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Single Idea: Decarbonising NZ's energy system through demand-side intervention

The CCC's draft Advice on transitioning to a low-carbon energy system focuses almost exclusively on energy supply, overlooking the cost-effective solutions available through a greater focus on electricity demand.

We agree with the CCC Advice that the "electrify-everything" approach is the most viable pathway to a low carbon energy transition although low-carbon fuels may still be required for some forms of long-distance transport, heat and other specialist applications.

However, given the major expansion of the electricity system that follows from this approach (as described in section 3.5.1 and "Transmission and distribution grid upgrades" and "Expand renewable generation base" in Budget 2 and Budget 3 in Table 3.1 and also in relevant Transpower projections), the identified "Principle 4: Avoid unnecessary cost" is particularly pertinent and, in our view, under-explored.

There has been much modelling and costing of NZ's renewable energy scenarios and these are often very complex. But a fundamental reality is that the costs of supply, transmission and distribution are driven by peaks in demand, as all infrastructure needs to be built in order to meet the highest peak (usually an evening in winter). If there are peaks in demand that are significantly above baseload capacity, then this results in largely underutilized and therefore economically inefficient infrastructure. In addition, since most renewables are non-dispatchable, as percentages of renewable supply rise, so the potential temporal mismatch between supply and demand increases and thus the need for over-building supply infrastructure. Economic solutions for shorter term (~days) supply-demand mismatches already exist, such as batteries, demand response, small-scale pumped hydro (although widespread implementation may require significant changes to current market structures, see submission by Jen Purdie). However, economic solutions for supply-demand mismatches that occur on a longer timescale (e.g. seasons), do not currently exist.

Unfortunately for our low-carbon transition plans, NZ already has a significant winter peak in electricity demand (the area under the winter demand peak is about 4 TWh (ICCC)). Implementing a ~100% renewable electricity system (with more non-dispatchable supplies and new forms of demand) is likely to give rise to even more temporal mismatches and increased costs. One particular example of this is the dry year issue for which supply-side and storage solutions are very expensive (e.g. overbuilding wind and solar plus large energy storage: $4.8 billion (ICCC)).

However, these capital-intensive infrastructure 'solutions' are predicated on unquestioned assumptions about demand. As noted earlier it is the peak demand in winter that determines the need for supply infrastructure. The key observation missing from the CCC analysis (see Sec 3.8.3) **is that space heating and in particular residential space heating is one of the dominant drivers for the seasonal variation in New Zealand's electricity demand** (see Fig.1).

The assumptions made in CCC Advice Section 3.8.2 that future heating demand will largely follow current trends are overly simplistic. Our analysis shows that even adjusting for climate, NZ buildings space heating intensity is far below most other OECD countries *(see Jack et al below)*. This is despite having very low indoor temperatures, with significant health impacts. This is not the desired outcome and cannot be considered a sustainable long term option. Therefore **assumptions on future home heating demand cannot be based on historical heating trends and instead need to start by assuming healthy indoor air temperature**. By not using this starting point the impact of home heating demand is significantly under-estimated and so, therefore, are any efficiency improvements, especially if projecting to 2050.

In recent research (presented at the Otago Energy Research Centre annual research symposium, and in a paper currently progressing through peer review: *see Jack et al. in references below)* we have modelled the potential increase in space heating demand under a range of different building performance scenarios assuming, in each case, that houses are heated to WHO recommended healthy temperatures (20 deg C). For example, in our modelling, space heating demand under business-as-usual energy efficiency standards **doubled** by 2035, which would result in an additional 3 TWh (i.e 10%) of electricity demand to the Advice's Figure 3.13. It would also add ~2TWh to the yearly winter peak 2035. By 2050 this will have grown to an additional 5TWh demand per year and an increase in the yearly winter peak by 3TWh.

However, our modelling also shows that **increasing the performance of existing residential to currently achievable efficiency standards** (suggested by MBIE's Building for Climate Change report) **could significantly reduce both annual and peak space heating demand** (Figure 1)**.** For example comparing to CCC Advice's Figure 3.12, this increase in energy efficiency in residential houses alone would lead to reductions of total electricity demand by 19 PJ (5TWh) per year (from business as usual) and actually reduce the current winter peak by 1TWh in 2035, while also increasing temperatures to healthy levels**.** Assuming that space heating demand is met by electricity this represents a significant impact on the "electrify everything" scenario by substantially reducing the total level of generation required and, in particular, the infrastructure required to meet the winter demand.

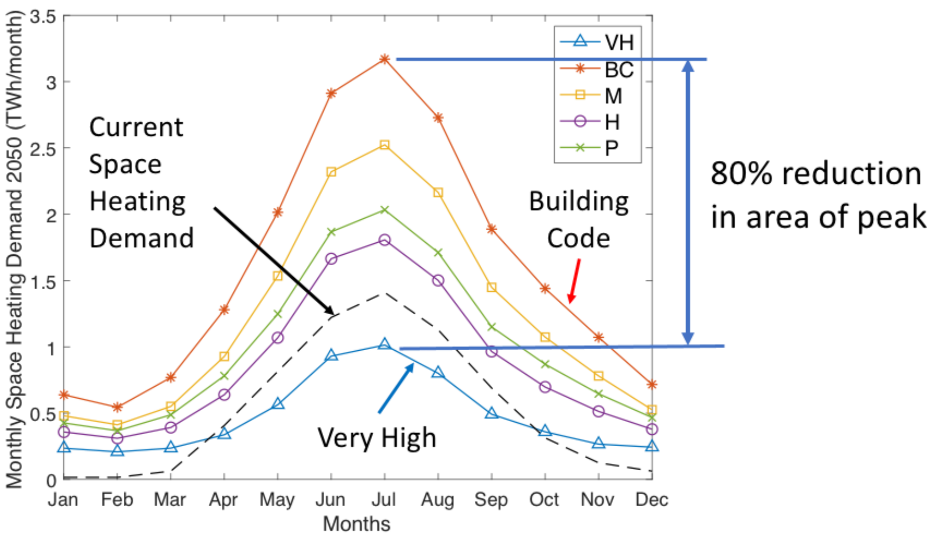

Figure 1: Monthly space heating demand in 2050 under each scenario. The scenarios shown are Building Code (BC), Medium (M), High (H), Very High (VH) and Progressive (P) reflecting progressively higher building code standards. For reference we also show the current space heating demand (black dashed line)

Overall, our modelling shows that applying currently-achievable best practice standards to new builds **and retrofit of existing stock** could reduce annual electricity demand to 1/3 (~6TWh) of business as usual by 2050 and the winter peak to 1/4 (~5TWh) of business as usual by 2050 (see https://www.otago.ac.nz/oerc/symposia/archives/otago759840.pdf). This reduction in winter peak represents a reduction in the current peak by ~1.5 TWh. This will **substantially** reduce the costs of the low carbon transition because excessive over-investment in supply side infrastructure will be avoided (c.f. “Principle 4: Avoid unnecessary cost”).

In addition, this will have known co-benefits in terms of health and economic outcomes for lower socio-economic groups (Chapman et al., 2009) and would create substantial post-COVID employment opportunities.

Finally, our research also shows that given the lifetime of housing, any delays to implementing this step change in energy efficiency result in any benefits being delayed to beyond 2050.

We conclude that aggressively reducing space heating demand through both improved new builds (as per recent MBIE proposals, but significantly accelerated) *and high quality retrofit of the existing stock* could play an important role in reducing the costs of future electricity supply infrastructure while providing a range of co-benefits.

In addition, further reduction in winter peak demand can be achieved through widespread adoption of high-efficiency lighting. In another study, our modelling has shown that while residential lighting comprises only 4 per cent of New Zealand’s total annual electricity consumption, it constitutes about 12 per cent of evening peak electricity consumption in winter. Uptake of more efficient residential lighting could reduce the winter evening peak demand (at around 6-8 pm) by at least 500 MW (9 per cent) and reduce New Zealand’s total annual demand by 1 TWh (Dortans et al., 2020).

Response to Action 9

We therefore recommend that Necessary Action 9 is changed to a time-critical necessary action: “Urgently implement a step change in energy-efficiency standards for all buildings including both new and existing stock” to reflect the impact of building energy efficiency on the economic viability of the “electrify-everything” scenario. This goes far beyond the direct emissions of buildings identified in Sec. 3.8.2. This also reflects Principle 7 of the CCC Advice as pursuing energy efficiency standards rather than large infrastructure builds provides a wealth of co benefits. To enable this there is a need for cross-sector policies that mandate energy efficient residential buildings based on their wide-ranging **health**, **efficiency** and **energy affordability** benefits *and* their role in **decarbonisation.**

References

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