Australian ITER Forum Website News Update 1/18

B.J.Green (20/1/18)

1. Tianwan 3 starts supplying electricity to grid

02 January 2018

Unit 3 of the Tianwan nuclear power plant in China's Jiangsu province was connected to the grid on 30 December. The Russian-supplied VVER-1000 is scheduled to enter commercial operation later this year.

http://www.world-nuclear-news.org/NN-Tianwan-3-starts-supplying-electricity-to-grid-0201185.html

Tianwan 3 and 4 are AES-91 VVER-1000 units designed by Gidropress and supplied by Russian state nuclear company Rosatom. AtomStroyExport is the main contractor, supplying the nuclear island. First concrete for unit 3 was poured in December 2012, while construction of unit 4 began in September 2013. Two similar VVER-1000 reactors (units 1 and 2) began operating at the site in 2007.

The process to load a total of 163 fuel assemblies into the core of Tianwan 3 got under way on 18 August. The start-up process began on 27 September, with the reactor achieving criticality two days later.

Following permission from the Chinese regulator, power at Tianwan 3 was raised to 25% of capacity, after which the turbine was brought into operation and electrical tests of the field and power delivery systems were carried out. This process was completed at 1.29pm on 30 December, Rosatom noted. "Power unit 3 was, thereby, connected to the grid. All systems performed in normal operational mode."

Power output from the reactor will now be maintained at 25%. Dynamic tests will later be performed at 50%, 75% and 100% of capacity. Upon completion of initial testing at full thermal capacity, demonstration operation will proceed at nominal capacity for 100 hours, after which preliminary acceptance procedures will follow. Preliminary acceptance is the starting point of a two-year warranty period for the operation of Tianwan 3. The unit is scheduled to enter commercial operation later this year.

"Construction of the third and fourth power units of the Tianwan nuclear power plant are being implemented in record-breaking time and can be considered examples of excellent international cooperation in the energy field," said Kirill Komarov, Rosatom's first deputy director-general for corporate development and international business."
The State Council gave its approval for the third phase of the Tianwan plant (units 5 and 6) - both featuring Chinese-designed 1080 MWe ACPR1000 reactors - on 16 December 2015. First safety-related concrete was poured for unit 5 later that month and for unit 6 in September 2016. Unit 5 is expected to enter commercial operation in December 2020 and unit 6 in October 2021.
The Tianwan plant is owned and operated by Jiangsu Nuclear Power Corporation, a joint venture between China National Nuclear Corporation (50%), China Power Investment Corporation (30%) and Jiangsu Guoxin Group (20%).

Researched and written
by World Nuclear News

2. First HTR-PM vessel head in place

04 January 2018

The pressure vessel head has been installed at one of the two high-temperature gas-cooled reactor units that make up the demonstration HTR-PM plant under construction at Shidaowan in China's Shandong province.

http://www.world-nuclear-news.org/NN-First-HTR-PM-vessel-head-in-place-0401185.html

The pressure vessel head was installed on unit 2 on 27 December, China Nuclear Industry 23 Construction Company Limited (CNI23) announced. In an operation lasting about 1 hour and 35 minutes, the 80-tonne component was attached to the pressure vessel with 76 bolts.
"This is the first installation of the pressure vessel cover of the world's first Gen IV reactor, indicating that the internal installation of the reactor pressure vessel has been completed before the closure," CNI23 noted.
Work began on the demonstration HTR-PM unit - which features two small reactors and a turbine - at China Huaneng's Shidaowan site in December 2012. China Huaneng is the lead organisation in the consortium to build the demonstration units together with China Nuclear Engineering Corporation (CNEC) and Tsinghua University's

Institute of Nuclear and New Energy Technology, which is the research and development leader. Chinergy, a joint venture of Tsinghua and CNEC, is the main contractor for the nuclear island.
The demonstration plant's twin HTR-PM reactors will drive a single 210 MWe turbine.
The pressure vessel of the first reactor was installed within the unit's containment building in March 2016. The vessel - about 25 metres in height and weighing about 700 tonnes - was manufactured by Shanghai Electric Nuclear Power Equipment. The second reactor pressure vessel was installed later that year.
The first of the graphite moderator spheres was loaded within the core of the first reactor in April last year. In July, the thermal hydraulic parameters of the steam generator were validated. The demonstration HTR-PM is expected to be connected to the grid and start electricity generation this year.
Researched and written
by World Nuclear News

3. Scientific panel urges US to stay in ITER

The report also calls for a national strategic fusion plan to resolve issues that won't be addressed by the mammoth undertaking in France.
David Kramer
http://physicstoday.scitation.org/do/10.1063/PT.6.2.20180105a/full/?utm_source=Physics%20Today&utm_medium=email&utm_campaign=9037273_NQ%20-%20TWIP%201–5%20January&dm_i=1Y69,5DP7D,E1OV2B,KT4R4,1

Shaky participation in a major experimental reactor threatens the US's progress in developing commercially viable fusion energy technology, according to a new report from the National Academies of Sciences, Engineering, and

Medicine. The report warns that the US risks being left behind in the high-risk, high-reward pursuit of bountiful emissions-free energy.

For years Congress has been haggling over funding for ITER, the international effort to build an experimental fusion reactor in southern France. In 2017 the Senate Appropriations Committee repeated previous years' calls for the US to end its participation in ITER. But a House-passed omnibus appropriations bill for fiscal year 2018 includes $63 million for the US contribution to the project, the same amount requested by the Trump administration. Last year, the US provided $161 million after the House's position prevailed over the Senate's. It remains to be seen whether that pattern will be repeated when the House and Senate versions of the appropriations bill are reconciled prior to signing by the president.

The National Academies report notes that the $22 billion ITER project is the only one capable of studying burning plasmas on the scale of a commercial power plant. Without the knowledge it will gain from ITER participation, the US fusion program would have to design, license, and construct a new facility capable of performing that research. The US fusion budget for FY 2017 was $437 million. President Trump's budget proposes to cut that by 29% in 2018.

Since rejoining ITER in 2003, the US has never come close to providing annual contribution levels commensurate with its 9% ownership share. Through FY 2017, it has contributed a total of $1.1 billion. ITER spokesperson Laban Coblentz says the US made no cash contribution to support operations at the French site in FY 2016 or 2017, and the unpaid balance for the two years stands at $65 million. In addition, the US in-kind contribution in 2017 fell short by about $50 million.

Five member nations—China, India, Japan, South Korea, and Russia—have the same ownership share as the US, and Coblentz says those countries are pulling their weight. As the host, the European Union is paying nearly half of ITER’s cost.

More than 80% of ITER’s estimated cost will be in the form of components provided by the partners. In December, project officials in Saint-Paul-lès-Durance declared ITER construction to be halfway finished. Completion of a machine capable of operating with deuterium is scheduled for 2025. Operations with deuterium–tritium that will produce a burning plasma will begin in 2035 at the soonest.

Ned Sauthoff, director of the US ITER office, said in an email that 17 subcontractors there were laid off in response to the FY 2017 funding shortfall. That leaves a project staff of 55 employees and 42 on-site subcontractors at the office, which is located at Oak Ridge National Laboratory in Tennessee.

So far, the US ITER office has managed to reprioritize work to avoid component delivery delays that would impact the reactor construction schedule. Should the US funding shortfalls be corrected in 2018, the overall ITER schedule shouldn't be impacted, according to Coblentz. Reassigning components from the US to other ITER members isn't feasible, he says, since years are often required to qualify companies to build them to exacting specifications.

Coblentz says he is hopeful that the US will meet its commitments this year. Yet the most optimistic likely outcome is for lawmakers to provide less than half of the 2017 contribution. A 2016 DOE report to Congress estimated the US requirement at $275 million this year, with annual amounts in excess of $200 million through FY 2024. Overall, $2.1 billion will be required through 2025 to meet the US commitment. Another $1.6 billion will be expected from the US from FY 2026–35 for the upgrade to deuterium–tritium operations.

Participation in ITER alone isn't sufficient to advance to commercial fusion energy, according to the report. Unlike the other ITER partners, the US has not composed a national strategic plan for the additional R&D needed for a commercial power reactor. Strategic plans “guide national research and innovation programs, help to engage industrial partners, and set the national priorities of our partners, enabling them to develop key areas of unique expertise,” the report states.

The lack of a US plan inhibits long-term planning by universities, national laboratories, and industry participants in fusion R&D. And there is plenty of R&D to be done: Unmet requirements for a working fusion power plant include methods for more efficient coupling of RF waves to the plasma, new materials that can withstand the intense neutron flux, and consistent breeding and safe handling of tritium inside the reactor chamber.

4. Six postdocs connect tokamak and stellarator

https://www.euro-fusion.org/newsletter/tokamak-stellarator-postdoc/

The announcement from the Scientific Board of IPP arrived just in time for tokamak expert Rachael McDermott and her stellarator colleague Oliver Ford. Rachael in Garching and Oliver in Greifswald were about to purchase new cameras to observe the plasma inside both experiments. Those cameras came with software which was not ideal for the needs of the two research teams.

Joining the paths

Developing proper software is not the only thing that researcher Rachael is interested in. “What will be really exciting to see, is how the two different groups of researchers tackle the same problem”, she says. “We usually have the same objectives, but we reach them via different paths. Exchanging and interacting here might create the best solution.”

Two teams, one goal

“We were kicking around ideas regarding how to develop the systems to better meet the goals of our spectroscopy groups”, says Rachael. “If we had the dedicated manpower we would be able to create something specific in a more efficient way and would not have to rely on commercial products that are designed for a more general audience.”
Rachael and Oliver used the newly created research opportunity to launch a call for a postdoc. He or she would become one of the six ambassadors who, from next spring onwards, will travel and work in both the tokamak and stellarator worlds. The person will receive equal training at ASDEX Upgrade as well as Wendelstein 7-X between 2018 and 2020 and will help to create resources that benefit both groups.

Creating extra space

“By allocating postdoc resources to such collaborative projects, we have created space for special projects to flourish. We were very impressed by the quality of the proposals that we received in response to this call”, says Thomas Sunn Pedersen, Director of the Stellarator Edge and Divertor Physics Division in Greifswald.

It is not only the creational aspect that looks promising: “The new postdoc will be in an optimum position to benefit from ASDEX expertise, and transfer this knowledge to the Wendelstein 7-X team. We in Garching have years of practice in running, for example, visible spectroscopy diagnostics and in interpreting the measurements. This will be very useful when the stellarator systems come online”, says Rachael.

5. US withdrawal from ITER project may isolate US scientists

By Jemima Owen-Jones3 January 2018
https://www.gasworld.com/us-withdrawal-from-iter-project-may-isolate-us-scientists/2013982.article
A new report by the National Academies of Sciences Engineering and Medicine, calls attention to the recent decision made by the US to withdraw from the ITER project – a large international burning plasma experiment.

The National Academies of Sciences fears that this decision could isolate scientists from the international effort and require a new domestic approach to study fusion. This report is the first in a two-phase study examining the state and potential of magnetic fusion research in the US and providing guidance on a long-term strategy for the field.

A burning plasma – an ionized gas like the sun and stars heated by fusion reactions – is a key requirement to make fusion energy. A magnetic fusion reactor can be thought of as a miniature sun confined inside a vessel. As an energy source, it has environmental advantages and its fuel is abundant, extracted from sea water. This area of interdisciplinary research results in technological and scientific achievements touching many aspects of everyday life and leads to new insights in related fields such as optics, fluid mechanics, and astrophysics.

So far, the US fusion energy science programme under the US Department of Energy has made leading advances in burning plasma science. For example, theoretical and computational models have substantially improved control of plasma stability, predicting plasma confinement, and enhancing fusion energy performance, and new techniques have been developed to avoid and mitigate transient events, which can erode plasma-facing materials in the experiment chamber. The overall understanding of burning plasma science has progressed significantly as well. If the US continues to participate in ITER, scientists within the country are also expected to make leading contributions to the study of fusion energy at the power plant scale, the report says.

Currently, the other parties involved in the ITER project – China, the European Union, India, Japan, the Republic of Korea and Russia – have developed national strategic plans for fusion energy demonstration, but the US does not have such a plan, the report says. Without a long-term vision, the US risks being overtaken as other partners advance the science and technology required to deliver fusion energy, said the committee that conducted the study and wrote the report. By adopting a national plan, the US has the potential to support strategic funding decisions and priorities within the national programme and foster innovation toward commercially-viable fusion reactor designs.

The report also calls attention to the need for more research to improve and fully enable the fusion power system, in addition to the ITER project. This research will help develop fusion energy devices that address the remaining science and technology challenges and demonstrate innovative solutions that lead to a reduced size, lower cost, full-scale power source, the report says.

The study was sponsored by the US Department of Energy. The National Academies of Sciences, Engineering, and Medicine are private, non-profit institutions that provide independent, objective analysis and advice to the nation to solve complex problems and inform public policy decisions related to science, technology, and medicine. They operate under an 1863 congressional charter to the National Academy of Sciences, signed by President Lincoln.

6. General Electric wins turbine contract for Paks II

17 January 2018

GE Hungary, a subsidiary of General Electric, has won a €793 million ($970 million) contract to manufacture and supply the turbines for two new reactors under construction at the Paks nuclear power plant, Russian news agency *RIA Novosti* reported yesterday.

http://www.world-nuclear-news.org/C-General-Electric-wins-turbine-contract-for-Paks-II-17011801.html

Citing the procurement website of Russian state nuclear corporation Rosatom, the report said GE Hungary had bid for the contract for its consortium with Alstom Power Systems, another General Electric subsidiary. Russian power plant equipment company Power Machines also took part in the tender, which was held by the general contractor for the Paks II project - Rosatom's engineering subsidiary ASE Group.

Paks currently comprises four Russian-supplied VVER-440 pressurized water reactors, which started up between 1982 and 1987. These units account for about half of Hungary's electricity production.

An inter-governmental agreement signed in early 2014 would see Russian enterprises and their international sub-contractors supply two new units at Paks - VVER-1200 reactors - as well as a Russian state loan of up to €10.0 billion ($11.2 billion) to finance 80% of the project. Under the agreement, Hungarian companies will conduct about 40% of the work on the project.

In May last year, Russia's ASE passed an audit as general contractor of the Paks II project and received a 'certificate of compliance' with the requirements of its EPC contract. The audit was conducted in Moscow and Nizhny Novgorod by its customer for the project, MVM Paks II, and the Hungarian Atomic Energy Authority. The award meant ASE can start the 'active phase' of construction work on two new units at Paks early next year, in line with the licensing process for the project. Construction work on Paks II is scheduled to start as early as this month.

General Electric companies won turbine tenders for Finland's Hanhikivi 1 nuclear power plant in 2016 and Turkey's Akkuyu nuclear power plant last year. Rosatom will provide the reactors for both these projects.

Researched and written
by World Nuclear News

7. UK committee says action needed on climate plan

18 January 2018

The UK government must take urgent action to "flesh out" plans and proposals set out in its Clean Growth Strategy if the country is to meet its emission targets to 2032, according to the Committee on Climate Change. Reliance on nuclear energy to decarbonise power generation calls for the timely completion of Hinkley Point C and the construction of additional nuclear power plants, it said.

http://www.world-nuclear-news.org/EE-UK-committee-says-action-needed-on-climate-plan-1801184.html

Under the UK Climate Change Act, the government is required to publish a set of policies and proposals that will enable the legally-binding carbon budgets, on track to the 2050 target, to be met. As part of the Act, the government needs to cut CO2 emissions by 57% from 1990 levels by 2050. In its Clean Growth Strategy, published in October 2017, the government sets out plans to meet the legislated fourth and fifth carbon budgets, covering UK emissions in the periods 2023-2027 and 2028-2032.

The Committee on Climate Change (CCC) yesterday published its findings and conclusions following an independent assessment of the UK's Clean Growth Strategy.

The CCC is an independent, statutory body established under the Climate Change Act 2008. Its purpose is to advise the UK government and devolved administrations on emissions targets and report to parliament on progress made in reducing greenhouse gas emissions and preparing for climate change.

The government has made a strong commitment to achieving the UK's climate targets, according to the committee. "It has placed the low-carbon economy at the heart of the UK's industrial strategy, framing the Clean Growth Strategy as a positive contribution to the economy (rather than a burden to be minimised)."

However, the CCC said: "Our assessment of the policies and proposals set out in the Strategy indicate that, even if these deliver in full, there remains a gap of around 10-65 million tonnes CO2 equivalent to meeting both the fourth and fifth carbon budgets on the basis of central projections."

CCC Chairman Lord Deben (John Gummer) said, "Urgent policy development is therefore required. We set out in this report our assessment of what is needed from the government by way of next steps - to firm up the current set of policies, proposals and intentions and develop further ways of closing the gap."

The government has set out plans for the decarbonisation of UK power generation to below 100 grams CO2 per kWh by 2030. The CCC said this "places a high reliance on new nuclear build and net imports across interconnectors, both of which have associated risks". It noted that the government's Energy and Emissions Projections "envisage an ambitious programme" of new nuclear build. The committee said for this to be achieved, it would expect contracts to be signed over the coming years.

The CCC suggests the government will need to "put in place a progress monitoring and contingency scheme to identify risks relating to delivery and, in the event that new nuclear plants are delayed or electricity imports lower, allow for additional low-carbon generation to be contracted".

The committee notes the strategy sets out three illustrative pathways to 2050, one of which excludes carbon capture and storage (CCS). "The government should not plan to meet the 2050 target without CCS."

Lord Deben said, "As it stands, the Strategy does not deliver enough action to meet the UK's emissions targets in the 2020s and 2030s. The government's policies and proposals will need to be firmed up as a matter of urgency - and supplemented with additional measures - if the UK is to deliver on its legal commitments and secure its position as an international climate change leader."

Researched and written
by World Nuclear News

8. EDF Energy expects 20% cost saving for Sizewell C

18 January 2018

EDF Energy is confident Hinkley Point C (HPC) will come on line in 2025 and that Sizewell C will be 20% cheaper to build, the company's new CEO, Simone Rossi, said yesterday in his first major speech since taking over from Vincent de Rivaz at the helm of the UK company in November.

http://www.world-nuclear-news.org/C-EDF-Energy-expects-20-cost-saving-for-Sizewell-C-18011801.html

Under a strategic investment agreement signed in October 2016, China General Nuclear (CGN) agreed to take a 33.5% stake in EDF Energy's Hinkley Point C project in Somerset, as well as jointly develop new nuclear power plants at Sizewell in Suffolk and Bradwell in Essex. The HPC and Sizewell C plants will be based on France's European Pressurised Reactor (EPR) reactor technology, while the new plant at Bradwell will feature the Hualong One design. The UK EPR successfully completed the Generic Design Assessment with UK regulators in December 2012, while the UK HPR1000 reactor design started this process last year.

In his speech titled '*New nuclear - responsibilities and opportunities*' at Cannington Court, near the HPC construction site, Rossi said replicating construction techniques from HPC, existing grid connections and the exploration of new finance models meant construction of the planned Sizewell C plant in Suffolk would cost GBP4 billion less.

Schedule

One of the main focuses at the HPC site, Rossi said, is 'J-zero' or June 2019 - when construction of the plant's structures above ground is scheduled to start.

"That can only happen once the foundations are in place for the first unit. All our 2018 goals will help us to achieve this major milestone on schedule by June 2019," he said. "Beyond J-zero, our goal is to put the first unit into service by the end of 2025. Are we confident that we can deliver by 2025? Yes, we are confident."

That confidence is based on the "innovative tools" and the lessons from other EPR projects, he said. The detailed 3-D digital model of the plant, for example, "helps teams get more jobs done right first time".

He added: "It shows the design down to the last light switch. Every engineer can see exactly where each of the 4000 kms of cable and 400 kms of pipe goes and in what order they are laid. Every team has the same plan with them in their hands - not away in an office. It's already making a big difference and significantly improving delivery of the programme."

Another example, he said, is working with suppliers "long before" contracts for the project were signed, in 2016. This means they have an "accurate idea of what they need to do and how much it will cost" before they start work, and testing equipment offsite means the quality of parts arriving on site is assured before they are put in place, he said.

Sizewell C

EDF Energy "understands the message" from the British government on cost reduction and the need to be competitive for future nuclear projects, Rossi said. The cost to consumers is made up of construction and financing and there is "potential to significantly reduce both" for Sizewell C, he added.

The key to reducing the construction cost is replication, he said. For example, HPC has eight emergency generators, which had to be designed and certified to meet the standards required for nuclear safety. The first two will cost GBP38 million, but the next six will be half that at GBP19 million each, he noted. At Sizewell, none of that development or certification work will need to be repeated and so all its emergency generators will be at the lower price, he added.

Repeating experience for a power plant that is largely identical to HPC makes a capital cost reduction of 20% possible, he said.

The successful adaptation of the EPR design to meet British regulatory requirements for its use at Hinkley Point C means "tens of thousands of hours" of engineering work does not need to be repeated for Sizewell C, he said.

Sizewell A, which houses two 210 MWe (net) Magnox gas-cooled reactors that started commercial operation in 1966, were permanently shut down in December 2006. Sizewell B is a 1188 MWe pressurised water reactor that began operating in 1995 and is due to shut down around 2035.

Rossi said: "Years ago, the site at Sizewell was built with a grid connection capable of handling a bigger power station - and it is relatively close to where demand is. Sizewell C can benefit from that big advantage with substantial savings in grid connection costs."

Financing

On financing, Rossi said reducing the cost of capital can "make a significant difference to the price for consumers". The final agreements enabling construction of two EPRs at HPC to proceed that the UK government, EDF and CGN signed in September 2016 included the contract-for-difference (CfD) and the Secretary of State Investor Agreement. The CfD - the ratepayer-backed guaranteed price for electricity generated by HPC - was originally agreed in October 2013 and guarantees the plant will get GBP92.50 per MWh for its first 35 years of operation. This strike price for HPC falls to GBP89.50/MWh if a final investment decision is taken on Sizewell C.

Rossi noted that the project's shareholders "bear all the risk" of building HPC, adding that the National Audit Office has suggested that other models of financing should be considered for the future.

"With government, we should explore alternative financing models that can create the conditions where institutional investors like pension funds can participate when they were not able to before. Sizewell C will be a proven technology, representing the 7th and 8th EPR Units, and the first 4 units will soon be operational in China, France and Finland," he said. "I am not saying financing will be easy - with the right framework in place, it will be possible."

Progress at Hinkley

EDF Energy's parent company, French utility EDF, has said the EPR unit under construction at its Flamanville site in France will be connected to the grid in May 2019 and reach full power in November 2019. EPRs are also under construction at Olkiluoto 3 in Finland and Taishan 1 and 2 in China. Olkiluoto 3 has been under construction since 2005 and has seen several revisions to its start-up date, which is now expected by the end 2018. Taishan 1 in China, which has been under construction since 2009, was expected to start up in the second half of 2017, while Taishan 2 was scheduled to begin operating in the first half of 2018. CGN said in late December, however, that commissioning of unit 1 is now expected this year and unit 2 in 2019.

Rossi noted that, at Hinkley, EDF Energy is building the fifth and sixth reactors of their type.

"It's one of the largest infrastructure projects in Europe and it will deliver safely for over 60 years. That said, like any major infrastructure project, we know we will face challenges and it is our job to deal with them. We will never compromise on safety and quality. What also matters is our impact on the local economy. Here in Somerset, all the activity on site is making a real difference to the economy and people," he said.

About 4000 businesses in the south-west region of England are registered to work on HPC and, by 2020, there will be GBP200 million of spending each year in the local economy, he noted.

"Money spent with companies like heavy engineering specialists Blackhill Engineering from Exeter or Somerset Larder which is already providing 65,000 meals a month," he said. "In November, the Social Mobility Commission highlighted the challenges facing West Somerset in providing opportunities for young and disadvantaged people. I know a lot is being done to tackle that and I am pleased that Hinkley Point C is playing its part," he added.

The Construction Skills Centre is training a new workforce for HPC and other large projects in the UK, he said.

"Trainees are learning skills in areas like steel-fixing where there is a national shortage. Next month the National Nuclear College is due to open here in Cannington. Without qualified people it wouldn't be possible to deliver the project. I want to take the opportunity to thank the local businesses, councils and education establishments. Without their support this would not be possible," he said.

Researched and written
by World Nuclear News

9. First borehole drilled in Canadian repository site search

19 January 2018

Canada's Nuclear Waste Management Organisation (NWMO) has completed drilling the first borehole near Ignace to a depth of about one kilometre. It is one of five sites in Ontario to be investigated for the siting of a deep repository for the long-term management of the country's used nuclear fuel.

http://www.world-nuclear-news.org/WR-First-borehole-drilled-in-Canadian-repository-site-search-1901184.html

Drilling began on 6 November in a rock formation known as the Revell Batholith about 35km west of Ignace, Ontario. The hole was drilled using a skid-mounted diamond drill rig. NWMO announced that drilling of the first borehole was completed on 16 January.

According to NWMO, it is anticipated that the deep geological repository in the type of geology found in the Ignace area (crystalline rock) would be developed at a depth of some 500 metres below ground surface.

NWMO anticipates drilling three initial boreholes, one after the other. Eventually, more extensive borehole drilling may be undertaken in a location identified together with people in the area as a preferred potential repository site.

Further activities to analyse the core samples and explore the borehole at depth are now under way, NWMO said.

Geoscience, environmental, engineering and repository safety specialists will continue to work through this year to complete the borehole analyses, interpret data and share the findings with an expert group for peer review. Once that is complete, NWMO will share findings with the community. The findings, along with those from earlier studies, will guide the NWMO in working with communities in planning any future study activities.

Mahrez Ben Belfadhel, vice president of site selection at NWMO, said: "Completing the drilling of our first borehole to obtain initial core samples and provide access to the geological conditions at depth marks another significant milestone in Canada's plan for the safe, long-term management of used nuclear fuel."

NWMO is searching for a suitable site for the repository through a long-term process called Adaptive Phase Management, launched in 2010. The process is progressively narrowing down study areas from a list of communities that registered interest. The preferred site must have a suitable rock formation in an area with an informed and willing host, and the project will only move forward in partnership with First Nation and Métis peoples and surrounding communities.

Twenty-one communities, all in Ontario or Saskatchewan, initially requested preliminary assessments. Of the 11 areas selected for Phase 2 studies, five in Ontario now remain: Ignace; Hornepayne; Huron-Kinloss; Manitouwadge; and South Bruce.

NWMO said it expects to be able to select the preferred site for detailed site characterisation by around 2023.

Researched and written
by World Nuclear News

10. Tepco surveys interior of unit 2 containment vessel

19 January 2018

An internal investigation of the primary containment vessel (PCV) of unit 2 at the damaged Fukushima Daiichi nuclear power plant in Japan was completed as scheduled today, Tokyo Electric Power Company (Tepco) has announced. The survey - using a suspended pan-tilt camera attached to a telescopic guiding pipe - identified deposits and fuel assembly components at the bottom of the pedestal area.

http://www.world-nuclear-news.org/RS-Tepco-surveys-interior-of-unit-2-containment-vessel-1901186.html

In February 2017, Tepco sent a "scorpion-shaped" robot - developed jointly by Toshiba and the International Research Institute for Nuclear Decommissioning (IRID) - into the PCV of unit 2. That survey discovered part of the grating of the platform inside its pedestal had dropped. Although the robot was unable to reach the area directly under the reactor pressure vessel, the company said the information it gathered would help it determine how to decommission the unit.

"Robotic explorations of unit 2's interior, especially inside the pedestal area at the base of the reactor, are essential to determine the location and condition of fuel that melted and reformed during the 2011 accident," Tepco said today. "But penetration of the area has been made challenging by deposits from the accident that has blocked the path of robots designed to crawl around it, and high radiation levels that limit the life of electronic equipment."

The company today carried out an investigation of the PCV of unit 2 using a suspended pan-tilt camera attached to a telescopic guiding pipe. The small and radiation-hardened device was also developed by Toshiba and IRID. The device was introduced into the PCV through a pipe about 12cm in diameter. It comprises a guiding pipe some 13m in length and with a diameter of around 11cm. Attached to this is a further telescopic guiding pipe, about 5m long. A camera module weighing some 2kg is mounted on the end of this. The camera module houses two cameras - a pan-tilt camera and a 'bird's eye camera' - as well as an LED lighting unit, a radiation dosimeter and a thermometer.

After examining the pictures obtained using the device, Tepco said: "The entire bottom of the pedestal was found to be covered with sandy and clay-like deposits. Some fuel assembly components have fallen to the bottom of the pedestal and deposits thought to be fuel debris were identified in the vicinity of these fallen components."

Tepco has also carried out robotic surveys of the PCVs of units 1 and 3 at the Fukushima Daiichi plant.

Last March, Tepco carried out an investigation of the PCV of unit 1 at Fukushima Daiichi using the PMORPH robot developed by Hitachi-GE Nuclear Energy and IRID. Equipped with a dosimeter and waterproof camera, it took radiation readings and digital images at ten different measurement points within that unit's PCV.

In July, it inserted a screw-driven submersible robot developed by Toshiba and IRID into unit 3's PCV.

Researched and written
by World Nuclear News

11. Compact Fusion: Are the Energy Equations About to Change?

Atul Pant

Group Captain Atul Pant is Research Fellow at the Institute for Defence Studies and Analyses (IDSA), New Delhi.

More from the author

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https://idsa.in/idsacomments/compact-fusion-are-the-energy-equations-about-to-change_apant_100118

Power generation through fusion reaction has been one of the most attractive fields of nuclear research and has consequently seen considerable investment since the middle of the last century. While the world has been awaiting a breakthrough in an affordable and clean power source for long, nuclear fusion has always been taunted, since the 1950s, as the energy source that was 50 years away from commercial availability and would always remain so. In recent years, however, there has been some noises about getting very close to the first real goals of harnessing this energy, i.e., working prototypes of fusion reactors. Advanced technologies and supercomputing have remarkably accelerated the pace of R&D in this field, which has probably led to the recent confident claims.

In nuclear fusion, various isotopes of hydrogen are fused together to form a new element, helium. In the process, a small amount of matter is converted into heat energy, as in the case of nuclear fission. This energy is enormous and could be harnessed. But the temperature required for nuclear fusion to occur is in the range of 13 million degrees centigrade. No material can withstand such high temperatures. Hydrogen fusion experiments are therefore presently being carried out in apparatuses called ‘Tokamaks’ (toroidal plasma chambers), where the hydrogen in extremely hot plasma form is fused together while being suspended away from the walls of the apparatus using extremely strong magnetic fields.

The problems in achieving successful nuclear fusion have mainly related to sustaining the reaction for long durations and plasma containment.[1] The moment the plasma comes into contact with any other material in the tokamak, it immediately loses heat and the temperature required to be maintained comes down drastically, stopping the reaction. At present, it has been possible to stably hold the plasma in the tokamak only for a few seconds or at best a few minutes. Large amounts of input energy are also required for the experimental apparatus to worknd to sufficiently raise the temperature of the plasma for the fusion reaction to start. In all the experimentation conducted till date, it has not proved possible to obtain a higher output of fusion energy than the input energy. The best output to input energy ratio has been 65 per cent.[2] For fusion to become a viable source of energy generation, the reaction will have to be sustained for long durations and output energy will have to be many times greater than input energy.

In 2013, Lockheed Martin's Skunk Works revealed experimental work on a new high-beta reactor design concept, a 'compact fusion reactor', for commercial fusion power.[3] 'Skunk Works' is the official pseudonym for Lockheed Martin's Advanced Development Programs (ADP), formerly called Lockheed Advanced Development Projects. When the project was initiated, the aim was to achieve a working prototype compact fusion reactor in five years (2018), make it available for military applications in ten years (2022-23) and make it commercially viable in 20 years. Further, the apparatus to be developed was to be as compact as to fit on the back of a truck and produce energy equivalent to a 100 MW power plant, sufficient for the energy needs of a small city of 100,000 people. Use of the term 'high-beta' is indicative of the high ratio of plasma pressure to magnetic pressure, loosely indicating high efficiency. If successful, compact fusion could be a revolutionary invention.

The compact fusion reactor will use deuterium and tritium isotopes of hydrogen as fuel (as in other tokomaks), and a neutron source for the reaction.[4] The reactor being researched on is just about two metres long and one meter in diameter (called linear compact reactors) as against tokamaks that are comparatively huge in size. The plasma containment concept being worked on is new and very different from tokamaks, with supposedly better results. The energy produced in the reactor would be in the form of heat which would be harnessed through a turbine as in a fission reactor. But unlike in the case of fission reactors, the by-products of the fusion reactor would be non-radioactive Helium and neutrons. The neutrons would be absorbed by a Lithium blanket on the walls of the reactor, which would produce more tritium –found only in rare quantities on earth.[5]

Skunk Works has, however, been secretive about the degree of success of the experiment so far and not released any data to prove its claims. It has been conducting briefings and presenting the research concept in many forums, and projecting the venture as a practical solution to all of the world's energy problems. Many in the scientific community have, however, been terming their claims as outlandish and impractical. But others have preferred to go with Skunk Works' optimism based on the reputation of the company and is earlier achievements, which include the designing of a number of state-of-the-art aircraft like the U-2, SR-71 Blackbird, F-117 Nighthawk, F-22 Raptor, and the F-35 Lightning II. But the degree of success achieved so far cannot be judged with any certainty at present because of the company's policy of closely guarding data and outcomes.

Another compact fusion experiment proclaiming success in the near future is the Spherical Tokamak-40 (ST-40) experiment by Tokamak Energy, a private company in the United Kingdom.[6] The experiment is on similar lines to Lockheed Martin, albeit with a spherical plasma chamber instead of a cylindrical chamber. This company is also keeping much of the experimental data classified. David Kingham, CEO of Tokamak Energy, has said that 'The ST40 is a machine that will show fusion temperatures - 100 million degrees - are possible in compact, cost-effective reactors. This will allow fusion power to be achieved in years, not decades.' And he added that, 'We are already half-way to the goal of fusion energy; with hard work, we will deliver fusion power at commercial scale by 2030.'[7]

Tri Alpha Energy is another US company working on commercial fusion power using linear compact reactors like Lockheed Martin with similar timelines.[8] A compact fusion device, Mega Amp Spherical Tokamak (MAST), is also being developed alongside Joint European Torus (JET), to validate the design for fusion power.

Though research is being carried out at almost 200 tokamaks worldwide, including the famous International Thermonuclear Experimental Reactor (ITER), none is envisaging imminent breakthroughs as in the case of compact fusion, even though some successes have been recently achieved in boosting the energy output tenfold by introducing Helium-3 isotopes in the fusion reaction.[9] India is also a prominent participant in the ITER programme.

The various claims being made on harnessing fusion energy in a cost-effective manner may give a feeling that the world is approaching a new clean energy era. But such a development is not likely, even if this technology has the potential to take care of all of mankind's energy needs. All the developed nations have made major investments in various other fields of the energy sector. None of them would allow their investments to be wrecked. The greatest and immediate hit of attaining success in harnessing fusion energy is likely to be on oil prices. For instance, the world saw a bloodbath in the oil market when the US opened up its oil reserves for export recently. Oil prices probably would similarly plummet if and when the fusion experiment succeeds. As such, global oil demand is predicted to see a downtrend beyond 2025.

Even other energy investments such as in wind, solar, coal, etc. could suffer major setbacks. With such a disruptive potential, it can be logically predicted that the technology would be under strict US or UK governmental controls for many years or even decades to follow. None would allow its own established energy businesses to take a sudden hit. The percolation of fusion technology to other nations in all likelihood would, therefore, be at very carefully measured rates for the next two to three decades. Besides, since compact fusion would be solely their creation, Western companies and governments are likely to exploit it for profits for many years to come. The latest National Security Strategy of the US released in December 2017 explicitly mentions the intention of the US to dominate the energy sector and reiterates the continuing role of fossil fuels in the future energy mix, which shows that even if compact fusion energy is achieved, the US would play all the energy resource cards to its advantage.[10]

Entities working on compact fusion also claim that their technology will avert the major environmental impacts of global warming, expected by 2050.[11] The positive climate mitigating impact of such technologies would, however, depend on the economic viability of fusion energy, which, in turn, would depend on the costs of reactors, cost of materials, complexity of technology, access to technology, product patenting, etc. Only time will tell whether these companies allow their inventions to become tools of environmental redemption. Cost effective fusion reactors would be able to provide practically limitless power for all the needs of mankind from domestic to industrial supply to desalination of sea water without environmental degradation and further energize pollution control mechanisms. It is, however, surprising that the World Energy Council has not factored-in any share of fusion energy in future energy scenarios that it has created for 2050. Even the International Energy Agency sees the possibility of energy being produced from fusion reactors only beyond 2050.[12]

Other facets of this technology are that it is safe and cannot lead to the making of a fusion bomb.[13] There would be no danger of accidents similar to Chernobyl as a runaway fusion reaction is intrinsically impossible and any malfunction would result in a rapid shutdown of the plant. Military applications of fusion reactors would probably be limited to powering the energy needs of ships, aircraft and spacecraft only. Interaction of the neutrons, produced as a by-product, with the walls of the reactor is expected to reduce the reactors' or their components' life. These would require replacements,[14] which, in turn, would give additional controlling power to the manufacturers. The companies engaged in developing this technology have, however, not drawn attention to this aspect. Research being undertaken in other fields of energy storage, especially vis-à-vis battery technology, are also showing encouraging results. High-capacity battery technology would form a perfect partner with compact fusion technology in providing clean energy in the future.

Although fusion does not generate long-lived radioactive products and the unburned gases can be treated on site, there would a short-to-medium term radioactive waste problem due to the activation of structural materials. Some component materials will become radioactive during the lifetime of a reactor due to bombardment with high-energy neutrons, and will eventually become radioactive waste. The quantity of such waste is, however, likely to be insignificantly small. There is also a possible risk of leak of Tritium into the atmosphere. While Tritium is radioactive and can be inhaled, it has a half-life of only 12.3 years and would be used in small amounts and the risk would still be less than from fission reactors.[15]

India has its own plasma research experimental tokamaks called 'Aditya' and SST-1 at the Institute of Plasma Research, Gujarat, for conducting fusion research.[16] These have given invaluable experience to Indian scientists because of which they have found a prominent place in the ITER project. India has not ventured into compact fusion research so far. In view of the various recent developments in compact fusion, India also needs to carefully tread forward in the energy sector, especially when getting into long-term contracts for power generation. India's demand for forthcoming decades is huge, for which there are plans afoot to have major ventures in various energy sectors. These would require heavy investments. If economically produced fusion power becomes mainstream, such investments would prove to be a waste. It would be prudent therefore to keep an eye on developments in this field, conduct technological forecasts of fusion research and revisit future energy plans as needed.

Views expressed are of the author and do not necessarily reflect the views of the IDSA or of the Government of India.

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12. The long wait for fusion power may be coming to an end

Some experts think that commercial fusion reactors could begin operation as soon as 2030

By Tom Metcalfe/ Dec. 29 2017/10:05 PM ET

https://www.nbcnews.com/mach/science/long-wait-fusion-power-may-be-coming-end-ncna833251

Renewable energy sources like solar and wind account for a growing share of the world's electric power. That's no surprise, given concerns about the carbon emissions from fossil fuel-fired power plants and their harmful effect on the climate.

Nuclear energy offers some advantages over renewables, including the ability to make electricity when the sun doesn't shine and the wind doesn't blow. But today's nuclear plants use fission, which splits atoms of rare metals like uranium. Fission creates radioactive waste and can be hard to control — as evidenced by reactor accidents like those at Three Mile Island, Chernobyl, and Fukushima.

Another form of nuclear energy known as fusion, which joins atoms of cheap and abundant hydrogen, can produce essentially limitless supplies of power without creating lots of radioactive waste.

Fusion has powered the sun for billions of years. Yet despite decades of effort, scientists and engineers have been unable to generate sustained nuclear fusion here on Earth. In fact, it's long been joked that fusion is 50 years away, and will always be.

But now it looks as if the long wait for commercial fusion power may be coming to an end — and sooner than in half a century.

LEADING THE CHARGE

One of the brightest hopes for controlled nuclear fusion, the giant ITER reactor at Cadarache in southeastern France, is now on track to achieve nuclear fusion operation in the mid- to late-2040s, says Dr. William Madia, a former director of Oak Ridge National Laboratory who led an independent review of the ITER project in 2013.

Construction of the ITER reactor — a doughnut-shaped vacuum chamber known as a "tokamak" that spans more than 60 feet — recently passed the halfway point.

Madia says the decades needed to bring the ITER reactor to full operation reflect the

huge engineering challenges still facing fusion researchers. These include building reactor walls that can withstand the intense heat of the fusion reaction — about 150 million degrees Celsius (270 million degrees Fahrenheit), or 10 times hotter than the core of the sun.

And then there’s the challenge of creating superconducting materials that can generate the powerful magnetic fields needed to hold the fusion reaction in place.

ITER has international backing and a budget of more than $14 billion. But it's not the only promising effort in the long quest for sustained nuclear fusion, or what some have called a “star in a jar.”

LOTS OF COMPETITION

Several smaller fusion projects, including commercial reactors being developed by Lockheed Martin in the U.S., General Fusion in Canada, and Tokamak Energy in the U.K., aim to feed fusion-generated power to electricity grids years before ITER produces its first fusion reactions.

“Our target is to deliver commercial power to the grid by 2030,” says Tokamak Energy’s founder, Dr. David Kingham.

Lockheed Martin’s legendary Skunk Works engineering division is developing a compact fusion reactor that uses cylindrical magnetic fields to confine the fusion

reaction instead of the donut-shaped reactor being built at the ITER site.
The company foresees its fusion reactors replacing the fission reactors used in warships and submarines — and being put on trucks so they can be deployed wherever power is needed. A 100-megawatt fusion reactor that fits on the back of a truck could generate enough power for 100,000 people, according to the company.
Other fusion power projects include the Wendelstein 7-X fusion reactor in Germany, which uses an alternative to ITER's tokamak design known as a stellarator. Like ITER, the German reactor is backed by an international consortium and serves mainly for experimental research.

The Wendelstein 7-X fusion reactor in Greifswald, Germany in 2015. Stefan Sauer / Dpa Via AP

Exactly which, if any, of these initiatives will crack the fusion nut is still uncertain. But experts hope fusion power one day can make fossil-fuel-fired plants and nuclear fission reactors obsolete, along with most of their environmental problems.
And we can take heart that the remaining challenges are all just a matter of advanced engineering. Says Madia, "We know the science is absolutely real because we can see it happening in the sun every day."