Czech-Austrian Winter and Summer School

"Comparison of the Price of an 5kWp PV-System in Austria and Czech Republic including subsidies"

Guidelines for the Student Papers
Michaela Turetschek, BSc
Patrik Šimůnek

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1. Abstract

Every country has a different way to fund renewable energy. In this paper, two European countries are compared, Austria and Czech Republic. The question is how a 5kWp PV-system is funded, depending on the country and when it will pay off. To answer the question, it is necessary to compare two cities with the same global radiation. After that, the net-present-value is used to find out, which PV-system is going to pay-off earlier, in Austria or Czech Republic. In the calculation the price with subsidies is used, therefore it is also possible, to compare the funding system in these countries, and which country has a better approach, to increase renewable energy.

2. Introduction

In the last years, renewable energies became more relevant. Especially, photo-voltaic-systems will play an important role in electricity production, because sustainable energy production increased. In this paper, we are going to write about the topic “Economies of decentralized small PV-systems”. Specifically, we are going to research how much electricity can provide a PV-system for a 4-person-household with 5kWp in a year. The main idea is to compare two countries, Czech Republic and Austria, with each other and answer the question, where a PV-system is the most cost-efficient, depending on investment costs and subsidies. To have a significant answer to the research question the two areas have the same global radiation of 1100kW/m². Subsidies are in every country different, therefore they will be compared in the last chapter, to find out in which country, in the sector of solar electricity, support renewable energy the most.

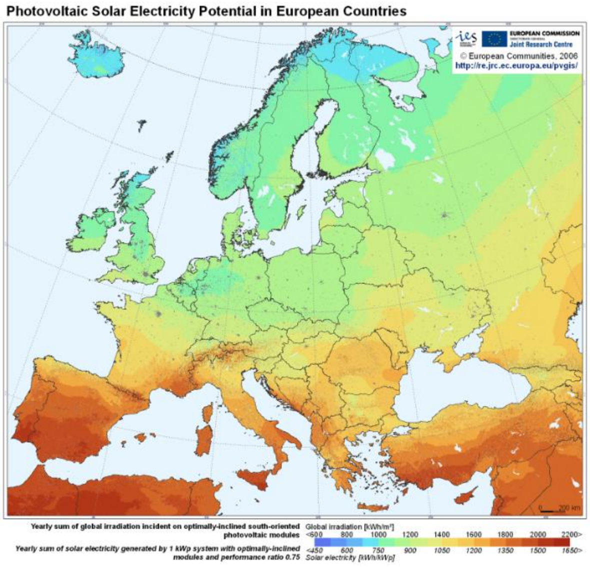

Figure 1- retrieved from https://ec.europa.eu/jrc/en/pvgis (21.7.2020)

2.1 State-of-the-art Austria

In general, the price for PV-systems are lower than the last years, the lower price for PV-panels and subsidies are responsible. The price for a grid-connected 5kWp decreased from 2017 to 2018 by 3.3%, this means from 1,621 Euro/kWp to 1,567 Euro/kWp. In year 2013 was the highest point of installed PV power, because of a funding process. In the years after that high point, the PV-Market stabilized, between 150MWp and 175kWp, are installed every year. In 2018 stand-alone systems with a total capacity of 212kWp were installed, in this paper will only stand-alone systems compared. In 2018 Austria was able, to reduce 509.356 tons of CO2-Emissions through PV-Electricity production.[1]

[1] P. Biermayr et al., *Innovative Energietechnologien in Österreich Marktentwicklung 2018*.

2.2 State-of-the-art Czech Republic

It should be noted at the outset that the price of installing photovoltaic panels is falling every year. This decline is happening all over the world and photovoltaics is becoming more economically efficient even without various subsidy supports from states.

The Czech Republic experienced a large increase in installed capacity in photovoltaic sources before 2013. In almost five years was 2,000 MW join to the Czech distribution system. These photovoltaic sources were very profitable for their investors, because the law stipulated a high purchase price and a green bonus for electricity. At that time, the amount was around 12 CZK / kWh. At the same time, the price of solar panels fell sharply. This situation has caused large financial losses from the state budget and electricity consumers. For this reason, since 2013, any support for photovoltaics has been stopped.

Since 2015, support for rooftop photovoltaic power plants up to 10 kWp has been introduced, known as the New Green for Savings.

Figure 2 - Photovoltaic power plant on the roof [2]

[2] PV, [Online], [26.07.2020], Available from https://www.bydlimesfilipem.cz/cs/uspory/jak-ziskat-dotaci-na-fotovoltaiku

3. Approach

3.1 Selected Areas

In order to build a new photovoltaic source, it is necessary to consider not only the installed power and consumption of the building, but also the location on the exposure map.

3.1.1 Austria

In Austria the selected area is in Lower Austria, the specific city is St. Pölten. The global radiation is 1100kWh per m² per year 2018 shown in the graphic below.

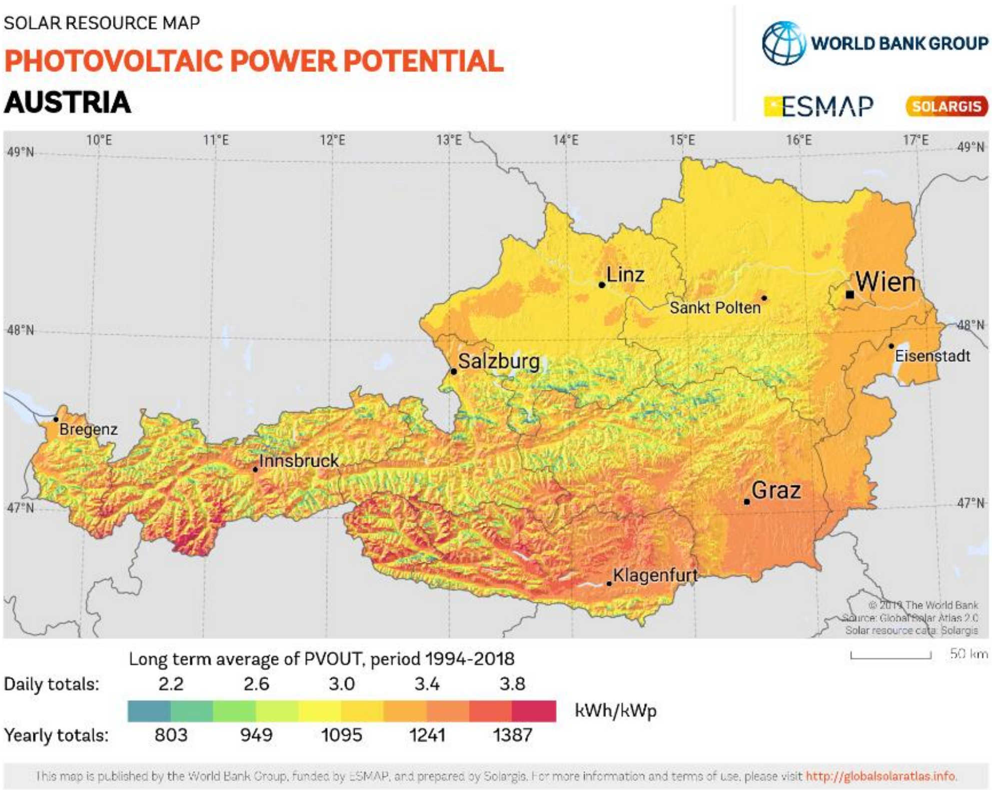

Figure 3- retrieved from https://solargis.com/maps-and-gis-data/download/austria (21.7.2020)

3.1.2 Czech Republic

On average, 1 kW of energy falls on 1 m2 in the Czech Republic under clear skies and full sun. It also means that in the Czech Republic, around 1,500 kWh of energy per 1 m2 falls to the ground every year. It is also based on the fact that the sun shines on the Czech Republic for an average of 1,500 hours a year.

The following exposure map is valid for the installation of a photovoltaic power plant in the Czech Republic.

The same area on the exposure map as in Austria was selected for the calculation. For a better comparison of economic efficiency. This area has an average annual exposure of 1,100 kWh / m2. The city of Jihlava is chosen for this area and calculation.

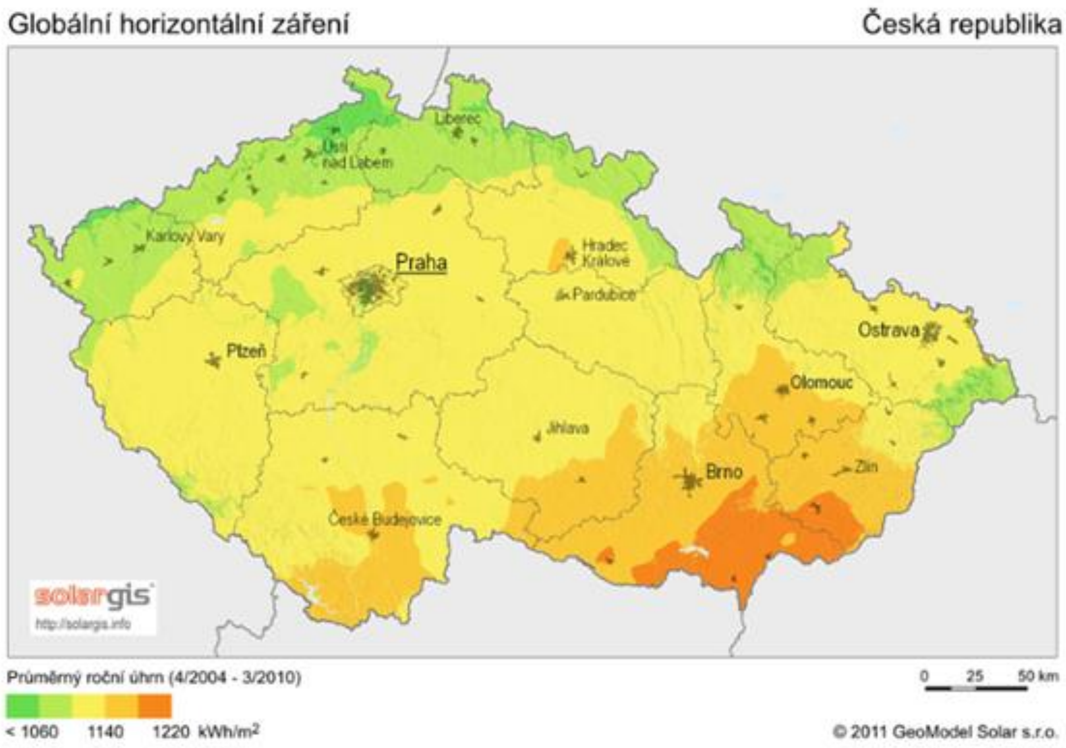

Figure 4 - Exposure map of the Czech Republic[3]

The same area on the exposure map as in Austria was selected for the calculation. For a better comparison of economic efficiency. This area has an average annual exposure of 1,100 kWh per m2. The city of Jihlava is chosen for this area and calculation.

3.2 Parameter

3.2.1 Global Radiation

The global radiation is the sum of direct solar radiation, minus reflection, absorption and reduction trough Rayleigh- and Mie-scattering, which are little molecules. The average in Austria is 1000W/m² per year. In Middle Europe the average is 900W/m² on a sunny day with no clouds. It is not the same the whole year, because there are different irradiation angles. In the cold months the global radiation is lower, than in the

[3] What you need to know before installing photovoltaics on the roof, [Online], [26.07.2020], Avaliable from https://www.topsrovnani.cz/aktuality/co-je-treba-vedet-pred-instalaci-fotovoltaiky-na-strechu

summer. It is not the same through the day, in the afternoon it is lower, and the highest normally at midday. A cloud cover also has a negative effect. It is measurable by a pyranometer, which measures the current value Watt per m². The global radiation is important for the power output of PV-systems.

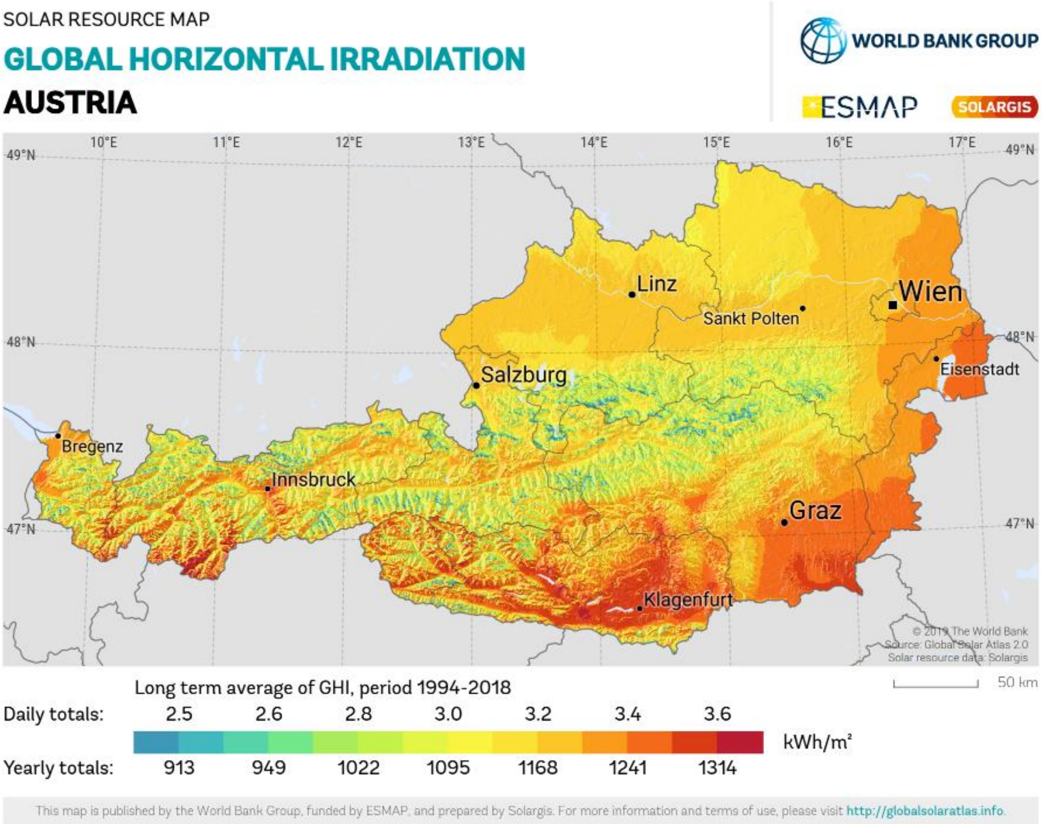

Figure 5 - retrieved from https://solargis.com/maps-and-gis-data/download/austria (21.7.2020)

3.2.2 Angle of PV-Systems

The global radiation is not the only parameter for the power output of PV-systems. If the solar panels have a south orientation and an angle of 37°, the power output has its maximum, shading can reduce the power output. Furthermore, this means it is important where the solar panels are installed and in which direction.

3.2.3 Power Output

The power output depends on global radiation and the angle of the PV-systems. In this paper a PV-system with 5kWp will be researched. The most common installed capacity of roof photovoltaic panels in the Czech Republic is 3.5 kWp. For such a domestic PV plant if the sky is clear and the sun is shining a 3.5 kWp source will produce about 3.5 MWh of electricity per year. With the average electricity consumption of households, which is 2.5 MWh. This produced output is one megawatt higher. However, it must be said that this average also applies to households living in prefabricated houses where electricity consumption is lower than in family houses. For family houses the level of consumption is up to 6.5 MWh/year. For this reason, storage batteries or water heating are supplied to the installed photovoltaics in order to achieve 70% of the consumption of the PV electricity produced on site and the customer to achieve savings on the New Green subsidy.

4. Results

4.1 Austria

4.1.1 Investment Costs and Power Output

The range of the price for an PV-system is since 2011 smaller. As shown in the graphic below, in 2018 between 1170€ and 2000€ pro kWp. This price includes the installation, but not the value added tax. In this paper, the mean will be used for the calculation. Therefore, it is 1567€ pro kWp.

$$Price_{invest} = 1567€ * 5kWp = 7835\ €$$

The investment for a fully installed PV-system is in Austria 7835€, without any subsidies.

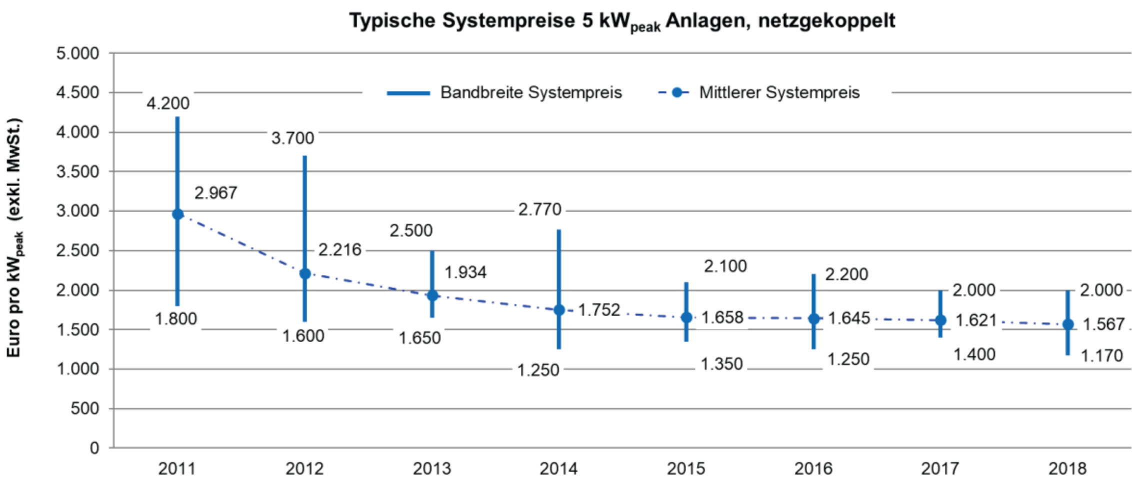

Figure 5 - Source Technikum Wien

Location	St. Pölten
Installed PV [kWp]	5
Inclination of the PV pant [°]	35°
Total area of PV panels [m²]	15
Panel type	Monocrystal
Price PV [EURO]	7835
Subsidy [EURO]	1375
Price of PV Plant with subsidy [EURO]	6460
Total electricity produced [kWh/year]	6266
Total electricity consumed [kWh/year]	4499

Table 1 - Calculated with PVGIS

For the comparison with Czech Republic, it is important to calculate the Net Present Value, therefore it can be compared after how many years the PV-system pay off. The price with the subsidy is used and the following parameters:

- electricity savings per year (electricity price (20cent with inflation rate of 3,7% * power generation)
- Annual output degradation 0,60%
- future value discount rate 2%
- present value (electricity savings * (1-2 %)^year)

NPV after 25 years [EURO]	3172	
YEAR	[EURO]	Cash flow
0	-6460	0
1	341,66	-6145,34
2	345,13	-5800,21
3	348,62	-5451,59
4	352,14	-5099,45
5	355,68	-4743,77
6	359,24	-4384,53
7	362,82	-4021,71
8	366,43	-3655,28
9	370,05	-3285,23
10	373,70	-2911,53
11	377,37	-2534,16
12	381,06	-2153,1
13	384,77	-1768,33
14	388,49	-1379,84
15	392,24	-987,6
16	396,01	-591,59
17	399,79	-191,8
18	403,60	211,8
19	407,42	619,22
20	411,26	1030,48
21	415,12	1445,6
22	418,99	1864,59
23	422,88	2287,47
24	426,78	2714,25
25	430,70	3144,95

Table 2 - Calculation NPV AU

4.1.2 Subsidies

The funding of PV-systems is different, depending on the state. The selected area is in St. Pölten, Lower Austria and there is the PV-system installed, i.e. the funding in Lower Austria is considering in this paper.
Funding is possible trough:

- Investment funding from Klima- & Energiefonds (KLIEN)
- Ökostromeinspeiseförderung (OeMAG)
- Wohnbauförderung depending on the state, in Lower Austria it is possible

4.1.2.1 Investment funding from federation (KLIEN)

Projects for PV-systems could be submitted between May and November and after the installation is finished, the amount of money is pay out. In 2018, the amount ranged between 275€ per kWp and 375€ per kWp for building-integrated photovoltaics. The funding is only until the power of 5kWp possible. In this paper, the PV-system is installed on the roof of a 4-person-home, that means the funding of 275€ per kWp is used for the calculation.

$$Price_{funding} = 275€ * 5kWp = 1375\ €$$

4.1.2.2 Housing subsidy Lower Austria

The state Lower Austria is funding PV-systems through housing subsidies and not every state in Austria is providing this kind of subsidy. The operating principle is a point-system, where a household can request a loan with low interest rates for 27,5 years. The application can be requested from the house owner of new buildings or first buy of apartments under a living space of 130m². The payments are staggered, 30% after finalization of the basement, 60% after finalization of the shell house and 10% after the report of the finalization. The energy parameter is important for achieving the points, the heating demand is crucial, with a low heating demand, more points can be achieved. The ÖKO-parameter is also important, it includes the choice of building material and if renewable energy systems are used within the building. The family situation (number of children) and income are also considered in the allocation of the points. After the first five years, the loan rate is 2%, from the sixth year it is 3% and every five year it gets higher per 1%. The loan must be paid twice a year. These following two figures show how the points are counted. One point is worth 300€ and the maximum are 30.000€.[4]

[4] Infina Redaktion, 'Wohnbauförderung in NÖ: Alles über Landeskredit & Co'.

Basisförderung

Gebäudehülle: Optimierte Wärmedämmung - Haustechnik: Standard												
A/V	≥ 1,00	0,95	0,90	0,85	0,80	0,75	0,70	0,65	0,60	0,55	0,50	Punkte
HWB Ref,RK	40	39	37	36	34	33	31	30	28	27	25	65
hocheffizientes alternatives Heizsystem: ☐ Wärmepumpe oder ☐ biogene Heizung oder ☐ Fernwärmeanschluss oder ☐ direkt elektrisch + hocheffiziente Wohnraumlüftung + Photovoltaikanlage ≥ 2,0 kWp												
Gebäudehülle: Standardwärmedämmung - Haustechnik: Optimiert												
A/V	≥ 1,00	0,95	0,90	0,85	0,80	0,75	0,70	0,65	0,60	0,55	0,50	Punkte
HWB Ref,RK	56	54	52	50	48	46	43	41	39	37	35	65
hocheffizientes alternatives Heizsystem: ☐ Wärmepumpe oder ☐ biogene Heizung oder ☐ Fernwärmeanschluss						zusätzlich erforderlich(ohne Punkte) PV Anlage ≥ 2 kWp* oder Solaranlage ≥ 4 m²* oder Wohnraumlüftung*						

Table 3 - retrieved from www.noe.gv.at (12.6.2020)

insgesamt maximal 100 Punkte möglich			
Tabelle 1 Energieeffizienz Ökologie Behaglichkeit Sicherheit	☐ PV-Anlage [3] ≥ 2 kWp (10 P) [7] ☐ PV-Anlage [3] ≥ 4 kWp (15 P) ☐ HWB Ref,RK [4] ≤ 5.500 kWh (10 P) ☐ ökologische Baustoffe (bis zu 10 P) ☐ Wohnraumlüftung (10 P) [7] ☐ passiver Sonnenschutz (5 P)	☐ Solaranlage ≥ 4m² AP [1] (10 P) [7] ☐ Solaranlage ≥ 10m² AP [1] (15 P) ☐ ökologische Gartengestaltung (3 P) ☐ grüne Infrastruktur am Haus (bis zu 5 P) ☐ Sicherheit: Alarmanlage (5 P)	bis zu **35**

Table 4 - retrieved www.noe.gv.at (12.6.2020)

In this paper the housing subsidies are included for the sake of completeness, but it will not be included in further calculations.

4.1.2.3 Funding from OeMAG

The funding from OeMAG is for PV-systems over 5kWp, hence it is not used in further calculations.[5]

4.2 Czech Republic

4.2.1 Investment Costs and Power Output

If we had the installation of rooftop photovoltaics with an output of 5 kWp in the Czech Republic as well as in Austria, then the purchase price of electricity supplied to the grid is 0.037 EUR / kWh. The price of electricity for a Czech household is 0.18 EURO / kWh. With photovoltaics with an output of 5 kWp and batteries with a capacity of 3.5

[5] Bundesministerium für Wissenschaft, Forschung und Wirtschaft, *Ökostrom-Einspeisetarifverordnung*.

kWh, it is possible to obtain a subsidy of 5,645 EURO for the entire project. The following table shows the parameters of the entire Czech photovoltaic project for a family house with support from New Green Savings.

Location	Jihlava
Installed PV [kWp]	5
Orientation of PV	Jih
Inclination of the PV plant [°]	35
Total area of PV panels [m2]	15
Panel type	Monocrystal
Battery capacity [kWh]	3,5
D25d	consumption with storage appliance
TDD5	
Price PV [EURO]	10 307
Subsidy [EURO]	5 622
Price of PV plant with subsidy [EURO]	4 685
Total electricity produced [kWh/year]	6 531
Total electricity consumed [kWh/year]	4 499
Discount [%]	2
The price of electricity will rise every year by [%]	2
Total electricity purchased [kWh/year]	1 349
Sales of electricity to the grid [Euro/kWh]	0,037
The price of electricity [Euro/kWh]	0,18

Table 5 - The parameters of the PV project

The whole project is calculated using cash flow and net present value. The table shows the return of the entire project with a grant for 15 years. The project has a lifespan of 25 years. This means that photovoltaics for a family house will create savings for the price of electricity for another 10 years.

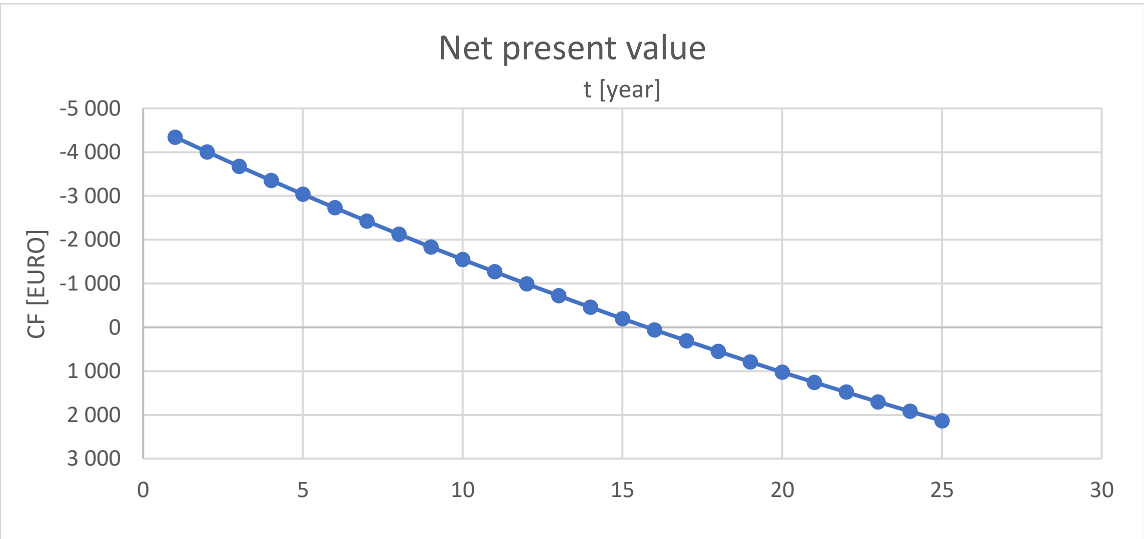

Figure 6 - NPV for PV in the Czech republic

NPV after 25 years [EURO]	2 474	
YEAR	[Euro]	Cash flow [Euro]
0	-4 685	0
1	342	-4 343
2	336	-4 007
3	329	-3 678
4	323	-3 356
5	316	-3 039
6	310	-2 729
7	304	-2 425
8	298	-2 127
9	292	-1 835
10	286	-1 549
11	281	-1 268
12	275	-993
13	270	-723
14	265	-458
15	259	-199
16	254	56
17	249	305
18	244	550
19	240	789
20	235	1 024
21	230	1 255
22	226	1 480
23	221	1 702
24	217	1 919
25	213	2 132

Table 6 - Calculation NPV

4.2.2 Subsidies

Subsidies the New green savings for the acquisition of PV is for all homeowners. It is provided up to CZK 150,000, depending on whether unused electricity is stored. When the system is installed without storing electricity in the battery or heating the water, the subsidy is lower. Financial support can therefore be obtained at PV plants with water heating, energy storage in batteries, hot water and hybrid systems. You can also apply for support for the preparation of an expert opinion, which costs CZK 5,000.

A family house can also be under construction, but for these buildings the condition of the subsidy is the approval date, which must be within 9 months from the submission of the application for the NGS subsidy. Previously, the customer could choose financial support such as the Green Bonus or the redemption price, which were stopped after 2013 for all new photovoltaics. The amount of support for the new green savings depends on the type of PV plant. The following table summarizes this in detail.

Parameter	Units				
Amount of aid	CZK/installation	55 000	70 000	100 000	150 000
Minimum power consumption energy at the place of production	%	70	70	70	70
Accumulation of surpluses el. energy for water heating	-	mandatory	optional	optional	optional
Accumulation of surpluses el. battery power	-	optional	mandatory	mandatory	mandatory
Minimum volume of the water tank	l/kWp	80	-	-	-
Minimum battery capacity	kWh/kWp	-	1,75/1,25	1,75/1,25	1,75/1,25

Table 7 - New Green for Saving

5. Conclusion

5.1 Comparison

	Austria	Czech Republic
Investment costs [EURO]	7835	4 685
Subsidies [EURO]	1375	5 622
NPV [EURO]	3172	2 474

Table 8 - Comparison Austria and Czech Republic

The return on the photovoltaic power plant project in the Czech conditions does not only depend on the subsidy and the price of the photovoltaic material, but especially on the price of electricity, the optimal choice of photovoltaic power and energy storage, but also mainly the weather. So, it depends on how the year will be and how much it will shine. Because if a power plant produces significantly less energy per year than last year and prices rise, this can prolong its return by several years.

In the Czech Republic, with the grant support New Green Savings, the project returns after 16 years. That is two years earlier than in Austria.

In Austria only one funding was possible, the subsidy for the investment. Furthermore, it is calculated after how many years the PV-system are going to save costs, depending on the price of electricity. In year 18, the household have a positive value. If it is compared with Czech Republic, Austria needs two more years before the investment pays off.

It is important to note, that it is difficult to compare two countries with different currencies and living costs. But it is possible, to get an insight, which country can provide which funding. It is also interesting, to see the difference between these two countries and how they fund renewable energy.

Other parameters determining the return on the project are the size of the discount and the choice of location for photovoltaics. For a better comparison, we chose the same discount and the same exposure for both countries. Although the discount and the total amount of incident sunlight are different for both countries. We tried to compare the effectiveness of support for small photovoltaic power plants, which are used for decentralized electricity supply. Therefore, we did not evaluate other parameters, but only the effectiveness of subsidies for the return on the project.

References

INFINA REDAKTION, ‘Wohnbauförderung in NÖ: Alles über Landeskredit & Co’, 2020 <https://www.infina.at/ratgeber/wohnbaufoerderung/niederoesterreich/#c8270>, updated 12 Jun 2020, accessed 12 Jun 2020.

Ökostrom-Einspeisetarifverordnung [2017].

P. BIERMAYR ET AL., *Innovative Energietechnologien in Österreich Marktentwicklung 2018* <nachhaltigwirtschaften.at>, accessed 8 Jun 2020.