> Competitiveness

Supporting Solar Photovoltaic Electricity
An Argument for Feed-in Tariffs

European Photovoltaic Industry Association

Photo cover
Ohta City Land Development Corporation

Executive summary

For a number of reasons, there is a great need to support renewable electricity in general and solar Photovoltaic (PV) electricity in particular. The accumulation of greenhouse gases in the earth's atmosphere is already posing a grave threat to mankind but is expected to get much worse in the coming decades. Even without the problem of climate change, the need for action would nevertheless exist. The global electricity generation portfolio is based on exhaustible and scarce fuels (uranium, gas, coal, petroleum). Global reserves are diminishing fast and fuel prices are increasing drastically which is seriously damaging the global economy. One needs to decouple economic growth from the supply of fossil fuels.

Vast deployment of renewable electricity is the only answer and PV is a technology with one of the highest potentials to do so. As a very positive side effect, employment and domestic industries are created.

Policy makers have started understanding the urgency of the situation and several policies to support renewable electricity are being put in place. A number of different support schemes at various locations around the world have been tried over the years.
Some general criteria should be used to evaluate such support schemes:

- **Investor security**: every support scheme that poses any risk for investors will fail
- **Simplicity and facility of implementation**: this is key to reach small scale investors like the ones investing in private PV systems
- **Cost effectiveness**
- **Triggering the growth for a mix of technologies**: only a support scheme that, includes new technologies with immense potential, can lead to a sustainable energy future
- **The simplest evaluation of the above criteria is the following: have a look at all countries where support schemes are put in place and ask where it worked out best, and then simply copy it!**

The success story of PV deployment in Germany speaks for itself: this country has one of the simplest feed-in tariff systems in the world. In 2007 alone, Germany installed approximately 50% of the annual global PV installations.

This report gives an overview over different support schemes and their characteristics. It shows that a feed-in tariff support scheme clearly meets the above criteria very well. Throughout the report, the reader will find detailed information and arguments, which should be taken up in order to spread the feed-in tariff to more and more countries.

Table 1: Evaluation of Different Support Mechanisms for PV

	Investor security	Simplicity	Proven Success	Cost Effectiveness	Guarantying a mix of different technologies
Feed-in Tariff	☺☺☺	☺☺☺	☺☺☺	☺☺☺	☺☺☺
Quota systems	☹☹☹	☹☹☹	☹☹☹	☹☹☹	☹☹☹
Investment subsides	☺	☺☺	☺	☺	☺
Voluntary demand	☹	☺☺	☹	☺☺☺	☹☹☹

1. Why do we support Renewable Electricity?

The European Heads of State concluded in March 2007 that the EU is “committed to transforming Europe into a highly energy-efficient and low greenhouse-gas-emitting economy”. To this end, they called for a new EU Energy policy respecting the following key objectives:

- increasing the security of supply
- promoting environmental sustainability and combating climate change
- ensuring EU competitiveness and affordable energy

The promotion of renewable energies is fully in line with these objectives and represents a crucial element in the new energy policy. Renewable energies contribute to security of supply as they are used domestically, and ensure long term competitiveness as they will be the cheapest option in the mid and long term. Moreover, they contribute substantially to one of the greatest global challenges: mitigating climate change. Furthermore, a domestic industry has already established itself and has shown an immense potential for exports and employment creation.

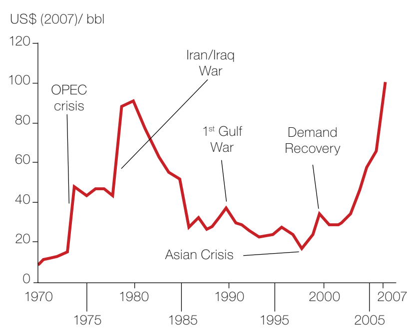
Security of supply

At present imports account for half of all European fossil fuel consumption. The share of imports is expected to continue increasing in the next 20 years, coming in particular from the Middle East and Russia. Additionally, many oil producing countries experience unstable political situations.

The International Energy Agency (WEO, 2007) predicted a growth of demand for oil by 37% by 2030 at a global level, mainly driven by China and India. Oil prices have increased by four since 2001, reaching a record price exceeding 98 $/bbl in early November 2007 (IEA). This situation clearly raises very significant concerns for EU competitiveness and the security of its energy supply.

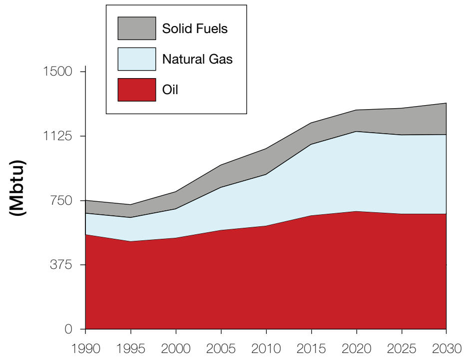
Figure 1a: Oil Price Development

Oil price has doubled in only three years (2004 - 2007)



Source: The Council of the European Union

Figure 1b: EU 27 Net Imports of Fuels



Source: European Commission, DG TREN, PRIMES Baseline Scenario

The EU must reduce its dependence on imported fossil fuels. Diversification of energy sources in particular via the development of a strong domestic renewable industry is a key part of the solution.

Climate change

The Intergovernmental Panel on Climate Change (IPCC) released a synthesis report in November 2007 which unambiguously confirmed the warming of the global climate and linked it directly to human activity. International action is therefore required to mitigate the negative consequences of climate change and limit the global increase of greenhouse gas emissions to no more than 2°C above pre-industrial levels. The European Union is willing to play a leading role in this fight. It is committed, under the international Kyoto Protocol, to a reduction of 8% of its greenhouse gas (GHG) emissions over the 2008-2012 period in comparison to 1990 levels. In March 2007, the Heads of state of the EU went even further: they endorsed an ambitious target of a 20% reduction of EU GHG emissions by 2020 and recognized the urgency for “redirecting and scaling up investment in low-carbon energy technology globally”.

These initial steps are important ones. However, even more drastic emission saving policies and targets will be necessary in the future. PV, as all other renewable energies, produces electricity in a CO_2 neutral way. Only insignificant CO_2 emissions arise during the production of PV modules and other equipment. Every single kWh of PV solar electricity saves between 835 – 879 g of CO_2 when replacing a European thermal power plant.

PV $C0_2$ emissions: 21 – 65 g/kWh. Average thermal power plant CO_2 emission: 900 g/kWh

The EU sets itself ambitious targets to reduce its carbon footprint in the next decade. Yet fulfilling these targets will require significant investment efforts particularly in new energy technologies.

Grid connected Solar Photovoltaic Electricity has not reached competitiveness yet but it has considerable long term potential

The photovoltaic industry has one of the highest long term potentials among renewable energies. Economies of scale and R&D achievements are the major driver for cost reductions. An increase in production capacities has already reduced PV production costs and prices tremendously. Today, the PV industry is on the verge of entering an era of real mass production. There is a general consensus that the potential for further cost reduction is immense. It is known that every time the global production output is doubled, production costs are being reduced by approximately 20%. Growth towards larger scale production is only possible with an increase in demand, trigged by support mechanisms. Mass production lowers production costs which leads to lower consumer prices which in turn triggers further demand. This self reinforcing, dynamic development will continue in the future, providing a cheap, reliable and clean energy source. To make that happen, market support is needed today. However, it is clear that this support can only be temporary.

In addition R&D efforts can speed up cost reductions for PV manufacturing. Both, private and public funding for R&D will be necessary for that. Currently the Photovoltaic industry is investing heavily in research.

While PV off-grid applications are for the most part already competitive, the majority of grid connected applications are no yet competitive with residential electricity prices. According to current estimates, PV solar electricity will become cost-competitive with peak power prices by approximately 2015 in Southern Europe and 2020 for most of Europe.

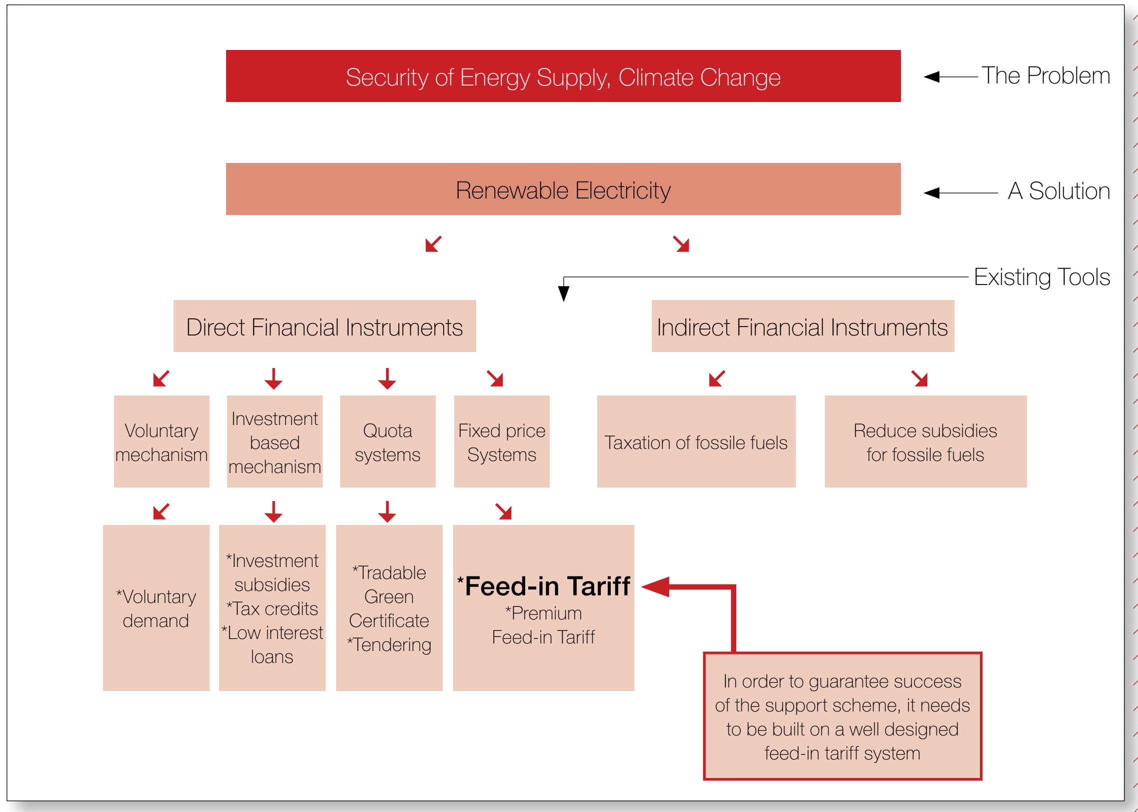
The photovoltaic industry has considerable long term potential, provided it is properly supported in its early stage.

Conventional energy technologies have been supported over decades
Why are electricity market prices for conventional technologies low? For decades fossil and nuclear technologies have benefitted from market support in the form of subsidies for R&D, tax incentives and waste disposal. Therefore, it is only fair that renewable technologies also receive the same opportunities. Furthermore, external costs (environmental destruction) from conventional technologies are not reflected in the market price. Putting a price tag on e.g. potential nuclear accidents or the consequences of extreme weather events and no simple task; these effects must nonetheless be reflected in the market price.

Conventional energies receive very significant subsidies. A fair treatment of renewables requires similar financial support.

2. What mechanisms are available and how do they work?

Figure 2: Origins and Structure of Support Mechanisms



It is evident that without the support of suitable instruments, the expansion of the worldwide solar PV electricity market will not happen at a 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. Like every other industry, the solar electricity sector will only move forward if sufficient investment is committed to provide for its expansion. Over the past few years, the solar industry has been very successful in drawing the attention of the financial world to this young and dynamic market. A "solar boom" is still evident in the investment community. Both industry and governments need to ensure that the financial world maintains its interest in renewables in order to make sure that the necessary financing is in place to keep up the current rate of expansion.

There are many different ways to support renewable electricity, including awareness building and removing barriers such as limited access to the electricity grid.
This publication however focuses on market support schemes.

Experience has shown that a well designed feed-in tariff is the most suitable form to support PV electricity.

The following chapter gives an overview about existing support instruments for renewable electricity in general and PV in particular.

✜ Direct support mechanisms

Fixed price systems

Feed-in Tariff

Contrary to a quota system, in a feed-in tariff schemes, a price for each kWh that is produced is fixed.

The basic idea behind a feed-in tariff is very simple. Producers of solar electricity

- have the right to feed renewable electricity into the public grid
- receive a tariff per generated kWh reflecting the benefits of solar electricity compared to electricity generated from fossil fuels or nuclear power
- receive the tariff over a fixed period of time

All three aspects are simple but it took considerable efforts to establish them. For many years, the power utilities did not allow the input of solar electricity into their grid, this continues to be the case in numerous countries to this day.

✜ Feed-in tariffs: A temporary measure to develop the market

Feed-in tariffs are a temporary measure to develop the competitiveness that will result from economies of scale. Competitiveness with conventional electricity sources will be reached in different regions at different times. Feed-in tariff systems therefore need to be adapted to national conditions. However, it is important that tariffs are paid over a period of roughly 20 years from the day the system is connected to the grid because the costs will be related to the initial investment. In a few years, investment costs will be low enough to be paid off without using the support of feed-in tariffs.

✜ Feed-in tariffs: Who pays for it?

In Germany in 2007 the utilities pay a tariff of between €0.38/kWh and €0.54/kWh (depending on the size and type of system) for solar electricity from newly-installed PV arrays. The utilities are authorized to pass on this extra cost, spread equally, to all electricity consumers through their regular electricity bill. This means that the feed-in program works independently from the state economy, and the extra cost which each electricity consumer has to pay in order to increase the share of renewable energy in the national electricity portfolio is very small. In Germany, the largest global PV market, the extra monthly cost per person due to the feed-in tariff for solar electricity was slightly over €0.20 per person in 2006. This also means that every electricity consumer contributes to the restructuring of the national electricity supply network away from a fossil-based one and towards a sustainable and independent structure. In the past many programs were financed through government budgets. The disadvantage of this approach has been that if the money ran out, or was curtailed, the program could be stopped. Feed-in tariff models which are fincanced by through the regular elelctricity bill do not suffer from this drawback.

2. What mechanisms are available and how do they work?

✜ Feed-in tariffs: The driver of cost reduction

The costs for solar electricity have been diminishing consistently since the technology was first introduced to the market. Even so, in most cases solar electricity cannot yet compete with grid electricity generated from fossil fuels. Whilst it is expected that prices for electricity generated from fossil fuels will keep rising, it is still very important to maintain a strong momentum in bringing down the costs for solar electricity.

For this reason, the feed-in tariff in Germany is reduced each year by 5%, but only for newly installed PV systems. Once a PV system is connected to the grid, the tariff remains constant over the complete period of 20 years. Through this 5% annual reduction, there is therefore constant pressure on the PV industry to bring the costs for solar electricity down by 5% each year in order to keep the market alive. At the same time, the customer can easily calculate the return on investment in their PV system. This planning security is an essential element of the success story of the feed-in tariff.

✜ Feed-in tariffs: The driver of high-quality solar electricity systems

Many solar electricity support programs are based on an investment subsidy in order to reduce the barrier of high up-front capital costs. The drawback of such an approach is the missing incentive to invest in high quality solar electricity systems and to ensure their efficient operation and maintenance. If the customer receives a fixed payment per installed capacity unit, there is no incentive to go for high-quality products, which usually means a higher price, or to operate the system at the highest possible level. With the feed-in tariff the return on investment is heavily dependent on the performance of the PV system. The customer gets his return on investment with each kWh that is fed into the grid. Therefore maximizing the power output of the PV system over its whole lifetime is essential to the customer, ensuring that the PV system will be well operated and maintained.

✜ Feed-in tariffs: Investment security

A feed-in tariff guaranteed by law over a sufficient period of time serves as an excellent security for the customer's bank in order to finance the system. The PV system itself, combined with the guaranteed feed-in tariff over 20 years in Germany, is usually sufficient to receive a loan from a bank. Of course it took some time for banks to become familiar with PV systems and the implications of the feed-in tariff. Nowadays the financing of PV systems via bank loans in Germany is no longer an unusual and time-consuming activity but very common and straightforward.

A feed-in tariff is not a guarantee for success, per se. It also needs to be well designed. The tariff needs to be high enough to interest investors but should not exceed a publicly acceptable level.

Feed-in Tariffs – Core Elements

- An efficient tool that has already proved to be successful
- A temporary mechanism
- Not a burden on taxpayers
- The driver for further cost reductions and economies of scale
- Ensures high quality PV systems and good performance
- Creates secure conditions for potential investors

Premium Feed-in Tariffs
Premium feed-in tariffs work similarly to the regular feed-in tariff schemes. The investor is guaranteed to receive a certain price for each kWh produced. However, with a premium feed-in tariff, the tariff consists of 2 separate payments. First the produced electricity is sold to the electricity market at regular market prices. As market prices vary according to demand and supply, any shortfalls are paid to the investor in the form of a premium tariff. In a regular feed-in tariff scheme investors receive a pre-determined fixed rate.
The premium feed-in tariff is rarely used as a support mechanism for PVs as it is a complex arrangement for owners of small installations. Premium feed-in tariffs are used however, to support wind electricity initiatives in Spain.

Investment based support

Investment subsidies
Investment subsidies are a frequently applied form of support for all kinds of goods and services. PVs are no exception as grants are a commonly used tool. A specific part of the investment costs (usually a fixed amount per kWp rather than relative share) is covered by a funding institution. The subsidy is dependent on the rated power capacity (kWp) and not on the annual electricity production (kWh). Compared to other support schemes which focus on annual electricity production, **investment grants do not sufficiently motivate investors to invest in highly efficient PV systems**. As the actual production is not subsidized, less efficient modules will be used to keep investment costs down. For the same reason, maintenance efforts will be rather low. A properly maintained PV system can significantly increase the electricity output over its lifetime.

Investment grants can easily be combined with other forms of support. However, the above mentioned disadvantage can not be entirely avoided by such a combination. Also a digression rate may be applied in order to compensate the annual price reduction of PV systems. California, the most important market in the USA, is using investment grants of 2.5 USD/Wp for residential and commercial projects under 100 kWp (IEA-PVPS).

Tax credits
Tax credits are another investment focused support. The US Energy Policy Act established a 30% tax credit for qualified PV systems to a maximum of 2,000 USD. Tax related benefits could be designed in various ways. VAT, income tax, energy tax or other forms of tax could be addressed by policy makers. Also accelerated depreciation might be appreciated under certain circumstances by investors. Whether an incentive is either a cash payment or a tax related benefit does not have much impact on the economic evaluation from an investor's perspective. However, politically there can be a difference depending on who is providing the payment. **Tax increases to provide direct subsidies might result in political difficulties.**

Bank loans
Bank loans with beneficial interest rates can be a very suitable supplementary to tool to trigger demand for PV systems. The successfully operating feed-in scheme in Germany is supported by a low interest loan offered by KfW Foerderbank. Up to 100% of the investment (max. 50,000) can be subject to a low interest loan for private costumers. The KfW payback period can be as long as the feed-in tariff program (20 years). Similar programs are provided for commercial investors.

Quota systems – Government fixes the quota

Quota systems can be designed in a variety of different ways. The main principle is that the government compels producers, providers or consumers of electricity to have a certain share of renewable electricity in its mix. Quota systems are also known under "Quota Obligation" or "Renewable Portfolio Standard (USA)". While the quota is imposed, the price is set through competition between different project developers and also different technologies. A quota system does not need to be combined with other support tools. However, quota obligations are commonly combined with the following mechanisms: Tendering and Tradable Green Certificates.

Tendering
Tendering, or competitive bidding, has been used for wind energy in different countries (such as Ireland, UK, France). Under a tendering scheme, project developers submit projects and indicate the wholesale price they would like to get for the produced electricity. The company with the lowest productions costs will be able to ask for the lowest price and will finally get the order. The project developer enters a contract which guarantees that the electricity will be bought over a defined period of time (power purchase agreement). The difference between the current market price and the contracted price in the power purchase agreement represents the value that needs to be financed either by a public promotion fund or a levy on the electricity bill.

Obviously, for small scale PV system, this mechanism is too complicated and transactions costs are too high. Also for bigger systems, tendering has a major drawback. In order to be able to participate in bidding procedures, a project incurs considerable planning costs. Planning costs in case of non-acceptance of a project are not refunded to the developer which undoubtedly reduces the attractiveness for developers.

The experience of tendering for wind project in the UK showed that contract holders waited for a long period of time (production becomes usually cheaper for renewable energy over time) until the system was built, if it was built at all. These factors resulted in ineffectiveness in the system. Furthermore, a penalty system needs to be put in place to avoid unrealistically low bids which can not be fulfilled.

Tradable Green Certificates (TGC)
Tradable Green Certificates resemble the Tendering mechanism. Instead of entering a power purchase agreement, in a TGC scheme, prices are set on a frequent basis. Due to varying prices (values of certificates), investors lose security on their returns on investment.

A typical TGC scheme works as follows: governments set a usually increasing quota for renewable energy in the supply portfolio. The producers, wholesalers, retailers or consumers (depending on who is obliged) are obliged to supply or consume a certain percentage from renewable electricity sources. For each unit of renewable electricity (eg. MWh), a certificate is generated and issued to the producer. This certificate serves as proof that renewable electricity was delivered into the grid.
Certificates can be obtained by the following paths:

- A supplier owns generations plants
- Certificates can be bought from other generation plants
- Certificates can be bought from a broker who often acts as an intermediate

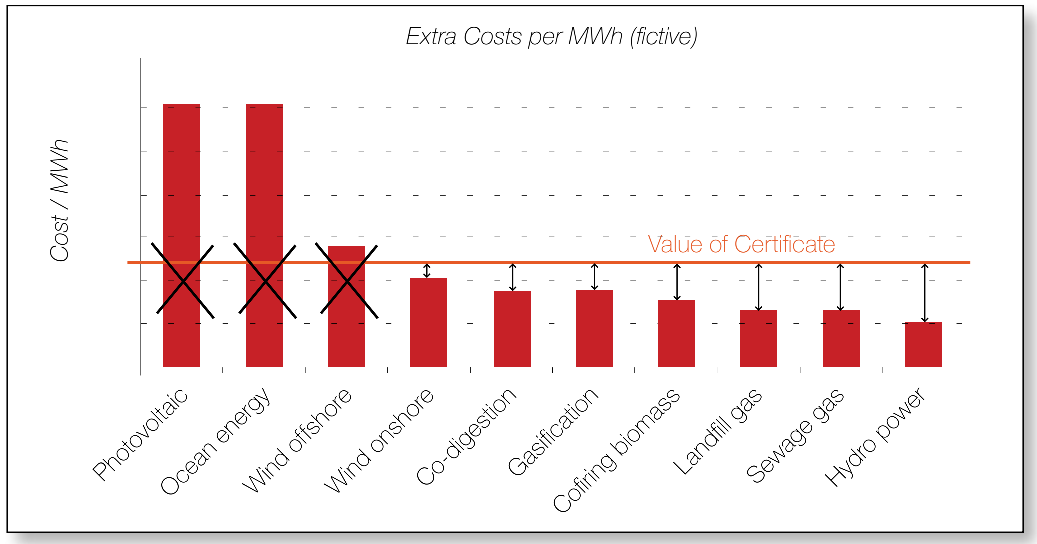
In order to enforce the scheme, penalties need to be set if quotas are not reached. Penalties need to be considerably higher than the expected value of certificates in order to motivate quota compliance. If penalties are set too low, they might have a price controlling factor.

By setting a quota which increases over time, the demand for certificates also increases over time. It is left to the market to deliver the certificates. The value of certificates will determine if it is profitable for generators to set up a generation plant or not. In case demand exceeds supply (meaning less renewable electricity is produced that set in the quota), the value of certificates will rise until further investors set up generation plants. The value of the certificates increases until a sufficient number of investors see a sufficiently high return on investment. An underlying aim of this support scheme is that the target should be fulfilled in the cheapest way. Technologies with the lowest generation costs will be able to operate under a TGC scheme. This will lead to a homogenous energy portfolio of technologies.

Technologies like PV are currently not competitive with other renewable technologies. However, their long term potential in cost reduction is immense and their potential of contribution to future production is larger than for other energy sources.

New and emerging technologies will not get a chance on a TGC market. A sustainable energy mix with large potential for CO_2 reduction can only be reached by a mix of different technologies.

Figure 3: Tradable Green Certificates – Costs per MWh versus Value of Certificate



Source: EnerQ

Figure 3 illustrates that some technologies will be excluded from a TGC scheme while already mature technologies are stimulated (only fictive values are used to show the impact). Unlike in the feed-in tariff scheme where each technology has a specific feed-in tariff which compensates the specific generation costs of the technology, a TGC scheme has no technology specific price. Therefore, a number of technologies will generate windfall profits, meaning that the compensation is higher than their actual generation costs. For this reason,

TGC schemes have proven NOT TO BE COST EFFICIENT and turn out to be more expensive than feed-in tariff schemes.

By setting a quota, there is no incentive to produce more than the quota stipulates. A quota is therefore acting like a cap which is avoiding additional production of renewable electricity.

Operators need to be active on 2 different markets. The electricity is sold on the electricity market and the certificates are traded on a separate market. Due to the complexity and transaction costs of the support scheme, centralized production of electricity is favored and therefore prevents the emergence of small scale decentralized electricity production.

In order not to exclude emerging technologies from TGC, technology specific quotas (or even application specific quotas – large scale versus roof top PV systems) would need to be set. However, this would increase even more its complexity and liquidity would be low. The low investor security remains the major limitation.

Voluntary mechanism

In theory, voluntary demand for renewable electricity could lead to a faster deployment of PV. High voluntary demand for clean electricity could attract new investors in renewable electricity. A new market would be created. However, investors need secured demand over years in order to payback the investment costs and generate profit. A voluntary support scheme can hardly guarantee demand over years.

The positive aspect about voluntary demand is that it is independent of policy support. Indeed no public opposition can be expected as no public budget is concerned. Such a support scheme is fully dependent on the awareness of customers of the benefits of PV and willingness to pay slightly more for green electricity. A number of utilities offer a high share of green electricity in their electricity mix. Although a high number of these offers can be found, **they have not shown to be successful by convincing a significant share of electricity consumers to switch to cleaner electricity technologies**.

In Germany for example, almost all green power providers exclude solar PV from their portfolio. Only Greenpeace energy has an obligation (set as a mandatory obligation by Greenpeace as a green power criteria) to have a minimum share of 1% of solar electricity in its green power portfolio. This created approx 3 MW of solar PV - partly in Austria -where there is not enough incentive to invest in PV (Greenpeace International).

Support schemes need strong non-financial co-drivers

Simple and quick administration

There are countries in Europe with an economically attractive feed-in tariff in place but without a viable PV market. How can this happen? The feed-in tariff needs a strong partner in order to release its full power; this is a simple and quick approval process. Even if an excellent feed-in tariff is in place, but the procedures for the approval of PV installations and their connection to the grid take many months, perhaps even more than a year, the number of potential customers will remain limited. The customer's effort in dealing with administrative and licensing issues therefore needs to be kept to a minimum. A complex and time-consuming administration and licensing process is a clear indication that an electricity market has not yet made substantial progress towards liberalization.

Guaranteed grid access

Given its major social and environmental advantages, solar electricity should be given priority and guaranteed access to the grid. In many countries there is an enormous over-capacity in conventional electricity generation, with a range of power sources – from fossil fuels through to renewables – all jostling for the right to be fed into the grid. Solar electricity generators must be guaranteed automatic access, because of their high ecological and technical value, including support for local grid stability.

Government and industry commitment

Governments that have taken steps to broaden their energy supply base with an abundant clean technology such as PV will be able to count themselves among the winners. Such diversification not only brings benefits in terms of greater security of energy supply and creation of employment and industrial activity. It also leads to wider environmental benefits though the deployment of zero-emission technologies.

At present, the nations of the industrialized world vary greatly in their commitment to solar electricity. While countries such as Germany and Spain, as well as others in Europe, have moved forward from discussion to implementing the necessary support schemes, others have not yet started supporting this important technology.

Both industry and governments, however, will have to expand their respective commitments to the solar sector if the potential is to be fully exploited. On the industry side, continuing and accelerated investment in the expansion of production facilities is needed in order to meet the demands of the market and to ensure that the cost, and ultimately the price, of the technology is brought down through production up-scaling and introduction of new manufacturing techniques and materials. On the government side, commitment to the solar electricity sector in many countries needs to be extended through such actions as the introduction of tariffs and the adaptation of building regulations to provide a greater incentive for the deployment of solar PV electricity systems in the built environment.

2. What mechanisms are available and how do they work?

✜ Indirect mechanisms

Certainly there are also a number of indirect financial support mechanisms for renewable electricity in general and PV in particular. In order to reflect the external costs of conventional electricity sources (see chapter 1), fossil and nuclear technologies can be taxed to compensate those external costs adequately. Consequently, PV and others renewable technologies would find it much easier to compete with conventional technologies. Reducing subsidies for those technologies would lead to a similar effect.

Programs for industrial development which facilitate the settling of PV component manufacturers in European countries would reduce start up costs for potential uprising technologies. Also national and European R&D funding programs have a major impact on the development of PV. Adequate public funding in fundamental as well applied research and demonstration projects is needed to develop new Photovoltaic technologies and improve existing technologies. A possibility of creating synergies is the inclusion of PV in other support programs for other sectors. Integrating PV in building policies is an example.

For each policy maker, target setting for electricity shares is an important tool to accelerate PV deployment and show real commitment. Targets need to be realistic but ambitious. Furthermore, targets need to be mandatory instead of indicative. Additionally, it is certainly beneficial to set targets for each technology instead of setting an overall electricity or even renewable energy target.

As demonstrated, there is a variety of different support mechanisms, instruments and supporting actions that can help PV become a major global energy source. The core of each support program should be a well designed feed-in tariff.

Kyoto based mechanisms

The aim of the Kyoto Protocol is a mandatory limitation of greenhouse gas emissions (CO_2 + 5 other greenhouse gases) to the signatory nations. United States are featured among notable exceptions. Other countries, like India and China, which have ratified the protocol, are not required to reduce carbon emissions under the present agreement.

On average emissions should be reduced to 5.2% under the level of 1990. The targets are national targets and differ greatly. In Europe, emissions should be reduced by 8% below the level of 1990.

How can signatory countries reduce the GHG emissions?

- Simply reduce domestic emissions
- Flexible mechanisms
    - Buy excess allowances from other countries (eg. ETS)
    - Clean Development Mechanism (CDM)
    - Joint Implementation (JI)

ETS

The overall target of the ETS is to reduce emissions in the most cost effective way. Within the ETS, the main EU industries can trade emissions. Member States assign quotas for those main industries (energy, steel, cement, glass, brick making, and paper/cardboard). Those 6 industries represent about 12,000 plants. If the assigned emission reductions are fulfilled, other companies who failed to reduce emissions can by buy the achieved reductions.

Private households are not included in the ETS trading, therefore the biggest market segment of PV (residential buildings) is not fostered by this mechanism. Also the power companies which are included in the ETS do not use PV to replace conventional fossil fuel based electricity. **The main industries in Europe have to reduce their CO_2 emissions, however PV was not used reach this obligation.**

CDM

Under the CDM, industrialized countries can do projects for greenhouse gas emissions reduction in non-industralized countries. The generated CO_2 reductions (so called CER – Certified Emission Reductions) are purchased by the industrialized country for a specific price. CER can be used for the domestic emission reduction target.

The Joint Implementation Mechanism (JI)

This mechanism works very similarly to the CDM except that under the JI scheme, industrialized countries can do projects in other industrialized countries, mostly in transitional Eastern Europe and the former Soviet Union, where the costs of reducing emissions are considered lower.

Theoretically PV projects qualify for CDM and JI requirements. However, one of the problems is that PV projects in developing countries are very small projects and a bundling of several projects would be necessary in order to minimize transaction costs. PV is hardly used for CDM projects. By November 2007 849 CDM projects were registered out of which only 2 were done with PV according to official UNFCCC statistics.

3. Comparing effectiveness of support mechanisms for renewable electricity?

Figure 4: Influence of Feed-in Tariff on annual PV installations in Germany (MWp)

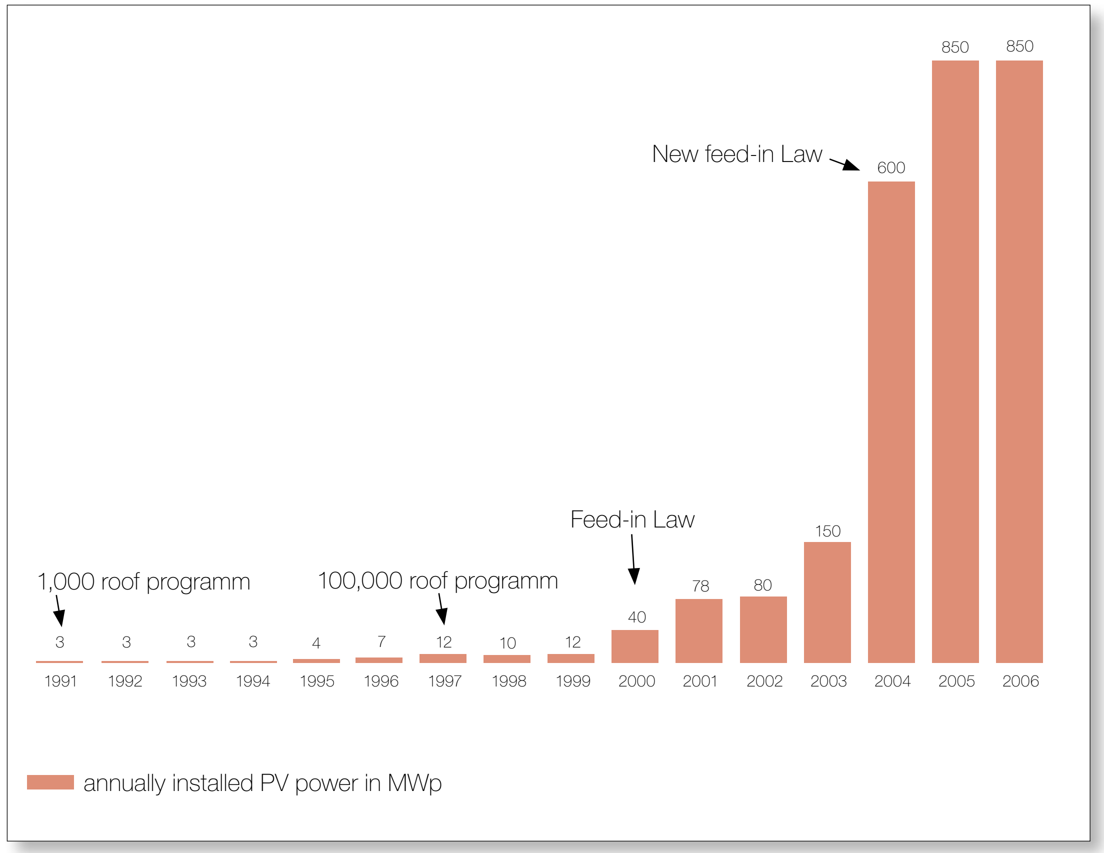


Figure 4 illustrates well the impact on a feed-in tariff on national PV deployment. Germany established a feed-in tariff for PV in 2001. In 2004 this tariff was modified and Germany became global market leader in installing Photovoltaic power systems.

Over a number of years, the feed-in tariff has proved its power and efficiency in developing new markets. Worldwide people are surprised by the fact that Germany, a country which is not one of the sunniest places in the world, has developed the most dynamic solar PV electricity market and a flourishing PV industry. How could this happen? Many different types of programs have been tried in many countries in the past in order to accelerate the PV market, but none has been as successful in such a short period of time as the feed-in tariff in Germany. The idea has been adapted for use in other European States, with each country adjusting the system according to its specific needs. Extending such feed-in tariff mechanisms beyond Germany is a cornerstone of the European Photovoltaic Industry Association's strategy for promoting the uptake of solar electricity in Europe. The simplicity of the concept and its low administrative costs mean that it is a highly effective tool for boosting the contribution of solar electricity in national energy mixes.

In the frame of the OPTRES Project PV support schemes were evaluated for their effectiveness. A support scheme is considered effective when the short term (year 2020) technical potential of PV is exploited to a large extent. It was clearly proven that feed-in tariff schemes are the most successful support scheme. Furthermore, stakeholders of the electricity market from all 27 EU Member States were consulted. **It was concluded that developers of renewable energy projects consider the stability of the program the most important factor for the scheme's success**. If this stability is not guaranteed, investors will be reluctant, banks or financiers will ask for higher equity/debt ratios or higher interest rates – resulting in lower penetration.

EPIA believes that a well designed feed-in tariff is the most adequate tool to provide the required long term stability.

EPIA- European Photovoltaic Industry Association

The European Photovoltaic Industry Association is the world's largest industry association devoted to the solar electricity market. The association aims to promote photovoltaics at the national, European and worldwide levels and to assist its members in the development of their businesses in both the European Union and in export markets.

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Text credits
Christoph Wolfsegger
Florence Limet
Eleni Despotou
Marie Latour
Michael Annett

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European Photovoltaic Industry Association
Renewable Energy House
Rue d’Arlon 63-65
1040 Brussels - Belgium
Tel.: +32 2 465 38 84 - Fax: +32 2 400 10 10
pol@epia.org
www.epia.org

Design: www.blisscommunication.be