Transmission's role in clean energy transition – *International, Australian (and a few Chinese) perspectives*

CARE and RESOC Webinar on Technologies for the renewables transition
22nd October 2020

Iain MacGill
Collaboration on Energy and Environmental Markets (CEEM)
School of Electrical Engineering and Telecommunications
UNSW Sydney Australia

UNSW SYDNEY

Glenne Drover • 1st
Secretary - AIE Melbourne
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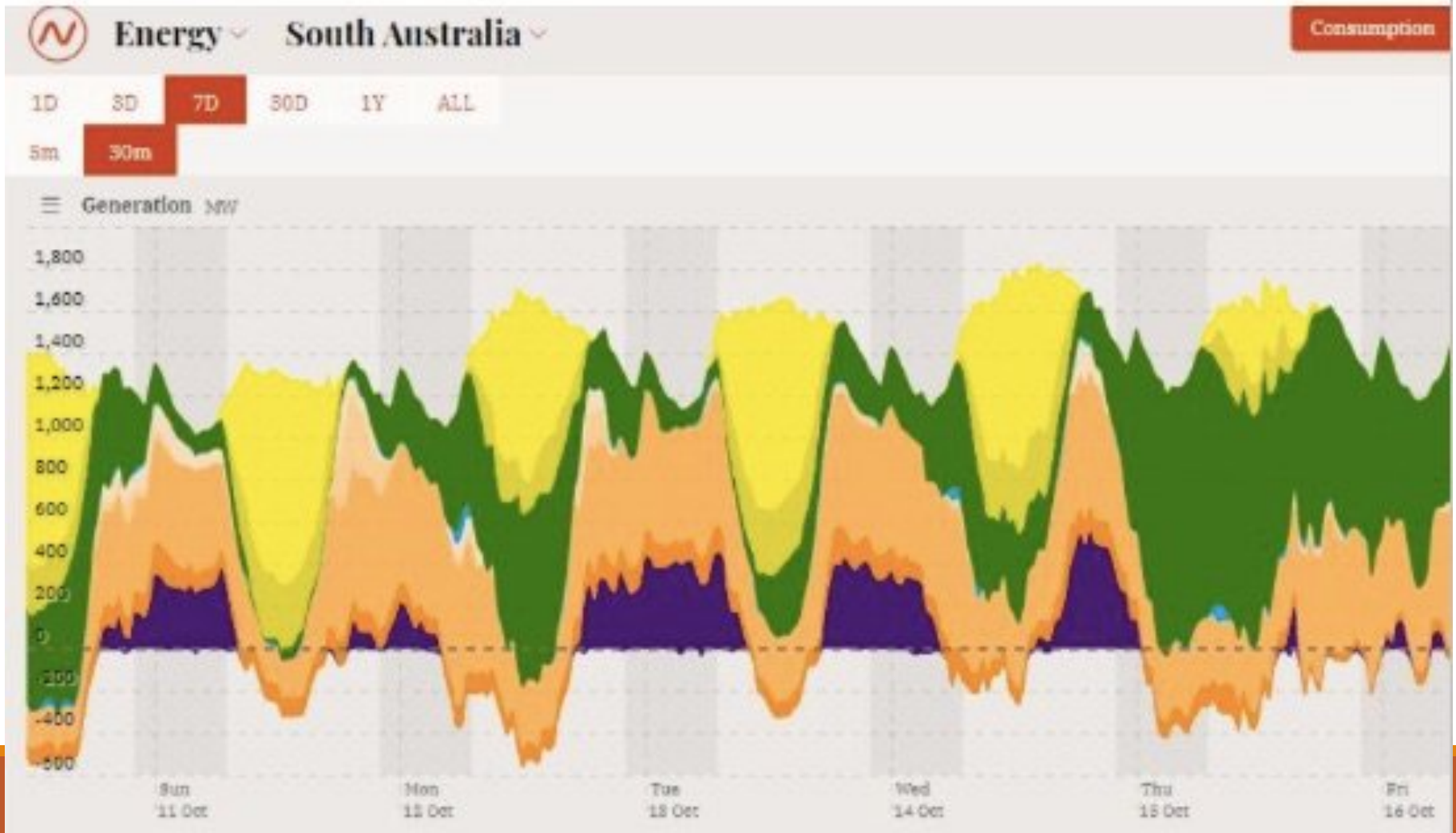
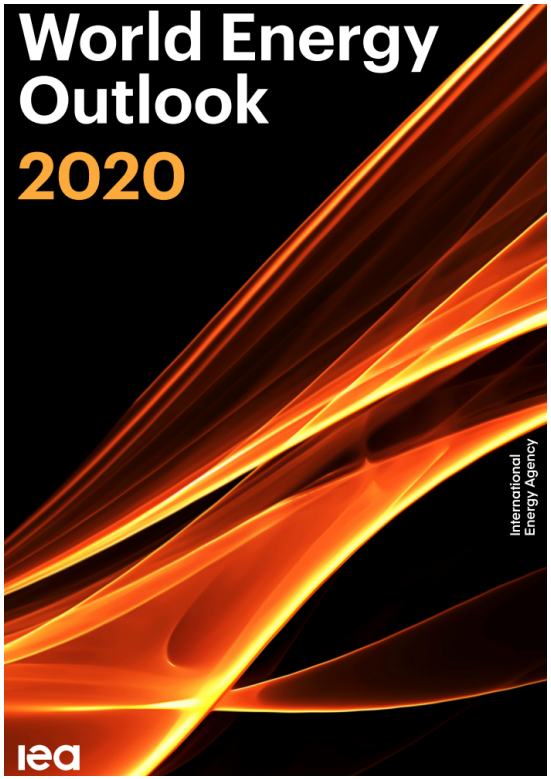
What a week for South Australia, ~100% solar powered on Sunday and ~100% wind powered on Thursday.



Recent perspectives on global energy transition



Impacts of Covid-19 on the energy outlook

1.1 The pandemic is far from over and many uncertainties remain

1.2 Today's policy settings do not produce a decisive break in the outlook for CO_2 emissions, but a more sustainable recovery is possible

1.3 Renewables are taking power and solar is the new king

1.4 Modern societies are becoming ever more reliant on electricity, bu weak grids could prove to be an Achilles heel

1.5 The pandemic could trigger lasting changes in consumer behaviour but these would not transform the oil market on their own

1.6 Lower fuel prices are a mixed blessing for energy security and sustainability

1.7 This is a crisis that penalises the most vulnerable

1.8 Covid-19 sharpens the dilemmas facing the oil and gas industry

Prospects for clean energy transitions

1.9 Enhanced clean energy policies and investments can make 2019 th peak year for energy-related emissions

1.10 Today's energy infrastructure, if operated as per past practices, would lock in a temperature rise of 1.65 °C

1.11 Within ten years, in the SDS, the drop in air pollutants would produce significantly cleaner air than experienced during the 2020 lockdowns

1.12 Gases – of different sorts – are pivotal to different stages of energy transitions, but are still in search of clear roles and business model

1.13 Transitions depend on government actions, but more than 70% of related investments could come from private actors

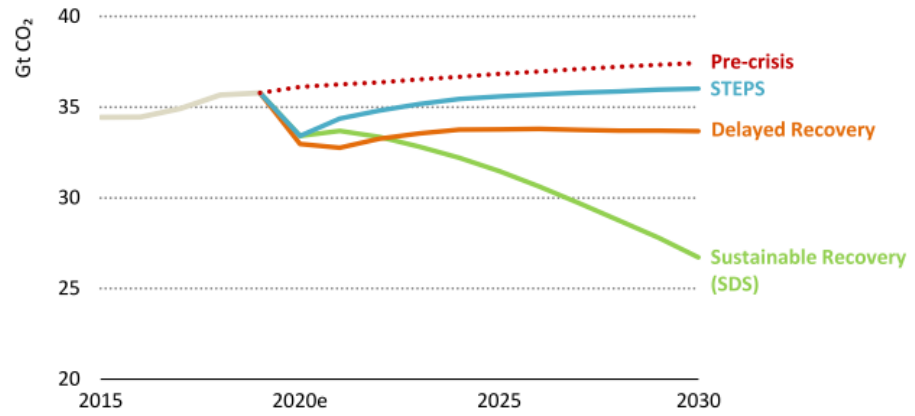
1.14 Net-zero pledges for 2050 and earlier are already essential to the SDS; achieving global net-zero by 2050 would require a dramatic extra push

1.15 Behavioural changes are essential to achieve the scale and speed o emissions reductions required in the NZE2050

1.16 If energy transitions are not secure, then they will not be rapid either

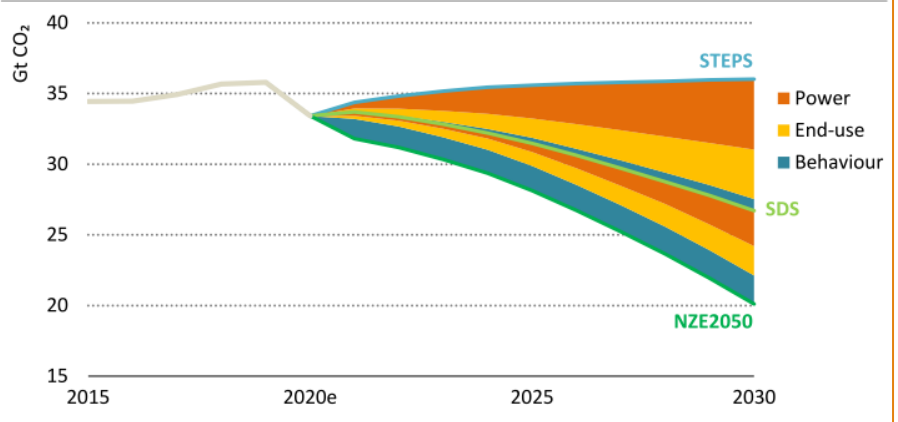
IEA scenarios – not predictions

Figure 1.3 ▷ Energy sector and industrial process CO_2 emissions by recovery trajectory

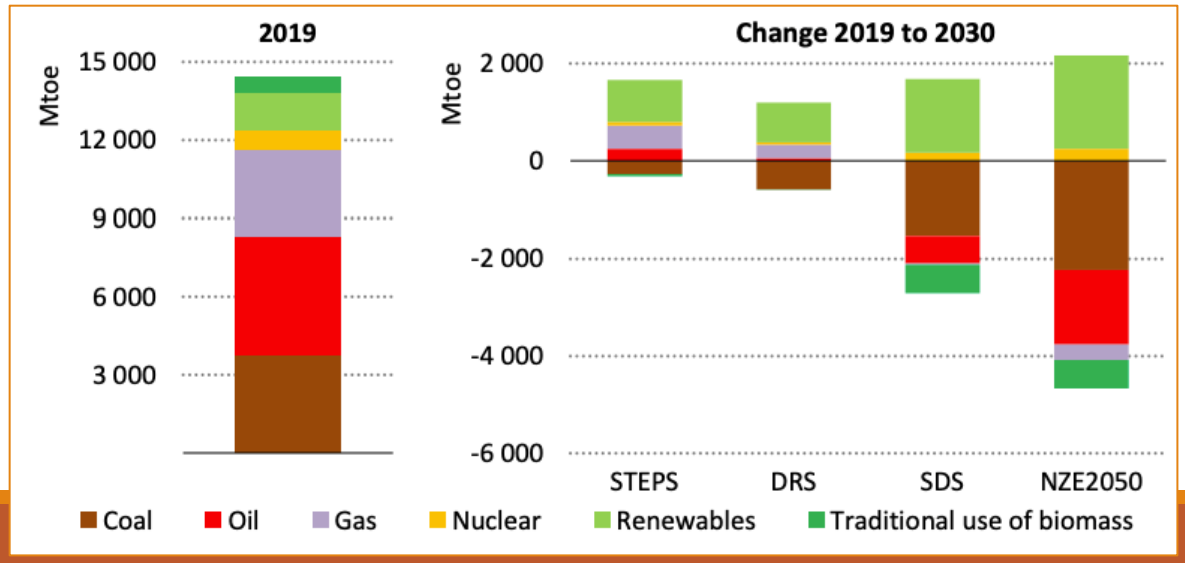


Emissions are reduced relative to a pre-crisis trajectory in each scenario, but only a fully sustainable recovery leads to their long-term structural decline

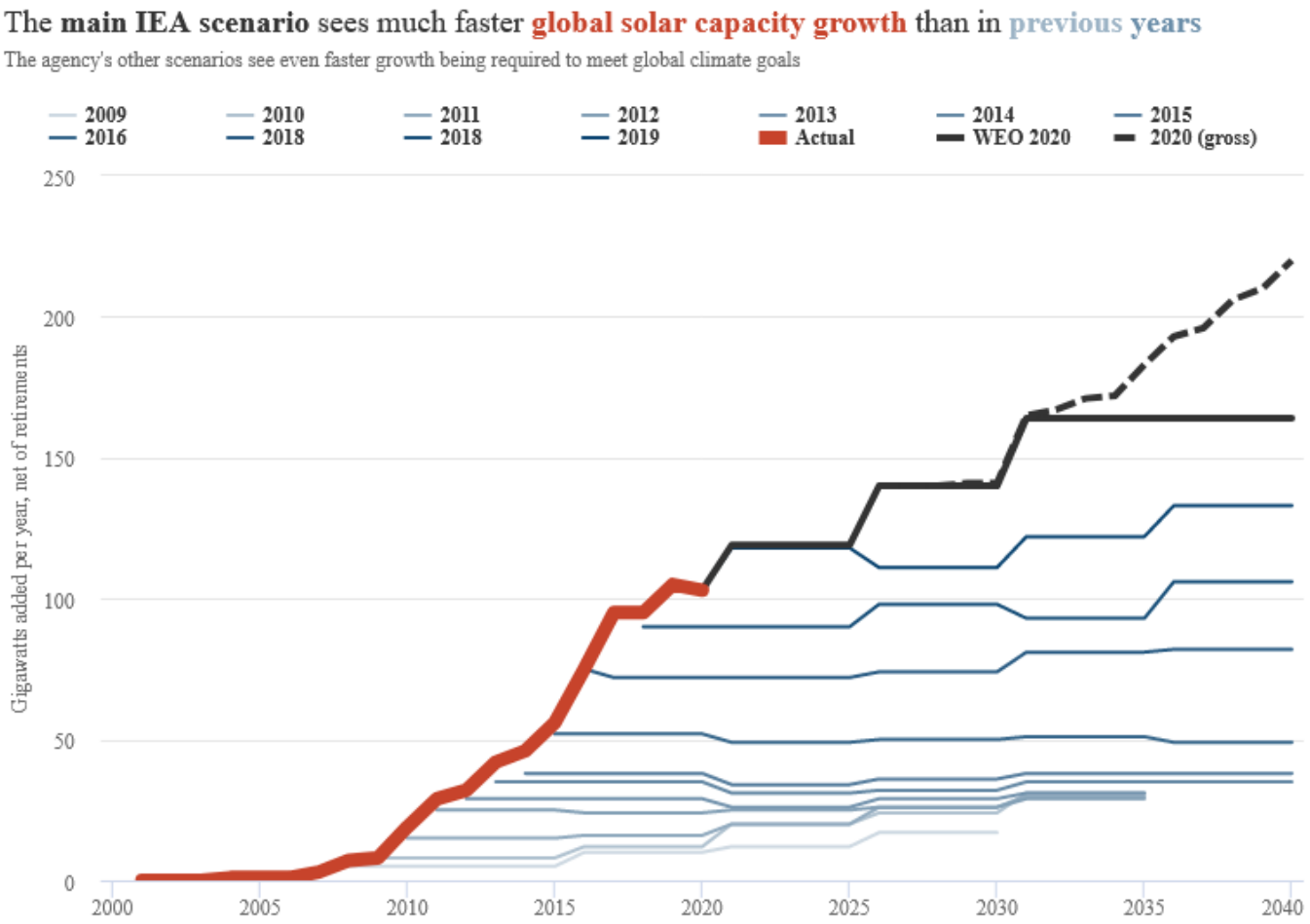
Figure 4.1 ▷ Energy and industrial process CO_2 emissions and reduction levers in the scenarios



An unparalleled transformation of the energy sector and major behaviour changes in the next ten years would be needed to achieve global net-zero emissions by 2050



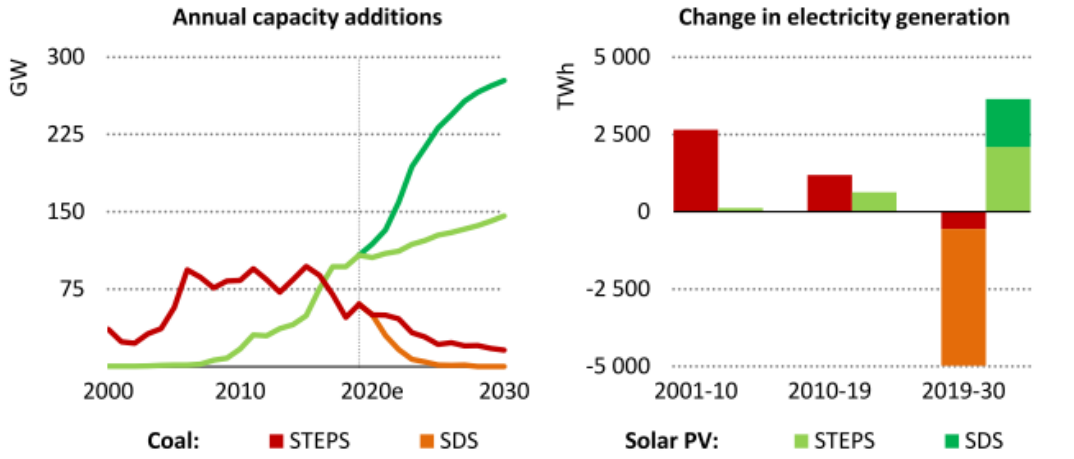
IEA has typically underestimated PV



Annual net additions of solar capacity around the world, gigawatts. Historical data is shown in red while central outlooks from successive editions of the WEO are shown in shades of blue. The WEO 2020 STEPS is shown in black. The dashed line shows gross additions, taking into account the replacement of older capacity as it retires after an assumed lifetime of 25 years. Source: Carbon Brief analysis of the IEA World Energy Outlook 2020 and previous editions of the outlook. Chart by Carbon Brief using Highcharts.

Still, coal's on the way out and PV is king

Figure 1.4 ▷ **Average annual solar PV and coal annual capacity additions worldwide and electricity generation by scenario**



Solar PV becomes a preeminent force in electricity supply in the STEPS due to falling costs and policy support, but the potential is there for much more rapid growth

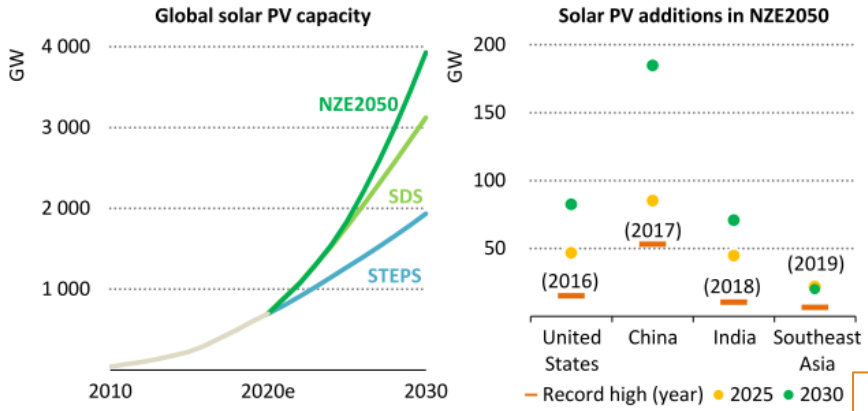
Solar PV becomes the new king of electricity supply and looks set for massive expansion. From 2020 to 2030, solar PV grows by an average of 13% per year, meeting almost one-third of electricity demand growth over the period. Global solar PV deployment exceeds pre-crisis levels by 2021 and sets new records each year after 2022 thanks to widely available resources, declining costs and policy support in over 130 countries. Our analysis of solar PV financing costs indicates that, despite monetary policy measures, the weighted average cost of capital edged up in 2020 after years of going down. Even so, policy support frameworks enable very low financing costs, making new solar PV more cost effective than coal- and gas-fired power in many countries today, including in the largest markets (United States, European Union, China and India). For projects with low cost financing that tap high quality resources, solar PV is now the cheapest source of electricity in history.

“PV is now the cheapest electricity in history”

But what of electricity where and when we want it?

Requires storage **and/or** networks

Figure 4.8 ▷ Global installed solar PV capacity by scenario, 2010-2030, and annual solar PV capacity additions in the NZE2050



Solar PV plays a key role in emissions reductions in the NZE2050, with major coal consumin economies, in particular, deploying solar PV at a pace well beyond previous records

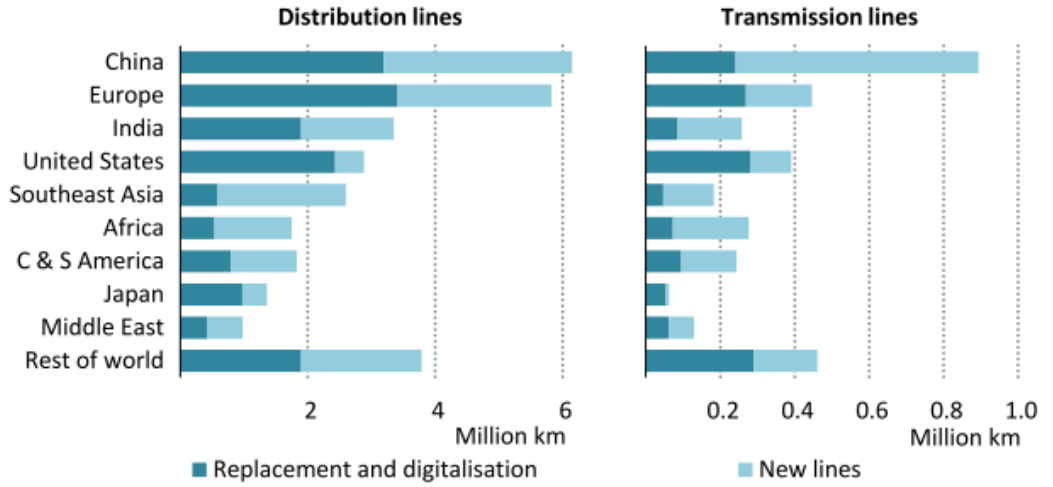
Flexibility needs in power systems rise rapidly in the NZE2050, necessitating the use of all available sources of flexibility. Hour-to-hour ramping requirements and other flexibility needs increase due to higher shares of variable renewables and changes in electricity demand patterns that reflect increasing numbers of electric cars and the electrification of end-use sectors. Conventional power plants continue to provide the bulk of flexibility in most systems, although coal plant retirements increase the need for new sources of flexibility. Energy storage technologies, including battery storage systems, scale up significantly in the NZE2050 to ensure the stability and security of electricity supply, so does the use of demand-side response measures. The expansion, modernisation and digitalisation of electricity networks is essential to pool all available flexibility sources and support the rapid low-carbon transition of electricity supply in the NZE2050. This requires a sharp increase in current levels of funding: investment in electricity networks reaches well over $800 billion by 2030, up from $270 billion in 2019.

Why **and/or?** *PV's extraordinary scalability*

… Li Ion energy storage even more scalable

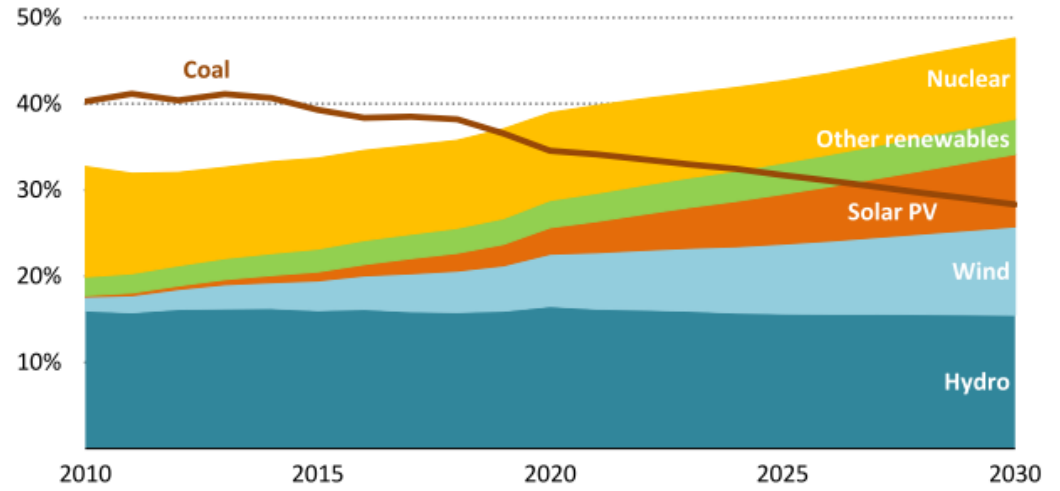
The IEA suggests more of both required for all scenarios

Figure 6.18 ▷ Length of new and replaced electricity network lines by selected region in the Stated Policies Scenario, 2019-2030



Advanced economies mainly replace and digitalise existing grids while elsewhere adding new lines to increase density is the focus in order to support growing demand

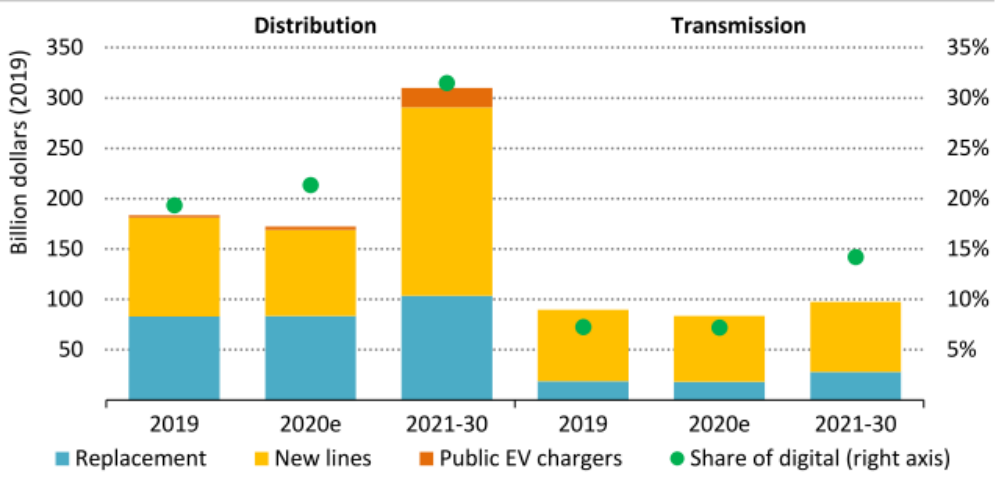
Figure 6.7 ▷ Renewables, nuclear and coal shares of global electricity supply in the Stated Policies Scenario, 2010-2030



Renewables and nuclear overtook coal for the first time in 2019 and extend their lead through to 2030; renewables are on track to supply more power globally than coal by 2025

Even more storage and **transmission** required for clean energy transition

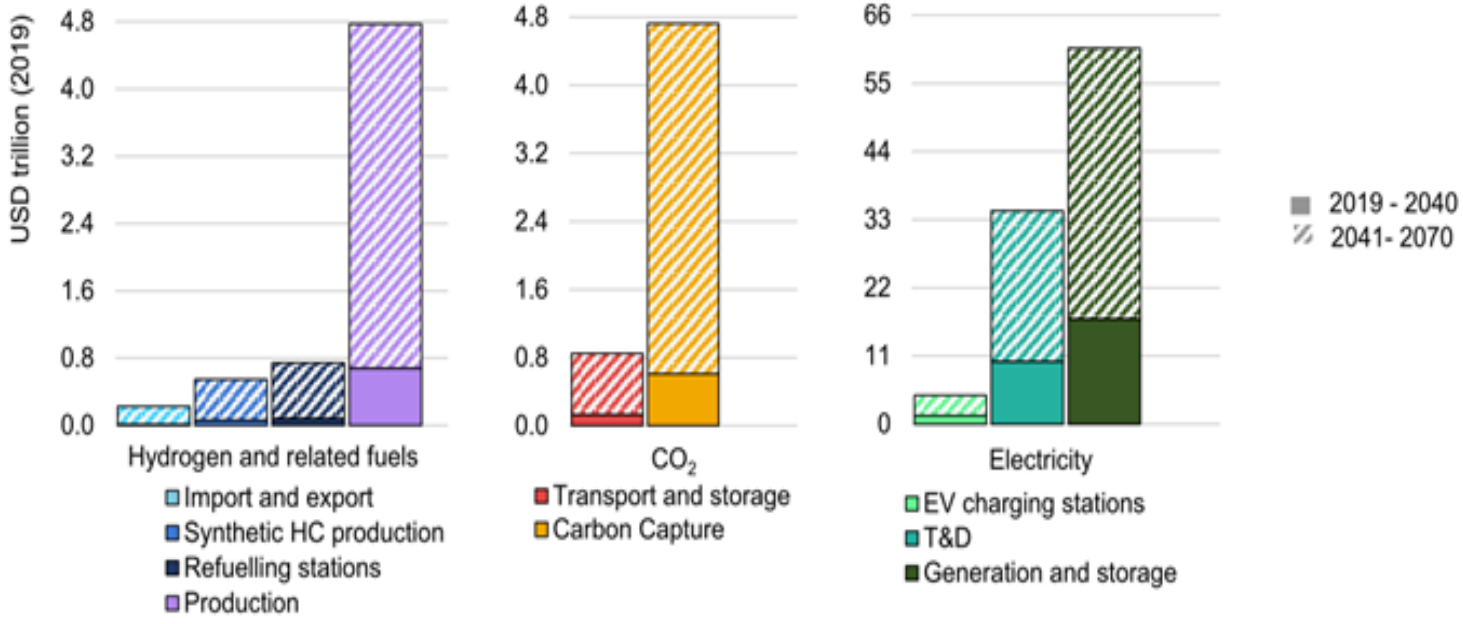
Figure 6.19 ▷ Annual investment in electricity networks by sector in the Stated Policies Scenario



Average investment per year in distribution and transmission networks increases by half over the next decade to support security and the clean energy transition

or 2020. Digital share includes digital grid

Figure 7.7 Global cumulative investment in selected energy infrastructure in the Sustainable Development Scenario



Why?

More demand, and more PV and other clean generation

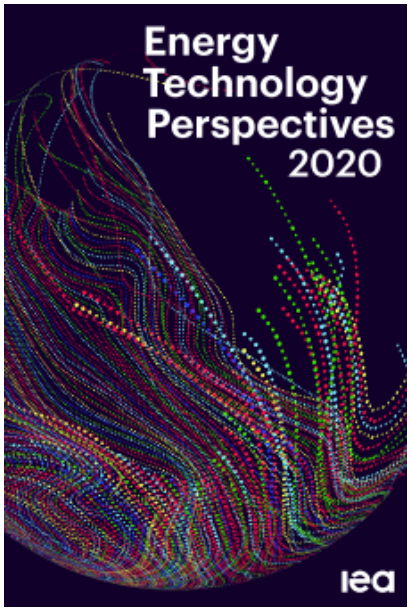


Figure 2.8 Growth in global electricity consumption by sector and scenario and electricity share in total final consumption in the Sustainable Development Scenario

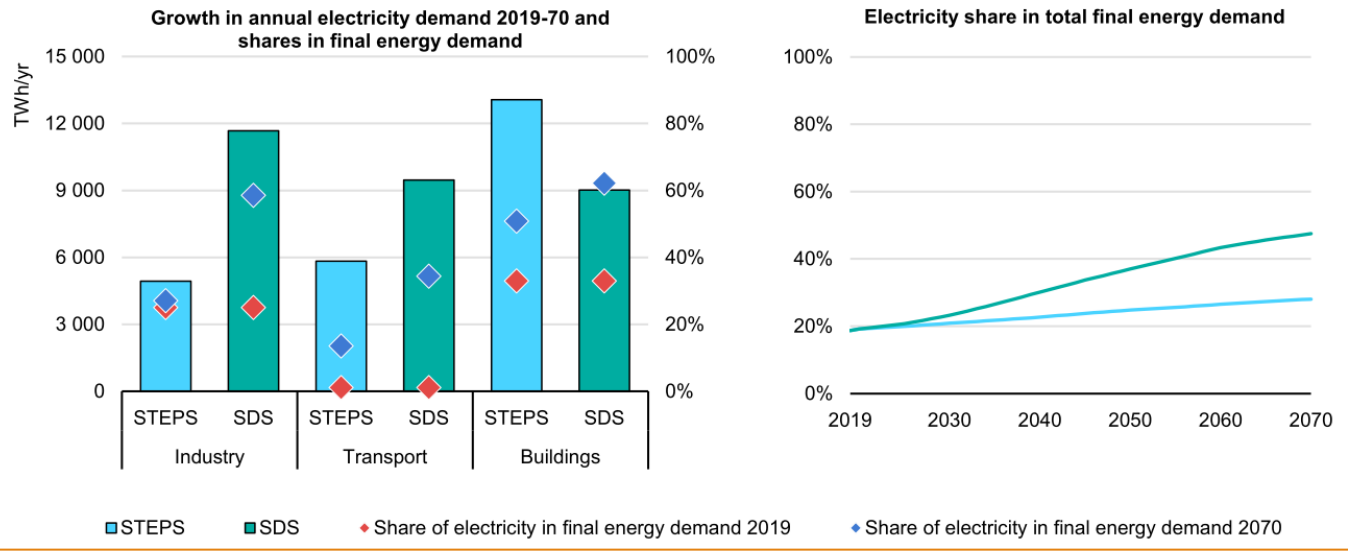
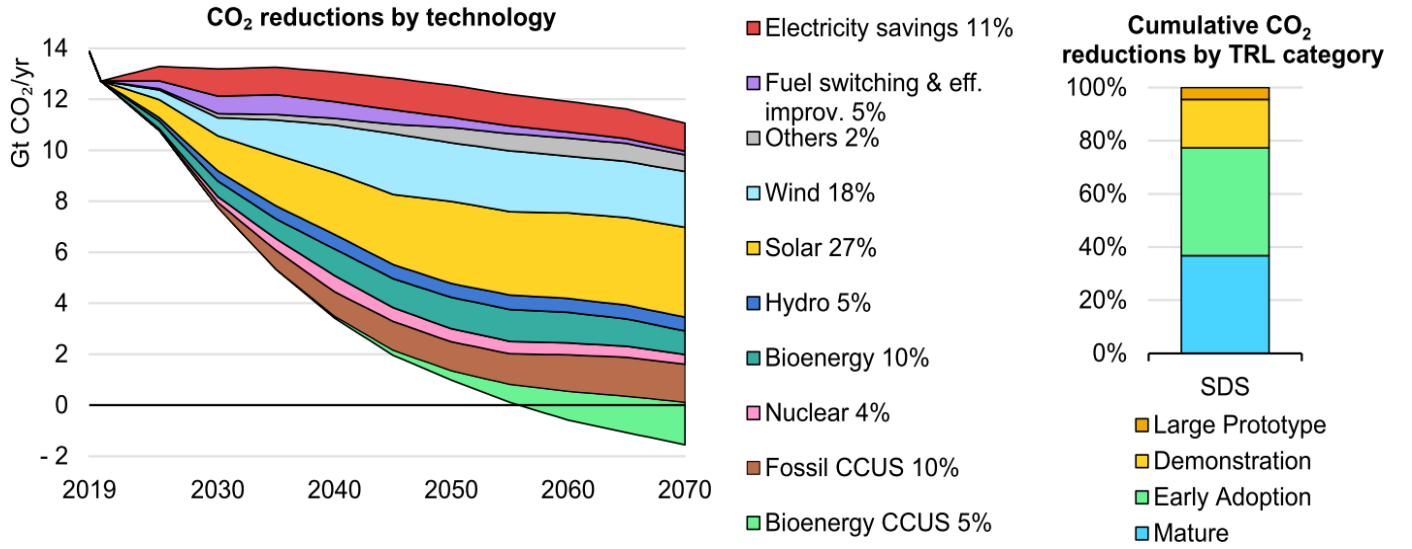
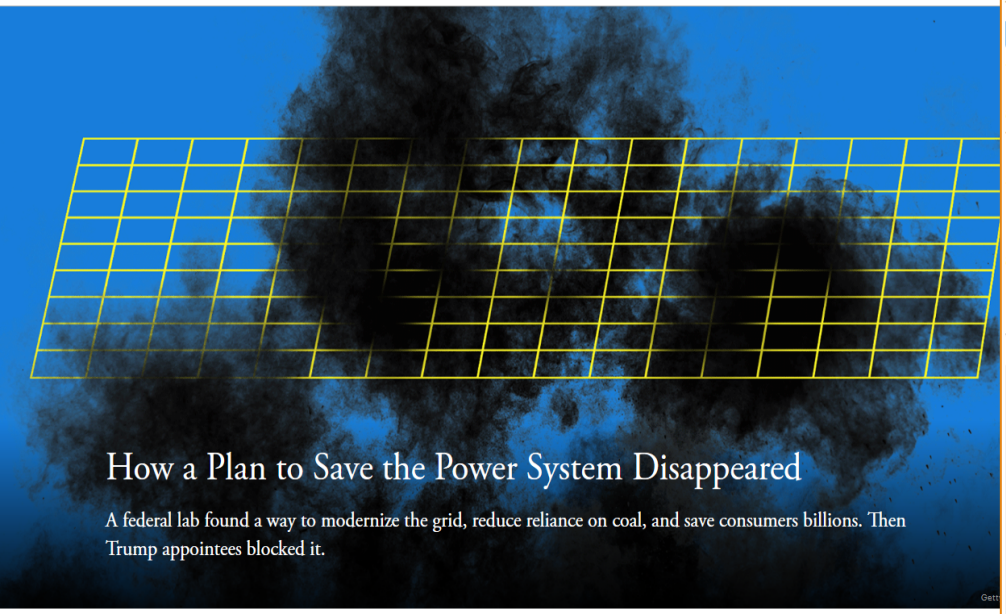


Figure 3.3 Global CO_2 emissions in the power sector by scenario and decomposition of the difference by technology type



Transmission can be political



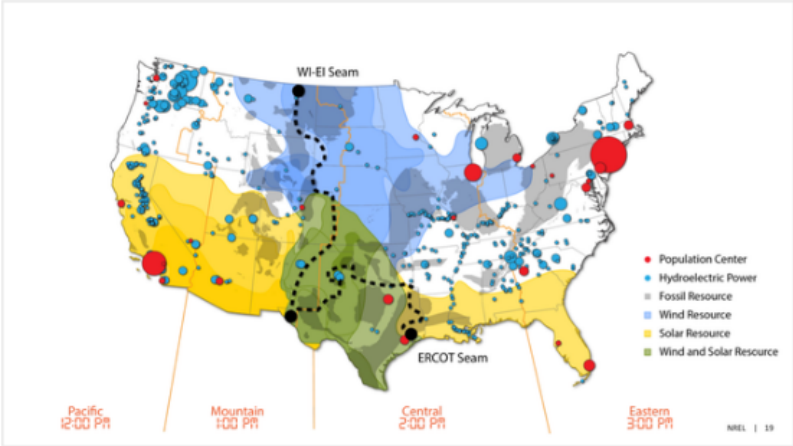
How a Plan to Save the Power System Disappeared

A federal lab found a way to modernize the grid, reduce reliance on coal, and save consumers billions. Then Trump appointees blocked it.

Story by Peter Fairley | AUGUST 20, 2020 | POLITICS

Trump officials would ultimately block Seams from seeing the light of day. And in doing so, they would set back America's efforts to slow climate change.

A nearly impermeable electrical "seam" divides America's eastern and western power grids. These giant pools of alternating current on either side of the Rockies contain a total of 950 gigawatts of power generation by thousands of power plants. (A third grid serves Texas.) But only a little over one gigawatt can cross between them. Western-grid power plants in Colorado send bulk power more than 1,000 miles away to California, for example, but merely a trickle across the seam to its next-door neighbor Nebraska. That separation raises power costs, and makes it hard to share growing surpluses of environmentally friendly wind and solar power. And years of neglect have left the grids—and the few connections between them—overloaded and ill-prepared to transition to highly variable renewable energy.



The East-West seam divides cities, time zones, and energy resources (NREL)

The Seams study set out to determine whether uniting America's big grids would pay. Seven aging converter stations presently mediate the meager power flows across the East-West seam. Should power companies simply rebuild these electrical "stitches," or should they upgrade to longer or stronger links? Seams' working hypothesis had been that upgrading might create a more reliable, sustainable, and affordable U.S. power system. The study's results bore that hypothesis out.

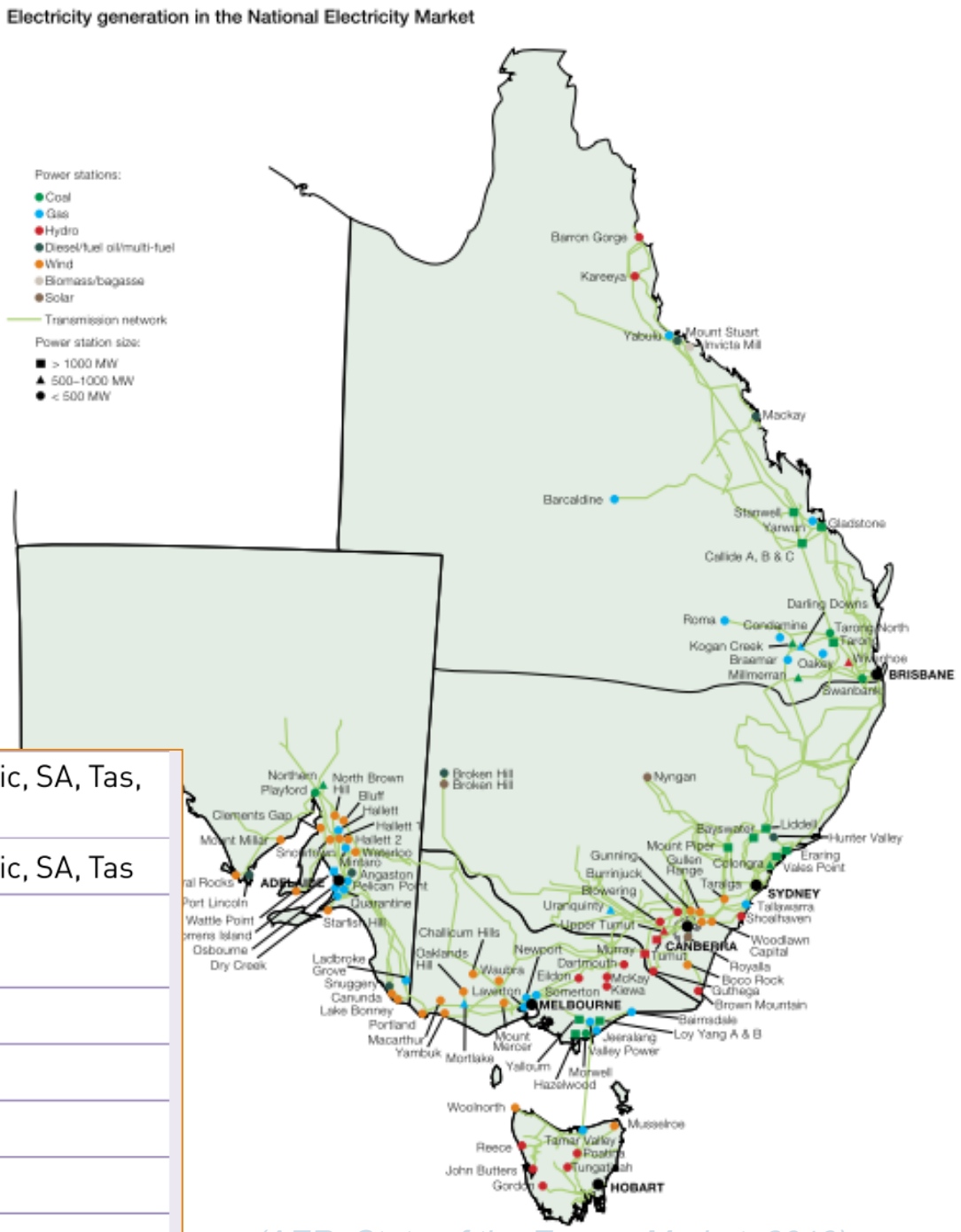
The Australian National Electricity Market (NEM)

Although not actually National in extent

And not primarily a Market, but a power system

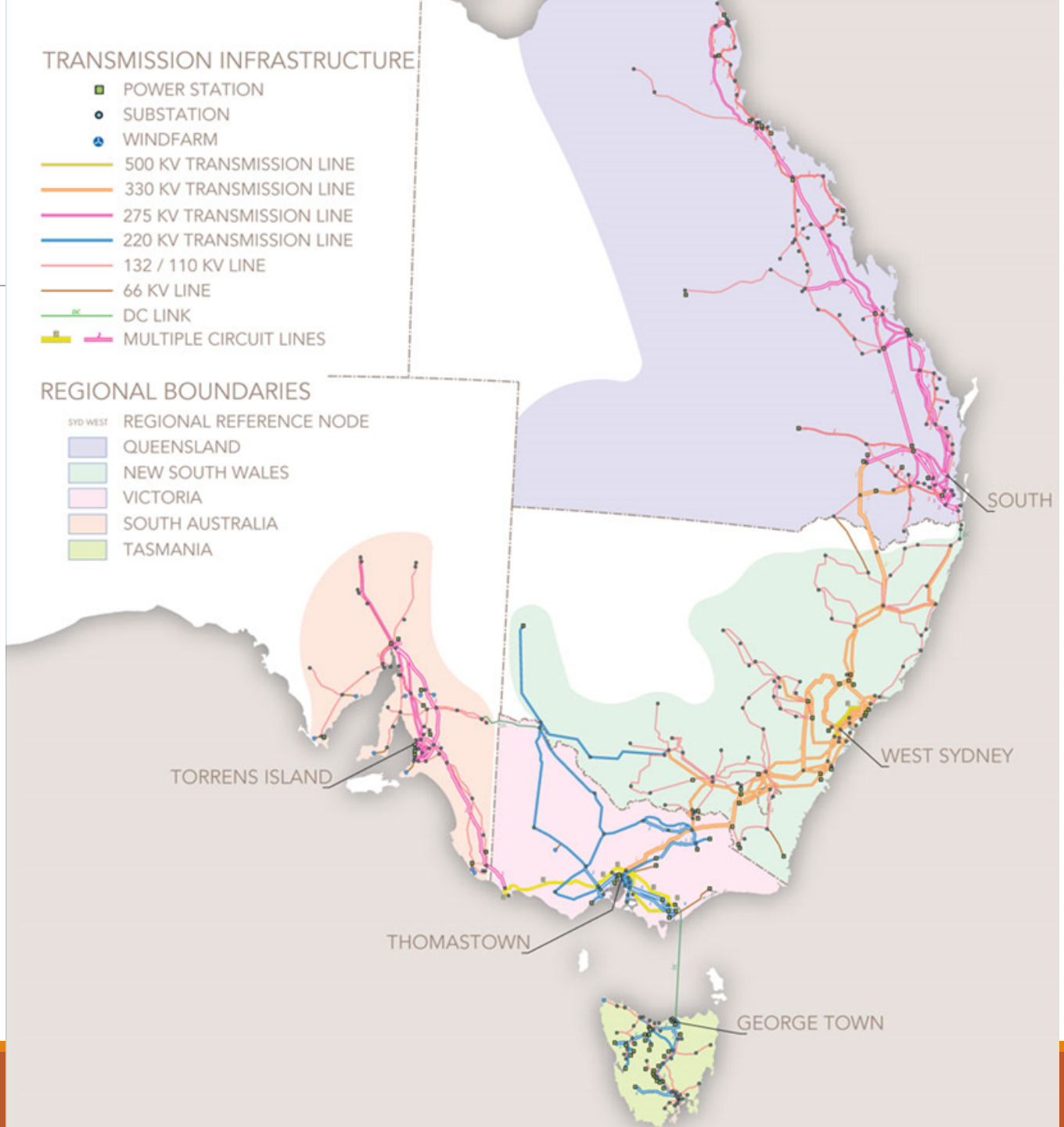
And distributed resources playing an increasing role

Participating jurisdictions	Qld, NSW, Vic, SA, Tas, ACT
NEM regions	Qld, NSW, Vic, SA, Tas
NEM installed capacity (including rooftop solar PV)	55 590 MW
Number of large generating units	240
Number of customers	9.7 million
NEM turnover 2017–18	$17 billion
Total electricity demand 2017–18[1]	203 TWh
National maximum demand 2017–18[2]	32 469 MW



(AER, State of the Energy Market, 2018)

The NEM Tx network

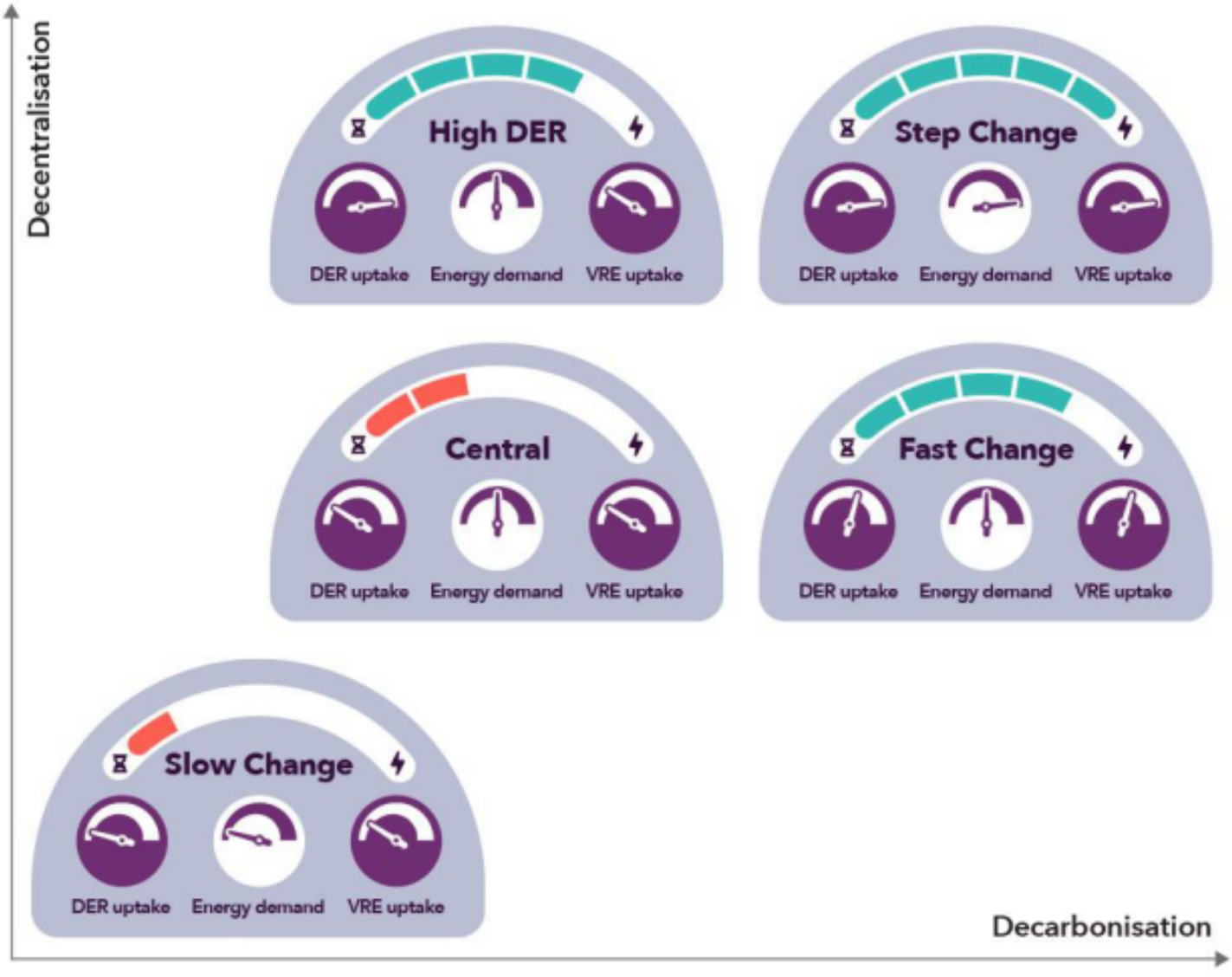


NEM planning

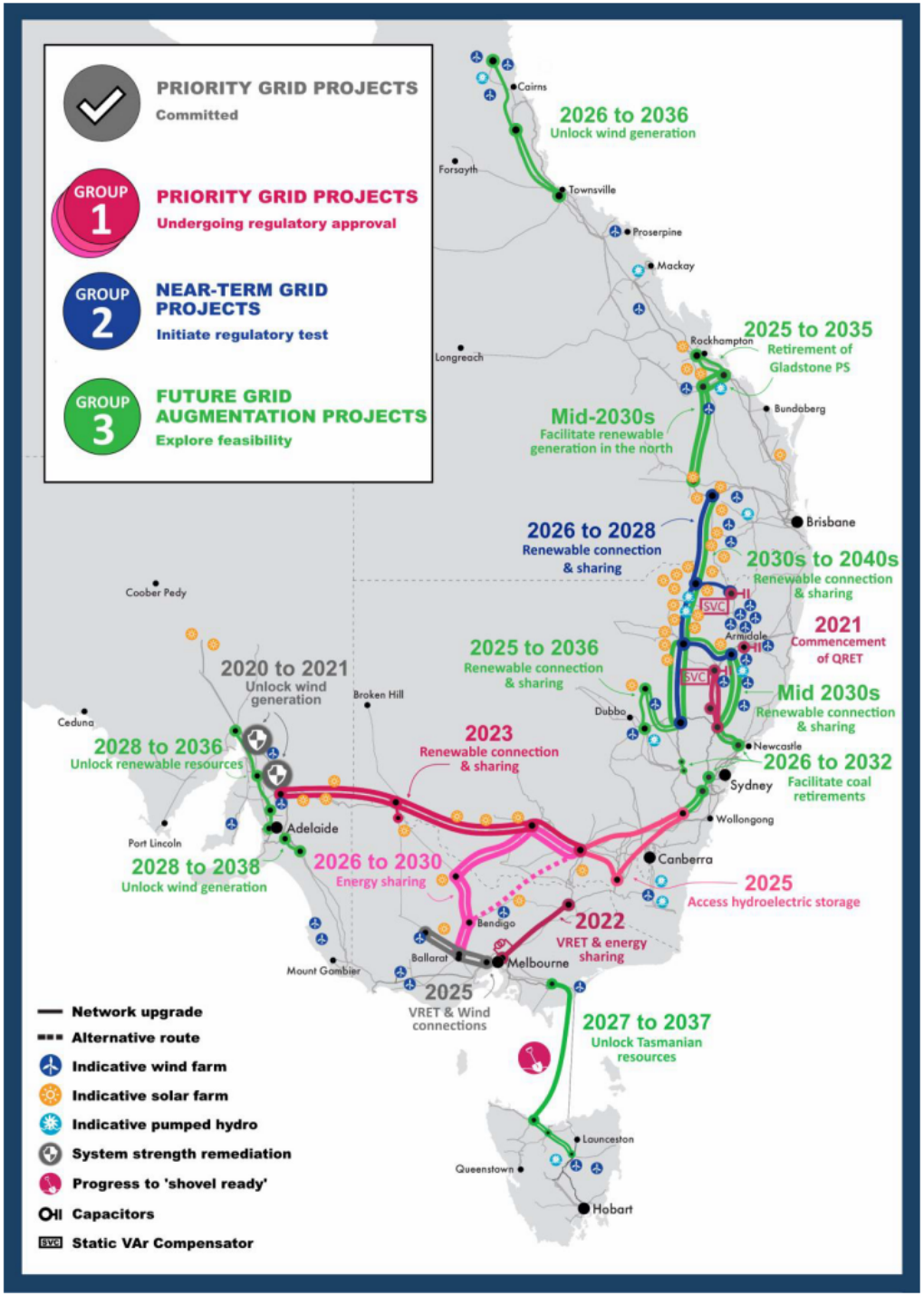
ISP 2018, and now 2020

AEMO scenarios- Large or small **or all**

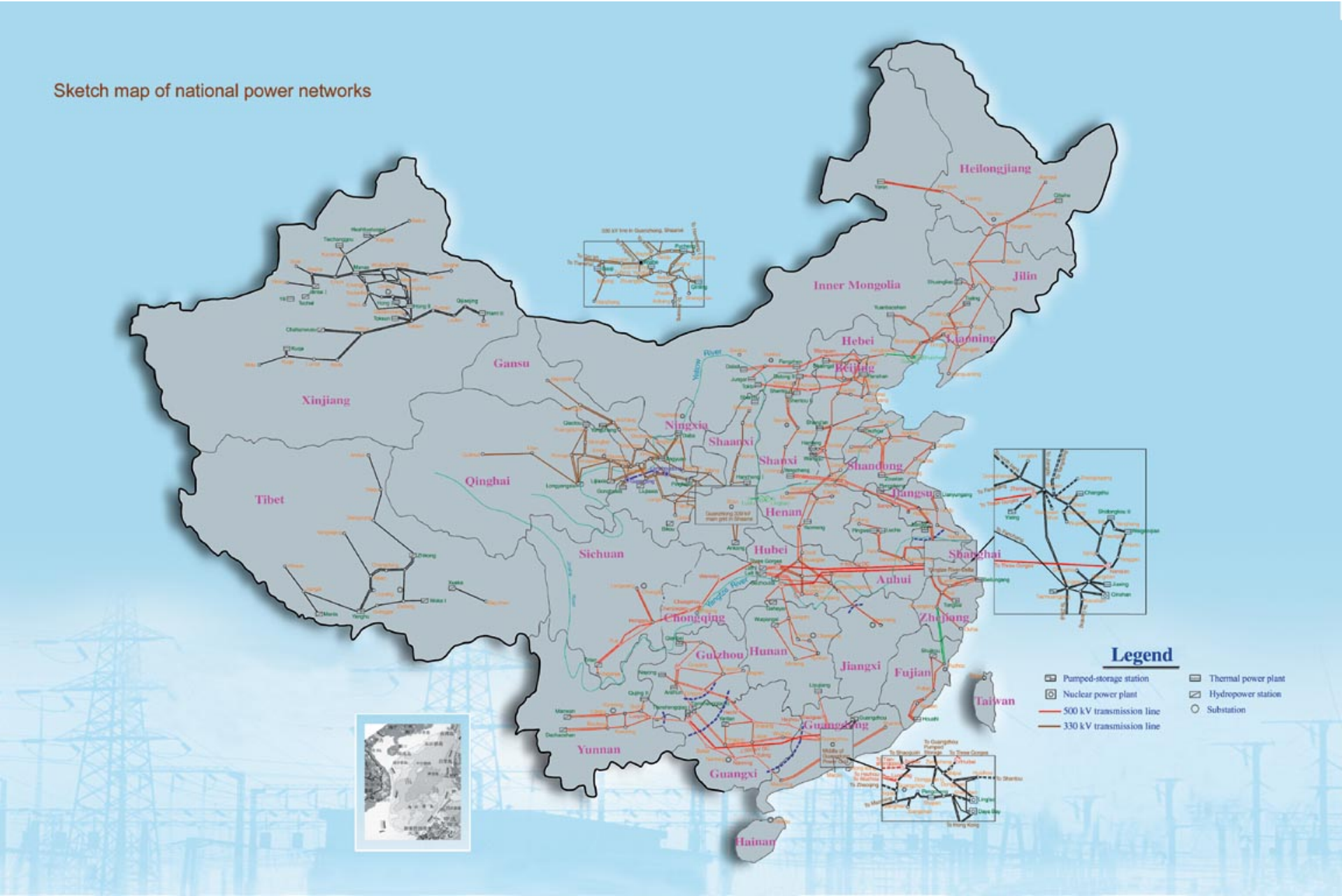
Figure 6 Comparative rates of decarbonization and decentralization across the five Draft ISP scenarios



Tx plans: *committed, priority, near-term, future*



China's transmission network www.geni.org



Feature | Energy | The Smarter Grid

21 Feb 2019 | 16:00 GMT

China's Ambitious Plan to Build the World's Biggest Supergrid

A massive expansion leads to the first ultrahigh-voltage AC-DC power grid

By **Peter Fairley**

Photo: State Grid Corp. of China

Big Picture: This Beijing dispatch center controls most of China's ultrahigh-voltage lines and monitors renewable energy use.

China's Hybrid AC-DC Grids

Ultrahigh-voltage DC lines move coal-fired and renewable generation thousands of kilometers to China's megacities. UHV AC helps distribute the imported electricity.

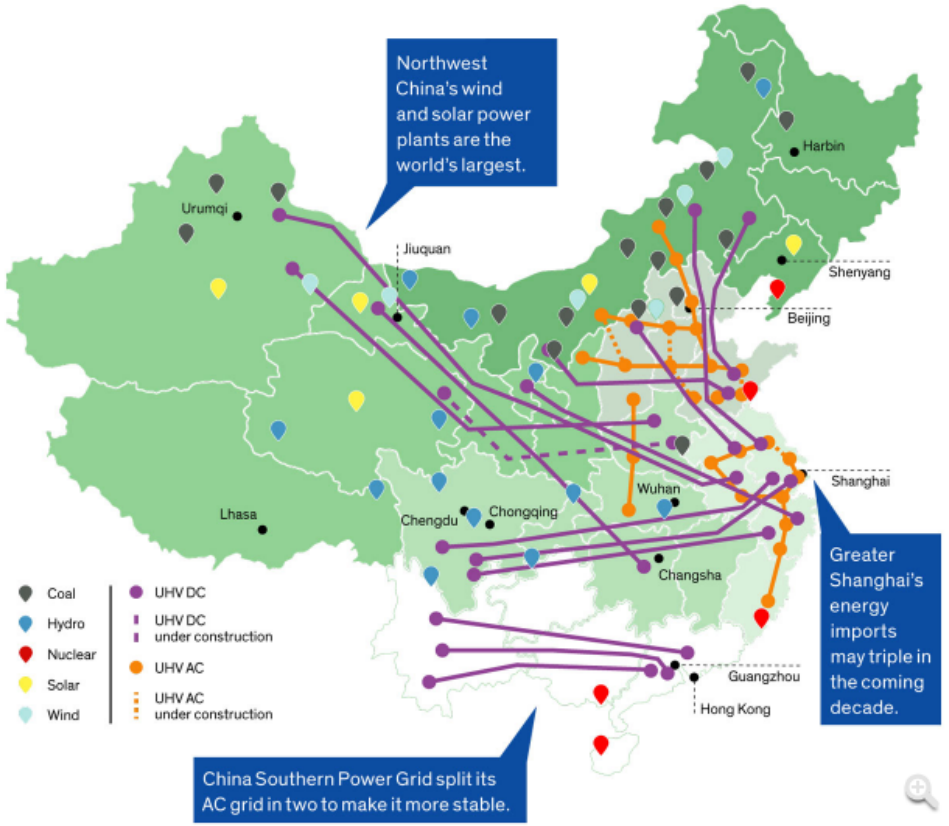


Illustration: Erik Vrielink

China's UHV movement was born of a limo ride. It was late 2004, and Liu Zhenya, then president of State Grid, was sharing a car with Ma Kai, minister of the National Development and Reform Commission (NDRC), the powerful state body that regulates China's growth and major investments. As Chinese policy expert Yi-chong Xu describes in her 2017 book *Sinews of Power* (Oxford University Press), Ma complained of the crippling power shortages of the day. Liu blamed "weak and fragmented" grids, ones ill-equipped to exchange bulk power. And he proposed a bold solution: massive cross-country power lines utilizing the most advanced UHV technologies.

Within a year, Ma's NDRC had approved an ambitious and comprehensive plan that embraced Liu's vision. It combined UHV DC lines, which excel at moving bulk power from one spot to another over long distances, and a UHV AC backbone to reliably distribute that power to consumers. State Grid would lead the engineering and ensure that domestic suppliers would manufacture 90 percent of the UHV equipment, thus building up a new high-tech export sector for China.

Over the next decade, Liu delivered. He put some 2,000 State Grid engineers on the project and funded more than 300 professors and 1,000 graduate students at Chinese universities to conduct power-grid-related R&D. State Grid expanded and refocused its research centers to attack specific UHV issues, including how to safely handle the higher electromagnetic fields and the more potent impulses during switching and faults.

In January 2009, State Grid energized its first UHV demonstration line—a 650-km, 1,000-kV UHV AC transmission line that linked the North China and Central China regional grids. Ten years on, State Grid has completed 19 of 30 proposed UHV lines.

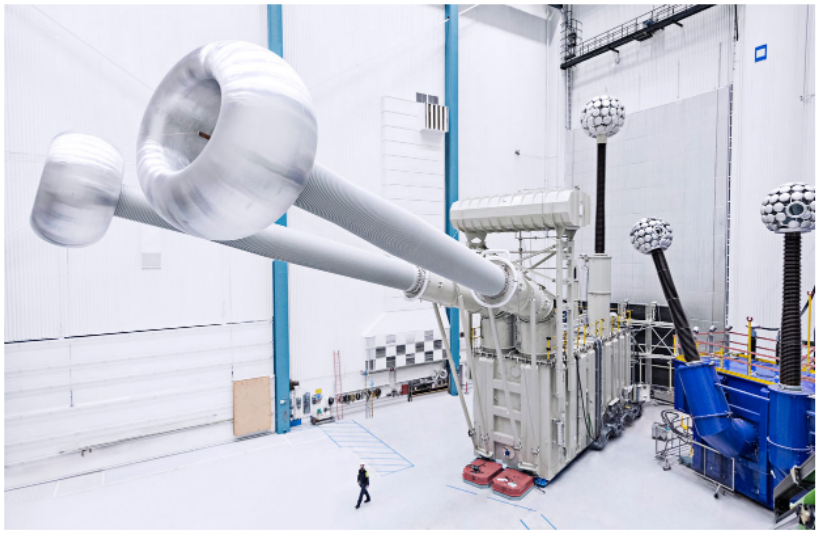


Photo: ABB

Supersized: Pushing UHV technology to 1,100 kilovolts requires upscaled components like this 800-metric-ton transformer.

For all of State Grid's progress, its UHV deployment remains uneven and incomplete. China could end up with just half of the 89,000 km of UHV lines that its plans called for by 2020 and none of the anticipated UHV links to Kazakhstan, Mongolia, and Russia. Many proposed projects—particularly for the UHV AC backbone—have failed to gain the NDRC's blessing. As a result, many areas still have no UHV AC lines, and both types of UHV are delivering well below expectations.

Photo: VCG/Getty Images

Crushing It: China's newest UHV line from Xinjiang to Anhui has set world records for transmission distance, power, and voltage.

Some experts have also criticized Liu's ultimate goal for the UHV AC backbone—linking up and synchronizing China's regional grids—as far too risky. Han Yingduo, a member of the prestigious Chinese Academy of Engineering and a professor at Tsinghua University, in Beijing, has warned that unifying China's grid would make it far more vulnerable to cascading blackouts, like the one in 2003 that knocked out power in the northeastern United States and Canada.

12 Sep 2019 | 18:30 GMT

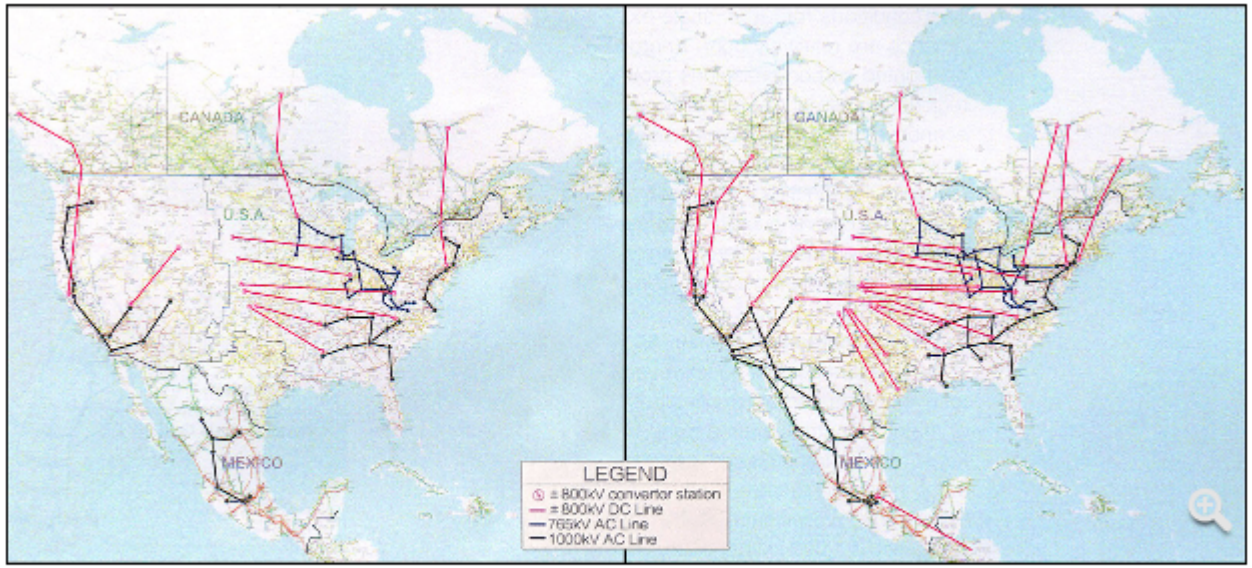
China's Grid Architect Proposes a "Made in China" Upgrade to North America's Power System

Liu Zhenya's vision for a global grid must overcome tensions between neighboring nation-states and growing distrust between superpowers

By **Peter Fairley**

Photo: Peter Fairley

Liu Zhenya signing a copy of his 2015 book "Global Energy Interconnection"



Images: GEIDCO

Ultrahigh-voltage grid expansions proposed by GEIDCO through 2035 (left) and 2050 (right).

Where next?

"The best way to predict your future is to create it!"

Abraham Lincoln

“Keep calm..
& carry on”

*Thoughtful,
careful but
major efforts now*