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How Could the Family-scale Photovoltaic Module Help the Poor Farmer out of Poverty and Reduce CO_2 Emission?

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BACKGROUND

As shown in Figure 1, on one hand, China's financial resource and influence are gradually increasing, leading hundreds of millions of people out of poverty; on the other hand, China still has about tens of millions people who can earn one dollar or even less a day (Figure 2).

As shown in Figure 2, though the impoverished population and its ratio decreased obviously in recently years, there are still 55.75 million impoverished people in China in 2015, which is 14.42 million less than 2014 (China Economic Net, published on Feb. 29, 2016. Data are calculated based on the standard of international poverty line, 2300 RMB/per year or 1 dollar/per day).

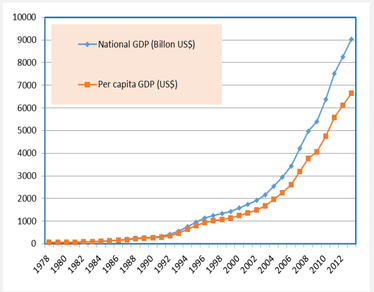

Figure 1 Changes in state total and per capita GDP in China in the period of 1978-2013. Data from Chinese National Bureau of Statistics.

Meanwhile, China is the largest producer of solar panels and the largest emitters of greenhouse gases in the world (Hillary Clinton, Hard Choice). As shown in Figure 3, the productivity of PV module in China increase very fast in last decade. However, many of them is for exporting to other countries. Though part of them are used inside China, most of the solar power stations are large-scale, which are usually over 1.0 MW. Family-scale PV plant is still not popular.

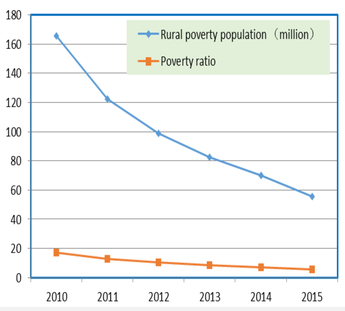

Figure 2 Rural poverty population and its ratio in 2010-2015 in China. Poverty level was set as daily income less than 1 US dollar. Data from Chinese National Bureau of Statistics.

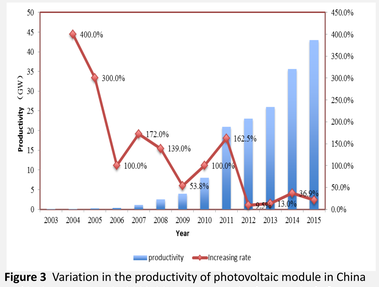

Figure 3 Variation in the productivity of photovoltaic module in China and its increase rate in 2003-2015. Data are cited respectively from L. Wang (2014, Master thesis of Peking University), http://www.miit.gov.cn/n11293472, http://www.solarzoom.com/, and http://newenergy.in-en.com/html.

OBJECTIVES

Could we find a feasible way to use photovoltaic (PV) module to help the poor and meanwhile reduce CO_2 emission? To do this, we reviewed literatures and investigated the related field sites and institutions in China.

PV POVERTY ALLEVIATION PROGRAM IN CHINA

In 2014, China Energy Bureau issued the strategy of using PV as a tool to fight poverty (Table 1). There are mainly two types of PV poverty reducing models.

1. Family-scale module: By increasing the number of underprivileged families to install family-scale PV modules (Figure 4).

2. Agricultural module: Using barren land, greenhouse or agriculture facilities to build PV plants (Figure 5).

Comparing to cities, the property right of roofs are clearer in rural. In addition, because access to electricity in these areas is often limited, PV plant can help them not only to increase their economic income but also to improve their life quality.

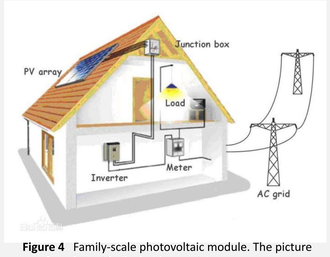

Figure 4 Family-scale photovoltaic module. The picture was from http://baike.baidu.com/pic

Figure 5 Agricultural module. Photos were taken by Headwater company in Anhui Province on March 18, 2016 .

Table 1 Planned and ongoing PV plants in 2015 for helping the poor farmers out of poverty in different Provinces in China. Data were collected by authors based on the public data and report of Headwater company.

Province	Scale (10^3 kW)	Government Input (Million US$)	Benefit Population	Busyness Model
Anhui	400	175.40	0.75 million	Government funded
Hebei	300		10,000 family	
Gansu	250		1,200 family	
Shanxi	200	3.97	50 village	
Ningxia	200	80.95	12,948 family	PPP
Qinghai	150	15.87	4,00 family	

BUSINESS MODEL

The two main models of PV alleviation are Public-Private-Partnership (PPP) model and Government-funded (GF) model.

(1) PPP model: This model encourages the cooperation between government, company and individual in the construction of PV plant.

(2) GF model: The central government fund 1/3 of the cost, local government fund 1/3 of the cost and the rest is paid by the individual.

Currently, most of the PV projects use PPP model in China. However, in the poverty alleviation program, the government funded model has more advantages than the PPP model.

CASE STUDIES

Figure 6 Projects of family-scale photovoltaic module to help the poor farmers out of poverty in Anhui Province, where is traditionally known as a poor area in the country. Photos were taken by Headwater company on March 18, 2016.

Table 2 Input and output analysis of 519 family-scale (3kW) PV plants in Anhui Province, China. The business model in this area is government-funded model. The central government, local government, and family shares 1/3 of the cost, respectively. The designed working period of the PV plants is 25 years and the estimated payback period is 7-8 years. Abbreviation G is for government.

Input (US$)				Annual output				
Total	Central G	Local G	Family	Electricity Generation kWh	G. Subsidy US$/kWh	Sell Price US$/kWh	**Total Income** US$/kwh	**Annual Profit** US$
3500	3500/3	3500/3	3500/3	3260-3800	0.077	0.092	**0.17**	**460-615**

CONCLUSIONS

The 3 KW PV plant of GF business model is suitable for rural area in China. The farmer can increase their income by 460-615 US dollars per year, which almost doubles their annual family income. In addition to its economic benefit, PV module can reduce CO_2 emission by 0.93 kg/kWh, which is equivalent to annual reduction of 3000-4000 kg CO_2 per family.

Therefore, it is concluded that the family-scale photovoltaic module not only can help the poor farmers out of poverty but also can reduce CO_2 emission significantly. To promote its sustainable development, it is worth to further investigate its business model and long-term support policies under different social and nature conditions.

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