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Submission on Low-emissions economy: draft report

The overall framework is good at this starting point and will surely evolve further in time. We must strike a balance between acting with greater intent quickly but realizing that those actions will be refined as we learn.

It could be improved significantly by adding another lens besides the usual economic and social perspectives to guide the transition.

That lens is Energy Return On Investment (EROI) (Hall 2017), a unifying principle between economics, energy, and physics, in the context of sustainability.

EROI is a young (Hall 2013) and flexible quantitative methodology (Hall and Klitgaard 2012) within the field of biophysical economics (Dale *et al.* 2012). It has particularly relevant application to assessing energy use and flows through systems and intimately linked are GHG emissions. These systems maybe as complex as a nation's economy (Brand-Correa *et al.* 2017), as diverse as farming systems in New Zealand (Norton *et al.* 2010), or as specific as energy production from a wind turbine (Kubiszewski *et al.* 2010).

EROI has an essential attraction as a compliment to our economic and social lenses for measures and goals in achieving a low emissions economy. That being it is rooted deeply but simply in the laws of thermodynamics. So it provides a physical reality check for our economic and social perspectives. Because ultimately society is enabled through a secure and abundant energy supply. And ultimately society must thrive within the physical and biological limits of our environment to achieve genuine sustainability.

A small team of people would develop the application of this methodology to the New Zealand situation guided by the Independent Climate Body. In turn they would feed information back to that body for consideration in making their recommendations. This would be setting an international precedent to be followed elsewhere as the developed world begins the essential task of engaging more meaningfully in de-carbonised, low emissions systems.

Expertise exists within New Zealand with links to international leaders in the field through individual contacts and the International Society for Biophysical Economics (Dale *et al.* 2012; Atkins 2016). The author of this submission is currently mid-way through a Nuffield International Agricultural Scholarship on the topic of applying EROI to New Zealand's primary food production systems. The aim of his topic is to employ the methodology to optimise our primary production systems under constraints due to emissions and/or physical availability of energy resources. This builds on his earlier work with the Agricultural Research Group On Sustainability (ARGOS) (Norton *et al.* 2011).

In essence, EROI works by making a ratio of the energy going into a system compared to the energy (or potentially other indicators of society health and wealth) coming out of that system. A good simple example is mining coal. Research shows that, internationally, around 50 units of energy are obtained by society for every one unit it invests in mining it. Thus it is a very lucrative energy source. Those 49 other units are used to maintain and grow society's systems. A value of around 20:1 is estimated for oil based fuels (Gagnon *et al.* 2009). For wind turbines the value is also 20:1 and for solar photovoltaics it is half that at about 10:1 (Hall 2017).

You can see fundamentally that our transition to these 'renewable' but less lucrative fuel sources will be an immense challenge for our net energy supply (Hall *et al.* 2009; Hall *et al.* 2014) (Lambert *et al.* 2013). The significance of this is not evident in the low emissions economy draft report. The likely explanation being that modelling by VIVID ECONOMICS has failed to accurately represent the physics-based implications of the transition. This is a serious problem, but the solution is simply to employ EROI in identifying realistic and robust pathways toward the low emissions goals.

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