ITER Forum website Update 2/16

B.J.Green (19/2/16)

1. Innovative imaging systems on the Wendelstein 7-X bring steady-state fusion energy closer to reality

January 29, 2016
http://phys.org/news/2016-01-imaging-wendelstein-x-steady-state-fusion.html

Since the world's largest superconducting magnetic fusion experiment, the Wendelstein 7-X stellarator, went online in December, innovative new imaging systems designed at Los Alamos National Laboratory are helping physicists peer into the roiling world of superhot plasmas as they test a promising alternative approach to harnessing fusion energy. The eventual result could be a plentiful source of clean and reliable power.

"This new stellarator uses optimized three-dimensional magnetic fields to enable continuous operation of high-performance, disruption-free deuterium plasmas," said Glen Wurden, of Los Alamos National Laboratory's Plasma Physics group. "The Los Alamos-designed diagnostic system plays an integral role in this collaboration and the studies of 3D magnetic field systems, especially pertaining to plasma boundary effects."
Within the stellarator, the magnetic fields contain the plasma, which is heated to 100 million degrees Celsius, at which point the deuterium—a heavy isotope of hydrogen—can fuse into helium and release tremendous, controlled energy.
The W7-X stellarator recently began operations at the Max Planck Institute for Plasma Physics in Greifswald, Germany, aided by researchers from several universities and institutes in the United States, including Wurden and John Dunn, also of the Los Alamos Plasma Physics group.
Preparations for the start of operations for this Department of Energy-sponsored, United States-German collaboration began four years ago, with a three-lab U.S. team consisting of Princeton

Plasma Physics Laboratory (PPPL), Oak Ridge National Laboratory, and Los Alamos, which provided hardware, software and fusion researchers.
As the W7-X was under construction, Wurden developed and installed the imaging systems needed to study plasma edge effects and interactions with the armored walls in three-dimensional magnetic geometries within the machine. These systems are higher resolution than the German systems, which are designed to view the entire inner surface of the machine.
Wurden also provided an infrared camera that offered the highest resolution available and a visible imaging system on the same line of sight. Wurden and Dunn designed imaging systems for two phases of W7-X operation. In the first phase, a poloidal graphite limiter, which intercepts energy from the edge of the plasma, will be observed. In the second phase, the limiters will be removed, and the W7-X will study a newer technique to handle energy at the edge of the plasma by using magnetic island divertors. The Los Alamos imaging diagnostics will observe the divertor hardware and scraper elements as they control the plasma energy over a range of plasma pressures.
The stellarator is currently operating in a test phase using helium gas, but it will switch to hydrogen gas in February to begin more realistic experiments. Within the next three years, the W7-X is expected to demonstrate maintaining steady state, high-temperature deuterium plasmas for up to 30 minutes at a time, limited only by the project's electricity bill and the daily capacity of on-site water-cooling systems.
The DOE Office of Science's Office of Fusion Energy Sciences funded the work at Los Alamos. The research supports the Laboratory's Energy Security Mission and the Nuclear and Particle Futures science pillar by building the scientific foundation needed to develop a fusion energy source.

2. **Livestream: Wendelstein 7-X produces first hydrogen plasma** **http://www.ipp.mpg.de/4010488/livestream_16**

Ceremony on 3 February 2016 / transfer via internet
January 28, 2016

The first hydrogen plasma on 3 February 2016 will mark the

start of scientific operation of Wendelstein 7-X. You may care to pursue the event per livestream on 3 February 2016 at 2.45 p.m.:
www.ipp.mpg.de/livestream_e_16

Federal Chancellor Angela Merkel has been asked to switch on the plasma at a ceremony attended by numerous guests from the realms of science and politics. Wendelstein 7-X has already been working since the beginning of December 2015 with a helium plasma as preparation for the first hydrogen plasma.

The objective of fusion research is to develop a power plant favourable to the climate and environment that derives energy from the fusion of atomic nuclei just as the sun and the stars do. Wendelstein 7-X, the world's largest and most modern fusion device of the stellarator type, is to investigate this configuration's suitability for use in a power plant.

3. 10 Facts You Should Know About Fusion Energy

January 25, 2016
http://www.pppl.gov/news/2016/01/10-facts-you-should-know-about-fusion-energy

1. **It's natural.** In fact, it's abundant throughout the universe. Stars – and there are billions and billions of them – produce energy by fusion of light atoms.
2. **It's safe** There are no dangerous byproducts. There is very little radioactive waste, and what waste there is requires only decades to decay, not thousands of years. Further, any byproducts are not suitable for production of nuclear weapons.
3. **It's environmentally friendly.** Fusion can help slow climate change. There are no carbon emissions so fusion will not contribute to a concentration of greenhouse gases that heat the Earth. And it helps keep the air clean.
4. **It's conservation-friendly.** Fusion helps conserve natural resources because it does not rely on traditional means of generating electricity, such as burning coal.
5. **It's international.** Fusion can help reduce conflicts among countries vying for natural resources due to fuel supply imbalances.
6. **It's unlimited.** Fusion fuel – deuterium and tritium – is available around

the world. Deuterium can be readily extracted from ordinary water. Tritium can be produced from lithium, which is available from land deposits or from seawater.

7. **It's industrial scale.** Fusion can power cities 24 hours a day regardless of weather.
8. **It's exciting.** Fusion produces important scientific and engineering breakthroughs and spinoffs in its own and other fields.
9. **It's achievable.** Fusion is produced in laboratories around the world and research is devoted to making it practicable.
10. **It's the Future.** Fusion can transform the way the world produces energy.

4. Amec Foster Wheeler wins ITER maintenance contract

20 Jan 2016

http://www.imeche.org/news/news-article/amec-foster-wheeler-wins-iter-maintenence-contract

Amec Foster Wheeler has signed a contract to supply maintenance and remote handling services to ITER, the world's largest nuclear fusion research project.
The framework contract, expected to be worth up to €4 million over four years, covers the provision of engineering support based on experience of nuclear installation in-service inspection for developing the maintainability and inspectability of the ITER structures, systems, and components during their design.
The contract will cover critical areas such as the hot cell, where irradiated components are dismantled and treated, and the Cryostat, at 3,850 tonnes the second largest high-vacuum pressure chamber ever built.

The company will also carry out work to analyse reliability, control costs, carry out virtual and physical mock-ups to test procedures, and produce maintenance documentation.
Greg Willetts, vice-president for consultancy at Amec

Foster Wheeler's Clean Energy business, said: "This contract win represents another step forward in our aspiration to play a major role across the ITER project. It underlines our leading expertise in nuclear remote handling and robotics and highlights the key role we are playing in developing future nuclear technologies while continuing to support the existing nuclear fission power industry."

A total of 35 nations are collaborating to build the world's largest tokamak, a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers our Sun and stars.

The experiments that will be carried out at ITER's base at Cadarache in the South of France are crucial to advancing fusion science and preparing the way for the fusion power plants of tomorrow.

In May a joint venture led by Amec Foster Wheeler won a €70 million, seven-year contract to carry out all activities ranging from design, manufacturing, factory testing, delivery, on-site integration, commissioning and final acceptance tests for ITER's neutral beam remote handling system.

5. January 14, 2016 | By Liezel Labios

Seeing Where Energy Goes May Bring Scientists Closer to

Realizing Nuclear Fusion

http://ucsdnews.ucsd.edu/pressrelease/seeing_where_energy_goes_may_bring_scientists_closer_to_realizing_nuclear_f

An international team of researchers has taken a step toward achieving controlled nuclear fusion—a process that powers the Sun and other stars, and has the potential to supply the world with limitless, clean energy.

The team, led by scientists and engineers at the University of California, San Diego and General Atomics, developed a new technique to “see” where energy is delivered during a process called fast ignition, which is an approach to initiate nuclear fusion reactions using a high-intensity laser. Visualizing the energy flow enabled researchers to test different ways to improve energy delivery to the fuel target in their experiments. The researchers published their findings online in the Jan. 11 issue of the journal *Nature Physics*.

Fast ignition involves two stages to start nuclear fusion. First, hundreds of lasers compress the fusion fuel (typically a mix of deuterium and tritium contained in a spherical plastic fuel capsule) to high density. Then, a high-intensity laser delivers energy to rapidly heat (ignite) the compressed fuel.

Scientists consider fast ignition a promising approach toward controlled nuclear fusion because it requires less energy than other approaches.

But in order for fast ignition to succeed, scientists need to overcome a big hurdle: how to direct energy from the high-intensity laser into the densest region of the fuel. “This has been a major research challenge since the idea of fast ignition was proposed,” said Farhat Beg, professor of mechanical and aerospace engineering and director of the Center for Energy Research at UC San Diego.

To tackle this problem, the team devised a way to see, for the first time, where energy travels when the high-intensity laser hits the fuel target. The technique relies on the use of copper tracers inside the fuel capsule. When the high-intensity laser beam is directed at the compressed fuel target, it generates high-energy electrons that hit the copper tracers and cause them to emit X-rays that scientists can image.

“Before we developed this technique, it was as if we were looking in the dark. Now, we can better understand where energy is being deposited so we can investigate new experimental designs to improve delivery of energy to the fuel,” said Christopher McGuffey, assistant project scientist in Beg’s High Energy Density Physics Group at the UC San Diego Jacobs School of Engineering and co-author on the paper.

And that’s what the team did. After experimenting with different fuel target designs and laser configurations, researchers eventually achieved a record high (up to 7 percent) efficiency of energy delivery from the high-intensity laser to the fuel. This result demonstrates an improvement on efficiency by about a factor of four compared to previous fast ignition experiments, researchers said. Computer simulations also predicted an energy delivery efficiency as high as 15 percent if the

experimental design was scaled up. But this prediction still needs to be tested experimentally, said Beg. “We hope this work opens the door to future attempts to improve fast ignition.”
The study was a collaborative effort involving researchers from UC San Diego, General Atomics, the University of Rochester, Lawrence Livermore National Laboratory, Japan’s Osaka University, France’s University of Bordeaux and the University of Nevada, Reno. Charlie Jarrott, the first author on the paper, conducted this research as a Ph.D. student in Beg’s High Energy Density Physics Group at the UC San Diego Jacobs School of Engineering. He is now a postdoctoral research staff member at Lawrence Livermore National Laboratory.

6. January 17, 2016 10:00 am

Hope springs eternal for nuclear fusion breakthrough

Clive Cookson

http://www.ft.com/intl/cms/s/0/fa1aa276-a41e-11e5-873f-68411a84f346.html#axzz3z4AwBDK7

Undeterred by taunts that fusion always seems to lie 50 years in the future as a commercial energy source, a growing programme of research is aimed at taming the nuclear reaction that powers the sun and the H-bomb. It releases energy by combining light elements, in contrast to the atom-splitting fission process that drives current nuclear power stations.
Fusion research falls into three different camps. One is the traditional “big science” approach — exemplified by ITER,

a project to build an experimental fusion reactor at Cadarache in France.
Second is a wave of start-ups whose ambition is to deliver power more quickly and less expensively than the big public projects. These companies are using the same hot fusion approach, forcing atomic nuclei together at extreme temperatures and pressures.

Lurking out in left field is a third way — utterly different in that it claims to release fusion energy in much more moderate conditions, close to room temperature. This approach, a successor to the “cold fusion” experiments carried out by Stanley Pons and Martin Fleischmann in 1989 and now usually called “low energy nuclear reaction” or LENR, is ignored by the scientific mainstream but making progress according to devotees in labs around the world.
All three techniques offer the long-term promise of virtually limitless carbon-free energy with much less radioactive waste than nuclear fission.
Hot fusion projects use various techniques to sustain the reaction. Leading the way is “magnetic confinement”. Here a powerful magnetic field keeps the reactants, a plasma of hydrogen isotopes heated to 100m degrees centigrade, inside the reactor. If they touch the vessel’s walls, the reaction stops.

The most popular magnetic reactor is the doughnut-shaped tokamak, invented in the 1950s Soviet Union. Its largest manifestation will be ITER, a partnership between the EU, China, Japan, South Korea, US, Russia and India, which is building a tokamak 10 metres high surrounded by superconducting magnets. When ITER was set up in 2006, it was expected it should have started up this year. Now completion is expected in 2025 and the estimated cost has soared above $20bn.
An alternative configuration for magnetic confinement is

the stellarator, which has a more sinuous twisted shape. The world’s most ambitious stellarator, the €370m Wendelstein 7-X in Germany, starts up this year.

Radically different is “inertial confinement”. More than 150 ultra-powerful lasers focus their energy simultaneously on a pellet of hydrogen fuel, triggering fusion. Two publicly funded facilities are taking this approach: the National Ignition Facility in California and Laser Mégajoule in France.

The new wave of privately funded fusion companies in Europe and North America is using both inertial and magnetic confinement. Among them is First Light Fusion, an Oxford university spinout that raised £22.7m last August.

Another UK fusion start-up Tokamak Energy is aiming for commercial energy from magnetic confinement, based on a miniature version of the technology used at ITER.

“Compact fusion power is no longer a pipe dream,” says David Kingham, Tokamak chief executive. “We are aiming for that ‘Wright Brothers’ moment of take-off for fusion energy within 10 years.”

If so there will be considerable competition from well-funded North American companies focusing on magnetic confinement. Leading fusion start-ups there include General Fusion in Canada and Tri Alpha Energy and Helion Energy in the US. At least one large company, Lockheed Martin, is also active in the field.

While there is considerable interaction between scientists working on hot fusion, cold fusion research takes place in a world of its own. Many mainstream scientists will not touch LENR which they see as tainted by the cold fusion fiasco of 1989, when Profs Fleischmann and Pons claimed to have achieved fusion on a lab bench — an experiment that others could not reproduce. However, after more than 25 years of experimentation, several research groups have built up evidence that real nuclear reactions lay behind the pair’s results. The problem according to Professor Huw Price, a philosopher of science at Cambridge university, is that cold fusion became a “reputation trap” which most researchers avoid because they know the scientific world will not take their work seriously.

7. Russian equipment plays vital role in ITER's thermonuclear reactor

January 14, 2016 ***SVETLANA ARKHANGELSKAYA, SPECIAL TO RBTH***

Russian engineers have developed innovative circuit breakers for the International Thermonuclear Experimental Reactor (ITER) in order to safely turn off electrical circuits during repairs, upgrades, and maintenance.

http://rbth.com/science_and_tech/2016/01/14/russian-equipment-plays-vital-role-in-iters-thermonuclear-reactor_559427

In December 2015, engineers at the Electrical Equipment Plant (EEP) in the west Russian city of Velikiye Luki developed new circuit breakers for the International Thermonuclear Experimental Reactor (ITER) under construction at the Cadarache Nuclear Research Center in the south of France.

Russian scientists spent 18 months developing the new equipment, and they managed not only to come up with an original solution, but also to significantly reduce the cost of production. The circuit breakers are designed in a modular fashion, which allows piling them like toy blocks, thus increasing the passing current. Thanks to the circuit breakers, workers will be able to ensure the safety of the reactor when disconnecting electric circuits during repairs, upgrades, and maintenance. Prototypes of the new equipment have been successfully tested, and production will begin in 2018.

"We wanted to help ITER keep the cost of circuit breakers low," Vladimir Ostreiko, the deputy general designer at EEP for scientific and technological development and publications, told RBTH. "Our modular design allows making circuit breakers for virtually any currents; for instance, 100,000, 200,000 or 300,000 amperes. By adding different numbers of modules, we can create circuit breakers for other customers; for example, the chemical and metallurgical industries."

ITER is an ambitious collaborative effort among the European Union, U.S., China, Japan, India, Russia and South Korea. Located about 60 kilometers northeast of Marseille, ITER will allow scientists to replicate the reactions taking place in the Sun and other stars, and to demonstrate the potential of nuclear fusion as a viable source of electricity. Construction of the reactor began in 2012, and while it was planned to be completed by 2016, the project's high costs postponed the opening to 2025.

ITER's experimental fusion reactor is based on the ``tokamak'' concept, which is also a Russian contribution. The tokamak is a device invented in the 1950s by Soviet physicists Igor Tamm and Andrei Sakharov, who were in turn inspired by their colleague, Oleg Lavrentiev. A tokamak utilizes a magnetic field to confine the plasma in the reactor. In Russia, more than 100 companies are already working on tasks related to ITER. The country participates only by supplying equipment, and in total Russia will deliver an amount valued at 1.5 billion euros, which is equal to approximately 10 percent of the reactor's total cost. Russia's main challenge is production of superconducting magnets, diagnostic sensors, and hot plasma composition analyzers. The country spent almost 11.5 million euros on this in 2014 alone.

8.

Top-5 Achievements at the Princeton Plasma Physic Laboratory in 2015

Published: January 13, 2016.
Released by Princeton Plasma Physics Laboratory

http://www.sciencenewsline.com/news/2016011304550008.html

From launching the most powerful spherical tokamak on Earth to discovering a mechanism that halts solar eruptions, scientists at the U.S. Department of Energy's Princeton Plasma Physics Laboratory advanced the boundaries of clean energy and plasma science research in 2015. Here, in no particular order, are our picks for the Top-5 developments of the year:

1. Starting up the National Spherical Torus Experiment-Upgrade (NSTX-U)

PPPL completed construction of the NSTX-U, the Laboratory's flagship fusion facility, doubling its heating and magnetic power and making it the most powerful spherical tokamak in the world. The machine is shaped like a cored apple, unlike conventional donut-shaped fusion facilities, and creates high plasma pressure with relatively low magnetic fields -- a highly cost-effective feature since magnetic fields are expensive to produce. The upgrade creates a flexible research platform that will enable physicists to directly address some of fusion's most outstanding puzzles.

2. Discovering a mechanism that halts solar eruptions

Solar eruptions are massive explosions of plasma and radiation from the sun that can be deadly for space travelers and can disrupt cell phone service and other crucial functions when they collide with the magnetic field that surrounds Earth. Researchers working on the Magnetic Reconnection Experiment (MRX), the world's premier device for studying the convergence and separation of magnetic fields in plasma, have discovered a previously unknown mechanism that causes eruptions to fail. The findings could prove highly valuable to NASA, which is eager to know when an eruption is coming and when the start of an outburst is just a false alarm.

3. First plasma on Germany's Wendelstein 7-X

On December 10, 2015, the Wendelstein 7-X (W7-X) stellarator produced its first plasma after 10 years of construction. PPPL, which leads the United States' collaboration in the German project and will conduct research on it, joined the worldwide celebration of the achievement. The Laboratory designed and delivered five barn-door size magnetic coils, together with power supplies, that will help shape the plasma during W7-X experiments. The Lab also designed and installed an X-ray diagnostic system that will collect vital data from the plasma in the machine. Stellarators are fusion facilities that confine plasma in twisty -- or 3D -- magnetic fields, compared with the symmetrical -- or 2D -- fields that tokamaks produce.

4. Enhanced model of the source of the density limit

Physicists have long puzzled over a mystery called the density limit -- a process that causes fusion plasmas to spiral apart when reaching a certain density and keeps tokamaks from operating at peak efficiency. Building on their past research, PPPL scientists have developed a detailed model of the source of this limitation. They've traced the cause to the runaway growth to bubble-like islands that form in the plasma and are cooled by impurities that stray plasma particles kick up from the walls of the surrounding tokamak. Researchers counter this heat loss by pumping fresh heat into the plasma, but even a tiny bit of net cooling in the islands can cause them to grow exponentially and the density limit to be reached. These findings could lead to methods to overcome the barrier.

5. Breakthrough in understanding how to control intense heat bursts

Scientist from General Atomics and PPPL have taken a key step in predicting how to control potentially damaging heat bursts inside a fusion reactor. In experiments on the DIII-D National Fusion Facility that General Atomics operates for the DOE in San Diego, the physicists built upon previous DIII-D research showing that these intense heat bursts -- called edge localized modes (ELMS) -- could be suppressed with tiny magnetic fields. But how these fields worked had been unclear. The new findings reveal that the fields can create two kinds of response, one of which allows heat to leak from the edge of the plasma at just the right rate to avert the heat bursts. The team also identified the changes in the plasma that lead to suppression of the bursts.

9. Denmark and Greenland confirm uranium agreements

02 February 2016

http://www.world-nuclear-news.org/UF-Denmark-and-Greenland-confirm-uranium-agreements-0202164.html

The governments of Denmark and Greenland have confirmed the signing of a series of agreements last month setting the framework for future cooperation on foreign, defence and security policy issues related to the mining and commercial export of uranium.

On 19 January, Denmark and Greenland announced they had

reached agreements concerning the export control and security of uranium and other radioactive substances from Greenland and the definition of competences in the raw materials sector.
In separate statements yesterday, the governments said that a set of four agreements had been signed specifying responsibilities and tasks between Danish and Greenland authorities in connection with possible future mining and export of uranium.
These consist of a general cooperation agreement on the specific foreign, defence and security policy issues related to the mining and export of uranium from Greenland; a joint declaration on safeguarding nuclear materials; a joint declaration on export control of products and technology that can be used for both civilian and military uses ("dual-use"); and, an agreement on Greenland's safeguarding of nuclear safety in mining.
The Danish ministry of foreign affairs said the government will introduce a bill to parliament on the safeguards of nuclear materials and export controls of dual-use products by mid-2016. Concurrently, legislative proposals will be introduced to the Greenland parliament for consideration.
Danish foreign minister Kristian Jensen welcomed the signing of the agreements. He said, "This means that Greenland can now continue its efforts to expand its mining, while we fulfil our international obligations and ensure that Greenland's uranium export lives up to the highest international standards, in terms of the peaceful and civilian use of uranium."
Business and growth minister Troels Lund Poulsen said the signing of the joint declaration on export controls "ensures that we fulfil our international obligations by taking control of exports from Greenland of uranium and other products with possible military use." He added, "Thus we help to create a clear framework for the implementation of mining projects in Greenland."
The island of Greenland introduced a zero-tolerance policy concerning the mining of uranium and other radioactive elements in 1988, while under Danish direct rule. It took a step towards greater autonomy from Denmark in 2009 with the official transition from 'home rule' to 'self rule'. This saw Greenland assume full authority over its mineral and hydrocarbon rights, which had formerly been overseen by Denmark. However, Greenland remains part of the kingdom of Denmark and its defence and foreign policies are still determined by Copenhagen.
In October 2013, Greenland's parliament voted to remove the ban on the extraction of radioactive materials, opening up the possibility for companies to begin mining uranium and rare earth minerals.

Kvanefjeld project

Australia's Greenland Minerals and Energy completed a feasibility study for its Kvanefjeld uranium and rare earth element project in

southern Greenland in May 2015. In November, the project received pre-hearing approvals from the government of Greenland and has moved into the permitting phase. The government also approved the terms of reference setting the agreed initial development strategy for Kvanefjeld.
In a 22 January statement Greenland Minerals said, "The agreement announced on 19 January represents another key step in Greenland enhancing its regulatory system to ensure that it is aligned with international standards and best practice associated with uranium and radioactive materials. It follows on from the government of Greenland ratifying its accession to a series of international safety conventions relating to uranium in late 2015."
It added, "This important development highlights the progress made by Greenland's authorities on regulatory aspects, which has taken place in parallel to Greenland Minerals working to establish an agreed development strategy with Greenland, and finalise an exploitation (mining) licence application for Kvanefjeld."
Researched and written
by World Nuclear News

9. Niger uranium project receives mining permit

01 February 2016

Niger has approved GoviEx's mining permit application for the Madaouela 1 tenement area, the company announced today. The approval means that the project is now fully permitted for construction and production.

http://www.world-nuclear-news.org/UF-Niger-uranium-project-receives-mining-permit-0102167.html

Canada-based GoviEx submitted its mining permit application in July 2015, having completed an environmental and social impact assessment for the project earlier in the year. Last week, the country's government issued the company with a permit to "exploit" uranium at Madouela in the Arlit region of northern Niger. According to documentation from Niger's Council of Ministers, the scope of GoviEx's licence application covers 243 square kilometres of the site funded by investments of $676 million.
GoviEx was awarded exploration permits for Madaouela 1 in 2006, and company chairman Govin Friedland said that the government's decision was the culmination of a decade of effort by the company and local stakeholders. "This decision of support is a stamp of approval for the quality of the work done to date by GoviEx, and the robustness of the Madaouela project," he said.
GoviEx's development plan for Madaouela envisages production of an average of 2.69 million pounds U_3O_8 (1035 tU) per year over a 21-year mine life from an open-pit mine using ablation technology

to treat ore slurries before processing. It is based on measured and indicated mineral resources of 110 million pounds U3O8 (42 311 tU) plus 61 million pounds U3O8 (23 463 tU) of probable mineral reserves.

Researched and written
by World Nuclear News

10. Ukraine approves investment in South Ukraine plant

02 February 2016

Ukraine's Cabinet of Ministers has approved a revised project to upgrade the South Ukraine nuclear power plant's water supply system, increasing its annual electricity output by up to 2.5 terawatt hours. Energoatom said yesterday that the project aims to "remove restrictions" on the plant caused by the insufficient cooling capacity of the Tashlykskaya reservoir.

http://www.world-nuclear-news.org/C-Ukraine-approves-investment-in-South-Ukraine-plant-02021601.html

Energoatom, the state-run operator of all 15 of Ukraine's nuclear power reactors, said the approval was given via a government decree dated 13 January.

After completion of the project, the additional annual electricity output of the plant will be between 0.5 TWh and 2.5 TWh, Energoatom said.

According to the Cabinet decree, the estimated cost of construction and equipment provided for the project is about Hryvnia 986 million ($38 million). Energoatom said this figure is up from the estimate contained in the draft project plan the cabinet approved in December of Hryvnia 205 million ($8 million). This original estimate is "insufficient to perform the necessary work and purchase the required equipment," Energoatom said. The cost of the work is expected to be covered by an increase in electricity tariffs, it added.

A tender is to be held this year for the supply of equipment for the project, which is to be completed within 36 months.

The South Ukraine plant is located on the banks of Pivdennyi Buh river in the town of Yuzhnoukrayinsk, in the Mykolayiv region. It consists of three VVER-1000 reactors with a total installed capacity of 3000 MWe. Also near the river are two twin-unit hydro power plants.

In 2014, the plant generated 18.6 billion kWh of electricity, which was 5.8 billion kWh (31%) more than in 2013.

In December, the board of the State Nuclear Regulatory Inspectorate of Ukraine approved the continued operation of unit 2 of the South Ukraine plant until the end of 2025. The unit was shut

down on 10 May, two days before the expiry of its design lifetime, for major upgrading over 300 days costing $114 million to enable a 10-year life extension.
Researched and written
by World Nuclear News

11. Port Augusta Renewable Energy Park Progress

February 3, 2016

http://www.energymatters.com.au/renewable-news/port-augusta-renewable-em5318/

An application to South Australia's Development Assessment Committee for Port Augusta Renewable Energy Park has now entered the public consultation phase.

The DP Energy project seeks to construct up to 59 wind turbines and up to 400 acres of solar panel arrays at a site approximately 8 kilometres from Port Augusta; which is around 300 kilometres from South Australia's capital city; Adelaide.

The company says the attributes of the site – an early evening peak for wind power and midday peak for solar – mean the generation profile of the facility can be tailored to provide a close match to the demand cycle.

The output capacity of the Park has grown considerably since it was first announced – from 300MW to up to 375MW; which is enough to power around 154,000 South Australian households. The project would avoid around 430,000 tonnes of greenhouse gas emissions each year.

The facility will have a wind generation capacity of 206.5MW, with the remainder being solar PV spread equally among three solar farms. It's expected up to 1.6 million solar panels will be used.

Up to 100 kilometres of underground cabling will be laid throughout Port Augusta Renewable Energy Park and the site is only 3km from Davenport substation.

Should the project be approved, construction would likely start in 2017 and last around two years. During the

construction phase, approximately 600 full-time jobs will be created and the project will bring more than $44.5m of construction expenditure into the Port Augusta regional economy.
Once fully operational, at least 20 full time jobs will be created. Annual operational-related expenditure once up and running is expected to exceed $3 million locally/regionally and $4.6 million at state level each year for the estimated 25 year life of the Park.
DP Energy says various dedicated environmental assessments have been carried out and that with proposed mitigation measures, environmental impacts of construction and operation will be avoided or minimised.

12. Green Light For Canberra's Williamsdale Solar Farm

February 1, 2016

http://www.energymatters.com.au/renewable-news/williamsdale-solar-farm-em5315/

The ACT's Minister for Planning and Land Management has approved a development proposal for a 11.18MW solar farm to be constructed south of Canberra, near Williamsdale.
The proposal was "called in", meaning the Minister assumed the role of assessment manager for the development application. The Minister is able to call in a project if a development is considered a major policy issue, has a major effect on government objectives and provides a substantial benefit.
"Once completed, the solar farm will power more than 2500 homes, contributing to the Territory's renewable energy and greenhouse gas reduction targets," said Minister Mick Gentleman.
"Under the Territory's greenhouse gas reduction strategy, renewable energy will account for roughly 73 per cent of the

emission reductions needed if the ACT is to reach its legislated 2020 target."

The solar farm will be situated on farmland near the Monaro Highway and Angle Crossing Road in Tuggeranong, at a site just a couple of hundred metres from the ACT's border with New South Wales. The new solar power station will be around 10 kilometres from the 24MW Royalla Solar Farm.

Minister Gentleman stated he has imposed strict conditions on the development as part of his decision, in order to address concerns raised in four submissions by members of the community. One of those conditions is that non-glare materials be used. Appropriate landscaping works will also be carried out and sufficient bushfire management measures put in place.

Even with the conditions imposed on the Williamsdale project, some still aren't happy the project is going ahead and feel the consultation process was lacking.

The Williamsdale site wasn't the first choice for the solar farm. It was originally proposed to be built adjacent to Uriarra Village. However, many Uriarra Village residents were strongly opposed to the project; primarily on the basis of aesthetics and what they stated was a lack of procedural fairness.

The ACT has a legislated target of 90% renewable energy by 2020; a goal it appears it will reach. In August, ACT Labor proposed an even more ambitious renewables target – 100% by 2025.

13.

Petawatt laser system passes key milestone

27 Jan 2016

Lawrence Livermore, developing HAPLS system for ELI Beamlines, reports power breakthrough - two months early.

http://optics.org/news/7/1/32

The High-Repetition-Rate Advanced Petawatt Laser System (HAPLS) under construction at **Lawrence Livermore National Laboratory**, Livermore, CA, US, has achieved a key average power milestone more than two months ahead of schedule, and is now moving into the next phase in its development.

The HAPLS high-energy diode-pumped solid-state pump laser, firing at a repetition rate of 3.3 Hz produced 70J of infrared (1053nm) energy and 39J of green (527nm) energy. Completion of this average-power milestone marks another major step in the HAPLS commissioning plan, say its developers: the beginning of the integration of the pump laser with the HAPLS high-energy short-pulse beamline, destined for the new **ELI Beamlines** facility in Prague, Czech Republic.
The ELI Beamlines facility will be a high-energy, high repetition-rate laser pillar of the overall ELI project. It will provide pulses from four laser systems. To meet the requirement for high repetition rates, three of these lasers will employ the state of the art technologies of diode-pumped solid state lasers (DPSSL) for driving broadband amplifiers. The fourth, multi-kilojoule laser will use a newly-developed flash lamp technology with an actively cooled gain medium.
Constantin Haefner, program director for Advanced Photon Technologies at LLNL commented, “Ramping the pump laser to this intermediary performance level was an important step for HAPLS. For the first time we ran the pump laser at significant energy and average power levels, meeting and exceeding the required goals for this milestone. This accomplishment required a huge team effort to make it happen.
"We are taking a risk-balanced approach in ramping HAPLS to its full performance. The data we collected confirmed our performance models and gave the green light to start integration with the short-pulse beamline before ramping to even higher power levels."
Representatives from the European Union’s Extreme Light Infrastructure Beamlines facility in the Czech Republic, where HAPLS will be installed, attended the demonstration. “We are delighted to see the HAPLS pump laser work with a performance exceeding the project expectations for this phase, and achieve this important milestone on budget and ahead of schedule,” said ELI Beamlines Chief Laser Scientist Bedrich Rus. “The partnership with LLNL has been a tremendously successful story, and this demonstration shows the robustness of the underlying design and technology. The L3 (HAPLS) beamline will be an ELI Beamlines’ user facility workhorse.”
HAPLS is designed to reach a peak power exceeding one petawatt at a repetition rate o
intensities on target up to 10^{23} Wcm^{-2}. Achieving this intensity is expected to open up ent
investigation, new applications of laser-driven X rays and particles, and allow researche
sea of virtual particles that comprise a vacuum.
Ramping of the laser to its full performance was organized in several phases. The first p
brought the pump laser to an intermediate performance level in a single shot regime. “In
“we brought it up to average power, and that was an intermediate performance level. No
and the short-pulse system. Together with ELI Beamlines we will integrate the short-puls
then we will ramp the short-pulse laser system first to energy and then to average powe

Systems Architect and Commissioning Manager Andy Bayramian explained the reason t operate the laser at the intermediate performance level, learn how to operate it, identify c data errors if they exist, and once we have gained operational experience, then we ramp Haefner added, "HAPLS will allow its users for the first time to approach the commercial generated secondary sources. There's no other laser which could actually produce suffic intensity light required for commercial applications."

Ultimately the system's pulses will be used to generate extremely bright and short X-ray at unprecedented spatial and temporal resolution. Another application is generating bunc therapy and materials science research. Scientists also will study the interaction of inten understanding of high energy density science.

About the Author

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14. Fusion vs fission: clean, green nuclear energy technologies explained

ABC Science By Stuart Gary

Posted Mon at 9:52am

Mon 8 Feb 2016, 9:52am

http://www.abc.net.au/news/2016-02-08/clean-nuclear-energy-are-we-there-yet/6777180

Clean, cheap nuclear energy is often touted as a means to battle climate change. But how close are we to having nuclear plants that fit the clean, green bill? What are the different technologies and what do they offer?

More than 10 per cent of the world's electricity currently comes from nuclear power plants. These existing plants all rely on nuclear fission — a chain reaction where uranium atoms are split to release extraordinary amounts of energy and, unfortunately, high levels of radioactive waste.

But a different type of nuclear reaction — nuclear fusion — has been the focus of research to develop nuclear power without the radioactive waste problem.

Nuclear fusion is the reaction that powers the Sun. It involves smashing hydrogen atoms together under extraordinary temperature and pressure, fusing them together to form helium atoms and releasing a large amount of energy and radioactive waste. But unlike fission, this radioactive waste is short-lived, quickly decaying to undetectable levels.

Nuclear fusion happens readily in stars like the Sun, because their cores reach extreme temperatures of over 15 million degrees Celsius, and pressures billions of times greater than our atmospheric pressure on Earth.
Fusion reactors would need to recreate these extreme conditions on Earth, and researchers are using two different approaches to achieve this: tokamak reactors and laser fusion.

Tokamak reactors

Separate groups of scientists in Germany and China have recently announced they have made breakthroughs in nuclear fusion using tokamak reactors.
Tokamak reactors use a doughnut-shaped ring to house heavy and super-heavy isotopes of hydrogen, known as deuterium and tritium.
Normal hydrogen — which is also known as protium — consists of a single proton in its nucleus orbited by an electron. Deuterium differs in that the nucleus also contains a neutron, and tritium has a proton and two neutrons in its nucleus.
These isotopes are heated to 100 million degrees Celsius by powerful electric currents within the ring.
At these extreme temperatures electrons are ripped off their atoms, forming a charged plasma of hydrogen ions.
Magnets confine the charged plasma to an extremely small area within the ring, maximising the chance that the superheated ions will fuse together and give off energy. The heat generated can be used to turn water into steam that spins turbines, producing electricity.
Over 200 experimental tokamaks have been built worldwide, but to date they have all consumed more energy than they produce.
A massive international tokamak project — the International Thermonuclear Experimental Reactor (ITER) — aims to turn that situation around.
The ITER is designed to produce 10 times as much energy as it takes to run, becoming the first ever net energy producing fusion reactor. It is currently being built in the south of France, but with the first fusion experiments scheduled for 2027 it will

be some time before we know if that goal has been reached.
In the meantime, physicists in Germany are using a variant of the tokamak, known as the Wendelstein 7-X stellarator. This uses a twisting ring design with changes in geometry and differing magnetic fields to control the plasma for longer periods of time compared to the short bursts tokamaks achieve.
Last week, physicists at the stellarator announced they had created a hydrogen plasma using two megawatts of microwave radiation to heat hydrogen gas to 80 million degrees Celsius for a quarter of a second.
At the same time, scientists in China said they had achieved temperatures of 50 million degrees Celsius (three times hotter than the core of the Sun) for 102 seconds at their experimental tokamak fusion reactor called the Experimental Advanced Superconducting Tokamak (EAST).

Laser fusion

While tokamaks and stellarators use magnets to confine plasmas, another body of research is focusing on a different strategy to trigger fusion reactions, using high-powered lasers.
Laser fusion uses ultra-short bursts of very powerful lasers to generate the extreme temperatures and pressures needed to trigger a fusion reaction.
These laser pulses can heat and compress hydrogen isotopes to a fraction of their size, forcing them to fuse into helium and release high-energy neutrons.
The Lawrence Livermore National Laboratory's National Ignition Facility in California achieves deuterium–tritium nuclear ignition using a laser producing over two million joules of energy in a sudden pulse lasting just one nanosecond (one thousand millionth of a second).
The downside to laser fusion systems using deuterium and tritium is that they still produce high-energy neutrons (neutron radiation) which can cause other materials to become radioactive.
An alternative laser fusion method being developed by scientists including Emeritus Professor Heinrich Hora of the Department of Theoretical Physics at the University of New South Wales, uses normal hydrogen protons and the

commonly found element boron 11.
Instead of high-energy neutrons, hydrogen–boron 11 (HB11) fusion produces an avalanche of helium nuclei, resulting in extremely low levels of radioactivity — less even than produced by burning coal.
"Every HB11 reaction produces three helium particles, each of which collide with more boron to produce another three reactions and so on," said Professor Hora.
The HB11 process requires two lasers, the first to generate a powerful magnetic confinement field in a coil to trap the fusion reaction in a small area for a nanosecond, while a second more powerful laser triggers the nuclear fusion process.
"The triggering laser provides an extremely short duration pulse of just a picosecond, which is a millionth of a millionth of a second, and a thousand times shorter than the [nanosecond pulse] lasers at Lawrence Livermore," said Professor Hora.
Picosecond pulses achieve fusion through electrodynamic forces — directly converting optical laser energy into mechanical motion — smashing the target material together to trigger fusion.
Professor Hora says early HB11 fusion trials at the Prague Asterix Laser System, using high-energy iodine lasers, have generated more energy than needed to trigger the fusion process.
"For every joule of energy put into the fusion process by the lasers, the HB11 reaction generates 10,000 joules," says Professor Hora.
"Nuclear fusion power could be a reality in 10 to 15 years."

The thorium wildcard

With the goal of clean energy in mind, the focus isn't only on nuclear fusion. A cleaner form of nuclear fission is the subject of research around the globe.
Existing nuclear power stations rely on fission, using uranium 235, which is unstable and readily loses neutrons. These neutrons collide with other uranium atoms, splitting them and causing further collisions with even more uranium atoms in a chain reaction.
But all these high-energy neutrons result in large amounts of radioactivity.

Thorium fission reactors — first developed in the 1950s — could be a cleaner alternative.
Thorium is lighter than uranium, it doesn't undergo fission, and can't create runaway meltdown like uranium. Instead a seed of uranium or plutonium is injected into the thorium fuel, or a particle beam is fired at it to kick things off.
The process involves thorium 232 atoms being bombarded with neutrons to produce thorium 233 atoms, which quickly decay into protactinium 233, and then uranium 233, which undergoes fission similar to current nuclear power plants.
Unlike uranium 235, which creates self-sustaining chain reactions, thorium reactors only work as long as you keep firing neutrons, giving them an automatic failsafe to prevent meltdown.
Thorium reactors also produce just a fraction of the radioactive waste of conventional nuclear power stations, they aren't suitable for making weapons grade material, and can even be used to consume existing nuclear waste as a fuel source.
Thorium is three times as abundant as uranium, with Australia having the world's largest known reserves.
The United States, India, Israel, the United Kingdom, China, Norway, Chile and Indonesia are all examining thorium nuclear reactor projects.

15. China's experimental fusion reactor maintains superheated hydrogen plasma for 102 seconds

NICK LAVARS

FEBRUARY 8, 2016
http://www.gizmag.com/china-fusion-reactor-plasma/41729/

A bit of friendly competition never hurt anyone. China's EAST tokamak and Germany's Wendelstein 7-X aren't exactly fusion energy's answer to Messi and Ronaldo, but through their own flashes of individual brilliance the reactors might one day command the world's attention in a much more important way.
Wendelstein 7-X made headlines last week after generating a quarter-of-a-second pulse of hydrogen plasma, and now scientists at China's Institute of Physical Science have reportedly flexed their fusion muscle to sustain the gas for an impressive 102 seconds.
Experimental reactors like China's Experimental Advanced Superconducting Tokamak (EAST) have been used as vehicles to pursue abundant, clean nuclear fusion power for decades. Inside these hollow, doughnut-shaped chambers, hydrogen gas is superheated to temperatures rivalling our Sun to produce plasma, which is contained by powerful magnetic fields. If it can be held in place for long enough periods, this hydrogen plasma may one day be harnessed to provide a practically inexhaustible source of energy.
In a recent experiment at China's Institute of Physical Science, it is claimed physicists were able to heat plasma in the EAST to around 50 million Kelvin, more than three times the temperature of our sun's core, and sustain it for 102 seconds. The idea behind experiments such as these is to recreate the nuclear fusion that occurs in stars, where atomic nuclei collide and fuse together to form helium atoms, releasing huge amount of energy in the process.
EAST's publicly stated goal is to reach 100 million

Kelvin and hold plasma for more than 1,000 seconds (around 17 minutes).

Truth be told, EAST's plasma has been outstripping Wendelstein 7-X's best effort since before Germany's €1 billion (US$1.1 billion) reactor was even constructed. Back in 2013, scientists reported a then record-breaking 30 second pulse of high-temperature plasma. They claimed this was a result of a new technique that reshaped the magnetic field lines that confine the plasma, and new internal coatings that stopped it drifting into the outer walls and collapsing. But another possible pathway to creating a stable environment for plasma to endure is the development of stellarator reactors. This design, adopted for the Wendelstein 7-X, instead drives the plasma through a twisted magnetic field that is engineered to constantly force the plasma stream into the center of the vessel to better avoid disruptions.

Equipped with 50 superconducting coils, the Wendelstein 7-X is designed to offer more than the relatively short bursts of plasma served up by tokamak reactors thus far. Last week's achievement, where a 2-megawatt pulse of microwave heating converted hydrogen gas into plasma at 80 million degrees for a quarter of a second, marks only the beginning of its scientific operation. The team has a series of upgrades planned over the next four years as it works towards its ultimate goal of achieving 30 minute discharges.

But while these two separate projects are at the forefront of nuclear fusion research, to measure their progress simply through discharge times is overly simplistic, and something of an apples and oranges comparison. As Dr Matthew Hole, senior fellow at the Centre for Plasmas and Fluids at Australian National University explains, there are a number of factors to consider.

"These are impressive feats in their own right, but they are different geometric problems using different magnetic confinement concepts," he tells Gizmag.

"One is twisted and one is a straight doughnut. They have different performance properties, but common to both of them, in addition to ultra long pulses, is you want high temperature, high density and long energy confinement times. This is great progress, but the next step is ITER."

ITER (International Thermonuclear Experimental Reactor) will be the largest tokamak fusion reactor in the world. The product of a collaboration between 35 countries, it is planned to be the first fusion device to produce net energy and is expected to begin operations in 2027.

Source: Institute of Physical Science via South China Morning Post

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