Submission to the Productivity Commission on the report “Low Emissions Economy”

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Thank you for the opportunity to comment on the draft report "Low-emissions economy".

I would like to submit the following comments and suggestions for consideration by the authors.

General observations: Overall this is a very comprehensive treatment of the topic and provides an excellent basis for further discussion. However there are two recurring issues of serious concern:

a) the consistent mis-use of the term “thermal” in relation to electricity generation;

ii) the use in places of reports by businesses and industry lobby groups as sole sources of information.

I suggest both issues are addressed in the revised version.

Specific comments:

p3, p39 and elsewhere: It should be emphasised in the report that the present NZETS is not a cap-and-trade system, it is merely a trade system. To be effective it must have cap with a sinking lid over time. The magnitude of the cap and the rate of contraction are policy decisions. Such a cap-and-trade system has proved successful in managing SO_2 emissions and thus acid rain in North America, although the circumstances were somewhat different and arguably simpler than for GHG emissions. It is good to see the cap discussed later in the report e.g. p 217 dual cap proposal.

p 7: the authors may wish to add hydrogen as a long-term option for aviation fuel. If NZ were to produce hydrogen for aviation it would require more than doubling our present electricity output (Mason et al., 2017b). The authors are encouraged to include in their report discussion of the ICAO voluntary Montreal protocol on aviation emissions which relies overwhelmingly for its success on the aviation industry purchasing offsets out to 2035. Under this arrangement offsets are predicted to account for about 85% of emissions, with remaining contributions from biofuels (yet to be proven at scale) and efficiency gains. Given that aviation emissions are equivalent to those of Germany, this will create serious competition for offsets, which may result in problems for NZ if it relies on offsets.

p 7: the term 'thermal' is incorrectly used here and elsewhere in the report. The word pertains to 'heat' and this is true regardless of the fuel used. It is strongly recommended that the authors replace the term 'thermal generation' with 'fossil-fuelled generation' in

respect of electricity generation throughout the report, as it is both incorrect and misleading to readers to imply that all thermal generation is, or will be in the future, reliant on fossil fuels. The authors would do a great service to the energy community by using 'fossil-fuelled' in place of 'thermal' in this context.

p 9: CCS cannot be accurately described as a 'rapidly evolving technology'. It has been around for many years e.g. to capture CO_2 stripped from natural gas in the Sliepner field in the North Sea from 1996. The report provides no evidence in support of the statement and references only a report from a CCS industry lobby group. The only full-scale application in electricity generation operates in Weyburn, Canada, is heavily subsidised and ironically the recovered CO_2 is not buried but re-injected in order to enhance further oil extraction. See (Page et al., 2009) for background.

p 9: the emphasis on innovation suggests that NZ must await a new technological fix before acting. This is incorrect and I suggest that more emphasis be placed on actions with the technologies we have available now.

p39: as noted above the authors are encouraged to point out that the present NZETS is a capless scheme.

p 85 no evidence for 'emissions leakage' is provided in the report. It should be noted that businesses move offshore for many reasons other than ETS charges. The authors are encouraged to examine whether talk of emissions leakage presents real issues or simply amounts to threats or bluff on the part of lobby groups advancing this argument. Some elements of emissions leakage are discussed by (Mason et al., 2012).

p 111: innovations in aviation are likely to very minor in the short-medium term and any improvements in efficiency which do occur are likely to be swamped by increased travel resulting in an overall increase in emissions. This is a well-documented phenomenon known as the 'rebound effect'. This argument applies to other sectors where the focus is on improvements in 'emissions intensity' rather than on absolute emissions.

p 115: the fact that environmental and social concerns are considered 'externalities' speaks volumes about the current economic paradigm. In the real world these matters are inherent, not external.

p 134, 148: the potential impact of the Task Force on Climate-related Disclosures should be monitored carefully. One should ask whether investors already obtain this information anyway and whether there are opportunities in this voluntary agreement for 'greenwash'.

p 222: It is possible that NZ will need to build offshore wind farms in order to fully replace fossil fuels in stationary energy and transport. Such a project could utilise the existing engineering infrastructure and skills in the Taranaki region and create new jobs. Expertise is coming closer to NZ via an offshore windfarm planned for Australia. See:

https://www.4coffshore.com/windfarms/star-of-the-south-energy-project-australia-au02.html)

p 330: the statement that "I. G. Mason et al. (2013) investigate the technical feasibility of eliminating all thermal plant from New Zealand's electricity system, while maintaining resource adequacy under conditions that pertained in recent years" is incorrect and should be deleted. A correct version would read "I. G. Mason et al. (2013) investigated the technical feasibility of eliminating all fossil-fuelled electricity generation from New Zealand's electricity system, while maintaining resource adequacy under climatic conditions that pertained between 2005-2010 inclusive". In addition to the geothermal generation mentioned in the next sentence, a small amount of biomass thermal was also present in the mix. We most certainly did not eliminate all thermal plant.

P 330: the dismissal of pumped hydro energy storage (PHES) is not supported by any evidence in the report and furthermore does not consider pumped seawater hydro energy storage (PHSES) which has been proven at full scale as an option. PHES is not only financially cheaper than chemical batteries on a $ per kWh basis, but importantly has a far longer lifetime, and thus a considerably superior ratio of Energy Stored on Energy Invested (ESOEI). This naturally leads to superior life cycle costing. A preliminary scoping exercise on the NZ coastline for suitable PHSES sites has been carried out at UC and a number of sites worthy of further investigation have been identified. An Australian report on PHES including seawater storage is recommended to the authors (Hearps et al., 2014).

p 330: the purpose of geothermal switching in the Mason et. al. (2013) study was to illustrate a means of utilising a more environmentally friendly energy resource (hydro) and holding back a less environmentally friendly resource (geothermal). Reported "Energy Returned on Energy Invested" (EROEI) ratios for hydro range up to about 200, whereas EREOI data for geothermal to electricity suggests about 9. Thus the laws of physics dictate that hydro energy should be used in preference to geothermal energy whenever possible. Furthermore geothermal energy is dispatchable and can be held back in reserve for use at a later time such as in a dry year, whereas when the storage lakes are full, hydro energy will need to be spilled if geothermal or other generation is not ramped down. The fact that a financial model has predicted that geothermal will move up the merit order to a position above natural gas fuelled CCGT when it is ramped down raises the key questions of a) 'what to spill" in an energy system with a high penetration of variable renewables and b) given the competitiveness of CCGT using natural gas under this model whether a market-based approach nested in the present-day neo-classical economic paradigm is capable of delivering the best environmental outcomes. An additional matter arising from this discussion concerns the production of energy carriers such as hydrogen from electricity which would otherwise be spilled. It is suggested that the authors pose 'what and when to spill' and 'is the present market fit-for-purpose' as a key questions for further investigation.

p 330: the inclusion of geothermal as a renewable resource is subject to debate. The rate of energy extraction for electricity generation (W/m2) typically far exceeds the rate of energy recharge (mW/m2). It's use has consequently been described as a form of 'mining' (Glassley, 2010). Geothermal fields used for commercial energy production eventually become depleted and recovery times of decades to hundreds of years are reported e.g. (Rybach, 2007). If we compare this with instantaneous recharge of solar and wind resources, annual regrowth cycles of many bio-energy crops, and the 30 year rotation for Pinus radiata, geothermal definitely lies in a grey area in terms of being considered as a renewable resource.

p 332: kindly delete the statement "Even the Mason et al. (2013) model, which entirely dispenses with thermal generation, still entails geothermal emissions."- this is incorrect. A suitable replacement would be "Even the Mason et al. (2013) model, which entirely dispenses with fossil-fuelled generation, still entails greenhouse gas emissions from geothermal generation.

p 333: It is good to see hydrogen mentioned here. It is suggested that the authors discuss, or at least mention, the potential for hydrogen to be directly used for heating, which would deliver far greater efficiencies than would be obtained by using hydrogen for electricity production at a later date. There is also emerging evidence of an export market for hydrogen. Present research at UC is investigating the ability of electrolysis to use intermittent spill as implied in this part of the report

p 333: the conversion of coal-fired thermal plants in the UK to biomass fuels completely contradicts the conflation of 'thermal' with 'fossil-fuelled generation' elsewhere in the report

p 333: increasing the storage capacity in Lake Pukaki would greatly enhance the operation of the electricity system provided the generation capacity to utilise the stored energy when it is required is present. See also previous comments regarding the electricity market.

p 339: the impact of 4000 MW wind on inertia in the system has been modelled and the additional fast reserves requirement calculated (publication in progress)

p 347: the scale of electricity system expansion required to electrify stationary energy and transport has been estimated by (Mason et al., 2017a). The required build rate presents a major challenge. See previous comments regarding CCS.

p 349: Natural gas has been shown to have minimal or no advantage over coal when leakage is taken into account, and will certainly not lower emissions to the extent required to limit climate change. A recent detailed analysis on this matter can be found in (Zhang et al., 2018). The authors should note to readers that the table presented on p 350 was provided by a Natural Gas company.

p 351: Spelling: 'Aalborg 2015' not 'Aalsborg 2015'. The authors should note to readers that this is a report from a commercial CSP company. It is suggested that the peer-reviewed literature be consulted on this matter in addition to commercial organisations.

p 360: see previous comments regarding CCS

p 385 the authors raise an important point by mentioning that in the built environment the rate of turnover is relatively gradual and are thus changes in the built environment are unlikely to make a significant contribution to emissions reductions in the short term. Additional observations are: a) that the built environment is already largely electrified; b) that electricity supply is moving towards 100% renewable; and c) that GHG reductions in building materials tend to be measured elsewhere. See (Hawken, 2017) for a fuller discussion.

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