Discussion Paper

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Grid Parity of PV-Installations: A Full Comparison Considering All Taxes and Levies on the Power Consumption of Private Households in Germany

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Dr. Sven Bode and Dr. Helmuth-M.Groscurth

arrhenius Institut für Energie- und Klimapolitik

Am Waldpark 18, 22589 Hamburg
info@arrhenius.de – www.arrhenius.de

1 Summary

In the discussion about the cost of electricity from photovoltaic systems, a so-called ‘grid parity’ is regularly mentioned. It is said to have been reached by now. According to this line of argument, electricity production costs from PV have decreased so far that the power generated is less expensive than the reference from the public grid.

However, the comparison of these costs is incomplete, particularly as various cost components such as levies and taxes are not included in calculation. According to our personal calculations, the use of self-consumption of photovoltaic systems is indirectly supported with up to 17cents / kWh subsidy. A community with 10, 000 households, of which 30% use the option of self-consumption, loses €48,000 in revenue from the concession fee per year. If an additional 10GW of PV system is installed on private homes, then the corresponding shortfall in taxes and levies amount to €240-460 million per year.

In order to increase the share of self-consumption on electricity generated by PV systems, batteries can be used as an additional energy source. Their use is to be subsidised with a support scheme of €50 million. The actual costs of such a program are significantly higher (by up to 14%), as various taxes and levies will not be paid by self-consuming households.

If the current budget is to be maintained at the same level by all electricity consumers, different options exist, including e.g. fixed charges. They would amount to about €250 per household per year in the case of grid fees.

2 „Grid parity“– What is it?

The term ‘grid parity’ was conceptualised in the context of the expansion of renewable energies and has found increasing use in recent years. Essentially, it describes the point at which the electricity production costs from systems using renewable energies are lower than the electricity purchase costs of the end customer. The term is used primarily in the context of photovoltaic systems.

If this point has been reached, it is often argued, the internal use of generated electricity would make sense not just from an individual economic perspective, but also from a macroeconomic perspective. A reference is often made to expensive electricity production from fossil fuels, which often have to be imported. This view, as it will be shown below, is erroneous.[1]

[1] This problem has been indicated elsewhere, for instance Frontier (2012), without however quantifying it.

2.1 Supply of PV systems and demand for electricity in private households

The reference to electricity production costs and consumer prices obscures the larger picture as the feed-in occurs on a supply basis, independently of consumption. In fact, actual supply and demand do deviate greatly from one another, in particular for photovoltaic systems:

a. Due to their nature, PV systems only produce electricity in the course of the light day. There is, of course, however, nightly demand as well.
b. PV systems produce electric power most intensively in summer whereas the demand is greatest in winter.

Figure1 shows this relationship again for two selected days in January and July. However, private customers, of course, wish to be supplied with electricity on a constant basis, on every day of the year, at the lowest possible cost.

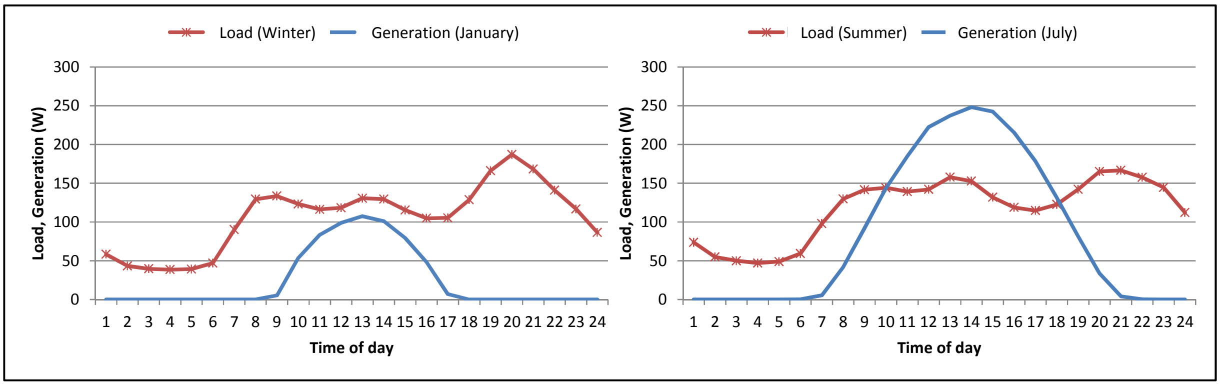

Figure1:Supply of PV systems and demand for electricity in private households using the example of two selected days (schematic diagram, see: Bode 2010).

2.2 Options to synchronize supply and demand

In order to bring supply and demand more in line, households have various options, including:

a. Use of (battery) reserves for storage of surpluses during the day and use later in the evening and the night;
b. Load transfer toward mid-day;
c. Realignment of PV systems (east-west orientation).

However, the problem remains of what to do with the seasonal imbalance between supply and demand. Sufficiently large storage is possible but increases the cost dramatically. For this reason, from an individual financial standpoint, it makes sense, at least for the duration of winter, to remain connected to the grid and take advantage of the associated supply security.[2]

Of these three options, storage using batteries will take on the most important role, at least in the short term. Just recently, the German Federal Ministry for the Environment (BMU) announced promotion of such systems with up to €50 million in subsidies. Depending on the costs per system, 2,000 to 3,000 installations are expected.[3] With the initial financial support, among other things, the costs of such storage systems are meant to be lowered.

If this cost reduction is in fact achieved (one should also take into consideration that declining costs are also expected for the PV systems themselves[4]), then the entire system (PV and storage)[5] could indeed continue to become more attractive from an individual economic perspective. At the same time, far-reaching consequences would be associated with a continuing increase in the proportion of energy consumption. These consequences are described and quantified as follows.

3 What does internal energy consumption actually cost?

In order to assess internal consumption or support for internal consumption, it is first necessary to look at the different components of electricity prices for household customers in Germany (cf. Table 1). A differentiation should be made between:

- The actual costs for the generation and distribution of electricity (generation, distribution, grid use)
- Taxes, duties and surcharges for financing various objectives
- The VAT that applies to all other components.

On average, a typical price of electricity for residential customers would amount to 29.11 cents per kilowatt-hour (ct/kWh) in 2012. For an average four-person household with an electricity consumption of 3,600 kWh/year, this results in electricity costs of some €1,000 per year. For all households, the costs add up to around €41 billion per year. Generation and distribution are responsible for around one quarter each, while the VAT makes up one sixth (of the gross price). The remaining third part is composed of taxes, duties and surcharges.

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2 Of course, other options are conceivable, such as the use of emergency generators. Whether this is an approach that can be implemented broadly is an open question, especially considering the associated poor efficiency and high emissions of classical air pollutants.

3 Refer to Mihm (2013), for example.

4 See, for instance, FhG-ISE (2012).

5 For concrete offers for storage systems, see, for instance, <http://enerix.de/photovoltaik/>.

Table 1:Components of the electricity price for household customers in Germany (FhG-ISE 2013, BMWI 2012, internal calculations).

Components of the electricity price for household customers	Specific, per kilowatt hour	Absolute, typical household	Absolute, all households
Electricity consumption		3,600 kWh/a	140 TWh/a
	ct/kWh	€/a	Billion €/a
Production, distribution	7.60	274	10.6
Grid usage	7.00	252	9.8
Renewable Energy Act (EEG) surcharge	5.30	191	7.4
Offshore liability surcharge	0.25	9.0	0.4
CHP surcharge	0.13	4.7	0.2
Electricity grid access act (StromNEV) surcharge	0.33	11.9	0.5
Concession fee	1.80	65	2.5
Electricity tax	2.10	75	2.9
Value-added tax	4.60	166	6.4
TOTAL	***29.11***	***1,048***	***40.8***

Under the currently enforced regulations for internal consumption of electricity from PV systems, an owner is relieved of all these expenditures, except for the VAT. An owner would only bear the costs of the PV system's servicing.[6] The following subsections will therefore discuss which exemptions can be reasonably justified here.

3.1. Production and distribution

This represents the costs for electricity procurement through the corresponding energy supplier. This variable is based on the relevant wholesale price. There are also costs for the distribution organization.

It is obvious that a self-producing consumer does not bear the costs of energy quantities that are not used. Energy companies, however, argue that the fixed costs of the electricity distribution are largely independent of the consumed quantity and thus the same problem arises as it does in the case of network charges, to be described in the next section. From the perspective of the author, however, it is up to companies to adapt their rates accordingly. Therefore, this cost position is not considered in the following.

3.2. Network usage and concession fee

[6] In the document recently presented by the Ministry of Environment (BMU) and Ministry of Economics (BMWi) 'Gemeinsamen VorschlagzurDämpfung der Kosten des Ausbaus der Erneuerbaren Energien' (Joint proposal for damping the costs of the expansion of renewable energy) (BMU / BMWi, 2013), the following statement is made (translation of original): "Self-generation and self-consumption: A minimum surcharge will be introduced for all systems. Except for plants with a capacity of less than 2 MW and CHP plants." A detailed design of the plan is still pending, however. With the targeted lower limit of 2 MW, PV systems for private homes would not be affected.

This is different in the case of network usage. The case of a completely autonomous, i.e. completely disconnected from the public network, household is not considered here. This is theoretically possible, but associated with very high costs. In practice, a PV system is typically installed in parallel with the mains. This makes it possible to feed in unused electricity as well as to receive electricity when the light day is over.

The maximum load occurs in Germany in the evening in autumn. At this time it is already dark, meaning that with the current load profile, PV systems will never contribute to covering the maximum load. For this reason, they cannot effect a reduction of the installed capacity. Since the network costs are essentially independent of the quantity of transmitted electricity, for households with a PV system, the same network connection costs apply as for a household without such a system.

The installation of a battery does not change this situation. It is true that in the course of the day, for many days in the year, the power drawn from the grid can be reduced. However, it is very likely that in winter, when demand is the greatest, PV systems, which produce very little at this point in time, are snow-covered. If the household is not willing to do without the use of electricity, it will need to draw electricity from the grid during this time.

Network costs are currently based on the quantity of energy, i.e. cents per kilowatt hour. This has less to do with objective reasons than with political ones. Lawmakers want to offer an incentive to save energy. Every kilowatt saved should have a direct financial impact.

A PV system owner who uses the generated electricity thus pays less for the construction, maintenance and operation of the power grid than a household that does not own a PV system, while receiving the same services, in particular supply security, which is a valuable commodity.

The same reasoning is applicable to the so-called concession fee. The latter is collected by municipalities from the network operators for the right to use public space for the power lines. The fee is a component of the financing of municipal activities, from which the self-producing consumers profit as well. In this case as well, PV system owners exclude themselves from communal solidarity.

3.3. Renewable Energy Act (EEG) surcharge

The Renewable Energy Act (EEG) surcharge is used to finance renewable energy generation. In this regard, it could be argued that a PV system owner has been proactive and should thus be freed from the surcharge. On the other hand, it was the significant support from rest of the electricity consumers that made the cost reduction for the PV systems possible. It can thus certainly be argued that PV system owners with own consumption should contribute to these efforts and their ongoing costs.

3.4. Offshore liability surcharge, CHP surcharge, electricity grid access act (StromNEV) surcharge

The offshore liability surcharge is used to financially insure windparks on the ocean that are built but not yet connected to the grid.

The CHP surcharge is used to provide incentives for the construction of combined heat and power plants. These belong to the category of supply-independent power plants that are needed to ensure the power supply when solar and wind power sources are not available. If they are designed as cogeneration plants, their waste heat should be used, thus achieving a higher efficiency level. Thus, a contribution is meant to be made for climate protection, which is a societal goal.

The Electricity Grid Access Act surcharge finances the exemption of the German industry from the electricity grid access. This exemption is justified by the fact that industrial competitiveness must be maintained. Thus, this is not in itself environmental policy, but rather an industrial one.[7]

All three surcharges mentioned are thus used to finance societal tasks to which one can well argue that all electricity consumers, including users of PV systems, should contribute.

3.5. Electricity tax

The electricity tax is part of the so-called ecological tax reform. Its objective is to provide relief for the production factor of labour (through payments to the public pension fund) and increase taxation of resources' consumption. This creates a positive incentive for work and a negative incentive for the consumption of resources. The essential character is, however, that regulatory aspect of this tax is secondary. Its primary purpose is to raise funds.

When a significant proportion of the payers are exempted because they generate their own electricity, this leads to the loss of revenue for the public sector, which must be compensated from elsewhere. Further, in principle all private PV electricity producers can profit from the benefits of the reduction in labour costs. For these reasons, PV system owners should pay this tax as well.

3.6. Value-added tax

The rules for VAT on internally consumed electricity for solar systems are very complicated. In general, value-added tax must currently be paid by PV system owners on the electricity that they themselves use. Since recent times, a general electricity price is used as the VAT's basic rate. For this reason, this tax is not further discussed here.

Table 2 summarizes the discussion by identifying the components of electricity price that:

a. Are directly related to electricity consumption;
b. Are used to finance societal functions.

The cost components listed under (Section 3.6.a) should certainly be financed by PV system owners as well. In the view of the author, the latter should also finance the components listed under (Section 3.6.b). As different perspectives are possible, the two categories are shown separately, and a minimum and maximum contribution of PV system owners towards these costs are reported. The costs from which PV system owners are exempted add up to 9-17 cents per kilowatt hour consumption (see Table 2).

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7 It should be mentioned for the sake of completeness, that the actual design of industry's exemption from the renewable energy surcharge is in need of reform.

Table 2:Minimum and maximum surcharges on the electricity price that should also be paid by PV system owners (internal calculations).

Components of the electricity price for household customers		Specific, per kilowatt hour
		ct/kWh
a.	**Components that are directly related to the provision of electricity and therefore should certainly be paid**	
	Grid usage	7.00
	Concession fee	1.80
Subtotal, net		88,00
b.	**Components that provide financing for general societal tasks**	
	Renewable Energy Act (EEG) surcharge	5.30
	Offshore liability surcharge	0.25
	CHP surcharge	0.13
	Electricity grid access act (StromNEV) surcharge	0.33
	Electricity tax	2.10
Subtotal, net		118,00
TOTAL, net		***16.91***

The following examples illustrate the dimension of the different economic structures from different perspectives:

Perspective 1: Single-family house owner

First, a single-family house is considered, which is inhabited by a family of four persons. It has a typical power consumption of 3,600 kWh per year. It lies in a region where a PV system can be used for an average of 900 full-load hours per year. Using the most basic calculation, a 4 kW PV system would be needed to cover the entire electricity demand of the house. However only 30% (1,080 kWh) of the electricity generated can be used directly in the house itself. A remaining 2,520 kWh must be taken from the grid. Installation and operation of the required grid connection would cost the same, regardless of whether 3,600 or 2,520 kWh of electricity pass through it. The family nonetheless saves between €95 and 183 per year (1,080 kWh times 8.8 or 16.9 ct/kWh) in surcharges.

The described PV system costs around €8,000 today. These savings in the surcharges thus represent an <u>additional</u> yield on the investment of 1.2 to 2.3%, a return that is hardly possible to achieve with a saving account.

Perspective 2: Totality of the private electricity consumers

Currently, PV systems are installed in Germany with an average capacity of around 30 GW. The Renewable Energy Act currently provides for an upper limit of 52 GW, which will however be evaluated when reached.

We will consider the case in which 10 GW of PV capacity is installed in private houses. At 900 full-load hours per year, 9 TWh of electricity can thus be generated per year, of which 30% or 2.7 TWh are used in the households themselves.

Thus, the public is denied revenue of €240-460 million per year. We can assume that relevant societal functions should continue to be financed, meaning that the funds missing must be provided by the remaining power users or taxpayers. If this sum is to be generated via the electricity not directly generated by PV systems, it results in an additional surcharge of 0.17 to 0.33 ct/kWh. This means that a new explicit or implicit surcharge looms for the other electricity consumers, which would reach a similar magnitude as the offshore surcharge, the Electricity Grid Access Act surcharge, or the CHP surcharge.

Perspective 3: A small community

Let us consider a town with 10,000 inhabitants, each of whom has a power consumption of 900 kWh per year. If 30% of this is generated by PV systems themselves, the community will lose revenue from the concession fee on the amount of €49,000 e per year.

Perspective 4: Battery storage

The German government plans to promote the building of small storage systems for PV systems at the cost of €50 million. This will be enough for financing the construction of about 3,000 systems. This type of storage, typically in the form of a battery, can increase the proportion of internally used electricity to about 50%. Thus, complete self-sufficiency of the house is not nearly achieved, which could justify an exemption from fees for network usage.

For the single-family house described above, this means additional savings of €63-122 per year. When applied to the 3,000 systems with the typical duration of the feed-in tariff of 20 years, additional costs of €3.8 to 7.3 million could thus be incurred.

4 What can be done?

The current arrangements for household consumption of electricity from PV systems would necessarily lead to a redistribution of costs from the owners of PV systems to other electricity consumers. It is unclear whether policy makers are aware of the possible implications of this development. If this redistribution of costs is not desired, then PV system owners should contribute to the cost coverage of electricity grid and other societal functions. The following options for the latter could be available:

- Network usage fees and other surcharges levied at the same rates for internally used electricity.
  - Advantage: The costs are distributed across all electricity consumers. The incentives to conserve electricity remain in place.
  - Disadvantage: Metering and billing expenses increase.
- Network access fees and other surcharges may also be levied as a fixed amount and not dependent on power consumption. Thus, a network connection for the example 4-person household, notwithstanding actual consumption, would cost around €250 per year (cf. Table 1).
  - Advantage: Fixed amounts are easier to handle than the billing based on internal use. They more closely represent actual distribution of fixed and variable costs.
  - Disadvantage: The incentive to conserve electricity is reduced.
- For houses with PV systems, different electricity tariffs may be introduced with correspondingly higher rates for the individual surcharges.
- The authorities may decide that the additional promotion of PV systems is desirable and the current system be kept intact. In this case it should be made clear, however, that PV systems are energy-efficient only from the private consumer’s perspective, and a macroeconomic evaluation of their impact would lead to a different result, in particular with regard to the costs’ distribution.

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