



China's Power, Renewable, Grid Policies and Outlook

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Agenda

1 Recent Development in China's Power Sector Development

Power Shortage

Latest Round of Power Market Reform

2 Decarbonizing the Chinese Power Sector and Its Implications

Solar, Wind and Energy Storage Capacity Expansion

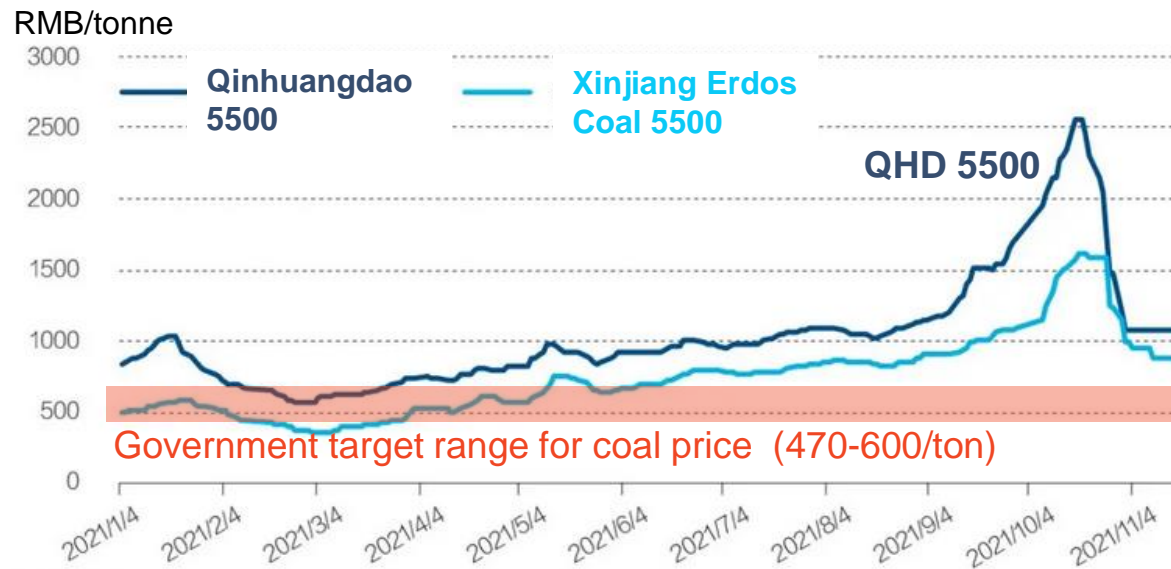
Grid Expansion

3 Summary

Power Shortage in 2021

The Sep-Oct power shortage in many provinces are primarily driven by coal fuel supply shortage

2021 Thermal Coal Prices, RMB/tonne



Many provinces have experience power shortages in September and October 2021.

1. **Mismatch between regulated on-grid coal tariff and coal prices.** Coal plants have no incentives to proactively generate more to meet the rising demand as marginal fuel cost is much higher than the regulated coal power tariff.
2. **Dual control measures.** Provincial governments reduce production from energy intensive users to meet the energy intensity and total energy consumption targets in 2021.
3. **Structural lack of flexible capacity.** Lack of flexible capacity to meet load in super-peak hours and/or manage increasing share of intermittent wind and solar capacity
 - For example, the power cut of residential demand in Liaoning on Sep 23, 2021 is partly due to the inability of the grid to deal with sudden reduction in wind generation].

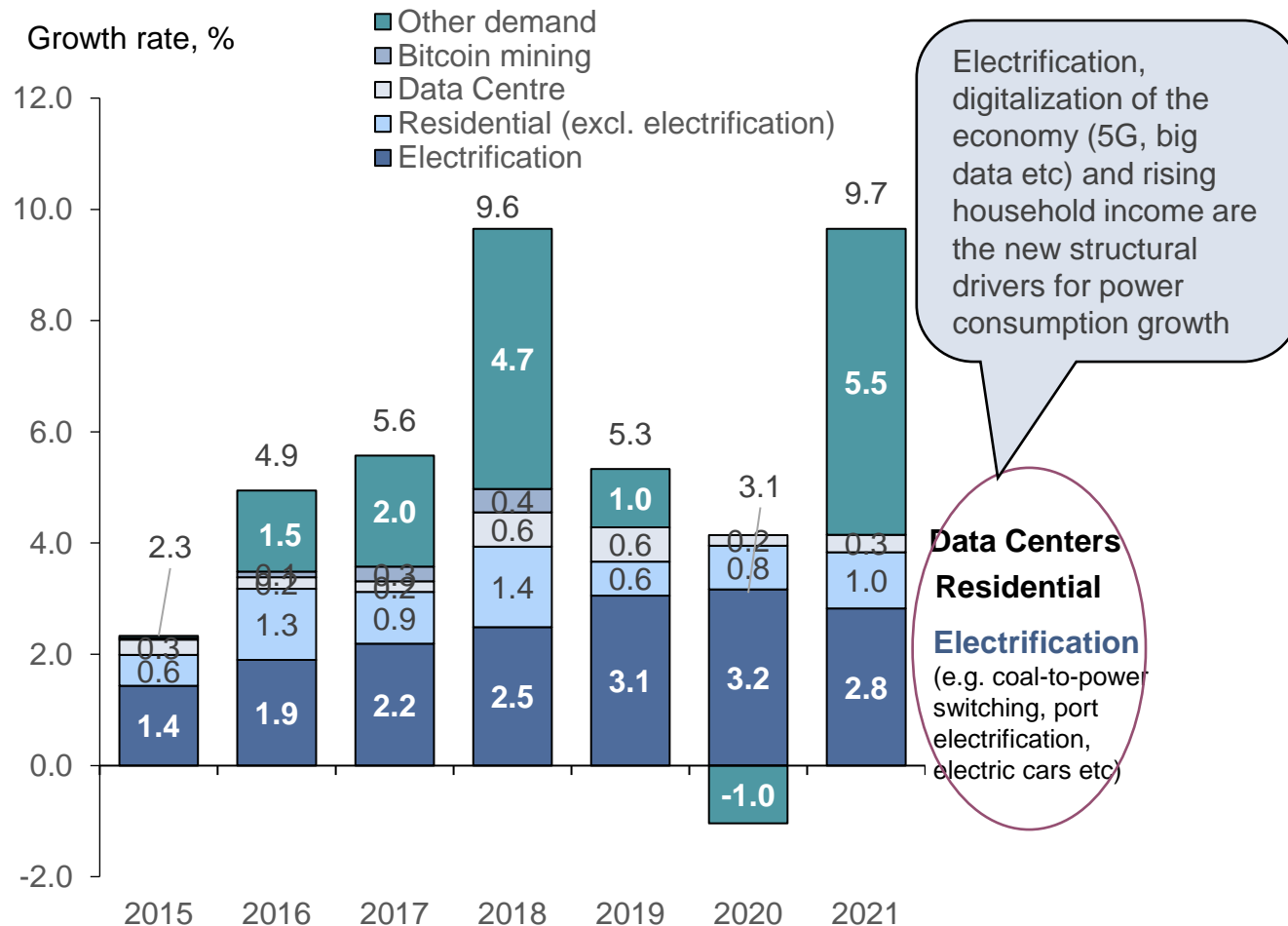
In November 2021, the power shortage issue is largely resolve. The power shortage has led to further market reform and power tariff has been increased across China.

- High coal prices are mainly due to coal supply shortage.
 - In Jan-Aug 2021, **coal supply** (domestic production plus import) **grew by 4.6% year-on-year while the growth rate of thermal coal generation was 14%.**
 - In Sep-Oct 2021, coal supply growth rate is 7.1%, which is slightly higher than the 6.8% growth rate of thermal coal generation.
 - In Nov-Dec 2021, coal supply is likely to continue to grow while we estimate that thermal coal generation will likely decline year-on-year.

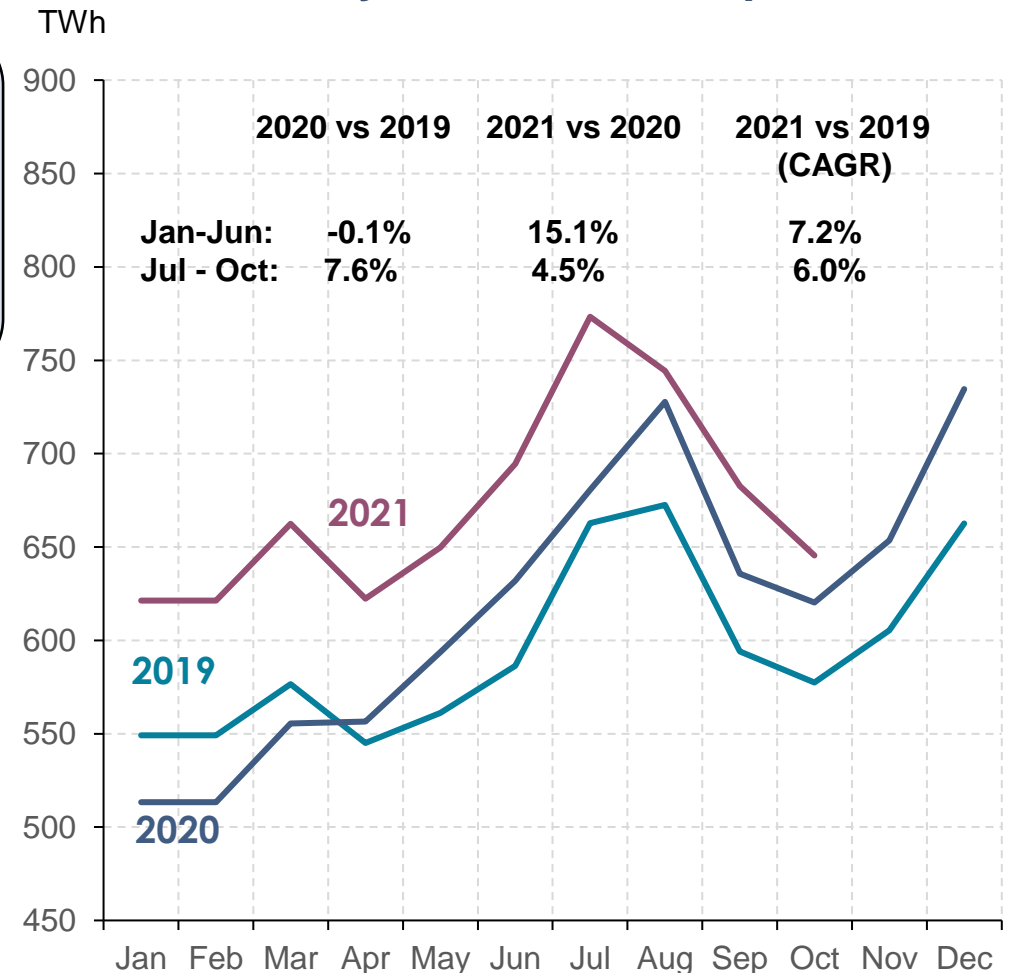
Market Fundamental – Demand Growth

Both structural and near-term demand drivers lead to rapid power demand growth in 2021

China Power Demand Growth Rate by Sectors



China Monthly Gross Consumption*



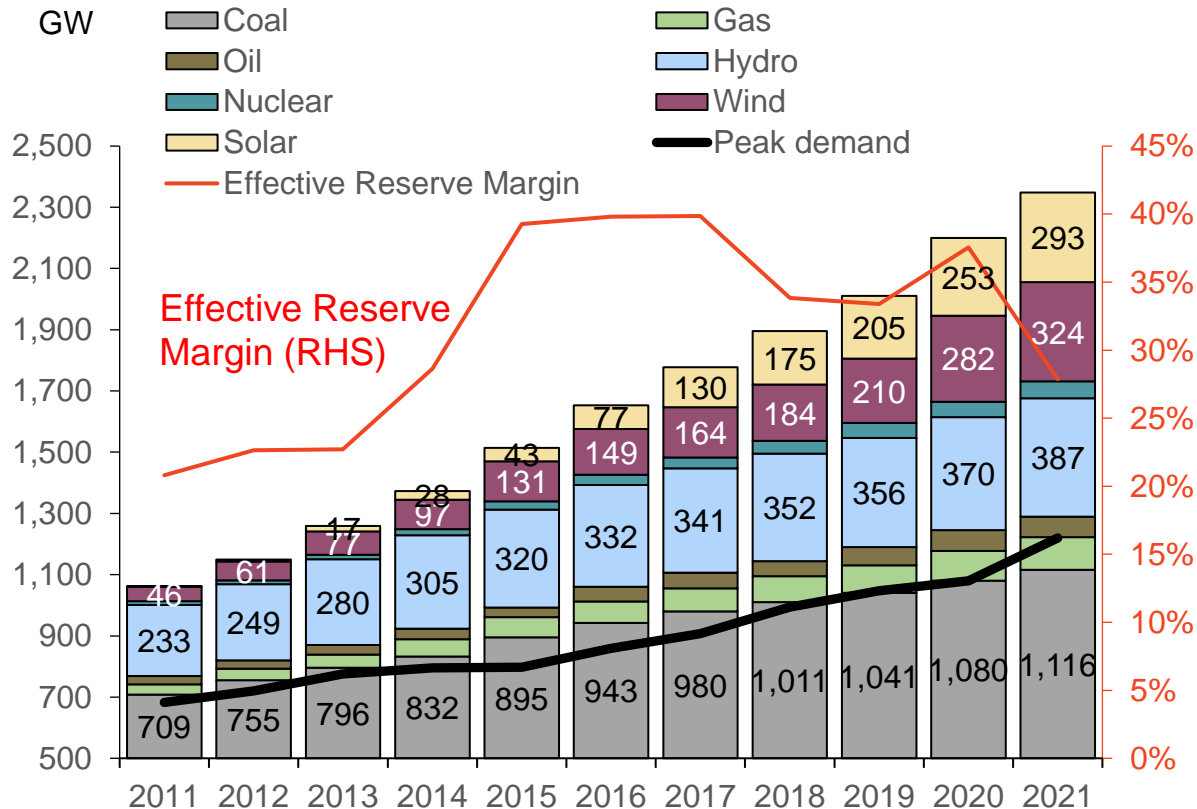
Note: * The monthly gross consumption is based on total monthly generation data reported by National Statistical Bureau.

Source: National Statistical Bureau, China Electric Council (CEC), State Grids, MIIT, Various news clips, research paper and WaterRock Energy analysis

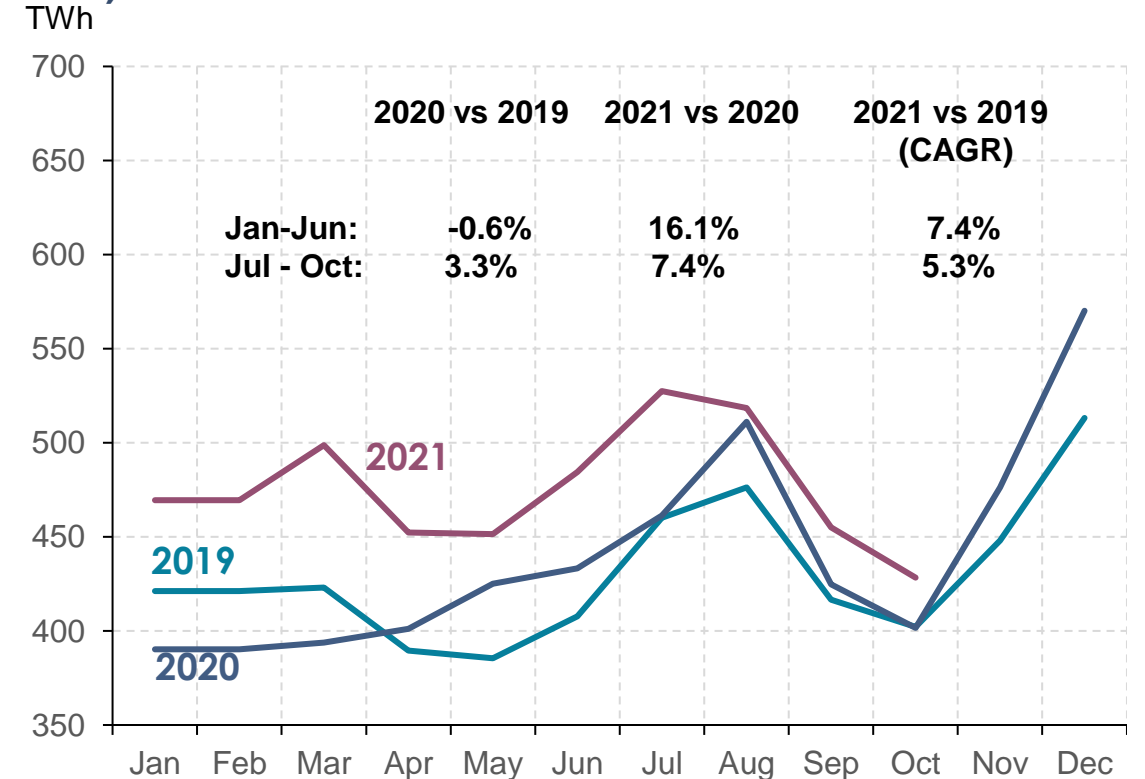
Market Fundamental – Supply Growth

Strong demand growth and slow down in new coal capacity addition has led to a tightening reserve margin since 2017

Power Supply and Demand Balance in China (2016-21)



Monthly Generation from Thermal Capacity (Coal plus Gas)



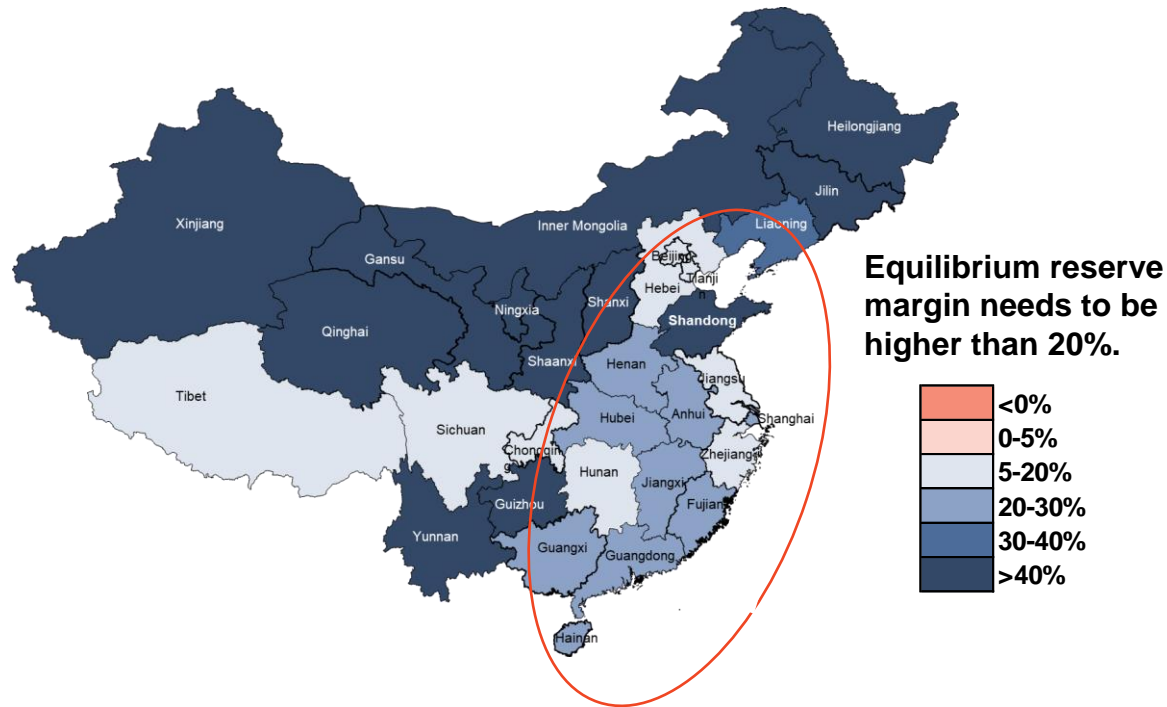
Average annual net coal capacity addition has declined from 40-50 GW before 2017 to 20-35 GW after 2017. Coal still plays an important role in meeting consumption, and 42% of incremental demand is met by coal in 2016-2020.

Note: Effective reserve margin calculation takes into consideration of availability factor of different types of capacity (Thermal – 90%, nuclear – 95%, Hydro and wind – actual capacity factor, solar – average capacity factor during day-time). Effective reserve margin = [available supply – peak load – net export]/peak load. As a rule of thumb, at a national level, a market is in balance with an effective reserve margin of 20-30%. If its reserve margin is higher than 30%, it is over-supplied; if it is less than 20%, it is a relatively tight market with seasonal shortage. Source: China Electric Council (CEC), National Energy Administration (NEA) and WaterRock Energy Research and Analysis

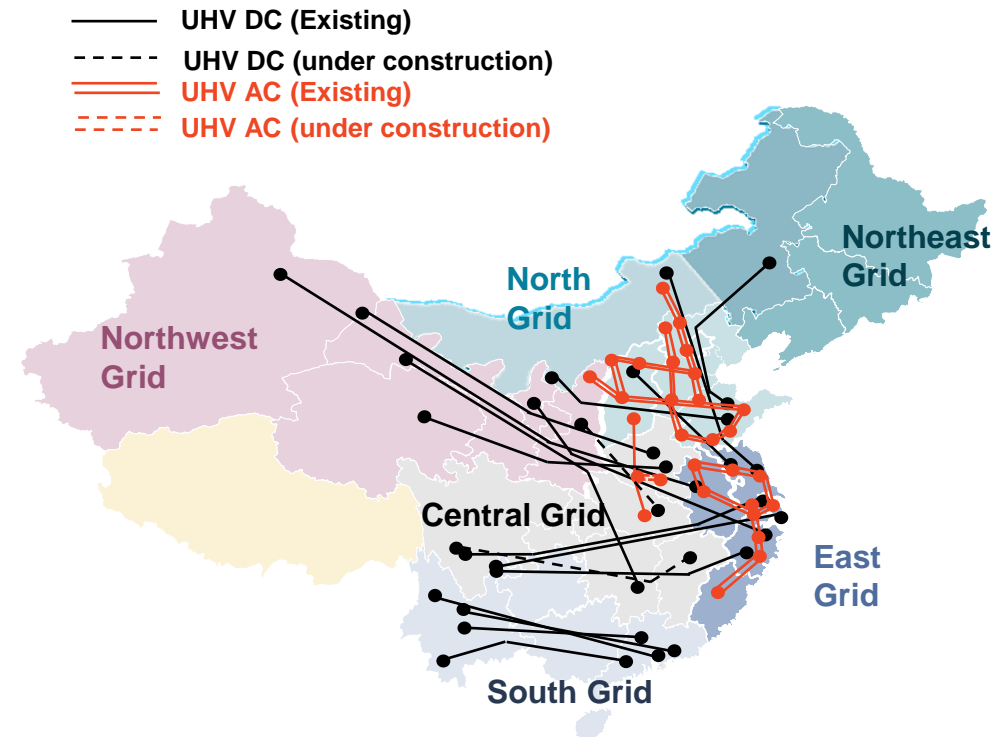
Provincial Balances

More UHV line infrastructures are expected to be built to export power from well-supplied regions (like Northwest) to coastal and central China

Effective Reserve Margin at Provincial Level in 2020 [After accounting for imports/exports], Mainland China



Six Regional Grids and UHV Lines in Mainland China



- Coastal and central China need more capacity to ensure resource adequacy; but environmental regulation in coastal and central China makes them much harder to build new coal capacity.
- Coastal provinces will likely push harder to expand offshore wind capacity. And both central and coastal provinces will need more imports from Northwest region and Inner Mongolia.

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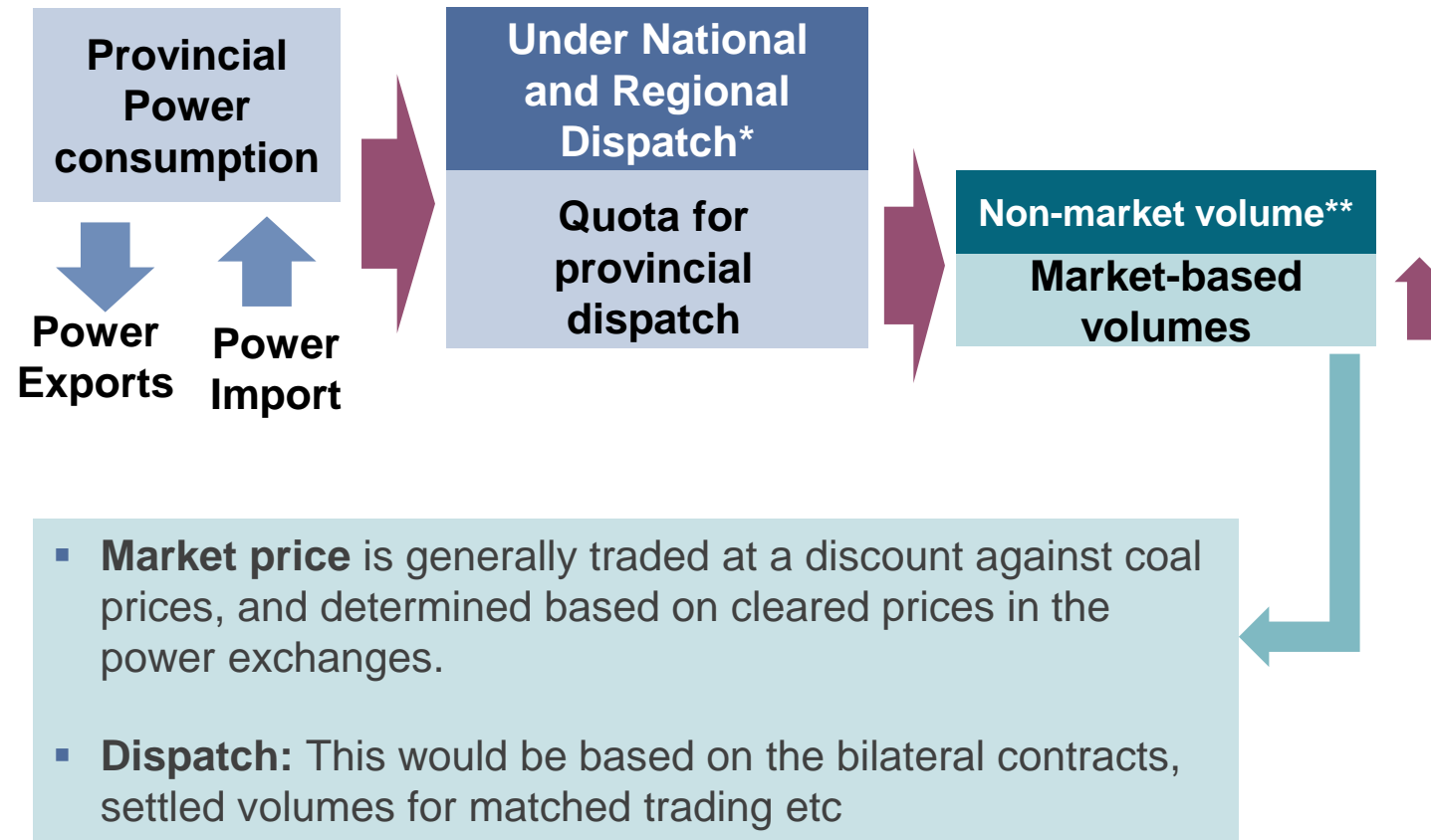
2 Decarbonizing the Chinese Power Sector and Its Implications

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Chinese Power Market Reform

Since 2015, increasing share of generation is based on “market” price and dispatch at the provincial level

Market reform at the provincial level



▪ Within the provinces

- Since 2015, market-based generation volumes are increasing across all provinces in China. Correspondingly, retail competition has also been increasingly.
- **Participation of wind and solar projects in the “market” varies by province as the regulation is done at provincial level.**

▪ Further market reform after mid October 2021

- **Generation:** All coal capacity needs to participate in the markets.
- **Retail:** all C&I customers above 10 kV needs to enter the market from October 15, 2021 onwards in principle. For the other C&I customers, they are encouraged to enter the market.

Note: * There are five levels of dispatch: national dispatch (voltage level > 500 kV), regional dispatch (voltage level 330 - 500 kV), provincial dispatch (220 kV), prefecture dispatch (voltage level <220 kV) and county dispatch (voltage level <110 kV).

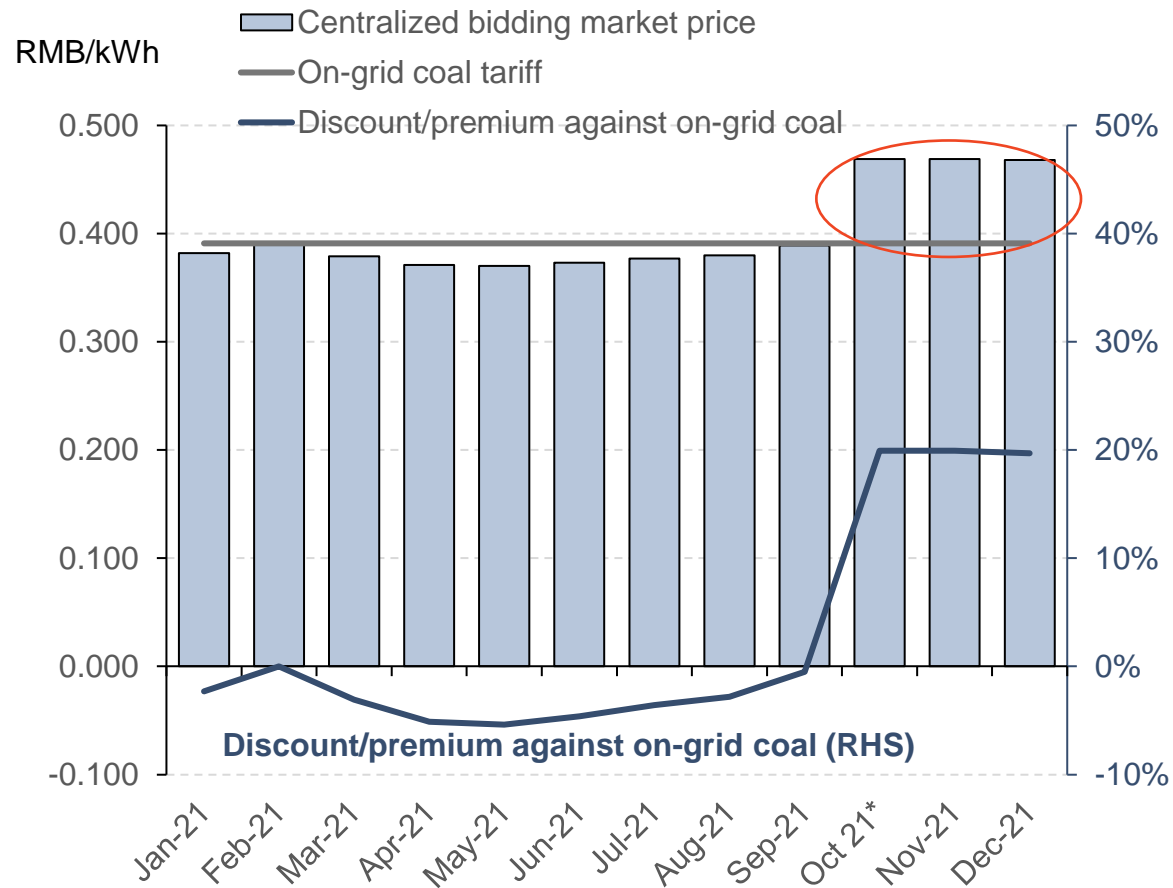
** Non-market base volumes are based on annual generation quota allocated to different generation types. It also accounts for priority dispatch volume for grid safety, coal peaking, combined heat and power, cogen and some solar and wind volumes.

Source: WaterRock Energy Research

Market prices

Monthly market price have largely traded at 20% against the regulated on-grid coal in November 2021

Centralized Competitive Bidding Market Price in Jiangsu [Including VAT]



Note: There was no transaction for October contracts from centralized bidding in late September 2021. Price was based on the average market price of matched trading in mid October 2021.

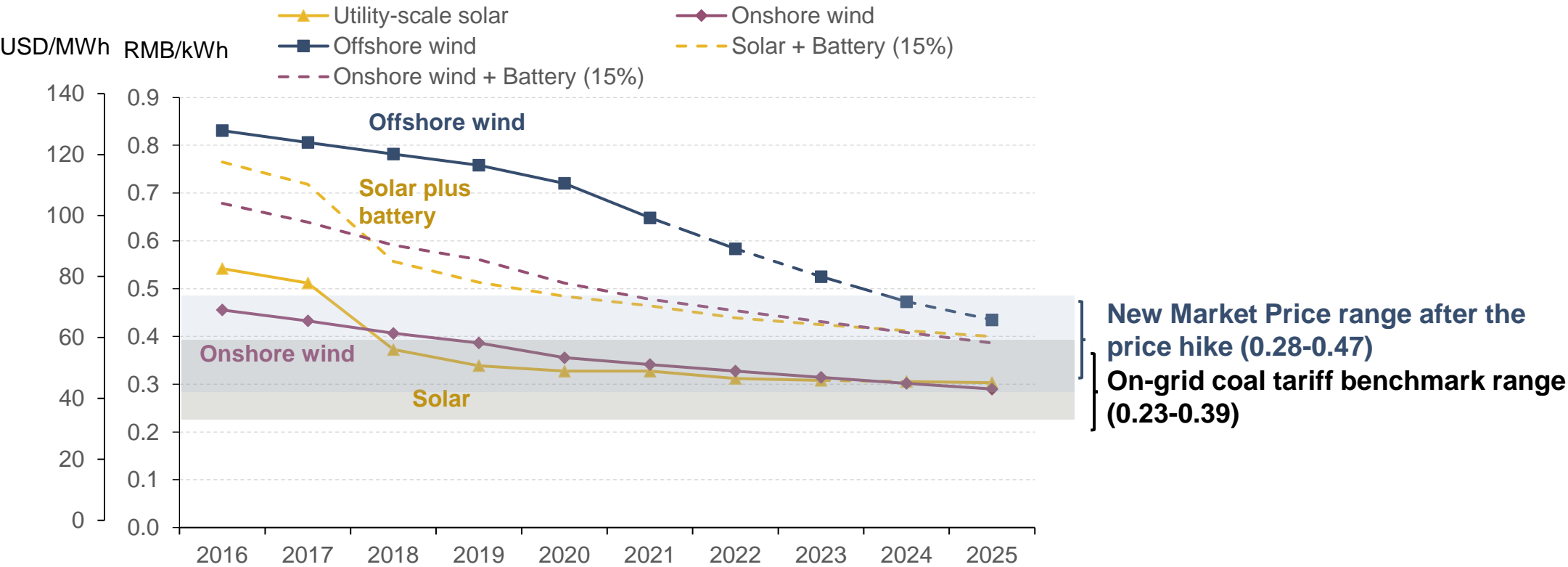
Source: Jiangsu Power Exchange, WaterRock Energy Research and Analysis

- In mid October 2021, the NDRC has stated that retailers/gen-tailers can “re-negotiate” and “re-sign” their 2021 annual contracts with the large end-users for November and December 2021.
- The “re-negotiated” prices for the bilateral contracts are **10-20% higher than the regulated on-grid coal tariff instead of a small discount against on-grid coal tariff.**
- The October monthly power trading in Zhejiang, Hubei, Shandong, Jiangsu and Guizhou also have a resulting trading price about 20% higher than the on-grid coal benchmark.
- The green power trading was 0.01-0.03 RMB/kWh (2-7%) higher than the on-grid coal tariff in September 2021. The recent price hike allows wind and solar developers to offer higher but still competitive prices to end-users.
- **Thus, the recent price hike can help to accelerate the uptake of green power and then potentially accelerate renewable investment.**

Economics of New Solar and Wind

The recent increase in market tariff can help to incentivize more wind and solar capacity expansion

Levelized Cost of Energy (LCOE) of Different Technology (Ex-tax)



- Future onshore solar and wind capacity expansion will be mainly driven by economics as they could be more cost competitive than new coal projects.
- New offshore wind projects may need local subsidies or “special” tariff, but they are largely more competitive than local gas plants.

Note: You can contact us for the key assumptions for the levelization cost calculation. We also assume that 50% of the BESS cost is recovered from ancillary service market.
Source: WaterRock Energy Research and Analysis

Key Concrete Initiatives for RE

Many recent regulatory changes can help wind and solar capacity to monetize its green attributes and also set up a better market for integrating RE

National Carbon Market

Trading started but limited impact

- The national carbon market has started trading since early July 2021, and the **market prices have been 40-60 RMB/tonne-CO2 (i.e. USD 6-10/tonne)**. **Trading volumes have been very low, partly because there are a surplus of carbon credits.**
- Trading of China Certified Emission Reductions (CCERs) has also started. Prices have been below 40 RMB/tonne.
- Over time, as the regulators gain experience and the amount of “free” carbon allowance is reduced, it will increasingly impact investment decisions for new capacity expansion.

Green Trading and Green Financing

Positive development

- Since September 2021, China has started **pilot green trading**, allowing corporates to directly purchase green power from wind and solar capacity. The green tariff has been **0.01-0.03 RMB/kWh above the regulated on-grid coal tariff**. With the recent increase in thermal market tariff, wind and solar capacity will be likely able to further increase the “green” tariff.
- The central government has been also working to facilitate **green financing** for renewable projects.

RPS and Green Certificate Trading

- The renewable portfolio standard continues to be rolled out, incentivizing the investment and import of renewable capacity across China.
- Green certificate trading is still not liquid. **Traded price for the grid parity green certificate is 0.05 yuan/kWh. Based on market research, the future traded price may be in the range of 0.02-0.03 yuan/kWh.**

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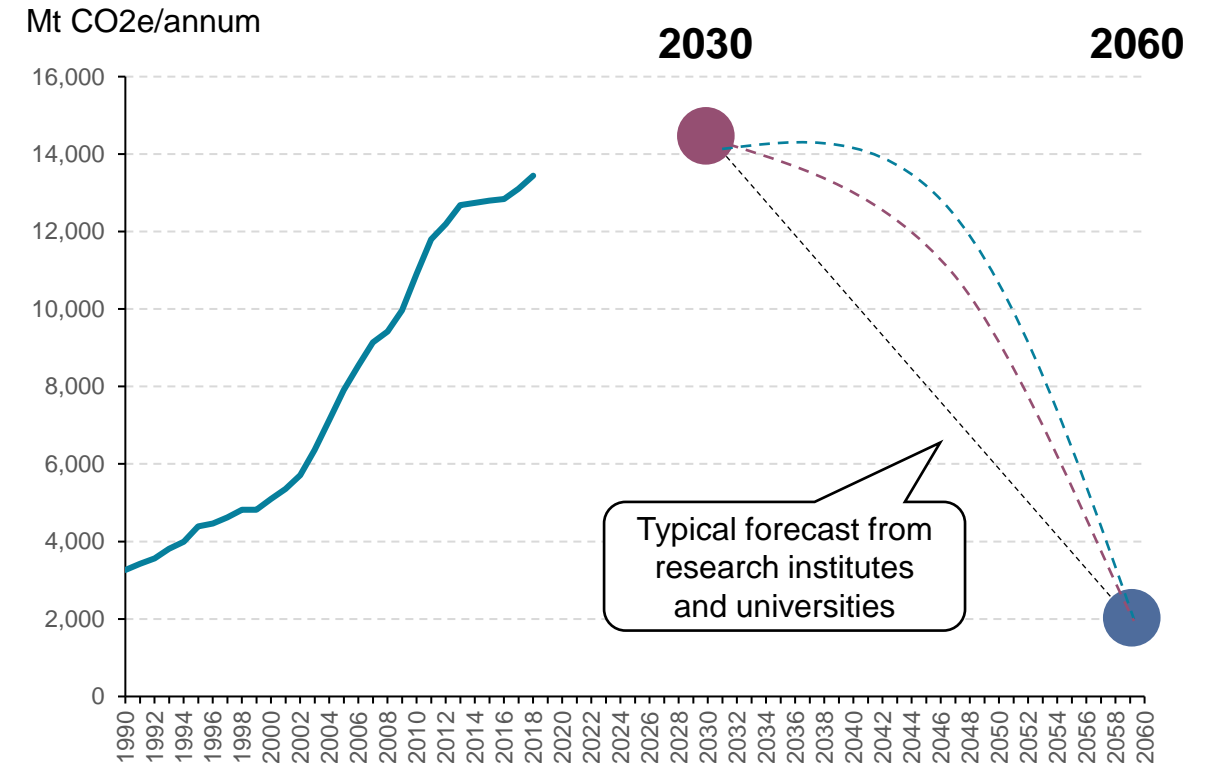
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Carbon Neutrality Target

The 2060 carbon neutrality target sets the direction for de-carbonization in the long term, but it may not affect power sector much in near- and medium-term

- President Xi Jinping UN Address on Sep 22, 2020
 - CO2 emissions **peak before 2030** and **achieve carbon neutrality before 2060**
 - “..... achieve a green recovery of the world economy in the post-COVID era....”
- **Non-fossil fuel mix** targets in primary energy consumption in 2014 under COP 21 Paris Agreement
 - **2020: 15%** [Actual non-fossil fuel mix is 9.4% in 2010 and 15.3% in 2019]
 - **2030: 20%.**
 - Propose to **peak CO2 emission around 2030** and make efforts to peak earlier if possible.
- President Xi Jinping Oct 2021
 - 80% of China's energy mix will be non-fossil fuel by 2060

CO2 Emission in China

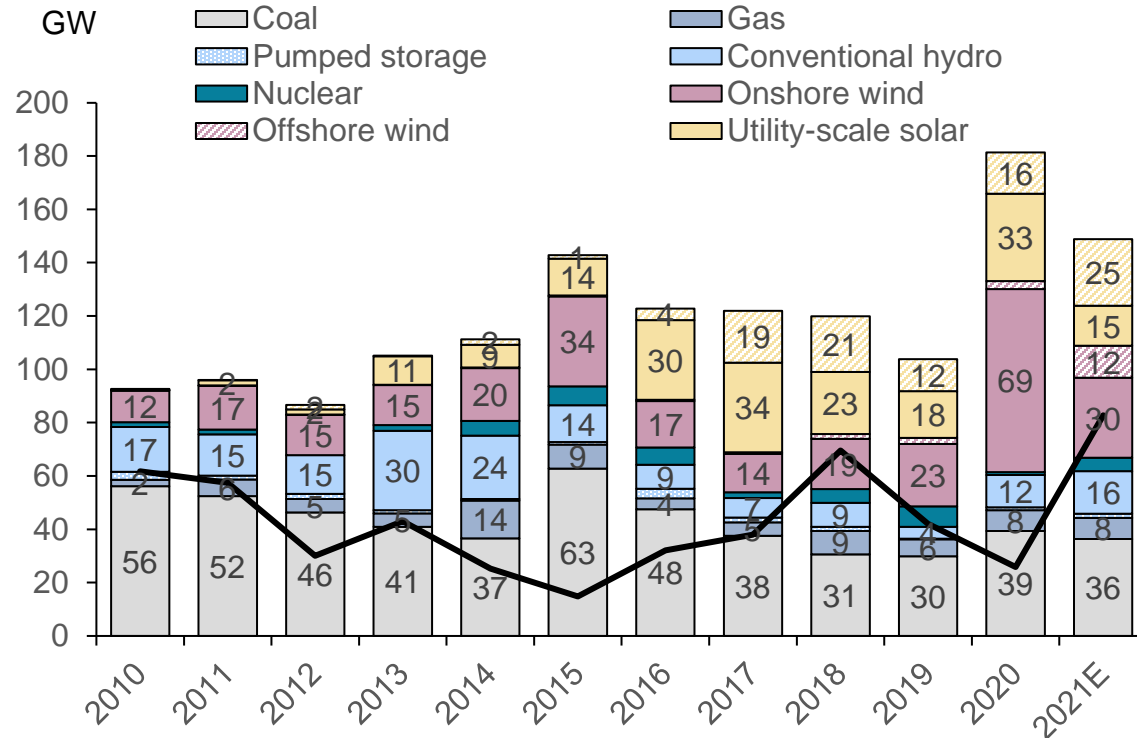


Source: Climate Action Tracker, WaterRock Energy Research and Analysis

Historical Incremental Capacity and Generation

Even with about 70 GW of wind+solar annual capacity expansion in 2016-2020, it still only meet about 25% of incremental consumption growth

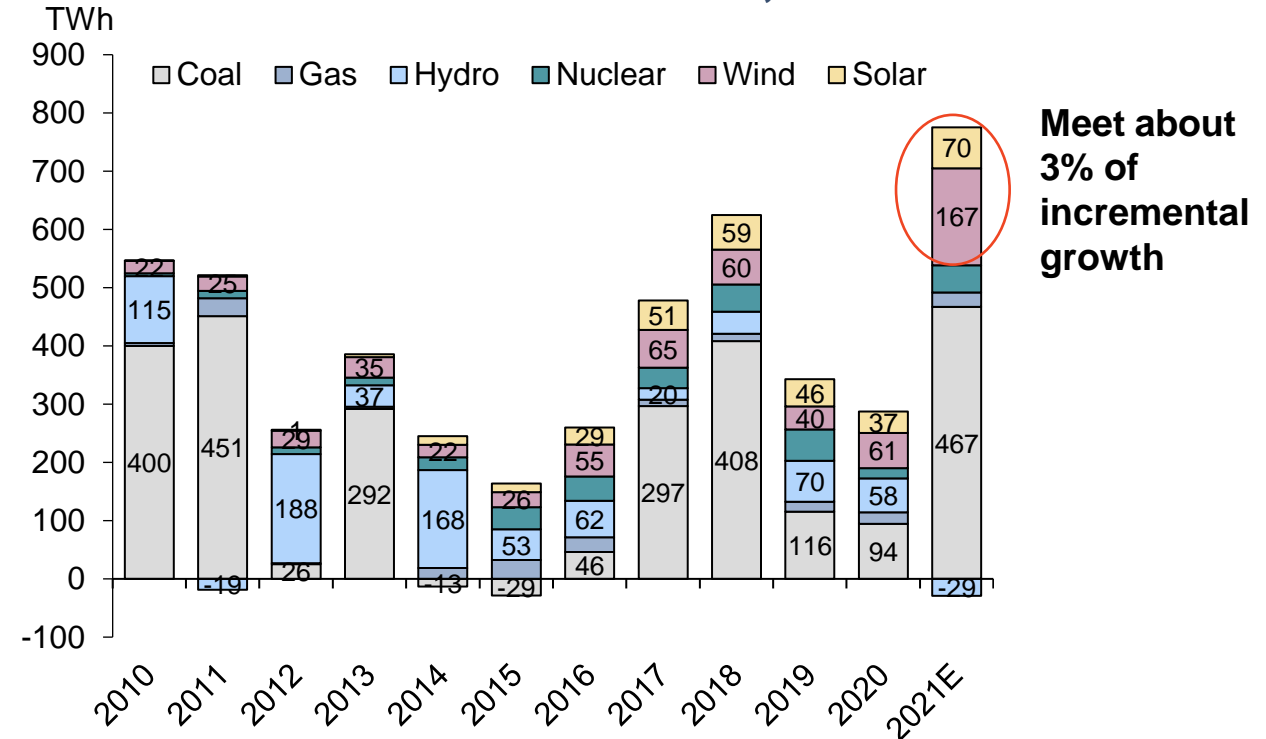
Incremental Supply Capacity, GW



Wind + solar average annual capacity addition:

- 2011-2015: 29 GW, accounting for 26% of capacity expansion.
- 2016-2020: 72 GW, accounting for 55% of capacity expansion.

Incremental Annual Generation, TWh



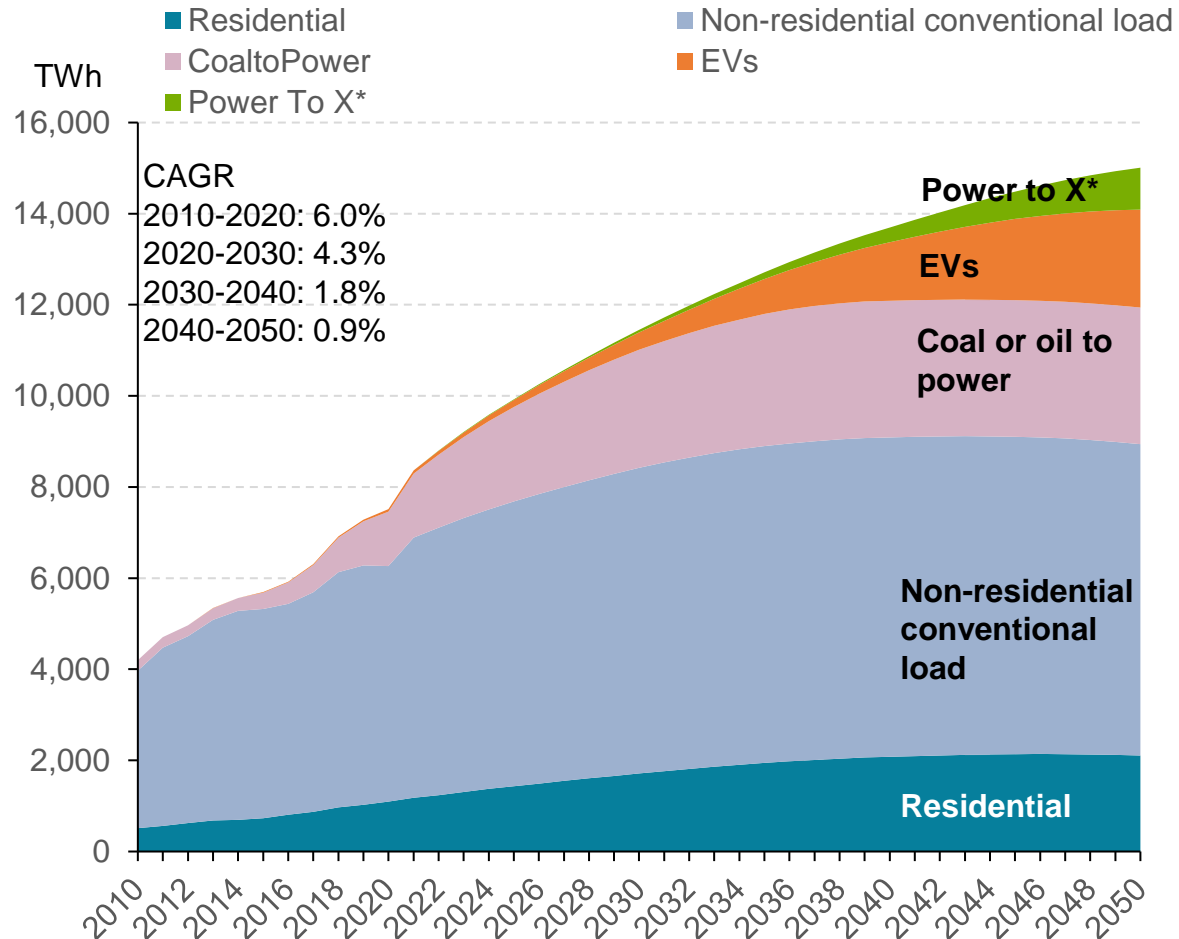
Wind + solar average annual generation addition:

- 2011-2015: 35 TWh, accounting for 12% of incremental generation.
- 2016-2020: 101 TWh, accounting for 25% of incremental generation.

Long-term Power Demand

The power market size is expected to double by 2050, mainly driven by electrification of the economy in the medium- and long-term

Power Consumption Growth (WaterRock)



Note: *Power-to-X is power to hydrogen or power to other chemicals, which can be used to replace fuels in the non-power sectors.

Source: Historical Data (CEC), forecast is based on WaterRock Energy internal research and analysis.

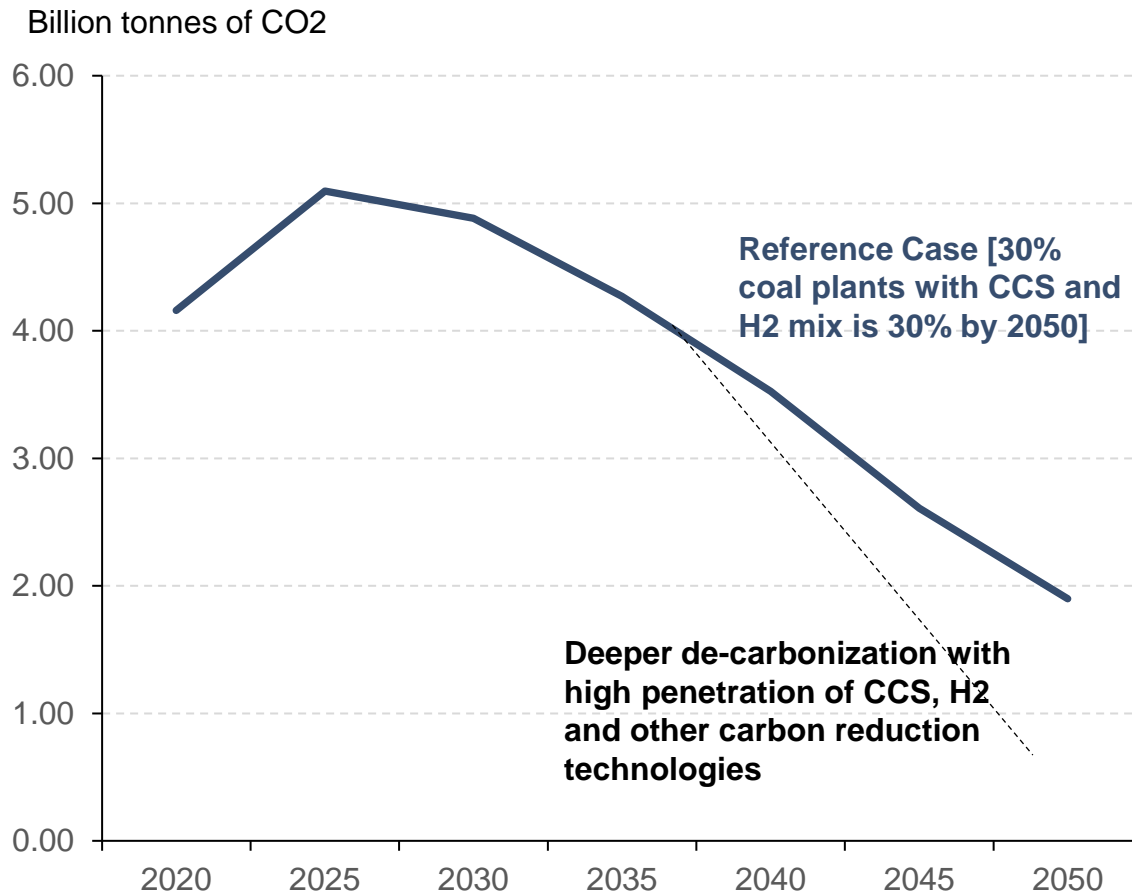
2050 Power market size is 2.0 times of 2020 market size.

- Long-term new demand drivers are electrification of the economy, including coal/oil to power, penetration of electric vehicles and power to X.
- Long-term power consumption growth is resilient across different scenarios as more aggressive “de-carbonization” effort will also mean higher rate of electrification in the economy.**
- Nonetheless, the power consumption growth rate will still decline over time as
 - Economic activity will shift from heavy industry towards high tech industry and services.
 - Increasing focus on energy efficiency and efficiency gains from replacing old equipment with new will lower the energy consumption in the different sectors, particularly in the industry sector.
- Our forecast is consistent with those from grid companies, government and research institutes.

Carbon Emission

The new supply capacity will be mostly zero carbon emission technologies, and adoption of CCS and H2 will be also needed to help achieve carbon neutrality

CO2 Emission from the Power Sector in China



Note: For our reference case, we assume that about 150 GW of remaining coal capacity have Carbon Capture and Storage (CCS) (i.e. about 30% of the total coal capacity in 2050), and blue/green hydrogen makes up 30% (in calorific value) of gas fuel consumption in 200 GW of gas capacity in 2050.

Source: WaterRock Energy Modelling and Analysis

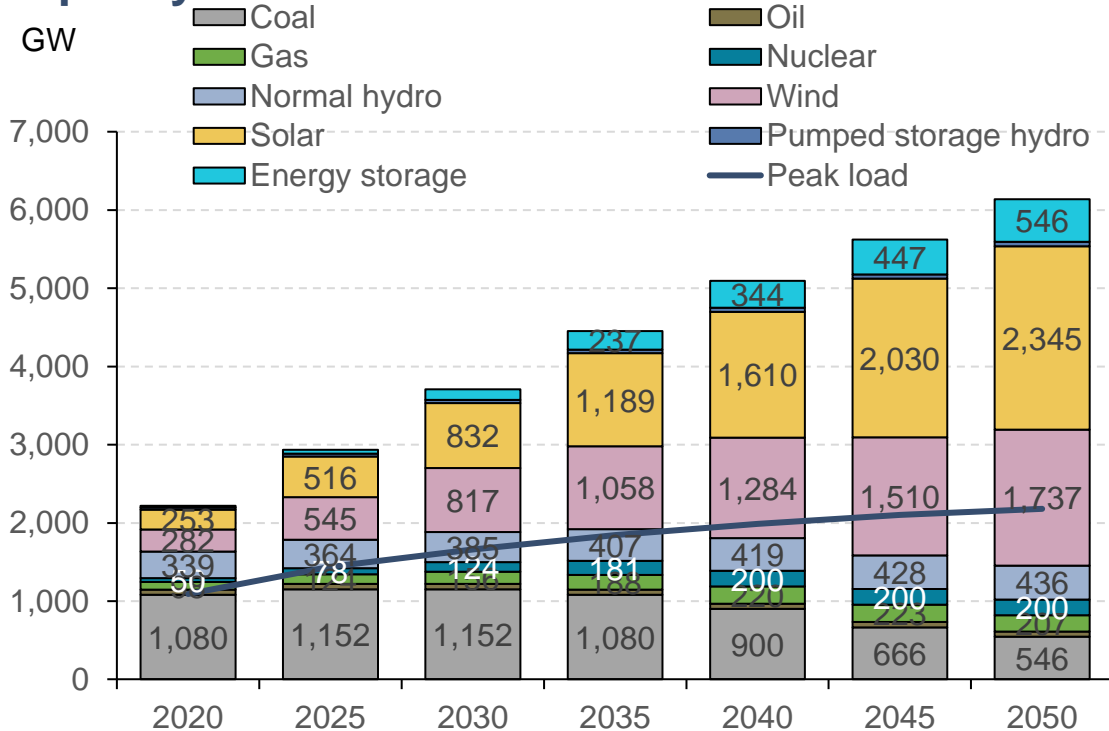
To bend the CO2 emission, zero/low carbon emission technologies need to be built to meet the growing demand and replace coal generation.

- **Hydro:** Most of the easy hydro resource is already exploited. Some large hydro power capacity can be further expanded in Sichuan and Yunnan, but the pace will be (much) slower
- **Nuclear:** The technical limitation on nuclear capacity expansion in China is mainly related to site availability. Its capacity **is likely capped around 200 GW in the long term**, if nuclear capacity can only be sited in the coastal provinces.
- **Onshore utility-scale wind and solar:** Due to the resource endowment and the land availability, the bulk of mega projects will be built in the inland provinces (Northwest, Inner Mongolia and Northeast)
- **Offshore wind:** coastal provinces will push further for offshore wind projects.
- **Distributed solar:** Distributed solar will be built across China. The government has been encouraging rural towns to build distributed solar to help meet their local load.

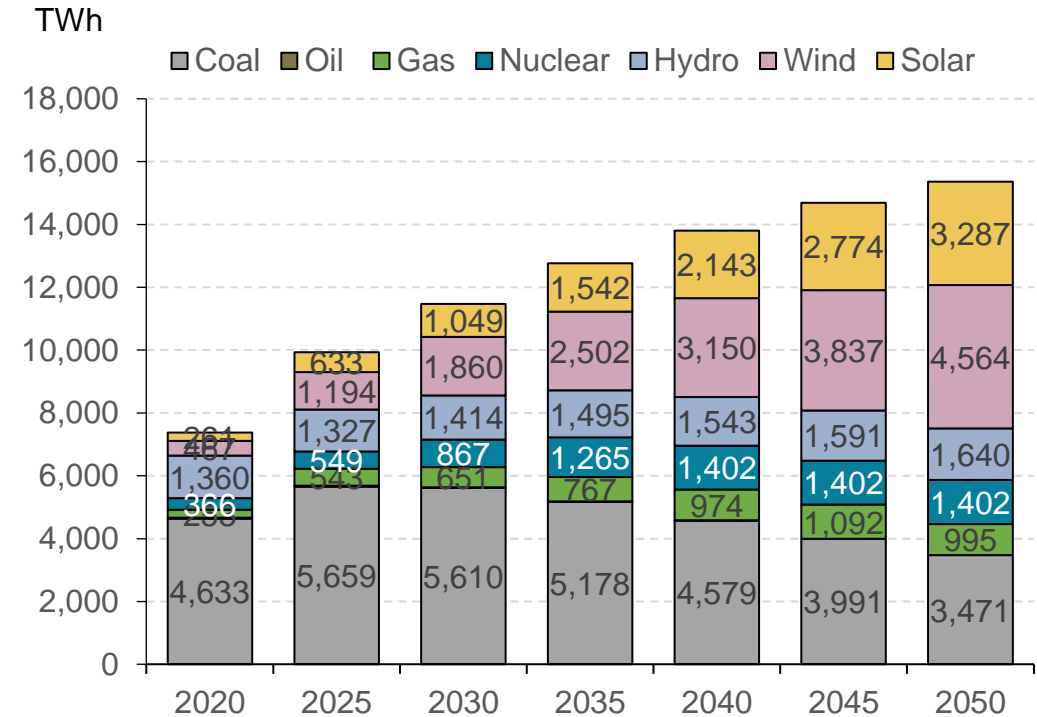
Capacity Expansion (Reference Case)

Wind and solar capacity could be 1.5-2.0 times of the expansion rate seen in 2016-2020 in order to help to reduce CO2 emission

Capacity Fuel Mix



Generation Fuel Mix

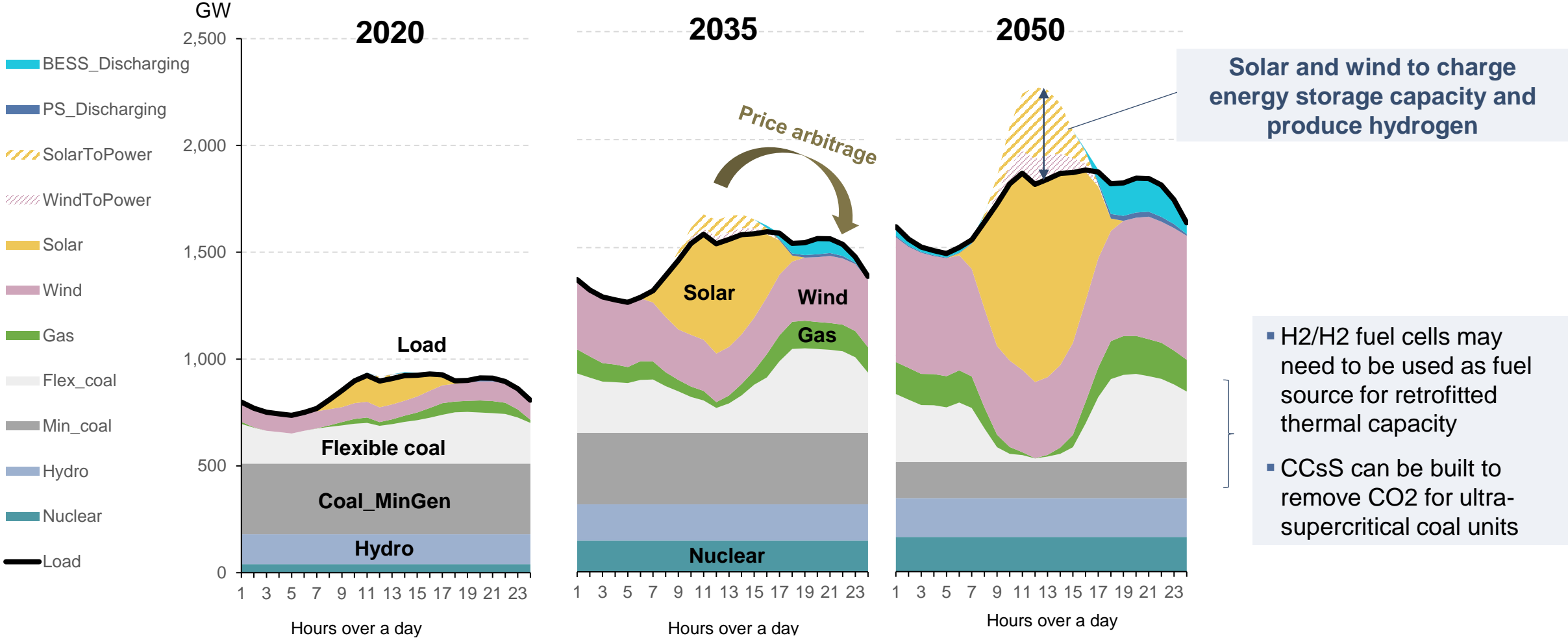


- In the medium- and long-term, average annual capacity addition is 45-55 GW for wind and 50-80 GW for solar, 1.5-2.0 times of the solar and wind capacity expansion rate in 2016-2020. Annual capacity expansion of energy storage facilities (pumped storage and battery energy storage) could be 5-10 GW in 2021-25 and then increase to around 20 GW to integrate RE after 2025.
- By 2050, coal and gas will still account for 30% of generation. Carbon capture and storage (CCS) and low carbon emission fuels (such as biomass and hydrogen) are critical for China to get to carbon neutrality in the power sector.

Typical Hourly Load and Generation

Flexible capacity will become increasingly important to help integrate higher renewable penetration in the power system

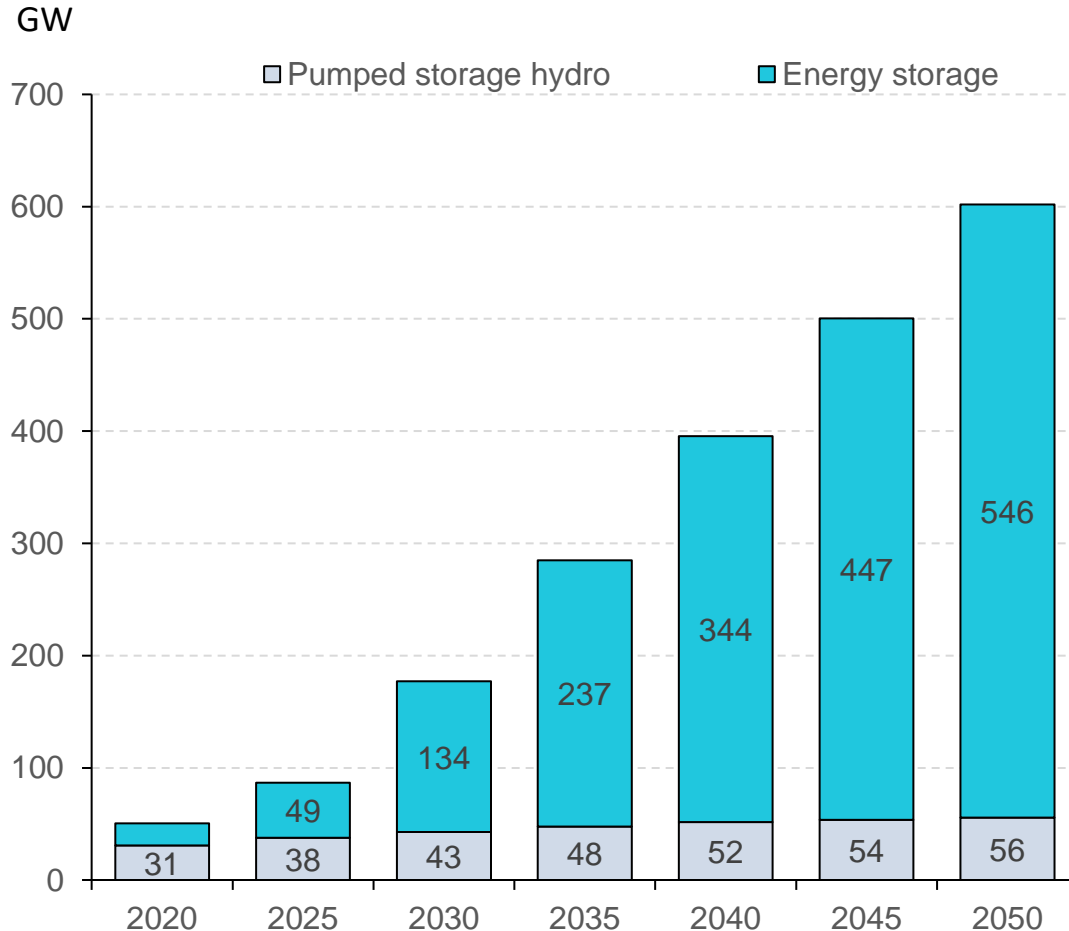
Power Balance Without Consideration of Battery Energy Storage and Power-to-X*



Energy Storage System

Large amount of energy storage capacity is required to balance the power system, accounting for about 15% of total solar and wind capacity after 2035

Requirement of Energy Storage System

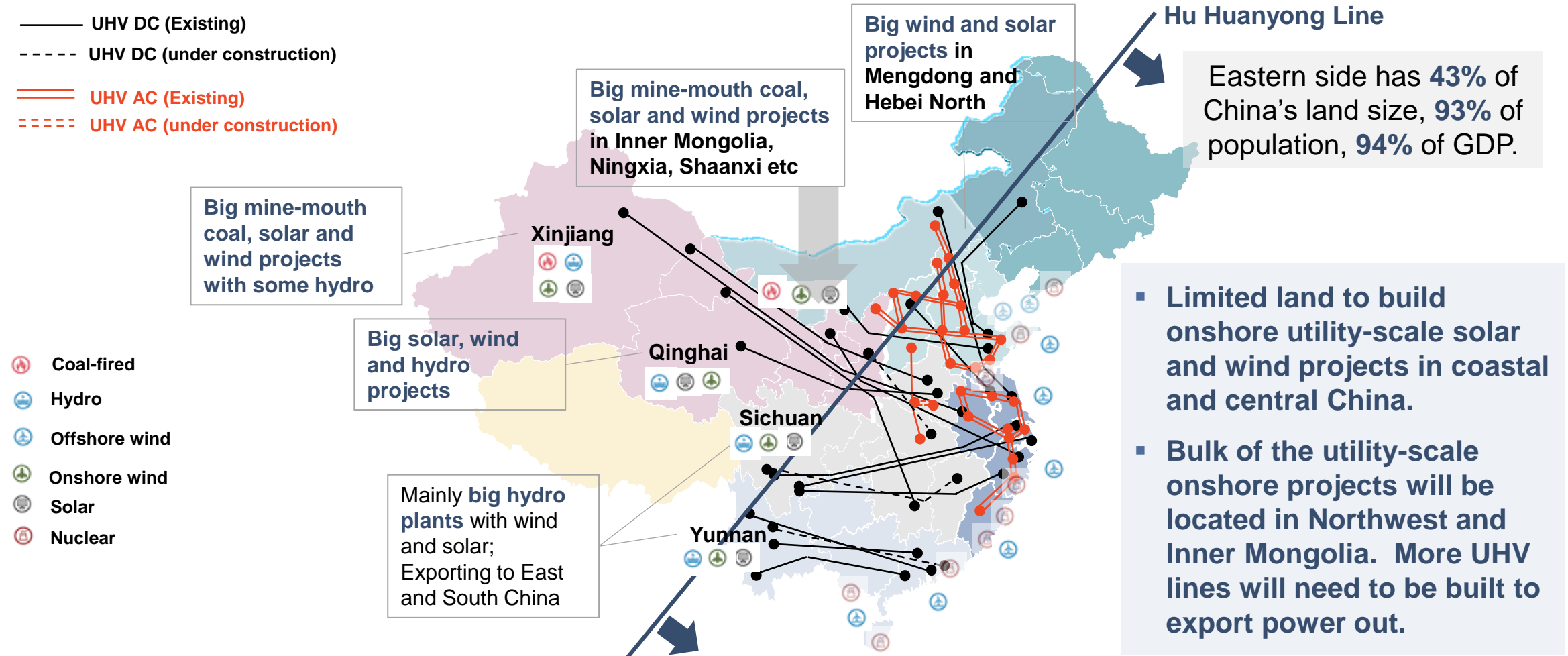


- There are still no clear revenue models for monetizing stand-alone large scale battery energy storage or other energy storage system solutions.
- Nonetheless, the government is working on creating a better regulatory framework for energy storage system solutions. Initiatives include:
 - Provide two-part pricing (i.e. capacity and energy tariff). In early May 2021, the NDRC introduced a new pricing regime to provide capacity payment for pumped storage plants.
 - Increase the peak off-peak prices in the tariff design in many provinces;
 - Create ancillary service products (like fast frequency response), which energy storage can serve well;

Grid Expansion (UHV Lines)

More UHV lines are expected to be built to export power from well-supplied regions (like Northwest) to coastal and central China

Ultra-high Voltage (UHV) Lines and Resource Distribution in Mainland China



Example: Planned UHV lines from Northwest China to Central or East China

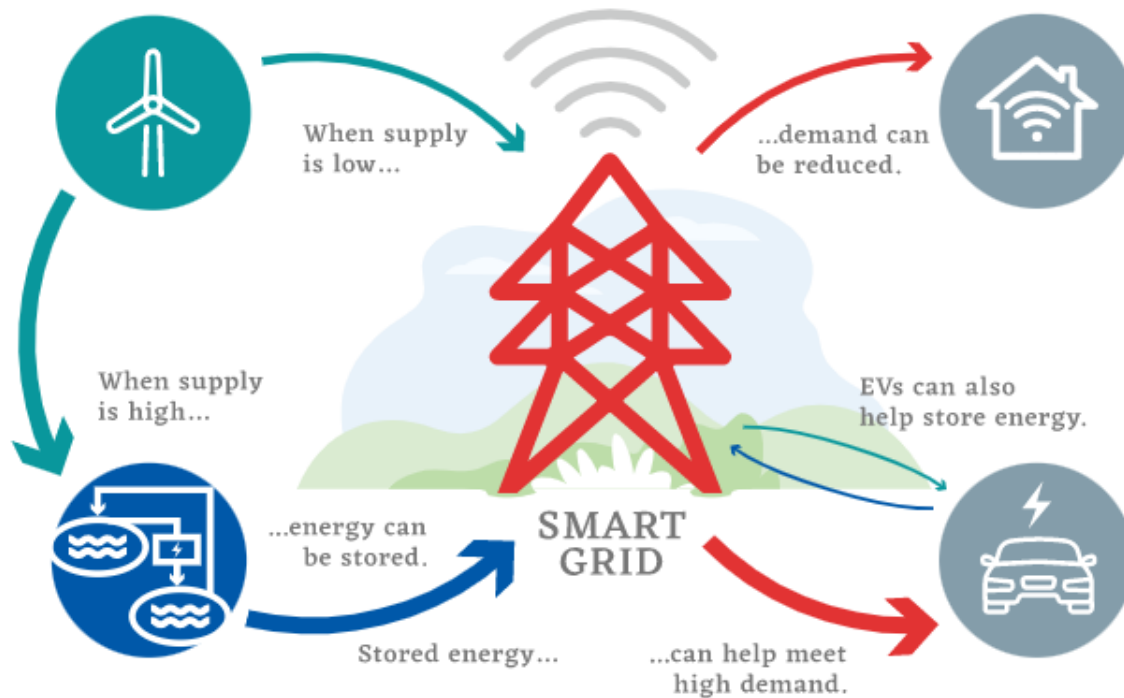
Name	Source of Power	Status
±800 kV Hami North – Chongqing UHV DC line and associated UHV AC lines linking Chongqing and Sichuan	Xinjiang wind, solar and new mine-mouth coal projects	<ul style="list-style-type: none"> This line has been considered since 2011. It was delayed mainly because of the surplus power capacity in Chongqing and Sichuan in 2015-2020. Power balance in central China, including Chongqing and Sichuan, has tightened since 2020, and both Chongqing and Sichuan have started to consider import from Xinjiang via the Hami North-Chongqing UHV DC line again. There are planned associated UHV AC lines linking Chongqing and Sichuan (甘孜-天府南-成都东、阿坝-成都东). In Sichuan, six UHV DC lines export its hydro power to East and Central China*. These projects are in Chongqing and Sichuan's 14th FYP, but they have yet to receive approval from the central government.
Haixi (Qinghai) – Central/East China	Wind, solar and hydro in Qinghai	<ul style="list-style-type: none"> This is in Qinghai's 14th FYP. It has not obtained approval from the central government, as the central government would like to evaluate the utilization rate of the recently commissioned Qinghai-Henan UHV DC line first.
Gansu-Shandong (陇东至山东) UHV DC line	Wind, solar and maybe coal from Gansu	<ul style="list-style-type: none"> It has not obtained approval from the central government, but NEA instructed it to carry preliminary feasibility studies in September 2020. Preliminary feasibility studies have been carried out; and sources of renewable supplies are being identified.
Ningxia – Central China UHV DC line	Wind, Solar and coal from Ningxia	<ul style="list-style-type: none"> Planned in Ningxia's 14th FYP, but has not received approval from the central government
Shaanbei-Central/East China UHV DC line	Wind, Solar and coal from Ningxia	<ul style="list-style-type: none"> Planned in Shaanxi's 14th FYP, but has not received approval from the central government

Note: * the six UHV DC lines exporting hydro power from Sichuan are the recently approved BaiHeTang-Zhejiang line, the BaiHeTang-Jiangsu UHV DC line under construction, the YaZhong-Jiangxi commissioned in June 2021, and the Xiangjiaba-Shanghai line commissioned in 2010, Jinping-Sunan line commissioned in Dec 2012 and Xiluodu-Zhejiang line commissioned in July 2014.

Smart grid

Grid companies have plans to roll out smart grid solutions, which integrate demand and supply at the distribution level

Smart Grid (Illustrative)



- A smart grid can connect energy production and storage facilities with consumers through digitization and the exchange of data. It's a key part of managing supply and demand when there's a large proportion of variable renewable energy sources in the mix at the distribution level.
- The grid companies have been talking about creating the smart grid since 2016. There have been no concrete regulation and policies on “smart” grid as they are difficult to formulate.
- Nonetheless, with increasing penetration of electric vehicles and the call to have more demand response, concrete actions will likely accelerate in the coming years.
 - In mid November 2021, China Southern Grid announced that it plans to invest 670 billion RMB in 2021-2025, over 20% higher than the previous five years. 320 billion RMB will be at the distribution grid, and creation of a smart grid with better digitalization is one of the key themes for new investment.

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Summary

Solar and wind capacity expansion rate will be higher, and there is a need to build much more flexible capacity, UHV and “smart” grid infrastructure

Recent Power Market Development

- The power shortage situation has been largely resolved with the increase of coal supply. But there is still a structural shortage of flexible capacity in coastal and central provinces.
- Higher “market” prices will help to incentivize faster capacity expansion of solar and wind capacity around China. The government has also introduced the national carbon market and green trading to help wind and solar capacity to monetize its green attributes.

De-carbonizing the Power Sector and Its Implication

- Electrification of the economy, residential demand growth and expansion of data centers will help to drive demand growth at 3-5% in the medium-term and 1-3% in the long term.
- Solar and wind capacity expansion needs to be 1.5-2.0 times of the expansion rate seen in 2016-2020 to help bend the carbon emission profile from the power sector.
- Much faster expansion of energy storage capacity and grid infrastructure are also required to help integrate increasing capacity and generation share of intermittent renewable sources in the grid system.

Thanks and Contact

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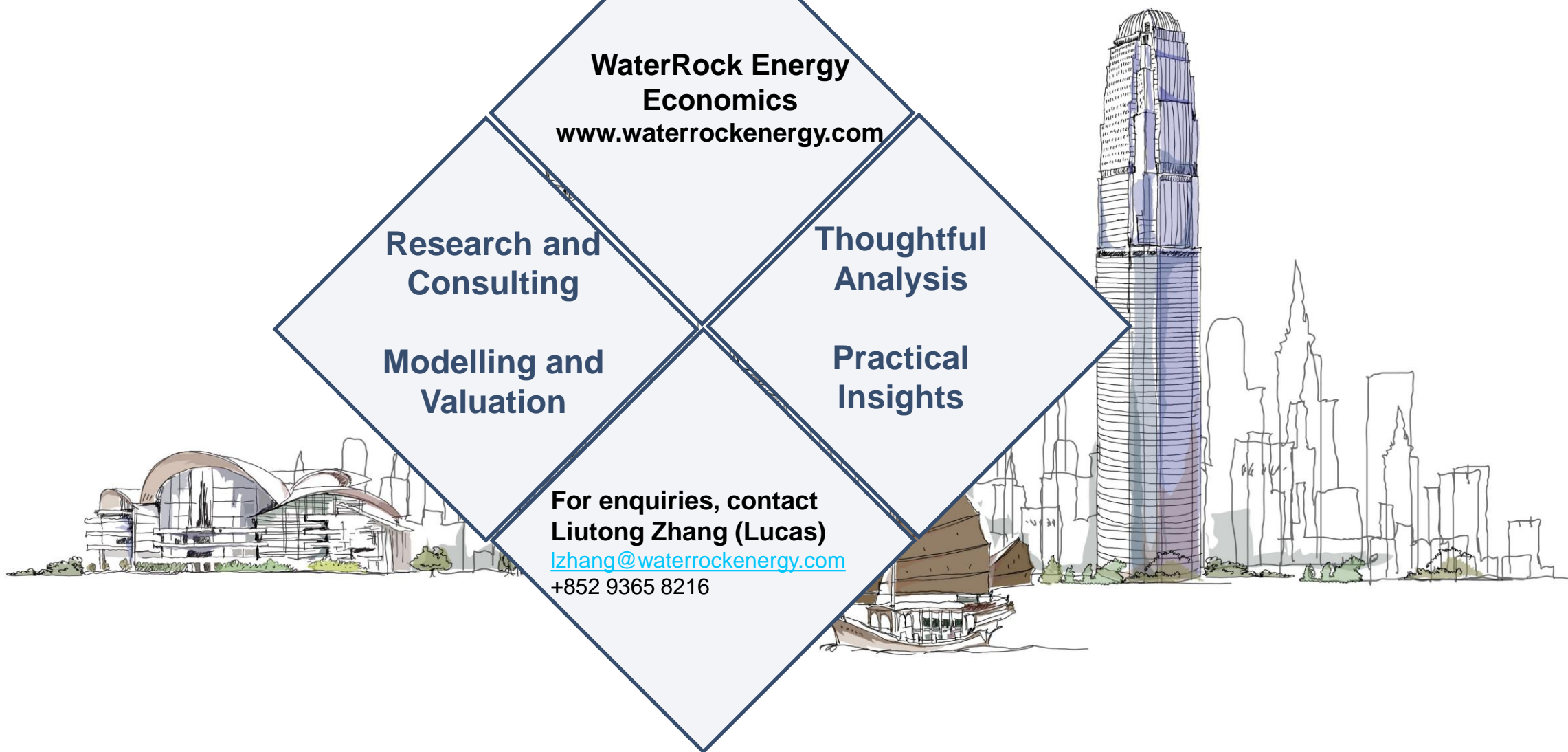
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Liutong has over 14 years' experience of providing advisory services on the power and gas market in China and ASEAN electricity markets.

He has in-depth knowledge in greater China region, including forecasting of solar and wind curtailment and power tariffs, asset valuation and evaluation of opportunities/risks of investing in renewables and gas infrastructure in mainland China, Hong Kong and Taiwan.

He has also been extensively involved in the market design of a Forward Capacity Market in Singapore since early 2019. In the Philippines, he was invited to present to the Philippines' Energy Committee of the Senate and Philippines' House of Representatives on the role of natural gas and economics of building new LNG terminals in early 2020.

He holds a Bachelor of Chemical Engineering with first class honours from the National University of Singapore (NUS). He is fluent in English and Mandarin.

WaterRock Energy offers advisory services to help clients to make better decision in the power and gas sector in Asia

A Boutique Market and Economic Consultancy

Focus on Asian power and gas markets and assets

Highly experienced team

Practical, analytical, nimble, client-focused with deep local knowledge and connection with local regulators/companies

Commercial and Regulatory Support

Transaction support, market analysis, regulatory support, Tariff benchmark

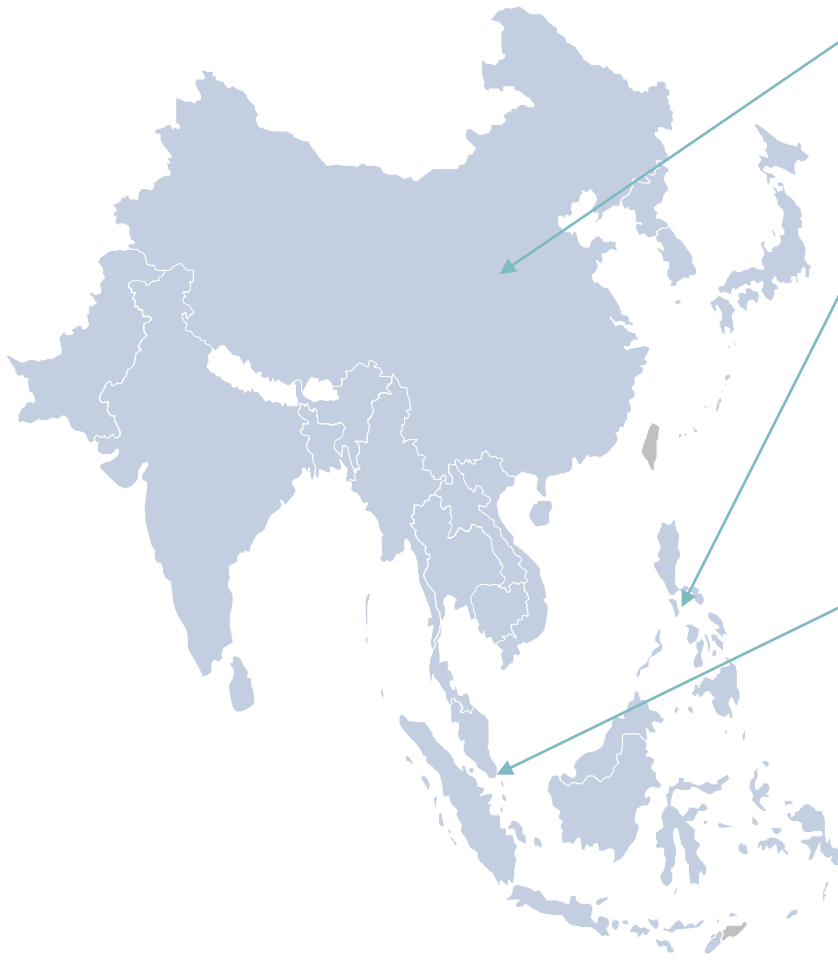
Strong client base

Regulators, grid companies, utilities, PE funds, financial institutions, gas suppliers and importers

Our Key Clients (since July 2018)



Extensive Experience in ASEAN and China Power and Gas Markets



For foreign investors and gas exporters to mainland China, Taiwan and Hong Kong:

- More than 10 GW of due-diligent studies on issues such as regulatory risks, fundamental power supply and demand, renewables curtailment and tariff forecast
- Multiple detailed provincial level natural gas studies on key drivers of gas demand, economics of gas-to-power and opportunities of selling LNG to greater China region.

For both domestic and international players in the Philippines:

- More than 5 GW of due-diligent studies on thermal and renewables plants.
- Multiple studies on the opportunities and risks of investing in LNG terminals.

For Singapore regulators:

- Energy market design issues such as market power mitigation and resource adequacy studies
- Fuel mix and carbon emission related projects

For existing generators, large consumers and potential investors:

- More than 2 GW of due-diligent studies on wholesale electricity price and end-user tariff forecast; modelling support to existing Gencos
- Over-contracted gas and financial sustainability issues.

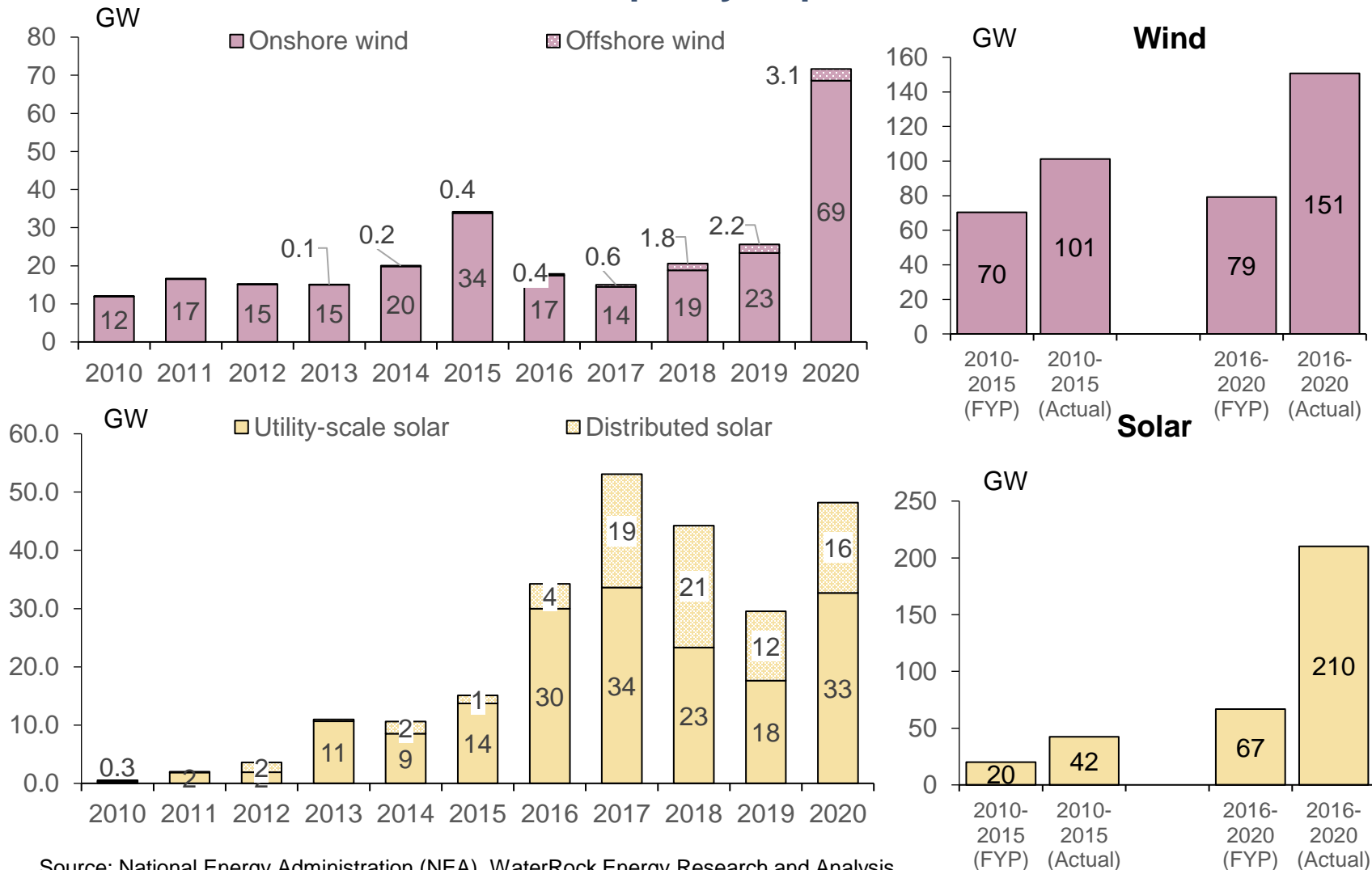
Regional studies:

- Multiple studies on investment opportunities in the electricity sector in Asia
- Multiple studies on regional gas market and opportunities of selling LNG to Asia.

Market Background – Chinese RE Expansion

Solar and wind capacity expansion have been consistently higher than government's plan, thanks to “promised” subsidies and rapid cost reduction

Wind and Solar Incremental Capacity Expansion, GW

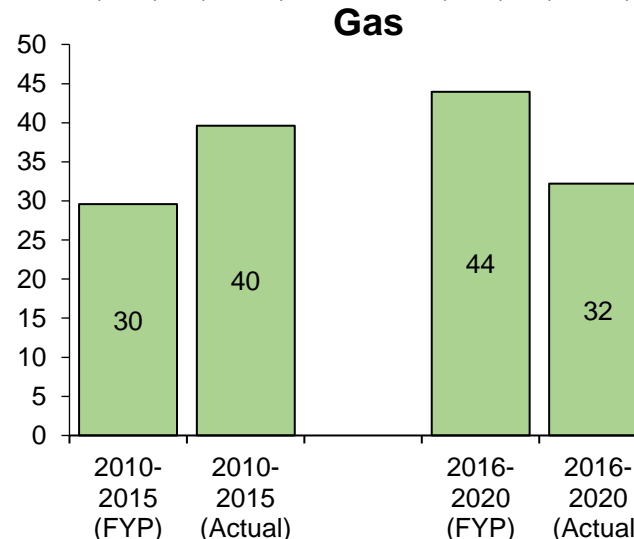
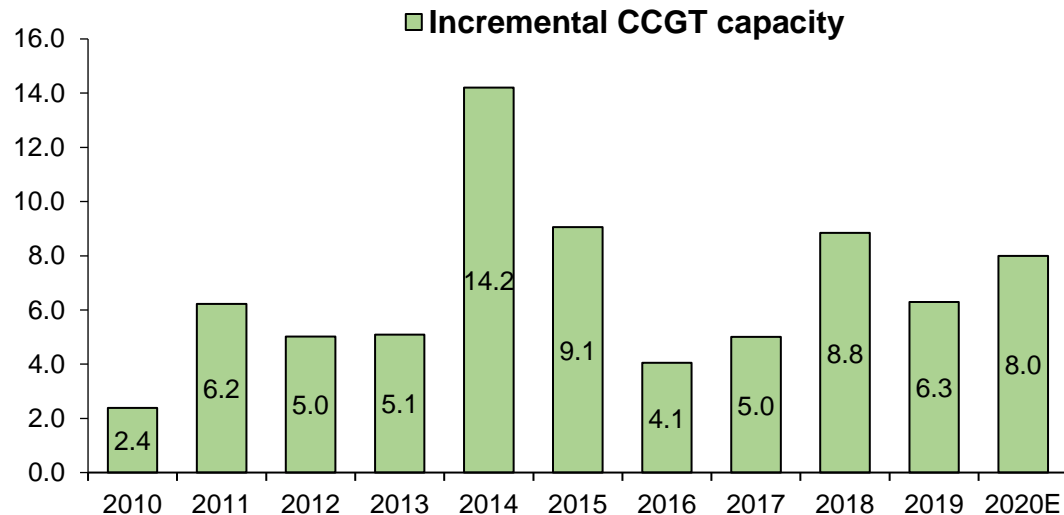
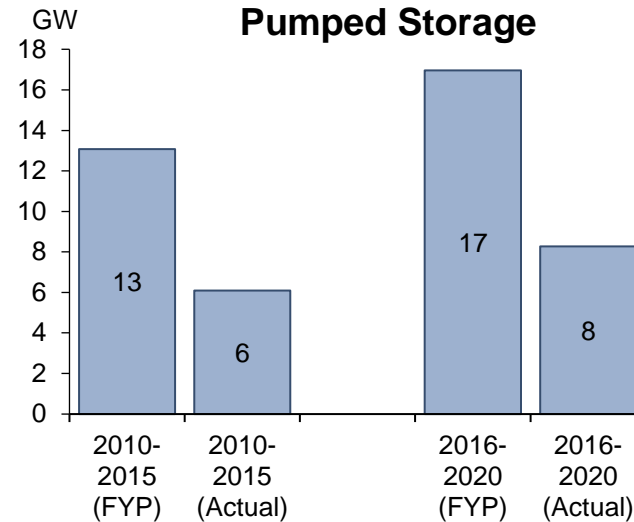
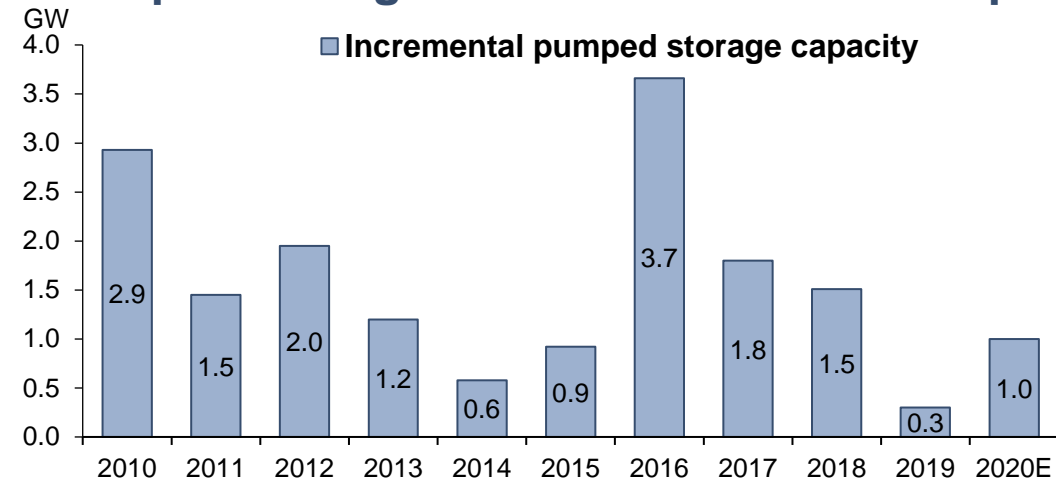


- Wind and solar capacity expansion has been consistently higher than government's plan.
- Solar and wind capacity expansion far exceeded government's expectation.
 - As the installation cost has declined faster than the feed-in tariff rate reduction, there was a solar rush in 2016-18. The solar rush has also led to increasing subsidy deficit since 2016.
- China has also built up an impressive value chain for solar manufacturing.
 - For example, more than 70% of solar panel is produced in China.

Issue (b): Lack of Flexible Capacity

But there have been under-investment in flexible capacity in the past decade due to rigid and low tariff setting

Pumped Storage and Gas Incremental Capacity Expansion, GW



- Pumped storage plants are the most flexible capacity in the Chinese power system. Its expansion has been much slower than government's plan.
- Gas capacity can also operate much more flexibly than coal. In the past five years, gas capacity expansion is also slower than government's plan due to rigid on-grid gas tariff and gas availability.

- In general, **the tariff and market design do not align the "regulated price" and value of flexible capacity well.**

- Tariff for flexible capacity is often too rigid and set too low.
- No adequate pricing mechanisms to differentiate peak and off-peak periods.

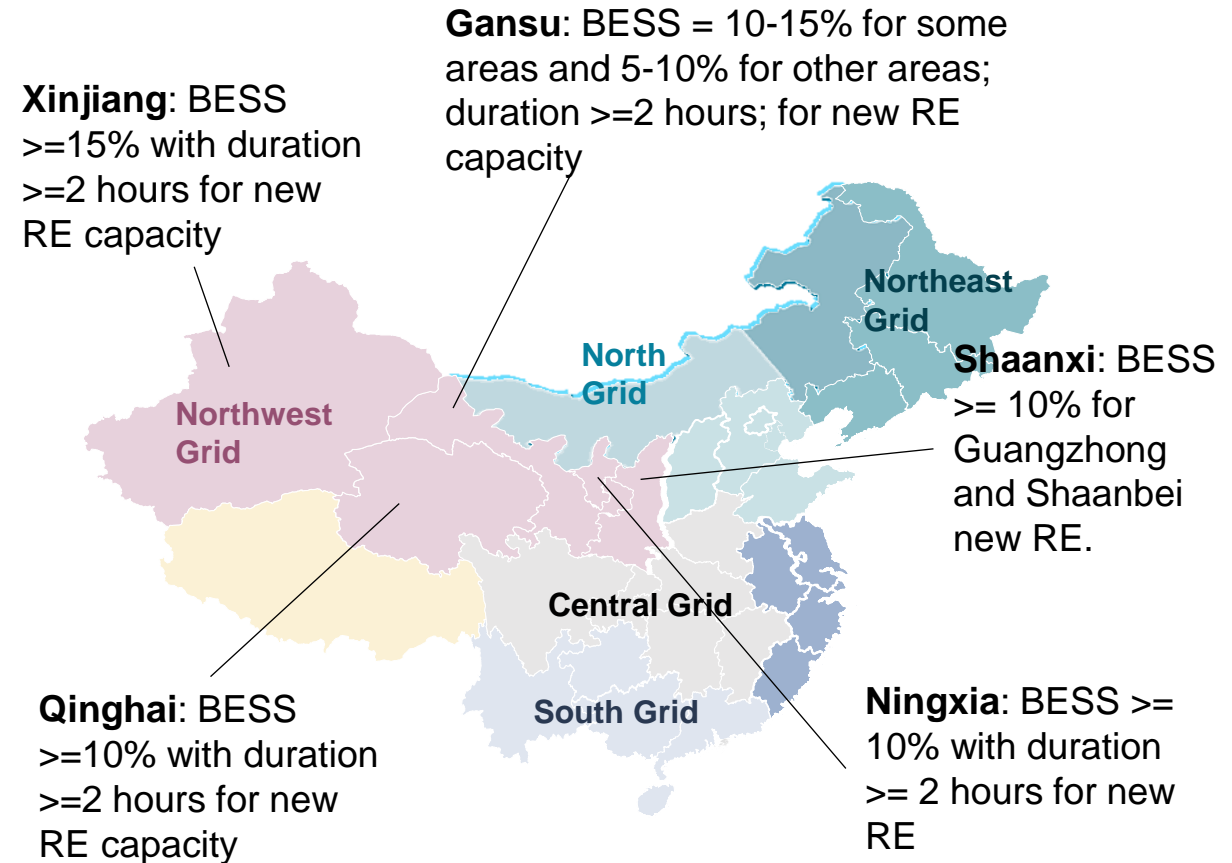
Flexible Capacity

There are almost no increase in flexible capacity in Northwest in 2015-2020, but pumped storage and battery are likely to be added in the coming years

Hydro Pumped Storage Capacity Plans

- Planned pumped storage hydro projects in Northwest grid do not make any progress in 2016-2020 as there are no clear tariff mechanism to help recover the high capex investment.
- In early May 2021, the NDRC introduced a new pricing regime to provide capacity payment for pumped storage plants. It also allows grid companies to recover the investment cost on pumped storage capacity from the transmission tariff.
- Under the new pricing regime, new projects in Northwest China may proceed this time.
 - Xinjiang** is building its first 1.2 GW pumped storage plant in Fu Kang, and the first unit is scheduled to be commissioned in 2024. It also plans to build another 1.2 GW pumped storage plant in Hami.
 - Gansu** is doing final studies to build its first 1.2 GW pumped storage plant in Yumen. It could take more than 6 years to build the plan.
 - Qinghai** manages to include 11 planned pumped storage projects in the 2021-2035 national pumped storage capacity plan issued by NEA.
 - Shaanxi** is building its first 15.5 GW pumped storage plant, scheduled to be commissioned in 2022. It also plans to build a dozen more in the next 20 years.

Battery Energy Storage System (BESS) after 2021

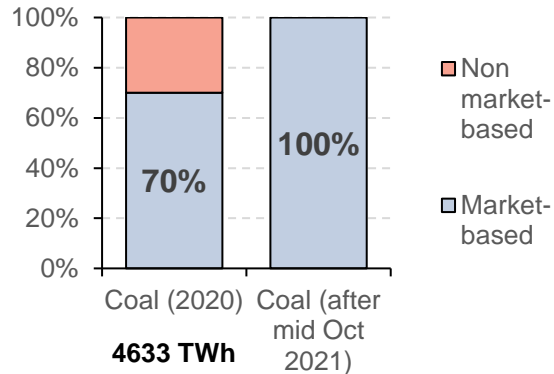


Latest Regulatory Change in the Power Sector

The latest regulatory change on coal trading is a step change to increase the “market” volume for coal capacity and the C&I end-users

Generation

Coal Capacity



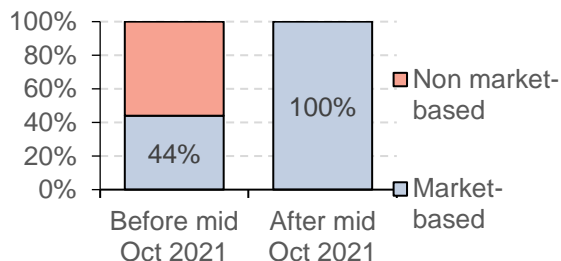
- **All Coal capacity** need to participate in the market after mid October 2021.
- **Market traded prices are allowed to fluctuate +/- 20% from the on-grid coal benchmark for coal-fired capacity selling to normal C&I customers; There will be no price cap/floor for energy intensive industries.**
- Over time, **Nuclear/gas/hydro/import, solar and wind** capacity will also need to participate in the market.

T&D

- Independent tariff setting for T&D assets has been implemented in all the provinces in China. Grid companies also need to provide open access to generation capacity.
- De-regulated retail prices = Generation Market price plus T&D charge plus surcharges and taxes

Retail

C&I Customers

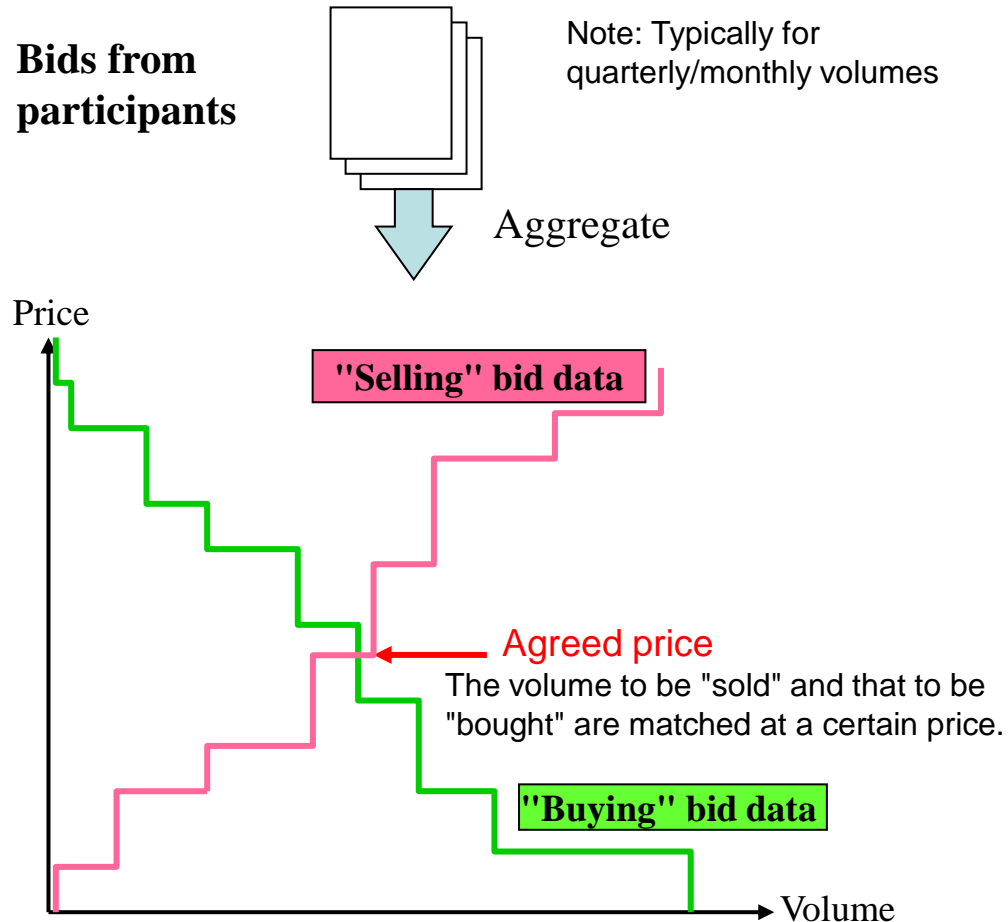


- Retail competition has been rolled out gradually in China since 2015.
- **On October 10, 2021, NDRC has announced that all C&I customers above 10 kV needs to enter the market from October 15, 2021 onwards in principle. For the other C&I customers, they are encouraged to enter the market.**

Types of “market” contracts

The most common type of “market” contracts is still bilateral contracting, but the amount of centralized trading could increase in the coming years

Centralized Competitive Bidding for Monthly Trading



- **Bilateral contracting:** Started since early 2000s; the transaction is mostly in terms of **physical volume**.
- **Power exchanges:** All provinces have set up provincial level power exchanges to facilitate **centralized** annual/monthly trading for independent retailers and generators and among the Gen-tailers.
 - Typical types of contracts in the power exchanges are:
 - **Annual contracts**, mostly via bilateral contracting. A small portion is via centralized competitive bidding.
 - **Monthly contracts**. These are via centralized bidding process (majority), rolling matched trading and post trading.
- **Spot market (similar to the Singapore SWEM market)**
 - Not ready yet, but arguably inevitable in the long term. There is evident of problems in absence of spot markets in power exchange contracting and settlement
- **“Green” markets:** (1) Direct “Green contract” trading between RE producers and end-users; and (2) trading of “green” certificates.