THE RISE OF SOLAR ENERGY

Consulting

If harvested and converted, the sunlight received by earth in one hour will be enough to meet the annual energy needs globally according to the National Renewable Energy Laboratory. The sun supports life on earth and this amazing resource radiates energy and provides us both heat and light by fusing hydrogen into helium at its core. This is called solar radiation. Though only about half of this solar radiation makes it to the Earth's surface, we still receive enough power from the sun to meet the power demands of all mankind and millions of times more. The rest is either absorbed or reflected by clouds and the atmosphere.

Wood was the main source of energy for heating, cooking, and light until the mid-1800s. From the late 1800's until today, fossil fuels—coal, petroleum, and natural gas—have been the major sources of energy. However, from 1990s renewable energy sector has been on rise and during 2008-2017 the world's renewable power capacity doubled reaching 2,297,167 MW, constituting almost 25% of the world's power demand.

The energy provided by the sun is more than enough to meet the whole world's energy needs, and unlike fossil fuels, it won't run out in foreseeable future, therefore the solar power is the key to a clean energy future. Solar panels produce electricity by transforming the continuous flow of energy from the sun to electricity at the same time releasing no harmful emissions into the air. The photovoltaic process of transforming sunlight into electricity doesn't require any fuel and has no variable costs. As a renewable energy source, the only limitation of solar power is our ability to turn it into electricity in an efficient and cost-effective way. Operational costs after solar panel installations are quite low compared to other forms of power generation. No fuel is required, and this means that solar power can create large amounts of electricity without the uncertainty and expense of securing a fuel supply.

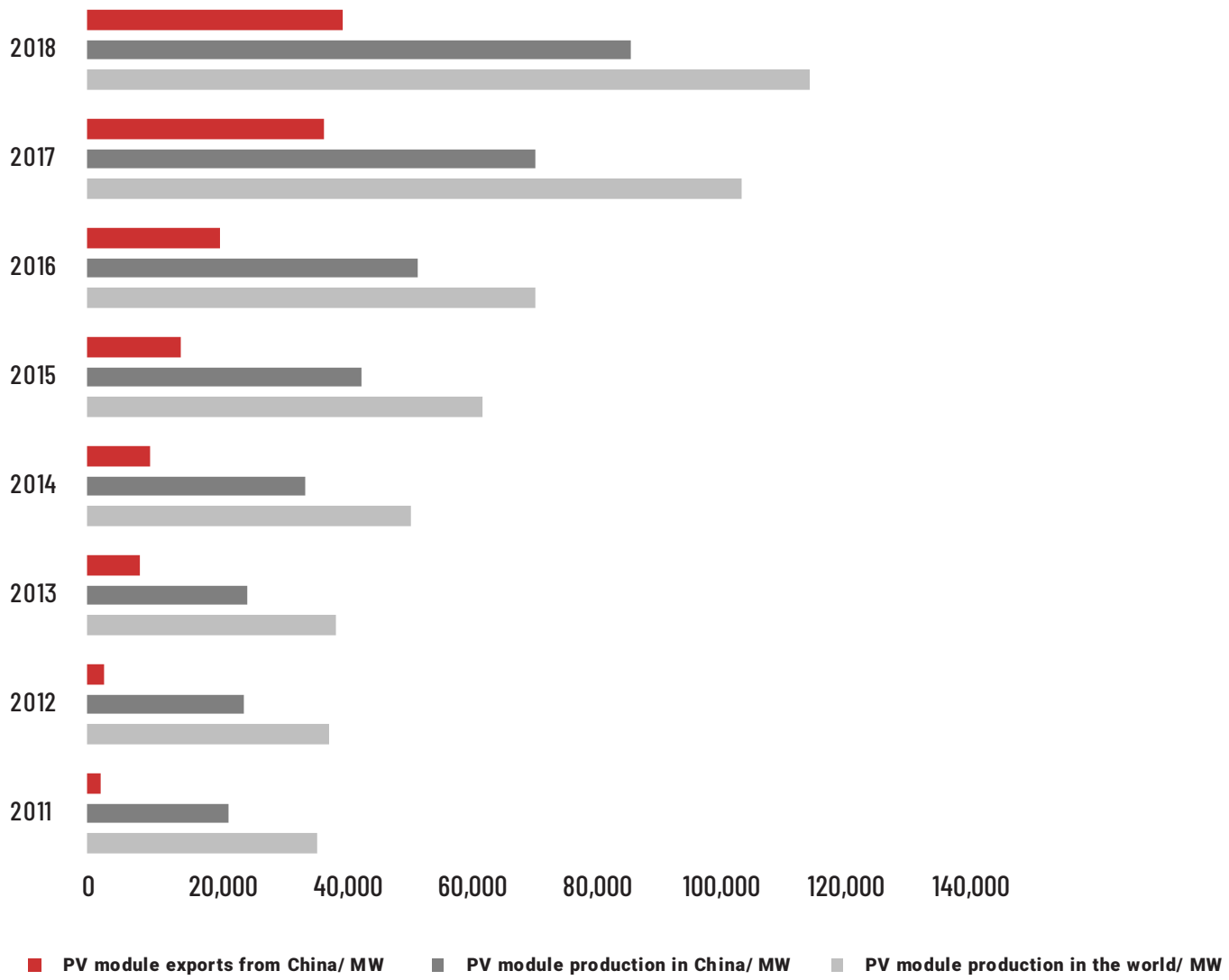
Two major technologies have been developed to harness the solar energy: solar thermal technology and photovoltaic (PV) solar technology. PV modules have become very popular compared to solar thermals due to their lower cost, width of geographical area of application and low maintenance costs.

Solar is the world's fastest growing energy source with accelerated growth rate of 38.71% CAGR during the last 10 years. The world's maximum net generating capacity of solar power plants and other installations increased by 2,350% in case of solar PVs and 830% for solar thermals during the period of 2008-2017, while hydropower, which is still the leader in the sector, increased by only 32%, and the second leader (wind) by almost 350% during the same period.

The reasons for solar's popularity are manifold. It is unique in its flexible and distributed clean nature, which allows innumerable applications, it is the lowest-cost power generation technology and it enjoys the governmental support in face of tax privileges in many countries, such as China, India, Taiwan, Spain, Canada etc.

Solar photovoltaic production market is led by Chinese producers and in 2017 their contributions to the list of top 10 module suppliers ranking were greater than 60%. China boosted it PV module production by more than 3 times during 2011-2018 and reached 87.2GW in 2018, while the world's total production was 116GW. China's exports of PV modules reached 41GW for the full year of 2018, about two times more than in 2016 (21.3GW). Chinese exports in 2018, were mainly to Europe, India, Middle East and South America. World's PV production increased with a slower pattern (214% during 2011-2018) than China's production (282% during 2011-2018).

Chart 1: World's and China's PV module production, 2011-2018



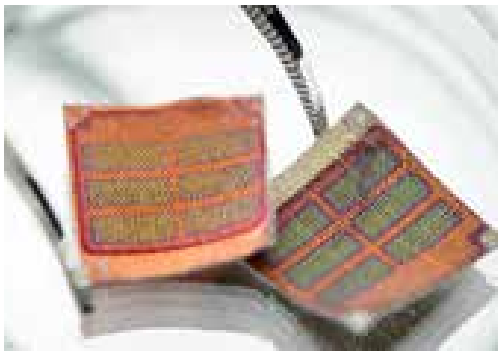
Source: Research Report on China's Photovoltaic Industry, 2018-2022

The world's cumulative installations of PV modules amounted to 512 GW at the end of year 2018 (almost 23% of renewable's power capacity). This represented a growth of 27% from 2017. The CAGR of PV installations was 36.8% in the period of 2010- 2018. In 2018, Europe's contribution to the total cumulative PV installations amounted to 25% (compared to 28% in 2017). In contrast, installations in China accounted for 36% (compared to 32% in 2017).

Traditional solar cells are made from silicon and generally are the most efficient even though they are also the most expensive ones. Second-generation solar cells are called thin-film solar cells. The 'competition' between solar technologies is either based on better efficiency or lower cost and the longer lifespan. The winner in this "battle" is quasi-monocrystalline solar technology which stands in the middle of mono and multi-crystalline solar cells with its characteristics.

Solar power, indeed, was in a constant state of innovation in 2019, with new advances in solar panel technology announced almost every week. In the past year alone, there have been milestones in solar efficiency, solar energy storage, wearable solar tech and solar design tech. Some of the recent and ongoing developments in the industry are provided below:

Some people avoid installation of the solar panels because of their unsightly appearance. To make them more presentable Sistine company made serious strides and created **Solar Skin** product which gives solar panels a customized look. Researchers from the Royal Melbourne Institute of Technology claim that solar power can also be harnessed and generated by using **Solar Paint**.



Solar devices are not new in the market, such as watches, phones and other gadgets, but innovation in solar textile is something new (developers are Marianne Fairbanks and chemist Trisha Andrew). The usage of solar "fasion" is manifold. The manufactured photovoltaic fibers may also be utilized to manufacture functional yarns by spinning and then fabric by weaving and knitting. Now some of our clothes can power our smartphones and other portable gadgets. PV tents, curtains, and tarpaulins generate electricity in more green and clean fashion.

Soochow University created special solar cells that can harness energy from the raindrops. When it rains, the friction created by the raindrops generates a static electricity charge.

Floating Solar - erect solar plants on the water, since over 70% of the Earth's surface is covered with water. The company has projects set up in France, Japan, and UK and other parts of the world including piloting projects in India and U.S (California).

Space Based Solar - space-based satellites capture sunlight and convert it into microwave energy that is then beamed back to earth. This type of technology promises to capture significant amount of sunlight (nearly ninety percent) since satellites can be positioned to optimize light capture round the clock. Currently, India, China and Japan are investing heavily in these technologies.

Stanford University researchers started to develop a new **nanostructured solar device** (2018) that can disinfect water in minutes when exposed to sunlight.

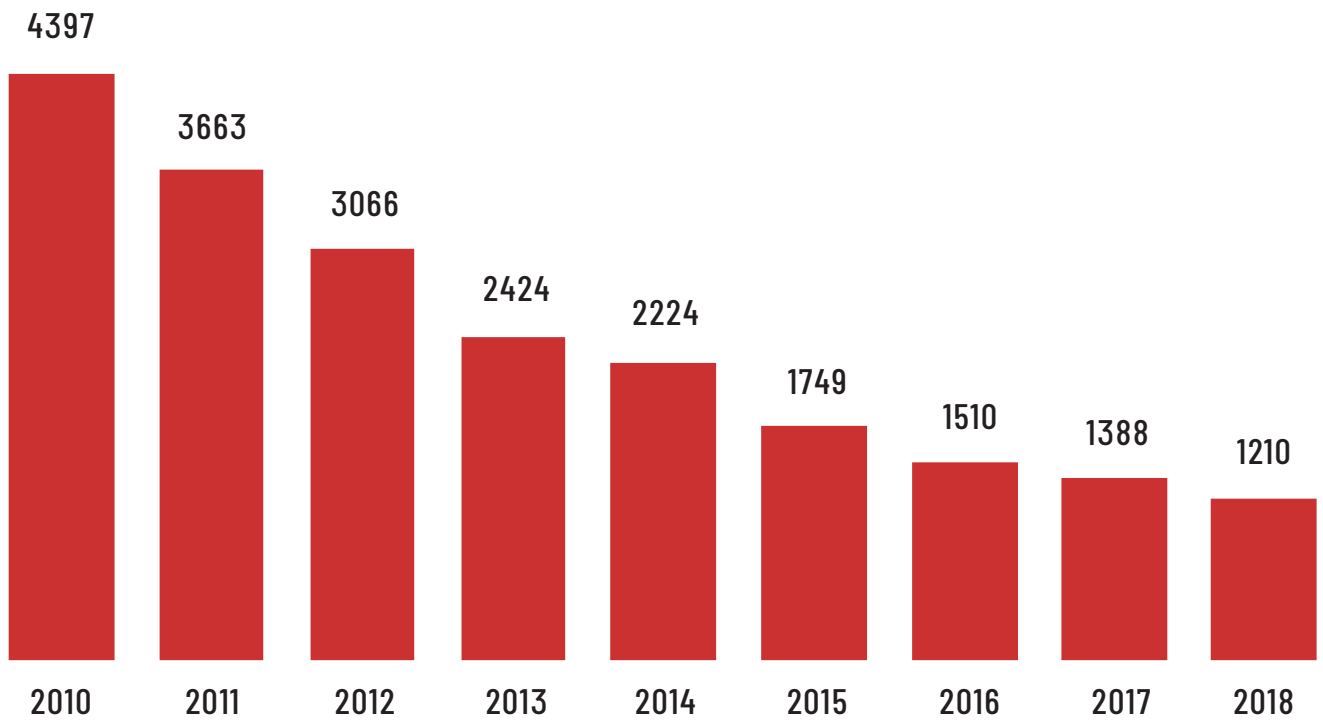
Taking into consideration ongoing and future R&D developments that propose more efficient ways to store and produce solar cells, it is expected to have 12.5% CAGR of global PV cell, wafer and module production market size till 2025.

Cost-effective production technologies, higher economies of scale, shrinking costs of silicon and the squeezing profit margins due to the anticipated high demand will lead to the decreased prices for solar modules. Moreover, the predicted rise in efficiency will bring the popularity of solar technologies to another stage. Even if nowadays commercially available modules have 23-25% efficiency, scientists have already reached to 45% of lab level efficiency and they are doing a tremendous job to bring it to our quotidian life.

However, the solar sector has drawbacks as well and there are several factors that explain why so little of solar energy it is still used and what stops it to rise in enormous rates.

While switching from traditional power sources to renewables one always balances costs and benefits that will be carried. In this case the most critical factor is capacity, i.e. the portion of the time the solar modules produce their rated capacity in practice. For many countries (especially European ones) it can be 10-20% of time that solar panels operate properly, while they produce absolutely nothing during the remaining time period. So, these countries need fossil backup, which makes the price that we bear for solar panel installation higher. At the beginning the clean technology was very costly than that produced by traditional sources, but over the past two decades, the cost gap has been closing.

Chart 2: Average installed cost for solar PV worldwide from 2010 to 2018, (in U.S. dollars per kilowatt)



Source: statista.com; irena.org

The average total installation costs for solar PVs decreased almost 3.5 times during 2010-2018. Price of PV cells has decreased dramatically due to different governmental policies, increase in efficiency, learning by doing, R&D, economies of scale etc.

The prices for PV modules are expected to continue to decrease in the long term perspective due to the cost-effective production technologies which will further reduce the volume of silicon used for the production of crystalline PV cells, higher economies of scale which will lead to reduction of the fixed costs, shrinking costs for poly-Silicon due to expansion of the poly-Silicon production capacities.

Another major problem is the expensive storage of solar energy. Scientists, however, suggest so many variants to solve these problems, but up to now, those are lab-level solutions, hence in near future this problem will have its solution which will make the solar more popular and more demanded. In addition, solar requires huge space, whereas scientists don't detain the transformation of this industry.

Solar power is weather dependent and can lose power because of soiling and shading and this makes it very vulnerable. Number of companies have started to develop technologies (such as nano-structured particles, etc.) to make this problem less severe. Due to the R&D in the sector, all the mentioned above disadvantages are either solvable or in the active research process.

Solar is clean and safe, it prevents destruction of habitats and combats climate change, it can be produced on a small scale directly by the end users and is considered a cheap and reliable energy source. Now, there is little room for doubt that solar energy will eventually be a significant, if not the dominant, form of power both on an industrial and an individual scale.

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