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The sunshine state: implications from mass rooftop solar PV take-up rates in Queensland

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Paul Simshauser[♣♦1] Tim Nelson[♣] & Joel Gilmore[♣]

The rise of rooftop solar photovoltaic (PV) in Australia's *sunshine state*, Queensland, has been remarkable. As of late-2022, 43.3% of Queensland households had installed a rooftop solar system – the highest take-up rate in the world. This has had profound impacts on the power system – for utilities, participating households and non-participating households.

The conditions which sparked the initial wave of installations comprised a combination of sharply rising household electricity tariffs, stalled household income growth, uncoordinated and overlapping policy subsidies by two levels of government (including a generous 'Premium' Feed-in Tariff), rapidly falling technology costs and ultimately, a very competitive installer market.

The effects of rooftop solar PV are complex. At the whole-of-system level, the production contribution is significant. Queensland's fleet of rooftop PV systems produce ~9% of total demand. At a consumer level, participating households are unambiguously better off. But the regressive nature of the kilowatt hour (kWh) and volumetric electricity tariffs means non-participating households are exposed to hypothecated taxes associated with solar subsidies – and these funded a large component of early system installations. When policymakers become aware of such adverse effects, policy is *necessarily adjusted*. This occurred in Australia, albeit imperfectly.

For utilities, the story is mixed. On balance, near-term impacts of solar PV have primarily been adverse. Generation investment opportunities have been curtailed

♣ Centre for Applied Energy Economics & Policy Research, Griffith University.
♦ Associate, Energy Policy Research Group, University of Cambridge.
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(~1500MW of base and peak plant) as rooftop solar PV displaces utility plant market share. Although one could also argue, we believe, that generator investors have been spared the risk of stranded investments given the recent acceleration of 'net zero' climate policy inAustralia.

Network utilities now have a more complex set of dynamics to deal with including reverse flows and metering demand (none of which is costless). However, networks are revenue regulated and consequently have not suffered any direct financial impact per se.

Retail supply businesses have lost material market share as consumers increasingly *'make their own'* electricity. Volumetric losses have been ~30% and in a static sense, retail supply customer asset values may be overly inflated during the privatisations since market start. But the outlook for such businesses may revert because, if there is a *'first law of decarbonisation'*, surely it is 'anything that can be electrified, will be'. So while grid-suppled household electricity demand has reduced, fuel switching is capable of reversing this trend.

One concern with the pace of change associated with rooftop solar PV take-up rates has been the challenge for utilities, including network and market operators, to adapt. The installation of hundreds of thousands of individual systems, most with limited telemetry and few of the sophisticated controls installed on large-scale systems, is creating new challenges, many of which are still being identified. How to maintain grid stability in neighbourhoods, or entire regions, with low or negative net demand remains a work-in-progress. The operation and behaviour of large numbers of systems following a fault can also create new risks and modes of failure which may be costly to mitigate.

The rapid rise of rooftop solar PV in Queensland, while dramatic, is unlikely to be unique. Such a shift in consumer behaviour will likely be seen in any market with good solar resources. How utilities should prepare for other widescale, distributed technologies such as behind-the-meter batteries and electric vehicles, and the electrification of natural gas appliances represents the next frontier.

Contact p.simshauser@griffith.edu.au
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