

Energy.Proj.AU presents: C. M. Waite's CONSOLIDATED PAPER

A Submission to SA's Nuclear Fuel Cycle Royal Commission

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Preface

South Australia has before it a great opportunity to PIVOT into Nuclear Energy, like the City of Toronto has done (making Fossil Fuel Electricity a thing of the past) & the Country of France did (decades ago, now getting ~80% of its Electricity from (what I call "Fukushima-era") Nuclear Reactors).

Since SA Government announced its \$20 Billion plan to PIVOT the State to a Nuclear Energy economy, I've seen indications of what NOT having had Nuclear Energy in AU can do to a people.

Decades ago, I noticed "Anti-Nuke" road signs, in the City of Charles Sturt; more recently, I was refused access (as a would-be renter) to a "Room with Projector" at West Lakes Community Center, by the City of Charles Sturt, after they were advised that the topic of my (intended) talk there was related to nuclear energy (ie, comparing+contrasting Old & New Reactor technology trade-offs).

Since SA's announcement, a fresh new "Anti-Nuke" has gone up across from Scotty's Motel; a photo of that sign appears on the first page of the Appendix of this Submission.

Recently, I noticed that a comprehensive book on almost all the old & new civilian reactor technologies (namely, Robert Hargraves' "Thorium – Energy Cheaper than Coal"), which it took me three (3) requests - to the Tea Tree Gully Library – before they would buy it. (The successful 3rd request came after I could cite SA Govt's \$20 Billion announcement.) Very recently, I noticed that one of the State Library's two (2) copies of that book had been listed - in the Library system's online book catalog - as a work of "Fiction" - you won't find that "error" today, after I mentioned it to a Librarian, in the system.

Post-Fukushima, it's fair enough to be wary of Nuclear Power Plants, at least those of the Fukushima-era. But today, we are designing very different reactors, based on Oak Ridge's MSR, which its then head – Dr Alvin Weinberg's argued were the safer type of reactor for civilian energy programs. He was ignored by a Bomb-focused Military department then, but today's "Pro-New-MSR-Nuke" Community will not be.

With China's 300+Engineers & Scientist & some more in India also moving in the direction of MSRs, I have every expectation, that SA can & should wait for MSRs to become available here, so we don't later regret rushing into a contract for an overly costly "dinosaur" that still uses Costly+Wasteful Fuel-Rods,

With MSRs due in the next Decade, neither us nor our children should not be weighted-down, with such an unnecessary & undue burden as one or more Reactor(s) with Fuel-Rods would be, IMO.

The Liquid-Fuel Molten Salt Reactor (MSR) - subtly cited by the title of Hargrave's book - has been proven safe & effective (in the Molten Salt Reactor Experiment (MSRE), conducted at Oak Ridge National Lab, decades ago). A growing, world-wide community has been holding international conferences (recently, at CERN, in Geneva, &, in June 2015, in Palo Alto, California).

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Hundreds of Physicists, Engineers, Chemists & Investors have been attending such conferences for well over 7 years, now. We in the Community are striving to acquaint people & politicians with the features & reduced risks of Liquid-Fuel Reactors, while at least 4 companies continue to move their designs through the Approval process, despite USA's Nuclear Regulatory Commission's "rules-based" fence, around the goal, which makes it easier for Old-Tech LWRs to win approval, than innovative, Lab-proven designs can, ie, today.

Not to worry! Bill Gates Foundation's choice of "New Nuke" maker has moved to China. And, in June 2015, ThorCon's Lars Jergensen reported his company's progress towards completing an MSR factory, in a South Korean shipyard. US NRC's slowness to recognise the successful results of R&D work in a US-based Lab & to update its approval process, to facilitate approval of today's spin-off MSR designs hasn't diminished the MSR / Thorium Community's interest in finding a way (or a place) to build them.

Canada's Terrestrial Energy is finding MSR-friendly attitudes in that country's Nuclear regulator, & even the Czech Republic has established an R&D centre, with whom others (eg, Copenhagen Atomics) have made cooperative arrangements. (BTW, representatives of the Czech Republic attended a very small conference on Nuclear Energy in Canberra, some years ago. I hope AU didn't "burn any bridges" with the Czechs.)

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Part 0: **EXECUTIVE SUMMARY** of this Consolidated Paper Submission

Our position is simple: **MSR+LFTR have many Features to recommend them**

South Australians should strive to inform themselves about "New Nukes"
where: "New Nukes" = Liquid-Fuel, Molten Salt Reactors (MSRs).

- Why? 0. MSRs have been proven safe, viable & reliable in the MSRE (Molten Salt Reactor Experiment, at Oak Ridge Lab's, USA).
1. Liquid-Fuel MSRs' cores run at Low-Pressure (~same as air), which do not require a large & costly core-envelope; a thin envelope suffices. Nothing (like the water in a non-MSR) is in an MSR, that needs to expand fast (like hot water does).
 2. MSRs' heat output is ~700 degrees C (ie, more than double that from LWRs), so that Electricity Generation can be more efficient than when done using 300 degree heat from LWRs.
 3. Since MSRs' heat is ~700 degrees C, Electricity Generators turbines' output is still hot enough to desalinate water, ie, in a suitable desalination plant (or one adapted to use it) instead of electricity-heated process-heat. (RC should inquire as to how costly SA's current desalination plant would be, to modify, to make it capable of using this 2nd-level heat.)
 4. MSRs do not require quantities of nearby water for cooling (unlike LWRs). MSRs are better-suited to the water situation in SA, (Cf Terrestrial Energy Inc.'s IMSR)
 5. MSRs to be factory-made (as are other complex systems, eg, large jets) & will benefit from factories' learning-curves, as production volumes increase.
 6. MSR cores are smaller & easily transported to a building-site from the factory that made them.
 7. MSRs can be designed to use energy from "spent" Fuel Rods, without requiring a large & costly, separate processing facility. (Cf TransAtomic Power's WAMSR)
 8. Today's Light Water Reactors (LWRs) need too much Water.

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9. Non-MSRs' use Water to cool their cores (&/or to transfer its heat to an external system, eg, generator turbines or desalination plant) requires that water to be pressurised (to 60-120 Atm., so the water can reach temperatures above its natural boiling-point of 100 degrees C).
High core pressures require a large & costly core envelope (in case of leak), with very large thickness (~20 cm), which means: very high reactor construction cost.

Want MORE reasons to "embrace" the Molten Salt Reactor (MSR)?

Rob't Hargraves' book "Thorium – Energy Cheaper than Coal" pp. 302-303 lists **34 Advantages** of an MSR: the Liquid Fluoride Thorium Reactor (LFTR)

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Part 1: Response to Issues Paper #3 Generating Electricity

3.1 Where to Locate a Reactor & Why?

I'd suggest that SA only agree to install Liquid-Fuel, Molten Salt Reactors, so that they can power BOTH Electricity Generation AND Desalination.

For these two linked applications, the MSR would need to be located near SA's existing Water Desalination plant, OR near a future plant.

3.2, 3.3 Can MSRs be connected to the NEM? Can any be run Off-Grid?

Surely, it is technically possible to connect a MSR to the NEM, or will be, ie, by the time MSRs are available to AU.

Existing non-NEM distribution lines can be used (regulations allowing) to enable several regions of SA to enjoy Green Electricity, as well as enabling future use of 100% Electric Vehicles, as they become available.

SA should consider owning some MSRs, ie, rather than being dependent on the whims of a private generator; since SA Govt's announcement of a plan to PIVOT the State to a Nuclear Energy economy, SA's main generator announced that it would soon cease generating Electricity.

SA's industry needs reliable & affordable Electricity, & having it, at low cost can only encourage industry to stay & perhaps even to move to SA. The same can also apply to people considering residing in SA.

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Part 2: Response to Issues Paper #4 Management, Storage & Disposal of Waste

4.1 What method(s) should be used to estimate economic benefits of waste to SA?

First, MSRs (eg, MIT-based TransAtomic Power's WAMSR) has been designed to extract & use, as its own fuel, most of the 99.5% residual energy normally to be found in "spent" Fuel-Rods.

An obvious model is (assuming WAMSR-like MSRs run in SA/AU):

1. Charge owners of "spent" Fuel Rods for taking them
2. Agree to assume ownership of these Fuel Rods
3. Temporarily store the Fuel Rods safely
4. As the need for "WAMSR fuel" arises, process Fuel Rods, by way of providing suitable material to feed to the MSRs
5. Either sell them to SA- or AU-based WAMSR-like MSRs, for use as fuel (post-processing) in their MSR(s).

It seems to me "best" for SA to own+run some WAMSR's, so that it has at least some customers for its processed Fuel Rods.

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Appendix A: p. 0: We, in South Australia, need **Facts & Data (NOT Slogans)** as we consider Nuclear.

Instead of "**NO New Nukes!**" (as some folks in SA seem to suggest):



We say: "**KNOW New [Liquid-Fuel, Molten Salt Reactor] Nukes!**"



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Appendix A p. 1: So, **how** can we, in SA, "**Know New Nukes**" before we make up our minds?

Some have, by chance (or others' conscious actions), viewed Robert Stone's doco. *first*, ie: + "**Pandora's Promise**" (cf¹ TEAC7's "**Pandora's Promise Tour - Nuclear Communication**") shows the pivoting of several Environmentalists, from Anti-Nuke to Pro-Nuke, which is fine.

However, from about 60 min. in, the film seems to focus on **GE-Hitachi's IFR PRISM** reactor, ie, a **fuel-rod based** reactor; **it requires** Costly+Wasteful **fuel-rods**, which – when removed from service - still contain ~99.5% of the fuel they had when first put in.

IFR is also costly because its **core runs at high pressures** (so its water can reach temperatures (over 100 deg C) hot enough to make Electricity) in the next stage. High core pressures call for a very thick (~20cm), & **extremely costly**, core envelope, in case of a leak.

IFR also requires a separate "spent fuel-rod" **Processing Facility**, so costly, that up to 6 IFR's must share one such facility, to keep it all "economical" to some degree.)

Both the IFR & Processing Facility require many human workers, adding yet more cost.

An earlier doco. on the IFR indicated that its owner would incur **two (2) billable costs**:

1. for Electricity produced by the IFR, &
2. for Processing of its "spent fuel-rods"

*I, for one, want users of Fuel-Rod based reactors as SA's Nuclear Waste customers;
I don't want SA to be needlessly generating quantities of "spent" fuel rod waste; &
I want SA's Electricity's cost to be as Low as Possible – both for me & our industries.*

Elsewhere, others focused on a proven reactor technology that needs No costly Fuel-Rods.

We came to know about this "post-Fukushima" Liquid-Fuel reactor technology (eg, those who like to view short talks on issues, at TED.COM²) may have found a 10-min. talk by former NASA employee: Kirk Sorensen:

+ "Kirk Sorensen: Thorium, an alternative nuclear fuel"

Additional leads & links to videos & papers on "New Nukes" can be found in Appendix B.

¹ Where no source URL is given, YouTube.com is the place to **search by surname or title**. For a calmer post-doco. Q&A (w/ both Stone & Michael Shellenberger fielding Q's), view: + "**Q&A w Robert Stone & Michael Shellenberger at Texas A&M Univ**"

² While Sorensen's short TED-talk can be found at TED.COM (access via browser), we've **not** been able to view it in app "TED" (perhaps because it was given in Calgary, Canada). It can, however, be viewed in app "**Thorium**" remix (on an iOS or Android device), along with about 20 other documentaries (some longer), comparing Liquid & Solid Fuel nukes.

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Appendix B: Links to Info: Safe, Green Liquid-Fuel Nuclear (Small MSR's & LFTR's): Due ~2024
(MSR = "Molten Salt Reactor" & LFTR = "Liquid Fluoride Thorium Reactor")

Intro.'s: Safe, green "post-Fukushima" reactors use Liquid Fuel, not Costly, wasteful, Solid fuel-rods:

1. (previously at NASA; now: **FLiBe Energy**) **Kirk Sorensen's** 10-min. TEDxYYC talk, given Apr. 2011:
www.TED.com/talks/kirk_sorensen_thorium_an_alternative_nuclear_fuel
- s1. (then: high school student) **Taylor Wilson's** 13-min. TED-talk, given Feb. 2013:
www.TED.com/talks/taylor_wilson_my_radical_plan_for_small_nuclear_fission_reactors
- s2. **Salim Zwein's** 13-min. talk at TEDxBeirut, given Nov. 2012:
TEDxTalks.ted.com/video/How-Thorium-can-save-the-world
2. **Prof Dr Eduardo Greaves'** 36-min. talk, given in April 2013: "**Thorium as Nuclear Fuel in the MSR**"
www.YouTube.com/watch?feature=player_detailpage&v=vBlyZZuQl4A

Books: + Robert Hargraves' **Thorium – Energy Cheaper than Coal** (~\$11 as Kindle eBook) ← EXCELLENT
+ David MacKay's **Sustainable Energy - Without the Hot Air** (free PDF here: WithoutHotAir.com)
An **extendable educators' edition** is available free here: <http://ck-12.org>); cf MacKay's talk:
+ www.ted.com/talks/david_mackay_a_reality_check_on_renewables

Application: Canada's [fracking] Miners are set to use small, MSR's (for process-heat) fr ~2024:

"**Nuclear in Alberta: Molten Salt Reactors to Lower Oilsands Carbon Footprint**":
+ www.YouTube.com/watch?v=CPpJicP7EKY (1 hr 13 min) ← **RECOMMENDED**
(Touches on Regulators: US: LWR Rule-Based; CA: Performance-based)

Collections of talks, interviews, Oak Ridge Lab.tours, & international conference talks, etc.:

1. Android / iOS app: "**Thorium**" remix (use this app to view any of 20+ docos) **RECOMMENDED**
2. TEAC7 - **Thorium Energy Alliance** Conference #7 (Palo Alto; 20 talks on YouTube.com) Jun.2015 ← RECENT
3. **International Conference (ThEC13)**, at CERN in Geneva CH):
+ ThoriumEnergyConference.org/Program (over 200 repr's from 32 countries)
+ home.web.CERN.ch/about/updates/2013/10/cern-hosts-international-conference-thorium-technologies
4. misc.: www.The-Weinberg-Foundation.org/resources/reports/
www.IThEO.org = International Thorium Energy Organisation

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