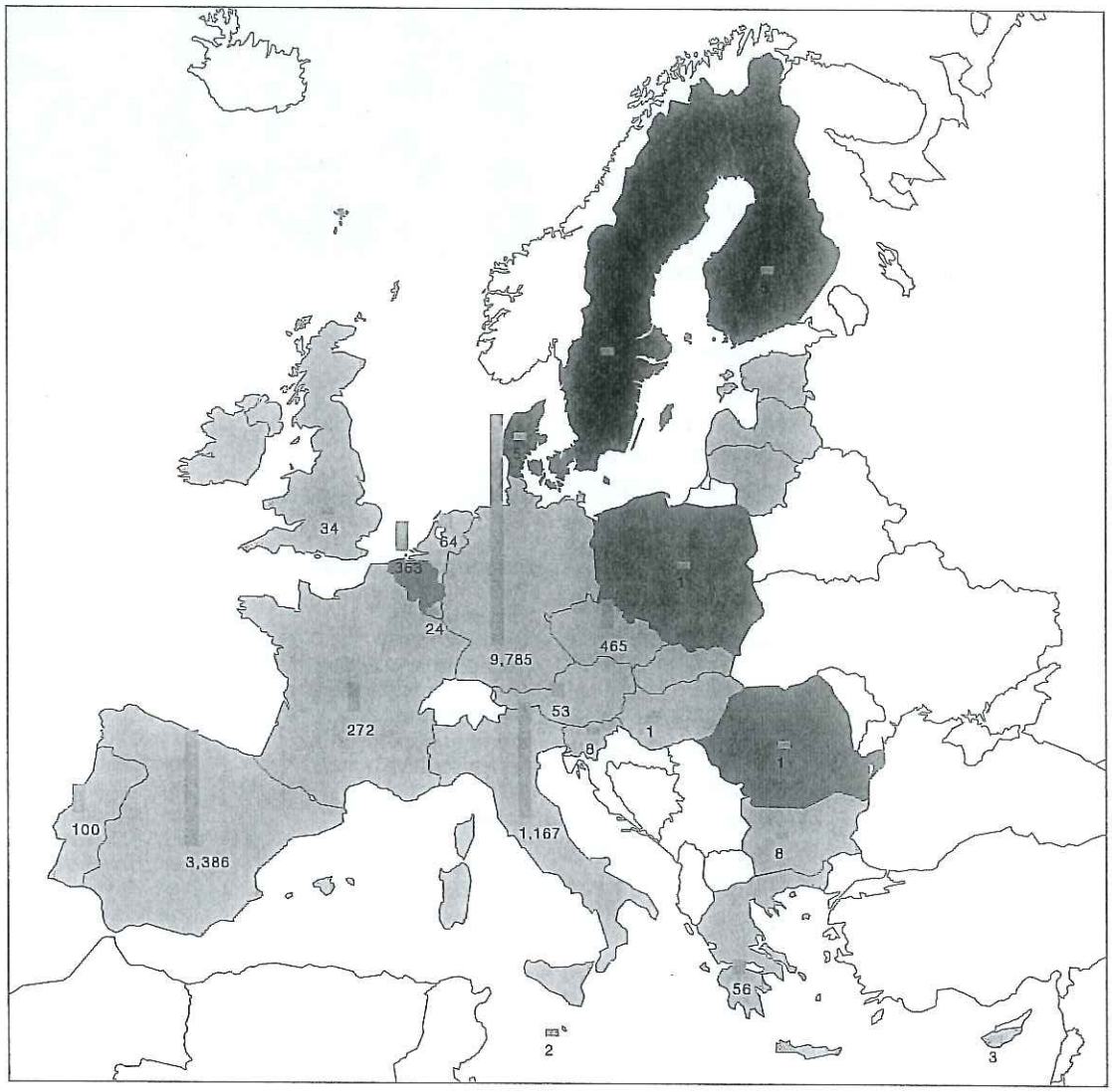
FIGURE 28
SUPPORT SCHEMES
IN EUROPE



"Levels of PV installations grow when a FiT scheme is established that is attractive to investors, well designed and accompanied by specific measures."

As shown on Figure 33, many EU Member States have implemented FiT, but not all of them have high levels of PV installation. Levels of PV installations grow when a FiT scheme is established that is attractive to investors, well designed and accompanied by specific measures (such as reduced administrative and grid connection procedures). The PV Legal project is analysing existing legal and administrative barriers in 12 EU countries that are preventing the PV market from developing to its full potential. Most of the countries under study have implemented a support scheme to deploy PV[19].

Supporting BIPV

Specific regulatory frameworks can be used to promote the inclusion of solar panels in the fabric of buildings (Building Integrated Photovoltaics or BIPV). The policies can be used to improve the energy performance of buildings and increase the amount of solar electricity in the overall energy mix.

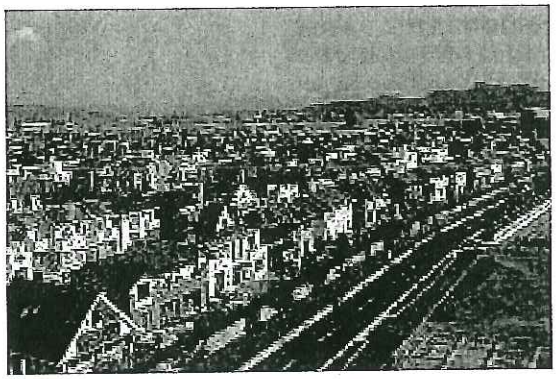
In Europe, several countries have put measures in place to support BIPV. This is largely in response to the *Energy Performance of Buildings Directive* (EPBD)[20] from the European Commission. Examples include:

"BIPV policies can be used to improve the energy performance of buildings and increase the amount of solar electricity in the overall energy mix."

- *France.* Legislation sets maximum energy consumption limits* for new and existing buildings. The limits indirectly promote the use of renewable energy and, in particular, solar technologies in new buildings and in existing buildings that are being substantially renovated.
- *Italy.* BIPV is promoted through a combination of specific requirements in the legislation to implement the EPBD Directive and the structure of the FIT.

Both in France and Italy, the requirements oblige owners of all new buildings, public or private, to install PV systems. For existing buildings, PV is mandatory if the building envelope is undergoing substantial refurbishment or, a building with a total useful surface exceeding 1,000 m² that is to be demolished and reconstructed.

- *Spain.* PV is compulsory on new buildings (see Table 13). According to the country's Technical Building Code (*Código Técnico de la Edificación*), the minimum requirements depend on the purpose of the building, the climate zone, and the dimensions of the building. Unfortunately, the obligations under this regulation are often not fulfilled. The local authorities do not always follow-up to ensure that PV has been installed.



In Ohta, Japan, an interesting experiment has been conducted. The entire town has been equipped with BIPV systems to test the feasibility of a large-scale implementation.

TABLE 13
PV OBLIGATIONS IN NEW BUILDINGS IN SPAIN

Building destination	Limits
Supermarkets	Over 5,000 m² built
Shopping and leisure malls	Over 3,000 m² built
Warehouses	Over 10,000 m² built
Administrative	Over 5,000 m² built
Hotels and hostels	Over 100 places
Hospitals and clinics	Over 100 beds
Fairground halls	Over 10,000 m² built

source: Spanish Technical Building Code.

* The limits for new buildings range between 250 and 80kWh primary/m2/year depending on the zone and the type of heating and from 130 to 80kWh primary/m2/year depending on the zone. For further information please consult the EPBD Country Energy Reports, available online at the following address: www.buildup.eu/publications/1916

4.2. Policies in the top ten markets

More than 40 countries in the world have introduced FiT for renewable energy systems including PV. The following case studies show the approaches of the top ten countries for PV deployment.

Germany

The German Feed-in Law (EEG) has inspired many other countries. It has been a strong driver for the German PV industry and has also shown the rest of the world that political commitment can achieve both environmental goals and industrial development at the same time. In June 2007, the German parliament decided to amend the EEG and introduced annual tariff decreases. In 2010, the first decrease in FiT occurred in January. Additional adjustments were made in July and October. Further decreases will be implemented in January each year. The drop in FiT has led to a sharp decline in both tariffs and system prices, putting a lot of pressure on the PV industry.

The bonus for facade-integrated systems has been suppressed and the tariff for ground-mounted systems on agricultural land has been abandoned.

Germany's scheme includes a corridor mechanism that automatically reduces the tariffs each year based on the level of the market during the past year. If the growth of the PV market (new installations) in a year is stronger or weaker than the defined growth corridor, FiT will be adjusted up or down the following year. The amount of the adjustment equals the percentage that the threshold was exceeded (or not met). In 2010, Germany reinforced the premium for auto-consumption of PV-generated electricity.

Italy

In Italy the FiT is paid by Gestore dei Servizi Elettrici (GSE). The tariffs change according to the plant size and the level of building integration.

A country that has naturally high levels of sunshine, Italy also offers an attractive support scheme. It mixes net-metering and a well-segmented FiT. In January 2009, the Italian government extended the net-metering *(Scambio sul posto)* to PV systems up to 200 kW. This ensures the PV system owners receive the same price for the electricity they produce and the electricity they consume from the grid. If, over a time period, there is an excess of electricity fed into the grid, the PV system owner receives a credit (unlimited in time) for the value of the electricity. This measure is quite attractive for the residential, public and commercial sectors. In addition to the value of the electricity they add to the grid, the PV system owners also receive a premium FiT on the total electricity produced by the PV system.

"The German Feed-in Law (EEG) has inspired many other countries."

There are also higher tariffs for BIPV systems that support the development of innovative products and applications for roof-mounted systems. The incentives will remain the same until the end of 2010 and are granted for 20 years.

After long discussions, the Italian government has finally approved the third Energy Bill *(Conto Energia)* which will reduce the tariffs in multiple phases. The government hopes it will not put the development of PV at risk in Italy. The second Energy Bill included a cap at 1,200 MW which was enhanced with a grace period. The new Bill will push this limit to 3,000 MW under the same conditions.

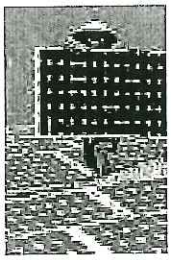
Japan

In 2009, Japan restarted its subsidy for residential PV systems and introduced a new programme to purchase surplus PV power. The changes were included in the *Promotion of the Use of Non-Fossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers* Act. Almost 99% of the PV systems installed in Japan during 2009 were grid-connected, distributed applications, mainly residential PV systems.

The Ministry of Economy, Trade and Industry (METI) allocates budgets for market revitalisation, subsidies for the installation of residential PV systems, technology development for PV power generation, field testing of new technologies, grid testing with large-scale PV power generation systems, and the development of an electric energy storage system.

In July 2009, the METI enacted legislation which obliges electricity utilities to purchase surplus PV power. Incentives also take other types of clean power generation (such as fuel cells) into consideration. Prices are expected to be reviewed annually and all electricity customers will contribute towards the costs.

Looking forward, the New Energy and Industrial Technology Development Organization (NEDO) has reviewed its 2004 PV technology roadmap. NEDO has brought forward the original timeframe by three to five years, and renamed it PV 2030+ with an outlook now to 2050. The government also increased the target for PV installed capacity in Japan from 14 GW to 28 GW by the end of 2020. By the end of 2030 the goal is to reach 53 GW[21].



Worker installing PV on roof.

United States

The United States have been a sleeping PV giant until recently.

The US economy has been in turmoil since 2008 and state legislatures faced severe budget crises in 2009. To compensate, federal and state leaders have adopted policies to develop cleaner and more diverse energy sources as tools for economic revitalisation.

In 2009, the investment tax credit cap was removed and the 30% federal investment tax credit for commercial and residential PV systems was extended to 2016. This credit can now also be used by electricity utilities. The relative vigour of the PV market depends on the approach of individual states. California, New Jersey, Florida, Colorado and Arizona are the top five states for new installations.

Between September 2008 and September 2009, approximately 40 new solar incentive programmes were created in 19 states. Incentive levels were reduced in ten states. The performance-based incentives for PV in 2009 included:

- 14 production incentives (other than FiT)
- 11 FiT
- 14 renewable energy credit (REC) purchase programmes.

California established a law, effective from 2011, that enables utilities that purchase electricity through the state's FiT to be eligible for credits under the state's renewable portfolio standards (RPS). By the end of 2009, RPS existed in 30 states. Seveteen of these states have specified the amount of solar electricity and/or distributed generation that must be provided. New financing options have evolved rapidly at the city and county level.

Through *Property-Assessed Clean Energy* (PACE) programmes, several local governments offered loans to property owners to help pay for PV systems. Several such programmes arose from the Department of Energy's Solar America Cities initiative. By the end of 2009, 18 states had authorised PACE programmes and approximately 30 municipalities had implemented a PACE programme[22].

Czech Republic

The Czech market has skyrocketed under the combination of a very favourable FiT and low administrative barriers in 2009 and 2010. There are a large amount of ground-mounted systems in the country, demonstrating that FiT have the capacity to develop a strong market, and how important a dynamic market control mechanism is for long-term success.

Expectations for 2011 are quite pessimistic and no real market is expected there due to measures that the government has adopted that don't favour PV market development.

This illustrates the need to balance all market development drivers to ensure the continuous growth of PV.

Belgium

Belgium could be seen as a strange inclusion in this list. It's green certificates support schemes in each of the country's three regions which have succeeded in developing the PV market. The scheme differs in each of the country's three regions (Brussels, Flanders, Wallonia).

There has been a decrease in the level of support and at the end of 2009, the government bonus was abandoned in the region of Wallonia in order to control the rapid growth of the local PV market.

Green certificates are issued for all renewable energies, with values that depend on the energy source. Utilities must ensure they can produce enough renewable energy, either through their own production, or by acquiring green certificates. The proportion of renewable energy required in the system is increased every year by 1%.

In the region of Flanders, green certificates have a fixed price. In Wallonia, their value fluctuates on an exchange market according to the laws of supply and demand. The fluctuations are limited by a lower value which is arbitrarily defined. The maximum value is equivalent to the penalty that must be paid by utilities if they cannot meet their renewable energy target at the end of the year.

France

Despite an attractive FiT, administrative and grid connection burdens have slowed down the growth of PV in France. The French FiT was modified in January 2010, and reviewed again in September 2010. Now, BIPV systems are favoured with multiple tariffs that are amongst the highest in the world. A good tariff for ground-mounted systems rewards north located installations with a correction coefficient that depends on local irradiation levels. The comparatively low BAPV tariff was being misused until the end of 2009 – some buildings were constructed only to install PV systems. This was corrected in the January 2010 decree, when more constraints were placed on those who can receive the highest BIPV tariff. Due to the high BIPV incentives, the BAPV market is now almost non-existent.

Another correction of FiTs should follow at the beginning of 2011. The side effect of such frequent changes in policy is a severe loss of confidence by investors.

China

The largest PV producer in the world still has a small PV market. Some regional initiatives have created local FiT, but there is no support mechanism at the national level.

The *Golden Sun programme* has a target of 500 MW of PV systems installed in three years for both on-grid and off-grid applications. Some installations could come on-line in 2010 and 2011, but it is unclear whether this will be enough to generate a real growth in the market.

There is a huge potential in China. Today the country is preparing for a future of PV which could transform rural electricity generation. During 2009, there were discussions about a FiT to support PV deployment in China. However, only the province of Jiangsu (located on the east coast and the hub of China's considerable PV manufacturing resource base) introduced a FiT. It is capped at 400 MW up to 2011 for three categories of systems: ground-mounted, rooftop and BIPV systems. The authorities are likely to reduce the FiT over the first three years. However, the overall binding period of the scheme is unclear.

China's policies and strategies in support of PV operate at the national, provincial and local government levels. Central government issues national targets and encourages the provinces to propose strategies to meet the targets. The provinces then start a bidding process with industry and other key market actors. In late 2009, the National Energy Authority (NEA) raised the national goal of solar energy from 1.8 GW to 20 GW by 2020, with 5 GW to be installed by 2015. Of the 2020 target, more than half of the installations are expected to be utility-scale PV systems[23].

South Korea

In South Korea the FiT was reduced in 2009. The change cut the annual installed PV power that year to one-third of the 2008 level. The change affected the development of larger sized (multi-megawatt) plants the most. Grid-connected centralised systems accounted for almost 78% of the total cumulative installed PV power by the end of 2009. Grid-connected distributed systems amounted to 21% of the total cumulative installed PV power (up from 15% the previous year). Most of these were installed under the FiT scheme and the 100,000 roof-top programme.

The Ministry of Knowledge Economy's *Third Basic Plan on New and Renewable Energy Sources R, D&D* (released in 2008) proposed the construction of one million green homes and 200 green villages by 2020. In support of this, the government provides 60% of the initial PV system cost for single-family and private multi-family houses, and 100% of the cost for public multi-family rental houses. By the end of 2009, almost 40,000 households had benefited from this scheme.

From late 2008, the FiT rate was reduced but the cap was increased from 100 MW to 500 MW. Beneficiaries can also choose between periods of 15 and 20 years. It is planned that a renewable portfolio standard (RPS) will replace the existing FiT scheme from the year 2012. Grid parity is anticipated around 2020 in Korea. Prior to the start of the RPS, the Korean Government initiated an RPS demonstration programme to run from 2009 until 2011.

Spain

World leader in 2008, the Spanish market has since been almost completely blocked by unhelpful political decisions. Since 2009, Spain has had a market control cap that limits the PV installations to around 500 MW each year. Due to the introduction of severe legal and administrative barriers, the market has had difficulties in reaching the 100 MW level since 2009. Many installations were cancelled or delayed due to the uncertainty , at the end of 2010 a Royal Decree with retroactive effect on existing plants was adopted, putting at stake the viability of many investments.

The FiT has a classification of eligible PV plants which include:

- Roof-top plants or plants developed for similar surfaces that are smaller or larger than 20 kW
- Any other type of plant – essentially ground-based PV plants.

The maximum size of a plant (either rooftop or ground-based) is now 10 MW.

The Spanish government has decided to reduce the FiT for 2011 to favour small residential installations and reduce the large, ground-mounted systems.

Other countries

Many other countries have implemented FiT or green certificates. The FiT approach dominates, and green certificates are being progressively replaced by FiTs. This occurred in the UK in 2010. The complexity of certificates often discourages investors, while the ease and cost-effectiveness of a FiT encourages them.

In many countries, a maximum market value (or cap) is used to control market growth and limit the financial impact of too much solar entering the system. However, the cap can discourage investors, as can be seen in Spain.

4.3. Developing a world-wide PV policy outlook

a. The European Union: A driver of PV development in Europe and in the world

European energy policies

The overall goal of European energy policy is to guarantee that citizens can get safe, secure, sustainable and low-carbon energy at affordable and competitive prices. The EU understands that renewable energy technologies can help achieve this objective, and it is setting up a positive legislative framework to foster their deployment.

The European Commission published a White Paper in 1997 setting out a Community strategy for achieving a 12% share of renewables in the EU's energy mix by 2010. The indicative target for PV was 3 GW in cumulative installations. By the end of 2010, PV's capacity in the EU will have surpassed this level over nine times with probably more than 28 GW installed in EU at the end of 2010!

In 2001, the EU adopted the *Directive for the Promotion of Electricity from Renewable Energy Sources,* which included a 22.1% target for electricity for the EU-15 by 2010. The legislation was an important part of the EU's measures to deliver on commitments made under the Kyoto Protocol. However, the targets were not binding and it became evident that they would not be met.

In January 2007, the Commission published a *Renewable Energy Roadmap* outlining a long-term strategy. It called for a mandatory target of 20% renewable energies in the EU's energy mix by 2020. The target was endorsed by EU leaders in March 2007[24] and became binding with the approval in 2009 of the *Climate and Energy* legislative package. That package includes a specific Directive dedicated to the promotion of the use of renewable energy sources.[25]

The overall binding target applies to the EU's total energy consumption by 2020. The Directive also sets individual binding national targets. This Directive presents an unprecedented legislative framework in favour of RES development and will probably be the main driver for PV market growth in the EU.

The European Union is now preparing a roadmap towards a low carbon energy mix by 2050. This should include a very significant increase in the share of renewable energy sources. The renewable energy sector considers that a 100% renewable energy mix will be technically and economically feasible by this date.

The EU is also promoting both renewable energy sources and energy efficiency measures in buildings. There is major scope for improvement here because the building sector is responsible for about 40% of EU energy consumption at present.

According to the revised *Energy Performance of Buildings* Directive adopted in 2010,[26] all new buildings will have to be 'nearly zero energy buildings' by 2020. This target should accelerate the development of buildings with a very high energy performance rating. The revised Directive should help foster PV deployment in buildings, in particular BIPV.

Another piece of European legislation that benefits the deployment of renewable energy technologies is the *Third Energy Package.* The package was adopted in 2009[27] and its primary goal is to pursue the liberalisation of the electricity and gas markets.

The package provides different options for Member States to separate electricity transmission networks from production activities – a practice known as unbundling. The *Third Energy Package* also established a formalised cooperation mechanism between national energy regulators and transmission system operators. They will work on common network access rules and joint planning of infrastructure investments to ensure easy access to a modern network.

In the years to come, EU decision makers are expected to further improve the framework conditions to ease the creation of a modern EU-wide grid. This in turn would mean increased and better penetration of the market by renewable electricity[28].

"According to the EU, renewable energy can help to get safe, secure, sustainable and low-carbon energy at affordable and competitive prices."

European funding for renewable energy projects

Compared to other countries like Japan and USA, the European Union's spending on research and development (R&D) is low. However, the EU is using part of its budget to finance important R&D projects that can accelerate the deployment of renewable energy technologies.

The *European Research Framework Programme* and the *Intelligent Energy Europe Programme* are the main schemes used to allocate grants to renewable energy projects. The *Solar Europe Industrial Initiative,* initiated by the European Commission and launched in June 2010[29] in the framework of its *Strategic Energy Technology* (SET) *Plan,* is expected to make public funds available to co-finance key R&D projects with the industry. These projects will mainly accelerate PV cost reduction and integration of PV electricity into the grid.

It was recently agreed that a number of allowances set aside from the *European Emission Trading Scheme* (ETS) could be used to finance part of the *Solar Europe Industrial Initiative,* especially pre-commercial innovative PV projects[30]. The EU may also decide to support energy efficiency and renewable energy projects in urban areas by using some unspent funds from the *European Energy Recovery Plan,* an instrument launched in July 2009 to boost investments in key energy infrastructure projects[31].

b. The desert is a perfect place to develop PV energy

Deserts have both high irradiation and low populations. That makes them the perfect place to install very large scale PV systems. Projects up to 2 GW are already being planned in China's deserts that will be a showcase for the feasibility of such huge installations[32]. The main challenges are the integration to the electricity networks and the transportation of electricity over long distances. The weather conditions in the desert should favour PV systems, which require limited water compared with other technologies.

Europe, together with northern African countries and the Union for the Mediterranean have created the *Mediterranean Solar Plan.* The Plan represents the first real attempt to conceive large PV power plants in desert areas. According to the plans, the electricity generated will be conveyed to Europe using DC lines to minimise electricity losses over long distances. Despite the high potential of the region in renewable energies, the project aims to generate 20 GW from all renewable sources in the Mediterranean region. While this is a limited target, it could demonstrate the potential that deserts close to highly populated regions can offer.

The concept was developed in the framework of the Desertec project which initially planned to use only Concentrated Solar Thermal Power. The steep decrease in PV prices, combined with its natural advantages has seen PV welcomed into the mix of renewable energy sources. PV industry is confident that solar technology can be deployed on a massive scale in the deserts of the world.

c. PV in the Sunbelt region: Ongoing policy developments

PV markets have developed initially in northern countries, even though they lack a lot of sunlight. FiTs have helped the market to develop and to lower prices world-wide. This temporary situation is about to change. There are many countries in the Sunbelt region (the area around 30° north and south of the equator) that could benefit from off-grid and on-grid PV systems. That region represents 78% of the world population, 27% of global GDP, and a huge potential market for PV before 2020.

In the Middle East and North Africa, policy support is quite limited. A FiT exists in Israel and one has been recently been adopted in Turkey. In 2010, Morocco launched a call for 2 GW of solar systems to be installed by 2015, in which PV could play a role. In most situations, heavy administrative procedures and complex grid connection schemes have held up PV development.

China, already the world's leading maker of solar PV modules, has made enormous strides in developing its renewable energy sector in recent years, yet its installed base of PV still pales in comparison with its manufacturing base. The *Golden Sun programme*, launched in 2009, is a first step to righting this imbalance with targets for PV set at 20GW by 2020. The current incentive structure for PV still assumes a subsidy based on the cost of the initial investment rather than on the cost of generation, with a cap on overall capacity. However, PV support measures are expected to evolve further, especially with renewable energy being named one of the Magic 7 emerging strategic industries under the 12th Five-Year Plan (2011-2015), which will be officially unveiled in March 2011.

In India, legislation establishing the *Jawaharlal Nehru National Solar Mission* passed in 2009, with a target of 22 GW of solar power by 2022. Not all of this will be generated through PV, however, the move represents major progress.

In Latin America, support for renewable energy exists in some countries, particularly Chile, Brazil, Mexico and Argentina. However, PV is not yet everywhere on the top of the political agendas.

d. Smart cities

The smart city concept refers to an urban environment where investments in transport and modern information and communication infrastructure provide sustainable economic development and a high quality of life. The holistic concept also aims for wise management of natural resources and participatory governance[33]. Environmental sustainability is a cornerstone of smart cities. The integration of renewable energies like photovoltaics in the urban environment is an essential component.

While they sound utopian, smart cities are now becoming a reality. The European Commission launched recently a *Smart Cities Initiative*[34] to foster the transformation of 25 to 30 European cities into low carbon cities by 2020. The indicative cost is set at €10 to €12 billion.

Smart cities are a key concept promoted by EPIA. Within the framework of the *Solar Europe Industry Initiative,* EPIA expects Solar Cities and Solar Islands to be developed. They will demonstrate the many options for large-scale integration of solar PV in urban and remote environments.

Large ground-mounted PV plant, Mallorca, Spain.

Off-grid PV system in Morocco.

Access to energy in developing countries: The FiT Support Mechanism

The FiT Support Mechanism (FTSM) is a proposal from Greenpeace International[35] for a renewable support scheme for the power sector in developing countries. FTSM aims to rapidly expand renewable energy in developing countries with financial support from industrialised nations. Investment in and generation of renewables, especially in developing countries, will be higher than that for existing coal or gas-fired power stations over the next five to ten years.

The FTSM concept was first presented by Greenpeace in 2008. The idea has received considerable support from a variety of different stakeholders. Deutsche Bank Group's Climate Change Advisors, for example, have developed a proposal based on FTSM called GET FiT. Announced in April 2010, the proposal includes major aspects of the Greenpeace concept.

Technology transfer to developing countries For developing countries, FiT are an ideal mechanism to help implement new renewable energies. Effective technology transfer from developed to developing countries will require a mix of a Feed-in Law, international finance and emissions trading.

"The basic aim of FTSM is to help introduce Feed-in Laws in developing countries."

The FiT Support Mechanism The basic aim of FTSM is to help introduce Feed-in Laws in developing countries that provide bankable, long-term and stable support for a local renewable energy market. For countries with a lot of potential renewable capacity, it would be possible to create a new no-lose mechanism that generates emission reduction credits for sale to developed countries. The proceeds could then be used to offset part of the additional cost of the FiT system. Other countries would need a more directly funded approach to pay the additional costs to consumers that a tariff would bring.

The key parameters for FiTs under the FTSM are:

- Variable tariffs for different renewable energy technologies, depending on their cost and technological maturity, paid for 20 years.
- Payments based on actual generation in order to achieve properly maintained projects with high performance ratios.
- Payment of the additional costs for renewable generation based on the German system, where the fixed tariff is paid minus the wholesale electricity price, which all generators receive.
- Payment could include an element for infrastructure costs such as grid connection, grid re-enforcement or the development of a smart grid. A specific regulation needs to define when the payments for infrastructure costs are made to achieve a timely market expansion of renewable power generation.

A developing country which wants to take part in the FTSM would need to establish clear regulations for:

- Guaranteed access to the electricity grid for renewable electricity projects.
- Establishment of a Feed-in Law based on successful examples.
- Transparent access to all data needed to establish the FiT, including full records of generated electricity.
- Clear planning and licensing procedures.
- Funding could come through the connection of the FTSM to the international emissions trading system or specific funds for renewable energies.

The design of the FTSM would need to provide stable flows of funds to renewable energy suppliers. There may need to be a buffer between the price of CO_2 emissions (which can fluctuate) and stable, long-term FiTs. The FTSM will need to secure payment of the required FiTs over the whole lifetime (about 20 years) of each project.

The FTSM would also seek to create the conditions for private sector actors, such as local banks and energy service companies, to gain experience in technology development, project development, project financing, operations and maintenance. This would help to develop and track projects, further reducing barriers to renewable energy development.

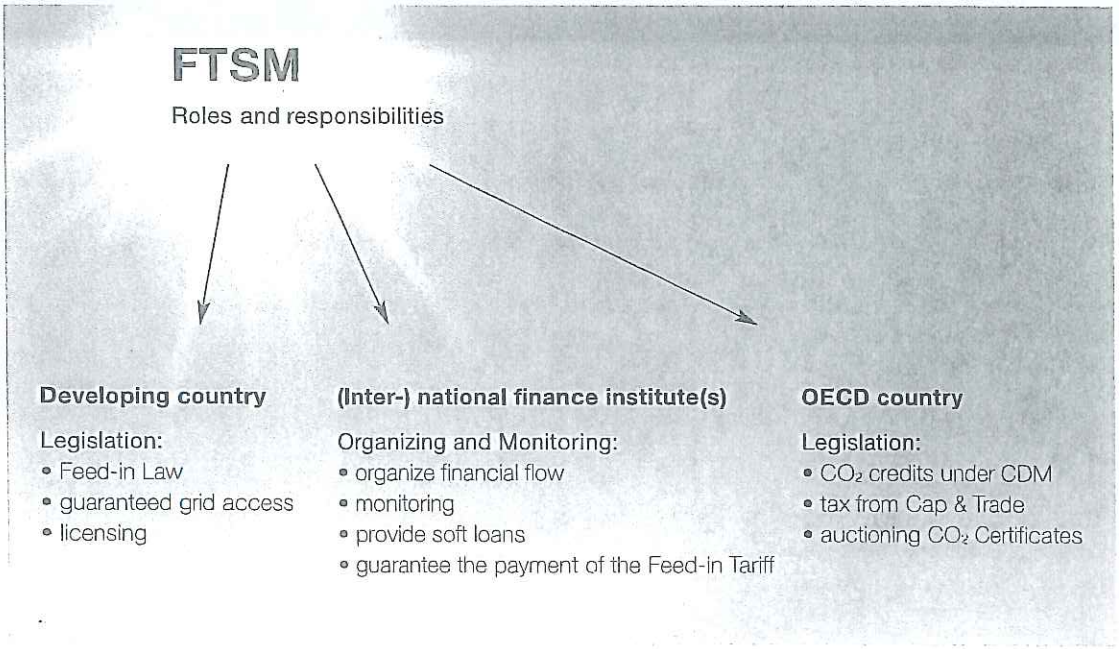
For this, Greenpeace proposes a fund, created from the sale of carbon credits and taxes. The key parameters for the FTSM fund would include:

- The fund guarantees payment of the FiTs over a period of 20 years as long as the project is operated properly.
- The fund receives annual income from emissions trading or from direct funding.
- The fund pays FiTs annually only on the basis of generated electricity.
- Every FTSM project must have a professional maintenance company to ensure high availability.
- The grid operator must do its own monitoring and send generation data to the FTSM fund. Data from the project managers and grid operators will be compared regularly to check consistency.

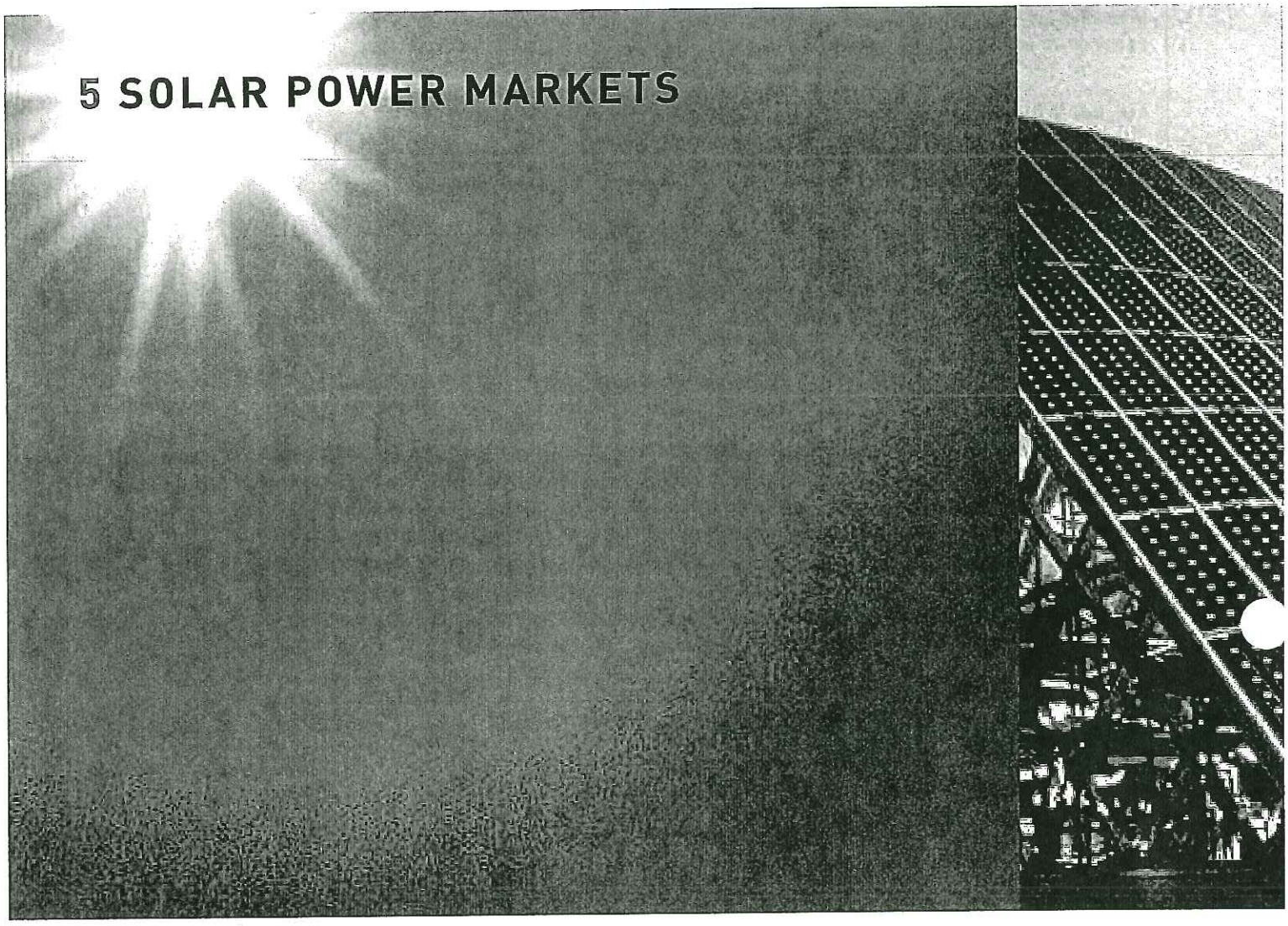
Ground-up participation While large-scale projects have fewer funding problems, there are difficulties for small, community-based projects, even though they have a high degree of public support. Strong local participation and acceptance can be achieved. There have been good examples in micro-credit schemes for small hydro projects in Bangladesh and wind farms in Denmark and Germany. The projects provide economic benefits that flow to the local community when carefully planned based on good local knowledge and understanding. Generally, when the community identifies the project – rather than the project identifying the community, the result is a renewables sector that grows faster from the ground-up.

"Ground-up participation is essential for the success of the model."

FIGURE 29
THE GREENPEACE
– PROPOSED FEED IN TARIFF MECHANISM



5 SOLAR POWER MARKETS



5. SOLAR POWER MARKETS

5.1. History of PV markets

The solar power market is booming. More than 22 GW were installed across the world by the end of 2009, and provisional figures show a global installed capacity exceeding 37 GW by the end of 2010.

In Spain and Germany, the average contribution from PV to electricity generation is more than 2% of the total on average per year. But PV provides much more in key regions with the right mix of Sun and good government support. For example, in the Spanish region of Extremadura, PV had made-up 15% of the electricity mix in 2010, with peaks of up to 25% in the summer. Without a doubt, PV has shown that it can compete with other electricity generation sources.

a. Europe at the forefront of PV development

Germany remains the world's largest PV market with a cumulative installed PV power of almost 10 GW at the end of 2009. By the end of 2010 this probably exceeded 15 GW. This is equivalent to two standard nuclear power plants.

Italy is one of the most promising mid-term markets with an additional 711 MW installed in 2009. The target for 2010 is more than 1.5 GW, possibly 2 GW. The country has high levels of Sun, and the new *Conto Energia* law announced in mid-2010 will continue to support the strong momentum of the Italian market.

The Czech Republic showed an important growth in 2009 with 411 MW installed. However, due to unsustainable support schemes, the market is expected to shrink significantly in 2011, after a hectic 2010 year marked by strong opposition from conventional stakeholders and more than 1.4 GW of cumulative installed capacity.

Thanks to favourable political will, Belgium made its entry into the top ten markets with 292 MW installed in 2009. The market had, however, slowed down or stagnated in 2010 due to a revision of the financial support scheme in early 2010.

France follows with 185 MW installed in 2009 and an additional 100 MW installed but not yet connected to the grid. France has huge potential but must solve grid connection issues in order for PV to penetrate decentralised power sources and to allow the market to develop. In the first six months of 2010, grid connection became easier and the market grew in response.

In Spain, a new market cap created in 2008, combined with the effects of the financial crisis, constrained the market to almost zero in 2009. In 2010, instability in political decisions created turmoil in the PV industry, holding the Spanish market back significantly.

"The solar power market is booming."

Greece, the UK, Slovakia and, to a certain extent Portugal, are showing a strong potential for growth.

b. Japan and USA lead outside Europe

Outside Europe, Japan became third largest market in 2009 with 484 MW installed and shows more growth potential thanks to favourable political support. The US market finally took off significantly with around 475 MW installed in 2009. It appears to be a potential leading market in coming years, with many ground-mounted systems starting production in 2010.

China and India are also expected to boom in the next five years with huge market potential and impressive projects in the pipeline. Canada and Australia showed significant market development in 2009 and are expected to open the way to the development of new markets. Brazil, Mexico, Morocco, Taiwan, Thailand, South Africa and many others are also seen as promising countries.

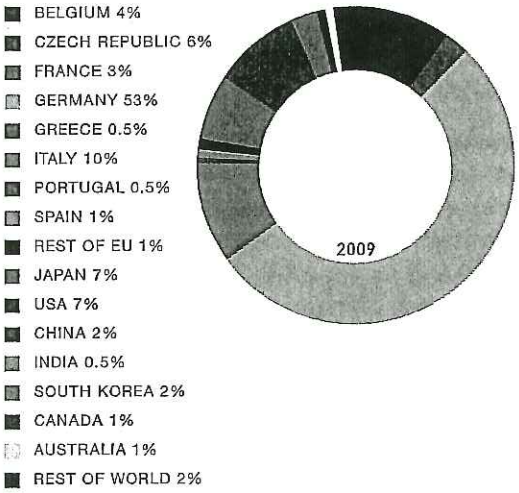
c. Distribution of the world PV market in 2009

The development of PV in the last ten years has been exponential. Driven by smart incentives such as FiT and other policies, the PV market surged and will continue to do so in the coming years.

Figure 31 shows the evolution of the cumulative installed capacity in the entire world since 2000. The split clearly shows the importance of the European Union in that development and how Japan, which was one of the initiators, was overtaken by Europeans. The development of PV in the rest of the world has now begun and will rapidly rebalance the market. The current domination of European countries shows how the right political choices influence the energy sector in general and PV in particular.

"Political support and the introduction of FiT has closed the gap with conventional energy sources and triggered greater market deployment."

FIGURE 30
THE WORLD PV MARKET IN 2009



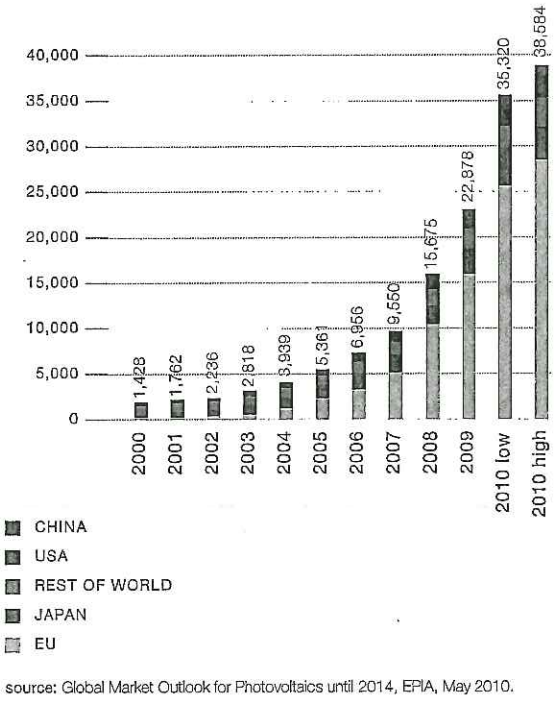
source: EPIA.

d. Root causes of PV market development

Photovoltaic electricity is becoming more prevalent progressing towards grid parity. However, in many cases today, PV remains more expensive than conventional electricity production methods. The price decrease is so fast that the competitiveness of PV with other energy sources will be achieved in around five years in several countries.

Political support and, especially in Germany, the introduction of FiT has closed the gap with conventional energy sources and triggered greater market deployment. This kind of support is currently the main driver to PV development. Other incentives complement the support schemes depending on the country.

FIGURE 31
GLOBAL EVOLUTION OF PV INSTALLED CAPACITY
MW



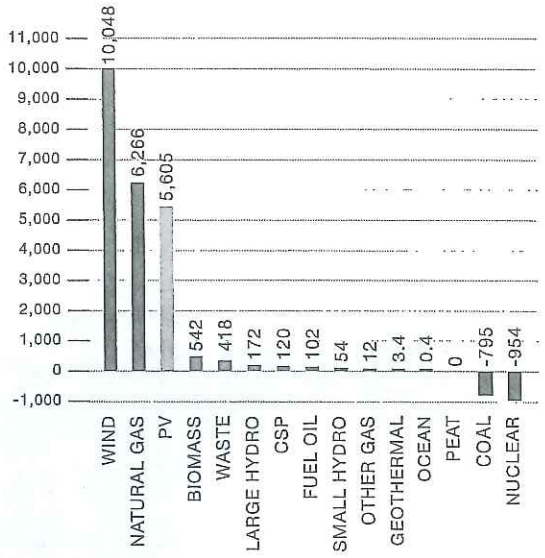
source: Global Market Outlook for Photovoltaics until 2014, EPIA, May 2010.

Electricity markets are driven by profitability rules; investors are keen to invest in power plants if they can benefit from an added value. This is why tariff schemes work. PV is now considered to be a reliable investment in many countries, in the same way conventional energy sources were viewed in the past.

In the 27 EU countries during 2009, PV took third place in terms of new electricity capacity, behind wind and gas, but ahead of coal and nuclear.

Depending on the amount of new gas power plants installed in Europe in 2010, PV could score the first or second place in terms of new added capacity. It will overtake all other power generation sources, from wind to coal and nuclear.

FIGURE 32
NEW INSTALLED ELECTRICAL CAPACITY IN 2009 IN THE EU
MW



source: EPIA, EWEA, ESTELA, OEA-EU, Platts PowerVision.

"In 2009, in the EU 27, PV took third place in terms of new electricity capacity, ahead of coal and nuclear."

e. Future PV markets: The Sunbelt region

The technology is mature and is available. Developed economies have contributed to achieve this. Lower system prices make PV more and more affordable and competitive in other regions of the world.

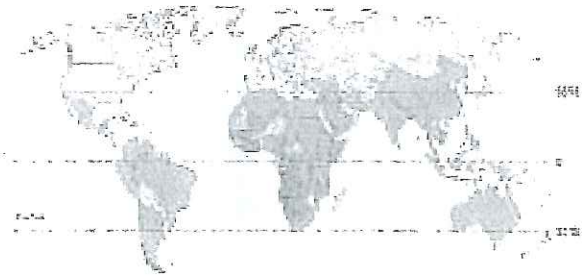
The Sunbelt region provides a massive opportunity to develop PV in the coming years. Moreover, sunny regions are not the only ones where PV can be part of the energy mix. Denmark's high electricity prices could help the country to reach grid parity before other, sunnier European countries.

New PV markets will appear progressively, driven by the falling cost of the technology and an appetite for energy. The combined effects of energy scarcity and the urgent need to mitigate climate change will drive the emerging PV markets.

f. A bright future for PV

New PV installations could have reach between 12 and 15 GW in 2010 globally, another year of significant growth. The future is somewhat harder to predict. While PV system prices are continuing to go down, an increase in conventional electricity prices will open new markets all over the world. Continued political support in Europe and elsewhere will be required to help PV get passed the pre-competitive phase and become a major global energy source within a decade.

FIGURE 33
PV IN THE SUNBELT COUNTRIES

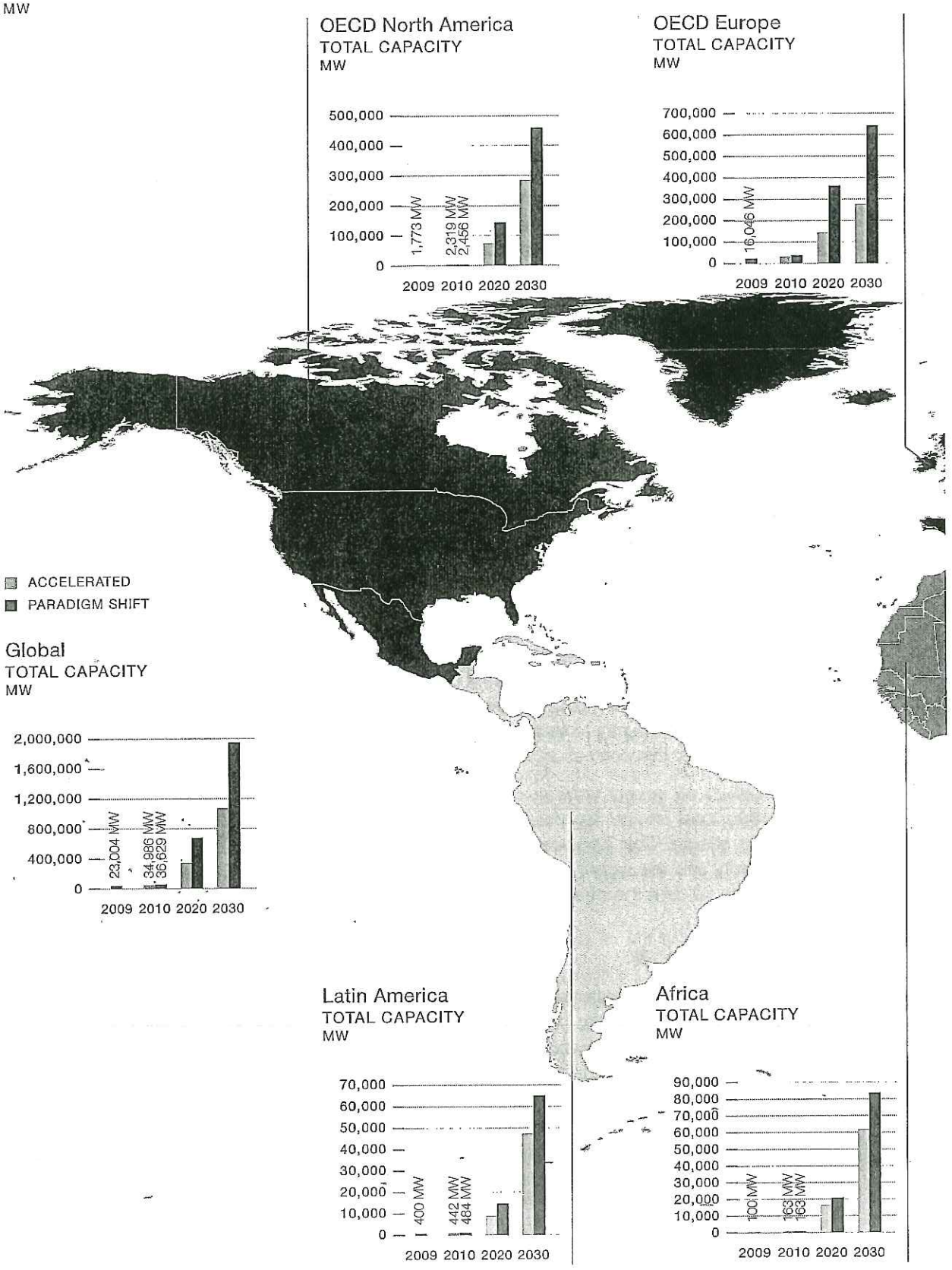


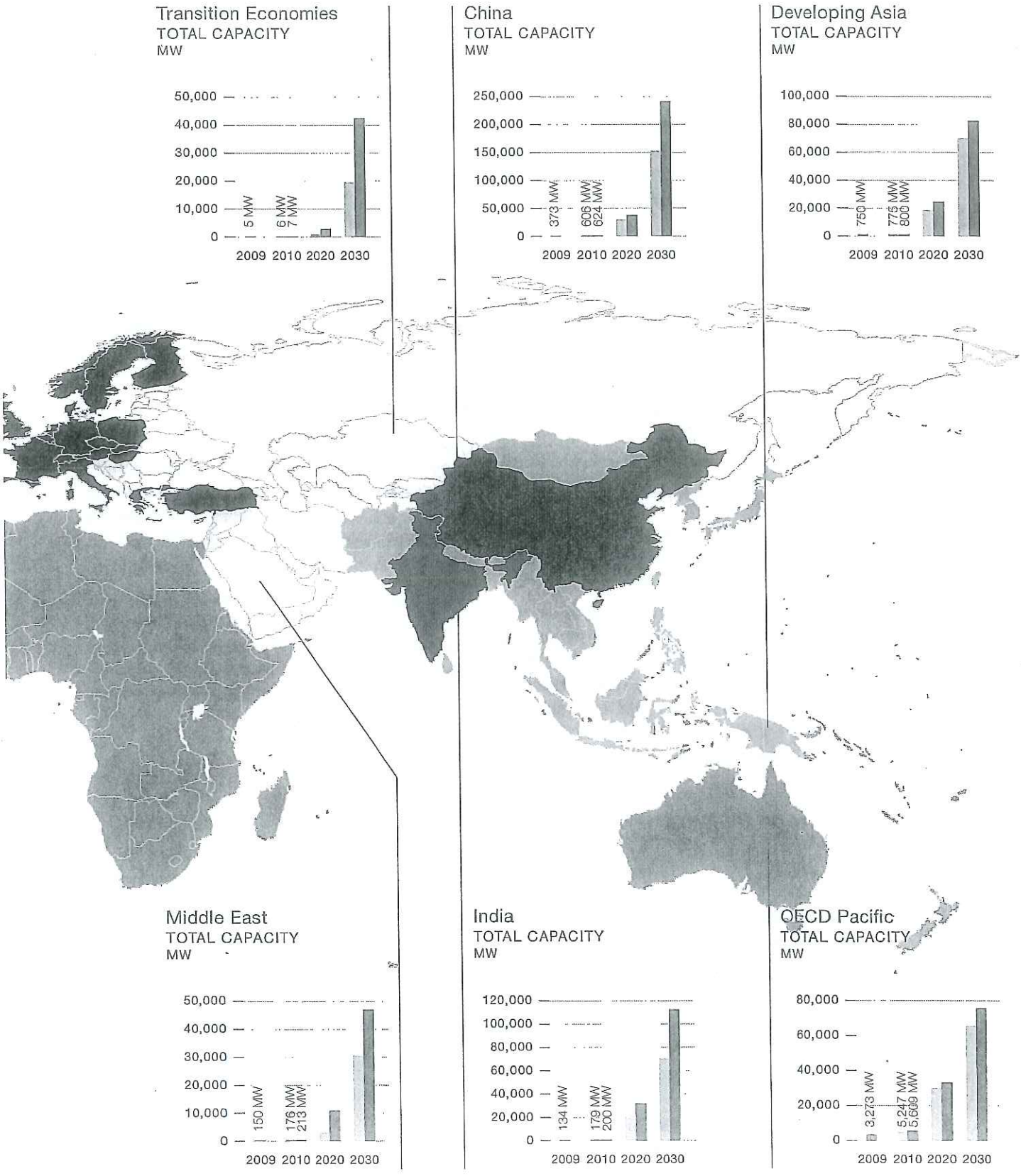
COUNTRIES IN SCOPE OF STUDY

	Sunbelt countries in scope	All countries in Sunbelt	World
# countries (2008)	66	148	201
Population (2008)	5.0 billion	5.3 billion	6.7 billion
GDP (2008)	15.7 trillion	16.4 trillion	60.0 trillion
Electricity consumption (2007)	6,800 TWh	7,000 TWh	17,900 TWh

source: World Bank, IMF, A.T. Kearney analysis.

WORLD MAP GLOBAL CUMULATIVE CAPACITY SHOWING THE ACCELERATED AND PARADIGM SHIFT SCENARIOS BY REGION




Transition Economies
TOTAL CAPACITY
MW
50,000
40,000
30,000
20,000
10,000
0
5 MW
6 MW
7 MW
2009 2010 2020 2030
China
TOTAL CAPACITY
MW
250,000
200,000
150,000
100,000
50,000
0
373 MW
606 MW
624 MW
2009 2010 2020 2030
Developing Asia
TOTAL CAPACITY
MW
100,000
80,000
60,000
40,000
20,000
0
750 MW
775 MW
800 MW
2009 2010 2020 2030
Middle East
TOTAL CAPACITY
MW
50,000
40,000
30,000
20,000
10,000
0
150 MW
176 MW
213 MW
2009 2010 2020 2030
India
TOTAL CAPACITY
MW
120,000
100,000
80,000
60,000
40,000
20,000
0
134 MW
179 MW
200 MW
2009 2010 2020 2030
OECD Pacific
TOTAL CAPACITY
MW
80,000
60,000
40,000
20,000
0
3,273 MW
5,247 MW
5,609 MW
2009 2010 2020 2030

5.2. The Greenpeace/EPIA Solar Generation scenarios

a. Methodology and assumptions

Greenpeace and EPIA have joined their resources to work out how much photovoltaic electricity could be available across the whole world in the coming decades. These scenarios have been developed using the extensive knowledge in both organisations of renewable energy and PV in particular.

The scenarios put forward details of potential markets up to 2030 and also provide global figures up to 2050.

"The Paradigm Shift scenario estimates the full potential of PV in the next 40 years."

The scenarios make projections for installed capacity and energy output. They also assess the level of investment required, the number of jobs that could be created and the crucial effect that increased input from solar electricity will have on greenhouse gas emissions.

The Paradigm Shift scenario

Called the Advanced scenario in previous editions of Solar Generation, this scenario estimates the full potential of PV in the next 40 years.

It has been renamed Paradigm Shift in order to reflect the need, over the next two decades, to shift energy policies from conventional electricity generation to renewable energy in general and PV in particular. It represents the real technical potential of PV as a reliable and clean energy source, in all parts of the world.

In the Paradigm Shift scenario, PV would produce up to 12% of the electricity needs in European countries by 2020 and in many countries from the Sunbelt (including China and India) by 2030 (this difference originates from the early development of PV in Europe). It is ambitious, but also feasible, providing some boundary conditions are met before 2020, especially in the EU. Even if this strong growth cannot be achieved in the first decade, the 2050 targets remain reachable without too many changes. At that point, a real global paradigm shift needs to happen.

The assumption is that current support levels will be strengthened, deepened and accompanied by a variety of instruments and administrative measures that will push the deployment of PV forward.

The Accelerated scenario

Called the Moderate scenario in previous Greenpeace Outlook reports, the name has been changed to Accelerated to reflect expectations. The scenario foresees the ability to deploy PV faster, in line with market developments, than has been seen in recent years.

In the Accelerated scenario there is a lower level of political commitment than the Paradigm Shift scenario. It can be viewed as a continuation of the current support policies and it could easily be achieved in 20 years without any major technology changes in electricity grids.

TABLE 14
SUMMARY OF EPIA/GREENPEACE PARADIGM SHIFT SCENARIO

	2011-2020	2021-2030	2031-2040	2041-2050
Average market growth rates under the Paradigm Shift	42%	11% for 5 years then 9%	7% for 5 years then 5%	4%

TABLE 15
SUMMARY OF EPIA/GREENPEACE ACCELERATED SCENARIO

	2011-2020	2021-2030	2031-2040	2041-2050
Average market growth rates under the Accelerated scenario	26%	14% for 5 years then 10%	7% for 5 years then 6%	4%

Over the longer term, the gap between the Accelerated and Paradigm Shift scenarios widens. Fast market deployment is difficult with insufficient additional global political support. Without the potential for economies of scale, PV production costs and prices will fall at a slower rate than in the Paradigm Shift scenario. This will result in a lower level of PV deployment, which impacts the final target.

The growth rates presented in this scenario represents an average calculated from varying rates of annual growth.

The Reference scenario

The Reference scenario is based on the scenario of the same name in the International Energy Agency's *2009 World Energy Outlook* (WEO 2009) analysis. The data has been extrapolated forward from 2030. Compared to the previous (2007) IEA projections, the WEO 2009 assumes a slightly lower average annual growth rate in world Gross Domestic Product (GDP) of 3.1% (down from 3.6% in the previous forecast) over the period 2007 to 2030. At the same time, the report expects energy consumption in 2030 to be 6% lower than in the WEO 2007 report. China and India are expected to grow faster than other regions, followed by the Other Developing Asia group of countries, Africa and the Transition Economies (mainly the former Soviet Union).

b. Scenario assumptions

The scenarios are based on many different country and regional scenarios from Greenpeace and EPIA released in recent years.* The value of PV in each scenario takes into account the limitations produced by the combination of different technologies. It also assumes little progress in storage systems in the short-term.

* Current PV market data from reliable sources (national governments, the International Energy Agency, PV industry). 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 radiation, the availability of suitable roof space and the demand for electricity in areas not connected to the grid. Existing EPIA and Greenpeace studies (such as EPIA's SETfor2020, Unlocking the Sunbelt potential for PV and EREC's RE-thinking 2050).

Regional split

The scenarios present a view of the future using global figures. They also estimate regional values for PV growth. The regions defined are European Union (27 countries), rest of Europe, OECD Pacific (including South Korea), OECD North America, Latin America, East Asia, Developing Asia (excluding South Korea), India, China, the Middle East, Africa and the Transition Economies (mainly the former Soviet Union).

Electricity consumption

This outlook also considers two estimates of growth in electricity demand over the first decades of the 21st century.

The Reference scenario for global electricity demand simply utilises the projections made by the IEA (WEO 2007[36]). These show global demand for power increasing without much constraint. Demand is expected to be:

- 17,928 TWh in 2010
- 22,840 TWh in 2020
- 28,954 TWh in 2030.

By 2050, the demand would top 39,360 TWh. The contribution from PV power is expressed as a percentage of this value.

The Alternative scenario for future electricity demand is based on the Greenpeace/European Renewable Energy Council *Energy [R]evolution* report (January 2007) and takes into account extensive energy efficiency measures. Those measures should ensure consumption of electricity is significantly lower in 2030 than today. This reflects what has to happen in order to meet the ambitious targets for CO_2 emissions required to keep the Earth's warming below two degrees centigrade. The scenario shows a global demand for power following a more controlled growth:

- 17,338 TWh in 2010
- 19,440 TWh in 2020
- 20,164 TWh in 2030.

In 2050 demand should reach 31,795 TWh. The contribution of PV (as a percentage) is therefore higher under this projection.

"Fast market deployment is difficult with insufficient additional global political support."

Carbon dioxide savings

An off-grid solar system which replaces a typical diesel unit will save about 1 kg of CO_2 per kilowatt hour of output. The amount of CO_2 saved by grid-connected PV systems depends on the existing energy mix for power generation in different countries. The global average figure is taken as 0.6 kg of CO_2 per kilowatt-hour.

Over the whole scenario period it has been assumed that PV installations will save, on average, 0.6 kg of CO_2 equivalent per kilowatt-hour. This takes into account emissions during the lifecycle of the PV system of between 12 and 25 g of CO_2 equivalent per kWh.

"On average, 30 full-time equivalent jobs are created for each MW of solar power modules produced and installed."

Employment generated

On average, 30 full-time equivalent (FTE) jobs are created for each MW of solar power modules produced and installed. While there are discrepancies between countries, between companies and between technologies, it is a useful estimate that represents a world-wide average.

The figure for employment takes into account the whole PV value-chain including research centres, installers, and producers of silicon, wafers, cells, modules and other components. The figure does not take into account the jobs lost in the conventional energy sector. This depends on the energy mix in each country. A reasonable decrease is around 20 FTE per installed MW in 2050. Maintenance jobs are expressed separately in the scenarios.

Capacity factor

The capacity factor for PV technology expresses how much of the Sun's energy is converted into electrical energy for PV. This is estimated to grow from around 12 to 17% by 2050 in both the Paradigm Shift and Advanced scenarios. The estimate takes into account all technologies, not only the most advanced ones. It assumes a reasonable penetration of more efficient technologies in the coming decades. However, the estimate is reasonably conservative considering how fast technologies are actually evolving and the arrival of concentrator photovoltaic (CPV) in regions with more Sun than in the current PV markets.

Learning curve

In the last 30 years, PV costs have dropped by more than 20% with each doubling of the production capacity. The rate of cost reduction will probably not be as strong in the coming decade. In the Paradigm Shift and Advanced scenarios we consider a reduction of 18% from 2020, 16% from 2030 and 14% from 2040 to 2050.

Cost of PV systems

PV markets in many countries are not yet mature. However prices today in Germany reflect the reasonable minimum prices that could be reached in other parts of the world. The outlook considers those prices, starting from an average €2.80/Wp in 2010 for PV systems. By mid-2010 one could find prices as low as €2.20/Wp for large ground-mounted systems in some countries. Costs will decrease with volume of production. Prices would decrease faster in the Paradigm Shift scenario than in the Accelerated scenario.

The SET For 2020 study:
Photovoltaic electricity, a mainstream power source in Europe by 2020

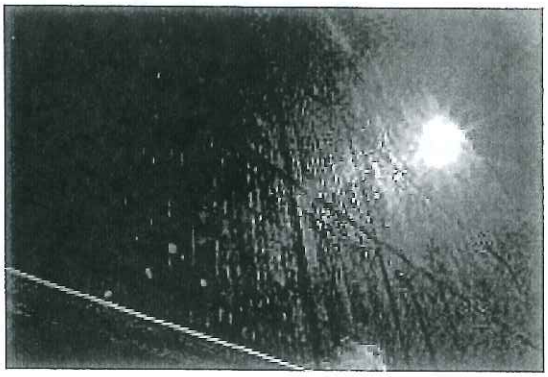
Published by EPIA in 2009, *SET For 2020* outlines how photovoltaics (PV) can become a mainstream energy supplier in Europe by 2020. The study provides a unique, wide-ranging combination of facts, figures, analysis and findings. *SET For 2020* is indispensable for anyone with an interest in the future of the European energy market. It contains an intensive and broad-based analysis of existing data as well as interviews with around 100 key people in industry, research institutes, utilities, regulatory agencies and governments across Europe and other parts of the world. The study concludes that boosting photovoltaic electricity's share of energy market will yield huge benefits to European society and its economy. This requires the active support of policy makers, regulators and the energy sector at large.

Among the findings:

- Europe needs to dramatically increase the share of PV to meet its 20/20/20 energy goals.
- A 12% market share for PV in Europe is a demanding, but achievable and desirable objective.
- Supporting the development of PV is an investment that will yield important positive returns for the European economy.
- The deeper and earlier the penetration of PV, the greater the net benefits.
- Mass penetration of PV will support European competitiveness, employment and energy security of supply.
- PV is the fastest-growing renewable energy technology, and costs are expected to drop faster than those of other electricity sources.
- By the end of 2020, PV can be competitive in as much as 75% of the European electricity market.

www.setfor2020.eu

"Supporting the development of PV is an investment that will yield important positive returns for the economy."



Polycrystalline silicon system integrated on a façade,St. Moritz, Switzerland.

5.3. Key results

a. Global scenario

At the end of 2009 the world had 23 GW of installed PV electricity. By 2020, we could see a Global installed capacity of:

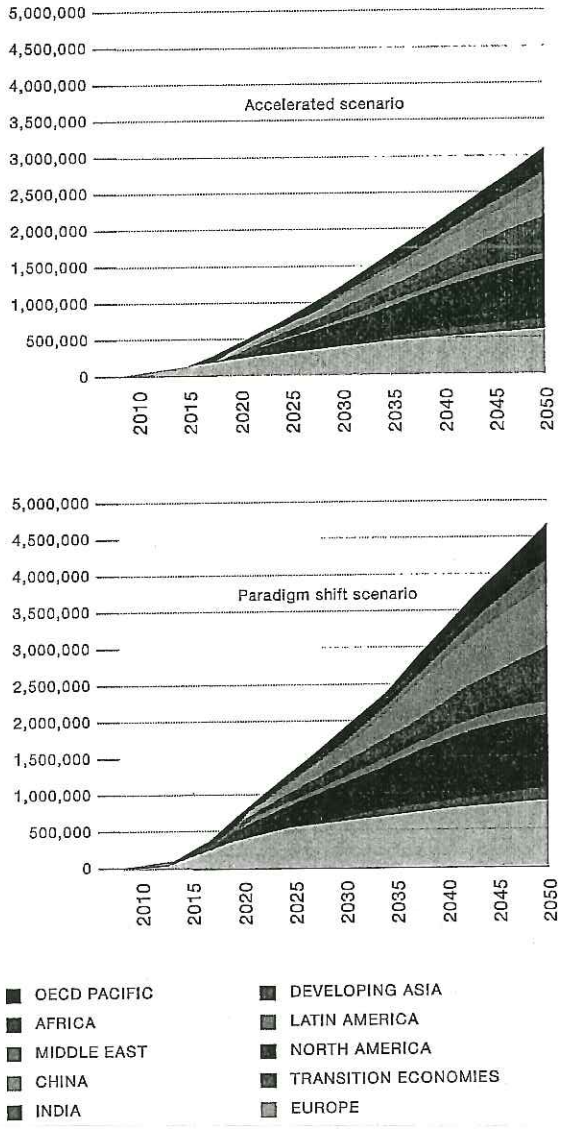
- 345 GW in the Accelerated scenario
- 688 GW with an achievable Paradigm Shift scenario.

By 2030, there could be around 1,082 GW and 1,845 GW of clean PV energy installed under the two scenarios respectively. After a decade, the initial rate of growth would slow down, taking into account repowering from 2025-2030 onwards.

Even with slower growth after 2030, the world should still reach impressive levels of solar power globally.

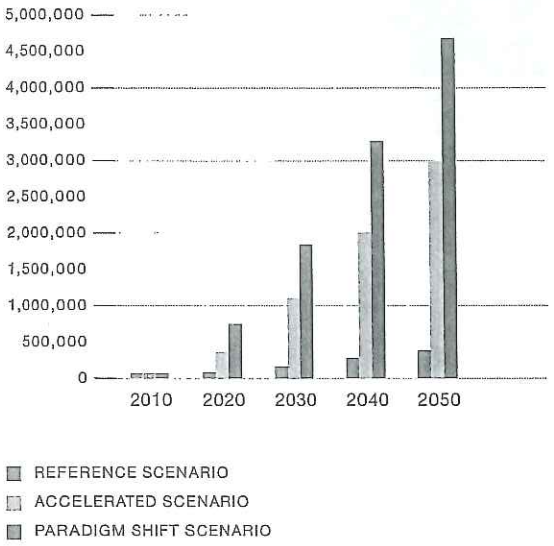
"By 2050, under a Paradigm Shift scenario there could be over 4,500 GW of PV installed world-wide."

FIGURE 34
EVOLUTION OF CUMMULATIVE INSTALLED CAPACITY BY REGION UNDER TWO SCENARIOS
MW



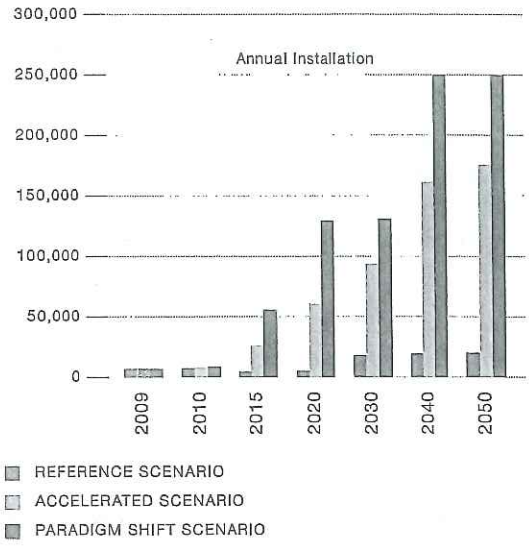
source: Greenpeace/EPIA Solar Generation VI, 2010.

FIGURE 35
TOTAL OF WORLD CUMULATIVE PV INSTALLED CAPACITY UNDER THREE SCENARIOS
MW



source: Greenpeace/EPIA Solar Generation VI, 2010.

FIGURE 36
ANNUAL MARKET TO 2050 UNDER THREE SCENARIOS
MW



source: Greenpeace/EPIA Solar Generation VI, 2010.

"About 250 GW of PV could be installed annually from the year 2040."

TABLE 16
WORLD-WIDE CUMULATIVE PV INSTALLED CAPACITY AND PRODUCTION TO 2050 USING THE REFERENCE, ACCELERATED AND PARADIGM SHIFT SCENARIOS

		2007	2008	2009	2010	2015	2020	2030	2040	2050
Reference	MW	3	15,707	22,999	30,261	52,114	76,852	155,849	268,893	377,263
	TWh	0	17	24	32	55	94	205	377	562
Accelerated	MW	3	15,707	22,999	34,986	125,802	345,232	1,081,147	2,013,434	2,988,095
	TWh	0	17	24	37	132	423	1,421	2,822	4,450
Paradigm	MW	3	15,707	22,999	36,629	179,442	737,173	1,844,937	3,255,905	4,669,100
	TWh	0	8	24	39	189	904	2,266	4,337	6,747

source: Greenpeace/EPIA Solar Generation VI, 2010.

b. Regional development

Europe will continue to lead the PV world until 2020 under the Accelerated and Paradigm Shift scenarios. By this date, North America will have developed enough capacity. China's capacity should be 29 GW in the Accelerated scenario, however, it could almost double that figure (38 GW) in the Paradigm Shift scenario.

The real take-off for non-western regions will happen during the period from 2020 to 2030. China and India both have massive potential for growth during this timeframe.

Erlasee Solar Park, one of the largest tracking PV solar power station in the world.

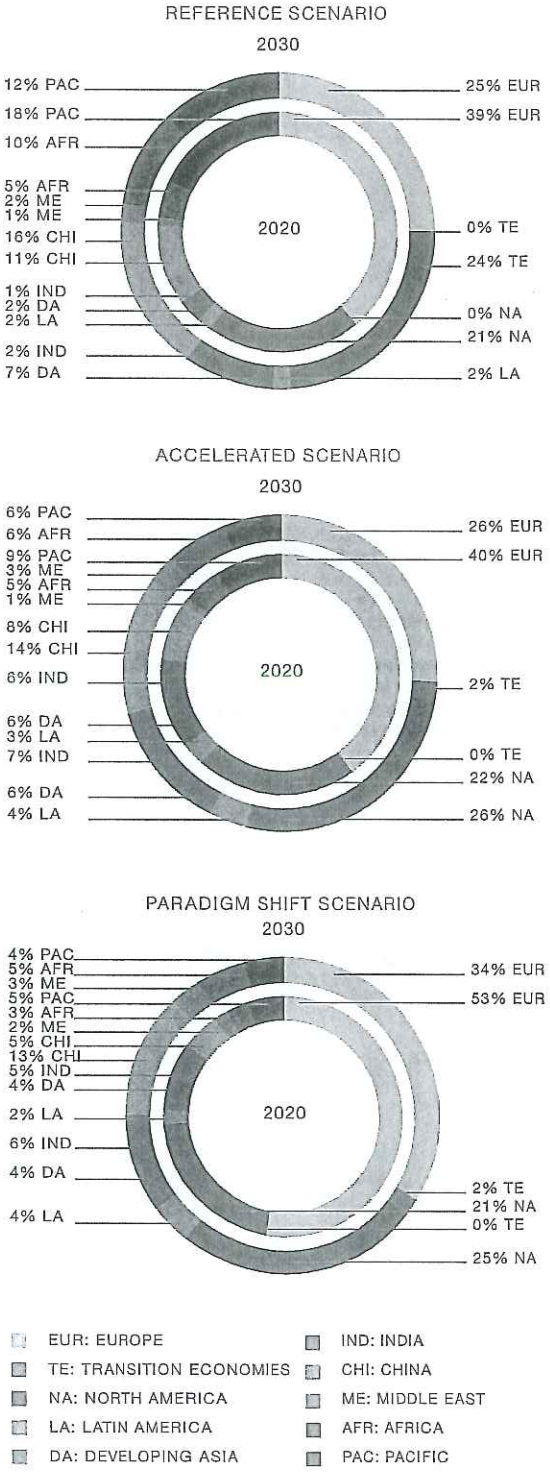
"Europe will continue to lead the PV world until 2020."

TABLE 17
PV INSTALLED CAPACITY EVOLUTION BY REGION UNTIL 2030
GW

Reference Scenario	OECD Europe	Transition Economies	OECD North America	Latin America	Developing Asia	India	China	Middle East	Africa	OECD Pacific	Total
2020	30	0	16	1	2	1	8	1	4	13	**77**
2030	38	0	37	3	11	4	25	4	15	19	**156**
Accelerated Scenario											
2020	140	1	77	9	19	20	29	3	16	31	**345**
2030	280	20	285	47	70	71	150	30	62	64	**1,081**
Paradigm Shift Scenario											
2020	366	3	145	15	24	33	38	11	21	33	**688**
2030	631	42	460	66	83	113	242	47	85	77	**1,845**

source: Greenpeace/EPIA Solar Generation VI, 2010.

FIGURE 37
REGIONAL DEVELOPMENT
LINKED TO PV EXPANSION
UNDER THREE SCENARIOS
%



source: Greenpeace/EPIA Solar Generation VI, 2010

The solar market has initially grown in developed countries; however it is expected to shift to developing countries in the coming decades. After 2020, North America, China and India will drive the PV market. After 2030, Africa, the Middle East and Latin America will also provide very significant contributions. Grid connected systems will continue to dominate the market in developed countries. In developing countries PV will be integrated into the electricity network in towns and cities, while off-grid and mini-grid installations are expected to play an increasing role in Asian and African countries to power remote villages.

Solar electricity is an efficient way to get power to people in developing countries, especially in regions with lots of Sun. While a standard household of 2.5 people in developed countries uses around 3,500 kWh annually, a 100 Wp system (generating around 200 kWh in a country from the "Sunbelt") in developing countries can cover basic electricity needs for 3 people per household. In Europe, the generation of 500 TWh of electricity would mean delivering electricity to 357 million of Europeans at home. In the non-industrialised world, each 100 GW of PV installed for rural electrification can generate electricity for 1 billion people.

"The solar market is expected to shift to developing countries in the coming decades."