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Solar photovoltaics is the only practical path to climate stabilization

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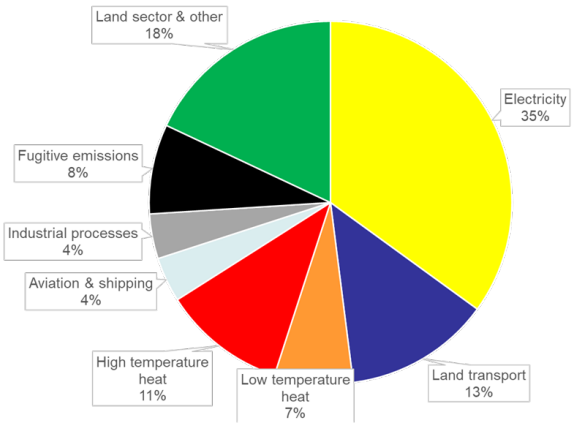
Solar PV is growing fast enough to eliminate global coal, oil and gas consumption within two decades, allowing greenhouse gas emission reductions of 80%, with the time frame depending mostly on politics. Silicon PV is doing for energy (and greenhouse gas emissions) what the silicon chip did for computing.

The exponential rise and rise of solar photovoltaics (PV) offers the only realistic chance of avoiding dangerous climate change. No other solution comes close to the prospects of PV. Indeed, it is difficult to see any timely solution to climate change that does not involve PV doing most of the heavy lifting.



About 80% of Australia's greenhouse gas emissions are due to the use of fossil fuels (Figure 1), which is typical for industrialised countries. Land clearing and agricultural emissions constitute most of the rest. PV (with assistance from wind and other renewables) is on track to eliminate this 80% of emissions within 20 years.

Sadly, attempts to capture and store large quantities of CO_2 emissions from burning fossil fuels have come to naught due to technical difficulties and high cost. Thus, coal, oil and gas use must be eliminated to curtail global warming. A replacement is needed that ideally would meet the following criteria:

- Very large and preferable ubiquitous resource base
- Small greenhouse gas emissions and other environmental impacts
- Unlimited raw materials
- Minimal security concerns in respect of warfare, terrorism and accidents
- Low cost right now, allowing low economic impact from discarding fossil fuels
- In mass production right now, allowing immediate scale-up from an existing very large base

Solar PV meets these criteria, while wind energy also meets many of them. Nothing else is close.

PV and wind depend only on solar energy, which will continue to be available for billions of years. Complete replacement of all fossil fuels requires solar and wind collectors covering much less than 1% of the world's land surface area. A large proportion of PV collectors are installed on rooftops and in remote and arid regions, thus minimizing competition with food production and ecosystems.

The solar resource is ubiquitous - we will never go to war over access to sunlight. Most of the world's population lives at low latitudes (less than 35 degrees) which has good solar availability that varies little with the seasons (unlike at high latitudes). Wind energy is also widely available, particularly at higher latitudes. Very wide distribution of PV and wind collectors over most regions of the world minimizes disruptions from natural disasters, war and terrorism.

The cost of PV and wind have been declining rapidly for many decades and is now in the range $50-70/MWh in Australia. This is below the cost of electricity from new-build coal and gas units. There are many reports of PV electricity being offered from very large scale plants for $30-50/MWh.

Solar PV and wind have been growing exponentially for decades and have now reached take-off. In 2018, PV and wind comprise 60% of net new electricity generation capacity additions worldwide, with coal, gas, nuclear, hydro and other renewable capacity comprising the rest (Figure 2).

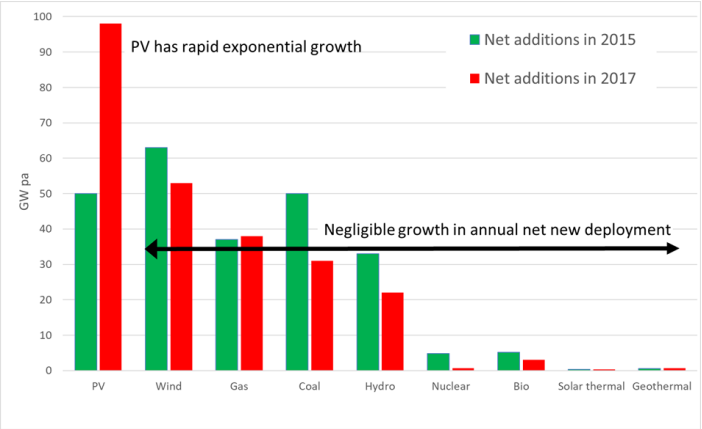


Figure 2: Net new global generation capacity added in 2015 and 2017. PV is growing rapidly whilst the other generation technologies have negligible growth in annual net new deployment or have negligible scale.

The share of annual generation by PV and wind is no longer invisible - together they are producing about 7% of the world's electricity and are growing much faster than competitors. The global growth rate of new PV and wind capacity over the past 5 years is 28% and 13% per year respectively. The net new installation rate of all other generation technologies is static or falling or miniscule.

PV and wind have minimal environmental impact and water requirement. PV utilizes raw materials that are effectively in unlimited supply: silicon, oxygen, hydrogen, carbon, aluminium, glass and steel, plus small amounts of other materials.

Wind energy is an important complement to PV because it often produces at different times and places, allowing a smoother combined energy output. In terms of annual electricity production wind is still slightly ahead of PV but is growing more slowly. The wind energy resource is much smaller than the solar resource, and so PV will likely dominate in the end. The other low emissions energy technologies can realistically play only a minor supporting role due to current very small annual deployment scale or constrained resources..

Stabilising an electricity grid with high levels of variable PV and wind is straightforward and comprises storage and strong interstate interconnection with high voltage cables over large areas to smooth out the effect of local weather. By far the leading storage technologies are pumped hydro and batteries.

In Australia, PV and wind comprise most new generation capacity. About 5-7 Gigawatts (GW) of PV and wind is expected to be installed in 2018 and 2019 compared with peak demand of 35 GW in the national electricity market. This installation rate is sufficient for Australia to reach 70% renewable electricity by 2030 (and thereby far surpass Australia's Paris target).

Deep cuts (80% reduction) in greenhouse gas emissions requires that fossil fuels are pushed out of all sectors of the economy (not just electricity). The path to achieve this is by electrification of all energy services. Straightforward and cost-effective initial steps are:

(i) to reach 100% renewable electricity;
(ii) to convert most land transport to electric vehicles; and
(iii) to use renewable electricity to push gas out of low temperature water and air heating.

These trends are already well established and would yield a 55% reduction in current greenhouse gas emissions (Figure 1) at zero net cost. High temperature heat, industrial processes, aviation & shipping fuel and fugitive emissions can be displaced by renewable electricity and electrically-produced synthetic fuels, plastics and other hydrocarbons. There may be a modest additional cost depending on the future price trajectory of PV and wind.

Taken together, the amount of electricity required to completely displace fossil fuels is about three times current electricity consumption. In other words, electricity production must triple. Remarkably, current annual global growth rates of PV (with support from other renewables) are enough to eliminate coal, oil and gas use within 20 years.