



APPG on Small Modular Reactors

Date: 27th April 2022
Time: 13.30
Location: Online via Microsoft Teams

Attendees:

Virginia Crosbie MP (Chair) (VC)
Liz Saville-Roberts MP (LSR)
Andrew Selous MP
Lord Howell of Guildford
Baroness Bloomfield of Hinton Waldrist
Josh Male – Trudy Harrison MP
Harry Wilkinson – Craig MacKinlay MP
Sally Clarke

Terrestrial Energy

Michael Drury (MD)
Louis Plowden-Wardlaw (LPW)
Sarah King
Michael Zdanowski

Secretariat

Havard Hughes, Barndoor Strategy
David Spencer, David Spencer

Apologies:

Viscount Trenchard
Lord Deben

Meeting Minute

Liz Saville-Roberts MP (LSR) and Havard Hughes (HH) from the Secretariat shared chairs responsibilities in the absence of Virginia Crosbie who was absent at the start of the meeting.

Havard Hughes introduced Mike Drury (MD) from Terrestrial Energy and invited him to make his presentation.

MD spoke to outline Terrestrial Energy, its technology and its funding

He highlighted the importance of meeting the decarbonisation targets for the last 30% and described Terrestrial Energy as a disruptor which had a product that could help. He explained that they had a Generation 4 Reactor that was based on reactor technology developed in the '50s and '60s. A lot of the underpinning evidence was from existing technology which should help to bring it to market faster and easier.



He explained that it could help to deliver low-cost electricity, low-cost heat, and help industries to achieve their decarbonisation targets.

Terrestrial Energy is primarily privately funded and is currently moving through the regulatory process. It is reaching completion of the Canadian regulator's VDR Phase 2 which is similar to UK's ONR regulatory process, GDA Stage 2

The deployment schedule is achievable by 2031 and Drury also outlined some of the potential UK IP development and export opportunities including technologies for fuel, instrumentation & control, new pumps, heat exchanges, and materials. He also noted how each reactor comes with a thermal and electrical plant and therefore drives jobs on site for operations plus in the supply chain.

He explained how Terrestrial Energy had been through the vendor design review process in Canada and Terrestrial has developed a deployment schedule achievable by 2031. He emphasised that the technology could offer low cost electricity and low cost heat so can produce hydrogen with that heat at a price of \$1.7 – \$2.2 per kilo. This is competitive and has been independently validated.

He explained that the technology consists of 3 elements:

- An Integral molten salt reactor
- A thermal and electricity facility; and
- A thermal storage centre to support flexibility for industrial applications.

He further noted that there are currently three main industrial target areas:

1. Hydrogen Production
2. Ammonia Production
3. Urea Production

Others like aluminium smelting, cement production, and desalination are possible but these three are the focus at the moment.

In summary, Drury said that Terrestrial Energy's technology was based on existing and proven technology, it was not starting from scratch. He stressed that the technology had good export and IP potential, funding has been raised privately and they believe this model is sustainable, and a supply date of 2031 is achievable. He added that the molten salt technology complements the UK Energy Mix.

Terrestrial Energy can deliver high quality heat at low cost and its technology addresses the 30 % question of decarbonising the hardest to abate parts of industry. It has an essential role on the pathway to Net Zero.

Andrew Selous MP – Asked about the 2031 delivery date noting that many politicians are impatient given the climate challenge and reports from the UN. He asked if there was any chance the generic design assessment and process done more quickly. He also asked about contact between Terrestrial and Rolls Royce.

MD: Deployment could be done faster. But this depends on factors like the GDA and DCO which requires eight years just in approvals of its own. If this can be expedited or done in parallel to reduce timeframes, deployment could be achieved sooner.



If the right type of conditions, such as the utilising and transferring work on the VDR process with Canada, are set, then maybe the process could be fast track and streamlined to support a faster UK delivery schedule.

On Rolls Royce, there is no link although Drury does have some experience of working with Rolls Royce personally when he was at the National National Laboratory.

Baroness Bloomfield declared that she was formerly on the advisory board of Terrestrial Energy and added that molten salt was a generation IV type plant which was very much cutting edge science and it was totally different. Rolls Royce was a type III technology.

MD continued, noting that molten salt technology was very different as it was a high temperature reactor which provided heat and could vary the amount of heat depending on the process meaning industry could use the heat to make hydrogen but could also use for making electricity in grid applications. A light water reactor like Rolls Royce's SMR does not have the high quality heat to do this – accordingly the IMSR technology vastly improves the economics for industrial processes.

Liz Saville-Roberts MP asked what would see if travel to Canada?

MD said you would not see a physical plant today. Terrestrial was at equivalent to GDA 2 so this meant the safety case was written and underpinned to get to a licensable technology. Testing was in place with a global supply chain showing various stages but Terrestrial Energy was ready to enter licensing phase with components and systems at an appropriate stage of design and procurement to enable this..

Liz Saville-Roberts MP asked what was necessary to bring this on as a viable technology at the moment?

MD said at the National Lab when originally investigated over four years ago, they would have agreed that it was academic. However, the technology was no longer academic and there were programmes of validation at work with supply chains delivering the technology. It was now no longer a question of is the technology ready, it is now whether the team can be brought together to demonstrate deployability and the business cases for each site/plant. This was what Terrestrial Energy was looking at now, in the UK, Canada and the US. There is a £1bn loan guarantee from the US Department of Energy if Terrestrial Energy were to do a first-of-a-kind in the US.

So, if Terrestrial Energy deployed on one of the NDA estates in the UK, – would the articles of association of the NDA be changed to facilitate this? Also, who would take the electricity? If this was the case, then Terrestrial Energy would need a grid link through contracts for difference or the new Nuclear Energy Financing Act and the Regulated Asset Base model, or a heat or electricity PPA with an industrial partner.

But he added they could also use the technology for heat provision sooner. This would enable decarbonisation to start today and establish the connections ready for when the reactor plant is licensed to operate, which would give a lot more efficiency. But decarbonisation could start today, which was the challenge now.

Liz Saville-Roberts MP asked what was the difference in the waste?



MD explained that spent fuel could go back into the reactor. Terrestrial Energy are looking to utilize spent fuel from its own reactors. As the technology develops and confidence in the regulation of Molten Salt reactors develop Molten Salt reactors could be utilised to take existing nuclear fuel stockpiles and burn this waste. With Molten Salt reactors, there is less waste especially when compared to the current conventional technology. Terrestrial Energy's design of the IMSR is a thermal reactor. Future reactor development of a fast breeder configuration specialised for waste burning could be done now but the developer would have to evolve the reactor design materially which would affect the early deployment schedule due to additional regulatory approval and validation for a fast breeder reactor. This would be significantly more involved than the validation and regulatory process suitable for a reactor such as the IMSR.

Virginia Crosbie MP asked about deployment sites. What would be the ideal sites? What was the state of engagement with potential site owners?

MD said Terrestrial Energy had looked at various sites such as Hartlepool because of the Tees Valley Cluster and also various international firms based in the Tees Valley using the heat. Hartlepool also has a nuclear site in the same region. Terrestrial Energy is also in discussion with multiple other sites including those in Oxfordshire and Trawsfynydd too as it would help prove the connection with renewables or in support of the power demand or medical isotope production. Terrestrial Energy is also extremely active exploring the potential of the IMSR for hydrogen and ammonia production.

Terrestrial Energy had already been in discussion with Preston regarding UF4 fuel which could be used as a base product for multiple types of reactors. There is a programme underway already with Westinghouse and the National Nuclear Laboratory to look at how this could be moved forward to a commercialised route.

Terrestrial Energy were also looking at brownfield sites where industry could be brought in where perhaps there hadn't been a history of nuclear. There had also been discussions around Dounreay about molten salt given their past history of test sites. There was also potential for other sites in the UK in industrial clusters such as those in Hull. There were plenty of others too which Terrestrial Energy wanted to support decarbonisation. The real advantage which Terrestrial Energy could tap into was where industry needed heat, they could provide that heat at a low economic cost.

Virginia Crosbie MP asked about level playing fields.

MD noted that Terrestrial Energy were not asking for a hand-out or financing but would apply for grants if these were available. It had raised \$100 million in capital to date due to the power of the business case and the economic return. For example, the announcements which we've had regarding high temperature gas reactors or Rolls Royce's UK SMR, these could be seen as adverse to molten salt deployment in the UK.

Terrestrial Energy would ask for a level playing field to allow firms to come in and show their business case and to be based on the merit of deployability of their technology within the time frames. Terrestrial Energy wanted a level playing field which said it wasn't closed off to other technologies.

Virginia Crosbie MP asked what could MPs do to help?

MD explained that specifics were always helpful. A discussion of sites and where do you want this would help them. Some areas had sites where operators wanted to stay. Others might not even have nuclear in their seats. For example, Oxfordshire had nuclear sites at Cullham and Harwell.



Virginia Crosbie MP asked, in terms of the supply and demand and who needed this technology.

MD said any industrial application that needed heat above 500 degrees in temperature. Some of those industries also demanded high power demand too so they would have high demand for electricity in clusters and the residual heat from the plant could be used to support additional benefits such as district heating systems. The key targets for Terrestrial Energy really were hydrogen production companies, chemicals, and ammonia. This would drive industrial efficiency whilst decarbonising to Net Zero and allow the UK economy to compete rather than send all industry to other countries.

Baroness Bloomfield asked who would buy and operate the plants?

MD said the client could be Government if they wanted to have an agreement for electricity and grid connection or it could be industry such as the large-scale heat or industry users. So, the likes of INEOS, CF Fertiliser or steel production companies looking to reduce the costs for initial heat. BoC for hydrogen production as well as BP were options too. When you started getting clusters of companies coming together you could get a grouping of power demand and a higher level of efficiency.

Terrestrial Energy would bring in a team to operate and had had multiple discussions with operators who had global footprints who could come into the UK and develop operational capabilities. They had 100 people working on delivering the technology now. But they would stand up a new operational team in each plant. They could bring in or stand this up and develop this in co-operation depending on the needs per site.

Virginia Crosbie MP asked for some more information on funding.

Louis Plowden-Wardlaw explained that Terrestrial Energy has a broad base of investors, mostly high net worth individuals and family offices. Don't have a dependence on any particular individual or any particular country. No insalubrious countries involved either. Had investment and had gone through several rounds of investment.

Virginia Crosbie MP asked about Terrestrial Energy: UK relationships and BEIS and also relationships with other governments.

MD said that in his previous roles he worked closely with BEIS and the policy team and also the nuclear research and development team. Terrestrial Energy has already had initiation discussions with BEIS. But we've deliberately not talked to them further until Terrestrial Energy have firmed up their UK strategy and direction of travel with launch programmes.

They have not approached them yet on specific plans as they are waiting for industry customers so could enter into a GDA once confirmed the industrial direction. They didn't want to go to BEIS without programmes in place on testing and deployment.

Virginia Crosbie MP asked about the Nuclear Financing Act and Rolls-Royce and what Terrestrial's views were?

MD said the RAB model did act to bring down the weighted cost of capital. It could keep the cost down and could keep down the cost of electricity for the consumer. The RAB model allowed government to support for grid application, industry might do it in a different way with the



companies that needed the energy. It could work to a CFD or a regulated asset base or different agreements for power provision with industrial clients directly.

Andrew Selous MP asked how British they were.

MD said he worked three to four years ago on programs similar to GB Nuclear. He would love to get involved with this and understand more. But bringing together all the relevant departments could only be hugely beneficial. He added that they were not at the moment a principally UK firm. Terrestrial Energy have set up a UK entity and he was its first employee.

The first challenge would be to set up the regulatory team to go through with the ONR. This would roughly be 30 individuals to go through the GDA so the requesting party could be put in place. As Terrestrial Energy grew and set up industrial programmes, it would set up the site specific technological teams. Terrestrial Energy have over 100 people predominantly in Canada and some more in the US too. The current engineering team is Canadian based.

Liz Saville Roberts MP asked about IP and where this would sit

MD explained that this would be on a contract to contract basis. As an example they were looking at specifically how this could work with fuel development programmes with IP and technology to reside in both the UK and Canada and to be able to pull back GDP to both. UF4 was one of the technologies or one of the parts. The mixture with the salt could be done in country potentially. So, this would be different. There were opportunities for supply chain all over the world and this was an important point about where the GDP came back to.

Andrew Selous MP asked if Terrestrial Energy were being courted by the UK Government?

MD said he knew where the Government was on the technology and the development path and would go back to the people in BEIS with the evidence of the landscape and why this had changed, and how it was not about the technology anymore, it is now about the deployability.

Baroness Bloomfield noted that she introduced Terrestrial Energy to Richard Harrington several years ago when there was a very firmly closed door! The evidence available now should be presented to BEIS as the technology developed today has reached a higher state of maturity and the landscape has significantly changed.

Virginia Crosbie MP thanked Terrestrial Energy for taking part and closed the meeting.

Future Business

Next meeting 18th May with Assystem looking at nuclear skills and the supply chain.

The Secretariat we also working on organising round-table meetings for May and June with a number of firms regarding specific aspects of SMR development and siting.

There were also plans for a site visit to a nuclear facility for SMR APPG members.

Meeting closed at 14:30