Energy Allocation Problem and Renewable Energy in China

I. Introduction

Since the economic reform in the 1980s, China has experienced rapid economic growth, which can be seen from various economic indicators such as GDP growth rate (National Bureau of Statistics of China, 2018). However, the remarkable economic development also fueled energy demand. Given endowment and geographical constraints, China faces a considerable number of energy problems (Shen, 2001; Liu, 2013). In particular, there is a spatial mismatch between energy demand and supply (Liu, 2013), causing a "statistical"[1] shortage and surplus in the Eastern and Western region respectively.

Table 1.15 The distribution of China's energy resources, electricity consumption and GDP (%)*.

Unit: % Item	Eastern Region	Central Region	Western Region
Share of hydropower (technically exploitable amount)	7.3	11.2	81.5
Share of coal basic reserves	10.5	38.2	51.3
Share of power installed capacity	46.0	22.7	31.3
Share of thermal power installed capacity	52.4	23.1	24.5
Share of electricity consumption	57.1	19.3	23.6
Share of primary energy consumption	53.5	21.7	24.8
Share of GDP	61.7	19.7	18.6

Source: The data in the table are calculated and organised according to information contained in *The 2003 Review of National Hydropower Resources*, *China Statistical Yearbook 2011*, *China Energy Statistical Yearbook 2011*, etc.

*The technically exploitable amounts of hydropower are 2003 figures; the rest are 2010 data. The eastern region includes the municipalities of Beijing, Tianjin and Shanghai, and the provinces of Heilongjiang, Liaoning, Jilin, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong and Hainan. The central region includes the provinces of Shanxi, Henan, Hubei, Anhui, Hunan and Jiangxi. The western region includes the provinces of Qinghai, Gansu, Shaanxi, Sichuan, Yunnan and Guizhou, the autonomous regions of Xinjiang, Tibet, Inner Mongolia, Ningxia and Guangxi, and the municipality of Chongqing.

Table 1 (Liu, 2013)

In light of this, the government initiated the West-East electricity transmission project, which aims at transferring the abundant energy resources in Southwest and Northwest to the East (HKTDC Research, 2017). Is it enough to solve the energy allocation problem? In the following, I would further explore the problem and evaluate renewable energy in a problem-solution structure.

[1]The shortage/surplus is only statistical in terms of regional demand vs endowment.

II. Allocation Problem on Micro-level

On a micro-level, energy allocation problem exists in China. Taking electricity as an example, the suppliers never know the instantaneous demand for electricity in the region. As a result, they estimate the demand and generate a higher amount to ensure stability. To reduce wastage, engineers and statisticians have done extensive researches in this area hoping to improve the estimation accuracy (Lo Verso et al., 2014; Cheung et al., 2015). However, this solution is bound to be rigid since no model can achieve 100% prediction accuracy[2]. In May 2018, Guangzhou experienced intermittent blackout (許可, 2018), proving that China is also subjected to energy allocation problem on a micro-level.

Ultimately, the cause of micro-level energy allocation problem is the design of electrical grid.s Currently, traditional electrical grid adopts a client-server architecture. The supplier connects generating stations with consumers through high-voltage transmission and distribution lines (Atkins, 2016). This may create instability as failure of generating stations (centers of their regional grids) would require rerouting and create pressure on other grids. Besides, there is low informational efficiency as consumers would not know their generating stations were out of order. If consumers are informed of the news, they may actually be encouraged to alter the consumption pattern temporarily (Gross, 2016). As a result, less pressure would be imposed on the whole energy system. These reasons shed light on applying peer-to-peer (P2P) networks to electrical grid (Beitollahi & Deconinck, 2007).

With the advancement in energy generation and smart devices, real-time energy management with P2P networks, namely the smart grid, seems to be possible in the coming future (Electric Power Research Institute, 2011). In smart grids, consumers can buy energy at low cost and store in their local area network (LAN). They can adjust their consumption patterns according to energy price or even sell their excess energy stored in LAN to other grids if there is a sudden failure (Davidson, 2011). As a result, energy stability and informational efficiency are improved comparing with the traditional grid.

[2] Even if we know the underlying distribution of energy consumption, there can be random shock.

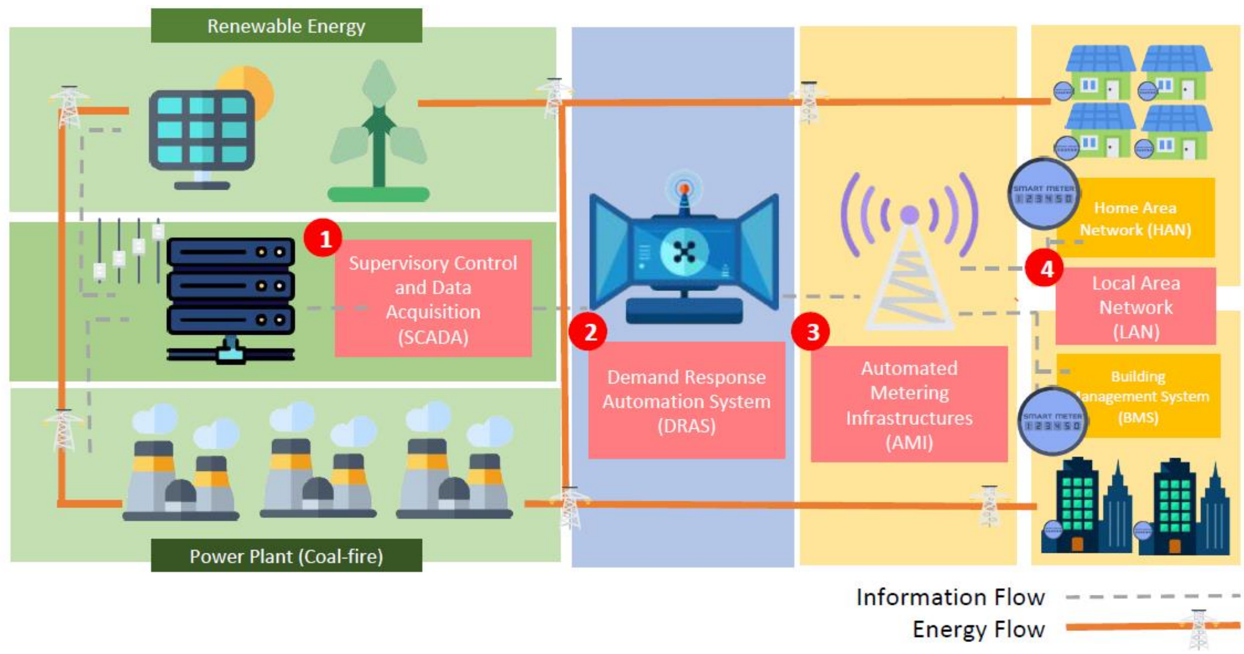

Figure 1 (Yip et al., 2017)[3]

If smart grids become completely feasible, China may use them to solve the energy allocation problem on micro-level. She may combine the development of smart grids with 5G network infrastructure. This is not only economical, but also environmental friendly as smart grids eliminate the intermittent issue of renewable energy. Nge et al. (2019) prove that it can be practical to combine solar PV with smart grids. Gross (2016) also shows that PV may be cheaper than coal sometimes. Therefore, more intensive use of renewable energy may be a possible solution in this regard.

III. Allocation Problem on Macro-level

On the other hand, the energy allocation problem in China on macro-level is more complex. Firstly, we can associate the problem with regional inequality. From Table 1 (p.1), it is observed that share of energy consumption approximately equals to share of GDP by region (Liu, 2013). However, energy resource endowment differs from the consumption pattern (Liu, 2013). Secondly, policies like "China Western Development" show that since there is regional inequality in living standard and economic growth (Yang et al., 2018), the government wants the Western to catch up. Taking these facts into consideration, China has two different allocation problems: a mismatch between energy demand and production in the short run and a "shortage" in Eastern energy in the long run.

In the short run, another factor aggravating the mismatch problem is a relatively weak energy transport system in China. Liu (2013) pinpoints that China's energy investments focused on

[3]This concept graph was created by my team for a case competition. It is not available online.

production and paid little effort on transportation in the past. As a result, China can only use railway to perform long-distance and large-scale coal reallocation (Liu, 2013). In 2017, 51.1% of the national wide cargo was coal (National Bureau of Statistics of China, 2018). Therefore, despite the government initiated the West-East electricity transmission project, energy allocation problem still exists.

While the mismatch problem can be alleviated with the use of renewable energy, regional difference still exists. Taking solar energy as an example, it seems to be more cost-effective to put PV in the West:

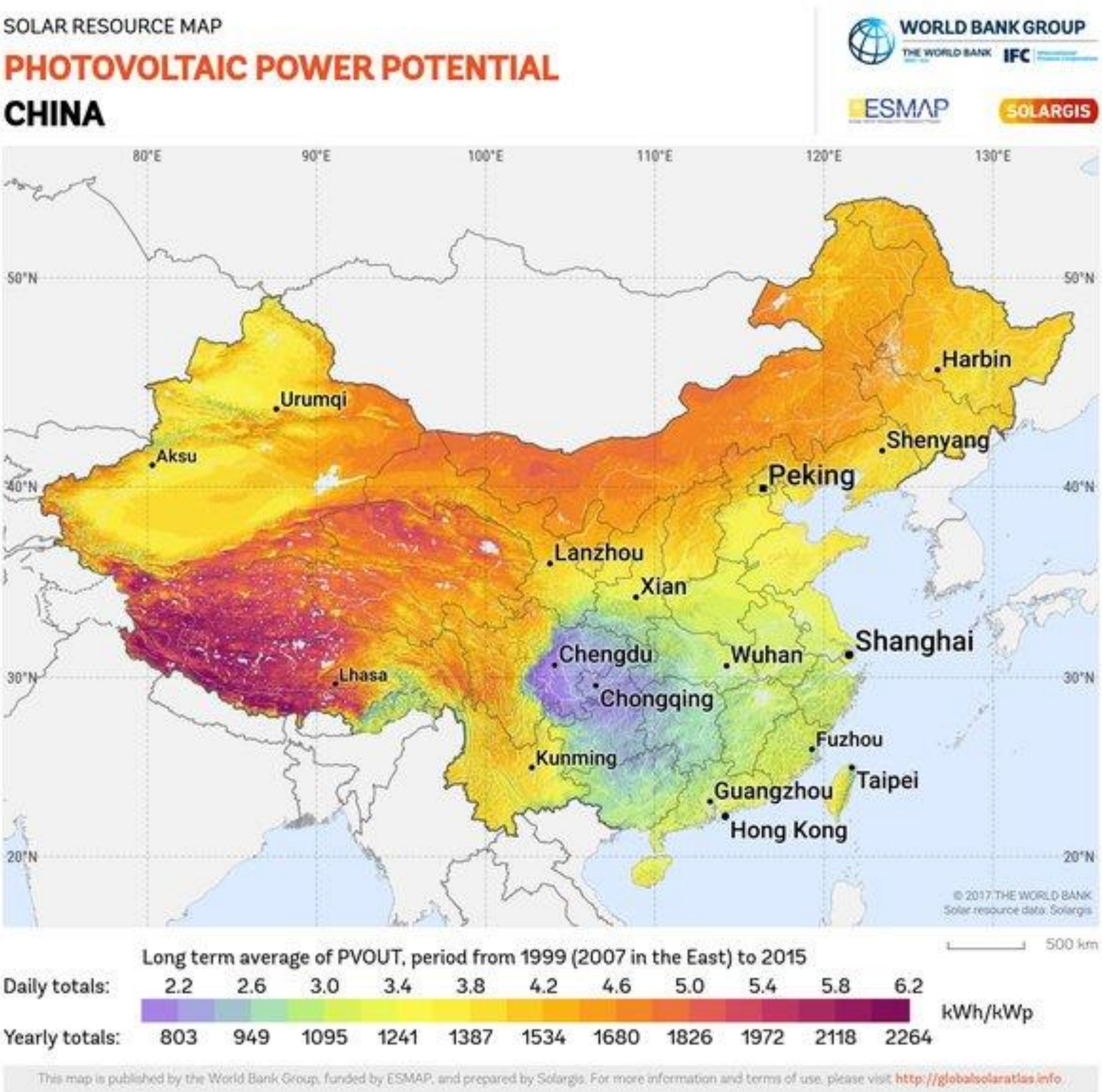

Figure 2 (Solargis, 2019)

To use renewable energy in the East without improving the energy transport system, another concern is whether it is possible to build generating stations there. Regional difference does not only exist in terms of resource endowment, but also of population. According to China Statistical Yearbook 2018, more than 80% of the population lives in the East[4] (National Bureau of Statistics of China, 2018), showing that it is more difficult to deploy generating stations in the East. Therefore, an improvement of energy transportation is essential in the long run for tackling the mismatch problem.

Nevertheless, even if China improves her energy transport network, there is another problem unsolved. That problem would be a "shortage" in Eastern energy. As the Western area gets developed, its economy will catch up in the long run and energy production may only be able to meet its regional demand. As a result, the West cannot transmit excess energy to the East and China may have to seek external resources. In this regard, there will be a global energy allocation problem and China will need to secure her energy import. For instance, China has been building different oil pipes with Russia, Burma, etc. (Erickson & Collins, 2010), in order to diversify the risk of relying on a single pipe.

To truly solve the "shortage" in Eastern energy, one of the good ways is to improve energy efficiency. Even if China could import fossil fuels from foreign countries, they would be used up some days as other developing countries could also be facing problems like informational inefficiency, mismatch, shortage, etc. By improving energy transportation and consumption/generation efficiency[5], China can make the best use of its resources and provide stable energy across regions.

IV. Conclusion

In a nutshell, the energy allocation problem in China can be divided into informational inefficiency (micro-level), spatial mismatch (short run macro-level) and Eastern "shortage" (long run macro-level). To tackle these problems, renewable energy is a nice dimension to look into. By building smart grids and combine with renewable energy, China can reduce informational inefficiency and protect the environment at a low cost. Nevertheless, transportation, consumption and generation efficiency of renewable energy should be taken care of before large scale usage to promote energy security as regional difference exists. (1234 words)

[4]Defined using the Hu Line.

[5]When consumption efficiency is increased, electrical appliance may use less energy. Thus, demand for energy is reduced. Generation efficiency is similar.

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