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LOST IN TRANSMISSION

Distributed Solar Generation in China

by Xiupei Liang

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Big changes can come from small actions. In December 2012, with little fanfare, Pengfei Xu, a solar power engineer in Qingdao, was the first individual in China to install solar photovoltaic (PV) panels on the roof of his house that were connected to the national grid.[1] Each day, these rooftop PV panels generate between two to eight kilowatt hours (kWh) to cover the Xu family's basic electricity needs, and Mr. Xu even earned a modest 400 RMB ($67) in the first few months by selling excess electricity to the grid.[2]

Generation of a small amount of electricity for a small sum reflects an exciting new twist to China's energy development. In recent decades, China has focused on large-scale energy deployment, for both fossil fuel and renewable energy generation: from large-scale (e.g., concentrated) coal-fired power plants that have dominated the Chinese power sector to vast wind and solar farms. The emergence of small distributed solar

PV generation including Mr. Xu's rooftop panels offers China a new approach to deepen clean energy penetration, and invites policymakers and industry leaders to rethink future pathways in the electricity sector.

In early 2014, the Chinese government laid out an ambitious goal for distributed solar generation—aiming for 14 GW of additional solar capacity over the course of the year, 60 percent of which is to be derived from distributed solar generation capacity rather than utility-scale projects.[3] However, this aggressive goal is facing numerous economic and political difficulties, which resulted in the disappointing fact that in the first half of 2014, half of the 13 provinces in a survey received zero application for distributed solar installation.

This brief explores how and why the big investment and policy push for distributed solar PV has received political, institutional, and investor pushback in China. It also reviews the United States' engagement in China's distributed solar PV sector. While the big potential of these solar PV installations is stalled, there are signs that distributed generation could emerge a strong component of the power mix in the long-run, promoting cleaner air, and prompting much-needed reforms in pricing and technology to overcome grid integration obstacles.

THINKING BIG ABOUT SMALL: CHINA'S TURN TO DISTRIBUTED SOLAR GENERATION

Producing electricity from many small-scale installations near the point-of-use, rather than a handful of massive energy bases located far away from the end users is a new trend in China.[4] According to *Interim Measures for the Management of Distributed Power Generation* issued by the National Development and Reform Commission, distributed generation in China refers to the generation facilities or Combined Heat and Power systems which are installed near users, and utilized with the principle of "generating for self-consumption, connecting surplus to the grid, adjustment by the grid." Comparing to the American distributed generation which is usually between 10 and 50 kW, the Chinese sense of "small" is at MW level—small hydro power and coal bed methane power generation less than 50 MW, and distributed renewables generation less than 6 MW are all qualified as distributed generation.[5] In this respect, distributed generation does not require any long-distance high-voltage line to bring electricity to users. Moreover, users can lower electricity costs if the proper policies are in place, by selling extra electricity generated back to the grid.

Dissemination of distributed generation could have significant economic and social implications for China. Li Hejun, member of the National Committee of the Chinese People's Political Consultative Conference, estimates that new distributed power generation infrastructure creates a direct market of approximately $160 billion and an indirect market of $480 billion.[6] Furthermore, according to a study from National Renewable Energy Laboratory (NREL), distributed generation improves the resilience of grids and alleviates damages from blackouts which might be caused by disaster events or ultra-high voltage transmission failures.[7] In addition, distributed generation is a cost effective strategy that may bring electricity to the remaining 1.19 million Chinese who lack access to electricity, because it does not require any grid infrastructure construction.[8]

With respect to the environment, distributed generation is an effective way to enhance the penetration of clean energy such as solar, wind, and natural gas in energy hungry China. In other words, distributed generation could help the Chinese government to further diversify the coal-dominated power sector—a step that would help to address the country's serious air pollution and related health problems. Supporting the spread of distributed generation helps the Chinese leadership fulfill domestic and current international climate change commitments, by reaching its goal of providing 15 percent of primary energy consumption from non-fossil fuel sources by 2020.[9]

In light of all these benefits, China's leadership is starting to think big about the small. Over the past three years, the idea of nationwide distributed generation implementation has been given increasingly more attention. The State Council first incorporated distributed generation into the October 2012 White Paper on Chinese Energy Policy 2012 as a means to promote clean energy.[10] Just several months later, the National Development and Reform Commission (NDRC) adopted distributed generation

in the 12th Five-Year Plan on Energy Development in January 2013 as one of the priorities for fostering the reform of the China's energy supply. By 2015, China expects to build 1,000 natural gas distributed power projects, and to reach a total installed capacity of 10 GW from distributed solar power. [11]

Undoubtedly, distributed solar generation is a point of emphasis for the Chinese government in this unfolding ambitious plan, not only because China set an aggressive annual installation goal of 8.4 GW for 2014, but also because China continuously increases its goals for the near future. In October 2013 the National Energy Administration (NEA) further raised the 2015 goal of distributed solar generation from 10 GW to 20 GW—doubling the goal issued in the FYP just nine months ago. In March 2014, NDRC again set up a mid-term goal for distributed solar generation—a total installation of 35 GW by 2017—in Plan on Energy Sector Bolstering Prevention and Control of Air Pollution, which makes solar the most significant power for distributed generation among other energy sources.[12]

DISTRIBUTED SOLAR GENERATION: LOST IN TRANSMISSION...?

Corresponding with its ambitious goals, the Chinese government is busy with creating a favorable policy environment to spur the growth of distributed solar generation. Since mid-2012, seven different ministries and agencies issued at least 20 policies which focus on distributed solar generation including mid-term development strategy, subsidy programs, grid interconnection service, financial funds, and pilot demonstration projects. (See Appendix)

These aggressive policies have not, however, necessarily led to a boom in distributed solar generation. Although the year 2013 was hoped to be "the starting year" of Chinese distributed solar power, the newly installed capacity only reached 800 MW by the end of the year.[13] Furthermore, this number is overinflated because it includes the installed capacity from the notorious "Golden Sun Project," which was China's first solar power subsidy program started in 2009 and finished in 2013. This project provides up-front subsidies which are attractive to solar companies, but led to numerous solar companies to siphon off subsidies by setting up a great number of poorly constructed and mismanaged solar projects. [14] *China Energy News* reported that only 600 MW of distributed solar generation installed was actually stimulated by the supporting policies by 2013.[15]

Worse yet, state-run distributed solar projects in China also struggle to thrive, despite a favorable policy environment. A recent NEA investigation reveals that almost none of the first eighteen national distributed solar demonstration projects were successfully launched even six months after approval.[16]

To put this in perspective, in the first half of 2014, approximately 3300 MW new solar capacity additions have connected to the grid in China of which 2300 MW is utility-scale installation, while only 1000 MW comes from distributed solar power.[17] Also, the China Renewable Energy Engineering Institute showed the data of the application of distributed solar generation in 13 provinces by the first quarter of 2014, which found that half of these provinces had zero application; the other half only received about 199 MW installation application in total.[18] (See Table 1)

Hence, it is not surprising that experts and entrepreneurs in Chinese solar industry show serious doubts over the NEA's goal for 2014 to install 8.4 GW distributed solar generation—almost triple the 2013 installation. Wang Jin, Director of Energy Research Institute at International Cooperation Center of National Development and Reform Commission, estimates that only 6 GW of new capacity can be installed by the end of 2014.[19] In this light, the cumulative 20 GW goal of distributed solar by 2015 appears increasingly unattainable.

"Doing small is actually hard for any country," says Mackay Miller, Technology Innovation Analyst at NREL when discussing the development of distributed solar generation in China, "Policy, technology, regulation, and finance need to be working smoothly together." [20] It is because of these interlocking needs that, despite the tremendous policy support, distributed solar generation in China seems "lost in transmission."

Table 1. Q1 2014 Completion Rate of Distributed Solar Generation in China

Province	2014 planned amount of distributed solar power application for permits (MW)	The amount of application by Q1 2014 (MW)	Completion Rate
Beijing	200	0.0	0.00%
Jilin	100	0.0	0.00%
Guangxi	100	0.0	0.00%
Chongqing	10	0.0	0.00%
Guizhou	30	0.0	0.00%
Henan	550	0.0	0.00%
Yunan	10	0.0	0.00%
Shangdong	1000	4.2	0.42%
Hunan	200	5.0	2.50%
Fujian	300	10.0	3.33%
Zhejiang	1000	44.8	4.48%
Heilongjiang	50	5.0	10.00%
Guangdong	900	130.0	14.44%

Source: China Renewable Energy Engineering Institute

MIND THE GAPS: OBSTACLES FOR DISTRIBUTED SOLAR GENERATION

"The biggest problem for distributed solar generation in China now is that there is no feasible business model," says Wenqian Tang, executive vice secretary-general of Chinese Renewable Energy Industries Association (CREIA).[21] What is primarily hampering the growth of the distributed solar PV business model are three key factors: low rates of return, high project risks, and financial plights.

1. *Low Rate of Return*

Distributed solar generation, similar to many other innovative technologies in China at the demonstration stage, is struggling with a low rate of return. A recent report from CREIA indicates that it could take up to 17 years for rooftop solar installations in the residential sector to recoup all the investment put forth in design and construction, since the rate of return in China is a meager 6.11 percent; this is based on a series of assumptions made by CREIA and the official principal "generating for self-consumption, connecting surplus to the grid, adjustment by the grid".[22] For industrial and commercial sectors, it takes seven to nine years to recover the investment because of its slightly higher rate of return (eight percent).[23] By comparison, China's coal, gas, nuclear, and wind generators achieved rates of return higher than 10 percent in 2013.[24]

Even in the renewable sphere, distributed solar PV does not have a comparative advantage because it does not enjoy the same feed-in tariffs (see Box 1) as utility-scale solar farms do. The feed-in tariffs for ground solar stations are approximately 1 RMB ($0.16) per kWh of energy generated, while distributed generation payments could be nearly 40 percent lower. This low rate of support is a particularly large hurdle for small-scale operators who make up the bulk of these bottom-up energy installations.[25]

2. *High Project Risk*

The central government currently targets developed cities along China's eastern coast for distributed solar generation expansion.[26] The uncertainty around recouping investment in the roof resources, however, increases the perceived risk of these projects. In the industrial sector, the gap between the lifespan of rooftop PV panels is 25 years, while the enterprises under the roof rarely remain with the same owner for that long period of time.[27] Hence, solar companies worry that new building owners will not continue to contract with them, which, absent contractual reforms, would terminate the projects.

The prospect for rooftop solar in the residential sector is also risky in that most apartments house hundreds,

Box 1. China's Solar Feed-in tariff Policy

Feed-in tariffs (FIT) typically guarantee that customers who own a FIT-eligible renewable electricity generation facility receive a set price from their utility for all of the electricity they generate and provide to the grid.

In 2013, China issued *The Notice of the National Development and Reform Commission on Improving the Development of Solar PV Industry by Utilizing the Price Leverage Effect*, a FIT scheme for encouraging solar power adoption. The policy divides China into three categories based on different regional sunshine strength, and respectively offers 0.9 RMB/kWh, 0.95 RMB/kWh and 1 RMB/kWh.

However, this FIT scheme only applies to utility-scale solar projects. Under the current electricity rate dynamic, distributed solar generation can only enjoy the local rate of desulphurization coal-fired plants—which differentiates by regions, and the rate is usually between 0.4 to 0.5 RMB/kWh along coastal provinces.

if not thousands, of residents. Thus, the property rights of the apartment roofs are unclear because all the residents share the building.[28] Therefore, for solar companies or individuals who attempt to install their PV panels, they have to obtain the consensus of all the residents under the target roofs. The situation could be alleviated with clear laws on collective rooftop leasing, but such rules are not yet a high priority on the policy agenda.

Another major challenge is how to ensure the collection of electricity fees. Currently, solar companies are not only responsible for PV panel construction, but also for collecting electricity bills from scattered customers. With no regulations concerning the issue, the small- and medium-sized solar businesses will not be sustainable if many of their clients dodge fees. Thus, these businesses, unlike state-owned utilities, possess limited capital and no political authority.

3. *Reluctant Capital*

The third obstacle is one that centers on financial circumstances. Due to a low rate of return and high project risks, commercial banks are reluctant to throw their money into the uncertain prospect of distributed solar power. Chinese banks do not accept distributed solar stations as collateral.[29] Nonetheless, Chinese small- and medium-sized solar businesses still attempt to tap commercial loans as their primary financial approach, as well as using their own capital.[30] Strikingly, even China's national distributed solar demonstration pilots are facing difficulties in obtaining funds from the China Development Bank for the same reasons.[31]

According to analysts at the Chinese magazine *Energy*, for China to reach the 2014 goal of an 8 GW increase in distributed solar generation, approximately $150 to $180 billion will be needed, assuming the average cost of $1,450 to $1,610 per kW.[32] The Chinese banking system cannot fulfill this sizable financial demand.

POLICY COORDINATION CHALLENGES

Apart from the three factors hindering the development of a viable business model, the problem of policy implementation also impacts the extent to which distributed solar generation expands in China. The central government issued numerous favorable plans and policies, but not all of them are effective due to the lack of policy coordination at the provincial level.

In 2012 for example, early adopters of rooftop distributed solar generation in Beijing had complications receiving subsidy payments for more than six months after connecting to the grid.[33] Delays occurred due to conflicts between different local governmental agencies—the Beijing grid company required commercial invoices in order to transfer the subsidies to individuals with rooftop solar installations, while the Beijing taxation authority did not issue any commercial invoice to individuals.[34] This gridlock in payments appears to have discouraged individuals from installing PV panels.

In addition, the NEA decided that all the distributed generation projects in China should report to the local energy authorities in order to obtain permits. These local authorities determine the permitting procedures, which currently are very cumbersome and opaque to the public. Nonetheless, a few big cities such as Beijing, Shanghai and Shenzhen have streamlined the permitting process of distributed generation projects in a way that navigates around the numerous local permitting and report obligations.[35] These local obstacles are yet another challenge to the commercial scale-up of the distributed solar industry.

The lack of grid interconnection standards is also another well-recognized bottleneck for distributed solar generation. Although China established a commission in charge of grid interconnection standards for solar power, the commission pays more emphasis on utility-scale solar power rather than to the emerging distributed solar generation in China. So far, only four grid interconnection standards have been approved and ten other critical technologies are still at the drafting stage. The lagging standardization of grid interconnection for distributed solar not only slows down installation pace, but also reinforces the financial dilemma for solar companies since banks cannot exam and judge the quality of numerous rooftop PV plants without technical standards.

U.S. ENGAGEMENT IN CHINESE DISTRIBUTED SOLAR GENERATION

The United States is one of the pioneer countries in distributed solar generation, along with Germany, Italy and Spain. In 2013, 792 MW of solar power was installed in the U.S. residential market, reflecting a 60% annual growth.[36] Furthermore, in the first quarter of 2014, residential PV installations for the first time exceeded commercial installations nationally since 2002.[37]

One of the driving forces behind the positive growth is business model innovations. For example, a model called third-party ownership—in which a solar leasing company is responsible for financing, permitting, designing, installing, and maintaining the PV system for residences—is dominant in states leading in renewables.[38] In California and Arizona, this model respectively accounted for 67% and 86% of the residential PV installations in the first quarter of 2013.[39] The maturity of the U.S. solar industry and private-public cooperation highlights productive partnership models that could be adopted in the Chinese distributed solar market.

Only a handful of U.S. businesses have entered the Chinese distributed solar generation market, and the potential for U.S.-China joint development in the solar industry has not yet been realized. There are, however, encouraging signs that further cooperation may occur. The U.S. and Chinese governments have created multiple renewable energy collaborations, and distributed solar generation is included in the agenda of these alliances, such as U.S.-China Renewable Energy Partnership and the associated US-China Renewable Energy Industry Forum.[40] In addition, specific U.S. engagement with China on distributed power focuses on undertaking joint technological research projects and providing policy advice. For example, the U.S. National Renewable Energy Laboratory currently manages 11 major joint projects with various Chinese research institutes, universities, and industrial associations. Various projects under this cooperation focus specifically on technical issues of distributed solar generation, such as a partnership to inform Chinese design codes for distributed solar generation access and micro-grids.[41] Furthermore, planned collaborations in 2015 include a particular focus on new business models for distributed solar, with a focus on highlighting the innovation in this sector in the United States.

SHINING A LIGHT ON NEW TRENDS FOR DISTRIBUTED SOLAR PV

According to William Chandler, Director for the Energy Transition Research Institute (Entri), "The Chinese government has been instrumental in pushing the country to embrace renewable energy, but current government policies are not yet sufficient to fully push the energy transition to distributed solar power."[42] *China's Future Generation: Assessing the Maximum Potential for Renewable Power Sources in China to 2050*, Entri's recent report for WWF, forecasts that China could reach 80 percent renewable electricity by 2050 at a far less cost than continuing to rely on coal if the government can implement proper policy packages.[43]

Fortunately, realizing all the woes that distributed

solar PV faces, the Chinese government is attempting to take effective action to rejuvenate the sector. In late June 2014, the NEA circulated a draft plan, *The Notice on Further Implement the Related Policies of Distributed Solar Generation*, among governmental agencies, major solar enterprises, grid companies and China Development Bank to ask for their suggestion. This draft attempts to shift away from the current market dilemma and form a set of clear principles to bolster distributed solar generation; and this draft involves 11 critical aspects, including project planning, non-residential market support, coordination in roof resources , electricity rate and subsidy adjustment, permits application, and so on.[44]

In addition, some initiatives such as the establishment of new financing institutions, an increased electricity purchase rate, and the deregulation of individual electricity generation, are all currently in progress. On April 21, 2014, under the lead of the NDRC, the Guolin Fund was established as a pilot financial platform to support distributed solar generation projects which started from promising national demonstration pilots. Unlike commercial loans, this fund makes equity investment, which tends to enhance the rate of return for investors, as well as assist developers with up-front fund raising.

The NEA is also attempting to carry out a policy to deregulate the electricity market for small distributed solar generation projects such as rooftop PV projects. [45] Under this policy, renewable energy-based generation whose capacity is no more than 6 MW could be exempt from applying for a power generation license.[46] Furthermore, China's State Administration of Taxation also participates in deregulating individual solar power generation. From July 1, 2014, the grid companies are entitled to issue commercial invoice to individual rooftop PV owners on behalf of taxation authorities, which may solve the dilemma of the case mentioned above.[47] These policies should help resolve the deadlock that individuals face when trying to obtain subsidies or even payments for generating electricity for the grid. This may increase the prospect of solar electricity generation to individuals and private firms, rather than just traditional power generation enterprises.

Furthermore, NEA officials are thinking about offering the same feed-in tariffs that large-scale solar stations enjoy to distributed solar projects, which would increase the income by selling extra electricity to the grid.[48] Such a step would make distributed solar generation more economically competitive.

These policy steps definitely benefit distributed solar growth, but more needs to be done besides addressing subsidies and profit considerations. Further government support is needed to help distributed solar generation fulfill its potential. Specifically, steps are needed to decrease project risk and ensure that the substantial implementation of all favorable policies is given equal attention.

The emergence of distributed power generation faces steep obstacles in China's electricity sector such as the business-as-usual mindset of finance, poor project management, and tricky political dynamics in China's energy sector.[49] The Chinese government appears to be committed to supporting distributed solar generation, but needs to take more than small actions to make the big shift to small-scale, bottom-up distributed solar industry. More comprehensive and coordinated policies will be key to help this sector shine.

"There are difficulties developing distributed solar generation in China at the current stage. However, where there is a will, there is a way," said Wu Xinxiong, the head of the NEA, after his visit to a distributed solar demonstration project in Jiaxing on August 4, 2014.[50] He pointed out that it is critical that the Chinese government take active measurement and responsibility, enterprises should be innovative about their development, financial institutes and grid companies should collaborate closely with other parties, and relevant policies should be coordinated with each other and fully implemented at the local level.

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Appendix. 2012 - 2014 Major Policies on Distributed Solar Generation in China

Date		Policy	Department/Agency
2012	July	The 12th Five Year Plan on Solar Power Development [太阳能发电发展"十二五"规划]	National Energy Administration
	October	Opinion of Good Implementation of Grid Interconnection Service for Distributed Generation (Temporary) [关于做好分布式光伏发电并网服务工作的意见（暂行）]	State Grid Corporation of China
	November	The Notice of the Organization of the Applications for Golden Sun and BIPV Demonstration Projects [关于组织申报金太阳和光电建筑应用示范项目的通知]	Ministry of Finance/Ministry of Science and Technology/Ministry of Housing and Urban-Rural Development/National Energy Administration
2013	March	Opinion of Good Implementation of Grid Interconnection Service for Distributed Generation [关于做好分布式电源并网服务工作的意见]	State Grid Corporation of China
	July	Relevant Opinion of the State Council in Improving the Healthy Development of Solar PV Industry [国务院关于促进光伏产业健康发展的若干意见]	State Council
		Interim Measures for the Management of Distributed Power Generation [分布式发电管理暂行办法]	National Development and Reform Commission
		The Notice of the Ministry of Finance regarding the Subsidies to the Distributed Solar PV Power Generation according to the Quantity of Power [关于分布式光伏发电按照电量补贴政策等有关问题的通知]	Ministry of Finance of the People's Republic of China
	August	The Notice of the National Energy Administration on Carrying out the Establishment of Demonstration Area of Distributed Solar PV Power Generation [国家能源局关于开展分布式光伏发电应用示范区建设的通知]	National Energy Administration
		The Notice of the National Energy Administration and China Development Bank on Supporting the Financial Services to the Distributed Solar PV Power Generation [关于支持分布式光伏金融服务的意见]	National Energy Administration/China Development Bank
		The Notice of the National Development and Reform Commission on Improving the Development of Solar PV Industry by Utilizing the Price Leverage Effect [关于发挥价格杠杆作用促进光伏产业健康发展的通知]	National Development and Reform Commission
		The National Energy Administration's Temporary Administration Rules of Solar PV Power Generation Plants [光伏电站项目管理暂行办法]	National Energy Administration
	September	The Notice of the National Energy Administration on Application of Large-scale Usage Demonstration Area of Distributed Solar PV Power Generation [关于申报分布式光伏发电规模化应用示范区的通知]	National Energy Administration
		The Notice of the Ministry of Finance on the VAT Policies on Solar PV Power Generation [财政部关于光伏发电增值税政策的通知]	Ministry of Finance

	November	Interim Measures for the Management of Photovoltaic Manufacturing Industry Norms Notice [光伏制造行业规范公告管理暂行办法]	Ministry of Industry and Information Technology
2014	January	The Notice of Annual Additional Construction Scale of Photovoltaic Power Generation of 2014 [关于下达2014年光伏发电年度新增建设规模的通知]	National Energy Administration
	March	Plan on Energy Sector Bolstering Prevention and Control of Air Pollution [能源行业加强大气污染防治工作方案]	National Development and Reform Commission
	April	The Notice on Clarifying Relevant Issues of Electricity Business License Management [关于明确电力业务许可管理 有关事项的通知]	National Energy Administration
	May	The Notice on Improving Data Collecting and Reporting of Photovoltaic Projects [关于加强光伏发电项目信息统计及报送工作的通知]	National Energy Administration
		Opinion of Good Implementation of Grid Interconnection Service for Distributed Generation (Revised) [关于做好分布式电源并网服务工作的意见(修订版)]	State Grid Corporation of China
	June	The Notice on Relevant Issues of State Grid Issuing Invoices for Distributed Power Purchase [关于国家电网购买分布式光伏发电项目电力产品发票开具等有关问题的公告]	State Administration of Taxation

Xiupei Liang is a recent graduate from the School of Advanced International Studies, The Johns Hopkins University, where he concentrated in international economics, energy and environment. He is currently a research assistant at the Woodrow Wilson Center's China Environment Forum. He can be reached at: liangxiupei@gmail.com.

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