CABINET

Report of: Director of Community Services

Date: 17th May 2021

Portfolio: Cabinet Member for Economy, Tourism, Leisure and Culture

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Re: STEP (Spherical Tokamak for Energy Production) fusion technology project

1.0 Purpose

1.1 The purpose of this report is to seek approval from Cabinet for Pembrokeshire County Council (PCC) to progress with an application to host the STEP (Spherical Tokamak for Energy Production) fusion technology project. This is subject to the expression of interest (nomination form) meeting the United Kingdom Atomic Energy Agency (UKAEA) 'showstopper' criteria, and the proposed Pembroke site (on land owned by both RWE and Valero Energy adjacent to the Haven Waterway) being included on a list of candidate sites.

2.0 Background

2.1 STEP is an ambitious programme for the conceptual design of a fusion power station. It is a UKAEA administered programme, currently with £220 million funding from the UK Government to produce a phase 1 concept design by 2024.

2.2 Beyond 2024 the project phase 2 intends to move into the engineering design and build phases of the programme where UKAEA will work with a range of partners to deliver the prototype of a commercially viable fusion plant. The STEP prototype intends to demonstrate the commercial viability of fusion. The learning from this will enable the future development of a UK fleet of commercial fusion plants.

2.3 The project phase 3 intends to construct a prototype fusion power plant, targeting completion by 2040. Once constructed, STEP will produce net energy and prove that electricity can be predictably and stably produced in a fusion power station.

2.4 In November 2020, the UK Government released an open call to communities across the UK to identify sites that could accommodate a STEP power station with submission of a nomination form required by end of March 2021.

2.5 A number of private sector partners and landowners have confirmed their support for the submission of the nomination form to develop a site to host STEP fusion technology park. The nomination form was submitted with the backing of the Haven Waterway Enterprise Zone Board (HWEZ) and Swansea University, and followed an informal Cabinet briefing with the UKAEA, WG and specialist consultant.

2.6 The site proposed to host STEP comprises land owned by both RWE and Valero Energy. Their site managers are members of the HWEZ and through that body have allowed parcels of land adjoining their operating sites to be nominated to host STEP.

Image 1. Proposed site on land adjacent to Valero Refinery and RWE Pembroke Power station.

2.7 HWEZ agreed to fund specialist consultant support from InSite Technical Services to complete and submit the nomination form on PCC's behalf.

2.8 With the project still in the inception phase, it is not possible to be too precise about exactly what buildings and facilities will be needed on site. This will become increasingly clear in future years as the design develops and a site is established.

Some of the key requirements for STEP are:

- Site footprint – this is not clear at this stage beyond a requirement for 100Ha minimum overall site area. This is required to accommodate power station infrastructure and to allow the opportunity to expand with associated future development and additional low carbon technology. On site developments will include the reactor itself, associated turbine hall, control facilities and auxiliary plant and development, design, and construction facilities.
- Access to High Voltage Grid.
- Access to cooling water –access to a major water source is important.
- Access to a skilled workforce.
- Strong transport links to facilitate delivery of major components, workforce, and international visitors to site (road, rail, air and port access of interest).
- Site environment – several criteria will be set out during site selection to ensure STEP is not impacting on a site of particular environmental or archaeological importance.
- Office accommodation – for research programmes and power station construction and operations.

2.9 STEP will have many of the features of a fully operational power station, including infrastructure and associated research and development facilities. It is likely to be of a comparable scale and value as any major power station. It will generate fusion energy and convert it into usable domestic and industrial electricity.

2.10 UKAEA's vision for the chosen site is that:

- STEP will be a project at the international forefront of the clean energy revolution, bringing visibility to the community on a global stage. The host community and region will become a global and world-leading hub for the development and deployment of fusion power, alongside the existing Culham Campus in Oxfordshire.
- The region will see significant development of supply chain and associated industry; both to support the STEP prototype design and build programme, and to service the global fusion industry which UKAEA expects to flourish on the back of STEP's proof-of-concept outputs.
- There will be long-term and enduring economic benefits to the host community. Supporting thousands of high-quality high-tech jobs STEP will support economic growth, providing the opportunity to attract £1.5bn of inward investment, and the training of highly skilled engineers. It will also be an integral part of meeting the global net zero challenge.
- The STEP programme will create 300 jobs directly, with even more in the UK fusion supply chain. In addition, the spin-outs from the design work are expected to be enormous – both in terms of synergies with other fusion power plant design activities (such as Europe's 'DEMO' prototype power station) and other hi-tech industries.
- STEP will create opportunities for growth across the UK, with jobs at all levels created in the region. The programme will also have a focus on skills development. The skills needed will mostly be in science, technology, engineering and maths (STEM) although there will be opportunities across a wide range of roles and skills. UKAEA has already allocated resources to support an apprentice training scheme in the local area and will work with local education and training providers at the earliest opportunity.
- That the region would potentially play host to future operational fusion power plants, subject to commercial, regulatory and planning requirements.

2.11 UKAEA will make a recommendation to the Secretary of State for BEIS on the most suitable locations for STEP following a rigorous process of assessment using a defined set of key criteria.

2.12 There will only be one site in the UK chosen and so it will be a very competitive process.

2.13 For more information about the programme and its siting process visit: www.step.ukaea.uk (page opens best using the Chrome web browser). The UK Government STEP pages can be found here: UK fusion electricity.

3.0 Fusion Technology

3.1 Fusion Energy is turning the process that powers the Sun into carbon-free, safe and abundant electricity for a cleaner planet. Often cited as the 'energy of the future' or the 'energy holy grail' fusion technology involves superheating hydrogen atoms into a plasma state so that nuclei fuse together releasing vast amounts of energy from a very small amount of fuel. This technology is the opposite of 'traditional' nuclear fission (splitting nuclei to release energy) which has a waste legacy and associated radioactivity dangers.

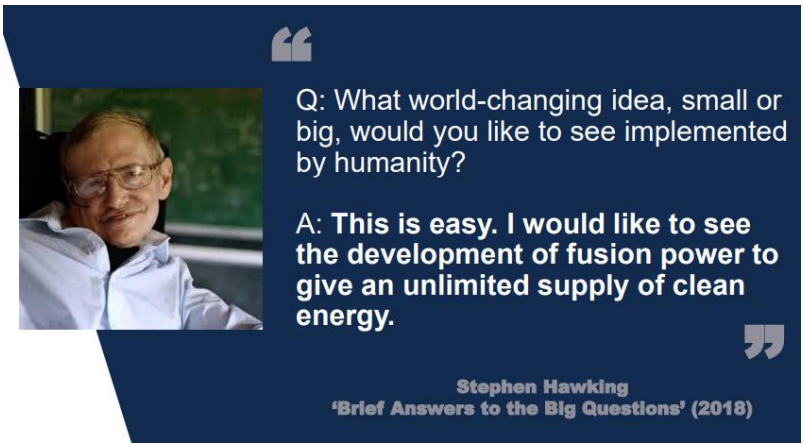
3.2 The key to nuclear fusion is obviously that the process needs to get more energy out than is initially put in. Nuclear fusion is the process that takes place in the heart of stars and provides the power that drives the universe. When light nuclei fuse to form a heavier nucleus, they release bursts of energy.

3.3 Potential advantages of fusion technology:

- Fusion research and development has been ongoing for many years. Following recent advances in technology, there is increasing confidence that a clear path to commercial operation can now be planned.
- An intrinsic property of the fusion process that it is inherently safe with low environmental impact and no risk of meltdown. Chernobyl or Fukushima-type accidents are not possible in a tokamak fusion device. It is difficult enough to reach and maintain the precise conditions necessary for fusion—if any disturbance occurs, the plasma cools within seconds and the reaction stops virtually instantly. Extensive studies over the last two decades have shown that no plant failure or accident could result in the need to evacuate public from outside the site.
- Abundant energy - Fusion fuels are widely available and nearly inexhaustible (deuterium can be extracted from water and tritium will be produced inside the power station from lithium, an element abundant in the earth's crust and seawater). As a simplistic rule of thumb UKAEA advise that a bath full of seawater and two lithium laptop batteries can meet a person's lifetime energy needs.
- Energy efficiency - Fusing atoms together in a controlled way releases nearly four million times more energy than a chemical reaction such as the burning of coal, oil or gas.
- No CO_2 - Fusion doesn't emit harmful toxins like carbon dioxide or other greenhouse gases into the atmosphere. Its major by-product is helium: an inert, non-toxic gas.
- No other harmful environmental emissions – Fusion process does not result in NOx, SOx, particulate or other emissions deleterious to local air quality.
- Limited risk of proliferation - Fusion doesn't employ fissile materials like uranium and plutonium. There are no enriched materials in a fusion reactor that could be exploited to make nuclear weapons.
- No long-lived radioactive waste - A fusion reactor produces helium, which is an inert gas and no radioactive waste by-products therefore result from the process. Reactor components themselves become

radioactive when neutrons interact with the steel within the tokamak structure; the level of activity depends on the structural materials used. The STEP programme seeks to maximise the recycling and re-use of materials and only use disposal routes where there is no other option. To this end research is being carried out on suitable materials to minimise decay times as much as possible. Any radioactivity of the components in the tokamak structure is classed as low level and relatively short lived.

- Fusion is regarded by Government as being carbon free, safe, low land use, low, manageable waste, reliable energy baseload with unlimited fuel.



4.0 Policy alignment

This funding bid aligns with several policy areas, namely:

- Welsh Government (WG) target for a carbon neutral public sector by 2030.
- WG policy for a 100% reduction in emission of greenhouse gases in Wales by 2050 against a 1990 baseline.
- WG target for 70% of electricity used in Wales to be from renewable sources by 2030.
- WG target for 1 gigawatt (GW) of renewable electricity capacity in Wales to be locally owned by 2030 and for all new projects to have an element of local ownership by 2020.
- WG 'Prosperity for All: A Low Carbon Wales' - A cross-government plan to cut emissions and contribute to the global fight against climate change.
- The UK Committee on Climate Change (UKCCC) recommendation and subsequent UK Government commitment for a net zero CO2 emissions target by 2050.
- WG Well-being of Future Generations Act – Long term thinking, Integration, Collaboration, Involvement and Prevention in a globally responsible Wales.
- PCC's, Welsh, Scottish and UK Governments declaration of a climate emergency and PCC's stated intention to work towards net zero carbon status with the Public Services Board and Swansea Bay City Deal partners to develop exciting opportunities to deliver carbon saving and to collaborate with experts from the private sector and 3rd sectors to develop innovative solutions to becoming net zero carbon.
- PCC's approval of the Net Zero Carbon 2030 Action Plan in December 2020.

5.0 Comments

Comments by Head of Resources

The financial issues are included within the body of the report. There is currently no allocated budget for any specific studies, so funding would need be identified if required.

Comments by Head of Legal and Democratic Services

There are no specific legal issues arising from this report.

Comments by Chief Human Resources Officer

No specific HR concerns.

6.0 Impact Assessment

Summarising the contribution against to well-being goals:

- A prosperous Pembrokeshire / Wales: significant long-term economic benefits with the creation of a UK/World centre for fusion technology, cutting edge decarbonisation of electricity and potentially heating and transport nodes. Retaining, developing highly skilled jobs and creating a strong replicable exportable product. Creates opportunists for existing supply chain in The Haven to take advantage of a fusion energy based energy revolution.
- A resilient Pembrokeshire / Wales: The project is focussed on decarbonisation which will help to mitigate the effects of climate change. The project creates enormous opportunities for the development of high quality employment and a space for new and existing industry to thrive and morph into a new low carbon fusion economy.
- A healthier Pembrokeshire / Wales: The scheme will see decarbonised electricity and potentially heating and transport nodes and can significantly improve air quality and noise pollution. The scheme could ultimately see a reduction in fuel poverty leading to health improvements.
- A more equal Pembrokeshire / Wales: The project will create/retain very highly skilled jobs.
- A Wales of cohesive communities: Creating a space for those employed in existing fossil fuel based industry to transfer skillsets to the fusion energy sphere will ensure communities stay together and prosper.
- A Pembrokeshire / Wales of vibrant culture & thriving Welsh language: No negative impact and a positive impact given that the project can take advantage of Wales' geography and location as a centre with major potential for fusion and renewable energy generation, a hydrogen economy and existing nationally important energy infrastructure.
- A globally responsible Pembrokeshire / Wales: The project offers an enormously positive contribution in developing a blueprint for the decarbonisation of electricity, and potentially heating and transport, with the creation of a fusion economy. It is a model with replication potential with great benefit in mitigating climate change, alleviating air and noise pollution and

creating a equal society. The predictable energy baseload of fusion aligns well with with Pembrokeshire possibilities for renewable energy and hydrogen production to allow UK to meets its 2050 decarbonisation target.

Summarising the contribution against the five ways of working:

- Long term – The project involve generational thinking and long term development with the creation of a UK centre for the fusion economy, cutting edge decarbonisation of electricity and potentially heating and transport nodes. Retaining, developing highly skilled jobs and creating a strong replicable exportable product. Creates opportunists for existing supply chain in The Haven to take advantage of a fusion energy based energy revolution.
- Prevention – The project can prevent damage from climate change, air and noise pollution and can prevent social issues and inequalities by retaining skills and creating opportunities.
- Integration – The proposal fits with the objectives of other public bodies and offers benefits to all members of the PSB for example the creation of replicable decarbonised electricity, heating and transports opportunities, heath improvements and reductions in health issues from air/noise pollution and fuel poverty.
- Collaboration - Working with other organisations is key to the project. Project partners already engaged and envisaged are Pembrokeshire County Council, Haven Waterway Enterprise Zone, major companies located on The Haven, the local supply chain, Port of Milford Haven and the Swansea Bay City Region.
- Involvement – The project has major provision to involve people and ensure that those people reflect the diversity of Pembrokeshire. The stakeholders identified for engagement throughout this project are primarily the local community, including residents of the Milford Haven Waterway, community organisations that serve them, and the local industrial and business communities.

Recommendations

1. Subject to the nominated site being included on the list of UKAEA candidate sites, Cabinet approval is required to agree to progress and support the progress of the nominated site through the full UKAEA assessment process.

2. Subject to recommendation 1, that Delegated power be given to the Director of Resources in consultation with the Cabinet Member for Economy, Tourism, Leisure and Culture, to authorise, if necessary, specific studies to progress the nomination.

Reason for Recommendations

To position Pembrokeshire at the international forefront of the clean energy revolution, bringing visibility to the community on a global stage. The project will bring long-term and enduring environmental, employment, skills and economic benefits to the host community.