# Photovoltaic in Lower Austria

## Comparison of different subsidy systems, possibilities and effects on employment for Lower Austria

A Master Thesis submitted for the degree of

"Master of Science"

supervised by

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Bruck/Leitha, November 2008

## Affidavit

I, Michael Hannesschläger, hereby declare

1. that I am the sole author of the present Master Thesis, “Photovoltaic in Lower Comparison of different subsidy systems, possibilities and effect on employment for Lower Austria”, 67 pages, bound and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
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## Abstract

Lower Austria wants to give impetus and enrich the development of energy production out of photovoltaic. But what are the driving aspects for Lower Austria to push photovoltaic?

- The consumption of annual electric energy has been growing for years. The “domestic production” in Lower Austria is also growing but not as fast as the consumption. So the gap between production of electric energy in Lower Austria and the demand of electricity is increasing.
- Climate change, shortage of resources and the cost development of electricity are essential parameters of the future life standards and quality of life. A sustainable electricity production is therefore a very important factor.
- “New” fast growing technologies offer a multitude of new job opportunities.

The federal government of Lower Austria has inquired whether a master thesis can compare different subsidy systems and show associated effects on the job market in Lower Austria.

A moderate development scenario of photovoltaic - 20% of the whole electricity consumption in the year 2050 - is the base assumption for the comparisons in this thesis.
Other scenarios, such as the EPIA assume that the share of PV in the year 2030[1] is about 13,8%. New forecasts assume a percentage of 12% PV in the year 2020.[2]
Out of a moderate scenario (20% in 2050) 3 different subsidy systems for Lower Austria were calculated - a pure feed-in tariff system, a mixed system out of feed-in tariffs and direct investments and a pure direct investment schema. To estimate the forecasting of the value of PV electricity three different variants were calculated. The experiences of the German EEG (job development, and costs for the state) were integrated and compared with the actual situation in Austria and Lower Austria.

[1] EPIA/Greenpeace Solar Generation V
[2] EPIA, SET for 2020, a mainstream power source in Europe by 2020

The results show that to bring a “new” and fast learning Technology forward the pure feed-in tariff system is the best. To bring stability in a fast growing market the subsidy system has to be stable and predictable. The feed-in tariff system should be located in a national act and should not be administered on a regional level of Lower Austria. Lower Austria could possibly subsidise the PV sector by giving simple, focused additional direct funding (lighthouse projects, GIPV-systems, demonstration and research plants, subsidies for education).

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# 1. Introduction

## 1.1. Motivation

The federalist system in Austria offers the nine federal states the right of self-determination in their area of competence. The renewable energy sector is supported by the state (e.g. Ökostromgesetz 2002) and the federal states have an important role in regulating and to boosting the renewable energy sector. In this context worth mentioning the duty of Co-Financing of countries in the green energy (eco electricity) law, but also the direct support systems of individual countries. Lower Austria wants to give impulses to push the photovoltaic systems in Lower Austria in the next few years and to look at possible job-effects in Lower Austria.

For many years the association Energy Park Bruck/Leitha, my current employer, has supported the implementation of renewable energy at a regional, and increasingly, at a national and international level. Despite great regional interest in photovoltaics, only few small plants have been built. The current financial subsidies for photovoltaic systems do not allow for a constant and wide regional spread of photovoltaic. Some financially attractive short-term "windows" could only be used by few people in the region.

The Administration of Lower Austria, Geschäftsstelle für Energiewirtschaft, has inquired whether a master thesis can evaluate possible subsidy systems and their job effects.

## 1.2. Core Objectives

Many experts predict that the Photovoltaic industry has a great future ahead – most importantly looking at our energy future and our energy supply PV will reduce energy costs (medium to long term).
Lower Austria wants to focus on PV and develop a consistent subsidy system. A key sign of a meaningful and sustained support is the involvement of all stakeholders (industry, trade, investors, to end consumer) and the establishment of clear guidelines.

These guidelines should help all stakeholders to bridge the period from the start up until the time the technology is cost competitive, which depends on the development of electricity prices, cost reduction of PV systems, subsidy systems and is expected to happen after a period of five to ten years. The established structures of production and maintenance should be subsidised until the technology can survive on the "free" market. At the same time the subsidy costs for the country should stay manageable and predictable. With the German EEG a framework was created, which guides the PV sector to grid parity. ("Grid parity is the point at which photovoltaic electricity is equal to grid power"[3]). The introduction of this subsidy system has started a veritable PV-boom in Germany.

In this master thesis, the experience of the EEG in Germany should be applied in order to elicit; which costs are to be expected for Lower Austria / Austria. Different subsidy systems will be compared - is the EEG Model a good option for Lower Austria? Furthermore, possible job effects will be shown. The conclusion of this research should give recommendations to the administration and local government of Lower Austria with a rough calculation of costs.

## 2. The Development of the Photovoltaic technology

In recent years Photovoltaic has made a very fast development. The worldwide production capacity has been multiplied and the technology is constantly being improved. Some future prospects of photovoltaic are pointed out in the following citation:

"The analysis performed by the Photovoltaic Technology Research Advisory Council shows that PV has the potential to deliver electricity on a large scale at a competitive cost. In 2030 PV could generate 4% electricity worldwide. However, the Council considered 2030 only as an intermediate milestone and stressed that PV would continue to grow steadily well beyond that date. It is envisaged that the technology will develop towards higher efficiency modules, cells and systems, with longer lifetimes and improved reliability, making use of new materials. Generation costs are expected to fall significantly, resulting in increased uptake and deployment both in industrialised markets and for offgrid applications in developing countries, thereby creating

[3] Wikipedia, Definition Grid Parity

employment and exports. The PV market will be highly competitive, and ensuring European leadership in this high-tech sector will require well-coordinated, concentrated and long-term efforts."[4]

Energy and photovoltaic experts consider the development of technology, the future costs for electricity from PV, the different application possibilities and the resulting development opportunities a great chance for Europe. In the forecasts for the future energy systems photovoltaic will have a central role.

## 2.1. Advantages of Photovoltaic[5]

- Flexibility in Terms of implementation
  Integrated into consumer goods or into buildings, installed as separate mobile or non- mobile modules - integration into architectural structures
- Modular set up
- Useable almost anywhere, inexhaustible
- Independence from network infrastructure ( "stand alone" or in network operation possible)
- Long life: at least 25-30 years (more 35 - 45 years), high reliability
- No mechanical wear
- Noiseless, odourless, no emissions during operation
- Production of electricity without greenhouse gas emission
- Highest yields during high cooling periods (peak loads)
- No fuel injection is required, low maintenance and high reliability
- Strengthening the security of local electricity supply (independence from fossil and nuclear Energy sources - local electricity generation, economic independence from a third party, greater economic independence)
- Positive economic aspects (high-tech economy, job effects, local value)
- High development potential cost-cutting potential,
- Efficiency gains, increased recyclability
- Complementary to other energy sources, both traditional and renewable

[4]European Community; A Vision for Photovoltaic Technology, Report by the Photovoltaic Technology Research Advisory Council (PV-TRAC), 2005
[5] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007

## 2.2. Challenges for Photovoltaic

- High initial investment
- Optimization of the Cell manufacturing, reduction of material use and the efficiencies are still far from the physical optimum
- Integration into existing electricity grid (fluctuating energy supply, regional differences).
- Efficient, safe and intelligent use of photovoltaic as a functional part of the building envelope and other architectural structures
- Dissemination about the potential of this technology.

## 2.3. Installed capacity worldwide and worldwide scenarios

"The solar electricity market is booming. By the end of 2007, the cumulative installed capacity of solar photovoltaic (PV) systems around the world had reached more than 9.200 MW, compared with 1.200 MW at the end of 2000. Installations of PV cells and modules around the world have been growing at an average annual rate of more than 35% since 1998.

Such has been the growth in the solar electricity industry that is now worth more than an annual € 13 billion."[6]

**Table 1:** Worldwide development of the annual MW Installation capacity, and the forecast from EPIA to 2010:

| Annual MW Installation Capacity | | |
|---|---|---|
| Year | Market results | forecast |
| 2001 | 334 | |
| 2002 | 439 | |
| 2003 | 594 | |
| 2004 | 1.052 | |
| 2005 | 1.320 | |
| 2006 | 1.603 | |
| 2007 | 2.392 | |
| 2008 | | 4.175 |
| 2009 | | 5.160 |
| 2010 | | 6.950 |

The table shows the dynamics of the market and the big potential for new producers, external suppliers and investors.

[6] EPIA, Solar Generation V, 2008

## 2.4. Cost development of Photovoltaic

One of the main aspects mentioned by critics in connection with the PV system is their high costs. The following table shows the module-development costs in Europe and the United States:

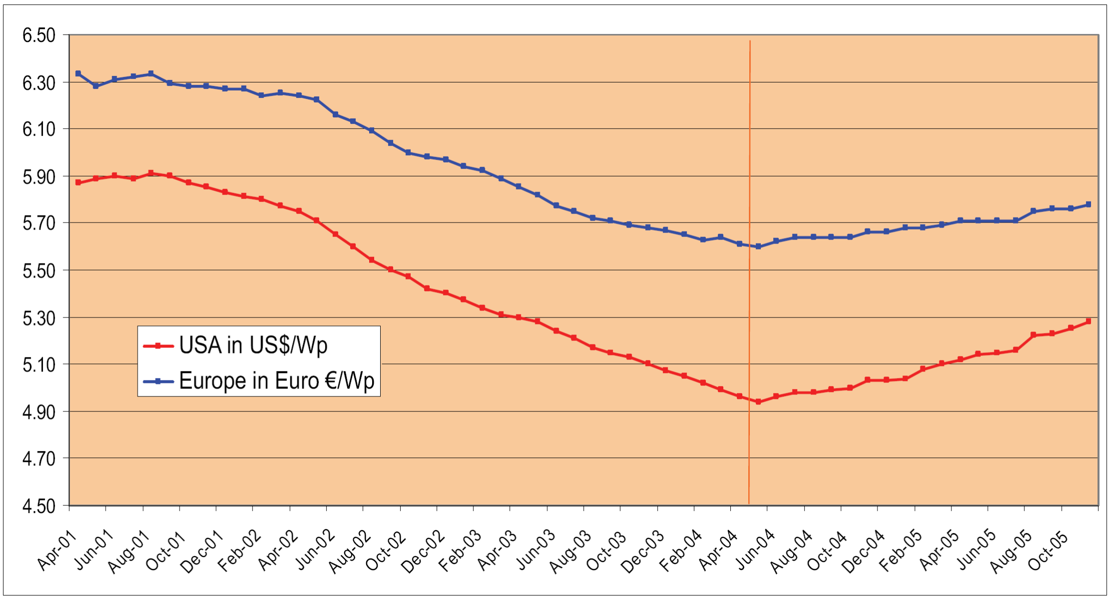


**Figure 1**: average PV Market prices in Europe and USA[7]

The average market prices for solar modules in the USA and Europe from April 2001 to October 2005 show an atypical development. New technologies normally have cost developments which follow typical learning curves (reduction of prices). Against this assumption the PV sector has shown an increase of costs since the year 2004. The shortage of pure silicon in photovoltaic quality is the main reason for the increase of module costs. But all major silicon producers currently enhance their production capacities and new producers can be expected. The bottleneck of PV modules and the high demand in some European countries (Germany, Spain, etc.) have also created a typical seller market. One trader was able to dictate the price owing to the shortage of PV modules on the market. The future development of the photovoltaic sector will be

[7] EPIA, A Strategic Research Agenda, 2007

very interesting. When will the market situation turn from a “seller to a buyer market” and at what prices will PV modules be available for the end consumer?

### 2.5. Energy payback time of Photovoltaic

An important parameter for the social acceptance and the political support (funding) of a new technology/ of a new alternative energy source is the energy payback time of the energy system. How much time an energy system takes to produce the energy amount, that is equal to the energy that was needed to produce the system. Mariska et. al. made the following calculation:
„The energy payback times were calculated for grid-connected roof-top installed PV-systems in two regions, South- and Middle Europe with annual solar irradiation of 1.700 and 1.000 kWh per square meter, respectively. The calculated Energy Payback time ranges from between 1,7 and 4,6 years, the exact figure depending on the annual irradiation and the type of silicon technology. This is already much smaller than the lifetime of PV modules, which is 30 years or more”.[8]

**Table 2:** Energy Pay-Back Time (in yr) for a grid-connected PV-system under an irradiation of 1.700 kWh/m2/yr (Southern-Europe) respectively 1.000 kWh/m2/yr (Middle-Europe).[9]

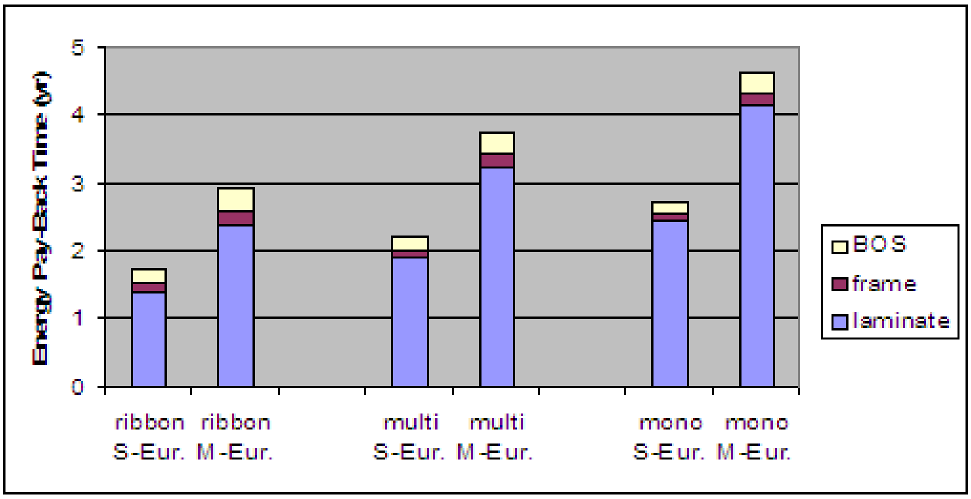


Table 2 shows the calculated energy payback time for grid-connected roof-top installed PV-systems. Three components make a PV system, (1) the laminated module, (2) the frame and (3) the inverter/cabling (Balance of System, BOS). As can be seen in table 2,

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[8] Mariska J. de Wild-Scholten, ECN Solar Energy, 2006
[9] Mariska J. de Wild-Scholten, ECN Solar Energy, 2006

the energy payback time is largely determined by energy requirements taken by the PV module laminate, i.e, encapsulated wafers on glass.

## 2.6. Grid integration of Photovoltaic

In Austria and nearly the whole of Europe the energy supply is centralised organised. Few big power plants produce electricity and this electricity is delivered to the end consumer. With the implementation of decentralised renewable power plants like wind power, cogeneration, biogas or photovoltaic the power supply structure will face a fundamental change.

"In the case of large power plants load fluctuations in the power grid are relatively easy to balance through central schemes. But who provides for the compensation, when many small producers are active? Small producers once connected to the grid, were soon forgotten. The motto was "fit and forget", which in practice meant that the small producers were taken from the grid in the slightest interference. They were not integrated, but only connected."[10]

The fact that they were only connected to the grid will cause problems when decentralised smaller power plants feed into the electricity in the low-voltage grid. The actual method to switch-off the producer will create an immediate collapse. With intelligent integration into the existing grids and new intelligent hard- and software, decentral produced electricity can be integrated rather than connected.

"A priority task must be to develop "multi-functional inverter" for voltage stability and quality of the grid. The advanced power electronics already allow this principle. In the field of technical solutions for grid integration Austria is, not at least because of its long experience in the electricity feed from small hydro power stations, perfectly established (Fronius, arsenal research, etc.)."[11]

Grid integration of photovoltaic is a main task for Research and Development. With intelligent solutions the integration and efficiency of the whole electricity grid can be increased. It is necessary to implement the outcome of research into pilot systems - grids where the technical solutions have to be tested and implemented into the existing grid.

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[10] Fechner, Solarstrom im Netz, 2008
[11] Fechner, Solarstrom im Netz, 2008

## 2.7. Potential of Photovoltaic in Austria/Lower Austria

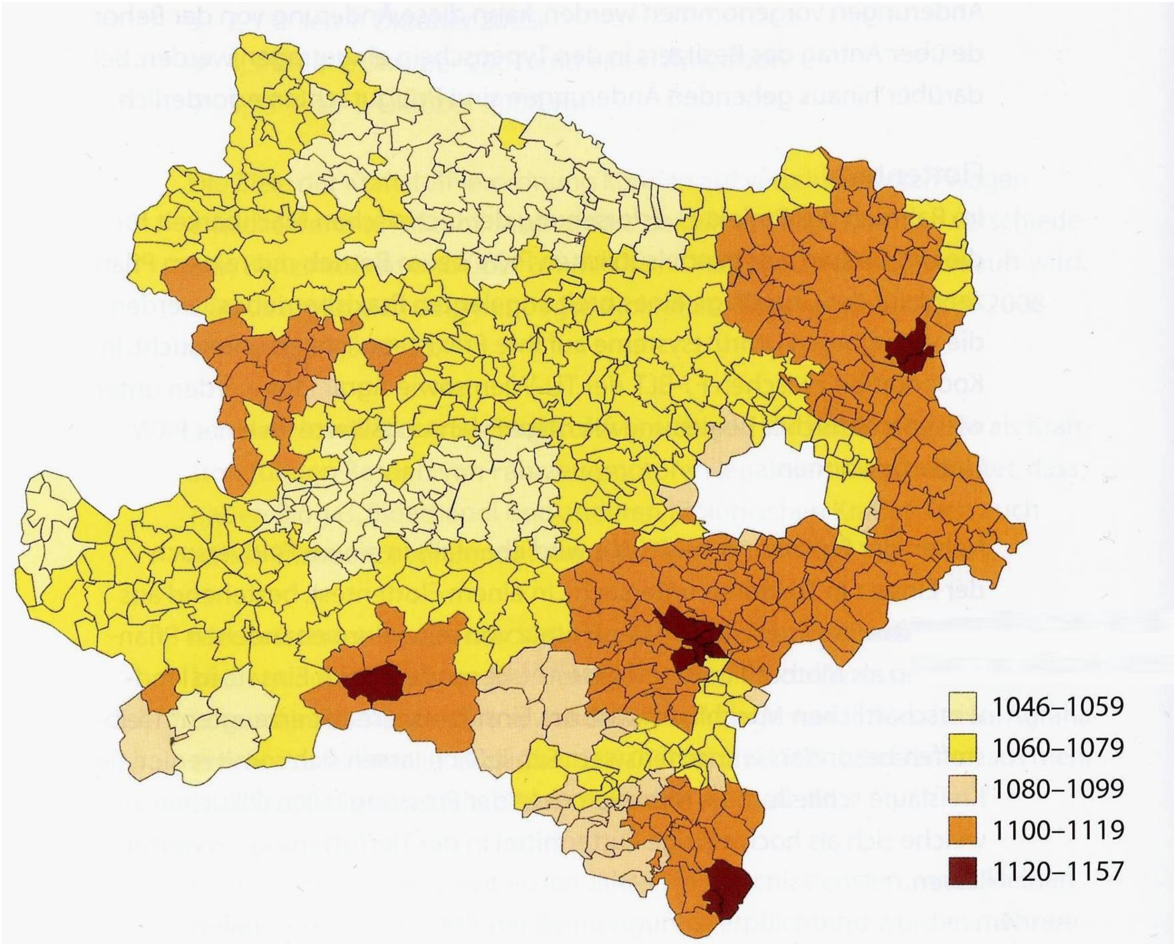


**Figure 2**: annual amount of global radiation on vertical area in Lower Austria in kWh/m²[12]

*The technical potential:*

A technical potential for PV can be estimated from available land/roofs to install PV, the regional differences in solar radiation and the used modules (efficiency, inclination, e.g.) The existing surface potential is calculated from the existing buildings and the facade as well as the available agricultural farmland.[13]

[12] G. Faninger, IFF-Klagenfurt, from NÖ Energiebericht 2007
[13] Neubarth, Kaltschmitt, 2000

In many photovoltaic potential assessments only areas with good solar radiation are included (e.g. 80% of the maximum annual national solar inputs) in the potentials. The result for Austria's surface potential in roof integrated systems is about 140 km² and in facade integrated plants about 52 km².[14]

With the current Module efficiencies of 10-12% a conservative estimation of the energy production volume is about 87.5 kWh / m² and year.
This results in a very simplified assessment of the following potential:
140 km ² + 52 km ² is 192 km ² area.
Per m² an average of 87.5 kWh / m² year can be produced, and out of these assumptions the potential is about 16.800 GWh / year.
This estimate does not consider the fact that the efficiency of the photovoltaic modules will improve (in 2050 the module efficiency of up to 20% is estimated). In addition no potential for plants to outdoor surfaces were adopted. Including these areas the potential would multiply.

Various studies show that potential in a magnitude of around 20.000 GWh per year in 2050 will be utilized. This corresponds to current energy consumption forecasts for the year 2050 with around 20% of the total energy demand at this time.

# 3. Political Framework of Photovoltaic

## 3.1. The European policy Framework[15]

At European level, several policy documents provide the background for the deployment of renewable energies in general and photovoltaics in particular:
• Green Paper towards a European Strategy for the Security of Energy Supply sets the target to double renewable energy from 6% in 1996 to 12% in 2010.
• Directive on Electricity Production from Renewable Energy Sources (RES-e) has the objective to increase the share of green electricity from 14 to 22% by 2010.

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[14] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007
[15] European Communities, A Vision for Photovoltaic Technology, 2005

European policy goals are targeted at the following:
• Increasing the diversity of energy supply sources and security of supply for Europe
• Reducing the effects on climate change
• Contributing to the sustainable economic growth of the world's economy and developing countries
• Developing a strong European high-tech industry in the field of renewable energies and ensuring its leading role in the world arena.

## 3.2. The Austrian policy framework

Photovoltaic, electricity directly converted from the sun rays, has been used in Austria since about 25 years - first, mainly in demonstration projects.
Energy companies, and later propagated in the housing and specialist simple applications without electrical grid - e.g. on houses in the mountains or as a power source in the transport sector. In Austria at the end of 2008 a total of 32,1 MW installed, which together account for about 26 GWh per year or 0.3 per mille of the total Austrian generated electricity. [16]

In Austria in 2008, installed capacity stands at 4,486 kWp (2,116 kWp in 2007), of which 4,553 kWp to estimated 1518 grid-connected systems, the remaining 133 kWp to 89 stand-alone facilities. In Austria at the end of 2008 photovoltaic installations with a total of 32,367 kWp were in operation, of which 29,030 kWp on grid-connected systems and 3,357 kWp on plants and small independent systems.[17]

### 3.2.1. Austrian Feed-In Tariff system:

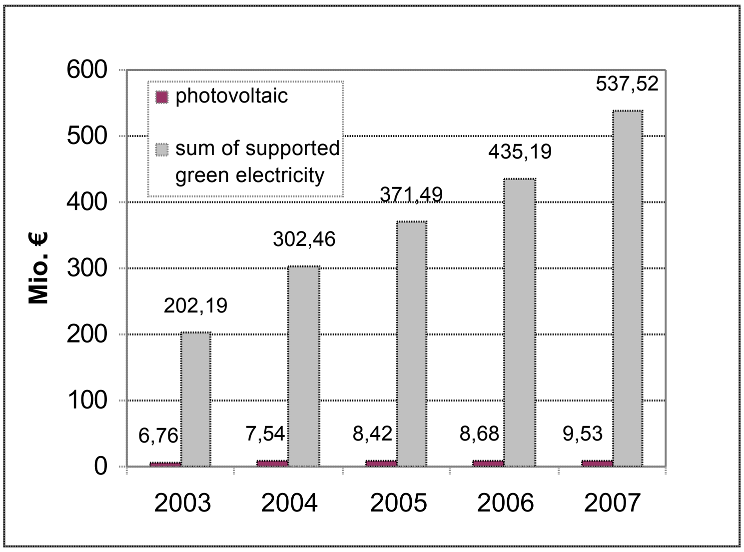
Since 2002 Austria has set up a feed-in tariff system. Before that the funding of renewable energy projects was subsidized in special programs from the state but mostly supported from the federal states.

[16] Biermayer et al., Erneuerbare Energie in Österreich, Marktentwicklung 2008
[17] Biermayer et al., Erneuerbare Energie in Österreich, Marktentwicklung 2008

**The most important actual vertices of this law:**

- Per year an additional funding volume of€ 17 million for all energy sources is available. In the year 2007 253,59 Mio€ [18] (excluding electricity market price) were spent via this feed-in tariff system.
- Photovoltaics and other green plants will receive 10% of the whole support volume.
- The duration of the guaranteed feed-In tariff is 10 years constant + 2 further years declining support.
- For Photovoltaics there is a co-financing requirement of the federal state.

**Table 3**: Subsidy volume for green electricity in Austria[19]




The table above shows the subsidy volume in Austria in the last years. The share of Photovoltaic was limited. The development of PV in Austria was shaped by this limitation. For the economic assessment the alternative costs are relevant.

**Table 4:** alternative costs market price and feed-in tariff for PV electricity in 2007 (Mio.€) [20]

| energy source | GWh | Cent/kWh feed-in tariff | Cent/kWh market price | difference Cent/kWh | Mio Euro subsidies |
|---|---|---|---|---|---|
| **photovoltaic** | 15 | 62,39 | 5,183 | 57,207 | 8,6 |
| **sum of supported green electricity** | 5.757 | | | | 239,00 |

[18] E-Control, Ökostrom, Bericht gemäß Ökostromgesetz, 2008
[19] E-control, Ökostrombericht, 2008
[20] E-control, Ökostrombericht, 2008

**Table 5:** alternative costs market price and feed-in tariff for PV electricity in 2008 (Mio€) [21]

| energy source | GWh | Cent/kWh feed-in tariff | Cent/kWh market price | difference Cent/kWh | Mio Euro subsidies |
|---|---|---|---|---|---|
| **photovoltaic** | 18 | 62,39 | 7,282 | 55,108 | 10 |
| **sum of supported green electricity** | 5.757 | | | | 216,00 |

Under the actual market price situation (strong increase) the yearly necessary alternative costs are decreasing compared to the years before. So the "funding" of photovoltaics in this market situation cause a reduction of the necessary public funds. A serious problem of the Austrian feed-in tariff system is its instability. The legislators have changed the law twice in the last 7 years. For investors, planners and the industry permanent stop and go decisions are obstructive. Under these conditions a constructive and constant development of a home market is impossible.

### 3.2.2. Actual development of the green energy law (Ökostromgesetz) in Austria (2008, 2nd amendment)

- New Photovoltaic plants with a maximum power of 5 kWp will be subsidised trough the Austrian Energy and Climate-Fonds.
- The subsidy is a direct investment and the produced electricity has to be fed into the grid. The benefit is the market price minus the balancing energy.
- For plants with a capacity over 5 kWp the energy has to be fed into the grid and the benefit is a guaranteed feed-in tariff. There will be no co-financing for the local authorities for plants with more then 5 kWp.
- The amount of the tariffs for 2009 is not fixed at the moment.

When does the amendment come into effect?[22]

- The amendment was notified
- The EU Commission has several points in mind (regulation of energy intensive companies, fuel cost component - no degression, amount of investment subsidies)

[21] E-control, Ökostrombericht, 2008
[22] Muttenthaler, Abteilung Energiewesen und Strahlenschutz des Landes NÖ, 2008

- It is very likely that the amendment has to be corrected and brought in front of the national parliament again.
- Currently the second revision is under preparation with European authorities in Brussels questioning specific aspects of the law.

## 3.3. The Lower Austrian framework situation

### 3.3.1. Co-financing system of Lower Austria

50% of the feed-in tariff for electric power from grid-connected photovoltaic systems has to be paid from the federal countries through co-financing. At the moment Lower Austria only supports plants with a maximum capacity of 5 kWp. The actual feed-in tariff by contracting in 2008 is 45.99 cents / kWh. [23]

The obligation of co-financing in Lower Austria started on the 1 October 2006. Up to the 31st of October 2008 funding commitments for 560 PV systems with a capacity of 2,500 kWp were approved. The yearly cost at the moment are at about 600.000€ under the assumption that all filed projects are going into operation. For the whole period of subsidies the costs for co-financing in Lower Austria are about 6,75 Mio€. [24]

**Table 6:** The distribution of the newly installed plants in Lower Austria in the co-financing system

| year | PV applications in Lower Austria in the Co-Financing system (numbers) | in operation | cancelled |
|---|---|---|---|
| 2006 | 120 | 81 | 11 |
| 2007 | 250 | 151 | 8 |
| 2008 | 190 | 48 | 11 |

### 3.3.2. Direct investment - subsidies in Lower Austria

The direct subsidies for photovoltaic systems are available for one-and two-family houses. The maximum possible funding goes up to € 15,000, - the funding is limited to the end of the year 2009.

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[23] Land Niederösterreich, Photovoltaikförderung, 2008
[24] Redl, Geschäftstelle für Energiewirtschaft des Landes NÖ, 2008

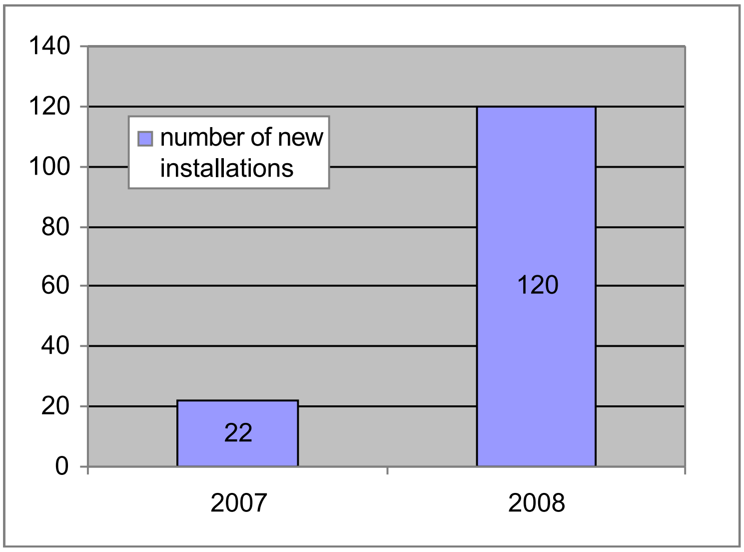
The following provisions are effective immediately:

- € 3,000 - in photovoltaic systems installed per kWp
- Maximum 4 kWp at home with a residential unit up to € 12.000, --
- High 5 kWp at home with two residential units of up to € 15.000, --

For photovoltaic systems of which the amount of funding does not exceed 50% of their investment. Since the funds come from the housing furtherance, the photovoltaic system has to be built on the plot of a block of flats.
Direct subsidies and the feed-in tariffs possibilities cannot be claimed together, but basically there is a freedom of choice between the two support models. The direct investment is limited until the 31 December 2009. An extension of collective co-financing with the direct subsidies is not possible. [25]

The actual statistic of the used direct Investments in the last 2 years:

**Table 7**: Development of PV in Lower Austria, direct Investment[26]




Lower Austria also has an additional indirect funding system of PV. If you install a housing ventilation system with hot water preparation, cooling function and the required

[25] Land Niederösterreich, Photovoltaikförderung, 2008
[26] Frank, NÖ Wohnungsförderung des Land NÖ, PV Tagung am 6.11.2008

electricity comes from a PV system, the housing ventilation will be subsidised with 1.500€.

For the actual direct investment subsidy the Lower Austrian housing furtherance is about 600.000 € for the year 2008.[27]
In Lower Austria many municipalities are members of the climate alliance and have additional funding for renewable energy projects. The funding varies between 10 up to 30% of the federal state funding. The administration is very simple: The applicant shows the confirmation for the receipt and the amount of the funding from the federal state to the municipality. After receiving this confirmation the municipality pays a percentage of the funding directly to the applicant. An additional incentive to install renewable energy plants is therefore given by the municipalities.

## 3.4. Example Erneuerbares Energie Gesetz (EEG) in Germany - figures and facts

The EEG is a great example for many countries how to support renewable energy. The following facts show the basics of this feed-in tariff system for PV:
The minimum fee for solar power installations in the year 2008 [2007/2006/2005/2004] installed is, for example, in open space, 35.49 [37.96 / 40.6 / 43.4 / 45.7] cents per kilowatt hour (kWh) fed into the grid.

- On a building or a sound barrier up to 30 kW 46.75 [49.21 / 51.80 / 54.53 / 57.4] cents / kWh,
- on a building or a sound barrier from 30 kW 44.48 [46.82 / 49.28 / 51.87 / 54.6] cents / kWh and
- on a building or a sound barrier from 100 kW 43.99 [46.30 / 48.74 / 51.30 / 54.0] cents / kWh.[28]

The salary is prorated: A roof system built in 2008 with a peak power of 40 kW will get a feed-in tariff of 46.75 cents / kWh for the first 30 kWp. For the remaining 10 kWp the subsidies will be 44.48 cents / kWh.

[27] Redl, Geschäftstelle für Energiewirtschaft des Landes NÖ, 2008
[28] Wikipedia, Erneuerbare Energie Gesetz (EEG), Photovoltaik, 2008

The feed-in tariff for an installed plant remains constant over 20 years and will continue until the end of the 20th on the commissioning date paid in the following year (e.g. until December 31, 2027 for a 2007 PV system).
The rate drops 5 percent each year (for open space installations since 2006 by 6.5 € per cent), compared to the values of the previous year, but after that the feed-in tariff is constant for the next 20 years.
A mid-2008 installed 4 kWp roof system, with an assumed yield of 850 kWh / kWp and year produces 3,400 kWh / year. When you multiply this electricity yield with the existing tariff and the duration the following calculation can be made: 20.5 years * 0.4675 € / kWh * 3,400 kWh / year = 32,600€. The actual system prices for a 4 kWp installation stand at about 20.000€.
Additionally the KfW (Bankengruppe, Kreditanstalt für Wiederaufbau) pays out loans for solar Systems. It is therefore possible to install a PV system without "free" capital for the plant. The operator, or better the subsidised person of the solar system, can also be an entrepreneur. Special tax incentives can be used and the EEG fees are net prices. So the range of user of the feed-in tariff system is extended.
For a PV facade systems there are 5 cents / kWh additional funding (up to the end of 2008). The legislature wants to make PV systems more interesting as a design element for architects and builders. Visible facade PV systems have greater multiplier effects than roof plants. Facade systems also have an image function for architects, builders and users and show their commitment to using renewable energies.
With the revision of the EEG, the feed-in tariffs are progressive for the year 2009: Installations on a building or a sound barrier, will receive up to 30 kWp 0.4301 € / kWh, up to 100 kWp 0.4091€ / kWh, up to 1 MWp 0.3958€ / kWh.
Facades will no longer be treated separately. Open spaces systems are equipped with 0.3194 € / kWh remunerated. [29]

Since the beginning of the EEG in 2000 in Germany, the share of renewable energy in primary energy consumption has increased from 2.6% to 5.8% in 2006. The total Energy consumption from renewable energies has risen from 3.8% to around 8.0% in the year 2006. As a result the share of renewable energies has doubled in the total

[29] Wikipedia, Erneuerbare Energie Gesetz (EEG), Photovoltaik, 2008

gross electricity: from 6.3% in 2000 to around 11.6% in 2006. For 2007, about 13% is expected.[30]

**Table 8:** Example EEG in Germany, Cost and Development of PV and Wind power[31]

| | **number of installed plants** | **new installed Power capacity (2006)** | **electricity production EEG (changes towards 2004)** | **CO2 Reduction** | **Paid EEG-Subsidies (changes towards 2004)** | **Investment Volume** | **Jobs created EEG** |
|---|---|---|---|---|---|---|---|
| | | **(MW)** | **(bn. kWh)** | **(Mio to)** | **(Mio. €/a)** | **(bn. EUR)** | |
| Photovoltaic (§ 11EEG) | ca. 200.000 | 2.831 | | | | | |
| of it open space | 171 | 187,6 | 2,2 (+298,6%) | 1,516 | 1.176,8 (+316%) | 4,28 | 26.900 |
| Wind energy (§ 10 EEG) | 18.685 | 20.622 (+2.224) | 30,71 (+20,4%) | 26,47 | 2.733,80 | | |
| of it repowering | | 286,8 (+140) | | | (+18,3%) | 2,9 | 82.100 |

The table above shows the impact and costs of the EEG on the production of photovoltaic and wind energy in Germany until the end of 2006. The numbers of wind were used for comparative values, because the cost of this technology currently nearly reaches grid parity to the market price.
For 1 MWh produced energy out of photovoltaics 534.91 € / MWh were spent in the EEG in 2006. In the year 2006, the market price was around 54€ / MWh (average values of the quarter figures)[32]. The comparison value for 1 MWh from wind is 89.02€ / MWh.

For the economic assessment of the EEG the alternative costs are relevant. These arise from the difference of total compensation payments (5.8 billion euros in 2006 for all renewable energies in Germany), the avoided conventional electricity of the energy companies for the produced energy out of the EEG (2.5 billion euros in 2006) and in 2006 amounted to approximately 3.3 billion euros. The resulting EEG levy (0.7 cents / kWh) is a share of less than 4% on average household electricity. For the increase of the electricity price for households in the years 2002 to 2006 the EEG is responsible for

[30] Deutsches Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Erfahrungsbericht 2007 zum EEG, 2007
[31] Deutsches Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Erfahrungsbericht 2007 zum EEG, 2007
[32] E-Control, Ökostrombericht, 2008

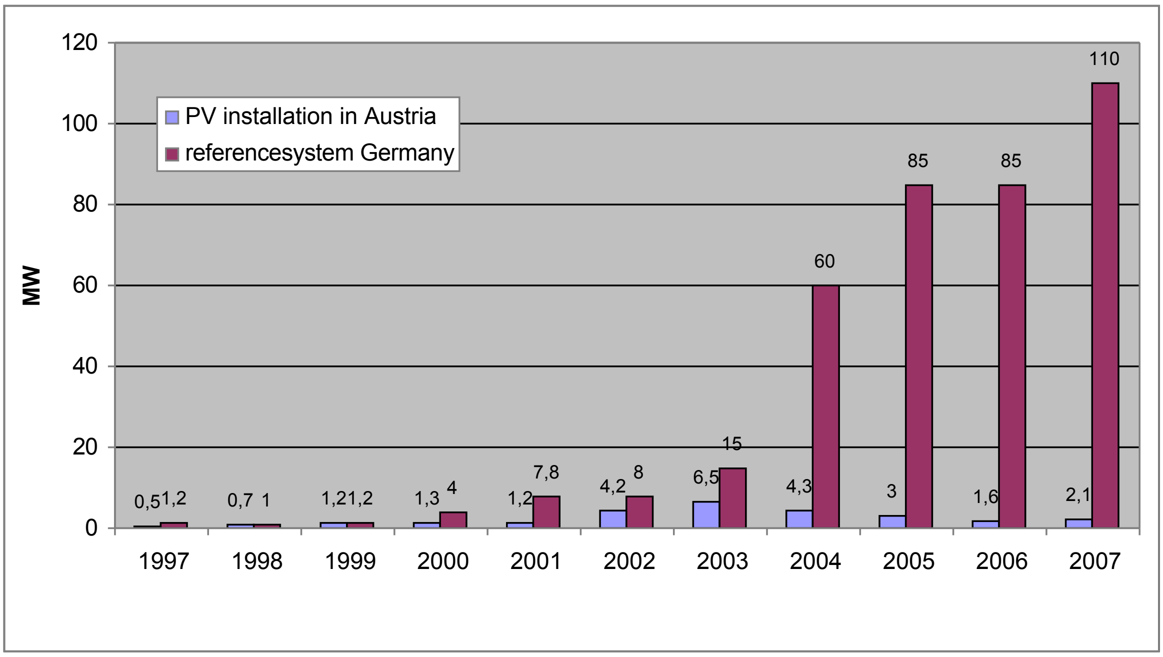
13%. 30,893 MW is the overall proportion of installed renewable energy in Germany (2006) and 2,831 MW installed capacity is the share of photovoltaic. [33]

The driving force behind the establishment of the EEG in Germany were the politicians. Individual politicians, such as Dr. Hermann Scheer, in consultation with experts from the various interest groups and environmental organizations (e.g. Greenpeace) define visions and develop them into a legislative framework cast. With the help of precise evaluations and equipped with regulatory mechanisms the law could be adjusted after two years. One example is the scaling of the new photovoltaic feed-in tariff. With this regulation, it is possible to guide photovoltaic on the market.

Another important aspect was that the information was pooled between the solar industry in the field of action and production businesses, politics and consumers. The solar associations BSI (Bundesverband Solar Industrie) and UVS (Unternehmensvereinigung Solarwirtschaft) merged in the year 2006 and formed the BSW-Solar. In Germany, the solar industry (with around 650 solar companies) is represented by the Bundesverband Solarwirtschaft (BSW-Solar). The association acts as informants, consultants and agents in the action field mentioned above and ensures security of investment growth in the solar industry. All major companies in the solar industry - from raw material suppliers and manufacturers, to trade, operators, planners and financiers are pooled in this organization and trust the expertise and communication assets of the BSW-Solar. In an annual general meeting the members have the possibility to participate and contribute to the development and the strategy of the association. The following figure shows the annual installations in Austria in comparison to the reference example with the annual growth of Germany:

[33] Deutsches Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Erfahrungsbericht 2007 zum EEG, 2007

**Table 9:** annual installations in Austria and the reference example in Germany[34]




[34] Höbarth, Klima und Energiefond, 2008

# 4. Photovoltaic - Economy and Employment

## 4.1 International

Globally, the photovoltaic sector has become a considerable industry. In Germany alone 26.900[35] new jobs in manufacturing, installation and operation of PV systems had been created in the end of 2006. Research and accompanying tasks are increasing this figure even further. Large companies such as Sharp, Kyocera, Sanyo and Mitsubishi, but also companies from the Oil business such as Shell and BP take a leading position in photovoltaics.

## 4.2. Austrian Photovoltaic Situation

Austria's population in terms of environmental awareness is among the world's leading nations. Solar and biomass installations per capita reach peak values across Europe and also worldwide. A strong home market is a good basis for a strong economic development. This is illustrated by the fact that about every third installed solar thermal collector in Europe originates from Austrian production. In contrast the Austrian PV industry depends on the basis of prevailing conditions and on the developments of international and especially German PV markets. The closeness to the German market is a major reason for the current positive employment development in the home PV industry. For several years there have been small and medium-sized PV module productions in Austria. In some production-parts (inverters, encapsulation, tracking systems) Austrian producer are international market leader or one of the top producers.

Currently, Austria finds itself in the value chain in all areas except the production of solar silicon ingots and wafers, and operates from crude silicon. Besides supply of single elements such as encapsulation transparencies, wiring and the inverter production since 2001 the production of modules (in the form of standard modules, or

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[35] Deutsches Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Erfahrungsbericht 2007 zum EEG, 2007

tiles) is part of the Austrian value in the PV production chain (roof panel, facade element, sound saving elements, transparent glazing ...). Individual companies are also excellently positioned on the world market of photovoltaic production.[36]

Examples for research and development institutes in Austria are:

- University in Salzburg, Labour of Christian Doppler
- Johannes Kepler University Linz
- Technical University Vienna, atom institute
- Arsenal research
- Technical University Vienna – Energy Economics Group

Industrial R&D is mainly undertaken by the following producers:

- The company Fronius International GmbH is currently the world-second Inverter producer
- Isovolta, as current world leader in the field of encapsulation materials
- PVT Austria in 2005 developed new modules, which cooled and modules with surface-treated glass – Lower Austria
- Ertex developing new solar PV modules - products in the field of (safety) glass facades and roof integration – Lower Austria
- SED developed in 2005, an integrated module concept for PV modules in sound barriers
- KIOTO (F&E in Lower Austria), SOLON-Hilber (200 Employees) and Energetica (about 75 employees) are 3 more innovative companies in the field of PV
- Falconcells/Lower Austria (new cell-producer), capacity: 20 MWp in the first year (Lower Austria)[37]
- Blue Chip Energy (new cell-producer), capacity: 100 MWp with 140 employees (Burgenland)[38]
- Energetica, (module producer and assembler), capacity 25 MWp with about 70 employees (Carinthia)[39]

Despite the discontinuous funding (unsteady conditions) in the Austrian home market, Austrian PV companies increase their business success significantly. The large

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[36] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007
[37] Falconcell, 2008
[38] Blue Chip Energy, 2008
[39] Energetica, http://www.energetica-pv.com/, 2008

German market nearby with its stable funding situation can largely compensate for the lack of a home market. The following table shows the production of two successful Austrian companies in the field of photovoltaic.

**Table 10**: Production capacity, Export rate from 2 successful Austrian Producer[40]

| companies | | prices | power for | export rate | year |
|---|---|---|---|---|---|
| Fronius | Inverters | 75.000 | 250 MWp | 95% | 2006 |
| Isovolta | Encapsolation | | 650 MWp | | 2005 |

Most of the cells are imported from different countries such as Germany, Spain, the United States, Taiwan or France. In 2008 a separate cell production was established in Austria. The company Falconcell Staatz / Lower Austria and Blue Chip Energy GmbH (Güssing) started a production of PV cells.

The value of exported components PV was in the "National Survey Report of PV power applications in Austria" amounted to over 440 million€. Mainly PV c ells for module production were imported with 120 million€. In an estimation based on existing studies (National Survey Report 2006, IEA, 2006; PV market study 2006, G. Faninger) values of production of PV system components, including jobs in the areas of research and development of production companies is described as following:
Currently in Austria already at least 900 jobs are expected, which are directly associated with the production, installation, research and development of PV systems and components.[41] Not included are the jobs of the new cell productions (Faconcell and Blue Chip Energy), with an estimated 180-200 new jobs.

It is very important is to have a network of people who can install, advise and act as multipliers for Photovoltaic. Arsenal Research has developed and certified an education programme for photovoltaic technicians and planners. Currently 83 people have completed this course. Out of these people 30 alumni live in Lower Austria. It is obvious that the interest in this program is increasing and the new courses were book out one and a half months before the start. Arsenal Research and "die Umweltberatung"

[40] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007
[41] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007

developed a data collection for installers and planners of Photovoltaic systems in Austria. At the moment 320 entries are collected[42]

This figures show that the trade of PV Systems is growing and there is a big group of professionals who see an attractive working area and possibilities of income in Photovoltaic systems.

One important question is what kind of jobs will be generated with the production of photovoltaic: The German Bundesverband Solarwirtschaft e.V. estimates the job distribution to the following segments:

| | |
|---|---|
| Trade | 60% |
| Wholesale trade | 10% |
| Industry | 30% |

PV offers important social benefits in terms of job creation. Significantly, much of the employment creation is at the point of installation (installers, retailers and service engineers), giving a boost to local economies. Based on information provided by the industry, it has been assumed that 10 jobs are created per MW during production and about 33 jobs per MW during the process of installation. Wholesaling of the systems and indirect supply (for example in the production process) each create 3-4 jobs per MW. Research adds another 1-2 jobs per MW. Over the coming decades, it can be assumed that these numbers will decrease as the use of automated machines will increase. This will be especially the case for jobs involved in the production process.[43]

EPIA described 2 scenarios (advanced and moderate) for the worldwide employment in PV-related jobs. In their forecasts they estimate that in the year 2030 9,9 Million (advanced scenario) and 3,7 Million (moderate scenario) people are working in PV-related jobs. In this context the question has to be raised which part of these future jobs should be in Austria?

EPIA, The European Photovoltaic Industry Association gathered together, over 4.000 scientists and about 750 companies in Valencia to present and discuss significant

[42] Fechner H., Arsenal Research, per mail 2008
[43] EPIA, Solar Generation V, 2008

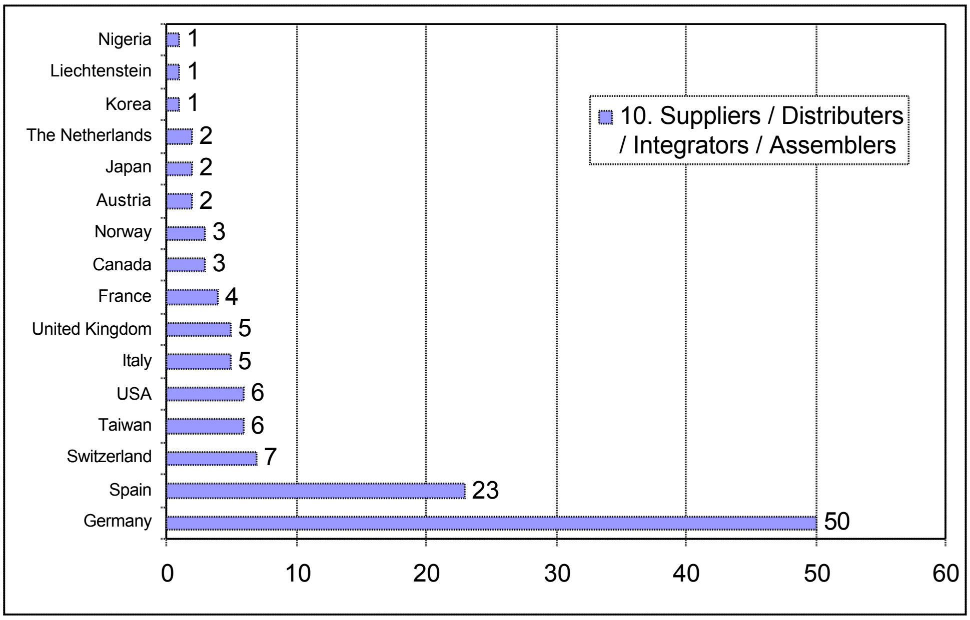
innovations in the field of the solar photovoltaic energy. The Exhibitors were listed in a catalogue which gives a good overview of the variety of companies, which operate in the PV sector. On the other side the dominating production countries and their significant coherence to good subsidy systems (feed-in tariffs) are shown. The catalogue naturally only gives a subjective picture but it gives you a good idea which, sectors and working areas photovoltaic have the potential to act as important job motors.
In Valencia more than a third of the exhibitors came from Germany (252 companies out of 716 exhibitors). Between 64 and 77 exhibitors from Spain, China and the USA were presenting their products in Valencia.[44] The EEG in Germany and the subsidies in Spain have developed a very strong home market in these countries.

Based on this data, the question arises whether there are significant differences between the individual product groups. Are there possible specializations of individual countries in the respective production groups?
Labour costs in European Countries such as Germany are similar to the ones in Austria. But is there a high dominance of companies from Asia in the area of labour intensive industries (low labour cost)?

50% of the 202 exhibitors in the category of Product Equipment Manufacturer came from Germany. In this area a significant dominance of German companies can be recognized. Similarly in the production group “supplier of materials” one third of the companies came from Germany. Materials which are difficult to produce can also be manufactured in countries with higher labour cost, but in general the parts of the production which are easily to produce will go to the origin of the raw materials.

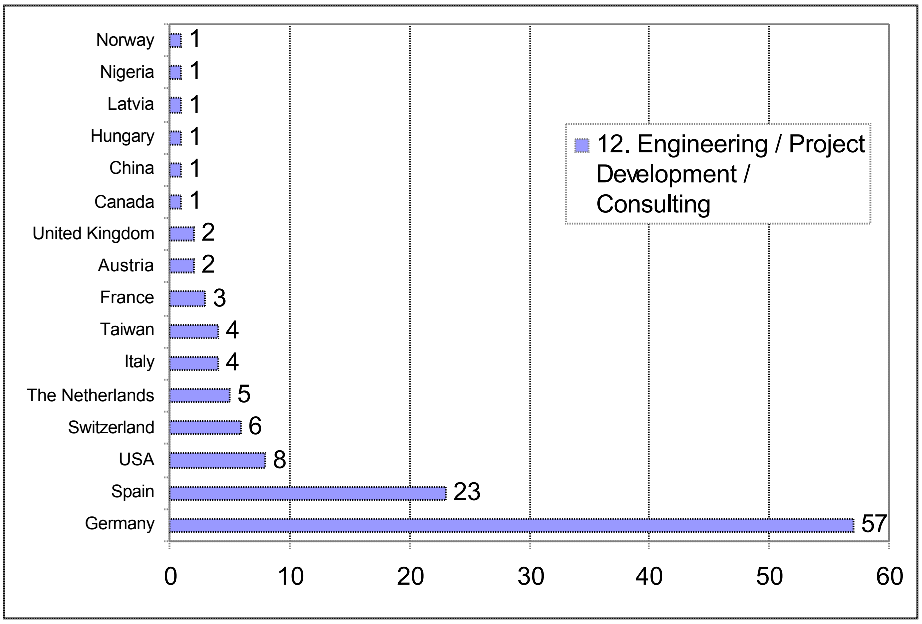
[44] 23rd European Photovoltaic Solar Energy Conference and Exhibition; Catalogue of Exhibitors, Valencia 2008

**Table 11:** Country allocation in the category Supplier / Distributors / Integrators / Assembler




In the category of Supplier / Distributors / Integrators / Assemblers (121 in total) more than 40% came from Germany. This includes typical regional work and assembling work. These parts were often manufactured in the country where the system is installed. This graph shows the typically strong installation markets in Europe. The assembling and supply is often done by regional players. But other strong companies will be established and offer their services over the whole Europe. Some suppliers install their systems in all European countries.

**Table 12:** Country allocation in the category Engineering / Project




In this category (120 in total) Germany dominates with more than 50%. A big part of the engineering and project development can be done in a centralized manner. Due to this fact companies focus on these areas and develop their businesses in this direction which in a next step will create high level jobs ideal for the future job situation in Austria. There is a long tradition of engineering of hydropower plants in Austria. These companies could possibly go into the PV engineering business.

The following can be concluded from the analysis of the exhibitor's catalogue in Valencia:
The data collection of the exhibition shows that the future job opportunities in Austria are similar to the German situation. High labour costs exclude "simple" manual working steps. Producing the materials will go to the origin of the feedstock. The area of assembling is typically regional work. This can bring new jobs, as shown in Germany. A main focus should be held on the engineering of the PV systems, which at the moment is highly dominated by the Germans. These represent high level jobs and are ideal for the future employment situation in Austria. Different niches can of course be used by single optimal working companies and bring significant job developments, but on a long-term perspective engineering and assembling will be the two major job development areas for Austria PV industry. There are strong Austrian / Lower Austrian companies which operate in "neighbouring" industries (e.g. Hydropower) and which can

include PV in their portfolio and take a place in the fast growing PV markets. The national government of Austria or directly the federal state of Lower Austria can support these companies by offering political and economic incentives.

# 5. Scenario of different support mechanism

The EPIA forecasted a scenario for the development of Photovoltaic up to the year 2030.

This scenario for the year 2030 is based on the following core inputs:

- PV market development over recent years, both globally and in specific regions
- National and regional market support programmes
- National targets for PV installations and manufacturing capacity
- The potential for PV in terms of solar irradiation, the availability of suitable roof space and the demand for electricity in areas not connected to the grid

**Table 13**: Outcome of the scenarios for 2030 made by EPIA[45]

| Global Solar Electricity Output in 2030 |
|---|
| 8.9 % of global electricity demand from PV – demand forecast from IEA Reference Scenario |
| 13.8 % of global electricity demand from PV – demand forecast from the Greenpeace Energy [R]evolution Scenario |

| Detailed Projections for 2030 | |
|---|---|
| PV systems cumulative capacity | 1,864 GW |
| Electricity production | 2,646 TWh |
| Grid-connected consumers | 1,280 million |
| Off-grid consumers | 3,216 million |
| Employment potential | 10 million jobs |
| Market value | € 454 billion per annum |
| Cost of solar electricity | € 7-13 per kWh depending on location |
| Cumulative $CO_2$ savings | 8,953 million tonnes of $CO_2$ |

It is evident that without the support of suitable instruments, the expansion of the worldwide solar electricity market will not happen at sufficient speed. In order to accelerate the reconstruction of our electricity supply system, it is necessary to implement powerful and efficient tools supporting the use of solar electricity. But for calculating scenarios with different supporting tools the electricity demand of the future has to be predicted.

To describe the scenarios, it is necessary to consider more precise parameters - the growth of electricity consumption and the development of the market price, or the development of the retail price. Currently we have an annual growth of electricity consumption in Austria. The following table was provided by the E-Control GmbH (Ökostrombericht 2008) and shows the development of gross national electricity demand in 1997 and 2007. At the same time, for 2010 and 2015 a forecast of the gross

[45] EPIA, Solar Generation V, 2008

national electricity demand was made. It shows that a moderate increase of electricity consumption is to be expected.

**Table 14:** Gross national Electricity demand, plus 1% per annum from 2008[46]

| Gross national electricity demand +1% p.a. from 2008 | | | |
|---|---|---|---|
| 1997 | 2007 | forecast 2010 | forecast 2015 |
| GWh | GWh | GWh | GWh |
| 56.083 | 70.736 | 72.879 | 76.597 |

Fechner et al (2007) developed an electricity demand scenario for the year 2050. The following figure shows the calculated assumptions of the demand scenario in Austria.

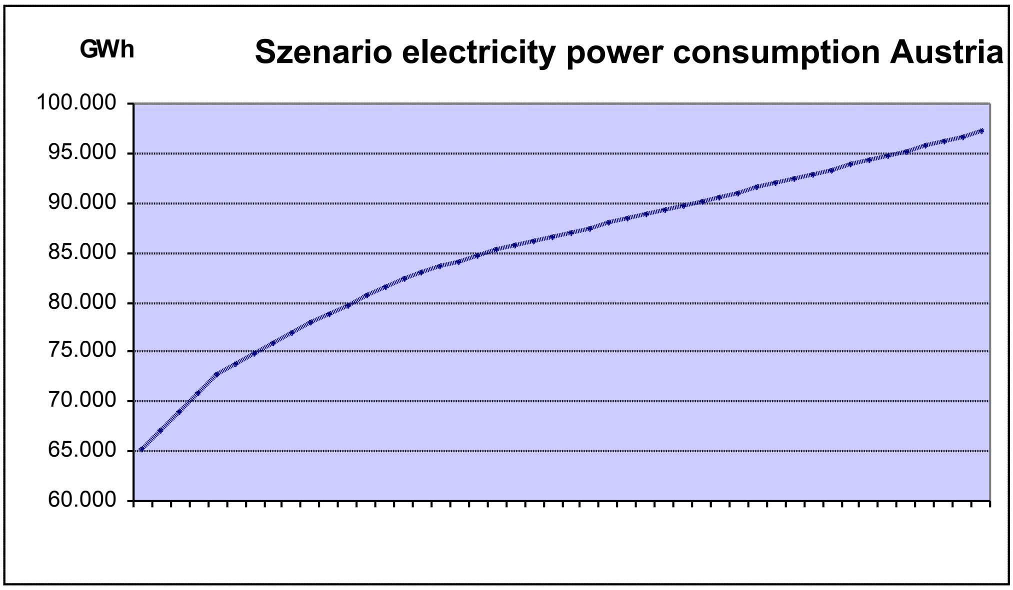



**Figure 3:** Forecast of electricity demand in Austria[47]

Out of this demand scenario a possible scenario of the future share of photovoltaic was developed. A rapprochement with the already implemented German or Japanese framework shows that the achievement of a share of at least 20% of the PV power in 2050 appears very realistic and was defined as a possible target for Austria[48]. The

[46] E-control, Ökostrombericht 2008
[47] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007
[48] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007

following table shows this scenario with 20% PV electricity in the Austrian electricity consumption.

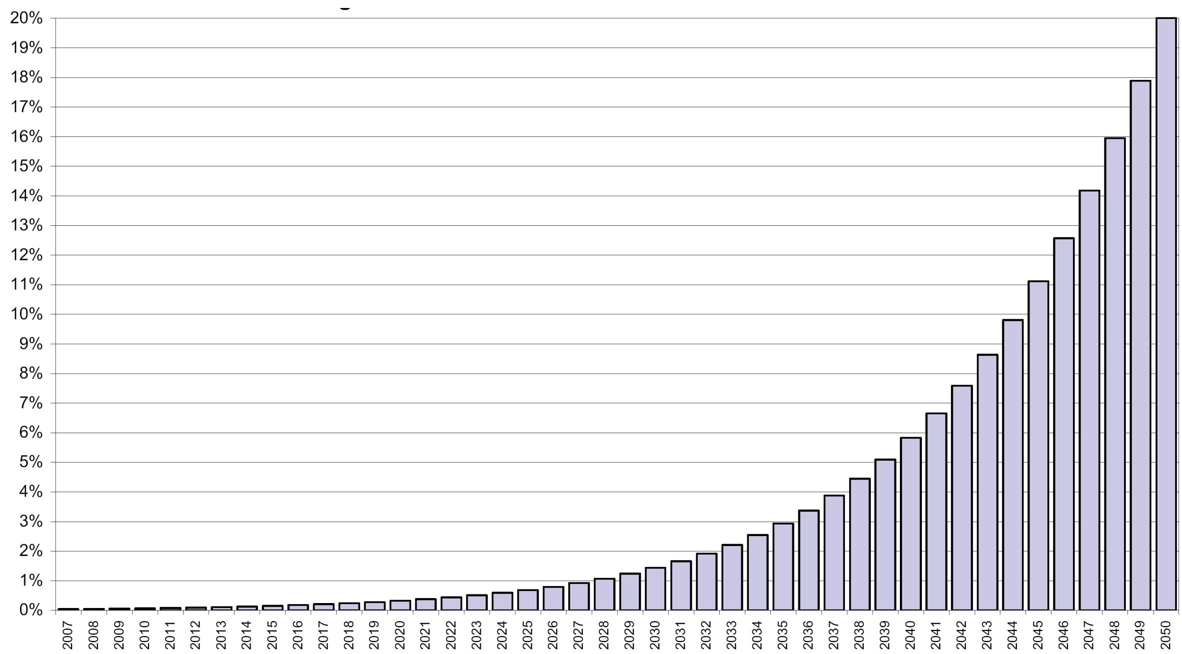



**Figure 4:** Scenario 20% PV electricity in 2050[49]

Another important factor for the cost development of the supporting systems is the prediction of the electricity prices in the future. Photovoltaic has a very high affinity to the peek load management and is characterized by a very high decentralisation of production. Therefore you have to think of different parities for the PV- systems. The comparison can be made with the actual market prices on the one hand and with the retail costs on the other hand (because of the decentralisation and the higher value of PV-electricity).

In the following graphs the development of the market prices and the retail prices in the last 5 years is shown.

[49] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007

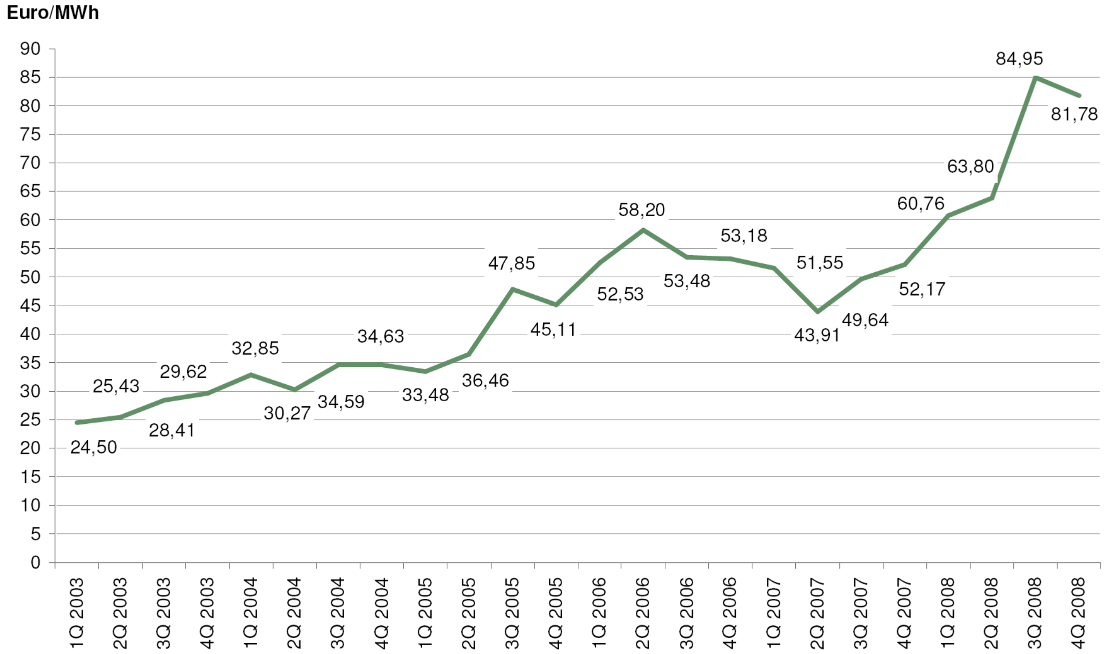



**Figure 5:** Development of the electricity market price[50]

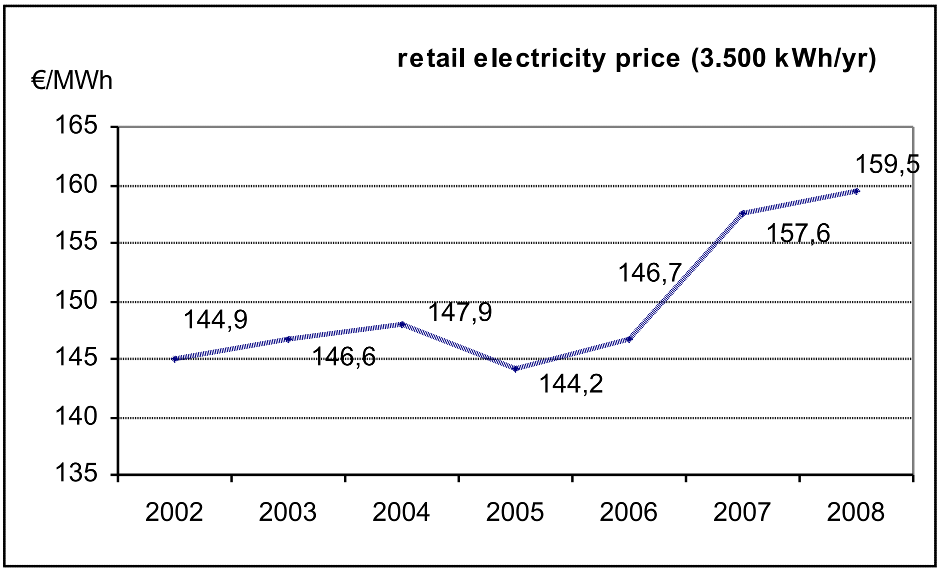



**Figure 6:** Retail prices in Austria, averaged data[51]

It is very important to calculate and estimate the energy prices of the future but at the same time a scenario for the costs for producing and installing future PV-Systems has

[50] E-control, Ökostrombericht, 2008
[51] E-control, Ökostrombericht, 2008

to be developed. The following tables give an estimation of the price of PV and the resulting costs per kWh from the EPIA. Bear in mind that the figures are expected for the Southern European regions. A solar radiation from 1,700 kWh / m² is predicted. In Lower Austria, the Austrian solar atlas shows values of 1,000 - 1,200 kWh / m². The following table summarises the key targets of the EPIA written in the SRA in 2007[52]:

**Table 15:** Scenario of the costs / kWh of PV systems[53]

| | 1980 | Today | 2015 | 2030 | Long term potential |
|---|---|---|---|---|---|
| Typical turn-key system price (2006 €/$W_p$, excl. VAT) | >30 | 5 | 2.5 | 1 | 0.5 |
| Typical electricity generation costs southern Europe (2006 €/kWh) | >2 | 0.30 | 0.15 (competitive with retail electricity) | 0.06 (competitive with wholesale electricity) | 0.03 |
| Typical commercial flat-plate module efficiencies | up to 8% | up to 15% | up to 20% | up to 25% | up to 40% |
| Typical commercial concentrator module efficiencies | (~10%) | up to 25% | up to 30% | up to 40% | up to 60% |
| Typical system energy pay-back time southern Europe (years) | >10 | 2 | 1 | 0.5 | 0.25 |

"Flat plate" refers to standard modules for use under natural sunlight, "concentrators" refer to systems that concentrate sunlight (and by necessity, track the sun across the sky).

EPIA, The European Photovoltaic Industry Association, gathered over 4.000 scientists and 750 companies in Valencia to present and discuss significant innovations in the field of the solar photovoltaic energy. Out of this development and forecasts the photovoltaic industry substantially revises its target of supplying 12% of European electricity demand by 2020.[54]

Competitiveness with retail electricity prices will be achieved earlier than expected in major energy markets. Industry is committed to increasing investment to accelerate cost reductions provided that appropriate political support is ensured in the individual member states, in harmony with the European framework, until competitiveness is

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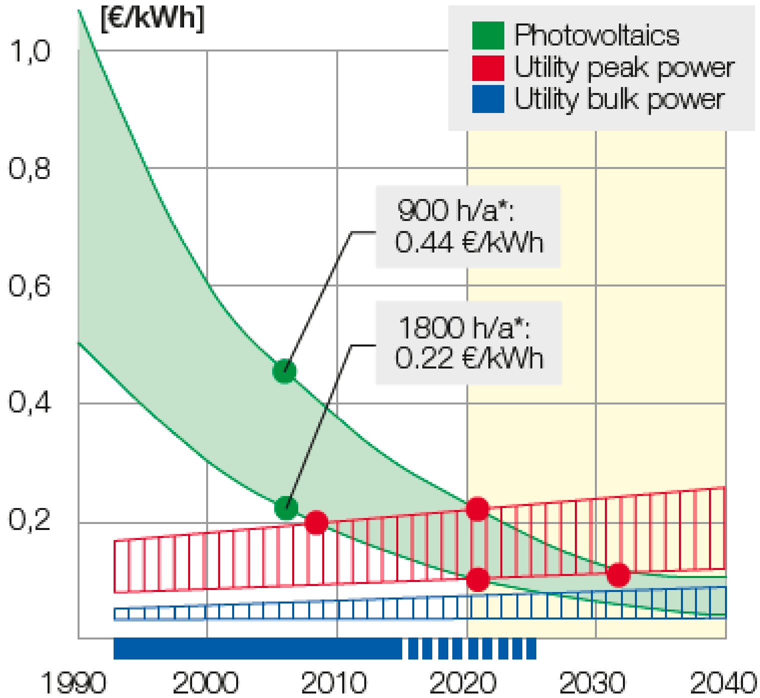
[52] EPIA, A Strategic Research Agenda, 2007
[53] EPIA, A Strategic Research Agenda, 2007
[54] EPIA, Press Release, Valencia 4th of September 2008

reached. The industry unanimously agreed that photovoltaic energy could provide 12% of European electricity demand by 2020. The evolution of solar photovoltaic technology will be quicker than previously announced. Grid parity competitiveness with retail electricity prices will be reached progressively from 2010 onwards in several European markets. Countries with the highest solar irradiation and higher electricity prices, such as Italy and Spain have the potential to reach grid parity starting in 2010 and 2012, respectively. Grid parity will be reached in Germany in 2015 and cover progressively most other EU countries up until 2020. Grid parity means that, for consumers, photovoltaic electricity will be cheaper than the expected retail electricity price.[55]
Out of their experiences of the past, assumptions and estimations of the future, the following figure shows the expected development of utility prices and PV generation costs in the future.

**Figure 7:** Development of PV utilization costs, and points of reaching grid parity[56]




*h/a: Hours of sun per annum
900 h/a corresponds to northern countries of Europe
1800 h/a corresponds to southern countries of Europe

Note: The blue band indicates that market support programmes will be necessary until about 2020 in some markets.

[55] EPIA, Press Release, Valencia 4th of September 2008
[56] EPIA, A Strategic Research Agenda, 2007

For Austria and especially for Lower Austria the reference line would be near to 900 h/y. The following graph shows the full load hours of PV systems in Austria 2007 divided up into the nine federal countries. It is important to bear in mind that very low full load hours can be a matter of new PV-installations in this year.

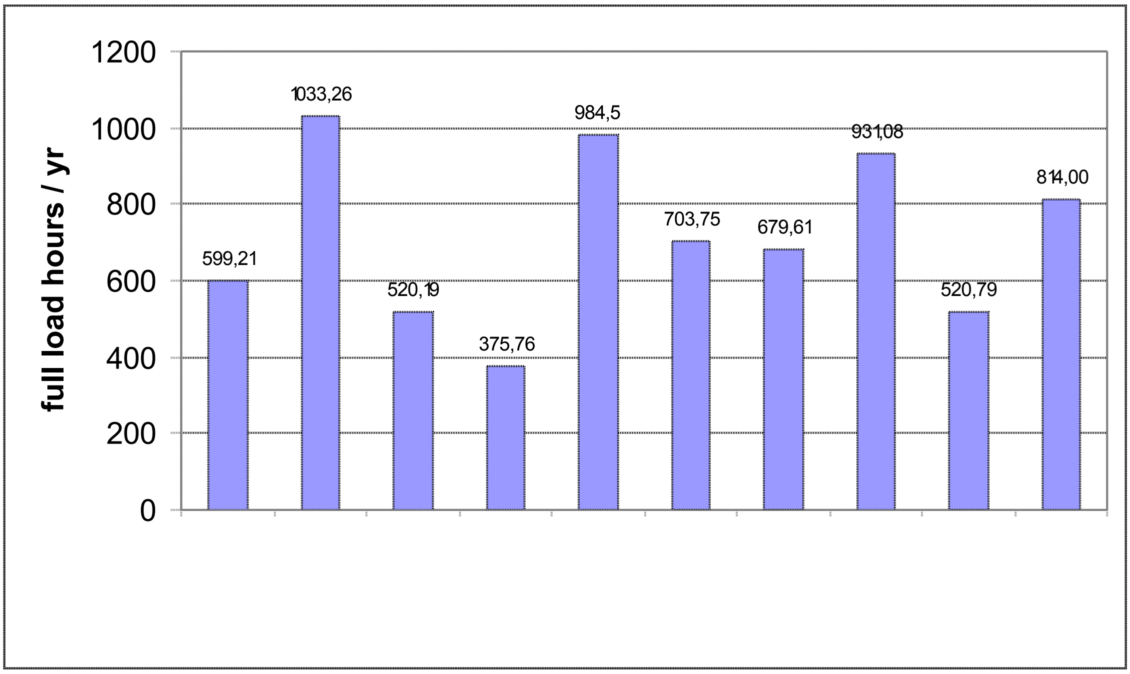



**Figure 8:** Actual full load hours in Austria and in the Federal States in 2007[57]

"Very large-scale deployment of PV is only feasible if PV electricity generation costs are drastically reduced. However, because of the modular nature of PV, the possibility to generate at the point-of-use, and the specific generation profile (overlap with peak electricity demand), PV can make use of "lead markets" on its way to eventually becoming as cheap as wholesale electricity. In particular PV may compete with peak power prices and consumer prices in the short and medium term. The corresponding PV system price targets are therefore very important for the rapid deployment of PV. Ambitious targets are also crucial for the global competitive position of the European PV industry sector. The evolution of turn-key PV system prices outlined the following figure of EPIA provides an excellent starting point to define underlying cost targets. It is noted that research and technology transfer to industry directly influences manufacturing and

[57] E-control, Ökostrombericht,2008

installation costs (as well as some other parameters), but not directly turn-key prices. The latter are also determined by market forces. Cost reduction targets are nevertheless essential to enable price reduction."[58]

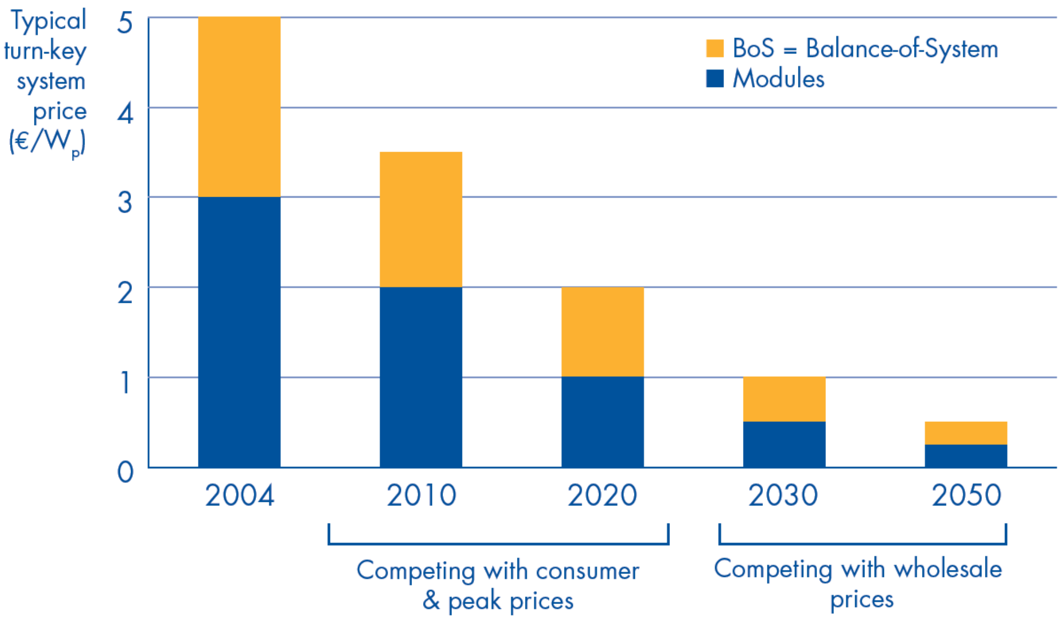



**Figure 9**: range of competitiveness of PV[59] Source EPIA; SRA

The gap between energy prices (retail and market) and the cost development of PV systems is becoming lower. As shown in the graphs before the prices for energy are increasing and the prices for PV systems are / should decrease in future. Different worldwide scenarios predict that energy generated out of PV will soon reach the retail and market prices. They only differ in the point of time when this will happen.

### 5.1. Scenario feed-in tariff

The basic idea behind a feed-in tariff is very simple.

1) Producers of solar electricity have the right to feed solar electricity into the public grid.

[58] EPIA, A Strategic Research Agenda, 2007
[59] EPIA, A Strategic Research Agenda, 2007

2) Therefore they receive a premium tariff per generated kWh reflecting the benefits of solar electricity compared to electricity generated from fossil fuels or nuclear power.
3) This premium Tariff is fixed over a period of time.

All three aspects are simple, but it took significant effort for them to be established. For many years, the power utilities have not allowed the input of solar electricity into their grid and this is still the case in many countries even today. The authority for a feed-in tariff system is the state. For Lower Austria the direct influence in this feed-in tariff system is limited. An active role is not possible.

The following figure shows the actual volume of produced electricity out of PV and the cumulated sum of green electricity in Austria:

**Table 16:** Subsidizes electricity in Austria in GWh[60]

| energy source | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2007 | 2008 forecast Aug. 2008 | 2009 forecast Aug. 2008 |
|---|---|---|---|---|---|---|---|---|---|
| Photovoltaic (GWh) | 3 | 11 | 12 | 13 | 13 | 15 | 0,03% | 18 | 20 |
| sum of supported green electricity (GWh) | 4.655 | 3.984 | 5.440 | 5.773 | 5.110 | 5.757 | 10,53% | 5.955 | 6.067 |

Feed-in tariffs are a temporary measure to develop competitiveness. Competitiveness with conventional electricity sources will be reached in different regions at different times, depending on the natural conditions (sun hours per year). Feed-in tariff systems therefore need to be adapted on national conditions. It is important that tariffs are paid over a longer period of roughly 20 years from the day the system is connected to the grid. In some years investment costs will be low enough to be paid off without using the support of premium feed-in tariffs.[61]

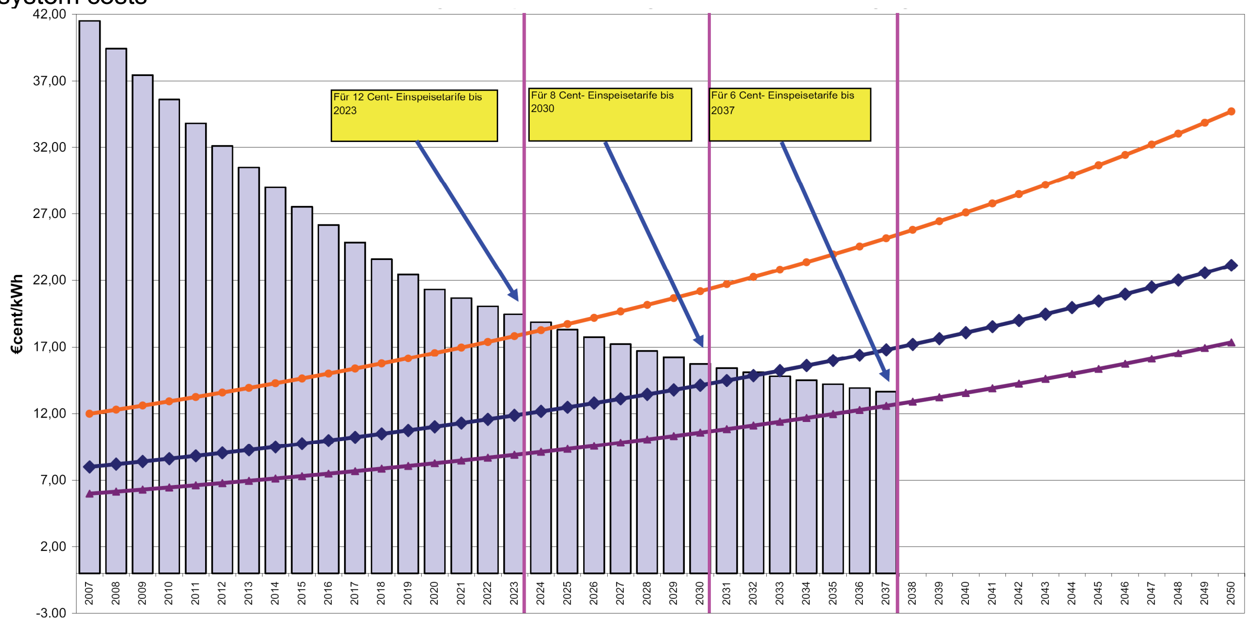
Fechner et. al (2007) define a scenario where the important parameters of the PV-development (e.g. learning curve, digression) and prognoses for energy prices are

[60] E-control, Ökostrombericht 2008
[61] EPIA, Solar Generation V, 2007

linked (3 Variants 12, 8 and 6€ct/kWh value for PV -electricity starting with the year 2006)

Based on this the costs of reaching the target of 20% photovoltaic energy in the overall consumption leads them to the following results:

**Table 17:** Scenario 20% PV in 2050; Development of feed-in tariffs in comparison to the PV system costs[62]




The main conclusion of the figure above is that the subsidy necessity is for:

- 12 €ct/kWh Scenario PV electricity needs subsidies up to the year 2023 (Variant 1),
- for the 8 €ct/kWh Scenario it lasts up to the year 2030 (Variant 2),
- and the 6 €ct/kWh Scenario up to 2037 (Variant 3).

A key factor for political decisions are the costs for the authorities or in the case of the feed-in-system the prices for the end consumers.

[62] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007

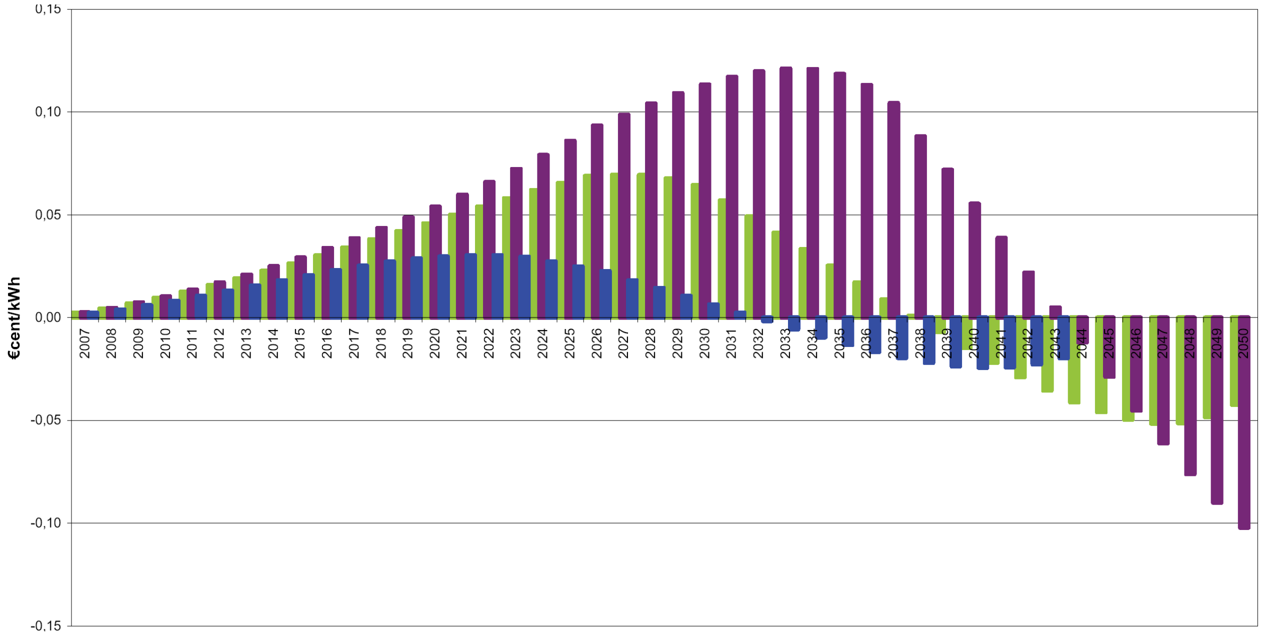



**Figure 10:** Scenario 20% PV in the year 2050, development of costs for the end consumer/Year, Scenarios: green 8 ct., blue 12 ct. and purple 6 ct.[63]

If you calculate an average household with 3.500 kWh/year the maximum costs for reaching this 20% target under the lowest energy price (Variant 3, starting with 6€ct./kWh) has to pay 4,3 €/year. Assembling the costs of the end consumer for Austria the overall cost of the feed-in tariff system is shown in the next figure:

[63] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007

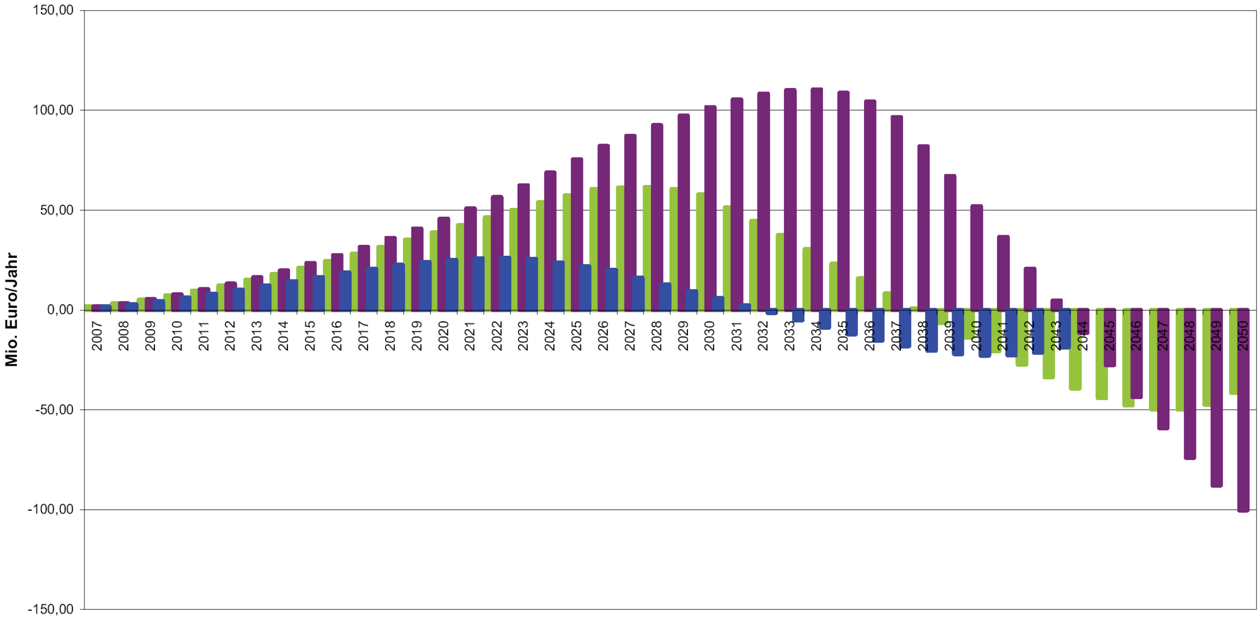



**Figure 11:** Scenario 20% PV in 2050, cumulated annual costs for the end consumer, Scenarios: green 8 ct., blue 12 ct. and purple 6 ct.[64]

Fechner et al (2007) and my own calculations shows the cost burden and cost discharge for the end consumers.

The maximum cost burdens / year are about:

26 Mio € in the year 2022 (Variant 1)

62 Mio € in the year 2028 (Variant 2)

131 Mio € in the year 2034 (Variant 3)

On the other hand there will be a maximum benefit of about:

13 Mio € in the year 2039 (Variant 1)

27 Mio € in the year 2046 (Variant 2)

70 Mio € in the year 2050 (Variant 3)

The resources needed for photovoltaic in Lower Austria are calculated (number of inhabitants) based on the figures for Austria as a whole. These figures are the basis for the following calculations and to make them comparable. The economic benefit of the time when the PV systems can produce cheaper electricity than the estimated prices is not included in the following table.

[64] Fechner et al; Technologie-Roadmap für Photovoltaik in Österreich, 2007

**Table 18:** Cumulated Volume (Mio. €) Subsidies for a feed-in System[65]

| | *Variant 1 (12€ct)* | *Variant 2 (8€ct)* | *Variant 3 (6€ct)* |
|---|---|---|---|
| **Austria** | 409,2 | 1.096,5 | 2.383,9 |
| **Lower Austria** | 81,6 | 218,7 | 475,5 |

If you look at Lower Austria's perspective only a feed-in-system cannot be implemented in their scope. But for a valid comparison of the costs it is necessary to include these parameters. The developments of the renewable energy market show that this form of subsidy system is the most effective in Europe.

### 5.1.1. Example German feed-in tariff (EEG) in Austria/Lower Austria:

In many discussions, the German EEG is mentioned and described as an example for a useful support of renewable energies. The following shows the development of photovoltaic by the EEG (like the base figures, the values used in 2006 - see Chapter 3.4.) from Germany. These experiences are applied to Austria and Lower Austria in order to show the necessary subsidy investments needed in Austria to arrive at the same monetary conditions as in Germany.

**Table 19:** Funding intensity in Austria and Lower Austria compared to the facts of the EEG 2007

| | | **PV** | | | | |
|---|---|---|---|---|---|---|
| | **Inhabitants** | **Prod. Energy/yr. GWh** | **costs/citizen €** | **Costs/MWh €** | **costs/yr €** | **New Jobs** |
| **Germany** | 82.169.000 | 2.200 | 14,32 | 534,91 | 1.176.800.000 | 26.900 |
| **Austria** | 8.032.926 | 215 | 14,32 | 534,91 | 115.045.179 | 2.630 |
| **Lower Austria** | 1.602.152 | 43 | 14,32 | 534,91 | 22.945.545 | 525 |

The costs of the EEG per capita are illustrated above. If you take these costs per capita and multiply them with the inhabitants of Austria and Lower Austria you get the costs for administration of the same model as in Germany. For Lower Austria alone the costs would be around € 23 million / year. For Austria annual costs of around € 115 million are necessary. A very interesting figure worth looking at is the amount of newly created jobs with the EEG for photovoltaic in Germany. If you assume the same success of new

[65] Fechner et al, Technologie-Roadmap für Photovoltaik in Österreich, 2007 and own calculations

jobs for Austria and Lower Austria 2.630 and 525 new jobs would be created. But especially in the sector of new jobs it is useful to look at the whole of Austria and not only at Lower Austria alone.

## 5.2. Scenario Combination feed-in tariff and direct investment

This type of subsidy system is a combination of a feed-in tariff and a direct investment system. The responsibilities are divided up between the national state and the federal states. The idea behind this mixed system is the following:
Define a fixed tariff for 20 years - assumption for this thesis is 25 €ct / kWh which is without degression. The remaining amount to make the system economically feasible, or at least close to that, is the part paid by the federal states (direct subsidy investment).

*Calculation Model:*
Database of the calculation in this model is the development of the energy prices and the generation costs of PV defined in Fechner et. al. Costs of PV modules, 3 variants of a forecast estimate and the value of photovoltaic electricity are estimated over the next years. It is a classic model with feed-in tariffs and the duration of support was adopted for 20 years. The difference to a "normal" feed-in tariff system is the combination of a fixed tariff over years and a "variable" direct investment, when building up the plant.

The following basic considerations are the basis of this funding model:

- An operation of the plant with feed-in tariffs motivates their operators to continuously maintain and optimize their plants.
- At the same time for a typical feed-in tariff system you have a very high total investment, which is often a barrier for private investors (e.g. households). Therefore, a combined system at the beginning can keep the investment costs lower.

One of the basic ideas of a well-functioning subsidy system is the fact that it has to be easy to handle. The following approach was used in this thesis:

The production cost of the photovoltaic modules will be identified and a cost development will be created (the same as in the calculation module of the feed-in tariff) - duration of the feed-in tariff is 20 years. The advantage of this system, however, is that the direct investments give a better control function in both directions - over-funding as well as sub-funding. It should be noted that money that is invested today has a higher value than if it is invested in some years to come. In a simple cash value calculation the time factor is defined[66]:

$$PV(Z_T) = Z_T / (1 + r_T)^T$$

To calculate the amount of direct investment the current value of those future payments must be calculated. Based on the cash value method and a 20 year duration with a constant yield (2.5%, is rather low in order to provide incentives) the calculation for direct subsidies is the yearly “feed-in tariff” multiplied with a factor of 12.21.

A practical example:
Assumptions:
For the year 2009 the production of 1 kWh from photovoltaic costs € 35.2 cents for 20 years to operate in an economically feasible way. The subsidy is assembled with a feed-in tariff of 25 € ct. From the difference (25 € ct minus the value of the PV electricity) for each variant (12.1 / 16.4 / 18.5 € cents) the funding costs for the federal government are allocated.
The difference of € 25 ct in the calculated model necessary feed-in tariff for the operator is 10.2 € cents. This subsidy is paid in form of direct support. Per kWp with an average annual production (mixture of a roof and facade system) of 850 kWh/yr benefit, the subsidy costs are the following: 850 * 0102 * 12.21 = 1,058 € / kWp.

In this calculation the revenue out of one kWp is estimated at 850 kWh / year. For a detailed calculation it would be useful to define different scenarios for roof and facade modules.

[66] Wikipedia, Barwert, 2008

**Table 20:** Cumulated sum of the subsidy volume feed-in tariff and direct subsidies

| | *Variant 1 (12€ct)* | | | *Variant 2 (8€ct)* | | | *Variant 3 (6€ct)* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Feed-in tariff* | direct-subsidies | sum | *Feed-in tariff* | direct-subsidies | sum | *Feed-in tariff* | direct-subsidies | sum |
| **Austria** | 370,7 | 25,0 | 395,7 | 1.035,2 | 25,0 | 1.060,3 | 1.927,2 | 25,0 | 1.952,2 |
| **Lower Austria** | 73,9 | 5,0 | 78,9 | 206,5 | 5,0 | 211,5 | 384,4 | 5,0 | 389,4 |

The table above shows the intensity of the costs of this mixed subsidy system. The overall costs for the Variant 1 for Austria would be 395,7 Mio €. The share of the Austrians federal states would be 25 Mio€ for di rect subsidies. If you calculated the sum of the feed-in tariff and the costs of the direct investment to reach 20 % of the electricity demand in the year 2050 for Lower Austria it would stand at 78,9 Mio €. In this Scenario the baseline for the value of electricity out of Photovoltaic started with 12 €ct in the year 2006. In the other 2 Variants the overall investment would be 211,5 Mio € (Variant 2) and 389,4 Mio € (Variant 3) for Lower Austria. The maximum payments for the direct investments have to be the same as in all three Variants. The direct subsidies are fixed and so the “moveable” part has to be the feed-in tariff. The maximum burden for the annual budget of implementing photovoltaic as an important part of our future electricity supply (20%) is shown in the next table:

**Table 21:** annual burden for the mixed system in Mio €

| | *Variant 1 (12€ct)* | *Variant 2 (8€ct)* | *Variant 3 (6€ct)* |
|---|---|---|---|
| **Austria** | 24,0 | 61,4 | 128,5 |
| **Lower Austria** | 4,8 | 12,3 | 25,6 |
| **Year** | 2022 | 2030 | 2036 |
| **Lower Austria direct** | 4,39 (2011) | 4,39 (2011) | 4,39 (2011) |

## 5.3. Scenario Direct investment

For a model with direct investments there are two basic questions:
Should the direct subsidy be cost neutral, offer a small benefit or should they just give incentives?

Ad  1 - cost neutral

It was noted that it will be very difficult to forecast the energy prices for the next 20 years. The base of the calculation is again the 20% scenario and the cost factor is calculated with a cash value method (see chapter 5.2.).

Ad 2 - only incentives

A second idea behind direct investments is to give people incentives and to create a situation whereby people invest not only out of economical reasons. This second idea was not taken into account in this thesis. But if you calculate the economically feasible direct investments the figures for direct incentives have to / can be lower. Which means to create a dynamic market (e.g. solar thermal in Austria) the direct investment can also be under the calculated “cost neutral” subsidies. The following table show the results of these calculations:

**Table 22:** Cumulated sum of the subsidy volume direct subsidies in Mio €

| | *Variant 1 (12€ct)* | *Variant 2 (8€ct)* | *Variant 3 (6€ct)* |
|---|---|---|---|
| **Austria** | 234,9 | 907,2 | 1.979,6 |
| **Lower Austria** | 46,8 | 180,9 | 397,7 |

The overall costs for the Variant 1 Austria would be 234,9 Mio€.  If you calculated the sum of the costs of the direct investment to reach 20 % of the electricity demand for Lower Austria in the year 2050 the result would be 46,8 Mio€. In this  scenario the baseline for the value of electricity out of Photovoltaic starts at 12 €ct in the year 2006. In the other 2 Variants the overall investment would be 180,9 Mio€ (Variant 2) and 379,7 Mio € (Variant 3) for Lower Austria. The maximum burden for the annual budget of implementing photovoltaic as an important part of our future electricity supply (20%) is illustrated in the next table:

**Table 23:** annual burden for the direct subsidy system in Mio€

| | *Variant 1 (12€ct)* | *Variant 2 (8€ct)* | *Variant 3 (6€ct)* |
|---|---|---|---|
| **Austria** | 21,5 | 60,7 | 112,3 |
| **Lower Austria** | 4,3 | 12,1 | 22,4 |
| **year** | 2017 | 2023 | 2029 |

The table above shows the calculated necessary direct subsidies.

With a direct subsidy system you have a very high flexibility to define the maximum level. In order to develop a growing industry you need a framework with stable parameters. Bearing this in mind you have to define the amount/ maximum of the direct subsidies over several years.

## 5.4. Results of the comparison of the different subsidy systems

The following table shows the results of this comparison in one table:

**Table 24:** Results of the comparison of different subsidy systems in Austria and Lower Austria

| | | 12 €ct (Variant 1) | 8 €ct (Variant 2) | 6 €ct (Variant 3) |
|---|---|---|---|---|
| | **Subsidies necessary up until** | 2023 | 2030 | 2037 |
| **national green energy law, with feed-in tariff, payment by the state**[67] | **Maximum costs** | | | |
| | Year | 2022 | 2028 | 2034 |
| | per capita and kWh (€ct) | 0,03 | 0,07 | 0,12 |
| | **cumulated maximal annual costs** | | | |
| | Year | 2022 | 2028 | 2034 |
| | Austria (Mio.€) | 26,0 | 62,0 | 130,9 |
| | Lower Austria (Mio€) | 5,2 | 12,4 | 26,1 |
| | Germany (benchmark, Mio€) | 266,0 | 634,2 | 1.339,0 |
| | **cumulated maximal annual discharge** | | | |
| | Year | 2039 | 2046 | 2050 |
| | Austria (Mio.€) | 13 | 27 | 70 |
| | Lower Austria (Mio€) | 2,6 | 5,4 | 14,0 |
| | Germany (benchmark, Mio€) | 133,0 | 276,2 | 716,0 |
| | **cumulated costs** | | | |
| | Austria (Mio.€) | 409,2 | 1.096,5 | 2.383,9 |
| | Lower Austria (Mio€) | 81,6 | 218,7 | 475,5 |
| | Germany (benchmark, Mio€) | 4.185,7 | 11.216,1 | 24.385,0 |
| | | | | |
| | **subsidies necessary up until** | 2023 | 2030 | 2037 |
| **national green energy law, with feed-in tariff and direct investment - mixed system** | **cumulated maximum annual costs** | | | |
| | Year | 2022 | 2030 | 2036 |
| | Austria (Mio.€) | 24 | 61,4 | 128,4 |
| | Lower Austria (Mio€) | 4,79 | 12,25 | 25,61 |
| | Direct Investment (Mio.€) | 4,39 (2011) | 4,39 (2011) | 4,39 (2011) |
| | Germany (benchmark, Mio€) | 245 | 628 | 1.313 |
| | **cumulated costs** | | | |
| | Austria (Mio€) sum | 395,7 | 1.060,3 | 1.952,2 |
| | Feed-in Tariff (Mio. €) | 370,7 | 1035,2 | 1927,2 |

[67] Fechner et al, Technologie-Roadmap für Photovoltaik in Österreich, 2007 and own calculations

| | | 2022 | 2030 | 2036 |
|---|---|---|---|---|
| | Direct Investment (Mio.€) | 25 | 25 | 25 |
| | Lower Austria (Mio€) | 78,9 | 211,5 | 389,4 |
| | Feed-in Tariff (Mio.€) | 73,9 | 206,5 | 384,4 |
| | Direct Investment (Mio.€) | 5 | 5 | 5 |
| | Germany (benchmark, Mio€) | 4.047,6 | 10.845,8 | 19.969,1 |
| | Feed-in Tariff (Mio.€) | 3.791,90 | 10.590,11 | 19.713,38 |
| | Direct Investment (Mio.€) | 255,73 | 255,73 | 255,73 |

| | | | | |
|---|---|---|---|---|
| | **subsidies necessary up until** | 2022 | 2030 | 2036 |
| direct investment | **cumulated maximum annual costs** | | | |
| | Year | 2017 | 2023 | 2029 |
| | Austria (Mio€) | 21,5 | 60,7 | 112,3 |
| | Lower Austria (Mio€) | 4,3 | 12,1 | 22,4 |
| | Germany (benchmark, Mio€) | 219,9 | 620,9 | 1.148,7 |
| | **cumulated costs** | | | |
| | Austria (Mio€) | 234,9 | 907,2 | 1.979,6 |
| | Lower Austria (Mio€) | 46,8 | 180,9 | 397,7 |
| | Germany (benchmark, Mio€) | 2.402,8 | 9.279,8 | 20.249,4 |

The period of time up until subsidies are necessary is nearly the same in all three systems.

The biggest difference is in the amount of the subsidies necessary over the years. In case of a pure direct subsidy system Lower Austria has a direct influence on the payment. A pure feed-in tariff system is controlled by the state and Lower Austria has hardly any influence. On the other hand taken from the experiences of the past and other countries a typical feed-in tariff system is the most promising subsidy system. The idea to combine the feed-in tariff system with a direct subsidy system is generally useful. But as illustrated in the figure above the biggest financial burden to pay is the feed-in tariff system. Only 25 Mio€ would be the share of all federal states in this system. At the same time this could be an important impulse to boost the technology because these 25 Mio€ would be necessary in the next few years. Another advantage of this mixed system is that with direct investments a limitation of costs is possible. But on the other hand the fact that this can discourage the industry to start a production line in the field of PV can be considered a disadvantage.

# 6. Possible future job development in Austria and Lower Austria

To calculate the future job development the 20% solar electricity scenario is taken as the base. For every new installed MW Photovoltaic about 48 new jobs are created.[68] In the future this average of jobs/ MW will decrease, especially in the area of production. This is why for these calculation conservative figures were taken (starting with 30 jobs/MW and then reduced to 26 jobs/MW). The impressive figures are demonstrated in the following table (see the whole list in the appendix):

**Table 25:** job development possibilities out of a 20% Scenario in 2050

| | Austria | | | Lower Austria | | |
|---|---|---|---|---|---|---|
| year | MW/year | new jobs/yr. | sum of new jobs | MW/year | new jobs/yr. | sum of jobs |
| 2010 | 4,9 | 146 | 1.264 | 1,0 | 29 | 353 |
| 2020 | 42,9 | 1.288 | 7.276 | 8,6 | 257 | 1.552 |
| 2040 | 813,5 | 21.150 | 159.760 | 162,2 | 4.867 | 36.314 |
| 2050 | 2.594,1 | 67.448 | 586.585 | 517,4 | 15.522 | 134.540 |

In the case of Lower Austria it is useful to look at the existing industries and check their readiness to step into the PV business. With the help of subsidies the establishment of the new business sector can be pushed and much higher employment can be achieved. E.g. the Upper Austrian welding company Fronius has established a department of Solar electronics for manufacturing photovoltaic inverters and has currently employed 550 people only in this quite new department.

Similarly regional clustering between companies can generate regional competence centres and create new regional jobs.

[68] EPIA, Solar Generation V, 2008

# 7. Conclusion

For the development of PV it is necessary to have a clear and stable policy framework - including an adequate market incentive policy. The experiences from different countries with funding instruments and the outcome of this thesis show that for the accelerated development of renewable energies a guaranteed feed-in tariff system is the most successful instrument in the electricity market to boost photovoltaic. A pure feed-in tariff system is controlled by the state and Lower Austria has hardly any influence.

In case of a pure direct subsidy system Lower Austria has a direct influence on the payment, but the costs for Lower Austria are very high (maximum 397 Mio€ until the year 2036). The idea to combine the feed-in tariff system with a direct subsidy system is generally useful. The main financial burden is the feed-in tariff system and additionally Lower Austria can give direct investment subsidies. Lower Austria can take a leading part to push PV in the next years to come. For Lower Austria the overall costs necessary for the next six years would be 25 Mio € (max. 4,4 Mio€ / year) . This would be an impulse to boost the technology. Another advantage of this mixed system is that with direct investments a limitation and regulation of costs is possible. On the other hand the fact that this can discourage the industry to start a production line in the field of PV (stable framework conditions) can be considered a disadvantage The complexity of a mixed system,a feed-in tariff system on a national level and the coordination of 9 federal states would be a political and administrative challenge.

*Job motor Photovoltaic*

In all calculations and studies investigated for this thesis investments in photovoltaic create a multitude of new jobs. It will be essential for Lower Austria to create a stronger home market, to develop the industry in cooperation with intensive research activities. At the moment we are lucky to be in Germany's neighbourhood. A high education standard for the professionals brings the development forward. By funding of education for companies Lower Austria can directly push the development of photovoltaic. Furthermore focused public relation can enhance the awareness of Photovoltaic – you are not afraid of something you know about.

*Size of the plants*

One major argument for Photovoltaic is decentralisation. From decentralised produced electricity a higher value range can be expected than from centrally produced energy. In the next years the gap of the economic necessary PV costs per kWh and the market or retail prices per kWh is given, but in a few years we can reach retail prices (5-10 years). The future target group for Lower Austria is the mainstream of private households. Out of marketing aspects and for decentralisation purposes it is very useful to concentrate on this target group. Once the market penetration in the segment of households is high enough, bigger applications will come along (economically feasible feed-in tariffs assumed). The framework conditions for bigger applications should also be done in the feed-in tariff system on national level.

*Marketing - lighthouse projects*

To reach the private households it is necessary to have optimised technical systems. In order to bring the ideas to the people it is necessary to establish lighthouse projects. On the other hand also the professionals have to be involved and convinced to install photovoltaic but this is only manageable with knowledge transfer. Lower Austria can increase the knowledge of the professionals by selective measure and make these people act as multiplier. By introducing regional lighthouse projects (e.g. solar cities, pilot projects in public buildings) Lower Austria can directly influence the development of special PV Systems.

*Finding the niches and synergies*

Lower Austria has a high potential in the field of niche products (e.g. building integrates photovoltaic). With direct investments for the companies or demonstration plants Lower Austria can push forward innovative systems which do not have cost optimization as their essential goal. Lower Austria has a strong industry which should be “scanned” and pushed to move into the “new” business of photovoltaics.

*Research activities*

A strong network between the industry and research is a key for innovation. Lower Austria can give direct impulses for the local employment and innovation by giving inducements (e.g. the system of the “innovation check”) for the industry and the research facilities. At the same time the strengths of the existing industry and research facilities can be provided.

*Qualification management*

An essential part for a fast growing market is the qualification of the acting professionals. These are the ambassadors of PV in front of the end consumer, especially when you think of funding in small power plant units (smaller than 5 kWp). Lower Austria can develop incentives so that SMEs start to invest in educating their staff in the field of Photovoltaic.

*Standardisation and Quality management*

To boost a growing market the standardisation and quality management of a product is essential. To make new products attractive to the mainstream, they have to be standardized and in consistently good quality. The future end consumer / user of a PV System are not technicians. Our cars are an example for this - nobody knows how the injection nozzle functions, but everyone drives a car.

*Strong and unified agency/association to represent the interests in Austria*

The examples of good structured an efficient representation of interests in Germany is the Bundesverband für Solarwirtschaft e.V. (BSW) on a national level and the EPIA on a European level. It is important is to bundle research, industry and operators/end consumer in one association and create a “one-stop-shop” for politicians, industry, research and operators.

Looking at the results of this research I would first of all recommend the federal state of Lower Austria to push for a good feed-in tariff for photovoltaic in the new national act. Feed-in tariff systems such as the example EEG are the actual best known subsidy systems for Photovoltaic to guarantee a steady and constant development. Secondly I would advise Lower Austria to give impetus and enrich the field of PV by introducing simple focused subsidies (education, F&E, lighthouse projects, etc. )

The following outstanding premises for a progressive development of the PV sector were defined by the EPIA in Valencia and show the internationally possible way of PV[69]: „The industry is committed to increasing investment levels to accelerate cost reductions, provided that the appropriate political framework is in place:

- Appropriate Feed-in Tariffs bridging the crucial period until grid parity is reached,
- Simplified administrative environment,
- Priority access to the grid,
- Implementation of the ambitious Strategic Energy Technology plan at European level to boost Research, Development and Deployment efforts.

EPIA will initiate consultation with other renewable technologies in order to coordinate efforts within a global renewable scenario. The target of 20% renewables in the European end energy mix by 2020 may be exceeded under such a cooperation scenario. More clean and distributed solar electricity means more local jobs across European regions."

[69] European Commission, EPIA, 23rd European Photovoltaic Solar Energy Conference in Valencia 2008

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## Appendix

Development of the Electricity consumption, deducted in (Fechner et.al. 2007)

| | | Austria | | Lower Austria | |
|---|---|---|---|---|---|
| **year** | **rise/year** | **GWh/year[1]** | **GWh/year[2]** | **GWh/year[3]** | **GWh/year[3]** |
| 2005 | 2,80% | 65.199 | | 13.004 | |
| 2006 | 2,80% | 67.025 | | 13.368 | |
| 2007 | 2,80% | 68.901 | 70.736 | 13.742 | 14.108 |
| 2008 | 2,80% | 70.830 | | 14.127 | |
| 2009 | 2,80% | 72.814 | | 14.523 | |
| 2010 | 1,40% | 73.833 | 72.879 | 14.726 | 14.536 |
| 2011 | 1,40% | 74.867 | | 14.932 | |
| 2012 | 1,40% | 75.915 | | 15.141 | |
| 2013 | 1,40% | 76.978 | | 15.353 | |
| 2014 | 1,40% | 78.055 | | 15.568 | |
| 2015 | 1,10% | 78.914 | 76.597 | 15.739 | 15.277 |
| 2016 | 1,10% | 79.782 | | 15.912 | |
| 2017 | 1,10% | 80.660 | | 16.087 | |
| 2018 | 1,10% | 81.547 | | 16.264 | |
| 2019 | 1,10% | 82.444 | | 16.443 | |
| 2020 | 0,70% | 83.021 | | 16.558 | |
| 2021 | 0,70% | 83.602 | | 16.674 | |
| 2022 | 0,70% | 84.187 | | 16.791 | |

| | | | |
|---|---|---|---|
| 2023 | 0,70% | 84.777 | 16.909 |
| 2024 | 0,70% | 85.370 | 17.027 |
| 2025 | 0,50% | 85.797 | 17.112 |
| 2026 | 0,50% | 86.226 | 17.198 |
| 2027 | 0,50% | 86.657 | 17.284 |
| 2028 | 0,50% | 87.090 | 17.370 |
| 2029 | 0,50% | 87.526 | 17.457 |
| 2030 | 0,50% | 87.964 | 17.544 |
| 2031 | 0,50% | 88.403 | 17.632 |
| 2032 | 0,50% | 88.845 | 17.720 |
| 2033 | 0,50% | 89.290 | 17.809 |
| 2034 | 0,50% | 89.736 | 17.898 |
| 2035 | 0,50% | 90.185 | 17.987 |
| 2036 | 0,50% | 90.636 | 18.077 |
| 2037 | 0,50% | 91.089 | 18.167 |
| 2038 | 0,50% | 91.544 | 18.258 |
| 2039 | 0,50% | 92.002 | 18.350 |
| 2040 | 0,50% | 92.462 | 18.441 |
| 2041 | 0,50% | 92.924 | 18.534 |
| 2042 | 0,50% | 93.389 | 18.626 |
| 2043 | 0,50% | 93.856 | 18.719 |
| 2044 | 0,50% | 94.325 | 18.813 |
| 2045 | 0,50% | 94.797 | 18.907 |
| 2046 | 0,50% | 95.271 | 19.002 |
| 2047 | 0,50% | 95.747 | 19.097 |
| 2048 | 0,50% | 96.226 | 19.192 |
| 2049 | 0,50% | 96.707 | 19.288 |
| 2050 | 0,50% | 97.191 | 19.384 |

[1] Fechner et al, Technologie-Roadmap für Österreich, 2007

[2] E-Control, Ökostrombericht 2008

[3] adapted Lower Austria (inhabitant key)

Job - development up to the year 2050 in a 20% Scenario in Austria and Lower Austria

| | Austria | | | Lower Austria | | |
|---|---|---|---|---|---|---|
| year | MW/year new | new jobs/yr. | sum of new jobs | MW/year | new jobs/yr. | sum of new jobs |
| 2009 | 3,9 | 117 | 1.117 | 0,8 | 23 | 323 |
| 2010 | 4,9 | 146 | 1.264 | 1,0 | 29 | 353 |
| 2011 | 6,1 | 183 | 1.447 | 1,2 | 37 | 389 |
| 2012 | 7,6 | 229 | 1.676 | 1,5 | 46 | 435 |
| 2013 | 9,5 | 286 | 1.962 | 1,9 | 57 | 492 |
| 2014 | 11,9 | 358 | 2.319 | 2,4 | 71 | 563 |
| 2015 | 14,9 | 447 | 2.766 | 3,0 | 89 | 652 |
| 2016 | 18,6 | 559 | 3.325 | 3,7 | 111 | 764 |
| 2017 | 23,3 | 698 | 4.024 | 4,6 | 139 | 903 |
| 2018 | 29,1 | 873 | 4.897 | 5,8 | 174 | 1.077 |
| 2019 | 36,4 | 1.091 | 5.988 | 7,3 | 218 | 1.295 |
| 2020 | 42,9 | 1.288 | 7.276 | 8,6 | 257 | 1.552 |
| 2021 | 50,7 | 1.520 | 8.796 | 10,1 | 303 | 1.855 |
| 2022 | 59,8 | 1.793 | 10.589 | 11,9 | 358 | 2.212 |
| 2023 | 70,5 | 2.116 | 12.705 | 14,1 | 422 | 2.635 |
| 2024 | 81,8 | 2.455 | 15.159 | 16,3 | 490 | 3.124 |
| 2025 | 94,9 | 2.847 | 18.007 | 18,9 | 568 | 3.692 |
| 2026 | 110,1 | 2.862 | 20.869 | 22,0 | 659 | 4.351 |
| 2027 | 127,7 | 3.320 | 24.190 | 25,5 | 764 | 5.115 |
| 2028 | 148,1 | 3.852 | 28.041 | 29,5 | 886 | 6.001 |
| 2029 | 171,8 | 4.468 | 32.509 | 34,3 | 1.028 | 7.029 |
| 2030 | 199,3 | 5.183 | 37.692 | 39,8 | 1.193 | 8.222 |
| 2031 | 231,2 | 6.012 | 43.704 | 46,1 | 1.384 | 9.606 |
| 2032 | 265,9 | 6.914 | 50.618 | 53,0 | 1.591 | 11.197 |
| 2033 | 305,8 | 7.951 | 58.569 | 61,0 | 1.830 | 13.027 |
| 2034 | 351,7 | 9.144 | 67.713 | 70,1 | 2.104 | 15.131 |
| 2035 | 404,4 | 10.515 | 78.228 | 80,7 | 2.420 | 17.551 |
| 2036 | 465,1 | 12.092 | 90.320 | 92,8 | 2.783 | 20.334 |
| 2037 | 534,9 | 13.906 | 104.227 | 106,7 | 3.200 | 23.534 |
| 2038 | 615,1 | 15.992 | 120.219 | 122,7 | 3.680 | 27.214 |
| 2039 | 707,4 | 18.391 | 138.610 | 141,1 | 4.232 | 31.447 |
| 2040 | 813,5 | 21.150 | 159.760 | 162,2 | 4.867 | 36.314 |
| 2041 | 935,5 | 24.322 | 184.082 | 186,6 | 5.597 | 41.911 |
| 2042 | 1.047,7 | 27.241 | 211.323 | 209,0 | 6.269 | 48.180 |
| 2043 | 1.173,5 | 30.510 | 241.833 | 234,0 | 7.021 | 55.202 |
| 2044 | 1.314,3 | 34.171 | 276.004 | 262,1 | 7.864 | 63.065 |
| 2045 | 1.472,0 | 38.272 | 314.275 | 293,6 | 8.808 | 71.873 |
| 2046 | 1.648,6 | 42.864 | 357.139 | 328,8 | 9.864 | 81.737 |
| 2047 | 1.846,5 | 48.008 | 405.147 | 368,3 | 11.048 | 92.786 |
| 2048 | 2.068,0 | 53.769 | 458.916 | 412,5 | 12.374 | 105.160 |
| 2049 | 2.316,2 | 60.221 | 519.137 | 462,0 | 13.859 | 119.018 |
| 2050 | 2.594,1 | 67.448 | 586.585 | 517,4 | 15.522 | 134.540 |

## Calculation feed-in tariff

| | Austria | | | Lower Austria | | Austria | | | | | Lower Austria | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| year | rise/year | GWh/year1 | GWh/year² | GWh/year³ | GWh/year4 | MW/year new | annual growth, installation | average harvest, roof & fassade (MWh/kWp) | annual installed in GWh | Austria sum GWh/year | MW/year | sum GWh/year | Cost covering of PV per kWh €ct | degression rate of PV development |
| 2005 | 2,80% | 65.199 | | 13.004 | | 3,0 | | | | | | | | |
| 2006 | 2,80% | 67.025 | | 13.368 | | 1,6 | | | | 21 | | | 41 | 5% |
| 2007 | 2,80% | 68.901 | 70.736 | 13.742 | 14.108 | 2,5 | 25% | 0,875 | 2,2 | 22,2 | 0,5 | 4,4 | 39,0 | 5% |
| 2008 | 2,80% | 70.830 | | 14.127 | | 3,1 | 25% | 0,875 | 2,7 | 24,9 | 0,6 | 5,0 | 37,0 | 5% |
| 2009 | 2,80% | 72.814 | | 14.523 | | 3,9 | 25% | 0,875 | 3,4 | 28,4 | 0,8 | 5,7 | 35,2 | 5% |
| 2010 | 1,40% | 73.833 | 72.879 | 14.726 | 14.536 | 4,9 | 25% | 0,875 | 4,3 | 32,6 | 1,0 | 6,5 | 33,4 | 5% |
| 2011 | 1,40% | 74.867 | | 14.932 | | 6,1 | 25% | 0,875 | 5,3 | 38,0 | 1,2 | 7,6 | 31,7 | 5% |
| 2012 | 1,40% | 75.915 | | 15.141 | | 7,6 | 25% | 0,875 | 6,7 | 44,6 | 1,5 | 8,9 | 30,1 | 5% |
| 2013 | 1,40% | 76.978 | | 15.353 | | 9,5 | 25% | 0,875 | 8,3 | 53,0 | 1,9 | 10,6 | 28,6 | 5% |
| 2014 | 1,40% | 78.055 | | 15.568 | | 11,9 | 25% | 0,875 | 10,4 | 63,4 | 2,4 | 12,6 | 27,2 | 5% |
| 2015 | 1,10% | 78.914 | 76.597 | 15.739 | 15.277 | 14,9 | 25% | 0,875 | 13,0 | 76,5 | 3,0 | 15,2 | 25,8 | 5% |
| 2016 | 1,10% | 79.782 | | 15.912 | | 18,6 | 25% | 0,875 | 16,3 | 92,8 | 3,7 | 18,5 | 24,5 | 5% |
| 2017 | 1,10% | 80.660 | | 16.087 | | 23,3 | 25% | 0,875 | 20,4 | 113,1 | 4,6 | 22,6 | 23,3 | 5% |
| 2018 | 1,10% | 81.547 | | 16.264 | | 29,1 | 25% | 0,875 | 25,5 | 138,6 | 5,8 | 27,6 | 22,2 | 5% |
| 2019 | 1,10% | 82.444 | | 16.443 | | 36,4 | 18% | 0,875 | 31,8 | 170,4 | 7,3 | 34,0 | 21,0 | 5% |
| 2020 | 0,70% | 83.021 | | 16.558 | | 42,9 | 18% | 0,875 | 37,6 | 208,0 | 8,6 | 41,5 | 20,0 | 5% |
| 2021 | 0,70% | 83.602 | | 16.674 | | 50,7 | 18% | 0,875 | 44,3 | 252,3 | 10,1 | 50,3 | 19,4 | 3% |
| 2022 | 0,70% | 84.187 | | 16.791 | | 59,8 | 18% | 0,875 | 52,3 | 304,6 | 11,9 | 60,8 | 18,8 | 3% |
| 2023 | 0,70% | 84.777 | | 16.909 | | 70,5 | 16% | 0,875 | 61,7 | 366,3 | 14,1 | 73,1 | 18,2 | 3% |
| 2024 | 0,70% | 85.370 | | 17.027 | | 81,8 | 16% | 0,875 | 71,6 | 437,9 | 16,3 | 87,3 | 17,7 | 3% |
| 2025 | 0,50% | 85.797 | | 17.112 | | 94,9 | 16% | 0,875 | 83,0 | 521,0 | 18,9 | 103,9 | 17,2 | 3% |
| 2026 | 0,50% | 86.226 | | 17.198 | | 110,1 | 16% | 0,875 | 96,3 | 617,3 | 22,0 | 123,1 | 16,7 | 3% |
| 2027 | 0,50% | 86.657 | | 17.284 | | 127,7 | 16% | 0,875 | 111,7 | 729,0 | 25,5 | 145,4 | 16,2 | 3% |
| 2028 | 0,50% | 87.090 | | 17.370 | | 148,1 | 16% | 0,875 | 129,6 | 858,7 | 29,5 | 171,3 | 15,7 | 3% |
| 2029 | 0,50% | 87.526 | | 17.457 | | 171,8 | 16% | 0,875 | 150,4 | 1.009,0 | 34,3 | 201,2 | 15,2 | 3% |
| 2030 | 0,50% | 87.964 | | 17.544 | | 199,3 | 16% | 0,875 | 174,4 | 1.183,4 | 39,8 | 236,0 | 14,7 | 3% |
| 2031 | 0,50% | 88.403 | | 17.632 | | 231,2 | 15% | 0,875 | 202,3 | 1.385,8 | 46,1 | 276,4 | 14,4 | 2% |
| 2032 | 0,50% | 88.845 | | 17.720 | | 265,9 | 15% | 0,875 | 232,7 | 1.618,5 | 53,0 | 322,8 | 14,2 | 2% |
| 2033 | 0,50% | 89.290 | | 17.809 | | 305,8 | 15% | 0,875 | 267,6 | 1.886,0 | 61,0 | 376,2 | 13,9 | 2% |
| 2034 | 0,50% | 89.736 | | 17.898 | | 351,7 | 15% | 0,875 | 307,7 | 2.193,8 | 70,1 | 437,5 | 13,6 | 2% |
| 2035 | 0,50% | 90.185 | | 17.987 | | 404,4 | 15% | 0,875 | 353,9 | 2.547,6 | 80,7 | 508,1 | 13,3 | 2% |
| 2036 | 0,50% | 90.636 | | 18.077 | | 465,1 | 15% | 0,875 | 407,0 | 2.954,6 | 92,8 | 589,3 | 13,1 | 2% |
| 2037 | 0,50% | 91.089 | | 18.167 | | 534,9 | 15% | 0,875 | 468,0 | 3.422,6 | 106,7 | 682,6 | 12,8 | 2% |
| 2038 | 0,50% | 91.544 | | 18.258 | | 615,1 | 15% | 0,875 | 538,2 | 3.960,8 | 122,7 | 790,0 | 12,5 | 2% |
| 2039 | 0,50% | 92.002 | | 18.350 | | 707,4 | 15% | 0,875 | 618,9 | 4.579,7 | 141,1 | 913,4 | 12,3 | 2% |
| 2040 | 0,50% | 92.462 | | 18.441 | | 813,5 | 15% | 0,875 | 711,8 | 5.291,5 | 162,2 | 1.055,4 | 12,0 | 2% |
| 2041 | 0,50% | 92.924 | | 18.534 | | 935,5 | 12% | 0,875 | 818,5 | 6.110,0 | 186,6 | 1.218,6 | 11,8 | 2% |
| 2042 | 0,50% | 93.389 | | 18.626 | | 1.047,7 | 12% | 0,875 | 916,8 | 7.026,8 | 209,0 | 1.401,5 | 11,6 | 2% |
| 2043 | 0,50% | 93.856 | | 18.719 | | 1.173,5 | 12% | 0,875 | 1.026,8 | 8.053,6 | 234,0 | 1.606,3 | 11,3 | 2% |
| 2044 | 0,50% | 94.325 | | 18.813 | | 1.314,3 | 12% | 0,875 | 1.150,0 | 9.203,6 | 262,1 | 1.835,6 | 11,1 | 2% |
| 2045 | 0,50% | 94.797 | | 18.907 | | 1.472,0 | 12% | 0,875 | 1.288,0 | 10.491,5 | 293,6 | 2.092,5 | 10,9 | 2% |
| 2046 | 0,50% | 95.271 | | 19.002 | | 1.648,6 | 12% | 0,875 | 1.442,5 | 11.934,1 | 328,8 | 2.380,2 | 10,7 | 2% |
| 2047 | 0,50% | 95.747 | | 19.097 | | 1.846,5 | 12% | 0,875 | 1.615,6 | 13.549,7 | 368,3 | 2.702,5 | 10,5 | 2% |
| 2048 | 0,50% | 96.226 | | 19.192 | | 2.068,0 | 12% | 0,875 | 1.809,5 | 15.359,3 | 412,5 | 3.063,4 | 10,2 | 2% |
| 2049 | 0,50% | 96.707 | | 19.288 | | 2.316,2 | 12% | 0,875 | 2.026,7 | 17.385,9 | 462,0 | 3.467,6 | 10,0 | 2% |
| 2050 | 0,50% | 97.191 | | 19.384 | | 2.594,1 | 12% | 0,875 | 2.269,9 | 19.655,8 | 517,4 | 3.920,3 | 9,8 | 2% |

1 Fechner et al, Roadmap

² E-Control, Ökostrombericht 2008

3 Fechner et al. Adaptiert auf NÖ nach Einwohnern

4 E-Control auf NÖ adaptiert nach Einwohnern

## Calculation feed-in tariff

| Cost development variants (annual +2,5%) | | | electricity costs (€ct/kWh) | | | cumulated costs, assumption 20 years start 2010, exit for operators (Mio. €) | | |
|---|---|---|---|---|---|---|---|---|
| 12 €ct/kWh (Variant 1) | 8 €ct/kWh (Variant 2) | 6 €ct/kWh (Variant 3) | 12 €ct/kWh (Variant 1) | 8 €ct/kWh (Variant 2) | 6 €ct/kWh (Variant 3) | 12 €ct/kWh (Variant 1) | 8 €ct/kWh (Variant 2) | 6 €ct/kWh (Variant 3) |
| 12 | 8 | 6 | 29,0 | 33,0 | 35,0 | 8,7 | 8,7 | 8,7 |
| 12,3 | 8,2 | 6,2 | 26,7 | 30,8 | 32,8 | 9,3 | 9,4 | 9,4 |
| 12,6 | 8,4 | 6,3 | 24,4 | 28,6 | 30,7 | 9,9 | 10,1 | 10,2 |
| 12,9 | 8,6 | 6,5 | 22,2 | 26,5 | 28,7 | 10,7 | 11,0 | 11,2 |
| 13,2 | 8,8 | 6,6 | 20,1 | 24,6 | 26,8 | 11,6 | 12,1 | 12,4 |
| 13,6 | 9,1 | 6,8 | 18,1 | 22,7 | 24,9 | 12,5 | 13,3 | 13,7 |
| 13,9 | 9,3 | 7,0 | 16,2 | 20,9 | 23,2 | 13,6 | 14,7 | 15,2 |
| 14,3 | 9,5 | 7,1 | 14,4 | 19,1 | 21,5 | 14,8 | 16,3 | 17,0 |
| 14,6 | 9,7 | 7,3 | 12,6 | 17,5 | 19,9 | 16,1 | 18,1 | 19,1 |
| 15,0 | 10,0 | 7,5 | 10,9 | 15,8 | 18,3 | 17,5 | 20,2 | 21,5 |
| 15,4 | 10,2 | 7,7 | 9,2 | 14,3 | 16,9 | 19,0 | 22,5 | 24,3 |
| 15,7 | 10,5 | 7,9 | 7,6 | 12,8 | 15,4 | 20,6 | 25,1 | 27,4 |
| 16,1 | 10,8 | 8,1 | 6,0 | 11,4 | 14,1 | 22,1 | 28,0 | 31,0 |
| 16,5 | 11,0 | 8,3 | 4,5 | 10,0 | 12,8 | 23,5 | 31,2 | 35,1 |
| 17,0 | 11,3 | 8,5 | 3,0 | 8,7 | 11,5 | 24,7 | 34,5 | 39,4 |
| 17,4 | 11,6 | 8,7 | 2,0 | 7,8 | 10,7 | 25,6 | 37,9 | 44,1 |
| 17,8 | 11,9 | 8,9 | 1,0 | 6,9 | 9,9 | 26,1 | 41,6 | 49,3 |
| 18,3 | 12,2 | 9,1 | 0,0 | 6,1 | 9,1 | 26,1 | 45,3 | 54,9 |
| 18,7 | 12,5 | 9,4 | -1,0 | 5,2 | 8,3 | 25,4 | 49,1 | 60,9 |
| 19,2 | 12,8 | 9,6 | -2,0 | 4,4 | 7,6 | 23,7 | 52,7 | 67,2 |
| 19,7 | 13,1 | 9,8 | -3,0 | 3,5 | 6,8 | 20,8 | 56,1 | 73,8 |
| 20,2 | 13,4 | 10,1 | -4,0 | 2,7 | 6,1 | 16,3 | 59,1 | 80,6 |
| 20,7 | 13,8 | 10,3 | -5,0 | 1,9 | 5,3 | 9,9 | 61,6 | 87,5 |
| 21,2 | 14,1 | 10,6 | -6,0 | 1,1 | 4,6 | 0,9 | 63,2 | 94,4 |
| 21,7 | 14,5 | 10,9 | -7,0 | 0,3 | 3,9 | | 63,7 | 101,2 |
| 22,2 | 14,8 | 11,1 | -7,8 | -0,4 | 3,3 | | 62,9 | 107,9 |
| 22,8 | 15,2 | 11,4 | -8,6 | -1,0 | 2,8 | | 60,5 | 114,4 |
| 23,4 | 15,6 | 11,7 | -9,5 | -1,7 | 2,2 | | 56,0 | 120,2 |
| 24,0 | 16,0 | 12,0 | -10,4 | -2,4 | 1,6 | | 48,7 | 125,2 |
| 24,6 | 16,4 | 12,3 | -11,2 | -3,0 | 1,0 | | 37,9 | 128,9 |
| 25,2 | 16,8 | 12,6 | -12,1 | -3,7 | 0,5 | | 22,8 | 130,9 |
| 25,8 | 17,2 | 12,9 | -13,0 | -4,4 | -0,1 | | 2,2 | 130,4 |
| 26,4 | 17,6 | 13,2 | -13,9 | -5,1 | -0,7 | | | 126,7 |
| 27,1 | 18,1 | 13,6 | -14,8 | -5,8 | -1,3 | | | 118,9 |
| 27,8 | 18,5 | 13,9 | -15,7 | -6,5 | -1,8 | | | 105,8 |
| 28,5 | 19,0 | 14,2 | -16,7 | -7,2 | -2,4 | | | 85,9 |
| 29,2 | 19,5 | 14,6 | -17,6 | -7,9 | -3,0 | | | 58,2 |
| 29,9 | 19,9 | 15,0 | -18,6 | -8,6 | -3,6 | | | 21,0 |
| 30,7 | 20,4 | 15,3 | -19,6 | -9,3 | -4,2 | | | |
| 31,4 | 21,0 | 15,7 | -20,5 | -10,1 | -4,8 | | | |
| 32,2 | 21,5 | 16,1 | -21,5 | -10,8 | -5,4 | | | |
| 33,0 | 22,0 | 16,5 | -22,6 | -11,6 | -6,1 | | | |
| 33,9 | 22,6 | 16,9 | -23,6 | -12,3 | -6,7 | | | |
| 34,7 | 23,1 | 17,3 | -24,7 | -13,1 | -7,3 | | | |
| 35,6 | 23,7 | 17,8 | -25,7 | -13,9 | -7,9 | | | |

| | Cummulated sum (Mio. €) | | |
|---|---|---|---|
| | *Variant 1 (12 €ct)* | *Variant 2 (8 €ct)* | *Variant 3 (6 €ct)* |
| **Austria** | 409,2 | 1.096,5 | 2.383,9 |
| **Lower Austria** | 81,6 | 218,7 | 475,5 |

## Calculation: Combination feed-in tariff an direct investment

| | Austria | | | | | Lower Austria | | | | Cost development variants (annual +2,5%) | | | alternativ costs - feed in tariff | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| year | MW/year new | annual growth, installation | average harvest, roof & fassade (MWh/kWp) | annual installed in GWh | Austria sum GWh/year | MW/year | sum GWh/year | Cost covering of PV per kWh €ct | degression rate of PV development | €ct/kWh (Variant 1) | €ct/kWh (Variant 2) | €ct/kWh (Variant 3) | €ct/kWh (Variant 1) | €ct/kWh (Variant 2) | €ct/kWh (Variant 3) |
| 2005 | 3,0 | | | | | | | | | | | | | | |
| 2006 | 1,6 | | | | 21 | | | 41 | 5% | 12 | 8 | 6 | 29,0 | 33,0 | 35,0 |
| 2007 | 2,5 | 25% | 0,875 | 2,2 | 22,2 | 0,5 | 4,4 | 39,0 | 5% | 12,3 | 8,2 | 6,2 | 26,7 | 30,8 | 32,8 |
| 2008 | 3,1 | 25% | 0,875 | 2,7 | 24,9 | 0,6 | 5,0 | 37,0 | 5% | 12,6 | 8,4 | 6,3 | 24,4 | 28,6 | 30,7 |
| 2009 | 3,9 | 25% | 0,875 | 3,4 | 28,4 | 0,8 | 5,7 | 35,2 | 5% | 12,9 | 8,6 | 6,5 | 22,2 | 26,5 | 28,7 |
| 2010 | 4,9 | 25% | 0,875 | 4,3 | 32,6 | 1,0 | 6,5 | 33,4 | 5% | 13,2 | 8,8 | 6,6 | 20,1 | 24,6 | 26,8 |
| 2011 | 6,1 | 25% | 0,875 | 5,3 | 38,0 | 1,2 | 7,6 | 31,7 | 5% | 13,6 | 9,1 | 6,8 | 18,1 | 22,7 | 24,9 |
| 2012 | 7,6 | 25% | 0,875 | 6,7 | 44,6 | 1,5 | 8,9 | 30,1 | 5% | 13,9 | 9,3 | 7,0 | 16,2 | 20,9 | 23,2 |
| 2013 | 9,5 | 25% | 0,875 | 8,3 | 53,0 | 1,9 | 10,6 | 28,6 | 5% | 14,3 | 9,5 | 7,1 | 14,4 | 19,1 | 21,5 |
| 2014 | 11,9 | 25% | 0,875 | 10,4 | 63,4 | 2,4 | 12,6 | 27,2 | 5% | 14,6 | 9,7 | 7,3 | 12,6 | 17,5 | 19,9 |
| 2015 | 14,9 | 25% | 0,875 | 13,0 | 76,5 | 3,0 | 15,2 | 25,8 | 5% | 15,0 | 10,0 | 7,5 | 10,9 | 15,8 | 18,3 |
| 2016 | 18,6 | 25% | 0,875 | 16,3 | 92,8 | 3,7 | 18,5 | 24,5 | 5% | 15,4 | 10,2 | 7,7 | 9,2 | 14,3 | 16,9 |
| 2017 | 23,3 | 25% | 0,875 | 20,4 | 113,1 | 4,6 | 22,6 | 23,3 | 5% | 15,7 | 10,5 | 7,9 | 7,6 | 12,8 | 15,4 |
| 2018 | 29,1 | 25% | 0,875 | 25,5 | 138,6 | 5,8 | 27,6 | 22,2 | 5% | 16,1 | 10,8 | 8,1 | 6,0 | 11,4 | 14,1 |
| 2019 | 36,4 | 18% | 0,875 | 31,8 | 170,4 | 7,3 | 34,0 | 21,0 | 5% | 16,5 | 11,0 | 8,3 | 4,5 | 10,0 | 12,8 |
| 2020 | 42,9 | 18% | 0,875 | 37,6 | 208,0 | 8,6 | 41,5 | 20,0 | 5% | 17,0 | 11,3 | 8,5 | 3,0 | 8,7 | 11,5 |
| 2021 | 50,7 | 18% | 0,875 | 44,3 | 252,3 | 10,1 | 50,3 | 19,4 | 3% | 17,4 | 11,6 | 8,7 | 2,0 | 7,8 | 10,7 |
| 2022 | 59,8 | 18% | 0,875 | 52,3 | 304,6 | 11,9 | 60,8 | 18,8 | 3% | 17,8 | 11,9 | 8,9 | 1,0 | 6,9 | 9,9 |
| 2023 | 70,5 | 16% | 0,875 | 61,7 | 366,3 | 14,1 | 73,1 | 18,2 | 3% | 18,3 | 12,2 | 9,1 | 0,0 | 6,1 | 9,1 |
| 2024 | 81,8 | 16% | 0,875 | 71,6 | 437,9 | 16,3 | 87,3 | 17,7 | 3% | 18,7 | 12,5 | 9,4 | -1,0 | 5,2 | 8,3 |
| 2025 | 94,9 | 16% | 0,875 | 83,0 | 521,0 | 18,9 | 103,9 | 17,2 | 3% | 19,2 | 12,8 | 9,6 | -2,0 | 4,4 | 7,6 |
| 2026 | 110,1 | 16% | 0,875 | 96,3 | 617,3 | 22,0 | 123,1 | 16,7 | 3% | 19,7 | 13,1 | 9,8 | -3,0 | 3,5 | 6,8 |
| 2027 | 127,7 | 16% | 0,875 | 111,7 | 729,0 | 25,5 | 145,4 | 16,2 | 3% | 20,2 | 13,4 | 10,1 | -4,0 | 2,7 | 6,1 |
| 2028 | 148,1 | 16% | 0,875 | 129,6 | 858,7 | 29,5 | 171,3 | 15,7 | 3% | 20,7 | 13,8 | 10,3 | -5,0 | 1,9 | 5,3 |
| 2029 | 171,8 | 16% | 0,875 | 150,4 | 1.009,0 | 34,3 | 201,2 | 15,2 | 3% | 21,2 | 14,1 | 10,6 | -6,0 | 1,1 | 4,6 |
| 2030 | 199,3 | 16% | 0,875 | 174,4 | 1.183,4 | 39,8 | 236,0 | 14,7 | 3% | 21,7 | 14,5 | 10,9 | -7,0 | 0,3 | 3,9 |
| 2031 | 231,2 | 15% | 0,875 | 202,3 | 1.385,8 | 46,1 | 276,4 | 14,4 | 2% | 22,2 | 14,8 | 11,1 | -7,8 | -0,4 | 3,3 |
| 2032 | 265,9 | 15% | 0,875 | 232,7 | 1.618,5 | 53,0 | 322,8 | 14,2 | 2% | 22,8 | 15,2 | 11,4 | -8,6 | -1,0 | 2,8 |
| 2033 | 305,8 | 15% | 0,875 | 267,6 | 1.886,0 | 61,0 | 376,2 | 13,9 | 2% | 23,4 | 15,6 | 11,7 | -9,5 | -1,7 | 2,2 |
| 2034 | 351,7 | 15% | 0,875 | 307,7 | 2.193,8 | 70,1 | 437,5 | 13,6 | 2% | 24,0 | 16,0 | 12,0 | -10,4 | -2,4 | 1,6 |
| 2035 | 404,4 | 15% | 0,875 | 353,9 | 2.547,6 | 80,7 | 508,1 | 13,3 | 2% | 24,6 | 16,4 | 12,3 | -11,2 | -3,0 | 1,0 |
| 2036 | 465,1 | 15% | 0,875 | 407,0 | 2.954,6 | 92,8 | 589,3 | 13,1 | 2% | 25,2 | 16,8 | 12,6 | -12,1 | -3,7 | 0,5 |
| 2037 | 534,9 | 15% | 0,875 | 468,0 | 3.422,6 | 106,7 | 682,6 | 12,8 | 2% | 25,8 | 17,2 | 12,9 | -13,0 | -4,4 | -0,1 |
| 2038 | 615,1 | 15% | 0,875 | 538,2 | 3.960,8 | 122,7 | 790,0 | 12,5 | 2% | 26,4 | 17,6 | 13,2 | -13,9 | -5,1 | -0,7 |
| 2039 | 707,4 | 15% | 0,875 | 618,9 | 4.579,7 | 141,1 | 913,4 | 12,3 | 2% | 27,1 | 18,1 | 13,6 | -14,8 | -5,8 | -1,3 |
| 2040 | 813,5 | 15% | 0,875 | 711,8 | 5.291,5 | 162,2 | 1.055,4 | 12,0 | 2% | 27,8 | 18,5 | 13,9 | -15,7 | -6,5 | -1,8 |
| 2041 | 935,5 | 12% | 0,875 | 818,5 | 6.110,0 | 186,6 | 1.218,6 | 11,8 | 2% | 28,5 | 19,0 | 14,2 | -16,7 | -7,2 | -2,4 |
| 2042 | 1.047,7 | 12% | 0,875 | 916,8 | 7.026,8 | 209,0 | 1.401,5 | 11,6 | 2% | 29,2 | 19,5 | 14,6 | -17,6 | -7,9 | -3,0 |
| 2043 | 1.173,5 | 12% | 0,875 | 1.026,8 | 8.053,6 | 234,0 | 1.606,3 | 11,3 | 2% | 29,9 | 19,9 | 15,0 | -18,6 | -8,6 | -3,6 |
| 2044 | 1.314,3 | 12% | 0,875 | 1.150,0 | 9.203,6 | 262,1 | 1.835,6 | 11,1 | 2% | 30,7 | 20,4 | 15,3 | -19,6 | -9,3 | -4,2 |
| 2045 | 1.472,0 | 12% | 0,875 | 1.288,0 | 10.491,5 | 293,6 | 2.092,5 | 10,9 | 2% | 31,4 | 21,0 | 15,7 | -20,5 | -10,1 | -4,8 |
| 2046 | 1.648,6 | 12% | 0,875 | 1.442,5 | 11.934,1 | 328,8 | 2.380,2 | 10,7 | 2% | 32,2 | 21,5 | 16,1 | -21,5 | -10,8 | -5,4 |
| 2047 | 1.846,5 | 12% | 0,875 | 1.615,6 | 13.549,7 | 368,3 | 2.702,5 | 10,5 | 2% | 33,0 | 22,0 | 16,5 | -22,6 | -11,6 | -6,1 |
| 2048 | 2.068,0 | 12% | 0,875 | 1.809,5 | 15.359,3 | 412,5 | 3.063,4 | 10,2 | 2% | 33,9 | 22,6 | 16,9 | -23,6 | -12,3 | -6,7 |
| 2049 | 2.316,2 | 12% | 0,875 | 2.026,7 | 17.385,9 | 462,0 | 3.467,6 | 10,0 | 2% | 34,7 | 23,1 | 17,3 | -24,7 | -13,1 | -7,3 |
| 2050 | 2.594,1 | 12% | 0,875 | 2.269,9 | 19.655,8 | 517,4 | 3.920,3 | 9,8 | 2% | 35,6 | 23,7 | 17,8 | -25,7 | -13,9 | -7,9 |

1 Fechner et al, Roadmap

² E-Control, Ökostrombericht 2008

3 Fechner et al. Adaptiert auf NÖ nach Einwohnern

4 E-Control auf NÖ adaptiert nach Einwohnern

## Calculation: Combination of feed-in tariff and direct investment

| € 12ct. Variant | | | | | Sum Directsubsidies Lower | € 8ct. Variant | | | | | € 6ct. Variant | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| difference cost fixed tariff 25 ct./year (mio. €) | cummulated sum tarif (mio. €) Tariff | difference cost of PV minus 25 ct./year (mio. €) | direct investment/kWp in € | Sum Directsubsidies (mio. €) | | difference cost fixed tariff 25 | cummulated sum tarif (mio €) | difference cost of PV minus 25 | direct investment/kWp in € | Sum Directsubsidies (mio. €) | difference cost fixed tariff 25 ct./year (mio. €) | cummulated sum tarif (mio €) | difference cost of PV minus 25 ct./year (mio. €) | direct investment/kWp in € | Sum Directsubsidies (mio. €) |
| | 8,7 | | | | | | 8,7 | | | | | 8,7 | | | |
| | 9,3 | | | | | | 9,3 | | | | | 9,3 | | | |
| | 9,9 | | | | | | 9,9 | | | | | 9,9 | | | |
| 0,413 | 10,3 | 0,3470 | 1.084,65 | 4,24 | 0,845 | 0,560 | 10,5 | 0,3470 | 1.084,65 | 4,24 | 0,634 | 10,5 | 3,4701 | 1.084,65 | 4,24 |
| 0,502 | 10,8 | 0,3587 | 896,87 | 4,38 | 0,873 | 0,691 | 11,2 | 0,3587 | 1.121,09 | 4,38 | 0,785 | 11,3 | 3,5866 | 1.121,09 | 4,38 |
| 0,610 | 11,4 | 0,3592 | 718,48 | 4,39 | 0,875 | 0,852 | 12,0 | 0,3592 | 1.122,63 | 4,39 | 0,973 | 12,3 | 3,5915 | 1.122,63 | 4,39 |
| 0,740 | 12,2 | 0,3430 | 549,01 | 4,19 | 0,835 | 1,050 | 13,1 | 0,3430 | 1.072,29 | 4,19 | 1,204 | 13,5 | 3,4305 | 1.072,29 | 4,19 |
| 0,896 | 13,1 | 0,3031 | 388,02 | 3,70 | 0,738 | 1,293 | 14,3 | 0,3031 | 947,30 | 3,70 | 1,491 | 15,0 | 3,0306 | 947,30 | 3,70 |
| 1,083 | 14,1 | 0,2295 | 235,07 | 2,80 | 0,559 | 1,591 | 15,9 | 0,2295 | 717,37 | 2,80 | 1,845 | 16,8 | 2,2950 | 717,37 | 2,80 |
| 1,306 | 15,4 | 0,1096 | 89,77 | 1,34 | 0,267 | 1,957 | 17,9 | 0,1096 | 342,44 | 1,34 | 2,283 | 19,1 | 1,0955 | 342,44 | 1,34 |
| 1,497 | 16,9 | -0,0736 | | | | 2,332 | 20,2 | -0,0736 | | | 2,749 | 21,9 | -0,7363 | | |
| 1,543 | 18,5 | | | | | 2,613 | 22,8 | | | | 3,147 | 25,0 | | | |
| 1,532 | 20,0 | | | | | 2,902 | 25,7 | | | | 3,587 | 28,6 | | | |
| 1,434 | 21,5 | | | | | 3,189 | 28,9 | | | | 4,067 | 32,7 | | | |
| 1,142 | 22,6 | | | | | 3,264 | 32,2 | | | | 4,326 | 37,0 | | | |
| 0,893 | 23,5 | | | | | 3,461 | 35,7 | | | | 4,745 | 41,7 | | | |
| 0,522 | 24,0 | | | | | 3,628 | 39,3 | | | | 5,181 | 46,9 | | | |
| -0,007 | 24,0 | | | | | 3,750 | 43,0 | | | | 5,628 | 52,5 | | | |
| -0,726 | 23,3 | | | | | 3,740 | 46,8 | | | | 5,973 | 58,5 | | | |
| -1,672 | 21,6 | | | | | 3,638 | 50,4 | | | | 6,293 | 64,8 | | | |
| -2,898 | 18,7 | | | | | 3,416 | 53,8 | | | | 6,573 | 71,4 | | | |
| -4,469 | 14,2 | | | | | 3,038 | 56,9 | | | | 6,792 | 78,2 | | | |
| -6,466 | 7,8 | | | | | 2,460 | 59,3 | | | | 6,924 | 85,1 | | | |
| -8,984 | -1,2 | | | | | 1,629 | 61,0 | | | | 6,936 | 92,0 | | | |
| | | | | | | 0,479 | 61,4 | | | | 6,789 | 98,8 | | | |
| | | | | | | -0,773 | 60,7 | | | | 6,729 | 105,6 | | | |
| | | | | | | -2,424 | 58,2 | | | | 6,419 | 112,0 | | | |
| | | | | | | -4,562 | 53,7 | | | | 5,862 | 117,8 | | | |
| | | | | | | -7,299 | 46,4 | | | | 4,988 | 122,8 | | | |
| | | | | | | -10,770 | 35,6 | | | | 3,714 | 126,5 | | | |
| | | | | | | -15,136 | 20,5 | | | | 1,937 | 128,5 | | | |
| | | | | | | -20,592 | | | | | -0,468 | 128,0 | | | |
| | | | | | | | | | | | -3,651 | 124,4 | | | |
| | **Austria** | | | **Federal State:** | **Lower Austria** | | | | | | -7,798 | 116,6 | | | |
| **Sum Tariff 12** | **370,7** | | **Sum Direct** | **25,0** | **5,0** | **Tariff 8** | **1.035,2** | | **Sum Dire** | **25,0** | **Sum Tariff 12** | **1.927,2** | | **Sum Direct** | **25,0** |

| | **Cummulated sum (Mio. €)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Variant 1 (12 ct)* | | | *Variant 2 (8 ct)* | | | *Variant 3 (6 ct)* | | |
| | *Feed-in-Tariff* | direct-subsidies | sum | *Feed-in-Tariff* | direct-subs | sum | *Feed-in-Tariff* | direct-subs | sum |
| **Austria** | 370,7 | 25,0 | 395,7 | 1.035,2 | 25,0 | 1.060,3 | 1.927,2 | 25,0 | 1.952,2 |
| **Lower Austria** | 73,9 | 5,0 | 78,9 | 206,5 | 5,0 | 211,5 | 384,4 | 5,0 | 389,4 |

| | **Maximum cost burden/year (Mio. €)** | | |
|---|---|---|---|
| | *Variant 1 (12 ct)* | *Variant 2 (8 ct)* | *Variant 3 (6 ct)* |
| **Austria** | 24,0 | 61,4 | 128,5 |
| **Lower Austria** | 4,8 | 12,3 | 25,6 |
| **year** | 2022 | 2030 | 2036 |
| **Lower Austria direct** | 4,39 (2011) | 4,39 (2011) | 4,39 (2011) |

## Calculation direct investment

| year | Austria | | | | | Lower Austria | | | | Cost development variants (annual +2,5%) | | | alternativ costs - feed in tariff | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MW/year new | annual growth, installation | average harvest, roof & fassade (MWh/kWp) | annual installed in GWh | Austria sum GWh/year | MW/year | sum GWh/year | Cost covering of PV per kWh €ct | degression rate of PV development | €ct/kWh (Variant 1) | €ct/kWh (Variant 2) | €ct/kWh (Variant 3) | €ct/kWh (Variant 1) | €ct/kWh (Variant 2) | €ct/kWh (Variant 3) |
| 2005 | 3,0 | | | | | | | | | | | | | | |
| 2006 | 1,6 | | | | 21 | | | 41 | 5% | 12 | 8 | 6 | 29,0 | 33,0 | 35,0 |
| 2007 | 2,5 | 25% | 0,875 | 2,188 | 22,2 | 0,5 | 4,4 | 39,0 | 5% | 12,3 | 8,2 | 6,2 | 26,7 | 30,8 | 32,8 |
| 2008 | 3,1 | 25% | 0,875 | 2,7 | 24,9 | 0,6 | 5,0 | 37,0 | 5% | 12,6 | 8,4 | 6,3 | 24,4 | 28,6 | 30,7 |
| 2009 | 3,9 | 25% | 0,875 | 3,4 | 28,4 | 0,8 | 5,7 | 35,2 | 5% | 12,9 | 8,6 | 6,5 | 22,2 | 26,5 | 28,7 |
| 2010 | 4,9 | 25% | 0,875 | 4,3 | 32,6 | 1,0 | 6,5 | 33,4 | 5% | 13,2 | 8,8 | 6,6 | 20,1 | 24,6 | 26,8 |
| 2011 | 6,1 | 25% | 0,875 | 5,3 | 38,0 | 1,2 | 7,6 | 31,7 | 5% | 13,6 | 9,1 | 6,8 | 18,1 | 22,7 | 24,9 |
| 2012 | 7,6 | 25% | 0,875 | 6,7 | 44,6 | 1,5 | 8,9 | 30,1 | 5% | 13,9 | 9,3 | 7,0 | 16,2 | 20,9 | 23,2 |
| 2013 | 9,5 | 25% | 0,875 | 8,3 | 53,0 | 1,9 | 10,6 | 28,6 | 5% | 14,3 | 9,5 | 7,1 | 14,4 | 19,1 | 21,5 |
| 2014 | 11,9 | 25% | 0,875 | 10,4 | 63,4 | 2,4 | 12,6 | 27,2 | 5% | 14,6 | 9,7 | 7,3 | 12,6 | 17,5 | 19,9 |
| 2015 | 14,9 | 25% | 0,875 | 13,0 | 76,5 | 3,0 | 15,2 | 25,8 | 5% | 15,0 | 10,0 | 7,5 | 10,9 | 15,8 | 18,3 |
| 2016 | 18,6 | 25% | 0,875 | 16,3 | 92,8 | 3,7 | 18,5 | 24,5 | 5% | 15,4 | 10,2 | 7,7 | 9,2 | 14,3 | 16,9 |
| 2017 | 23,3 | 25% | 0,875 | 20,4 | 113,1 | 4,6 | 22,6 | 23,3 | 5% | 15,7 | 10,5 | 7,9 | 7,6 | 12,8 | 15,4 |
| 2018 | 29,1 | 25% | 0,875 | 25,5 | 138,6 | 5,8 | 27,6 | 22,2 | 5% | 16,1 | 10,8 | 8,1 | 6,0 | 11,4 | 14,1 |
| 2019 | 36,4 | 18% | 0,875 | 31,8 | 170,4 | 7,3 | 34,0 | 21,0 | 5% | 16,5 | 11,0 | 8,3 | 4,5 | 10,0 | 12,8 |
| 2020 | 42,9 | 18% | 0,875 | 37,6 | 208,0 | 8,6 | 41,5 | 20,0 | 5% | 17,0 | 11,3 | 8,5 | 3,0 | 8,7 | 11,5 |
| 2021 | 50,7 | 18% | 0,875 | 44,3 | 252,3 | 10,1 | 50,3 | 19,4 | 3% | 17,4 | 11,6 | 8,7 | 2,0 | 7,8 | 10,7 |
| 2022 | 59,8 | 18% | 0,875 | 52,3 | 304,6 | 11,9 | 60,8 | 18,8 | 3% | 17,8 | 11,9 | 8,9 | 1,0 | 6,9 | 9,9 |
| 2023 | 70,5 | 16% | 0,875 | 61,7 | 366,3 | 14,1 | 73,1 | 18,2 | 3% | 18,3 | 12,2 | 9,1 | 0,0 | 6,1 | 9,1 |
| 2024 | 81,8 | 16% | 0,875 | 71,6 | 437,9 | 16,3 | 87,3 | 17,7 | 3% | 18,7 | 12,5 | 9,4 | -1,0 | 5,2 | 8,3 |
| 2025 | 94,9 | 16% | 0,875 | 83,0 | 521,0 | 18,9 | 103,9 | 17,2 | 3% | 19,2 | 12,8 | 9,6 | -2,0 | 4,4 | 7,6 |
| 2026 | 110,1 | 16% | 0,875 | 96,3 | 617,3 | 22,0 | 123,1 | 16,7 | 3% | 19,7 | 13,1 | 9,8 | -3,0 | 3,5 | 6,8 |
| 2027 | 127,7 | 16% | 0,875 | 111,7 | 729,0 | 25,5 | 145,4 | 16,2 | 3% | 20,2 | 13,4 | 10,1 | -4,0 | 2,7 | 6,1 |
| 2028 | 148,1 | 16% | 0,875 | 129,6 | 858,7 | 29,5 | 171,3 | 15,7 | 3% | 20,7 | 13,8 | 10,3 | -5,0 | 1,9 | 5,3 |
| 2029 | 171,8 | 16% | 0,875 | 150,4 | 1.009,0 | 34,3 | 201,2 | 15,2 | 3% | 21,2 | 14,1 | 10,6 | -6,0 | 1,1 | 4,6 |
| 2030 | 199,3 | 16% | 0,875 | 174,4 | 1.183,4 | 39,8 | 236,0 | 14,7 | 3% | 21,7 | 14,5 | 10,9 | -7,0 | 0,3 | 3,9 |
| 2031 | 231,2 | 15% | 0,875 | 202,3 | 1.385,8 | 46,1 | 276,4 | 14,4 | 2% | 22,2 | 14,8 | 11,1 | -7,8 | -0,4 | 3,3 |
| 2032 | 265,9 | 15% | 0,875 | 232,7 | 1.618,5 | 53,0 | 322,8 | 14,2 | 2% | 22,8 | 15,2 | 11,4 | -8,6 | -1,0 | 2,8 |
| 2033 | 305,8 | 15% | 0,875 | 267,6 | 1.886,0 | 61,0 | 376,2 | 13,9 | 2% | 23,4 | 15,6 | 11,7 | -9,5 | -1,7 | 2,2 |
| 2034 | 351,7 | 15% | 0,875 | 307,7 | 2.193,8 | 70,1 | 437,5 | 13,6 | 2% | 24,0 | 16,0 | 12,0 | -10,4 | -2,4 | 1,6 |
| 2035 | 404,4 | 15% | 0,875 | 353,9 | 2.547,6 | 80,7 | 508,1 | 13,3 | 2% | 24,6 | 16,4 | 12,3 | -11,2 | -3,0 | 1,0 |
| 2036 | 465,1 | 15% | 0,875 | 407,0 | 2.954,6 | 92,8 | 589,3 | 13,1 | 2% | 25,2 | 16,8 | 12,6 | -12,1 | -3,7 | 0,5 |
| 2037 | 534,9 | 15% | 0,875 | 468,0 | 3.422,6 | 106,7 | 682,6 | 12,8 | 2% | 25,8 | 17,2 | 12,9 | -13,0 | -4,4 | -0,1 |
| 2038 | 615,1 | 15% | 0,875 | 538,2 | 3.960,8 | 122,7 | 790,0 | 12,5 | 2% | 26,4 | 17,6 | 13,2 | -13,9 | -5,1 | -0,7 |
| 2039 | 707,4 | 15% | 0,875 | 618,9 | 4.579,7 | 141,1 | 913,4 | 12,3 | 2% | 27,1 | 18,1 | 13,6 | -14,8 | -5,8 | -1,3 |
| 2040 | 813,5 | 15% | 0,875 | 711,8 | 5.291,5 | 162,2 | 1.055,4 | 12,0 | 2% | 27,8 | 18,5 | 13,9 | -15,7 | -6,5 | -1,8 |
| 2041 | 935,5 | 12% | 0,875 | 818,5 | 6.110,0 | 186,6 | 1.218,6 | 11,8 | 2% | 28,5 | 19,0 | 14,2 | -16,7 | -7,2 | -2,4 |
| 2042 | 1.047,7 | 12% | 0,875 | 916,8 | 7.026,8 | 209,0 | 1.401,5 | 11,6 | 2% | 29,2 | 19,5 | 14,6 | -17,6 | -7,9 | -3,0 |
| 2043 | 1.173,5 | 12% | 0,875 | 1.026,8 | 8.053,6 | 234,0 | 1.606,3 | 11,3 | 2% | 29,9 | 19,9 | 15,0 | -18,6 | -8,6 | -3,6 |
| 2044 | 1.314,3 | 12% | 0,875 | 1.150,0 | 9.203,6 | 262,1 | 1.835,6 | 11,1 | 2% | 30,7 | 20,4 | 15,3 | -19,6 | -9,3 | -4,2 |
| 2045 | 1.472,0 | 12% | 0,875 | 1.288,0 | 10.491,5 | 293,6 | 2.092,5 | 10,9 | 2% | 31,4 | 21,0 | 15,7 | -20,5 | -10,1 | -4,8 |
| 2046 | 1.648,6 | 12% | 0,875 | 1.442,5 | 11.934,1 | 328,8 | 2.380,2 | 10,7 | 2% | 32,2 | 21,5 | 16,1 | -21,5 | -10,8 | -5,4 |
| 2047 | 1.846,5 | 12% | 0,875 | 1.615,6 | 13.549,7 | 368,3 | 2.702,5 | 10,5 | 2% | 33,0 | 22,0 | 16,5 | -22,6 | -11,6 | -6,1 |
| 2048 | 2.068,0 | 12% | 0,875 | 1.809,5 | 15.359,3 | 412,5 | 3.063,4 | 10,2 | 2% | 33,9 | 22,6 | 16,9 | -23,6 | -12,3 | -6,7 |
| 2049 | 2.316,2 | 12% | 0,875 | 2.026,7 | 17.385,9 | 462,0 | 3.467,6 | 10,0 | 2% | 34,7 | 23,1 | 17,3 | -24,7 | -13,1 | -7,3 |
| 2050 | 2.594,1 | 12% | 0,875 | 2.269,9 | 19.655,8 | 517,4 | 3.920,3 | 9,8 | 2% | 35,6 | 23,7 | 17,8 | -25,7 | -13,9 | -7,9 |

1 Fechner et al, Roadmap

² E-Control, Ökostrombericht 2008

3 Fechner et al. Adaptiert auf NÖ nach Einwohnern

4 E-Control auf NÖ adaptiert nach Einwohnern

## Calculation direct investment

| 12 ct | | | 8 ct | | | 6 ct | | |
|---|---|---|---|---|---|---|---|---|
| direct investment/kWp in € | Sum Austria Direct subsidies (mio. €) | Sum Lower Austria Direct subsidies (mio. €) | direct investment/kWp in € | Sum Directsubsidies (mio. €) | Sum Lower Austria Direct subsidies (mio. €) | direct investment/kWp in € | Sum Directsubsidies (mio. €) | Sum Lower Austria Direct subsidies (mio. €) |
| 2.979 | 9,31 | 1,86 | 3.492 | 13,64 | 2,72 | 3.748 | 14,64 | 2,92 |
| 2.714 | 10,60 | 2,11 | 3.240 | 15,82 | 3,16 | 3.503 | 17,11 | 3,41 |
| 2.460 | 12,01 | 2,40 | 2.999 | 18,31 | 3,65 | 3.269 | 19,95 | 3,98 |
| 2.216 | 13,52 | 2,70 | 2.768 | 21,12 | 4,21 | 3.045 | 23,23 | 4,63 |
| 1.981 | 15,11 | 3,01 | 2.547 | 24,29 | 4,84 | 2.830 | 26,99 | 5,38 |
| 1.754 | 16,73 | 3,34 | 2.335 | 27,83 | 5,55 | 2.625 | 31,29 | 6,24 |
| 1.536 | 18,31 | 3,65 | 2.131 | 31,75 | 6,33 | 2.429 | 36,19 | 7,22 |
| 1.325 | 19,75 | 3,94 | 1.935 | 36,05 | 7,19 | 2.240 | 41,73 | 8,32 |
| 1.122 | 20,89 | 4,17 | 1.747 | 40,67 | 8,11 | 2.060 | 47,95 | 9,56 |
| 925 | 21,54 | 4,30 | 1.566 | 45,57 | 9,09 | 1.886 | 54,90 | 10,95 |
| 735 | 21,38 | 4,26 | 1.391 | 50,62 | 10,10 | 1.720 | 62,57 | 12,48 |
| 550 | 20,01 | 3,99 | 1.223 | 52,51 | 10,47 | 1.560 | 66,97 | 13,36 |
| 371 | 15,93 | 3,18 | 1.061 | 53,75 | 10,72 | 1.406 | 71,23 | 14,21 |
| 246 | 12,46 | 2,49 | 953 | 56,99 | 11,37 | 1.307 | 78,13 | 15,58 |
| 122 | 7,29 | 1,45 | 847 | 59,74 | 11,92 | 1.210 | 85,31 | 17,01 |
| | | | 742 | 60,70 | 12,11 | 1.113 | 91,10 | 18,17 |
| | | | 638 | 60,54 | 12,07 | 1.019 | 96,68 | 19,28 |
| | | | 535 | 58,89 | 11,75 | 925 | 101,87 | 20,32 |
| | | | 433 | 55,29 | 11,03 | 833 | 106,40 | 21,22 |
| | | | 332 | 49,18 | 9,81 | 742 | 109,94 | 21,93 |
| | | | 232 | 39,83 | 7,94 | 652 | 112,07 | 22,35 |
| | | | 132 | 26,38 | 5,26 | 563 | 112,28 | 22,39 |
| | | | 34 | 7,76 | 1,55 | 475 | 109,89 | 21,92 |
| | | | | | | 406 | 107,99 | 21,54 |
| | | | | | | 337 | 103,02 | 20,55 |
| | | | | | | 267 | 94,07 | 18,76 |
| | | | | | | 198 | 80,04 | 15,96 |
| | | | | | | 128 | 59,60 | 11,89 |
| | | | | | | 58 | 31,08 | 6,20 |
| | **Austria** | **Lower Austria** | | **Austria** | **Lower Austria** | | **Austria** | **Lower Austria** |
| **Sum Direct** | **234,9** | **46,8** | **Sum Direct** | **907,2** | **180,95** | **Sum Direct** | **1.979,6** | **397,7** |

| Cummulated sum (Mio. €) | | | |
|---|---|---|---|
| | *Variant 1 (12 €cat)* | *Variant 2 (8 €cat)* | *Variant 3 (6 €cat)* |
| **Austria** | 234,9 | 907,2 | 1.979,6 |
| **Lower Austria** | 46,8 | 180,9 | 397,7 |

| maximum cost burden/year (Mio. €) | | | |
|---|---|---|---|
| | *Variant 1 (12 €cat)* | *Variant 2 (8 €cat)* | *Variant 3 (6 €cat)* |
| **Austria** | 21,5 | 60,7 | 112,3 |
| **Lower Austria** | 4,3 | 12,1 | 22,4 |
| **year** | 2017 | 2023 | 2029 |