Renewable energy update

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Summary

- Australia has declining electricity emissions ***and*** declining electricity prices. This means that deep emissions reductions will have low or negative cost.
- Australia is the global #2 for per capita deployment rate of renewables.
- Fossil fuel energy causes 80% of Australia's emissions. We reach zero fossil energy in 2040 by doubling the solar and wind deployment rate, which is straightforward at low cost using existing technology.

The consequences of Australia's world-leading per capita solar and wind deployment are (i) falling emissions from the electricity system; (ii) falling electricity prices; and (iii) declining use of gas.

According to the Clean Energy Regulator, 7 Gigawatts (GW) of new solar and wind energy capacity was added in 2020. As a consequence, renewable electricity reached 30% in the National Electricity Market and 70% in South Australia and is tracking towards 45% and 100% respectively in 2024.

Australian greenhouse emissions fell by 4.4% in the year to September 2020. Renewables are reducing emissions in the electricity sector while COVID-19 reduced transport emissions (expected to rise again post-pandemic).

Remarkably, wholesale spot electricity prices ***halved*** in the past year compared with the average over 2016-19.

The fact that Australia is reducing electricity emissions ***and*** prices is truly significant.

If Australia installs solar and wind faster, then electricity emissions will fall faster while prices remain low.

Australia is well placed to double deployment of low-cost solar and wind to reach zero fossil fuel energy by 2040 through renewable electrification of all energy services. This would allow a 70-80% reduction in emissions.

This good news is tempered by the urgent need for additional powerlines to efficiently bring new solar and wind power to the cities and to strongly interconnect the states.

Policy recommendations – consistent with 70-80% emissions reduction by 2040

1. Target 14 Gigawatts per year of new solar and wind
2. Establish a National Transmission Network (NTN, by analogy with the NBN)
3. Strongly encourage electric vehicles; heat pumps for water & air heating in buildings
4. Strongly encourage electric furnaces in place of gas for high temperature heating
5. Strongly connect Perth and Far North Queensland to the southeast via High Voltage DC

Short CV: *Andrew Blakers is Professor of Engineering at the Australian National University. He founded the solar PV research group at ANU in 1991. In the 1980s and 1990s he was responsible for the design and fabrication of silicon solar cells with world record reported efficiencies of 18%, 19%, 20% and 22%. He was lead co-inventor of the PERC silicon solar cell, which has 90% of the global solar market and cumulative module sales of $90 billion. PERC cell deployment is mitigating 0.8% of global Greenhouse gas emissions through displacement of coal (and will soon go much higher). Prof Blakers engages in detailed analysis of energy systems with 50-100% penetration by wind and photovoltaics for which he was co-winner of the 2018 Eureka Prize for Environmental Research. Prof Blakers' team developed a comprehensive global atlas of off-river pumped hydro energy storage sites.*

Australia's global leadership

Arguably, the fastest change in global energy systems in history is underway.

In 2020, new solar photovoltaics (PV) and wind capacity comprised 75% of global net new generation capacity (Figure 1). New PV and wind capacity was 10 times larger than net new hydro and coal capacity and 100 times larger than net new nuclear, carbon capture & storage, bioenergy, geothermal, solar thermal and ocean energy generation capacity.

Extravagant deployment growth rates are required for other low-emission technologies to catch PV and wind.

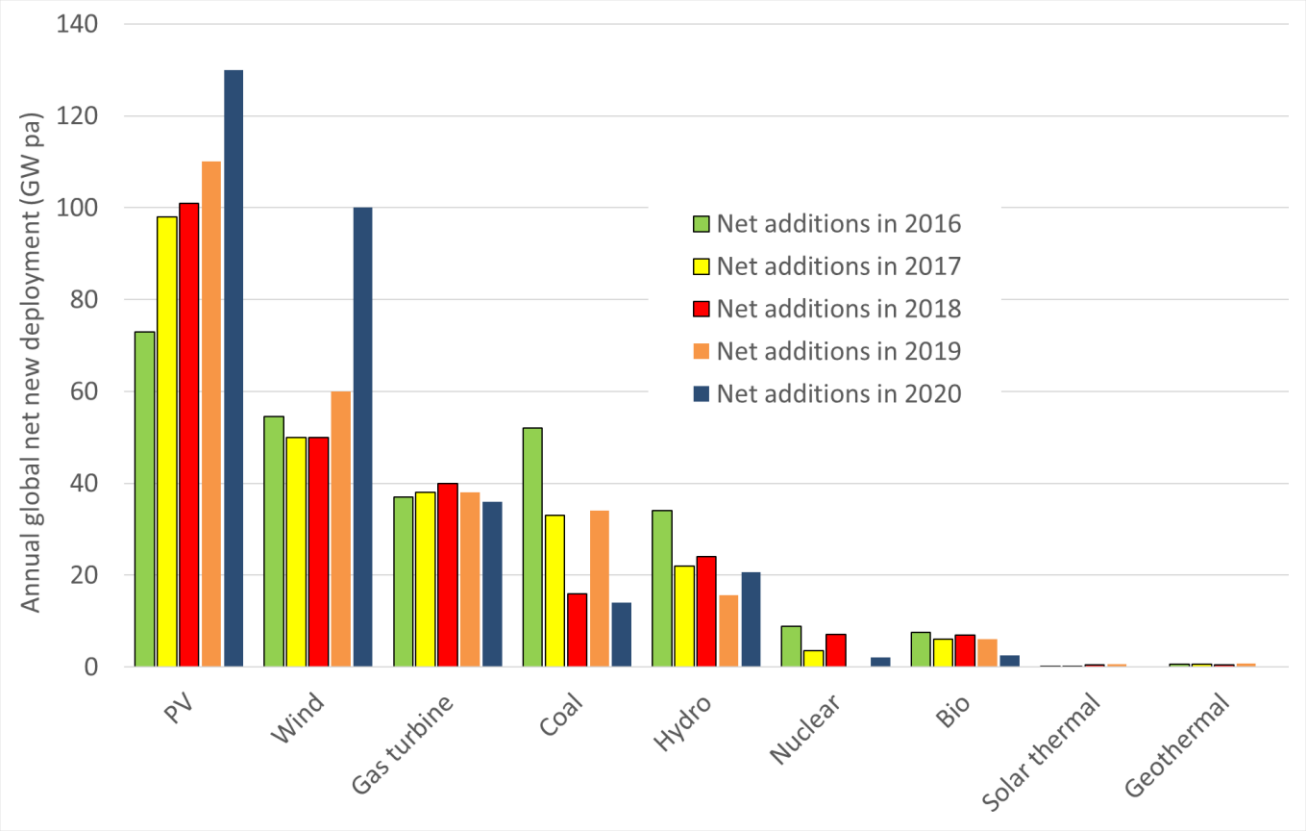

Figure 1: Solar and wind comprise three quarters of global net annual capacity additions, with fossil, hydro and nuclear energy accounting for balance. Sources.

PV and wind generators are derived from vast production runs and produce cheap electricity. The International Energy Agency recently declared that "*For projects with low cost financing that tap high quality resources, solar PV is now the cheapest source of electricity in history*".

The global solar and wind energy resource is vastly larger than global energy requirements.

In Australia, solar PV and wind comprise 99% of new generation capacity because they are cheap.

The global per capita leaders in deployment of new renewable generation capacity in 2020 were the Netherlands, Australia and Norway (figure 2). They deployed new renewables per capita at 10 times the global rate and 3 times faster than China and the USA.

Australia has the most installed solar PV capacity per capita, ahead of Germany, the Netherlands, Japan and Belgium. Since the Australian solar resource in the populated southeast is 30-50% better than in those countries, Australia is by far the leading country in terms of per capita solar generation and also solar deployment speed.

In respect of deployment of wind capacity, Australia is in 4th and 13th places for deployment speed (Watts per person per year) and total deployment (Watts per person) respectively. Eleven European countries and Uruguay rank ahead of Australia for the latter.

Australia is a pathfinder for the three quarters of humanity who live in the sunbelt where most of the world's growth in population, energy use and Greenhouse emissions are occurring.

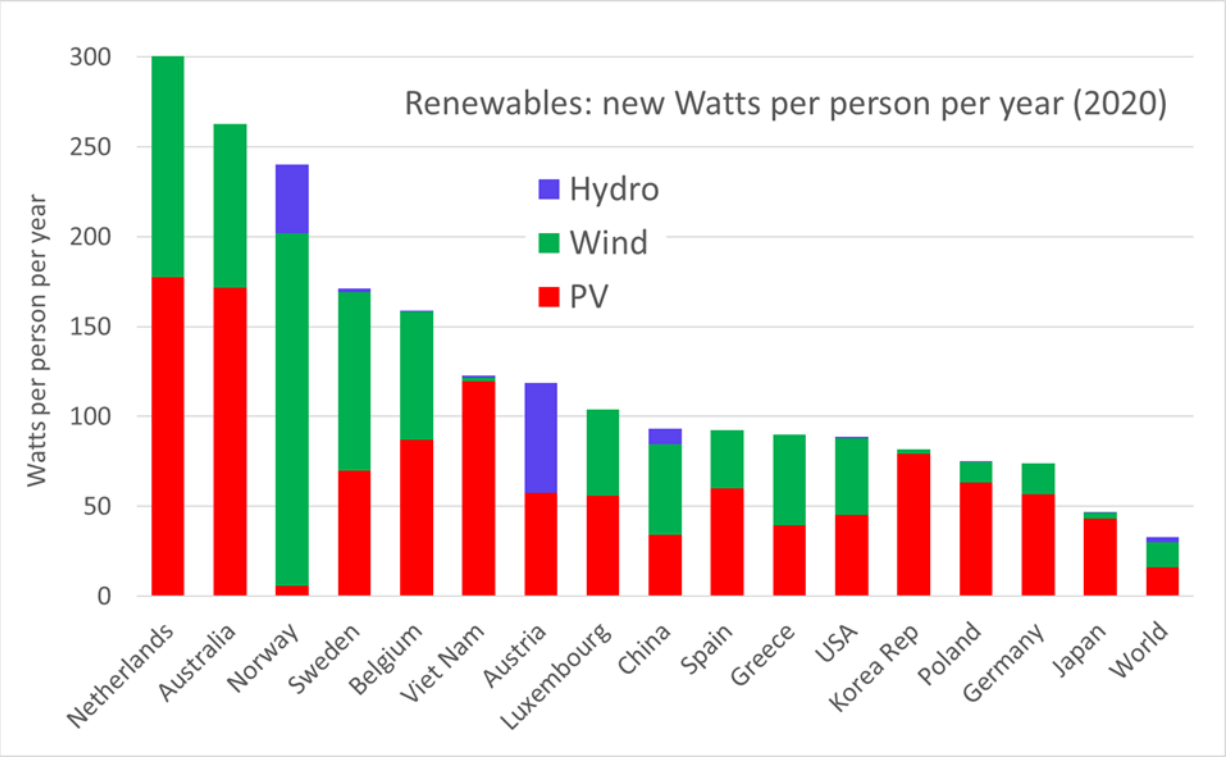

Figure 2: Deployment speed of PV and wind for 2020 in terms of Watts per person per year [IRENA].

Solar and wind in Australia

Renewable electricity reached 30% in the National Electricity Market (Fig. 3) and is tracking towards 50% renewables in 2025 (linear projection).

Solar and wind electricity in South Australia reached 70% (Fig. 4) and is tracking towards 100% in 2024 (linear projection). South Australia is an important global exemplar of rapid and sustained growth in renewable energy.

Gas is ***declining to low levels*** because it cannot compete with solar, wind, pumped hydro and batteries.

According to estimates from the Clean Energy Regulator, 7 Gigawatts of new solar and wind energy capacity was added in 2020 comprising 4 GW of utility scale wind and solar farms and 3 GW of rooftop solar. This brings the total over 2018-20 to 18 GW. The pipeline of new solar and wind remains strong until at least 2022. Costs of solar and wind are continually falling. Expanding markets include large-scale voluntary purchases of renewable electricity, mining precincts and commercial building rooftops "behind the meter".

The renewable energy industry is now worth $11 Billion per year (including both rooftop and utility solar and wind systems) and is employing 27,000 people.

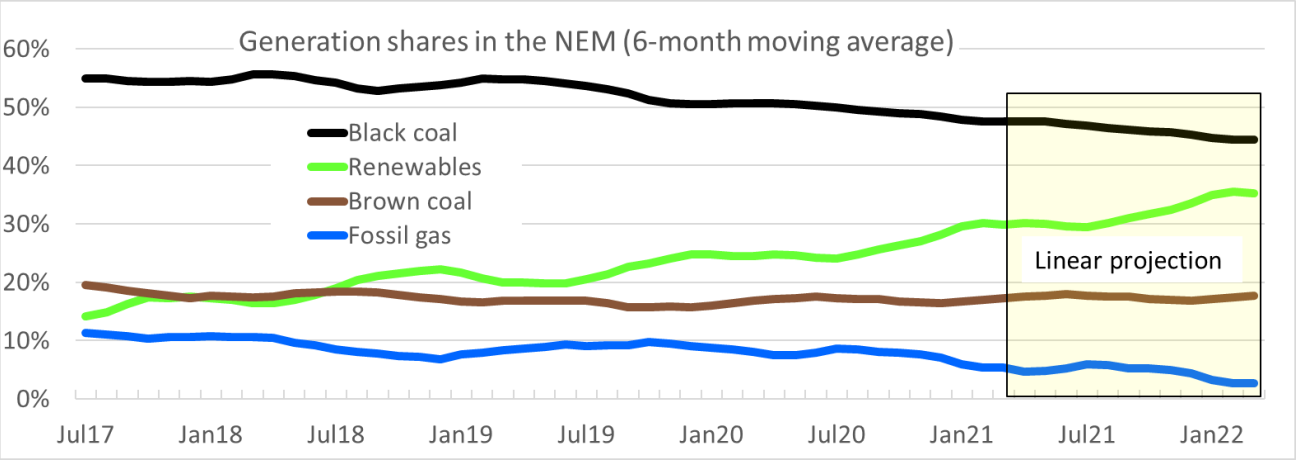

Figure 3: Renewable generation in the National Electricity Market reached 30%.

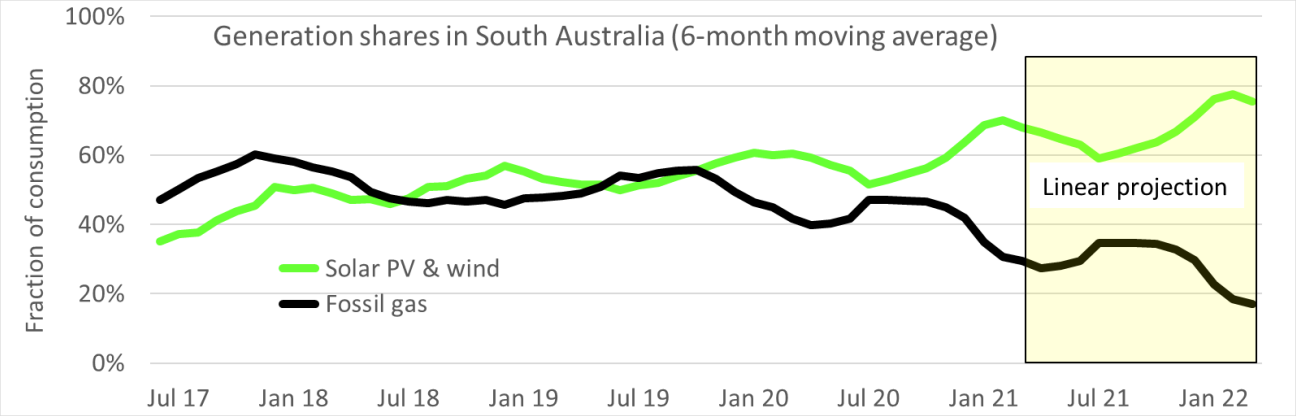

Figure 4: Solar PV and wind electricity generation in South Australia reached 70%

Declining electricity prices

Australia is experiencing low wholesale electricity prices (Fig. 5). Prices halved over the past year compared with the average over 2016-19 as a flood of new solar and wind electricity enters the market.

Continuing reductions in the price of solar and wind may cause a wave of early coal generator retirements during the 2020s. The early closure of the 1.5 Gigawatt Yallourn power station was recently announced.

The economics of PV and wind are compelling. Australia is demonstrating that rapid deployment of solar and wind can lead to declining emissions ***and*** low electricity prices. Now is the time to plan ahead to accelerate renewable deployment and decarbonize the entire economy.

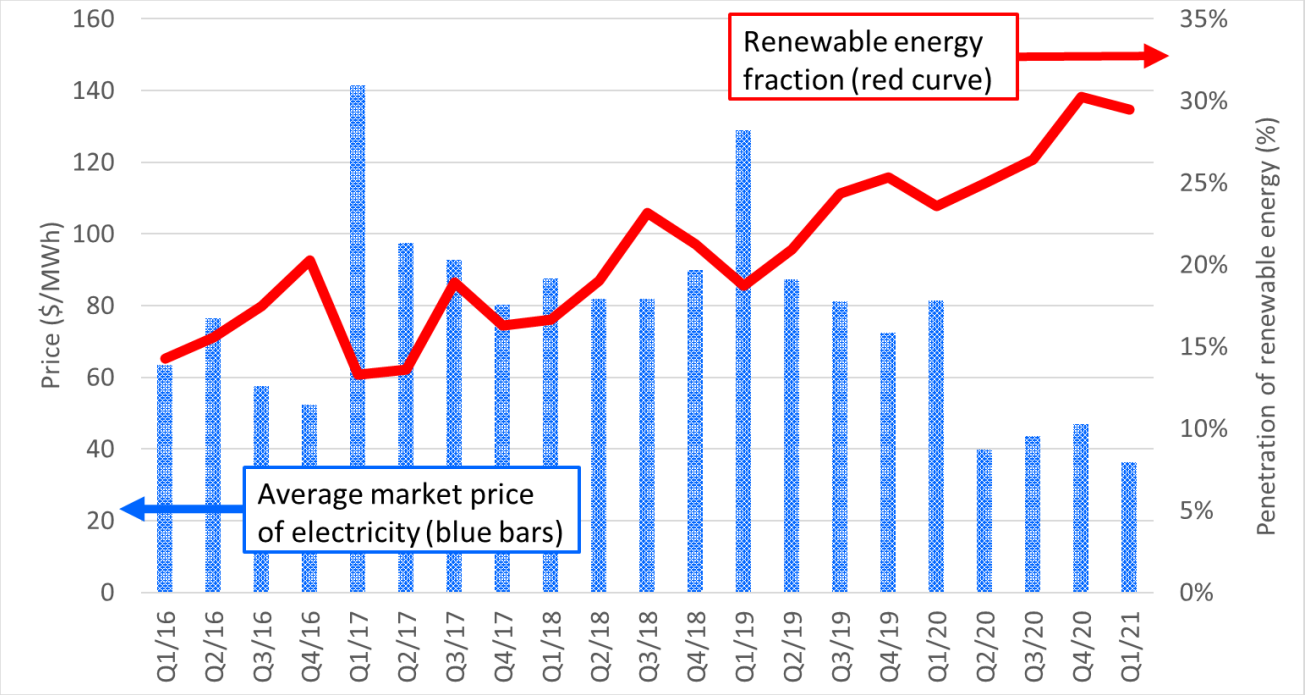

Figure 5: Wholesale prices (blue bars, LH axis) and renewable energy fraction in the NEM (red curve, RH axis).

Balancing solar and wind

Balancing variable PV and wind is straightforward using off-the-shelf techniques: stronger long distance transmission (to smooth out variable local weather), storage (pumped hydro and batteries) and demand management.

Stronger transmission is urgently needed to bring new solar and wind power to the cities. An effective way to do this is to upgrade transmission lines from rural Renewable Energy Zones to the cities.

Pumped hydro energy storage comprises 95% of global storage power and 99% of global storage energy. It provides lowest cost storage for periods of more than a few hours. The global pumped hydro storage atlas (Figure 6) lists 616,000 sites (4,000 in Australia) with 23 million Gigawatt-hours (GWh) of combined storage, which is two orders of magnitude more than required to support a global 100% renewable electricity system. In Australia, two pumped hydro systems are under construction (Snowy 2.0 and Kidston) with combined storage power and energy of 2.3 GW and 350 GWh respectively. About a dozen large pumped hydro systems are being considered. None include new dams on rivers.

Batteries (utility, home and in electric vehicles) complement pumped hydro by providing short term storage. About 2 GW (2 GWh) of utility batteries are under development in Australia.

The "Step Change" scenario in the Australian Energy Market Operator's 2020 Integrated System Plan is a guide to the changes needed in the electricity system. The 2021 Plan will include a scenario that assumes much faster renewable energy deployment and associated emissions reductions.

Strongly connecting Perth and Far North Queensland to the southeast via High Voltage DC reduces electricity prices. Such a project would contribute to nation building.

Figure 6: 616,000 potential [off-river PHES sites]

Emissions

The rapid rise to dominance of PV and wind in generation capacity construction has immense implications for greenhouse emissions trajectories through displacement of fossil fuels (which cause 3/4 of global emissions).

Australian greenhouse emissions from electricity have been falling since 2016 because solar and wind are pushing out coal and gas. However, emissions outside electricity were rising until the impact of COVID-19 was felt. Overall, emissions have slowly fallen since 2018 (Figure 7).

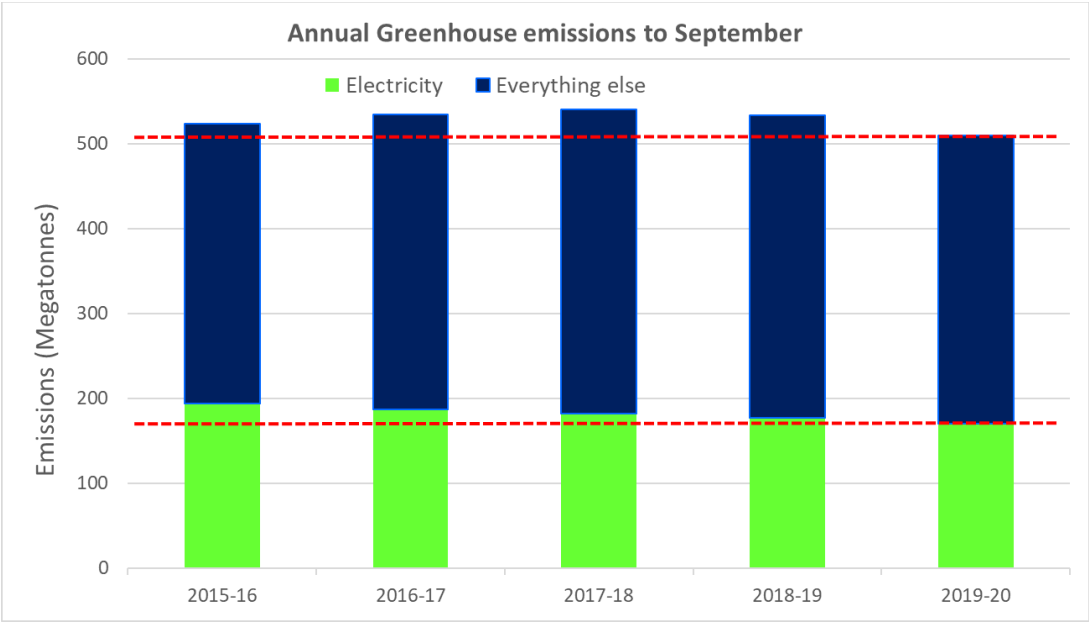

Figure 7: Australian annual emissions to September 2020 from electricity (green bars) and everything else combined (blue bars).

The National Greenhouse Gas Inventory shows that Australia's emissions fell 4.4% in the year to September 2020. Much of the decline resulted from COVID causing reduced transport emissions – which will rise towards normal during 2021. Fast declines in emissions requires faster deployment of solar and wind.

Europe, China, Japan, Korea, the USA and many other countries are pledging zero emissions by 2050-60. All Australian State and Territory governments have committed to zero emissions in 2050.

Zero fossil fuel energy, 70-80% emissions reductions

PV and wind can readily decarbonize electricity systems. Electrification of most land transport (via electric vehicles) and heating (via electric heat pumps and electric furnaces) is straightforward using existing widely deployed technology. A recent paper shows that electricity production in Australia **needs to double** to decarbonise these sectors. This would eliminate ~70% of emissions with insignificant impact on electricity prices.

To accomplish this task by 2040, the deployment rate of solar and wind needs to double from 7 GW in 2020 to 14 GW per year.

Fugitive emissions from fossil fuel mining comprises a further 10% of emissions, which vanish as fossil fuel use and export vanishes.

The balance of emissions comprises waste (3%); chemical production, aviation & shipping (8%); and the land sector (10%). These sectors are harder to decarbonize. An early focus on electrification of land transport and heating buys time to scale up the technology needed to decarbonize these sectors.

Hydrogen has an important role in decarbonizing the chemical industry in the 2030s. However, electrification is by far the technology and market leader in decarbonizing electricity, transport and heating (80% of emissions).

A possible scenario for zero fossil fuel energy in 2040 is shown in figure 8.

Continued deployment of 7 GW per year reaches the current Paris target.

Doubled deployment rate (14 GW/year) produces much faster declines in emissions. This is not hard considering the ever-falling price of solar and wind, and the fact that their current deployment rate is already seven times faster than in 2015 (when it was 1 GW per year).

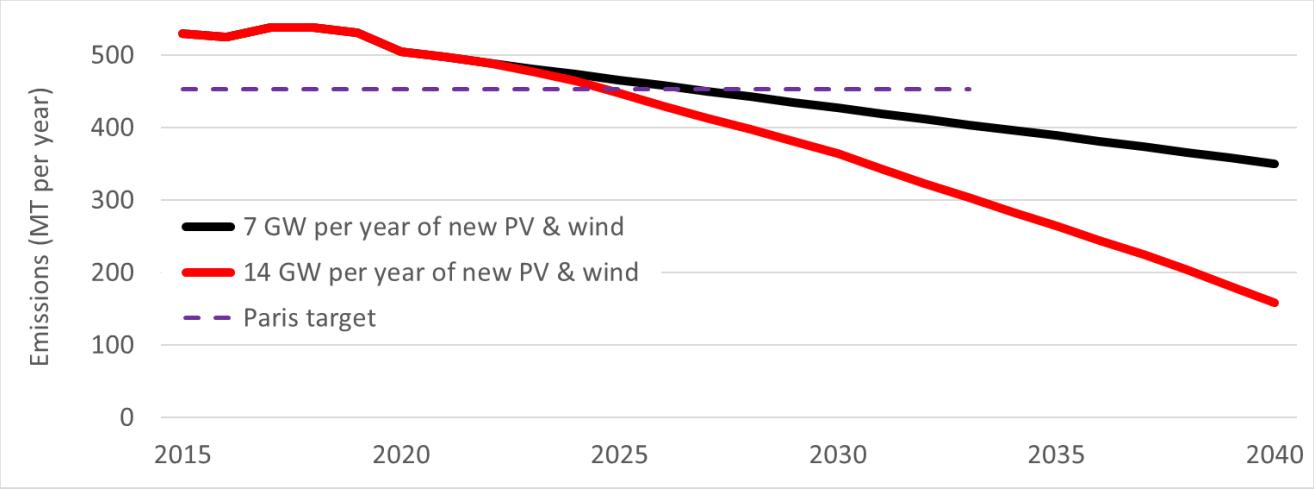

Figure 8: Scenario of rising electricity demand caused by renewable electrification of transport, heating and industry, which is met by solar and wind. This allows zero fossil fuel energy in 2040 and a 70-80% reduction in emissions.