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Accelerator-Driven Subcritical Reactor Outlook

Thorium Energy Amplifier Association Strategic Roadmapping: 7th-8th September 2009

Foreword

The aim of the Thorium Energy Amplifier (ThorEA) Association is to aid and promote research and development (R&D) into Accelerator-Driven Subcritical Reactor (ADSR) technology, with the ultimate goal of seeing a commercial demonstrator reactor constructed and tested. To ensure that ThorEA continues to best utilise the skills of its members, a strategic roadmapping session has been hosted. The session gave members the opportunity to step back from their specialist research interests and consider the overall status of ADSR technology and its potential place in society. This has enabled the organisation to ratify its identified aims and objectives and R&D priorities, while also generating ideas for how to best realise ThorEA's aspirations. This document summarises how the roadmapping session was enacted and its conclusions.

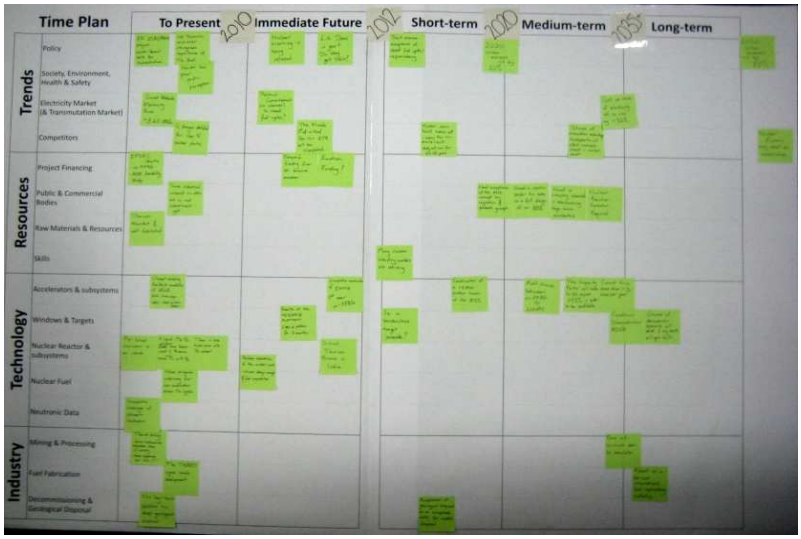
Format of the Roadmapping

The roadmapping was carried out over two days. It was integrated into one of ThorEA's quarterly workshop meetings, which took place on the 7th and 8th of September 2009; it was hosted at the University of Glasgow. All attending members of the ThorEA meeting participated. On the first day there were over a dozen members in attendance, on the second day there were 10 people. Details of the meeting schedule are available on the ThorEA web pages here: http://agenda.hep.manchester.ac.uk/conferenceDisplay.py?confId=1126 [Accessed 5th May 2010]

Session Preparation

The ThorEA meeting took place over 2 days. The time available for roadmapping was only a part of this. Thorough preparation was undertaken to make the most of that time. The preparatory work was carried out with the assistance of the University of Cambridge Institute for Manufacturing (IfM). The IfM has a dedicated and experienced strategic roadmapping research group (see: http://www.ifm.eng.cam.ac.uk/ctm/trm/ [Accessed 5th May 2010]). A special thank you is given to Dr Robert Phaal from that group for his assistance in the preparations.

The time plan before it was taken to the workshop, after small scale test roadmapping session.



In advance of the workshop a time plan was developed. The time plan (used on Day 1) was designed to loosely shape discussions at the workshop, while not going so far as to force the discussion to fit into a predefined structure. The plan was drawn on two A0 sheets of paper. It had columns non-linearly indicating time into the future, while its rows were categorised and subcategorised to cover all aspects of ADSR design (e.g. engineering, physics, economics, policy, social concern, environment etc). Identifying these categories in advance served two purposes. First, they were a prompt for participants while they brainstormed ideas, and, second, it allowed the generated ideas to be grouped in such a way that the time plan visually conveyed how the aspects of ADSR R&D might interlink and affect one another. This further aided the generation of ideas.

A small-scale test session, at which 5 ThorEA members were in attendance, was hosted in advance of the workshop. This was to help manage the time constraints of the roadmapping session, expediting the process by including upfront the straightforward considerations of ADSRs. Already having written information to look at aided in orientating the other participants at the roadmapping session proper.

On Day 2 the ThorEA members were tasked with identifying specific actions that could be taken on ADSRs. To do this they were asked to fill a page of brainstormed ideas and identified actions. To aid the participants, in advance of the session an example was created on the unrelated topic of the UK national rail network.

Day 1

In general the members of ThorEA were not familiar with the IfM roadmapping methodology that was employed. The day began with a brief introduction and explanation of what was going to be asked of them. There was one task on the first day. The pre-prepared time plan was pinned up beside the projector screen, where the contributed talks for the rest of the workshop were presented. During lunch the time plan was mounted in the dining room. The ThorEA members were asked to be mindful of the time plan while they listened to ADSR topics being discussed over the course of the day. Each member was handed post-it notes and a pen. They wrote down any thoughts

they had, be they positive or negative. During session breaks they placed their comments at an appropriate place on the time plan. This built up an overview picture of the factors affecting ADSR development.

When the first day was over the time plan was photographed for record keeping purposes. In the evening the roadmap session organisers then rearranged all of the comments into rough categories. The chosen categories are listed below:

- Pressure Groups, Politics and Regulators
- Skills and Shortages
- Markets and Mining
- Industrial Partners and Operators
- Competition
- Waste Reprocessing and Disposal
- Reactor Engineering Challenges
- Accelerator Engineering

The contributed comments grouped into categories. The time plan was used only as a canvas at this stage.

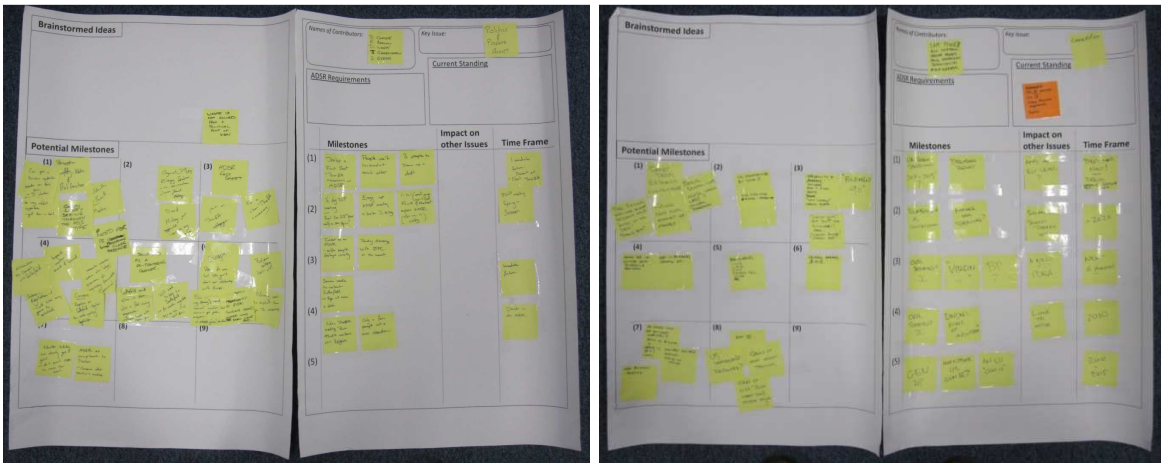
Day 2

During the second day there was a long session dedicated to roadmapping. In this session the members were split into two groups. They each examined one of the categories identified at the end of the previous day. A consensus was reached that, as there would be only two groups, most benefit would be gained through examining the two categories that members of ThorEA ordinarily spend the least time examining. Therefore, “Pressure Groups, Politics and Regulators” and “Competition” were selected.

The small group session was broken down into two phases. While taking the comments of the previous day into consideration, in the first phase potentially significant milestones, such as changes in the market environment or satisfying the concerns of pressure groups, were brainstormed. These ideas were then discussed and the most promising among them were carried forward to the second phase. In this phase actionable solutions to or specific mechanisms for enabling the identified

milestones were identified, usually with a time scale estimate for when they might be carried out. Combining the two groups once more, the identified actionable ideas were discussed and final conclusions drawn.

The brainstormed ideas and the identified actions determined by the groups examining "Politics, Pressure Groups and Regulators" and "Competition".



The Actionable Ideas

The following are the actionable ideas that were presented at the end of the second day of the roadmapping session. *They are only suggestions.* The ideas are grouped into "Pressure Groups, Politics and Regulators" and "Competition", the ideas are not listed in any particular order.

"Pressure Groups, Politics and Regulators"

(1) "Factsheet" {Immediately}

Develop a ThorEA ADSR "factsheet" for public use and to benefit ThorEA members, who may be specialists in one or a few aspects of research, but do not necessarily appreciate the most recent developments and challenges in all areas of ADSRs. Develop a draft to be discussed at next ThorEA meeting, 24th November 2009.

(2) Meetings {Spring/Summer 2010}

Host a ½ day Institute of Physics meeting (or perhaps as an alternative, a 350th anniversary of Royal Society special topic meeting?). Focus the meeting on energy and not specifically ADSRs. The purpose being two-fold: to consider the potential of ADSRs alongside other future energy technologies, rather than just its internal challenges; and to generate wider awareness of the technology.

A more challenging idea: hold one-on-one small meetings with individuals who are prominent for their anti-nuclear opinions. This could only take place after further refinement of the ADSR design, at a stage when an attempt to carefully account for the concerns of anti-nuclear members of society has already been made. This would no doubt benefit from the completion of the "factsheet".

(3) Accelerator-Driven test Reactor {No timescale specified}

Turn a research reactor into an ADSR by attaching a medical accelerator to it. The benefits of such a test would be that it would set a precedent for safety regulators in identifying what actions are acceptable for a subcritical reactor core. It would cultivate practical UK nuclear engineering experience in building and operating ADSRs. It would also open up many research opportunities and make it possible to test design features of ADSRs.

(4) Reprocessing and Regulation {Immediately}

It is becoming apparent that there are important unanswered questions regarding how regulation of thorium fuel in an open or closed fuel cycle might differ for subcritical reactors compared to critical reactors. Sellafield Ltd has been identified as a potentially useful first port of call to answering these questions.

(5) ThorEA could meet with members of EUROTRANS {Immediately}

Given the strong parallel between ThorEA's R&D efforts into ADSRs for commercial power generation and EUROTRANS' efforts in developing ADSRs for the transmutation of nuclear waste it might be mutually beneficial to arrange a meeting between members of ThorEA and those involved with the planned XT-ADS reactor.

"Competition"

(1) R&D Funding Following the Coming Election {2010}

What will short-term public spending look like? What will be the R&D spending priorities of the incoming government?

(2) Competition from Renewable Technologies {~2020}

A large increase in renewable energy sources for electricity generation may eliminate the need for base load electricity. This could be to the detriment of the economic case of ADSRs. How will they perform if they are not needed as a base load provider? This same issue will affect technologies such as the Severn Barrage and SolarTec.

(3) Possible Strategy I {next 6 months}

Approach a large company, which has no history in the nuclear industry, but that might be open to expanding into new industries (e.g. Virgin). This would be an attempt to separate ADSRs from the rest of the nuclear industry, making it easier to brand them as a genuinely clean form of energy generation. To be able to justify the branding claim will require a strong continued effort in R&D in waste transmutation matters.

(4) Possible Strategy II {~2010}

Strategy I would likely place ADSRs in competition with the rest of the nuclear industry. It may be that the technology is better placed as a commercial venture by situating it in a supportive role to the rest of the nuclear industry. The ADSRs could be configured to emphasise the burning of waste from other power stations. Revenue in this case would come not only from direct electricity sales, but also from other nuclear power generators, who would pay to have their waste transmuted. There are obvious parallels here to India's nuclear power program.

(5) An EU Gen IV {2010-2015}

Is there merit in developing a set of Generation IV reactors for the EU, instead of falling back on the assessment made by the USA? How would ADSRs fair today in a comparison with the Gen IV technologies selected by the USA?

Progress Following the Roadmapping Meeting

Presently (June 2010, 9 months following the meeting) a number of the identified actions have been followed up. The follow-up activities are summarised below:

(1) The ThorEA Information Site

Inspired by the proposed factsheet, the ThorEA information site is a freely accessible online repository of information about physical, engineering, economic and social factors affecting ADSRs. The web site was created in April 2010. All of the members of ThorEA can make contributions to the site. It is openly available to the public and follows the academic style of citing from where all of the information is presents originates.

(2) Pursuing Construction of a Test Reactor

Follow-up meetings and discussions regarding the construction of an ADSR test reactor have taken place since the roadmapping meeting. Potential avenues for how such a reactor might be realised have been identified. The practical challenges faced by these avenues are currently being looked into in detail.

(3) Attendance to a EUROTRANS Conference

In March members of ThorEA attended the First International Workshop on Technology and Components of Accelerator-driven Systems in Karlsruhe, Germany. At this meeting they both discussed their own research and listened to the findings of their EUROTRANS counterparts. Proceedings from the meeting are in press; they are being published by the OECD – Nuclear Energy Agency.