SET FOR 2020

Solar Photovoltaic Electricity:
A mainstream power source in Europe by 2020

EXECUTIVE SUMMARY

EPIA
European Photovoltaic Industry Association

Solar Photovoltaic (PV) Electricity is poised to become a significant and competitive supplier to the European electricity market, concludes a comprehensive study conducted by the European Photovoltaic Industry Association (EPIA) with the strategic management consultancy A.T. Kearney. While boosting the share of PV will yield huge benefits to European society and economy, it requires the active support of policy makers, regulators and the energy sector at large.

Contents

Time has come for PV

- The economic, financial and energetic world is changing: this fluid situation creates a perfect window of opportunity to create the basis for the Paradigm Shift. These difficult times need to be seen as an opportunity to start a new wave of decentralised energy generation.

Oil is a finite resource, PV is renewable and sustainable

- There is a now a widespread awareness of the finiteness of the traditional hydrocarbon fuels and of their negative impact on the environment. This awareness facilitates communicating the advantages of renewable power generation.

Solar energy is *de facto* an infinite resource

- No technological or physical limitations to PV growth have been identified. This *de facto* infiniteness sets PV apart from most other electricity sources.

PV can grow faster than other sources

- PV is already demonstrating quick ramp up capability, outperforming most optimistic previsions: in 2008, about 4.5 GW have been installed in Europe, representing about 19% of new installed capacity in Europe (however, it should be noted that the operating hours of PV plants are lower than those of conventional plants). PV is the fastest growing renewable energy technology.

PV prices can decrease faster than other sources

- PV system and its components are technology driven products and prices will decrease quickly based on the rapid technological development. With the current technological advancements and volume installations, a 8% price decrease year-on-year can be expected. This price decrease progression is not expected by any other electricity source.

PV can grow well above 12% once Paradigm Shift is enabled

- The SET For 2020 study considers different scenarios for PV deployment in Europe. The Paradigm Shift Scenario demonstrates that PV electricity could provide up to 12% of the EU electricity demand by 2020, provided the right conditions are created. Once the Paradigm Shift has been enabled, the 12% target by 2020 is just an intermediary stage to a higher penetration rate.

1. CONTEXT AND RATIONALE

In March 2007, the European Union adopted an integrated climate and energy policy, putting forth ambitious quantitative policy goals for implementation by 2020. These goals are to:

- Reduce greenhouse gas emissions unilaterally by 20% from 1990 levels;
- Ensure that renewable energy represents a 20% share of total energy use. This implies a share of as much as 35% of electricity consumption;
- Reduce overall energy consumption by 20%.

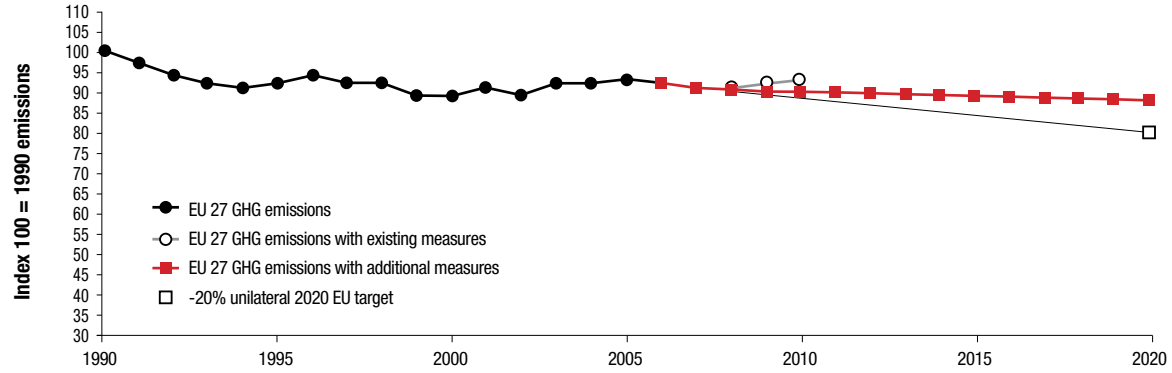
The so-called "20/20/20" goals are underpinned by a broader EU policy rationale to:

- Promote environmental sustainability and combat Climate Change;
- Increase the security of energy supply;
- Support the EU economic competitiveness and the availability of affordable energy.

Dramatically increasing the share of PV in the European electricity market will support all of these objectives and help the EU meet its 20/20/20 targets.

Achieving the 20/20/20 targets, however, requires decisive action. Current projections from the European Environment Agency indicate that, even taking into account the positive effects of the current national measures and policies and including the additional planned actions under discussion, the EU would reach 12% emission reduction, i.e. 8% short of its unilateral 20% reduction target (relative to 1990).

EU 27 Greenhouse gas emission trends and projections until 2020



Source: EEA "Greenhouse gas emission trends and projections in Europe", 2008.

The "SET For 2020" study, conducted by EPIA with the strategic management consultancy A.T. Kearney, is based on interviews with nearly 100 key people in industry, research institutes, utilities, regulatory agencies and governments across Europe and other parts of the world, backed up by the firm's global expert network.
It delves deeper and is more comprehensive than other existing studies on PV in Europe.

This study was commissioned by EPIA for the following fundamental reasons:

- **The global environmental, economic and energy landscape is changing**. These are challenging times, but they provide a unique opportunity to reconsider some of the fundamentals of the current, dominant model of centralised energy production and distribution.
- Widespread awareness of the **limited nature of hydrocarbon resources** and their **impact on the environment** is creating growing consensus on the urgent need for renewable power generation.
- PV has a **unique advantage** in that there are virtually no technological or physical growth limitations.
- PV is technology-driven and the industry has consistently demonstrated its ability to cut costs. Based on the current pace of progression in technology and installation volumes, **the cost of PV electricity is expected to decline 8% each year**, halving the generation cost every 8 years.

- The PV industry has been demonstrating quick **ramp-up capability**. In 2008, PV accounted for about 19% of all new installed power capacity in the EU.
- PV power generation will be **competitive** in parts of southern Europe as early as 2010 and is poised to become progressively competitive in the entire European region.

Providing a unique, wide-ranging combination of facts, figures and analysis, "SET For 2020" is indispensable for anyone with an interest in the future of the European energy market and the now upcoming National Action Plans for renewable energy in EU Member States.

2. WHAT THE STUDY SHOWS

The SET For 2020 study considers different scenarios for PV deployment in Europe, concluding that the most ambitious scenario is not only achievable, but also the most desirable.

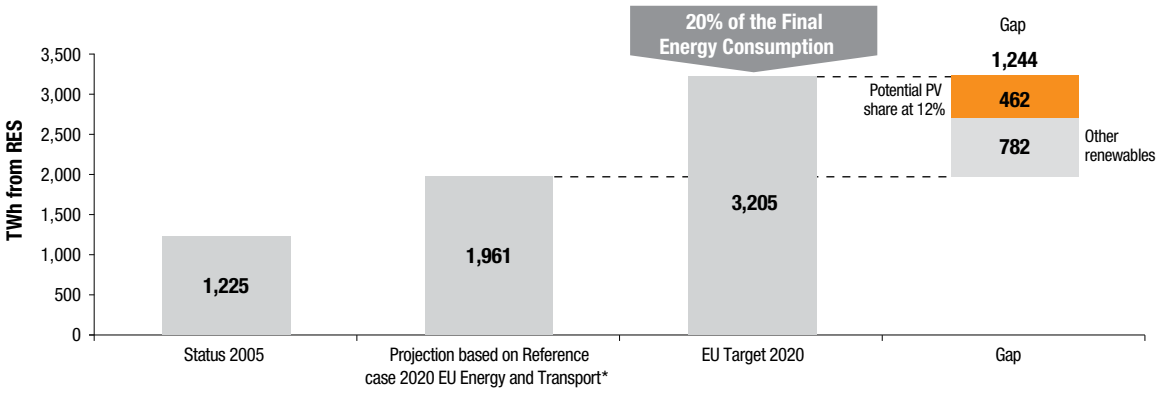
Ambitious 12% market share

The study demonstrates that PV electricity could provide up to 12% of the EU electricity demand by 2020, from less than 1% today, provided the right conditions are created by EU policy makers, national governments and energy industry stakeholders, including the PV sector.

A 12% market share for PV is a demanding, but achievable and desirable objective.

The 12% PV target is a necessary objective if the EU is to generate sufficient renewable energy to meet its 20/20/20 objectives.

EU 27 policy target for total final energy consumption vs. likely RES Scenario



* These projections include 75 TWh or "Solar and other RES" which make up a portion of the overall PV share.
Sources: EREC "Renewable Energy Technology Roadmap" - EU DG TREN "European Energy and Transport: trends to 2030 - update 2007".

PV can supply a significant share of the 1,244 TWh gap in renewable energy production required by 2020. With a 12% market share, PV will yield more than a third of the additional renewable production required, with the remainder supplied by wind, biomass, concentrated solar power, geothermal, hydro, tidal, wave and other forms of renewable energy.

Major net benefits

The study demonstrates that the development of PV has important and wide-ranging benefits for European society. **Supporting the development of PV now and for the coming few years is an investment that will yield hugely positive returns for European society.**

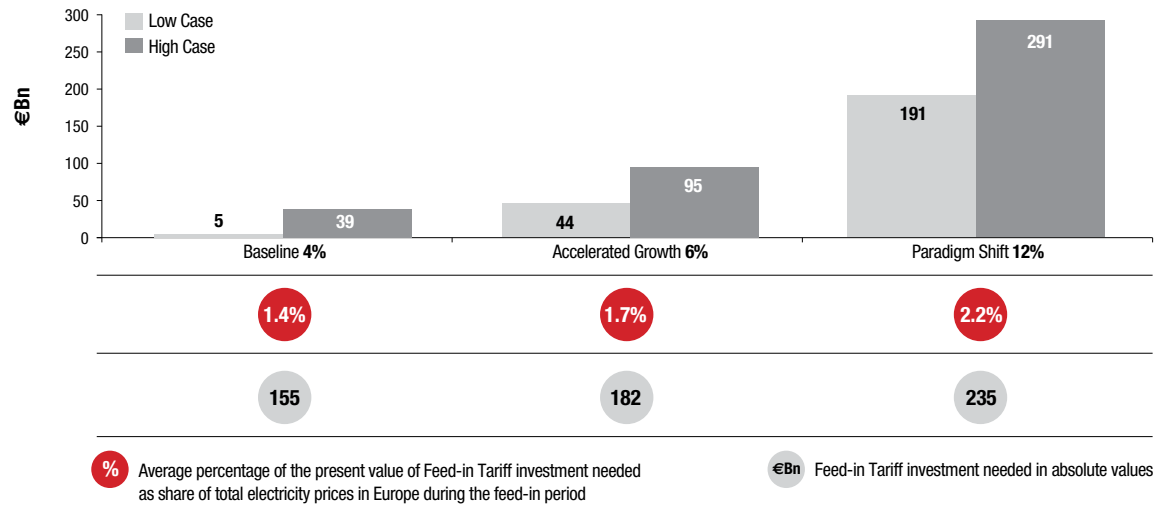
Environmental benefits

PV directly reduces rising CO_2 emissions by replacing CO_2 power generation, such as, for example, gas-fired power plants. With a 12% penetration by 2020, **PV would cut as much as 196 million tons in CO_2 emissions per year.**

Economic benefits

PV deployment will bring overall net economic benefits to the EU. **The higher the penetration of PV is, the greater the net benefits are.**

Net present benefit from PV deployment



Sources: LBBW "PV Sector, Valuing the invaluable", 2008 - A.T. Kearney analysis.

The net benefit calculation takes into account avoided CO_2 emissions, reduced volatility of energy prices and reduced grid losses, among other factors. The required temporary investment in the form of Feed-in Tariffs is relatively modest as it does not exceed 2.2% of the total value of electricity consumption.

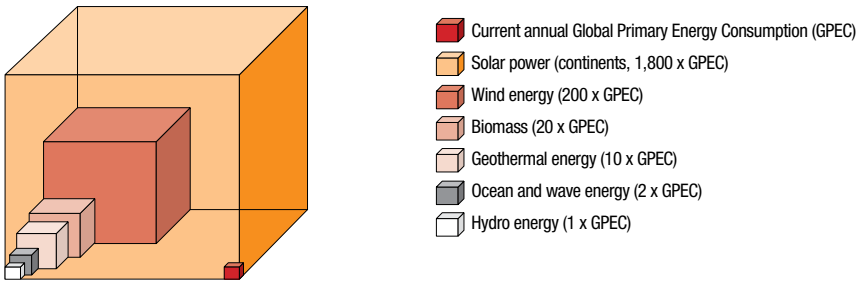
Mass penetration of PV will support European competitiveness and employment. It will underpin Europe's global industrial leadership in a competitive, high-tech industry sector and support the creation of quality employment firmly anchored in Europe.

The mainstream integration of PV will promote energy efficiency and sustainability across the board. It will reduce network losses and promote the emergence of smart, decentralised electricity distribution systems that are needed for most forms of renewable energy and also beneficial to traditional utility markets.

Social benefits

By transforming sunlight into electricity, PV uses a resource that has virtually unlimited potential. PV therefore has a direct, positive effect on Europe's **energy independence and security of supply**. Energy independence is an increasingly important factor for economic stability and political security.

The physical potential of renewable energies

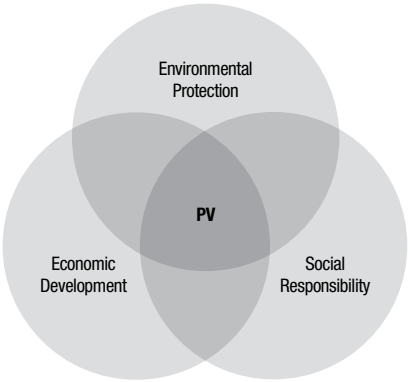


Source: Nitsch F. "Technologische und energiewirtschaftliche Perspektiven erneuerbarer Energien, Deutsches Zentrum für Luft- und Raumfahrt (DLR)", 2007.

Because PV power can be produced virtually anywhere and on a small scale, it supports energy independence at national, regional, local and individual levels, and allows for local communities and households to become energy self-sufficient.

PV is already a responsible profitable investment for many homeowners, farmers, and communities in Europe. **By bringing secure, renewable power to society in a decentralised way, PV is an enabling technology for a secure, prosperous and sustainable European society.**

PV can make an important contribution to meeting the EU's policy objectives and provides many additional benefits

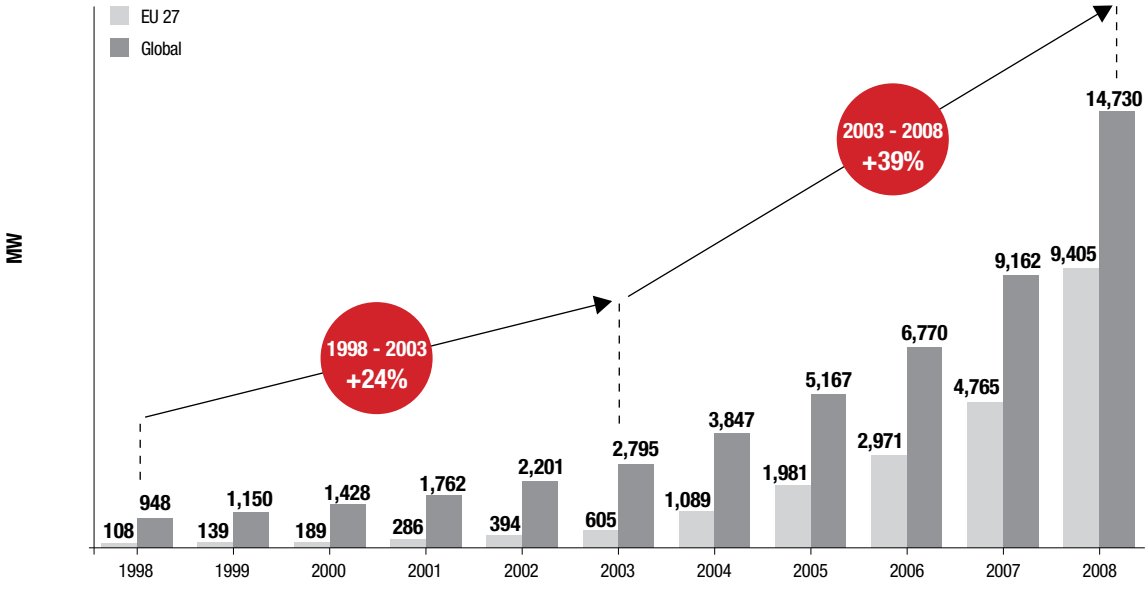


Source: A.T. Kearney analysis.

Price-driven growth potential

The many benefits of PV explain why the technology is experiencing **rapid growth** in the EU and in the world.

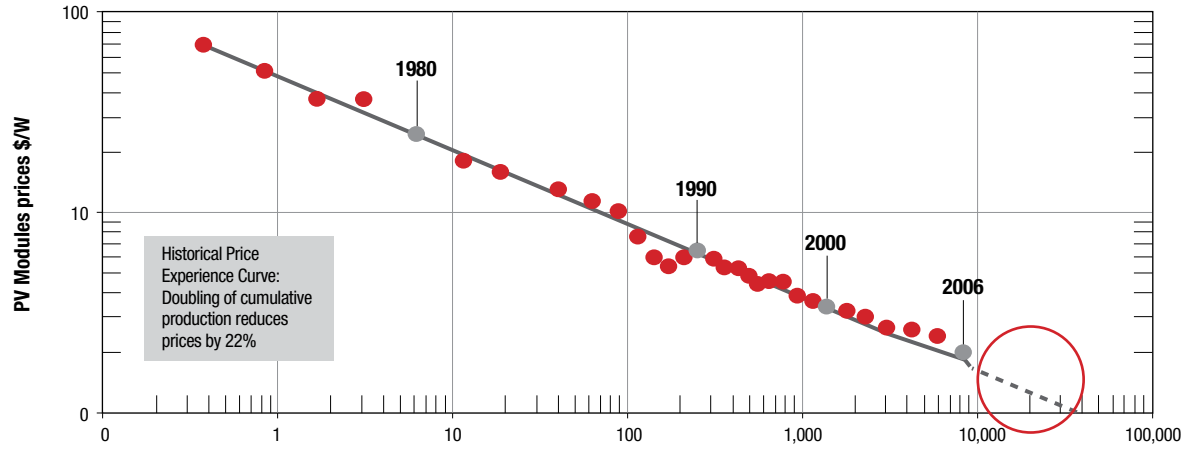
Cumulative installed PV capacity in EU 27 and in the world



Sources: EPIA « Global Market Outlook for Photovoltaics until 2013 », 2009 - A.T. Kearney analysis.

Cost is the only major factor that, so far, has limited the growth of PV and prevented it from joining the energy mainstream. The PV industry, however, has consistently demonstrated its capability to achieve fast price reduction.

Photovoltaic module price experience curve since 1976 ($/W)



Sources: EU Joint Research Centre - EIA - National Renewable Energy Laboratory - A.T. Kearney analysis.

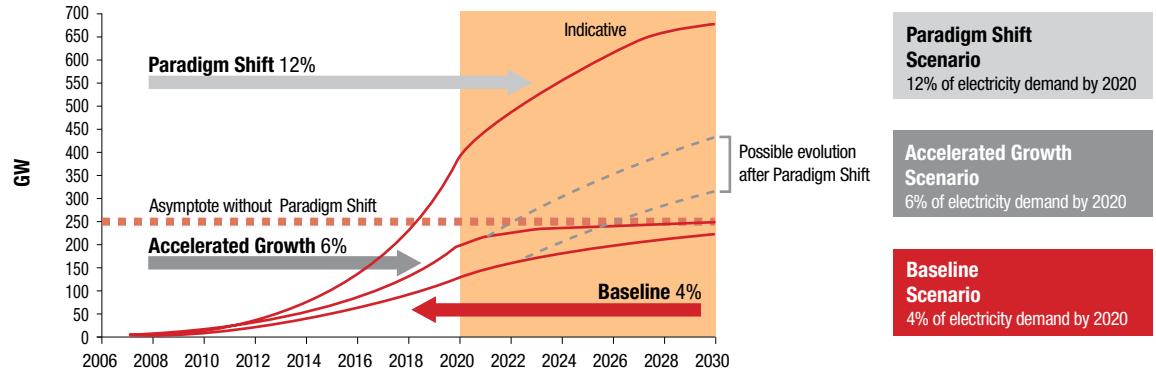
Technological progress will enable further substantial PV cost reductions, while fossil fuel-based electricity prices are expected to continue their long-term increase.

3. VARIABLES AND DIFFERENT PATHS TO FULL COMPETITIVENESS

Three scenarios

The SET For 2020 study has identified three possible PV deployment scenarios, which are determined by a series of conditions. **Only the more ambitious scenario will yield the full benefits described above.**

PV deployment Scenarios in Europe 27, Norway and Turkey



Sources: EPIA - EU DG TREN "European Energy and Transport: trends to 2030 - update 2007" - Eurostat Data Portal - EU Joint Research Centre Photovoltaic Geographical Information System - A.T. Kearney analysis.

The **Baseline Scenario** foresees 4% penetration of PV by 2020. This is the "business as usual" case. The scenario does not require changes to the existing electricity system, but it does require full dedication from the PV industry to achieve cost reductions, marketing efforts and wider policy support of PV in Europe.

The **Accelerated Growth Scenario** aims for 6% of the market, largely within the current infrastructure limits. In addition to the baseline requirements, accelerated growth requires minor changes to the existing electricity system, optimised PV supply chains, greater cooperation with utilities and a compelling product and service offering.

The **Paradigm Shift Scenario** sets a target of 12%. In addition to the conditions above, this requires the rapid and widespread adoption of power storage and smart grid technologies, and further improvements in the supply chain, operations and marketing strategies of the PV industry. EPIA's vision goes beyond 2020, with PV penetration well above this 12% target.

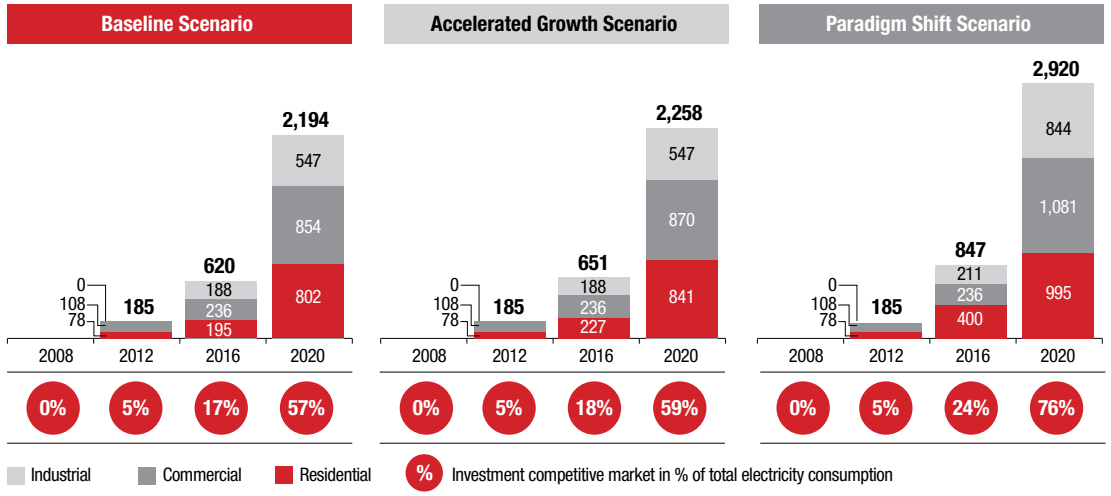
Investment competitiveness

An important concept explored in the study is that of "investment competitiveness".

Investment competitiveness describes the moment when the business case to invest in a PV installation that will deliver electricity for 20 years is profitable compared to the price of a grid contract for 20 years, in the absence of any form of external price support or subsidy.

The study shows that investment competitiveness will be reached in some regions of Europe as soon as 2010. **By the end of 2020, PV can be competitive in as much as 76% of the European electricity market.** The faster the penetration of PV, the greater the accessible market, as costs will decline more rapidly.

Size of the accessible end-user market for PV (TWh of final energy consumption in Europe)



Sources: EPIA "Solar Generation V", 2008 - A.T. Kearney analysis.

Framework conditions

The potential of PV deployment depends on six different framework conditions:

- System integration
- Cost competitiveness
- Market deployment
- Policy framework
- Interaction with other renewable energy sources
- Supply chain

These framework conditions are interdependent. They are shaped by numerous stakeholders ranging from the PV industry to policy makers, regulators, the R&D community, utilities and grid operators, among others.

System Integration

The evolution of the generation mix in place as well as the "smartening" and strengthening of distribution and transmission infrastructure will determine the technical limits to the penetration of PV (and of other renewable energy sources).

The daily and seasonal variations of PV generation across geographic regions also require increased flexibility in grid management and in the generation mix, as well as grid-integrated power storage capacity. Increased flexibility in the generation mix will only be possible through better coordinated long-term planning of investments in new generation capacities (additional and replacement) across the European electricity market.

Cost Competitiveness

Increased global deployment of PV will quickly fuel fast price reductions towards investment competitiveness across Europe, thus enabling, in the near to mid-term, market-driven growth without Feed-in Tariffs.

Technological progress will enable substantial price reduction at system level. Price declines require extensive R&D investment as well as continued support of PV market development to secure economies of scale.

Market Deployment

The development of the right value proposition for final customers will be key to a successful PV deployment. This means innovative products that fit the different customers requirements, certification for safety and reliability, but also availability of appropriate financing solutions, from banks or suppliers, customised for the specific cash flow profiles of PV installations. Cost improvements must be passed on to consumers as pricing is clearly a key success factor. Utilities are in a very good position to market PV to their final customers, but PV deployment could benefit from active promotion via installers and building material wholesalers. Finally, various business models will emerge involving traditional stakeholders (Utilities, PV distributors and installers) and new players to combine a broad range of customer services (installation, maintenance, optimisation of electricity flows) and develop growing capabilities to directly operate in the electricity markets.

Policy Framework

The implementation of temporary support policies including lean and transparent administrative procedures is needed to ensure sustained PV penetration.
Feed-in Tariffs are the best support scheme for successful PV deployment, but the level of support must be sustainable and not unduly generous. Support schemes must evolve with the growing share of PV. High administrative barriers and slow or costly grid connections will hamper PV deployment despite appropriate Feed-in Tariffs.

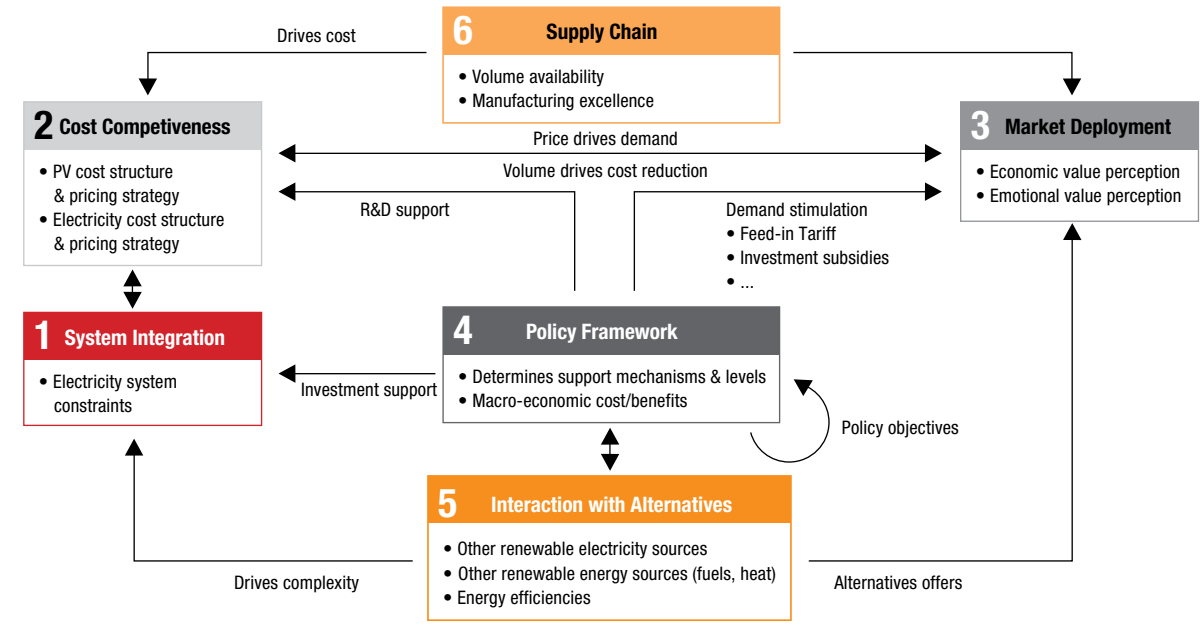
Interaction with other renewable energy sources

Current projections indicate that the EU's 20/20/20 objectives can be met only with a combined effort, and PV is an essential component of the solution. Wind and PV have common interests, such as grid development, CO_2 awareness, smart grids and metering, financing needs, resource mapping and forecasting, and proving the feasibility of the "Virtual Power Plant" concept (ability of PV in combination with Wind and Biomass to deliver baseload power).

Supply Chain

The PV supply chain is expected to deliver and sustain production at a multi-gigawatt level in the coming years to support a market between 80 GW and 160 GW worldwide.The supply chain will need to address four key challenges: the availability of polysilicon, the availability of commodity materials, cell and module capacities, and the availability of qualified professionals. Education and training is an important condition to maintaining a leading PV industry base in Europe.

PV framework conditions map



Source: A.T. Kearney analysis.

4. RECOMMENDATIONS TO STAKEHOLDERS

Achieving a significant penetration of PV in the European electricity market requires the active involvement of EU policy makers, governments and energy industry stakeholders, including the PV sector.

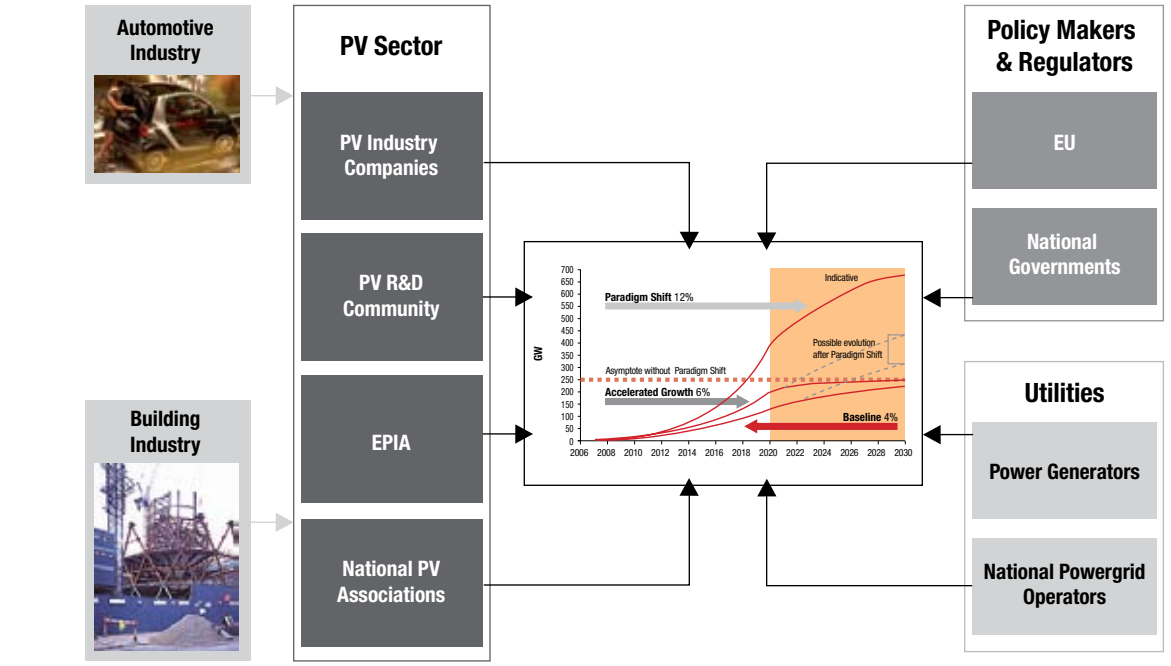
The need for a comprehensive approach

Policy makers, regulators and industry need to collaborate to support PV's mass-market penetration by fostering technological progress and cost reductions, as well as by creating an appropriate financial and regulatory environment.

While PV moves towards the mainstream and plays an increasingly significant role in supporting EU policy objectives, it will require temporary support of policy makers to bridge the competitiveness gap.

Public support can only be justified if the PV industry commits its own resources to this goal. The EPIA membership strongly believes in seeking a sustainable, long-term development of the industry that will deliver the full benefits of PV to society.

The PV stakeholders' interaction



Source: A.T. Kearney analysis.

Recommendations to the PV industry

PV Industry companies must maintain their strong R&D commitment to continue the dynamic PV cost reduction momentum. Technology research can lead to efficiency improvements of 30% by 2020 and to electricity generation costs being cut by half every 8 years. The PV industry is committed to reaching a target cost of below 10 €ct per kWh of electricity by 2020 for industrial size systems and well below 15 €ct per kWh for residential systems.

The competitiveness of PV investment vs. grid purchase will be reached by 2010 in some southern regions of the EU. But attaining this competitive level will not, by itself, necessarily lead to a rapid market uptake. Therefore, the PV industry must direct increased efforts at developing and marketing innovative PV applications to final consumers.

The PV R&D Community must further accelerate its progress on delivering research results in line with the focus areas defined by the PV Technology Platform in its Strategic Research Agenda. These focus areas are to:

- Enhance performance by higher device outputs and improved systems performance;
- Improve manufacturability and reduce process costs;
- Ensure the sustainability aspects of the technology through the entire life cycle, from manufacture to use and recycling;
- Address applicability by developing products and technologies to meet specific market needs.

PV industry companies will continue to collaborate closely with R&D institutes to ensure the ready uptake of innovation in the end product. They will seek to fully leverage the research support granted by EU and national governments to this end.

EPIA will help to increase market transparency in Europe and provide support to policy makers to define sustainable support schemes and manage the policy transition to competitive PV markets. For this purpose, a "PV observatory" will provide an annual overview of the policy status, including comparisons of the internal rate of returns based on a European reference price for various systems. Such a PV observatory will also measure administrative and connection lead times and formulate country-specific recommendations.

National PV Associations must be proactive in supporting national industry and governments in their task while maintaining a long-term perspective on sustainable PV market development. EPIA will support and strengthen national associations where needed, and seek to organise national PV stakeholders to establish national PV associations in countries where they do not yet exist.

Recommendations to policy makers, regulators and utilities

The EU must increase its support for PV R&D efforts and large demonstration projects, with a focus on accelerated cost reduction and integrated approaches to make the necessary changes in the power distribution system. Decisive action must be taken on PV integration and facilitating investment in EU-based production capacities to boost the European export potential of PV technology.
Regarding energy sector regulation, the EU must promote time-of-use electricity billing and net metering to facilitate the penetration of renewable energy sources. The EU must further promote PV market deployment by supporting high and certified European quality standards which will help lower the investment barrier.

National governments must act swiftly to de-bottleneck administrative procedures and ensure sustainable levels of temporary financial support by means of well-designed Feed-in Tariffs to ensure continuous PV deployment. In addition, national governments must be proactive in facilitating domestic investment in PV production capacity and supplying the required skilled workforce through adapted education and training programmes.

Utility sector companies with generation assets and established end-user relationships must consider PV development as an opportunity and become proactive PV investors and marketers to maintain and expand their market share by meeting client demand and offering them advanced customer services.

Grid operators must help decentralise the infrastructure and become actively involved in implementing the necessary smart grid technology such as improved measurement, communication and control technologies. They also need to help develop and install storage technologies to increase the absorption of distributed power in grids, while collaborating with the renewable energy sector to ensure that regulators reflect the necessary investments in their distribution tariffs. By seizing the opportunity offered by fast PV growth, DSOs will be able to quickly internalise related high-tech evolutions and create new sources of value for their customers and their employees.

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EPIA
European Photovoltaic Industry Association

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About EPIA

With over 200 members active along the whole value chain, the European Photovoltaic Industry Association (EPIA) is the world's largest industry association devoted to the solar photovoltaic electricity market. EPIA's mission is to deliver a distinct and valuable service driven from the strength of a single photovoltaic voice. The association aims to promote PV at national, European and worldwide levels and to assist its members in their business development in both the European Union and export markets.

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