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The Road to Enablement for Thorium-fuelled Molten Salt Reactors

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Introduction

- What is the Weinberg Foundation, and what does it do?
- In late 2013, how can we expedite the development of Molten Salt Reactors?
- Four key issues:

  i. Divisions within the next-generation nuclear community
  ii. Political hurdles and the global energy market
  iii. International scientific and technical collaboration
  iv. Commercially-orientated MSR design

- Lastly, is there an emerging road-map for Molten Salt Reactor development?

Danger of division with the next-gen nuclear community

- Emerging divisions with the next-generation nuclear community are disturbing

- After decades of antipathy, a coalition of businesspeople, greens, scientists, and the general public increasingly recognises the need for a revitalised programme of nuclear research and development

- With lobbying, some governments may renew/increase their commitment to nuclear research and development

- *But* governments will only support nuclear if the next-gen nuclear community has a clear, unified 'pitch'. We must all speak with a united voice. (Even if we still have our preferred technologies.)

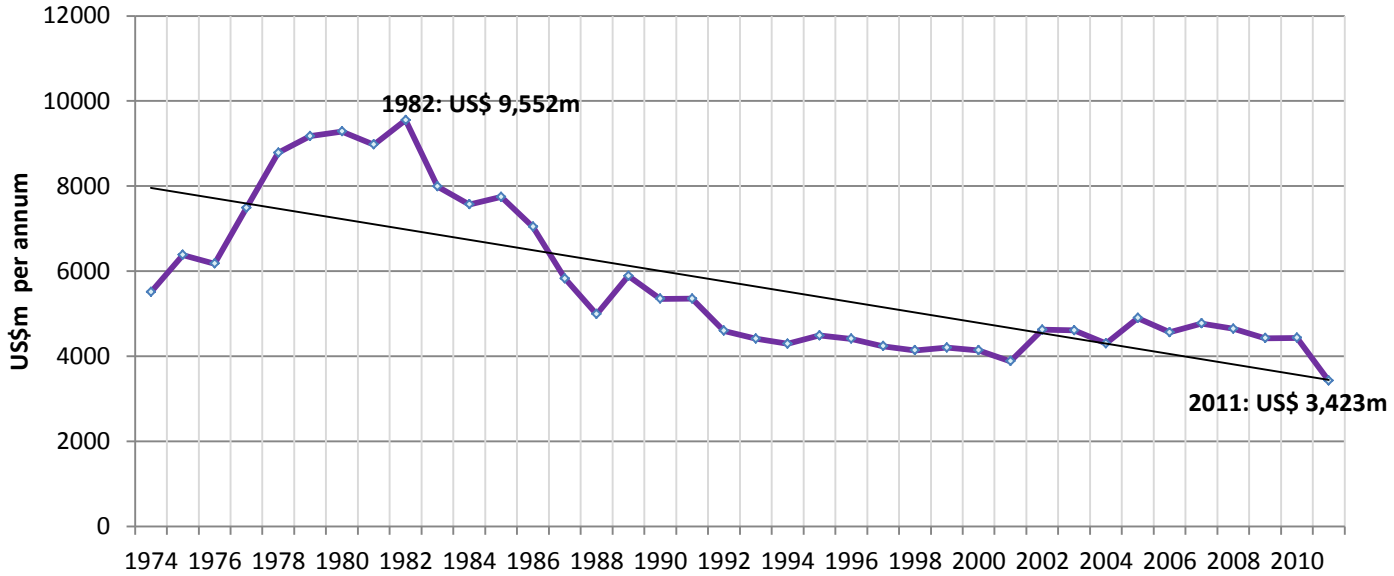
- We must present a compelling case for **next-generation fission *as a broad suite of technologies to improve human livelihoods and cure social ills*** *(e.g. Air pollution)*

- History is littered with examples of good ideas that were damaged by internecine struggles. Nuclear must not be a new example.

Socio-political hurdles: dearth of fission R&D

- In 2011 OECD spending on fission research was just ~35% of the 1982 maximum
- The great hopes are China, India and increased international collaboration
- In OECD countries, we must create a supportive political environment and excite the general public

Annual spending on fission R&D: OECD countries, 1974-2011



Source: International Energy Agency review of fission RD&D investment, 2011

- In addition, we **must train the next generation of nuclear scientists and engineers** and need to excite our young scientists about the potential of nuclear fission

Climate change and the global energy market

- There is no meaningful global agreement on climate change

- Expected drivers of expansion of nuclear fission, such as carbon taxes or effective carbon trading schemes, have not materialised

- Liberalised energy markets discourage fission R&D

- Emergence of fracking has drastically lowered costs of natural gas in US, with detrimental consequences for nuclear industry

- Global policy-makers are torn between the allure of purported cheap energy (e.g. fracking) and enacting necessary long-term policies to support zero-carbon electricity. They may choose former.

- **The nuclear industry has to decide not whether it will survive, but in what form it will survive.** Will the industry be a thriving innovator?

- Solution: to develop new reactors that meaningfully reduce the capital cost of NPP

International scientific and technical cooperation

- Historic international collaboration (e.g. via OECD NEA) is unappreciated
- We need a major push to **increase global collaboration**
- Thorium and MSR researchers are a small band. Budgets are (currently) limited. We need to work together.
- China is a great example of 21st century international collaboration
- For example, should NEA and IAEA establish dedicated MSR research projects?
- Global collaboration could accelerate the development of critical tools for MSR research. What technological tools are required for all MSR R&D?
    - E.g. Development of high-quality suite of Codes
    - E.g. Databases of materials' properties (e.g. Corrosion)
    - Open-access databases of previous MSR research (e.g. ORNL, UKAEA)
    - Materials Test Reactors for MSRs
    - Sharing knowledge of regulatory systems

Nuclear R&D in 21st Century

- We have to **shorten nuclear fission's innovation cycle**.

- Let us consider the example of fracking and renewable technologies. For example, crystalline silicon solar cell prices have fallen from $76.67/Watt in 1977 to an estimated $0.74/Watt in 2013 (2013 US$).

- Both renewables and unconventional fossil fuels have short innovation cycles that current nuclear cannot compete against.

- Is nuclear R&D a commercial or a scientific activity? Should nuclear be put in a different 'box' to other forms of R&D?

- Let's meet half-way: **Nuclear R&D *is* a different kind of R&D and should be publicly supported, but nuclear R&D must also become easier to do *and from the outset must aim to produce a viable commercial product***.

- To support the above, collaboration between national laboratories and commercial companies will be critical.

Commercially-orientated MSR design

- **Reform of licensing** is urgently needed: demo-scale reactors should not be subject to same licensing regime as GW-scale reactors

- $26bn+ - excluding subsidies - for two reactors, as at Hinkley C in UK, is simply too expensive to compete in an era of liberalised energy markets and cheap natural gas.

- MSR designers must aim at significantly lowering the capital cost of new nuclear power plants. Nuclear should be able to compete without subsidies.

- Lowering costs requires:

  - Inherent safety
  - Inherent simplicity
  - Improved waste profile
  - Working with "the grain" of the licensing regime (e.g. Using pre-licensed materials)
  - Modular construction
  - *Prima facie* business case

- MSR researchers: what is the simplest (but licensable) MSR design that you can imagine?

- Does the shortest route to a thorium MSR lie via a uranium/plutonium-fuelled MSR?

Key characteristics of enabling environment for R&D

- Unified community of next-gen nuclear proponents
- Licensing regime that actively supports innovation
- Supportive political class; supportive civil society
- Public excitement about the potential of next-gen fission to improve lives
- Recruitment of bright and ambitious young scientists into fission
- Widespread international scientific collaboration
- Simplified MSR designs that minimise regulatory overhead
- Private investors' interest to spur commercialisation of MSR technology (e.g. Venture capital, pension fund investment, sovereign wealth funds)

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Thank you for listening.
Questions, please!

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