1. MASSIVE GLOBAL COOLING process discovered as Paris climate deal looms
'Could explain recent disagreements'
http://www.theregister.co.uk/2015/09/30/massive_global_cooling_factor_discovered_ahead_of_paris_climate_talks/

As world leaders get ready to head to Paris for the latest pact on cutting CO₂ emissions, it has emerged that there isn't as much urgency about the matter as had been thought. A team of top-level atmospheric chemistry boffins from France and Germany say they have identified a new process by which vast amounts of volatile organic compounds (VOCs) are emitted into the atmosphere from the sea - a process which was unknown until now, meaning that existing climate models do not take account of it.

The effect of VOCs in the air is to cool the climate down, and thus climate models used today predict more warming than can actually be expected. Indeed, global temperatures have actually been stable for more than fifteen years, a circumstance which was not predicted by climate models and which climate science is still struggling to assimilate.

In essence, the new research shows that a key VOC, isoprene, is not only produced by living organisms (for instance plants and trees on land and plankton in the sea) as had previously been assumed. It is also produced in the "microlayer" at the top of the ocean by the action of sunlight on floating chemicals - no life being necessary. And it is produced in this way in very large amounts. According to an announcement just issued by the German
government's Leibniz Institute for Tropospheric Research: Atmospheric chemists from France and Germany, however, can now show that isoprene can also be formed without biological sources in the surface film of the oceans by sunlight and so explain the large discrepancy between field measurements and models. The new identified photochemical reaction is therefore important to improve the climate models. Global models at the moment assume total emissions of isoprene from all sources - trees, plants, plankton, the lot - of around 1.9 megatons per year. But, according to the new research, the newly discovered "abiotic" process releases as much as 3.5 megatons on its own - which "could explain the recent disagreements" between models and reality.

"We were able for the first time to trace back the production of this important aerosol precursor to abiotic sources. So far global calculations consider only biological sources," explains Dr Christian George from French lab the Institute of Catalysis and Environment, in Lyon.

VOCs such as isoprene are known to be a powerful factor in the climate, as they cause the formation of aerosol particles. Some kinds of aerosol, for instance black soot, warm the world up: but the ones resulting from VOCs actually cool it down substantially by acting as nuclei for the formation of clouds. It has previously been suggested that production of VOCs by pine forests could be a negative feedback so powerful that it "limits climate change from reaching such levels that it could become really a problem in the world."

With the discovery of the new abiotic sea process, the idea that cutting carbon emissions may not be all that urgent is looking stronger. That's probably good news, as it has emerged lately that efforts to cut carbon emissions to date are having the unfortunate side effect of poisoning us all.

The new research is published here courtesy of the learned journal Environmental Science and Technology, and as the Leibniz Institute notes: "Because of the great importance this paper will be open access".

2. Keeping fusion plasmas hot

David C. Pace, William W. Heidbrink and Michael A. Van Zeeland

October 2015, page 34
Interactions between electromagnetic waves and the most energetic ions in a plasma can perturb the orbits of those ions enough to expel them from the confining magnetic field.

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3. SEPTEMBER 27, 2015

Ask a Scientist: What’s a superconductor? How does it work?

They’re special materials that can conduct electricity perfectly


BY MARLA VACEK BROADFOOT
Correspondent
Justin Schwartz is department head and Kobe Steel Distinguished Professor at N.C. State’s Department of Materials Science and Engineering. Here, he explains the science between superconductors and superconducting materials. Questions and answers have been edited.

Q: What is a superconductor and how does it work?

A: First, you have to understand that materials can be divided into many categories, depending on how they conduct electricity. Insulators, like wood or plastic, hold tightly to their electrons so electrical current cannot flow through them. Conductors – metals like copper or aluminum – allow electrical current to move easily, but a few electrons get lost along the way. Superconductors are special materials that can transport electrons without any loss, meaning they can conduct electricity perfectly.

Superconductors have another exceptional feature known as “perfect” diamagnetism, which means they repel the magnetic field that normally penetrates other materials. In other words, magnets can literally float above superconductors. But there are limitations. Superconductivity only occurs at very low temperatures, about 225 degrees below zero (Fahrenheit) or colder. Therefore, these materials have to be stored in frigidly cold liquid helium or liquid nitrogen; otherwise, they lose their amazing properties.

Q: How is this technology already being applied in our everyday lives?

A: The primary place people experience superconductivity in their everyday lives is through magnetic resonance imaging: MRI, a procedure commonly used to diagnose medical conditions. MRI scans have primarily been used to assess orthopedic injuries – I’ve had my knees and shoulders imaged a few
times – but recently its application has expanded to the brain and other organs. Superconductors are also used in the high-energy physics colliders like the Large Hadron Collider operating outside of Geneva at CERN, the European Organization for Nuclear Research. This device has a large number of superconducting magnets, both for guiding the particle beams that collide, and also as part of the detectors used to figure out what happens in the particle physics experiments.

Q: What are some futuristic ideas for the use of superconductors?
A: There has been a lot of progress in recent years for more superconducting applications. One area that gets a lot of attention is generators for wind turbines. Many feel that superconducting systems have particular advantages for such applications. Another area is in high-speed rail. The fastest train in the world is a magnetically levitated – or “maglev” – train in Japan that recently broke its own speed record. This train is based upon superconducting technology.

Another future application is in fusion power reactors. The ITER reactor currently under construction in France uses a number of very large superconducting magnets to confine and control a “plasma” fuel source. ITER alone is using hundreds of miles of superconducting cables. If ITER succeeds and the technology is transformed to commercial power reactors, the amount of superconductors required will be vast. Perhaps the most futuristic use of superconductors is for space exploration. The magnetic field from large magnets can be used to shield people in space from space irradiation. But this application is a few years off.
4. We must make the dream of a nuclear fusion reactor a reality

http://www.heraldscotland.com/opinion/13779640.We_must_make_the_dream_of_a_nuclear_fusion_reactor_a_reality/

In 1961 President Kennedy made an historic announcement that the United States would put a man on the moon before the end of the decade. Defying the many sceptics, eight years later Neil Armstrong stepped onto the lunar surface uttering the immortal words: “That's one small step for man, one giant leap for mankind."

However, Mr Kennedy could have made another announcement that in retrospect would have had a much greater impact on the US position in the world. He could have declared that, within a decade, America would crack fusion power and give the world virtually limitless energy so that it did not rely on fossil fuel. Think of a world that could run for millions of years on the hydrogen locked up in water, with no CO2 emissions; a world that neutralises the influence of oil producing nations on world politics.

The total cost of the lunar mission reported to US Congress in 1973 was $24.5 billion (£16bn); about $150bn (£98bn) in today’s money. It shows that, if the general public and politicians are behind a project, great technical challenges can be overcome. If the same amount of money and effort
had gone into fusion, we would be living in a very different world, one where we had little or no dependence on polluting fossil fuels, where the Middle East did not dictate the oil price and the pace of the global economy, and one where virtually limitless energy could address the many of the environmental problems such as production of clean fresh water.

My grandfather, GP Thomson, was one of those scientists who in the late 1940s pioneered the techniques for making fusion possible. I remember him saying that he would like to see fusion happen in his lifetime but if not certainly his children’s. At this rate it will be a push to see commercial fusion happening in his grandchildren or even great grandchildren’s lifetime. So why hasn’t more progress been made and what is the position at present?
First, to understand why more progress has not been made, we need to understand a bit about the technical problems. Nuclear energy is produced by fission where large atoms such as those of uranium are split to produce smaller radioactive atoms and energy.

Fusion is at the opposite end of the spectrum where the smallest atoms, hydrogen, are fused together to form helium and energy. This is the way the sun produces heat. The problem is that each hydrogen is positively charged so, to get two atoms to come together, they have to fire at each other at full belt to be close enough to fuse. The core temperature of the sun is about 15 million centigrade so atoms have more than enough energy to hit each other and fuse. However to heat up a gas of hydrogen to anything like that temperature a container that will not melt is required. The way that is achieved on earth is with a huge magnet called a Tokamak that uses its field to contain the hot hydrogen gas. Fusion is theoretically possible but what is
tricky is to get a magnet strong enough to work for more than a few seconds. Why we have not got further on fusion is down to three reasons. The first is funding. In the 1970s American researchers estimated that getting fusion power on the grid would demand investment of $2-3bn (£1.3-£2bn) annually for 20 to 30 years in research and development; in other words the same order of magnitude as getting a man on the moon. Nothing like that amount was spent. Less than 0.2 per cent of the revenue of the energy market is spent on research into new forms of energy including fusion. Secondly, politicians are swayed to maintain the status quo by the powerful oil, aviation and car industries, all of which have a vested interest in not developing other forms of energy. Lastly, the public is either largely unaware of or uninterested in fusion; perhaps they have heard too much hype over too many years and lost interest. Unlike CERN, the Swiss particle accelerator which is widely known about, ask about ITER, the European project to build a fusion reactor, and you mostly get blank faces. Yet ITER is bigger than CERN and one of the biggest world-wide projects currently under construction. It means ”the way” in Latin and its aim is to build the first commercially viable fusion reactor that will produce 500 megawatts of energy while needing only 50 megawatts to operate. The initial impetus for the project was the meeting between presidents Reagan and Gorbachev in 1985 when they were looking for a joint energy project to collaborate on and building a fusion reactor was put forward. However the project took until 2006 to actually get going and when it did it was a collaboration involving Europe, America, India, Japan, China, Russia and South Korea. The site at Cadarache in the south of France was cleared and building started in 2013. The assembly of Tokamak magnets has begun
and work should finish in 2019. However, after testing to ensure the facility is fully working, producing power will not happen until 2027; a far cry from the original timetable envisaging completion in 2016. It is typical of joint European projects such as the Channel Tunnel. Weak management, indecision and bureaucracy are getting in the way of driving the project forward and frustrating those who want to see a real priority on getting commercial fusion prototype working. A new director, Bernard Bigot, was appointed earlier this year to try to get better control over a project with with spiralling costs as well as delays. The original cost estimate back in 2006 was $5bn (£3.3bn) and is now estimated at $15bn (£9.8bn). It should be the ambition of the international community to deliver a fully working fusion plant within a decade with the same focus as putting a man on the moon, overcoming the barriers which are more political and economic than scientific.

The ITER project is one the public should be fully engaged with. Not only do we need to scrutinize it as it is a major project that has all the hallmarks of allowing costs to run away due to the lack of clear controls and managing so many different representative nations; but we also need to encourage our politicians to resource it in a way that gets it completed faster. I only hope that we do demonstrate commercially viable fusion in the next decade as it will allow mankind to help overcome the technical difficulties of supporting a population expected to be around 8.5 billion with fresh water, food and housing. However, it will need a different, more energized approached by our politicians to make this happen; if we achieve the goal, that certainly would be a giant leap for mankind.
ITER superconductor production nearing completion
September 17, 2015
The single largest superconductor procurement in industrial history is drawing to a successful close. An eight-year campaign to produce the superconductors for ITER's powerful magnet systems is in its final stages, with nearly 70 percent of the conductor unit lengths accepted by the ITER Organization. Six ITER Members—China, Europe, Japan, Korea, Russia and the United States—have been responsible for the production of 200 kilometres (2,800 metric tons) of cable-in-conduit conductors, worth an estimated EUR 610 million. Without superconductivity, the pursuit of fusion energy would be impossible. Superconductors consume less power and are cheaper to operate than conventional counterparts, while carrying higher current and producing stronger magnetic fields. In ITER an array of superconducting magnet systems, with a combined stored magnetic energy of 51 Gigajoules (GJ), will produce the magnetic fields that will initiate, confine, shape and control the plasma at temperatures reaching 170 million °C. The building blocks of the magnet system are high-performance, internally cooled superconductors called CICC (cable-in-conduit) conductors, made up of bundled superconducting and copper strands that are cabled together and contained in a structural steel jacket. ITER's extraordinary technical requirements and the sheer amount of material required—200 kilometres, equivalent to 2,800 metric tons—resulted in a worldwide collaborative procurement effort involving ITER Members China, Europe, Japan, Korea, Russia and the United States. Beginning in 2007, the ITER Organization pioneered a global procurement strategy to establish the processes and systems to ensure the standardization of conductor production and testing around the world. Eleven conductor Procurement Arrangements were signed with the ITER Domestic Agencies between 2007 and 2009—each one defining technical and quality control requirements such as the qualification of suppliers, the qualification of manufacturing processes, control points at critical
manufacturing steps, and the testing of representative full-size conductor samples.
Production has been underway since 2008, with painstaking oversight by the ITER Organization and the Domestic Agencies. Outside reference laboratories have contributed their expertise, performing third-party verification on critical acceptance tests. For the most technically challenging raw material—the niobium-tin (Nb3Sn) superconducting strands used in ITER's toroidal field and central solenoid magnet systems—500 metric tons (more than 100,000 km) of strand were produced by nine suppliers. This large-scale industrial effort demanded a ramp-up of global production capacity from 15 metric tons/year to 100 metric tons/year, as well as the introduction of three new strand suppliers.

To date, nearly 70 percent of the produced conductor unit lengths have been accepted by the ITER Organization. At a ceremony on 17 September 2015, a plaque was unveiled in the ITER Headquarters at Saint-Paul-lez-Durance, France to acknowledge the contribution of many different partners in the success of the ITER's longest-lead procurement campaign. "The 11 conductor Procurement Arrangements have posed many technical and management challenges, but they have also been an amazing human adventure," says Arnaud Devred, ITER head of Superconductor Systems & Auxiliaries. "I credit many people—past and present—for the success of the ITER conductor effort." Magnet Division head Neil Mitchell, who has stewarded the development of the ITER conductors since 1992, agreed: "It is inspiring to see the ITER conductors as a reality after a development program that goes back over 30 years, with ITER partners working as a team to master the complex technologies involved."
ITER Director-General Bernard Bigot emphasized the project's multi-faceted nature: "This milestone is remarkable on several levels. Economically, we have injected EUR 610 million into industrial companies and laboratories around the world, which have now gained invaluable expertise that can be applied in other critical fields such as medical imaging, energy, and transportation. Technologically, we have used the latest materials science while pushing production to unprecedented levels. But perhaps the greatest achievement is reflected in the successful multinational collaboration on design attributes, production standards, quality assurance measures and testing protocols for a project of this technical complexity. We will continue to build on this success."
The next stage in the fabrication of ITER magnets is the integration of the superconductors into the final coil assemblies.

6. 200km of superconducting cables manufactured for ITER
17 September 2015
By Tereza Pultarova

Some 200km of superconducting cables have been manufactured to form the superconducting magnets of the world’s largest tokamak fusion reactor ITER. The cables, worth some €610m (£444m), are the single largest superconductor procurement in industrial history. ITER has already received 70 per cent of the superconductors, which took seven years to manufacture. China, Europe, Japan, Korea, Russia and the United States were responsible for the production of the superconductors, which will be used to make the magnets that will shape and control the plasma inside the vacuum vessel.

“Economically, we have injected €610m into industrial companies and laboratories around the world, which have now gained invaluable expertise that can be applied in other critical fields such as medical imaging, energy, and transportation,” said ITER director-general Bernard Bigot. “Technologically, we have used the latest materials science while pushing production to unprecedented levels.”

Without superconducting technology, nuclear fusion wouldn’t be possible. Superconductors consume less power and are cheaper to operate than conventional magnets, while carrying higher current and producing stronger magnetic fields. The ITER superconducting magnet systems, with a combined stored magnetic energy of 51GJ, will produce the magnetic fields that will initiate, confine, shape and control the plasma at temperatures reaching 170 million degrees Celsius. The internally cooled superconductors are made of niobium-tin (Nb3Sn) superconducting strands and will be cabled together and contained in a structural steel jacket. The next stage in the fabrication of ITER magnets is the integration of the superconductors into the final coil assemblies.

“It is inspiring to see the ITER conductors as a reality after a
development programme that goes back over 30 years, with ITER partners working as a team to master the complex technologies involved,” said Magnet Division head Neil Mitchell, who has led the development of the ITER conductors since 1992.

7. Miranda Devine: Perth electrical engineer’s discovery will change climate change debate

A MATHEMATICAL discovery by Perth-based electrical engineer Dr David Evans may change everything about the climate debate, on the
eve of the UN climate change conference in Paris next month.

A former climate modeller for the Government’s Australian Greenhouse Office, with six degrees in applied mathematics, Dr Evans has unpacked the architecture of the basic climate model which underpins all climate science. He has found that, while the underlying physics of the model is correct, it had been applied incorrectly. He has fixed two errors and the new corrected model finds the climate’s sensitivity to carbon dioxide (CO2) is much lower than was thought. It turns out the UN’s Intergovernmental Panel on Climate Change has over-estimated future global warming by as much as 10 times, he says. “Yes, CO2 has an effect, but it’s about a fifth or tenth of what the IPCC says it is. CO2 is not driving the climate; it caused less than 20 per cent of the global warming in the last few decades”.

8. The Southern Ocean’s carbon sink gets stronger
Earth’s most important sink for anthropogenic carbon dioxide is more variable than researchers realized. 
R. Mark Wilson

Since 1750 Earth’s oceans have absorbed nearly 30% of anthropogenic carbon dioxide emissions. Although the Southern Ocean—the circumpolar waters surrounding Antarctica—occupies just a quarter of the total ocean area, it’s thought to be responsible for up to half of that uptake (see the article by Adele Morrison, Thomas Frölicher, and Jorge Sarmiento, Physics Today, January 2015, page 27). Air–sea fluxes of CO₂ are proportional to the difference in partial pressure Δp of the gas in the atmosphere and in the ocean. In 2007 flux estimates indicated that the Southern Ocean’s carbon sink had weakened in recent decades—a trend attributable to an intensification and southward shift of the westerly winds: The stronger the winds, the greater the upwelling of deep, carbon-rich waters. According to two new studies, the slowdown ended in 2002, and by 2012 the Southern Ocean had regained its expected strength, absorbing about 1.2 petagrams (1.2 × 10¹² kg) of carbon per year. To reach that conclusion, an international collaboration led by ETH Zürich postdoc Peter Landschützer used new statistical methods to interpolate the relatively scarce Southern Ocean
ΔpCO₂ measurements in space and time over a 30-year period. The other study, led by University of Colorado Boulder postdoc David Munro, found the same reinvigoration by analyzing a particularly dense time series of Δp measurements through just one region—the Drake Passage, which extends from the tip of South America to West Antarctica. What accounts for the trend reversal isn’t entirely clear. The westerly winds have not weakened, though circulation-driven changes in sea-surface temperatures, which affect CO₂ solubility, is a likely factor. (P. Landschützer et al., Science 349, 1221, 2015; D. R. Munro et al., Geophys. Res. Lett., in press, doi:10.1002/2015GL065194.)

9. Scientists push boundaries to find alternative energy

By Tim Radford
From algae to alloys, ingenuity in the world’s laboratories is fuelling experiments to find new ways of providing viable sources of clean energy.

http://www.climatenewsnetwork.net/scientists-push-boundaries-to-find-alternative-energy/

LONDON, 8 October, 2015 – Wind and solar energy remain the only obvious replacements for fossil fuels, but recent research shows that scientists are clearly thinking outside the box to come up with future alternatives.

They have recently been able to report at least theoretical progress with nuclear energy, algae, and a novel alloy. In just a few days, they proved that thermonuclear fusion – once somebody works out how to make it happen – will be economically viable.

They have worked out how to cultivate green algae for biofuel in huge quantities at US$50 a barrel, which is about the cost of crude oil.

They have even found a way to get electrical energy directly from cyanobacteria, or blue-green algae.
And they have exploited an alloy that can deliver a colossal pulse of electric power when you kick it.

**Experimental stage**

None of these technologies has advanced beyond the experimental stage, but all are testament to the ingenuity now being deployed in the world’s laboratories and experimental start-ups.

Fusion power – not to be confused with nuclear fission – exploits the thermonuclear conversion of hydrogen to helium with little or no noxious discharge and the generous release of energy.

This is what powers the sun and fuels the planet’s life. It is also the basis of the thermonuclear bomb. For the last 60 years, humans have been trying to make fusion work peacefully on Earth, with only tantalising flickers of success. But if it does work, British scientists report in the journal *Fusion Engineering and Design*, it will not be too expensive. They analysed the cost of building, running and ultimately decommissioning a fusion power station, and found it comparable to fission or nuclear energy.

The challenge of nuclear fusion is to heat stripped-down heavy hydrogen atoms to 100 million °C so that they fuse into helium, while finding a way to tap the released energy, and at the same time keep the reaction going.

The *International Thermonuclear Experimental Reactor* (ITER), now being built in the South of France, might in a decade show that it could happen. Assuming it works, the process should be affordable. There would be no high-level radioactive waste, no problems with finding fuel, and no by-product that could be turned into nuclear weaponry.

“Obviously we have had to make assumptions, but what we can say is that our predictions suggest fusion won’t be vastly more expensive than fission,” said Damian Hampshire, of the Centre for Materials Physics at Durham University, UK.

“Calculating the cost of a fusion reactor is complex, given
the variations in the cost of the raw materials and exchange rates. However, this work is a big step in the right direction.”

Biofuel is currently based mostly on the conversion of agricultural crops – sugar cane, or corn – to feedstock for ethanol, which can be converted into gasoline or other fuels. But, in a hungry world, this is not an ideal solution. So researchers have been looking at the microbial plant life in waste water and ponds as a possible answer, with promising experimental results on the small scale. But now an Israeli company called Univerve has pioneered a cultivation system that gets ever more sunlight to speed up photosynthesis and get the algae working ever harder. They report in Technology journal that they bubbled air through a suspended, modular triangular structure with transparent walls so the algae get their solar energy from all sides and their oxygen at all times. They promise green reactors up to 100 metres, holding 100 cubic metres of “production medium”, or algae. There is a bonus: algae make omega-3 oils, so it could also serve the food industry and deliver cattle feed, as well as feedstock for the biofuel business.

In Montreal, Canada, researchers report in the same journal that they can tap into the photosynthesis in the tank full of algae and directly retrieve clean energy in the form of electricity. The process involves tapping into the electron transfer chains in the plant life that turn sunlight into carbon-based tissue. In essence, the tank of cyanobacteria serves as the anode in a biological battery.

**Commerically-useful**

Having demonstrated the principle, the next step is to work out how to get commercially-useful power from what becomes, quite literally, the power plant. In the US, civilian and military scientists have been looking
again at an alloy of iron doped with gallium that has been around for decades, but which has just shown that it can produce electricity.

It has been named Galfenol, and is described in the Journal of Applied Physics as magnetoelastic. Squeeze or deform it, and its magnetisation changes. Stick it in a magnetic field, and it changes shape.

The scientists found that when boxed in a clamp so that it could not deform, wrapped with copper wire and subjected to a powerful impact, Galfenol generated as much as 80 megawatts of instantaneous power per cubic metre. That is, it converted mechanical energy into electromagnetic discharge.

Right now, like the other advances, it remains a discovery awaiting an application. But energy researchers are certainly applying great ingenuity to the search for clean energy sources. – Climate News Network

10. Is nuclear fusion about to change our world?

By Thom Patterson, CNN
Updated 1222 GMT (1922 HKT) October 7, 2015 | Video
Hey 21st century, where's that nuclear fusion power reactor you promised? Tens of billions of dollars have been spent in the past 60 years, entire careers have been invested, but the ability to produce a commercially viable nuclear fusion reactor remains undemonstrated. After beating our heads against the wall for so long, you might ask: Why keep trying? Because on paper, fusion has the potential to save the planet. Imagine a world powered by a cheap, safe, clean, virtually limitless, sustainable fuel source such as water. If fuel and energy are cheap and available to all nations, that reduces global political tensions. If our energy comes from a clean-burning fuel source, that reduces air pollution. All that would be good, right?

Billionaires such as Amazon founder Jeff Bezos, PayPal co-founder Peter Thiel and Microsoft co-founder Paul Allen apparently think so. They've each thrown their money into a different fusion development company, each with its own idea how to solve the fusion puzzle, according to Forbes. "What we're really doing here is trying to build a star on Earth," said Laban Coblentz at the International Thermonuclear Experimental Reactor (ITER), a massive fusion reactor being built by 35 countries in southern France. When Coblentz said "star," he meant that quite
literally. Fusion is what keeps stars, including our own sun, burning bright.
Oversimplified, of course, here's how fusion is supposed to work:
You take two gases called deuterium and tritium and you heat them under pressure to at least 100 million degrees Celsius. That's 180 million degrees Fahrenheit. These substances will get so hot that they change from gas to plasma. Then they fuse together -- releasing a burst of additional heat. That burst is called a fusion reaction.
The heat boils water into steam, which drives a turbine and generates electricity that powers your neighborhood.
Here's the really important thing: To be commercially viable, you have to create more energy than the original energy you used to heat the fuel. And there's the rub: We haven't been able to figure that part out.
The ITER project in Cadarache, France, aims to do just that.
Five years after construction began, activity is ramping up to a higher level. Several 33-foot-tall, 86-ton drain tanks have recently arrived from the United States. Workers have been busy gathering components to build giant electromagnets that Coblentz called the "largest superconductor procurement in the history of the planet."
The mood at Cadarache is hopeful, Coblentz said. "There's a very palpable sense that at last we're entering this phase where we're seeing physical change," he said. "We're seeing the progress of the project."
But design changes and construction delays have resulted in rising costs. One estimate says the project will cost $21 billion by the time it's expected to be finished around 2020. U.S. contribution: $3.9 billion. The real question is can the organization work in an internationally harmonized way and be reliable and stick to the schedule. .. I'm confident that it really is going to happen. We're going to be surprising a lot of the skeptics."

ITER recently cut the ribbon on a nearly 200-foot-tall Assembly Building, one of the first massive structures at the site. Inside, workers will piece together large reactor components before they're inserted into the main facility that houses something called a tokamak.

What's so hard about fusion?

Handling plasma is one of the big challenges that make fusion so hard. To achieve fusion, you have to bottle up that super-hot plasma so it's really dense. Then you have to keep it dense, hot and contained long enough to get it to fuse.

The billionaires such as Allen, Thiel and Bezos have put their money into private companies that are running projects on a much smaller scale than ITER. Allen is reportedly an investor in a firm called Tri-Alpha Energy, in Orange County, California. Thiel is said to be backing Helion Energy in Redmond, Washington, and Bezos has his hopes riding on an outfit called General Fusion in the Canadian town of Burnaby, British Columbia.

All these companies are using electromagnets in their
attempts to unlock the promise of fusion. But others are trying methods that don't rely on electromagnets. In Livermore, California, the National Ignition Facility has been focusing on a process called inertial confinement fusion. Here's how it works: You take a pellet filled with deuterium and tritium gas and place it inside a gold plated cylinder. Then you shoot it with intense laser light. The light heats the inner walls of the cylinder, creating a superhot plasma that showers the pellet with soft X-rays. The X-rays heat the outer surface of the pellet, causing it to implode. The implosion compresses and ignites the plasma and burns the fuel, causing a fusion reaction.

Experts say science has made a lot of progress recently and for some, confidence is high. "For $20 billion in cash, I could build you a working reactor," Professor Steven Cowley, CEO of the UK Atomic Energy Authority, told Popular Mechanics. "It would be big, and maybe not very reliable, but 25 years ago we didn't even know if we'd be able to make fusion work. Now, the only question is whether we'll be able to make it affordable."

Nonetheless, it's unlikely the big push for fusion will disappear altogether, as long as it promises to solve the world's energy needs for the next millennium. "Sure. It would solve that. There's no question," Coblentz said. "We just have to demonstrate it, and then replicate it on a scale that will actually be practical."
Nuclear fusion financially viable in decades claim researchers

5 October 2015

http://www.theengineer.co.uk/energy/news/nuclear-fusion-financially-viable-in-decades-claim-researchers/1021166.article

Fusion reactors could become an economically viable means of generating electricity within a few decades, a team of UK researchers has claimed.

The group, from Durham University and Culham Centre for Fusion Energy in Oxfordshire, has re-examined the economics of fusion, and taken into account recent advances in superconductor technology.

The research, published in the journal Fusion Engineering and Design, builds on earlier findings that a fusion power plant could generate electricity at a similar price to a fission plant and identifies new advantages in using the new superconductor technology.

Fusion reactors generate electricity by heating plasma to around 100 million degrees centigrade so that hydrogen atoms fuse together, releasing energy. This differs from fission reactors which work by splitting atoms at much lower temperatures.

The report, which was commissioned by Research Council UK’s Energy Programme focuses on recent advances in high temperature superconductors. These materials could be used to construct the powerful magnets that keep the hot plasma in position inside the containing vessel, known as a tokamak, at the heart of a fusion reactor.

This advancing technology means that the superconducting magnets could be built in sections rather than in one piece. This would mean that maintenance, which is expensive in a radioactive environment, would be much cheaper because individual sections of the magnet could be withdrawn for repair or replacement, rather than the whole device.

While the analysis considers the cost of building, running and decommissioning a fusion power plant, it does not take into account the costs of disposing of radioactive waste that is associated with a fission plant.
For a fusion plant, the only radioactive waste would be the tokamak, when decommissioned, which would have become mildly radioactive during its lifetime. Professor Damian Hampshire, of the Centre for Material Physics at Durham University, who led the study, said: “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.” Hampshire said he hoped that the analysis would help persuade policy-makers and the private sector to invest more heavily in fusion energy. “Fission, fusion or fossil fuels are the only practical options for reliable large-scale base-load energy sources. Calculating the cost of a fusion reactor is complex, given the variations in the cost of raw materials and exchange rates. However, this work is a big step in the right direction” he said.

A test fusion reactor, the International Thermonuclear Experimental Reactor (ITER), 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.

12. Falling costs bring fusion power closer to reality

The cost of producing energy in fusion reactors has now become cheap enough to be commercially viable according to researchers. Academics from Durham University and the Culham Centre for Fusion Energy in Oxfordshire recalculated the costs of the technology in the light of recent advances in superconductor technology. They found that electricity could be generated at a similar cost to fission reactors without the associated disadvantages.

Fusion is capable of producing energy without contributing to global warming or the dangers associated with fission such as the production of hazardous waste. In addition, fusion reactors only require deuterium, or heavy water,
to operate which can be derived from seawater allowing for a potentially limitless supply of energy and eliminating fears around resource security.

The technology works by heating plasma to 100 million degrees centigrade so hydrogen atoms fuse together, releasing energy. Fission reactors work by splitting atoms at much lower temperatures.

Advances in superconductors mean they could be used to build the powerful magnets needed to keep the hot plasma in position. Damian Hampshire, the Durham University Professor who led the study, said: "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. "We have known about the possibility of fusion reactors for many years but many people did not believe that they would ever be built because of the technological challenges that have had to be overcome and the uncertain costs.

"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."

Hampshire hopes that the study will encourage politicians and the private sector to invest in the technology ahead of a proposed test reactor in France that is around a decade away from being operational.

Last year, the European Commission launched an €850m (£632m) programme to foster development of nuclear fusion as a future energy source.

13. Energy: Are fusion reactors ready for prime time?

Posted on October 4, 2015 by Bob Berwyn

http://summitcountyvoice.com/2015/10/04/energy-are-fusion-reactors-ready-for-prime-time/

Advances in superconductor technology could help spur economic viability of fusion energy

Staff Report

Recent advances in superconductor technology could bring fusion reactors online within the next few decades, energy researchers said in a new study, advising policy makers to start making plans for replacing nuclear power plants.

The analysis compared building, running and decommissioning fusion power stations to traditional fission nuclear power, showing that fusion is close to being economically viable.

"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,” said Professor Damian Hampshire, of the Centre for Material Physics at Durham University, who led the study.

The findings were published in the journal *Fusion Engineering and Design*. Within a generation or two, fusion reactors could offer an almost unlimited supply of energy without contributing to global warming or producing hazardous products on a significant scale, according to the study. Fusion reactors generate electricity by heating plasma to around 100 million degrees centigrade so that hydrogen atoms fuse together, releasing energy. This differs from fission reactors which work by splitting atoms at much lower temperatures.

The advantage of fusion reactors over current fission reactors is that they create almost no radioactive waste. Fusion reactors are safer as there is no high level radioactive material to potentially leak into the environment which means disasters like Chernobyl or Fukushima are impossible because plasma simply fizzles out if it escapes. Fusion energy is also politically safer because a reactor would not produce weapons-grade products that proliferate nuclear arms. It is fueled by deuterium, or heavy water, which is extracted from seawater, and tritium, which is created within the reactor, so there is no problem with security of supply either.

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. Professor Hampshire said he hoped that the analysis would help persuade policy-makers and the private sector to invest more heavily in fusion energy. “Fission, fusion or fossil fuels are the only practical options for reliable large-scale base-load energy sources. Calculating the cost of a fusion reactor is complex, given the variations in the cost of raw materials and exchange rates. However, this work is a big step in the right direction” he said.

“We have known about the possibility of fusion reactors for many years but many people did not believe that they would ever be built because of the technological challenges that have had to be overcome and the uncertain costs.”

“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 this kick-starts investment to overcome the remaining technological challenges and speeds up the planning process for the possibility of a fusion-powered world.”

The report, which was commissioned by Research Council UK’s Energy Programme focuses on recent advances in high temperature superconductors. These materials could be used to construct the powerful magnets that keep the hot plasma in position inside the containing vessel, known as a tokamak, at the heart of a fusion reactor.

This advancing technology means that the superconducting magnets could be built in sections rather than in one piece. This would mean that maintenance, which is expensive in a radioactive environment, would be much cheaper because individual sections of the magnet could be withdrawn for repair or replacement, rather than the whole device.
While the analysis considers the cost of building, running and decommissioning a fusion power plant, it does not take into account the costs of disposing of radioactive waste that is associated with a fission plant. For a fusion plant, the only radioactive waste would be the tokamak, when decommissioned, which would have become mildly radioactive during its lifetime.

14. Wisconsin bill aims to overturn nuclear construction ban
09 October 2015

Lawmakers in Wisconsin have introduced legislation that would end the US state's 32-year-old effective ban on the construction of new nuclear plants. Bills introduced to both of the state's legislative houses seek to change the approval process for new nuclear power plants by repealing current legislation and specifically including nuclear in a list of generating options.

Bill 288 was introduced to the Wisconsin Senate on 6 October by sponsors led by Senator Frank Lasee. A similar bill, number 384, was submitted to the state's Assembly on 8 October by Representative Kevin Petersen. Both have had their first reading and been referred to the relevant committees: the Senate Committee on Natural Resources and Energy and the Assembly Committee on Energy and Utilities.

Under current Wisconsin law, construction of any new power plant requires a certificate from the state's Public Service Commission (PSC). In addition to the requirements that must be satisfied for any new power plant, for proposed nuclear plants the existing legislation prohibits the PSC from issuing a certificate unless two further conditions are satisfied: firstly, there must be available a federally licensed facility with sufficient capacity to receive the used fuel from all nuclear power plants in the state; and secondly, that construction of the power plant is economically advantageous to ratepayers based on specified factors. As no federally licensed facility for receiving used fuel is operational anywhere within the USA, the first requirement effectively bans the PSC from approving any nuclear construction project. The new legislation would eliminate the two extra conditions imposed on proposed nuclear power plants.

Current Wisconsin law also requires state agencies and local governments to design new and replacement energy projects, to the greatest extent cost-effective and feasible, in accordance with a pre-ordained list of priorities. The new legislation would specifically
include nuclear capacity in that list, introducing "advanced nuclear energy using a reactor design or amended reactor design approved after December 31, 2010, by the US Nuclear Regulatory Commission" as an option that must be considered after "combustible renewable energy resources" but before "non-renewable combustible energy resources".

Wisconsin has two operating 591 MWe pressurized water reactors at NextEra Energy's Point Beach plant. Unit 1 has been in operation since 1970, and unit 2 since 1972. Both units underwent an extended power uprate in 2011 and are currently licensed to operate until 2030 and 2033. According to data from the US Nuclear Energy Institute, the Peach Bottom units generate nearly 18% of the state's electricity. The Kewaunee nuclear power plant was shut down in 2013 by owner Dominion after it failed to find a buyer for the plant and is now being decommissioned.

Research and written by World Nuclear News

15. European approval for UK waste disposal charges


09 October 2015

The pricing methodology for waste transfer contracts between the UK government and operators of new nuclear power plants meets European state aid rules, the European Commission has concluded.

The methodology sets the price that operators of any new nuclear power plants built in the UK will have to pay for the final disposal of the intermediate- and high-level wastes generated from them in a planned national repository. The methodology aims to ensure that the cost of disposing of this waste is borne by the plant operators and not by the taxpayer. Plant operators will be expected to set aside sufficient funds to cover their future liabilities.

The methodology will establish a waste transfer price that reflects the actual disposal costs, the European Commission said. However, it noted this price will only be determined when most of the currently unknown costs factors of the repository have become clear. This is expected to be about 30 years after the start of operation of any new plant, it said. The price will cover all projected variable and fixed costs linked to the disposal of used fuel and intermediate-level waste, plus "an appropriate risk premium" to reflect possible cost increases after the setting of the price.

The UK government has also said it will set a price cap to provide some visibility of future liabilities to attract investors and secure financing.
The European Commission has now concluded the pricing methodology does not involve state aid according to EU rules. It also concluded that the actual disposal costs to be faced by operators are "very unlikely" to exceed the cap set by the government.

The UK plans to build a repository for the disposal of used fuel and intermediate-level waste from existing and future nuclear power plants. The facility - the site of which has yet to be selected - is expected to start operating around 2040. The disposal of intermediate-level waste in the facility is likely to begin around that time, while used fuel disposal is expected to take place between 2075 and 2140.

Europe's approval of the waste transfer contract means that, for the first time, the eventual decommissioning and waste management costs associated new nuclear power plants - such as EDF Energy's planned Hinkley Point C - will be paid by the generator at the time of generation. The cost of this Funded Decommissioning Program has already been taken into account in the strike price agreed by EDF Energy and the government for electricity generated by Hinkley Point C.

Nuclear Industry Association CEO Keith Parker welcomed the commission's decision on the waste transfer contract. He said, "The endorsement of the UK's responsible plans for ensuring the cost of dealing with and storing waste is paid for by the operator is another clear signal that nuclear power can play a key role in the UK's energy mix."

Researched and written by World Nuclear News

16. Regulator completes safety review of Takahama units


9 October 2015

The restart of units 3 and 4 of Kansai Electric Power Company's Takahama nuclear power plant moved a step closer today with Japan's nuclear regulator confirming the units meet new safety requirements.

Kansai submitted a joint application to the Nuclear Regulation Authority (NRA) in July 2013 for the necessary permissions to restart both units. These approvals include making changes to the reactor installations; its construction plan to strengthen the plant; and its operational safety programs for the units.

The NRA gave Kansai approval in February to make changes to the reactor installations at both units. That approval - which meant the NRA considered the two reactors, and the plant as a whole, to be safe for operation - represented by far the major part of the
licensing process. Approval of the company's construction plan for unit 3 was given on 4 August, while that for unit 4 was given today.

The NRA also today approved Kansai's operational safety plans for the Takahama plant. These include emergency response plans in case of fire, flooding or other natural disasters, or a serious accident.

Now that the utility has been granted all approvals in the three-step review process, the units - both 870 MWe pressurized water reactors - must undergo pre-start-up inspections before their operation can resume. 'Pre-use' inspections got under way at unit 3 on 17 August.

Units 3 and 4 of its Takahama plant in Fukui prefecture have remained offline since being shut for periodic inspections in February 2012 and July 2011, respectively. Kansai reportedly aims to restart the two reactors by the end of this year.

So far, just one of Japan's nuclear power reactors - unit 1 of Kyushu Electric Power Company's Sendai plant - has cleared the regulatory restart process and resumed operation. Sendai 1 began operating again on 11 August, with unit 2 expected to restart in the coming weeks.

*Researched and written by World Nuclear News*