China Energy Outlook (2015-2016)

In the early September 2015, my research team of the annual *World Energy China Outlook* – a major innovation project of Chinese Academy of Social Sciences (CASS) – concluded its interim report. We employ both Current Policies Scenario (CPS, i.e. a set of policies released during our research and their implications) and Eco-friendly Energy Strategy (EES, i.e. our recommended scenario with certain assumptions) when conducting our Outlook.

We believe that current policies are well oriented since major intended targets (including building up of a well-off society by 2020) would be met. However, some associated uncertainties in the structural adjustment and reform, energy efficiency enhancement and energy saving remain. Therefore, an expected trajectory of energy transition may not be absolute, risk-free and so against higher economic growth.

We argue comparing with the CPS that the energy transition could also come up with a pattern shift featured with lower economic growth as a natural trajectory, together with repositioning of coal, oil, and gas sectors in the final consumption ends, debottlenecking of non-fossil fuels, and justifying the ties between energy saving and CO_2 emission reduction. Therefore, we recommend our EES scenario that suggests and pursues a new economic development pattern and dynamics with increasing quality of growth, coupled with an optimized energy system, higher efficiency and lower-carbon development. This leads to eight insights or designated trends towards energy transition indicating a fact that current policies are not only achievable but also would be realized earlier under our recommendations into 2030.

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1. Energy Demand Could Reach Its Plateau in 2020 and Start to Decouple from Economic Growth

Our research indicates that energy demand in the country will continue to grow at a rate nearing 2 percent from 2015 (30.21 mtoe) to 2030 (40.46 mtoe) under the CPS, however, it could otherwise reach its plateau (33.80 mtoe) in 2020 and onwards until 2030 (33.94 mtoe) due to deepening structural change and efficiency enhancement against slowdown of economic growth. Therefore, the total primary energy demand under our recommended scenario would be 6.43 mtoe lower than that under CPS in 2030.

From the perspective of energy demand elasticity, the closer link between energy demand growth and economic growth could be relaxed after 2025 reflecting a moderate slowdown in gross domestic product (GDP) growth in favor of energy-saving, structural reform and energy efficiency. Eventually, a decoupling between energy demand and economic growth could be witnessed from 2030 onwards.

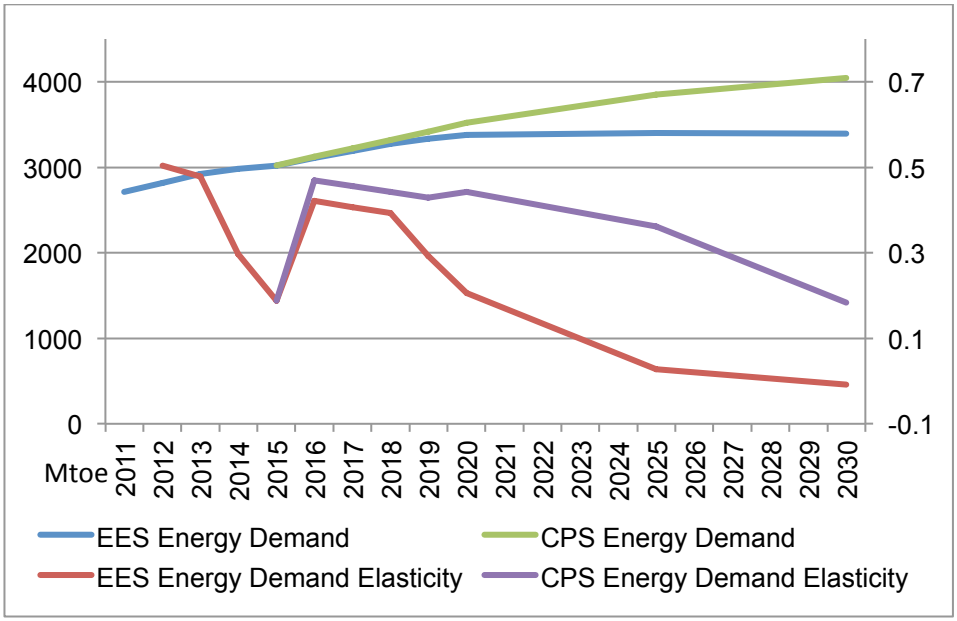

Figure 1: Energy Consumption vs. Economy Growth

2. Electricity Generation Could Slow Down at Pace While Societal Electrification Is Improved Significantly

We believe that both total electricity generation in giga watts and its elastic modulus continue to be upwards steadily, whereas electrification (electricity use in final consumption fields) increases accordingly under the CPS. By contrast, under the EES, although both total

electricity generation capacity and its elastic modulus are lower though, astonishing enough, the level of electrification proves to be higher than that under CPS. So would the application of electricity be widely spread out in the final use, rendering final end of energy system cleaner, more environmentally-friendly, and sustainable. This helps build up a low-carbon society, new lifestyle and happiness with brand of "Beauty China".

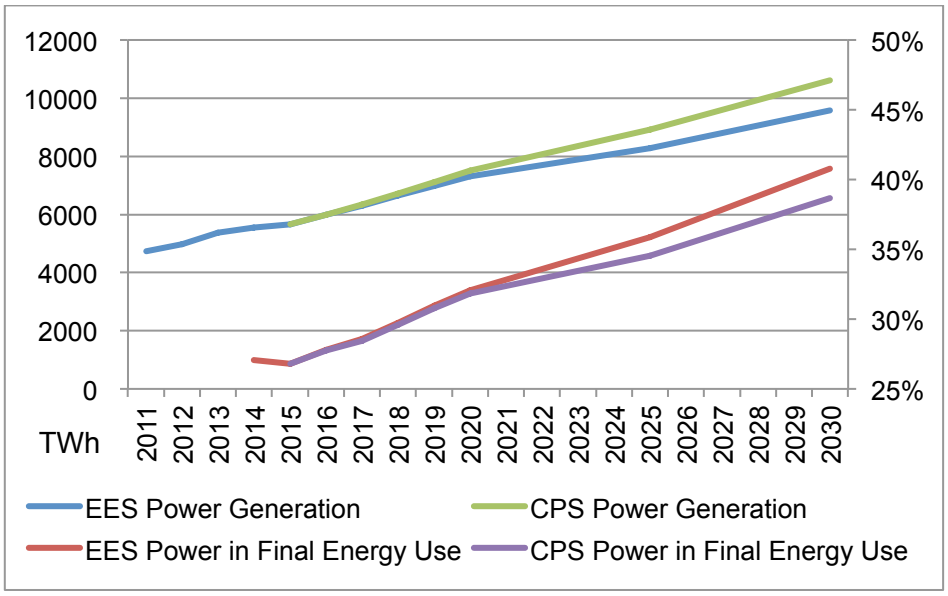

Figure 2: Electricity Generation vs. Electrification

3. Clean and Efficient Coal Use Contributes To Energy-Saving and Emission-Reduction a Great Deal

Coal use is a crucial to energy transition in China. Thanks to new realities and tendencies described above, coal demand could be reaching its plateau in 2019-2025 at about 3.1 billion tons of coal equivalent (tce) under CPS, whereas it could otherwise be at its peak at 2.9 billion tce before declining thereafter under EES. Accordingly, the share of coal in the total energy consumption mix would decline, year on year, standing at below 60 percent in 2020 and nearly 50 percent in 2030 under CPS. By contrast, the share of coal demand could drop below 44 percent in 2030 under EES, an approximate 7 percent difference to the CPS. Again, since the slowdown in coal demand is obviously envisioned, there would be bigger resilience for an increase in clean and efficient use of other types of energy sources.

Please note that coal sources used for power generation have tended to increase over the years while coal used in the final consumption (especially residential and industrial fields)

has shrunk. The both constitute a trade-off interaction. With this dynamic that the share of coal for power generation increases at a faster pace in EES than that of CPS, dirty coal could be boiled cleaner, being a much bigger contributor to the energy transition.

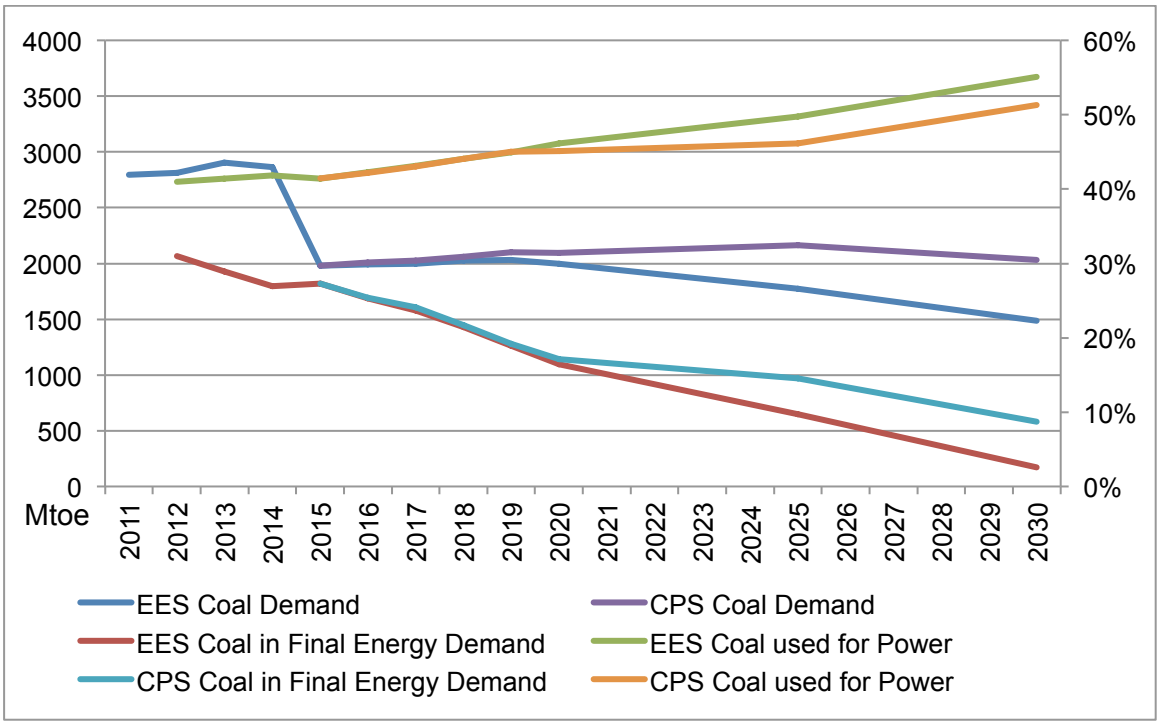

Figure 3: Coal Outlook Under Two Scenarios

4. The Dependence On Foreign Oil and Gas Could Be Lower Through Systematic Optimization

We argue that oil prices were low prior to 2020 (the Brent crude in the range of 45-65 dollars per barrel). Under this circumstance, both scenarios require an increase in dependence on foreign oil and gas to China, accordingly. The dependence on foreign oil will increase steadily from 60.67 percent in 2015 to above 63 percent in 2020 and will maintain that level until 2030 under CPS, taking into account the potential substitute of oil fuels by coal lique faction, electric vehicles and LNG transportation. By contrast, under the EES, it will also maintain the level at 62.40 percent in 2020 and then fall to 59 percent in 2030. The difference lies in the way in which oil is factored into the energy optimization process and the implementing of the energy-saving measures under the EES. We estimate that the amount of substitution fuels could be more than 50 million tons in 2020 and higher, resulting in an effective decrease in oil imports. The dynamic optimization is also applicable to decrease the dependency on foreign gas as well.

Based on our latest review on natural gas, the anticipated growth of gas demand should be lower than the estimated double-digit rate, while gas imports would be under serious pressure (i.e., facing possible surplus of supplies) somehow until gas utilization is justified in 2030.

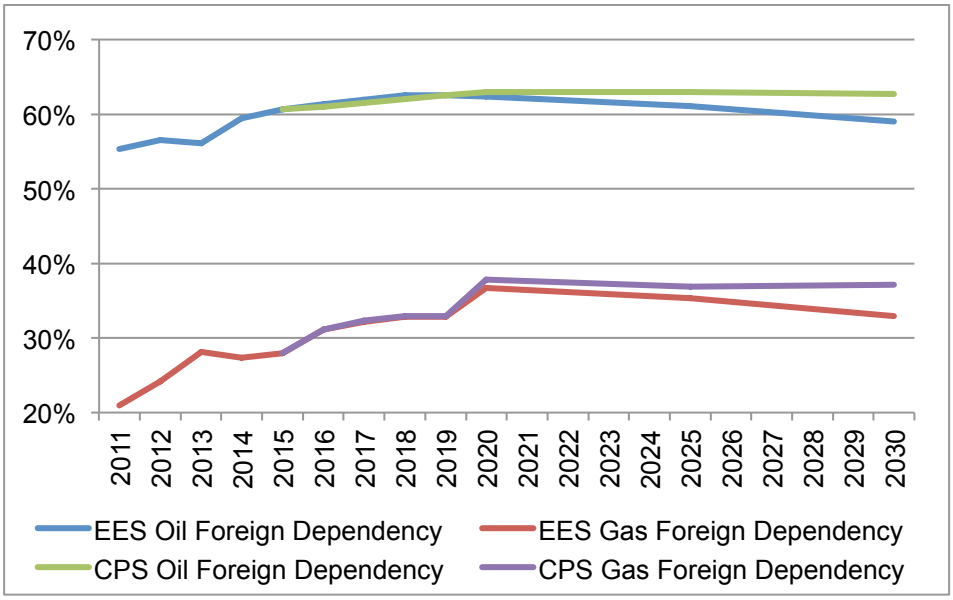

Figure 4: Comparative Dependencies Of Foreign Oil and Gas

5. The Targeted Share Of Non-fossil Fuels Might Come Earlier

The share of non-fossil fuels in primary energy consumption and its proportion in power generation capacity increases every year in both scenarios. Specifically under CPS, non-fossil fuels account for a lower share and a slow increase, although it will nonetheless reach the policy objective, i.e. around 20 percent in 2030 as agreed with the US. Comparatively, the share of non-fossil fuels could be increased rapidly in our EES circumstance, reaching 24 percent in 2030, indicating that the 20 percent policy objective can be realized four years ahead of time under the EES if managed in an unconventional manner.

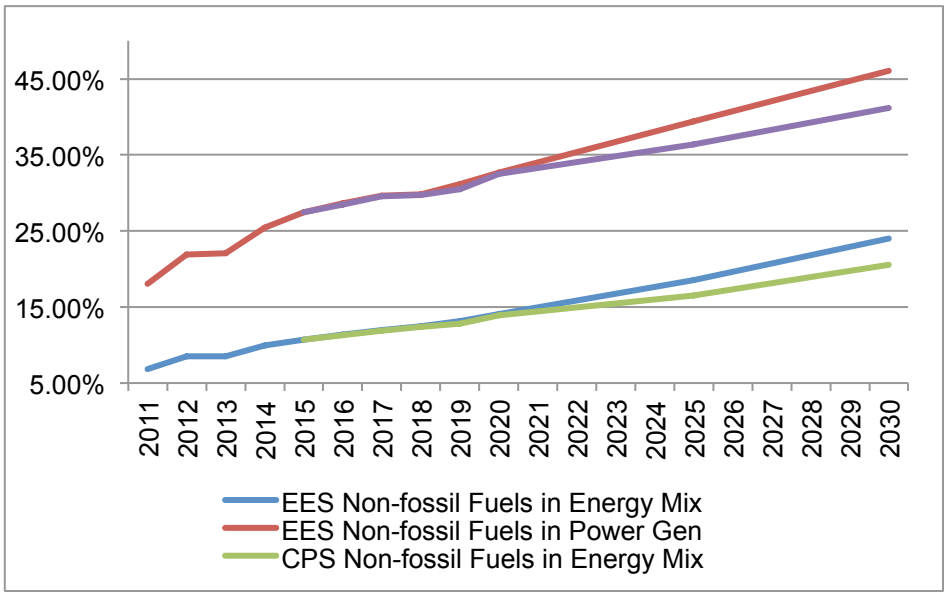

Figure 5: Different Non-fossil Fuels Outlooks

6. Nuclear Power: Indispensable and Ready to Grow Without Delay

Nuclear power is indispensible and ready to grow without delay in China giving it an increasingly important role in satisfying the above-mentioned share of non-fossil fuels in 2030. We calculated that the scale of nuclear power could be over 170 GW, accounting for about 6 percent in 2030 under CPS, slightly lower in the EES. As a result, China would lead the world nuclear power sector by installed capacity, surpassing Japan, France and the United States prior to 2030. However, the steady growth in nuclear installed capacity is subject to an enhancement of its comprehensive strength as well as competitiveness. Construction will commence in 2015 through to 2020 (8 to 10 units put into construction annually). However, how to build up one or two world-class brands with industrial strength corresponding to the designated scale of nuclear power stated above remains a major challenge.

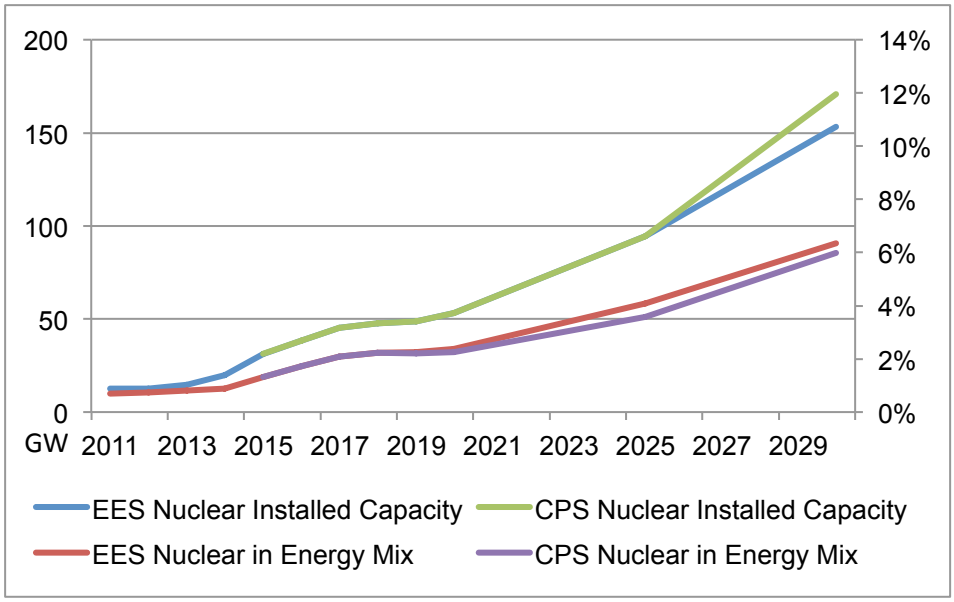

Figure 6: Nuclear Energy Outlook

7. Energy Efficiency Is Vital Always

Energy efficiency is always crucial to energy-saving, transformation and development. Obviously, this factor is highly positioned in our recommended scenario, quite above that in the CPS. We confirmed this setting in the wake of a study tour to a place called Shanghai Waigaoqiao No. 3 Electric Generation Company with a power supply cost at 276 gram per kWh from its two one GW generators. These achievements convinced us that energy efficiency holds a huge potential in China and should be deemed as vital in the energy transition period as well as a change in consumption patterns.

Through the energy system optimization, the total industrial output per energy unit cost under CPS stands at 37306 RMB in 2030 (by 2011 constant prices calculation), whereas the output could also reach 41626 RMB in EES, nearly 10 percent higher than the former.

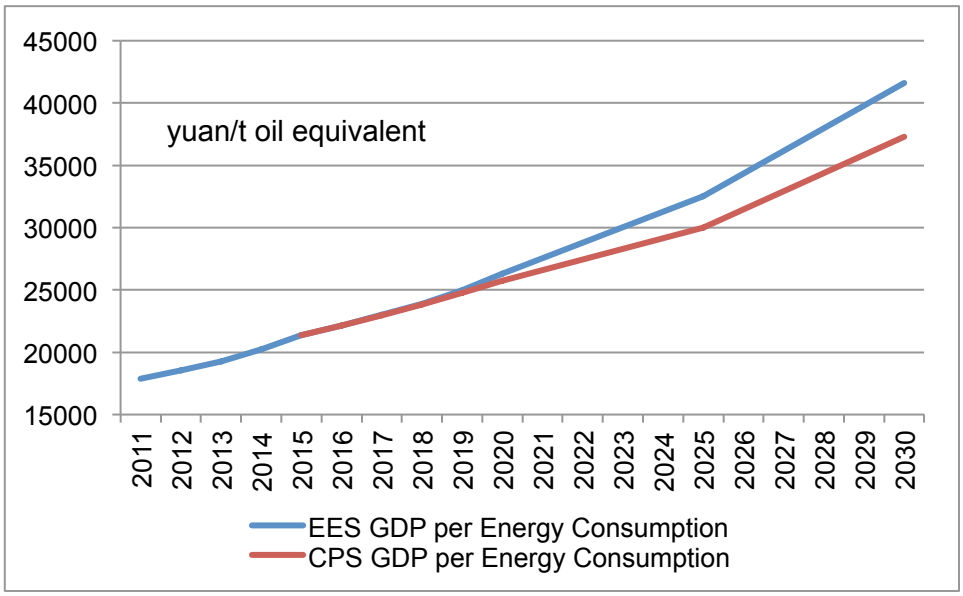

Figure 7: Energy Efficiency

8. Carbon Emission Could Peak Before Declining in 2020

Through the above-stated energy system optimization and transformation under two consistently advanced scenarios, carbon intensity of both scenarios tends to peak and decline in different timeframes, respectively, while in order to meet its commitments to climate change, CO_2 emissions from fossil fuels could reach a plateau in 2025 followed by a steady slowdown afterwards at 11 billion tons in 2030 under CPS, this emission could also possibly reach its peak at 10 billion tons in 2020 followed by an evident downturn in 2030 in our recommended scenario. This clearly indicates that the peak of carbon emission could be achieved in advance and decline afterwards if all above-mentioned assumptions and changes are realized.

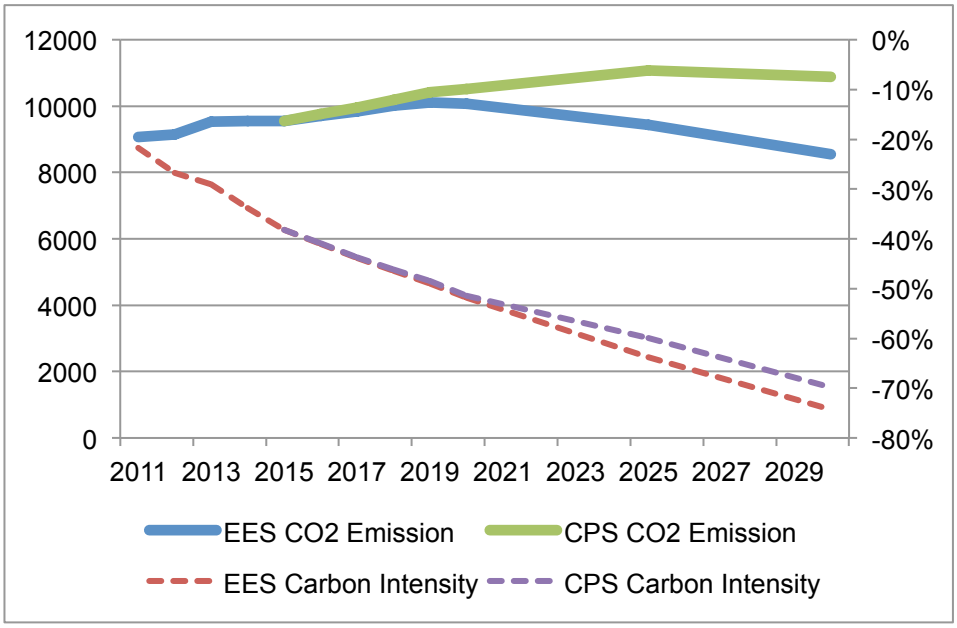

Figure 8: Carbon Emission Outlook Under Two Scenarios

Note: the illustrated carbon intensity trend refers to the declining rate of the year against 2005

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Conclusions and Policy Advices

1. Economic Growth: policy makers are advised not only to review the growth rate over single GDP size but also those ties between growth rate (speed), development quality and effectiveness. A slight fall in GDP growth to 6.6 percent between 2016 and 2018, even much lower rate is wiser and possibly in our outlook period. Most importantly, the slowdown in growth aims at a further shift of our policy focus onto higher quality and new economic pattern built with greater scope for a set of structural reforms launched and many measures implemented.

2. Final Consumption Orientation: Such an orientation will increase the level of electrification and drive final consumption towards a clean, low-carbon and sustainable end. Moreover, through our database optimization, this goal could be met on the basis of a lower level of electricity use. Final consumption therefore has to be re-focused at the policy-making stage.

3. Coal Industry: On the one hand, a decrease of final coal uses in residential and industrial ends is a must and has to be implemented strictly, especially in the eastern part of the country. On the other hand, the level in clean and efficient coal-fired generation has to be encouraged and increased. Under strict surveillance of the total consumption, lower emissions, higher efficiency and significant reduction coal consumption per kWh before CCUS deployed have to be factored into coal policy and regulations, followed by further self-oriented structural reform to tackle the serious realities of downturn. Policy-wise, not only should the bigger coal-fired plants be consolidated, but also only most efficient ones survive. A large-scale divesture and transformation of the coal sector is a must and will be seen in the years 2020 and 2025. Consequently, policy-makers have to learn how to calculate the interests vs. goals with additions, subtractions, division, and multiplications in the process of restructuring coal.

4. The Oil and Gas Industry: the trajectory of the oil and gas supply and demand has to be reviewed through an energy system optimization process instead of an isolated approach and self-planning. We advise policy makers to re-focus on solid supplies of indigenous oil and gas sources, emphasizing hydrocarbon saving and substitution as fuels. Those "increasing gas while maintaining oil" featured policies require stable back-up markets at home and subject to market-oriented options.

5. Non-fossil Energy Sources: We maintain hydropower in China continue to expand steadily at higher costs while sources such as nuclear, wind, solar, geothermal increase in a cost-effective way. Currently, however, an increase of these clean sources is subject to an absorbing capacity of power grids at all levels and by centralized and distributed ones, as well as by smart grid supports and the enhancement of end-consumer electricity accountability. Because of this reason, expansion and upgrading of the power grid capacity should be stressed as a positive contributor to the power sector reforms under way, rather than being the object of reform.

6. Energy Saving & Emission Reduction: The next round of energy saving has to be through innovation and energy efficiency enhancement since energy saving would not only result in emission reductions but also represents a prerequisite for the latter. Afterwards, emission reductions lie on structural optimization, technology innovation, plus CCUS deployed economically.

7. In Conclusion: We believe on-going policy points to the designated goals as our data analysis indicates that the desired goals of the country are achievable under the CPS. But some uncertainties remain with regard to untapped potentials through structural adjustment, efficiency improvements and energy saving, thus, a trajectory of energy transition may not be absolute and risk-free and could be more serious against a higher growth and a larger scale of economy. We therefore recommend that, in order to ensure energy transition, a slowdown of economic growth is necessarily as a general pre-condition. Based on an end-consumer oriented approach, the re-direction of the coal sector and the repositioning of oil and gas - de-bottlenecking non-fossil energy sources - and correcting the relationship between energy-saving and emission-reduction are advised. With these policy shifts in mind, not only can the current policy objectives be achieved, but it can also be done ahead of schedule and in a more effective manner with ideal outcomes.

Appendix I: Assumptions

		2015	2016	2017	2018	2019	2020	2025	2030
GDP Growth %	CPS	7.00	7	7	7		7		5.50
	EES	7.00	6.60	6.60	6.60	6.00	5.50	4.50	5
Output of per Mtoe in Secondary Industry	CPS	41.60	41.08	40.56	40.04	39.52	39	37.50	35
	EES	41.60	41.05	40.50	39.95	39.40	38.85	36.00	33
Gram/kWh in Coal-fired	CPS	315.4	312.8	310.2	307.6	305.0	302.4	293.0	283.6
	EES	314.9	311.7	308.6	305.5	302.4	299.2	289.8	275.3

Appendix II: Dataset for energy transition

		2015	2016	2017	2018	2019	2020	2025	2030
Energy Demand mmtce	CPS	43.16	44.58	46.00	47.42	48.84	50.26	54.98	57.81
	EES	43.16	44.36	45.55	46.73	47.64	48.29	48.59	48.48
Energy Demand Elasticity	CPS	0.19	0.47	0.46	0.44	0.43	0.44	0.36	0.18
	EES	0.19	0.42	0.41	0.39	0.29	0.21	0.03	-0.01
Electricity Generation TWh	CPS	5666	6000	6334	6717	7114	7515	8916	10622
	EES	5666	5982	6295	6655	6989	7320	8275	9574
Electricity Elasticity	CPS	0.31	0.84	0.79	0.86	0.84	0.81	0.70	0.67
	EES	0.31	0.85	0.79	0.87	0.76	0.72	0.55	0.59
Electrification %	CPS	26.80	27.76	28.42	29.60	30.79	31.82	34.55%	38.67
	EES	26.80	27.81	28.57	29.73	30.95	32.05	35.88%	40.81
Coal % in Primary Energy Mix	CPS	65.47	64.37	62.84	62.09	61.45	59.55	56.23%	50.17
	EES	65.47	64.20	62.67	61.91	60.92	59.08	52.08	43.76
Coal Demand Mtce	CPS	28.26	28.69	28.90	29.45	30.02	29.93	30.91	29.00
	EES	28.26	28.48	28.55	28.93	29.02	28.53	25.30	21.22
Coal % in Power	CPS	41.45	42.17	43.03	44.05	45.02	45.14	46.15	51.35
	EES	41.45	42.24	43.15	44.11	44.94	46.16	49.76	55.09
Coal in Final Use %	CPS	27.30	25.43	24.12	21.72	19.17	17.16	14.58	8.71
	EES	27.30	25.29	23.68	21.47	18.94	16.40	9.74	2.55
Oil Foreign Dependency %	CPS	60.67	60.98	61.48	62	62.52	63	63	62.69
	EES	60.67	61.37	61.98	62.55	62.57	62.41	61.09	59.02
Gas Foreign Dependency %	CPS	27.99	31.12	32.30	32.92	32.92	37.84	36.88	37.12
	EES	27.99	31.12	32.20	32.83	32.83	36.67	35.38	32.96
Non-fossil fuels Power %	CPS	10.67	11.29	11.90	12.37	12.81	13.93	16.47	20.54
	EES	10.67	11.34	11.95	12.43	13.10	14.09	18.57	24.02
Nuclear in Primary Energy %	CPS	1.32	1.73	2.08	2.22	2.21	2.26	3.58	5.98
	EES	1.32	1.73	2.09	2.24	2.25	2.37	4.09	6.34
Output per Toe*	CPS	21356	22125	22942	23812	24736	25721	30014	37306
	EES	21356	22149	22993	23892	24987	26278	32542	41626
CO2 Emission Mt	CPS	9550	9761	9949	10181	10416	10522	11073	10886
	EES	9550	9705	9842	10019	10109	10074	9429	8551

* It refers Chinese Yuan per unit oil costs to oil pricing.