A COMPARISON OF THE DEVELOPMENT OF PV-SYSTEMS OVER TIME IN CZECH REPUBLIC AND AUSTRIA

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1. Introduction

This paper is focused on Photovoltaic systems and their development over time in Czech Republic and in Austria. We aim to give a comprehensive report about PV systems in both countries, focusing on the role these resources play, on the support that is given to them and the consequences of this support. For Austria we mainly focus on a historical outline that led to development of photovoltaics. For Czech Republic the main focus is on solar boom in 2011, what was the cause and what are the results.

2. Austria

2.1. Development of power supply in Austria

Until the 1990s the power supply in Austria was based almost exclusively on hydro and thermal power. Through the liberalisation of the European electricity market, international electricity trading started to play an important role. This led to a reduction of domestic electricity production from thermal power in favour of electricity imports. From being a net exporter, Austria has become an electricity importing country by the year 2001. Furthermore, electricity generation from renewable sources, in particular wind power, photovoltaics and biogas, began to play an important role by the year 2000. This development of the Austrian power supply is shown in Figure 1. Electricity imports are shown in grey, thermal power is orange, hydro power is shown in blue and the green colour represents renewable electricity sources. [1]

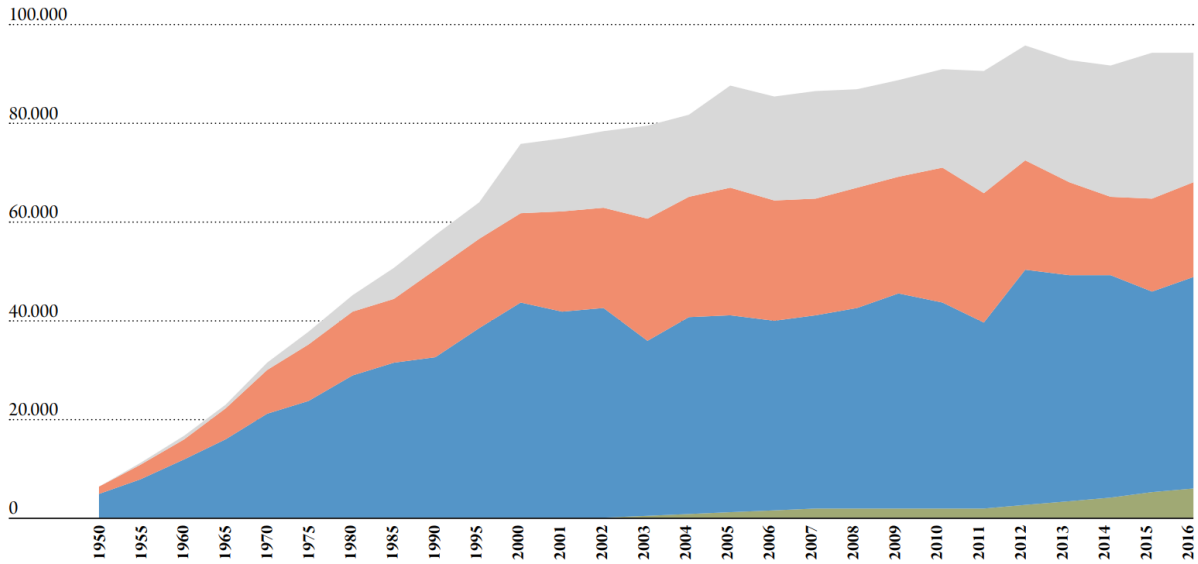

Figure 1 Development of the Austrian power supply [1]

2016 electricity from PV contributed 1% of the renewable final energy consumption, which are 1.096 GWh. The total share of renewable energy in electricity generation was 71.7% in 2016. [1] [2] Figure 2 shows the final energy consumption provided by renewable energy.

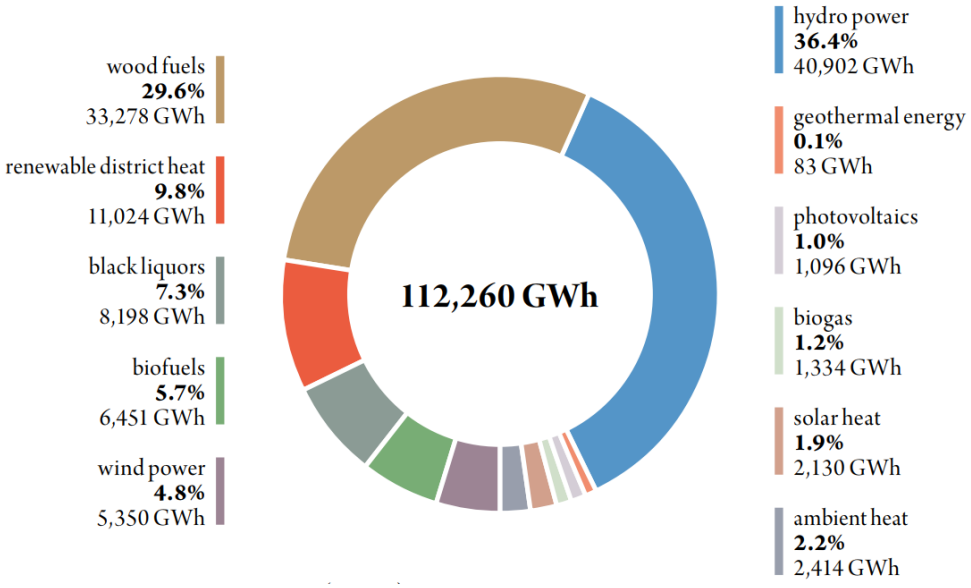

Figure 2 Final energy consumption provided by renewable energy [2]

2.2. A History of PV in Austria

Since the early 90ties, Austria has been a leading country in the expansion of thermal solar energy, a position it holds to these days. It seemed that solar power generation will experience the same successful development some years later. 2003 the number of installed PV-systems in Austria was higher than the international average, which can be seen in Figure 3. [3]

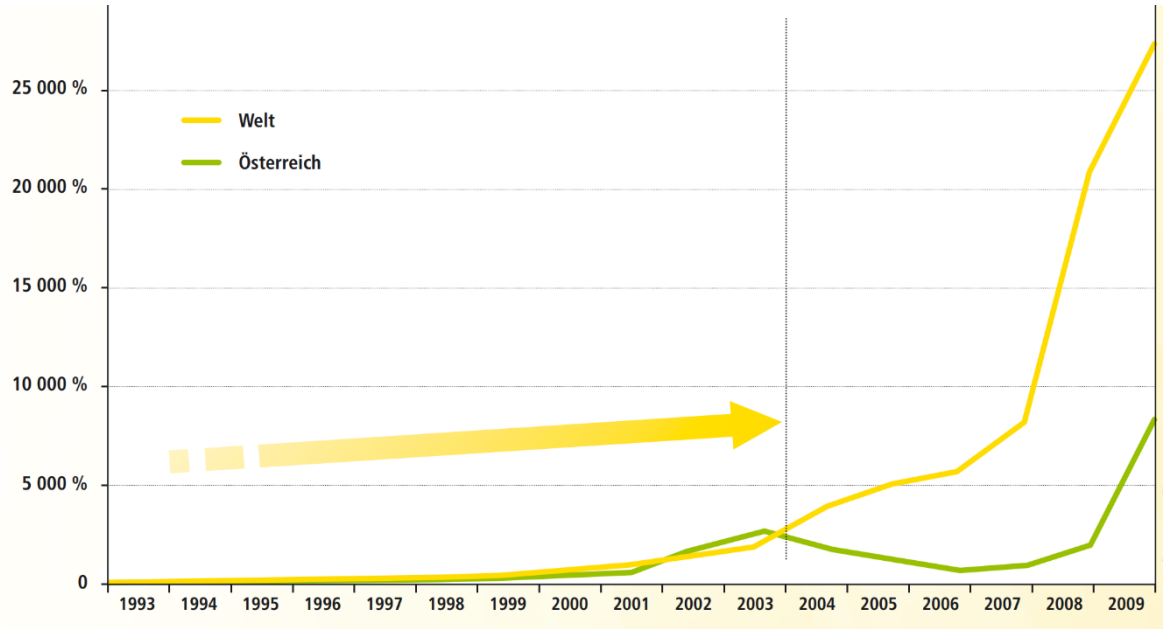

Figure 3 Comparison of the development of PV markets [3]

The green curve represents the development for Austria and the yellow one for the whole world.

1992 the first Austrian funding programme, the so called “200 kW Photovoltaik-Breitentest” started. Private solar power systems with a capacity of 3.6 kWp were supported. The main purpose of this funding programme was making solar power popular in Austria. It turned out that there really was a need for it. When some PV-pioneers planned to install a PV-system on the roof of the Federal’s president villa, the government building agency refused this project. They were afraid, that a damage of the PV cells would cause an entry of water into the premises of the president. This story shows that a lot of publicity work had to be done. [3]

The Austrian photovoltaic market experienced an upturn as the green electricity act (“Ökostromgesetz”) was introduced in 2002. This law regulated the purchase of green electricity throughout Austria, for the first time. Until then, every federal state had its own funding regulations for green energy. The green electricity tariffs where set in the green electricity regulation (“Ökostromverordnung”). [4]

Immediately it could be seen, that there is much more potential in photovoltaics, than previously assumed. At that time an installed capacity of 6.3 MWp was a considerable number.

Due to the capping of feed-in tariffs, the PV-market collapsed again in 2004. There were a lot of critical voices towards PV, including the Austrian Chamber of Labour, Chamber of Commerce and even energy suppliers. Thanks to some small support programmes, photovoltaics in Austria could survive at a low level. Compared to Germany, Austrians politicians did not commit themselves to the improvement of PV systems. While the PV market started booming in most European countries, the Austrian PV market remained stable for quite a long period. In 2008 the installed PV capacity in Austria was 28.4 MWp, which were 0.04% of the overall power consumption. In comparison, Germany’s installed PV capacity reached 5,000 MW. [3]

By introducing the PV funding programme of the Climate and Energy Fund (PV Förderungen des Klima- und Energiefonds) and implementing some changes to the green electricity act, the Austrian PV-market finally started to grow significantly in 2008 [4]. The funding included subsidies for feed-in tariffs for PV-systems with a capacity over 5 kWp (limited to 2.1 million euros). Additionally, an investment funding for smaller systems (< 5kWp) was introduced. [5]

It turned out quickly, that 2.1 million euros were not enough. Driven by the public debate, the funding amount was increased to 8 million euros, which turned out to still not sufficient. After just 16 minutes this funding amount was exhausted. 2.9 million euros were added and so the share of new PV-installations was doubled compared to the previous year. Nevertheless, the total number of installed capacity was still at a low level (4.6 MWp) but at least it started to grow and photovoltaics became an important topic in public debates. In addition, PV finally got enough media attention. At this time, the PV-nation Germany was a big role model but surprisingly even the Czech Republic pulled Austria away. [3]

In 2009 the funding amount was increased to 19 million euros, which was also exhausted after one day. So, it was decided to increase it even more for 2010. At the same time some federal states began to start their own funding programmes. All these actions have had its initial success – the total amount of new installed PV capacity in 2009 was 20 MWp, still not a large amount, but it was the beginning of a fast and continuous growing. [3]

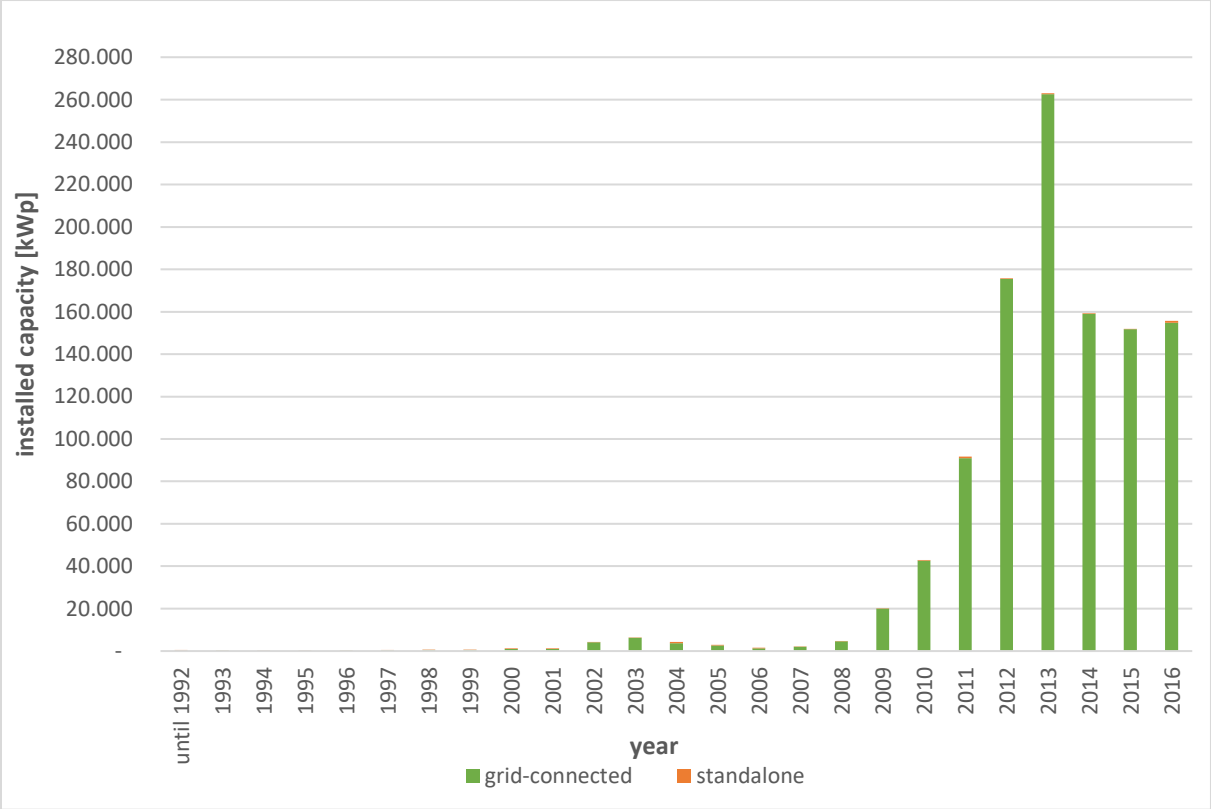

Figure 4 yearly installed PV-capacity in Austria in kWp [6]

In recent years, the total amount of the yearly installed PV capacity in Austria, was kept constant at around 150 – 160 MWp. As can be seen in Figure 4, the only exception was year 2013. Due to a one-off additional funding, the new installed capacity was around 100 MWp above the average of the previous years. [6] [7]

In 2016 the total amount of the new installed PV-capacity has increased to 155.754 kWp, which includes grid-connected plants with a total capacity of 154.802 kWp and stand-alone systems with a total capacity of approximately 952 kWp. According to the underlying data, this corresponds to 11.972 new installed PV-system in 2016. [6]

After long negotiations, the National Council has agreed upon some changes to the green electricity law ("Ökostromgesetz"), in 2017. This amendment simplifies the use of PV-systems on the top of community buildings and makes it also more economical. Since the electricity generated on the roof itself can be consumed directly by each party, network fees and taxes can be saved. [5] [8]

2.3. PV systems in operation

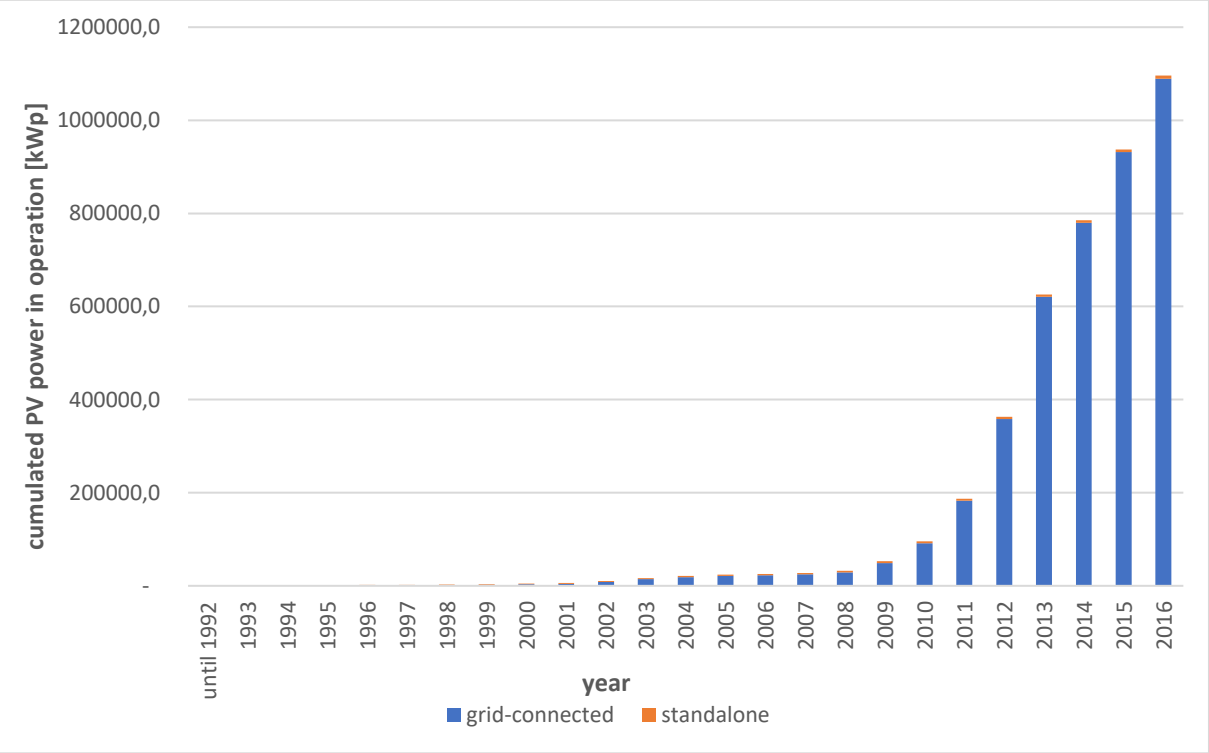

Figure 5 cumulated PV power in operation in Austria [6]

The development of the PV systems in operation can be seen in Figure 5. In 2016, the cumulated total, installed capacity increased significantly by 16.96% to 1,096MWp, compared with 2015.This includes an increase of the cumulated power of grid-connected PV systems from 931.56 MWp in 2015 to 1,089.53 MWp in 2016, and a growth of the standalone systems from 5.54MWp to 6.49MWp. [6]

Figure 6 shows the development of installed PV systems in Austria, including both, the yearly new installed capacity and also the cumulated PV power in operation.

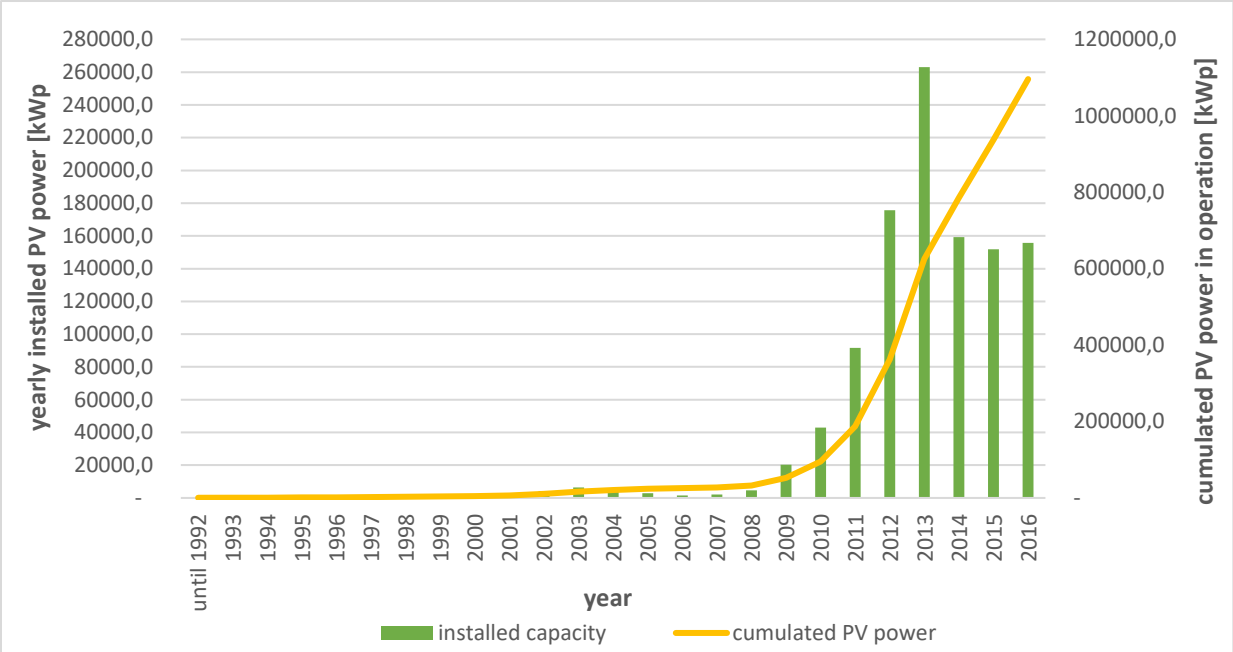

Figure 6 Development of installed PV systems in Austria until 2016 [4]

2.4. Production, import and export of PV-modules

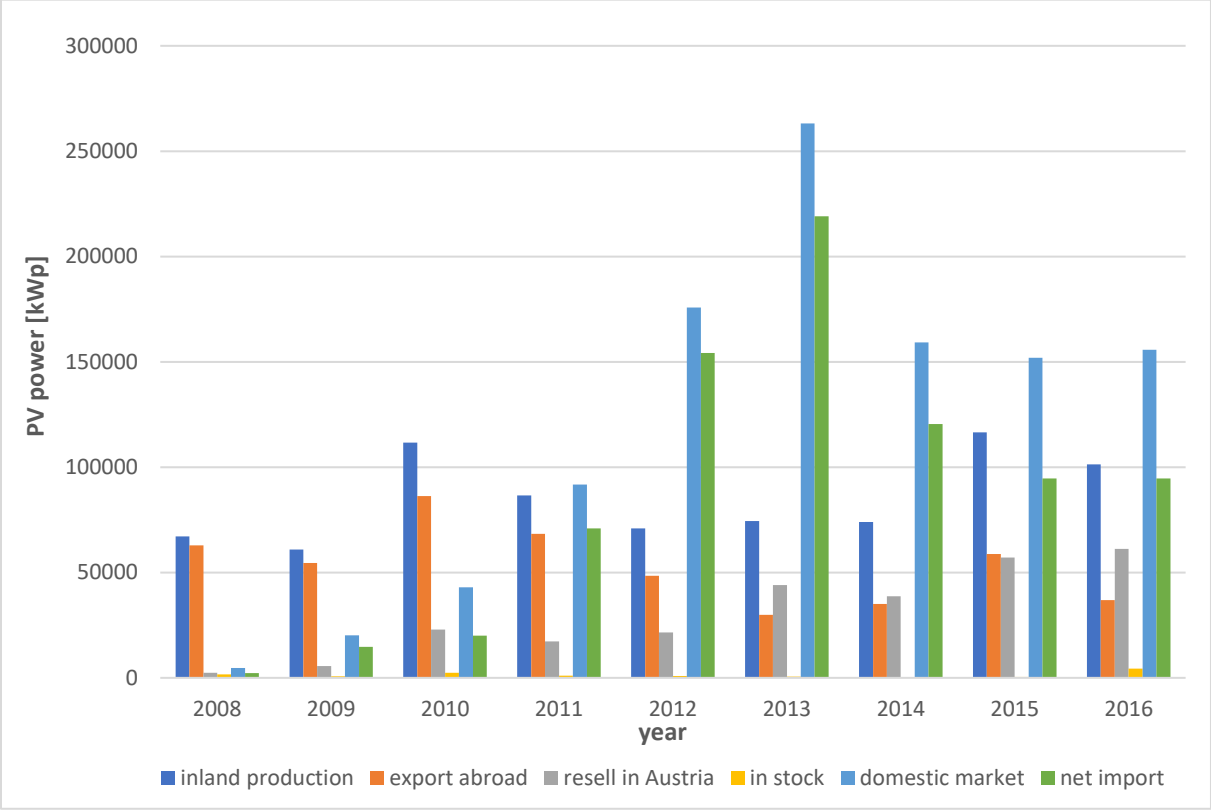

Figure 7 Austrian PV-module market since 2008 [6]

The development of the Austrian photovoltaic-module market from 2008 till 2016 is shown in Figure 7. The slow growth of the Austrian PV-market from 2009 onwards, can be recognized in the domestic market figures. One can also see the extraordinarily high amount of new installed PV capacity in 2013. Compared to former years, the inland production remained stable, so the increased demand had to be satisfied by a higher number of imports, which also show a peak in the figure. [6]

Regarding most recent figures, Table 1 shows, that the power of the produced photovoltaic modules in 2016 amounted 101.28 MWp. 36.84 MWp of this were exported, which corresponds to an export rate of 36.4%. 61.71 MWp or approximately 60.4% of the produced modules were resold in Austria. Compared to 2015, the share of the domestic production on the domestic market increased to around 39.3%. Regarding the export rate, it must be mentioned, that the survey did not analyse, which amount of this 61.71 MWp was exported through retailers. Therefore, it is likely, that the real export rate is way higher than the 36.4% of Biermayr's survey. [6]

year	2008	2009	2010	2011	2012	2013	2014	2015	2016
inland production	67084	60910	111614	86600	70890	74475	73975	116520	101280
thereof export abroad	62949	54550	86218	68284	48480	29850	35079	58850	36840
share of inland production [%]	93.8%	89.6%	77.2%	78.8%	68.4%	40.1%	47.4%	50.5%	36.4%
thereof resell in Austria	2447	5560	22941	17306	21550	44036	38746	57170	61170
share of inland production [%]	3.6%	9.1%	20.6%	20.0%	30.4%	59.1%	52.4%	49.1%	60.4%
share of domestic market [%]	52.2%	27.5%	53.5%	18.9%	12.3%	16.7%	24.3%	37.6%	39.3%
thereof in stock	1688	800	2455	1010	880	590	150	500	4430
share of inland production	2.5%	1.3%	2.2%	1.2%	1.2%	0.8%	0.2%	0.4%	4.4%
domestic market	4686	20209	42902	91674	175712	263089	159273	151851	155754
share of inland production	7.0%	33.2%	38.4%	105.9%	247.9%	353.3%	215.3%	130.3%	153.8%
net import	2239	14649	19961	70868	154162	219053	120527	94681	94584
share of domestic market	47.8%	72.5%	46.5%	77.3%	87.7%	83.3%	75.7%	62.4%	60.7%

Table 1 Austrian PV-module market since 2008, numbers in kWp [6]

2.5. Average prices of PV-systems

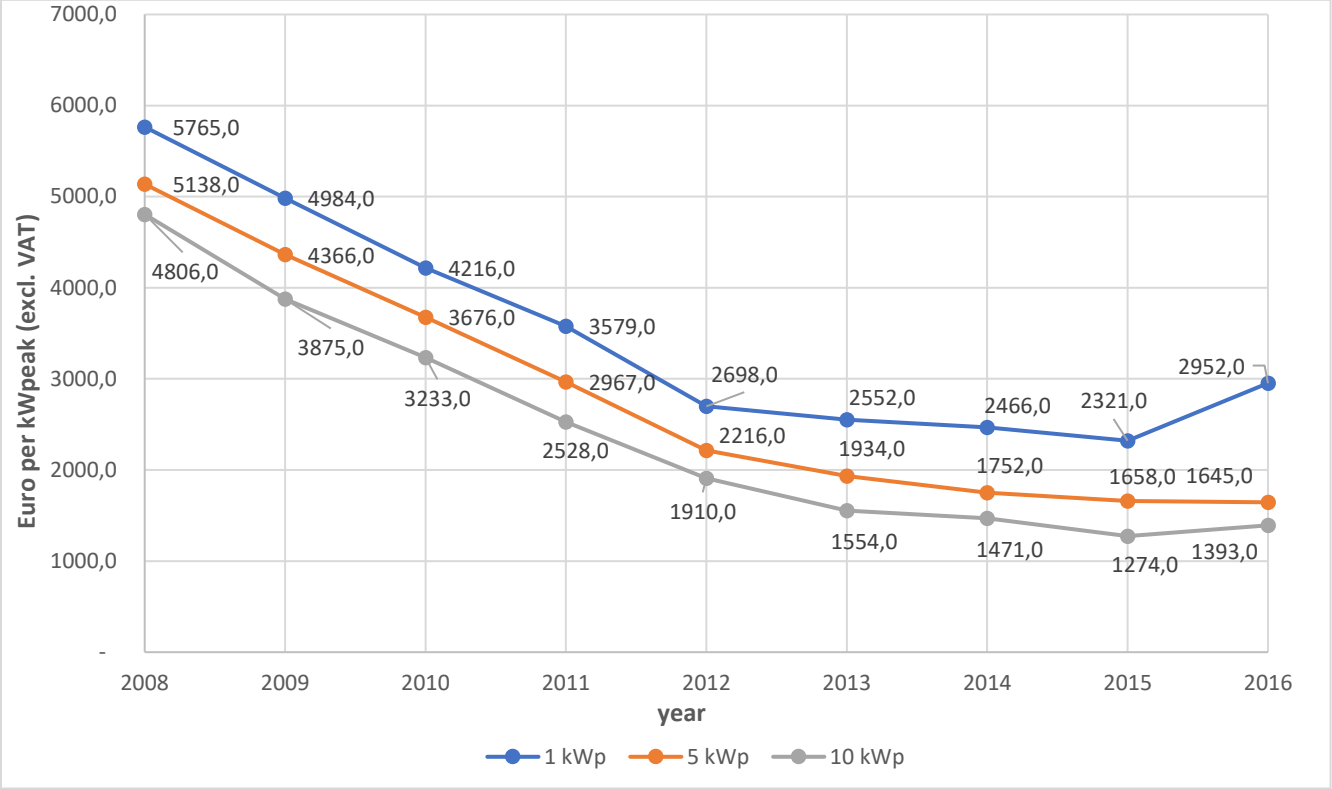

Figure 8 Specific system prices of 1 kWp-, 5 kWp- and 10kWp - PV-systems [6]

Figure 8 shows the price development of photovoltaic systems with 1kWp, 5kWp and 10kWp installed power.

The first thing to be noticed, is that the prices of all system sizes have fallen sharply until 2012/2013, from then the price curve is clearly flatter than the years before.

It can be seen, that the specific system prices are decreasing with increasing PV-system size (in terms of installed power). The costs per kWp are almost 53% lower for a system size of 10kWp, then for one with 1kWp. This gap remained roughly the same over the years.

According to the survey of Biermayr [6], the price of a 1 kWp PV-system in 2016 was around 2,952 €/kWp. This means, that the average system price of a 1 kWp PV-system increased by 27.21% compared to the year 2015. But looking at larger systems, the prices stayed approximately at the level of the prior years. [1] [6]

2.6. Funding programs in Austria

A brief history about the development of promotion strategies and their impacts on the growing PV market has already been given in Chapter 2.1. The present section describes the current situation of funding programs in Austria.

In general, two types of subsidies can be distinguished: those at a national level and those at the federal state level. Moreover, a distinction is made between private PV systems and business installations.

The following table (Table 2) shows the subsidy amounts at the national level for 2017.

	Freestanding and rooftop installations	Building integrated PV-systems
Small private PV-systems (<5kWp)	275 €/kWp	375 €/kWp
Small community systems (<5kWp/person and <30kWp together)	200€/kWp	300€/kWp
PV systems from 5kWp up to 200kWp	Investment support 30% of construction costs	

Table 2 Subsidies for PV systems at the national level for 2017 [9]

As an example, for a funding programme at the federal state level we will point out Vienna. 2017 the subsidy amount for small private PV-systems (<5kWp) was 275€/kWp and for systems with more than 5kWp capacity: 275€/kWp for the first 5kWp and after that 400€/kWp. [9]

Additionally, there are subsidies for feed-in tariffs. Figure 9 shows the development for feed-in tariffs over the time in cent/kWh. As can be noticed the subsidies are decreasing constantly to this day, the subsidy amount for the year 2018 is 7.91 cent/kWh. [8] [9]

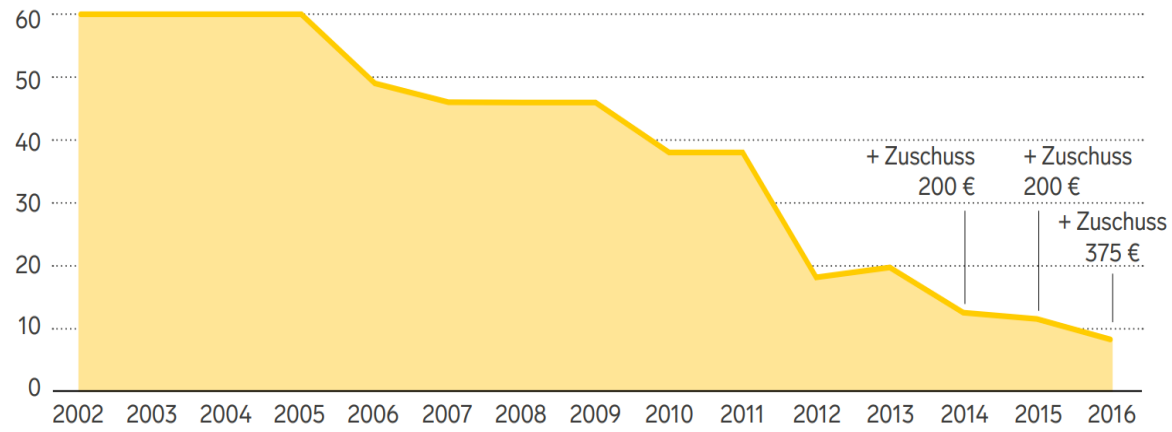

Figure 9 Development for feed-in tariffs over the time in cent/kWh [8]

3. Czech Republic

3.1. PV in Czech Republic now

Photovoltaics play an important role in Czech Republic´s electricity generation. Even though in 2016 electricity generation dropped by 132 GWh (-6%), the installed power is steadily climbing since 2011 by a few percent every year, which meant 2047 MW by the end of 2016. If we take renewables, the PV systems take 3 out of 13% of Czech Republic electricity generation. Generally, we can say that renewables have reached around 13% and stayed there for the last 3 years. Below you can see a table depicting brutto electricity generation from different energy sources for the past 10 years. [10]

Brutto electricity generation	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	88 023,8	83 516,4	82 250,0	85 900,1	87 560,6	87 573,7	87 064,9	86 003,4	83 888,3	83 301,9
Nuclear	26 172,1	26 551,0	27 207,8	27 988,2	28 282,6	30 324,2	30 745,3	30 324,9	26 840,8	24 104,2
Steam	56 728,2	51 218,8	48 457,4	49 979,7	49 973,0	47 261,0	44 737,0	44 419,3	44 816,5	45 701,1
Steam fired	2 097,8	2 431,7	2 250,8	2 349,6	2 344,4	2 200,4	2 092,8	2 204,7	2 749,0	4 049,2
Gas	375,1	681,0	974,3	1 250,8	1 610,7	2 234,7	3 179,6	3 494,4	3 574,7	3 613,8
Hydro	2 089,6	2 024,2	2 429,6	2 789,4	2 134,1	2 231,5	2 856,4	1 909,2	1 794,8	2 000,5
Pumping hydro	434,1	352,0	553,1	591,2	700,8	731,4	905,3	1 051,5	1 276,0	1 201,5
Wind	125,1	244,7	288,1	335,5	396,8	417,3	478,3	476,5	572,6	497,0
PV	1,8	12,9	88,8	615,7	2 118,0	2 173,1	2 070,2	2 122,9	2 263,8	2 131,5

Table 3: Brutto electricity generation [10]

3.2. Legislature

Up until 2001 there was no systematic support for renewables in Czech Republic to speak of. In 2002 ERÚ (Energy regulatory bureau) started to offer set buyout prices, which were valid for one year. But a serious support came for renewables in 2004 with the entry of Czech Republic into European Union (EU). Since this moment, the support for renewables was highly affected by EU policies, namely targets set for years 2010, 2020 and so on. These targets dictated how much of its electricity must a county produce from renewable resources. For Czech Republic, these targets were 8% of its consumption by 2010 and 13% by 2020. These targets were reached, thanks mainly to solar boom in 2011, which I will detail later in the paper. The goal was set as just the percentage, the means to achieving it was left to individual countries. It seems that Czech Republic made the goals, but it cost them more than it had to.

After the entry into EU there was a need to create laws, that would define how the situation around renewables was handled. They would define the state support of renewables and would implement EU´s targets into state legislature. The main law to do it was Law No. 180/2005 about the support of renewable resources. This defined what renewable resources were, what support they could get and what rights and obligations would each subject have. This law was cancelled in 2013 and was replaced by Law No. 165/2015.

Among other laws that deal with renewables are for example Law No. 586/1992, which stated that the producers with renewable resources will not pay a tax. This was true until 2011, when it was cancelled due to solar boom. Another important law is Law No. 458/2000, which deals with energy branches altogether, including renewables. This law generally states conditions for entrepreneurs in energy business. We also cannot forget document from ERÚ, that set concrete parameters for support of renewables. [11]

3.3. Types of promotion

The core mechanisms of support are fixed buyout prices or so called green bonuses. The prices of these are set by ERÚ. If a producer decides to generate electricity and supply it into the grid, he must obtain a license first. The most used type of support is the fixed buyout price. The principle is that for the lifetime of the PV system (20 years according to legislature) the producer is guaranteed a price he will get for his generated electricity. The transmission system operator or the distribution system operator is required to buy out all the electricity generated. The green bonus is mostly used when the electricity generated is consumed by the producer. Then he gets rewarded by the electricity produced.

The drawback here is that the electricity not consumed by the producer must be consumed somewhere, and the producer should find some other consumer that would do so. So, the producer has another costs, plus the risk he cannot find anyone. This is the reason why the buyout price support is much more used, even though the price is a little bit lower than the green bonus. [11]

3.4. Solar boom

Now we come to the most important event that shaped the solar energy in Czech Republic – solar boom. Thanks to legislature, we had fixed buyout prices of electricity and the prices could not drop by more than 5% each year. These prices were set by ERÚ, when they calculated the return of the investment with costs from early 2000s. But around 2008 the costs of PV panels started to drop rapidly and in two years they dropped by more than a half. You can see the price drop on the graph below.

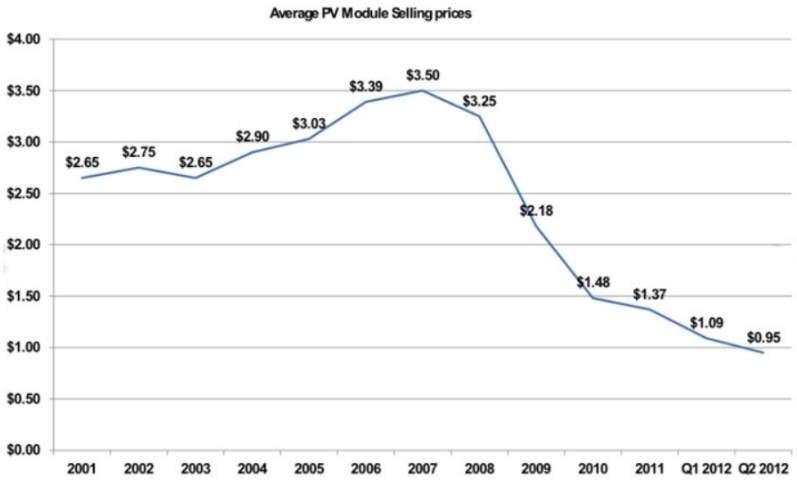

Figure 10 Price of PV modules [12]

Czech legislature was too slow to react so we had fixed buyout prices, that could not change by more than 5% and the costs that dropped by more than 50%. This situation attracted investors from around the world and caused the boom of PV systems. You can see how much the situation changed on the graphs below.

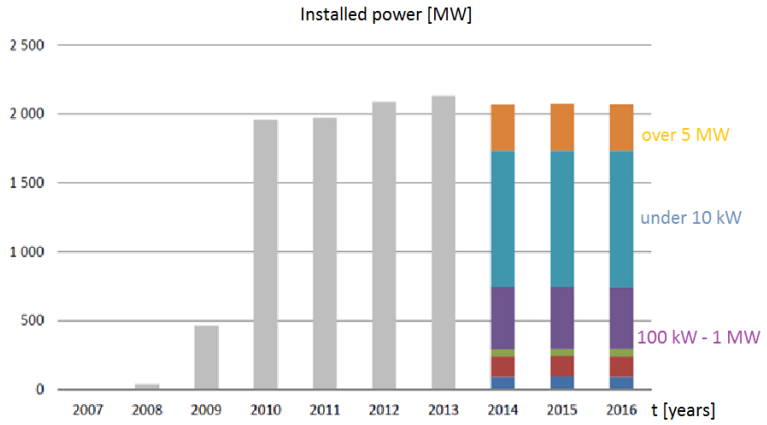

Figure 11 Installed power [10]

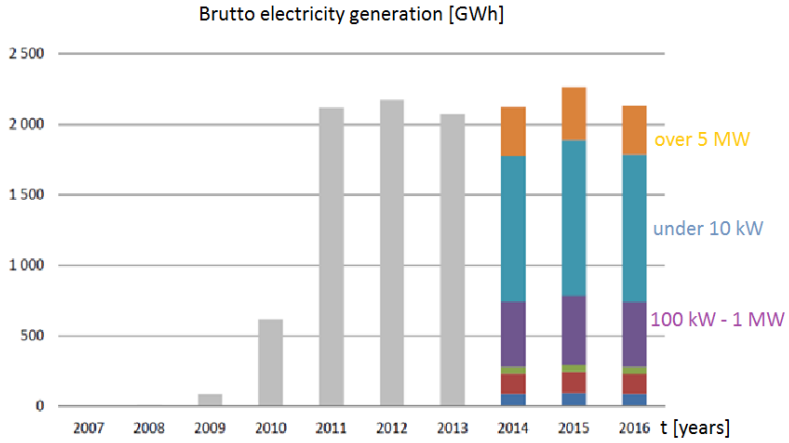

Figure 12 Electricity generation [10]

On a free market, without fixed buyout prices, such an increase in supply would mean a significant decrease in price. However, with the buyout prices, this would mean increase in costs to support renewables, and since it is the customers, who pay for it, there was a real risk of a drastic increase in prices of electricity. To prevent this, Czech Republic had to make several steps. One of those was a controversial ex post taxation of producers of electricity. This led to a lawsuit by the producers, but this was ultimately unsuccessful. Even so this led to a situation that we have today – customers pay for renewables a much higher price and the costs to state are also enormous, as we can see on the graph below.

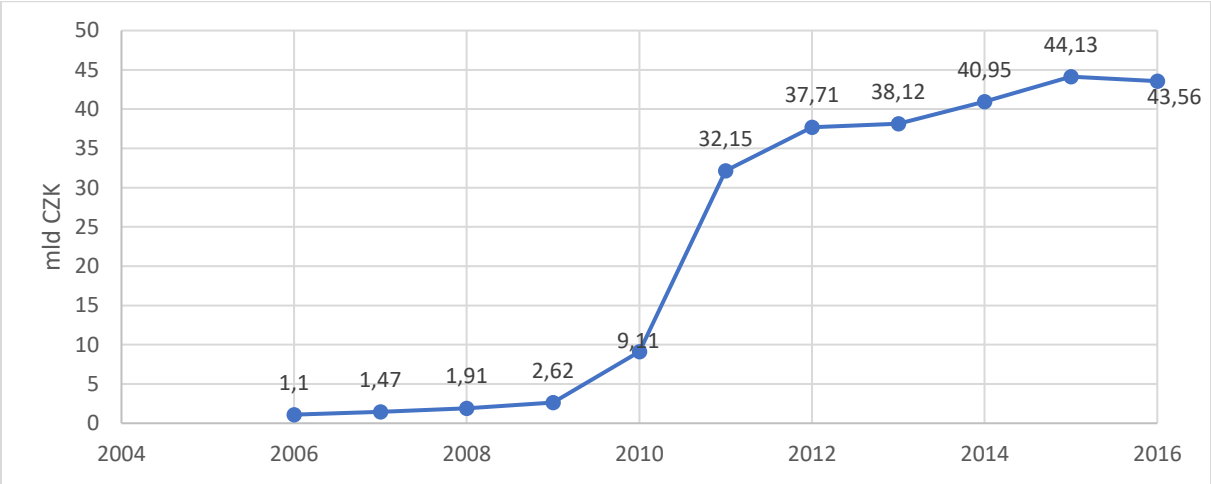

Figure 13 Cost to state [13]

We can see then why solar energy gets such a bad reputation with Czech people. They paid 28 CZK per MWh, and suddenly this price skyrocketed up to 583 CZK. This meant a huge money loss for people, especially those, who use electricity for heating. Their consumption can be around 15 MWh per year, so suddenly they had to pay several thousands more. Currently this fee is set to 495 CZK/MWh (from 2014) [14]

3.5. After solar boom

After 2011, when the buyout prices were corrected, the solar boom practically ended. You can see it in the progress of installed power, after the boom, it stayed nearly same. Only new installations were those for own consumption. This however, does not change the fact that Czech government made some commitments and it has to honour those. For the next 10 years or so, we still have to pay the buyout prices for the PV systems built in 2010.

Another issue is the tax. After the failed law suit, Czech Republic lowered the ex post tax, which was set for 26%, to the current level of 10%.

But it is not the only sign of problems we face. Since 2014, there are no subsidies, no support issued for renewable resources. Which means, that if you want to build a PV panels on your roof, you will get no help from the state, at least not for the electricity generated. Which might mean a problem for the future, because the renewables are considered a source for the

future, and if we stop supporting them now, who knows what problems that could cause going forward. [12]

3.6. Promotion strategies

Support for PV systems nowadays

Even though the support for renewables is costing state considerable sum of money, it does not mean we would stop the support altogether. But the type of support has changed, instead of subsidizing electricity generated, the state is reimbursing some of the costs to build a PV plant for lowering your own consumption. It must be said however, that EU is the source of the money put in the support. In 2017, we were given the first called named: "Nová zelená úsporám". The aim of this was mainly to test out, if there was any interest in building the PV systems. The call ended very successfully, with over 250 subjects answering the call, with the requested volume of subsidies exceeding 600 mils. CZK. We can call it a success, even though the complete volume dedicated to this matter was 2 bil. CZK. This call was unprecedented, plus it was issued at the start of summer vacation, and since the project planning and the bureaucracy take a lot of time, only the fastest ones managed to get the money. The second call is expected to reach much higher numbers.

As for the projects in the first call, the average subsidy was 2,23 mils. CZK, which means investment costs approximately 4,5 mils. CZK. If we consider only PV systems without batteries, this would correspond to PV systems with 150 kWp. [15]

2nd call for PV systems

After the success of the first call, it was only a matter of time when the second one would be issued. The window to ask for the subsidy was decided to be from January to April 2018. It was meant to be for any legal entities, no matter how big. The only exception were people located in Prague, those were excluded from the call. The subsidy promised to reimburse up to 80% of the costs, depending on the applicant.

There were a few changes made since the first call. First one was the manner of evaluation. The first ones sent were to be the first ones evaluated and if you passed the minimum requirements, you would get the subsidy, without having to wait for the end of the call. But the most important change is the increase of allowed excessive electricity that would make its way to the grid to 30% (up from 20%). [15]

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