ENERGY TRANSITION OUTLOOK

An accelerated decarbonisation strategy for China: Stopping new investment in fossil power and vehicles from 2020

A report for Professor Jørgen Randers

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1 EXECUTIVE SUMMARY

In a previous study (DNV GL, 2017) we forecast the global energy transition in 10 regions, including China, towards 2050. In this report, we use the same model to investigate the effect of introducing an accelerated decarbonization policy in China, but not in the world. Our goal was to study the effect of banning investment in new fossil-fired electricity-generating capacity from 2020, and at the same time banning the purchase of fossil cars and vehicles as soon as possible.

In order to make the study less theoretical, we chose to study the effect of banning investment in new fossil power capacity from 2020 onwards, but allow for capacity additions already in the pipelines in 2020 to be completed over the following years. We also assumed a rapid introduction of electric vehicles, through a ban on the purchase of new fossil cars introduced gradually, from 50 % of new car sales in 2020 to near 100% of new vehicle sales in 2030.

The study shows that the accelerated decarbonisation policy would indeed reduce China's greenhouse gas emission by 15 % in 2030 and 22 % in 2050. However, the accelerated decarbonization slows the decline in coal-fired electricity production in the 2020s, in order to ensure enough electricity to drive the rapidly increasing fleet of electric vehicles. In the longer run, the ban on new fossil vehicles works as intended, and helps a transition to more renewable electricity by 2050: in that year the accelerated scenario implies a 63% reduction relative to the Most likely scenario.

These numbers should be treated with caution, since the detailed implementation, including timing, of the acceleration policy has not been investigated. Furthermore, our analysis omits the (huge) benefit to the wellbeing of China's population by the rapid decline in city air quality that would result. The rest of the world would benefit to some degree from such a move in China, mainly through an accelerated decline in the cost of solar, wind, and battery capacity that would result from rapid growth in Chinese renewable electricity production. Lower battery costs would additionally arise from the explosive uptake of electric vehicles in China.

The cost (in China) of such a "ban" on new fossil power plants and vehicles is limited: Our model shows and increase in China's annual expenditure on energy supply by less than 1 % of China's GDP. Actually, the increase would be 0,8 % from 3,8 to 4,6 % in 2025 - the most challenging year.

2 INTRODUCTION

In a previous effort, DNV GL (2017) has developed an Energy Transition Outlook Model (ETOM) that contains data and computational algorithms. It has been used to paint a picture of a future 'most likely' energy use and -production. Divided into ten regions, it forecasts demand and supply mixes of such an interconnected global energy world. It can also be used as a tool for policy investigation. As a pilot study, the present one considers critical questions to Chinese authorities that try to help China decarbonize and help also the wider world succeed in providing for a sustainable future in line with the SDGs and the Paris agreement.

The report first briefly presents the ETO model, then lists assumptions made for the present study. Thereafter results are presented. The results are discussed and further analysis is suggested.

3 ENERGY TRANSITION OUTLOOK MODEL

Regions - Map.

In Energy Transition Outlook Model, the world consists of ten inter-relating regions that link energy demand and energy supply. Electricity demand is however met by the electricity supply in the same region without any exports or imports. Regions are classified to maximize two criteria: geographic proximity and level of economic development. This gives the following regional map in figure 1:

Figure 1: Map of the regions used in the ETO model

The model interrelationships.
For each region, sectors are interwoven so that energy supply responds to the demand in the most economical way, taking also public policy into consideration.

While energy demand is mostly driven by external forces, such as standard of living dynamics, population and productivity growths, supply is responding to this demand in various forms. Some supplies, such as crude oil, is based on an international competition between various regions and technologies (conventional, unconventional and offshore). Other demands are first provided locally because of high transportation costs (such as gas or coal), then imported from surplus regions. Other demands, such as power, is supplied only from the same region where it is used.

In each region, based notably on levelized cost of electricity (LCOE) of competing power sources and their distribution, ETO algorithms every year evaluates the need for additional capacity expansion of power, taking also present subsidies and preferential treatment, expected retirements, and capacity utilization into consideration.

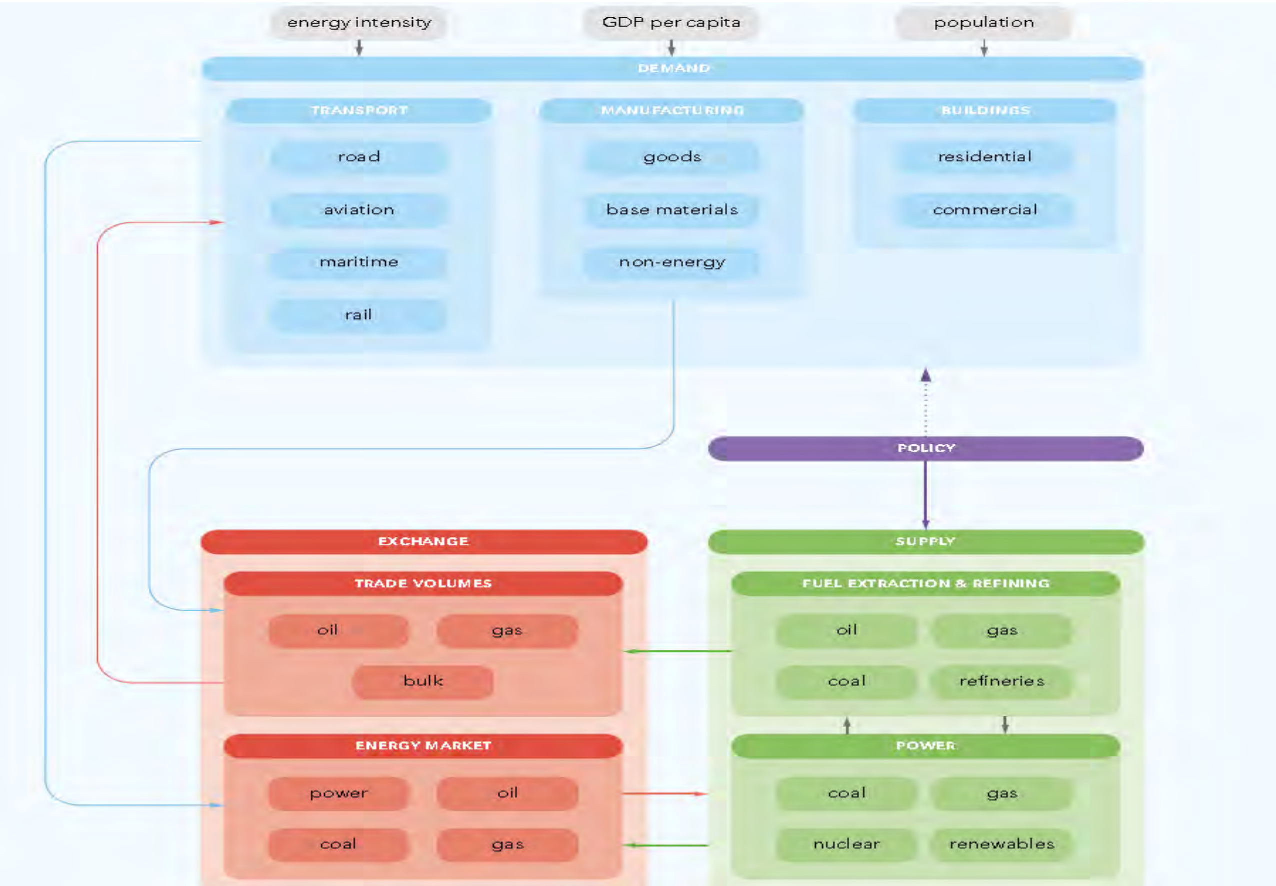

Figure 2: ETO Model structure

The base scenario provides the following uptake curves for electric vehicles, based on EV/ICEV cost parity by 2022, and taking into consideration buyer regional preferences and grid densities, we get the following dynamics of light vehicle share of new vehicle sales:

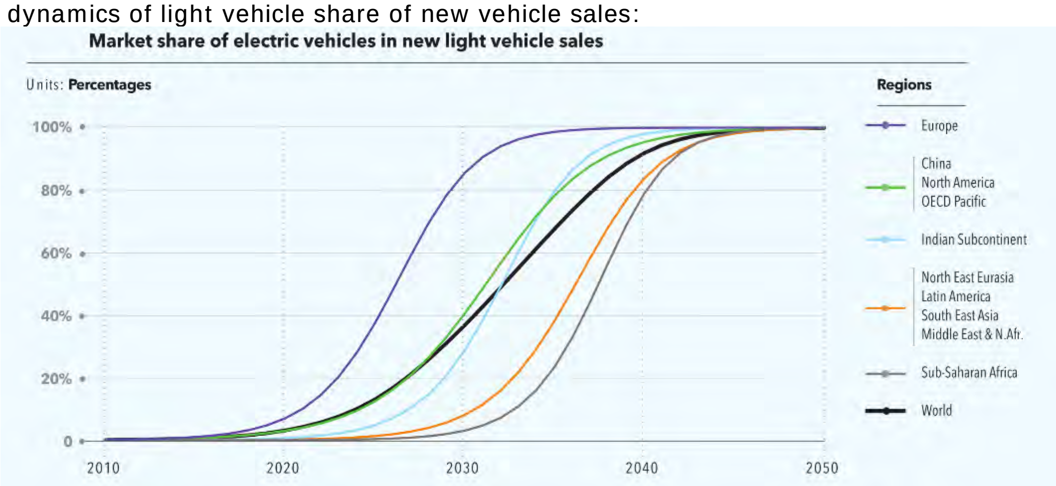

Figure 3: The uptake of electric vehicles assumed in the ETO model

Note that for heavy vehicles, the 50 % uptake threshold happens 10-20 years later, depending on the region.

Table 1 below provides some results, reported elsewhere (DNV GL, 2017) and contrasts them with recent IEA WEO scenarios (IEA, 2017).

	Global	IEA-NPS	DNV GL-ETO	IEA-SDS
Growth 2015-2040	Population	25 %	21 %	25 %
	GDP	123 %	81 %	123 %
	Energy use	**29 %**	**15 %**	**3 %**
	CO2 emissions	**11 %**	**-31 %**	**-43 %**
	Coal use	2 %	-66 %	-54 %
	Gas use	48 %	11 %	18 %
	Oil use	12 %	-27 %	-24 %
	Wind generation	410 %	1800 %	729 %
	PV generation	1180 %	5100 %	2032 %
	Hydro generation	59 %	87 %	78 %
	Nuclear generation	50 %	40 %	108 %
	Electricity generatio	62 %	88 %	48 %
In 2040	**Fraction CCS'ed**	**0 %**	**0,3 %**	**10 %**
	CAPEX/GDP* 2015-2040	1,0 %	1,8 %	1,0 %
	Renewable of supply	19 %	32 %	29 %
	Electricity of demand	23 %	32 %	27 %
	PV/Electricity	8 %	32 %	15 %
	Wind/Electricity	11 %	24 %	19 %
Peak year	**Coal production**	after 2040	2013	ca 2020
	Gas production	after 2040	ca 2036	ca 2040
	Oil production	after 2040	ca 2022	ca 2025
EV fleet in 2040	Light	280 m	900 m	900 m
	Heavy	?	20 m	?
*	1: generation + oil + coal + gas (half of current IEA Inve			
	2: OPEX is currently half of Energy Expenditure in ETO			

Table 1: DNVGL 'Energy Transition Outlook' is a forecast that projects a 'Most Likely Future' which is transitioning faster than, but in line with the IEA back-casted 'Sustainable Development Scenario' than its forecast 'New Policies Scenario'

4 POLICY ASSUMPTIONS

In this study, we take aside China and let the standard ETO algorithms take care of the rest of the world. For China we introduce an accelerated scenario and contrast it with the base 'Most likely' scenario. In the former, we introduce the following 'model overrides':

- No new capacity additions initiated in coal or gas power plants after 2020
    - But capacity additions already initiated will be completed and put to normal use
    - Capacity additions thus needs to be handled by all other power stations types, based on their LCOE merits. For heat power, biomass and gas are the only alternatives.

- 50 % threshold for electric vehicles (both light and heavy) is moved forward from 2030 (light) and 2040 (heavy) to 2020 for all vehicle types.

5 CHINA RESULTS

In the base – Most likely - scenario, China introduces very few fossil-fired power stations after 2020. This implies that from a situation in 2012 when 85 % of electricity was provided by coal fired plants, such plants provide only 30 % in 2025 amidst a doubling of power generation. Before 2030, manufacturing takes over as the main user of coal. Thus, introducing the accelerated policy of no new fossil fuelled power plants after 2020 makes no dramatic change in fossil fuel use, as seen in Figure 1a and b. In fact, the faster introduction of EVs provides a counter-intuitive boost to coal fuelled generation in the accelerated scenario by increasing their capacity utilization. Such increased coal plant utilization is cheaper in the 20'ies than adding renewable generation.

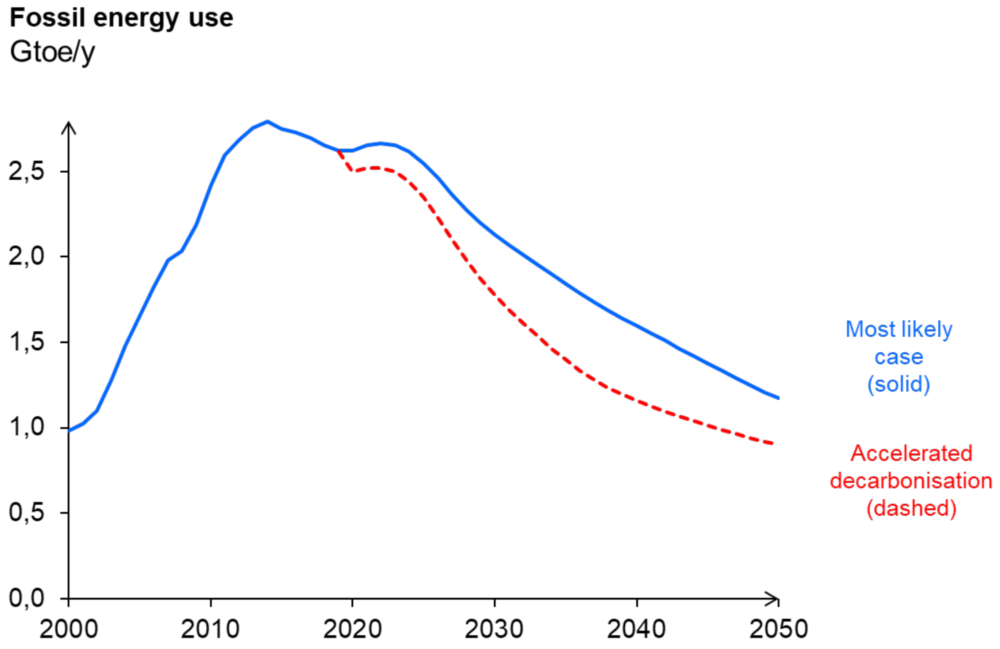

Figure 4: China's use of fossil energy in the Most likely and Accelerated decarbonisation scenarios

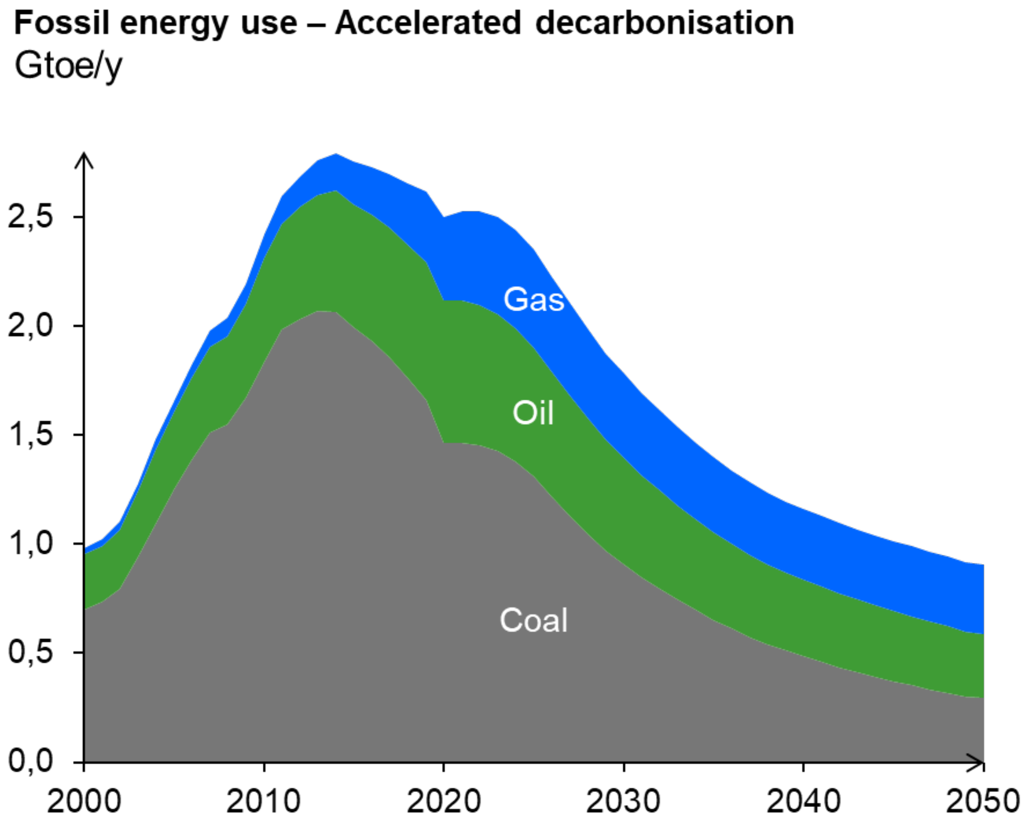

Figure 5: Breakdown of China's fossil use in the Accelerated decarbonisation scenario

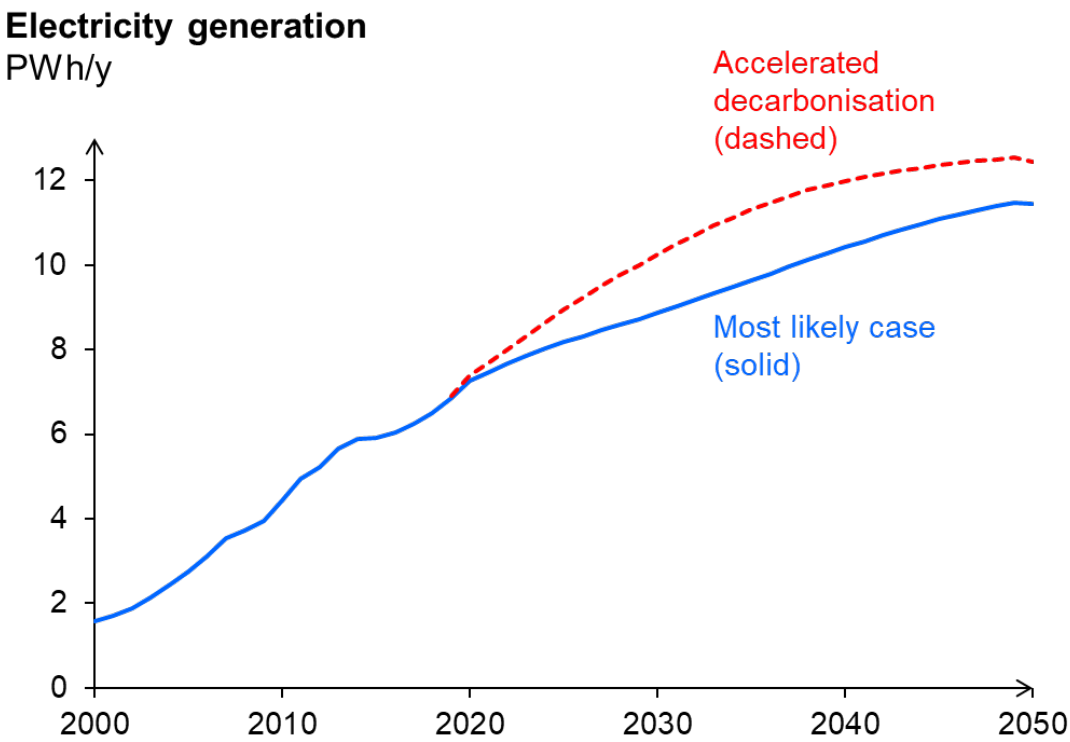

Figure 6: China's total use of electricity in the Most likely and Accelerated decarbonisation scenarios

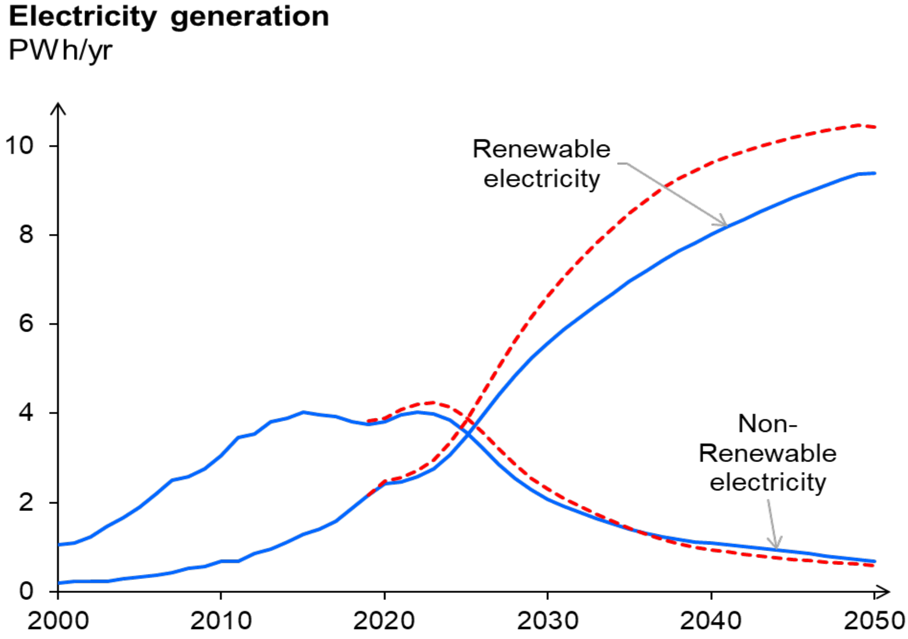

Figure 6: The rapid addition of electric cars in the 2020s leads to higher electricity demand, and delays the phasing out of fossil power production while new renewable capacity is being built.

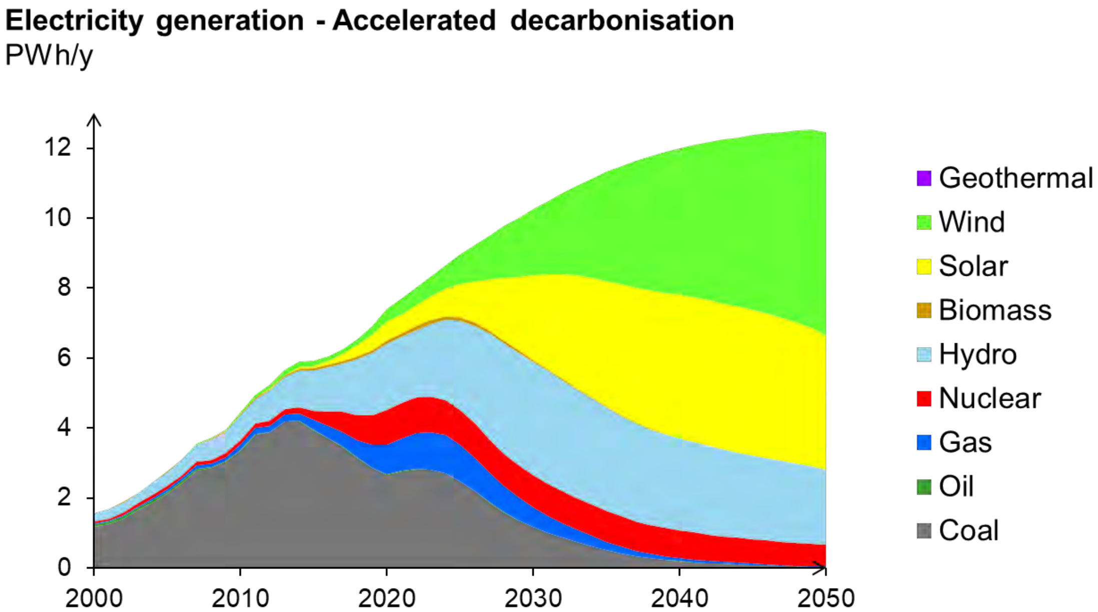

Figure 7: Breakdown of China's power supply in the Accelerated decarbonisation scenarios

We have also computed the investment and operations costs of the two scenarios. These costs include upstream Chinese fossil extraction expenditures, as well as those of power generation. Grid costs and transportation costs are excluded, both as far as vehicles and transport/distribution of fossil fuels and electricity are concerned.

Our estimate is that for the omitted costs, electric vehicles would imply substantial savings in the accelerated scenario as such vehicles will be less costly already in 2022. On the other hand, increased electrification would require boosting grid investments in general and charging infrastructure in particular, to offset the savings. As a percentage of GDP, the accelerated scenario would make a dent of ¼ to ¾ % into GDP, but in terms of energy costs still require a boosting of them by 5 to 15 % depending on the year.

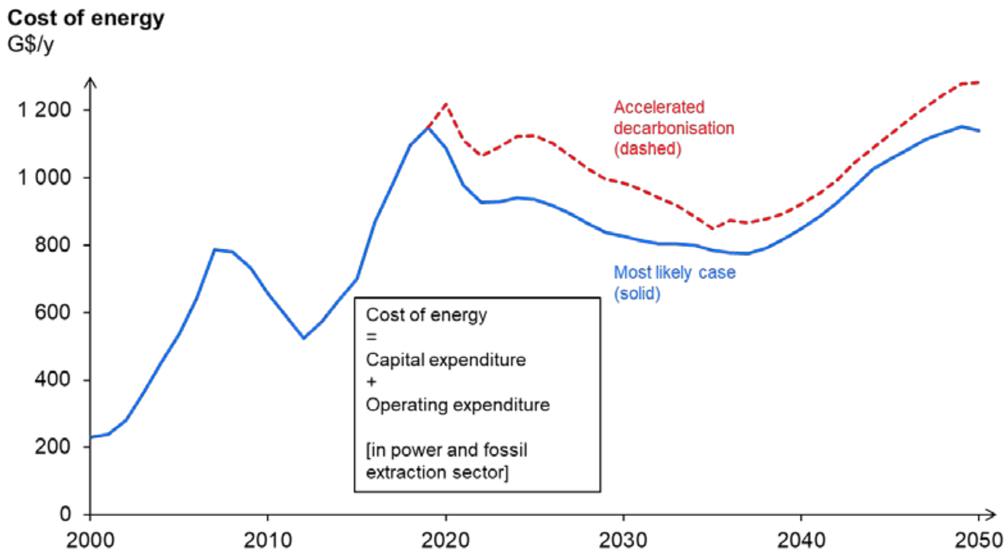

Figure 8: Energy costs in billion US$ in the Most likely and Accelerated decarbonisation scenarios

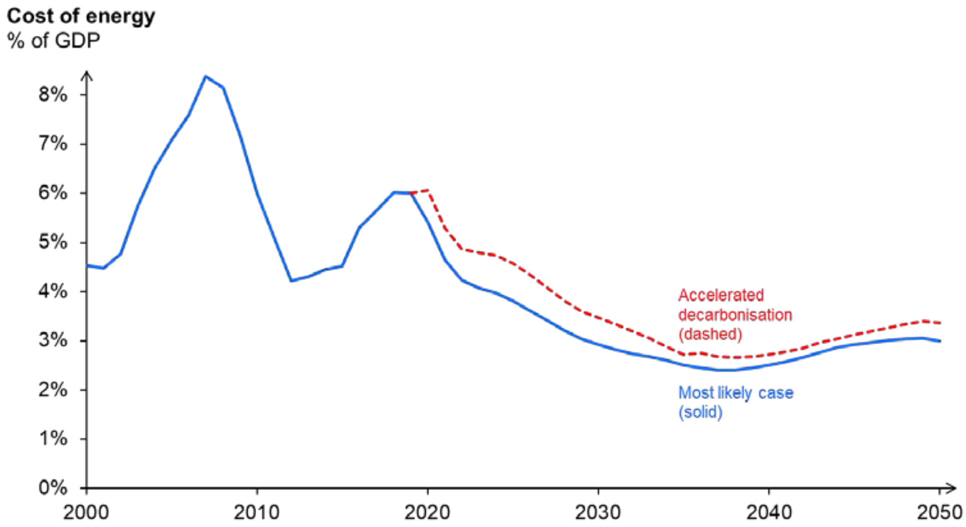

Figure 9: Energy costs as % of China's GDP in the Most likely and Accelerated decarbonisation scenarios

The accelerated decarbonization of the Chinese energy system was mainly predicated to enable reduced climate emissions. Given the quite aggressive decarbonization in the base Most likely scenario, the additional reductions amount to about ¼ of the base case. The accelerated scenario targets the lowest hanging decarbonization fruits. Additional decarbonization of manufacturing and buildings would mean additional costs, except for energy efficiency, which has not been investigated here.

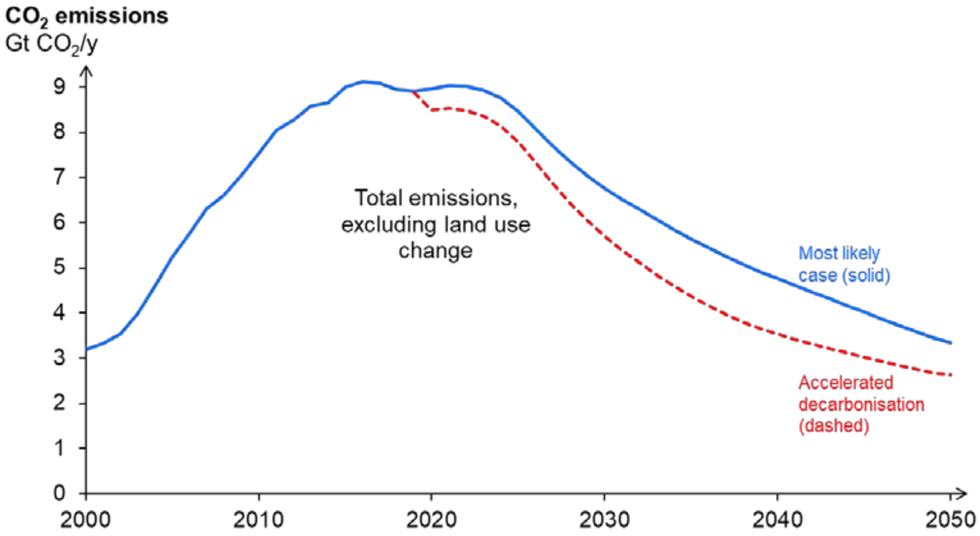

Figure 10: CO2 emissions from China in the Most likely and Accelerated decarbonisation scenarios

6 FUTURE WORK

In ETO 2017, energy mix and energy efficiency of the demand sectors is largely trend forecasted. For ETO 2018, both energy efficiency and energy mix will be driven by investors preference for less costly investments, including the effects of public policy. Thus, evaluations of regional decarbonization policies also on energy demand sectors will be possible in a consistent way.

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