ITER Forum Website update 9/12
B.J.Green (16/9/12)

1. News in Science › Energy and Transport

Ocean power could supply entire cities

Wednesday, 25 July 2012
Conor DuffyABC

http://www.abc.net.au/science/articles/2012/07/25/3553331.htm?topic=energy

A report released by the CSIRO has found ocean power generated by waves, currents and tides could supply a city the size of Melbourne by 2050.

In homes across the country, power bills are under scrutiny as prices continue to rise.

The CSIRO has also been running the ruler over a range of future energy options including ocean power which is generated from waves, tides and currents.

The report, *Ocean renewable energy: 2015-2050*, found that areas that could benefit from wave energy technology include Perth, the southern coastline and to a lesser extent the east coast of Australia.

It also identifies north east Tasmania and the Kimberley region in Western Australia as areas best placed for tidal technology.

Alex Wonhas, the director of CSIRO's Energy Transformed Flagship, says waves could be a big part of the future.

"We found it could provide up to 10 per cent of Australia's future energy needs by 2050. That's roughly equivalent of a city the size of Melbourne," he says.

But that is likely to be a long way off. Wonhas says getting ocean energy off the sea floor and into homes is fraught with environmental as well as technical and commercial barriers.

"The technical challenges are really around making sure these devices last in the quite hostile ocean environment for maybe one or two decades," he says.

"The commercial challenge is about reducing the cost of these devices."

Perth-based company Carnegie is working on technology to harness the power of waves.

It recently signed a deal with defence to supply power to Australia's largest naval base at Garden Island near Perth.

The company's chief operating officer, Greg Allen, says the company has invested more than $60 million with another $16 million coming from state and federal governments.

"The overall cost of the project is more than the revenue that we'll get from the sale of powers will recover," he says.

While it may be more expensive for some time to come, Allen says Australia risks falling behind without the investment.

"It's not just the Australian Government that's doing this. Other governments around the world are funding the emerging renewable technologies - and in particular wave."

2. News in Science › Energy and Transport

Hydrogen storage no longer up in the air

Thursday, 16 August 2012
Stuart Gary ABC

http://www.abc.net.au/science/articles/2012/08/16/3569478.htm?topic=energy

Scientists have developed a safe and practical method of storing hydrogen in nanoparticles, opening the way for its wide spread use as a fuel source.

Hydrogen has long been touted as a fuel of the future with applications ranging from powering buildings and cars, to portable electronic devices such as computers.

However, developing a useful means of storage has been a major stumbling block.

Existing methods involve cryogenic storage at extremely high pressures.

Meganne Christian and Dr Kondo-Francois Aguey-Zinsou of the University of New South Wales have successfully used a core-shell nanostructure to store, release and reabsorb hydrogen at practical temperatures and pressures.

The research, reported in the journal *ACS Nano*, uses tiny particles of synthesised sodium borohydride encased in nickel shells.

Aguey-Zinsou says the compound, which includes lithium and sodium, was known to be an effective storage material because it could bond large amounts of hydrogen.

"Hydrogen is a gas of very low density, so if you want to power a car with it you need big volumes," says Aguey-Zinsou. "[You would need] a five metre diameter tank to drive 400 kilometres."

"But sodium borohydride acts like a sponge, allowing you to store the same amount of hydrogen in something the size of a normal car fuel tank."

Initial hurdles

Normally the compound could only be used once because it requires temperatures above 550° Celsius to release hydrogen, causing it to break apart. It can be recombined, but only under extremely high temperatures and pressures.

"Encasing the compound in tiny nanoshells lets us fine tune their properties, making them reversible at lower pressures and temperatures, allowing them to continually reabsorb and release hydrogen," says Aguey-Zinsou.

"Initial hydrogen release is now happening at just 50°C with significant release at 350°C."

Ongoing research

Aguey-Zinsou and colleagues are currently working to better understand the features of the nanostructure, and are building a demonstration project showcasing the technology.

"It will use electricity from solar and wind energy to extract hydrogen out of water using an electrolyser," says Aguey-Zinsou. "This is then stored in a tank of sodium borohydride and used to drive a fuel cell to generate electricity at night or when there's no wind."

"The first commercial applications could be just three or four years away."

3. Ice-core warming 'within bounds'

BY:GRAHAM LLOYD From: The Australian August 23, 2012 3:00AM

http://www.theaustralian.com.au/news/health-science/ice-core-warming-within-bounds/story-e6frg8y6-1226456144974

RECENT warming of the Antarctic peninsula is unusual but not unprecedented relative to natural variation, according to research published today in Nature.

The Antarctic is currently one of the most rapidly warming regions on Earth but an analysis of ice-core records has found the rise in

temperatures is "within the bounds of natural climate variability over the past 600 years".

The research by Robert Mulvaney of the British Antarctic Survey, Cambridge, countered assumptions that human factors were responsible for the warming of the Antarctic ice shelf.

But it said if warming continued, it would still pose a danger to the stability of the ice shelf.

Dr Mulvaney's temperature estimates, based on an ice-core record, show that warming of the northeastern Antarctic peninsula began about 600 years ago.

> Dr Mulvaney and colleagues present a deuterium-based record from about 12,000 years ago to the present. Deuterium is a naturally occurring isotope of hydrogen, which is found in water and can be used to accurately determine historic temperature.

According to Dr Mulvaney's research, the ice record indicates that after peak warmth in the early Holocene epoch, temperatures were stable until about 2500 years ago when a sharp cooling took place.

Although temperatures have risen by about 1.5C over the past century, the authors note that this increase is within the bounds of natural climate variability over the past 600 years.

The Nature report said the long-term climate history provided by the ice core confirmed a close connection between past temperature and ice-shelf stability.

The authors conclude that continuing warming might lead to destabilisation of ice shelves southward along the peninsula.

Meanwhile, new research has reconfirmed "a small amount of ice loss in the high mountains of Asia during the 21st century".

These results differ from earlier results, also published in Nature, which suggested a "mass balance indistinguishable from zero".

The latest analysis relies on remote sensing with more detail than the previous report.

The Nature report said glacier changes over the high mountains of Asia could have knock-on effects on water resources and sea

levels, but it had been difficult to monitor ice-mass changes accurately.

The latest estimate of thinning of glaciers is more in line with previous estimates of ice loss.

4. Siberian thaw unlocks ice-age carbon vault

From:AFP August 31, 2012 12:00AM

http://www.theaustralian.com.au/news/world/siberian-thaw-unlocks-ice-age-carbon-vault/story-e6frg6so-1226461953329

A VAST outcrop of the Arctic Siberian coast that had been frozen for tens of thousands of years is releasing huge carbon deposits as rising temperatures thaw parts of its coastline, a study warned yesterday.

The carbon, a potential source of Earth-warming CO2, has lain frozen along the 7000km northeast Siberian coastline since the last ice age. But atmospheric warming and coastal erosion are gnawing at the icy seal, releasing about 40 million tonnes of carbon a year - 10 times more than previously thought, said a study in the journal Nature.

About two-thirds of the carbon escapes into the atmosphere as carbon dioxide and the rest becomes trapped in higher layers of ocean sediment.

> About half the carbon pool in soil globally is held in permafrost in the Arctic, a region that is experiencing twice the global average of climate warming, said the study led by researchers at Stockholm University.

Earlier this week, US scientists revealed that the sea ice in the Arctic Ocean had melted to its smallest point ever.

Yedoma, the Siberian region covered by the Nature study, is twice

the size of Sweden but has been poorly researched because it is so remote. The finding touches on a vicious circle, or positive feedback, in climate parlance. Under this, man-made warming caused by the burning of fossil fuels releases naturally occurring stocks of CO2 that have been stored in permafrost since the last ice age, called the Pleistocene. The released gases in turn add to global warming, which frees even more locked-up carbon, and so on.

"Thermal collapse and erosion of these carbon-rich Pleistocene coastline and seafloor deposits may accelerate the Arctic amplification of climate warming," the paper warned. The atmospheric leakage from Yedoma is equivalent to the annual emissions of about five million passenger cars, on the basis of average carbon output (five tonnes per year) of vehicles in the US.

In a separate study also in Nature, researchers in Britain, The Netherlands and the US used computer models to estimate there could be as much as four billion tonnes of methane under Antarctica's icesheet. Methane is 25 times more efficient at trapping solar heat than CO2.

Before it froze over, the region teemed with life whose organic remains became trapped in sediment later covered by ice sheets.

"Our modelling shows that over millions of years, microbes may have turned this old organic carbon into methane," the researchers said.

AFP

5.

Laser fusion work wins APS John Dawson Award

30 Aug 2012

Seven-person team working on laser-matter interaction with implications for fusio

http://optics.org/news/3/8/37

Six high-energy laser researchers from Lawrence Livermore National Laboratory (LLNL) and a seventh from Los Alamos National Laboratory (LANL) have won the American Physical Society's 2012 John Dawson Award for Excellence in Plasma Physics Research.

The team is being recognized for its work on what the APS describes as “a far-reaching discovery about laser-matter interaction, which has important implications for LLNL’s **National Ignition Facility (NIF)**”.

More specifically, the award is for “predicting and demonstrating the technique of laser scatter on self-generated plasma-optics gratings that enables generation and redirection of high-energy laser beams important for indirect drive inertial confinement fusion and high-power laser-matter interactions.”

The members of the winning team are: Debra Ann Callahan; Laurent Divol; Robert Kirkwood; Edward Williams; Nathan Meezan; and Pierre Michel (all LLNL), as well as George Kyrala from LANL. They share $5000 in cash and a certificate, and will officially accept the award at the 54th Annual Meeting of the APS Division of Plasma Physics being held in Providence, RI, this October.

As the giant laser system at NIF nears its aim of generating fusion with energy gain, one of the toughest challenges has been to maintain a highly symmetrical beam. Any distortions affect the way in which the fusion targets implode under the colossal pressures generated, and make fusion with gain more difficult to achieve.

Crossing the beams According to LANL, the award-winning research has its roots in discoveries made during the late 1990s, when physicists noted that laser beams crossing each other’s paths in a plasma could exchange energy – an effect that could degrade the implosion symmetry of fusion ignition targets. The phenomenon is one of many that fall under the laser-plasma interaction umbrella term, which describe ways in which the plasma created by a laser can interfere with the beam.

Since that initial discovery, experiments at the University of Rochester's OMEGA laser and new supercomputer models have led to a better understanding of the phenomenon. Researchers have concluded that the energy transfer process can be controlled using slight adjustments to the wavelengths of the laser beams, and even to tune the implosion symmetry of NIF targets.

> Last month, scientists at NIF revealed that they had **hit a 2 mm target containing a mixture of hydrogen, deuterium and tritium with a 1.8 MJ, 500 TW blast** from the 192-beam laser system at the California facility.

They described the achievement as bringing them “tantalizingly close” to creating fusion with energy gain, adding that the combination of energy and power confirmed that the laser system does operate at the levels required for inertial confinement fusion to take place.

Since then, the NIF team has been working on “alpha heating”, a process in which helium nuclei generated in the fusion reaction add even more heat energy to the fusion fuel.

6. 900 seconds of stable plasma

Posted August 20th 2012 in JET, Number of the week

http://www.efda.org/2012/08/900-seconds-of-stable-plasma/

One of the great advances that ITER will make will be its ability to maintain plasma pulses for much longer than any previous experiment. ITER pulses will extend to around 480 seconds, an achievement made possible by superconducting electromagnets, which are able to carry extremely high current. On the other hand, JET, with its previous generation copper electromagnets, can only create plasma pulses around twenty seconds long. Nonetheless to test wall materials for ITER, a recent JET experiment emulated ITER operation by running 151 consecutive identical pulses, totalling around 900 seconds of stable ITER-Like operation.
The next stage of this experiment is to remove the tiles from the vessel and analyse how the materials have behaved – where has material been eroded from, and where has it ended up. This information will complement the measurements taken during pulses of how much gas is extracted from the vessel after a pulse compared with what was injected. These gas balance measurements indicated that the retention of fuel was around ten times lower than that observed with the prior carbon wall tiles – however, says E2 Task Force Leader Dr Sebastijan Brezinsek, the new measurements will be more accurate: “We think the fuel retention may be quite a lot lower than was measured by the gas balance. Also these measurements will show where the fuel is being retained, and which mechanism is responsible.”
In addition to information about retention, the prolonged campaign was a triumph for plasma stability with the new wall materials. “We have proved we can operate Type 1 ELMy H-mode with high reproduceability, low disruptivity, and no negative tungsten events at all, even though it is quite different to the carbon wall.” says Dr Brezinsek. “The operational window is quite narrow, but now we know how much fuelling and central heating is required to keep the divertor cool while still maintaining a minimum ELM frequency to flush the tungsten impurities.”

The current world record for the longest single pulse in a tokamak is six minutes and thirty seconds, held by Tore Supra in France. It seems likely that record will be smashed by ITER, but any trophies associated with the record will not have to move far – ITER and Tore Supra share the same CEA site in Cadarache.

7. Get big diagnostics out of the way

Posted August 21st 2012 in JET in close-up

http://www.efda.org/2012/08/get-big-diagnostics-out-of-the-way/

It is now three weeks since the last plasma pulse of 2012, and JET is now in a state called ‘shutdown’.

At the end of operations a lot of work has to be done before access is gained to the inside of the torus, which is planned to happen in a few weeks. When the machine is running, the torus is kept at 200 degrees celsius and inside the torus there are some cryo panels which are cooled to nearly minus 270 celsius. The cryopanels continuously collect (freeze) ‘condensable’ vapours such as water and practically all common gases. By keeping these two components at such a large temperature difference the exceptional cleanliness of the plasma-facing components is maintained.

After the end of operations, first the cryopanels were warmed to ambient temperature and the gas was collected. Then the torus was cooled. As it cools it contracts and the outer diameter of the torus decreases by about 30 mm. Essentially it shrinks onto some supporting features and locks itself into a fixed position until the end of the shutdown.

Now the task of removing some of the larger ancillary items has begun, with several big diagnostic systems being lifted out of the torus hall for storage. Some of them weigh tens of tonnes, but this is light work for the main crane. Once they are out of the way, engineers can get into the areas that they need to use to gain access to the inside of the torus, which brings us to the reason for this shutdown.

As you will know if you have followed the recent history of JET in the Shutdown Weekly series, the main purpose of 2009 shutdown was to allow a complete metal inner wall to be installed, replacing the previous carbon wall. Some of the 4,500 new tiles had been marked with thin layers of beryllium, molybdenum and tungsten. The layers are typically only 10 microns thick and these are the tiles that we plan to remove and replace during this shutdown. Careful examination of the marker layers will reveal which areas have been eroded by interaction with the plasma, and where that eroded material is deposited. You might think of this as being similar to erosion of part of a coastline by the action of the sea. The material that is removed

from one place is washed along the coast and deposited somewhere else.

> Of course this is only part of the work planned for the next few months. While the machine is out of action there is an opportunity for other equipment to be maintained. As the shutdown progresses you will see regular updates on the progress of some of this work.

8. Japan set to reject nuclear

BY:RICK WALLACE, TOKYO CORRESPONDENT From: The Australian September 15, 2012 12:00AM

http://www.theaustralian.com.au/news/world/japan-set-to-reject-nuclear/story-e6frg6so-1226474403555

JAPAN was expected last night to announce a major shift away from atomic energy in response to rising anti-nuclear sentiment from its citizens, who will soon vote in a general election.

Prime Minister Yoshihiko Noda's government was expected to announce plans to phase out nuclear power by the 2030s in a new energy policy to be launched in the early evening.

To its critics, the plan will dent Japan's already waning economic competitiveness. To its supporters, it will kick-start a clean energy revolution in Japan, although fossil fuel imports will rise initially. The phase-out is opposed by Japan's peak business lobby group, the Keidanren, which has warned of damage to industry from power shortages, although 20 per cent of large firms actually support the move.

> The Prime Minister is believed to have initially opposed a move to zero nuclear, but facing a looming election and dire polls was persuaded to adopt the target.

At face value, the plan is a positive for Australia's LNG industry, as Japan will have to turn to gas to provide an alternative energy source. There has been a wave of investments in Australian gas projects by Japanese firms since the Fukushima disaster. Conversely, Australian uranium sales may fall slightly.

However, doubts persist over the effectiveness of the plan and whether it will be enacted.

Japan-watcher Richard Katz, who publishes the Oriental Economist Alert, said it was "an election commercial, not an energy plan" and a "desperate gamble" by the ruling Democratic Party of Japan to cut its electoral losses.

He said if the final plan was as expected - where reactors older than 40 years would be shut down and no new ones built - it would take until 2050 to reach zero.

Prior to the March 2011 disaster, nuclear power accounted for almost 30 per cent of Japan's electricity generation capacity and was set to increase to 50 per cent.

Under the plan, gas-fired generation is expected to rise, but the main increase is predicted to come from renewables, which now account for a paltry 8 per cent of generation.

Leading Japanese businesses, including Masayoshi Son's Softbank, are rushing in to large-scale solar energy projects in Japan and windfarm developments are expected follow, but doubts still persist on renewables reaching the 20 per cent target within a decade.

Credit Suisse Japan energy analyst Yuji Nishiyama said the plan was just a series of arbitrary goals and the market would effectively dictate generation sources.

The DPJ, which won office in 2009 ending 50 years of almost unbroken rule by the Liberal Democratic Party, is expected to be swept from office in an election to be held between November and January.

The new government, likely to be lead by the more pro-nuclear LDP, would be expected to revisit the energy policy.

However, Mr Katz said if it could not govern in its own right with ally New Komeito, then all its other potential partners favoured the zero nuclear policy.

9.

A Fracking Good Story

PROJECT SYNDICATE

A WORLD OF IDEAS

Project Syndicate 

Bjørn Lomborg

Bjørn Lomborg is an adjunct professor at the Copenhagen Business School. He also founded and directs the Copenhagen Consensus Center, which seeks to study environmental problems and solutions using…

Sep. 13, 2012

http://www.project-syndicate.org/commentary/a-fracking-good-story-by-bj-rn-lomborg

PRAGUE – Weather conditions around the world this summer have provided ample fodder for the global warming debate. Droughts and heat waves are a harbinger of our future, carbon cuts are needed now more than ever, and yet meaningful policies have not been enacted.

Illustration by Tim Brinton

Comments

But, beyond this well-trodden battlefield, something amazing has happened: Carbon-dioxide emissions in the United States have dropped to their lowest level in 20 years. Estimating on the basis of data from the US Energy Information Agency (EIA) from the first five months of 2012, this year's expected CO2 emissions have declined by more than 800 million tons, or 14%, from their peak in 2007.

Comments

The cause is an unprecedented switch to natural gas, which emits

45% less carbon per energy unit. The US used to generate about half its electricity from coal, and roughly 20% from gas. Over the past five years, those numbers have changed, first slowly and now dramatically: in April of this year, coal's share in power generation plummeted to just 32%, on par with gas.

Comments

America's rapid switch to natural gas is the result of three decades of technological innovation, particularly the development of hydraulic fracturing, or "fracking," which has opened up large new resources of previously inaccessible shale gas. Despite some legitimate concerns about safety, it is hard to overstate the overwhelming benefits.

Comments

For starters, fracking has caused gas prices to drop dramatically. Adjusted for inflation, gas has not been this cheap for the past 35 years, with the price this year 3-5 times lower than it was in the mid-2000's. And, while a flagging economy may explain a small portion of the drop in US carbon emissions, the EIA emphasizes that the major explanation is natural gas.

The reduction is even more impressive when one considers that 57 million additional energy consumers were added to the US population over the past two decades. Indeed, US carbon emissions have dropped some 20% *per capita*, and are now at their lowest level since Dwight D. Eisenhower left the White House in 1961.

Comments

David Victor, an energy expert at the University of California, San Diego, estimates that the shift from coal to natural gas has reduced US emissions by 400-500 megatonnes (Mt) of CO2 per year. To put that number in perspective, it is about twice the *total* effect of the Kyoto Protocol on carbon emissions in the rest of the world, including the European Union.

Comments

> It is tempting to believe that renewable energy sources are responsible for emissions reductions, but the numbers clearly say otherwise. Accounting for a reduction of 50 Mt of CO2 per year, America's 30,000 wind turbines reduce emissions by just one-tenth the amount that natural gas does. Biofuels reduce emissions by only ten Mt, and solar panels by a paltry three Mt.

10. **SMART PLANET**
| 13 August 2012

Fusion: The quest to

recreate the Sun’s power on Earth

Gaia Vince
http://www.bbc.com/future/story/20120810-the-quest-to-recreate-the-sun
Gaia Vince watches the construction of the world’s biggest fusion energy reactor and wonders whether this ambitious and expensive project will actually work.

Related

Will we ever... give up gas?

An expensive scientific gamble?
The International Thermonuclear Experimental Reactor (Iter) is no quick fix for the world's energy problems. Not even its staunchest supporters would argue that.
Cadarache: In the dusty highlands of Provence in southern France, workers have excavated a vast rectangular pit 17 metres (56 feet) down into the unforgiving rocks. From my raised vantage point, I can see bright yellow mechanical diggers and trucks buzzing around the edge of the pit, looking toy-like in the huge construction site. Above us, the fireball Sun dries the air at an unrelenting 37C.

These are embryonic stages to what is perhaps humankind's most ambitious scientific and engineering project: to replicate the Sun here on Earth.

When construction is complete, the pit will host a 73-metre-high machine (240 feet) that will attempt to create boundless energy by smashing hydrogen nuclei together, in much the same way as stars like our Sun do. Physicists have dreamed of being able to produce cheap, safe and plentiful energy through atomic fusion since the 1950s. Around the world, researchers continue to experiment with creating fusion energy using various methods. But as people within the field have said the dream has always been "30 years away" from realisation.

The need for a new energy source has never been more pressing. Global energy demand is expected to double by 2050, while the share coming from fossil fuels – currently 85% – needs to drop dramatically if we are to reduce carbon emissions and limit global warming.

Fusion, many believe, could be the answer. It works by forcing together two types, or isotopes, of hydrogen at such a high temperature that the positively charged atoms are able to overcome their mutual repulsion and fuse. The result of this fusion is an atom of helium plus a highly energetic neutron particle. Physicists aim to capture the energy released by these emitted neutrons, and use it to drive steam turbines and produce electricity.

When the reaction occurs in the core of the Sun, the giant ball of gas applies a strong gravitational pressure that helps force the hydrogen nuclei together. Here on Earth, any fusion reaction will have to take place at a tiny fraction of the scale of the Sun, without the benefit of its gravity. So to force hydrogen nuclei together on Earth, engineers need to build the reactor to withstand temperatures at least ten times that of the Sun – which means hundreds of millions of degrees.

Heated doughnuts

It's just one of the huge number of challenges facing the designers of this groundbreaking project. The concept was discussed and argued over for several decades before finally being agreed in 2007 as a multinational cooperation between the European Union, China, India, Japan, South Korea, Russia and the US – in total, 34 countries representing more than half of the world's population. Since then, the budget of 5 billion euros has trebled, the scale of

the reactor has been halved, the completion date has been pushed back, and the project has somewhat lost its shine – which is somewhat ironic given the project is called Iter, meaning 'the way' in Latin.

But despite the difficulties, some progress is being made. The parts are being manufactured and tested by the participating nations, many of whom hope to develop the expertise to compete in any new fusion energy market that would be expected to follow a successful outcome at Iter.

Since they don't have access to the special conditions available in the Sun, physicists have designed a doughnut-shaped reaction chamber, called a tokamak. Hydrogen isotopes are heated to the point to which they lose electrons and form a plasma, and this is held in place for fusion but held away from the reactor walls, which could not withstand the heat. The tokamak deploys a powerful magnetic field to suspend and compress the hydrogen plasma using an electromagnet made of superconducting coils of a niobium tin alloy.
Once atomic fusion occurs, the heat produced will help to keep the core hot. But unlike a fission reaction that takes place in nuclear power stations and atomic bombs, the fusion reaction is not self perpetuating. It requires a constant input of material or else it quickly fizzles out, making the reaction far safer. And unlike what you might have seen in a recent Batman movie, the chamber cannot be transformed into a nuclear bomb. The neutrons will then be absorbed by the surrounding walls of the tokamak, transferring their energy to the walls as heat, and this in turn will be dissipated through cooling towers.

Because one of the hydrogen isotopes used, tritium, is radioactive (with a half-life of 12 years), the entire site must conform to France's strict nuclear safety laws. And to complicate matters further, the site is also moderately seismically active, meaning that the buildings are being supported on rubber pads to protect them from earthquakes.

These issues, plus the logistics of dealing with multiple nations with their own fluctuating domestic budget constraints, mean that the site won't be ready for the first experiments until 2020. Even then, they will just be testing the reactor and its equipment. The first proper fusion tests, reacting deuterium (a hydrogen isotope

abundant in sea water) and tritium (which will be made from lithium), won't take place until 2028.

Power up

Those will be the key tests, though. If all goes to plan, the physicists hope to prove that they can produce ten times as much energy as the experiment requires. The plan is to use 50 megawatts (in heating the plasma and cooling the reactor), and get 500 MW out. Larger tokamaks should, theoretically, be able to deliver an even greater input to output power ratio, in the range of gigawatts.

And that is the big gamble. So far, the world's best and biggest tokamak, the JET experiment in the UK, hasn't even managed to break even, energy-wise. Its best ever result, in 1997, achieved a 16 MW output with a 25 MW input. Scale is an extremely important factor for tokamaks, though. Iter will be twice the size of JET, as well as featuring a number of design improvements.

If Iter is successful in its proof of principle mission, the first demonstration fusion plants will be built, capable of actually using and storing the energy generated for electricity production. These plants are slated to begin operation in about 2040 - around 30 years away, in fact...

Despite the seductive promise of finally getting a supply of electricity that's "too cheap to meter", the long wait to readiness and the fact that the technology remains unproven, means that many politicians are hesitant or even hostile to the expensive project. Additionally, because fusion energy won't be ready for decades, even if it works, other low-carbon energy sources must still be pursued in the short-term at least.

But if we do manage to replicate the Sun on Earth, the consequences would be spectacular. An era of genuinely cheap energy – both environmentally and financially, would have far reaching implications for everything from poverty reduction to conflict easement.

It’s exciting to think that the next generation could in some way be fusion powered – perhaps even within the lifetimes of the workman digging below me. But I can’t help but remember the 30-year rule.

Update (14/08): The original text contained factual inaccuracies regarding the fusion reaction within the reactor. This has now been rectified.

11. PPPL-designed coils arrive in Germany for fusion experiment

News at Princeton

Thursday September 13, 2012

Posted August 27, 2012; 02:42 p.m.

http://www.princeton.edu/main/news/archive/S34/60/92O82/index.xml?section=topstories

Engineers at the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) have designed and delivered to Germany two critical components for a major device to develop fusion power. The "trim coil" components, each the size of a barn door, are the first of five installments of one of the largest hardware collaborations that PPPL has conducted with an international partner. The 2,400 -pound trim coils have been produced at PPPL for the Wendelstein 7-X stellarator, or W7-X, that the Max Planck Institute for Plasma Physics (IPP) is building in Greifswald, Germany. The powerful coils will fine-tune the shape of the superhot, charged gas called plasma that the W7-X will use to study conditions required for fusion when the machine begins operating in 2015. In exchange for the coils, PPPL scientists will be able to lead and carry out experiments on the W7-X. Stellarators are one of the two major devices that scientists are using to develop fusion as a source of clean and abundant energy. The other device is the tokamak. "Stellarators offer solutions to problems facing magnetic fusion reactors that haven't been solved in any other way to date," said George "Hutch" Neilson, director of advanced projects at PPPL. Delivery of the first trim coil on Ju ne 26 capped two years of teamwork between PPPL and IPP and a final month of intense activity. PPPL engineers Michael Mardenfeld and Steve Raftopoulos, with colleagues from IPP, traveled to coil manufacturer Everson Tesla in Nazareth, Pa., when surface imperfections appeared in the epoxy-like resin that encases the copper coil. "The stakes are fairly high," said Neilson. "Whenever you build the first of anything there are always unexpected surprises that you have to work your way through. In this case, the imperfections turned out to be nothing and were easily removed." The five coils are to be delivered to IPP by January. "Getting the first coil out the door was very challenging," said PPPL engineer Stephen Langish, who manages the trim coil project and monitored the first one with Mardenfeld,

Raftopoulos and quality assurance engineer Frank Malinowski. "We just had a very aggressive schedule." Delivery of the first coil over the 4,300-mile sea and land route to Greifswald proved no less challenging. Workers at Everson Tesla had to crate the device standing up since it was too wide to travel on German roads without a police escort. "There was enough wood in the crate to build two backyard decks," said Greg Naumovich, the president of Everson Tesla, which is manufacturing the coils under an $800,000 contract with PPPL. The crate was barely within the 13 -foot height ceiling for German roads when the coil arrived in Antwerp, Belgium, from Chester, Pa., and was loaded onto a flatbed truck. Planners carefully plotted the 500-mile route from Antwerp to Greifswald in northeast Germany to avoid low highway clearances. The similarly packaged second coil traveled the same route and arrived on Aug. 3. Safe delivery of the first coil ended a period of anxious waiting in Greifswald. "I was relieved that the coil was not damaged, and also proud of the result of our teamwork with PPPL," said engineer Konrad Risse, the trim coil project leader at IPP. "This collaboration was very special because the trim coils are the first large component to be provided by another scientific laboratory." Technicians will assemble the coils on the W7 -X alongside other key parts from more than 30 companies throughout Europe. Installation of the first trim coil is scheduled in September. The coils will enable stellarator experiments to run smoothly by correcting any errors in the magnetic field that surrounds and shapes the plasma. Back at PPPL, engineers have completed the design of five electric power supplies that will run the W7-X trim coils when the stellarator begins operating. Applied Power Systems of Hicksville, N.Y., received the contract to produce the supplies, which are to be delivered to Greifswald by August 2013. Timely delivery of the first trim coil was a key step for the overall project. "It's an important accomplishment that puts us on target to deliver all five coils in excellent fashion," said Neilson, the PPPL director of advanced projects. "We're probably going to come in ahead of schedule and under budget." Prince ton Plasma Physics Laboratory, funded by the U.S. Department of Energy and managed by Princeton University, advances the coupled fields of fusion energy and plasma physics. Fusion is the process that powers the sun and the stars. In the interior of stars, matter is converted into energy by the fusion, or joining, of the nuclei of light atoms to form heavier elements. At PPPL, physicists use a magnetic field to confine plasma. Scientists hope eventually to use fusion energy for the generation of electricity.

by John Greenwald