“Future Security and Resilience”

I am a retired academic, CEO and philanthropist who has been following global energy issues for almost 3 decades.

"This work supports New Zealand’s commitment to achieving net zero emissions by 2050, and the Government’s aspiration to achieve 100 percent renewable electricity by 2030.”

Both of these goals are important and should be pursued. However, **the assumption that a demand management approach to determining how much electricity should be generated by 2050 needs to be seriously questioned.**

Several university based energy research groups around the world have questioned the demand management approach to power generation and the transition to renewable energy sources.

These researchers describe, and quantify, the limitations of renewable energy sources which current policy are generally overlooking. A central issue is the net energy surplus available from not only individual renewable energy sources such as wind and solar PV installations, but most importantly, the net energy

surplus available from a mostly renewable energy **system.**

Once the need for dealing with the intermittency and storage issues are taken into account, the net energy surplus declines precipitously. The implications for the net energy surplus of a mostly renewable electricity system are profound.

Yet **the issue of net energy surplus from a mostly renewable energy system in NZ is not mentioned at all in the reference document for NZ's future energy needs. This is a serious oversight and should be corrected prior to any further work being done on this project.**

Net energy surplus is measured by calculating the energy return on energy invested or EROI (sometimes referred to as EROEI).

The following quotes from various independent energy research groups emphasize the importance of integrating net energy analysis into planning for an energy transition.

Quotes from Research Groups (all bolding added to original)

Professor Paul E. Brockway, Ph.D., MSc, MEng, et al, University of Leeds, UK, Faculty of Environment, School of Earth and Environment, Sustainability Research Institute

*"This [study] translates to an **urgent need** to include fossil fuel EROI at the final energy stage in energy–economy models, **to study possible socioeconomic impacts and responses**. These insights are urgently required, as future policy and energy infrastructure investment decisions are being made now to meet climate change mitigation commitments.*

….. the average energy return on investment for all fossil fuels at the finished fuel stage declined by roughly 23 per cent in the 16 year period we considered. This decline will lead to constraints on the energy available to society in the not-so-distant future, and ***these constraints might unfold in rapid and unexpected ways****."*

Nature Energy VOL 4 **612** | JULY 2019 | 612–621 https://www.nature.com/articles/s41560-019-0425-z#article-info **Estimation of global final-stage energy-return-on-investment for fossil fuels with comparison to renewable energy sources**

Dr. Michael Carbajales-Dale, Ph.D., et al, Clemson University, Department of Environmental Engineering and Earth Science

*"(1) NEA [****Net Energy Analysis****] should be incorporated into future efforts in energy supply system modelling as* ***a fundamental feasibility check*** *on scenarios and so that the* ***assumption of demand growth driving supply should be subject to physical constraints and depletion****; (2) EROI should be considered in policies to encourage, fund, or subsidise energy supply developments and; (3)* ***energy conservation and energy efficiency should be policy priorities****."*
https://www.researchgate.net/publication/236649206_Future_Scenarios_for_the_Global_Energy_Supply_System_-a_Biophysical_Perspective

Dr. Charles, A.S. Hall, Ph.D., et al, State University of New York, College of Environmental Science and Forestry

"We believe that the future is likely to be very different, for while there remains considerable energy in the ground it is unlikely to be exploitable cheaply, or eventually at all, because of its decreasing EROI.

…… If ***any resolution*** *to these problems is possible it is probable that it would have to* ***come at least as much from an adjustment of society's aspirations for increased material affluence and an increase in willingness to share as from technology."***

https://www.sciencedirect.com/science/article/pii/S0301421513003856?via%3Dihub **EROI of different fuels and the implications for society**

Dr. Iñigo Capellán-Pérez, Ph.D. Economics, et al,

Universidad de Valladolid | UVA · Group for Energy, Economics, and System Dynamics of the University of Valladolid
"The results show that **a significant systemic-energy scarcity risk exists**: future global energy demand-driven transitions as performed in the past might be unfeasible. These critical energy constraints have the potential to **provoke unexpected abrupt changes in societies** …..
In order to find global scenarios compatible with fossil fuel restrictions and sensible limits to technological development, we are obliged to set hypotheses which are hardly used in Global Assessment scenarios, such as **zero or negative economic growth**. Therefore, an

authentic economic paradigm shift might be needed in order to avoid dangerous energy lock-in pathways in a context of climate deterioration in the coming decades.
……The analysis performed here shows that depletion should be incorporated into such policy-influential analyses as the IEA and IPCC reports."
*"**Fossil Fuel Depletion and Socio-Economic Scenarios: An Integrated Approach**."*
Energy. Accessed October 25, 2014. doi:10.1016/j.energy.2014.09.063.

Dr. Iñigo Capellán-Pérez, Ph.D. Economics, et al,

Universidad de Valladolid | UVA · Group for Energy, Economics, and System Dynamics of the University of Valladolid

*"This result puts into question the viability of the Green Growth paradigm as it is being currently presented. In fact, one the key assumptions of this narrative, i.e. the **absolute decoupling of economic growth in relation to energy use, is showed not to be consistent with the levels of material and energy required to perform the energy transition towards RES {Renewable Energy Systems]***
*…….Finally, a **holistic analysis of the full energy-economy-environment system** in the context of the transition towards RES is needed, taking into account the interaction between declining EROI levels with other key factors such as climate change impacts, non-renewable energy resources availability or demand-management policies which go beyond the usual technological policies."*
https://www.researchgate.net/publication/327346201_Dynamic_EROI_of_the_global_energy_system_in_future_scenarios_of_transition_to_renewable_energies

Dr. James H. Brown, Ph.D., et al, *distinguished professor at the University of New Mexico and external faculty of the Santa Fe Institute*

*"Our explicitly macroecological and metabolic approach uses new data and analyses to provide quantitative, mechanistic, and practically relevant insights into energetic limits on economic growth. We hope the evidence and interpretations presented here will **call the attention of scientists, policymakers, world leaders, and the public to the central but largely underappreciated role of energetic limits to economic growth**."*
Energetic Limits to Economic Growth, BioScience • *January 2011 / Vol. 61 No. 1*
https://www.jstor.org/stable/10.1525/bio.2011.61.1.7?seq=1

David J. Murphy and Charles A. S. Hall Department of Environmental and Forest Biology, and Program in Environmental Science, State University of New York, College of Environmental Science and Forestry, Syracuse, New York, USA.
*"We are amazed that there are **no government, private, or nongovernmental organization programs or entities dedicated to attempting to understand and calculate EROI** and its effects as well and as objectively as possible given that it **may be the largest determinant of many aspects of our future.**"*
Year in review—EROI or energy return on (energy) invested. ANNALS OF THE NEW YORK ACADEMY OF SCIENCES, 1185 (2010) 102–118

http://www.soest.hawaii.edu/GG/FACULTY/ITO/GG410/EROI_Future_Energy_Sources/Murphy_EROI_AnNYAcSci10.pdf

While there has been no study of the net energy surplus from the current electricity grid, data from MBIE indicate that as the system has grown over the previous 30 years there has been a significant increase in the Losses and Own Use category of national energy use.

In 1990, the Losses and Own Use was 116 PJ (or 20% of total produced). By 2020 this category more than doubled to 238 PJ.

These data do not constitute a net energy analysis but they do highlight the implications of increasing the renewable energy component of the national system.

The renewable energy system almost doubled over this same period, suggesting that much of the increase in Losses and Other Uses was attributable to the integration of renewables into the system.

What will yet another doubling of the renewable energy capacity do to the system in terms of Losses and Other Uses, as well as to the net energy surplus of the entire system?

The current approach to NZ's energy future ignores this critical perspective of net energy surplus and should be corrected as quickly as possible.

Other limitations of renewables have to do with the availability of key mineral resources, as well as the GHG emissions associated with the expansion of the renewable energy system.

Furthermore, these so called "renewable" energy technologies are not renewable in that raw material limits, as well as declining net energy surplus, mean that many of these installations will not be replaceable when they are no longer functional in a few decades.

NZ currently uses over 170 GJ per capita, 40 % of which is "renewable." This provides approximately 70 GJ of "renewable" energy per capita.

100 GJ pc is said to be necessary for a high levels of wellbeing, determined both subjectively (life satisfaction/ happiness measures), and objectively (e.g. infant mortality levels, female morbidity as an index of population health, access to nutritious food and educational and health resources, etc).

Other studies which consider the minimal energy needed for wellbeing suggest a much lower level of per

capita energy consumption is required. These studies take a different approach and focus on ensuring basic wellbeing is maintained, but not necessarily with all the trappings of a complex industrial society. Their results indicate a level of approximately 20 GJ per capita is adequate.

70 GJ pc is similar to the total energy consumption for a number of countries as well as the global average for all nations.

We in NZ need a national dialogue about our future. And energy availability is only one aspect. We need to discuss what our carrying capacity is, what level of consumption is sustainable for our population, and whether we wish to make adjustments in either our per capita consumption or our population. Both together determine whether we are on the sustainable side of carrying capacity. Currently we are on the unsustainable side, meaning our way of life cannot endure.

The Electricity Authority should be considering our energy future in the context of this larger issue of ecological overshoot. How much energy consumption is consistent with living well within our carrying capacity?

The current path of the EA’s work will only increase ecological overshoot, as well as carbon emissions in the construction of an expanded renewable energy system, and not serve future generations well.