SOLAR POWER
MORE JOBS
LESS CO_2
www.solarCOP16.org

SEIZING THE SOLAR SOLUTION:

Combating Climate Change through Accelerated Deployment

2010 Edition

A Joint Report by the Solar Trade Associations from Around the World

EPIA
European Photovoltaic Industry Association

SEIA
Solar Energy
Industries
Association®

Australian PV
Association

CanSIA

SNEIA
www.sneia.org

CREIA 中国资源综合利用协会可再生能源专业委员会
Chinese Renewable Energy Industries Association

ESTELA

ESTIF
European
Solar
Thermal
Industry
Federation

JPEA 太陽光発電協会
Japan Photovoltaic Energy Association

المركز الوطني لبحوث الطاقة
National Energy Research Center

الجمعية اللبنانية للطاقة الشمسية
The Lebanese Solar Energy Society

SEANZ
Sustainable Electricity Association New Zealand

SVENSK SOLENERGI

gensed
gunes enerjisi sanayicileri ve endustrisi dernegi

SWISSOLAR

(사)한국신 재생에너지학회
The Korean Society For New And Renewable Energy

중요 공지사항 안내

APPA
Asociación de Productores
de Energías Renovables

BSW
Bundesverband
Solarwirtschaft

Gruppo
Imprese
Fotovoltaiche
Italiane
ANIE

HUPIA
Hungarian Photovoltaic Industry Association

SOLAR POWER
MORE JOBS
LESS CO_2
www.solarCOP16.org

TABLE OF CONTENTS

Executive Summary

The Solar Energy Industry Fighting Climate Change Now

Finding solutions to address climate change is vital for our future. Fortunately, solar energy can play an important role in reducing greenhouse gas emissions while generating the energy and jobs needed on a global scale. Not only is the sun an unlimited fuel source, but it also provides the cleanest form of energy available at any scale, large or small. Solar has the potential of being a major player in global mitigation efforts if the right policies and incentives are put in place now, and should be considered a part of the climate negotiations.

More than 40 international associations active in the solar and renewable energy sector have joined forces to speak with one voice at COP16. These associations show the capacity of the solar industry to deliver clean energy, create jobs, and decisively contribute to the fight against climate change now.

MORE JOBS

Deploying solar stimulates economic activity and creates jobs. The data presented in the following pages of the 2010 edition of the "Seizing the Solar Solution: Combating Climate Change through Accelerated Deployment" report shows that **the European Union alone is projected to create 1,130,000 jobs by 2020, and the United States projected to create 683,000 jobs by 2020** with each country's respective solar energy targets.

MORE ENERGY

Solar is ready to significantly reduce the world's dependence on conventional fuels and satisfy the energy demand of a growing population. Solar is already a major success story in the countries that have adopted effective policies for solar energy that have stimulated the growth of solar energy markets. The combined world solar targets provided by the countries within this report show that **the solar electric capacity will reach 700 GW by 2020, while solar thermal capacity will reach 280 GW-th by 2020**.

For developed countries, feed-in tariffs have proven to be the most successful mid-term support scheme for solar technology deployment within Europe and Japan, while tax incentives have been the primary policy driver in the United States. Solar technology is rapidly reaching grid parity with fossil fuels in an increasing number of developed countries. Similar performance based incentives, such as innovative and well-designed feed-in tariffs supported by public and/or private funding, are currently being designed for a number of developing countries. These support mechanisms are being shaped in the context of national infrastructure development, energy regulatory frameworks, and low carbon development strategies in each country.

Employing solar energy allows developing nations to leapfrog past traditional energy sources to clean, sustainable technology and reach underserved populations in rural locales. The International Energy Agency estimates that roughly 85% of the people without electricity live in rural areas in developing countries. Solar energy is one of the most suitable, affordable and environmentally friendly solutions to provide electricity to

"By 2020, combined world solar deployment could reach a level that reduces carbon pollution by 570 megatonnes, equivalent to taking 110 million cars off the road, or shutting down 100 coal plants."

rural areas. Just as cell phones can help bring the advantages of 21st century commerce and connectivity to regions which lack a traditional telecommunications infrastructure, solar technology is uniquely capable of bringing renewable thermal energy and electricity to parts of the developing world. Solar is thereby an active catalyst for sustainable development by providing basic services such as lighting, drinking water, healthcare and education, which are crucial to meet the Millennium Development Goals aimed at poverty alleviation

Whether a nation be considered a developed or developing country, policies aimed at promoting deployment of solar energy should be a central part to any low-emissions development strategies within the country.

LESS CO2

Solar technology is already making a significant contribution to the reduction of greenhouse gases. Deploying solar energy presents a concrete measure our nations' leaders can take to reduce carbon emissions now. **The solar industry stresses the crucial importance of internationally agreed mid-term and long-term emission reduction targets for all developed countries** in order to guide investment decisions, provide investment security, and create green investment patterns, **as well as the inclusion of solar policies in Nationally Appropriate Mitigation Actions for developing countries**. In addition, the solar industry believes that a **price on carbon is essential** to reflect the true cost of fossil fuels.

Solar energy technologies are available now and ready to deliver energy with environmental and economic benefits. As previously mentioned, with the right policies, the combined solar targets provided by the countries in this report show that solar electric capacity by 2020 could reach 700GW, with solar thermal capacity at 280GWth by 2020. This is equivalent to a **world total reduction in carbon pollution by 570 Mt, which is equivalent to eliminating the carbon emissions from the UK, Canada, or South Korea, or taking 110 million cars off the road, or shutting down 100 coal plants**.

The solar energy industry is fighting climate change now. Solar energy means more jobs, more energy, and less CO2.

Combined World Solar* Targets and Carbon Reduction

	Solar Electric Capacity by 2020	Solar Thermal Capacity by 2020	Associated Carbon Reduction by 2020
World Total	**700 gigawatts**	**280 gigawatts-thermal**	**570 megatonnes****

*** Includes countries represented in this report.**

****Carbon reduction equal to eliminating carbon emissions from United Kingdom, Canada, or South Korea. Carbon reduction is equal to taking 110 million cars off the road or shutting down 100 coal plants.**

Solar Energy and Climate Change Policies

The Road to Cancun

From the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and its entering into force in 1994, the ultimate objective of the 192 parties who ratified the convention treaty has been to stabilize greenhouse gas concentrations in the atmosphere at a level that would "prevent dangerous anthropogenic interference with the climate system."[1] Since this time, the UNFCCC has made progress on achieving this goal with the Kyoto Protocol, the Montreal Action Plan, the Bali Action Plan, and the noted Copenhagen Accord.

The Kyoto Protocol, an internationally binding instrument, commits its signatories to reduce their greenhouse gas emissions by 5.2% from a 1990 level in the target period of 2008-2012. The Kyoto Protocol also provided a number of mechanisms to the Parties to meet their quantified emission limitation and reduction commitments. Therefore, some countries have adopted a series of reduction targets in order to meet their obligations under the Protocol. In the European Union (EU), for example, the commitment is to an overall reduction of 8%. To help get there, the EU has agreed to increase it's proportion of renewable energy from 6% to 12 % by 2010. The Montreal Action Plan established in 2005 agreed to "extend the life of the Kyoto Protocol beyond its 2012 expiration date and negotiate deeper cuts in greenhouse-gas emissions".[2]

Climate negotiations received a major boost in Bali at COP-13, which established two new subsidiary bodies under the Convention for dealing with future negotiations, and produced the Bali Action Plan. The Bali Action Plan identified five central pillars for an enhanced international response to climate change: shared vision for long-term cooperative action, enhanced international action on climate change in developed and developing countries, enhanced action on adaptation, technology transfer and finance.

COP-15 in Copenhagen produced the Copenhagen Accord, a non-binding letter of political intent taken note of by the Conference of Parties. The accord contains a number of important provisions on mid-term targets for developed countries, mitigation actions by developing countries, and financial and technological support for developing countries to carry out actions to respond to climate change. The international community has already taken steps to implement the provisions of the Copenhagen Accord; the solar industries request that governments maintain this momentum and bring the non-binding pledges and financing under the Copenhagen Accord into a legally binding form.

Global Benefits of Solar Energy

While delegates struggle to complete the urgent task of agreeing on all the terms and policies in a larger agreement, either a successor to the Kyoto Protocol or a new treaty, solar technology is already making a significant contribution to the reduction of greenhouse gases. Solar has the potential of being a major player in global mitigation efforts if the right policies and incentives are put in place now. Solar is already a major success story in the countries that have adopted effective policies for solar energy. The technology is rapidly reaching grid parity with fossil fuels in an increasing number of countries. Solar energy also has a virtually unlimited potential for energy production due to the abundant availability of sunlight. The promotion of solar energy is a task that should be considered a part of the climate negotiations.

Mitigation

Mitigation can be understood as the adoption of policies that reduce emissions of greenhouse gases. The solar industry would like to stress the crucial importance of **internationally agreed mid-term and long-term emission reduction targets for all developed countries** in order to guide investment decisions, provide investment security, and create green investment patterns. The solar industry is ready to be a central part of the green transformation of the energy sector in all countries.

The solar industry believes that renewable energy targets on a domestic level form an essential complement to economy-wide targets and are crucial in attracting the investment necessary for decarbonizing energy infrastructure. Experience shows that a renewable energy target, when combined with the right support schemes, can generate multi-billion dollar investments into renewable energies and lead to the rapid reduction of greenhouse gas emissions.

In addition, the solar industry believes that a **price on carbon** is essential in order to ensure a level playing field and factor externalities into the costs of conventional fuels. Possible measures include the establishment of a carbon tax, cap and trade systems, and the encouragement of the Kyoto mechanisms. The global carbon market is an important source of new and innovative financing that will be needed in order to meet the Copenhagen funding commitments and generate further investment into renewable energies on a national level. The solar industries also welcome developments in other international fora, including the G20, that have established an international consensus on **removing the incentives associated with fossil fuel subsidies**.

Taking into account the importance of "common but differentiated responsibilities" in terms of greenhouse gas emissions targets for developed and developing countries, the Bali Action Plan called for **Nationally Appropriate Mitigation Actions (NAMAs) by developing country Parties**. The solar industry would like to highlight the fact that a renewable energy target can qualify as a nationally appropriate mitigation action-a policy that can promote the deployment of solar technology. Not only can solar play a central role in the achievement of the NAMAs envisioned by Parties, but solar fits into the arena of sustainable development as well.

The solar industry supports that the targets and NAMAs be measurable, reportable, and verifiable, as included within the Bali Action Plan, to give investors the confidence they need, and to ensure the full accountability of the nationally appropriate actions, and to ensure that greenhouse gas emission reductions are achieved worldwide.

Financial Resources and Investment

The solar industry welcomes the funding commitments provided by developed countries during the COP-15. Private sector financial resources can significantly widen the reach of public resources and thereby greatly accelerate the green transformation of the world economy. An international financing framework is needed that will encourage technology transfer and the investment in solar projects around the globe. This financing framework must attract both public and private funds, must be sufficient and affordable, and should provide direct support for every type of solar energy. Article 8 of the Copenhagen Accord established the Copenhagen Green Climate Fund, which would provide adequate funding and improved access to the funds for developing countries. This financing framework should provide direct support for every type of solar energy. Such funding would provide countries with the means to implement renewable energy programs and solar technologies, providing the basis for a sustainable, low-carbon energy future. With fast-track financing, solar projects could be jump-started and make contributions to emissions reduction objectives in the near term. The solar industry encourages the establishment of such a Green Climate Fund.

Technology Transfer

The policies surrounding the technology transfer to developing countries have become increasingly imperative to reaching any global climate deal, as technology transfer will help achieve a sustainable energy structure. The solar industry welcomes the Parties' consideration of various additional institutional arrangements in order to accelerate technology development and deployment. The Bali Action Plan calls for "enhanced action on technology development and transfer to support action on mitigation and adaptation, including...ways to accelerate deployment, diffusion, and transfer of affordable environmentally sound technologies; cooperation on research and development of current, new and innovative technology, including win-win solutions".[3] Solar energy is one of these win-win solutions, and knowledge of solar energy technologies could be shared with developing countries, provided Intellectual Property rights are followed. The UNFCCC should build on the work of the Major Economies Forum Technology Action Plan on Solar Technology and in particular the Global Atlas for Solar as announced by the Multilateral Solar and Wind Working Group at the July 2010 Clean Energy Ministerial. The aim of the Global Atlas for Solar is to combine and expand existing databases on solar potentials and socio-economic framework conditions around the globe into one open web-portal from which user-tailored data can be derived and accessed.[4] It can serve as a useful example for the sharing of knowledge and capacity-building at the international level.

Policies that enhance tech transfer must also encourage capacity building. Again, the work of the Multilateral Solar and Wind Working Group on a "Long Term Strategy on Joint Capacity Building"[5] should be taken into account and incorporated into any policies. Private sector input should be welcomed as well.

Adaptation

Adaptation is the flipside of mitigation measures. The solar industry welcomes the fact that the international community has recognized the scientific imperative of keeping global temperature rise below 2 degrees Celsius; however, even with this temperature rise limitation and action on emission targets, a certain degree of adaptation will still be unavoidable. The potential of solar energy to contribute to climate change adaptation should not be underestimated. Advanced and decentralized energy grids are less vulnerable to extreme events and can provide reliable electricity even in periods of crisis. In addition, solar energy is particularly well-suited for bringing communities back to the grid after extreme events have occurred; solar energy can also provide electricity to off-grid locations. Solar provides a double dividend that addresses energy poverty while also contributing to the reduction of greenhouse gas emissions.

Country-Specific

On a country level, there are numerous policies that can aid in the deployment of solar technology. These policies should be a central part to any **low-emissions development strategies** of a country. For example, fair access to the energy grid in each country should be a mandatory policy. This would encourage the deployment of large-scale as well as distributed generation solar technologies. Furthermore, policies that promote transmission and distribution capacity for solar technologies are also needed. Price based mechanisms, such as feed-in tariffs, tax and investment incentives, or quantity based mechanisms, such as renewable energy certificates or tender schemes, have proven to be successful in deployment of solar energy in many countries, and should be encouraged. Feed-in tariffs have proven to be the most successful mid-term support scheme for solar technology deployment within Europe and Japan. However, it is well understood that performance based mechanisms must be put in the context of national infrastructure development, energy regulatory frameworks, and low carbon development strategies of any given country.

With the implementation of the above named policies, it will be possible to seize the solar solution to climate change. Solar technologies are ready now. Solar energy means more jobs, more energy, and less CO2.

[1] http://unfccc.int/resource/docs/convkp/conveng.pdf

[2] http://en.wikipedia.org/wiki/Montreal_Action_Plan

[3] http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_act_p.pdf

[4] http://www.energy.gov/news/documents/Renewables-Fact-Sheet.pdf

[5] A Long-Term Strategy on Joint Capacity Building will help train the global clean energy workforce of the future by providing a range of international training opportunities along the whole value chain of solar and wind technologies, from basic working skills to academic education.

[6] http://www.bcse.org/images/IntlCCTF/clean-energy-ministerial-fact-sheet.pdf

About Solar Energy Technology

Photovoltaic (PV) Solar Energy

Photovoltaic (PV) solar energy uses semiconductors to convert sunlight directly to electricity. PV can be used in many types of applications, making it one of the most flexible energy technologies. It utilizes a virtually limitless renewable resource: each year the sun irradiates the Earth's surface with energy equal to 2,000 times the total global energy demand.

From the manufacturing phase to end-of-life PV recycling, photovoltaics have a minimal environmental impact. PV systems typically have a energy payback time of 6 months to two years and a useful life of more than 25 years.

PV can be used both for central and distributed power generation, which makes it a highly functional energy technology. PV systems are used as utility-scale projects, remote standalone generating systems, and distributed systems capable of being integrated in densely-populated urban environments.

An extremely scalable technology, there are virtually no material, environmental or industrial limitations to the growth of PV. With more than 7,000 MW added in 2009, the cumulative installed capacity is now well over 22 GW.

Photovoltaic (PV) systems

Photovoltaic systems use cells to convert sunlight into electricity. Each cell consists of one or two thin layers of a semi-conducting material. Light shining on the cell creates an electric field across the layers, causing electricity to flow. As the intensity of the light increases, the flow of electricity increases as well.

A photovoltaic system does not need bright sunlight in order to operate. It can also generate electricity on cloudy days. Due to the reflection of sunlight, slightly cloudy days can even result in higher energy yields than days with a complete cloudless sky.

Components

Two of the most important components in a PV system are the cells—which collect the sun's light—and the modules, which connect the cells. Another important aspect of a PV system is the balance of system (BOS), made up of a racking system and an inverter, which converts the electricity generated into a form suitable for everyday use. For standalone PV systems that are not connected to the electric grid, a battery and a charge controller are also required.

PV Cells and Modules

The solar cell is the basic unit of a PV system. An individual solar cell can vary in size from about one centimeter to about 15 centimeters across and typically produces between 3 and 4.5 watts.

PV cells are generally made either from crystalline silicon, which is sliced from ingots or castings, or from grown ribbons or thin film, which is deposited in thin layers on a low-cost backing. (see page 8 for chart)

The power of the cell is increased by connecting cells together to form larger units called **modules**. The module is composed of the interconnected cells that are normally encapsulated between a transparent cover (glass) and a weatherproof backing (back sheet made typically of a thin polymer). To give additional mechanical strength, modules can be framed.

Crystalline Silicon Technology

Crystalline silicon cells are made from thin slices cut from a single crystal of silicon (monocrystalline) or from a block of silicon crystals (polycrystalline).
There are three main types of crystalline cells:

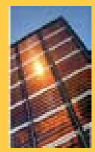
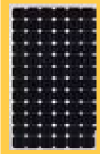
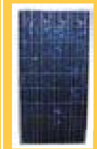
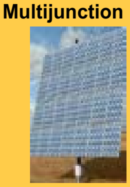
- Monocrystalline (Mono c-Si)
- Polycrystalline (or Multicrystalline) (multi c-Si)
- Ribbon sheets (ribbon-sheet c-Si)

Thin Film Technology

Thin film modules are constructed by depositing extremely thin layers of photosensitive materials onto a low-cost backing such as glass, stainless steel or plastic. Unlike crystalline silicon modules, the material deposited is divided by a laser creating multiple thin cells which are needed to obtain enough power.

Thin film modules are normally encapsulated between two glasses and are frameless. However, the active material can also be deposited in a thin plastic thus making the cell/module flexible. This opens the range of applications, especially for building integration and end-consumer applications.
Four types of thin film modules (depending on the active material used) are currently commercially available:

- Amorphous silicon (a-Si)
- Cadmium telluride (CdTe)
- Copper Indium/gallium Diselenide/disulphide (CIS, CIGS)
- Multi junction thin silicon Film (a-Si/µc-Si): based on two or more layer of amorphous silicon and micro-crystalline silicon

Commercial Module Efficiency								
Technology	Thin Film					Crystalline Silicon		CPV
	(a-Si)	(CdTe)	CI(G)S	a-Si/ µc-Si	Dye s. cells	Mono	Multi	III-V Multijunction
								
Cell efficiency	4-8%	10-11%	7-12%	7-10%	2-4%	16-22%	14-18%	30-38%
Module efficiency						13-19%	11-15%	~25%
Area Needed per KW (for modules)	~ 15 m²	~ 10m²	~ 10m²	~12m²		~7m²	~8m²	

Source: EPIA 2010, Photon international, March 2010, EPIA analysis
Efficiency based on Standard Test conditions.

Concentrator Photovoltaics (CPV)

Some solar cells are designed to operate with concentrated sunlight. These cells are built into concentrating collectors that use a lens to focus the sunlight onto the cells. The main idea is to use very little of highly efficient but expensive semiconducting PV material while collecting as much sunlight as possible. Concentrator PV (CPV) can be based in both either silicon cells or III-V compounds (generally Gallium arsenide: GaAs) and concentrating factors go from x2 to up to x1000 suns.

The use of precise and accurate lens sets requires the modules to be permanently oriented towards the sun. This can be done by the use of a tracking system.

New and Emerging Technologies

The production of PV cells is constantly improving as a result of both technology advances and changing industrial processes. Further material developments include further optimization of the previously identified cell concepts but also the development and commercialization of new concepts such as polymer solar cells and other types of organic solar cells (dye sensitive solar cells).

PV Modules

The **PV module** is the main component of any PV power system. Modules consist of clusters of PV cells incorporated into a unit, usually produced by soldering them together under a sheet of glass. They can be adapted in size to the proposed site and quickly installed. They are also scalable, reliable and weatherproof. Module producers usually guarantee a power output of 80 percent of the module's nameplate capacity after 20 to 25 years.

Modules can be connected to other modules to form even larger units know as arrays.

Inverters

Inverters are used to convert the direct current (DC) power generated by a PV generator into alternating current (AC) compatible with the local electricity distribution network and most common electrical appliances. This is essential for grid-connected PV systems. Inverters are offered in a wide range of power classes, from a few hundred watts (normally for stand-alone systems) through the most frequently used range of several kW up to central inverters for large-scale systems (up to 2000 kW).

Batteries and Charge Controllers

Standalone (off-grid) PV systems require a battery, frequently of the lead acid type, to store the energy for future use. The battery is connected to the PV array via a charge controller, which protects the battery from overcharging or discharging and can also provide information about the status of the system or enable metering and pre-payment for the electricity used. The battery is connected to the PV array via a charge controller, which protects the battery from overcharging or discharging and can also provide information about the status of the system or enable metering and pre-payment for the electricity used. If AC output is needed, an inverter is required to convert the DC power produced by the array.

Types of PV Systems

PV systems can be used for homes, offices, public buildings or remote sites where grid connection is either unavailable or too expensive. PV systems can be mounted on rooftops or on building facades or operate as standalone systems. With innovative PV array technology and mounting systems, PV can be retrofitted on existing roofs or easily incorporated during the construction stage. Modern PV technology has advanced rapidly and PV is no longer restricted to square and flat panel arrays but can be curved, flexible and shaped according to the building design.

Grid Connected vs. Stand Alone/Off Grid

PV systems connected to the local electricity grid allow any excess power produced to feed the electricity grid and to sell it to the utility. These PV systems are designed to meet all or a portion of the daily energy needs. Typical on-grid applications are roof-mounted systems on private houses or commercial buildings. "Off-grid systems" have no connection to an electricity grid. Off-grid systems are contributing to rural electrification in many developing countries. PV is also used for many industrial applications where grid connection is not possible e.g. telecommunications, especially to link remote rural areas to the rest of the country.

PV Manufacturing

The PV manufacturing process is a multi-staged process that depends on coordination among many material and component suppliers and manufacturers. Though PV modules are not dependent on extremely rare raw materials, the industry has in the past been subject to supply shortages and oversupplies, leading to module price volatility. In the future, improved communication and standardization throughout the supply chain will contribute to greater price certainty.

Additionally, as the PV industry matures and reaches scale, consolidation and vertical integration will occur, and module prices will fall. PV modules prices have steadily declined in recent years, largely as a result of improved manufacturing processes and experience.

PV and the Environment

The environmental benefits of PV are among the most compelling reasons for widespread adoption. Use of solar energy reduces greenhouse gas emissions and regional and local pollution, because PV generation is entirely non-emitting, utilizing a clean and renewable resource—sunlight—to produce electricity, rather than burning fossil fuels.

Additionally, land use requirements and impacts are relatively benign, especially for rooftop PV, which utilizes existing building space and requires little to no additional land.

Solar Thermal: Heating and Cooling (SHC)

Solar thermal technologies, also referred to as solar heating & cooling (SHC), harness the energy of the sun to provide thermal energy for solar water heating, solar pool heating, solar space heating and cooling (including district heating supply), and industrial process heating. The umbrella term "solar thermal" represents solar thermal technologies used for a variety of point-of-use applications. Global solar radiation is significant enough for solar thermal technologies to be an integral part of a clean energy future in nearly any region. Solar thermal systems are composed of three main elements: solar collector(s), insulated heat transport piping, and heat storage. Some systems also employ the use of electronic controls, and in colder climates, a freeze protection strategy.

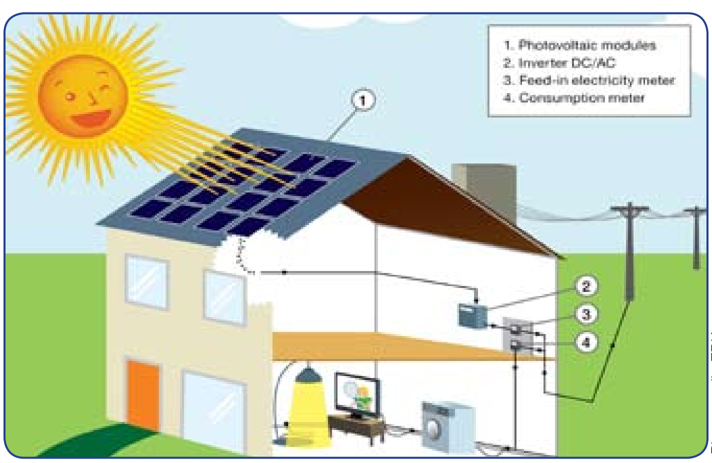


Photo credit: EPIA

An example of a grid-connected house.


Photo credit: Caleffi Solar

An example of flat plate collectors.

Solar Thermal Collectors

The primary component of solar heating & cooling systems is the solar collector. Solar thermal collectors produce heat, and are different from photovoltaic (PV) modules, which produce electricity. There are several types of thermal collectors: flat plate, evacuated tube, concentrating, unglazed and air collectors. Flat plate collectors and evacuated tube collectors are the most common type of solar thermal collectors for domestic hot water or space heating applications while unglazed collectors are the most common for heating swimming-pools. These collectors are used in different systems, such as natural circulation (thermosiphon), forced circulation or drainback systems. In systems with flat plate collectors, copper pipes are typically affixed to an “absorber plate” contained in an insulated “box” covered with a tempered glass or polymer “coverplate.”

Evacuated tube collectors consist of rows of parallel, transparent glass tubes. Each tube encloses an “absorber” assembly, and the entire tube is “evacuated” of air, leaving a vacuum. This vacuum acts as a highly efficient insulator, since air is required to transmit heat from the absorber to the glass. A fluid transfers the heat from the solar collector to a storage tank, where it is distributed for water or space heating purposes. Evacuated tube systems are generally used when higher temperatures or higher volumes of water are needed as well as for process heating and solar air conditioning systems.

Solar Heating and Cooling Applications

Solar Water Heating

Incorporating a solar water heater is one of the most cost-effective ways to include renewable energy technologies in a residential or commercial building. A typical solar water-heating system installed in an average residence can reduce the need for conventional water heating by about two-thirds, and minimizes the expense of electricity or fossil fuel to heat the water. It also reduces the environmental impact associated with using fossil fuels for water heating, which can be significant.

Most solar water heaters have two main components—a solar collector and a storage tank. The solar collector(s) converts solar radiation into heat and transfers the heat to potable water. This heated water flows out of the collector to a water tank, and is used as necessary. The storage tank can be a modified water heater, but it is usually larger and very well-insulated.

Photo credit: SEIA

An example of evacuated tube collectors.

A conventional water heater (using electricity, natural gas, oil, or propane) can provide additional heating if needed. In a colder climate where temperatures can drop to 32°F or below, an antifreeze solution, such as a mixture of non-toxic propylene glycol added to water, is used. This solution is circulated from the solar collector through a heat exchanger connected to a storage tank. The potable water in the storage tank is warmed by the hot, antifreeze solution through the heat exchanger, and the heated water can then be used as necessary, while the cooled solution is piped back to the solar collector to be heated again. Another common type of solar water heating system design for cold climates is called “drainback.” This type of solar thermal system typically uses regular water as a heat transfer fluid, and is designed to allow all of the water in the solar collector to “drain back” to a holding tank in a heated portion of the building it is used on.

Solar Pool Heating

In a solar pool-heating system, the existing pool filtration system is used to pump water through solar collectors where the heat is collected and transferred directly to the pool water. Solar pool heating systems typically operate at a slightly warmer temperature than the surrounding air and normally use unglazed, low-temperature collectors made from polymers. Glass-covered solar collectors are not typically used in pool heating systems, except for indoor pools, hot tubs, or spas in cold climates. Solar heaters can stand alone or work in conjunction with an existing fossil fuel heater to make a “hybrid” system.

In residential solar pool heating applications—where the purpose of the system is typically to extend the swimming season into spring and fall—heating a swimming pool with solar energy requires a solar collector that is 50 percent to 100 percent of the surface area of the pool. In general, adding more square footage lengthens the swimming season and allows owners to use the pool in colder weather.

Solar Space Heating

Just as solar energy can heat the water for a building, solar energy can also be captured to heat the air in the building, which saves money spent on fossil fuels for heating. Solar space-heating systems can either be passive or active systems, or a combination of both.

Active Solar Space Heating

Like solar water heating systems, active solar space heating systems consist of collectors that absorb solar radiation to transfer and distribute solar heat. These systems also typically have storage systems attached to provide heat when the sun is not shining. Active solar space heating systems use either liquid or air as the heat-transfer medium in the collectors. Liquid-based heating systems heat water or antifreeze in a hydronic collector, and air-based systems heat air in an air collector. Both systems collect and absorb solar energy, then transfer the solar heat to the interior space of the building or to a storage system, from which the heat is distributed.

Solar Cooling

Solar radiation can be captured to provide cooling and refrigeration using thermally activated cooling systems (TACS). These systems can provide year-round utilization of collected solar heat (water and space heating during winter and cooling in the summer), which increases the cost effectiveness of solar installations. These systems are typically sized to provide 30 to 60 percent of building cooling requirements using solar, with the remainder usually dependent on natural gas.

The sun's radiation is actually more effectively used for cooling than for heating, as the solar potential is highest during the summer when cooling is most needed. Furthermore, solar cooling offers environmental and economic benefits which traditional compressor driven cooling systems do not. While compressor driven systems use refrigerants that damage the ozone layer and consume electricity generated from dirty energy sources, solar cooling systems do not. The use of compressor systems can also be very costly in warmer regions where there is high demand for air conditioning; the high electricity usage during peak hours often leads to grid overload and blackouts in these regions. With solar cooling, peak cooling demand often correlates with peak solar radiation, eliminating the chance of grid overload

There are two kinds of active solar cooling systems: desiccant systems and absorption chiller systems. In a desiccant system, air passes over a common desiccant or "drying material" such as silica gel to draw moisture from the air and make the air more comfortable. This involves the use of solar thermal or other heat source. A solar thermal system dries out the desiccant and regenerates it for reuse. A PV system can also be used to assist in the process by powering a motor to slowly rotate the disk filled with the desiccant and by powering a low-energy circulation fan to disperse the cold air.

Absorption chiller systems, the most common solar cooling systems, use solar thermal collectors and a thermal-chemical sorption process to produce air-conditioning, without using electricity. The process is nearly identical to that of a refrigerator, only no compressor is used. Instead, the absorption cycle is driven by a thermal transfer fluid- heated water or glycol mixture from a solar thermal collector.

Industrial Process Heating

Similar to residential solar water heating, industrial process solar thermal systems heat water or other fluids, but for use in manufacturing processes. These systems may use high-temperature solar collectors, which can concentrate sunlight to achieve temperatures up to 800°F. In some cases, heat at 480°F (250°C) is required for steam generation, washing, drying, distillation, and many other processes - making solar industrial process pre-heating an optimal technology for such applications. Many process water heating applications require very large volumes of relatively low temperature water, below 212°F (100°C) making flat plate solar collectors a good choice in these circumstances. It takes almost the same amount of energy to heat water from 100°F to 101°F as it does to heat the same amount of water from 180°F to 181°F, making any fluid heating application a good candidate for solar thermal.

Global Solar Heating and Cooling Market

Because of their relative lack of complexity, low cost, and functionality in a wide range of climates, solar water heating is the most common solar heating & cooling technology. At the end of 2009, solar water heating capacity totaled over 180 GW (thermal). The leading countries in this technology are China, Turkey, Germany, Japan, and Greece, with China accounting for 70 percent of the total market.

The solar space heating and cooling markets are still small but are growing rapidly as costs decline. The European Union and the United States both show good promise as solar space heating and cooling markets.

Concentrating Solar Power (CSP)

Concentrating solar power (CSP) technologies use mirrors or lenses to efficiently concentrate the sun's energy and convert it to thermal heat, which can be used to produce electricity via a steam turbine or a heat engine driving a generator. Unlike photovoltaic solar energy used for distributed generation on rooftops, CSP is most cost-effective when designed on the scale of hundreds of megawatts (MW), making it attractive as wholesale energy suppliers to utilities.

Concentrating solar power technologies can generate electricity at relatively low cost and deliver power during periods of peak demand. In addition, integration with thermal storage adds efficiency by allowing for power generation for up to ten hours after sunset. Researchers are continuing to discover ways to reduce costs and improve efficiency. As a result, many utilities are including concentrating solar power in their energy-generation portfolios.

Types of CSP Systems

Parabolic Trough

Parabolic trough systems use curved mirrors to focus the sun's energy onto a receiver tube that runs down the center of a trough. In the receiver tube, a high-temperature heat transfer fluid (e.g., synthetic oil) absorbs the sun's energy, reaching temperatures of around 700° F, and passes through a heat exchanger to heat water and produce steam. The steam drives a conventional Rankine steam turbine power system to generate electricity.

A typical solar collector field contains hundreds of parallel rows of troughs connected as a series of loops. These loops are placed on a north-south axis so the troughs can track the sun from east to west. Individual collector modules are typically 15 to 20 feet tall and between 300 and 450 feet long. Most existing CSP plants use parabolic trough technology.

Photo credit: Acciona

An example of a parabolic trough system.

Compact Linear Fresnel Reflector

Compact linear fresnel reflectors (CFLR) utilize similar technology to parabolic trough systems, consisting of reflectors that track the sun on one axis and focus the beam radiation onto fluid-carrying receivers.

To reduce some of the up-front capital costs of plant construction, CLFR developers rely on the principles of curved-mirror trough systems, but use long parallel rows of lower-cost flat mirrors. These modular reflectors focus the sun's energy onto elevated receivers, which consist of a system of tubes through which water flows. The concentrated sunlight boils the water, generating high-pressure steam for direct use in power generation and industrial steam applications. The benefits of CFLR technology include lower upfront costs, though these systems tend to have lower efficiencies.

AREVA Solar operates its 5 MW Kimberlina plant in Bakersfield, California, the first CLFR facility in North America.

Photo credit: AREVA Solar

An example of a linear fresenel reflector.

Power Tower

Seeking higher operating temperatures for greater efficiencies, other plant designers opt for a central receiver system. In power tower systems, computer-controlled flat mirrors (called heliostats) track the sun along two axes and focus solar energy on a receiver at the top of a high tower. The focused energy is used to heat a transfer fluid (800° F to 1,000° F) to produce steam and run a central power generator. The operating temperature for power tower systems is higher than for parabolic trough and CFLR systems, but lower than dish-engine systems.

Dish-Engine

This technology utilizes fields of individual parabolic-shaped dish reflectors that focus sunlight onto a receiver fixed at the focal point. In contrast to other CSP technologies that employ steam to create electricity via a turbine, a dish-engine system uses a working fluid such as hydrogen that is heated up to very high temperatures in the receiver to drive an engine, which directly produces electricity. Because dish receivers capture the maximum amount of direct solar radiation throughout the day and can achieve very high temperatures (about 1,452 degrees F) and high efficiencies, they can convert over 30% of the sunlight to electrical energy. Individual dish-engine units currently range from one to 25 kW in size. Power plants of any size can be built by installing fields of these systems. They can also be built on uneven land, unlike other CSP technologies. One advantage is that these systems are well-suited for areas with limited water resources.

A 1.5 MW dish-engine plant, Tessera Solar's Maricopa Solar, is currently operating near Phoenix, Arizona. The plant utilizes Stirling Energy Systems' 25 kW SunCatcher™ technology, and each dish is 38 feet tall and 40 feet wide.

An example of a dish engine.

Supporting Technologies

Other than the solar collectors and receivers that collect solar energy and convert it to heat or electricity, there are a number of technologies that support CSP projects.

Turbine/Engine

With the exception of dish-engine systems, CSP plants produce steam to power a conventional turbine, which then generates electricity. These turbines are widely used throughout the power generation industry and the technology is very familiar to utilities. Dish-engine systems use a Stirling engine coupled with a generator. These technologies are less common but relatively mature.

Storage

As with all solar technologies, CSP plants only produce power when the sun is shining. To counteract this, many project developers are incorporating thermal energy storage systems into CSP plant designs in order to continue generating power after sunset. Molten salt and other materials can capture thermal energy to be stored, much like coffee in a thermos, and used later in the day after the sun is no longer shining. Storage capabilities can make CSP systems a baseload resource, promoting grid reliability and enabling widespread integration of solar power in utility portfolios.

Transmission Network

It is necessary to upgrade and improve our transmission infrastructure to ensure that areas with vast renewable energy potential can deliver clean electricity to high demand areas. Like the turbines used to convert the sun's thermal energy to electricity, transmission grid technologies are well-known and familiar to utilities and project developers.

Requirements for CSP Systems

To date, about one GW of concentrating solar power exists worldwide. Most of these projects are located in the southwestern U.S. and Spain, with a few demonstration projects in France, Germany, and other European countries. New projects are planned for Italy, Abu Dhabi, Morocco, Egypt and Algeria. CSP plants are ideally situated in areas with the following characteristics:

Areas of high direct normal solar radiation – In order to concentrate the sun's energy, it must not be too diffuse. This feature is captured by measuring the direct normal irraditation (DNI) of the sun's energy. Worldwide, the areas with very high direct normal solar radiation are the Southwestern U.S., northern and southern Africa, the Middle East, and Australia. Parts of southern Europe, South America, and central Asia also have adequate solar resource potential for CSP facilities.

Contiguous parcels of dry, flat land with limited cloud cover – A CSP plant operates most efficiently, and thus most cost-effectively, when built in sizes of 100 MW and higher. While land needs will vary by system type, a typical CSP plant, requires approximately five to ten acres of land per megawatt of capacity. The larger acreage is usually associated with the addition of thermal energy storage. Most reflector systems that track the sun are best situated on relatively flat lands.

Access to water resources – Like other thermal power plants, such as coal and nuclear, some CSP systems require access to water for cooling. All require small amounts of water to wash collection and mirror surfaces. CSP plants can utilize dry or hybrid cooling techniques to conserve water. Some projects are proposed on former agricultural land that will consume only a fraction of the water previously used for irrigating crops.

Thoughtful Development

The solar industry is committed to solving our most pressing energy and environmental challenges in a thoughtful manner. Solar power plants can be developed in a way that balances environmental protection with our energy demands. CSP and other utility-scale solar energy projects undergo a thorough environmental review process to minimize impacts on water resources, lands, and habitat.

Many CSP projects are proposed on public lands overseen by the federal government. Pursuant to federal law, a National Environmental Policy Act (NEPA) review is conducted for each project by the U.S. Bureau of Land Management, the U.S. Fish and Wildlife Service, and state and local authorities. The process requires months of detailed surveys and analyses of the project site to identify any possible impacts. In addition, multiple public meetings are scheduled for community input. An Environmental Impact Statement is produced before a final permit to begin construction is awarded.

Argentina

EPIA Analysis

Population: 40,913,584

GDP: $548.8 billion

Energy Mix CO2 Content: 0.366 kg CO2/kWh

SOLAR ENERGY TARGETS*:

3.3% of electricity production by 2020

1.8 Mt CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**3.3% of electricity demand**
Corresponds to:	• 3,300 MW installed capacity • 5,200 GWh produced annually • $9.2 billion invested
CO_2 Reduction Equivalent	**1.8 Mt CO_2 per year**
Corresponds to:	• 62,000 hectares of trees planted each year • 800,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Burkina Faso

Main Assumptions:
99 TWh of electricity demand in 2010, projected to become 160 TWh by 2020.
*Target corresponds to PV market potential according to EPIA's "Unlocking the Sunbelt potential of PV" study (Paradigm Shift Scenario)

Useful links:
www.epia.org/sunbelt

Key Statistics:
2010 electricity demand: 99,210 GWh
2020 electricity demand: 160,000 GWh
PV share today: 0.02%
Annual installed capacity (2010e): NA
Cumulative capacity (2010e): 10 MW

Policies to achieve targets:

Photovoltaics (PV)

- Argentina currently has 10MW cumulative installed PV capacity, which suggests a huge scale-up will take place over the next 10 years to achieve its 3,300 MW target by 2020. Argentina has been one of the earliest adopters of solar energy in the region; besides broad support for renewable energy policies the PV market is supported by a feed-in tariff which was introduced in 2006, and is valid for 15 years.
- There are already a significant number of conventional mini-grids installed in remote areas. Turning such systems into hybrid systems to include PV could be one of the easiest ways to achieve rapid PV deployment. Increased awareness for the potential of PV among policy makers, the media, and utilities would lay the foundation for improved PV support policies and the removal of administrative barriers.

Photo credit: socialedge.org

Workers install a PV system in Argentina

Photo credit: Elecê Argentina

A PV system on the roof of a building in Buenos Aires.

Australia

Population: 21,262,641

GDP: $851.1 billion

Energy Mix CO2 Content: 0.883 kg CO2/kWh

SOLAR ENERGY TARGETS*:

4% of electricity production by 2020

10 Mt CO_2 displaced annually by 2020

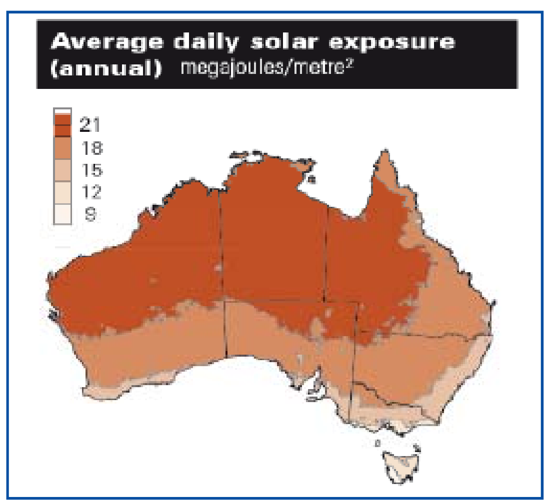
*PV only

Photovoltaics	
2020 PV Target	**4% of electricity demand**
Corresponds to:	• 6,000 MW installed capacity • 12,000 GWh produced annually • 15,000 jobs • $40 billion invested
CO_2 Reduction Equivalent	**10 Mt CO_2 per year**
Corresponds to:	• 330,000 million hectares of trees planted each year • 4.5 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Ghana

Main Assumptions:
Australian electricity demand: 297 TWh by 2020 (ABARE); 0.9 T CO_2 per MWh by 2020; 5 MWh/MWp/day; 200MWp per year on residential rooftops; 20,000 X 5 kWp schools, community buildings; 500 X 200 kWp electric car charging stations; 50 X 50 MWp regional power plants; 500 X 1 MWp warehouse roofs; 2 X 250MWp PV Flagships.

Useful links:
http://tinyurl.com/37y2oea
www.abare.gov.au/publications_html/energy/energy_10

Key Statistics:
2010 electricity demand: 222,000 GWh
2020 electricity demand: 297,000 GWh
PV share today: 0.13%



Policies to achieve targets:

Photovoltaics (PV)

On the federal level, Australia has adopted a Renewable Portfolio Standard (adopted in 2001 and renewed in 2009). To aid in the deployment of renewable energy, in 2007 Australia implemented a feed-in tariff in 5 states to promote PV and meet its 20% renewable electricity target by 2020. Australia will further expand its feed-in tariff policy and will also launch a diesel replacement program for off-grid and mini-grid applications. Investment tax credits, grants, capital subsidies, and rebates are also available on the State level. Other incentives include: Renewable Energy Targets for 2030 and 2040, carbon pricing, diesel replacement programs for off-grid and mini-grid applications, feed-in tariffs, accelerated depreciation for business use, building rating schemes, zero net energy home targets, training, accreditation and standards.


Photo Credit: Aussie Solar

A residential application for a PV system.


Photo Credit: Aussie Solar

Solar panels are the perfect complement to homes along the beach, where it's usually sunny.


Photo Credit: Aussie Solar

A worker installs a commercial scale PV system.


Photo Credit: Aussie Solar

A solar farm in Australia.

Brazil

EPIA Analysis

Population: 198,739,269

GDP: $2.013 trillion

Energy Mix CO2 Content: 0.089 kg CO2/kWh

SOLAR ENERGY TARGETS*:

3.3% of electricity production by 2020

1.3 Mt CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**3.3% of electricity demand**
Corresponds to:	• 10,500 MW installed capacity • 18,200 GWh produced annually • $29.4 billion invested
CO_2 Reduction Equivalent	**1.3 Mt CO_2 per year**
Corresponds to:	• 44,000 million hectares of trees planted each year • 600,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Sierra Leone

Main Assumptions:
404 TWh of electricity demand in 2010, projected to become 549 TWh by 2020.
*Target corresponds to PV market potential according to EPIA's "Unlocking the Sunbelt potential of PV" study (Paradigm Shift Scenario)

Useful links:
www.epia.org/sunbelt
http://tinyurl.com/2c8b3eb

Key Statistics:
2010 electricity demand: 404,300 GWh
2020 electricity demand: 549,000 GWh
PV share today: 0.01%
Annual installed capacity (2009): NA
Cumulative capacity (2009): 13.5 MW

Policies to achieve targets:

Photovoltaics (PV)

General support policies for renewables exist in Brazil; nevertheless there must be PV specific support to really unleash PV growth in Brazil. The "Luz para Todos" ("Light for All") program was launched in November 2003 to improve rural electrification through network expansion by distributing generating systems to those in isolated networks. The generating systems use renewable energy to produce electricity. No specific support currently exists for on-grid applications. The expansion of rural electrification remains an important goal; mini-grids with hybrid systems, including PV, could go a long way to fill the gap.

Photo Credit: USAID

Solar panels are installed to power a rural computer center in São João, Brazil.

Canada

Population: 33,487,208

GDP: $1.279 trillion

Energy Mix CO2 Content: 0.181 kg CO2/kWh

SOLAR ENERGY TARGETS*:

1.5 GW-thermal by 2020

135,000-200,000 tons CO_2 displaced annually by 2020

*ST only

Solar Thermal	
2020 ST Target	**1.5 GW-thermal**
Corresponds to:	• 670,000 MWh-th • 5,200 GWh produced annually • 8,000-12,000 jobs created
CO_2 Reduction Equivalent	**135,000-200,000 tons CO_2 per year**
Corresponds to:	• 20 million gallons of gasoline displaced • 35,000 cars taken off the road each year • 1,700 acres of forest preserved from deforestation

Main Assumptions:
The Solar Thermal Hot Water target is for both glazed and unglazed collectors. Canada does not currently have a target for solar air heating.

Useful links:
The Canadian Solar Industries Association: http://www.cansia.ca/
http://fit.powerauthority.on.ca/
http://www.mei.gov.on.ca/en/energy/gea/
http://www.ecoaction.gc.ca/ecoenergy-ecoenergie/index-eng.cfm
http://tinyurl.com/24hh5rl

Key Statistics:
2010 electricity demand: 536,100 GWh
2020 electricity demand: 683,000 GWh
PV share today: 0.02%
PV Annual installed capacity (2009): 70 MW
PV Cumulative capacity (2009): 95 MW
ST installed capacity (2009): 1.2 million m^2
ST market size in 2009: 18,000 m^2

Policies to achieve targets:

Photovoltaics (PV) and Solar Thermal (ST)

CanSIA is currently working on a Solar Vision document that will set PV targets to 2025.

The 14-year ecoENERGY for Renewable Power program will invest roughly CAD 1.5 billion to increase Canada's supply of clean electricity from renewable sources such as wind, biomass, geothermal and solar PV. Public budgets increased significantly due to the market incentive program in the province of Ontario, which introduced a feed-in tariff (differentiated by installed system size) for PV installations in 2009. A national renewable energy and GHG reduction strategy is needed from the federal government, including an extension of the feed-in-tariffs program. In the longer term, solar obligations should be instated for all new buildings and major refurbishments and renovations for PV and ST systems.

Photo Credit: Carmanah Technologies Corp

A commercial system on the roof of the Hershey Center in Mississauga, Canada.

Photo Credit: Mondial Energy

The Toronto Skyline shown with a commercial solar thermal system.

Photo Credit: Swiss Solar Tech Ltd.

A modern residential home with solar panels and a metal roof.

China

Population: 1,338,612,968

GDP: $8.748 trillion

Energy Mix CO2 Content: 0.745 kg CO2/kWh

SOLAR ENERGY TARGETS*:

0.6% of electricity production by 2020

24 Mt CO_2 displaced annually by 2020

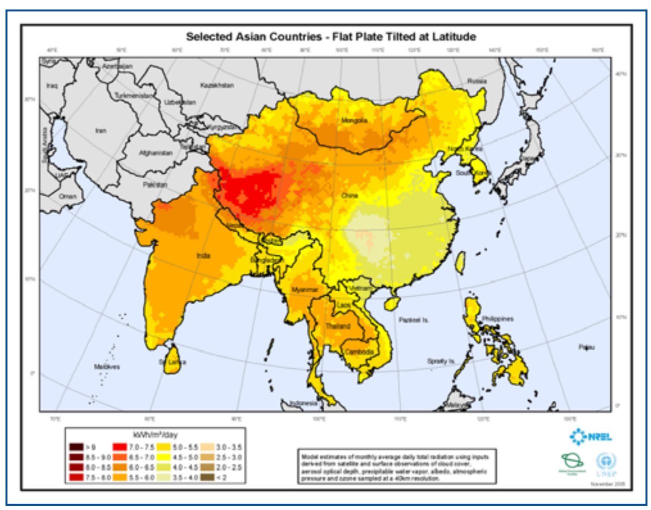
*PV only

Photovoltaics	
2020 PV Target	**0.6% of electricity demand**
Corresponds to:	• 32,000 GWh produced annually • 500,000 jobs created • $160 billion invested
CO_2 Reduction Equivalent	**24 Mt CO_2 per year**
Corresponds to:	• 780,000 hectares of trees planted each year • 10 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Tunisia

Main Assumptions:
3.438 TWh of electricity demand in 2010, projected to become 5.460 TWh by 2020. RES currently counts for 10% of the primary energy mix, and it is expected to reach 15% by 2020.

Useful links:
http://www.creia.net/
http://tinyurl.com/26uvhqd

Key Statistics:
2010 electricity demand: 3,438,000 GWh
2020 electricity demand: 5,460,000 GWh
PV share today: 0.02%
Annual installed capacity (2009): 215 MW
Cumulative capacity (2009): 360 MW



Policies to achieve targets:

Photovoltaics (PV)

China's PV targets are generally supported by the Renewable Energy Law of 2007 (renewed in 2009) and the Medium to Long Term Renewable Energy Development Plan (2007). Capital subsidies, tax credits and a reduction in import duties are amongst the measures introduced to spur growth and highlight China's commitment to taking a leading role as an innovator and producer of renewable energy. Various PV support programs have also been launched that provide subsidies for rooftops and BIPV. On a national level, there is the “Golden Sun” program (July 2009) which heavily subsidizes (50-70% of capital costs) pilot PV projects; however, support is capped at 20MW per province. Nevertheless, 2012 PV targets (600MW) are likely to already be reached by the end of 2010. Feed-in tariffs are currently set on a case by case basis, but there is no national feed-in tariff policy for PV as of yet. In order to decisively foster PV deployment, the establishment of a feed-in tariff support system is considered a necessary step.

Photo credit: Washington Post

PV technicians perform maintenance in China

Photo Credit: Suntech

Workers hold up a panel at a PV manufacturing facility in China.

Photo credit: Treehugger.com

Workers clean off a commercial scale PV system.

European Union

Population: 501,260,000

GDP: $16.45 trillion

Energy Mix CO2 Content: 0.475 kg CO2/kWh

SOLAR ENERGY TARGETS*:

14% of electricity production by 2020

3.6% of thermal energy production by 2020

325 Mt CO_2 displaced annually by 2020

*PV and CSP contribute to the electricity target

Photovoltaics	
2020 PV Target	**12% of electricity demand**
Corresponds to:	• 390,000 MW installed capacity • 462,000 GWh produced annually • 500,000 jobs created • 780 billion euro invested
CO_2 Reduction Equivalent	**220 Mt CO_2 per year**
Corresponds to:	• 7.3 million hectares of trees planted each year • 98 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Thailand
Concentrating Solar Power	
2020 CSP Target	**2% of electricity demand**
Corresponds to:	• 30 GW of installed capacity • 90 TWh produced annually • 150,000 jobs created • 9 billion euro invested
CO_2 Reduction Equivalent	**36 Mt CO_2 per year**
Corresponds to:	• 1.2 million hectares of trees planted each year • 16 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Slovakia
Solar Thermal	
2020 ST Target	**3.6% of energy demand for heating and cooling**
Corresponds to:	• 388 million m^2 (271,600MWth) installed capacity • 470,000 jobs created • 214 billion euro invested
CO_2 Reduction Equivalent	**69 Mt CO_2 per year**
Corresponds to:	• 2.4 million hectares of trees planted each year • 31 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Syria

Main Assumptions:

Photovoltaics (PV): 3,431 TWh of electricity demand in 2010, projected to become 3,988 by 2020. Renewable energy currently accounts for 14% of the primary energy mix, and is expected to reach 20% by 2020.

Concentrating Solar Power (CSP): 3,431 TWh of electricity demand in 2010, projected to become 3,988 by 2020. RES currently counts for 14% of the primary energy mix, and is expected to reach 20% by 2020. 30 GWe of CSP plants to be operational by 2020, providing 90 TWh of electricity per year.

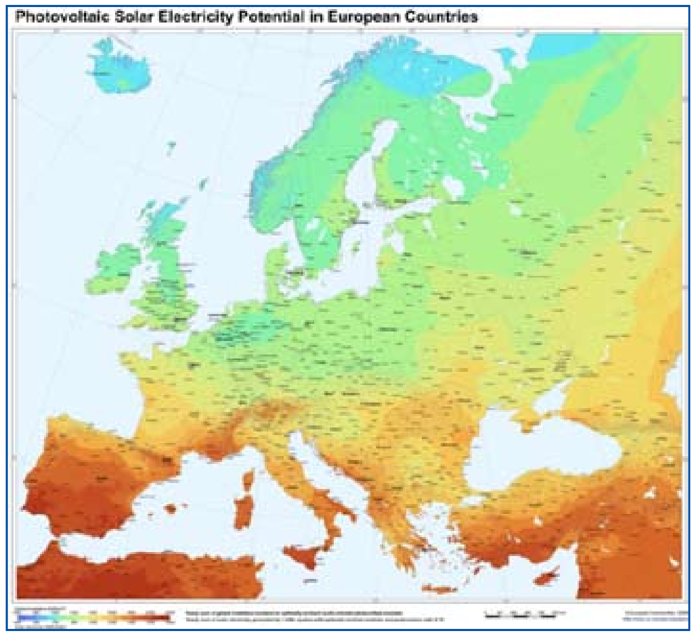
Solar Thermal (ST): Significant reduction of the heat demand compared to 2006 projected due to energy efficiency measures (on average: -9% by 2020). Full political support mechanisms assumed as above; main focus on solar combi-systems for hot water preparation and space heating in the residential sector. Solar combi-systems with low solar fraction (10-20%) until 2020; substantial market diffusion in all other sectors. High growth rate of installed capacity expected (~25% per annum until 2020).

Useful links:

www.epia.org
www.setfor2020.eu
www.estif.org
www.estelasolar.eu

Key Statistics:

2010 electricity demand: 3,431,000 GWh
2020 electricity demand: 3,988,000 GWh
PV share today: 0.9%
Annual installed capacity (2010e): 10 GW
Cumulative capacity (2010e): 26 GW
Cumulative ST capacity: 21.7 MW-th



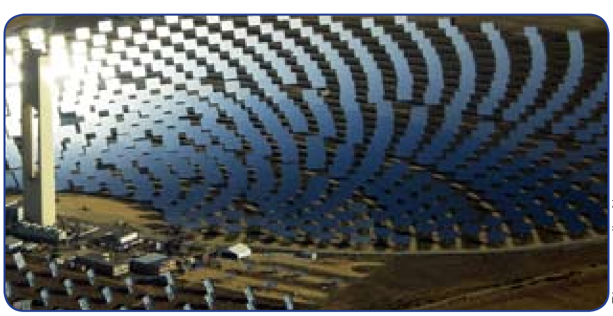


Photo credit: Abengoa

The PS10 solar plant.


Photo Credit: TiSun GmbH

The Hotel Alixares in Granada, Spain with a commercial solar thermal system.


Photo Credit: Velux

Roof integrated flat-plate collectors on a house in Denmark.

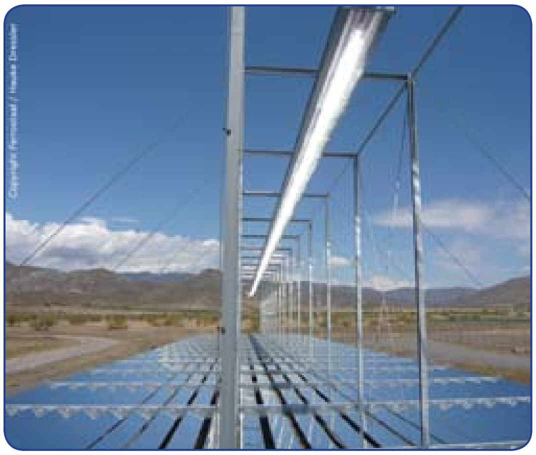


Photo Credit: Ferrostaal-Hauke Dressler

A Fresnel collector is an example of a concentrating solar technology.

Photo credit: ESTELA

A parabolic trough system.

Photo credit: Schott Solar

PV panels on the external building walls.

Policies to achieve targets:

Concentrating Solar Power (CSP)

- Current policies include Feed-in Tariffs, national grants, 7FP, and support mechanisms from the World Bank Group and the European Investment Banks.
- Further support mechanisms to be introduced include NER300, SET-Plan, Mediterranean Solar Plan, and "Cooperative Mechanisms" as foreseen in the 2009/28 RES Directive.

Solar Thermal (ST)

- Solar obligations/ordinances: integrate in the building codes obligatory requirements for the installation of solar thermal systems in residential, service and commercial buildings, applicable to all new buildings and those undergoing large renovation.
- Financial incentive schemes, R&D programs, awareness-raising campaigns.

Photovoltaics (PV)

Well designed and reasonably profitable feed-in tariffs, adequate administrative procedures combined with priority access to the grid, easy financing of PV investments and industry development policies are required.

Decentralized storage, as well as large storage equipments and smart grid development (including advanced network controllers, Virtual Power Plants, smart metering, a fully EU-wide integrated electricity network, including a pan-European super-grid) will be needed to achieve the massive potential of PV in Europe.

Right now, the European Union's RES directive paves the way for reaching 20% of renewable energies in the primary energy mix in 2020. In addition the EU has committed to reduce its GHG emissions by 20% in 2020 from the levels of 1990. That number could be upgraded to 30% of reductions by 2020. The SET plan and the Solar Energy Industry initiative represent additional policies that will help to reach the full potential of PV in Europe.

The pioneer introduction of a feed-in tariff in Germany in 2000 initiated the deployment of PV in Europe. One decade later, the PV installations will overtake 10 GW in 2010 in the entire European Union and the total installed capacity will reach more than 26 GW. In addition to the European Union initiatives, the market has developed based on national PV policies: the most efficient are described hereafter.

Belgium
Belgium has to be considered as three different entities: the southern region of Wallonia, the northern region of Flanders and the area of Brussels. In the last 2 areas, Green Certificates with a market-driven price are available to support PV installations, with the number of assigned certificates depending on system size. In Flanders, instead, the price of green certificates is fixed for 20 years, making the system in practice equivalent to a feed-in tariff. Net-metering is available across the country for PV systems smaller than 10 kWp, while tax incentives and investment grants are also present, depending on the area and the market segment.

Bulgaria
The Renewable and Alternative Energy Sources act of 2006 has established a feed-in tariff of PV installations in Bulgaria; a simplified administrative procedure for PV will clearly trigger the PV deployment in the country. Apart from the feed-in tariff, investment grants of 50-70% of PV system cost are made available through the Operational Programme 2007-2013.

Czech Republic
An attractive feed-in tariff scheme allowed for the Czech PV market to grow very rapidly in the last 2 years. The current scheme provides either a feed-in tariff or a feed-in premium, in case the electricity is sold separately. The other most relevant support measure is an exemption from income taxes for the first 5 years of operation of the PV system.

France
In France, the development of the PV market has recently been driven by the introduction of an attractive feed-in tariff scheme that stimulates the architectural integration of PV in buildings. Large ground installations are also supported by a variable feed in tariff compensating for the lower irradiation of the northern regions. Tax credits and other fiscal measures ensure the attractiveness of a PV investment in particular for the residential and commercial market segments.

Germany
The German PV market is supported by a feed-in tariff instituted by the federal *EEG* law of 2000. The tariffs, which are adjusted every year based on installed PV capacity growth, were consistently reduced in 2010 to follow the price decrease. *EEG* also introduces incentives for self-consumption of the produced electricity. Completing the effective German support framework, investment grants are available on a regional basis, while income tax deductions and soft loans are available at federal level.

Greece
Greece introduced its generous feed-in tariff scheme in 2009, and a simplified administrative was put in place in 2010. In consequence, the PV market is developing fast in the country. In addition, tax exemption measures are reserved for those private persons that install a PV system. The Operational Programme for Entrepreneurship and Competitiveness (2007-2013) further provides investment grants for the commercial segment.

Italy
The *Conto Energia* decree, updated for the third time in 2010, provides the main support for grid-connected PV installations in Italy. A feed-in premium, diversified by system size and type, is granted to the total electricity

Photo credit: BP Solar

PV panels work at the Munich Airport.

Photo credit: Solar World

PV modules on a race car.

Photo credit: ENEL

PV panels provide shade to cars and electricity to a town nearby.

produced by a PV system, while the unused electricity injected into the grid is further valorised either by net-metering or energy sale. Investment grants are available, especially for public administrations, hospitals and schools. In addition, Italy is one of the few European countries to have established the compulsory use of PV in new buildings.

Netherlands

In the Netherlands, PV installations up to 100 kWp are supported by a variable feed-in tariff (made up by a fixed part and a variable bonus) that is assigned every year based on a call for tender. A series of tax incentives targeted at the residential and commercial segments completes the support framework.

Portugal

A new law providing feed-in tariff support for small residential PV systems was recently introduced in Portugal. Within the end of 2010, further legislation is expected supporting the installation of PV systems of up to 150 kWp in size. Investment grants are available for PV installations in agricultural farms. Tax credits and reduced depreciation periods for PV investment costs are also available for investors.

Slovakia

The Act on the Promotion of Renewable Energy Sources provides, since January 2010, a feed-in tariff for PV installations. Electricity tax exemption is provided to operators of PV systems. In addition, several investment grants financed by European funds are available on tender application basis.

Spain

The development of PV installations in Spain is supported by a feed-in tariff valid for 25 years. However, the feed-in tariff that led to the installation of almost 3.5 GW in Spain is now limited to a volume of installations of 500 MWp per year. Investment grants are available at regional level. Spain was also the first European country to have introduced the obligation to use PV in the construction of specific new buildings.

Sweden

While PV is often seen as a technology for sunny countries, Sweden shows the technology is suitable for northern countries as well. A new financial support financed by the Swedish government was introduced in July 2009. Support is provided for all types of grid-connected photovoltaic systems. The investment covers up to 60% of the investment cost, except for large companies receiving funding up to 55% of the costs. The current system of electricity certificates should be revised or replaced by an adequate feed-in tariff to really support the PV deployment in Sweden.

United Kingdom

The UK government introduced in April 2010 the “Clean Energy Cashback” framework that establishes a 25 years feed-in tariff for PV installations. This support scheme introduces further incentives for self-consumption of the electricity produced. This is currently triggering a real market development in the UK.

Other EU countries

Other EU countries such as Austria, Slovenia, Luxemburg, and others have set interesting feed-in tariff support schemes. This all makes the European Union the largest adopter of PV support schemes in the entire world, and without any doubt the most competitive and efficient proof of PV’s potential.

Photo credit: Tessera Solar International

The Marcicopa Solar Field.

Photo credit: Tenesol

The tourism office in Ales, France boasts a PV system.

Photo Credit: Ritter Solar

A solar thermal combisystem provides hot water and heating to German home.

India

EPIA Analysis

Population: 1,156,897,766

GDP: $3.57 trillion

Energy Mix CO2 Content: 0.938 kg CO2/kWh

SOLAR ENERGY TARGETS*:

3.3% of electricity production by 2020

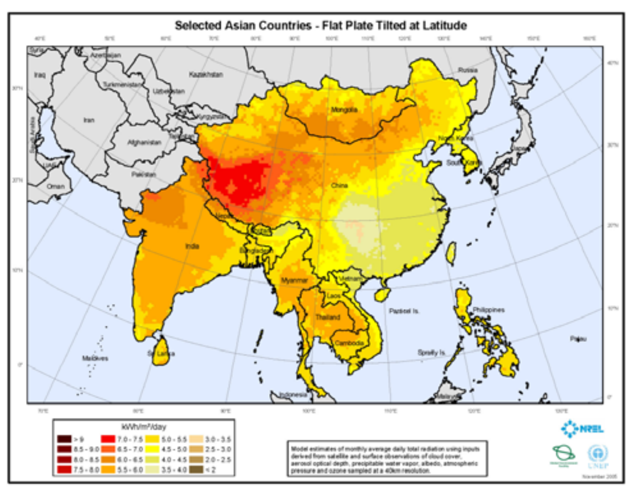
38 Mt CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**3.3% of electricity demand**
Corresponds to:	• 38.6 GW installed capacity • 75,600 GWh produced annually • 5,200 GWh produced annually • $108 billion invested
CO_2 Reduction Equivalent	**38 Mt CO_2 per year**
Corresponds to:	• 1.3 million hectares of trees planted each year • 17 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Hong Kong

Main Assumptions:
620 TWh of electricity demand in 2010, projected to become 1260 TWh by 2020. While the Solar Mission envisages 20 GW by 2022, EPIA estimates the real potential of PV in India to be around 38 GW in 2020.
*Target corresponds to PV market potential according to EPIA's "Unlocking the Sunbelt potential of PV" study (Paradigm Shift Scenario)

Useful links:
www.epia.org/sunbelt
Solar Energy Society of India (SESI): http://www.sesi.in/



Key Statistics:
2010 electricity demand: 610,000 GWh
2020 electricity demand: 1,260,000 GWh
PV share today: 0.04%
Annual installed capacity (2009): 30 MW
Cumulative capacity (2009): 120 MW

Policies to achieve targets:

Photovoltaics (PV)

In its landmark National Solar Mission (announced in November 2009), India set solar energy installation targets of 20GW by 2022 (90% on-grid, 10% off-grid) in a 3-phased approach. These targets will be evaluated and possibly revised at each of the three stages, allowing for more ambitious targets along the way. The National Solar Mission presents a variety of incentives, including tax credits and subsidies, as well as a national feed-in tariff for a period of 25 years for solar PV installations. The emphasis for the National Solar Mission is on establishing a stable policy process that will allow for well adapted players and technologies to emerge. This will facilitate a significant scale up to be possible after the initial phase of the Mission.

Photo credit: constructionweekonline.in

PV panels absorb sunlight in India.

Photo Credit: K. Ramesh Babu

A PV system in India provides electricity to the grid.

Photo Credt: Barefoot Photographers of Tilonia

Solar systems bring energy to remote locations in India.

Indonesia

EPIA Analysis

Population: 240,271, 522

GDP: $962.5 billion

Energy Mix CO2 Content: 0.726 kg CO2/kWh

SOLAR ENERGY TARGETS*:

0.55% of electricity production by 2025

1 Mt CO_2 displaced annually by 2025

*PV only, 2020 target not available.

Photovoltaics	
2025 PV Target	**0.55% of electricity demand**
Corresponds to:	• 870 MW installed capacity • 1,300 GWh produced annually • $2.45 billion invested
CO_2 Reduction Equivalent	**1 Mt CO_2 per year**
Corresponds to:	• 30,000 hectares of trees planted each year • 400,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Malawi

Main Assumptions:
119 TWh of electricity demand in 2010, projected to become 230 TWh by 2020.

Useful links:
www.epia.org/sunbelt
Current solar PV prospects in Indonesia: http://tinyurl.com/26rzgj5
Indonesian Renewable Energy Society: http://www.meti.or.id/

Key Statistics:
2010 electricity demand: 119,300 GWh
2020 electricity demand: 230,000 GWh
PV share today: 0.04%

Policies to achieve targets:

Photovoltaics (PV)

Indonesia has enacted a series of laws to promote renewable energy in general, including PV. Several examples include the Energy Law of 2007, the Green Energy Policy of 2004, and the Renewable Energy Utilization Law- most recently revised in 2008. In terms of support policies, in 2002 Indonesia introduced a feed-in tariff (though tariff levels are quite low) which covers generators over 10MW. Earlier this year a new 5% tax credit was also adopted. However, there are currently no significant policy plans reported to foster large-scale PV deployment.

Photo credit: blogbaliwww.com

PV panels provide electricity in Indonesia

Photo credit: Solar Power Indonesia

This solar system can track the path of the sun to provide even more electricity.

Photo Credit: EPIA

A 12 kWp PV water pumping system in Jogjakarta.

Photo Credit: EPIA

A 40 kWp PV system on top of an office building in Jakarta.

Japan

太陽光発電協会
Japan Photovoltaic Energy Association

Population: 127,078,679

GDP: $4.15 trillion

Energy Mix CO2 Content: 0.436 kg CO2/kWh

SOLAR ENERGY TARGETS*:

2% of electricity production by 2020

9.3 Mt CO_2 displaced annually by 2020

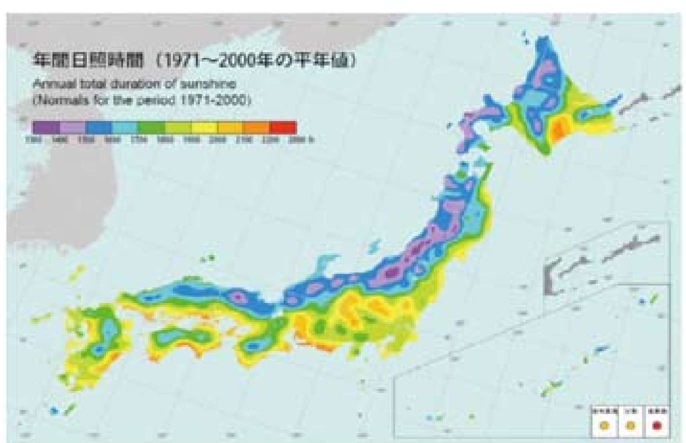
*PV only

Photovoltaics	
2020 PV Target	**2% of electricity demand**
Corresponds to:	• 38 GW installed capacity • 22,000 GWh produced annually • 100,000 jobs created • 8 trillion Yen in investment
CO_2 Reduction Equivalent	**9.3 Mt CO_2 per year**
Corresponds to:	• 300,000 hectares of trees planted each year • 4 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Zimbabwe

Main Assumptions:
PV installations on 210,000 residential dwellings per year (70% of newly built houses) and on 10% of the potential of industrial and public buildings from 2011 to 2020. (Target: residential house 1,960MWp, industrial and public 840MWp).

Useful links:
Japan Photovoltaic Industry Association: http://www.jpea.gr.jp/

Key Statistics:
2010 electricity demand: 925,000 GWh
2020 electricity demand: 1,061,000 GWh
PV share today: 0.4%
Annual installed capacity (2009): 484 MW
Cumulative capacity (2009): 2,633 MW



Source: New Energy and Industrial Technology Development Organization (NEDO)

Policies to achieve targets:

Photovoltaics (PV)

Japan re-emerged as a serious PV contender in 2009 (coming in third place globally) by doubling its installed capacity to 485 MW. This was largely triggered by re-instating residential rebates (equivalent to 25-35% of installation costs) and introducing a feed-in tariff program, though for now these only apply to residential rooftop systems. Subsidies for research and development have also helped to boost market growth. However, the extent to which the government will further build upon these encouraging measures and promote further growth is somewhat uncertain at the present due to another recent change in government.

Photo Credit: Sharp Corporation

PV panels are installed on the Sharp Corporation factory in Mie Prefecture, Japan.

Photo Credit: Sharp Corporation

This photo shows PV panels installed on a modern residential roof in the Osaka prefecture in Japan.

Photo credit: Solar Frontier K.K.

PV Panels are installed in an old style traditional Japanese roof.

Photo credit: Solar Frontier K.K.

A modern style roof has installed a PV system.

Photo credit: Solar Frontier K.K.

A commercial scale PV application is shown in the Niigata prefecture in Japan.

Jordan

Population: 6, 269,285

GDP: $32.41 billion

Energy Mix CO2 Content: 0.589 kg CO2/kWh

SOLAR ENERGY TARGETS*:

7.65% of electricity production by 2020

1.3 Mt CO_2 displaced annually by 2020

*PV, CSP, and ST

Photovoltaics	
2020 PV Target	**1.65% of electricity demand**
Corresponds to:	• 200 MW installed capacity • 335 GWh produced annually • 2,000 jobs created • $560 million in investment
CO_2 Reduction Equivalent	**0.2 Mt CO_2 per year**
Corresponds to:	• 7,300 hectares of trees planted each year • 95,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Central African Republic
Concentrating Solar Power	
2020 CSP Target	**6% of electricity demand**
Corresponds to:	• 700 MW installed capacity • 1,200 GWh produced annually • 7,000 jobs created
CO_2 Reduction Equivalent	**0.8 Mt CO_2 per year**
Corresponds to:	• 29,200 hectares of trees planted each year • 380,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of French Polynesia
Solar Thermal	
2020 ST Target	**400 MW-th**
Corresponds to:	• 5,000 jobs created
CO_2 Reduction Equivalent	**0.3 Mt CO_2 per year**
Corresponds to:	• 10,950 hectares of trees planted each year • 142,500 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Grenada

Main Assumptions:
13 TWh of electricity demand in 2010, projected to become 31 TWh by 2020. RES currently counts for 1.5% of the primary energy mix, and is expected to reach 10% by 2020.

Useful links:
www.epia.org/sunbelt
www.nerc.gov.jo
http://www.memr.gov.jo/Portals/0/energystrategy.pdf

Key Statistics:
2010 electricity demand: 11,300 GWh
2020 electricity demand: 20,000 GWh
PV share today: 0.02%
PV Annual installed capacity (2009): NA
PV Cumulative capacity (2009): 1.5 MW

Policies to achieve targets:

Photovoltaics (PV)

The National Energy Research Center is the governmental body in charge of promoting research, development and training in the field of renewable energy and energy efficiency use in Jordan. In 2004, it entered into an International Energy Action Program and set the target of 5% of total energy used in Jordan coming to come from renewable energy by 2015. With respect to PV, Jordan supports PV with individual large scale developments. However, support mechanisms such as feed-in tariffs have not yet been introduced in Jordan or the entire Mediterranean and North African region, with the exception of Israel.

Photo Credit: Arabcrunch

Solar panels in Jordan.

Lebanon

الجمعية اللبنانية للطاقة الشمسية
The Lebanese Solar Energy Society

EPIA Analysis

Population: 4,125,000

GDP: $33.6 billion

Energy Mix CO2 Content: 0.638 kg CO2/kWh

SOLAR ENERGY TARGETS*:

1.5% of electricity production by 2020

75,000 tons CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**1.5% of electricity demand**
Corresponds to:	• 100 MW installed capacity • 176 GWh produced annually • $280 million in investment
CO_2 Reduction Equivalent	**75,000 tons CO_2 per year**
Corresponds to:	• 3,750 hectares of trees planted each year • 50,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Montserrat

Main Assumptions:
Around 10 TWh of electricity demand in 2010, projected to become 12 TWh by 2020. EPIA estimates the real potential of PV in Lebanon to be around 100 MW in 2020 and 300 MW in 2030.
*Target corresponds to PV market potential according to EPIA's "Unlocking the Sunbelt potential of PV" study (Paradigm Shift Scenario)

Useful links:
www.epia.org/sunbelt
www.lses-lb.org

Key Statistics:
2010 electricity demand: 10,000 GWh
2020 electricity demand: 12,000 GWh
Cumulative capacity (2009): 155kW

Policies to achieve targets:

Photovoltaics (PV)

In July 2009 the Central Bank of Lebanon launched Decree 10187 to facilitate loan procedures between end-users and private banks for environmentally-friendly, green architecture, and renewable energy projects.
The National Energy Efficiency and Renewable Energy Account (NEEREA) offers loans with a zero percent interest rate for renewable energy projects.

Many steps must yet be taken in order to develop the PV market in Lebanon, including access to the grid, support schemes, tax exemptions and custom fees. For large systems, power purchase agreements and land-use regulations are needed.

Photo credit: solarenergylebanon.com

PV panels in Lebanon

Photo credit: solarenergylebanon.com

A residential PV system on a roof in Lebanon.

Malaysia

EPIA Analysis

Population: 25,715,819

GDP: $383.6 billion

Energy Mix CO2 Content: 0.656 kg CO2/kWh

SOLAR ENERGY TARGETS*:

4% of electricity production by 2020

4 Mt CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**4% of electricity demand**
Corresponds to:	• 4,100 MW installed capacity • 6,200 GWh produced annually • $11.5 billion invested
CO_2 Reduction Equivalent	**4 Mt CO_2 per year**
Corresponds to:	• 133,000 hectares of trees planted each year • 1.8 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Paraguay

Main Assumptions:
99 TWh of electricity demand in 2010, projected to become 156 TWh by 2020.
*Target corresponds to PV market potential according to EPIA's "Unlocking the Sunbelt potential of PV" study (Paradigm Shift Scenario)

Useful links:
www.epia.org/sunbelt
Malaysian Photovoltaic Industry Association: http://www.mpia.org.my/

Key Statistics:
2010 electricity demand: 99,250 GWh
2020 electricity demand: 156,000 GWh
PV share today: 0.25%
Annual installed capacity (2009): NA
Cumulative capacity (2009): 160 MW

Policies to achieve targets:

Photovoltaics (PV)

Malaysia's Renewable Energy Act will be brought before the Parliament in December 2010. Once the Act is passed, the Ministry of Energy, Green Technology and Water of Malaysia will establish a new statutory body called the Sustainable Energy Development Authority (SEDA), whose main role will be to manage a new 21-year feed-in tariff scheme, including PV. Significant additional incentives would be offered for rooftop and building-integrated photovoltaic systems, with small incentives for locally produced modules and inverters. Malaysia's emergence as a strong manufacturing hub in South East Asia is clearly supporting its PV development at home.

Photo credit: Spiegel.de

The mounting structure is in place for a PV farm in Malaysia.

Photo credit: Solar Power Solutions

A PV system on top of a roof in Malaysia.

Mexico

Population: 111,211,789

GDP: $1.465 trillion

Energy Mix CO2 Content: 0.440 kg CO2/kWh

EPIA Analysis

SOLAR ENERGY TARGETS*:

3.4% of electricity production by 2020

4.2 Mt CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**3.4% of electricity demand**
Corresponds to:	• 6,500 MW installed capacity • 11,600 GWh produced annually • $18.2 billion in investment
CO_2 Reduction Equivalent	**4.2 Mt CO_2 per year**
Corresponds to:	• 139,000 hectares of trees planted each year • 1.85 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Albania

Main Assumptions:
181 TWh of electricity demand in 2010, projected to become 288 TWh by 2020.
*Target corresponds to PV market potential according to EPIA's "Unlocking the Sunbelt potential of PV" study (Paradigm Shift Scenario)

Useful links:
www.epia.org/sunbelt

Key Statistics:
2010 electricity demand: 181,500 GWh
2020 electricity demand: 288,000 GWh
PV share today: 0.04%
Annual installed capacity (2009): 17 MW

Policies to achieve targets:

Photovoltaics (PV)

Although Mexico has set renewable energy targets, solar PV in Mexico currently lacks specific support mechanisms, including a feed-in tariff system. However, Mexico is by far the largest manufacturing base in Latin America, and further commitment to manufacturing would greatly enhance government attention towards supporting local PV deployment.

Photo credit: Puerto callart solar

A PV system works on a rooftop in Mexico.

Photo Credit: Instituto Internacional de Recursos Renovables

A student sits next to a successfully installed PV panel.

Morocco

Population: 31,285,174

GDP: $145.6 billion

Energy Mix CO2 Content: 0.718 kg CO2/kWh

SOLAR ENERGY TARGETS*:

7% of electricity production by 2020

2.6 Mt CO_2 displaced annually by 2020

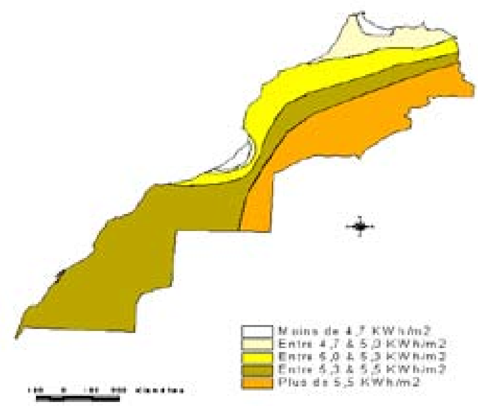
*PV only

Photovoltaics	
2020 PV Target	**7% of electricity demand**
Corresponds to:	• 2,000 MW installed capacity • 3.640 GWh produced annually • 15,000 jobs created • $5.6 billion in investment
CO_2 Reduction Equivalent	**2.6 Mt CO_2 per year**
Corresponds to:	• 85,000 hectares of trees planted each year • 1.1 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Mozambique

Main Assumptions:
The targets for PV and CSP are combined to produce 2,000 MW for 2020. It is assumed each technology can reach the maximum target, with the share of PV and CSP being mostly balanced. Renewable energies currently represent 15% of the Moroccan energy mix and produce 10% of the total electricity demand. This share is forecast to double by 2020, reaching over 32%. Current electricity demand is set at 24 TWh per year, and it is expected to reach 52 TWh by 2020.

Useful links:
www.epia.org/sunbelt

Key Statistics:
2010 electricity demand: 24,000 GWh
2020 electricity demand: 52,000 GWh
PV share today: 0.1%
PV Cumulative capacity (2009): 13 MW
CSP Cumulative capacity (2009): 20 MW
ST cumulative capacity (2009): 240,000 m^2



Policies to achieve targets:

Photovoltaics (PV)

Morocco's Renewable Energy Law 13.09 was adopted in January 2010. It represents a legal framework for investing in renewable energy projects in Morocco, including information on authorizations, administrative procedures, permits, export of electricity, and other items. The new law created the National Agency for Solar Energy in order to promote and manage the country's solar energy sector. The agency will be entrusted with coordinating the National Integrated Project for Solar Electricity Production, with an emphasis placed on large-scale solar. The agency recently unveiled the development of a very ambitious project that would achieve a total installed capacity of 2GW by 2020, and would consist of 5 generation sites (for PV and CSP). Tax, financial incentives, and a clearly defined policy will be key to Morocco's success and that of future PV development.

Photo credit: Eco Factor

Morocco plans to build a utility scale solar plant such as the photo shows. The plant is designed to provide 40% of Morocco's energy needs by 2020.

New Zealand

Population: 4,200,000

GDP: $115.3 billion

Energy Mix CO2 Content: 0.214 kg CO2/kWh

SOLAR ENERGY TARGETS*:

5% of electricity production by 2020

1.9 Mt CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**5% of electricity demand**
Corresponds to:	• 1,830 MW installed capacity • 2,500 GWh produced annually • 1,370 jobs created • $5 billion in investment
CO_2 Reduction Equivalent	**1.9 Mt CO_2 per year**
Corresponds to:	• 63,000 hectares of trees planted each year • 900,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Martinique

Main Assumptions:
Solar energy displaces remaining coal and some gas from the current mix to come to 85% renewables for electricity generation by 2020. The costs for installed PV reduce by 5% each year while the amount of installed capacity added doubles each year. The MED Energy Outlook 2009 Reference Scenario was use for expected energy demand.

Useful links:
Solar Industries Association: http://www.solarindustries.org.nz
New Zealand Energy Quarterly: www.med.govt.nz/energy/nzeq/
New Zealand's Energy Outlook 2009 Reference Scenario: www.med.govt.nz/energyoutlook
SEANZ: http://www.seanz.org.nz/

Key Statistics:
2010 electricity demand: 42,400 GWh
2020 electricity demand: 48,700 GWh
PV Cumulative capacity (2009): 6 MW

Policies to achieve targets:

Photovoltaics (PV)

The New Zealand Government currently has no policies in place to help enable or incentivize solar generation. Solar PV is also not currently featured in the New Zealand Energy Outlook 2009 Reference Scenario by the Ministry of Economic Development. The following policies are suggested to enable deployment of PV and to achieve the Solar PV Target:

- Climate Change Legislation
- National Net Billing Standard and uniform Connection Policy
- Renewable Energy Payments (Feed-in Tariff)

Photo credit: SEANZ

A family stands proudly in front of their home with a PV system.

Photo credit: SEANZ

A residential PV application in New Zealand provides 2.5kW of electricity.

South Africa

EPIA Analysis

Population: 49, 052,489

GDP: $505.3 billion

Energy Mix CO2 Content: 0.835 kg CO2/kWh

SOLAR ENERGY TARGETS*:

3.4% of electricity production by 2020

8.7 Mt CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**3.4% of electricity demand**
Corresponds to:	• 5,500 MW installed capacity • 10,400 GWh produced annually • $15.4 billion in investment
CO_2 Reduction Equivalent	**8.7 Mt CO_2 per year**
Corresponds to:	• 291,000 hectares of trees planted each year • 3.9 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Honduras

Main Assumptions:
215 TWh of electricity demand in 2010, projected to become 308 TWh by 2020.
*Target corresponds to PV market potential according to EPIA's "Unlocking the Sunbelt potential of PV" study (Paradigm Shift Scenario)

Useful links:
www.epia.org/sunbelt
Sustainable Energy Society of Southern Africa (SESSA): http://www.sessa.org.za/
Southern African Alternative Energy Association (SAAEA): http://saaea.blogspot.com/

Key Statistics:
2010 electricity demand: 215,100 GWh
2020 electricity demand: 308,000 GWh
PV share today: 0.01%
PV Cumulative capacity (2009): 12 MW

Policies to achieve targets:

Photovoltaics (PV)

In 2009, South Africa's National Energy Regulator (NERSA) approved the country's first renewable energy feed-in tariff (REFIT) scheme. The REFIT places an obligation on Eskom (South Africa's public utility) to purchase the output from qualifying renewable energy generators at pre-determined prices based on the levelized cost of electricity. The scheme seems to be focusing mainly on wind and CSP technologies at this stage, rather than PV. However, the government's current review of its Integrated Resource Plan could allow for a bigger role for PV. South Africa recently also announced the intention to construct one of the largest solar parks in the world. This park would generate 5GW of power and have a potential investment of USD 21bn, though investor appetite remains to be tested.

Photo credit: Green Peace.org

Volunteers install PV panels in South Africa

South Korea

(사)한국신 재생에너지학회
The Korean Society For New And Renewable Energy

Population: 48, 508,972

GDP: $1.364 trillion

Energy Mix CO2 Content: 0.459 kg CO2/kWh

SOLAR ENERGY TARGETS*:

0.7% of electricity production by 2020

2.2 Mt CO_2 displaced annually by 2020

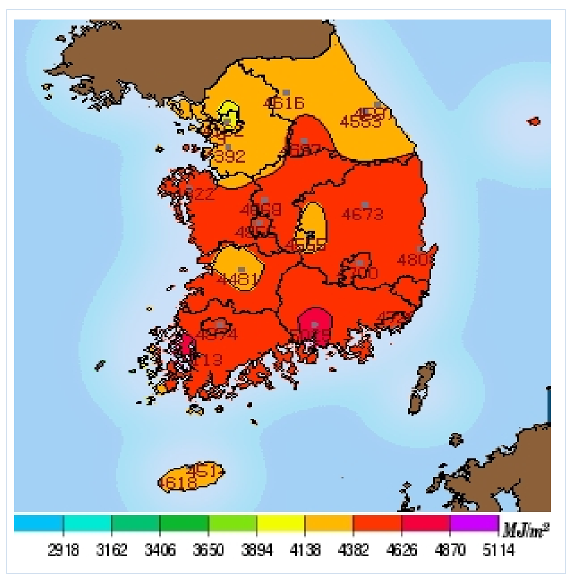
*PV only

Photovoltaics	
2020 PV Target	**0.7% of electricity demand**
Corresponds to:	• 2,500 MW installed capacity • 3,300 GWh produced annually • 350,000 jobs created • $7 billion in investment
CO_2 Reduction Equivalent	**2.2 Mt CO_2 per year**
Corresponds to:	• 48,500 hectares of trees planted each year • 650,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Guadeloupe

Main Assumptions:
464 TWh of electricity demand in 2010, projected to become 546 TWh by 2020. RES currently counts for 2.6% of the primary energy mix, and it is expected to reach 8% by 2020.

Useful links:
Korea Power Exchange: http://www.kpx.or.kr/english

Key Statistics:
2010 electricity demand: 464,000 GWh
2020 electricity demand: 546,000 GWh
PV share today: 0.15%
Annual installed capacity (2009): 160 MW
Cumulative capacity (2009): 520 MW



Policies to achieve targets:

Photovoltaics (PV)

There are currently two policies in South Korea that significantly support PV: the Electricity Business Law of 2001, which established a feed-in tariff, and the Renewable Portfolio Agreement of 2005. South Korea's commitment to renewable energy has been considerable, to the point that the country spent 80% of its fiscal stimulus package on renewable energy development. Additional dedicated support measures include a 20-year feed-in tariff, an income tax credit (20% of investment costs), a 50% import duty reduction for renewable energy equipment (until 2011), and various national and local development programs aimed at fostering the deployment of PV. The 100,000-rooftop program subsidizes up to 70% of the installation costs, and is expected to install 300MW of solar PV by 2011.

Photo Credit: Conergy

Asia's largest solar energy plant, in SinAn, South Korea, was recently expanded to 24MWp, producing 33,000 MWh annually.

Photo Credit: Best Solar Energy.com

A PV system powers the Donggwang Green Village on Jeju Island in Korea.

Switzerland

Population: 7,604,467

GDP: $314.7 billion

Energy Mix CO2 Content: 0.0275 kg CO2/kWh

SOLAR ENERGY TARGETS*:

2% of electricity production by 2020

3% of heat consumption by 2020

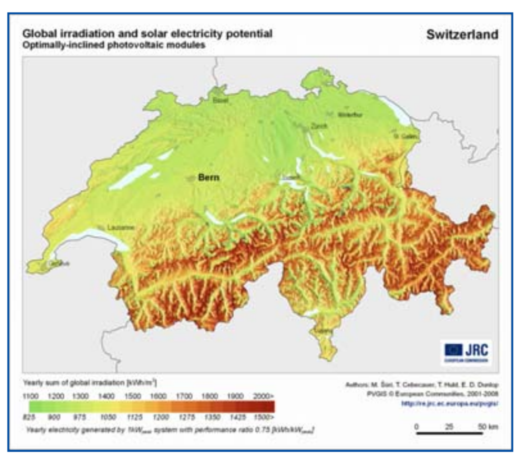
0.92 Mt CO_2 displaced annually by 2020

*PV and ST

Photovoltaics	
2020 PV Target	**2% of electricity demand**
Corresponds to:	• 1,250 MW installed capacity • 1,400 GWh produced annually • 3,000 jobs created
CO_2 Reduction Equivalent	**0.02 Mt CO_2 per year**
Corresponds to:	• 600 hectares of trees planted each year • 7,500 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Saint Elena
Solar Thermal	
2020 ST Target	**3% of heat consumption**
Corresponds to:	• 1 m^2 per capita • 3,300 GWh-th • 4,000 jobs created
CO_2 Reduction Equivalent	**0.9 Mt CO_2 per year**
Corresponds to:	• 27,000 hectares of trees planted each year • 164,000 cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Maldives

Key Statistics:

2010 electricity demand: 66,000 GWh
2020 electricity demand: 70,000 GWh
PV share today: 0.12%
PV Annual installed capacity (2009): 37 MW
PV Cumulative capacity (2009): 71.4 MW
ST Annual installed capacity (2009): 145,000 m^2
ST Cumulative capacity (2009): 7,140,000 m^2



Main Assumptions:
66 TWh of electricity demand in 2010, projected to become 70 TWh by 2020. RES currently counts for 58% of electricity production, and is expected to reach 63% by 2020.

Useful links:
Swiss solar systems: http://www.3-s.ch/

Policies to achieve targets:

Photovoltaics (PV)
Current support measures for PV include: a 25 year feed-in tariff diversified by system type and size (the total cap of 16 million CHF has already been reached), tax rebates and different incentives in 4 federal cantons. The Swiss Energy Action Plan began in 2001, following the Energy2000 program. The objectives of Swiss Energy are to reduce the consumption of fossil fuels, to slow the growing electricity demand, and to increase the contribution of renewables to energy supply.


Photo Credit: Schweizerische Vereinigung für Sonnenenergie SSES and Canton de Genève

A roof-integrated PV system provides 7.7kWp.


Photo credit: Photo Credit: Schweizerische Vereinigung für Sonnenenergie SSES

A worker installs a combi water heating and PV system on a roof.


Photo credit: Photo Credit: Schweizerische Vereinigung für Sonnenenergie SSES and Karl-Heinz Hug

A PV system on a barn in Switzerland provides 110kWp.

Thailand

EPIA Analysis

Population: 65,998,436

GDP: $540.1 billion

Energy Mix CO2 Content: 0.529 kg CO2/kWh

SOLAR ENERGY TARGETS*:

3.3% of electricity production by 2020

6 Mt CO_2 displaced annually by 2020

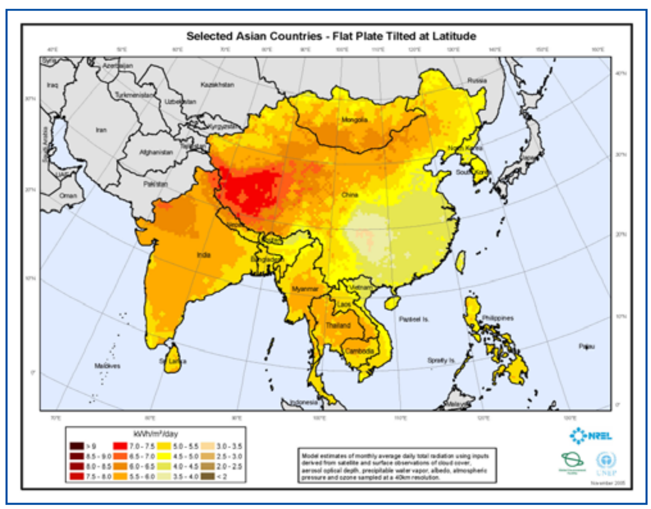
*PV only

Photovoltaics	
2020 PV Target	**3.3% of electricity demand**
Corresponds to:	• 4,400 MW installed capacity • 7,200 GWh produced annually • $12 billion in investment
CO_2 Reduction Equivalent	**6 Mt CO_2 per year**
Corresponds to:	• 200,000 hectares of trees planted each year • 2.7 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Georgia

Main Assumptions:
134 TWh of electricity demand in 2010, projected to become 218 TWh by 2020.
*Target corresponds to PV market potential according to EPIA's "Unlocking the Sunbelt potential of PV" study (Paradigm Shift Scenario)

Useful links:
www.epia.org/sunbelt

Key Statistics:
2010 electricity demand: 134,400 GWh
2020 electricity demand: 218,000 GWh
PV share today: 0.05%
Annual installed capacity (2009): NA
Cumulative capacity (2009): 40 MW



Policies to achieve targets:

Photovoltaics (PV)

Comprehensive support policies for PV have recently emerged in Thailand in the form of a generous feed-in tariff (for a period of 10 years). This has resulted in an explosion in demand and has led to Thailand having the largest installed PV base in South East Asia. Last year, authorities announced a 500MW target for PV by 2022, but within 6 months had received applications for over 3GW of installations. Thailand, together with Malaysia, are leading the way in South East Asia in terms of introducing measures designed to ensure sustainable support levels based on competitive installed system prices.


Photo credit: panda.org

Performing maintenance on panels in Thailand


Photo credit: Gizmo watch

Thailand's first Bio-Solar House includes a PV system and produces zero waste.

Turkey

Population: 76,805,524

GDP: $874.5 billion

Energy Mix CO2 Content: 0.495 kg CO2/kWh

SOLAR ENERGY TARGETS*:

2% of electricity production by 2020

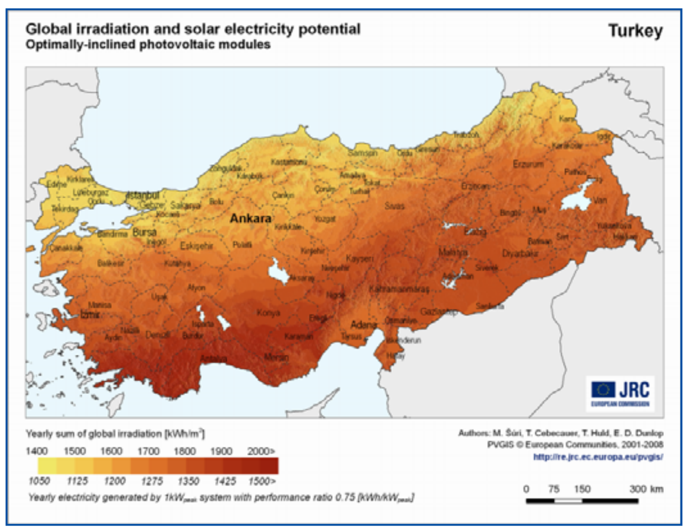
4 Mt CO_2 displaced annually by 2020

*PV only

Photovoltaics	
2020 PV Target	**2% of electricity demand**
Corresponds to:	• 5,400 MW installed capacity • 8,200 GWh produced annually • 20,000 jobs created • $15 billion in investment
CO_2 Reduction Equivalent	**4 Mt CO_2 per year**
Corresponds to:	• 130,000 hectares of trees planted each year • 1,7 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Paraguay

Main Assumptions:
200 TWh of electricity demand in 2010, projected to become 410 TWh by 2020. RES currently counts for 22% of electricity production and is expected to reach 40% by 2020.

Key Statistics:
2010 electricity demand: 198,100 GWh
2020 electricity demand: 410,000 GWh
PV share today: 0.02%
Annual installed capacity (2009): 3 MW
Cumulative capacity (2009): 30 MW



Policies to achieve targets:

Photovoltaics (PV)

In terms of national renewable energy policy, Turkey has an official goal of 30 percent renewable energy use by 2023; however there is no specific official goal for solar electricity generation. Instead, solar PV has been identified as a source of huge potential in the coming years. PV is currently not supported by any feed-in tariff or other incentive mechanisms. This is reflected in the small size of the market (less than 1 MWp of installed capacity per year). An important draft law for feed-in tariffs was submitted in 2010 to the Turkish Parliament, but it has been under discussion ever since.

Photo credit: Entrophyenergy.net

A utility scale PV plant in Turkey.

United States of America

Population: 307,006,550

GDP: $14.59 trillion

Energy Mix CO2 Content: 0.718 kg CO2/kWh

SOLAR ENERGY TARGETS*:

4.85% of electricity production by 2020

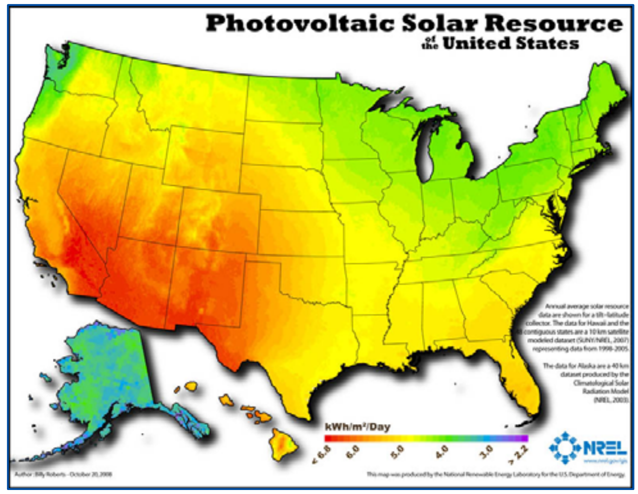
117 Mt CO_2 displaced annually by 2020

*PV, CSP, and ST

Photovoltaics	
2020 PV Target	**3% of electricity demand**
Corresponds to:	• 110GW of installed capacity • 115 TWh produced annually • 600,000 jobs created
CO_2 Reduction Equivalent	**72 Mt CO_2 per year**
Corresponds to:	• 2.34 million hectares of trees planted each year • 14 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Chile
Concentrating Solar Power	
2020 CSP Target	**1.3% of electricity demand**
Corresponds to:	• 24 GW of installed capacity • 58 TWh produced annually • 78,000 jobs created
CO_2 Reduction Equivalent	**31 Mt CO_2 per year**
Corresponds to:	• 1 million hectares of trees planted each year • 6 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Ecuador
Solar Thermal	
2020 ST Target	**0.2% of electricity demand**
Corresponds to:	• 5 GW-th of installed capacity • 6.35 TWh-th produced annually • 5,000 jobs created
CO_2 Reduction Equivalent	**14 Mt CO_2 per year**
Corresponds to:	• 455,000 hectares of trees planted each year • 2.7 million cars taken off the road each year • Equivalent to the yearly CO_2 emissions of Jamaica

Main Assumptions:
4,030 TWh of electricity demand in 2010, projected to become 4,475 TWh by 2020. Capacity factor of solar systems assumed to be 16% for PV, 28% for CSP, and 14% for SWH. The price of PV is expected to decline from $5.71/watt in 2010 to $2.32/watt in 2020.

Key Statistics:
2010 electricity demand: 4,030 TWh
2020 electricity demand: 4,525 TWh
PV share today: 0.2%
PV annual installed capacity (2009): 435 MW
PV cumulative capacity (2009): 2.2 GW
CSP annual installed capacity (2009): 6 MW
CSP cumulative capacity (2009): 430 MW
ST annual installed capacity (2009): 2.6 million ft^2
ST cumulative capacity (2009): 97 million ft^2



Useful links:
www.seia.org
www.solarelectricpower.org
www1.eere.energy.gov/solar/
www.dsireusa.org

Policies to achieve targets:

Effective solar policy in the United States requires the successful alignment of incentives and regulations at the federal, state, local and utility levels. Several key federal policies interact with hundreds of different state, local and utility programs and have the broadest impact on U.S. solar markets.

Federal Solar Policies:

- **Federal Investment Tax Credit (ITC):** The ITC enables the owner of a solar energy system to recover 30 percent of upfront capital costs through a dollar-for-dollar reduction in tax liability. This drasticly improves the value proposition to a potential solar energy customer.
- **Treasury Grant Program (TGP) :** The TGP is claimed in-lieu of the ITC. The owner of a commercial solar system can opt to receive a grant for 30 percent of the upfront capital cost instead of the tax credit. This policy is especially important during a slow economy when *tax equity* is scare.
- **Manufacturing Investment Tax Credit (MITC) :** The MITC enables companies to receive a tax credit for 30% of the cost of advanced energy manufacturing capital costs. Similar to incentives offered in other countries, this policy enables additional domestic manufacturing of solar energy equipment. All funds for this program have been exhausted under current law but there are several proposals for extension.
- **Loan Guarantee Program (LGP) :** This program addresses the high cost and scarcity of debt financing for large solar energy projects by protecting creditors from default risk.

State-level policies define market accessibility and often provide additional financial incentives.

Types of State Solar Policies:

- **Renewable Portfolio Standards (RPS) :** 29 states, the District of Columbia and Puerto Rico have RPS policies. These quota systems require utilities to generate obtain a minimum percentage of their electricity supply from renewable sources. Many RPS policies include solar carve-outs that further specify a minimum supply from solar energy.
- **Net metering:** For solar energy systems located on most homes and businesses, net metering allows owners to sell energy to the utility when generation exceeds demand and buy from the utility when demand exceeds generation.
- **Rebates:** Rebates offer are cash incentives that help reduce the upfront cost of an investment in a solar energy system.
- **Performance-Based Incentives (PBI):** PBIs work in conjunction with net metering to make an investment in a solar energy system more attractive. Owners receive an incentive for every unit of energy produced by their solar energy system over a specific period of time.
- **Tax incentives:** Many states offer tax incentives like the federal ITC. Others offer exemptions from sales or property taxes.

Photo credit: SEIA

Workers install a PV system on a roof.

Photo credit: SEIA

An evacuated tube solar thermal system is installed and provides hot water for the home.

Photo credit: SEIA

A utility scale solar plant in the California desert.

About the Solar Groups in this Report

Australian PV Association

The Australian PV Association (APVA) encourages participation of Australian organisations in PV industry development, policy analysis, standards and accreditation, advocacy and collaborative research and development projects concerning photovoltaic solar electricity. APVA provides:

- Up to date information on PV developments in Australia and around the world (research, product development, policy, marketing strategies) as well as issues arising
- A network of PV industry, government and researchers which undertake local and international PV projects, with associated shared knowledge and understanding
- Australian input to PV guidelines and standards development
- Management of Australian participation in the IEA-PVPS

www.apva.org.au - Australia

Bundesverband Solarwirtschaft (BSW)

With about 800 member companies, Bundesverband Solarwirtschaft e.V. is the interest group of the German solar energy industry. Forming a strong community of companies, BSW-Solar acts as an informant and intermediary between business and the political and public sectors. It represents the common commercial interests of businesses within the solar energy value chain. BSW-Solar exerts a decisive influence on creating and securing a suitable policy framework for stable growth, and thus on ensuring investment security throughout the solar industry. Our objective is to establish solar energy as a permanent pillar of a global energy industry.:

http://www.solarwirtschaft.de/- Germany

Canadian Solar Industries Association

CanSIA works to strengthen the Canadian solar industry, increase the professionalism of companies, foster domestic and international markets, and promote the use of renewable energies.

www.cansia.ca - Canada

Chinese Renewable Energy Industry Association (CREIA)

Since its establishment, Chinese Renewable Energy Industry Association (CREIA) has been serving as a window bringing together national and international project developers and investors; a bridge between regulatory authorities and the industry; and a network for enterprises, drawing together renewable energy experts on research and development, production and sales, professionals and entrepreneurs to accelerate the development of Chinese renewable energy. As an industrial association, CREIA has succeeded in attracting over 100 corporate members and about 160 individual members covering all the subsectors of renewable energy in China.

www.creia.net - China

European Photovoltaic Industry Association

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.

www.epia.org - Belgium

European Solar Thermal Electricity Association

ESTELA is the industry European Solar Thermal Electricity Association that was created in 2007 and started operating in Brussels in March 2008. ESTELA currently has 52 members. One of these members, the national Spanish association PROTERMOSOLAR has 80 members itself. Thus, ESTELA represents -directly and indirectly- more than 130 companies, in fact most of the European companies that have activities in the solar thermal electricity sector.

www.estelasolar.eu - Belgium

European Solar Thermal Industry Federation

ESTIF is the voice of the solar thermal industry, actively promoting the utilisation of solar thermal heating and cooling technologies in Europe. It now has over 100 members representing the whole solar thermal value chain from collector manufacturers to component suppliers, research institutes, service providers, national solar thermal and renewables associations.

www.estif.org - Belgium

Hungarian Photovoltaic Industry Association (HUPIA)

HUPIA promotes the generation of electricity from solar power in Hungary, by uniting researchers, developers, manufacturers, contractors and end-users from the domestic solar-cell industry. In order to ensure that the PV industry in Hungary achieves a growth similar to that of other energy sources, HUPIA represents the interests of the PV industry at political and regulatory institutions and advises policy-makers on a number of issues. HUPIA also publishes market/ industry forecasts and future trends, and holds numerous workshops.

www.manap.hu - Hungary

Italian PV Industry Association (ANIE/GIFI)

ANIE/GIFI is the largest PV industry association in Italy. It represents about 150 companies all along the PV industry value chain. ANIE/GIFI is an active member of EPIA with particular input into the policy and communication areas.

www.gifi-fv.it/cms/index.php - Italy

Japan Photovoltaic Energy Association

Established in 1987, Japan Photovoltaic Energy Association (JPEA) has been consistently committed to promoting the dissemination of photovoltaic energy and its industrial development. JPEA consists of 95 members including most of the PV manufactures in Japan.

www.jpea.gr.jp - Japan

The National Energy Research Center of Jordan

The National Energy Research Center has been established in Amman - Jordan for the purposes of research, development and training in the fields of new and renewable energy; raising the efficiency of using energy in the different economic sectors. This research center is considered as one of the specialized science and technological centers working under the umbrella of the Higher Council for Science and Technology.

www.nerc.gov.jo/ -Jordan

The Korean Society for New and Renewable Energy

www.ksnre.or.kr/ - Korea

Lebanese Solar Energy Society

LSES was established in 22nd of April 1980 in Beirut on the initiative of highly educated engineers and was comprised of solar energy company owners, chairmen of university engineering departments and electrical, mechanical, chemical engineers.

LSES currently has around 30 members with a main target to promote the use of solar & renewable energy with consideration for the protection of the environment, energy saving, and the quality of life.

www.lses-lb.org -Lebanon

Photovoltaic Industry Association of Turkey-GENSED

GENSED is the first and only national association consisting of more than 50 companies, active in Turkish solar market as a PV manufacturer, component supplier, R&D institution, integrator, investor, project developer or consultant. GENSED has been founded with the premium target of:

- creating public awareness towards solar energy
- assisting the decision makers for overcoming legal barriers
- helping its members to create new business oppurtunities both in Turkey and neighbouring countries

www.gensed.org/ -Turkey

Shanghai New Energy Industry Association

Shanghai New Energy Industry Association (SNEIA) pushes forward the technologic al and economic information exchanges inside the association, improves the relationship between its members and the government, society and organisations at home and abroad, prompts the technological advancement of new energy and the publicity work as well as providing trade, technology and information services for Chinese and overseas new energy enterprises.

www.sneia.org – P.R. China

Slovenian Photovoltaic Industry Association (ZSFI)

The Association's aim is to promote photovoltaics at the national level and to assist its members in the development of their businesses in both the European Union and in export markets.

http://www.zsfi.si/ - Slovenia

Solar Energy Industries Association

Established in 1974, the Solar Energy Industries Association is the national trade association of U.S. solar energy industry. As the voice of the industry, SEIA works with its 1,000 member companies to make solar a mainstream and significant energy source by expanding markets, removing market barriers, strengthening the industry and educating the public on the benefits of solar energy.

www.seia.org - USA

Spanish Renewable Energy Association (APPA)

APPA was established in 1987 and represents various technologies within the Spanish renewable energy sector. Today, APPA has more than 500 members within 10 different sections of all kinds of renewable energy technologies (wind energy, high and low temperature geothermal energy, PV, CSP, small hydropower, biomass, biofuels, ocean energy and small-wind power).

http://www.appa.es/ - Spain

Sustainable Electricity Association of New Zealand

This industry association represents the interests of all stakeholders on the smaller scale of the renewable /distributed generation (SSR/DG) industry. New Zealand's energy supply can be supported by photovoltaic (PV) solar, small scale hydro and small wind technologies. Its objective is to increase the uptake of small scale renewable power generation.

www.seanz.org.nz - New Zealand

Swedish Solar Energy Association

The Swedish Solar Energy Association is the national industry association with a member base of more than 60 professional organizations representing Swedish research and industrial interests in solar energy. The association pursues its objective of actively ensuring that solar energy - direct transformation from solar radiation to heat and/or electricity - play an important role in a sustainable Swedish energy system, and that Swedish companies be recognized for their technological and innovative leadership in Europe.

www.svensksolenergi.se - Sweden

Swiss Association for Solar Energy

Swissolar is the solar energy trade association of Switzerland. It is active both in the photovoltaic and solar thermal sector. The 200 members are manufacturers, installers and planners. Activities include information, quality assurance, education and lobbying.

www.swissolar.ch – Switzerland

SOLAR POWER
MORE ENERGY
LESS CO_2

European Photovoltaic Industry Association

Solar Energy Industries Association®

www.solarCOP16.org