Renewables in China: the road ahead

CHRISTIAN ROMIG, ROB LEE
INTRODUCTION

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INTRODUCTION

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China is home to the world’s largest electricity system, composed of more than 30 diverse electricity markets.

China’s electricity demand is roughly...

~7200TWh (Gross)

...2 Europes...

...12 Germanys...

...or 20 UKs
INTRODUCTION TO CHINA

Rising demand has been met primarily by thermal plants...

**Generation (TWh)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Nuclear</th>
<th>Wind</th>
<th>Solar</th>
<th>Thermal</th>
<th>Hydro</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>200</td>
<td>300</td>
<td>100</td>
<td>500</td>
<td>700</td>
<td>1700</td>
</tr>
<tr>
<td>2011</td>
<td>250</td>
<td>350</td>
<td>150</td>
<td>550</td>
<td>750</td>
<td>1800</td>
</tr>
<tr>
<td>2012</td>
<td>300</td>
<td>400</td>
<td>200</td>
<td>600</td>
<td>800</td>
<td>2100</td>
</tr>
<tr>
<td>2013</td>
<td>350</td>
<td>450</td>
<td>250</td>
<td>650</td>
<td>850</td>
<td>2300</td>
</tr>
<tr>
<td>2014</td>
<td>400</td>
<td>500</td>
<td>300</td>
<td>700</td>
<td>900</td>
<td>2600</td>
</tr>
<tr>
<td>2015</td>
<td>450</td>
<td>550</td>
<td>350</td>
<td>750</td>
<td>950</td>
<td>2800</td>
</tr>
<tr>
<td>2016</td>
<td>500</td>
<td>600</td>
<td>400</td>
<td>800</td>
<td>1000</td>
<td>3000</td>
</tr>
<tr>
<td>2017</td>
<td>550</td>
<td>650</td>
<td>450</td>
<td>850</td>
<td>1050</td>
<td>3150</td>
</tr>
<tr>
<td>2018</td>
<td>600</td>
<td>700</td>
<td>500</td>
<td>900</td>
<td>1100</td>
<td>3300</td>
</tr>
<tr>
<td>2019</td>
<td>650</td>
<td>750</td>
<td>550</td>
<td>950</td>
<td>1150</td>
<td>3500</td>
</tr>
</tbody>
</table>

**Key Statistics**

- **5200 TWh** Generation from **thermal** in 2019
- **1800 TWh** Increase in **thermal** generation from 2010
- **1200 TWh** Generation from **hydro** in 2019
- **~30%** Generation from **low-carbon** sources in 2019

Notes: Gross generation incl. power station self consumption and pumped storage consumption.
... However, China has big ambitions for renewable deployment.

**INTRODUCTION TO CHINA**

**CAPACITY DEPLOYED TO DATE (GW)**

- Solar PV
- Offshore wind
- Onshore wind

**KEY STATISTICS**

- **2050 target** for non-fossil fuels in total final energy consumption
- **10-year CAGR** of wind and solar PV
- **Yearly average capacity additions** (wind and solar PV) in the last decade
- **Number of years RES capacity additions have outpaced fossil fuels**

**Source:** National Energy Administration, National Bureau of Statistics.
China’s energy resources are largely located far away from demand centres, which has led to the development of an electricity super-grid.
INTRODUCTION TO CHINA

Provincial systems are distinct, diverse and currently display only low levels of market integration

**Xinjiang**
- Demand: 214 TWh
- Net Exports: 44 TWh

**Shanxi**
- Demand: 216 TWh
- Net Exports: 78 TWh

**Yunnan**
- Demand: 168 TWh
- Net Exports: 142 TWh

**Shandong**
- Demand: 592 TWh
- Net Imports: 57 TWh

**Guangdong**
- Demand: 632 TWh
- Net Imports: 142 TWh

Notes: Charts are illustrative and AFRY has no view or position on what constitutes an administrative region in the People’s Republic of China or other nations, states or regions. Example provinces only, AFRY covers all individual provinces. Data for 2019.
Integration has been a challenge, though this has improved in recent years.

**WIND AND SOLAR PV CURTAILMENT**

Curtailment rate, %

0% 2% 4% 6% 8% 10% 12% 14% 16% 18% 20%


**REGIONAL DISTRIBUTION OF WIND CURTAILMENT (2019)**

Source: National Energy Administration

Note: Charts are illustrative and AFRY has no view or position on what constitutes an administrative region in the People’s Republic of China or other nations, states or regions.
The support scheme for utility wind and solar is transitioning and subsidy levels are being reduced, we expect this trend to continue.

<table>
<thead>
<tr>
<th>Revenue structure</th>
<th>Feed in Tariff</th>
<th>‘Grid parity’ PPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>National subsidy*</td>
<td>Revenues from trading**</td>
<td>Local subsidy?</td>
</tr>
<tr>
<td>Coal benchmark price</td>
<td>Coal benchmark price</td>
<td>Green certificate?</td>
</tr>
<tr>
<td>Revenues from trading**</td>
<td>Local subsidy?</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Allocation</th>
<th>Auctions with capped budgets</th>
<th>Regulated standard agreement, No caps, no quotas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term</td>
<td>20 years</td>
<td>20 years</td>
</tr>
<tr>
<td>Offtaker</td>
<td>Local grid / end users</td>
<td>Local grid</td>
</tr>
<tr>
<td>Risk profile</td>
<td>Policy: Low - High</td>
<td>Policy: Low - High</td>
</tr>
<tr>
<td></td>
<td>Price: Low - High</td>
<td>Price: Low - High</td>
</tr>
<tr>
<td></td>
<td>Volume: Low - High</td>
<td>Volume: Low - High</td>
</tr>
</tbody>
</table>

*Some capacities can also be awarded a local subsidy. Other support exists in the form of fiscal and other incentives. **Only possible in certain provinces.
The introduction of competitive markets in China are bringing about a shift in the operational paradigm of the system.

### CENTRALLY DETERMINED GENERATION SCHEDULE

- **Dispatcher**: Variable dispatch
- **Hour allocations shared**: 1300 hrs
- **2000 hrs**
- **3600 hrs**
- **7500 hrs**
- **4500 hrs**

Guaranteed hours for wind and solar PV offer some ‘priority dispatch’ in some regions.

### MARKET-BASED DISPATCH

- **Price (RMB/MWh)**
- **Demand**
  - In merit
  - Out of merit
- **Clearing price**

**Available capacity (MW)**
- **RES**
- **Hydro**
- **Nuclear**
- **Coal**
- **CCGT**

Notes: Hour allocations shown here are illustrative, and based on forecasts of operating hours, demand, and capacity.
AFRY expectations: Wholesale prices under an efficient market should fall by +/- 30% relative to current coal benchmark price

CURRENT PRICING MECHANISM FOR COAL VS. WHOLESALE MARKET

- Coal benchmark price
- “Plus”
  - Profits
  - Tax
  - Balancing cost
  - Fixed components\(^1\)
- Cost
  - Fuel component
- Linkage\(^2\)
- Coal price

- Base price + floating:
  - Set relative to coal benchmark, adjusted at regular intervals
- Centrally calculated (infrequent)
- Centrally adjusted (frequent as of 2020)
- Wholesale market prices
- Market determined (granular)

POSSIBLE IMPACTS OF REFORM

- Lower carbon emissions as dispatch is reformed
- Less RES curtailment
- Pressure on inefficient thermal plants
- More efficient trading between provinces and regions
- Lower consumer bills

Notes:
1. Fixed components include desulfurization, denitrification, dust removal, etc.
2. The coal-electricity price linkage mechanism was set up in 2004, but the mechanisms failure in 2018 & 2019 led to its abolition in Sept 2019.
INTRODUCTION TO CHINA

Future outlook – key drivers

- The volume and composition of electricity demand
- The future generation and capacity mix in China
- Falling technology costs
- Prices
Demand in China was historically driven by growth in manufacturing, now China’s economic growth has shifted towards services which are less energy intensive.

DEMAND GROWTH

- As the pace of economic growth in China begins to slow, growth in electricity demand will also slow.
- China’s electricity demand growth has historically been driven by secondary industry.
- China’s economy has shifted towards tertiary industry in recent years.
- Tertiary industry is less energy intensive than secondary.
- The widespread rollout of electric vehicles will be a key driver in China’s growing electricity demand.

Notes: Based on AFRY Central scenario, excludes power station self consumption and pumped-storage pumping.
As the energy mix in China evolves, coal plant will begin to be squeezed out of the mix by low carbon sources of generation.

**INTRODUCTION TO CHINA**

- Coal still has an important role to play in the near term.
- Growth from renewables, particularly wind and solar will play a vital role in meeting new demand (~4000TWh growth).
- Nuclear will also play an important role, limited to the coastal regions.
- As coal begins to decline and retire, batteries will become more widespread.

**GENERATION MIX TRENDS**

Notes: Generation net of power station load
AFRY expects substantial growth in wind, solar, and storage to 2050

### INTRODUCTION TO CHINA

- Near-term firm capacity needs limited and regional
- Inefficient coal plant will begin to retire first
- Substantial capacity growth coming from wind and solar PV (~2000GW growth)
- Batteries will play a limited role in the short term, but will become increasingly important
- Thermal plant will need to run more flexibly, combined with growth in transmission capacity to successfully integrate RES
- Nuclear will play an important role in coastal regions

Notes: Capacities quoted as net to grid
Deployment of renewables and batteries across China will be driven by falling costs

Notes:
- LCOE - Levelised Cost of Electricity, is the electricity price a generator must achieve for each megawatt hour generated for investors to receive an adequate return on invested capital.
- Ranges based on differences in LCOE’s between provinces across China.
- Annualised cost is the total required profit required at a project level for an investor to receive an adequate rate of return to incentivise investment. Based on AFRY’s Central scenario. Real 2018 money. Assumes 9% unlevered pre-tax real IRR for wind and batteries, 8% for solar. Representative of AFRY expectations of a merchant project, LCOE’s for supported projects or projects with a fixed long term contract with a creditworthy counterparty may be significantly lower.
The wholesale electricity price that any asset is able to capture will vary widely between provinces and will be highly dependent on local market conditions.

Each line represents price trajectory in a different province.

Conflicting and compounding fundamental drivers determine the trajectory of prices: technology mix, fuel costs, demand growth etc.
Key takeaways for the future of renewables in China

- China has big ambitions for renewables, and we expect these to materialise...
- ...key drivers will include falling costs, continued policy support and greater diversity for RES generators’ route-to-market;
- Overcoming the integration challenge will require accelerated reforms to China’s electricity market and system operation philosophy as well as efficient use of transmission infrastructure – these are underway;
Key takeaways for investors

- China’s market represents a significant opportunity in renewables;
- Succeeding in the market will require a solid understanding of China’s fast-paced policy environment, particularly its evolving support schemes;
- Market reforms are key, these will change how revenues are accessed in the market;
- Significant diversity between provinces requires taking a provincial-level approach to the market.
AFRY support for opportunities in China

- Off-the-shelf market reports;
- Bespoke studies – regionally and/or technology focussed;
- Modelled scenarios including price projections at a provincial level;
- Market scoping – identification of target regions/technologies;
- Due diligence/transaction support;
- Market readiness – adapting to China’s changing markets;
- Market design and regulatory advice.
CONCLUDING REMARKS

Contact us

- **Reach out** to us for more information:
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  rob.lee@afry.com

- **More webinars** will follow with relevant topics, and any update on the evolving situation.

- Next week:

  **Digitalisation in the energy sector: uncovering hidden value in operations**
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