ITER Forum website Update 6/16

B.J.Green (21/6/16)

1. # Ronald C. Davidson, 74, pioneer of fusion power

By Kenneth Chang NEW YORK TIMES MAY 31, 2016

2. https://www.bostonglobe.com/metro/obituaries/2016/05/30/ronald-davidson-pioneer-fusion-power/5CaSeBIIh24ysZ2VFjyBtK/story.html

NEW YORK — Ronald C. Davidson, who oversaw one of the biggest advances in fusion energy research, attempting to replicate the power of the sun, died May 19 at his home in Cranbury, N.J. He was 74.

The cause was complications from pneumonia, said the Princeton Plasma Physics Laboratory, where Dr. Davidson was director from 1991 to 1996. Before that, he was the director of the Plasma Fusion Center at the Massachusetts Institute of Technology.

Fusion is the process that powers the sun, generating energy through the merging of atoms, and, for decades, scientists have tried to reproduce that on Earth. During Dr. Davidson's tenure, the Princeton lab made major advances toward that goal, studying ways to make the fusion self-sustaining.

In 1993, the laboratory's immense Tokamak Fusion Test Reactor began a series of runs using a mix of deuterium and tritium, two heavier forms of hydrogen. ("Tokamak" is an acronym of three Russian words that mean "toroidal magnetic chamber," referring to the doughnut-shaped reactor that housed the ultrahot gases.)

In November 1994, the reactor generated 10.7 million watts of fusion energy, a world record at the time and enough to power 3,000 homes, if only for an instant.

"Very exciting times," said Robert J. Goldston, a laboratory scientist who succeeded Dr. Davidson as director in 1996. "He guided that with a very steady and calm hand in what were fairly trying circumstances."

With that much energy, "You had to do this very, very safely," Goldston said. "We never had a problem with safety, but we had problems that made you think we better be careful."

The experiments laid the groundwork for future advances, including Iter, a much larger reactor under construction in France. The Princeton Tokamak reactor was shut down in 1997.

Born on July 3, 1941, in Norwich, Ontario, Ronald Crosby Davidson grew up on a dairy farm, learning to drive a tractor by 11. After graduating in 1963 with an undergraduate physics degree from McMaster University in Hamilton, Ontario, he enrolled in the plasma physics program at Princeton. He completed his doctorate in three years.

After a postdoctoral fellowship at the University of California Berkeley, he became a professor at the University of Maryland. He then moved to the Massachusetts Institute of Technology, where he was the founding director of the plasma fusion center.

"His biggest contribution was taking the plasma activities at MIT from a group of warring fiefdoms to a unified and productive laboratory," Ronald

Parker, who succeeded Dr. Davidson as the director, said in a Princeton statement.

In 1991, he was enticed to move back to Princeton, where Harold P. Furth had spearheaded the efforts to build the Tokamak Fusion Test Reactor. Furth stepped down in 1990 as director of the laboratory because of health problems.

After Dr. Davidson left as director, he returned to research, continuing as a professor in Princeton's astrophysics department until 2011.

He was an author on more than 500 scientific papers and four textbooks. He also edited the journal Physics of Plasmas.

Dr. Davidson leaves his wife of 53 years, Jean; a daughter, Cynthia Premru, of Groton, Mass.; a son, Ronald Jr., of Princeton Junction; and four grandchildren.

A memorial service will be held at 1:30 p.m. Thursday, at the Princeton United Methodist Church.

Dale Meade, deputy director under Dr. Davidson, recalled phone calls with him every Sunday promptly at 9 a.m. to discuss the tasks for the week.

"He was highly organized and structured," Meade said, recalling separate small green notebooks — one for his tasks as journal editor, one for what he needed to do as director, one for his personal research.

"He had lots of persistence," Meade said. "Maybe that's how he was able to inspire people without having to raise his voice."

2. **Decline of US nuclear industry is accelerating**

New electricity pricing policies are needed to help nuclear plants remain open

and allow them to compete with cheap, abundant natural gas, officials say.
David Kramer

01 June 2016
http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.1075?utm_source=Physics%20Today&utm_medium=email&utm_campaign=7177312_The%20week%20in%20Physics%2030%20May–3%20June&dm_i=1Y69,49U1S,E1OV2B,FM6S9,1

Alarmed by the growing number of US nuclear power plants that have closed or might soon close because of cheap, abundant natural gas, industry officials are calling for speedy government action to rebalance an electricity market that they say is stacked against them.

"I'll be straight with the [Obama] administration people here: We know you want to help nuclear, but all we hear about is renewables," complained Marvin Fertel, president of the Nuclear Energy Institute, the industry's trade association. Fertel addressed the issue at a 19 May Capitol Hill conference on nuclear power.

Over the past few years, US companies have closed or announced plans to close eight reactors with a combined capacity of 6300 MW. Fertel claimed that another 15 to 20 plants are at risk of closure over the next 5 to 10 years. "We're driving companies to make decisions that our nation will regret for the next 20 or 30 years, or longer, on the basis of short-term, unsustainable price signals," he said.

Replacing all the shuttered plants with new natural-gas generation would wipe out about one-quarter of the carbon emissions reductions that are projected in the administration's Clean Power Plan. The changeover would also cancel out 40% of the cuts to greenhouse gas emissions that the US committed to in December at the Paris climate change conference.

Most recently, on 12 May, the utility that operates the Fort Calhoun nuclear plant in Nebraska announced it will likely close the single-reactor facility by the end of the year. Secretary of Energy Ernest Moniz told conference attendees that another 6.5 GW of nuclear capacity will likely be retired by 2030. A typical commercial reactor produces about 1 GW. "We are supposed to be adding zero-carbon sources, not subtracting or merely replacing by treading water," Moniz lamented.

Over the past seven years, Exelon has lost $800 million operating its Quad Cities and Clinton nuclear plants in Illinois, and the energy company has said it can't continue to sustain those losses. Although Quad Cities' production cost is only 2.8 cents per kilowatt-hour, Fertel said it still can't compete with natural gas.

"We've got to support the existing nuclear fleet," said Senator Cory Booker (D-NJ). "We must make a goal of passing a law that establishes an economy-wide price on carbon to allow nuclear to compete on a level playing field." Bill Mohl, president of electricity merchant provider Entergy Wholesale Commodities, added, "If the federal government can't take the lead on a price for carbon, the states will have to do that."

Electricity markets have failed to give nuclear energy credit for being a clean, zero-carbon source that has provided around-the-clock, base-load power. To encourage the growth of wind and solar energy, Congress has subsidized them with 30% production tax credits. But because they are intermittent sources and there are currently no reliable energy storage systems, neither is as dependable as nuclear or coal. Nuclear's ongoing, seemingly intractable waste-disposal issue was not discussed, nor was the public's uneasiness with the technology.

"Subsidies of renewables were done in a different time, when the price of gas was high and [electricity] load was growing at a fairly constant rate," said William Levis, president of PSEG Power. In addition to nuclear power's high reliability—US commercial plants operated at 92% of their capacity last year, far higher than other generating sources—the power generated is stored on site. Natural gas, by contrast,

is supplied through pipelines, which could be severed in a natural disaster.
Nuclear power plants supply nearly 20% of US electricity needs, whereas wind produced less than 5% in 2015. “It’s conceivable that wind and solar may produce as much electricity in 2040 as nuclear does today,” Fertel said.
As part of its quadrennial energy review, the Department of Energy is analyzing how nuclear might be provided credit, or valuation, for its zero-emissions status, Moniz said. But Fertel warned that the situation demands urgent action. “A report on it doesn’t do anything unless the regional transmission organizations and the Federal Energy Regulatory Commission do something with it,” he said. “You need to get it to them, they need to do something with it, and it needs to be done sooner rather than later.”
Matt Bennett, founder of the centrist think tank Third Way, suggested that the government could maintain closed plants so they might be restarted when market conditions warrant. Power purchasing agreements might also be struck with the Defense Department or other federal agencies to help prop up the industry.

3. NIF may never ignite, DOE admits

The new goal is to determine whether a milestone can be achieved at the Lawrence Livermore laser by 2020.

David Kramer

17 June 2016

http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.1076?utm_source=Physics%20Today&utm_medium=email&utm_campaign=7233195_The%20week%20in%20Physics%2013–17%20June&dm_i=1Y69,4B163,E1OV2B,FREJA,1

More than three years after the deadline passed for obtaining a sustained, high-energy-yield nuclear fusion reaction at the National Ignition Facility (NIF), the US Department of Energy is still unsure whether the $3.5 billion laser can ever attain that milestone. Much as it did in 2012, the agency has established a new, less ambitious goal for NIF several years hence: to determine whether the machine can ever achieve its eponymous goal, and if not, why not.
“The question is *if* the NIF will be able to reach ignition in its current configuration and not *when* it will occur,” states a May report prepared by DOE’s National Nuclear Security Administration (NNSA). The reassessment of progress toward ignition at the Lawrence Livermore National Laboratory facility was conducted three years after the NNSA suspended its formal two-year-long ignition campaign in September 2012. Ignition, the threshold at which more energy results from a fusion reaction than is required to spark it, is an essential determinant in whether inertial confinement fusion (ICF) could ever become a source of fusion power.
Despite the report’s assurances that much progress has been made toward ignition since 2012, the NNSA appears no closer to committing to ignition on NIF than it was then. In a December 2012 report to Congress, the agency found “no compelling information suggesting that the [NIF’s] indirect-drive approach cannot achieve ignition.” Still, then-NNSA administrator Tom D’Agostino said it was “too early to say whether or not ignition can be achieved at the NIF.”
In a new plan for the ICF program, the NNSA establishes a goal, with a deadline of 2020, to “determine the efficacy of reaching ignition on NIF.” That contrasts sharply with the virtual assurances of ignition that were made by proponents in 2009, when NIF began operating. Although ignition experiments continue at NIF, they have been interspersed with experiments designed to deepen understanding of other nuclear

weapons–related phenomena, such as the behavior of materials under extreme pressures and densities.

Since 2012 NIF's 1.8 MJ laser has nearly doubled the frequency of shots, the machine's diagnostics have been improved, and progress has been made on identifying key impediments to ignition, the new report states. NIF's indirect-drive approach focuses 192 beams on a cylinder, or hohlraum, containing a tiny capsule of fusion fuel. The hohlraum converts the light to x rays, which implode the capsule.

In the meantime, the University of Rochester's Omega laser and Sandia National Laboratories' Z machine—both also supported by the NNSA's inertial confinement fusion program—continue research on alternative approaches to ignition. Omega, a glass laser like NIF, uses direct drive, which brings beams to impinge directly on targets; Z uses electromagnetic fields to produce implosions.

The NNSA review says computer models and codes predicting that NIF would attain ignition conditions "are not capturing the necessary physics to make such predictions with confidence. A lack of appreciation for this, combined with a failed approach to scientific program management, led to the failures" in the ignition campaign.

Although the performance of NIF's targets containing fusion fuel continues to improve, "currently, there is no known configuration, specific target design, or approach that will guarantee ignition on the NIF," says the review.

Stephen Bodner, a former director of the laser fusion program at the US Naval Research Laboratory (NRL), has been a vocal critic of NIF since before its construction began. In a 1995 paper published in *Plasma Physics and Controlled Fusion,* Bodner predicted that the highly intense NIF laser would create instabilities in the plasma. That, plus the formation of unpredictable magnetic fields, would prevent the symmetrical implosions required for ignition.

"Basically [the report] is confirmation of what I predicted in 1995," Bodner says. "It took the community 21 years, and many billions of dollars, to vindicate my predictions. So sad."

Regardless of whether ignition is achieved, there are other compelling nuclear weapons stewardship questions concerning the properties of thermonuclear plasmas with multi-megajoule yields, the NNSA report says. Planned Russian and Chinese laser facilities may surpass NIF's capabilities, it warns, and in an era without nuclear testing, a source capable of producing 500 MJ of fusion energy "will be essential for the health of the [weapons] program." Such energy yields are unlikely to be achieved within the next decade but should be considered an ultimate goal, the report says.

Bodner argues, however, that NIF's regimes of temperature, ionization, pressure, density, and radiation spectrum are fundamentally different from those that occur in a nuclear weapon. "To extrapolate the regime in the laboratory that they're using to anything in nuclear weapons would be outrageously irresponsible," he says. "They should not be using any of that science in the nuclear weapons program."

David Crandall, a former NNSA scientist who helped oversee NIF, disagrees. He says the realization that the codes predicting ignition were wrong has instilled a new level of caution among weapons scientists about extrapolating from data sets of nuclear tests. "That piece of reality was extremely important to the weapons program," he says. Further, Crandall says, new methods have been developed for using NIF-generated fast neutrons to test weapons codes. For those techniques, neutron yield is more important than ignition. Also, he explains, experiments at NIF have already provided important new information about the behavior of plutonium at high pressures.

John Edwards, associate director for the NIF's ICF program, declines to say whether he's optimistic or pessimistic about ignition at NIF. Progress since 2012 includes the first ever laboratory demonstration of the alpha heating process, in which thermal energy is supplied by the helium nuclei that result from fusion. "But there are obstacles which we are quite open about," Edwards acknowledges. Researchers think they can overcome the instabilities inside the hohlraums by making the

cylinders larger; the question is whether NIF's energy is sufficient to drive the larger targets, he says.
Reconfiguring NIF to perform direct-drive experiments is being evaluated by a University of Rochester–led team. But that will require a major revamp costing several hundred million dollars.
Bodner argues that solid-state lasers like NIF and Omega won't work; he says the krypton fluoride gas laser—two of which he helped build while at the NRL—is the best option for an ignition driver. The KrF laser in a direct-drive mode produces a broader bandwidth beam that can be "smoothed" to eliminate asymmetric hot spots, he says. But the NNSA's plan doesn't include KrF lasers among its driver candidates.
Stephen Dean, president of the nonprofit Fusion Power Associates, says DOE's justification for NIF has shifted from the energy-relevant milestone of achieving ignition to a focus mainly on weapons research. "They don't want to be held to ignition," he says. Dean sees a parallel with DOE's magnetic fusion program. In 1980 the project was sold as an energy program with a 2000 deadline for construction of a working fusion power plant; today it's classified as a science program.
"You have people working who were goal-oriented," Dean says. "And when the program doesn't accomplish those goals, there's a scramble to do something to save it."
Correction (20 June 2016): Stephen Bodner was incorrectly identified as the head of the plasma physics program at NRL. He was, instead, the head of the laser fusion program at NRL.

4. *Wall Street Journal* opinion editors are attacked for deep climate bias

A big ad on the *WSJ* opinion page itself proclaims they must "become part of the solution on climate change."

Steven T. Corneliussen

17 June 2016

http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.8177?utm_source=Physics%20Today&utm_medium=email&utm_campaign=7233195_The%20week%20in%20Physics%2013–17%20June&dm_i=1Y69,4B163,E1OV2B,FREJA,1

In the climate wars, a little-known but apparently well-financed environmental group is assaulting the *Wall Street Journal*'s (*WSJ*'s) opinion page, a mighty bastion for climate scoffers. A 14 June *Politico* blurb summarizes:
TAKING THE FIGHT TO THE WSJ, IN THE WSJ: The Partnership for Responsible Growth, a pro-growth climate action group that advocates for a carbon tax, will launch a $350,000 ad campaign today in the pages of the Wall Street Journal. The first of a series of 12 ads will run on the op-ed page today and read in part, "Exxon's CEO says fossil fuels are raising temperatures and sea levels. Why won't the Wall Street Journal?" The ads will run ... through July 21. The group will also run ads on Fox News during the Republican National Convention in Cleveland.
That first ad filled the lower-right-hand quarter of one of the *WSJ*'s three opinion pages. It ended by doubling down on its headlined challenge: "Historically, when faced with a national security threat like climate change, Americans have set aside ideology, faced facts and taken action. It is time for the editorial board of the WSJ to become part of the solution on climate change. Watch this space for how."
To watch that space, *WSJ* nonsubscribers have cost-free options. They can sign up for email notifications or periodically consult the webpage where the partnership has

begun displaying the dozen ads. The first two can already be seen there. “We want to bring accurate, mainstream climate science to readers of this publication’s opinion pages,” the group announces, “and show that pricing carbon is a bipartisan, market-based solution to the climate challenge that will increase economic growth and American competitiveness.”

The second *WSJ* ad, which ran on 16 June, carries the headline “Carbon dioxide traps heat on Earth,” with the subhead “If we can agree on that, we can have a conversation.” Concerning the trapping, it says, “We’ve known this for more than a century.” Citing work by Spencer Weart, historian emeritus at the Center for History of Physics, American Institute of Physics (publisher of *Physics Today*), the ad recalls, “In the 1820s, French physicist Jean-Baptiste Fourier identified the Greenhouse Effect. By 1896, Swedish physicist Svante Arrhenius showed how CO2 from industrial emissions would cause temperatures to rise.”

The partnership calls its vision for climate policy “Climate 2.0.” The idea is to “harness” the free market in nonpartisan ways, with energy-innovation incentives and “a revenue-neutral carbon fee.” The partnership explains that “about half of the revenue could be used to reduce the corporate tax rate from 35 percent (the highest in the industrialized world) to 25 percent. Most of the balance could be returned to low and middle income families through a lump sum tax credit, rebate, or other tax reductions. We call this bipartisan approach ‘carbon-funded tax cuts.’”

In a 14 June *Washington Post* piece, media reporter Paul Farhi insinuated that the *WSJ* charged an extra $9000 for the initial *WSJ*-bashing ad, but he also reported a *WSJ* official’s denial. Farhi quoted partnership cofounder and chief executive George Frampton: “We’re not really trying to convert or attack the paper. We’re trying to reach out to a business audience in a medium that never tells them the science is basically settled and that this is a national-security and economic problem. ... I’d say if the Journal won’t cover it, we’ll pay to have them cover it.” The *Post* piece identified Frampton as a lawyer and former Wilderness Society president, and it added that cofounders Walter Minnick and William Eacho are, respectively, a Democratic former congressman from Idaho and a businessman and former ambassador to Austria.

The assault force prepared extensively for its attack on the *WSJ* scoffing bastion. Researchers for the Partnership for Responsible Growth analyzed some 602 *WSJ* editorials, columns, and op-eds going back two decades. The partnership has posted online a spreadsheet titled “Database: How the Wall Street Journal opinion section presents climate change.” According to the group, the analysis shows “a consistent pattern that overwhelmingly ignores the science, champions doubt and denial of both the science and effectiveness of action, and leaves readers misinformed about the consensus of science and of the risks of the threat.”

Once a cursor has been placed within it, the spreadsheet can be navigated with keyboard arrows. Its oldest entry cites the op-ed “Keep cool about global warming,” from 16 October 1995. A blurb reports, “Robert C. Balling Jr, the director of the Office of Climatology at Arizona State University in Tempe, offers four environmental statistics that dispel the notion of global warming brought about by use of fossil fuels.”

The group has also placed online a 15-page report that opens by declaring why the *WSJ* matters: It’s “the premier paper of the business world and one of the widest circulating daily papers in the United States. From small business owners to titans of industry to policy makers in state capitals and Washington, the Journal has long been a powerfully influential source of news for those responsible for turning a profit and setting economic policy.”

The introduction stipulates that the “reporting of the Journal is widely recognized as some of the best in the world,” but it adds, “Yet this analysis indisputably shows that its opinion page has done its readers a disservice by consistently ignoring or ridiculing the scientific consensus on the reality and urgency of climate change, and in so doing minimizing the potential economic, social and environmental risks of

climate change." It charges that "such an out-of-balance view cannot help but hinder its readers' ability to make accurate assessments of the risk climate change poses to their businesses."

The analysts found that of 201 *WSJ* editorials since 1997, not a single one acknowledged that fossil fuels cause climate change. (To emphasize that graphically, they included a pie chart with no slices shown—only a full, or maybe empty, pie.) Of 279 op-eds published since 1995, they found only 40—14%—that reflect mainstream climate science. Of 122 columns published since 1997, they say that only four—3%—"accept as fact that fossil fuels cause climate change, or endorse a policy to reduce emissions."

They also assert that mainstream scientists "routinely" criticize the op-eds. My own anecdotal surmise, however—from more than a decade of observation—is that criticism specifically via letters to the *WSJ* editor, in any case, is not routine, whether thanks to nonfeasance by experts, or rejections by the letters editor, or both. The report says only, "Letters to the editor were dismissed for technical reasons (multiple letters exist on a single URL) and because their purpose is often to oppose the opinions presented by a paper."

The analysts level the accusation that the *WSJ* opinion page "consistently highlights voices of those with vested interests in fossil fuels—though only sporadically are these industry ties disclosed." They also charge that "downplaying established science and battling health protections is an established pattern for the Wall Street Journal's editorial board. The paper exhibited editorial bias on: the harmful health effects of tobacco; the safety and efficacy of airbags and seat belt laws; the danger of dioxin/Agent Orange; and other environmental threats."

The analysts conclude the following:

The Wall Street Journal's opinion section gives readers a distorted understanding of climate change. This does a disservice to the Journal's audience—particularly their business audience—which relies on accurate information to plan for the impact of climate impacts and environmental regulations. By mixing political attacks with scientific misinformation, the Journal introduces undue uncertainty, casting doubt on solid science while promoting fringe opinions.

"Casting doubt on solid science"? In realms other than climate, the *WSJ* opinion page generally does the opposite, as when it published physicist Michio Kaku's op-ed both explaining and celebrating LIGO's detection of gravitational waves.

How, if at all, will the editors react to the assault? As of 16 June, they had not responded.

Steven T. Corneliussen, a media analyst for the American Institute of Physics, monitors three national newspapers, the weeklies Nature *and* Science, *and occasionally other publications. He has published op-eds in the* Washington Post *and other newspapers, has written for NASA's history program, and was a science writer at a particle-accelerator laboratory.*

5. Fusion megaproject confirms 5-year delay

Page added on June 18, 2016

http://peakoil.com/alternative-energy/fusion-megaproject-confirms-5-year-delay

The ITER fusion reactor will fire up for the first time in December 2025, the €18-billion project's governing council confirmed today. The date for "first plasma" is 5 years later than under the old schedule, and to get there the council is asking the project partners—China, the European Union, India, Japan, Russia, South Korea, and the United States—to cough up an extra €4 billion ($4.5 billion).

"It is expected, if there are no objections, that we can approve [the schedule] by November and then we can move forward," says ITER director general Bernard Bigot.

ITER aims to show that it is feasible to fuse hydrogen nuclei together to form helium and thereby release enough excess energy to make a viable source of power. To achieve that requires heating two hydrogen isotopes—deuterium (D) and tritium (T)—to temperatures above 100 million degrees Celsius. ITER will feature an enormous vessel to contain the D-T plasma, powerful superconducting magnets to confine it, and elaborate particle accelerators and microwave generators to heat it.

The international consortium that is building the reactor has parceled out the construction work to hundreds of companies across the globe. But the sheer complexity of the effort has led to delays and cost increases as researchers sought to finalize the design, maintain standards, and get the million-plus components delivered on time to the reactor site at Cadarache, France.

Bigot was brought on in March 2015 to get the project back on track. He presented a revised schedule to the council last November, pushing back the first plasma from 2020 to 2025 and asking for an additional €4.6 billion for staff and equipment. The council asked an independent panel to review the schedule and asked ITER management to cut costs. The panel declared in April that the 2025 goal is technically feasible but warned that there was no slack in case of unexpected problems.

The council meeting yesterday and today rubberstamped the 2025 target and accepted a price tag of slightly under €4 billion, down by €600 million. Managers shaved off some of the cost of reaching first plasma by delaying the construction of some components—ones that aren't needed for early experiments—until later dates. ITER staff is now working on a staged approach in which a few years of experiments are followed by upgrades, then more experiments and more upgrades, and so on. Early studies will use only hydrogen or deuterium for simplicity, leaving the radioactive tritium for later. That may end up delaying the first D-T experiments and increasing the overall cost, but "it reduces annual cost for the partners and it was supported by all of them," Bigot says. "They all feel more

comfortable and there is no rush." The partners have agreed to the approach in principle while management works out the schedule in more detail. The final decision will be made at the next council meeting in November.
The council also approved a boost in staff by 350 to 1050 and the domestic agencies—bodies in each partner that handle the industrial contracts to build components—will contribute 100 more. The council also agreed to a proposal from the United States for more regular independent reviews of key project aspects, because of considerable opposition to ITER in U.S. Congress. Bigot says these may occur every 6 months and will be tightly focused, covering topics such as the project's risk assessment and mitigation strategy or whether production of a critical component is moving fast enough.
With agreement coming together on the schedule and cost, "the atmosphere is much more positive now compared with a year ago," Bigot says. "There is a common will to make this project a success."
sci mag

6. Fusion megaproject confirms 5-year delay, trims costs

By Daniel Clery Jun. 16, 2016 , 4:00 PM
http://www.sciencemag.org/news/2016/06/fusion-megaproject-confirms-5-year-delay-trims-costs
The ITER fusion reactor will fire up for the first time in December 2025, the €18-billion project's governing council confirmed today. The date for "first plasma" is 5 years later than under the old schedule, and to get there the council is asking the project partners—China, the European Union, India, Japan, Russia, South Korea, and the United States—to cough up an extra €4 billion ($4.5 billion).
"It is expected, if there are no objections, that we can approve [the schedule] by November and then we can move forward," says ITER director general Bernard Bigot.
ITER aims to show that it is feasible to fuse hydrogen nuclei together to form helium and thereby release enough excess

energy to make a viable source of power. To achieve that requires heating two hydrogen isotopes—deuterium (D) and tritium (T)—to temperatures above 100 million degrees Celsius. ITER will feature an enormous vessel to contain the D-T plasma, powerful superconducting magnets to confine it, and elaborate particle accelerators and microwave generators to heat it.
break
The international consortium that is building the reactor has parceled out the construction work to hundreds of companies across the globe. But the sheer complexity of the effort has led to delays and cost increases as researchers sought to finalize the design, maintain standards, and get the million-plus components delivered on time to the reactor site at Cadarache, France.
Bigot was brought on in March 2015 to get the project back on track. He presented **a revised schedule to the council last November**, pushing back the first plasma from 2020 to 2025 and asking for an additional €4.6 billion for staff and equipment. The council asked an independent panel to review the schedule and asked ITER management to cut costs. The panel **declared in April that the 2025 goal is technically feasible** but warned that there was no slack in case of unexpected problems.
The council meeting yesterday and today rubberstamped the 2025 target and accepted a price tag of slightly under €4 billion, down by €600 million. Managers shaved off some of the cost of reaching first plasma by delaying the construction of some components—ones that aren't needed for early experiments—until later dates. ITER staff is now working on a staged approach in which a few years of experiments are followed by upgrades, then more experiments and more upgrades, and so on. Early studies will use only hydrogen or deuterium for simplicity, leaving the radioactive tritium for later.
That may end up delaying the first D-T experiments and increasing the overall cost, but "it reduces annual cost for

the partners and it was supported by all of them," Bigot says. "They all feel more comfortable and there is no rush." The partners have agreed to the approach in principle while management works out the schedule in more detail. The final decision will be made at the next council meeting in November.

The council also approved a boost in staff by 350 to 1050 and the domestic agencies—bodies in each partner that handle the industrial contracts to build components—will contribute 100 more. The council also agreed to a proposal from the United States for more regular independent reviews of key project aspects, because of **considerable opposition to ITER in U.S. Congress**. Bigot says these may occur every 6 months and will be tightly focused, covering topics such as the project's risk assessment and mitigation strategy or whether production of a critical component is moving fast enough.

With agreement coming together on the schedule and cost, "the atmosphere is much more positive now compared with a year ago," Bigot says. "There is a common will to make this project a success."

/article_body/

Posted in: **Funding Physics**

DOI: 10.1126/science.aag0618

7. Hotter all the way: Lithium wall contains plasma without cooling it

Date:

June 15, 2016

Source:

Department of Energy, Office of Science

Summary:

You may have known lithium from its role in rechargeable batteries, but did you know it may be a vital in fusion reactors?

These reactors require walls that don’t sputter out metals or overly cool the plasma at the heart of the reaction. Researchers showed that lithium-coated walls can handle heat.
https://www.sciencedaily.com/releases/2016/06/160615102658.htm

Nearly everybody knows about lithium -- a light, silvery metal -- used in rechargeable batteries. But did you know it may be a vital part of fusion reactors, which harness the same reaction that fuels our sun? Fusion reactors require walls that don't sputter out metals or overly cool the plasma at the heart of the reaction. Researchers demonstrated that lithium-coated walls can handle temperatures exceeding 200 eV. The influx of lithium to the reactor's core is expected to decrease as the plasma edges heat up to fusion-relevant temperatures. Also, because lithium is the lightest of all solid metals, if modest amounts of lithium are sputtered, it does not impact performance.

Cooling the edge plasma in a donut-shaped reactor called tokamak to low temperatures cools the core as well, and the reactor's performance is reduced. If a hot plasma edge can be tolerated by the wall, fusion performance will increase. Very flat

temperature profiles with a hot plasma edge have now been achieved in the Lithium Tokamak Experiment, located at DOE's Princeton Plasma Physics Laboratory, by adding a lithium wall. Such uniformity in the radial temperature profile may also significantly reduce the means by which plasma instabilities are driven, and hence decrease energy and particle losses.

In large tokamaks with tungsten walls, the edge plasma must be cooled to low temperatures before it contacts the wall. This reduces sputtering of the wall by the plasma, which can lead to the introduction and accumulation of heavy impurities in the plasma. Sputtering of a heavy wall material, such as tungsten, increases continuously with the plasma energy, until very high energies are reached. The mass difference between the hydrogen plasma ions and the wall atoms is much smaller for lithium than tungsten, and sputtering of lithium peaks at relatively low energies (around 200 eV).

The lithium sputtering decreases continuously at higher energies, up to temperatures of 10 keV or more. This is because higher energy ions "bury" themselves in the light wall material, and transfer little energy to the surface atoms. Aside from the potential performance improvements for tokamaks, the Lithium Tokamak Experiment (LTX) provides an opportunity to investigate the behavior of plasmas with flat temperature profiles.

Plasmas with uniform temperature throughout, *i.e.,* without a temperature gradient, are in a regime that has never been previously achieved for any magnetically confined plasma. This work was performed as a collaboration between the Princeton

Plasma Physics Lab and Oak Ridge National Laboratory, with participation by the University of Washington Plasma Science and Innovation Center, and the University of California, Los Angeles.
/1002721/ScienceDaily_Mobile_Middle_Rectangle

Story Source:
The above post is reprinted from materials provided by **Department of Energy, Office of Science**. *Note: Materials may be edited for content and length.*
/story_source

Journal Reference:
J. C. Schmitt, R. E. Bell, D. P. Boyle, B. Esposti, R. Kaita, T. Kozub, B. P. LeBlanc, M. Lucia, R. Maingi, R. Majeski, E. Merino, S. Punjabi-Vinoth, G. Tchilingurian, A. Capece, B. Koel, J. Roszell, T. M. Biewer, T. K. Gray, S. Kubota, P. Beiersdorfer, K. Widmann, K. Tritz. **High performance discharges in the Lithium Tokamak eXperiment with liquid lithium wallsa)**. *Physics of Plasmas*, 2015; 22 (5): 056112 DOI: 10.1063/1.4921153

8. U.K.-E.U. fission could harm fusion research

By Daniel Clery Jun. 14, 2016 , 6:00 PM
http://www.sciencemag.org/news/2016/06/uk-eu-fission-could-harm-fusion-research
If the United Kingdom votes to leave the European Union on 23 June, the exit will break up cross-border collaborations and cut off E.U. funding for U.K. scientists. For fusion

research, the possibility of a Brexit is particularly worry ing. Europe's largest fusion facility, the Joint European Torus (JET), is sited just south of Oxford, U.K.; a vote to leave would put it in a legal limbo that could halt vital research supporting the International Thermonuclear Experimental Reactor (ITER), now under construction in southern France. JET dominates much of the work at its host institution, the Culham Centre for Fusion Energy. A Brexit "certainly will make us very vulnerable," says Steve Cowley, the center's director.

Polls suggest the referendum's outcome is too close to call, and a vote for a Brexit would not affect some pan-European research facilities because the European Union does not control them. These include the CERN particle physics laboratory in Geneva, Switzerland; the Paris-based European Space Agency, which has a technology center at Culham; the European Southern Observatory in Garching, Germany; and the European Molecular Biology Laboratory, which has a bioinformatics institute in Cambridge, U.K.

Fusion is different. The nuclear arm of the European Union, known as Euratom, pays a consortium of national labs and university groups—dubbed EUROfusion—to carry out fusion research, most of which is aimed at supporting ITER. EUROfusion will receive €424 million for the work over 5 years (2014–18), and another €283 million will go to the Culham Centre for operating JET and hosting ITER-related research.

break

JET is the world's largest tokamak—a doughnut-shaped fusion reactor like ITER. Its innards have been coated with the same beryllium and tungsten that will line ITER, and its heating power has been boosted to make it as ITER-like as possible. JET is also the only tokamak in the world equipped to use the fuel that will eventually power ITER: a mix of the hydrogen isotopes deuterium and tritium. Tritium is radioactive and hard to handle, but this mixture is the easiest to "burn," meaning fusing its nuclei can release

excess energy. JET researchers are currently testing how the machine behaves when filled with hydrogen, deuterium, and tritium individually before attempting deuterium-tritium burns in 2019.

A Brexit could halt those experiments. “We would be less well prepared for ITER operation,” says Lorne Horton, JET’s exploitation manager. “From a scientific point of view, I hope it doesn’t happen.” Tony Donné, head of EUROfusion in Garching, thinks that after a “leave” vote, the United Kingdom would operate the machine at least until the end of the current contract in 2018. But what might happen after that “is really crystal ball–gazing.” The United Kingdom could opt to buy into the Euratom research program, as some non-E.U. nations like Switzerland have done, but that process could take years and is likely far down the list of negotiations that the U.K. government will need to complete following a Brexit vote.

Donné says EUROfusion has been working on plans to turn JET into a fully international facility so that the other ITER partners—China, India, Japan, Russia, South Korea, and the United States—can also use it for ITER preparation. “If it flies, this would be a fantastic project,” Donné says. By cutting ties to Euratom, a Brexit could scuttle that plan, too.

/article_body/

Posted in: **Europe Physics**

DOI: 10.1126/science.aaf5782

9. IPP in Greifswald as “Landmark in the Land of Ideas”

Prize presentation in October / Wendelstein 7-X: fusion research for the power plant of tomorrow

June 10, 2016

http://www.ipp.mpg.de/4063820/06_16

The project, “Wendelstein 7-X: for the Power Plant of Tomorrow”, has earned Max Planck Institute for Plasma Physics (IPP) in Greifswald the distinction of being one of the 100 prizewinners in the 2016 competition “Landmarks in the Land of Ideas”.

As one of about a thousand candidates the fusion research

device was elected by a high-grade jury: Under the slogan "CommUnityInnvovation – a model for success" the research device ranks as one of the projects able to provide a convincing answer to the question how joint action can afford innovative solutions for tomorrow's challenges: An international team had worked for ten years constructing Wendelstein 7-X, which went into operation at the end of last year.
The competition is intended by "Germany – Land of Ideas" and Deutsche Bank to promote outlooking ideas that use the potentials of community in the form of joint action, cooperation and networking and thus enhance joint efforts to meet present and future challenges.

Wendelstein 7-X is the world´s most modern and largest fusion research device of the stellarator type. National and international teams are working on the device to develop the fundamentals for a power plant that will derive energy on the same principle as the sun. The fuel, a hydrogen plasma, whose behaviour scientists want to investigate, has a temperature of 100 million degrees. To prevent the plasma from cooling on contact with the cold vessel walls, it is levitated by magnetic fields with almost no contact in the interior of a vacuum vessel. With almost unlimited resources available everywhere on earth it should be possible for fusion power plants – which are climate neutral, favourable to the environment and suitable for base load – in conjunction with renewable energies to contribute to a sustainable energy supply in the future.

The prize presentation, with a certificate signed by Federal President Joachim Gauck, will take place on 26 October 2016 at IPP in Greifswald. "Germany – Land of Ideas" is a joint site initiative of the Federal Government and German industry, represented by the Federal Association of German Industry. Since 2006 Deutsche Bank has been a partner and national promoter of the "Landmarks in the Land of Ideas" competition. The objective is to make visible at home and abroad innovations from Germany and reinforce their present performance and future potential.

10. **Culham physicists chosen for ITER Science Fellows network | 10/06/2016**

http://www.ccfe.ac.uk/news_detail.aspx?id=386
Three Culham researchers have been appointed ITER Scientist Fellows. Yueqiang Liu, David Moulton and Rob Akers will be part of a group of around 20 experts working on plasma simulation and theory looking ahead to the experimental phase of **ITER**, the international fusion project being built at Cadarache, France.
Their work will focus on the plasma physics research areas of integrated modelling, divertor and scrape-off layer simulations, and pedestal confinement and stability, which have been identified as critical to the ITER scientific R&D programme.
In January 2016, over one hundred research laboratories and institutes were invited by ITER Director-General Bernard Bigot to nominate staff for the programme, to create a network of scientists working on simulation and theory with strong ties to the ITER project.
The network's focus is very much on the future operational phase of ITER and exploiting the machine's potential and optimising its performance. When it reaches this stage of the project, ITER will rely on major contributions from the experts in the member nations' fusion communities.
“I would like to congratulate Rob, David and Yueqiang on their appointments as ITER Fellows, which show that they are recognised internationally as experts in their fields,” said Martin O'Brien, Head of CCFE's Theory and Modelling Department. “Putting forward some of our top scientists for the Fellowships and giving them the time to help ITER develop its programme is one way CCFE is making a contribution to ITER, which is of course a high priority in our programme.”
Full details of the launch of the ITER Scientist Fellows can be found on the ITER newsline at: **https://www.iter.org/newsline/-/2343**

11. Start of scientific experimentation at the Wendelstein 7-X fusion device

June 7, 2016
http://phys.org/news/2016-06-scientific-experimentation-wendelstein-x-fusion.html
Following nine years of construction work and one year of technical preparations and tests, on 10 December 2015 the first helium plasma was produced in the Wendelstein 7-X fusion device at the Max Planck Institute for Plasma Physics (IPP) in Greifswald.

The production of the first hydrogen plasma followed on 3 February 2016 and marked the start of the experimental operation of the device. The purpose of the Wendelstein 7-X, the world's largest stellarator-type fusion device, is to investigate the suitability of this configuration for use in a power plant.

The assembly of the Wendelstein 7-X started in April 2005: the centrepiece of the device is a ring consisting of 50 approximately 3.5-metre-tall superconducting magnetic coils. Their special shapes are the result of elaborate optimization calculations carried out by the IPP's "Stellarator Theory" division and the quest for a particularly effective heat-insulating magnetic cage that took over ten years. The coils are threaded onto a steel plasma vessel and enclosed in a ring-shaped steel casing. In their vacuum-pumped interior space, the coils are cooled down to a superconduction temperature close to absolute zero using liquid helium. Thus, they consume practically no energy once they are switched on. The magnetic cage generated by them can keep the 30 cubic metres of ultra-thin plasma suspended continuously, i.e. for up to 30 minutes.
Following a construction period of nine years and over one million assembly hours, the main work involved in the assembly of the Wendelstein 7-X was completed in April 2014. Preparation for the operation of the device then began: all of the technical systems were tested in turn – the vacuum in the vessels, the cooling system, the superconducting coils and the magnetic field they generate, the control system, and the heating and measuring devices.
On 10 December 2015, the big day had arrived: The operating team in the control room energized the magnetic field and launched the computer-operated experiment control system. It fed around one milligram of helium gas into the evacuated plasma vessel and switched on the microwave heating for a short 1.3-megawatt pulse: the first plasma in the machine was observed by the installed cameras and measuring devices. It lasted one tenth of a second and reached a temperature of around one million degrees Celsius
It was decided to use helium as a working gas for the launch of the device, as the noble gas is easier to ionize than the subsequent test object hydrogen. Hydrogen forms molecules that must first be broken up by the microwaves, and then tend to react chemically with the wall of the vessel. This can be avoided with the chemically-inert atomic helium. As a result, a plasma can be

developed more easily and safely than with hydrogen. In addition, the heavy helium ions are more efficient when it comes to cleaning the vessel walls, on which water and tiny dirt particles had accumulated during the lengthy assembly period.

This emerged clearly from the subsequent approximately 300 helium discharges carried out in the Wendelstein 7-X. The cleaner the vessel walls, the higher the temperature attained by the plasma. In addition, the microwave heating and data recording were tested during these initial discharges and the measuring instruments for observing the plasma were operated for the first time. These include the interferometer, laser scattering and video diagnostics, and the x-ray spectrometer.
The discharges were characterized by very high electron temperatures at the beginning of the microwave pulse – approximately 10 keV, i.e. 100 million degrees Celsius at a density of around 1019 particles per cubic metre and four megawatts of microwave output, followed by increasing densities and ion temperatures of up to 1020 particles per cubic metre and 2 keV (Fig. 2). The moderate temperatures measured on the wall covering indicate that stationary conditions were not yet reached and a large proportion of the heat power is used to increase the plasma energy.
The generation of the first hydrogen plasma followed on 3 February 2016 as part of a ceremonial event with a large number of guests from the fields of science and politics (Fig. 3). When German Federal Chancellor Dr Angela Merkel pressed the button, a 2-megawatt pulse from the microwave heating system transformed approximately one milligram of hydrogen gas into an ultra-thin hot hydrogen plasma. The plasma ions reached a temperature of around 10 million degrees Celsius and the plasma electrons reached a temperature of around 100 million degrees Celsius.

Research tasks of Wendelstein 7-X

The aim of the international fusion research is to develop a climate- and environmentally-friendly power station which generates energy using the fusion of atomic nuclei. Two different configurations have emerged for the magnetic cage, the tokamak and the stellarator. The IPP is the only institute in the world that is testing the two different types simultaneously: the Wendelstein 7-X stellarator in Greifswald (Fig. 4) and the ASDEX Upgrade tokamak in Garching. This enables the direct comparison of the two configurations.

The current view is that an energy-producing plasma can only be generated by a tokamak – the international test[IM1] reactor ITER, which is currently being under construction as a global cooperative project in Cadarache. The Wendelstein 7-X, the world's biggest stellarator-type fusion device, will not generate any energy; however, the system should demonstrate that stellarators are also capable of becoming power stations. With the Wendelstein 7-X, it is intended to show for the first time that a stellarator can achieve the same plasma containment quality as a tokamak. With the Wendelstein 7-X's 30-minute-long discharges, it is intended to demonstrate the key advantage of the stellarator: i.e. the capacity to operate for extended periods. As opposed to this, without complicated additional measures, tokamaks can only work in pulses.
The modular coils for the generation of the magnetic field play a key role in attaining this objective. Thanks to their curved shape, they generate the entire magnetic field and dispense with the need for a current in the plasma as required by the tokamak. Moreover, thanks to the irregular coils, the stellarator's magnetic field can be generated relatively freely so that its local strength and curvature can be optimally adapted to the physical laws of the hot plasma. The optimized magnetic field should fulfil seven of the requirements identified for a power plant at once: first, the plasma pressure should have a low retroactive effect on the containing magnetic field and, second, a high quality magnetic field and resilience to possible magnetic field perturbations are required. Third, the energy density of the plasma needed for the economically viable operation of a power station with a sufficiently low magnetic field must be provided. Fourth, the plasma heat loss should be in the right range – the heat losses in the earlier stellarator models were unacceptably high. Fifth, the so-called "bootstrap" current must be negligible. This ring current arises through the drop in radial density and temperature and could cause the undesirable deformation of the magnetic field. Sixth, fast particles must also be well contained – a particularly weak point in the "classic" stellarators. In a future power plant, the rapid helium nuclei that arise during fusion must keep the plasma at fusion temperature when the external heating is switched off. Seventh, and finally, it must be possible to construct the magnetic field cage using a system of modular superconducting coils in a way that is as technically simple and cost-effective as possible.
These seven criteria required the formulation of complex new computer codes. Another prerequisite was the development of

suitable computing methods to channel the large codes through the computer at an acceptable speed. This optimization was only possible thanks to the development of the 1980s generation of supercomputers.

Outlook

The experiments started in February and continued until March 2016. After that, it was planned to open the plasma vessel again to enable the installation of carbon tiles to protect the vessel walls. This will make it possible to reach higher heat power, higher temperatures and longer discharges of around one second. Further phased developments are planned until 30-minute discharges can be generated in approximately four years' time, and it will be possible to test whether the Wendelstein 7-X can fulfil its optimization targets at a full heat power of 20 megawatts.

Explore further: US joining the Wendelstein 7-X fusion project

More information: T. Klinger et al. Towards assembly completion and preparation of experimental campaigns of Wendelstein 7-X in the perspective of a path to a stellarator fusion power plant, *Fusion Engineering and Design* (2013). DOI: 10.1016/j.fusengdes.2013.02.153 T. Sunn Pedersen et al. Plans for the first plasma operation of Wendelstein 7-X, *Nuclear Fusion* (2015). DOI: 10.1088/0029-5515/55/12/126001

Provided by: Max Planck Society

12. PPPL dedicates upgraded fusion reactor, a powerful new 'star on Earth'

Posted May 23, 2016; 04:30 p.m.

by Morgan Kelly, Office of Communications, and Larry Bernard, Princeton Plasma Physics Laboratory

http://www.princeton.edu/main/news/archive/S46/40/28M92/

In a towering building just outside of Princeton, scientists, policymakers and Princeton University administrators walked among twisting pipes, countless valves, massive control panels and lofty catwalks to see the newest "star on Earth" — an enhanced fusion energy device that produces plasma at temperatures that exceed those of Earth's sun.

The National Spherical Torus Experiment-Upgrade (NSTX-U), a spherical tokamak housed at the Princeton Plasma

Physics Laboratory on Princeton's Forrestal Campus, was dedicated by the U.S. Department of Energy (DOE) May 20 following a four-year, $94-million upgrade funded by the DOE Office of Science. The NSTX-U now stands as the most powerful spherical torus fusion facility in the world. NSTX-U will allow researchers around the world to explore how to create fusion reactions, wherein light elements collide and fuse together, releasing enormous amounts of energy. Fusion reactions power stars and occur within the high-temperature state of matter plasma. Fusion energy could provide society with clean, reliable, safe and abundant energy that uses seawater as fuel. It would greatly reduce or eliminate the need to burn fossil fuels or manage nuclear waste, and curtail the accumulation of greenhouse gases in Earth's atmosphere.

"This upgrade means that fusion remains a priority in the nation's energy portfolio," said Princeton President Christopher L. Eisgruber. "NSTX-U keeps the United States and Princeton at the forefront of fusion science, poised to seize exciting opportunities to create a clean, safe and prosperous future."

After touring the device, U.S. Department of Energy Secretary Ernest Moniz discussed the importance of NSTX-U — which he called the "most promising path right now to fusion" — to the nation's fusion program and energy sector. Moniz also unveiled a plaque mounted in the NSTX-U control room that is dedicated to the physicists, engineers and technologists who made NSTX-U a reality and will keep it running for at least the next decade.

"This is a big step for our fusion program, for the country's fusion program and, in a broader context as well, for understanding the challenges of plasma science," said Moniz, who also is a physicist. "The next 10 years will produce a lot of terrific science and attack some pretty tough engineering problems."

Moniz said that public support of research and innovation such as NSTX-U is essential to the United States' investment and contribution to the growing clean-energy sector, which he called a "trillion-dollar opportunity." He noted that when the country's national laboratories — of which PPPL is one of 17 — have "good, strong connections

to the university, it just adds to the effectiveness."
"We're going to have to have increasing ambition year in, year out and decade in, decade out going forward to reach the kind of goals that the vast majority of the scientific community would argue that we need to reach," Moniz said.
Spherical tokamaks such as NSTX-U are compact fusion facilities shaped like "apples with the core taken out," said PPPL Director Stewart Prager. Conventional tokamaks, which are in wider use, have a doughnut-like shape. The compact shape of spherical tokamaks enables the confinement of highly pressurized plasma within lower magnetic fields than conventional tokamaks, potentially making them more cost-effective.
Designed and built at PPPL, NSTX-U doubles the heating power, magnetic-field strength and plasma current of its predecessor, and increases the duration of fusion experiments to up to five seconds. The machine produces plasma every 15-20 minutes and 350 researchers at 55 institutions around the globe help analyze the results.
"This is exciting new territory, and we're thrilled to embark on the next frontier of fusion research. This device could transform the world by showing us the way to a pilot plant design for the generation of power from fusion energy for use by all," Prager said.
U.S. Sen. Cory Booker and U.S. Rep. Bonnie Watson Coleman also attended the dedication. Booker discussed the promise that clean energy holds for the health and wellbeing of people. He talked about asthma and the other ailments caused by air pollution that plague residents of cities such as Newark, where he lives.
"Today I celebrate a milestone, an achievement right here at Princeton University," Booker said. "I'm proud to stand before scientists and engineers who are working on something that can be a bold step forward for humanity.
"I want to thank you on behalf of a lot of folks who can look forward to a brighter future," he continued. "The metaphor that is most fitting really is that of a star because the light that you cast truly could push away a tremendous amount of darkness."
Watson Coleman said that NSTX-U and the potential of

fusion energy are encouraging for the future of research in the country and the state, especially in a political environment that can be dismissive of science.
"New Jersey is very much instrumental in the innovation that we need, but we're not necessarily getting the attention we deserve," Watson Coleman said.
"While I may not completely understand the science of it, I do understand that we need energy that is sustainable," she said. "We must recognize that evidence-based science is much better for us to pursue than anecdotes and half-hearted ignorance."
NSTX-U draws on a 65-year-old legacy of fusion energy research at PPPL, where in the 1950s physicist Lyman Spitzer created a machine he called a stellarator to produce energy the same way as the sun. Experimental stellarators and tokamaks, the two most prominent fusion reactor designs, now dot the globe.
PPPL, on Princeton's Forrestal Campus in Plainsboro, New Jersey, is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for the creation of fusion energy. Results of PPPL research have ranged from a portable nuclear materials detector for anti-terrorist use to universally employed computer codes for analyzing and predicting the outcome of fusion experiments. The laboratory is managed by the University for the U.S. Department of Energy's Office of Science, which is the largest single supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time.

13. Takahama units cleared for extended operation

20 June 2016
http://www.world-nuclear-news.org/RS-Takahama-units-cleared-for-extended-operation-2006165.html

The Japanese nuclear regulator has today approved the operation of units 1 and 2 of Kansai Electric Power Company's Takahama nuclear power plant for up to 60 years. They become the first Japanese units to be granted a licence extension beyond 40 years under revised regulations.

Previously, operating licences lasted for 40 years, subject to a review every ten years. During that period the regulator checked the operator's maintenance plan for the unit.
The Nuclear Regulation Authority (NRA) approved a ten-year operating extension for unit 1 of the Takahama plant in Fukui prefecture in November 2014. The 780 MWe (net) pressurized water reactor (PWR) began operating in November 1974. Takahama 2 - also a 780 MWe PWR - was granted a ten-year life extension in April 2015. That unit started up a year after unit 1.
However, under revised regulations which came into force in July 2013, reactors have a nominal operating period of 40 years. Extensions can be granted once only and limited to a maximum of 20 years, contingent on exacting safety requirements.
Kansai applied to the NRA in April 2015 to extend the operation of the Takahama 1 and 2 reactor by 20 years under the new regulations.
As part of its application, special inspections were conducted, including ultrasound tests on the reactor vessels' welds and eddy current tests on the primary coolant nozzles to identify degradation. The units' containment vessels and their concrete barriers were also inspected for cracks.
Kansai was also required to submit to the regulator a long-term maintenance management policy, as well as implement an aging technology evaluation.
At a meeting today, the NRA approved Kansai's licence extension application.
Takahama 1 and 2 are progressing through the restart process. In April, the NRA confirmed the units meet new safety regulations. The units are the oldest of the seven reactors so far deemed to conform to the new safety standards.
Researched and written
by World Nuclear News

14. Changjiang 2 starts supplying power to grid

20 June 2016
http://www.world-nuclear-news.org/NN-Changjiang-2-starts-supplying-power-to-grid-2006164.html

The second unit at the Changjiang nuclear power plant on China's southern island province of Hainan has been connected to the electricity grid, China National Nuclear Corporation (CNNC) has announced.

The 650 MWe CNP-600 pressurized water reactor (PWR) was connected to the grid at 4.01am on 20 June, the company said. The unit achieved first criticality on 9 June following the completion of loading 121 fuel assemblies into its core on 12 May.

CNNC said Changjiang 2 is scheduled to enter commercial operation in early August.

Initial approval for construction of the Changjiang plant was granted by the National Developmental and Reform Commission in July 2008. Early site works began in December 2008. Construction of unit 1 began with the pouring of first concrete on 25 April 2010, while that for unit 2 was poured on 21 November 2010. Changjiang 1 achieved first criticality on 12 October 2015 and entered commercial operation in December.

The plant, near Hoi Mei Tong village in China's Hainan province, is being built as a joint venture between CNNC and China Huaneng Group, with shares split 51% and 49%, respectively. The plant will eventually comprise four units, with units 3 and 4 housing either CNP-650 or ACP-600 reactors. Construction of both those units is scheduled to begin by 2018.

CNNC has said that the first two Changjiang units will together provide almost one-third of the electricity needs of Hainan. By using nuclear power instead of coal-fired generation, the units will avoid the burning of some 300 million tonnes of coal and the resulting emission of about 7.5 million tonnes of carbon dioxide and 5.8 tonnes of sulfur dioxide, it claims.

Researched and written
by World Nuclear News

15. Vattenfall board approves Forsmark upgrades

16 June 2016

http://www.world-nuclear-news.org/C-Vattenfall-board-approves-Forsmark-upgrades-1606164.html

Swedish utility Vattenfall has decided to invest in safety upgrades to enable the three reactors at the Forsmark plant to continue operating beyond 2020. The decision follows the government's announcement last week that it will abolish a tax on nuclear power.

A variable production tax on nuclear power introduced in Sweden in 1984 was replaced by a tax on installed capacity in 2000. Since its introduction, this tax has gradually increased and currently stands at about 7 öre (0.8 US cents) per kilowatt-hour. Swedish utilities, which claimed that, combined with low electricity prices, the tax made their reactor operations unprofitable, had sought redress against the tax through the courts. However, the European Court of Justice ruled last October that Sweden could continue to tax nuclear power, deciding the tax is a national, rather than European Commission, matter.

A framework agreement announced on 10 June by the coalition government will now see the tax phased out over two years. It also allows for the construction of up to ten new nuclear reactors at

existing sites, to replace plants as they retire.
Vattenfall's reactors at Forsmark and Ringhals have already undergone a comprehensive modernization program to allow them to operate until the mid-2040s. However, in October 2014, the Swedish Radiation Safety Authority said by 2020 all operating Swedish reactors must have a "robust permanent installation that includes power supply and systems for pumping of water and an external water source independent of those used in existing emergency cooling systems". This requires engineering deep within the reactor building and potentially its primary coolant circuit.
Yesterday, Vattenfall announced that its board of directors had taken the decision to install independent core cooling at the three boiling water reactors at Forsmark, in which it holds a 66% stake. However, the final decision to proceed with the upgrade must be made by the board of Forsmark Kraftgrupp AB, which operates the plant on behalf of Vattenfall and minority owners EOn and Mellansvensk Kraftgrupp, with stakes of 8.5% and 25.5%, respectively.
Torbjörn Wahlborg, head of generation at Vattenfall and chairman of the board of Forsmark Kraftgrupp AB, said: "The safety upgrades will be implemented in parallel with a program for cost and efficiency improvements with the goal to meet competitive market conditions. Following this upgrade, the reactors will be able to generate electricity into the 2040s."
Vattenfall noted the project to install independent core cooling in all three reactors at Forsmark "will take several years and will be planned not to impact energy production".
Vattenfall CEO Magnus Hall said in a separate statement, "One prerequisite for us being able to take any sort of position at all on whether to continue investing in nuclear power, including the measures to improve safety in independent core cooling, which can't actually be recouped in any other way than through being able to run the reactors, was that the nuclear power tax would be removed."
The company said a decision on whether to install independent core cooling at units 3 and 4 of the Ringhals plant - in which it owns a 70.4% stake - will be taken in early 2017.
Researched and written
by World Nuclear News

16. Federal funding for advanced nuclear technology R&D

15 June 2016
http://www.world-nuclear-news.org/NP-Federal-funding-for-advanced-nuclear-technology-RD-1506165.html
Over $82 million in nuclear energy research, facility access, crosscutting technology development and infrastructure

awards were announced yesterday by the US Department of Energy (DOE).

Overall, 93 projects were selected to receive funding to help push innovative nuclear technologies towards commercialization. The awards provide funding for nuclear energy-related research through the Nuclear Energy University Program (NEUP), Nuclear Science User Facilities (NSUF), and Nuclear Energy Enabling Technology programs. In addition to financial support, a number of recipients will receive technical and regulatory assistance through the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative.

The DOE said it has awarded almost $36 million to support 49 university-led nuclear energy research and development projects through NEUP. This program "seeks to maintain US leadership in nuclear research across the country by providing top science and engineering students and faculty members opportunities to develop innovative technologies and solutions for civil nuclear capabilities", the DOE said.

In addition, 15 universities will receive nearly $6 million for research reactor and infrastructure upgrades.

Under the GAIN initiative, through which the DOE offers access to its nuclear energy-related knowledge and capabilities, the department has also announced a $2 million award to GE Hitachi. This project will cover the cost of placing material samples into a NSUF-affiliated nuclear reactor to analyse the effects of radiation on their properties. The DOE is also supporting a nearly $3 million collaborative effort with Westinghouse as the lead of one project and as a collaborator in two other projects, led by Argonne National Laboratory and Virginia Polytechnic Institute to develop advanced communication methods for nuclear facilities.

The DOE said these awards under the GAIN initiative complement the Nuclear Energy Voucher Program that will provide $2 million this year to help eight small businesses to build the collaborations necessary to accelerate the development and deployment of innovative nuclear technologies.

The DOE is also providing $21 million for six Integrated Research Projects (IRPs). These include a jointly-funded project between its Office of Nuclear Energy and the Office of Environmental Management for enhanced glass forms for waste vitrification. The Office of Environmental Management will also fund two IRP projects for "advanced nuclearized robotics capabilities".

In addition, almost $7 million will be awarded for seven R&D projects led by DOE national laboratories, industry and US universities to conduct research to "address crosscutting nuclear energy challenges" that will help to develop advanced sensors and instrumentation, advanced manufacturing methods, and materials for multiple nuclear reactor plant and fuel applications.

The DOE has also selected eleven university, national laboratory

and industry-led projects to take advantage of NSUF capabilities to investigate nuclear fuel and material applications. The DOE will fund over $9 million in facility access costs and expertise for experimental neutron and ion irradiation testing, post-irradiation examination facilities, synchrotron beamline capabilities and technical assistance for design and analysis of experiments through the NSUF. It will also provide over $1 million for three projects at the Oak Ridge National Laboratory, Pacific Northwest National Laboratory and Argonne National Laboratory for further materials and instrumentation research.

Energy secretary Ernest Moniz said, "Nuclear power is our nation's largest source of low-carbon electricity and is a vital component in our efforts to both provide affordable and reliable electricity and to combat climate change." He added, "These awards will help scientists and engineers as they continue to innovate with advanced nuclear technologies."

The DOE said its Office of Nuclear Energy has awarded some $464 million to 113 US colleges and universities since 2009 "to continue American leadership in clean energy innovation and to train the next generation of nuclear engineers and scientists through its university programs".

Researched and written
by World Nuclear News

17. Hollande renews support for Hinkley Point nuclear reactors

French president backs project despite fears that £18bn price tag could bankrupt EDF, which is 85% state-owned

https://www.theguardian.com/uk-news/2016/may/17/hollande-renews-support-edf-hinkley-point-nuclear-reactors

François Hollande has renewed his support for the controversial nuclear project planned by the French energy company EDF at Hinkley Point in Britain.

“I am in favour that this project goes ahead,” the French president told Europe 1 radio on Tuesday.

“It’s very important to understand that we need a high-performance, highly secure nuclear industry in France, and that we cannot let others take over terrain, including on exports, that has been French up to now,” he said.
A final decision on the plan to build two new-generation nuclear reactors at Hinkley Point in south-west England was due this month, but was delayed after unions at EDF demanded a review of the costs.
A joint project between EDF and China General Nuclear Power Corporation, it carries a projected price tag of £18bn ($26bn, €23bn) that will make it one of the world’s most expensive nuclear power plants.
Unions at EDF, which is 85% state-owned, fear it could bankrupt the company, which is already saddled with more than €37bn of debt.
Last month, the management agreed to consult the internal committee which has brought in outside experts to review the financial implications of the project.
Hollande said the review would be completed “in the coming weeks”.
There have been dissenting voices over Hinkley Point within the French government.
On Friday, France’s environment minister Ségolène Royal, who is also mother to Hollande’s children, told the Financial Times that she was worried about the “colossal sums” involved in the project and questioned whether it should go ahead.
Ratings agencies Standard and Poor’s and Moody’s both lowered their forecasts for EDF last week, saying efforts to streamline the company were insufficient.
Hollande restated his vow to restructure and boost financing at EDF and rival energy giant Areva, “because they are the future”.
“The French nuclear industry has 200,000 employees. It represents our energy independence,” Hollande told Europe 1.
“EDF and Areva are public companies on which we should

rely. But at the same time, we must give them new support." CGN, which is due to cover a third of the costs, said on Monday that it would not go ahead with the project if EDF pulls out.