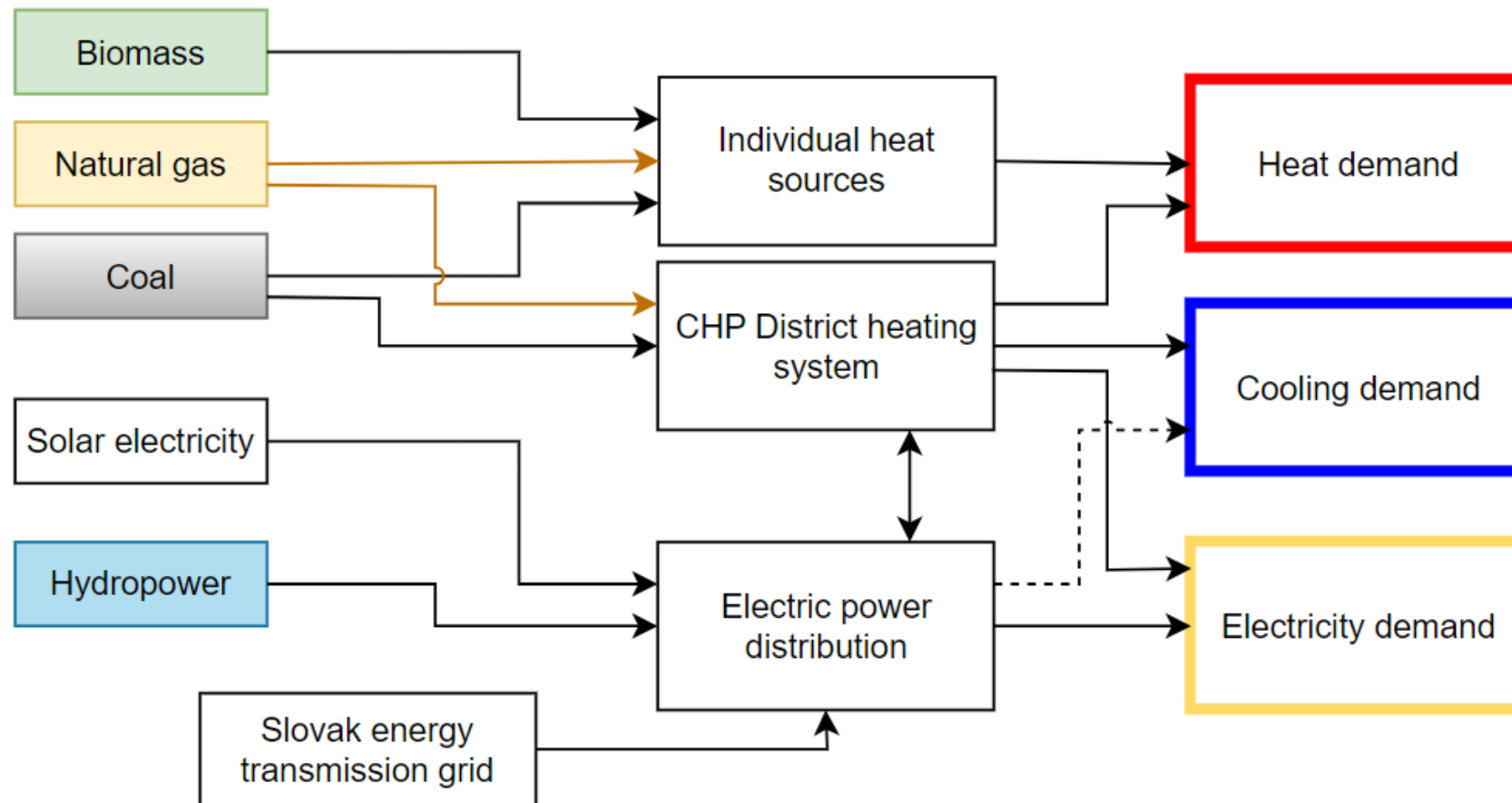
- Located in north of Slovakia,
Climate: Dfb
- fourth largest city in the Slovak Republic
- 81.736 inhabitants as of 31.12.2022
- In January, the average monthly air temperature ranges around $-4.0\text{ }^{\circ}\text{C}$
- Highest recorded temperature: $37,8^{\circ}\text{C}$; 20.7.2007
- Lowest recorded temperature: $-24,5^{\circ}\text{C}$; 8.1.2017



Source: google.sk/maps

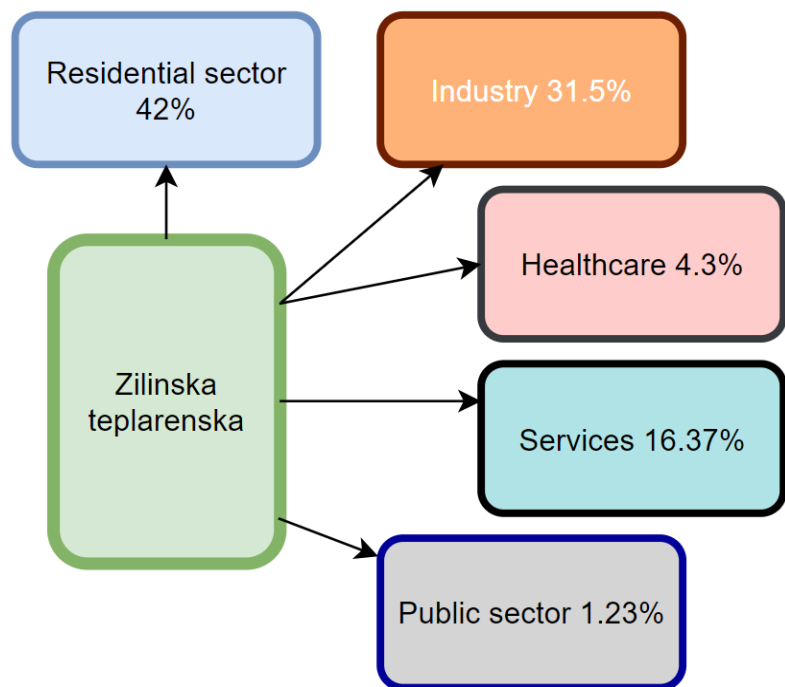
Zilina – energy production and consumption

- Supply and demand side



Zilina – energy production and consumption

- Heat supply from district heating system



Zilina – energy production and consumption

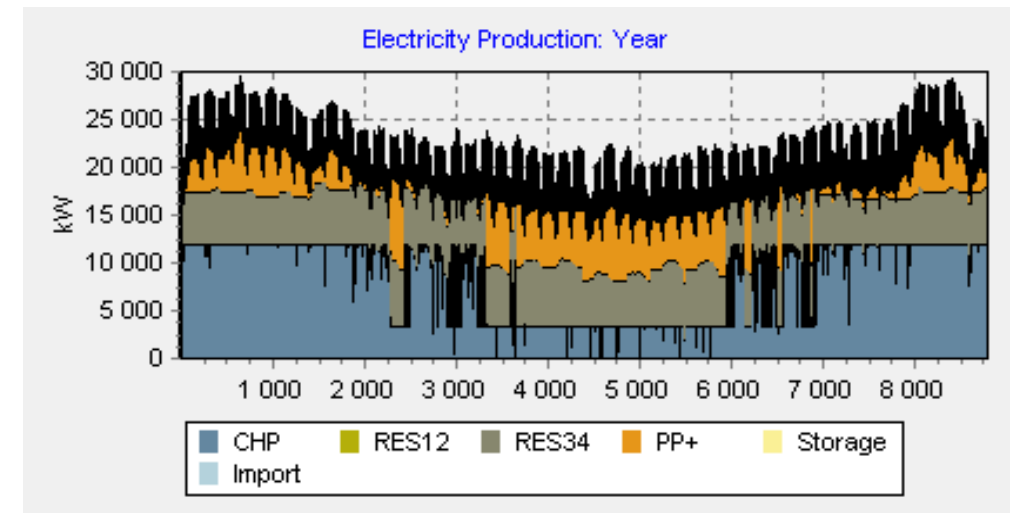
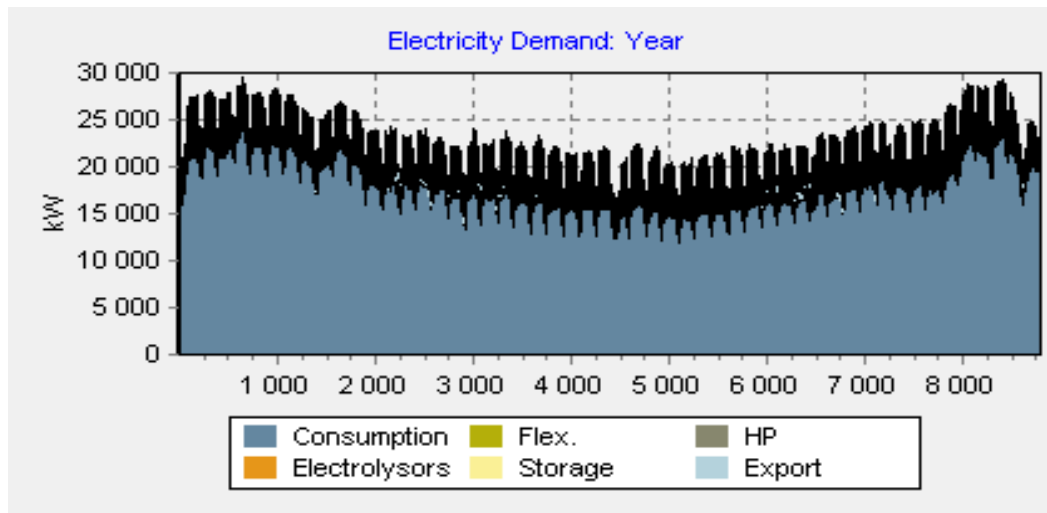
Energy power plants located in Zilina and near surroundings

Location	Type of power plant	Installed capacity [MW]	Average annual energy production [GWh]
<u>Mikšová</u>	hydro	94	186,5
<u>Žilina</u>	hydro	72	173
<u>Sučany</u>	hydro	38	59,1
<u>Hričov</u>	hydro	32	
<u>Zilina region</u>	photovoltaic	8,82	
<u>Zilina region</u>	photovoltaic	0,499	
<u>Zilina region</u>	photovoltaic	0,03	
<u>Zilina</u>	Central Heat source	3x 58,3	Electricity:
<u>Zilina</u>	Central Heat source	97,5	CHP: 2x12+25 MW

Zilina – energy production and consumption

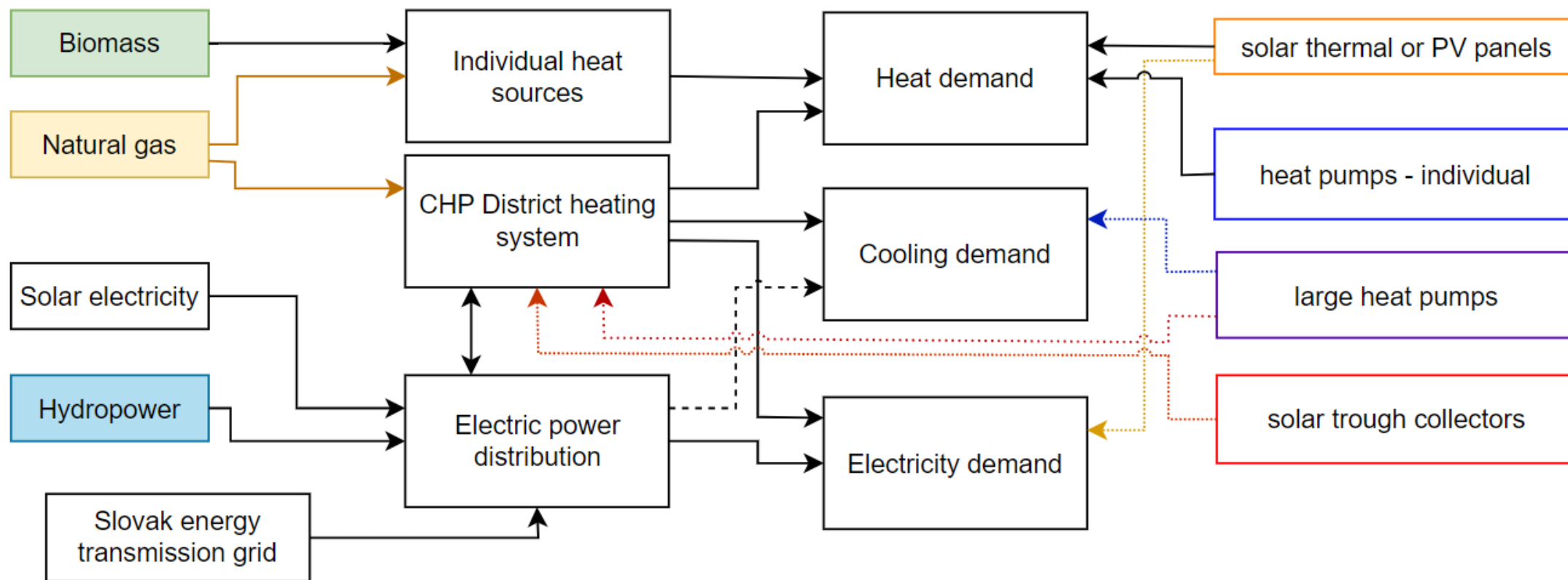
Energy consumption – estimated

ANNUAL FUEL CONSUMPTIONS (GWh/year)	Estimated current state
Fuel Consumption (total)	1290,95
Coal Consumption	299,65
Oil Consumption	116
Ngas Consumption	689,04
Biomass Consumption	132,82
CO2-emission (total) kt	277,904



Zilina – possible future development

Future development with more RES



Zilina – possible future development

Scenario	Type of energy source	Range/installed capacity
Scenario 1		Energy saving 30%
Scenario 2	Solar energy, photovoltaic panels	3,5 MW, power to heat available
Scenario 3	Solar energy, photovoltaic panels	13,9 MW, power to heat available
Scenario 4	Heat pumps, water/water	5 MW
Scenario 5	Heat pumps, water/water	10 MW
Scenario 6	Solar/solar trough, heat only	3,5 MW
Scenario 7	Heat pump, Solar heat	10 MW HP, 3,5 MW solar
Scenario 8	CSP power plant	3,5 MW
Scenario 9	Heat pumps, water/water; Solar energy, photovoltaic panels	5 MW; 3,5 MW, power to heat available

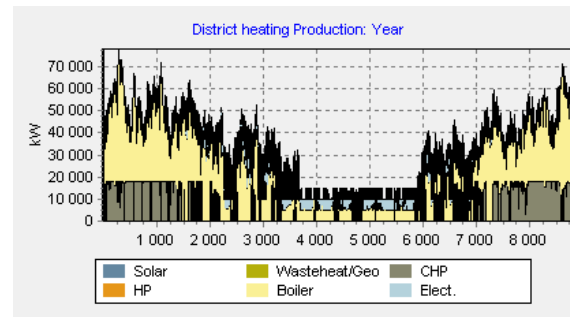
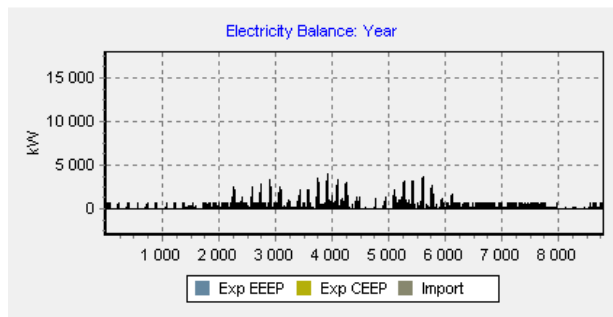
Zilina – possible future development

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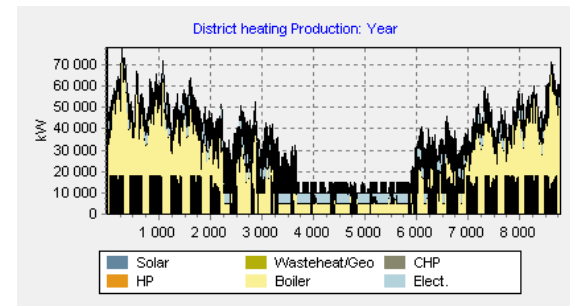
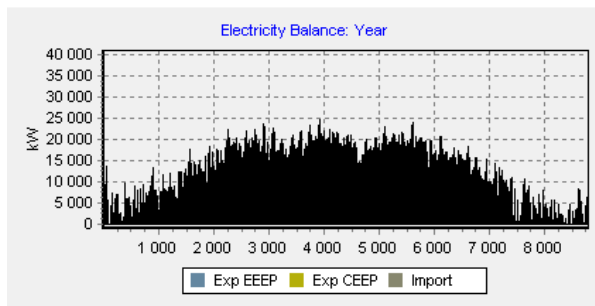
Scenario	1	2	3	4	5	6	7	8	9
Fuel Consumption (GWh/year)	881,8	879,61	958,47	875,37	874,72	874,70	874,72	871,63	869,83
Coal Consumption	199,34	178,2	159,2	199,01	199,35	199,31	199,35	192,8	176,44
CO2-emission (total) kt	185,72	179,60	185,45	184,34	184,34	184,21	184,25	181,95	177,324

Zilina – possible future development

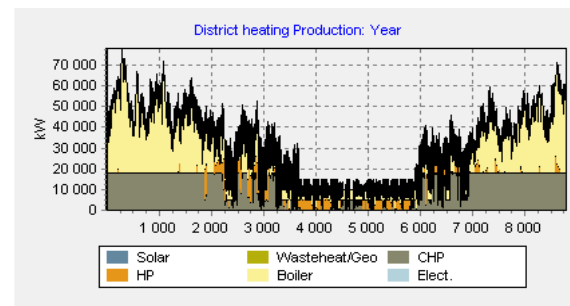
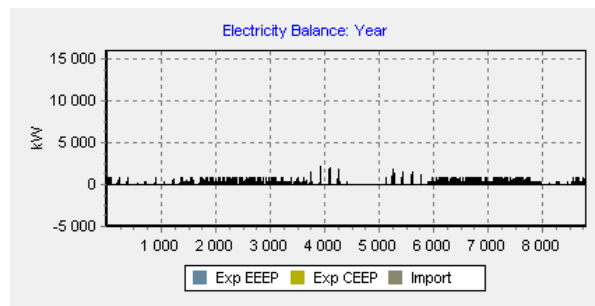
Scenario 2
3,5 MW photov.p



Scenario 3
13,9 MW photov.p

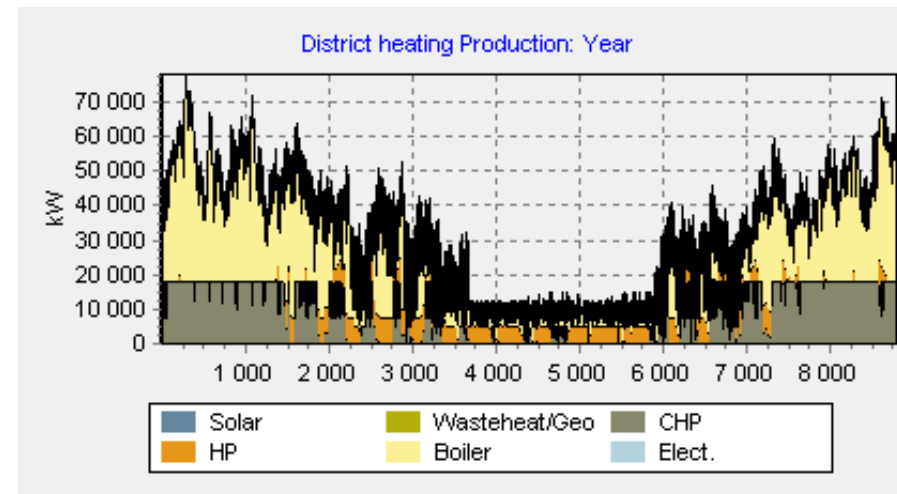
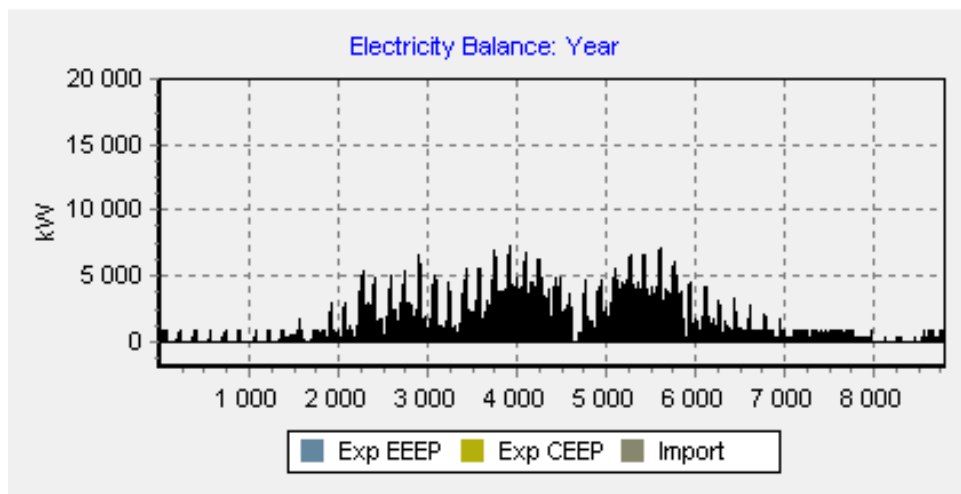


Scenario 4
5 MW HP



Zilina – possible future development

Scenario 9 – combination of smaller sources – 3,5 MW photovoltaic + 5MW heat pumps



Discussion – possible renewable sources as fuel for DH systems



Source: freepik.com



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Thank You for Your attention

Literature:

1 <https://www.zilina.sk/wp-content/uploads/2021/04/Koncepcia-rozvoja-mesta-Zilina-v-oblasti-tepelnej-energetiky-2015.pdf>

2 <https://www.zilina.sk/samosprava/hospodarenie-mesta/vyrocne-spravy/>

3 <https://www.mhth.sk/verejne-informacie/vyrocne-spravy>

4 <https://www.sepsas.sk/pre-partnerov/dispecing/rocenky-sed/>

Pictures: freepic.com