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IS A SOLAR FUTURE INEVITABLE?

HOW TO SHAPE POLICIES TO CAPTURE THE OPPORTUNITIES OF CHEAP SOLAR

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SUMMARY

Solar power has already grown much faster globally than most governments and analysts expected. This looks set to continue: our model suggests solar is on track to dominate the global power sector, even with no additional deployment subsidies. Its deployment will increase faster than is typically assumed, and we project costs including storage to continue falling. New coal and gas plants are set to become uneconomic earlier than anticipated, potentially costing twice as much as solar power with energy storage by the end of this decade. Grid upgrades and policies to support the deployment of energy storage will be important to taking full advantage of this opportunity.

Solar growth likely to continue outpacing expectations

The growth of solar power globally has already outpaced expectations. In 2006, projections based on governments' targets suggested that around 50 GW of solar power would be deployed globally by 2020.[i] In reality, over 700 GW of solar was deployed by that year – more than ten times as much.[ii]

Rapid deployment has gone hand in hand with an astounding rate of reduction in costs. With every doubling of global deployment, the cost of solar power has fallen by around 20%. Since solar power's first deployment in the mid-20th century, its cost has fallen by a factor of around 10,000. Over the last decade, it has fallen by 80%.[iii]

Rising deployment and falling costs have pushed each other on, in a virtuous circle, or reinforcing feedback. Deployment drives learning in both the production and installation of solar panels, as well as economies of scale, pushing down costs; the fall in costs then encourages further deployment. Past projections for solar deployment were so wide of the mark because they failed to take full account of these feedback effects.

A new baseline scenario: solar dominates the global power sector

Our state-of-the-art macroeconomic model[iv] includes these feedback effects. Instead of making a static calculation of the 'optimum' technology mix in the power sector at a future moment in time, as conventional models do,[v] it performs a bottom-up simulation of investor choices, based on observed historical relationships in technology development and diffusion.

We find that, if observed trends in technology development continue, solar PV could make up over half of global electricity generation by 2050, even with no additional deployment subsidies or carbon pricing. This is significantly more than previous modelling suggests: for example, the International Energy Agency's baseline scenario projects solar will take only a 20% share of global electricity generation by 2050.[vi] This also implies greatly higher yearly capacity additions than historically seen, before solar PV reached cost-competitiveness.[vii]

The rapid expansion of solar in our model is driven by its fast construction time, in combination with its low cost and the strong reinforcing feedback between deployment and cost reduction. Batteries, which can balance the supply of solar power with respect to the day-night cycle, continue to experience the steep cost declines already observed. Wind power costs fall quickly too, consistent with empirical data, not as quickly as solar.[viii] The result is that if these trends continue, then even with the costs of energy storage added in, solar (plus storage) becomes the cheapest form of power generation almost everywhere in the world within the next five years (see Figure 1).

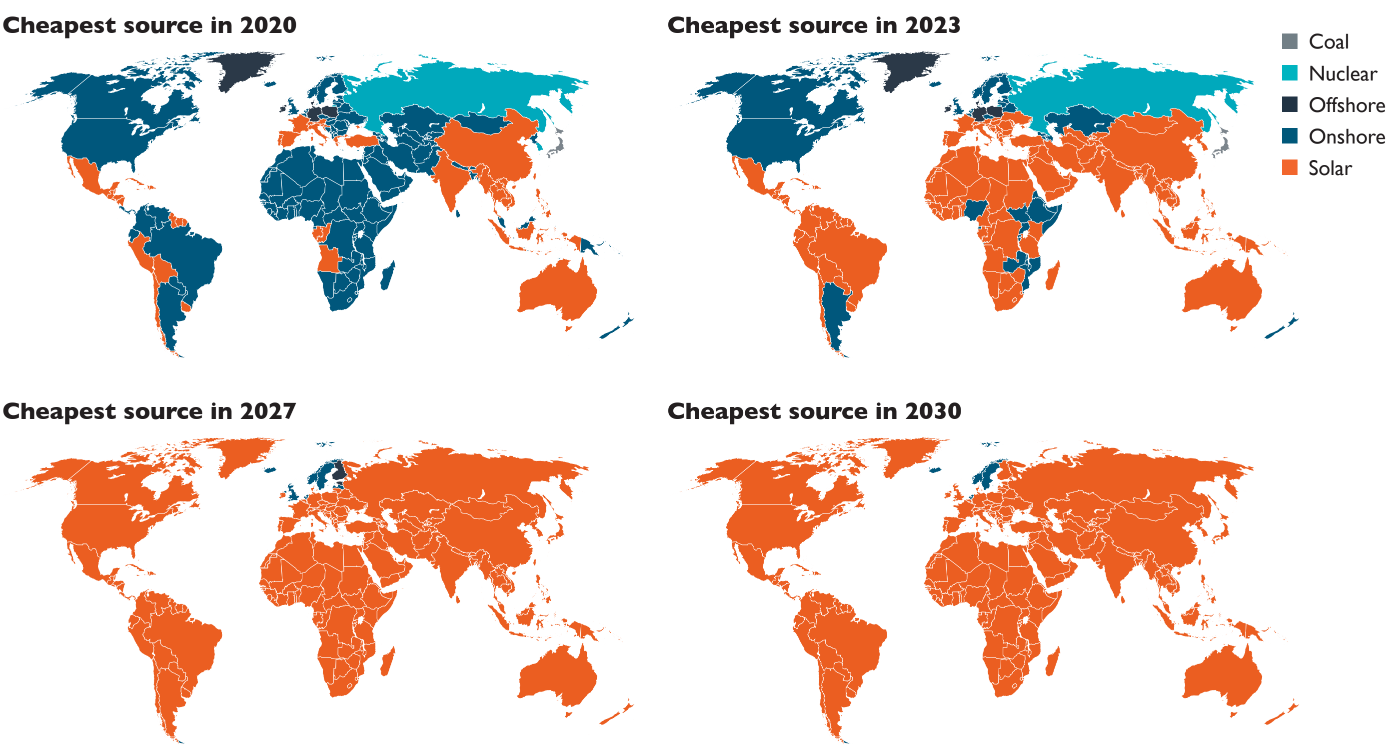

Figure 1. Maps showing the energy source with the lowest levelised cost of electricity (including necessary storage) in 70 world regions, in 2020, 2023, 2027 and 2030. The biggest shift occurs between 2020 and 2027, which sees a range of technologies give way to solar PV as the cheapest form of energy.

The expansion of solar could be slowed by delays in the expansion of grids, the deployment of energy storage, or the growth in supply of critical minerals. In the Global South, investment in renewable energy is still held back by lack of access to affordable finance. However, in simulations to investigate the effect of variations in solar power price declines, fossil fuel prices, unequal costs of lending, and supply-side or grid-expansion delays, 70% of model variations nevertheless suggested that solar should make up more than half of global electricity supply by 2050.

To reiterate, this is a 'baseline' scenario in which solar power receives no additional financial support for deployment. While vested interests could push to slow the transition, it is equally possible that governments will push for a faster transition than this. Many countries have committed to reach net-zero emissions by 2050 (e.g. EU, UK, Japan, Korea), 2060 (China) or 2070 (India). These targets imply mass-scale deployment of zero-carbon energy technologies such as solar and wind power, especially given the limited feasibility of negative emissions.[ix]

Solar and storage dramatically undercuts coal and gas before the end of this decade

Faster global deployment implies faster cost reduction. We project the globally averaged levelised cost of electricity (LCOE) for solar, *including* the costs of rising energy storage needs (both short and long-term), to drop by another 60% between 2020 and 2050. This in turn implies even greater future cost savings in a solar-dominated power system compared to a coal or gas-dominated system. We project that solar plus storage will be *half as expensive* as coal by 2030 in six key regions: the EU, US, India, China, Japan and Brazil (see Figure 2). And this is not even taking into account spikes in fossil fuel prices. Gas power plants typically have lifetimes of more than 25 years, and coal plant lifetimes are usually longer. Our projections suggest that investments in new coal and gas power plants are a bad bet: they will provide unnecessarily costly electricity for most of their lifetimes. In grids with a high diffusion of variable renewables, fossil fuel plants operate discontinuously, driving up costs. Countries that continue to invest in new coal and gas power generation risk putting their electricity-intensive industries at a competitive disadvantage, and unnecessarily increasing the cost of living for their citizens.

Grids, storage and supply chains are central to success

The rapid expansion of solar power globally is highly likely, creating the opportunity of very low-cost electricity. However, there are barriers that countries need to overcome to take full advantage of this opportunity. Most importantly, grids need to be adjusted to accommodate a more variable and distributed supply of energy, making increasing use of energy storage and long-distance transmission. Markets will need to be reformed to provide more incentives for diverse or flexible energy resources.

In the Global South, investment may be delayed due to lack of access to finance for renewables.[x] Strategies to address this finance gap can include mechanisms to absorb currency and investment risks; alongside well-designed power sector regulatory reforms, these can unlock international capital flows.

Finally, it will be important to maintain a steady supply of the materials that are needed for the manufacturing of solar panels and batteries. Measures to increase security of supply, such as geographical diversification of mining, can be complemented by measures to increase efficiency (both in the use of materials and in the use of electricity) and recycling.

As the world moves rapidly towards a solar-dominated power sector, countries that take the right steps to encourage investment and upgrade their grids will realise significant benefits, making low-cost electricity available to their consumers and industries.

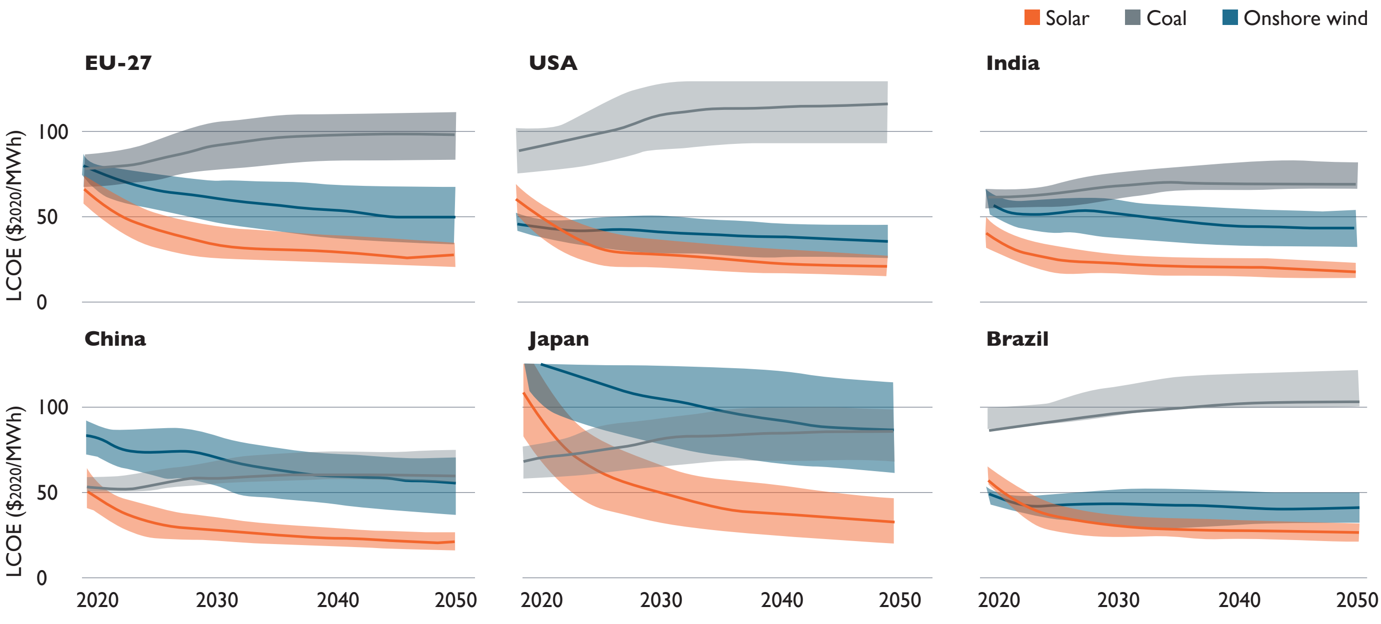

Figure 2. Cost projections for three key technologies in six countries. The costs include a 'system storage' component; wind and solar pay extra depending on how much storage is needed, depending on the diffusion of either technology.

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Footnotes:

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i www.g20-insights.org/policy_briefs/the-tipping-point-how-the-g20-can-lead-the-transition-to-a-prosperous-clean-energy-economy

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ix Vaughan, N. E. & Gough, C. Expert assessment concludes negative emissions scenarios may not deliver. Environmental Research Letters 11, 095003 (2016).

x Ameli, N. et al. Higher cost of finance exacerbates a climate investment trap in developing economies. Nature Communications 12, 1–12 (2021).

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