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Offshore wind in China enables the 1.5º C Climate Target

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Abstract

We evaluate the capacity for offshore wind in China's power sector and also the infrastructure requirements for its large-scale integration with the national power planning [1]. We utilize the SWITCH-China power sector capacity expansion model to explore transformative role that off-shore wind can play in China meeting 1.5℃ climate goals.

Introduction

1. China is the leading manufacturer of wind turbines worldwide, with the largest fleet of on-shore turbines in operation today.

•Growing from 0.3 GW of cumulative wind power capacity in 2000 to 184 GW in 2018

2. Onshore wind is facing two main challenges:

•Rapid growth in renewables energy development accompanied by high levels of curtailments.

•Geographic imbalance between resource-abundant western regions and demand centers in the east, resulting in inverse distribution between energy resources and electricity demand.

3. Offshore wind is expected to be alternative way to not only replace coal-fired power plants which dominate the energy mix in Chinese coastal regions, but also reduces requirements for ultra-high-voltage (UHV) transmission lines.

•China has abundant offshore wind resources.

•offshore wind will be cost-competitive compared with other renewables by 2030 [2].

4. Few studies explored integrating future offshore wind power into the power sector to decarbonize China's power systems.

•Physical offshore wind resource potential only represents an upper bound on offshore wind capacity and generation assuming full deployment.

•Most of the assessment methods do not fully consider the challenges of grid integration: how power system treat offshore wind generation, flexibility requirements, and transmission network constraints

Results

1. Offshore wind enable the coastal provinces to be a "hub" of energy generation
•The share of offshore wind generation could be 28% of electricity demand of the costal provinces by 2030.
•Large-scale wind enables coastal provinces to increasingly generate their own electricity needs reaching 28.6% of nine province (Fujian, Guangdong, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, Zhejiang) by 2030.

2. Offshore wind is a good resources to complement the production of solar and onshore wind
•Deploying offshore wind could significantly reduce requirements for onshore wind and solar capacity in non-costal provinces.
•Offshore wind could decrease needs for high-flexibility gas-fired generators to incorporate inland renewables.

3. Offshore wind development enable the China's power sector to cost less to achieve 1.5 ℃ climate goal
•Given the rapid cost reduction assumption in renewables and storage, 11% reduction in CO_2 emissions can be achieved in a lower cost than the cost under the BAU scenario.
•Under C70 scenario, CO_2 emissions would be only 30% of 2016 emission level, and cost less about USD20 billion less compared with the C70-LO scenario by 2030, a 5% reduction.
•The contribution in cost reduction for offshore wind mainly comes from the cross-provincial transmission lines, and fuel costs of coal and natural gas.

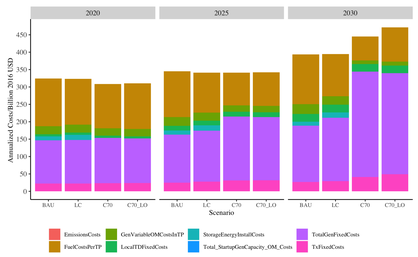

Figure 2. Annual Cost

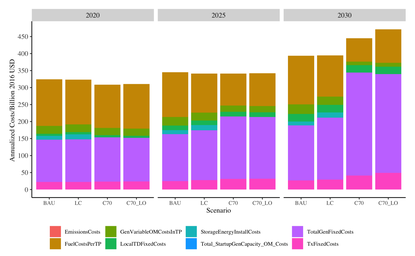

Figure 3. Energy self-sufficiency rate of the costal provinces

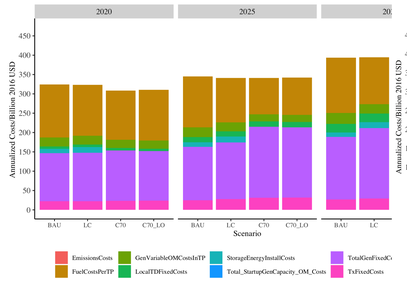

Figure 4. Installed Capacity

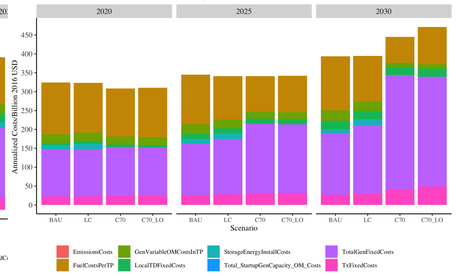

Figure 5. Generation

Materials and Methods

1. The SWITCH-China model [1,3]
•A mixed-integer linear program of the power system whose objective function is to minimize overall costs of generation, storage, and transmission to meet electricity demand through period.

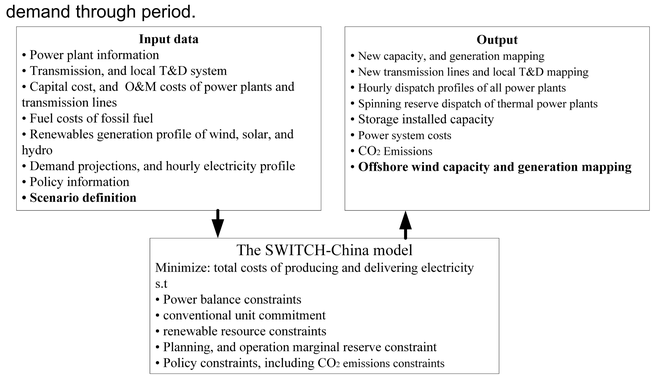

Figure 1. Diagram of the Switch-China Model

Table 1. Scenario Descriptions

	BAU	LC	C70	C70-LO
Research periods	Three investment periods: 2016 to 2020, 2021 to 2025, 2026 to 2030			
Existing policies	The Chinese "Five-year plan" from 2016 – 2020; No new coal-fired power plants after 2020			
Future renewable cost trends [4]	Moderate cost reduction in renewables	rapid cost reduction in offshore wind	Moderate cost reduction in renewables	Moderate cost reduction in renewables
Carbon cap emissions	-	-	A 70% reduction in carbon intensity from 2016 to 2030	A 70% reduction in carbon intensity from 2016 to 2030
Offshore wind	-	-	-	Maximum capacity limits

Conclusions

1. Offshore wind enable the coastal provinces to be a "hub" of energy generation
2. Offshore wind is a good resources to complement the production of solar and onshore wind
3. Offshore wind development enable the China's power sector to cost less to achieve 1.5 ℃ climate goal

References

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