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Public submission for the project known as the Iron Boomerang

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SUMMARY

The focus of this submission has been primarily on the viability of the project from the point of view of macroenvironmental factors – specifically, the degradation of global energy supply chain efficiency and associated financial collapse. Our overall assessment is that, under circumstances that existed during Australia's more industrialised era, such a project may have been possible, however the global financial and energy ecosystem has deteriorated significantly since that time and is now well into the early stages of terminal decline. We further posit that the connection between declining energy supply chain efficiency and faltering credit has not been identified by most analysts or decision makers, so is rarely factored into strategic analysis.

Given the present global situation, new energy technologies are required across the board, not just for the Iron Boomerang Project but for all industrial activities and energy supply chains at large. Unless a project such as this is planned with such advances built-in from the outset, the macro-scale influences will render it untenable before completion. Finally, sample assessments from similar use cases that have been developed using *n*Geni technology have been included to show how the project could be made economically and thermodynamically viable, whilst shielding it from the impacts of these externalities.

Submissions have been called on the Iron Boomerang Project concerning:

a) the employment likely to result from the project during construction and once completed;

b) the effect on Australia's gross domestic product and balance of payments from this significant change in Australia's productive capacity;

c) capital, energy and resources required to build and operate the proposed 10 steel plants, 5 at Port Headland, Western Australia and 5 in the Bowen Basin, Queensland;

d) the feasibility of the proposed clamshell design and electric/diesel propulsion to safely transport iron ore and coal across the 3000-kilometre route;

e) the environmental benefit of the reduction in bulk ore exports in regard to marine pollution and energy consumption;

f) any environmental impacts from the proposed alignment;

g) any impacts of the rail line or steel parks on the Aboriginal community;

h) the relevance of the Iron Boomerang project to our national security; and

i) any other related matters.

Our assessment is as follows:

Having studied the Project from engineering, ecological, climate, social, sustainability and energy perspectives we concluded as follows:

Regarding item g, we are not in a position to comment. This is a matter for the relevant Aboriginal communities to comment on.

Regarding items a, b, d, e, and h, on paper the project appears attractive.

Regarding item c, the current AU$100 billion cost estimate appears reasonable. However, a thorough examination of detailed costing would be required.

Our main focus is on items f and i.

Not enough information is currently available to assess environmental impacts from the proposed alignment. Considerable detail is required to do justice to this Project, merits or otherwise. What can be said though is that it appears feasible to design the project in such a way as to minimise impacts.

However, our concerns are far more fundamental. Notwithstanding the reductions in bulk ore and coal transport that the Project would achieve entailing a significant reduction in energy requirements and in pollutions (air pollution and emissions of Greenhouse Gases, GHG), the Project as currently defined would not be thermodynamically viable and would still generate far too high GHGs and air pollution.

Our work demonstrates that worldwide no mining nor transport can be made sustainable with current technology. This is not a long-term issue nor a matter of choice. Instead, it concerns a real and present threat that to date nearly all decision-makers are unaware of because they have become fixated on the Climate Emergency and assess matters in financial terms while the determinants are purely thermodynamic. The Climate Emergency is a side effect, symptomatic of the core thermodynamic issue. By focusing on the symptoms, decision-making ignores the root causes whose impacts are far more immediate and likely to be far more powerful than the already strong climate impacts.

In short, we estimate that within a decade at most the global energy supply and use system (GESUS) will have largely disintegrated, i.e., this concerns the very thermodynamic foundations of our world. Three recent studies corroborate our own estimates. They are:

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1. Simon Michaux, 2019, Oil from a Critical Raw Material Perspective, *Geological Survey of Finland* (GTK);
2. Louis Delannoy, Pierre-Yves Longarettia, David J. Murphy and Emmanuel Pradosa, 2021, Peak oil and the low-carbon energy transition: a net-energy perspective, *HAL,* https://hal.archives-ouvertes.fr/hal-03360253, and Elsevier;
3. Charles A.S. Hall, Jessica G. Lambert, Stephen B. Balogh, EROI of different fuels and the implications for society, *Energy Policy* 64 (2014) 141–152, http://dx.doi.org/10.1016/j.enpol.2013.05.049.

Dr Nafeez Ahmed's review of the very detailed Michaux's report summarises it and highlights how the global energy situation is dire and much more immediate than *"mere"* global warming: *"the global oil industry is on the brink of a meltdown… We are not running out of oil, but it's becoming uneconomical to exploit it"* (https://www.vice.com/en_us/article/8848g5/government-agency-warns-global-oil-industry-is-on-the-brink-of-a-meltdown.

Delannoy *et al.* focus on the energy costs of getting transport fuel and thus Energy Returns on Energy Investments (EROI). They consider only the Standard EROI at the wellhead level (direct and indirect energy costs to explore and extract oil, E&P costs). They assess E&P energy cost of producing oil at 15.5% of gross energy in the oil extracted and also other liquids produced.

However, this is only a fraction of the total energy cost of obtaining transport fuels of any kind. Most analysts ignore the huge hidden part of the Oil-based Energy Supply system, i.e., the oil industry support subsystem that includes everyone and everything required by the Oil Industry to deliver net energy to the Globalised Industrial World in the form of transport fuels and petrochemicals.

The Oil Industry Support System includes the coal and metal mines, the production of electricity, gas, water, metals, machinery to make the machinery to make the machinery to produce the equipment required by the Oil Industry, to maintain and to upgrade its facilities, as well as the people involved and their own support systems.

The Oil Industry grows bigger and bigger as it works its way through resources that are ever more difficult to exploit and of poorer and poorer quality, at ever increasing energy costs. In consequence, the Oil Industry Support System grows even more as it also requires large, ever-increasing amounts of energy to fulfil the Oil Industry's requirements. We further estimate that up to 2 billion people are involved in the overall Oil-based Energy Supply and Use System, also with large, increasing energy requirements.

When considering the energy cost to get net energy from oil, i.e., essentially transport fuels, the whole system must be considered, i.e., Oil Industry + Support System. Most studies, like that of Delannoy *et al.* only consider a small part of this total and thus substantially overestimate net energy extracted from oil.

This is where the work of Hall *et al.*, is very important. It shows, as an order of magnitude, that the total energy cost, as defined above (i.e., corresponding to what Hall *et al.* call Extended EROI) is at least some 8 times more than the Wellhead production cost.

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Hence, the total energy cost to get net energy from oil and other liquids is in the order of 124% of the gross energy in crude oil, i.e., the Oil Industry is no longer self-powered. Instead, it is drawing large amounts of energy from non-oil parts of the GESUS – to the tune of nearly a quarter of the gross energy in an average barrel.

This energy drain is what we call the Big Mad Energy Scramble (BigMES) for short. BigMES is typical of an extractive industry in the end phase of depletion. It cannibalises itself and other parts of the GESUS in order to keep going and still meet the vital global demand for transport fuels. However, in turn, the non-oil energy sector very much depends on net energy from oil for its operations. The situation is like a mad dog running round in circles trying to bite its flea infested tail. This situation cannot last for very long. We must expect that by about 2030, GESUS will have disintegrated.

Figure 1

100+

- **The current drive to *"decarbonise"* with so-called *"renewables"* and/or nuclear would require over 100TW of power to be installed within 30 years, to replace the fossil-based 19TW[1] - it's a deadly mirage**
- Costing over US$131 Trillion to build up that much capacity (wind turbines, photovoltaics, batteries, nuclear, etc.)[2]
- Draining energy away from current economic activities = inducing recession, then depression, then social breakdown[3]
- Requiring materials well over current and foreseeable world production capacities, with huge ecological impacts[4]
- Resulting in a large *"burp"* of greenhouse gases pushing global warming well over 2ºC by 2040 and 3ºC by 2050 [4]
- And with actual, usable *"renewable"* resources grossly over estimated (e.g. maximum wind resource is in the order of only 1TW, energy returns on investments [EROI] are well below minimum viability level [5]…)
- **Wholly unviable, bound to fail - We urgently need *"Something-else"***

1 See,e.g., Sgouris Sgouridis, Denes Csala and Ugo Bardi, 2016, The sower's way: quantifying the narrowing net-energy pathways to a global energy transition, *Environmental Research Letters*, doi:10.1088/1748-9326/11/9/094009; and and Simon P. Michaux, 2021, *The Mining of Minerals and the Limits to Growth*, Report 16/2021; *Assessment of the Extra Capacity Required of Alternative Energy Electrical Power Systems to Completely Replace Fossil Fuels*, Report 42/2021; *Restructuring the Circular Economy into the Resource Balanced Economy*, Report 3/2021, GTK Mineral Intelligence, Geological Survey of Finland.
2 International Renewable Energy Agency, 2021, *World Energy Transitions Outlook: 1.5°C Pathway*, Preview
3 E.g., Andrew Jackson, Tim Jackson, 2021, Modelling energy transition risk: The impact of declining energy return on investment (EROI), *Ecological Economics*, https://doi.org/10.1016/j.ecolecon.2021.107023
4 Arnoux, Louis, 2020, *Thermodynamics, Fossil Fuels and Renewables, the Good, the Bad and the Ugly*, Fourth Transition Ltd; and Michaux cited in 1 above.
5 Carlos de Castro, Margarita Mediavilla, Luis Javier Miguel and Fernando Frechoso, 2011, Global wind power potential: Physical and technological limits, *Energy Policy* 39, 6677–6682, doi:10.1016/j.enpol.2011.06.027; Pedro A. Prieto and Charles A.S. Hall, with the assistance of Rigoberto Melgar, 2013, *Spain's Photovoltaic Revolution. The Energy Return on Investment*, SpringerBriefs in Energy Energy Analysis; Adrien Fabre, 2019, Evolution of EROIs of electricity until 2050: Estimation and implications on prices, *Ecological Economics* 164, 106351, https://doi.org/10.1016/j.ecolecon.2019.06.006.

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No civilisation can survive without a self-powered energy supply and use system. Presently there is no viable alternative. The thermodynamics of the technologies currently used and of the overall systems make it impossible for so-called renewables or nuclear to forms the basis for a potential GESUS 2.0. The matter is summarised in Figure 1.

We call the dynamic that led to the present situation the Energy Seneca – Energy because the thermodynamics of the globalised industrial world is the main driver of what is happening and Seneca as the dynamic characterised by a long process of growth breaking into an abrupt fall – coined by Prof. Ugo Bardi after the Roman philosopher who first identified this dynamic. Figure 2 summarises the energy trap the industrial world has fallen into on the downside of the Energy Seneca. With the existing technology mix there is presently no way out of that trap. It is simply lethal. It is not a matter of finance. It is a matter of thermodynamics of complex systems. The sooner decision-makers come to terms with this and focus on building *"Something-else"* that they presently no idea of, the better, i.e., begin to learn from experts who have been working on such matters for over 20 years.

Figure 2

Why is there no possible solution to the Energy Seneca Challenges under the prevailing paradigm?

"Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!" (Alice in Wonderland)

Due to the rapid decline of net energy per barrel, the Oil Industry is under the sway of the ***"Red Queen Effect".*** It must *"run"* faster & faster, pumping more & more oil per year, to meet end-users' demands - ditto for all other fossil & nuclear resources that are subject to the same *RQ Effect*.

However, the net energy/barrel needed to keep *"running"* will have run out by about 2030…

While all other energy sources depend on net energy from oil for their own operations…

"Now, here, you see, if you run too fast you die!" (paraphrasing Lewis Carroll)

All alternatives, PVs, wind turbines, biomass, shale oil, tar sands, new nuclear, etc., are under the sway of the ***"Inverse Red Queen Effect"***:*

- If alternatives to fossil grow at above ~5%/year, the energy needed to build up capacity drains net energy out of the industrial world, just when it requires much more energy
- Yet to address the *Energy Seneca,* they actually need to grow at over 22%/year - **at that rate the net energy drain would kill the industrial world: current alternatives are a lethal impasse**

* Barreto, Raul A., 2018, Fossil fuels, alternative energy and economic growth, Economic Modelling, https://doi.org/10.1016/j.econmod.2018.06.019.; Davidsson, S. 2016. Natural resources and sustainable energy. Growth rates and resource flows for low-carbon systems. Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology 1414. 49 pp. Uppsala: Acta Universitatis Upsaliensis. ISBN 978-91-554-9671-5; Davidsson, S., Grandell, L., Wachtmeister, H., Höök, M., 2014, Growth curves and sustained commissioning modelling of renewable energy: Investigating resource constraints for wind energy. *Energy Policy*, (0) http://dx.doi.org/10.1016/j.enpol.2014.05.003; Gutowski, Timothy G., Gershwin, Stanley B. and Bounassisi, Tonio, 2010, Energy Payback for Energy Systems Ensembles During Growth. IEEE, International Symposium on Sustainable Systems and Technologies, Washington D.C., May 16-19; Murphy, Tom, 2011, *The Energy Trap.* https://dothemath.ucsd.edu/2011/10/the-energy-trap; Joshua M. Pearce, 2008, Thermodynamic limitations to nuclear energy deployment as a greenhouse gas mitigation technology, Int. J. Nuclear Governance, Economy and Ecology, Vol. 2, No. 1., pp.113-130.; Pearce, J. M., Limitations of Greenhouse Gas Mitigation Technologies Set by Rapid Growth and Energy Cannibalism, *Proceedings Climate 2008/Klima 2008,* http://www.climate2008.net/?a1=pap&cat=1&e=61; Pearce, J. M., 2009, Optimizing Greenhouse Gas Mitigation Strategies To Suppress Energy Cannibalism, *2nd Climate Change Technology Conference,* May 12-15 May, Hamilton, Ontario, Canada; R. Kenny, C. Law, J.M. Pearce, 2010, Toward real energy economics: energy policy driven by life-cycle carbon emission, Energy Policy 38, pp. 1969-1978.;Weissbach et all, 2013, Energy intensities, EROIs (energy returned on invested), and energy payback times of electricity generating power plants; Tyner, Gene, 1985, Net enregy analysis of nuclear and wind power systems, PhD thesis, University of Oklahoma; Gene Tyner Sr, Robert Costanza And Richard G. Fowler, 1988, The Net-Energy Yield Of Nuclear Power, Energy Vol. 13, No. 1, pp. 73-81.; Carlos de Castro, Margarita Mediavilla, Luis Javier Miguel and Fernando Frechoso, 2011, Global wind power potential: Physical and technological limits, Energy Policy 39, 6677–6682, doi:10.1016/j.enpol.2011.06.027; Iñigo Capellán-Péreza, Carlos de Castroa, Luis Javier Miguel Gonzáleza, 2019, Dynamic Energy Return on Energy Investment (EROI) and material requirements in scenarios of global transition to renewable energies, *Energy Strategy Reviews* 26, 100399, https://doi.org/10.1016/j.esr.2019.100399; Paul E. Brockway, Anne Owen, Lina I. Brand-Correa and Lukas Hardt, 2019, Estimation of global final-stage energy-return- on-investment for fossil fuels with comparison to renewable energy sources, Nature Energy, VOL 4, 612–621, https://doi.org/10.1038/s41560-019-0425-z; Simon P. Michaux, 2021, The Mining of Minerals and the Limits to Growth, Report 16/2021; Assessment of the Extra Capacity Required of Alternative Energy Electrical Power Systems to Completely Replace Fossil Fuels, Report 42/2021; Restructuring the Circular Economy into the Resource Balanced Economy, Report 3/2021, GTK Mineral Intelligence, Geological Survey of Finland.

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Of course, we are well aware that the above is startling and sounds preposterous to non-specialists. In fact, there have been many warnings and pointers to the dangers ever since the 1970s, e.g., the Meadows work on *Limits to growth* (1972). There were mostly ignored or dismissed as economic growth kept on apparently unabated.

However, as shown in Figure 3, since 1980, world GDP falterings have been increasing in frequency and magnitude. The overall trend is clear. Our estimates show that by 1980 total direct net energy from oil began to decline (i.e., net energy produced using only the gross energy in crude oil). As stressed earlier, the whole GESUS rests on the delivery of net energy from oil. Yet, 1980 is also when total global debt began to shoot to the stars (i.e., governmental, business and household debts). To date, World debt growth has masked the decline of the energy flow the entire industrial world depends on. After 2000 the oil industry drew increasing energy from the non-oil part of the GESUS to continue, with the overall problem still masked by overall debt.

We are now in the acute part of the BigMES. As the situation worsens inexorably on the thermodynamic front, we must expect that difficulties in servicing debt and financial stress will become increasingly problematic globally.

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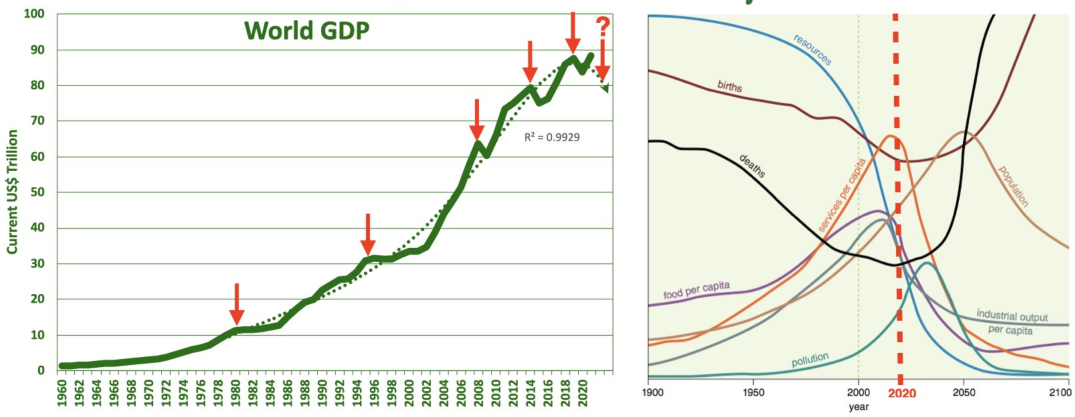
Figure 3

"Civilisation, we have a problem"



- World GDP falterings have been increasing in frequency and magnitude since 1980 (left hand chart)
- This dynamic was anticipated accurately as early as 1972 by Meadows, *et al.* (right hand chart)*
- **The overall dynamic is the Energy Seneca** – a long period of growth breaking into an abrupt fall where thermodynamics is key
- **The Seneca is the cause of Climate Emergency symptoms: deal with the cause instead of messing up with the symptoms**
- **We have now passed onto the Seneca's downside – a lethal situation**
- **The *"decarbonising"* drive stands to make the Meadows' anticipation look like a tame dress rehearsal**

* Turner, G. 2008. A comparison of The Limits to Growth with 30 years of reality, *Global Environmental Change*, 18: 397-411; Tim Jackson, Robin Webster, 2016, *Limits Revisited, A review of the limits to growth debate*, UK All-Party Parliamentary Group.

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The net energy driven breakdown of the GESUS on the Seneca's downside is a global matter. No country is immune, especially not countries like Australia that are highly dependent on transport fuel imports. We must stress also that the breakdown of the GESUS includes that of the global food system.

Under the Energy Seneca threat, even assuming that the Iron Boomerang Project could be built in time and within the projected budget, it is most unlikely that energy required to operate it would be available at any remotely affordable price. Bankruptcy is near certain even before the Project is implemented.

In summary, this Project is half a good idea. It lacks the kind of viable thermodynamics that could enable profitable operation.

We anticipated this kind of situation over twenty years ago. We are systems-thinking, science, engineering and finance people who have figured out the defining challenge of our time:

❒ How and why current efforts to combat the Climate Emergency are bound to fail and make matters far worse,

❒ That the much more urgent core problem is the Energy Seneca, and

❒ How to address the Seneca and the Climate Emergency it is part of, over 20 years, in a rapidly self-funding, highly profitable way, with the potential of unleashing a new era of sustainable prosperity for all involved, by redefining how we access and use energy.

Our Initiative leverages a substantial body of prior R&D, with funding in the order of €50 Million. It has not been easy, with numerous knocks along the way. We persevered. We arrived at a package of solutions, *n*Geni, that directly addresses the Seneca's market imperatives in a radical way. Figure 4 summarises the four sets of breakthroughs that we have achieved.

Figure 4

To sum up: four sets of breakthroughs

The Fourth Transition Initiative is based on a series of game changing breakthroughs:

1. **Understanding the global situation and its dynamics:** lethal, double Energy Trap on the Seneca's downside that the globalised industrial world has no way to escape from
2. **Translating this understanding into specific, actionable, detailed thermodynamic and systemic imperatives:** achieving 1/2 Earth over 20 years by doing 3 times more with twice less through a redesign of how we access and use energy that emulates Earth-Life
3. **Integrating available scientific and engineering knowledge to produce a package of seamlessly integrated solutions meeting the above imperatives: *n*Geni**
4. **Producing a Development Programme** that enables implementing globally the solutions virally, over some 20 years instead of the over 100 years that would be required along prevailing developmental lines: **building the *Cool Planet* Internet of Energy**

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Based on the above, in 2021, we incorporated *n*Geni Australia Pty Ltd with, as first objectives, the implementation of *n*Geni to make mining and transport green.

In short, *n*Geni emulates what life on Earth has been doing for some 3.8 billion years thermodynamically speaking. The Earth-Life system leverages the energy it receives from the sun to achieve an overall performance in the order of 440%. The present GESUS achieves only about 12% and has entered its terminal decay phase.

Instead of bound-to-fail *"decarbonising with renewables"*, our technology is a radical redesign of how we access and use energy that emulates Earth-Life across all components of the GESUS to achieve about three times more with twice less primary energy inputs, eventually 100% solar-based, sustainable, safe, affordable and highly profitable for all involved.

The rationale for our focus on mining and transport is simple:

- Mining is under severe threat in the face of the Energy Seneca, Climate Emergency and ecological impacts and yet mining is necessary to address the Energy Seneca and the Climate Emergency;

- Australia is in a highly vulnerable position with 98% of transport fuels imported from increasingly uncertain sources (Persian Gulf and refineries in Indonesia and China); and
- *n*Geni has the potential to enable *"green"* mining: solar version + carbon capture and recycling + green algae based effluent remediation + bio-oil transport fuel production – solving several problems at once instead of current expensive piecemeal approaches that are bound to fail.

Here is not the place to detail our package of solutions to the defining challenge of the 21st century. Instead, we append to this submission two white papers:

- GEM – Green Energy Mining, *"Green and Gold"* a solution for all – presents in lay language the application of *n*Geni to make all forms of mining and transport 100% sustainable;
- *n*Geni Solar + Mass Carbon Recycling – White Paper – presents in lay language the concentrated solar version of the *n*Geni technology class and technological system that enables the GEM initiative and the mass CO_2 capture and recycling that it incorporates. This is a redacted version that does not include the detail of our highly sensitive proprietary IP. The full version is only available under strict NDA.

To conclude, the Iron Boomerang Project has distinct merits but, in our analysis, cannot succeed in its present form. It needs to be augmented to render it thermodynamically viable and thus profitable. This is readily feasible within the timeframe for the Project's implementation. We offer our expertise and technology package to build the specific solutions that it presently lacks. We will be delighted to answer the questions this submission will no doubt elicit.