China’s Energy Future

How economic rebalancing, environmental concerns, and policy reforms will accelerate change

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Overview

• Historical growth in China’s energy consumption

• Future energy projections

• Key drivers of China’s energy future
  – Scale and structure of China’s economic growth
  – Local and global environmental concerns in China
  – Economic, energy, and environmental policy reforms
Historical growth in China’s energy consumption
China’s energy mix is evolving…

Data source: IEA World Statistics and Energy Balances
Fuel mix shifts as societies become wealthier

Data source: IEA via Paul J. Burke
…but mainly through addition rather than substitution

China primary energy consumption

Quadrillion Btu

Data source: IEA World Statistics and Energy Balances

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Regional energy consumption has been shifting east
1971

Country size scaled by share of global energy consumption

China’s GDP

$0.4$ trillion

China’s GDP in 1978 was $0.6 trillion. 

Country size scaled by share of global energy consumption.

1990

China’s GDP

$1.6 trillion

Country size scaled by share of global energy consumption

2001

China’s GDP

$4.6 trillion

Country size scaled by share of global energy consumption

China’s GDP

$13.3 trillion

Country size scaled by share of global energy consumption

Future energy projections
Global energy consumption projections suggest wide variation in potential pathways.

Note: U.S. EIA and BP estimates omit non-marketed biomass.
China’s uncertain energy future comprises a significant part of this global uncertainty.

Note: U.S. EIA estimates omit non-marketed biomass.

China’s GDP

Country size scaled by share of projected global energy consumption

1971

China’s GDP

$0.4$ trillion


Country size is scaled by share of global energy consumption
Global energy flows shifting towards Asia

Source: Newell, Raimi, and Qian (forthcoming) derived from IEA 2014 World Energy Outlook, New Policies Scenario
Key drivers of China’s energy future
The Kaya Identity in China (growth rates add up)

$%P + \%G/P + \%E/G = \%E$

$\%E + \%C/E = \%C$

Scale and structure of China’s future economic growth
How quickly will China’s economy grow?

<table>
<thead>
<tr>
<th>Source</th>
<th>Real GDP growth rate (%) estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEA (GDP PPP)</td>
<td>6.7</td>
</tr>
<tr>
<td>IMF</td>
<td>6.8</td>
</tr>
<tr>
<td>World Bank</td>
<td>7.1</td>
</tr>
<tr>
<td>Economist IU</td>
<td>6.8</td>
</tr>
<tr>
<td>UN</td>
<td>6.9</td>
</tr>
<tr>
<td>OECD</td>
<td>7.3</td>
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- China’s Energy Research Institute assumes average annual GDP growth of 6% during 2020-2030
- Some economists predict much lower growth around 4%
The *structure* of China’s economic growth will also impact energy consumption

- How quickly will China transition from heavy industry, infrastructure investment, and manufacturing to a more service- and consumer-based economy?

![Diagram showing the percentage of value added to GDP by sectors over time.](image-url)

Data source: World Bank
Market-oriented policy changes could also accelerate change in China’s energy system

<table>
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<th>Example market-oriented policy reforms</th>
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<tbody>
<tr>
<td>Opening up fossil fuel assets to independent exploration</td>
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<tr>
<td>Reorganization of state-owned energy companies</td>
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<tr>
<td>Pricing deregulation</td>
</tr>
<tr>
<td>Expanded market mechanisms in the power sector</td>
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<tr>
<td>Liberalization of interest rates</td>
</tr>
<tr>
<td>Allowing Chinese to more easily buy foreign assets</td>
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</tbody>
</table>
Local and global environmental concerns in China
Air pollution drawing attention in China

Average daily PM$_{2.5}$ readings in Beijing

- Very Unhealthy to Hazardous
- Unhealthy
- Healthy to Moderate

winter peaks

Data source: U.S. State Department
Air quality has been improved before in other large cities

Daily max ozone concentrations in Los Angeles

Data source: U.S. EPA

Very Unhealthy to Hazardous
Unhealthy
Healthy to Moderate
Efforts to reduce CO$_2$ emissions are likely to further accelerate change in energy

Data source: IEA World Statistics
Energy and environmental policy reforms in China
2050 cost-effective CO₂ mitigation opportunities in China

- Total fuel switching in industry: 11%
- Reduced Transport Demand: 0.3%
- Reduced GDP: 3%
- Industrial Efficiency: 18%
- Building Efficiency: 6%
- Grid Efficiency: 0.4%
- CCS Coal: 11%
- CCS Gas: 11%
- Natural Gas: 4%
- Nuclear: 12%
- Renewable (excl. biofuels): 1%
- Biomass Power: 3%
- Solar: 7%
- Wind: 8%
- Hydro: 2%
- Energy Efficiency: 30%
- End-Use Sector: 16%

Data source: Analysis based on AMPERE results

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China has launched policy goals and reforms to transform its energy system and reduce CO$_2$.

**Existing policy initiatives**

- 40-45% reduction in CO$_2$/GDP by 2020
- 15% share of non-fossil energy by 2020
- Carbon-trading pilots in 7 regions
- Low-carbon development pilots in 42 municipalities
- Energy efficiency measures by industry and energy sector
- Renewable energy supports
- Concerted reforestation efforts (+40 million hectares by 2020)

**2014 status relative to 2005**

- 34% reduction in CO$_2$/GDP
- 90 times more installed wind capacity
- 400 times more installed solar capacity
- Three times more hydro and nuclear capacity
- Forest stock expansion (21 million hectares; 1.3 billion m$^3$)

Source: *Enhanced Actions on Climate Change: China’s Intended Nationally Determined Contributions*, submitted June 2015 as part of the UNFCCC
China’s INDC identifies key targets and policies and measures for achieving them

<table>
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<th>2030 targets relative to 2005 levels</th>
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<tr>
<td>Peak CO\textsubscript{2} emissions around 2030; best efforts to peak early</td>
</tr>
<tr>
<td>Reduce CO\textsubscript{2}/GDP by 60-65%</td>
</tr>
<tr>
<td>Increase non-fossil share of primary energy to around 20%</td>
</tr>
<tr>
<td>Increase forest stock by around 4.5 billion m\textsuperscript{3}</td>
</tr>
</tbody>
</table>

- Commitment also to launch national carbon trading program in 2017

Source: Enhanced Actions on Climate Change: China’s Intended Nationally Determined Contributions, submitted June 2015 as part of the UNFCCC
China’s INDC 2030 goals require new non-fossil electricity capacity equivalent to total U.S. capacity today

China Non-Fossil Capacity Growth, with Estimated Additions by 2030

Sources: Bloomberg New Energy Finance; White House
Note: Marine, Solar Thermal Electric Generation and Geothermal have been excluded from this graph due to their relatively small historic values

http://bit.ly/1emydFk
China’s uncertain energy future has important implications for CO₂ emissions.

China coal consumption: When will it peak and decline?

Coal consumption

(billion metric tonnes)

China oil consumption: Possible pathways

Oil consumption (million barrels per day of oil equivalent)

- IEA Historical
- IEA Current Policies
- IEA New Policies
- IEA 450
- U.S. EIA

History vs. Projections

China natural gas consumption projected to rise 3-4 fold

China nuclear plants to rise from 29 to hundreds

China hydro projected to rise by >50%

Conclusions

• China experiencing rapid growth in energy consumption since ~2000

• The link between economic growth and energy is weakening, but growth is still a key driver

• Economic rebalancing will further reduce overall energy intensity

• Environmental concerns are spurring action in the energy sector

• There are a wide range of options in play for China’s policymakers to accelerate change in its energy systems
For more information

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