

HIGHER EDUCATION SYSTEM REVIEW TERMS OF REFERENCE CONSULTATION

I believe that human civilisation in some or possibly all countries will collapse by 2050. Humanity is behind schedule in implementing the one hope for the salvation of civilisation of a paradigm shift disruptive transformation of the energy, transportation, and food sectors to avoid, or attenuate, the sixth mass extinction and retreat of the remnants of the biota to live on Antarctica. I am an Australian, living in Australia, and a Master of Science student in renewable energy engineering at a European university. Most economists believe the economy is in equilibrium despite the warnings of the Limits to Growth, Will Steffen, and others.

I understand the first simple differential equation economic model was formulated and published in the 1870s. In the interim and particularly in the last fifty years economics is the profession that has exploited advances in computing the least. The extent to which the vast majority of economists are unable or unwilling to correctly apply calculus to economics is extremely embarrassing. I advocate that Australian governments should stop funding all contemporary economics teaching and research and that all economics departments should be transitioned into university science faculties. Australian governments should commence funding economics teaching and research which has a rigorous sophisticated mathematical and scientific basis including a three year bachelor of economic science degree with a year of ordinary differential equations lectures and a four year bachelor of economic science with honours degree with an additional year of partial differential equations lectures.

This is a relatively simple problem to solve. I anticipate there are many unemployed or underemployed people with dual economics and technical qualifications or mathematicians, scientists, and engineers who could quickly convert to teaching economics. I advocate that to expedite the transition all existing university economics staff should be offered the option of either a voluntary redundancy or commit to studying and continuing to pass, a doctorate in mathematics, science, or engineering. This is a relatively quick problem to solve. Whilst the full benefits will not be realised until the first cohorts of economists, who are competent in calculus, are appointed to senior positions in industry and government mandating this transition in academia would send a signal throughout Australia of an increase in expectations in basic economic mathematical competence.

Professor of Economics Steve Keen was recently awarded the third Friede Gard Prize for Sustainable Economics by the University of Trier and in 2022 published an accessible critique of mainstream economics and an introduction to a more sophisticated, representative, and relatively simple alternative employing calculus. Whilst the economic curriculum is being revised I advocate that study in sustainable circular economics should be integral to teaching and research. Steve Keen alleges the mathematics of the IPCC Working Group Sixth Report of 2022 pages 16 to 65, which predicts a maximum decline of 23 percent in annual global GDP, is incorrect. Rather than diverse contrarian Neo-classical, post-Keynesian, Austrian, Ecological, Behavioural, Gender, and Ethnic theories if economics students were taught calculus by mathematicians they might develop a more integrated, coherent, unified, and cohesive theory of economics.

I infer that the University of New South Wales has pioneered many seminal advances in photovoltaic solar research in recent decades. However, I am not aware that Australia has the same advantage in concentrated solar power, solar perovskites, wind turbine design, solid state, liquid metal, lithium or sodium chemistry battery research. Despite the efforts of Monash University in lithium sulphur batteries, SunDrive, GELION, Redflow, TINDO, Li-s Energy, Tritium, and Energy Renaissance an Albermarle representative asserted that Australia is too far behind to establish an electric vehicle battery manufacturing industry. Perhaps I am too optimistic but I believe the Australian government should approach ARRIVAL, APTERA, ACM, and / or Sono Motors to re-establish a local vehicle manufacturing industry. I believe each of these organisations was established with the intention of exploiting their predominately composite, rather than metal, construction techniques to facilitate low volume niche vehicle production in the region where the vehicles are to be used.

In my opinion, the global best postgraduate qualification in wind turbine design is the European Wind Energy Masters alliance offered, depending on the specialisation, by Delft University of Technology, Danish Technical University, Norwegian University of Science and Technology, and the University of Oldenburg. The Queensland Government, which has belatedly pledged to try to catch up to the renewable energy transition, recently announced it intends to manufacture wind turbine components.

The University of Technology Sydney has recently published the Australian Electricity Workforce for the 2022 Integrated System Plan Projections to 2050 in which the Step Change scenario is forecast to require an average of 8000 professionals and 7000 managers per year. The Hydrogen Superpower scenario is forecast to have correspondingly higher requirements for resources and personnel.

In my opinion, there is not enough, and there are gaps in the scope of, renewable energy science and engineering education available in Australia. When I did my due diligence to apply for a Master of Science at a European university the leading Australian candidates were the University of New South Wales and Murdoch University. I advocate that Australian universities should offer more renewable energy degrees and in particular that some degrees be offered completely online so that to expedite the transition experienced professionals are facilitated to study part time whilst continuing to work in their current job. To truly acknowledge the climate emergency I suggest the Australian Government would permit a Higher Education Contribution Scheme tax debt for renewable energy degrees from any country which is a party to the Washington Accord or is recognised as having a similar quality of engineering or science professionalism. I suggest that this would be economical to attenuate the need to encourage experienced professionals to immigrate to Australia.

I believe the Australian academic sector currently offers more teaching in fossil fuels than renewable energy. I anticipate that many Australian universities should offer an enhanced diversity of renewable energy degrees but perhaps there should be a coordinated strategy for some institutions to specialise in particular technologies. Does Australia intend to have the following facilities for wind turbine commissioning and research; rotor blade fatigue test, wind tunnel, wind tunnel integrated with a wave model test basin, roller bearing facility, generator dynamic test, and foundation soil mechanics?

I have reservations about the hydrogen economy as I understand the patent holder, Saul Griffith, for the design of hydrogen tanks advises that hydrogen will kill any humans and mammals in the vicinity of a pressurised transport pipe or hydrogen fuelled vehicle in three ways; the explosion shock wave will collapse the lungs; suffocation; and burning. The world currently produces and consumes approximately 100 million tonnes of hydrogen per year. This is currently produced predominately by steam methane reforming and used in the fossil fuel processing, ammonia, or plastics industries. Hydrogen requires at least 39 kWh per kilogram, more realistically 50 kWh per kilogram to produce renewably by electrolysis unless some direct solar, or acoustic catalyst, process can be commercialised. This 5000TWh per annum of electricity would significantly displace renewable energy from other uses for the foreseeable future. Even if hydrogen vehicles were technically viable and safe I anticipate that legacy brands, ARRIVAL, Aptera, Sono Motors, Lightyear, VOLTA, and Janus Trucks will soon have an unassailable commercial economy of scale production advantage over hydrogen vehicles. At the dawn of the modern electric vehicle the electric charging cable is already obsolete. Are there research priorities to facilitate the introduction of wireless charging in taxis, garbage trucks, buses, logistic vehicles, service vehicles, passenger trams and light trains?

Therefore I suggest one of the historical research questions is: is it more effective, efficient, and economical to transport hydrogen, will an industry transporting hydrogen, or hydrogen carriers, in pipes and ships be developed, or is it better to process commodities where resources and renewable energy are cheapest and transport energy intensive commodities? Is it more efficient, effective, and economical to use hydrogen or can the process employ electricity directly? In what is possibly a biased opinion even Rio Tinto recently stated it would be better to burn gas than

transport hydrogen. I advocate that research should be targeted to facilitate Australia developing an economy that is more innovative and has a higher value add component than the largely exploitative and extractive historical economy. Perhaps there are contemporary research priorities to be studied in the transition from industrial agriculture supported by ammonia fertiliser to precision fermentation supported by hydrogen feedstock?

In 2019 the Crowther Lab of ETH Zurich published in the journal Science a summary of an analysis that identified approximately 10 million square kilometres of land which could be reforested predominately in six countries Russia, United States, Canada, Australia, Brazil, and China. I anticipate that if precision fermentation is a success and can deliver food cheaper than contemporary industrial agriculture the land available for reforestation is in excess of 20 million square kilometres. Large scale reforestation might make a significant reduction in atmospheric carbon dioxide concentration. Are there contemporary research priorities to manage and finance reforestation and the potential decline of industrial agriculture in Australia in this paradigm shift transformation? The significance of agriculture livestock may transition from a food source to a spreader of fertiliser. Australia has lost 40 percent of the forest cover it had prior to European settlement. Perhaps there would be less damaging floods if there were more trees. I believe carbon capture use or storage as a gas has consistently in recent decades been shown to be a waste of time, money, and effort. I advocate the focus should be on carbon capture use and storage in forests, earth, kelp, mangroves, peridotite rocks, calcium carbonate, concrete, graphene, and high value uses like those being commercialised by Mineral Carbonation.

Representatives of the Royal Air Force recently stated that they are satisfied that hydrogenated vegetable oil is an acceptable substitute for aviation fuel with equivalent performance. I anticipate battery electric aviation will be commercialised for short haul and processed vegetable oil will be substituted for commercial long haul and military aviation. VOLVO and SSAB were the first to pioneer low carbon dioxide emissions from steel production. There are alternatives being developed for high carbon emission cement and concrete including fly ash and others. Several years ago Australian low carbon emission cement researchers moved to Belgium when they could not get funding in Australia and it is anticipated that an aviation fuel initiative will go overseas if it does not get funding within twelve months.

Perhaps the most intractable climate change challenge for which a technical and economic solution is not yet evident is global shipping due to cheap contemporary fuels being approximately one half of shipping costs. The renewable transition is potentially a multi-trillion dollar opportunity for Australia. Perhaps there are contemporary research questions of how Australia can insulate itself from comparatively, relative to the American Inflation Reduction Act, parsimonious incentives or exploit the opportunities of this transition? Perhaps Australia can exploit its knowledge of mineral extraction and commercialise processes that are less exploitative of the environment like those being pioneered by EnergyX.

In the event that humanity successfully makes this transformation in the energy, transportation, and food sectors by 2040 and is able to attenuate the worst impacts of climate change I anticipate that there will still be conflict in the medium term, particularly on access to drinkable water. Are there research priorities to attenuate the impact of 25 percent of homes being uninsurable by 2030?

I commend the intentions of this Australian university review and advocate that two priorities for reform need to be

- a) enhance economics teaching and research with an understanding of calculus and a sustainable finite environment and,
- b) the science and engineering of the most consequential transformation of civilisation in history of the paradigm shift disruptive transformation by 2040 in the energy, transportation, and food sectors.

Perhaps there was an implicit assumption that there would be some additional funding to restore the industry's reputation and to position the industry to realise opportunities of the future. The collapse of civilisations is the lesson of history and at this point it will take some inspired leadership

for this civilisation to survive. I believe many Australians would be disappointed if Australia were to become a failed fossil fuel state. Australia needs to become a renewable energy superpower or we can continue with the status quo. That will be exciting.

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