ITER Forum website Update 6/15

B.J.Green (23/6/15)

1. Elon Musk of Tesla Motors stirs media excitement for house- and industrial-scale batteries

Technological optimism strongly colors extensive print coverage and analysis of the energy-storage prospects.

Steven T. Corneliussen

08 May 2015

http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.8116?utm_source=Physics+Today&utm_medium=email&utm_campaign=5681027_Physics+Today%3a+The+week+in+Physics+4-8+May&dm_i=1Y69,3DRIB,E1OV2B,C3JQW,1

On a stage in a darkened room last week—under roving spotlights, with pulsating music, and before a cheering crowd—Elon Musk presented an 18-minute product announcement designed to incite enthusiasm. To introduce Tesla Motors' forthcoming batteries for houses, businesses, and utilities, the physics-educated techno-entrepreneur opened with this: "What I'm going to talk about tonight is … a fundamental transformation of how the world works, about how energy is delivered … across the earth." An associated Tesla press release asked, "What if we could move the electricity grid off of fossil fuels and towards renewable energy sources?"

The high-wattage initial product illumination worked for Musk, who is already known for high-visibility enterprises in internet commerce, space exploration, and electric cars. Excitement about his batteries is soaring in publications across the country and around the world, as vividly shown in the extensively proliferating articles' and commentaries' very headlines.

At the business site Forbes.com, contributor Carmine Gallo's posting carries the headline "Tesla's Elon Musk lights up social media with a TED style keynote," meaning the 18-minute presentation. Gallo begins:

When Elon Musk introduced a new home battery that delivers stored solar energy, I expected to read about it briefly and move on to other news. But his keynote kept appearing on my radar. Readers encouraged me to watch it. A writer for the *Verge* titled his blog post, "The best tech keynote I've ever seen." "Dude's selling a battery and he still managed to be inspiring," writes T. C. Sottek.

Nature's headline on Davide Castelvecchi's news report (reprinted at *Scientific American*) repeats a widely asked question: "Will Tesla's battery change the energy market?" Castelvecchi opens by summarizing the news, with a bit of skeptical framing:

Tesla Motors, the electric-car maker based in Palo Alto, California, has announced that it will sell versions of its battery packs directly to consumers to help to power their homes, as well as to businesses that run larger facilities,

and utility companies.
At a press conference in Los Angeles on 30 April, the company's charismatic founder Elon Musk said that the firm's lithium-ion batteries would enable economies to move to low-carbon energy sources. Solar energy sources are erratic—but by storing their energy and then releasing it when required, batteries could solve that problem, he said.
Many other companies also sell stationary battery storage for buildings and for power grids—but analysts say that the technology is still too expensive for widespread use. Here, *Nature* explores whether Tesla's announcement might change the game.
Castelvecchi cites a March 2014 *Nature* article to emphasize that Tesla has not invented a new technology; the manufacturer is selling standard lithium-ion batteries. He writes, "Although companies and academic labs are pouring billions of dollars into research and development to significantly increase the amount of energy that batteries can store and to lower their cost, it could take years before significant breakthroughs reach the market." He adds that whether Tesla has lowered the cost of the standard technology isn't clear. Concerning utility firms he stipulates:
The US Department of Energy estimates that for energy storage to be competitive, it must not cost much more than $150 per kWh. Assuming a cost of $700 per kWh, Tesla's systems are still much more expensive than that. Right now, the cheapest way to store energy is to pump it uphill into a hydropower reservoir—where one is available. The next-best storage solution is to compress air in large underground reservoirs.
But at the *Huffington Post*, under a headline extolling "the latest step toward our clean-energy future," Vivek Wadhwa predicts, "Tesla is about to do to the power grid what cellphones did to the land line: free us from it." Last year the former software entrepreneur and present technological evangelist published a *Washington Post* blog piece predicting planetwide energy transformation. Now Wadhwa predicts a Moore's-law-like extension of a technological trend for solar power, and declares success for Powerwall, the home version of Tesla's battery:
Most people are skeptical that we're heading into a clean-energy future. They find it hard to believe that solar energy is fewer than 14 years away from meeting 100 percent of today's energy needs. They argue that today solar energy hardly provides 1 percent of Earth's energy needs, and that we can't effectively store sunlight and therefore have a long way to go.
But when technologies advance exponentially, as solar is doing, 1-percent solar means we are halfway from 0.01 percent to the goal of 100 percent. The prices of solar panels have fallen 75 percent in the past five years and are advancing on a scale comparable to Moore's law, as tech guru Ramez Naam has documented. At this rate, solar energy is only six doublings away from 100 percent. Even then we will use hardly one 10,000th of the sunlight that falls on Earth, so we can increase our usage dramatically without fear of running out.
What has been holding solar back so far has ostensibly been the cost of storage. Technologies such as batteries were prohibitively expensive, large and cumbersome. Residential solar installations needed to feed into the electric grid during the day and buy back energy during the night. This is a problem that Tesla has just fixed, through, with its Powerwall, a rechargeable

lithium-ion battery.
Consider a sampling of similarly optimistic headlines:

- For a piece by Chris Mooney, known in part for his book *The Republican War on Science,* the *Washington Post* used "Why Tesla's announcement is such a big deal: The coming revolution in energy storage."
- *Slate* published "Freedom, Tesla-style: The company's new home-based battery isn't just nifty. It's liberating."
- Dow Jones's *Market Watch* headlined a news report "Australian economist: Tesla battery can solve climate change."
- CBC Radio-Canada went with "Tesla battery could power big change in electricity use."
- Forbes.com printed a piece by contributor Roger Kay called "Tesla gets ready to drop the final piece of the energy puzzle into place."

Some of the headlined optimism focuses directly on sectors of the energy industry:

- *Clean Technica*, which calls itself "the #1 cleantech-focused news & analysis site" in the world, citing major publications that have referred to it, published a piece called "Tesla battery system could speed exit of coal generation."
- Forbes.com identified pieces by columnist Jeff McMahon with "Did Tesla just kill nuclear power?" and "Why Tesla batteries are cheap enough to prevent new power plants."
- *The Conversation* published "The Tesla battery heralds the beginning of the end for fossil fuels."

Some of the headlined optimism addresses Tesla's marketing prospects:

- *Business Finance News* published "Here's why Tesla Motors Inc energy will be 'multi-billion dollar' business in 'near term.'"
- Alexander C. Kaufman, business editor of the *Huffington Post*, predicts via a headline that "Tesla's new home battery could be the iPad of energy storage."
- At *Wired*, a headline declares "Tesla's new battery will make lithium ion the next AA," referring to what the text calls "the day when large-scale energy storage batteries become commodities, as interchangeable as the AA batteries you throw into your cart in the checkout line."

Sometimes the headlines focus on specific energy users, as at Defense One ("Here's what the new Tesla battery means for the military") or at a specialty blog ("New Tesla battery could be a game changer for marijuana growers").
Less easy to find, but not rare, are headlines conveying skepticism. At Canada's *Financial Post*, the business section of *National Post*, Peter Foster's column's headline includes disdain-conveying quotation marks: "Tesla chief Elon Musk's battery 'breakthrough' is off the wall." At Forbes.com, physicist Varun Sivaram, concerned that possible Tesla market dominance could discourage energy-storage advances, contributed "Ensuring Tesla doesn't crowd out the batteries of the future." A subhead at the *Guardian* expresses worry that Powerwall's "price raises questions about its economic viability." At the website Fox Business, the headline was "Tesla home battery met with questions on Wall Street," followed by an opening paragraph that includes

this: "While the announcement was met with much fanfare, Wall Street wasn't as impressed."

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2. House panel explores research into nuclear fission and fusion technologies

With some reservations, lawmakers expressed bipartisan support for continued R&D funding.

Michael S. Henry

12 June 2015

http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.1046?utm_source=Physics+Today&utm_medium=email&utm_campaign=5805081_Physics+Today%3a+The+week+in+Physics+8-12+June&dm_i=1Y69,3GF89,E1OV2B,CDD0B,1

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On 13 May, the House Committee on Science, Space, and Technology's energy subcommittee hosted a hearing to explore the state of nuclear fission and fusion technologies, including the role that research advances in these fields might play in driving the future energy economy of the US. The witnesses and committee members presented their respective views on nuclear fission and fusion and discussed the relative merits of continued and enhanced federal investments in these areas, with some members clearly expressing preference for one over the other and others showing support for the full gamut of nuclear energy research. Witnesses testifying were Mark Peters, associate laboratory director for energy and global security at Argonne National Laboratory, which built the first working nuclear reactor and continues to be at the forefront of nuclear fission technology; Frank Batten Jr, president of the Landmark Foundation, a charitable foundation that provides support for nuclear fuel recycling; Nathan Gilliland, CEO of General Fusion, one of the three leading private fusion energy companies; and John Parmentola, senior vice president for the Energy and Advanced Concepts Group at General Atomics, a defense contractor specializing in nuclear physics.

In his opening statement, subcommittee chairman Randy Weber (R-TX) heaped praise on nuclear energy technology, touching on its unique benefits as a source of energy and the historical role of the US in founding and leading the field. In particular, he extended his support to continued development of new nuclear fission technologies: "The US has a definite national interest in maintaining our position at the forefront of nuclear technology development. Nuclear energy is in a class of its own with the highest energy density of any fuel, and yet yields zero emissions … and it's associated with the world's strongest economies. In the United States, we invented this technology and cannot forgo … the opportunity to export more efficient and safer reactor systems that will mitigate proliferation concerns while increasing global stability by providing a reliable energy source."

Subcommittee ranking member Alan Grayson (D-FL) took the opportunity in his opening statement to back fusion energy. Nonetheless, he indicated his openness to supporting continued research funding for both fission and fusion energy: "This morning … we will learn more about innovative future fusion energy concepts … that have the potential to accelerate the development and deployment of commercial fusion reactors dramatically. Fusion holds the promise of providing a practically limitless supply of clean energy to the world." Grayson continued, "I do have my reservations about fission … not about the physical process itself but the applicability of that to our energy needs. I have described fission as … a failed technology. There is a problem with spent fuel that doesn't seem to have a solution after many decades of consideration. We've had three nuclear disasters worldwide. But the answer to that may not be the German solution of simply scrapping. The answer to that may be to do further research and try to find solutions to these problems."

Rep. Lamar Smith (R-TX), chairman of the full committee, joined subcommittee chairman Weber in backing nuclear energy broadly, saying it "represents one of the most promising areas for growth and innovation to increase economic prosperity and lower the cost of electricity over time" and would keep the US globally competitive. Smith devoted much of his remarks to the value of the Department of Energy laboratory system to the country. Several DOE labs, including Argonne, Los Alamos, Sandia, Lawrence Livermore, Oak Ridge, and Idaho National Laboratories, have major programs in nuclear physics or engineering or are connected closely to the nuclear sciences. Smith commended the DOE labs for serving as a foundation for the nation's fundamental research capabilities and for attracting "America's best and brightest scientists" to stay in the US to conduct research. He expressed particular admiration for DOE's ongoing efforts to collaborate closely with the private, academic, and defense sectors: "The DOE's national laboratories provide vital opportunities for the private sector to invest in innovative energy technologies. This includes its open-access user facilities, which are one-of-a-kind machines that allow researchers to investigate fundamental scientific questions … [and] enable a wide array of researchers from academia, defense, and the private sector to develop new technologies without favoring one type of design."

The first witness to testify, Mark Peters of Argonne National Laboratory, spoke to the US's storied history in nuclear fission research but cautioned that the US would likely fall behind in its leadership if the prevailing trend of declining demand for new nuclear power plants holds: "The US continues to be the lead source of innovation globally for the current generation of light water reactors and small modular reactors, as well as leading in regulatory process, independence, and rigor. But a 30-year hiatus in the construction of new US reactor projects has impacted domestic production capacity, investment in technology and innovation, and the domestic supply chain." Peters outlined some of the perils of the US slipping from its leadership perch in nuclear fission energy: "Without a commitment to advanced reactor technology development and demonstration in the US, our country runs the risk of defaulting on seven decades of investment in nuclear science and technology and infrastructure. That lead position has allowed the US to become the recognized world leader of efforts to control nuclear proliferation, ensure the security of nuclear materials, and promote safe and secure operation of nuclear power plants." Peters called for a reinvigorated commitment to a type of public–private partnership that would see the US support and lead the development of the next generation of advanced reactors, calling the time we have short due to the age of our current reactor fleet.

The second witness, Frank Batten Jr of the Landmark Foundation, spoke of a promising US technology for processing and recycling used nuclear fuel, called pyro-processing. Said Batten, "Once the fuel is recycled, it can then be used again as fuel to generate electricity in advanced reactors. This approach could result in a continued public–private partnership related to pyro-processing for decades into the future."

Another witness, Nathan Gilliland of General Fusion, focused on "the game-changing nature of fusion energy." Said Gilliland: "It is energy production that is safe, clean, and abundant. … Humanity would have abundant energy for millions of years. There's also no longer radioactive waste, no chance of meltdown in fusion reactions, and the benefits to security can hardly be overstated." Gilliland called for continued and enhanced support for the federal government's major research programs in fusion energy, including ITER, a large-scale scientific facility under construction in southern France that aims to demonstrate the technological and scientific feasibility of fusion energy, and the National Ignition Facility (NIF), a large laser-based inertial confinement fusion research device located at Lawrence Livermore National Laboratory in Livermore, California. "US support for magnetic fusion programs like ITER and inertial confinement programs like NIF have created an enormously beneficial source of research. ITER and NIF have justifiably been the highlights of the US fusion energy framework and developed key insights into plasma behavior, materials science, simulation codes, and many others." Gilliland further highlighted what he called alternative pathways to fusion that a number of national laboratories and private companies are pursuing in parallel with ITER and NIF: "Innovation in alternative pathways to fusion have accelerated. These alternative approaches, both in private companies and in labs and universities, offer potentially faster and less expensive concepts, and demonstrable progress is being made both in these labs, universities, and the private companies."

The final witness, John Parmentola of General Atomics Energy, warned that it appears that nuclear energy is dying in the US and called on the federal government to intervene: "I believe, as many others do, that it is important to the future national security, energy security, and environmental quality of the United States that ample supplies of competitively priced nuclear energy are available. Unfortunately … there are few new plants being built, several have closed recently, and most of the 99 existing plants will be closed down within the next 40 years. To place this in context, last year nuclear was 20% of the electricity consumed by Americans, who paid $80 billion for it. We believe this death spiral can be avoided, but it will require active involvement by the US government." Parmentola touted the next generation of advanced nuclear reactors, which he said are designed to address "the foremost prominent concerns with nuclear power—its safety, its cost, its waste, and its proliferation risk."

During question and answer, Rep. Dana Rohrbacher (R-CA) weighed in with his views on nuclear energy, strongly backing investments in the future of fission energy over fusion: “What is not a good use of our money … is something that is aimed at fusion instead of fission. … We’ve spent I don’t know how many billions of dollars to find that [fusion] is possible. No. After spending billions of dollars, we should actually be at a point where … it will be ready in two or three years, but we’re nowhere near that with fusion. But we do know that if we focus on this next generation of fission reactors—especially modular fission reactors—we actually can do it … rather than just know it’s possible.”

Rep. Bill Foster (D-IL), a PhD physicist, added that he would like to see increased government support for nuclear research: “I’m a big fan of turning up research in this field. The payoff if one of these comes up with a home run and a really viable zero carbon energy source for our world is enormous.”

Rep. Daniel Lipinsky (D-IL), who counts Argonne National Laboratory among the research institutions in his district, concurred, adding that he “helped to get language in the [America] COMPETES bill supporting advanced nuclear reactor test facilities.”

As the hearing came to a conclusion, Parmentola had the last word: “Nuclear is a technology that can meet the requirements that people are asking for, in terms of the economics, the waste reduction, the proliferation risk, and the safety. There’s nothing in the laws of physics that would prevent that. What has happened unfortunately to nuclear is it’s been on the same technology for 60 years. … The nuclear community is not research driven, in my opinion. … They want to build things. That isn’t the way to develop new technology. You have to do research that drives. … Right now, nuclear has remained stagnant because research is lacking. We haven’t gone to higher performance technologies and materials. … That’s what’s going to matter in the end.”

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3. Mini-star being built in France could solve power problems

Andrew Griffin | 15th May 2015 7:00 AM

http://www.stanthorpeborderpost.com.au/news/mini-star-being-built-france-could-solve-power-pro/2639815/

ENGINEERS and scientists are constructing a huge mini-star, which will produce the same reactions that happen in the sun to provide energy for the future.

The project, known as Iter, is based in near Aix-en-Provence in southern France. It will weigh three times as much as the Eiffel Tower and be as big as 60 football pitches.

Inside the new building will be a nuclear reactor that scientists hope can provide power through nuclear fusion. In doing so it could generate clean, safe energy and reduce reliance on fossil fuels.

Earlier this year, the team behind the project appointed a new leader, Bernard Bigot.

"We are now entering into manufacturing and preparations for assembly," he said as he joined in March. Bigot said that he had joined as part of a new management team that was set up to deliver "both a research and an industrial facility".

Inside that facility there will be a smaller and controlled version of the same reactions that happen in our sun, nuclear fusion. That happens when two atomic nuclei collide with each other, releasing energy in the form of photons. The scientists hope to harness that energy and re-use it, to replace the dirty and limited forms of energy that we use today.

The project was launched in an early stage in 1987. It is now being pushed forward by a group of seven entities - including the EU, as well as the US, Russia and China.

Since then, the project has repeatedly run into problems, with the schedule being pushed back. But scientists hope that early operations can begin in the 2020s, with harnessed energy coming sometime after that.

Iter is the Latin for "the way" - intended to highlight the possibilities of the energy as a way of creating safe and peaceful power for the world.

But it was once known as International Thermonuclear Experimental Reactor, a name that was dropped because of its potential worrying connotations.

4. Fusion researchers use Titan supercomputer to burst helium bubbles

Jun 10, 2015 by Eric Gedenk

http://phys.org/news/2015-06-fusion-titan-supercomputer-helium.html

Scientists look to the stars when it comes to developing clean, virtually limitless energy. Though humanity understands how stars power themselves—nuclei of hydrogen and its isotopes fuse together in extreme conditions, releasing bursts of energy in the process—they have been unable to replicate this massive fusion process on Earth in a way practical for power production.

As part of a Scientific Discovery through Advanced Computing (SciDAC) project, a partnership between the US Department of Energy's (DOE's) Advanced Scientific Computing Research Leadership Computing Challenge and Fusion Energy Sciences programs, researchers are using the Oak Ridge Leadership Computing Facility's (OLCF's) Titan supercomputer to try to get closer to producing sustainable fusion for electricity.

The project, led by Brian Wirth, a researcher with the University of Tennessee and DOE's Oak Ridge National Laboratory, brings researchers from various organizations together to work on different aspects of the ITER experimental fusion reactor under construction in southeastern France. An international collaboration, ITER will be by far the largest fusion reactor ever built. Participating countries hope the reactor will serve as proof of concept for future fusion power plants.

"Essentially fusion is the ultimate energy source," Wirth said. "The stars fuse hydrogen isotopes together, and that produces all of the periodic table, and we're trying to replicate that with the fusion program here on Earth."

ITER is a tokamak, or doughnut-shaped, reactor. Scientists will use two hydrogen isotopes, deuterium and tritium, and create a plasma, the fourth state of matter. They then will send the plasma around the tokamak at high speeds and at very high temperatures—anywhere between 10 million and 100 million degrees kelvin. When deuterium and tritium collide in such an extreme environment, they fuse together. This fusion process transforms two hydrogen isotopes into a helium atom, releasing energy and an excess neutron.

"Our particular project is focused on the divertor," Wirth said, referencing the part of ITER that serves as a cache for heavier, more energetic particles from fusion byproducts and reactor material that can pollute the plasma, lower its temperature, and ultimately make it difficult to sustain the fusion reaction. "ITER will hopefully answer a major question for fusion, whether we can make and sustain the plasma conditions at high-enough density and hot-enough temperature, but we still don't have the materials and technology to make a reactor to extract electricity out of."

Wirth and his collaborators are using Titan, a Cray XK7 supercomputer capable of 27 petaflops, or 27 quadrillion calculations per second, to shed light on how fusion plasma interacts with the materials used to build the reactor. The team received computing time at the OLCF, a DOE Office of Science User Facility, through the Advanced Scientific Computing

Research Leadership Computing Challenge program.

Testing the toughness of tungsten

Researchers designing ITER plan to use tungsten—one of the toughest materials known—for the divertor. However, despite tungsten's relative strength, there is still concern about how the plasma could affect the divertor over time.

As helium particles bombard the tungsten wall, they begin to form clusters within the material. Once a helium atom is embedded in the wall, it attracts other helium particles. When enough helium is bunched together, it can "knock out" a tungsten atom from its normal position within the material, forming a nanoscale cavity, or hole, within the tungsten. This forms the nucleus of a helium bubble that can then grow very large, reducing the durability of the material. These bubbles also serve as traps for tritium, which reduce the amount involved in the fusion reaction and introduce a radiological hazard.

In addition to tritium retention, helium bubbles cause other problems. As they cluster together and push out tungsten atoms, the divertor's surface is left with a fuzz-like nanostructure, literally appearing like steel wool, but on the nanoscale. The concern is that these nanoscale wires can erode into the plasma, degrading its quality, cooling the reaction, and making the reaction far more difficult to maintain.

A Los Alamos National Laboratory (LANL)-based team made up of Luis Sandoval, Danny Perez, Blas Uberuaga, and Arthur Voter is working to understand more fully how tungsten behaves in such harsh conditions. The group hopes that by better understanding the interactions between helium bubbles and tungsten, they can predict the evolution of the material and maybe even mitigate concerns over tungsten in the reactor.

"If ITER researchers can't mitigate tungsten turning into a fuzz-like structure, they may have to turn to another material for a reactor that's halfway built," Voter said. "We're working on one small part here to try to understand something more about how, when the helium bubbles come to the surface, they contribute to this fuzzy roughness."

Particle interactions in parallel

Many computational scientists use molecular dynamics (MD) simulations to model particle interactions. Though MD can model complex and relatively large atomic systems, its sequential nature—in which calculations must be done one at a time—makes it computationally expensive to reach experimentally relevant time scales. Therefore, the LANL team is using an alternative to traditional MD and is getting a massive speedup in time-to-solution in the process.

The team is using the Parallel Replica (ParRep) method, developed at LANL in the 1990s with the support ofDOE's Office of Basic Energy Sciences (which also supports Voter's work on this fusion project). Applying an implementation of ParRep in the LAMMPS code, they achieve that drastic speedup—a simulation using more than half of Titan's computing power can be done in 30 minutes using the LANL method, whereas it would have taken 7 months using traditional MD simulations.

In traditional MD, researchers calculate forces on all particles in a particular model. Then, researchers choose a very small time increment—typically about a femtosecond (one quadrillionth of a second)—and run this force calculation repeatedly to observe particles in motion, by integrating Newton's equations of motion. Even with leadership-class computing resources like Titan, running a simulation of a few thousand tungsten and helium atoms in a fusion reactor for a microsecond would require many weeks of computation with MD.

ParRep works in similar fashion to traditional MD but streamlines the process on molecular systems that only occasionally change their average position—like atoms in the divertor wall. As opposed to other parallelization strategies for MD, which parallelize the spatial dimensions, ParRep parallelizes the time domain. To grasp the essence of the algorithm, think of 100 people holding egg cartons that only have one egg each. Each person shakes his or her carton until one egg in any one of the 100 cartons hops from one hole to another. When this event happens, everyone else stops shaking. You would then multiply the time it took by 100 (because 100 people were shaking cartons), and that would give you the average time it would take to see that event if only one person were shaking one egg carton.

Though ParRep was developed in the 1990s, Sandoval says powerful computers are required to take full advantage of the method. "The method was first developed almost 20 years ago, but it's only because of access to machines like Titan that we can do these simulations," he said.

By using ParRep, Sandoval was able to simulate many microseconds of time rather than pico- or nanoseconds (10^{-12} and 10^{-9}, respectively). This speedup allows researchers to more fully understand how helium particles interact with the divertor wall. In particular, the LANL team found that the evolution of bubbles, when simulated over these realistic time scales, is qualitatively different from what is observed when traditional MD is used. The team's findings were published in the March 11 issue of *Physical Review Letters*.

Ultimately, the LANL work will serve as the foundation for the larger SciDAC project. The SciDAC group is developing a suite of computer codes that will together create a more comprehensive fusion materials simulation. "Part of our SciDAC is learning the most important processes that occur over nanosecond or microsecond timescales, and learning how to integrate them into a continuum code," Wirth said. "Our ultimate objective is to develop a continuum-level code that we've got confidence simulates the most important aspects of fusion materials physics when we don't have experimental facilities that can tell us that."

Though ITER is still far from completion, the Wirth collaboration plans to continue to refine its code suite and try to solve as many problems as possible before ITER goes online.

5. Fusion energy boost for high-tech Australia

May 07, 2015

http://phys.org/news/2015-05-fusion-energy-boost-high-tech-australia.html#inlRlv

The world's largest fusion energy experiment, ITER, has turned to Australian physicists to supply a crucial imaging system for the multi-billion-euro experiment.

Engaging with ITER is a great opportunity for Australian high technology industry and researchers, said Director of the ANU Australian Fusion Facility, Professor John Howard.

"There is huge potential if Australian businesses get listed as high-tech providers for ITER," he said.

Nuclear fusion is the process that powers stars. It promises carbon-free clean power, by fusing hydrogen nuclei to form helium in high-temperature plasmas like the sun, and has none of the waste by-products associated with current uranium-based nuclear power.

The ITER project is under construction in the south of France and is expected to produce 500 megawatts of power in experiments by the end of the next decade.

Scientists at ANU Research School of Physics and Engineering have been contracted to undertake a design study for the installation of an advanced system that images plasma temperature and flow in ITER.

"It's effectively a Doppler speed gun for a fusion plasma," said Professor Howard. "These coherence imaging systems were pioneered at the ANU and are installed on fusion devices around the world."

Head of Diagnostics at ITER Central Team, Michael Walsh, said the ITER project hoped build stronger links to the ANU and its technology.

"This has been a missing piece of the jigsaw puzzle for some time," he said.

The system developed by ANU focusses on the floor of the fusion reactor known as the divertor.

"The centre of the plasma is over 200 million degrees. Where the edges touch the divertor it's like a welding arc," Professor Howard said.

"During unexpected turbulence the fusion plasma can inflict power fluxes onto the walls comparable to those at the sun's surface.

"Figuring out how to manage the divertor heat flows is a major problem to solve. No other system can meet ITER's requirements for measuring and understanding the flows in this region of the experiment," he said.

Professor Howard has been invited to meet ITER personnel at the construction site in the south of France in June to discuss installing the ANU system.

The ITER construction contracts are shared between the seven partner organisations: the European Union, the United States, India, Japan, China, Korea and Russia.

Because Australia is not a member of ITER, the ANU group is fostering links with the USA ITER partners, who have already installed a number of coherence imaging systems on their fusion experiment DIII-D, in San Diego. ITER USA will be responsible for the relevant observation ports on the ITER device.

6. Nuclear physics: Pull together for fusion

Bernard Bigot

09 June 2015

http://www.nature.com/news/nuclear-physics-pull-together-for-fusion-1.17708

ITER director-general Bernard Bigot explains how he will strengthen leadership and management to refocus the project's aim of harnessing nuclear fusion.

Ten years ago this month, China, the European Union, Japan, South Korea, Russia and the United States agreed on the location for the world's largest nuclear-fusion experiment: ITER, the International Thermonuclear Experimental Reactor, which they had decided to build jointly. India joined six months later. The project's aim is to fuse two isotopes of hydrogen — tritium and deuterium — to deliver a powerful, clean source of electricity. This requires the containment of plasma at temperatures ten times higher than the Sun's core.

Roughly €4-billion (US$4.4-billion) worth of construction contracts and €3 billion in manufacturing contracts worldwide are under way. The first large components are being delivered to the site at St-Paul-lez-Durance in southern France for assembly.

The project has been plagued by delays and difficulties. The seven ITER members are designing and manufacturing key components. When deadlines or standards are not met, the knock-on effects across the whole project can be dire. Late contracts for tools have kept one of the largest buildings — in which ring-shaped magnets up to 24 metres in diameter will be manufactured — inactive since its completion in December 2011. When problems arise, bickering ensues as to who should foot the bill.

I have been a privileged observer from the start, as the high representative for ITER in the host country, France. Because France itself is not a formal member of ITER — it contributes to the European Union budget for the project and to some basic site infrastructures — I, like many others, could only witness with frustration the slipping of the schedule despite the best efforts of the more than 2,000 dedicated people working on ITER.

Since becoming director-general of the ITER Organization, which manages the project, in March, I have realized that ITER's main problem has been the lack of a clearly defined authority to oversee the entire project. Having someone firmly in the driving seat, with the power to take decisions, is the key to success in any project. I have learned this over the course of my career — through building an innovative higher-education institute from scratch (École Normale Supérieure de Lyon) and as head of the French Alternative Energies and Atomic Energy Commission for 12 years.

Here, I set out my vision for ITER. The project must overcome its organizational problems so that it can deliver on its promise of taking a firm step towards harnessing an unlimited, continuous, safe and clean source of energy. These lessons apply to any major international collaboration.

A rocky transition

Since construction began on ITER five years ago, it has become increasingly apparent that the project's management structure is poorly adapted to the challenge of building a large, complex research facility.

Take the 8,000-tonne ITER vacuum vessel, the doughnut-shaped central component of the 'tokamak' reactor that houses the fusion reactions. Seven of its nine sectors are to be manufactured in Europe and two in South Korea, with each region or country taking responsibility for how they are sourced. Having two contractors is a risk, because each has its own manufacturing techniques; duplicating the processes that validate the quality and function of components, such as fabricating mock-ups, adds to the cost; and the tolerance margins that each contractor has adopted differ. Yet the ITER Organization is responsible for assembling the final vessel.

Any modification has a cascading impact on other components. This has generated an almost endless to-and-fro between the ITER Organization, procuring member countries and suppliers. This situation has already cost ITER tens of millions of euros.

People know there is a problem. A 2013 management-assessment report described the decision-making process at the ITER Organization as “ill-defined and poorly implemented”. The management structure has proved incapable of solving issues and responding to the project's needs, so accumulating technical difficulties have led to stalemates, misunderstandings and tension between staff around the world. These problems stem from how the organization was set up through an international treaty in 2007 (see ‘The Promethean dream’).

First, deputy director-generals from each member country or region were given responsibility for one large technical or administrative department of the ITER Organization. These managers also acted as official representatives for their nation or nations.

Second, the procurement of components, systems and buildings is split among the member states so that each could gain experience. The work is assigned according to the industrial capacities of members and a cost-sharing scheme that allocates 45.5% to the European Union (as the host) and just over 9% to each of the others. Each member has a procurement centre, called a domestic agency, that is legally and administratively independent from the central ITER Organization.

The organization is responsible for validating the design of the facility; compliance with safety regulations; coordination of manufacturing and quality control of the numerous components; their on-site assembly; and later, the operation of the facility.

Paperwork abounds. For each work package, the organization signs a procurement arrangement with the relevant domestic agency that details all technical specifications and management requirements. The domestic agency then launches a call for tender to select a company or consortium to do the work.

Such a system has benefits: procurements are shared widely, industries in member states develop, spin-offs are generated, jobs are created and specialists trained. Intellectual property generated by the project is shared. But it has become ever more obvious — as successive reports have pointed out — that the costs outweigh the benefits.

Team building

I accepted the job of director-general on the condition that the position was newly invested with full authority over the whole project. Authority and a radical redefinition of how the organization interacts with the domestic agencies are at the core of the action plan that I submitted to the ITER Council in January, before my formal appointment.

The domestic agencies will retain their distinct legal identity. But they will be integrated functionally and put on an equal footing with the departments in what we now call the ITER Organization Central Team, based in St-Paul-lez-Durance.

A new executive project board brings together the managers of the central team and the domestic agencies at least once a month, in person or by video conference. Disputes can be settled and decisions taken swiftly.

Technical issues — from construction to radioprotection and cryogenics — are handled by project teams of 20 to 50 people, depending on the scope. They comprise staff from the central team and domestic agencies on the basis of technical need, professional skills and experience. When necessary, representatives of contracting industries participate.

It is too late and costly to reverse decisions that have already been made — such as how the tokamak vacuum vessel is fabricated. Problems must be solved downstream; in April, the executive project board formed a joint ITER Organization and domestic agency project team to anticipate and overcome integration and assembly issues. Had this decision been taken earlier it would have saved time, money and frustration.

The ITER Organization and domestic agencies together employ 2,000 people. Changing how ITER is managed will alter its culture. I aim to foster an atmosphere in which each party or individual feels personally responsible for the whole project, not just their area of competence. One of my first actions after becoming director was to address the staff of each domestic agency. The most striking moment was in a video session with all four Asian agencies. For the first time, colleagues in Japan, India, South Korea and China saw the faces of their counterparts, changing the dynamic towards a shared global ambition.

I am also implementing a new type of mobility throughout the project. This will enable appropriate domestic-agency staff to be temporarily seconded to the ITER site, or central-team staff to be assigned to domestic agencies.

The ITER Council has agreed to this new organization. I am grateful for their strong support and the progress already made in solving technical issues and improving communication.

Discretionary fund

There is still much more to do. Authority requires the financial means to exercise it. I have asked for the creation of a reserve fund, to be put at my disposal. Each domestic agency will contribute, allowing me to take quick and efficient decisions to address issues as they arise. Terms of reference will be presented to the council in June for approval. The money will be drawn from the contributions of the ITER members in proportion to the amount they pay in.

In my experience of industrial projects, a reserve fund must comprise about 20% of fabrication costs over the duration of construction. In my view, it was naive not to establish such a fund much earlier in ITER's history.

Before the end of this year, I am expected to submit, along with all stakeholders, an updated, robust and reliable schedule to the ITER Council, and a cost and risk analysis. With renewed management and a streamlined organization, we are now ready to prepare for the assembly and commissioning phase, the step before fusion switches on.

Further delays and costs are inevitable. ITER will meet these challenges if it has the unanimous political support of the seven members, on the basis of the long-term value of fusion technology. All of us at ITER have a huge, historic responsibility. The project

may be the last chance we have this century to demonstrate that fusion is manageable.
Nature **522,** 149–151 (11 June 2015) doi:10.1038/522149a

The Promethean dream

ITER has been political from the start. At a meeting in Geneva, Switzerland, in November 1985, then US President Ronald Reagan and leader of the Soviet Union Mikhail Gorbachev proposed an international effort to develop fusion energy “as an inexhaustible source of energy for the benefit of mankind”. Easing geopolitical tensions at the height of the cold war was one of their motives. ITER engaged political leaders in a common venture for the good of all. It gave scientists and engineers around the world an opportunity to acquire knowledge and expertise to lead fusion from research to the commercial phase.

Fusion energy — produced by the melding of the nuclei of light atoms into heavier ones — powers the Sun and stars. Since discovering this in the 1920s, scientists have hoped to recreate fusion reactions and reap the energy produced to generate electricity. ITER's completion will answer the question that has obsessed three generations of physicists and engineers: is it technologically possible to realize the Promethean dream of bringing the fire of the Sun down to Earth?

Because of the turbulence that arises in a confined, magnetized plasma, a fusion machine aiming for a significant energy gain must be large. The ring-shaped ITER reactor will be about 29 metres high and 29 metres in diameter, housed in a building that will be comparable in size to the Arc de Triomphe in Paris. It requires huge human and financial investment. No nation has the resources to go it alone.

Twenty years on, ITER has seven partners — China, the European Union, India, Japan, South Korea, Russia and the United States — and is managed by the ITER Organization, which was established on 24 October 2007 by an intergovernmental treaty. The design is settled: ITER will be a 'tokamak' (from the Russian acronym for 'toroidal chamber with magnetic coils'). Construction is under way in France.

7. How Do You Contain A Material So Hot It Vaporizes

Everything It Touches?

by Julia Bobak

http://inventorspot.com/articles/how-do-you-contain-material-so-hot-it-vaporizes-everything-it-to

That question is one of the major challenges facing proponents of fusion energy. Fusion power generation attempts to mimic the processes occurring in center of stars by heating atoms to incredibly high temperatures and pressures such that they slam together with enough force to fuse, thereby releasing energy. The problem is that the temperature required to achieve such a reaction is on the order of 150 million degrees Celsius, ten times hotter than the center of the sun and a heat level that no material on Earth can withstand.

Fusion energy, though currently unproven at a commercial scale, offers sufficient advantages to make ongoing investment worthwhile. Unlike traditional fossil fuels, it produces no greenhouse gases and has a virtually limitless fuel supply, and contrary to nuclear power it does not yield long-lived nuclear waste. Think fusion reactions are something out of the distant future? Think again; mankind is actually already quite good at their production. Maybe even too good: the hydrogen bomb is simply an uncontrolled fusion reaction. If we can only find a way to confine and manage the energy produced in the explosion, we will have an essentially limitless supply of clean energy. Therein lies the challenge.

The primary (though not sole) method of confining the superheated, ionized gas called *plasma* which leads to fusion reactions is through a device known as a *tokamak*. Traditionally, tokamaks are donut-shaped devices that use strong magnetic fields to confine the plasma, thereby ingeniously circumventing the problem of vaporization of the chamber walls. This technology is not at all the esoteric specialty of a few scientists, the tokamak-based International Thermonuclear Experimental Reactor (ITER) currently being built in France is positioned to be the first commercial scale nuclear fusion reactor and will require an investment of at least $18 billion from its international partners by the time of its completion in 2027.

Tokamaks have been around since the 1950s when they were developed in Russia, and though they have advanced considerably in the decades since, one thing has remained relatively constant: their toroidal shape. Now, researchers are revealing that a spherical shape (picture something less like a donut and more like a cored apple) may allow tokamaks to be made smaller, cheaper, and faster. Given that ITER is expected to be 10 stories tall and the mass of three Eiffel Towers, this could be a considerable breakthrough. Not to delve too far into the complex physics, the basic principle of the spherical device is that particles contained in such a tokamak will possess an unusual stability near the center of the sphere allowing them to be more easily confined.

In the upcoming few years, spherical tokamaks will be tested in the several top laboratories in preparation for the next step: upscaling. Certain companies are already taking notice with the suggestion that these devices may be able to produce more power than they consume within the next decade, a timeline on par with ITER. While it may still be ten or more years before fusion reactors become a reality, one thing we've learned with this week's reveal is that apples trump donuts in more areas than just healthcare.

Julia Bobak
Science Innovations
InventorSpot.com

8. SCIENCE:

Under new leadership, the long hunt for emission-free fusion energy rumbles on

Umair Irfan, E&E reporter

ClimateWire: Monday, June 1, 2015

http://www.eenews.net/stories/1060019369

CADARACHE, France -- In a polished warehouse spanning two football fields, a half-dozen wood-paneled crates along a wall patiently await unpacking in the cavernous, empty building.
The lonely crates are a small sign of progress in the world's most ambitious energy experiment. They house spools of metal that, when cooled to 4 degrees above absolute zero, will act as superconductors.
The conductors are some of the first components to arrive at the work site carved into the hills of southern France, joining drain tanks and electrical transformers. The warehouse itself will become a factory, using the conductors to build some of the largest and strongest magnets the world has ever seen.
Over the next five years, they will integrate with cooling systems, containment chambers, microwave heaters and fuel injectors manufactured all over the world to form the International Thermonuclear Experimental Reactor.
Also known as ITER, the project aims to lay the groundwork for solving humanity's energy conundrums once and for all, pooling know-how and hardware from 35 countries to harness the reaction that powers the sun, yielding gargantuan amounts of emission-free energy at an affordable price from a fuel measured in grams (***ClimateWire***, Sep. 20, 2014).
But with costs projected to top $20 billion -- more than triple the initial estimate -- and yearslong delays from mismanagement, the project's new director is now working to right the ship, trying to maintain ambitions without yielding to cynicism in a complicated experiment assembled in an even more complicated way.
Unlike other big international science projects like CERN, ITER members contribute in kind, each building a given set of components and then putting them together in Cadarache.

The slow politics of cooperative science

Though the technical challenges of getting tiny atoms to stick together are immense, the greater hurdle is keeping bickering, skittish member nations on task and on time. This experiment in international cooperation on energy could serve as a microcosm of broader action on climate change.
Later this year, 460 miles north in Paris, countries will meet to hash out an agreement on greenhouse gas emissions.
Pacific islands threatened by rising seas will have to work with nations that depend on oil exports. Developed countries blessed with abundant hydropower will have to come up with a plan that's acceptable to billions around the world who see fossil fuels as their ladder out of poverty.

These climate negotiations hinge on how humanity will reach equilibrium with its environment, and managers at ITER are confident that part of the answer is a bet on fusion, the longest of long shots.

"All [countries] are very keen to understand how they will get their energy supply in the long term," said Bernard Bigot, director-general of ITER. "All of them know that the way they proceed is not sustainable, and they want some alternative."

Bigot, who is now two months into the job, previously led France's nuclear energy agency, CEA.

He noted that fusion has long been an international endeavor, springing from the intersection of idealism and research. ITER itself emerged in November 1985 at a summit in Geneva, where President Reagan, Soviet General Secretary Mikhail Gorbachev, French President François Mitterrand and U.K. Prime Minister Margaret Thatcher agreed to pursue fusion for peace in the waning years of the Cold War.

However, fusion experiments predate ITER by decades, and many continue in parallel around the world, all having failed to reach the tipping point of producing more energy than needed to trigger the reaction.

The hope is that ITER will accomplish collaboratively what nations have failed to do individually. In the process, the project will serve as an international fusion academy, training scientists and engineers all over the world to develop their own reactors. "It's a big headache, but that's the beauty of ITER," Bigot said.

Decision delays have been expensive

As part of the reforms for the project, Bigot said ITER's central organization would now take a more decisive role rather than deferring to members in steering the experiment.

This will allow the project to make faster decisions. Bigot noted that every day of delay while awaiting a decision on procurement or design costs the project more than $1 million.

In the near term, Bigot and ITER's management plan to issue a revised schedule for the project this November, accounting for progress in manufacturing hardware, problems with integrating components and the logistical difficulties of shipping massive, sensitive pieces of equipment around the world. He declined to comment on the pace of progress before the schedule comes out, though administrators have previously said they expect to start running experiments at ITER by 2020.

Yet, as the new administration tackles governing issues, scientists still have to grapple with the vast technical challenges of fusion.

When it comes to the project's scale, Bigot was adamant that ITER would not budge. "I do believe, as it was worked out in the beginning, that the size and the scope of this facility is the right one," he said.
Outside the superconducting magnet warehouse, tower cranes loom over a concrete pit that will house the world's largest tokamak, a Russian acronym meaning toroidal (doughnut-shaped) chamber with magnetic coils.
When complete, the tokamak will be about as large as the Jefferson Memorial, and the reaction chamber will be big enough for an elephant to saunter through. It's a huge step up in size and complexity from the current king, the Joint European Torus in the United Kingdom.
The goal is to harness the reaction that powers the sun, a process so powerful it can burn your skin from 93 million miles away. One gram of fusion fuel -- deuterium and tritium isotopes of hydrogen -- produces as much energy as 8 metric tons of oil.
Add heat to the hydrogen fuel and you form a plasma, a high-energy state of matter where electrons are ripped from their nuclei. When two hydrogen nuclei collide and stick, they form helium and eject a high-energy neutron. The resulting nucleus has a mass slightly less than the sum of its parts. This mass difference is dissipated as energy as described by Einstein's mass-energy equivalence formula, $E=mc^2$.

Thinking and building big

ITER's Q ratio, the amount of energy produced relative to the amount put in, will be greater than 10, yielding 500 megawatts of power. The current Q ratio record, held by the Joint European Torus, is around 0.65.
The sun's advantage is that it has so much matter that it exerts significant gravity, which pulls atoms close together to make them fuse. Without this gravity, ITER needs higher temperatures, to the tune of 150 million degrees Celsius, 10 times hotter than the sun.
Containing this much plasma at such high temperatures requires powerful magnets, the likes of which have never been built before. ITER's design calls for magnets that generate a magnetic field 200,000 times stronger than that of the Earth. To operate, scientists will have to cool the magnets to -269 C less than a yard away from the heated plasma, the hottest substance in the solar system.
The United States, among its contributions, is responsible for the central solenoid, the magnets that go through the middle of the doughnut in the tokamak.

The solenoid will stand more than 40 feet tall and will be built from six magnets, each weighing 110 tons. The forces they exert could levitate an aircraft carrier.
John Parmentola, senior vice president at General Atomics, the subcontractor that is currently building the six magnets -- plus one spare in San Diego -- said that his company is learning a great deal by building a device like this on such a large scale and that the final product will cost around $200 million.
"I think it's safe to say it's the highest-power central solenoid ever built," he said. "This is a monumental undertaking."
Though researchers are learning by doing, at this point, scientists still don't know what they don't know when it comes to fusion, so more hiccups and curveballs may yet crop up. This uncertainty keeps ITER in the political crosshairs in the United States.

U.S. budget-cutters become restless, again

Last week, Sen. Lamar Alexander (R-Tenn.), chairman of the Energy and Water Development Appropriations Subcommittee, proposed cutting $150 million for ITER. In the previous Congress, the committee voted to withdraw entirely from ITER, noting that the move could save taxpayers close to $6.5 billion over the life of the project.
ITER's delays and cost overruns also triggered an investigation from the U.S. Government Accountability Office, which faulted poor management for these problems. The United States previously withdrew from the project in 1998 before rejoining it.
On the other hand, in a House Energy subcommittee hearing earlier this month, Rep. Alan Grayson (D-Fla.) said he was more optimistic about fusion than conventional fission reactors, which generate electricity by splitting uranium to boil water.
Other member countries face similar dilemmas over where to invest in their energy future, weighing economic demands and environmental concerns like smog-covered skies and rising temperatures.
When compared with existing energy systems like fission power plants and wind turbines, a process that has never been demonstrated and has a history of broken promises is a tough sell, but Mark Henderson, a scientist at ITER, remains a true believer in fusion and humanity's need for it.
"We're not only eating up our resources at a faster rate, but we are very undisciplined, we have no forethought, and we are just consuming," Henderson said. "And to me, before we basically just die in our excrement like yeast, I think we need to start dreaming."
Henderson likened the project to building a cathedral, an endeavor

that spans decades to serve the future. "It may not be for our generation," he said. "I expect to retire before I see a [deuterium-tritium] plasma."
As ITER rises from the concrete and rebar under the Mediterranean sun, Henderson and his colleagues are hustling to ensure they are building a temple and not a tomb to one of humanity's greatest efforts to save it from itself.

9. Fabrication Begins for ITER Fusion Reactor Central Solenoid

06/01/2015 | Thomas W. Overton, JD
http://www.powermag.com/fabrication-begins-for-iter-fusion-reactor-central-solenoid-2/

Workers at San Diego's General Atomics (GA) on April 10 began the years-long process of winding the 1,000-ton superconducting electromagnet that will power the ITER fusion reactor under construction in southern France.
The $16 billion ITER project, a consortium of the U.S., the European Union, Russia, China, Japan, and other nations, aims to test reactor-scale nuclear fusion using plasma contained within a magnetic field. ITER has been under development for nearly a decade and will be the largest tokomak (toroidal magnetic chamber) ever constructed. The ultimate goal, once the facility is online in the 2020s, is to produce net power from fusion for the first time—up to 10 times the energy required to generate the magnetic field.
The central solenoid, being manufactured in a specialized facility built by GA for the project, will form the heart of the tokomak. It will be composed of more than four miles of superconducting cables wound into six individual modules and will stand nearly 60 feet tall (Figure 2). The cables are composed of copper, niobium, and tin components within a steel jacket, but because the superconductor material is brittle, it must be created by heating the modules after winding.
The wound modules will be placed inside a large oven, where they will be baked at 650C over a five-week process, with the heat converting the cable interior into a superconducting niobium-tin ceramic. After the winding and heating processes, the cable will be wrapped with fiberglass insulating tape and fused together with resin to create a single solid module.
Each module, composed of 3,000 feet of cable, will take two years to complete. GA expects the seven modules it is manufacturing (one is a

spare) to be completed by 2019. They will then be shipped to Texas for transport across the Atlantic to the ITER site in Saint Paul-lez-Durance, France. The individual components of ITER, including the solenoid modules, are so large and heavy that specialized transport vehicles had to be produced and the French government spent €110 million to upgrade the roads and bridges leading to the site.

When operating, the central solenoid will achieve a peak field strength of 13.1 Teslas and store enough energy to lift a Nimitz-class aircraft carrier. The field will contain plasma heated to more than 200 million degrees Celsius, where the fusion reactions will take place. ITER will initially use hydrogen in the plasma, later transitioning to deuterium, and ultimately, a deuterium-tritium mixture.

Ned Sauthoff, director of the U.S. ITER Project Office, said power density is what sets fusion apart from all other generation resources. “There’s a factor of 20 million between the amount of energy you get per pound of fuel from fusion relative to chemical processes.” If fusion can be made economic, he said, “It would really change the world.”

The ITER group is officially shooting for first plasma by 2020, but Sauthoff told *POWER* he thinks 2025 is a more realistic date.

The ITER project will test a wide variety of heating, control, diagnostics, and remote maintenance technologies that would be required for use of fusion for power generation. If successful, ITER could lay the groundwork for commercial fusion reactor plants that could be online by the 2040s.

—Thomas W. Overton, JD, associate editor

10. Star Power: Troubled ITER nuclear fusion project looks for new path

AFP May 22, 2015, 11.45AM IST

http://articles.economictimes.indiatimes.com/2015-05-22/news/62504099_1_international-thermonuclear-experimental-reactor-nuclear-fusion-tokamak

SAINT-PAUL-LES-DURANCE, FRANCE: In 1985, then Soviet leader Mikhail Gorbachev and US president Ronald Reagan launched one of the unlikeliest ideas of the Cold War. Under it, the Soviet Union would team up with United States and other rivals of the day to develop nuclear fusion: the same limitless energy source that powers the Sun. Today, 30 years on, their dream is still a long and agonising way from reality. Launched in 2006 after years of wrangling, the International Thermonuclear Experimental Reactor (ITER) project is saddled with a reputation as a money pit.

It has been bedevilled by technical delays, labyrinthine decision-making

and cost estimates that have soared from five billion euros ($5.56 billion) to around 15 billion. It may be another four years before it carries out its first experiment.
But, insists its new boss, a page has been turned. "There has been a learning process," said Bernard Bigot, 65, a scientist and long-term chief of France's Atomic Energy Commission (CEA) who was named ITER's director general in March, replacing Japanese physicist Osamu Motojima. "Today, there's a real awareness among all the partners that this project has to have a dimension of strong management to it."
ITER's job is to build a testbed to see if fusion, so far achieved in a handful of labs at great cost, is a realistic power source for the energy-hungry 21st Century.
Fusion entails forcing together the nuclei of light atomic elements in a super-heated plasma, held by powerful magnetic forces in a doughnut-shaped chamber called a tokamak, so that they make heavier elements and in so doing release energy. The principle behind it is the opposite of nuclear fission -- the atom-splitting process behind nuclear bombs and power stations, which carries the risk of costly accidents, theft of radioactive material and dealing with dangerous long-term waste.
Despite the long haul, buildings are now emerging from the dry, yellowish soil near Aix-en-Provence, in the Mediterranean hinterland of southern France.
"The tokamak building is scheduled to be finished in 2018 and all 39 buildings by 2022," Laurent Schmieder, in charge of civil engineering, told journalists during a press tour of the site.
The tokamak -- a word derived from Russian -- by itself is an extraordinary undertaking: a 23,000-tonne lab, three times heavier than the Eiffel Tower. "This is a project of unprecedented complexity... a real challenge," said Mario Merola, in charge of ITER's internal components division.
Part of ITER's problems lie in a diffuse managerial structure and decision-making among its partners: the 28-nation European Union, which has a 45-percent stake, the United States, Russia, Japan, China, India, South Korea and Switzerland.
The partners are providing their contributions mostly in kind, which has been a cause of messy, protracted debate about who should provide what, when and how. It has been further complicated by the role of national agencies, which in turn deal with their own suppliers.

In some cases, said Bigot, discussions have dragged on for six whole years without resolution. He said that he told ITER's board he would only take the top job if everyone agreed there was a need for change.
"A CEO has to have the power to make a decision and to have it applied," he said. Bigot has named his first priority as getting a fix on where the project stands overall.

By November, there will be a new progress report, with the likelihood of a further increase in the price tag. The project has no reserve fund to deal with the unexpected - something that Bigot hopes to change.
In 2010 ITER abandoned its goal of obtaining the first plasma in 2018 and set a new date for a year later, but Bigot said that this deadline "clearly isn't feasible".
So far around seven billion euros have been contractually committed to the thousand or so companies working on the scheme. Every year of delay adds 200 million euros to the bill.
"There have been difficulties, but we still have total faith in nuclear fusion as being worthy of the investment," said Bigot. "But clearly if we can't manage this project correctly, if undertakings are not kept... (the project) could be in danger."

11. A little drop will do it: Tiny grains of lithium can dramatically improve the performance of fusion plasmas

By Raphael Rosen
May 22, 2015
http://www.pppl.gov/news/2015/05/little-drop-will-do-it-tiny-grains-lithium-can-dramatically-improve-performance-fusio-0
Scientists from General Atomics and the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) have discovered a phenomenon that helps them to improve fusion plasmas, a finding that may quicken the development of fusion energy. Together with a team of researchers from across the United States, the scientists found that when they injected tiny grains of lithium into a plasma undergoing a particular kind of turbulence then, under the right conditions, the temperature and pressure rose dramatically. High heat and pressure are crucial to fusion, a process in which atomic nuclei – or ions – smash together and release energy — making even a brief rise in pressure of great importance for the development of fusion energy.
"These findings might be a step towards creating our ultimate goal of steady-state fusion, which would last not just for milliseconds, but indefinitely," said Tom Osborne, a physicist at General Atomics and lead author of the paper. This work was supported by the DOE Office of Science.
The scientists used a device developed at PPPL to inject grains of lithium measuring some 45 millionths of a meter in diameter into a plasma in the DIII-D National Fusion Facility – or tokamak – that General Atomics operates for DOE in San Diego. When the lithium was injected while the plasma was relatively calm, the plasma remained basically unaltered. Yet as reported this

month in a paper in Nuclear Fusion, when the plasma was undergoing a kind of turbulence known as a "bursty chirping mode," the injection of lithium doubled the pressure at the outer edge of the plasma. In addition, the length of time that the plasma remained at high pressure rose by more than a factor of 10.

Experiments have sustained this enhanced state for up to one-third of a second. A key scientific objective will be to extend this enhanced performance for the full duration of a plasma discharge.

Physicists have long known that adding lithium to a fusion plasma increases its performance. The new findings surprised researchers, however, since the small amount of lithium raised the plasma's temperature and pressure more than had been expected.

These results "could represent the birth of a new tool for influencing or perhaps controlling tokamak edge physics," said Dennis Mansfield, a physicist at PPPL and a coauthor of the paper who helped develop the injection device called a "lithium dropper." Also working on the experiments were researchers from Lawrence Livermore National Laboratory, Oak Ridge National Laboratory, the University of Wisconsin-Madison and the University of California-San Diego.

Conditions at the edge of the plasma have a profound effect on the superhot core of the plasma where fusion reactions take place. Increasing pressure at the edge region raises the pressure of the plasma as a whole. And the greater the plasma pressure, the more suitable conditions are for fusion reactions.

"Making small changes at the plasma's edge lets us increase the pressure further within the plasma," said Rajesh Maingi, manager of edge physics and plasma-facing components at PPPL and a coauthor of the paper.

Further experiments will test whether the lithium's interaction with the bursty chirping modes — so-called because the turbulence occurs in pulses and involves sudden changes in pitch — caused the unexpectedly strong overall effect.

PPPL, on Princeton University's Forrestal Campus in Plainsboro, N.J., 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. For more information, please visit science.energy.gov.

12. IEA outlines 'four pillars' for

success of climate talks

15 June 2015

http://www.world-nuclear-news.org/NP-IEA-outlines-four-pillars-for-success-of-climate-talks-1506201501.html

The International Energy Agency (IEA) said today that a peak in global energy-related emissions could be achieved as early as 2020 and at no net economic cost, as one of four "key pillars" it believes are needed "to make the upcoming UN climate talks a success, from an energy perspective". Those talks - the 21st UN Conference of the Parties (COP21) - take place in Paris in December.

The IEA outlined the four pillars in its *World Energy Outlook Special Report on Energy and Climate Change* published today. The other pillars are: to review national climate targets regularly; to translate the world's climate goal into a collective long-term emissions goal; and to establish a process for tracking achievements in the energy sector.

"World greenhouse gas emissions from energy production and use are double the level of all other sources combined, meaning that action to combat climate change must come first and foremost from the energy sector," the Paris-based agency said.

IEA Executive Director Maria van der Hoeven said the IEA's analysis had repeatedly shown that the cost and difficulty of mitigating greenhouse gas emissions increases every year, meaning "time is of the essence".

"It is clear that the energy sector must play a critical role if efforts to reduce emissions are to succeed. While we see growing consensus among countries that it is time to act, we must ensure that the steps taken are adequate and that the commitments made are kept," she said.

The report states that nuclear power is the second-biggest source of low-carbon electricity, adding that in the last few years almost half of all new reactor units have been built in countries with de-regulated electricity markets or with state-owned companies building, operating and owing them. China had 28 GWe of new nuclear power capacity under construction at the end of last year and could have more nuclear capacity than the current global leader, the USA, by 2030, according to the report.

Four pillars

Of its second pillar, a five-year review cycle to test the scope for further action, the IEA said: "the world's shrinking 'carbon budget' means that any delay in taking action can be costly, while the pace of energy sector innovation means that a five-year review would allow national targets to keep up with events and help build investor confidence."

In its third pillar, the IEA recommends that the goal of keeping the increase in long-term average global temperatures to below two degrees Celsius also be expressed as a long-term greenhouse gas emissions target, "making it more straightforward to apply in the energy sector". This would "help anchor future expectations, guide investment decisions, provide an incentive to develop new technologies, drive needed market reforms and spur the implementation of strong domestic policies, such as carbon pricing - all of which are necessary to meet the two degrees Celsius goal," it said.

The final pillar, that the COP21 agreement establishes a strong process for tracking progress in the energy sector, "would both provide clear evidence of results, reassuring the international community that others are acting diligently, and identify countries that are struggling with implementation, enabling assistance to be provided if needed," the IEA said. The new report sets out metrics to monitor energy sector decarbonisation, it added.

Collectively, countries accounting for around two-thirds of global energy-related emissions have either formally submitted their climate pledges for COP21 or have signalled their possible content. "A first assessment reveals these pledges will have a positive impact on future energy trends, but fall short of the major course correction required to meet the two degrees Celsius goal," the IEA said.

These pledges show that the growth in global energy-related emissions slows but does not peak by 2030, it added. The economy grows by 88% from 2013 to 2030 and energy-related carbon dioxide emissions by 8%.

According to the IEA's 'bridge scenario', a peak in global energy-related emissions could be achieved as early as 2020 if governments implement five key policy measures. These are: increasing energy efficiency in the industry, buildings and transport sectors; reducing the use of the least-efficient coal-fired power plants and banning their construction; increasing investment in renewable energy technologies in the power sector from $270 billion in 2014 to $400 billion in 2030; gradual phasing out of fossil-fuel subsidies to end-users by 2030; reducing methane emissions in oil and gas production.

Renewables are the leading source of electricity by 2030, according to the report, but inefficient coal-fired power generation capacity declines only slightly.

"Such findings underline the need for ambitious national pledges for COP21 that can act as a solid base upon which to build stronger action, such as those enabled by a transfer of resources (technology or finance)," the IEA said.

Researched and written
by World Nuclear News

13. IAEA approves 'fuel bank' agreements

12 June 2015

http://www.world-nuclear-news.org/UF-IAEA-approves-fuel-bank-agreements-1206157.html

The International Atomic Energy Agency (IAEA) Board of Governors has approved two agreements enabling the agency to move to full-scale implementation of its proposed low-enriched uranium (LEU) 'fuel bank' in Kazakhstan.

Kazakhstan, covering the establishment of the facility to be hosted at the Ulba Metallurgical Plant in north-eastern Kazakhstan, and a transit agreement with the Russian Federation to permit the transport of IAEA LEU to and from the bank through its territory.

IAEA Director General Yukiya Amano said the conclusion of the agreements and their approval represented a "significant milestone" for the project, enabling it to proceed to full-scale implementation.

The repository, which the agency is referring to as the IAEA LEU Bank, is intended to provide an assurance of supply mechanism of last resort. Owned and controlled by the IAEA but operated by Kazakhstan, the bank's safety and security will be governed by Kazakhstan's legal and regulatory requirements. It must also comply with applicable IAEA safety standards and security guidance, and will be subject to IAEA safeguards.

The facility will be a physical reserve of up to 90 tonnes of LEU, available to IAEA member states should they find themselves unable to obtain LEU on the commercial market. Members requesting LEU from the bank must meet a set of criteria approved by the IAEA's board: the member's supply of LEU must be disrupted; the state must be unable to secure LEU from the commercial market, state-to-state agreements or other such means; and the state must have in place, and be in compliance with, a comprehensive safeguards agreement with the IAEA.

A key principle of the bank is that it must not distort the open market. Once a state has agreed to a supply agreement with the IAEA, it must pay the full cost of re-stocking the LEU stored in the bank. On receipt of the payment, the cylinders of LEU will be shipped from the UMP site and transferred to a facility where it can be made into fuel. It cannot be further enriched, processed, retransferred or re-exported without IAEA agreement.

The IAEA LEU Bank is fully funded by voluntary contributions including $50 million from the US-based Nuclear Threat Initiative (NTI) organization, $49 million from the USA, up to $25 million from the European Union, $10 million each from Kuwait and the United Arab Emirates and $5 million from Norway.

The bank's existence does not affect the rights of IAEA member states to develop their own nuclear fuel cycle facilities, but the NTI's support for the project reflects that organization's commitment to reducing the risks of nuclear proliferation, as highlighted by NTI co-chairman and former US senator Sam Nunn. "If the dozens of countries interested in nuclear energy also choose to pursue uranium enrichment, the risk of proliferation of dangerous nuclear materials and weapons would grow beyond the tipping point", he said. "The IAEA LEU Bank now gives countries an alternative to that choice and direction."

Nunn thanked the funding partners and NTI advisor Warren Buffett, who financially backed NTI's $50 million commitment made in 2006 on condition that the IAEA received a further $100 million in matched funds. "We are also appreciative of the leadership shown by the IAEA and its Board of Governors and the government of Kazakhstan and President Nursultan Nazarbayev," he said.

The IAEA LEU Bank is one of several global efforts to create an assured supply of nuclear fuel. Other assurance of supply mechanisms, established with IAEA approval, include a guaranteed physical reserve of LEU maintained by Russia at the International Uranium Enrichment Centre in Angarsk, and a UK assurance of supply guarantee for supplies of LEU enrichment services. The USA also operates its own LEU reserve.

The formal signature of the host-state agreement by the IAEA and Kazakhstan is expected in late August. NTI anticipates that the facility will become fully operational in 2017.

Researched and written
by World Nuclear News

14. IEA Sees A Bright Future For Solar

June 16, 2015

http://www.energymatters.com.au/renewable-news/iea-solar-emissions-em4872/

Energy related carbon emissions could peak as early as 2020 if five key policy measures are implemented by governments says the International Energy Agency – including the phasing out of fossil fuel subsidies.

The IEA's "Bridge Scenario" in the just-released World Energy Outlook Special Report on Energy and Climate Change report says peak emissions could be achieved by that year without detriment to the economic and development prospects.

The five measures are:

- Enhancing energy efficiency in the industry, buildings and transport sectors
- Minimizing use of least-efficient coal-fired power plants and

banning construction of new ones
- Boosting investment in renewables from USD $270 billion in 2014 to $400 billion in 2030
- Gradual phase out of fossil-fuel subsidies to consumers by 2030
- Reducing methane emissions in oil and gas production

The impact of fossil fuel subsidies is having a significant effect on the climate change battle, amounting to an incentive to pollute worth $US115 per tonne of carbon-dioxide.

A working paper published last month by the International Monetary Fund (IMF) estimates post tax energy subsidies reached USD $4.9 trillion globally in 2013 and are projected to reach $5.3 trillion (AUD $6.73tn) in 2015. Renewable energy subsidies are a comparatively meager $120bn a year

While the IEA believes electricity from renewable sources such as solar and wind power will be the leading source of electricity by 2030, inefficient coal-fired power generation may reduce only slightly. This means ambitious pledges by leading nations are needed and the energy sector must be at the forefront of positive change.

"It is clear that the energy sector must play a critical role if efforts to reduce emissions are to succeed," said IEA Executive Director Maria van der Hoeven. "While we see growing consensus among countries that it is time to act, we must ensure that the steps taken are adequate and that the commitments made are kept."

The IEA was initially dedicated to responding to physical disruptions in the supply of oil in the wake of the 1973–1974 oil crisis. In the past, it had been criticized of underestimating the role of renewable energy; however, its attitudes towards renewables has changed greatly in the last few years.

15. Nuclear Power in Japan

(Updated June 2015)

http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Japan/

- **Japan needs to import about 84% of its energy requirements. Its first commercial nuclear power reactor began operating**

in mid 1966, and nuclear energy has been a national strategic priority since 1973. This came under review following the 2011 Fukushima accident but has been confirmed.
The country's 50+ main reactors have provided some 30% of the country's electricity and this was expected to increase to at least 40% by 2017. The prospect now is for at least half of this, from a depleted fleet.
Currently 43 reactors are operable and potentially able to restart, and 24 of these are in the process of restart approvals.

Despite being the only country to have suffered the devastating effects of nuclear weapons in wartime, with over 100,000 deaths, Japan embraced the peaceful use of nuclear technology to provide a substantial portion of its electricity. However, following the tsunami which killed 19,000 people and which triggered the Fukushima nuclear accident (which killed no-one), public sentiment shifted markedly so that there were wide public protests calling for nuclear power to be abandoned. The balance between this populist sentiment and the continuation of reliable and affordable electricity supplies is being worked out politically.

Japan's energy situation and international dependence

Japan's shortage of minerals and energy was a powerful influence on its politics and history in the 20th century. Today it depends on imports for over 90% of its primary energy needs. As it recovered from World War II and rapidly expanded its industrial base it was dependent on fossil fuel imports, particularly oil from the Middle East (oil fuelled 66% of the electricity in 1974). This geographical and commodity vulnerability became critical due to the oil shock in 1973. At this time, Japan already had a growing nuclear industry, with five operating reactors. Re-evaluation of domestic energy policy resulted in diversification and in particular, a major nuclear construction program. A high priority was given to reducing the country's dependence on oil imports. A closed fuel cycle was adopted to gain maximum benefit from imported uranium.
Nuclear power has been expected to play an even bigger role in Japan's future. In the context of the Ministry of Economy, Trade and Industry (METI) Cool Earth 50 energy innovative technology plan in 2008, the Japan Atomic Energy Agency (JAEA) modelled a 54% reduction in CO_2 emissions (from 2000 levels) by 2050 leading on to a 90% reduction by 2100. This would lead to nuclear energy contributing about 60% of primary energy in 2100 (compared with 10% in 2008), 10% from renewables (from 5%) and 30% fossil fuels (from 85%). This would mean that nuclear contributed 51% of the emission reduction: 38% from power generation and 13% from hydrogen production and process heat.
In June 2010 METI resolved to increase energy self-sufficiency to 70% by 2030, for both energy security and CO_2 emission reduction. It envisaged deepening strategic relationships with energy-producing countries. Nuclear power would play a big part in implementing the plan, and new reactors would be required as well as achieving 90% capacity factor across all plants. However, following the Fukushima accident, in October 2011 the government

sought to greatly reduce the role of nuclear power. This appears to have been a significant factor in them losing office in 2012 elections (see later section). The new government in 2014 adopted the 4th Basic (or Strategic) Energy Plan, with 20-year perspective and declaring that nuclear energy is a key base-load power source and would continue to be utilized safely to achieve stable and affordable energy supply and to combat global warming.

Early in 2011, nuclear energy accounted for almost 30% of the country's total electricity production (29% in 2009), from 47.5 GWe of capacity (net) to March 2011, and 44.6 GWe (net) from then. There were plans to increase this to 41% by 2017, and 50% by 2030.

IEA figures indicate that in 2013 Japan generated 1059 TWh gross, 338 TWh from coal, 408 TWh from gas (up from 300 TWh in 2010), 9 TWh from nuclear (cf 288 TWh in 2010), 161 TWh from oil (up from 94 TWh in 2010), and 84 TWh from hydro. The country's nuclear capacity was progressively shut following the March 2011 Fukushima accident. Renewables contribution in 2013 was small: solar 10 TWh, wind 5 TWh, geothermal 2.6 TWh, biomass & waste 41 TWh. Final consumption in 2010 was about 1000 billion kWh, or about 7870 kWh per capita. This dropped to 923 TWh, or 7200 kWh/capita in 2012.

Capacity (IEA figures) at end of 2012 was 295 GWe, this being 46 GWe nuclear, 45 GWe hydro, 36 GWe coal, 47 GWe gas, 41 GWe oil, 16 GWe oil or coal, 50.6 GWe autoproducers' 'combustible fuels', 6.6 GWe solar, 2.5 GWe wind and 0.5 GWe geothermal. In response to nuclear difficulties, coal capacity is planned to increase 21% to 47 GWe by early 2020s.

In April 2015 the government announced that it wanted base-load sources to return to providing 60% of the power by 2030, with about one-third of this being nuclear. Analysis by the Research Institute of Innovative Technology for the Earth estimated that energy costs would then be reduced by JPY 2.4 trillion (USD 20.0 billion) per year compared with the present 40% base-load scenario (renewables being 30%). At the same time, it was reported that 43 coal-fired power projects were planned or under construction, totalling 21.2 GWe and expected to emit 127 million tonnes of CO_2 per year.

According to a 2011 government report generation costs per kWh were JPY 9 for nuclear, JPY 10 for wind and JPY 30 for solar. In 2014 the estimates were nuclear JPY 10.1, coal JPY 12.3, LNG JPY 13.7, solar (non residential) JPY 24.3.

The electricity market is due to be deregulated in April 2016, with legal separation in April 2020 between generation, transmission, and distribution. As the first step towards this, the Organization for Cross-Regional Coordination of Transmission Operators (OCCTO) was set up in April 2015 to function as a national transmission system operator (TSO). All power companies are required to join OCCTO. It will ensure greater interconnection among present utility networks, and increase the frequency converter capacity across the 50-60 Hz east-west divide to 3 GWe by 2021. OCCTO is expected to invest about JPY 300 billion.

In February 2015 the prime minister said that 80% of Japan's oil and 20% of its natural gas came from the Persian Gulf through the Strait of Hormuz.

Other energy information for Japan can be found at http://www.eia.gov/countries/cab.cfm?fips=JA

16. No hiatus in the climate wars

Scientists find that the warming slowdown never happened—and that their report draws attacks.

Steven T. Corneliussen

15 June 2015

http://scitation.aip.org/content/aip/magazine/physicstoday/news/10.1063/PT.5.8121;jsessionid=7z1rjv8dzjx3.x-aip-live-02

A 4 June scientific paper at *Science* magazine presented “an updated global surface temperature analysis” bearing on the much-discussed global warming hiatus. The paper concluded that “the IPCC’s statement of two years ago—that the global surface temperature ‘has shown a much smaller increasing linear trend over the past 15 years than over the past 30 to 60 years’–is no longer valid.” Climate-consensus scoffers across the media immediately began reacting—usually derisively, and sometimes with outright vituperation.

The paper comes from Thomas R. Karl of the National Centers for Environmental Information at the National Oceanic and Atmospheric Administration (NOAA) and eight coauthors. It reports on “newly corrected” data. The closing paragraph points to a figure and summarizes as follows:

[T]here is no discernable (statistical or otherwise) decrease in the rate of warming between the second half of the 20th century and the first 15 years of the 21st century. Our new analysis now shows the trend over the period 1950-1999, a time widely agreed as having significant anthropogenic global warming, is 0.113°C dec^{-1}, which is virtually indistinguishable with the trend over the period 2000-2014 (0.116°C dec^{-1}). Even starting a trend calculation with 1998, the extremely warm El Niño year that is often used as the beginning of the “hiatus,” our global temperature trend (1998-2014) is 0.106°C dec^{-1}—and we know that is an underestimate due to incomplete coverage over the Arctic.

Many in the media simply reported that scientists at NOAA now believe that no hiatus happened. A few such articles displayed some sarcasm against the scoffers. “Sorry, deniers,” taunted a *Daily Beast* headline. *Salon*’s subhead, alluding to a stunt in the Senate chamber by Republican senator James Inhofe, asked, “Bummed about the news that the ‘hiatus’ never existed? Try throwing a snowball!” A *Science* magazine commentary opened by recalling that global warming skeptics “crowed” about the formerly perceived but now vanished hiatus.

Certitude with attitude? Scoffers more than matched it, as shown just by the headlines.

Breitbart.com lobbed “Making the planet warmer by fiddling with spreadsheets” and “‘Hide the hiatus!’ How the climate alarmists eliminated the inconvenient ‘pause’ in global warming.” For an *Investor’s Business Daily* editorial it was “NOAA scientists can't find the heat, so they start a fire.” At the *Examiner*: “How NOAA rewrote climate data to hide global warming pause.” The *Register*’s headline mocked: “A pause in global warming? Pah, FOOLS. There was NO PAUSE: Oh, people can come up with statistics to prove anything.” The *Patriot Post*, which advertises endorsements of its work from national figures, leveled blunt accusations: “NOAA lies to justify UN climate treaty" and "NOAA lies about the warming hiatus." The *Examiner* invoked the totalitarian memory hole from the novel *1984*: "How NOAA took a page from George Orwell to disappear the global warming hiatus."

Headlines at the *Daily Caller* and at *Power Line* continued the dishonesty accusations: "NOAA fiddles with climate data to erase the 15-year global warming 'hiatus'" and "New paper on the 'pause' is another exercise in data fudging."

Elsewhere, journalists dispassionately included in their reports news of what they saw as plausible cautiousness about the NOAA paper, or even disagreement with it. A *Los Angeles Times* news report put it this way: "Researchers representing the scientific mainstream also rejected the idea that global surface temperatures never stopped rising." That article quoted a scientist well known on the West Coast, NASA's William Patzert: "It's always good to go back and look at the data as carefully as possible and make sure it's calibrated correctly. But the hiatus is history and it was real."

The Australian Science Media Centre published comments from 10 experts. Notes of caution appeared from Tim Osborn, a climate scientist at the University of East Anglia; from Peter Stott, head of climate monitoring and attribution at the UK's Met Office Hadley Centre; and from Piers Forster, a professor of climate change at the University of Leeds.

A long piece at *Mashable* made, but did not fully substantiate, this claim: *Mashable* sought out the views of about a dozen top climate scientists not involved in the new study. Remarkably, they were nearly unanimous in saying that while it improves the accuracy of surface-temperature records, the study does not support the authors' conclusion that the so-called warming pause never happened. Instead, they said it simply proves that changing the start and end dates used for analyzing temperature trends has a big influence on those measurements, a fact that was already widely known.

The article reported in particular on cautions from Gerald Meehl at the National Center for Atmospheric Research in Boulder, Colorado, and Lisa Goddard, director of the International Research Institute for Climate and Society at Columbia University.

Lots of news reports have quoted Judith Curry of Georgia Tech. "Color me 'unconvinced,'" she wrote in a blog posting that ends with this widely quoted put-down: "While I'm sure this latest analysis from NOAA will be regarded as politically useful for the Obama administration, I don't regard it as a particularly useful contribution to our scientific understanding of what is going on."

But wait, isn't Professor Curry an incorrigible and not-credible climate-consensus scoffer, same as John Christy and Richard Lindzen? That's a question beyond the scope of this media report and the reporter's capacities, but bearing on it is this fact: In January 2014, when Steven Koonin welcomed participants to the Climate Change Statement Review Workshop he was chairing for the American Physical Society, he made a point of acknowledging the participation of "experts who credibly take significant issue with several aspects of the consensus picture." Curry, Christy, and Lindzen participated.

Like Curry, Christy and Lindzen are being quoted in the current climate-wars battle over the NOAA paper. The *Washington Post* called Christy "the University of Alabama-Huntsville climate scientist who has constructed and studied temperature records of the lower atmosphere using satellite data" and

reported that he believes “atmospheric data do not exhibit the short term warming seen in Karl’s analysis.”
Also at the *Post*, Chris Mooney joined a few other observers in watching another skirmish in the battle over the NOAA paper:
Another major issue is what all the published studies seeking to explain the “hiatus,” with respect to natural changes in the climate system that suppressed warming, were actually doing, if there wasn’t actually a hiatus. Karl’s answer is that these researchers were studying real natural phenomena that did suppress warming—meaning that without such phenomena, the last 15 years might have been a blockbuster warming period.
“Those things won’t persist, and when they’re gone, that means the rate of temperature is free to increase even more than it would have,” he says. “And you can make the case that had those factors not been operating, we might be talking now about why the temperatures have been warming more rapidly.”
By these lights, the work remains valuable. But some are a bit more critical of scientists for seeming to validate the notion of a slowdown, including by publishing such a thick shelf of studies of a phenomenon that, now, NOAA is saying may not exist.
Harvard science historian Naomi Oreskes recently co-authored a paper depicting research on the “hiatus” as a case study in how scientists had allowed a “seepage” of climate skeptic argumentation to affect the formal scientific literature. Of the new NOAA study, she said in an e-mail: “I hope the scientific community will do a bit of soul searching about how they got pulled into this framework, which was clearly a contrarian construction from the start.”
National Geographic boiled that down: “‘A huge amount of scientific work and effort has gone into explaining a phenomenon which actually doesn’t exist,’ Oreskes says.” That article also quotes Gavin Schmidt of NASA and the blog RealClimate: “The fact that such small changes to the analysis make the difference between a hiatus or not merely underlines how fragile a concept it was in the first place.”
But it also quotes Marc Morano, a former aide to Sen. Inhofe and “publisher of the contrarian Climate Depot website,” who says that the NOAA paper “merely adds to the dueling data sets” and predicts that it will have “virtually no impact in the climate debate.”

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 is a science writer at a particle-accelerator laboratory.*