From Survive to Thrive

- Gas Power Industry and Policy in China

Co-authors: Leigh YANG, Ronnie C.TIAN

Asia Carbon Energy (Beijing) Co., Ltd.

This paper aims to provide a frame work to understand the gas power industry in China. Firstly, it introduces an overview of industrial status quo through a four driving forces model. Then, it categorizes various policies on energy industry and gas power under the driving force model. It then gives a brief on key stakeholders and major operators of gas power in China. Finally, it presents some noteworthy points which may impact the future of China's gas power sector.

The Paradox of Gas Power in China

News from China on gas power is either too optimistic or pessimistic. Some industrial companies and consultancies are bullish about the future of China's gas power. They say the golden age of gas is coming. Looking at overall statistics and plans at the national level, they are probably right. China is now the 2nd largest market by installed gas power with 87.93GW capacity, which creates an attempting after-sales service market.

Not only after-sales service market, people are also optimistic about the new order market of gas turbine. In 2017, in its latest plan for energy structure transition, the National Energy Administration (NEA) sets a target to have 25% of its total energy consumption from non-fossil energy, and 15% from gas. In 2017, 237.3 billion m^3 gas was consumed with annual increase of 15.3%, and 20% of this amount was used for gas power.

On the other hand, the voice from Chinese gas power operators are mostly pessimistic especially in Zhejiang and Guangdong provinces, who are under pressure of just surviving. The average annual operating hour of gas turbine units in Zhejiang province was as low as 1,359 in 2015. Plants are operated under deficit or just-break-even.

Gas fleet operators and owners have little influence on policy making in energy sector comparing with coal fleet. Gas power only accounts 4.3% of total installed power capacity of China in 2017. While in the US and Japan, the number is 34.0% and 28.0% respectively.

The two opposite side are all true about China. How do we understand this paradox? How do we look at the future of China's gas power sector? We use the industrial driving force model with a regional perspective.

The Five Driving Forces

Looking at the history of how energy sector transit, we identified four forces as main drivers namely economy, environment, technology and security. They lay the foundation of the energy policy, and in return shaped by policy. What are the dynamics of China's four drivers? Below are some snapshots.

1. Economy

China became the 2nd largest economy of the world in 2010. For the last 40 years, China's GDP increased 224 times, from 59.3billion USD in 1978 to 13,340billion USD in 2016. The economy fly especially after 1990s' stimulated the demand for electricity. As a result, China tapped on the massive development of gas power since 2000.

China's economy development varies largely by regions. The total GDP of top 5 provinces accounts over 55% of China's total GDP (Guangdong, Jiangsu, Shandong, Zhejiang, Henan). It is 17 times of the last 5 provinces (Tibet, Qinghai, Ningxia, Hainan, Gansu). This prominent regional disparity lays foundation to understand energy sector in China.

2. Environment

China's economy develops at super high speed come with a cost of environment pollution. It relies on energy-extensive industries such as chemical, metal, cement, steel and glass, etc. China is the largest energy consumer worldwide with 4.36 Gtce (billion tonnes of standard coal equivalent) in 2017, which is 1.4 times of the U.S., 7 times of Japan, and over 9 times of Germany.

2013 is a turning point of China's environment and energy policy. On 14th Jan, Beijing encountered what the Economist called the "darkest day". The PM2.5 index reached 993. It is two times higher than the EPA's standard of dangerous, as per EPA the index over 100 is unhealthy, over 400 is dangerous.

China's leadership responded with the severe situation quickly; issued the "National Clean Air Action Plan". Beijing phased out all coal-fleets and shifted to 13.4GW gas-powered CHP plants within three years. A large scale coal-shift-to-gas program are executed across China, particularly in Jing-Jin-Ji region (incl. Beijing, Tianjin and Hebei province). In 2017, over 70% cities' (among 338 included in the national air quality monitoring system) air index were still over

the standard. Environment issue has become the top priority of Chinese government's agenda.

3. Security

China is a country that rich in coal and poor in oil and gas. Its energy resources are located in remote and less developed regions. 87% of its coal resources are buried in the north, while 70% of hydro resources are in the west. China replies heavily on imported oil and gas with 65% and 33% each in 2016. The imported gas has increased significantly for the past decades, from 24.5 billion m^3 in 2000 to 224 billion m^3 in 2016.

In early 2000, electricity shortage was common in Guangdong, Zhejiang and Jiangsu provinces. IT triggered the first round of fast-growing gas power. In 2011, under the a series of economic stimulation programs, China's economic development warmed up after after the global financial crisis. But electricity shortage again dragged the economic development in these provinces. Take Zhejiang as an example, 14 gas-powered CHP plants with 7.93GW capacity were installed in 2012 and 2013.

In the winter of 2017, Northern China encountered gas shortage. To speed-up Gas infrastructure development has been put on the government's agenda. As of 2017, the major gas pipeline is 74,000km and the gas storage capacity is just 11.7 billion m^3. 41 LNG terminals are under operation, while 17 under operation.

4. Technology

China prefers to develop and localize energy technology. Chinese companies now compete in global power technology market with its coal, hydro, wind, and solar power generation technologies.

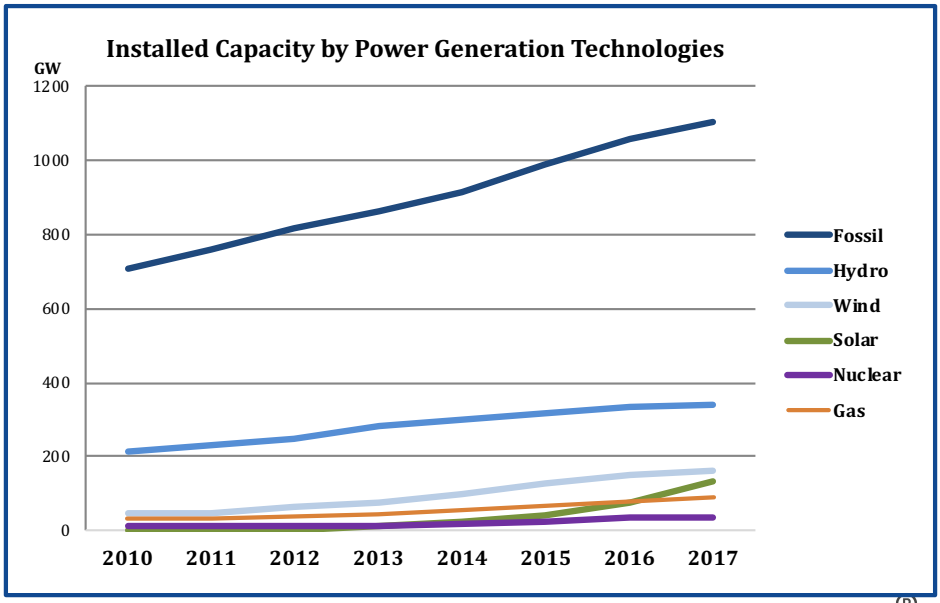

Chart 1

For coal power, China's coal units operates at as low as 270g/kWh for the advanced 1000MW scale double reheating units is. By 2017, the total installed capacity of coal power is 1,050GW.

For hydro-power, Chinese manufactures are capable to design, manufacture and build 100MW scale hydro plants, including underground hydro-power. By 2017, the total installed capacity of hydro power is about 341.2GW.

For wind power, Chinese companies form a complete industrial chain from raw material processing, component to compact unit manufacture. Chinese manufactures can provide unit with capacity from 1.5MW to 6MW, both on-shore and off-shore. Wind power industry is a multi-billion (by RMB) business in China, providing half-million jobs. By 2017, the total installed capacity of wind power is about 164.7GW.

In solar power, Chinese companies are prominent players in global market. The recent IEA "2017 Renewable Energy Market Report" says China contributes 50% of the new-added manufacture capacity of global PV industry in 2016. The industry sees a soar domestically since 2013, when Chinese government launched PV top runner program to encourage green energy. By 2017, installed capacity of solar PV in China reached 130GW.

While, gas power is the weakest point of China's power technology portfolio. China is far behind of global gas turbine technology owners, and this is said to be one of major concerns of the central government when it makes related energy policies. Under the license of global technology owners, Chinese gas turbine manufacturers are not allowed to have the hot gas path component manufacturing technologies, and the service market is dominated by global OEMs.

However, the industrial dynamics has changed in the past five years due to the emerge of game changers. The most well known case is Shanghai Electric's investment in Ansaldo Engergia, which enables Shanghai Electric to fully manufacture hot gas pass components of F class gas turbine in Shanghai. While on service market, joint ventures are emerged as well. China Huadian Group and Sulzer incorporated joint venture since 2016. It has signed several contracts since then.

Regarding the China's own gas turbine technologies, Dongfang Electric has been developing its 50MW scale gas turbine since 2009. It achieved milestone of successful compressor and combustion test in 2018. Harbin Electric tested

30MW scale gas turbine at PetroChina's gas compression station since 2015. Another major manufacture-China Aviation Engine tested its 110MW gas turbine at CNOOC's gas power plant in Shenzhen since 2012.

Policy and its Level

Above drivers have major impacts on China's energy policy. We categorize these policies into 3 levels, in terms of its hierarchy and administrative level.

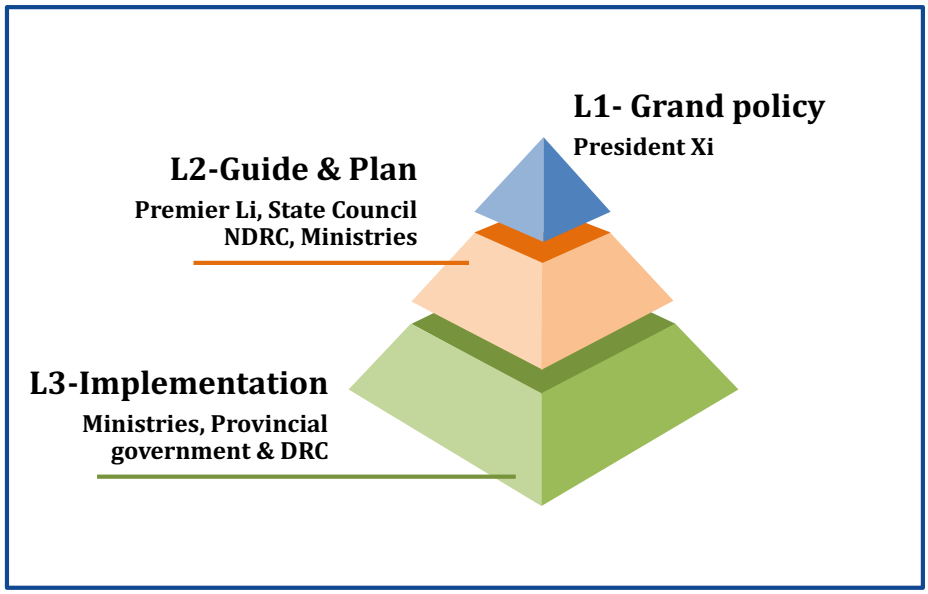

Chart 2

Level 1 Grand Policy: from the highest leadership of the party and central government to set principles and basic directions.

Level 2 Guide & Plan: from state council, ministries and commissions at central level to set target, frameworks, and rules.

Level 3 Implementation: from ministries and commissions at central or provincial level to implement the plan, enforce rules, and fulfill the targets.

Level 1 policies are mid or long-term, while level 2 and level 3 are mostly mid of short term. Many of the polices could be a result of various drivers, but we listed them under its main driver. We categorize China's energy policy (with a focus on gas power) by 3 levels and its leading force as below.

At level 1, President Xi lays foundation of China's current policies. His important remarks about economic, environment, security and technology include:

- "New Normal": China's economic development will transit from quantity to quality.

- "Beautiful China": put environment on the top priority of government agenda, and as the new KPI of local government officials.
- "Energy Revolution": China will undergo overall energy resolution in terms of energy supply, demand, structure and technology, China will pursue energy security in the open world through international cooperation.

Under such framework, every five years, the National Development and Reform Commission (NDRC), National Energy Administration (NEA) and relevant ministries will issue strategic plans to reinforce and fulfill the grand policies, which are called the Five-Year-Plan (FYPs). Currently, there is no separate dedicated plan for gas power or gas turbine, but it is fragmented in the plan for electric power, natural gas and energy technology innovation.

Under the outline of national FYPs, provincial governments then issue provincial FYPs on energy or electric power to specify its target for each energy sector. Besides the FYPs, there are also outlines, guidelines, suggestions, opinions, action plans for dedicated issues such as air pollution, electric power system, oil and gas pipelines.

At level 3, NDRC, NEA, ministries and provincial governments will further issue notice, policies and regulations to fulfill policy targets from Level 1 and Level 2, through more effective measures and tools such as tax, subsidies, incentives, fundings and loans. But this is normally subjected to the financial capabilities and willingness of local governments.

Changes emerge under each driving force from time to time, policies from different levels or drivers might be against each other in short-term. For instance, due to the severe gas shortage last winter, the "Three-year Action Plan to Win the Battle for a Blue Sky 2018" says the new build of gas-powered CHP plant will be suspended principally, though the national "13th FYP of Gas Industry" sets a target of gas power capacity as 110GW by 2020.

Stakeholders

Like other economies, policies also reflect the interests of powerful stakeholders. While in China, the influence is extremely powerful and limited to a few companies.

State Grid is the largest and most profitable energy company in China, which receives 376.94billion USD revenue, makes 14.68billion USD profit and creates 1.63million jobs by 2017. While it principally reluctant to support gas power and distributed energy, instead it is more favorite to transmit electricity by its highly invested Ultra-high-voltage transmission line, especially from remote

regions. And the gas-powered distributed energy may pose potential threat as they may build micro grid and sell electricity directly to buyers.

Oil and gas companies are at the 2nd largest level. The China National Petroleum Company (CNPC) receives 375.8billion USD revenue, makes 8.60billions USD profit and creates 1.51million jobs by 2017. It is more likely to pro gas power, as it owns 70% gas pipelines of China. CNOOC and Sinopec are also investing heavily on gas, e.g. LNG terminals.

The big five national SOE power companies are at the 3rd tier. They are much smaller than State Grid and CNPC in scale. Take China Huaneng Group as example, which is the second largest gas power investor with 10.4GW capacity. It receives 41.73billion USD revenue, makes about 164.52million USD profit and creates 143,691 jobs by 2017, which is just about 11%, 1.1% and 10% of State Grid. Power companies are more likely to seek supportive policies for gas power, however their hands are tide up with large number of coal fleets.

If policy-making is a power game, it is clearly enough to see grid and oil & gas companies have more bargaining power. However, things are changing with progress of reform in energy sector. Meanwhile they are all under pressure to meet the energy transition target with more non-fossil energy in long term.

Major Gas Power Operators

Generally, it seems that China's gas power is glooming now and brightening in the future. So who are the pioneers of developing gas power? Over 70% of the installed gas power belong to 13 power companies, with about 40% from the big five national SOEs, 30.42% from big six provincial SOEs, CNOOC Gas & Power and the largest private developer Golden Concord Group (GCL).

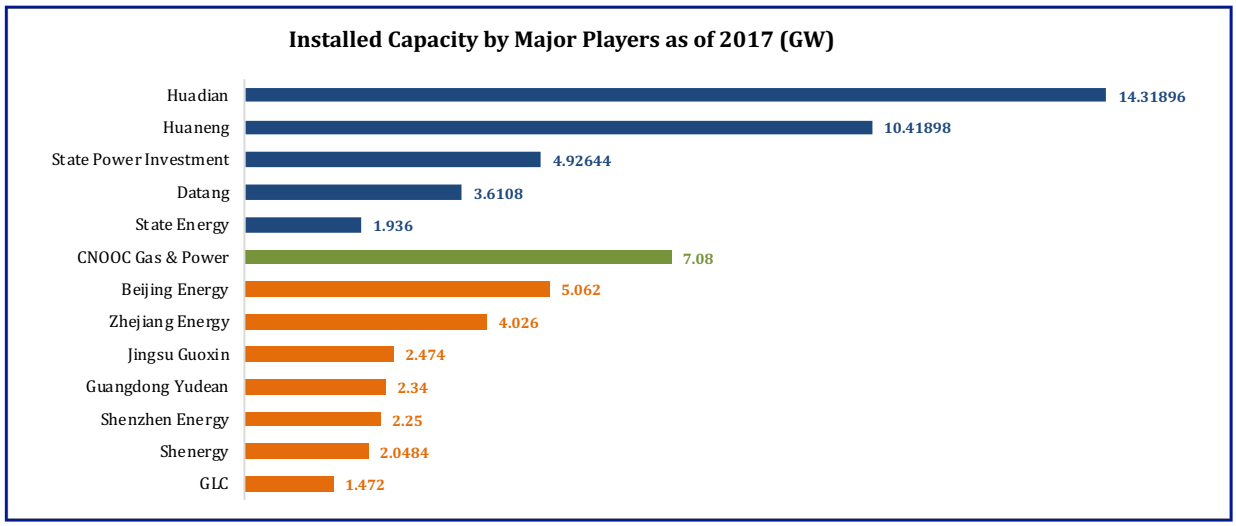

Chart 3

Their assets are highly concentrated in developed regions. Nearly 90% of gas power capacity are installed in Yangtze Delta, Pearl Delta and Jing-Jin-Ji (Beijing, Tianjin, Hebei Province). The trend seems to continue in the near future. Look at the near future, the "13th FYP of power industry" says 50GW capacity will be added by 2020 and total capacity will reach 110GW. At provincial level, Guangdong and Jiangsu province plan to have 23 GW and 20GW gas power capacity respectively by 2020, which will maintain their leadership in this market. And these two provinces in total accounts for 86% of the national new-built target quota.

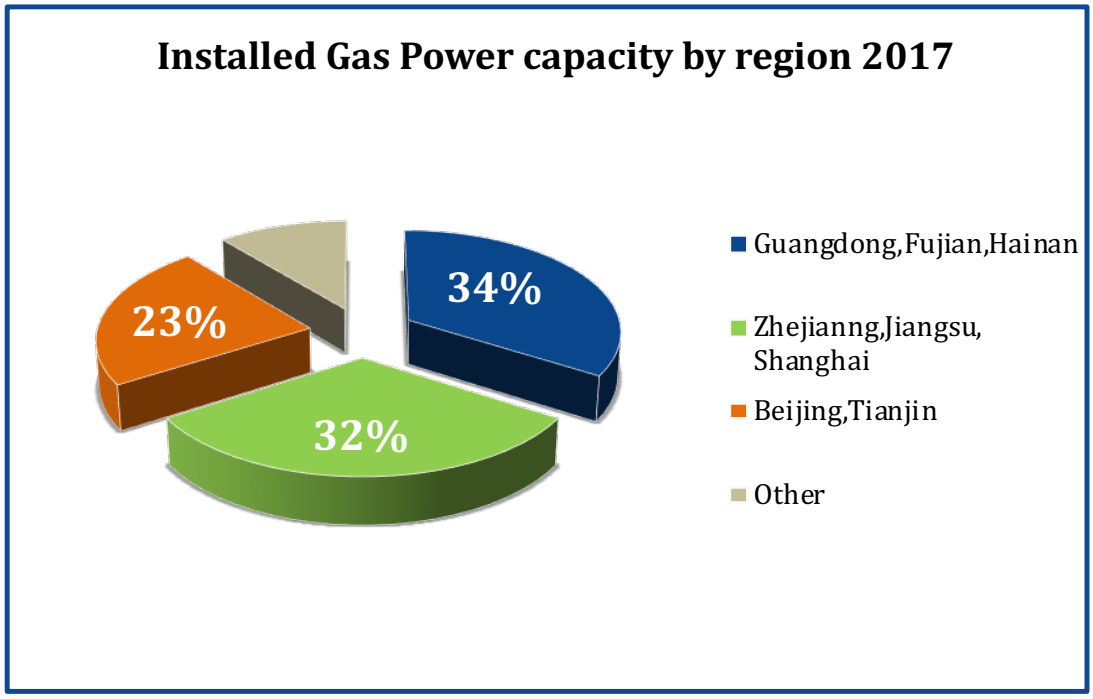

Chart 4

Glance at Regional Leaders

Guangdong is the pioneer of developing gas power since late 1980s' and early 1990s'. It is the NO. 2 province by installed gas power capacity. Previously, Guangdong gas power market was dominated by local SOE utilities and IPPs, while in late 2000, the national SOE utilities began to tap on this market by acquiring assets from IPPs.

In the near future, we see Guangdong gas power market to grow supporting by two major factors, one is the strong electricity and industrial steam demand due to the upgrade on local industry. Another one is to balance renewable energy curtailment. Guangdong province sets an ambitious plan on offshore energy. According to Guangdong's offshore wind power development plan 2017-2030, it will construct more than 12GW offshore wind power by 2020, with 2GW of them on operation. By 2030, Guangdong plan to have

about 30GW offshore wind power on operation. On the other hand, as offshore wind power will have priority of connecting the grid, the gas power unit may subject to lower operating hours and frequent starting and stopping.

Jiangsu surpassed Guangdong province in 2017 and become the NO.1 province by 13.4GW installed gas power capacity. It is now dominated by China Huadian Group which owns 10GW capacity and sets up the gas turbine service JV with Sulzer in Nantong city. Most of gas tubing units in Jiangsu are in CHP configuration with relative higher unit operating hours due to strong industrial steam demand and favorable gas price deal with PetroChina. Jiangsu province is strong in gas turbine industrial chain. It has shops, factories and test facilities of gas turbine from component manufacturer, auxiliary equipment manufacturer, O&M service company and R&D institutes.

Zhejiang is the NO.3 province by 12.28GW installed gas power capacity. Most units operate at very low operating hours as peaking power and Zhejiang to supplement large amount of electricity transited from other provinces. Some power plants' annual operating hour may be as low as 500 in 2017, while just cross the provincial border, the number could be more than 7000 hours.

Beijing is another province strong in gas power in China, though it is not a coastal city. It just achieved a mega program to replaced all its coal fleet with gas turbine, which adds 11GW gas power to its power portfolio within 3 years. In Beijng, gas power operators are less concerned about their survival. They usually operates as base-load with government subsidies. Local SOE utility-Beijing Energy Investment Corp. dominates this market with 42.7% capacity share with 7 gas power plants.

Near-term Outlook

Finally, let us take a look at the near future of China gas power market by four driving forces.

On economy, there are two regions to watch. One is Yangtze River Economic Belt, which covers Jiangsu, Anhui, Jiangxi, Hubei, Hunan, Sichuan, and Guizhou provinces and Chongqing municipality. The industrial transfer from coastal provinces to inland provinces stimulates the power and industrial steam demand, and gas-powered distributed energy is a rising market in particular.

The other one is Bohai Rim Economic Circle in north. Shangdong and Hebei provinces are two major forces of developing gas power and distributed energy. Shangdong just made breakthrough by the first gas turbine unit operation in May 2017, and plan to have 4GW capacity by 2020. Regarding

Hebei province, its 13th FYP of Gas Development clearly supports gas power in peak shaving and CHP, and strives to develop gas-powered distributed energy.

Key players also have an important role on economic side. Along with the reform of gas industry and to secure the gas supply, both SOE and private power companies go upstream to buy domestic and global gas assets and build LNG receiving terminals. For example, the largest gas power generator-China Huadian Group formed the clean energy company to develop shale gas and LNG business in 2014. The largest private gas power generator-Golden Concord Group (GCL) acquired gas assets in Ethiopia in 2013 and invest in gas pipeline from Ethiopia to Gjibouti and LNG terminals in Djibouti with target capacity of 10million tons per year. GLC also invest in LNG receiving terminal in Jiangsu province. The first stage project has 2.70million tons per year capacity and is planned to be operation in 2020.

On environment, we will see higher emission standard across China to compliance with the "Three-year action plan to win the battle for a blue sky". For instance, Shenzhen city will soon implement the new gas power plant NO_X emission standard of 15mg/m³ (9ppm), which is half of the national standard of 30mg/m³. As a result, it will create obvious business opportunities for gas turbine combustion upgrade or SCR retrofit.

On gas supply security, in 2017 NEA announced the "Mid and Long Term Oil & Gas Pipeline Plan". In this plan, China will increase the gas storage capacity from current 11.7billion m³ to 30billion m³ by 2025, almost three times more. The backbone gas pipeline will be increased by 40.5% (30,000 km) to 104,000 km by 2020. Meanwhile, after the gas shortage in 2017, China already started to enhance the interconnections of gas pipeline between different operators to increase the transportation efficiency and supply security eventually.

On technology, as mentioned above, gas turbine has been included in all major national energy technology programs. The noticeable "National Aero-engine and Gas Turbine Special Program" was already kicked-off with 30billion and 3.2billion USD (180billion and 20billion RMB) funding respectively. Foreign companies are also actively involved in China's gas turbine technology program. Siemens just reached an agreement of providing engineering consulting service for CEC Heavy Combustion Gas Turbine Technical Co., Ltd. which is a consortium of gas turbine manufacturers, power generator and leading research institutes, registered in Shanghai and building test facility there.

Summary

In summary, we see quite positive policy signals regarding gas power, distributed energy and gas turbine technologies at level 1 of grand policy.

At level 2 of ministerial guideline and plan, big efforts will be needed to define the responsibility and coordinate among different government bodies, ministries and powerful SOEs, and supervise the implementation performance at provincial level.

While for different provinces, they have own implementation policies based on their financial, economic and environmental situations. Generally speaking, China is too big and diversified to be seen as a uniform market, instead it should be examined by different provinces and regions. If the policy implementation can be consistent from level 1 to level 3, we would see a general gas power market from survive to thrive after 2020.