AN ASSESSMENT OF THE CHINESE ENERGY INDUSTRY

COLLECTIVE RESPONSIBILITY

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Collective Responsibility
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1 INTRODUCTION

China's rapid economic growth and development over the past 30 years has resulted in significant changes to its economic framework and in terms of Purchasing Power Parity (PPP) it is now considered the world's strongest economy (World Bank, 2014). Much of this growth is due to the rise of China's urban and industrial development, and as the country has moved from an agrarian society to one of industrial dominance a far greater proportion of its population has moved into cities.

Energy, as a core provision to all human based activity, has been fundamental to this rise and establishment of China as an economic super power. Despite efforts to reduce its energy reliance, China remains 8th in global energy intensity (Enerdata, 2015), a measure of a country's reliance on energy for growth. One of the key facets to this energy make up has been the dominance of coal, accounting for 66% of total consumption in 2012 (EIA, 2014). The prominence of coal has led to high levels of emissions and resultant international interest, and whilst the environmental consequences of its burning places pressure on the Chinese authorities to reduce their reliance on it, another important factor influencing China's energy is the reduction in the levels of domestic reserves. Given these environmental effects and supply risks, diversification of the energy mix is vital to China's economic and environmental future.

China now represents the primary model for modern urbanization. It has the largest urban population in the world and by 2030 ~1 billion people are expected to reside in its cities (UN, 2015). This development creates major challenges to the structure of the energy industry. The status quo within China is now changing. In order to achieve the scalability required, it is acknowledged that the sectors current make up is not fit to drive economic, social and environmental sustainability, and as a result the industry is undertaking a multilayered approach to its restructuring. An additional factor for change is that greater Chinese affluence is creating more engaged citizens and increasingly demands are being placed on stakeholders across the industry.

This report identifies industrial mega trends and actions being taken as a result of them. It provides insight into the sectors major movements over recent years and proposes a future outlook of the industry for potential actors within the system to consider. It does not act to provide a definitive outcome but a platform to an understanding in order to approach investing and decision-making within the context of the inevitable need for a sustainable approach.

2 MEGATRENDS

Actors across the Chinese energy sector are to be challenged by the inevitable changes required to achieve its sustainable future. In order to fully assess ones position it is important to understand the key movements that are driving the industry into a new era of development.

Urbanization

Since opening its economic boundaries China's urban population has experienced drastic growth as economic centers such as Beijing, Shanghai, and Guangzhou provide a hive of economic activity and opportunity.

Much of the growth has come through rural-urban migration with individuals seeking the prospects of a rising income and living standards. With each individual migration, footprints rise and as a result energy consumption required to build and provide for cities has been a major driver in consumption increases. With the expectation of continued urban growth, it is this physical expansion of cities that will place the greatest pressure on the country's energy systems.

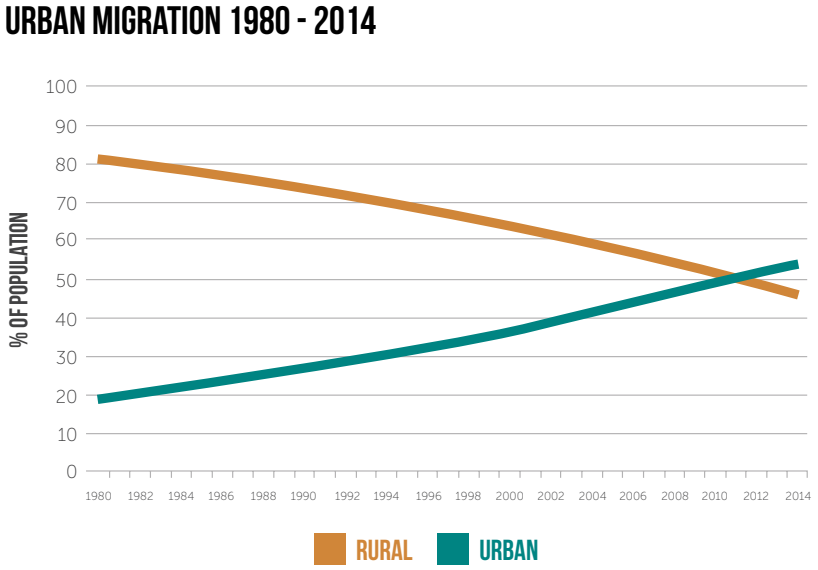


Figure 1: Urban-Rural Population Change in China. Source: World Bank, 2015

Water

Water and energy are intrinsically linked; given its importance to the cooling process thermal power generation is one of the largest consumers of water. China like many states is facing major regional scarcity problems. The industrial centers of Beijing, Shanghai and Tianjin have on average $114m^3$ per capita of water resources – 1.43% of the world average (CNBS, 2014). Like these cities much of China's energy production is located in the east of the country, provinces with higher levels of water scarcity. Further construction of power plants in these areas will only increase pressure on the water tables. These are areas of high population density where water is also required to supply municipal and agricultural needs.

Growth of Negative Externalities

China's reliance on coal has led to growing levels of greenhouse house gas (GHG) emissions and contributed to a major deterioration of the country's air quality. In 2014 it emitted 8337 million tonnes of CO2, making it the world's top GHG emitter (Enerdata, 2015). There has been much global attention on the effects of such emissions on the global atmosphere and resulting international pressure has been placed on China.

Air Pollution

In 2013 only one of China's major cities (tier 1-6) had a yearly average $PM_{2.5}$ concentration below the considered WHO standard (Greenpeace China, 2014) and in 2014, 99.6% of the Chinese population was exposed to PM levels above it (World Bank, 2015). Many of the most polluting cities are in the densely populated North East, areas of major economic development and ever increasing personal wealth and affluence, this has resulted in more informed and concerned citizens who are no longer willing to accept the situation. The government in China now realizes that strong policy and action toward $PM_{2.5}$ reductions is and will be required to maintain trust within the populous and reduce this risk of political pressure.

Resource Scarcity

China has long been reliant on its domestic coal reserves for energy production, but as China's energy needs have grown, domestic reserves have been heavily utilized to keep up with demand and significant pressure is now being placed on the country's reserves.

With the scalability required within the energy sector, the traditional model is ill equipped to take China forward. The current industry norms are unsustainable and a continuation of them would lead to fast depletion of reserves and low resource security. As a result actions must be taken on both to move away from coal as the dominant energy source and innovative models and technologies should be adopted to facilitate this shift.

Economic Transformation

China is now entering the final (tertiary) stage of its economic cycle and is moving from an investment led system to one focused on consumption. All economies transition from primary through secondary to tertiary. As this takes place it has a major impact on energy consumption, as economies enter the tertiary stage a shrinking of the energy intensive manufacturing sector occurs and leads to a reduction in energy consumption or at least in China's case energy intensity. Indeed service led economies are in the region of 6 times less power intensive than manufacturing led economies (Carbon Tracker, 2015). With the growth rate of cement output at 3.0% in 2014, its lowest rate of the last 10 years (CNBS, 2015), it may signify that a shift away from these industries is under way, and although China is likely to experience absolute demand increases in its cities in the medium term, energy intensities will decrease and lead the transition to a future reduction in total demand.

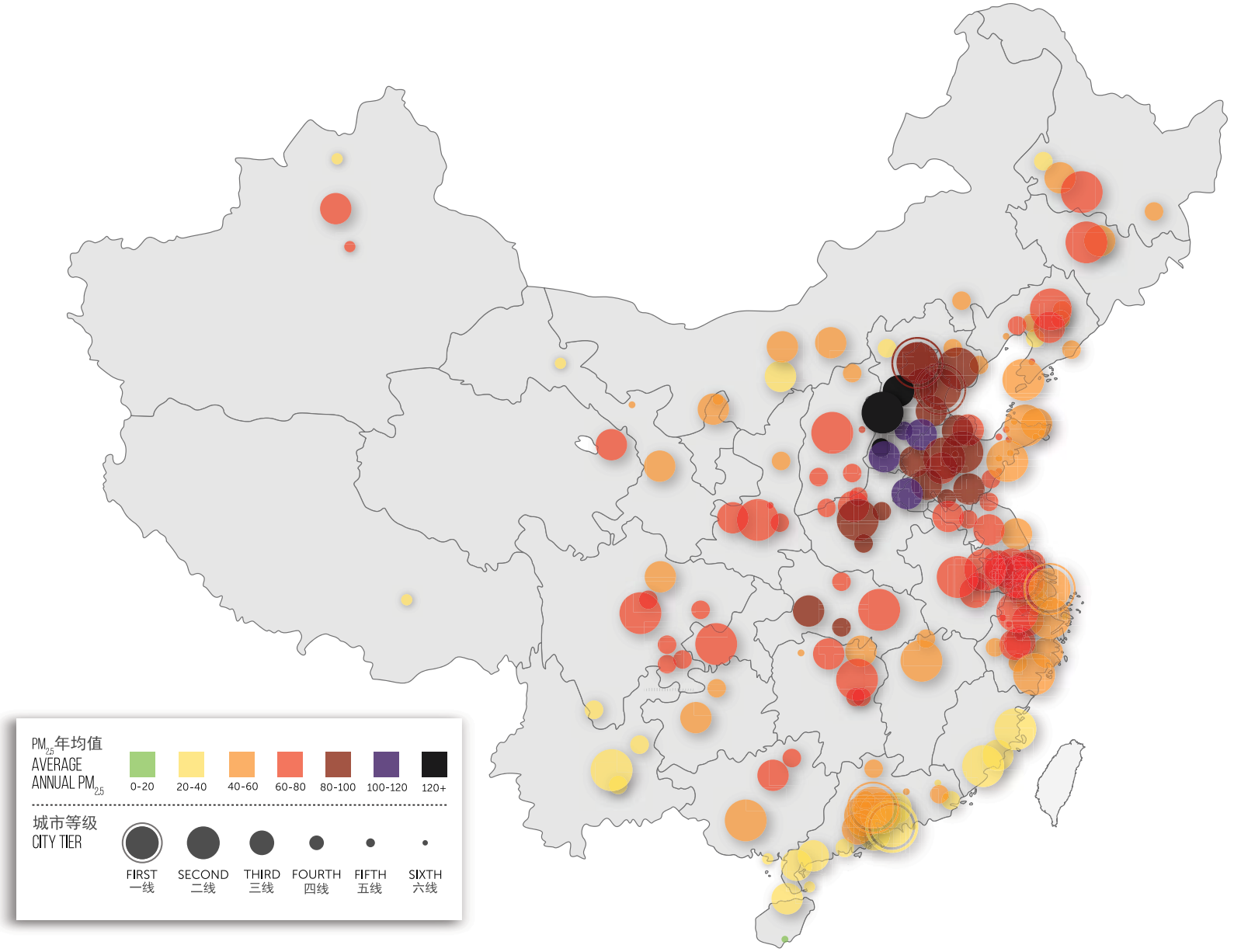
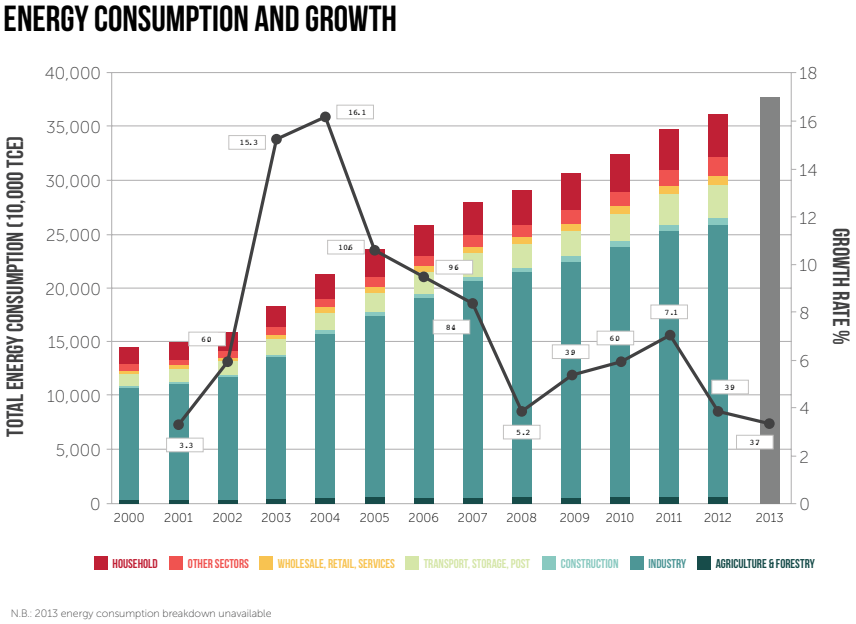


Figure 3: Average annual PM2.5 (ugm^{-3}) readings in China's cities (2013). Source: Greenpeace China, 2014

3 ENERGY DEMAND

When analyzing an energy system, insight into demand is vital to understanding its make up given it is the driver behind all supply. Here the country's demand is introduced and the complex regional nature of China's energy reliance assessed.

Industrial activity is the major consumer of energy, accounting for approximately 70% of energy consumption each year. Although consumption has continued to rise, growth rates have slowed to 3.9% and 3.7% in 2012 and 2013 (CNBS, 2014). This reflects a push from central government for better performance of demand side factors and is highlighted by the introduction of energy intensity targets in the most recent 11th and 12th 5-year plans. China has been successful in reducing its energy intensity by 29.0% from 2000 - 2014 (Enerdata, 2015), but despite this, when analysed on a regional level, both fossil fuel consumption and intensity have wide ranges. For example, Beijing's consumption has decreased by 62.0% in this time frame, whereas Xinjiang has seen a 19.1% decrease and Hainan a 2.1% increase (CNBS, 2014).



N.B.: 2013 energy consumption breakdown unavailable

Figure 4: Breakdown of energy consumption and growth figure (2000-2013). Source: CNBS, 2014

Figure 4 further emphasizes these differences showing that despite an overall decreasing growth, consumption in certain provinces is mounting. Negative growth has occurred in first tier cities such as Shanghai and Guangdong whereas Qinghai and Shaanxi have experienced 20.5% and 16.0% growth respectively. These increases in some central provinces have come as a result of local coal resource development policy to exploit the reserves available in the regions. Whilst the growth in the regions is significant on a localized scale, the lower and negative growth rates in the traditionally energy intensive provinces will likely dictate national consumption and therefore a tailing off of growth rates in energy resources should be expected in the coming years.

The first tier cities of Beijing, Shanghai and Guangdong have the lowest reliance on fossil fuels for their regional domestic product (RDP). Alongside this they rank first, second and fourth in the proportion of tertiary contribution at 72.9%, 62.2% and 46.8% respectively (CNBS, 2014). They represent regions that have gone through the full cycle of Chinese development to reach a largely service-based sector, and hence have moved away from the more energy intensive primary and secondary industries. As regions of China move toward more tertiary-based industry a decrease in fossil fuel and energy intensity can be expected. However, many other provinces are yet to experience their full industrial capabilities and for the second, third and fourth tier cities this is likely to be vital to their economic development.

This analysis explains the complex nature of energy demand in China with national figures not painting the full picture. As some regions decrease their energy consumption others are growing. The result is that certain provinces are likely to experience far greater environmental and industrial pressure over the coming decades. Although China has made great strides in regard to some demand based indicators, overall energy consumption will continue to increase over the next 10 years.

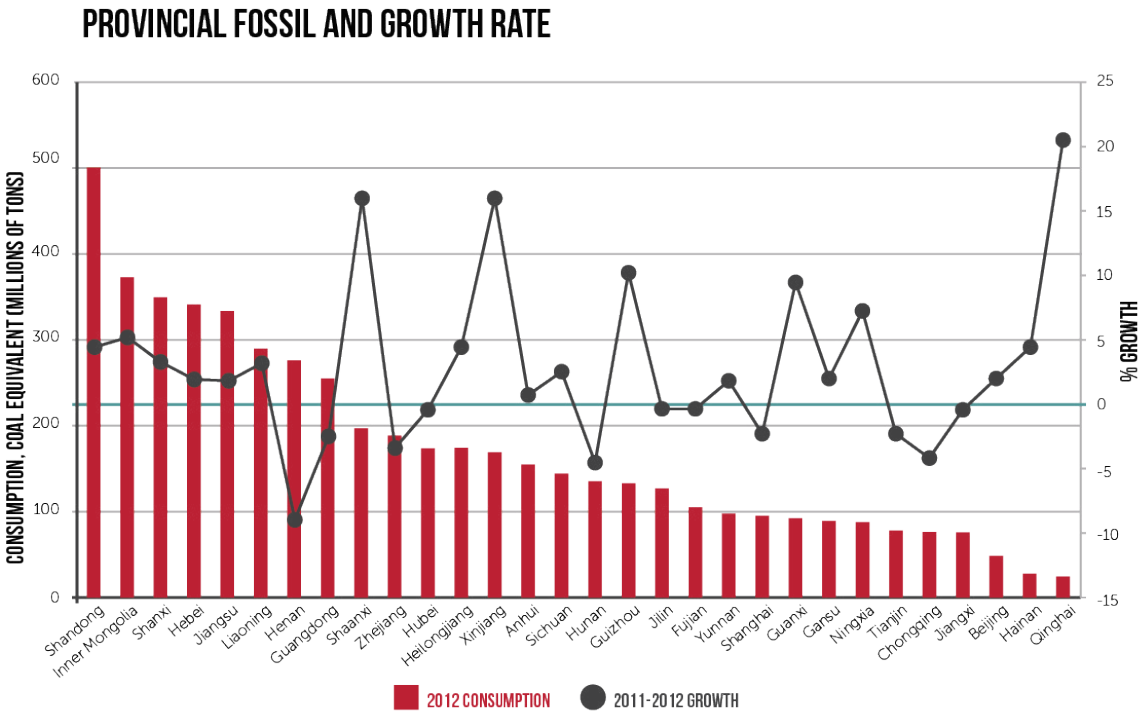


Figure 5: 2012 Provincial fossil fuel consumption and 2011-2012 % growth rate. Source: CNBS, 2014

4 ENERGY SUPPLY

Traditionally China has been able to rely on its domestic reserves of coal and other fossil fuels to account for demand. However, with the recent increases in demand and the inability of domestic supply to continually account for it, the complexity of supply and sources contributing to it have increased.

Coal

Despite an acceptance from government and state owned enterprises (SOEs) of the environmental and supply side problems associated with coal, the insatiable nature of Chinese industry and production means that coal consumption, in the immediate term, will remain the most prominent source of energy in China.

Coal's dominance in China is in large part due to the size of its domestic supply, the cost effective extraction economics, and a lack of domestic alternatives. Until recently, domestic reserves have been able to keep up with China's economic demands but of late the growth in energy demand has required China to import coal to satisfy it. Imports that steadily rose until 2014, when a tailing off was observed. Seen as many as an indication that a structural shift away from coal was beginning to take place, while for others the decline was attributed to a wider economic slowdown.

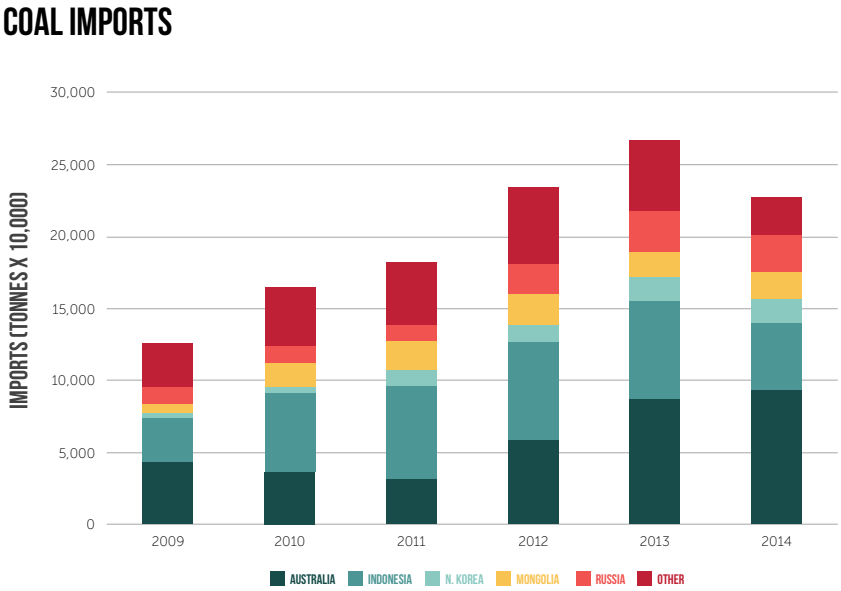


Figure 6: Coal imports to China, highlighting top 5 importers (2009 – 2014). Source: UN COMTRADE, 2014.

Despite these increased levels of imports, when compared to total consumption they accounted for a small fraction (5.2% in 2012) and it is expected that the majority China's coal will continue to be sourced from domestic reserves.

Further action to help reduce coals influence and associated environmental problems was taken in the 12th Five-Year Plan which outlined specific targets on coal production, setting a consumption limit of 4.6bn tonnes in 2015. e Although these actions clearly outline the beginnings of the push away from coal we fully expect it to remain an important part of the energy mix over the coming 10-20 years, after which recent investments in alternatives and renewables will lead to a shift of dominance in the energy mix once peak coal is reached.

Natural Gas

Natural gas is seen as an integral part of a cleaner energy future. Both internal and external infrastructural investments have been made to help account for increased demand. In recent years domestic consumption, production and imports have seen significant rises. Since 2004 domestic consumption has increased over 80m tonnes, from 30.6m tonnes, with over 70% of production coming from the provinces of Xinjiang, Shaanxi and Sichuan (CNBS, 2014).

Made possible by the creation of a west to east pipeline to bring gas from the major western producing provinces to eastern and southern regions of the country, a considerable proportion of demand has been satisfied by domestic reserves. In spite of this imports of natural gas have also increased from a number of other countries. This imported natural gas enters the country in two forms - liquid natural gas (LNG) and gaseous natural gas (GNG).

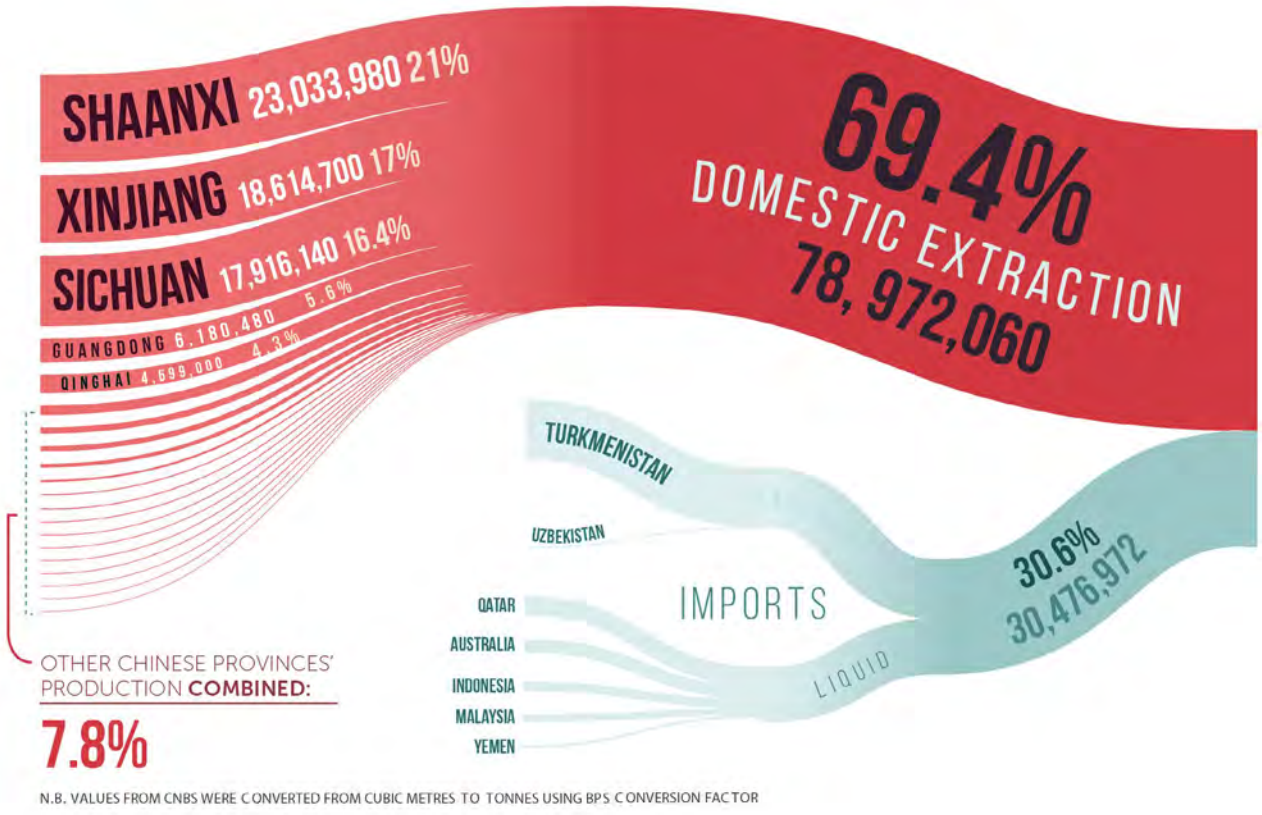


Figure 7: Material flow diagram of domestic production and import of natural gas (2012). Source: UN Comtrade, 2014; CNBS, 2015.

A reason for such rapid change in gaseous imports has been the construction of the Central Asia-China Gas Pipeline, which started construction in 2008 and will have an expected output of 55bn m^3 (40.7m tonnes) by the end of 2015. Additionally, an agreement for the building of lines with Uzbekistan, Tajikistan and Kyrgyzstan was signed in late 2013 (China National Petroleum Coorperation, 2015) and further agreements with both Myanmar and Russia for overland imports of natural gas have recently been made to boost potential supply. All of these developments show China's intent to diversify supply away from coal and imply that rises in both natural gas consumption and imports will continue.

Oil

In China crude oil consumption has increased in recent years with an average yearly consumption rise of 6.6% since 2004 (CNBS, 2014). Now, fourth in the world in terms of total production, the exponential rise in demand has now far exceeded China's domestic production capacity and imports account for ~70% of domestic demand. This high percentage of imports to total supply can result in a decrease in the level of resource security for oil. In recognition of this China has diversified its supply sources and 10 countries are responsible for 80% of its import supply with no one country accounting for more than 15% of total (UN Comtrade, 2015).

When a wide range of sources exist, the import market is less susceptible to individual supply shocks. This is because no one event in one country can cut off supply of the resource. Another facet of supply risk is in the transportation process, much of China oil comes through the Malacca straight; a narrow channel with high congestion and transport risk. This prompted the agreement of pipelines through Myanmar in 2008, which became active in 2015 and successfully bypasses the straight, reducing transport time and risk.

In response to these trends, China has also invested heavily in overseas oil exploration and reserves, allowing the country to establish a wider range of sources. In 2010, Chinese National Oil Companies (CNOCs) invested US$29.4bn abroad, up from US$18.2bn in 2009, to establish operations in 31 countries. Investments have also been made in the form of loans to resource-rich countries for infrastructure investment and development (IEA, 2011). A trend likely to continue, possibly accelerate given the current six-year low in oil prices.

Renewables

Driven by the environmental pollution associated with the burning of fossil fuels and a will to increase domestic electricity supply, renewable targets and statements of intent have been set out by the Chinese central government. These have included the implementation of specific development plans, financial support systems and incentives for emission reductions, and a series of feed-in-tariffs.

These have contributed to the growth of the renewable industry and in 2012 China's renewable electricity generation stood at 21.1% of total, with 1.9% of generation from nuclear (EIA, 2014). However, electricity generation does not paint the full picture and renewable contribution to primary energy supply (supply of all energy, inclusive of transport, factory etc.) is lower. However, by the end of 2015 it is expected that 12% of total primary energy consumption will come from renewable sources and by 2020 a targeted value of 15% is expected (China National Energy Association, 2014).

Hydro

In 2000 renewable supply came almost solely from hydro electricity (99%). This form of renewable energy has long been the workhorse of the Chinese renewable sector. The construction of the 3 Gorges Damn, with an installed capacity of 22,500 MW, signified a long-term commitment to its part of the energy mix. Since 2000 it has consistently accounted for 15.0% - 17.5% of total electricity generation (EIA, 2014; CNBS 2014), whilst its proportion of the renewable energy mix has been reduced by the rise of wind and, to a lesser extent solar its remains vital to production. The Lawrence Berkley Lab in there scenario based model expects 2050 hydro generation to account for 12% - 16% of electricity generation (Lawrence Berkeley National Laboratory, 2011). Given the intermittencies associated with other renewable options and the resource security issues associated with the fossil fuels, hydro will provide the reliable backbone to production as China's demand structure changes.

The generation type does not come without its opposition however, ecological problems associated with the flooding of areas and ecosystem destruction are often highlighted by environmentalist groups and future destabilizing environmental effects can never be fully known.
Dam construction also requires the displacement of large numbers of people, although under the current status quo this is generally an accepted action, as incomes and awareness rise opposition may increase.

RENEWABLE ELECTRICITY GENERATION

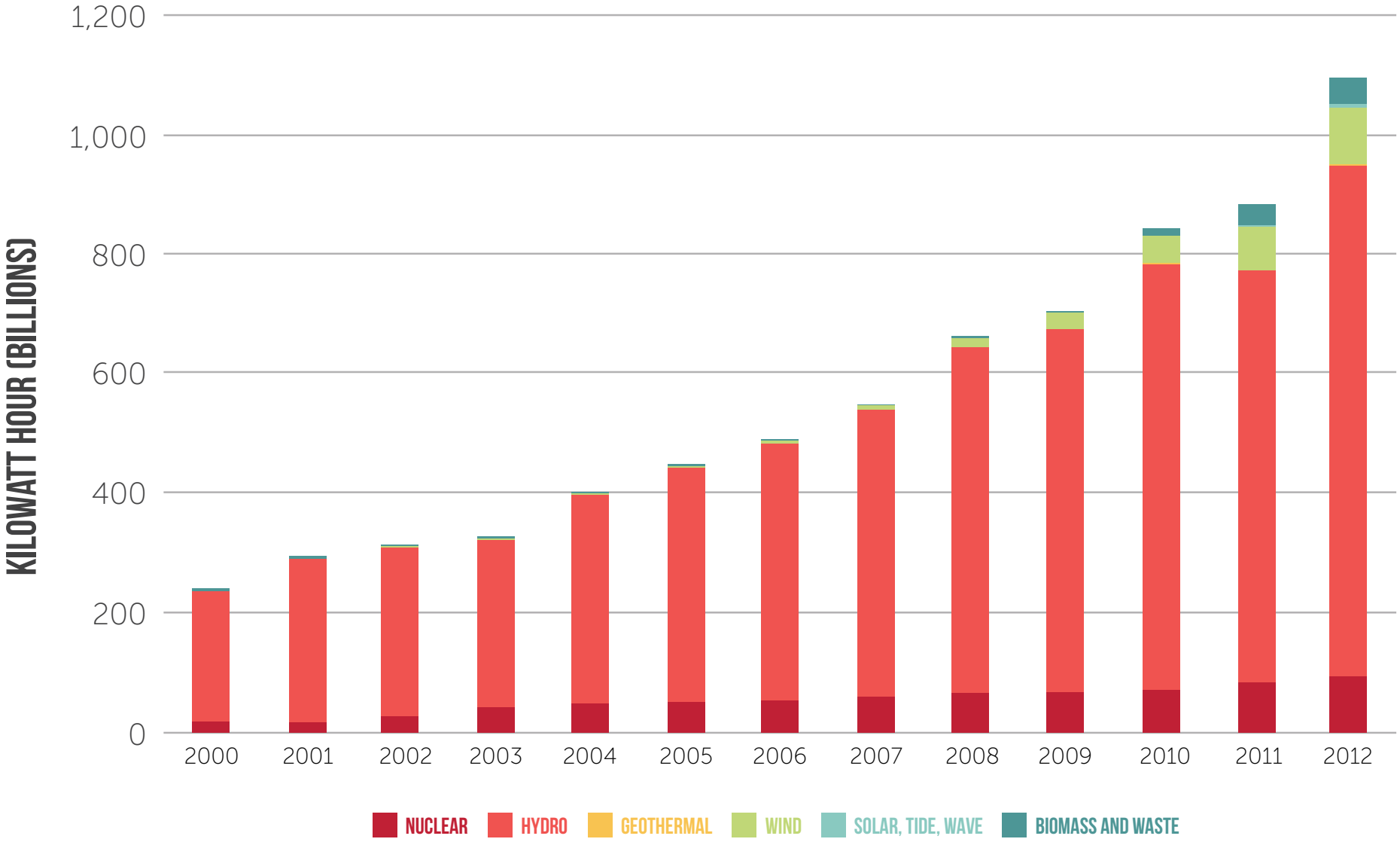


Figure 8: Development of the renewable energy mix in China (2000-2012). Source: EIA, 2014

Whilst many of the large-scale hydro developments are complete or nearing completion, with the future operations smaller, large scale environmental and social issues may be less likely. However, localized projects could also see opposition from residence in the regions of proposed development.

Additionally, planned construction on certain Tibetan rivers, such as the Yarlung Tsangpo, could have a direct impact on its relationships with neighboring states, India and Bangladesh. This is a point of growing tension and could impact on China's ability to increase hydro capacity and, as many experts now believe water to be a future instigator of trans boundary conflict, could be an issue in Sino-Indian relations.

Wind

China now hosts 31.0% of the world's wind capacity (GWEC, 2014) and it has vast levels of potential capacity, calculated at 43 million GWh (Lu, Mcelroy, & Kiviluoma, 2009). Acknowledging this, China is targeting a total capacity of 200 GW by 2020, up from 91.4 GW in 2013 (GWEC, 2014) and planned development to 1000 GW by 2050 (Xinhuanet, 2015).

Despite the capacity increases at the front end of wind supply there are a number of factors that reduce the effectiveness of wind as a power source. The first is the problems of intermittency, put simply wind does not always blow and therefore consistent power generation cannot be guaranteed. This can pose problems to those reliant on wind for their electricity consumption and back up options are required. Furthermore, the current capability of the grid structure is not sufficient to account for new installed capacity. Compared to other countries investment ratios between power generation expansion and grid infrastructure investment is considerable lower than many other countries with ~40% spent on grid development since 1978, as opposed to ~65% in France (Li, Hubacek, & Siu, 2012). Given the remoteness of many wind operations this is a major barrier to successful utilization of capacity. This lack of investment has resulted in a large percentage of idle wind farms, totaling 30% in 2010 (Zhao et al., 2012) and 20% in mid 2015 (Reuters, 2015). This has in part come to due to poorly managed incentivized system that has encouraged rapid capacity development without fully addressing issues related to quality and transmission (Wu et al., 2014).

Solar

Although the contribution of solar energy to total production is currently small, the level of development in this sector has mirrored that of other renewables. China's installed capacity now stands at 23 GW, second only to Germany, and total production boomed 22-fold between 2009-2012. In 2013, 12 GW was added and $23.6bn committed to the technology, with a further 3.3 GW installed in the first half of 2014. An ambitious target has been set of 50 GW capacity by 2020 and incentives in the form of feed-in-tariffs have been offered to boost sectorial development.

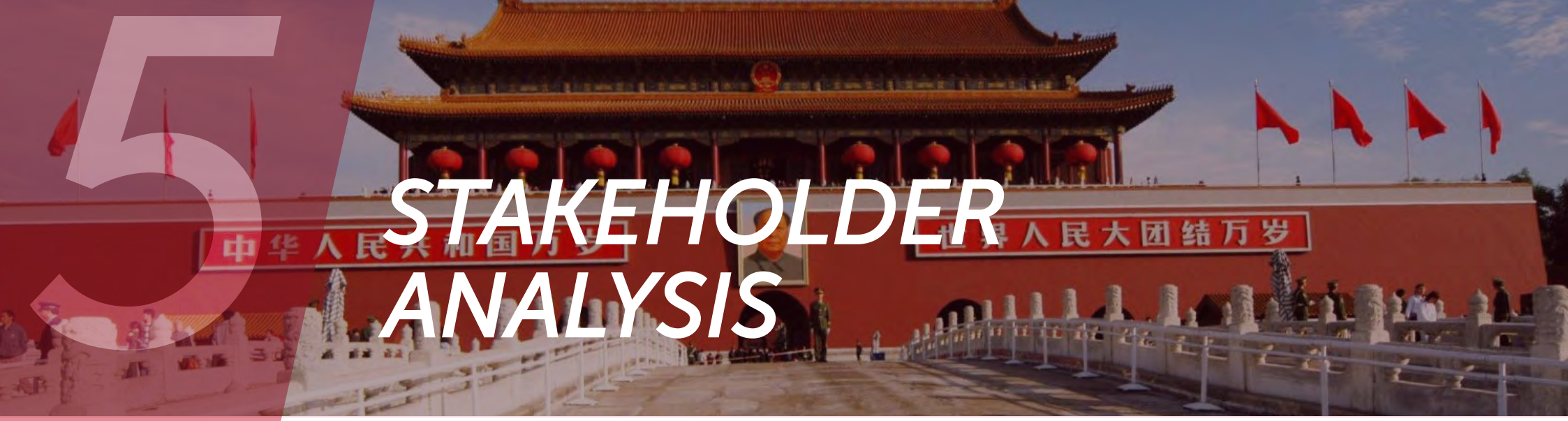
Capacity issues faced by wind are also experienced within the solar industry, much of the photovoltaic (PV) potential is in the remoter provinces such as Tibet and Sichuan, but in these regions connectivity infrastructure is lacking and surplus capacity results. In addition to this, incentives for the delivery of PV have resulted in over construction of solar farms and grid connectivity developments have been unable to keep up, further contributing to idle capacity. In the first half of 2015 it was announced that 9% of total solar capacity was idle due to grid inefficiency in remoter provinces (China National Energy Association, 2015).

Nuclear

Within China, nuclear technology is an important component in the move toward a cleaner energy mix. Currently there are 30 plants operational and 21 under construction with further projects expected to be forthcoming. While the rising costs associated with nuclear technology have impacted nuclear development internationally, China so far has been unaffected by such barriers and continues to commit capital to a wide range of projects. The 11th and 12th Five-Year Plans have allowed for large development in the nuclear sector with phase I and II projects initiated in a number of provinces. The 12th Five-Year Plan also saw 16 provinces, regions and municipalities commit to the construction of reactors to increase regional and national capacity. In 2015, installed nuclear capacity will be ~50GW but with on going developments the expectation is that capacity will reach 58 GW by 2020 and 150 GW by 2030 (World Nuclear Association, 2015).

One potential limitation to China's nuclear developments is the relatively low level of domestic uranium reserves. If capacity targets are achieved it could require as much as 30000 tonnes of uranium in 2030 and in 2009 only 750 were mined domestically (Dittmar, 2012). As a result it will have to look elsewhere for uranium resources, further increasing the reliance on imports of China's energy industry.

Another area of importance to Chinese nuclear expansion is the public perception of the technology. The Fukishima disaster has not gone unnoticed in China. Research by L.Huang et al., concluded that it had profoundly impacted on the level of confidence that the Chinese population has in the technology and public acceptance has decreased, in particular in areas in close proximity to reactors (Huang et al., 2013). With a growing middle class these concerns should not go unnoticed by government and nuclear developers.



5 STAKEHOLDER ANALYSIS

With the environmental and social challenges associated with the externalities of current policies, sources of energy, and emissions, it is important to note that a significant shift in stakeholder expectations and alignments is beginning to occur. The expected influx of 300 million Chinese residents into cities has meant that, in order to address the changing demand structure, stakeholders are required to take action to move away from the current framework to a more efficient, sustainable system.

Actions have already been taken by a number of stakeholders; the government is developing supply side factors through diversification of the energy mix and greater pressure exist from NGOs and consumers in relation to environmental problems. Greater media attention is being focused on the area and resultant pressure on state owned enterprise (SOE) is growing. If China is to achieve what is required in 2025 then the furthering alignment of stakeholder ambition is going to be vital to its energy future and actions towards the same goals can and should be prioritized.

Government

As China's key stakeholder in the energy industry, the Chinese government has a powerful role as both an active player and referee within the system. It has both the ability to shape the energy industry through plans and policies, but is also the body that sets pricing for raw materials and energy, with final authority on investment approvals. It is a stakeholder that is an umbrella of powerful agencies and actors, with the National Development and Reform Commission (NDRC), responsible for formulating energy policy and pricing, and the National Energy Administration (NEA) tasked with drafting and implementing such plans and policy. In the development of these policies the NDRC pays attention to factors including economics, social and environmental harm. Due to the state-owned nature, China's power producers, and grid operators represent institutions that have significant capacity for change or resistance. For these organizations, their unwillingness to follow environmental regulations, install basic environmental controls, or increase the cleanliness of energy supplies has been a core source of friction.

Proactive actions have been taken in the areas of domestic supply and security and a focusing of sustainable alternatives towards a longer-term energy strategy. The 12th 5-year plan saw action in regards to greater efficiency and reduction in energy intensity, couple with renewable subsidies and targets. These provide example of greater government led impetus for internal and external developments.

They now realize the importance of guaranteeing energy security to the future of energy and actions and policies are reflecting this. Development of domestic production alternatives to coal and

and efficiency developments are examples of this but in light of growing import percentages overseas developments may act to increase the level of security that China holds over its energy resources. However when compared to the current situation the level of influence that the centralized government can have will diminish as China's energy portfolio moves to a more import based system, and with the Lawrence Berkley Institute predicting that by 2050 fossil fuels imports could be up to 97% of total supply this situation may well occur. This may see the consumers shoulder some of the cost and energy price rises may result. The situation will have to be well managed by the government in order to guarantee supply and is one reason why strong external developments, often funded by China, and contracts have been signed.

Producers & Distributers

An added complexity of the energy industry is the state-owned nature of a number of China's biggest energy companies and distribution channels. The government has large stakes in a wide range of companies including Sinopec and Petrochina. As a result, internal industrial activity and investment can be directly influenced by government decision-making. This coupled with goals and regulations further compounds the state-level control on the sector and as a result if there is a desire within government, sectorial behavior can be heavily influenced. The overseas investments by many of the major SOEs have reflected this attitude, with extraction and infrastructure developments growing over recent years. Despite the state core to many of these organization, their growing size and influence has meant that they have become more decentralized and as a result their ability to have impact has grown. Ultimately, when dealing with overseas investments, they are market driven and central regulators cannot influence decision making as heavily. As China domestic reserves deplete the influence of these state owned enterprises may grow, overseas operations will become more privatized and expansion decisions less centralized.

Industrial Consumers

To date it has been industrial users who have faced the greatest pressure from stakeholders with heavy industrial users of energy often the target of government shutdowns as part of efforts to clean the air, particularly in the capital, Beijing. These shutdowns have been supported through changes in investment policies inside city limits, relocation of heavy industry and polluters, and a series of energy tariff increases. Paralleled with government action is a burgeoning NIMBY movement, at times government supported, by citizens concerned with the direct impacts of an industrial plant's emissions on a local community. Despite the previous dominance of the industrial sector to energy demand, China is going through an economic transformation to a more service based economy, particularly within first tier cities. As these changes occur the energy intensive industry proportion of the countries consumption will reduce. Although it will still be the main consumer of energy its level of influence will diminish and actors within sectors such as transport and commercial industries will impact demand.

Residential Consumers

With the continued growth of cities, and affluence of city dwellers, household consumers' demand for energy will rise. Without conscious efforts to conserve energy, household consumers tend to use energy inefficiently. Ultimately a large part of consumer motivation to reduce their demand for energy is related to price. Currently the price structure set by the government does not result in a need for consumers to reduce costs through energy efficiency. With the lack of pricing deterrent, traditionally there has been poor awareness from Chinese consumers about the effects of wasteful individual actions. Despite a lack of incentive to alter behavior "in home", due to affordable pricing, the effects of and reasons behind air pollution are creating greater awareness of this issue. There is still a long way go however, many in China feel that individuals can do little and look to the government to take action.

Media

Over the last five years the Chinese media has been given increased latitude to report on issues of the environment. Such reporting has increased public awareness of environment issues and the media has gained influence as a stakeholder in this area, particularly when aligned to an NGO or citizen group. Issues that were once considered sensitive are now regularly disclosed. An example of this was the release of "Under the Dome", a documentary that highlighted the negative impacts of air pollution. This stimulated great debate in the country, and despite eventual removal, showed that government has a greater willingness to allow these stories and leverage them as part of its own agenda.

NGO

While at times finding their relationships with the government unstable, the role of NGOs as a stakeholder has improved significantly over the last five years. Unlike in the West, however, where the NGOs would be activists or campaigners, organizations like Greenpeace, The Climate Group, and the Natural Resources Defense Council have carved out a niche as researchers who publish data in partnership with government agencies, academic institutions, and industry associations. As such, they have become in the eyes of many, a resource for information in a space where information is often lacking, and are able to provide guidance for stakeholders that help catalyze policy discussions and identify violators.

6 EXPECTED FUTURE ACTIONS

With the expectation that by 2030 China will have over 1 billion urban residents, overall energy demand will continue to grow well into the next two decades. China has begun to act to reduce the potential risk associated with the continuation of the business as usual scenario, but further actions are required in order to shore up energy supply and develop the transition to a greener energy mix. In light of this, we see a number of areas of importance that will set the basis for shaping the future of the industry.

Energy Supply Access and Extraction

Maintaining resource security is something that China and its government are desperate to achieve. In an attempt to reduce this reliance and increase security China has taken considerable action. A push for diversification of the energy mix has signified recognition of this problem and attempts to develop this security. Large-scale infrastructural investments internally and internationally have been made to boost the sector. Domestic production of natural gas has grown considerably in recent years and the Sino-Russian agreement was signed in May 2014 and is a 30-year pledge to import reserves of LNG through northern China. However, recent concerns by the Chinese energy giants regarding their inability to extract their vast shale gas resource, so successfully utilized by US, will place greater pressure on domestic supply and the import market. Therefore the development of overseas resources may be an area of continued emphasis from the central government and SOEs, but the development of domestic energy production and sources will be a major priority.

Continued Investment in Efficiency

An area in which China has been successful is in the reduction of its energy intensity – a measurement of energy's importance to GDP. It has achieved a 29.0% reduction in this indicator since 2000 (Enerdata, 2015) and although the regional picture of this statistic remains more complex, this implies that China has begun to decouple its economic growth from energy production. This is often observed when an economy moves towards a more service-based industry.

Demand Side Efficiency

Within the city, efficiency investments will come in large part through building efficiency. An area that in the past has been lacking as building codes went unenforced and the investment models promoted speed over quality. Going forward, as can be seen in the increasing number of 3 Star and LEED developments, opportunities in providing goods and services into the building of greener buildings will continue to grow.

Despite opportunity and growing impetus existing to develop a higher standard of new builds the real challenge exists in increasing the efficiency of existing building stock - a stock that has been built over the last 15 years, and was built with little consideration for efficiency. Retrofitting is one solution and growing levels of installations have begun. With impetus from the central government a code for retrofitting now exists in the North and specific targets have been set with local governments expected to meet and help to finance them. Additionally government buildings have been targeted for retrofit programs and financial mechanisms for energy service companies have been introduced. Continued investment in this area will aid the efficiency increases and contribute to bettering national energy and carbon intensity.

Supply Side Efficiency

Focusing on generation efficiency is an effective way to reduce per unit costs associated with energy production. Energy losses occur in all form of production types, but increasing efficiency benefits resources in all spheres. A percentage point increase in efficiency will reduce the amount of water, coal, natural gas required to produce a unit of energy, reducing resource demand. China's 5-year plan focused heavily on the aspect to power generation and, for coal, success has been achieved but seemingly no attempt has been made for oil and gas.

THERMAL GENERATION TYPE	1999	2011
COAL	28.9	35.7
GAS	38.9	38.9
OIL	33.6	33.6

Table 1: Efficiency improvement by thermal generation type (1999-2011). Source: Ecofys, 2014

Despite the improvements in coal efficiency when China's fossil fuel rates are compared to the best in the world there is still considerable room for improvement.

THERMAL GENERATION TYPE	WORLD LEADER (%)	CHINA (%)
COAL	43	35.7
GAS	53	38.9
OIL	46	33.6

Table 2: : Efficiency comparison by thermal generation type, China vs World Leader (1999-2011). Source: (Ecofys, 2014)

Given the energy and carbon intensity targets set out in the most recent 5-year plans, bettering production and consumption efficiencies is an important mechanism to aid achievement. Increasing levels will improve the country's resource security and reduce per unit emissions. As such, continued investment will be vital to developing a lower carbon future for China.

Investments in Renewables & Nuclear

Over the past 10 years China has begun to diversify its renewable energy production. For much of its energy development hydro almost solely accounted for the renewable contribution. Since then there have been significant rises in all other forms of alternative energy – from wind to biomass production and growing investment is occurring. If China is to achieve the target of 15% renewable contribution by 2020 and the desired move away from fossil fuels then further development and investment in the renewable and nuclear sectors are required. Modeling predictions suggest that if China is to truly decouple coal from its energy mix then nuclear must be developed to shoulder a large amount of electricity supply. Were China to achieve the accelerated improvement scenario outlined by the Lawrence Berkley Lab, driving demand down whilst achieving efficiency improvements and diversifying the mix toward nuclear and renewables, it is considered that by 2050 China could potentially move it's reliance on fossil fuels from 77% (2010) to 9%, with nuclear accounting for 54% of production (Lawrence Berkeley National Laboratory, 2011).

RENEWABLE CONTRIBUTION TO ELECTRICITY GENERATION

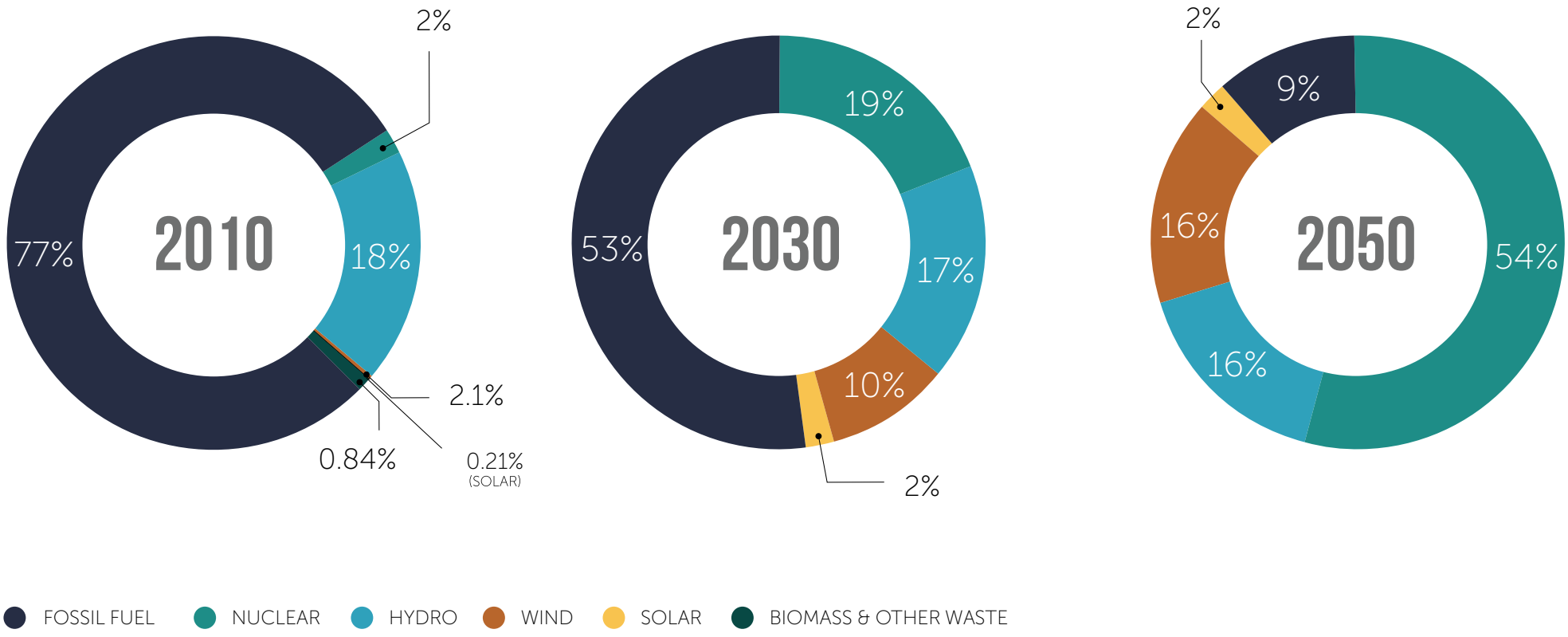


Figure 9: Electricity generation mix and projections under accelerate improvement scenario. Source: Adapted from Lawrence Berkeley National Laboratory, 2011

7 CONCLUSIONS

With China's plan to urbanize another 20-30 million people per year until 2030, there is little doubt that overall energy demand will continue to grow for the next two decades. As will the size of the challenges that China faces with addressing the imbalances in its energy systems; a system that by some estimates will grow by more than 250% over the same time period.

At Collective Responsibility, whether it be through the increased political pressure of expanding overseas energy sources or the pressure to address the deteriorating air quality conditions, we view the imbalances highlighted in this report as the entry point opportunities for stakeholders to bring scalable solutions to the market.

Opportunities whose value propositions will grow more attractive as economic transportation of regions, increased regulation of emissions, resource price adjustments, investments in building efficiency and other incentives are all brought forward.

To learn more about the opportunities we see, particular to your industry, please contact us.

Contact us at:
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REFERENCES

Carbon Tracker. (2015). Lost in Transition – How the energy sector is missing potential demand destruction.

Chinese National Bureau of Statistics (CNBS). Various years. China Statistical Yearbooks. China Statistics Press.

China National Energy Association. (2014). Renewable Energy Power Generation. Official Website (In Chinese).

China National Petroleum Coorperation. (2015). Central Asia-China Gas Pipeline. Official Website.

Dittmar, M. (2012). Nuclear energy: Status and future limitations. Energy, 37(1), 35–40.

Ecofys. (2014). International Comparison of Fossil Power Efficiency and CO2 Intensity.

EIA, U. S. (2014). World Energy Statistics. Independant Statistics and Analysis.

Enerdata. (2015). World Energy Statistics | World Energy Consumption & Stats.

Greenpeace China (2014). National Urban PM2.5 Rankings (In Chinese).

GWEC. (2014). Global Wind Report. Wind Energy Technology, 72.

Huang, L., Zhou, Y., Han, Y., Hammitt, J. K., Bi, J., & Liu, Y. (2013). Effect of the Fukushima nuclear accident on the risk perception of residents near a nuclear power plant in China. Proceedings of the National Academy of Sciences, 110(49), 19742–19747.

IEA. (2011). Overseas investments by chinese national oil companies.

Lawrence Berkeley National Laboratory. (2011). China's Energy and Carbon Emissions Outlook to 2050.

Lu, X., Mcelroy, M. B., & Kiviluoma, J. (2009). Global potential for wind-generated electricity, 106(27), 10933–10938.

National Bureau of Statistics (NBS). Various years. China Statistical Yearbooks. China Statistics Press.

Reuters. (2015). Chinese wind earnings under pressure with fifth of farms idle.

UN. (2015). World Urbanization Prospects - The 2014 Revision. doi:(ST/ESA/SER.A/366)

UN Comtrade. (2015). International Trade Statistics Database.

World Bank. (2014). GDP Rankings in terms of Purchasing Power Parity (PPP).

World Bank. (2015). China Country Information.

World Nuclear Association. (2015). Nuclear Power in China.

Wu, Z., Sun, H., & Du, Y. (2014). A large amount of idle capacity under rapid expansion : Policy analysis on the dilemma of wind power utilization in China. Renewable and Sustainable Energy Reviews, 32, 271–277.

Xinhuanet. (2015). China to develop wind power (In Chinese). Retrieved from http://news.xinhuanet.com/2014-10/15/c_1112834118.htm

Yu, S., Evans, M., & Shi, Q. (2014). Analysis of the Chinese Market for Building Energy Efficiency.

Zhao, X., Zhang, S., Yang, R., & Wang, M. (2012). Constraints on the effective utilization of wind power in China: An illustration from the northeast China grid. Renewable and Sustainable Energy Reviews, 16(7), 4508–4514.

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