POLICY BRIEF SERIES

Distributed Solar Power Generation in China

TianjianGao*

January 28, 2015

INTRODUCTION

In the past three years, distributed electricity generation (DG) by solar photovoltaics (PV) has leapfrogged in China, dwarfing even the growth of the Chinese solar industry itself. The year 2012 saw China's first household DG system installed in Beijing. [1]Two years later, as of the third quarter of 2014, DG capacity had expanded to 3.1 GW, effectively representing 16% of China's total solar capacity.[2] What may have given rise to the rapid growth of DG, and what challenges lie ahead? The following sections will first discuss the benefits of DG, and the market and policy drivers behind DG's recent growth in China. Then, a main bottleneck of DG, energy storage, will be discussed.

DISTRIBUTED VERSUS UTILITY-SCALE

Aside from its vast environmental benefits, distributed solar power generation strengthens the reliability of the electric grid by sharing its load. Therefore, DG possesses apparent utility to the Chinese policymakers, because grid reliability is vital to socioeconomic productivity. To illustrate, consider the summer months in China when the surge in air cooling activities across the economic sectors triggers the annual peak grid load. Solar DG could substantially alleviate the peak pressure on the grid. The reason is that, during the summer, the daily peak in air cooling use in most Chinese cities coincide roughly with the peak in solar radiation, and thus in DG electricity output, which then could be applied to the air cooling needs that would have had to depend on the grid. By being capable of peak shaving and load diversion, DG reduces the risk of regional blackouts induced by grid overload, and prevents the consequent economic impacts.

Another factor that has contributed to the recent thriving of DG in China is the National Development and Reform Commission (NDRC)'s 2012-2013 relocation of its policy priority from utility-scale PV to DG[3,4]motivated by several key problems found in the utility-scale industry discussed below.

To start with, the great excess in the generation capacity of utility-scale solar PV since the early

[1] Zhang, Y., Li, Z., & Zhang, M. (2013, January 25). 北京首个个人光伏发电站正式并网. Retrieved January 23,2015, from http://news.xinhuanet.com/fortune/2013-01/25/c_124281653.htm

[2] The Central People's Government of the People's Republic of China. (2014, November 20). 2014 年前三季度全国光伏发电量比去年全年翻番. Retrieved from http://www.gov.cn/xinwen/2014-11/20/content_2781423.htm

[3]NDRC implemented two main measures to reorient the policy priority to rein in the expansion of the utility-scale industry. First, the lump-sum subsidy on utility-scale projects was replaced by a per-KWh subsidy in 2012. Second, the per-KWh subsidy has been downsized from RMB1.15/KWh to as low as RMB 0.90/KWh in 2013. See http://www.gov.cn/zwgk/2011-08/01/content_1917358.htm and http://jgs.ndrc.gov.cn/jggs/dljg/201308/W020130830580646101742.pdf.

[4] Ma, J. (2013, October 10). 反思"金太阳"_北京商报. Retrieved January 23, 2015, from http://www.bjbusiness.com.cn/site1/bjsb/html/2013-10/10/content_230288.htm?div=-1

*Tianjian Gao ("James") is a is a Master of International Affairs '16 candidate at the School of International and Public Affairs, Columbia University.

2010s could no longer justify the huge subsidies[5] that had been going into it. From 2009 up until 2012, the utility-scale subsidy had featured a lump-sum payment that covers up to 70 percent of the overnight cost of a utility-scale project, without a single KWh having to be generated by the assets beforehand. [6] The lax and lucrative business environment led first to widespread uptake of utility-scale projects, and then to such overcapacity that, by 2013, around 40 percent of Chinese utility-scale solar PV generation assets had been idle, according to the NDRC head Zhang Ping[7].Therefore, since around 2012-2013, it had gradually become clear to the Chinese regulators that to grow the larger solar industry efficiently, the policy priority must shift from the temporarily overstocked utility-scale sector to the DG sector.

Second, by virtue of the intermittent nature of solar radiation, utility-scale solar PV is low in dispatchability. This is why utility-scale projects are a relatively unreliable source of electricity that, when connected to the grid, may increase the risk of the grid failing to maintain the critical generation-load balance. On the other hand, the firming of utility-scale generation requires energy storage to smooth out the intermittency, yet the current storage options are either unavailable (i.e. pump-hydro) in the arid Northwest, where the majority of China's utility-scale capacity is sited; or is yet to be commercially viable (i.e. battery storage).

IMPROVING THE ECONOMICS OF DG

To stimulate DG uptake, In August 2013, the first DG support program was launched in China. The highlight is, again, the subsidy: each KWh of electricity generated and consumed by a DG user is paid a national subsidy at RMB 0.42/KWh plus a local subsidy determined by each province (denoted type A subsidy hereinafter). In addition, the DG user receives a subsidy tantamount to the desulfurized coal-generated electricity price at RMB 0.38 for each KWh s/he sells back to the grid[8](denoted type B subsidy hereinafter). However, some residential DG users believed that the subsidy was not enough to attract wider adoption. Ren Kai, known to be the first in China to install a residential DG system, observed that the type A subsidy implies a payback period of around 9 years for an average residential DG project, assuming 100 percent electricity self-sufficiency. However, because a DG user in reality would still depend on the grid for a good chunk of his/her electricity needs, and because the type B subsidy is somewhat low (RMB 0.38/KWh, which is less than the RMB 0.50/KWh grid price), the project payback period could come out considerably longer than 9 years. [9]Due partly to the unattractive economics, in 2013, the actual addition to the national DG (about 1 GW) capacity was only about one-third of what NDRC had planned (3 GW).[10] Realizing this issue, in September 2014, NDRC unveiled a second DG support policy package that upped the Type B subsidy significantly. Instead of fixing it at the

[5]The subsidy could otherwise be construed as a way to accelerate the domestic consumption of the massive overstock of Chinese solar panels which, had it not been for the 2012-2013 anti-subsidy and anti-dumping duties imposed by the EU and the U.S., would have been mostly exported to those markets.

[6] Ma, J. (2013, October 10). 反思"金太阳"_北京商报. Retrieved January 23, 2015,from http://www.bjbusiness.com.cn/site1/bjsb/html/201310/10/content_230288.htm?div=-1

[7] China Daily. (2013, March 7). 发改委主任张平：化解产能过剩是当前重点 Retrieved January 23, 2015, from http://www.chinadaily.com.cn/hqpl/zggc/2013-03-07/content_8436066.htm

[8] Ren, K. (2014, June 16).发展分布式光伏需尽快出台上网标杆电价 Retrieved January 23, 2015, from http://www.chinapower.com.cn/newsarticle/1212/new1212654.asp

[9] Ren, K. (2014, June 16).发展分布式光伏需尽快出台上网标杆电价 Retrieved January 23, 2015, from http://www.chinapower.com.cn/newsarticle/1212/new212654.asp

[10] Zhu, M., & Fang, Z. (2014, May 9). 中电观察：关于发展分布式发电的几点思考.Retrieved January 23, 2015,fromhttp://www.cpnn.com.cn/zdyw/201405/t20150509_675493.html

desulfurized coal electricity price (RMB0.38/KWh), NDRC brought it up to the same level as the utility-scale solar electricity, which ranges from RMB 0.95/KWh to RMB1.00/KWh.[11] This represents an increase by more than 150 percent. Although the effect of this increase shall be clearer towards the end of 2015, as the economics of DG has improved, a wider uptake of DG in China may have been made considerably more likely.

But how far, and how fast would this uptake go? The answers depend as much on the absolute economics of DG as illustrated above as on its relative economics, that is, when benchmarked against the grid electricity price. Improving the absolute economics of DG is important; but only if the price of electricity derived from DG can be brought past socket parity would then a significant number of grid customers be wooed over to adopt DG in China. Put otherwise, the price of electricity drawn from a DG system, as expressed by

levelized cost of electricity from DG
***minus* subsidies A,B/KWh**
***minus* grid price spared (commercial or residential)/KWh i)**

should be equal to or lower than the grid price per KWh in order for DG to be capable of substantial expansion. The following exhibit from a 2013 Citibank report estimates that socket parity would happen around 2020.[12] But it should be further noted from formula i) that if 1) the subsidy on DG should be reinforced, as exemplified by the 2014 reinforcement of the Type B subsidy; or 2) the solar panel and the balance-of-system cost of a solar system should travel down the experience curve faster than expected; or 3) grid price rises by a visible margin in the future, then socket parity might arrive even sooner than 2020, contributing to faster larger-scale DG uptake in China. Another dynamic to be observed is, now that the grid retail price of the commercial sector (shopping malls, office buildings, etc.) is considerbly higher than of the residential sector, DG uptake in the commercial sector may potentially develop faster than in the residential sector, ceteris paribus.

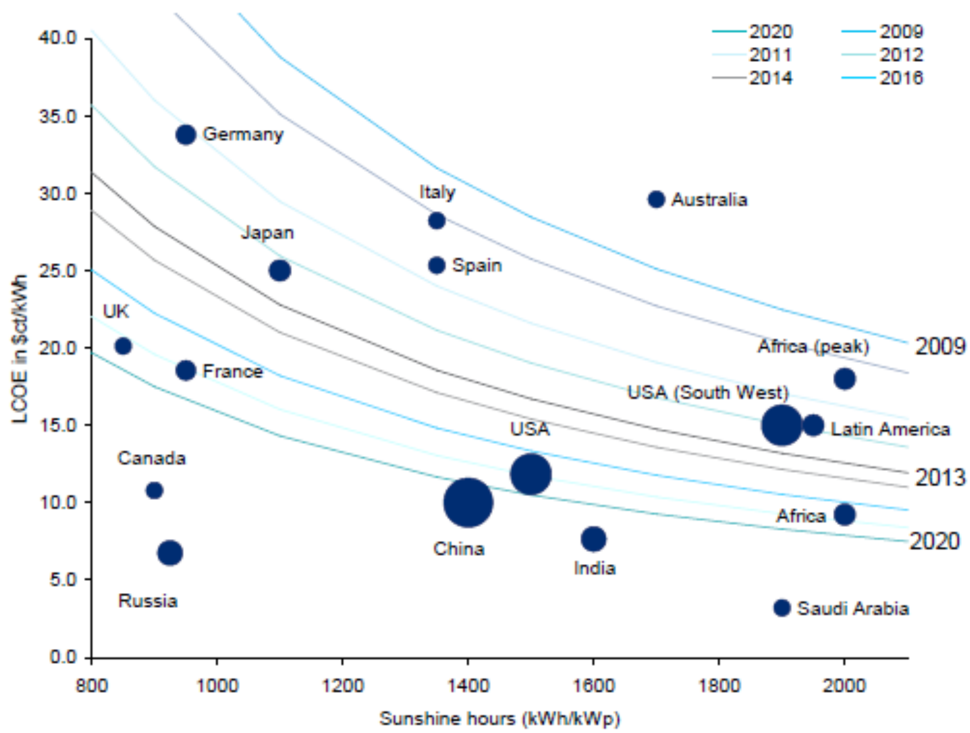
However, it would be misleading to suggest that appealing economics would *automatically guarantee* uptake. What stands in the way is the current lack of energy storage. The relative scant storage opportunities in China undermine the value of DG, especially for the residential users, whose incentives for further adoption or continuation of DG would then be affected. This would negatively impact future expansion of DG in China even with improving economics, as will be discussed below.

ENERGY STORAGE AND DG

Currently, solar energy storage in China has yet to graduate from the pilot stage. The nation's largest renewable energy storage pilot in Zhangbei, Hebei has been experimenting with various chemical storage technologies since 2009, but it has yet to discover a technology

[11] National Development and Reform Council. (2014, September 2). 全国光伏发电上网电价表. Retrieved January 23, 2015, from http://www.sdpc.gov.cn/zwfwzx/zfdj/jggg/dian/201308W020130830584301805574.pdf

[12] Channell, J. (2013). The $5.7trn Renewables Opportunity That Still Remains. *Citi Climate Change Universe*.



SOURCE: *The $5.7trn Renewable Opportunities That Still Remains*, Citibank, 2013

that is commercially viable enough for mass DG deployment. [13] Without readily accessible electricity storage options, the ability of DG to divert load from the grid is constrained. Indeed, if electricity generated during the day cannot be stored for use at night, generators must continue to depend on the grid after sundown. This would almost certainly hamstring the ability of DG to cut a user's utility bill, thus hurting the incentives for the continuation of DG operations, and the overall growth prospects of DG in China. Second, DG without sufficient storage could pose reliability threat to the grid. For instance, the possibility that the electricity produced by urban residential DG users could be wasted due to low daytime residential electricity use incentivizes the users to sell their electricity back to the grid to take better advantage of the type B subsidy. But, without appropriate storage devices to remove the solar intermittency, large-scale DG supply could disrupt the delicate grid balance, thus pose serious risks of cascading grid failures.

It is worth noting that the 2014 DG policy is problematic rightly because it strengthens the type B subsidy in the absence of wider storage adoption. As a result, the policy may expose the grid to considerable stability risks. The problem with the 2014 policy only underscores the urgent necessity for the incorporation of energy storage into the DG industry in order for the economy to fully exploit the energy, economic and environmental benefits of DG, while successfully avoiding the negative grid impacts that it may cause.

[13] Zhao, C., & Ma, Y. (2014, June 25). 储能行业调查：新能源破局关键. Retrieved January 23, 2015, from http://finance.ifeng.com/a/20140625/12600141_0.shml

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CONCLUSION

Distributed electricity generation by solar photovoltaics has been experiencing rapid growth in China since 2012 because of its energy, economic and climate benefits. Given the increasing support for DG from the state government and its improving economics, DG might continue to experience high penetration growth over the years to come. However, the lack of energy storage could potentially overshadow the promising prospects of DG. At the macro level, DG without energy storage exposes the grid to high supply volatilities and to the failure to maintain the critical supply-demand balance. At the micro level, the absence of storage in a DG system would impede the adoption of DG by individual users (especially ones from the residential sector), because DG not paired with storage will be constrained in its ability to cut their utility bills, which ultimately could affect people's incentive to purchase and deploy DG projects. It could be argued, then, that the importance of energy storage should very well place it at the front and center in both the Chinese DG market and in the solar policy agenda of NDRC.