Industry analysis for photovoltaic plant industry

EVOTECHCAPITAL

Industry analysis for the Chinese photovoltaic(PV) power plant industry

1. Recent developments within the Chinese PV power plant industry

According to the report on the Chinese Photovoltaic and industry outlook there is a huge potential for growth within the industry. The most promising market is large-scale PV power stations in deserts. In China deserts and present and potential desertification areas total 2.5 millionkm^2. If a 1% of these areas are used for PV the total capacity is supposed to reach 2.5 billion kW generating some 3 trillion kWh electricity amounting to China's total electricity generation at present. Under such conditions, mega solar systems represent the most attention-attracting market for China's PV industry.

In 2009, the Chinese government offered to further promote the domestic PV market of which the central part is for mega solar systems. The largest obstacle to the mega solar system development is the uncertainty about policies. For example feed-in-tariffs for PV electricity is expected to accelerate its development. There are other problems regarding China's mega solar system development. While China's Midwest is rich with solar energy resources and less populated and can be characterized as the most suitable for large-scale system locations, China's electricity consumption is concentrated in the East. Therefore, the selection of specific mega solar system locations and the construction of relevant electricity transmission/distribution systems are very significant.

In 2014 the photovoltaic sector in China is recovering slowly as banks are reluctant to give out loans to power station operator. This means that there are high risks within the business of operating PV power stations. There is a huge funding gap in PV power station development as a result of incomplete financing support.

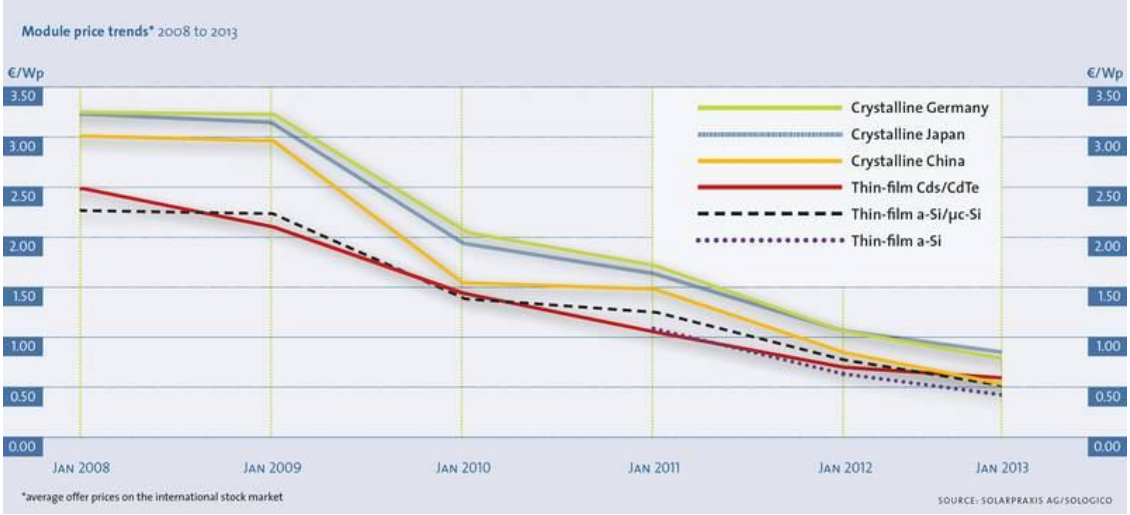
The capital demand for station construction is predicted to be around 60 billion Yuan ($9.79 billion) per year, much of which cannot be satisfied by the capital market. Companies within the industry face capital shortage because of lagging aid despite strong official support policies.

Therefore most banks still do not want to lend for the construction of PV power stations, although the sector is reviving. So far the National Development Bank, which is a state-owned bank focused on serving the national economic strategy. According to the

government's plan, China's annual new PV power installations stood at around 10 gigawatts from 2013 to 2015, with total volume predicted to reach 35 gigawatts by end of next year. In 2013 a majority of listed cell producers have posted profits in their 2013 annual financial reports or made optimistic forecasts in preliminary statements thus far, which indicates that the Chinese PV industry is recovering.

The driving forces of the worldwide PV plant market are the decreasing system costs of photovoltaics and the surging prices of electricity generated using conventional technologies. In 2013 the prices for solar module could stabilize (see figure 1), while system costs are more likely to change.

Figure 1: Module price trends from 2008 until 2012



The European Photovoltaics Industry Association (EPIA) estimates that the price of PV systems belonging to the utility-scale sector (2.5 MW and above) will fall by a quarter within the next ten years, from 1.22 euros per watt (W) in 2012 to 0.92 euros per W in 2022.

The reluctance in investing in PV power plants in China is puzzling since Photovoltaics is becoming increasingly inexpensive. In contrast, the prices for electricity from conventional power plants are climbing. This is making the solar farm market segment progressively more lucrative for financially strong investors. Furthermore as figure 2 shows, when it comes to the weighted average cost of capital (WACC) solar energy has the lowest WACC with 6 percent compared to wind, combined cycle gas turbine and liquid gas turbine. The main disadvantage of solar energy is that it has the lowest capacity factor of all energy sources as can be seen from figure 3. The capacity factor of a power station is the ratio of average output power to peak power that the station could deliver. Due to fluctuations in the availability of the primary energy source and outages due to maintenance of the equipment, the capacity factor is never

100%. In fact, for renewable energy sources, it is mostly below 50%.The capacity factors of solar plants are particularly low. After all, the sun is only half of the time above the horizon.All electrical components have to be sized such that they can deliver peak power, which is more cost-efficient when the plant runs at high capacity. Higher capacity factors imply less fluctuation.

Figure 2: WACC for solar PV, Wind, combined cycle gas turbine and liquid gas turbine

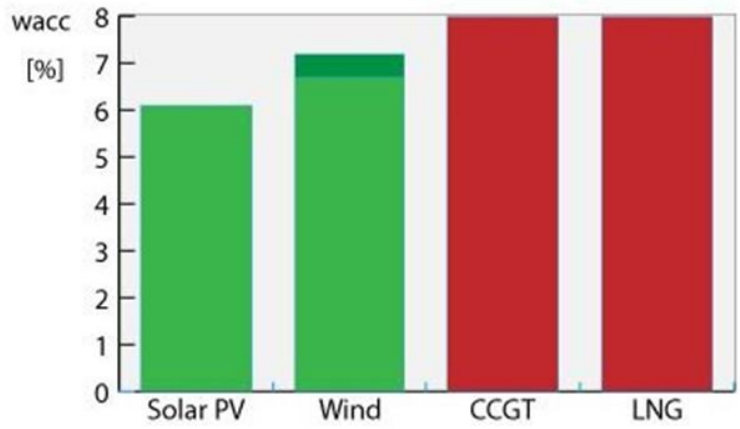
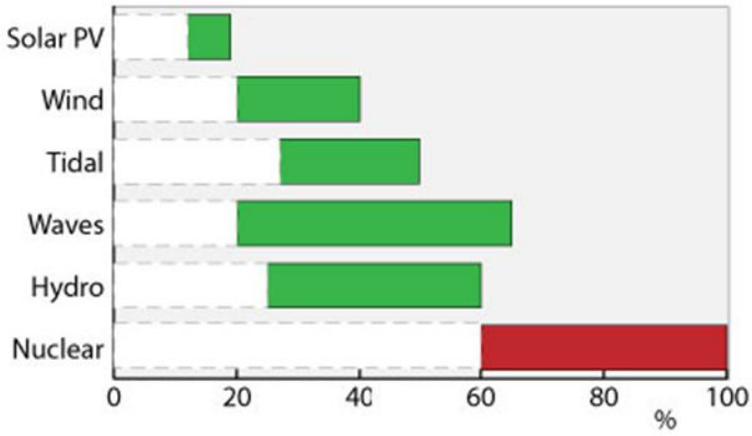
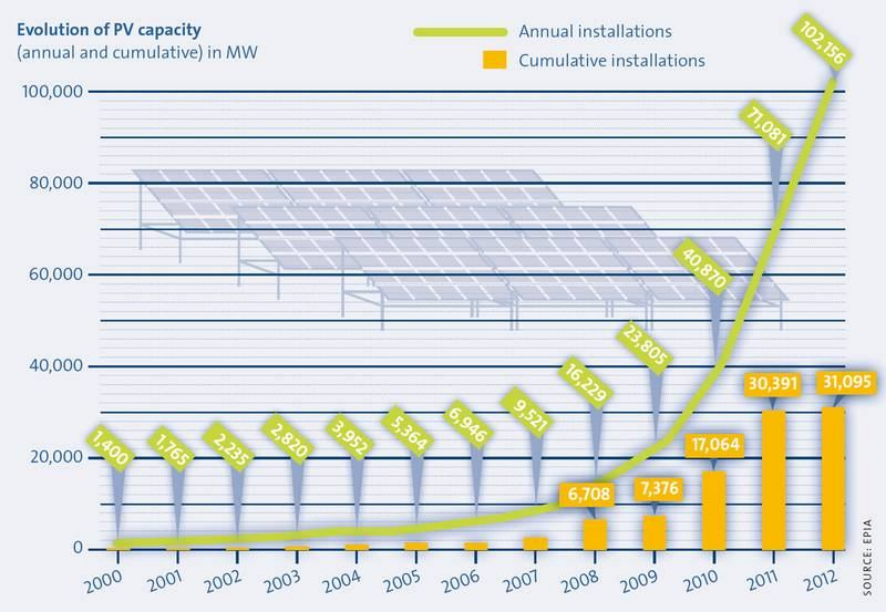


Figure 3: Capacity factor of energy sources

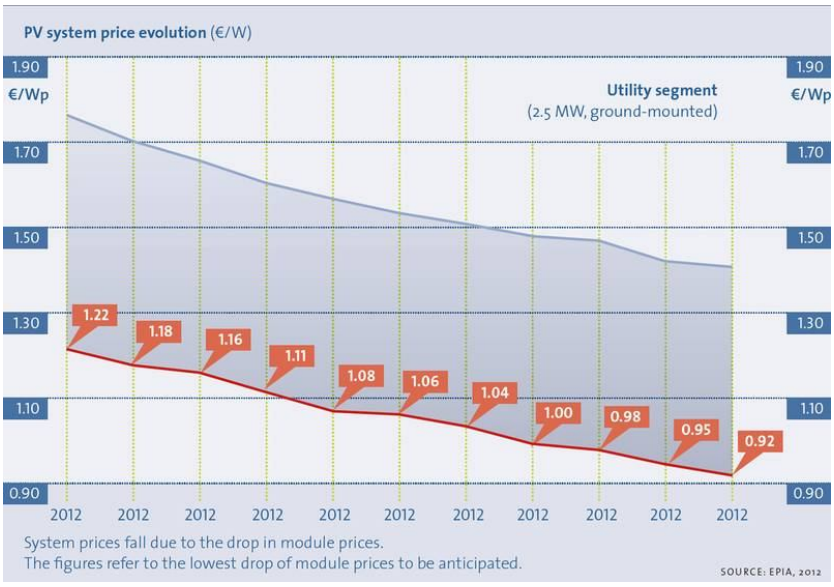


In recent years photovoltaics is gaining an ever larger presence in the energy industry and therefore the PV power plant industry has to gauge itself by the cost price per kWh. This means that also every bit of expenditure on realizing the solar project, the operating costs and financing have to be taken into account and not only the system costs.

Figure 4: Evolution of PV capacity



Graph 5: PV system price evolution in 2012



There is a difference in the cost and quality of PVs: Thin-film plants are at the bottom end of the scale in terms of investment costs, while monocrystalline silicon parks with tracking systems are at the upper end. New module technologies (thin-film silicon, CIs or CIGs) are now also increasingly being classed as creditworthy, particularly if they are used in projects that mix them with proven technologies such as crystalline modules.

In the past investors had unrealistic high expectations regarding the return on investment in PV power plants, especially in Europe. The recent economic downturn in 2008 forced investors to

adopt a more realistic view. Meanwhile the technology has matured and the risk of default is low.

Within the PV power plant industry there is no further production-related bottlenecks that could limit the growth of photovolataics as an industry, and solar parks in particular. Now the critical factors that have to be considered are area and growth. The attractiveness of operating PV power plants led PV module manufacturers to also operate as developers of large solar parks.

Despite its impressive investment volumes and consistent growth, China's solar PV market is currently dwarfed by Europe's significant market control of over 75% of the globe's total capacity in the global solar PV market. However, given the hard times that are now befalling Europe, China is positioning itself to fill a distinct niche in this particular sector as the EU shifts its attention to fixing their domestic financial crisis. The EU domestic financial crisis also means that its demand for PV is decreasing, thus paving the way for China to sustain growth in this industry.

2. Levelized Cost of Energy (LCOE)

In the PV power plant industry the Levelized Cost of Energy is a very importantin accessing the NPV of solar parks. LCOE determines what costs are incurred when generating solar power. LCOE is stated in Euros or in US dollars per kWh. Most importantly it incorporates the investment costs for the plant itself, operating and maintenance costs, and other variable costs for the entire lifetime of the photovoltaic system into the total costs of generating power.

According the a report published by the EPIA the cost of capital expressed as the weighted average cost of capital (WACC) is a key factor in the LCOE because the cost of capital has a greater impact on LCOE than module prices, insolation at the site and plant lifetime.

3. Securities in PV power plant industry

In recent years project financing within the business was too tight. Therefore investors require specific securities, e.g. transfer of ownership of the PV plant; the transfer of rights from project contracts (delivery contracts, operating and maintenance contracts, contracts of use and occupation for the site, insurance contracts), encumbrances, pledges of the operator's account or pledging of shares in the business. Investors also set stricter demands on the use of cash flow, which leads to reduced profit distribution.

4. Chinese government solar energy policies

Many countries have adopted different policies to support the generation and distribution of solar energy. In Europe a statutorilyguaranteed feed-in-tariff is used. China intends to designate large areas for solar power plants with capacities of several GW, though so far has only introduced uniform feed-in tariffs for small-scale installations. There, projects are controlled exclusively by the state and put out to tender through auctions.Recently the domination by large SOEs in the former auction scheme which caused unintentional consequences of underbidding on large scale projects with the intent to capture market share is no longer allowed, thanks to the national Feed in Tariff (FiT), and it has stabilized the Chinese solar sector ever since – creating greater market competition and true dynamism within it. The goal of feed-in-tariffs is to offer cost-based compensation to renewable energy producers, providing price certainty and long-term contracts that help finance renewable energy investments. In December 2013the Chinese government has specified a 0.42 Yuan subsidy for every kilowatt-hour of electricity produced by distributed PV power units.The government has previously subsidized PV units on a project-investment basis. With the new standards in place since December 2013 it will also cover units that were not included in the previous policy. This change in feed-in-tariff policy by the Chinese government occurred because the previous feed-in-policy policy failed to incorporate regional differences. Prior to 2013 the feed-in-policy led to an incentive to install solar parks in the sunshine-wealthy West of China (like Qinghai, Gansu, Ningxia, Xingjiang and Inner Mongolia). However because of lower population in West of China and the resulting lower energy demand, the installations in those areas were faced with issues related to grid connection, transmission and distribution. The new-feed-in-tariff policy for solar PV projects has split the country into three different regions and provided a different feed-in-tariff for each region. The new Feed-in-Tariffs exceeds what was originally proposed in the disclosure draft and is higher than the market expectation.

The applicable Feed-in Tariffs are:

• 0.90 RMB per kWh for Type-I areas, including Ningxia; Haixi of Qinghai Province; Jiayuguan,Wuwei, Zhangye, Jiuquan, Dunhuang, Jinchang of Gansu Province; Hami, Tacheng, Aertai, Kelamayi of Xinjiang Province; Inner Mongolia (other than Chifeng, Tongliao,Xinganmeng,Hulunbeier);
• 0.95 RMB per kWh for Type-II areas, including Beijing; Tianjin; Heilongjiang; Jilin; Liaoning; Sichuan; Yunnan; Chifeng, Tongliao, Xinganmeng, Hulunbeier in Inner Mongolia; Chengde, Zhangjiakou, Tangshan, Qinhuangdao of Hebei Province; Datong, Suzhou, Yizhou of Shanxi Province; Yulin, Yanan of Shannxi Province; places other than the Type-I areas in Qinghai, Gansu and Xinjiang;
• RMB per kWh for Type-III for areas other than the above

The new level of Feed-in-Tariff will be more proportionate because it is determined by the level of solar radiation in each region. The New Feed-in-Tariff Proposals are aimed at ensuring an IRR of more than 8% across all four regions. **For distributed solar PV projects, the New Feed-in-Tariff Policy has proposed an additional 0.42 RMB/kWh Feed-in-Tariff on top of the local electricity tariff to be paid by the grid companies to the project companies.** This additional Feed-in-Tariff will generally be for a 20 year period. However, the amount and period of the additional Feed-in-Tariff will depend on the project and the specific region. Given the different levels of retail electricity tariffs throughout China, a number of provinces will certainly be more attractive from an IRR perspective than others. Chinese renewables projects involve a unique set of risks. Developers and lenders need to understand these risks, and address and adapt their project structures and project documents accordingly.The challenges cannot be underestimated.

5. Weak Infrastructure

The biggest threat for the development of the Chinese PV industry is the insufficient state of power grid. In the province of Qinghai, where roughly half of China's large solar farms are located, around 1 GW of capacity was newly installed in 2012, but only 50 percent of it was connected to the grid in good time. Above all, there are not enough transformers for the 380 kilovolt (kV) transmission lines.

6. Competitors

6.1 Trina Solar

Founded in 1997, and listed on the New York Stock Exchange in 2006, Trina Solar specializes in the manufacture of crystalline silicon photovoltaic modules and system integration. Trina Solar is not only a pioneer of China's PV industry, but has become an influential shaper of the global solar industry and a leader in solar modules, solutions and services.

6.2 Poly Energy Holdings Ltd.

Poly Energy Holdings is a globally leading polysilicon and silicon wafer supplier who provides high-quality and cost-efficient raw materials for solar power generation. Meanwhile, GCL-Poly is a world-class expert in providing solar farm solutions as well as the solar farm developer and operator. GCL-Poly owns a number of solar farms worldwide with extensive experiences in development, construction and operation of solar farms. This means that the company is quite diversified compared to Yunkun New Energy

6.3 Hareon Solar

Hareon Solar is a solar pioneer, and stands as a leader in today's shift to clean, renewable energy for our planet. The company isone of the fastest growing and largest PV companies in the world with production facilities and services around the globe the company manufactures over 1.6 GW of cells and 1.1 GW of modules annually, and has invested in over 700 MW of PV power-plant projects.

6.4 SuntechPower China

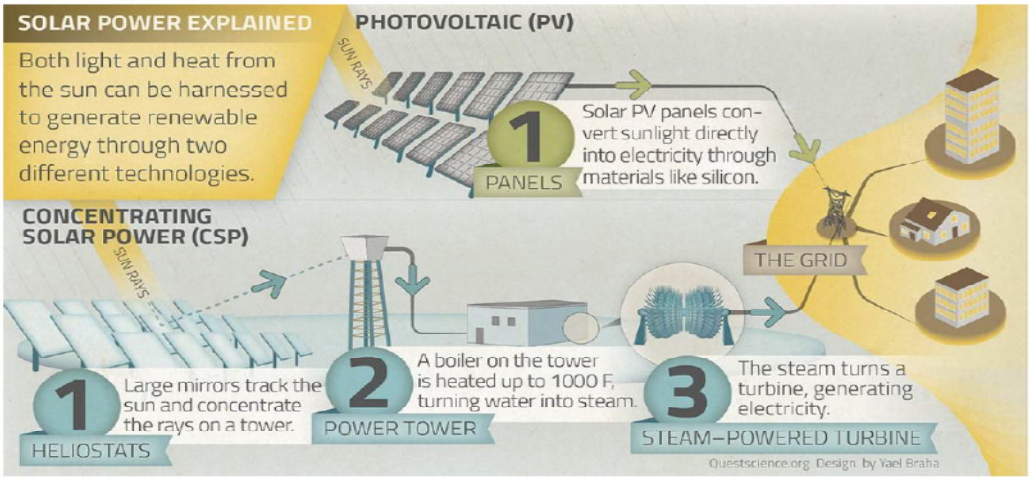
Suntechwas founded in 2001 and is the world's largest producer of solar panels. It develops, manufactures, and delivers the world's most reliable and cost-effective solar energy solutions. The company has supplied more than 8 GWs photovoltaic panels to more than a thousand customers in more than 80 countries.

7. Case study about Hunaghe Hydropower Golmud Solar Park

7.1 General overview

The Goldmud Solar Park in the West of China has a capacity of 200 MWp. The construction time of this project lasted from August 2009 until October 2011. The 200 MW photovoltaic station generates an output of 317.2 GWh and the totals costs were 530 million US dollars. Graph 1 illustrates how solar power is produced by photovolataic and concentrating Solar Power (CSP).

Graph 1: Photovoltaic (PV) and Concentrating Solar Power (CSP) technology



The main advantage of photovoltaic is that it directly converts sunlight into electricity whereas the process of concentrating solar power takes much longer to finally generate electricity via a turbine.

7.2 Benefits of the project

The main benefits of the project are that it is easy to install, that there is a long-term duration of use, that solar energy is a green power technology with minimal pollution and negligible noise. The maintenance costs of the project are quite low ($850,000 per year).

7.3 Problems with the project

There were a couple of problems which had to be dealt with. The first issue was related to system design flaws. Because of the location of the plant in the desert there were geological problems, e.g. corrosion and high elevation. Because the insulation did not comply with the requirements, cables exploded and there was no stable control device, which led to a zero capacity of generated energy in the first two months since the design department did not have experience in implementing PV in this geological environment. The solution to the problem encountered was to build anti-corrosion systems and to cooperate with the supervision department. Other problems in the project management were related to rush deadline. There was a poor quality management and supervision, e.g. inverters; and also construction issues. The solution was to maintain and view all the time and to build an operation standard for construction management. However regarding the solution to construction management there are barriers set because of strict construction policies. Environmental problems needed also to be addressedbecause of the destruction of vegetation, mainly soil and water loss on the area of the solar power plant. The cause of this problem was by concrete structures. The installation of PV required excavation and filling, which caused damage to vegetation and soil erosion. In order to deal with this problem spiral pile were used. Spiral piles have the advantage of being easily removed, recyclable and therefore it protects the ecological environment.

7.4 Summary of case study

The planning, construction and design is very important to succeed in the PV power plant industry. The case study of Hunaghe Hydropower Golmud Solar Park highlights that the earth's surface and environmental issues play a very important role since as a result of these problems arising there was a zero capacity in the first two month.

8. Chinese nuclear power energy

In China the nuclear power energy still remains an important source for generating electricity. Mainland China has 20 nuclear power reactors in operation, 28 under construction, and more about to start construction.Additional reactors are planned, including some of the world's most advanced, to give more than a three-fold increase in nuclear capacity to at least 58 GWe by 2020, then some 150 GWeby 2030, and much more by 2050. The impetus for increasing nuclear power share in China is increasingly due to air pollution from coal-fired plants like in the case of

photovoltaic industry. At the time of the Fukushima disaster in March 2011 the Chinese government had plans to build up to 100 reactors over the following two decades. The accident brought a 20-month moratorium on approvals of new plants, and safety checks on existing sites. But reactors were not shut down, and construction was not suspended.In November last year the moratorium was lifted, and further reactors received the go-ahead. According to the International Atomic Energy Agency, China now has 18 operating nuclear power reactors on seven sites and a further 28 under construction.Practice is showing that along with the inestimable virtue of being safe, renewables have a long list of other advantages. Unlike nuclear power, which in China needs imports of uranium fuel, renewables tap into huge local resources of unused energy. The technologies used in renewables are far simpler than for nuclear; as well as tending to reduce malfunctions, this means that the skills needed for construction and maintenance are less exotic and more widely available.Build times for renewables are a fraction of those for nuclear, and the wind farms can start delivering power long before construction is complete. With wind and solar photovoltaic, there is no need to expend water supplies on cooling — an important consideration in much of inland China.

9. Analysis of projects

Yunnan province enjoys an average 2,200 sunshine-hours per year, or over six hours per day, whereas Tianjin municipality receives 2,522 hours of bright sunshine.Following the expansive growth of solar power in China, the Chinese government is now targeting its total installed capacity to reach 21 GW by 2015 and 50 GW by 2020. This revised target demonstrates the Chinese government's determination towards achieving their overall renewable energy targets and signals a firm belief this industry remains poised for growth, as well as being a suitable and sustainable platform for investment.**Furthermore for the Dali 2 MW project the company received financial subsidies from the central government. The project is less risky because it is a Building-Integrated Photovoltaics (BIPV) compared to the Tianjin-Ninghe 20 MW project, which is agricultural-photovoltaics project and therefore has environmental risks inherent. The** Tianjin-Ninghe 20 MW project has a feet-in-tariff of only 0.41 RMB per kWh. The Dongchuan 20 MW and the Malong 110 MW project are more risky and have a feet-in-tariff of 0.95 RMB per kWh as a result of the new feed-in-tariff policy. The operational and constructional risks are low since Yunkunhas expertise in installing and operating PV solar parks. The Dali MW project is not very attractive to invest in because of the low feet-in-tariff, especially since the 1st year revenue in percent of the total cost of the project is only 4.69%, which is the lowest value for all projects. The Tianjin-Ninghe 20 MW project has the highest percentage of first year revenue divided by total project cost of 17 percent, followed by the Dongchuan 20 MW project and the Malong 110 MW.

Large scale solar projects have come under criticism. There are no economies of scale in large PV solar plants since land cost and other soft costs make big plants more expensive. The biggest problem with the multi-MW solar PV plant is that it loses 12-15 percent of expensive power as it passes through a series of power transformers. PV solar inverters generate power at 400V three-phase. In large plants, this power is first boosted to 66kV or more with several power transformers and then stepped down to 400V with another string of transformers to suit consumer requirements. In addition, there is a further transmission loss of 5-7 percent in the power grid. Why suffer an avoidable 20 percent loss of expensive solar power? In sharp contrast, smaller solar plants with close proximity to their users incur no energy loss during transmission. This means that the Dali 2 MW is the most favorable project when it comes to energy loss during transmission and has the lowest operational risk since it is built on a roof. According to figure 6, solar energy also has the highest cost of capital of all renewable energy sources but still a lower cost of capital than nuclear energy.

According to the internal return of investment (IRR) the Dongchuan 20 MW is the most lucrative investment with an IRR of 11.89%, followed by Tinanjin-Ninghe 20 MW project with an IRR of 11.41%. TheDongchuan 20 MW is also the preferred project to invest to when it comes to payback period in years (7.3 years) and a feet-in-tariff of of 0.95 Yuan per kWh. Table 1 summarizes the most important features of the four projects.

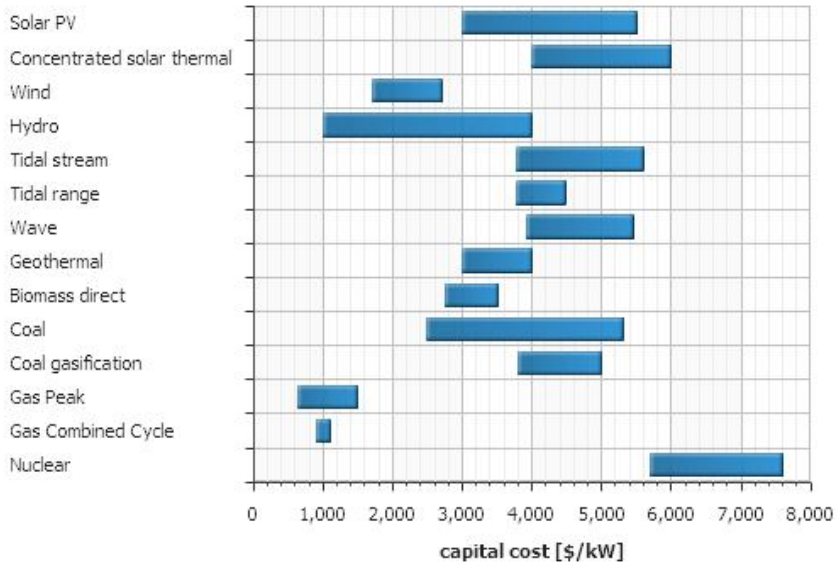
10. Summary of photovoltaic industry

The Chinese photovoltaic industry faces the potential of high growth rates if the industry manages to overcome a few obstacles that lie on its way. For example the industry has a huge capital demand in order to finance the projects. So far investors are reluctant to lend money to fund solar park projects even though the technology has become more mature and unrealistic assumptions regarding returns on solar projects should be a thing of the past. Solar energy unfortunately is not the most efficient source of energy since a part of the energy is lost during the transport from the solar power plant to the grid. The driving forces of the industry are the low costs for solar cells, the subsidies from the Chinese government, the introduction of feet-in-tariffs. It therefore is a very interesting industry to invest to.

Table 1: Individual projects and characteristics

Projects	Malong 110 MW	Tianjin-Ninghe 20 MW	Dongchuan 20 MW	Dali 2 MW
1st year Power Generation	158,518,000	28,858,100	30,198,400	2,622,400
annual generation estimation	143,000,000	26,033,000	27,242,000	2,365,700
1st year Electricity Revenue	128,717,000	28,258,100	24,250,000	787,000
Total project cost	1,005,069,500	163,910,000	163,820,600	16,796,600
1st year revenue as % of total p	12.81%	17.24%	14.80%	4.69%
IRR	11.46%	11.41%	11.89%	8.70%
Payback Period in years	7.4	7.6	7.3	9.6
Feet-in-tariffs	0.95	0.41	0.95	0.3513
Typ of solar project	LSPV	LSPV	LSPV	BIPV
Energy loss during transmission	high	high	high	low

Figure 6: Capital costs of energy sources



References:

- CPI Report (2011), Survey on Photovoltaic Industry and Policy in Germany and China.

http://climatepolicyinitiative.org/wp-content/uploads/2011/12/PV-Industry-Germany-and-China.pdf

- Wiley Rein LLP (2010), 12th Five-year for the Solar Photovoltaic Industry.

http://www.americansolarmanufacturing.org/news-releases/chinas-five-year-plan-for-solar-translation.pdf

-http://www.pv-power-plants.com/industry/national-markets/

-http://www.pv-power-plants.com

-ChinaDaily Europe (2014), China's PV plants hungry for financing

http://europe.chinadaily.com.cn/business/2014-03/17/content_17352404.htm

- China's Largest Solar Power Farm Approved — To Be Built By GCL-Poly Energy, World's Largest PV Polysilicon Producer

http://cleantechnica.com/2012/08/28/china-largest-solar-power-plant

http://www.kysq.org/teach/ECN482/Jessie.pdf

http://www.ecology.com/2013/03/15/solar-power-in-china/

http://www.greenrhinoenergy.com/renewable/context/economics.php

State subsidy per kW: 0.40 to 1 RMB

For private persons: 1 RMB per kW