Filling the power vacuum - an opportunity for solar power in Japan

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Japan Uncertainty Modelling Project

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1. Introduction

Following the Tohoku region Pacific Ocean offshore earthquake (東北地方太平洋沖地震) and resulting tsunami, major infrastructure on the East Tohoku coast of Japan sustained substantial damage. Most prominently, the Fukushima Daiichi nuclear power plant has been shut down, and most probably will never return to operational status. This power plant has a rated power output of 4.7GW. Other smaller damaged (conventional) power plants with a combined output of 4.8GW are expected to return to service, but even this may take some time. The resulting shortfall in power generation is having a substantial impact on the Japanese economy.

This poster explores the viability of one method to plug the gap, or at least ameliorate the problem. Japan regularly introduces building regulations to better protect modern buildings against earthquake damage. Supposing the next regulation were the requirement to install solar power on every new build?

2. Power Generation

Peak (summer) demand in the East Japan area served by TEPCO (Tokyo Electric Power Company, which operates the Fukushima plant) is about 60GW, and current power generation capacity is 35GW. TEPCO expects to achieve a total production (including buy-in) of 47GW by this summer, leaving upwards of 10GW shortfall after anticipated energy-saving measures. The problem may even continue into next summer, as replacement power plants will take time to plan and build. The TEPCO area is currently implementing rolling power cuts and major industrial facilities are shut down. The costs to the Japanese economy may be substantial, as industrial production can be severely impacted even by occasional power cuts.

Potential power generation

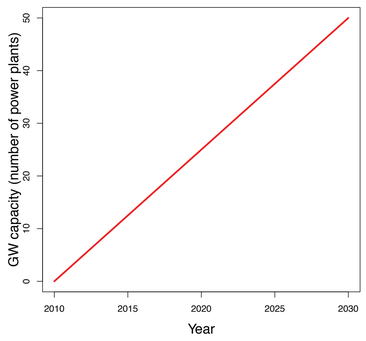

Figure 1: Peak solar power production if all East Japan new builds included solar installations (4kW per house). Units are GW, which is the approximate power output of one nuclear reactor

One common criticism of solar power is the intermittency of power generation, with its average power output or "capacity factor" around 15% of peak. However, the daily generation cycle is quite well matched to demand in Japan (with our air-conditioner-driven early afternoon peak, highest in summer) and thus it is actually rather well suited to coping with the urgent problem of the peak demands in Japan.

Japan builds a remarkable 1.2 million housing units per year - as many as the much larger USA, and roughly 10 times more than the UK - with over half of them in the TEPCO and east Japan area. West Japan is electrically independent from the eastern side of the country, so housing in that area are not considered further. Roughly half of these new builds are single-family dwellings, so there is plenty of roof area available. Build-integrated solar PV on these, with an average single domestic 4kW unit on each, would amount to around 2.5GW extra capacity in a single year. Japan has a production capacity of several GW/y of solar PV, with the Miyazaki factory alone capable of 1GW/y production. Most of this is output is currently exported, but with sufficient incentives for domestic installation, the potential exists for solar PV to make a substantial contribution to filling Japan's power vacuum.

3. Cost

Cost comparisons are generally performed on a total output basis, which is reasonable enough for steady loads and general comparisons. Indeed, as mentioned above, the intermittency of solar power is often seen as a major disadvantage. On this basis, solar power is a relatively expensive proposition, and even when running costs are taken into account, it is generally not viable without government subsidies. However, when we are interested in peak capacity, solar power becomes much more attractive. The total cost per Watt (peak) for solar power is in the same ballpark as for other forms of power generation.

Figure 2: Comparison of capital costs for solar versus nuclear/conventional power production. We assume a typical capacity factor of 15% for solar, and an estimated ¥1Tn ($12Bn) for the clear-up at Fukushima. Running costs are ignored. These strongly favour solar, albeit not sufficiently as to make much difference in the case of the average load comparison.

Costs of solar vs nuclear/conventional capacity

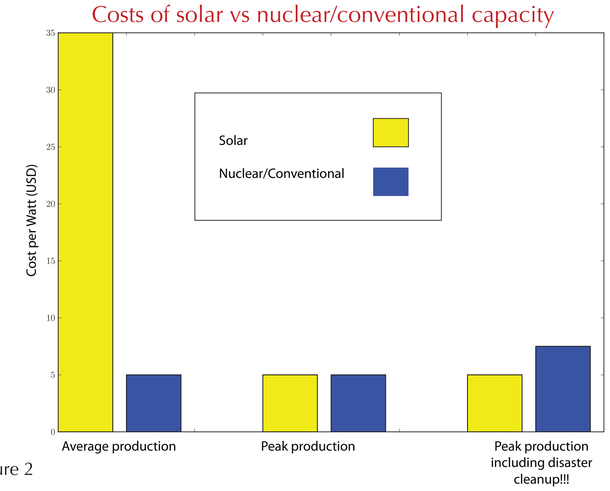

Figure 2

4. Aesthetics

Some quick web-surfing revealed many novel designs for incorporation of solar power technology into building construction

5. Conclusion

In the face of so much negative publicity for nuclear power (some of which may even be justified), the Japanese public may be receptive to the idea of paying a bit more for their houses, with the multiple benefits of ameliorating the power shortage, providing cheap carbon-free power, and reducing the need for more nuclear reactors to melt on their doorsteps.

The total cost should be below $20,000 per house (for 4kW capacity), probably dropping significantly through economies of scale and build-integration.