ENABLING CHINA'S LOW-CARBON ENERGY TRANSFORMATION THROUGH EXPANDING ITS TRANSMISSION GRID

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Overview

With a total population of 1.36 billion (World Bank 2017), China faces the dual challenge of fighting climate change while maintaining its growing economy. Accounting for 29.5% of the world's total CO_2 emissions (European Commission 2017), China's energy roadmap will have a significant impact on the global low-carbon energy transformation throughout the coming decades. In their submitted Intended Nationally Determined Contribution (NDRC 2015), the country aims to achieve the peaking of CO_2 emissions around 2030 or earlier while increasing the total share of renewable energy fuels in primary energy consumption to 20%. Given its track record of overachieving set climate goals (see NEA and NDRC 2016), this research's model results confirm China's abilitity to fulfill its ambitions towards a sustainable energy economy throughout 2050.

Methods

With the aim to project China's energy system, the linear cost-optimizing model GENeSYS-MOD (Löffler et al. 2017) is applied to power, heat, as well as transportation sectors. Being a sector-coupling model, a wholistic energy path based on regional (geographic, demographic, and economic) assumptions until 2050 is calculated at a resolution of five-year steps. For this purpose, technological parameters, such as operational lifetimes, timeslices efficiency and availability factors are integrated. To allow a deeper understanding of regional disparities, primarily caused by varying renewable fuel potentials, power and heat consumption, China is segmented into eight sub-regions. The 100% RES scenario of this research restricts the total CO_2 budget with the aim of an energy system powered by solely renewable technologies. In comparison, the database for the Business As Usual (BAU) scenario is provided by the New Policies scenario of the IEA (2016) and lays out a more conservative path. Furthermore, GENeSYS-MOD has been expanded by endogenous grid simulation. In addition to model specific analyses, this research provides a profound foundation on the political framework and existing policies by integrating information from China's 13th Five Year Plan (CCCP 2015; NEA and NDRC 2016).

Results

Throughout the nation's energy transformation, solar power will dominate the energy mix with a share of 70% (see Figure 1 and Table 1) by 2050, followed by wind generation (17%) and hydropower (12%). China's current heavy reliance on fossil energy carriers in the process (high) heat sector, primarily based on coal and gas will slowly fade out in favor of biomass (around 50%) and power to heat (around 40%). As for district (low) heat, mainly heat pumps and a 10% share of biomass are projected for 2050. Concerning the transportation sectors, both passenger and freight slowly shift towards renewable technologies, including hydrogen and electric-based means of transit.

Table 1: China's regional power production in the 100% RES scenario (2050)

[TWh]	China-Central	China-East	China-North	China-Northeast	China-Northwest	China-South	China-Tibet	China-Uygur
Solar PV	1379	772	2966	1289	3618	3639	53	212
Onshore Wind	285	106	282	737	642	116	2	0
Offshore Wind	0	473	593	0	0	0	0	0
Hydro	756	78	27	61	181	597	448	68
Other Renewables*	4	36	9	3	2	3	2	2

* *includes Geothermal, Wave and Tidal Energy.*
Source: Own illustration.

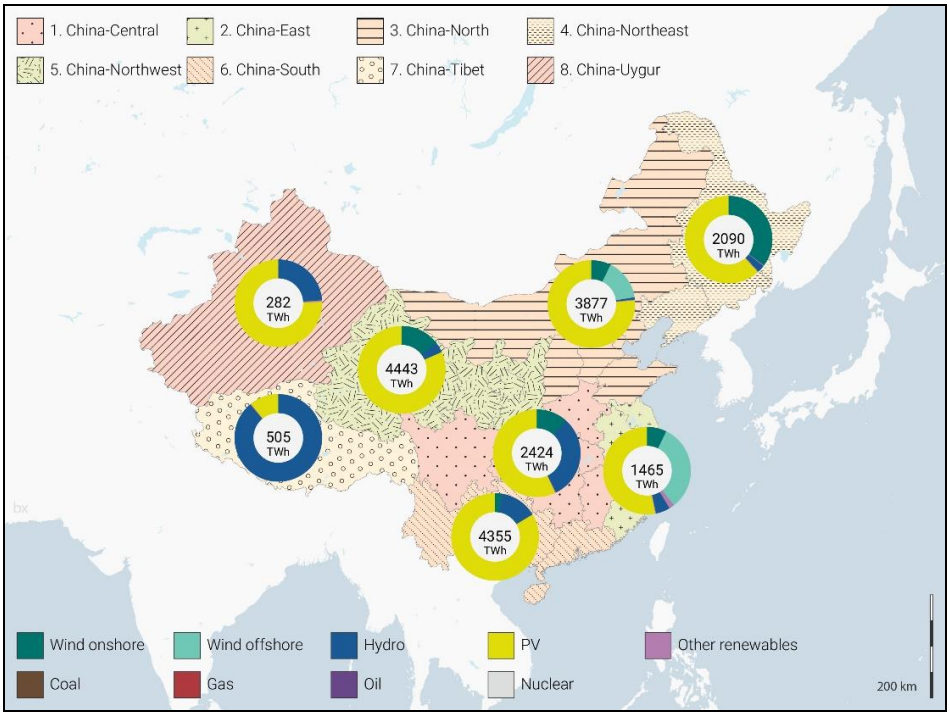

Figure 1: China's regional power production in the 100% RES scenario (2050)
Source: Own illustration.

Conclusions

The model results proof that a transition towards a low-carbon energy system in the power, heat, and transportation sector until 2050 is both technically feasible and economically archievable. Due to existing potentials and large-scale applicability, solar power will establish as the key power technology by 2050. While the northwestern regions are high in hydroelectric and solar power, the east coast is struggeling to supply the needs of the high populated megacities. Given the imbalance of high renewable potentials in the west and heavy energy demand in coastal regions in the east, the model confirms the necessity to expand China's existing backbone grid from west to east. By increasing the capacity of the West-to-East transmission line, China can become independent of fossil fuels.

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