ITER Forum website Update 9/15

B.J.Green (17/9/15)

1. Stellarator Wendelstein 7-X: Congratulations from all over the world

https://www.euro-fusion.org/newsletter/stellarator-wendelstein-7-x-congratulations-from-all-over-the-world/?utm_source=Fusion+in+Europe+Newsletter&utm_campaign=ce2e3f796a-Fusion_in_Europe_2015_1_FiE&utm_medium=email&utm_term=0_018c991ab2-ce2e3f796a-415524053

It seems like the international fusion research community could hardly wait for it to happen:

On 16th of July, the Max Planck Institute for Plasma Physics (IPP) announced the first magnetic field in the Wendelstein 7-X stellarator. Well-known fusion scientists from all over the world congratulated the institute and its researchers for reaching this essential milestone in operational preparations. Later this year, Wendelstein 7-X will produce its first plasma. With the help of IPP Fusion in Europe compiled a selection of the congratulations:

My compliments on this success! Today, I'm even more pleased that Wendelstein 7-X has become an integral part of the European Fusion Roadmap.

Prof Tony Donné, EUROfusion Programme Manager

Princeton Plasma Physics Laboratory and the entire U.S. collaboration team are extremely excited to see the initial field line mapping results from the Wendelstein 7-X device. We applaud the IPP team and Max Planck Institute […].We look forward to continuing

to work with our German colleagues on this intriguing scientific experiment and

to its coming important research contributions to fusion energy.

What a great step!! Congratulations! Looking forward seeing the real […] soon.

Prof Hiroshi Yamada, National Institute of Fusion Science, Tokio, JapanDr David A. Gates,

Congratulations to you and the IPP team on this monumental

achievement. It bodes
very well for a rich and productive programme in the coming years and represents a great
leap forward for the international stellarator program.
Prof John Howard, Director of the Australian Plasma Fusion Research Facility, Head of the Plasma Research Laboratory at Australian National University, Canberra, AustraliaStellarator Physics Leader, Princeton Plasma Physics Laboratory, USA
The successful first operation [...] is a major technical milestone for which the entire IPP team must be congratulated.[...] Its result will be transformational towards our understanding of transport, stability and boundary plasmas in stellarators, and bring us closer to producing intrinsically steady-state, high fusion performance plasmas.
Prof Dennis G. Whyte, Director, Plasma Science and Fusion Center, Massachusetts Institute of Technology, USA

2. Science 28 August 2015:
Vol. 349 no. 6251 pp. 912-913
DOI: 10.1126/science.349.6251.912
IN DEPTH
ENERGY
Dark horse scores a fusion coup
Daniel Clery*
http://www.sciencemag.org/content/349/6251/912.summary?sid=9893a665-5a85-46be-bb14-b65f9248ce28

Nuclear fusion has always required titanic machines and vast amounts of public money—and success is always decades away. Now, a privately funded company has taken what some physicists say is a significant step toward mastering fusion **energy** with a smaller, cheaper, faster approach. **Tri Alpha Energy** announced this week that it has built a machine that forms a ball of gas—superheated to about 10 million degrees Celsius—and holds it steady for 5 milliseconds without decaying. Those conditions are well short of what is needed for fusion, but the feat shows for the first time that **Tri Alpha**'s unorthodox approach can trap hot fusion gas in a steady state. Now, the scientists hope to scale up the technique toward times and temperatures that cause atomic nuclei in the gas to fuse together, releasing **energy**.

3. The Dayside : Unlimited energy
By: Charles Day
28 August 2015
http://scitation.aip.org/content/aip/magazine/physicstoday/news/the-dayside/unlimited-energy-a-dayside-post;jsessionid=6wd2vl2p432.x-aip-live-06

On Monday *Science* magazine's website published a news story with the attention-grabbing headline, "Exclusive: Secretive fusion company claims reactor breakthrough." Reporting from a suburban industrial park in a Los Angeles suburb, Daniel Clery told readers that

Tri Alpha Energy has built a machine that forms a ball of superheated gas—at about 10 million degrees Celsius—and holds it steady for 5 milliseconds without decaying away. That may seem a mere blink of an eye, but it is far longer than other efforts with the technique and shows for the first time that it is possible to hold the gas in a steady state—the researchers stopped only when their machine ran out of juice.

That nuclear fusion might serve as a potent source of energy became apparent once Francis Aston had determined in 1920 that the helium-4 nucleus is less massive than its constituents, the difference being liberated as rest-mass energy when the constituents combine. Aston's Cambridge University contemporary, Arthur Eddington, grasped the significance of the measurement and proposed soon after that fusion could power the Sun. For identifying solar fusion's underlying processes in 1939, Hans Bethe was awarded the 1967 Nobel Prize in Physics.

Concepts for harnessing fusion as a source of useful energy arose in the 1940s. The difficulty in implementing any of them remains the same: creating and maintaining the extreme conditions under which protons, deuterons, and tritons overcome their mutual electrostatic repulsion to get close enough to fuse.

Wikipedia's list of fusion experiments runs to 76 entries in two broad categories, magnetic confinement and inertial confinement. Given that global effort and news reports, such as Clery's, of progress, I'm optimistic that the engineers, scientists, and mathematicians who are working on fusion power will one day make it practical.

What would future generations do with an abundant, cheap, and inexhaustible supply of energy? Processes that currently consume too much energy to be cost-efficient could become widespread and beneficial. For example, the desalination of seawater would relieve Earth's water shortages. Trash could be recycled on a massive scale to extract valuable trace elements, such as rare earths. Carbon dioxide could be sucked out of the atmosphere to mitigate climate change. People could live comfortably in Earth's polar regions.

My incomplete list might seem like science fiction for now. Indeed, my favorite writer of science fiction, the late Iain M. Banks, set nine of his novels amid an interstellar civilization known as the Culture, whose energy sources and other technologies are so advanced that every good and service is free. Plots unfold when the Culture's humanoids and artificial intelligences interact to dramatic effect with other civilizations that inhabit the galaxy.

Fantasy aside, access to energy and the devices that it powers is essential to civilization. In rich countries, ready availability of cheap lighting, heating, refrigeration, and transport is taken for granted. In poor countries that lack reliable and bountiful sources of energy, those technological amenities are luxuries.

Meeting the energy needs of the world’s poor is a challenge, especially given our reliance on fossil fuels and the additional greenhouse gas emissions that would entail. Still, it’s surely an easier, more attainable goal than building the world’s first practical fusion-powered generator.

4. Climate change impacts: The growth of understanding

Spencer Weart

September 2015,
Physics Today
page 46
http://scitation.aip.org/content/aip/magazine/physicstoday/article/68/9/10.1063/PT.3.2914?utm_source=Physics+Today&utm_medium=email&utm_campaign=6102114_September+2015+Table+of+Contents&dm_i=1Y69,3MSF6,E1OV2B,D26BE,1

In this peculiar history, the main actors are committees and no seminal papers or scientific giants emerge. Seat-of-the-pants guesses made in the 1960s proved to be roughly correct, and the details are still being fleshed out today.

We are now quite certain that over the next century the world will warm up by a few degrees. A few degrees—the difference between early morning and mid morning—doesn't sound like much. But, in fact, the impacts turn out to be dire. It's worth asking, how did scientists come to understand this? We need to convince the public of the threats we face; yet how can we convince them if we don't explain how scientists came to know what they know? The history of any scientific development can address general questions of how scientists do their work and reach their conclusions. But the history of climate change impact studies turns out to be a peculiar kind of history, not at all the sort of story that historians of the physical sciences are used to telling.

To be sure, the study of impacts began like most histories of science: in the realm of speculation. And poor speculation at that. Through the first half of the 20th century, when global warming from the greenhouse effect was itself only a speculation, the handful of scientists who thought about it supposed any warming would be for the good. For example, Svante Arrhenius published the first calculations in 1896 and claimed that the world "may hope to enjoy ages with more equable and better climates."[1] Others tended to agree that global warming, or any effect of the progress of human industry, could only lead to a beneficent future.

In the late 1950s, a few scientists realized that the level of carbon dioxide gas in the atmosphere might be rising and suggested that the average global temperature might climb a few degrees Celsius before the end of the 21st century. Roger Revelle, the most senior of those researchers (figure 2), publicly speculated that in the 21st century the greenhouse effect might exert "a violent effect on the earth's climate" (as quoted by *Time* magazine in its 28 May 1956 issue). He thought the temperature rise might eventually melt the Greenland and Antarctic ice sheets, which would raise sea levels enough to flood coastlines. In 1957 Revelle told a congressional committee that the greenhouse effect might someday turn Southern California and Texas into real deserts. He also remarked that the Arctic Ocean might become ice free. But everyone understood that it was all speculation, more science fiction than

scientific prediction.
More scientists began to look at the matter after 1960, when observations showed that the level of CO_2 in the atmosphere was indeed rising rapidly. In 1963 a pathbreaking meeting was convened by the private Conservation Foundation; called “Implications of Rising Carbon Dioxide Content of the Atmosphere,” that meeting set the pattern for many later exercises in impact studies. Already at that embryonic stage of understanding, the meeting brought together experts in CO_2 chemistry, climate, fisheries, agriculture, and so forth. And it resulted in a consensus report, which warned that if fossil-fuel burning continued, “the earth will be changed, more than likely for the worse.” But the group admitted that they could scarcely say what dangers might lie a century ahead. They suspected forest productivity would improve, which did not sound bad. And the distribution of species—including important ones for commercial fisheries—would change, which could be bad or good. The only thing the assemblage of experts felt confident about was that rising temperatures would increase melting of the world’s glaciers, which would raise the sea level and bring immense flooding to low-lying areas. There were no numbers or probabilities. It was science only in the sense that scientists were making their best guesses and admitting that it was sheer guesswork.

Global warming caught the attention of the US President’s Science Advisory Committee in 1965. They reported that “by the year 2000 the increase in atmospheric CO_2 … may be sufficient to produce measurable and perhaps marked changes in climate.”[2] Without attempting to say anything specific, they remarked dryly that the resulting changes “could be deleterious from the point of view of human beings.” The following year, a panel of the US National Academy of Sciences (NAS) took a different tack, warning against “dire predictions of drastic climatic changes.”[3] Dire predictions of one or another imminent climate catastrophe had, in fact, been a staple of the popular press for decades as magazines, books, and other media peddled colorful speculations of every variety. The academy panel expected no extraordinary climate change until well into the 21st century, and that was so far away! As for the long run, the panel remarked that the geological record showed swings of temperature comparable to what the greenhouse effect might cause, and “although some of the natural climatic changes have had locally catastrophic effects, they did not stop the steady evolution of civilization.”
That conclusion was not entirely reassuring. Concern grew among the few scientists who paid attention to climate theories. Meanwhile, the rise of environmentalism was raising public doubts about the benefits of human activity for the planet; smoke in city air and pesticides on farms were no longer tokens of progress but instigators of regional or even global harm. A landmark study conducted at MIT in 1970 covered a variety of environmental problems and included a section on greenhouse warming. The experts concluded it might bring “widespread droughts, changes of the ocean level, and so forth,” but they could not get beyond such vague worries.[4] A meeting in Stockholm the following year came to similar conclusions and added that we might pass a point of no return if the Arctic Ocean’s ice cover disappeared. That occurrence would change the world’s weather in ways that the scientists could not guess at but that they thought might be serious.[5]
Governments were now putting some of the environmental movement’s demands into law; thus arose a practical need for formal environmental

impact assessments. A new industry was born with expert consultants who strove to forecast effects on the natural environment of everything from building a dam to regulating factory emissions. Beyond the local scale, concerned people applied increasingly sophisticated scientific tools to study the impacts of deforestation, acid rain, and many other far-ranging activities. They looked at impacts not only on natural ecosystems but also on human health and economic activities. Assessing the long-term impacts of greenhouse gases fitted easily into such a research paradigm.

One example of the broadened view was the 1977 report *Energy and Climate*, from a panel of geophysicists convened by the NAS.[6] By now models of all sorts, from elementary radiation physics to elaborate computer exercises, projected an average global warming of 3°, give or take, following a doubling of the atmosphere's CO_2 level. What would that mean? Like all studies of the period, the experts just used general physical principles to deduce what sort of consequences might result; they had no detailed scientific projections or observations to cite. On the positive side, the Arctic Ocean might eventually be opened to shipping. On the negative side, there would be "significant effects in the geographic extent and location of important commercial fisheries… . Marine ecosystems might be seriously disrupted." Stresses on the polar ice caps might lead to a surge of ice into the sea and bring a "rise in sea level of about 5 meters within 300 years." As for agriculture, there would be "far-reaching consequences" that "we cannot specify… . We can only suggest some of the possible effects. A few of these would be beneficial; others would be disruptive." There could be terrible "human disasters" like the recent African droughts. However, the panel made clear it could not foresee what would actually happen. Two years later another academy panel said much the same and took brief note of an additional threat—the rise of CO_2 in the atmosphere would make the oceans more acidic. Here, too, they thought the consequences were beyond guessing.[7]

All those committees managed to reach a consensus on what they were saying: Everybody signed off on the conclusions. They could do that because in most areas they agreed to tell the public that they were uncertain—except they were certain there were risks, serious possibilities that needed to be addressed with dedicated research efforts.

More categories of impacts emerged, and each began to attract its own little band of specialists. For example, an elaborate 1983 study by the US Environmental Protection Agency looked into sea-level rise. The experts concluded that by the end of the 21st century they "could confidently expect major coastal impacts, including shoreline retreat, … flooding, saltwater intrusion, and various economic effects."[8]

By the early 1980s the studies were starting to look less like seat-of-the-pants guesses; they had numbers, equations, and references to a growing peer-reviewed scientific literature. The key developments were computer projections of future temperature rise along with changes in precipitation, soil moisture, and so forth. A 1983 NAS report was the most detailed assessment up till then.[9] In a category like agriculture, the experts looked, for example, at how soybean yields had varied with temperature in the past and what a physiological simulation for wheat said about the response to changes in solar radiation and soil moisture. For sea-level rise, they could calculate how much seawater would expand with heat and make a very rough model of what might happen to the Antarctic ice sheets. They also looked at coral-reef records of sea level during previous warm epochs. With less of an attempt at precision, the academy’s experts pointed out that an increase in extreme summer temperatures would worsen the “excess human death and illness” that came with heat waves. Also, melting of permafrost in the Arctic could require adaptations in engineering. In addition, climate shifts “may change the habitats of disease vectors.” Finally and most important, “In our calm assessment we may be overlooking things that should alarm us.” There might be effects that no expert could predict or even imagine, effects all the more dangerous because they would take the world by surprise.

The studies to this point had used a simple cause-and-effect model. Physical scientists would run computer models to predict changes in precipitation and the like. Others would then step in to calculate immediate consequences—for example, using historical records to predict how corn yields would vary with the weather. But if farmers could no longer get good results from corn, wouldn’t they plant something more suited to their new climate? During the 1980s, some impact studies began to take account of how humans might adapt to climate change. By the end of the decade, some studies were linking models of crop responses with economic models. Complex interactions were no less crucial in natural ecosystems. Life scientists began to calculate how forests, coral reefs, and other environments might respond to the rise of greenhouse gases. For example, could tree species move their ranges poleward fast enough to keep up with the temperature rise? At a still higher level of complexity, some studies began to account for the way different climate impacts might interact with each other.

Those more sophisticated approaches guided the first comprehensive official US government report, ordered by Congress in 1986 from the EPA.[10] The EPA’s findings continued the trend toward predicting more serious, more numerous, and more specific kinds of damage. The experts concluded (as summarized by the *New York Times* on 20 October 1988) that “some ecological systems, particularly forests …, may be unable to adapt quickly enough to a rapid increase in temperature… . Most of the nation’s coastal marshes and swamps would be inundated by salt water… . An earlier snowmelt and runoff could disrupt water management systems… . Diseases borne by insects, including malaria and Rocky Mountain spotted fever could spread as warmer weather expanded the range of the insects.” Many of the predictions, such as the expansion of diseases, had been mentioned before but were only now coming under detailed discussion.

Studies of how climate change might affect human health expanded particularly swiftly in the 1990s, catching the attention of both experts and the public. As in some other categories, the health-effects work was increasingly supervised not by a particular government but by international organizations, including the venerable World Health Organization and the new Intergovernmental Panel on Climate Change (IPCC), established in 1988. Yet with health, as in other arenas, it was becoming clear that global generalizations were of much less value than studies at a regional level. For example, insects that carry tropical diseases like dengue fever and malaria would expand their ranges. The main impacts would be felt in developing nations, while people in the developed world tended to worry chiefly about how such diseases might spread to the temperate zones.

Any regional analysis had to start with the climate changes that would result from a given level of greenhouse gases, as calculated by computer models. But although the increasingly sophisticated models had come to a rough agreement on global features like the rise of average temperature, they differed in the regional details. In places where many factors balanced one another—for example, in the region between the Sahara and the African rain forests—one model might predict a benign increase of rainfall and another, terrible droughts. Policymakers did not much care about the average global temperature—they wanted to know how things would change in their own locality.

Unable to make quantitative predictions of just what might happen in each region, the IPCC decided to study “vulnerabilities”—the nature of damage that a given regional system might sustain from any of the likely sorts of climate change. That approach was in line with an established practice of vulnerability studies in many other research areas, from food supplies to earthquakes. The experts also considered benefits, but the very term “vulnerability” showed that by now most of them believed the net effects of greenhouse warming would be harmful. Some disagreed, which raised a serious controversy during the discussions leading to the IPCC’s initial report of 1990 (available at http://www.ipcc.ch along with subsequent assessments). Russian climatologists argued that warming would have important benefits—for frigid Siberia, warming sounded like a great idea.

In the usual IPCC fashion, the 1990 Working Group on impacts forged a consensus by admitting deep scientific uncertainty. The panel couldn’t even say whether net global agricultural potential would increase or decrease on a doubling of atmospheric CO_2. While acknowledging there might be benefits in some northern locales, the panel warned that “there may be severe effects in some regions,” ranging from extinction of species to a 1-meter rise in sea level by 2100, which would displace tens of millions of people. Droughts could be a problem, although in areas like the western US with elaborate dam systems, the panel thought the problem would be manageable. On the other hand, it foresaw increased frequency and severity of flooding. Again, consensus was achieved only by agreeing that the report could not assert much for certain beyond generalized statements about risks and, especially, vulnerabilities.

The IPCC and the computer modeling community made a big step forward in 1997 with a pioneering report titled *The Regional Impacts of Climate Change: An Assessment of Vulnerability*.[11] Each of seven regions of the globe got its own detailed account of vulnerabilities, based on computer runs carried out expressly for the exercise. More than a dozen different models were compared in order to assess the degree of reliability. At that level it was obviously necessary to consider not only the local climate and ecological systems but also the local economic, social, and political conditions and trends and to draw in the social sciences as equal partners with geophysics and biology. It was becoming a standard practice to consider how people might adapt. For example, the panel concluded that Africa was “the continent most vulnerable to the impacts of projected changes.” That was not just because so many parts of Africa were already water stressed, subject to tropical diseases, and so forth, but still more because population pressures and political failings were causing environmental degradation that would multiply the problems of climate change. Above all, Africa's "widespread poverty limits adaptation capabilities." By contrast, the carefully managed agricultural systems of Europe and North America might even contrive to benefit from a modest warming and rise in the level of CO_2 (which could act as a fertilizer for some crops), although the developed nations would certainly suffer some harmful impacts as well.

Such assessments, and the publics they addressed, could see impacts in the developed world as manageable because they were looking little more than half a century ahead. The late 21st century was still so far away! Surely by then, humanity would have taken control of its emissions; surely CO_2 would not rise to three or four times the preindustrial level.

The future state of the climate would depend crucially on what emission controls nations chose to impose—and that was the biggest uncertainty of all. Thus was exposed a problem with the standard way of predicting impacts. Scientists had tried to look into the future by looking to a most likely outcome within a range of possibilities: "Global average temperature will rise 3° plus or minus 50%" or the like. People would then estimate the consequences of a 3-degree rise.

Professional futurologists in the social sciences had abandoned that method of prediction decades earlier, when they realized that most of their predictions had been far off the mark. They turned to an approach practiced by military planners and war gamers since the 1940s: Instead of working only with the most likely future, imagine a wide range of possible futures, and for each of them develop a detailed scenario. The aim was to stimulate thinking about how operations should be structured so they would hold up for any of the likely contingencies. Since the 1980s most corporations and government agencies had used scenarios for their planning.

The IPCC had taken up that approach from the outset, assembling experts to write scenarios in a lengthy intergovernmental process. The result, published in 1992, was a set of six scenarios, each describing a way that the world's population, economies, and political structures might evolve over the decades. Experts in various fields of physical and social sciences could try to figure how much of each of the various greenhouse gases would be emitted by the society of a given scenario, compute the likely climate changes, and then estimate how that society would try to adapt. A second try in 1996 produced no fewer than 40 scenarios. There were so many unknowns, and so many differences from region to region with each region demanding its own detailed study, that the small community of researchers could explore only a few of the possibilities in depth. Many research projects used only one scenario, the middle one with emissions neither sharply restricted nor rising explosively.

Meanwhile, the IPCC got increasingly specific about just what the consensus of experts meant. The panel reported whether they judged a given impact to be "more likely than not," or "likely," or "very likely," and so forth. In the panel's 2001, 2007, and 2013 reports, the most impressive parts resembled the earlier reports; they simply laid out a variety of the possible impacts. In fact, all the major impacts of climate change as we now understand them were well understood on the global scale by 2001. The later IPCC reports were mainly distinguished by their increasing regional specificity and their increasing certainty that the impacts were well on their way. "Likely" shifted to "very likely," and the wording of the executive summaries of the reports got increasingly strong in the hope that people would pay heed.

Most people read only the executive summaries. The IPCC impacts reports themselves were enormous, but they were an odd sort of science. They could not be read like a physics paper, presenting a logical sequence of arguments and observations explaining why, for example, wheat yields in the American Great Plains were expected to decline by 4%. The reports were more like review papers, citing hundreds of studies of computer models, historical records, and so forth. Anyone seeking to be convinced would have to dig down into the papers, which were themselves often elliptical; computer modelers' papers in particular rarely had space to do more than specify the special characteristics of the model of the moment and give graphs and tables of the results.

Attempts at precision could be misleading. For example, studies published from the 1970s into the mid 1980s estimated that by 2100 the sea level might rise anywhere from a few tenths of a meter to a few meters. The upper limit dropped to about half a meter in the IPCC's 1995 report, and it stayed there in the reports through 2007; many readers did not notice that the 2007 report explicitly did not include an addition that might come if polar ice sheets began to surge into the oceans in the next few decades. Most scientists considered that quite unlikely, but there were always some who argued that it was possible. Not until its 2013 report did the IPCC grudgingly admit that the sea level might rise a meter and a half by 2100. And even then the IPCC gave scant attention to such impacts that did not seem pretty likely to happen, even if they would be catastrophic if they did befall us.

That cautious approach was different from the practice in many other kinds of impact studies. For example, the building codes of cities in earthquake zones and evacuation plans for people living near nuclear reactors dealt with problems that might have less than one chance in a hundred of happening in the next century. The IPCC, by contrast, was preoccupied with impacts that were more likely than not. Those were shaping up to be bad enough.

This brief summary of the history of scientific understanding of the impacts of climate change is a peculiar history, as histories of science go. Since the real work began in the 1960s, I have not had occasion to mention a single name of an individual: My actors were committees. I have not even cited any single landmark discovery paper; the committees were looking over dozens of papers, then hundreds, each contributing a little bit to the overall picture. Nor have I described any grand false leads, dead ends, or controversies, which are so common in the history of science. The seat-of-the-pants guesses that scientists started with in the 1960s turned out to be roughly correct; the story was one of adding to the list of impacts, putting numbers to each item, and becoming ever more certain that the things foreseen would indeed come to pass. And in this short article I have certainly not been able—any more than the IPCC in its lengthy reports—to present a convincing case, based on logic and observations, of why anyone should believe the consensus statements.

A closer look, if I had much more space, would certainly turn up plenty of individuals, along with lots of mistakes and controversies about details. Each new idea was first brought up by someone and then argued out at length. Our history of committees is like the swan that glides serenely on the surface while paddling furiously underneath. Still, I haven't been telling a Whig history, reconstructing after the fact an understanding that never existed at the time. In this peculiar case a consensus was constructed by committees on the fly, a consensus that became increasingly detailed and certain decade by decade. The topic was so important that people recognized very early on that it could not be left to a few individuals making statements to the newspapers. Experts had to analyze the entirety of the peer-reviewed literature, even have elaborate computer studies done expressly for their use, and get together to hammer out conclusions that everyone could agree were scientifically sound. To be sure, in some areas they could only agree on the extent of their uncertainty, but that, too, was a genuine and important scientific conclusion.

On the other hand, many people have argued vociferously against the entire scientific consensus on impacts, right up to the present. For example, a Hoover Institution publication held that "global warming, if it were to occur, would probably benefit most Americans." There would be lower heating bills and other energy savings. Others emphasized, as a Heartland Institute publication declared, that "more carbon dioxide in the air would lead to more luxuriant crop growth and greater crop yields" while taking no account of the likely heat waves and droughts.[12] No careful study or hard analysis backed up such statements. Our mainstream history, the history of expert committees, stands aside from all that.

The public knew little of how the committees came to exist and nothing of how they functioned. The experts' consensus reached ordinary people as a few paragraphs, at most, in a news story, boiling down an already much compressed executive summary.

submit that a major problem in communicating climate realities to the public is that the media, and everyone else addressing the public, feature individual scientists and their discoveries and disagreements. We have scarcely come to grips with committee consensus, a different kind of history of science. You will find no account digging into details of committee deliberations. I haven't been able to do it here, and I am not sanguine about prospects for getting it done. In fact, the IPCC and the NAS and their members have been highly reluctant to make public any documents or recollections about just what goes on in the committee deliberations. Only recently, under pressure from critics, has the IPCC made its review process entirely transparent to the public. Be that as it may, I suggest historians and social scientists should give more attention to those committees. If we did, the public would have a better idea of how "science" comes to say what it does say about global warming —and a good many other issues.

This article is adapted from the author's lecture on accepting the American Physical Society's 2015 Abraham Pais Prize for History of Physics, delivered at the 2015 APS March Meeting in San Antonio, Texas. A longer version of this article with complete references is available at http://www.aip.org/history/climate/impacts.htm.

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5. The future of ITER

John P. Heinrich[1]

September 2015,
Physics Today page 10
http://scitation.aip.org/content/aip/magazine/physicstoday/article/68/9/10.1063/PT.3.2895

Fusion has long been an interest of mine, and I have followed closely the progress of ITER, the international prototype fusion reactor project. I found David Kramer's story (*Physics Today*, May 2015, page 21) particularly revealing.

I began my career as a program manager and had the good fortune to serve under a group of managers who worked together on the Apollo program, where many of the tools for program management were developed. Coincidentally, the programs I took part in were primarily fusion related, including the Large Coil Project intended to develop prototype toroidal field coils for tokamaks.

The current state of ITER is easy to understand. None of the basic tenets of program management—well-defined specifications and budgets, effective change control, clear lines of authority, and a manager with the ability to promptly make key decisions—have been applied to it. The optimism apparently associated with the recent appointment of Bernard Bigot as director general is laughable. Until the participants are committed to converting ITER from a technopolitical hodgepodge into a real project, the US is completely justified in its skepticism. ITER has no chance of success under the current conditions.

6. Argentina: from Huemul island fusion fraud to physics fortune

18 August 2015
By Katia Moskvitch
http://eandt.theiet.org/magazine/2015/07/huemul-nuclear-fusion.cfm

It was arguably the scientific fraud of the century, but a hugely expensive failed project to create energy from nuclear fusion laid the foundation for Argentina's success in physic.

The ruins are ghostly, silent. The crumbling buildings and labs – hidden on an island that's drowning in a dense, green forest – look as if they are an abandoned villain's lair from an early James Bond movie. And in a way, they are a villain's making – they're all that remains of a top-secret project, 'Proyecto Huemul', which turned out to be one of the biggest and most expensive frauds in scientific history – and ironically also became the foundation of a scientific success story.

Tiny Isle Huemul, with an area of just two square kilometres, is covered in alerce trees; it resembles the head of a giant crocodile taking a snooze on a sunny August afternoon, poking out of the mesmerising deep blue waters of Lake Nahuel Huapi in Patagonia, amid the snow-capped mountains of the Argentinian Andes.

These days, it takes a kayak to get here. Our paddles slice silently into the chilly water as we navigate slowly past a rickety wooden pier and the semi-submerged wreck of a boat. The lonely figure of Huemul's only resident, a policeman, greets us as we wade ashore. Tourists don't come here anymore, not since the last boat sank, but the policeman knows the kayakers and lets our group pass. They come here often, to pick overripe apples or wander amongst mossy trees, wild roses and thorn bushes.

Leading us is Ingo Allekotte, from the nearby mountain resort of San Carlos de Bariloche, famous for its outdoors, its chocolate shops – and its physics institute. It's this scientific connection that gives us permission to be on the island.

Power of the sun

It all started in 1948, with a tempting promise to solve the world's energy problems. Ronald Richter, a recent émigré from Austria, claimed that he could achieve controlled fusion, recreating the power of the sun on earth. He convinced Argentina's then-leader General Juan Domingo Perón that he could produce unlimited energy – and the dictator was hooked. After all, he was desperate for Argentina to industrialise and needed cheap electricity to power the factories and steel mills envisaged by his five-year plan.

Back then, nuclear power seemed to hold all the promise. In 1942, Enrico Fermi had created the first nuclear reactor in Chicago producing the first self-sustained fission reaction using uranium. Fusion, however, was still a dream – even in its uncontrolled form, with the hydrogen bomb still in secret development in labs in the United States and the Soviet Union.

Richter promised that he could trigger self-sustaining fusion using just hydrogen, the simplest and lightest of all elements, as well as deuterium, lithium, and heavy water. It proved all too tempting for Perón, who agreed to give the Austrian a blank cheque and build his lab and a nuclear reactor on Isle Huemul. The island was chosen partly because of its ample water supply, but mainly because it was so far away from the public eye, back then two days of travel from the capital Buenos Aires. Perón wanted to keep the project a secret: he had fallen out with many in Argentina's scientific community and didn't want them to meddle.

Construction began in late 1949, and Richter quickly burned through the president's 1,000 million pesos (or more than £150m in today's money). He built a 12-metre-high cube-like concrete bunker, which sheltered a machine he called a 'thermotron'. Residents of Bariloche still remember the huge electrical charges released by his experiments, which made the windows shake in their homes.

Finally, on 16 February 1951, Richter reported a "net positive result": hydrogen, fed into an electric arc, had reached a temperature necessary to produce a sustained fusion reaction. Or so he thought. Perón, eager to announce the feat to the world, rapidly organised a news conference. In March 1951, the dictator proclaimed that Argentina had discovered "the controlled liberation of atomic energy" from thermonuclear reactions and would be able to solve the world's energy problems. It was done, he said, not with radioactive uranium, but with hydrogen.

The revelation led to media frenzy, although even then some science journalists took the announcement with a large pinch of salt. Argentina, after all, back then was a mainly rural nation of some 16 million people. How could it have leapfrogged the US and the Soviet Union, neither of which had even managed to build a hydrogen bomb yet?

But Perón's promise of a future where energy would be "sold in half-litre bottles, like milk" quickly turned out to be a fraud.

The international scientific community had been sceptical from the start. Hans Thirring, the director of the Institute for Theoretical Physics in Vienna, wrote at the time that "it is a 50 per cent probability that Perón is giving credit to the ravings of a fantasist; a 40 per cent probability that the president has been the victim of a huge scam; and a nine per cent chance that Richter is telling the truth."

A few months later, Perón sent a group of researchers to Huemul to investigate. They were led by physicist Jose Antonio Balseiro and it didn't take them long to debunk Proyecto Huemul. Richter retired to Buenos Aires in disgrace. It was Argentina's – if not the world's – biggest modern-day scientific scandal.

Today, says Gerardo Aldazabal, one of the physicists working in Bariloche, the remains of Richter's lab look like 'the Zone' in the cult movie 'Stalker', an epic 1979 sci-fi film by Russian director Andrei Tarkovsky, which depicts a forbidden wasteland area where all one's wishes are supposed to come true.

In an ironic twist, the fiasco of Huemul was indeed the seed for one of Argentina's biggest scientific feats. After he had unmasked Richter's experiments as fraudulent, Balseiro managed to persuade Perón to use all the expensive equipment from the island to do some real science in nearby Bariloche. This is how 60 years ago the Instituto Balseiro, one of South America's most prestigious scientific establishments, was born. It's part of Argentina's National Atomic Energy Commission, and home to the Bariloche Atomic Centre, which overlooks the island.

"In some sense, it was the best expectable outcome from a failure," says Allekotte, walking in one of Huemul's empty, echoey buildings. "The creation of the Institute was a turn of the page."

The road to success

Soon, Argentinian physicists at Instituto Balseiro developed advanced research nuclear reactors – real ones – and a uranium enrichment plant. Over the years, the university was home to both the renowned physicist Guido Beck and the brilliant Juan Maldacena, a string theorist who in 1997 startled the world with his discoveries supporting the suggestion that our universe might be

nothing but a hologram.
It's tough to gain admission to the Balseiro Institute; just 30 to 40 students a year pass the entrance exam and are allowed to complete the final three years of their undergraduate studies in physics, nuclear, mechanical or telecommunications engineering here in Bariloche. In total, only around 90 undergraduates and 160 graduate students study in the prestigious place, all of them on full scholarships. They do their experiments at the Bariloche Atomic Centre, the research institution on campus, where many continue working after graduation.
The Institute is also home to the majority of the Argentinian physicists working on the world's largest cosmic ray project, the Pierre Auger Observatory, among them Allekotte. Here they do calculations for the huge observatory based in nearby Mendoza province, with its 1600 detectors spread across 3000 square kilometres. Another team at Balseiro is currently designing a dark matter lab, planned to be housed in a tunnel to be built between Argentina and Chile.
Inadvertently, Ronald Richter also triggered scientific success well beyond the Instituto Balseiro. The Austrian's fraudulent claims spurred American physicists into action, prompting them to reflect on the design of a real thermonuclear reactor. Lyman Spitzer, then a 36-year-old Princeton astrophysicist working on the hydrogen bomb project, read Perón's announcement, and began to wonder whether it would be possible to confine a hot plasma in a magnetic field. He submitted the concept to the newly formed US Atomic Energy Commission, promising to build a 'magnetic bottle' to re-create the sun's energy on Earth.
Fast-forward two years, and in the autumn of 1953 Spitzer developed the so-called Figure 8 Stellarator, the first step to various nuclear fusion research projects.

Future hopes

The hunt for cheap and inexhaustible energy continues to this day. The biggest venture right now is ITER, formerly known as the International Thermonuclear Experimental Reactor. This international megaproject is currently building the largest-ever experimental tokamak nuclear fusion reactor in the south of France. Just like other labs, such as the National Ignition Facility (NIF) in the US, the goal is to have a commercial reactor that would not only create plasma by fusing atoms, but by doing so generate more energy than was used to create the plasma. Scientists call it 'ignition' – exciting the plasma so that it begins to heat itself like a star.

In Bariloche, meanwhile, nobody is working on fusion anymore, except for some theoretical research. Allekotte hopes that the ruins at Isle Huemul will be left intact: to him, and his colleagues at the Instituto Balseiro, these ruins are a reminder of how they managed to snatch scientific victory from the jaws of defeat.

7. Science 11 September 2015:
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REPORT

The reinvigoration of the Southern Ocean carbon sink

Peter Landschützer[1,*], Nicolas Gruber[1,2], F. Alexander Haumann[1,2], Christian Rödenbeck[3], Dorothee C. E. Bakker[4], Steven van Heuven[5,†], Mario Hoppema[5], Nicolas Metzl[6], Colm Sweeney[7,8], Taro Takahashi[9], Bronte Tilbrook[10], Rik Wanninkhof[11]

http://www.sciencemag.org/content/349/6253/1221.short

Several studies have suggested that the carbon sink in the Southern Ocean—the ocean's strongest region for the uptake of anthropogenic CO_2 —has weakened in recent decades. We demonstrated, on the basis of multidecadal analyses of surface ocean CO_2 observations, that this weakening trend stopped around 2002, and by 2012, the Southern Ocean had regained its expected strength based on the growth of atmospheric CO_2. All three Southern Ocean sectors have contributed to this reinvigoration of the carbon sink, yet differences in the processes between sectors exist, related to a tendency toward a zonally more asymmetric atmospheric circulation. The large decadal variations in the Southern Ocean carbon sink suggest a rather dynamic ocean carbon cycle that varies more in time than previously recognized.

8. The Energy of the Future: The Status of Nuclear Fusion Research and the Role of the IAEA

By Aabha Dixit, IAEA Office of Public Information and Communication
https://www.iaea.org/newscenter/news/energy-future-status-nuclear-fusion-research-and-role-iaea

Scientists are becoming increasingly excited about the prospects that within the foreseeable future a reactor can replicate the sun's energy source on Earth through scientific and technological innovation of a scale previously unimagined. During the annual IAEA General Conference, a side event on nuclear fusion technology was held to discuss latest advances in research and development in fusion technology.
"The world is getting warmer with emissions getting from bad to worse, it is hopeful that alternative sources of energy such as fusion technology can provide electricity worldwide by the middle of this century," said Steve Cowley, Director of the Culham Centre for Fusion Energy in the United Kingdom, in his introductory remarks.

He also highlighted the pioneering work of the IAEA in promoting international collaboration in this field since 1958 and without this support, the development of fusion technology would be further behind. "We now need to urgently ramp up the work going on at the International Thermonuclear Experimental Reactor (ITER) and to push the experiment forward to meet the growing energy demands."
Discussions provided insights into the status of fusion research presently and possibilities for its upscaling to commercial energy production. Global collaboration was the best way forward to close the technological and scientific gaps to realize the dream of a functioning fusion power plant within the foreseeable future, panelists agreed.
"It is too expensive and technologically challenging to attempt charting a lonely research path," Richard

Kamendje, a fusion physicist at the IAEA, told the audience. “Therefore the role played by the IAEA in fostering international collaboration and facilitating the exchange of scientific and technical information in the fusion field is key for its success.”

Global Experiment aims to harnessing fusion energy

The challenge to create a source of energy similar to that of the sun itself in a reactor is yet to be conquered. With dedicated research and unprecedented international collaboration, scientists believe that there is light at the end of the tunnel to re-create this energy in a reactor that can deliver energy to the electricity grid.

This innovative experiment is to be carried out at a global nuclear fusion experiment facility presently under construction. Known as ITER and located in Cadarache, in the south of France; it is an international project with seven members: China, India, Japan, South Korea, the European Union, the Russian Federation and the United States.

“There are so many international partners who are working on the components and manufacturing areas of the ITER project,” said Cowley. “Though we may compete in the advances made at the national level in fusion science and technology, we gain from the constructive outcomes. The competition to find the solutions to a problem benefits the goals of ITER. Fusion prototype reactors are being built at the national level, but what is also motivating scientists like us, is the global eagerness to see an end result that is positive for humanity.”

The ITER experiment boldly represents the magic of international collaboration for the peaceful uses of the atom. ITER, should the experiment succeed, would show the path to building a power plant that uses controlled nuclear fusion, as a potentially inexhaustible energy source. More significantly, it will demonstrate how the greatest of challenges in modern science and technology can be successfully overcome through international cooperation.

Giving an overview of the current status of the project and the challenges, David Campbell, Director of the Science and Operations Department at ITER pointed out that this project is the largest international scientific collaboration on earth to create sustainable energy.

“From the delivery of large plant components for the experimental reactor to building additional support structures, are among some of the challenges we are facing. Without international collaboration and support, this project would just not be possible.”

Proponents of fusion technology are also aiming for commercial utilization, and this on-going experiment needs to speed up, move ahead as rapidly as possible to make ITER operational at the earliest, he reiterated.

The theory is relatively straight forward. The nuclear fusion reactor should achieve self-sustaining fusion reactions and produce in excess of several hundreds of MW of fusion power. But turning science to practical application is complex and challenging. While the ITER facility will test key technologies necessary for a fusion reactor, many countries are independently initiating new research and development activities leading to a demonstration of fusion energy’s readiness for commercialization (DEMO). But it would all come together, in the spirit of international collaboration under a world “DEMO Programme.” The IAEA organizes a series of DEMO programme workshops to facilitate and strengthen international cooperation to define and coordinate DEMO programme activities.

Scientists and policy makers are convinced that we are on the edge of an 'Age of Fusion' and the ITER facility and demonstration plants would establish the technology to significantly meet, in the not too distant future, humanity's energy needs through a virtually inexhaustible, safe, environmentally-friendly and universally-available resource.

The IAEA has been in the forefront of nuclear fusion research efforts since the 1950s. The IAEA has focused its efforts on facilitating the coordination of international fusion undertakings and enhancing the interaction among developing Member States with leading fusion initiatives. The Agency can rightfully claim its share of credit in supporting the pioneering ways to make fusion energy a reality for meeting the global energy demand.

9. Fusion energy could be the future

(31 August 2015)

https://www.dur.ac.uk/news/newsitem/?id=25499&itemno=25499

Fusion energy offers the tantalising possibility of clean, sustainable and almost limitless energy. But can it be an economically viable option?

Research led by Durham University, in collaboration with the Culham Centre for Fusion Energy, has looked in-depth at the economics of fusion energy.

The team calculated the cost of building, running and decommissioning a fusion power station and how this compares to current fission nuclear power plants.

They concluded that a fusion power plant could generate electricity at a similar price to a fission plant.

Professor Damian Hampshire, of the Centre for Materials Physics at Durham University, who led the study, explains: "Obviously we have had to make assumptions, but what we can say is that our predictions suggest that fusion won't be vastly more expensive than fission."

Such findings support the possibility that, within a generation or two, fusion-generated energy could become a reality.
Professor Hampshire hopes that the study will help persuade policy-makers and the private sector to invest more heavily in fusion energy.
“While there are still some technological challenges to overcome, we have produced a strong argument, supported by the best available data, that fusion power stations could soon be economically viable.
We hope that this kick-starts investment to overcome the remaining technological challenges and speeds up the planning process for the possibility of a fusion-powered world.” he said.
The study considers recent advances in high temperature superconductors, which could be used to build the powerful magnets that keep the hot plasma in position inside the containing vessel, called a tokamak, at the heart of a fusion reactor.
These developments mean that superconducting magnets could be built in sections, rather than in one piece. This would help to reduce the costs of maintenance by allowing individual sections of the magnet to be repaired or replaced, rather than the whole device.
Fusion reactors create energy in a similar way to the sun, heating plasma to around 100 million degrees centigrade. At this temperature, hydrogen atoms fuse together and release energy.
This differs from more traditional fission nuclear reactors that create energy by splitting atoms at lower temperatures.
So what advantage does fusion energy offer over fission? Fusion reactors are safer. They produce no radioactive waste and there is no high level radioactive material to potentially leak, meaning that disasters such as Chernobyl and Fukushima are impossible.
Fusion energy is also politically favourable. It does not produce any weapons-grade products that could proliferate nuclear arms.
Security of supply is not a concern either as the fuels for the reactors, deuterium, or ‘heavy water’ which is extracted from sea water, and tritium, which is created within the reactor, are readily available.
The study, which was commissioned by Research Council UK’s Energy Programme, does not include the costs of disposing of radioactive waste as, unlike a fission plant, no radioactive waste is created. The only radioactive material would be the tokamak, which would become mildly radioactive during its lifetime.
A test fusion reactor, the International Thermonuclear Experimental Reactor, is about 10 years away from operation in

the South of France. Its aim is to prove the scientific and technological feasibility of fusion energy.
The research paper is published in Fusion Engineering and Design journal and can be accessed via [Durham Research Online].

10. Research boost for future fusion reactor

Harnessing nuclear fusion could generate unlimited, sustainable energy. An EU-funded project has helped advance atomic modelling in preparation for a future fusion reactor.

Published: 19 August 2015

http://ec.europa.eu/research/infocentre/article_en.cfm?id=/research/star/index_en.cfm?p=s1-adas_eu&calledby=infocentre&item=Infocentre&artid=35637

Since the 1920s, scientists have known that it is possible to fuse hydrogen isotopes – versions of hydrogen that contain extra neutrons – to release energy without creating carbon emissions or excessive radioactive waste. The promise of unlimited clean energy is driving a quest for commercially-viable fusion reactors that could meet the world's growing demand for secure, safe energy.
The ADAS-EU project has helped researchers to model and measure the radiating properties of atoms and ions in plasmas – extremely hot gases in which electrons are detached from their parent atoms to form ions – used for fusion. These models are essential to developing one particular type of plant, a magnetically confined fusion plasma reactor, currently being built in France within an international 30-year project, ITER.
In this type of reactor, atoms in hydrogen plasma within a magnetic field are accelerated to very high speeds so that they can collide and fuse with each other. The plasma will have to be 10 times hotter than the Sun for fusion to occur. This process releases energy that can be harnessed to generate electricity. Models from ADAS-EU are helping scientists learn how to contain the plasma, heat it and control the energy it produces.
Ultimately, ITER will produce the same amount of power as a gas-fired power station (500 MW), albeit for only a few minutes. This would prove that fusion could be a commercially viable source of energy. Actual electricity generation for continuous periods will then be realised at the next stage in the quest for commercial fusion – DEMO – the demonstration fusion power plant.
Project coordinator Hugh Summers of the University of Strathclyde in the United Kingdom says: "Researchers are trying to make plasma hot enough for long enough, and with other conditions right, for hydrogen fusion to occur." Accurate models that predict atomic processes amongst the different parts that make up the plasma are therefore crucial in developing a large-scale reactor such as ITER, he explains.

Project achievements

ADAS-EU was an extension of ADAS (the Atomic Data and Analysis Structure) – an initiative supported by European, US and other international laboratories, universities and the EU to link theoretical and experimental atomic physics in fusion research.

The four-year project worked on six themes relevant to ITER: heavy element spectroscopy, medium-weight elements, charge exchange spectroscopy, neutral beam stopping/emission, diatomic spectra and collisional-radiative models.

It supported improvements to atomic physics models around Europe by placing specialist staff in laboratories, developing training courses on ADAS modelling and data techniques and publishing data on public websites.

These improved models incorporated new atomic fusion information and modelled heavier elements than had been done previously. The project also helped manage databases of atomic data and promoted key atomic data calculation and measurement methods.

In particular, the EU-funded project helped researchers understand a number of factors influencing hydrogen atoms' behaviour in high-temperature reactors.

One was the impact of tungsten contamination. Used for the divertor, a reactor part subject to enormous heat that removes waste particles and heat from the plasma, this very hard, brittle heavy metal can release particles when plasma touches it.

A second was X-ray forbidden emissions, found in high-temperature conditions where the usual rules of atomic transitions are 'broken'. "We discovered that these carry a lot of the power of the total atomic emission," states Summers. "It helps us know what to look for to check that emissions are occurring as expected."

Sharing its new knowledge, ADAS-EU also created the OPEN-ADAS website, putting ADAS data and the work from ADAS-EU in the public domain. This has become one of the primary sources in the world for information about how atoms radiate and on interpreting spectra in plasma, says Summers.

International effort

Collaboration with the International Atomic Energy Agency and Euratom-associated laboratories was important for the project's achievements.

"From its beginnings in the 1950s, European fusion energy research has always been a coordinated programme – it is very complex and investment-intensive," says Summers.

He adds that expert European university groups that contributed special knowledge to the ADAS-EU themes are now collaborating in further research into fusion power generation.

The project achieved all its objectives, he adds, "leaving the ongoing ADAS Project in excellent health, very heavily used, fully engaged with ITER, and with world-leading data and outstanding fusion modelling and analysis capabilities."

Project details

Project acronym:ADAS-EU
Participants:UK (Coordinator)
Project Reference N° 224607
Total cost: €1 004 400
EU contribution: €899 085
Duration: January 2009 - September 2013

11. Britain needs Hinkley Point C, says EDF Energy head

16 September 2015

As EDF Energy approaches a final investment decision for the planned Hinkley Point C nuclear power plant in the UK, the company's CEO, Vincent de Rivaz, has said it is "the right technology, at the right price, at the right time".

http://www.world-nuclear-news.org/NN-Britain-needs-Hinkley-Point-C-says-EDF-Energy-head-1609155.html

As that decision approaches, "scrutiny has naturally increased", de Rivaz said during a visit yesterday to the company's Dungeness nuclear power plant in Kent. "The project has faced rigorous scrutiny from government - including the Chancellor and the Secretary of State - from parliament, the European Commission, the regulator, the unions, from our workforce, suppliers, customers, partners and many other stakeholders. It has helped us to improve our plans and bring us to the brink of a final investment decision."

He noted that the analysis of the project has been conducted through a "rigorous, comprehensive and exhaustive set of processes which has taken the best part of a decade". De Rivaz added, "The processes are led by responsible and accountable people who concluded that it is an investment which Britain needs and that it is based on a good deal and a strong project."

An October 2013 deal between the British government and EDF says that the former would pay the difference between the agreed price of electricity from Hinkley Point C and the market price if this is lower. This strike price has been set at £92.50 ($151.60) per MWh with this reducing to £89.50 ($146.72) if a further plant at Sizewell is built. If the market price is higher than these, EDF would pay the difference to the government.

"Some critics have compared the strike price to the current electricity price," he said. "The price today is not a relevant comparison to the electricity Hinkley Point will produce in decades to come. Today's market price depends on fossil fuels and ageing plants. Our project will ensure we don't need to continue to depend on them in future."

He added: "Short-term events have not changed the long-term case on which this project was based and its price deemed fair. The market price today is similar - even if it has decreased a little - to where it was two years ago when the price for Hinkley Point C was agreed and welcomed."

Describing the Hinkley Point C project as "a vast undertaking", he said, "It is a good deal. It is affordable and fair".

Regarding the reactor technology to be employed at the planned

plant, he said, "Hinkley Point C will be the fifth and sixth EPRs worldwide".
"It is true that there have been delays at Flamanville," he said. "The experience gained there - and at Taishan in China - will be immensely valuable when we come to Hinkley Point C. And for the UK we have a design that is stable. We are sure of what we will build before we begin construction [...] Our experience will ensure that this technology - which has been through a teething and somewhat challenging period - will mature to deliver its full potential for the UK and around the world."
He said that many other large infrastructure projects in the UK - such as Crossrail, the Channel Tunnel and Heathrow's Terminal 5 - have faced scepticism in the final stages of development. "For me, this is a great pity. Britain's infrastructure would be all the weaker if its leaders had allowed the doubters and procrastinators to derail those projects," de Rivaz said.
However, he said that Hinkley Point will be built on time. "Not too early, not too late," de Rivaz said. "When it arrives it will be welcomed and it will be needed ... In a few short years, Britain will need Hinkley Point C, and we are on track to deliver for when it does."
Researched and written
by World Nuclear News

12. Russia-Norway 'early notification' protocol signed

16 September 2015

Russia and Norway yesterday signed a protocol on the practical measures required for their inter-governmental agreement on early notification of nuclear accidents and exchange of information on nuclear facilities. The protocol was signed in Vienna during the International Atomic Energy Agency's General Conference by Rosatom director general Sergey Kirienko and Norwegian Radiation Protection Authority director general Ole Harbitz.

http://www.world-nuclear-news.org/RS-Russia-Norway-early-notification-protocol-signed-16091502.html

The protocol includes new procedures for information exchange on various aspects of nuclear and radiation safety, the Russian state nuclear corporation said. These make the entire process between the two countries more systematized, it added. The new document covers nuclear power plants, including Russia's Kola and Leningrad nuclear power plants, nuclear reactors aboard ships, fresh and used nuclear fuel storage, as well as research and other reactors located in Norway and within the 300km border with Russia.
Rosatom said: "This package of joint measures is undoubtedly to

strengthen environmental control in the region and to develop neighbourly relations and cooperation in various areas."
The protocol has been developed in full compliance with the international commitments and national laws of the two countries, as well as IAEA documents, Rosatom said. In the near future, Russia plans to sign similar documents with other countries that share a border and common interests with Russia, to ensure nuclear and environmental safety, it said.
Researched and written
by World Nuclear News

13. Nuclear power can address two 'existential threats', says former US official

16 September 2015
http://www.world-nuclear-news.org/NP-Nuclear-power-can-address-two-existential-threats-says-former-US-official-16091501.html

The nuclear power industry has a unique role to play in tackling two "existential threats" facing all humanity - climate change and nuclear war, Daniel Poneman, president and CEO of Centrus Energy Corp told delegates at the World Nuclear Association's Annual Symposium in London last week. From 2009 to 2014, Poneman was US deputy secretary of energy and also served as the COO of the US Department of Energy.

History will record 2015 as a pivotal year for both of those existential threats, Poneman said.
"First, when it comes to the most pressing global proliferation threat - the possibility of Iran acquiring nuclear weapons - the P5+1 and Iran have concluded a Joint Comprehensive Plan of Action, which will constrain Iran's nuclear program and subject it to enhanced international monitoring. Second, three months from now, negotiators from 190 nations will meet in Paris for historic climate talks aimed at finding a way to limit global warming to 2°C this century - an ambitious target that many scientists say is necessary to avert the worst consequences of the change in climate," he said.
The International Energy Agency (IEA) "has urged with growing insistence", he said, "that the window available to take action to deal with this threat effectively is closing rapidly".
Reading a quote by German philosopher Friedrich Nietzsche - "The most common form of human stupidity is forgetting what we were trying to do in the first place" – Poneman said, "If our goal is to address climate change and to reduce the threat of proliferation, then we must have a strong and focused nuclear power policy that

supports both things". This means that laws, regulations and public policies "should not pit one carbon-free energy source against the other", he said.
Citing World Nuclear Association data, Poneman said there are at least 60 reactors under construction and at least 500 more that are planned or proposed around the world. At the same time, however, the industry is constrained by competition for alternatives and issues regarding cost, safety, environmental factors and non-proliferation, he said.
Poneman praised World Nuclear Association director general Agneta Rising for her speech at the Symposium, during which she said the industry should aim to add 1000 GWe of new nuclear power by 2050. He said: "Interestingly, the IEA view is largely consistent with that, telling us that we need 930 GWe of new nuclear by 2050 if we are to do our part in meeting the 2 Degree Scenario." He was referring to Paris-based IEA's report *Energy Technology Perspectives 2015*, which argues that the transformation to clean-energy is progressing at levels well short of those needed to limit the global increase in temperature to no more than 2°C.
Using Centrus Energy as an example, Poneman said that a "robust nuclear growth scenario" will require many things, including reliable fuel supply and strong competition with multiple suppliers. Centrus Energy was formerly known as United States Enrichment Corp.
"While we view ourselves as an important partner in supporting the US national security mission, we are also keenly focused on providing our LEU customers with reliable, on-time deliveries on commercially attractive terms. While current uranium prices will not support investment in global new capacity today, we are also keenly focused on ensuring that our own suppliers can count on us to be reliable counterparties," he said. "Today's market has too much supply but not too many suppliers. We are optimistic about the long term that, eventually, the market will support investment in new enrichment capacity. To be able to commit to that 2 Degree Scenario, we'll need to more than double our enrichment capacity by 2050."

Non-proliferation

The issue of Iran's potential to have nuclear weapons has "riveted the world's attention and has great relevance for our industry", he said.
"Iran has justified its activities under the colour of the Nuclear Non-Proliferation Treaty (NPT), but the international community and the International Atomic Energy Agency (IAEA) have responded consistently and forcefully that this program has serious proliferation concerns. Now that a deal has been reached the hard work will continue. Both the supporters and opponents of this deal are intently focused on the need for enforcement and verification of

compliance. Much of that work will fall to the IAEA, but there's one aspect where our industry can play a useful role - shaping the environment surrounding the reliable supply of nuclear fuel services in the years ahead," he said.
Poneman put forward the idea of "international consortia" being created between now and that time to provide a "set of guarantees" that Iran, or any NPT compliant nuclear energy program, would have assured access to civilian nuclear fuel.
"Could such a set of assurances be relied upon? I'd say that they could if the following conditions were met - the fuel services provided come from a variety of sources, thus ensuring diverse, secure and competitive supplies; the assurances would always be based on IAEA safeguards or other non-proliferation requirements as determined by the IAEA and/or the UN Security Council; the assurances would be supported by backstopping national commitments which in turn could be backed up by IAEA assurances," he said.
An example of this is the IAEA Fuel Bank that was launched last month in Kazakhstan. This could be reinforced, he said, by other forms of peaceful nuclear cooperation in areas such as advanced technology, the fuel cycle and small modular reactors, in order to underscore the net benefits of participating in this program.
"We are living in critical times. In the 1940s Albert Einstein wrote a letter to fellow scientists calling atomic energy 'the most revolutionary force since pre-historic man discovered fire'. He warned that: 'This basic power of the universe cannot be fitted into the outmoded concept of narrow nationalisms. For there is no secret and there is no defence; there is no possibility of control except through the aroused understanding and insistence of the peoples of the world'. Now, almost 70 years later, his words are a poignant reminder of our shared responsibility to unleash this power for constructive rather than destructive ends."
The nuclear power industry has "the understanding, the capabilities and the resources to execute this important mission for the benefit of our citizens, our customers, our stakeholders and the world," he said.

Researched and written
by World Nuclear News

14. Australia's Largest Commercial Solar Rooftop For Darwin

September 17, 2015 Energy Matters
http://www.energymatters.com.au/renewable-news/casuarina-commercial-solar-em5071/

GPT Group, one of Australia's largest diversified listed property groups, is having a 1.25MW rooftop solar panel system installed

at its Casuarina Square shopping centre in Darwin.
SunEdison Australia is providing engineering, procurement and construction (EPC) services for the project and installing in partnership with local company, Country Solar.
What will be Australia’s largest commercial solar rooftop installation is expected to be fully operational in November this year.
Casuarina Square has been serving the local community since 1973. The complex houses more than 190 stores and retailers, plus cinemas.
According to Energy Matters, the suburb of Casuarina receives significant solar irradiation levels; around 5.77 kilowatt hours on average per square metre each day. Currently, there 686 solar installations in Casuarina totaling 2734.52 kW capacity, so GPT Group’s project will provide a significant boost to the 0810 postcode’s collective tally.
GPT Group has previously installed solar at other locations; including two properties at Sydney Olympic Park, the Maribyrnong Homemaker Centre and the Rouse Hill Town Centre. In 2012, GPT harnessed solar power to create one of the most self-sufficient offices in New South Wales at 5 Murray Rose, Sydney Olympic Park.
Founded by Dick Dusseldorp as The General Property Trust in 1971, today GPT Group has more than 37,000 investors and $18.7 billion of assets under management.
Last week, the company was recognised for its sustainability efforts in the Dow Jones Sustainability Index (DJSI) for 2015/16; achieving the highest score among property companies globally in the ‘environmental dimension’ of the DJSI.
“GPT continues to minimise the environmental impact of the business, while also delivering better commercial outcomes for our customers and investors,” said GPT Head of Asset Management Matthew Faddy.
“Last year, GPT achieved $23.5 million in energy cost savings when compared to the energy intensity of our buildings in 2005.”
The Casuarina Square project will add to SunEdison Australia’s

already impressive commercial solar portfolio. In 2014, the company installed more capacity in the 10-100kW range than any other installer in Australia.

Editor's note: Energy Matters is a SunEdison company.

15. Aqueous Hybrid Ion Battery Inventor Wins $500,000 Prize

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http://www.energymatters.com.au/renewable-news/ahi-battery-prize-em5068/

Jay Whitacre, Ph.D., a Materials Scientist and Professor at Carnegie Mellon University's College of Engineering, is the recipient of the prestigious 2015 Lemelson-MIT Prize for his "saltwater" battery.

The Aqueous Hybrid Ion (AHI) battery uses abundant materials including water, sodium and carbon. The battery's major internal components are a saltwater electrolyte, manganese oxide cathode, carbon composite anode and synthetic cotton separator.

The energy storage device doesn't contain heavy metals or toxic chemicals and is non-flammable and non-explosive. Given these attributes, the AHI is claimed to be the safest and most sustainable battery in the world.

AHI is the world's first Cradle to Cradle Certified battery. Cradle To Cradle certification examines a product through five categories – material health, material reutilization, renewable energy and carbon management, water stewardship and social fairness.

Flexible and scalable, AHI batteries are supplied in "stacks". The energy storage system is designed for use in residential on-grid applications, off-grid scenarios, microgrids, energy management and grid services; in configurations from kilowatt-hours to megawatt-hours capacity.

S-Line Battery Stacks are ~2 kWh systems and can be connected in series or parallel. M-Line Battery Modules are ~25 kWh systems comprising twelve S-Line Battery Stacks in a parallel configuration.

Dr. Whitacre's company, Aquion Energy, began delivering AHI batteries to customers early last year and has installations in place globally, including in Australia.

Dr. Whitacre will use part of his prize money to create a fellowship that will support graduate students and nurture interest in innovative energy solutions.

"We are proud to recognize Jay Whitacre as this year's Lemelson-MIT Prize winner," said Joshua Schuler, executive director of the Lemelson-MIT Program. " He personifies the mission of Lemelson-MIT through his commitment to mentorship, his desire to solve some of our world's greatest problems and his ability to commercialize his technologies."

Dr. Whitacre is a prolific inventor and holds 30 patents or pending patent applications.

Other accolades Aquion Energy has received include Fast Company's World's Top 10 Most Innovative Companies of 2015 in Energy, and Popular Science's Best of What's New 2014: Innovation of the Year. In June this year, the company won the ees AWARD 2015 at Intersolar Europe.