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Submission to the enquiry on

Framework Agreement for International Collaboration on Research and Development of Generation IV Nuclear Energy Systems, as extended by the *Agreement Extending the Framework Agreement for International Collaboration on Research and Development of Generation IV Nuclear Energy Systems*

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About *Bright New World*

Bright New World

- is an environmental non-governmental organisation registered in Australia.
- has a base of members and supporters from around the world.
- is governed by an independent board of directors with an independent Chairperson.
- is not a corporate lobby group; our constitution forbids membership of Bright New World by bodies corporate.

Our objectives, as stated our constitution, are:

1. *to contribute to the stabilisation and rapid reduction in greenhouse gas emissions so as to achieve the lowest practicable level of atmospheric concentration of greenhouse gas, thereby contributing to the stability of Earth's climate;*
2. *to further the urgent needs of human development and welfare worldwide through the elimination of poverty and the promotion of international cooperation;*
3. *to create a planet that is richer in natural resources and biodiversity through:*
    a. *the progressive decoupling of human development and welfare from activities that place pressure upon, consume the resources of, and degrade the quality of the natural environment; and*
    b. *the application of rigorous research and human ingenuity to the restoration, conservation and protection of the natural environment*
4. *to promote pathways to the provision of plentiful, globally scalable energy that is free of greenhouse gas emissions and minimizes all impacts on the natural world for the purposes of meeting clauses 1, 2 and 3 , including a non-exclusive focus on the beneficial uses of nuclear fission technologies;*
5. *to provide an inclusive, a-political and intellectually rigorous destination for like-minded individuals and organisations to explore and collectively act upon clauses 1, 2, 3 and 4;*
6. *to provide a source of credible resources for government, media, educational institutions and private enterprise in issues related to clauses 1, 2, 3 and 4; and*
7. *to operate a fund that will accept donations of money or property in compliance with the Tax Act.*

Bright New World makes this submission in support of the above-stated objectives.

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Introduction

We welcome the opportunity to provide a submission relating to *the Framework Agreement For International Collaboration On Research And Development Of Generation IV Nuclear Energy Systems* ('the agreement').

Bright New World is strongly supportive of Australia using its strong and relevant capacities in nuclear science and technology to maintain and grow its participation in the development of advanced nuclear technologies.

We offer the following reflections in support of this agreement.

Responses to the agreement

CONSIDERING the expected increase in energy demand worldwide, and the contribution that the development and deployment of innovative technologies and fuels can make to meet future global energy demand in a sustainable manner;

We strongly agree that a realistic paradigm relating to global energy demand must be central in efforts to address the interrelated challenges of tackling climate change and the alleviation of poverty at a global scale.

We are concerned research efforts to date that arbitrarily exclude of nuclear technologies from consideration in sustainable energy pathways done so from a premise of substantial reductions in global energy demand, even in the face of increasing human population and continuing high levels of poverty [1]. These troubling assumptions are illustrated in Fig. 1 and Fig. 2 from Heard, Brook [1].

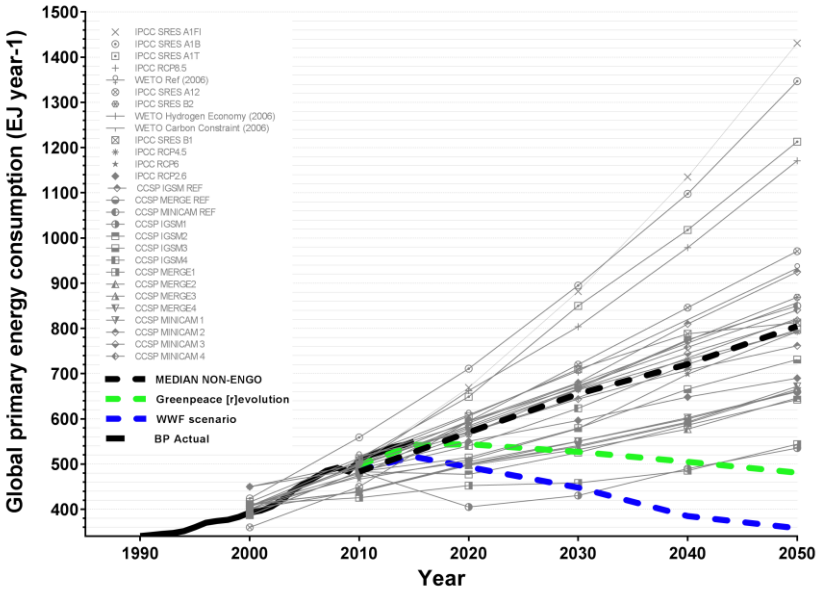

Fig. 1 Comparison of scenarios for global primary energy from the Intergovernmental Panel on Climate Change (IPCC), the Climate Change Science Program (CCSP), the World Energy Technology Organisation (WETO), the BP Statis ical Review, Greenpeace and the World Wildlife Fund (WWF). Sources: US Energy Information Administration (EIA) [2]; Intergovernmental Panel on Climate Change [3]; Jeffries at al. [4] Teske et al. [5]; European Commission [6], Van Vuuren et al [7]. All WETO values are converted from million tonnes oil-equivalent. All EIA values are converted from quadrillion British Thermal Units. Greenpeace values are converted from petajoules. All WWF values were published as final energy only and are converted from final energy to primary energy based on the ratio of primary to final energy provided in the Greenpeace scenario.

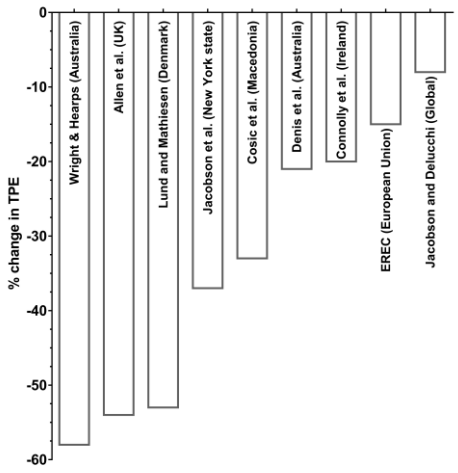

Fig. 2 Summary of percentage changes in Total Primary Energy (TPE) from baseline years across nine scenarios of 100 % renewable energy. Baseline years vary among scenarios [8-16].

Furthermore, while much attention is paid to the generation of electricity without the emission of greenhouse gas emissions, the energy sectors of *i)* industrial heat and *ii)* transportation remain profoundly under-addressed in both literature and available solutions. The former (industrial energy) is largely a demand for high-grade and reliable heat, currently provided almost entirely by combustion of fossil fuels[17]. The only potentially scalable, fossil-carbon free substitute for this energy sector is advanced, high-temperature nuclear reactors. The latter (transportation) will in part be addressed through electrification (with commensurate increased demand for cleanly generated electricity). However we do not know that electrification will be able to satisfactorily meet all transportation requirements. The creation of synthetic fuels using carbon-free heat as a major feedstock is likely to be another essential component in a comprehensive climate change response [18-23].

Advanced nuclear technologies have a crucial role in meeting future energy demand in sustainable way, including and also beyond the substitution of coal, oil and gas from existing electricity generation systems. For this reason we strongly support Australia's continued participation in the Generation IV International Forum and endorse the highlighted statement from the agreement.

CONSIDERING that collaboration on research and development by many countries on the development of advanced next generation nuclear energy systems will aid progress toward the realization of such systems;

We strongly agree. Australia has impressive capabilities in nuclear science and technologies. This is reinforced regularly when we interact with international nuclear providers, in their reflections on the strong capabilities and impressive achievements of ANSTO.

One of the major root barriers to more successful deployment of existing nuclear technologies has been the development of science and industry that is sovereign in nature (likely tied to early military eras of nuclear technology development) and treated, in many ways as "special" compared to other high-technology, high-stakes industries like, for example, manufacture of commercial aircraft.

For advanced nuclear technologies to fulfill their crucial potential, it is essential that they are developed, licensed and deployed in conditions of minimal sovereignty, maximum

cooperation and, for all intents and purposes, rendered commercially and industrially "normal".

We view this agreement and its goals as an important step to these important outcomes.

We regard the potential for Australia to provide a service to the international community in the management of used light water reactor fuel to be a potentially beneficial catalyst, based in international cooperation, for not just research and development but near term commercialization and deployment of a range of advanced nuclear technologies. We have estimated such integrated projects may deliver net benefits in the tens of billions of dollars to Australia while advancing international peace and stability and accelerating the deployment of important technologies [24].

1) The objective of this Framework Agreement is to establish a framework for international collaboration to foster and facilitate achievement of the purpose and vision of the GIF: the development of concepts for one or more Generation IV Systems that can be licensed, constructed, and operated in a manner that will provide a competitively-priced and reliable supply of energy to the country(ies) where such systems may be deployed, while satisfactorily addressing nuclear safety, waste, proliferation and public perception concerns.

We strongly endorse this objective, particularly the end-goal of "competitively-priced and reliable supply of energy". Absent such energy options, it is troublingly clear that fossil fuels will continue to be exploited en masse to meet global energy demand, even in the face of rapid increases in the deployment of renewable technologies (Figure 3).

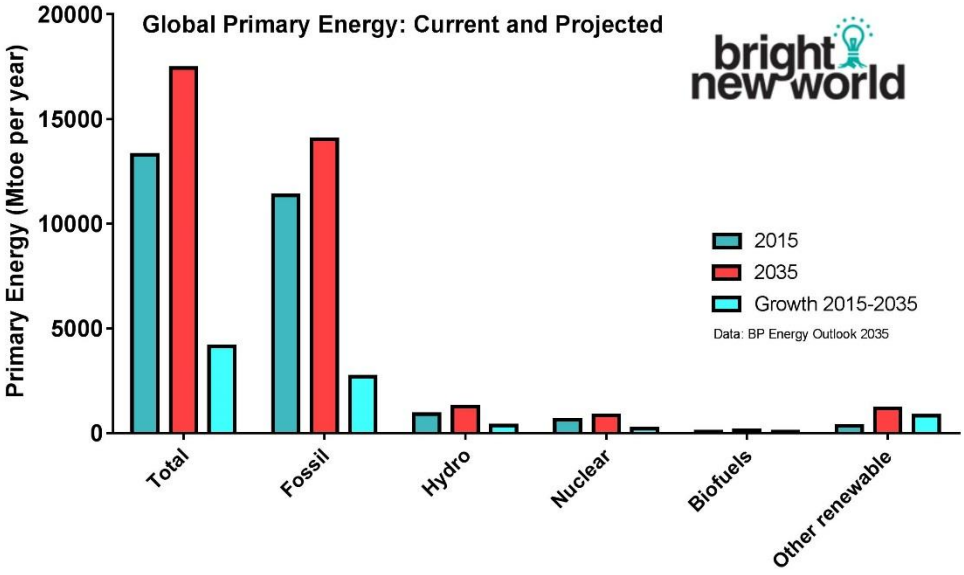

Fig. 3 Curernt and project global primary energy demand, total and by energy source, in 2015 and 2030

We caution that, on the basis of readily available data, the existing nuclear power sector, globally, based predominantly on light-water reactor technology, has an outstanding record of safety, and waste management, most especially when compared, as it ought to be, with the performance of oil and coal which are the first and second largest sources of global energy respectively.

At all times, it is important that developments in advanced nuclear technologies are appropriately framed so as not to undermine the vital and continuing role of light-water reactors or diminish the contribution of this sector being

i) a quiet global leader in dependable, low carbon supply for over five decades, with over seventeen thousand reactor years of operation [25] ;

ii) with average lifetime emissions to be equal or lower than renewable energy technologies [26]

iii) a sector that has delivered transformational energy sector outcomes in countries like Sweden, France Switzerland and the large Canadian province of Ontario extremely low electricity consumption-related emissions [27]

iv) a sector that has been deployed at rates commensurate with an urgent response to climate change [28]

iv) a sector that has directly contributed to cleaner air and greater population-wide health [29, 30].

Existing commercial nuclear reactors already by-products on-site as solid, insoluble material encased in multiple layers of robust shielding, isolated from the environment. The potential improvements in back-end waste management of advanced nuclear technologies are inarguable and will be welcomed. However the existing challenges are largely political and institutional, not technical. Advanced reactor systems will also produce waste streams that will required political and institutional solutions.

In summary, we consider the most crucial role of advanced reactor technology will be in meeting existing levels of safety and satisfactory waste management *at lower cost, with greater scalability and potentially more readily established social acceptance*; not delivering *better* performance per se. We must not make perfection the enemy of excellence.

Conclusion

With the mounting threat of climate change and the immediate and serious problems of poverty and energy-related pollution, a direct substitute for new coal needs the greatest level of support.

Modern nuclear energy is that direct substitute. It has the support of Bright New World. We applaud the Australian Government for its continued participation in the Generation IV International Forum. We respectfully offer this submission and the discussion herein for further and ongoing consideration.

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REFERENCES

1. Heard, B.P., et al., *Burden of proof: A comprehensive review of the feasibility of 100% renewable-electricity systems.* Renewable and Sustainable Energy Reviews, 2017. **76**: p. 1122-1133.
2. US Energy Information Administration, *International Energy Outlook 2013*. 2013: Washington, DC.
3. Intergovernmental Panel on Climate Change, *IPCC Special Report Emissions Scenarios: Summary for Policy Makers*. 2000: Switzerland.
4. Jeffries, B., et al., *The energy report: 100% renewable energy by 2050*. 2011, WWF International: Gland, Switzerland.
5. Teske, S., et al., *energy [r]evolution*, in *World Energy Scenario*. 2012, Greenpeace, Global Wind Energy Council & European Renewable Energy Council: Amsterdam, Netherlands.
6. European Commission, *World Energy Technology Outlook – 2050*. 2006: Brussels.
7. van Vuuren, D.P., et al., *The representative concentration pathways: an overview.* Climatic Change, 2011. **109**(1-2): p. 5-31.
8. Allen, P., et al., *Zero Carbon Britain" Rethinking the Future*. 2013, Centre for Alternative Technology: Powys, UK.
9. Lund, H. and B.V. Mathiesen, *Energy system analysis of 100% renewable energy systems—The case of Denmark in years 2030 and 2050.* Energy, 2009. **34**(5): p. 524-531.
10. Gilbraith, N., et al., *Comments on Jacobson et al.'s proposal for a wind, water, and solar energy future for New York State.* Energy Policy, 2013. **60**: p. 68-69.
11. Ćosić, B., G. Krajačić, and N. Duić, *A 100% renewable energy system in the year 2050: The case of Macedonia.* Energy, 2012. **48**(1): p. 80-87.
12. Denis, A., et al., *Pathways to Deep Decarbonisation in 2050: How Australia can prosper in a low carbon world*. 2014: Melbourne, Victoria.
13. Connolly, D., et al., *The first step towards a 100% renewable energy-system for Ireland.* Applied Energy, 2011. **88**(2): p. 502-507.
14. Council, E.R.E., *RE-thinking 2050: A 100% Renewable Energy Vision for the European Union*. 2010: Brussels, Belgium.
15. Delucchi, M.A. and M.Z. Jacobson, *Providing all global energy with wind, water, and solar power, Part II: Reliability, system and transmission costs, and policies.* Energy Policy, 2011. **39**(3): p. 1170-1190.
16. Jacobson, M.Z. and M.A. Delucchi, *Providing all global energy with wind, water, and solar power, Part I: Technologies, energy resources, quantities and areas of infrastructure, and materials.* Energy Policy, 2011. **39**(3): p. 1154-1169.
17. U.S. Department of Energy, *TA 61: Industrial Process Heating Systems*, in *Quadrennial Technology Review*. 2015: Washington D.C.
18. Olah, G.A., A. Goeppert, and G.K.S. Prakash, *Beyond Oil and Gas: The Methanol Economy*. Second ed., Weinheim, Germany: Wiley-VCH.
19. Seimer, D., K. Sorenson, and B. Hargraves, *Nuclear Ammonia: A Sustainable Nuclear Renaissance's 'Killer Ap'*, in *8th Annual NH3 Fuel Conference* 2011: Portland, OR.
20. Zamfirescu, C. and I. Dincer, *Ammonia as a green fuel and hydrogen source for vehicular applications.* Fuel Processing Technology, 2009. **90**(5): p. 729-737.
21. Zamfirescu, C. and I. Dincer, *Using ammonia as a sustainable fuel.* Journal of Power Sources, 2008. **185**(1): p. 459-465.
22. Eisaman, M.D., et al., *CO2 extraction from seawater using bipolar membrane electrodialysis.* Energy & Environmental Science, 2012. **5**(6): p. 7346.
23. Jaszczur, M., et al., *Hydrogen production using high temperature nuclear reactors: Efficiency analysis of a combined cycle.* International Journal of Hydrogen Energy, 2016. **41**(19): p. 7861-7871.
24. Heard, B.P. and B.W. Brook, *Closing the Cycle: How South Australia and Asia Can Benefit from Re-inventing Used Nuclear Fuel Management.* Asia & the Pacific Policy Studies, 2017. **4**(1): p. 166-175.
25. International Atomic Energy Agency. *Power Reactor Information System*. 2017 [cited 2017 5 March]; Available from: https://www.iaea.org/pris/.

26. National Renewable Energy Laboratory. *Life Cycle Assessment Harmonization*. 2014 March 7 2016 [cited 2016 7 August]; Available from: http://www.nrel.gov/analysis/sustain_lcah.html.
27. Heard, B., C.J.A. Bradshaw, and B.W. Brook, *Beyond wind: furthering development of clean energy in South Australia.* Transactions of the Royal Society of South Australia, 2015. **139**(1): p. 57-82.
28. Qvist, S.A. and B.W. Brook, *Potential for worldwide displacement of fossil-fuel electricity by nuclear energy in three decades based on extrapolation of regional deployment data.* PLoS One, 2015. **10**(5): p. e0124074.
29. European Commission, *ExterneE: Externalities of Energy 2005 update*. 2005: Luxembourg.
30. Kharecha, P.A. and J.E. Hansen, *Prevented mortality and greenhouse gas emissions from historical and projected nuclear power.* Environ Sci Technol, 2013. **47**(9): p. 4889-95.