

1. Could a man-made star solve Earth's energy crisis?

SCIENCE CORRESPONDENT

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Where do we get our energy in the second half of this century? The world's population is rising and we will need ever more electricity.

Burning fossil fuels is not the answer, given its ability to alter the Earth's climate. Renewables such as wind, solar and wave might be getting cheaper, but will they ever be enough?

For [On Assignment](#) - which airs on Tuesday night - I went to take a look at the most futuristic idea for how to solve our energy crisis, something that is not guaranteed to work but, if it did, could one day save the world.

Set in the serene countryside of Saint Paul-lez-Durance in Provence, I saw the most sophisticated, expensive machine ever conceived taking shape - this is Iter, an attempt by scientists and engineers to recreate a star on Earth.

Stars such as our Sun shine because the hydrogen atoms are pushed together at their cores until, two by two, they fuse into helium - a process that releases a little energy.

For decades, scientists have wondered if we might be able to do something similar on Earth.

What is nuclear fusion?

Nuclear fusion is different to the more familiar nuclear fission, which involves splitting heavy atoms such as uranium and is at the heart of modern nuclear power plants.

Fusion has an almost unlimited source of fuel (in seawater) and its radioactive byproducts stay dangerous for a lot shorter time than traditional nuclear fission (where waste can remain harmful

for thousands of years).

But the technical (and political) challenges for fusion are enormous.

Iter is a joint attempt, by 7 partners representing 35 countries, to prove that nuclear fusion could work.

It will boil up heavy versions of hydrogen gas (deuterium and tritium) to around 150 million degrees Celsius inside a vast ring-shaped container, called a tokamak. And all that gas will be kept in place by superconducting magnets, which only work when they are kept as cold as the vacuum of space.

A global solution to a global problem?

The million parts for this machine are being built all over the world.

Sixty miles from the main site for Iter, in Toulon, I visited a giant temperature-controlled warehouse that had been built at the harbour side location of the French engineering company, Constructions Industrielles de la Méditerranée.

Here, metallurgists were painstakingly making D-shaped, 15-metre-long steel plates that hold the superconducting cables in Iter's magnets.

The superconducting cables, which are made from niobium-tin, would fly apart under their own immense magnetic field without the structural support of this steel.

Each D-shaped plate started as 24 tonnes of high-grade stainless steel. Inside the warehouse in Toulon, a giant drill spends several months, working night and day, to carve out a spiral of grooves into each side of the plate, shaving away mere thousandths of a millimetre from the metal at each circuit. When it is complete, only 8 tonnes of metal remain.

This is just one piece of the puzzle. The 100,000 kilometres of the superconducting wire for the magnets (enough to wrap around the equator twice) will be made across China, Japan, Russia, South Korea and the US. The magnet itself will be built in China and France. Parts of the tokamak vessel will come from South Korea.

That internationality is reflected in multiple ways: the flags fluttering at the main entrance to Iter's entrance; a series of

small, empty offices in the recently-finished headquarters building, one each for any representatives of the partner nations who might be visiting; a grand, UN-style meeting chamber at the top of the building near the main entrance where the big decisions about the project get made by the organisation's council members.

That internationality can be seen in Iter's canteen, which buzzes with different languages. I sat down with an Irish fusion physicist who is starting her sixth year with Iter. The enormous technical challenge of making fusion a viable option for everyday energy are not lost on Dr Deirdre Boilson.

'Enormous advantages for humanity'

“Working on this project day to day ok it can be stressful, the tempo is really high,” she says. “The advantages are so enormous [but] for humanity it's a no-brainer that we should be putting energy and effort into this to make it work.

We need this for the future and this is why all these people are here. Everybody here believes that this is the way we should go and that's why I think the seven international partners have all come together... I actually feel goose pimples and I think I am part of this, I have built this. This is an important step towards the future. I love it here.”

Across the road at the vast Iter building site, I met Professor Steven Cowley, who has been working on the theoretical physics of nuclear fusion for three decades and is now chief executive of the UK Atomic Energy Authority (UKAEA), which runs the experiment that was the precursor to Iter, a nuclear fusion reactor in Oxfordshire called Jet.

The last time he had seen the site, there was still mud at the bottom of the main pit. Standing over the recently-finished concrete platform, he pointed to where the super-hot gas will one day start burning and fusing atoms.

“It's not ordinary by any stretch of the imagination - and when it's working, you know, it will be one of the great wonders of the world.”

2. 66th Republic Day of INDIA

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<http://www.azernews.az/analysis/76506.html>

India became Republic on 26th January 1950 and made progress in all fields including Science & Technology. India's space technology is at its' highest reaching the skies.

Reaching for the stars through 'Mangalyaan'

The success of India's maiden mission to Mars is hailed as a global landmark as it paves the way for cheap and reliable inter-planetary travel, this has been possible only because of a robust high technology infrastructure that has been put in place by the country. The same is also true in the sector of atomic energy where India's prowess is slowly being recognized so much so that in the world's only fusion energy reactor being constructed in France, India is a full member. Today, the country's Mars Orbiter Mission (MOM) truly symbolizes 'Make in India'.

Speaking at the 'Make in India' workshop on December 29, 2014 The Prime Minister Narendra Modi said 'Human Resource Development, Innovation and Research should become part of the Government's DNA. He said these should be aligned to the nation's overall goals in various sectors.' Modicalled upon all sectors of manufacturing in India to take inspiration from the "Space" sector, and the achievements of India's space scientists.

On his recent visit to New York where Prime Minister had the crowd in raptures as he repeatedly brought up India's success of reaching Mars. Modi said 'everything about Mangalyaan is indigenous,... made in small factories. We reached Mars at a smaller budget than a Hollywood

movie," he said adding "India is the only country to reach Mars on its first attempt. If this is not talent, then what is?' Not many know that the darling of the masses, Mangalyaan is truly also the flag bearer for Modi's 'Make in India' campaign where he is pitching for India becoming the hub for making 'satellites to submarines'. *India Incorporated* a website dedicated to promoting India's strengths highlighted that 'some 40 industries are directly involved in the making of the spacecraft itself that was put together by the Indian Space Research Organisation (ISRO). From small firms like Sangvi Aerospace Pvt Limited from Ahmedabad that supplied the wires and cables to giants like L&T and Godrej, to Technocom in Rajkot which helped with the camera that gave MOM its first view of Mars. All truly symbolize the humble 'made in India' tag that Mangalyaan carries.'

'Space is the last frontier so push and push some more' was part of Prime Minister Narendra Modi's pitch to India space scientists when he came to the partake in the joys and sorrows of the small 16,000 strong space community that made India proud by hitting bull's eye in the very first attempt of reaching planet Mars. A feat not achieved even by great space powers like USA and America.

Acknowledging India's achievement NASA Administrator Charles Bolden called it 'an impressive engineering feat'. Another 100 or so industries are directly involved with the making of the rocket that launched MOM into space on November 5, 2013.

What caught the attention of the world was the relatively small cost of the mission Rs 450 crores or about \$ 75 million, which is ten times cheaper than the NASA's latest mission that reached Mars two days ahead of India's. This was undoubtedly the lowest cost inter-planetary mission ever to be undertaken in the twenty-first century. As ISRO chairman K. Radhakrishnan says 'modularity' of sub-systems helps reduce costs and the low wage bills alongside the long hours put in by ISRO's 500 work force

that worked on the Mars satellite helped keep the cost very low.

On June 30, Modi watched the majestic lift-off of the 114 Indian mission of the Indian space agency the launch of the Polar Satellite Launch Vehicle that has till date launched 40 satellites from as many 19 different countries. ISRO's commercial arm the Antrix Corporation Limited has an annual turnover of about Rs 15,000 million and it has already procured orders for three more dedicated commercial launches using the PSLV, which will place in orbit another 14 foreign satellites in the coming years. V S Hegde, Chairman and Managing Director of Antrix Corporation Limited says `we are already a force to be reckoned with and we are definitely going to grow'.

Reaching for the stars is not the only frontier where India's efforts are bearing fruit, tapping nuclear energy is also a big aspirational dream for India. India today is contributing actively in world's largest science project to generate fusion energy.

Evergreen atomic energy a possibility!

A star is set to be born in southern France, a humongous over \$ 20 billion effort is being made to make a nuclear reactor like never before, a special steel cauldron where fusion energy could be tapped and it is called the International Thermonuclear Experimental Reactor (ITER). Ratan Kumar Sinha Chairman of the Atomic Energy Commission says `fusion energy holds the promise of becoming an unlimited source of environment friendly energy for the world.'

This is till date world's largest scientific project ever to be undertaken and it is getting off the ground in Europe, a mammoth project that experts say will pave the way for generating unlimited clean nuclear energy by fusing atoms, a process not very different from what happens on the Sun.

The reactor will weigh about 23,000 tons the equivalent of the weight of 3 Eiffel Towers in Paris. Some 80,000

kilometres of special super conducting wires will be used. Six nations India, China, South Korea, USA, Japan, Russia and the European Union have joined hands as equal partners to see if they can jointly harness the power of the Sun by literally confining it in a steel bottle.

Within the massive steel frame gas will be heated to over 150 million degrees temperature and it will be confined into a limited space using giant magnets, some atoms will then fuse together releasing huge amounts of heat which can then be directed to run turbines to generate electricity. In the first instance, it is hoped the fusion reactor will produce ten times more energy than what is used to initiate the reaction estimated to produce the equivalent of 500 MW of power.

But it is easier said than done since taming the power of the Sun is a Herculean task and for the last half a century scientists have dreamt about this feat but it was only in 2006 that the ITER organisation come into being when things started become real.

India's role

India is a full member of this enterprise providing about ten percent of the components for the massive nuclear complex unfolding at Cadarache in France. New Delhi is contributing what would when completed in 2021 would be world's largest refrigerator. It also acts like a thermos flask but operates at some of the coldest temperatures ever seen in the universe working at minus 269 degrees Celsius (-269 degrees Celsius) and technically called a 'cryostat', it is being made to order for the Department of Atomic Energy by L&T Industries. M V Kotwal, President, Heavy Engineering L&T industries, Mumbai says 'manufacture & installation of the cryostat has been entrusted to L&T. Work on this project is already in progress in our Hazira Manufacturing Complex. We have also constructed a special workshop at the site in Cadarache, France to enable site assembly of the large & complex stainless steel structure from components which

will be supplied from Hazira in India.'

India will make in-kind investment probably totalling about Rupees 9000 crores over the next decade thus contributing about 9.1% of the share of the total costs.

Sinha says 'participation of India in the ITER project, with its immense scientific talent and industrial competence, has provided an opportunity to India to master the cutting edge technologies manifest in this massive project. In the near term, it has facilitated a huge impetus to scientific research, manpower development and building an internationally competitive industrial capability within Indian private sector in the highly advanced field of fusion energy'.

Once the proof is established that mankind can harness the power of the Sun, India could well build its own fusion reactors possibly very soon after 2050, thus providing unlimited energy.

Modi said ISRO has made it a habit of 'making the impossible possible'. So could India, literally pave the way for cheaper, durable and reliable satellites in the 'Make in India' movement that Modi has flagged off. A multi-billion dollar space and nuclear energy market is waiting to be tapped.

In this bold new initiative Modi called for making a globally recognized "Brand India" famous for "Zero Defect, Zero Effect" Manufacturing – free from defects, and with no adverse impact on the environment.

ITER-India

India is a full member of the world's largest scientific experiment to make a fusion energy reactor coming up at Cadarache in France.

At the International Thermonuclear Experimental Reactor (ITER) being made at France the world's largest refrigerator is being made by India, a truly 'make in India' initiative.

By Pallava Bagla: An eminent science writer is also co-author of the book 'Reaching for the Stars: India's Journey

to Mars and Beyond' published by Bloomsbury India. He can be reached at pallava.bagla@gmail.com and Twitter: [pallavabagla](#)

3. Energy research

The Observer

When you wish upon a star: nuclear fusion and the promise of a brighter tomorrow

Decades in the making, Iter, a huge experimental fusion reactor in rural France, could be the site of breakthroughs that could provide limitless, clean energy and secure the planet's future

<http://www.theguardian.com/science/2015/jan/25/iter-nuclear-fusion-cadarache-international-thermonuclear-experimental-reactor-steven-cowley>

The countryside of Saint-Paul-lez-Durance in Provence is a serene terrain of thickly wooded hills. On chilly January mornings, the air becomes thick with mist and the sky glows red as the sun pokes up above the horizon at dawn. By mid-morning, that haze is usually gone, leaving behind a bright blue sky with only the faintest wisp of high-altitude cloud. As picture-postcard scenes go, it is as rural and peaceful as it gets. But incongruously nestled among these hills and vineyards, the most sophisticated, expensive machine ever built is slowly taking shape at the local **Cadarache nuclear facility**. It is a scientific collaboration on a worldwide scale, meant to tackle one of the biggest challenges of the 21st century – with the human population growing every year, how do we continue to make ever more electricity past 2050 (the date that the **EU has set** for full decarbonisation of power generation) without destroying the environment? The scientists and engineers in Saint-Paul-lez-Durance think the solution is nuclear fusion –

they want to recreate a star in a box on Earth.

Everything about the project, known as Iter (formerly known as the International Thermonuclear Experimental Reactor), is huge. The main fusion reactor will be built on a flattened area of concrete that has been blasted into the hills at Cadarache and stretches to 60 football pitches. Around 2.5m cubic metres of earth and rubble were excavated from what was originally a small valley that undulated by several hundred metres in parts. That concrete baseplate sits on dozens of pillars containing layers of rubber sandwiched between the mortar and cement – not only do these pillars raise the building above the height of the surrounding countryside (the height was calculated to be above the maximum height that water would flow past if the nearby dam broke), they also create a “seismic isolation pit” that will protect the building from earthquakes.

At the centre of the concrete box where the main building will go, you can already see a circle of steel bars that trace the shape of what will become the ring-shaped vacuum vessel, where the fusion reactions will take place. Ready to haul in the huge components over the coming years, four giant cranes are rooted into the site, one of them within the circle itself. When the main building containing the reactor is complete, it will rise 60 metres into the air and reach 10 metres below the ground.

Advertisement

When the million or so pieces that make up the Iter machine have been delivered to site and are finally bolted and welded together, the whole thing will weigh around 23,000 tonnes, three times the weight of the Eiffel tower. The entire reactor complex – including the foundations and buildings that will sit in the seismic isolation pit – will weigh 400,000 tonnes, more than the weight of the Empire State Building.

Visiting the Iter site, I meet Steven Cowley, who has been working on the theoretical physics of nuclear fusion for three decades and is now chief executive of the [UK Atomic Energy Authority](#) (UKAEA). The last time he saw the site, there was still mud at the bottom of the main pit. Standing over the recently finished concrete platform, he gestures to where the

super-hot plasma will one day start burning and fusing atoms. “It’s not ordinary by any stretch of the imagination and when it’s working, you know, it will be one of the great wonders of the world.”

Cowley has been waiting for Iter his whole career. His commitment to it is not just driven by a desire to answer scientific questions that have occupied his mind for so many decades, though. “We don’t know where we are going to get our energy from in the second half of this century, and if we don’t get fusion working we are going to be really stuck,” he says. “We have to make [Iter] work. It’s not just because I work in it that I think that: it has to work and all this effort of thousands of people all the way round the world is to make sure that in 2100 you can flick a switch on the wall and have electricity.”

Nuclear fusion is different from the more familiar nuclear fission, which involves splitting heavy atoms of uranium to release energy and which is at the heart of all nuclear power stations. The promise of fusion, if scientists can get it to work, is huge – unlimited power without any carbon emissions and very little radioactive waste.

The process goes on at the core of every star and the idea that mimicking it could become a source of power on Earth has been around since the years after the second world war. But for many decades fusion has seemed out of reach, requiring materials and an understanding of the chaotic behaviour of hot plasmas that was beyond the technology of the time. However, decades of smaller experiments have led to Iter, the giant project in which fusion scientists have their best possible chance to finally show that this technology could work.

Iter has its roots in a summit between Ronald Reagan and Mikhail Gorbachev towards the end of the cold war, in 1985. They agreed on very little but, almost as an afterthought, they mentioned developing fusion as a new source of energy that could benefit all mankind. Europe and Japan joined the Americans and Russians on the tentative project soon after it was conceived and, today, it also includes China, India and

South Korea – in total there are 35 countries involved. Its design is centred on heating a cloud of hydrogen gas to 10 times hotter than the core of the sun, some 150m degrees celsius, inside a ring-shaped container called a tokamak, which has superconducting magnets fixed around it like hoops fitted on a circular curtain rail. These magnets create an overlapping set of fields that keep the electrically charged gas inside from touching the sides of the tokamak and therefore losing energy. Building a working tokamak is not straightforward. “The plasma is a bit like a lump of jelly and you are holding it with a magnetic field which is a bit like knitting wool – and imagine holding a lump of jelly with a few pieces of knitting,” says Cowley. The magnets have to be strong and Iter’s design uses superconducting magnets that only work at -269C. Since the earliest designs, several generations of tokamak-based nuclear fusion reactors have proved that it is possible to build and run the technology at increasingly large sizes. The biggest of these is the [Joint European Torus](#) (Jet), based at Culham in Oxfordshire and run by the UKAEA. In the early 1990s, experiments there showed it was possible to fuse hydrogen and then release the resulting energy in a controlled way. But it took more energy to fuse atoms at Jet than the scientists got back out at the end – which is useless if you want to use the technology to build a power plant. Iter’s primary goal is to fix that problem by creating what they call a “burning” plasma, something that keeps going without the need for external heating, in the same way that a log fire keeps burning after it has initially been set alight by a match. Its design is a scaled-up version of Jet and the scientists here want to produce 500 megawatts of power, 10 times its predicted input. But scientific challenges are not the only complexities with a mega-project such as Iter. With so many countries involved, so much money and so many engineering contracts, the path to laying even the first building block of this experimental reactor has been far from smooth. The seven partners agreed on Cadarache in 2004 and they signed an agreement two years later, which costed the project at

an estimated €5bn to build and a similar amount to run for its 20-year lifetime. The agreement stated that, as hosts for the project, Europe pays 45% of the total cost while the remaining partners split the bill for the rest between them. Countries do not pay funds directly to Iter but rather provide the equivalent value in parts and services to the reactor project. The ratios are important – they were to remain in place even if the cost rose. Which it did: after a design review in 2008 that incorporated several advances in fusion science into the basic design and also took into account the increased cost of steel and concrete, the construction budget rose to €15bn.

When the Iter agreement was signed in 2006, the reactor was supposed to begin operations in 2016. With the subsequent redesign and construction delays, the current timetable does not involve a switch-on until 2020 and there will not be a working plasma in the tokamak before around 2022. The all-important fusion reactions are not likely to occur before 2027, more than 20 years after building started.

Iter's director general, the Japanese plasma physicist [Osamu Motojima](#), has been in charge since 2010 and is now in the final months of his tenure. His team came under criticism in 2013 in an assessment carried out by independent consultants, who said the project's management was inflexible and top-heavy.

Motojima says that managing a project to develop a radically new technology with so many political partners was a new experience for the world, and required a “new standard of collaborative culture”. The cost increases, he added, were mainly the result of inflation from the original estimate in 2001 and also the increase in cost of basic building materials. “In general, cost is increasing but that is, I believe, within acceptable levels for stakeholders and the public.” Iter's governing council has since accepted the thrust of the findings of the assessment report and promised change in how the project is organised, in a bid to keep it on track.

Some of the higher costs are perhaps inevitable when you are building new technologies from scratch. In Iter's case, this is exacerbated by the partners' wish to build the components of the

reactor in facilities all over the world.

The task of making the million or so parts of Iter has been distributed among the seven partners. Iter will need 100,000km of superconducting wire for its magnets, for example – enough to wrap around the equator twice – which will be made in China, Japan, Russia, South Korea and the US. The magnets are being built in pieces in France and also China. The vacuum chamber, which will contain the hot hydrogen gas, will come in pieces from South Korea and also parts of Europe.

Getting all of this to the site in Cadarache is a huge logistical challenge. The giant magnets and vacuum chambers will begin arriving this month along a specially designated 104km road from the nearest Mediterranean port, known as the Iter Itinerary. The pieces will be enormous – the 18 D-shaped coils of wire that will make the main magnets each weigh 360 tonnes, approximately the same as a fully loaded jumbo jet. The heaviest component will weigh 900 tonnes including its transport vehicle and some will be more than 30m long; the tallest will rise four storeys from the road.

Part of this distribution of labour is to do with bringing jobs, money and prestige into hi-tech industries within the partner nations. But also, these countries will need their own expertise in building and running fusion power plants if Iter is successful and this form of power takes off.

Iter's job is to show that fusion can be achieved and controlled for sustained periods in the tokamak design. It will not be a power station itself: that is the job of the next generation of fusion reactors, which will be built by countries individually with knowledge gained from the Iter experiments and which are collectively known as "DEMO" projects. China has already started planning the precursor to its DEMO project, a test device called China Fusion Engineering Test Reactor. Construction could start by 2020 and the test plant could be in operation by the mid-2030s, ready to move on to building the first fusion power plants a decade or so after that. Plans to build DEMO power plants are at an earlier stage in Japan and South Korea. There are many hurdles to get over between Iter and a

commercial power plant – engineers need to come up with new materials for the walls of the vacuum vessels and the shielding around the plasma, for example. The high-grade steel being used in Iter is good enough to deal with the plasma and the radiation from the relatively small amounts of power (500MW) that will be produced there for a few minutes at a time, but commercial power plants will need much harder materials in order to deal with the result of a plasma producing three or four times that much power, day in, day out. If all the technical and design refinements in successive experimental reactors go to plan, it is expected that the very first fusion power plants could be producing electricity for the grid by 2045-2050.

It has always been a dark joke about nuclear fusion that a commercial power station is 30 years away and that it always will be. But Iter, despite its delays and cost overruns, might finally tip the balance. It's hard not to be hopeful that, because of the experiment under way in Cadarache, a commercial fusion reactor really is only 30 years off.

Indeed, if Iter gets its plasma working and scientists can extract more energy from the burn than they had to put in, it will change the world, says Cowley. "When this machine works I will be here, you know. The end of my career is going to be watching this machine do a fusion burn," he says. "There are probably, over history, a handful of historic moments where in a flash the future changed. In a flash the future will change with this machine... What this is going to show is that man can make a star."

Fusion facts: how to re-create a star on Earth

At the centre of our sun, the nuclei of hydrogen atoms (which are bare protons) are being jostled around under unimaginable pressures. Once in a while, two of them will overcome their mutual repulsion and fuse to form a nucleus of helium, releasing a little energy in the process.

It is not a straightforward process, however. Such is the repulsive force between protons that it takes millions of years to fuse two of them, even in the intense conditions within a star. Fusing bare hydrogen is therefore out of the question if you

want a power station to mimic the process on Earth, so physicists tend to use two of its isotopes instead, deuterium and tritium, which are heavier versions of hydrogen that contain one and two extra neutrons in their nuclei respectively. Deuterium is abundant in seawater – around one in every 6,000 molecules contains it – and tritium can be made by the fusion reactor itself. By heating the deuterium-tritium mixture to hundreds of millions of degrees celsius inside a ring-shaped vessel, the two elements fuse to form helium, energy and fast-moving neutrons. The neutrons will be absorbed by shielding around the reactor vessel that contains lithium, and this interaction will create more tritium.

There is a virtually limitless source of fuel in the world's oceans to feed future nuclear fusion reactors. And though there are some radioactive waste products that come from the process, they all have short half-lives and will become inert within a few hundred years, as opposed to the thousands of years for which waste from fission reactors stays dangerous.

Further, fusion power plants cannot go critical, produce runaway reactions or a meltdown in the way people sometimes worry about with nuclear fission. Like an internal combustion engine, fusion reactors will only burn the fuel put into them. And you only need a very small amount of fuel for each fusion burn in a large power station – tenths of a gram of the mixture will fill up the reactor – since the deuterium-tritium mixture is a million times more energy-dense than petrol.

Alok Jha is science correspondent for ITV News. You can see his visit to ITER as part of [On Assignment](#), ITV, 27 January at 10.40pm

4. Jay Weatherill appoints royal commission to debate SA nuclear industry

The Australian Financial Review

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South Australian Labor Premier Jay Weatherill has revived the politically volatile issue of whether Australia should use its rich uranium resources to found a nuclear industry by calling a royal commission into the possibility.

The initiative threatens to split the Labor party at a time when its political fortunes are recovering rapidly around the country from the low point in 2013, after the Rudd-Gillard government lost power and most states had fallen to the Coalition.

Labor's national policy platform remains staunchly opposed to any extension of the nuclear industry from uranium mining and sales into nuclear power in Australia.

"Federal Labor has a long-standing position on nuclear power, based on the best available expert advice," federal Opposition Leader Bill Shorten said.

But party elders, such as energy spokesman Gary Gray, former energy minister Martin Ferguson, former prime minister Bob Hawke and former Australian Workers Union secretary Paul Howes have backed the idea as a way to add value to Australia's vast -uranium resources, boost exports and generate reliable, carbon-free energy.

The idea is more popular among Coalition politicians, but they have been forced to run for cover by scare-mongering over the risk of nuclear -accidents, on the rare occasions they have raised it. Labor campaigned under Kevin Rudd in 2007 by saying a returned Howard government would build nuclear reactors in people's -backyards. The Nationals' Barnaby Joyce sought a debate in 2009 and Tony Abbott broached the issue when he became federal leader, but then Liberal Senate leader Nick Minchin said there was no community appetite for nuclear power.

Mr Weatherill's announcement of a royal commission opens the door for a nuclear industry to be set up in the state, which hosts one of the largest uranium deposits in the world at BHP Billiton's Olympic Dam, but has been hit hard by car assembly closures and uncertainty over ship and submarine building.

RISKS AND OPPORTUNITIES INVESTIGATION

He will set up a royal commission to look at the risks and opportunities in expanding the industry to include enrichment, energy and storage to both deliver better economic growth and help alleviate climate change. "The question is whether we should deepen our involvement for our -benefit," Mr Weatherill said at a press conference on Sunday.

He said consultation on the terms of the royal commission would start on Monday, and it would call on experts from a broad range of fields.

The Minerals Council of Australia backed the move wholeheartedly.

Dan Zavattiero, executive director of the uranium division of the Minerals Council said the move by Mr Weatherill “should be widely applauded”.

“It is clear nuclear power will play a critical role in sustainably producing electricity in the world, in the 21st -century,” he said.

Mr Weatherill said he had -previously been opposed to the nuclear industry but it was time to have a -wide-ranging debate about the whole issue.

“This is not going to be a short debate, this is going to be an extended debate,” he said.

He declined to put a time frame on when the royal -commission might report, and -emphasised that any changes would need to go through the political process and have -community support.

South Australia hosts four out of five of Australia’s uranium mines, with ERA’s Ranger mine in the Northern Territory the other mine.

The others in SA beside Olympic Dam are -Honeymoon, Beverley and Four Mile.

But some of the smaller uranium mines in far north South Australia are mothballed because of a slump in -uranium prices, which happened after the nuclear reactor disaster in Japan at Fukushima in 2011.

MANY PROPOSALS FROM COMPANIES

Mr Weatherill said he hadn’t yet -consulted BHP, which is still working on new lower-cost expansion plans for the Olympic Dam copper and uranium mine, 560 kilometres north of Adelaide.

But he said there had been many -proposals advanced by various companies over the years seeking to set up nuclear projects in far north SA, which has -stable geology and is considered ideal for nuclear storage.

“There’ve been many proposals that have been advanced by companies almost on a regular basis,” Mr Weatherill said.

BHP in 2012 scrapped a planned \$30 billion expansion of the Olympic Dam mine because of falling copper and uranium prices, in a big blow to the South Australian economy.

South Australia is host to about 30 per cent of the world’s known -uranium deposits and supplies about 7 per cent of the world’s uranium.

Mr Weatherill said the royal commission would look closely at all phases of the nuclear cycle including mining, enrichment, energy and storage.

“The truth is we are already in the nuclear fuel cycle. I mean we are selling uranium to the world,” he said.

This had been the case for more than 25 years. Olympic Dam mine began exporting uranium soon after it became operational in the late 1980s. The mine’s owner WMC was later acquired by BHP. Mr Weatherill said the nuclear debate needed to be carried out in a way that “understands the potential -economic benefits for our state and our nation”.

He said the matter had been -discussed in State cabinet, and he was entitled to change his mind from earlier in his political career, when he had been a fierce opponent.

MOTHBALLED MINES

“When the facts change, people should change their mind,” he said.

Uranium prices fell more than -50 per cent after the meltdown of the -Fukushima nuclear reactor in 2011 but have since partially recovered.

The Honeymoon mine in northern SA, owned by a subsidiary of United States nuclear giant General Atomics was mothballed in 2013, and the -Beverley mine followed soon after. But the nearby Four Mile mine has -uranium processed at Beverley.

South Australian Opposition Leader Steven Marshall said he would support holding an inquiry into the issues, but warned that Mr Weatherill was using the issue as a distraction from a crisis in the state’s hospital system.

The Labor Party at a federal level in 1983 put in place a three-mines -uranium policy under then prime -minister Bob Hawke but this was axed by coalition Prime Minister John Howard in 1996 after he won government, meaning more mines could open.

Plans for a resurgence of nuclear power station building in some western countries were shelved after the -Fukushima nuclear disaster in 2011, and Japan and Germany moved to close much of their nuclear industry.

But emerging giants China and India are rapidly expanding their nuclear power industries and Japan is considering re-opening its more modern nuclear reactors amid difficulties obtaining alternative energy supplies on global markets.

Proponents say nuclear power is a proven way to generate reliable -carbon emissions-free power and that modern “third generation”

and “fourth generation” reactors are much safer than older reactors of the 1970s generation that melted down at Fukushima.

5. Dino Grandoni

Dino.Grandoni@huffingtonpost.com

author social buttons

Why It's Taking The U.S. So Long To Make Fusion Energy Work

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LAINSBORO, N.J. -- Hidden in the woods two miles from Princeton University's main campus sits a drab white building easily mistakable for a warehouse. Inside is one of the Ivy League school's most expensive experiments: a 22-foot-tall metal spheroid surrounded by Crayola-colored magnets.

About half a dozen blue beams ring the sphere horizontally, while another set, painted red, rise vertically from the floor to wrap the contraption, like fingers clutching a ball.

Last fall, construction workers hustled to finish an upgrade to yet another magnet, this one jutting through the center of the sphere like a Roman column. On a recent November afternoon, Michael Williams, the lab's head of engineering, weaved his way through workers and up a stainless steel scaffolding to get a better view.

"Fusion is an expensive science, because you're trying to build a sun in a bottle," Williams said.

This endeavor in the New Jersey woods, known as the National Spherical Torus Experiment, was created to study the physics of plasma, in the hopes that one day humans will be able to harness a new source of energy based on the reactions that power stars. The project has been shut down for two years

to undergo an upgrade that will double its power. The improvement costs \$94 million, and is paid for -- like the rest of the Princeton Plasma Physics Lab -- by the U.S. Department of Energy.

Impressive as it may appear, this experiment is small compared to what once stood there. Earlier in the day, while walking over to the site from his office, Williams pointed out a sign on the National Spherical Torus Experiment building that read "TFTR." The abbreviation stands for Tokamak Fusion Test Reactor, a bigger, more promising fusion experiment that was scrapped in the mid-1990s.

"I keep telling them to take that down," he said.

The history of the U.S. Department of Energy's magnetic fusion program is littered with half-completed experiments and never-realized ideas. Currently, the most ambitious project in all of fusion work is the International Thermonuclear Experimental Reactor, or ITER, a collaborative scientific effort backed by the European Union and six other nations, including the United States. Once it's built in southern France, ITER will be largest fusion reactor ever. The plans for this project dwarf the three similar U.S. fusion experiments, including the one at Princeton, in both scale and expense.

But ITER is sputtering with delayed construction and ballooning costs, and U.S. physicists are increasingly worried that their work at home, such as the National Spherical Torus Experiment, will be sidelined to fund the international project. They see the domestic research as crucial to understanding the nature of the plasma used in certain fusion reactions -- crucial, even, to getting facilities like ITER built in the first place.

Meanwhile, critics view magnetic fusion research as a money-wasting boondoggle that will never be able to produce energy as cheaply as methods like solar and wind power.

After the visit to the facility, Williams returned to his office and I met with his boss, Stewart Prager, the head of the Princeton lab. Sitting in a tidy glass-paneled office overlooking the woods, he recalled an old joke about fusion -- it was "30 years away 30 years ago, and it's 30 years away now" -- and explained why the quip has taken hold.

"The true pioneers in the field didn't fully appreciate how hard

a scientific problem it would be," he said.

But then he added: "Even having said that, if you look back at documents from the past, they laid out how much it would cost. That amount of money was never nearly delivered." Fusion scientists make an incredible proposition: We can power our cities, they say, with miniature, vacuum-sealed stars. According to those who study it, the benefits of fusion power, if it ever came to fruition, would be enormous. It requires no carbon drawn from the ground. Its fuel -- hydrogen harvested from seawater -- is inexhaustible. It emits no gases that warm the planet. And unlike its cousin fission, which is currently used in nuclear power plants, fusion produces little radioactive waste, and what it does produce can be recycled by the reactor. The only hurdle, as many U.S. physicists tell it, is the billions of dollars needed before the first commercially viable watt of power is produced. Researchers lament the fact that the U.S. hasn't articulated a date for when it hopes to have fusion go online, while China and South Korea have set timetables to put fusion online in the 2040s.

A so-called magnetic confinement fusion reactor would work by spinning a cloud of hydrogen until it reaches several hundred million degrees Celsius -- at which point it would be so hot that no known material could contain it. Instead, high-powered magnets in a vacuum would envelop the ring of hydrogen plasma.

Spun with enough heat and pressure, the positively charged hydrogen atoms, stripped of their electrons, would begin to overcome their usual tendency to stay apart. They would fuse into helium, spitting out an extra neutron. When those neutrons embed into a surrounding blanket of lithium, they would warm it enough to boil water, spin a turbine and make electricity. The long-term goal is to create a self-sustaining reaction that produces more energy than is put in.

The oil shortages of the 1970s kick-started federally funded fusion research. When petroleum-pumping nations in Middle East turned off the spigot in 1973 and then again in 1979, much of the world, including the U.S., was rattled by gas shortages and high prices. With Americans waiting in mile-long lines to fill up their tanks, there was a keen national interest in finding any fuel to replace oil.

The crises prompted Congress and President Jimmy Carter to create the Department of Energy, which immediately began to channel funding into alternative energy programs, including fusion. By the end of the '70s, experimental reactors were being built at the Massachusetts Institute of Technology and at Princeton -- including the latter's Tokamak Fusion Test Reactor, the "TFTR" whose outdated sign Michael Williams now walks past.

Adjusted for inflation, the U.S. was spending over \$1 billion per year on magnetic confinement fusion research by 1977, according to Department of Energy figures collected by Fusion Power Associates, a nonprofit that promotes fusion research. But by the time Ronald Reagan was elected president in 1980, gas prices had dropped. Eyeing cuts to government spending, Reagan and his Republican colleagues in Congress tightened funding for research into fusion and other alternative energy sources.

"The Republicans hated the Department of Energy because they were messing around with the private sector energy business," said Steve Dean, a former Department of Energy official who oversaw fusion experiments in the 1970s and now runs Fusion Power Associates.

In 1984, however, as the Cold War thawed, Reagan inked a deal with the Soviet Union, along with Europe and Japan, to fund and build what would become ITER. India, China and South Korea would eventually sign up as well. And even with the downturn in U.S. funding, investments made in the '70s started paying off. In 1994, Princeton's TFTR produced what was then a record-breaking 10 megawatts, enough energy to keep 3,000 homes lit for... well, for nearly a second.

Actually, less than one second of power is a bigger deal than it might at first seem. Fusion research can only advance in baby steps across generations of scientists, say experts. First, their goal is to build a multimillion-dollar reactor capable of sustaining plasma for a second. Then, perhaps within a decade of achieving that, their goal is to construct yet another reactor that keeps the plasma going for a minute. It's all part of a painstaking march toward creating a self-sustaining reaction that lasts indefinitely.

"One would have expected these ground breaking results to

lead to an upsurge on fusion funding in the U.S.," said Dale Meade, the former deputy director of the Princeton lab, in an email to HuffPost. "It didn't."

Several months later, in Washington, D.C., then-Rep. Newt Gingrich (R-Ga.) gavelled in his first session as Speaker of the House. The GOP-led Congress soon slashed spending yet again in order to balance the federal budget.

"It was a lot of people losing their jobs and being knocked out of the field," said Raymond Fonck, an experimental fusion physicist at the University of Wisconsin who did some work on TFTR. "Some people left the field out of disgust."

Overnight, funding for magnetic fusion research fell by 33 percent -- some \$173 million in today's dollars. Princeton's TFTR was shut down. Plans for a new machine to be built where TFTR stood were postponed indefinitely. (Today, the National Spherical Torus Experiment stands on that site.) And the U.S. pulled out of its agreement to help fund ITER, citing cost concerns -- only to **rejoin a few years later**.

The magnetic fusion program "never really recovered from that budget cut," said Meade.

With less money available, the Department of Energy went ahead and funded a less expensive experiment at Princeton that became the National Spherical Torus Experiment, which began operating in 1999. All the while, Europe maintained its magnetic fusion program, and China and South Korea each started programs of their own. (In fact, designs for the scrapped U.S. experiment were eventually incorporated into reactors built in both countries.)

Magnetic fusion researchers received \$505 million from the federal government for the 2014 fiscal year -- about half of what they used to get, when adjusted for inflation. About \$200 million of that pot went overseas to help build ITER.

And even with the downturn since the 1980s, critics still say the program receives too much funding given that it has yet to build an economically viable reactor.

"The magnetic fusion energy program is one of these programs that gets a steady flow of money like clockwork, although it may not receive on a constant dollar basis what it used to," said Robert Alvarez, a former senior policy adviser for the Energy Department who now works at the Institute for Policy

Studies, a Washington think tank. "But it still commands a great deal of money in the energy research and development portfolio. You've got to ask yourself: When is it time to fish or cut bait on this?"

Alvarez and other skeptics believe that magnetic fusion will never be inexpensive enough to compete with other sustainable energy sources, because new fusion reactors require billions of dollars to build and decades to complete. "At \$10 to \$20 billion a pop, it just doesn't lend itself to innovation like wind or solar," said Thomas Cochran, a consultant with the Natural Resources Defense Council. He added that the "people who are closest to the technology" are unable to see the dead ends.

While money for magnetic fusion was cut during the '90s, funding for an alternate form of fusion, called inertial confinement fusion, took a dramatic leap. After the U.S. signed a treaty banning nuclear weapons testing, Congress paid for the construction of the world's largest laser 40 miles east of San Francisco, designed to compress a pellet of hydrogen with enough heat and pressure for its atoms to fuse into helium.

The laser-based approach to fusion is meant to offer both a potential new energy source and a way to develop hydrogen bombs without actually blowing anything up. Its early years, however, have not been entirely trouble-free. After falling five years behind schedule, going three times over budget and failing to achieve its 2012 goal of producing a self-sustaining reaction, the laser was labeled a fiasco by critics. Finally, though, the lab was able to **produce** its first significant fusion reaction in 2013.

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lthough magnetic fusion is further along, the stumbles of inertial confinement may have given all of fusion research a black eye. With magnetic fusion, the Department of Energy is under yet another budgetary constraint today. Eleven years behind schedule and crippled by decentralized management, ITER is becoming increasingly expensive. The U.S. is obligated

to fund about 9 percent of the project, and what was once a \$1 billion commitment is swelling beyond the \$4 billion mark. With Congress gridlocked, the money must come from within the department. In October, a Department of Energy advisory committee floated the idea of shutting down the fusion reactor at MIT, and, if necessary, shutting down one of the two other experimental reactors in the U.S. (the one at Princeton or another at General Atomics in San Diego). Even though the resolution was non-binding, the decision **drew the ire** of many fusion physicists. Fifty experts signed an emphatic letter to the department saying that the "underlying strategic vision that guides this report is flawed."

"The DOE is committed to creating opportunities for its fusion researchers to assert strong leadership in the next decade and beyond," said Ed Synakowski, the associate director at the Department of Energy who oversees fusion funding. He said that while the department has proposed closing the MIT lab, it would close one of the other two reactors only under dire budgetary conditions.

Earlier this year, the Obama administration slated the reactor at MIT for closure. **An aggressive lobbying effort** by Massachusetts politicians was the only thing that kept it open. The possible closures have put the fusion community on edge. But what some find more worrying is the idea that the young scientific minds needed to tackle this multi-generational problem will instead look for careers in disciplines that are better funded and more stable.

"The older generation," said Fonck, "we get concerned that the younger generation will say, 'Well, there's no jobs in this field.'"

6. **Energy and technology**

Let there be light

Thanks to better technology and improved efficiency, energy is becoming cleaner and more plentiful—whatever the price of oil, says Edward Lucas

Jan 17th 2015 | From the print edition

<http://www.economist.com/news/special-report/21639014-thanks-better-technology-and-improved-efficiency-energy-becoming-cleaner-and-more>

A CAREFUL OBSERVER might note the chunky double glazing on the elegant windows and the heat pump whirring outside the basement entrance. From the outside the five-storey house in London's posh Notting Hill district looks like any other. Inside, though, it is full of new technologies that aim to make it a net exporter of power. They exemplify many of the shifts now under way that are making energy cleaner, more plentiful, cheaper to store, easier to distribute and capable of being used more intelligently. The house in Notting Hill is a one-off, paid for by its green multimillionaire owner. But the benefits of recent innovations can be reaped by everybody.

That makes a welcome change from the two issues that have dominated the debate about energy in the past few decades: scarcity and concerns about the environment. Modern life is based on the ubiquitous use of fossil fuels, all of which have big disadvantages. Coal, the cheapest and most abundant, has been the dirtiest, contributing to rising emissions. Oil supplies have been vulnerable to geopolitical shocks and price collusion by producers. Natural gas has mostly come by pipeline—and often with serious political baggage, as in the case of Europe's dependence on Russia. Nuclear power is beset by political troubles, heightened by public alarm after the accident at Japan's Fukushima power station in 2011. Renewables such as wind and solar—beneficiaries of lavish subsidies—have so far played a marginal role. The main worries were whether enough energy would be available for power generation, transport, heating, cooling and industry; and if so, whether it would cook the planet.

Now new factors are in play. Technological change has broken the power of the Organisation of the Petroleum Exporting Countries (OPEC) to keep the oil price high. Hydraulic fracturing (“fracking”) and horizontal drilling have turned America into a big oil producer, with 4m barrels a day coming from sources which used to be deemed “unconventional”. The boom in producing oil and gas from shale has yet to spread to other countries. America enjoys some big advantages, such as open spaces, accommodating laws, a well-developed supply chain and abundant finance for

risky projects. So far it has refrained from exporting its crude oil or natural gas, but exports of liquefied natural gas (LNG) will start this year. Increased trade in LNG will create a more global gas market and greater resilience of supply, undermining Russia's pipeline monopoly in Europe. America is already exporting lightly refined oil.

An increase in supply, a surprising resilience in production in troubled places such as Iraq and Libya, and the determination of Saudi Arabia and its Gulf allies not to sacrifice market share in the face of falling demand have led to a spectacular plunge in the oil price, which has fallen by half from its 2014 high.

This has dealt a final blow to the notion of "peak oil". There is no shortage of hydrocarbons in the Earth's crust, and no sign that mankind is about to reach "peak technology" for extracting them. But the fall has created turmoil in financial markets as energy companies lay off workers and cut or delay investment projects.

The implications are more complicated than the headlines suggest. For a start, low prices do not instantly cause supply curbs or make investment dry up. Even costly projects do not stop pumping when the oil price falls. Fracking is a small-scale business. New projects can be halted quickly and restarted when the price picks up. American frackers are now the world's swing producers, reacting to price fluctuations in a way that was once the prerogative of the Saudis. On a 15- to 25-year time horizon, today's slide in the oil price needs to be set against the likely long-term trend. Futures markets are betting that the oil price will be back to \$90 per barrel in the early 2020s.

For now, though, low oil prices put money in consumers' pockets and give a bit of breathing space to governments, making it easier to cut fossil-fuel subsidies (and perhaps even tax carbon emissions). In 2013 some \$550 billion was spent on subsidising fossil fuels, a policy of extraordinary wrongheadedness that favours the rich, distorts economies and aggravates pollution.

A bigger question on many minds is the effect of rock-bottom oil prices on the shift towards low-carbon energy. Solar, wind and other renewables have recently benefited from unprecedented investments: an average of \$260 billion a year

worldwide over the past five years. Long, and wrongly, decried as mere boondoggles, they have begun to show real commercial promise in places as diverse as India, Hawaii, and parts of Africa where the climate is favourable, costs are low and other sources of power are expensive. Renewables capacity is rising even as subsidies are falling. China, for example, has already installed nearly half the 200 gigawatts (GW) of wind power it had been planning for 2020, so it is sharply cutting back the subsidies it introduced in 2009. But the relationship is not always straightforward. Renewable electricity mainly competes with gas- and coal-fired power stations, not with oil. In North America, low oil prices may, paradoxically, lead to higher natural gas prices. Less fracking means there will be less of the associated gas that is produced along with shale oil. More broadly, much of the support for renewables has been political, and there is little sign that this is changing. Worries about climate change continue to ensure that clean energy enjoys strong political support in many developed countries. Whereas shares in oil companies have in recent months fallen along with the price, the S&P Global Clean Energy Index, which covers the industry's 30 biggest listed companies, has barely budged. The economics—and particularly the whopping subsidies of the past decade paid out in countries such as Germany and Britain—remain contested. Solar and wind are intermittent, so they are truly useful only if the power they produce can be stored; otherwise they need back-up capacity, typically from fossil-fuel sources. Dieter Helm, an energy expert at Oxford University, says that subsidies for primitive green technology, such as the current generation of solar panels, have been a “colossal mistake”. It would have been much better, he argues, to invest in proven technologies such as electrical interconnectors (linking Britain and Norway, for example) and support research into new kinds of solar power, such as films that can be applied to any outside surface and technologies that use a wider chunk of the spectrum. Bits of the green-energy world are wilting under the impact of low oil prices. Some biofuels have become less attractive. The same is true for electric cars, which currently make up less than 1% of America's light-vehicle fleet. Bloomberg New

Energy Finance reckons that with petrol at \$3.34 a gallon (\$0.87 per litre), that share could rise to 9% by 2020. With petrol at \$2.09, it would go up to just 6%. At the same time countries and companies thinking of switching from oil-fired power generation to renewables may reconsider. Saudi Arabia, for example, was planning to invest \$110 billion in 41 GW of solar capacity by 2032, but may now want to think again.

Take the long view

Yet the long-term trend is clear. In particular solar electricity, and ways of storing it, are getting ever cheaper and better, as this special report will show. Sanford C. Bernstein, a research firm, sees “global energy deflation” ahead. Most of the investment decisions in the fossil-fuel industry are taken a decade or two ahead. The International Energy Agency (IEA), an intergovernmental organisation often criticised for its focus on fossil fuels, says the world will need to stump up about \$23 trillion over the next 20 years to finance continued fossil-fuel extraction, but the prospect of much cheaper solar power and storage capability may put investors off. The story may be not so much what falling oil prices mean for clean energy than what the prospect of clean energy will mean for the oil price. Old energy industries are changing too. Gas will become more abundant and easier to trade. Even coal, the most widely used and so far most polluting fossil fuel, is not inherently dirty. It does not need to be burned but can be cooked instead to produce methane, which can then be used as a fuel or in petrochemicals. Modern coal-fired plants, though pricey, are far cleaner than the belching monsters of the past. The heat they produce is used, not wasted as in many traditional power plants. The emissions are scrubbed of the oxides (of nitrogen and sulphur) that eat away at bodies and buildings. In some projects—albeit for now on a tiny scale—the CO₂ is also captured for storage or use. Such improvements could make coal as relatively clean as other fossil fuels, though they make commercial sense only if the rules are tilted in their favour. But if the price of such techniques comes down and the cost of pollution goes up, clean coal could be competitive. Nuclear power, in theory, is a source of cheap, dependable, constant electricity. In practice it is too costly for private

investors to back without government guarantees, and its perceived danger makes it unpopular in some European countries and in Japan. One of several flaws in Germany's *Energiewende*—supposedly a big shift to green technology—was the hurried abandonment of the country's nuclear capacity. Besides, many of the world's existing nuclear power stations will have to close in the coming two decades. Barring a political shift or a technological breakthrough—perhaps in small, mass-produced nuclear plants—it is hard to see the fortunes of nuclear energy reviving.

Demand for energy is likely to hold up for some time yet, mainly thanks to rapid economic growth in emerging economies. The IEA predicts that over the next 25 years it will rise by 37%. Yet increasing efficiency in energy use and changes in behaviour have meant that the hitherto well-established link between economic growth and energy use is weakening.

More for less

America's economy, for example, has grown by around 9% since 2007, whereas demand for finished petroleum products has dropped by nearly 11%. In Germany household consumption of electricity is now lower than it was in 1990. Global demand used to rise by 2% a year, but the rate is slowing. Even emissions in China, the world's largest and dirtiest energy consumer, may peak by 2030, thanks to huge investments in new clean-coal power generation, nuclear and renewable energy and long-distance transmission lines.

Simon Daniel, an energy expert, sees two conflicting trends: on one hand greater efficiency, local production and storage, on the other increased consumption from the billions of new devices that will be hooked up to the "internet of things".

On current form the emissions from oil, gas and coal would, on most models, make it impossible to keep the rise in global temperatures below 2°C by the year 2100; the most likely outcome would be a 4°C rise, which has prompted calls for most of the world's remaining hydrocarbons to be left in the ground. The IEA estimates the investment needed for "decarbonising" future electricity production alone at an astounding \$44 trillion. The best hope of avoiding that much warming is a huge increase in energy efficiency.

One big component of that task will be to adapt the existing stock of buildings. Amory Lovins, one of the foremost prophets of energy efficiency and founder of Rocky Mountain Institute, a think-tank and consultancy based in Colorado, believes that the scope for improvement remains huge. He has long preached that proper building design and energy storage can eliminate the need for air-conditioning and space heating in most climates, and illustrates this by growing bananas in his own house, on a windswept mountainside in Colorado where winter temperatures can drop to -44°C . Eliminating the heating system for his house, he says, saved more money than he spent on insulation and fancy windows. His optimism is slowly winning converts.

Despite all the obstacles, pretty much all the technology the world needs for a clean, green future is already available. As A.T. Kearney, a consultancy, notes in a recent report for the World Energy Council, a think-tank: “Energy-efficiency potentials combined with renewable-energy sources and shale-gas potentials provide an abundance of energy that can be made accessible with currently available technologies.” Transmission costs for electricity are plunging, thanks to solid-state technology, which makes efficient direct-current circuitry safer and more flexible. Power grids which were previously isolated can now be connected: one audacious plan involves a 700-mile, £4 billion (\$6 billion) link between Britain and Iceland. Such projects are costly up front, but offer big long-term savings from cheaper power, better storage and increased resilience.

More effective management of supply and demand also offers scope for big savings, as this special report will show. Sensors can now collect vast amounts of data about energy use, and computer power and algorithms can crunch that information to offer incentives to customers to curb consumption at peak times and increase it when demand is low. At the same time business models which can turn a profit from thrifty energy use are developing, and capital markets are waking up to their potential.

That splendidly energy-efficient house in Notting Hill demonstrates just how much can be done right now, even if it does not yet come cheap. Its owner, Michael Liebreich,

founded a business called New Energy Finance, which he sold to Bloomberg, a financial-information company, in 2009. He has spent tens of thousands of pounds on making his home thrifty, resilient and productive.

The house is no stranger to energy revolutions. In 1865 its original builders installed a state-of-the-art delivery and storage system: a coal hole in the pavement, sealed by a handsome cast-iron hatch. Gas and then electric lighting, central heating and hot water came later. But the revolution under its current owner is the biggest yet. Despite the airtight insulation the rooms feel airy. Specially designed chimney cowls suck stale, moist air from the house while a heat exchanger keeps the thermal energy indoors.

The house now requires remarkably little input of energy. Gas and electricity bills for a dwelling of this size would normally run to at least £3,500 (\$5,500) a year, but once everything is in place the owner expects not only to spend nothing but to receive a net payment for the electricity he produces. On the roof is a large array of solar panels which deliver two kilowatts (kW) of electricity on sunny days. Another source of power is a 1.5kW fuel cell in the former coal bunker. It runs on gas, with over 80% efficiency—far more than a conventional power station or boiler. The electricity from these two sources powers the household's (ultra-frugal) domestic appliances and its low-energy lighting, as well as a heat pump (a refrigerator in reverse) that provides underfloor heating. A water tank stores surplus heat. Spare electricity is fed back into the grid. Mr Liebreich does not claim that his house is easily copied, but he insists that through "thinning mist" the future is visible. "The only things that are inherently costly are the thermodynamic process and resource depletion—for everything else costs have come down, are coming down and will come down in future," he says. In short, most of the forces changing the energy market are pushing in the right direction.

7. Tidal power scheme backs UK engineering with turbine work coming to UK

Project to generate electricity from tides in Swansea Bay appoints GE-Andritz consortium to build turbines

Daily Telegraph

<http://www.telegraph.co.uk/finance/newsbysector/industry/engineering/11400932/Tidal-power-scheme-backs-UK-engineering-with-turbine-work-coming-to-UK.html>

British engineering companies will play a major role in producing the huge turbines which will generate environmentally friendly energy in a ground-breaking £1bn project to harness the power of the tide.

Tidal Lagoon Power's plan to build a huge lagoon in Swansea Bay which generates power from the movement of the sea has announced a General Electric-Andritz Hydro consortium as the winner of a £300m contract to build the 16 turbines the scheme will use.

As part of the contract, GE and Andritz, which are headquartered in the US and Austria respectively, have committed to produce majority of the turbines' major components in the UK, along with all of the generators they contain. The generators, the highest value component of the turbines, will be built at GE's plant in Rugby.

The turbines generate power by taking advantage of the rise and fall of the tide in Swansea Bay, which at between 20ft and 30ft, is one of the highest in the world.

This is harnessed by building a huge seawall with 16 turbines mounted in it. As the tide rises they spin, generating power, as water flows through them and fills up the lagoon.

Once the tide turns, this process is reversed, letting water out of the lagoon, with the turbines – each 60ft long, 20ft high and capable producing 20 megawatts per hour – again generating power from the flow of water as the lagoon empties.

Click here for a film explaining how the system works.

Due to come into service in 2019, the lagoon project involves creating an enclosed body of water by building a 6.5 mile seawall which will also contain the generators.

As well as being the first of its kind and expected to generate enough energy to power 155,000 homes, the Swansea lagoon is hoped to act as a proof of concept for five larger lagoons around the UK. Together it is hoped they will provide 8pc of the UK's energy.

These will each need more than 60 of the 700-tonne turbines, creating a new manufacturing sector in the UK, and could put

Britain at centre of a new industry which has the potential for new export markets.

Stephen Crabb, Secretary of State for Wales, said: “This project, if planning consent is granted, has the potential to transform the South Wales economy by creating hundreds of jobs and countless supply chain opportunities for local businesses across the region. “It would also help secure our nation’s energy future and position Wales as a pioneer in low carbon technology. That’s why I am right behind this scheme and want to see it built in Wales..”

Mark Shorrocks, chief executive of Tidal Lagoon Power, said: “Tidal lagoons will employ British industry to harness a British natural resource and return profits to British institutions. We are now well placed to meet the targets we set ourselves for 50pc of the capital expenditure for the Swansea Bay Tidal Lagoon to stay in Wales, rising to 65pc for the UK as a whole.

“The project will lay the strongest possible foundations for a brand new industry in which Britain can lead the world.”

8. ENERGY & ENVIRONMENT

Worry for Solar Projects After End of Tax Credits

By DIANE CARDWELLJAN. 25, 2015

http://www.nytimes.com/2015/01/26/business/worry-for-solar-projects-after-end-of-tax-credits.html?_r=0

For more than a year now, an enormous solar thermal power plant has been humming along in the Arizona desert, sending out power as needed, even well after sunset. The plant, called Solana, was developed by the Spanish energy and technology company Abengoa and has succeeded in meeting an elusive solar goal — producing electricity when the sun is not shining — and displacing fossil-fuel-based power in the grid.

“With the sun going down at 6 or 7 o’clock at night, all the other forms of solar production are essentially going to zero,” said Brad Albert, general manager for resource management at Arizona Public Service, the state’s main utility, “while Solana is still producing at full power capability. It just adds a whole lot of value to us because

our customer demand is so high even after the sun goes down.”

Indeed, Abengoa opened another mammoth plant on Friday in the Mojave Desert in California that uses a similar approach. But despite the technology’s success, Abengoa and other developers say they do not have plans at the moment to build more such plants in the United States.

And that is largely because of uncertainty surrounding an important tax credit worth 30 percent of a project’s cost. Although the subsidy, known as the Investment Tax Credit, is to remain in place until the end of 2016, when it will drop to 10 percent, that does not give developers enough time to get through the long process of securing land, permits, financing and power-purchase agreements, executives and analysts say.

“It is difficult to start construction of new facilities until there is clarity,” said Santiago Seage, chief executive of Abengoa Yield, a publicly traded subsidiary created last year to own and manage power plants.

But the difficulty is not because of any shortcomings in the technology. The Solana plant uses a network of parabolic mirrors that focus sunlight on pipes that carry the heat to tanks of salt. It can stay there for up to six hours until the plant pulls it out to make steam for electricity. A result is a source of power that can help a utility smooth variations in output from renewable power sources like solar and wind. The Mojave plant, which does not include the molten salt storage, is expected to supply enough power for 91,000 homes throughout Northern and Central California, under a long-term contract with Pacific Gas and Electric.

Ken Johnson, chief spokesman for the Solar Energy Industries Association, the main solar trade group, said that his group planned to lobby Congress to extend the credit beyond 2016. “That’s our top priority for this session of Congress,” he said, adding that developers across the solar industry were “trying to do as much as possible before it drops to 10 percent in 2017.”

In addition to the tax credit, the existing solar thermal plants have benefited from heavy government support in the form of loan guarantees — \$1.2 billion in the case of the Mojave plant — but that program is no longer active. As a result, utility-scale development, which accounted for almost two-thirds of the nation's solar capacity installed last year, according to industry estimates, could drop off.

For example, BrightSource, which last year [opened the vast Ivanpah solar plant](#) in the Mojave Desert, also has no additional projects set for construction in the United States, said Joseph Desmond, senior vice president for marketing and government affairs, through a spokeswoman. Instead, he said, the company is focused on other countries, including China and Israel.

And Abengoa and BrightSource last year withdrew plans to develop another big project in California, called Palen, over investors' concern that the tax credit would expire. Still, analysts say, companies have been preparing for a decrease in the tax credit.

“Solar technology companies have been aware of this expected decrease well in advance, so a lot of them have responded by really implementing cost reductions into their technology development,” said Mark Barineau, an analyst at Lux Research.

Mr. Barineau added that demand for solar projects, especially conventional ones, would remain strong and that there was optimism that the credit could be extended, in part because the industry had been creating thousands of new jobs every year.

The industry is also looking to other financial mechanisms to spur interest from investors.

Congress, for example, is weighing allowing solar projects to use master limited partnerships, investment vehicles that are open to the oil and gas industries. Advocates and solar executives are also urging the Obama administration to expand its proposal to include solar projects in real estate investment trusts to cover large-scale solar farms as

well. Both vehicles let companies take advantage of tax benefits unavailable to more traditional companies, passing along much of their income directly to investors. Where those efforts will go is anybody's guess, especially given the changing political dynamics in Washington. "There is significant momentum in Congress now for eliminating many of the 42 existing energy tax subsidies," with Republicans largely against subsidies for renewables and Democrats largely against those for fossil fuels, said Paul Bledsoe, a former Senate Finance Committee staff member who is now an energy fellow at the German Marshall Fund.

The broader question, he added, was whether the government could find a way to phase out incentives over the next few years and "replace them with a more technology-neutral approach, like extending master limited partnerships."

Dan W. Reicher, executive director of the Steyer-Taylor Center for Energy Policy and Finance at Stanford University, who has been urging that approach, said that the Obama administration was also taking input on ways to phase out the credit that might give the industry "a smoother glide path" toward its elimination.

"Could you have a gradual, multiyear phaseout of this from 30 to zero, instead of a cliff next year from 30 down to 10, and then 10 continues indefinitely?" he said, adding that a long-term extension of the credit "has serious political challenges these days."

Correction: January 28, 2015

An article on Monday about a slowdown in the development of solar thermal plants because of uncertainty over continuation of a federal tax credit described incorrectly the design of the Spanish company Abengoa's Mojave Desert plant in California. Its parabolic solar panels concentrate heat to produce steam, but, unlike Abengoa's Solana plant in Arizona, it does not have salt tanks to store the heat.

Climate Change's Bottom Line

By BURT HELMJAN. 31, 2015

<http://www.nytimes.com/2015/02/01/business/energy-environment/climate-changes-bottom-line.html>

It was 8 degrees in Minneapolis on a recent January day, and out on Interstate 394, snow whipped against the windshields of drivers on their morning commutes. But inside the offices of Cargill, the food conglomerate, Greg Page, the company's executive chairman, felt compelled to talk about [global warming](#).

"It would be irresponsible not to contemplate it," Mr. Page said, bundled up in a wool sport coat layered over a zip-up sweater. "I'm 63 years old, and I've grown up in the upper latitudes. I've seen too much change to presume we might not get more."

Mr. Page is not a typical environmental activist. He says he doesn't know — or particularly care — whether human activity causes climate change. He doesn't give much serious thought to apocalyptic predictions of unbearably hot summers and endless storms.

But over the last nine months, he has lobbied members of Congress and urged farmers to take climate change seriously. He says that over the next 50 years, if nothing is done, crop yields in many states will most likely fall, the costs of cooling chicken farms will rise and floods will more frequently swamp the railroads that transport food in the United States. He wants American agribusiness to be ready.

Mr. Page is a member of the Risky Business Project, an unusual collection of business and policy leaders determined to prepare American companies for climate change. It's a prestigious club, counting a former senator, five former White House cabinet members, two former mayors and two billionaires in the group. The 10 men and

women who serve on the governing committee don't agree on much. Some are Democrats, some Republicans. Even when it comes to dealing with climate change, they have very different perspectives. Some advocate a national carbon tax, some want to mandate companies to disclose their climate risks. Mr. Page suggests that the world may be able to get by without any mandatory rules at all. Some members want to push investors to divest from fossil fuel companies. Several favor construction of the [Keystone XL](#) pipeline, while one member has spent more than \$1 million lobbying to stop it. But they all do agree on one issue: Shifts in weather over the next few decades will most likely cost American companies hundreds of billions of dollars, and they have no choice but to adapt.

The committee started in June as a way to promote a study that it commissioned, "[Risky Business: The Economic Risks of Climate Change in the United States.](#)" But it has since evolved into a loose network of missionaries who publicize the report's ominous data far and wide, in talks at the Clinton Global Initiative conference, briefings with the American Farm Bureau Federation and breakfast meetings with local chambers of commerce.

On Jan. 23, the group released the second chapter of the Risky Business project, focused on the effects on the Midwest: "[Heat in the Heartland.](#)" A report on California is next. With \$1.7 million in grants from the MacArthur Foundation and others, the group is hiring a full-time staff.

The group is led by three men: Tom Steyer, the hedge fund billionaire whose [super PAC](#) spent \$73 million last year attacking Republicans who denied climate change and promoting awareness of the issue; [Henry M. Paulson Jr.](#), the former chief executive of Goldman Sachs and the Treasury secretary under President George W. Bush; and [Michael R. Bloomberg](#), New York City's former mayor and the billionaire founder of the financial information company Bloomberg L.P. Each spent \$500,000 to

commission the Risky Business research and each has his own particular goals for the initiative, all of which would be served by making the climate threat feel real, immediate and potentially devastating to the business world.

Mr. Paulson wants companies to implement and regulators to enforce disclosure rules regarding climate risk and carbon emissions for publicly traded companies. Mr. Bloomberg views the work as a way to spur city governments and local businesses to work together on climate issues and not “kick the can down the road,” he said. Mr. Steyer sees the dollars-and-cents research as a way to neutralize conservatives’ arguments that environmental regulation always hurts business.

“One side argues morality and polar bears, and the other side argues jobs,” Mr. Steyer said. “You’re never going to win with polar bears.”

Embracing Adaptation

To understand how the Risky Business Project came to be, it’s helpful to look at how the climate change battle has been waged over the years. In the early days, discussion was focused on fixing the problem and staving off disaster. This has been the strategy environmentalists have used to respond to all sorts of risks for years: Scientists identify the harm, publicize it, debate with the responsible industry and expect legislators to take action.

The very idea of thinking about how to adapt to drastic environmental changes was basically considered taboo, an acknowledgment of defeat. “Earlier on, you wouldn’t use the ‘A’ word in polite conversation,” said Henry D. Jacoby, a professor at the Sloan School of Management at M.I.T. and a climate policy researcher

— the “A” word being “adaptation.”
“People thought you weren’t serious about mitigation. ‘Oh, you’re giving up.’”

But climate change defied that playbook. There was no immediate crisis to point to — no bird eggs laced with DDT, no acid rain corroding city monuments. There was no one industry to target or overwhelming constituency to push legislators.

“The rationalist, evidence-driven, faith in the political process approach to solving environmental problems has been really effective in many realms,” said Hal Harvey, who advised the Risky Business group and is chief executive of Energy Innovation, a green policy firm. “But it has done bupkis for climate change.”

Indecision and indifference have prevailed instead. A majority of Americans in 2014 surveys by [Pew Research](#) and [Gallup](#) acknowledged climate change was happening, and 83 percent of Americans say that without emissions reductions, global warming will be a problem in the future, according to a January survey conducted by The New York Times, Stanford University and the environmental group Resources for the Future. But in survey after [survey](#), those same Americans rank climate change at or near the bottom of pressing issues, far behind jobs, the economy and health care.

In the meantime, powerful lobbies, including fossil fuel groups, the U. S. Chamber of Commerce and the National Association of Manufacturers, stand in the way of regulation. Climate change has become a partisan issue — a cause for conservatives who fear government overreach. It was in this context that in November 2012, Mr. Steyer convened a meeting at his Pescadero, Calif., ranch. The month before, he had stepped down from running his

hedge fund, Farallon Capital Management, to devote himself to the environment. He wanted to devise a way to fight climate change more effectively, and he had assembled some highly regarded thinkers to help him brainstorm. Attendees included the environmentalists Bill McKibben and Mr. Harvey, and the political strategists John D. Podesta and Chris Lehane.

As cattle grazed on native grasses outside, and a water-filtering eco-sculpture bubbled on the patio, the participants tossed ideas around the kitchen table. Mr. McKibben discussed his fossil fuel divestment campaign. Others suggested stoking a social media groundswell. One suggested making life hard for climate change-denying politicians (the latter idea became the basis for Mr. Steyer's super PAC, NextGen Climate Action).

While Mr. Steyer was devising his political strategy, the staff at Next Generation, his nonprofit group, were at work trying to solve another critical question: How do you make climate change feel real and immediate for people?

Kate Gordon, senior vice president of Next Generation, Mr. Steyer's nonprofit, whose mission focuses on climate change and improving the economic prospects of families, found inspiration in a British report called the [Stern Review](#), published in 2006. It was an economic analysis, sponsored by the British government, which examined all the costs of climate change, eventually concluding that the price of curbing global warming paled compared with the costs of doing nothing.

Ms. Gordon pitched Mr. Steyer on an American version — what would become the Risky Business report. It would be a way to discuss in a practical, dollars-and-cents way how businesses would have to adapt to climate change, while also making a clear case for taking action to mitigate the coming environmental crises. He liked what he heard. The team wanted to bulletproof the report, so that public discussion would not become a politicized debate about their methods or their messengers. So they contracted an

economic research firm, the Rhodium Group. They also reached out to Mr. Paulson, a Republican, and Mr. Bloomberg, an independent, to see if they would co-sponsor the study and help form a bipartisan committee. Both agreed, and over the following summer and fall, the three enlisted other leaders through their personal networks.

Mr. Paulson called Mr. Page, whom he knew from the Latin America Conservation Council. Through a contact of Ms. Gordon's, they signed up Henry G. Cisneros, the former housing and urban development secretary under President Bill Clinton and now a real estate developer. Mr. Steyer called Robert E. Rubin, the former secretary of the Treasury under President Clinton and a longtime friend and mentor from their days at Goldman Sachs.

For some, like Mr. Cisneros, it was the first public involvement with climate change. For Mr. Rubin, it marked a change in perspective. During his time in the Clinton administration, the Treasury Department argued the aggressive emissions reductions proposed in the [Kyoto Protocol](#) would harm the economy. Mr. Rubin wouldn't make that argument now. "I think it's the existential threat of our day," he said. "Once you see it as having catastrophic impact, any economic argument follows that, because you're not going to have an economy."

Mr. Page's involvement with the committee was the subject of "a fairly energetic debate" within Cargill, he said. In the end, he decided to participate because the study was an analysis of potential outcomes, not one that purported to make concrete predictions or specific policy recommendations. He also figured it would be best to be involved in any report that planned to say something about his industry, especially one with such prominent backers. He didn't want them "using the Risky Business report to terrify the U.S. population about its food supply," he said.

Cargill "hasn't weighed in" on the regulatory debate, Mr.

Page said, because the company prefers to examine rules case by case. (“Is [cap-and-trade](#) per se bad? No. Is the way it was administered in Europe ineffective? Absolutely,” he said). Unlike other committee members, he seems to favor voluntary commitments to reduce greenhouse gases. Generally, the company is opposed to any regulation that will force it to shut plants, retire equipment or otherwise “destroy fixed capital,” he said.

In May 2014, the committee members gathered at the Bloomberg Philanthropies offices in Manhattan to hear two of the authors commissioned by the Rhodium Group — Robert E. Kopp, a climate scientist at Rutgers University, and Solomon M. Hsiang, an economic policy researcher at the University of California, Berkeley — present their findings. Among their conclusions if the status quo persisted: Climate change would increase energy demand in Texas by between 3.4 and 9.2 percent by midcentury. Crop yields in Missouri and Illinois would face a 15 percent decline over the next 25 years. And in the Northeast, annual property damage from severe storms — from hurricanes to blizzards — would likely increase \$11.1 billion, to a total of \$15.8 billion by the end of the century. Of all the members, Mr. Rubin is most preoccupied with the so-called tail risks — low-probability events where the most damage is done. Mr. Page, on the other hand, prefers to prepare for the most likely outcomes.

At the meeting in May, some of those differences were discussed. As the report was being put together, Cargill scientists had argued that the agriculture industry was well prepared to adapt to changes. Mr. Bloomberg was skeptical, Mr. Page recalled. During a break, Mr. Bloomberg took Mr. Page aside and peppered him with questions: Do these technologies exist? Or are you saying they will someday — “as in, we know there will be a cure for cancer, but we have no idea when or how?” Mr. Page said he respected Mr. Bloomberg’s diligence in seeking answers, although he maintained that adaptation was more a matter of execution for the food industry, not

research and development. “But the guy’s a good reporter, let’s put it that way,” Mr. Page said.

Light Touch With the Message

Mr. Paulson works on the upper floors of a skyscraper in downtown Chicago, with a conference room overlooking the Chicago River. In January, the wind across it is cutting, and ice floes drift along the sides. By midcentury, if the Risky Business report is right, those ice floes will be gone.

When Mr. Paulson speaks to local groups, he makes sure to bring data from the report tailored to their county. “I’m not just having an abstract conversation about climate being this big risk. I can say, ‘Let me tell you!’ ” he said, slapping the table. “Here’s what this is going to mean to you, your industry and your family. Suddenly people are interested.”

Mr. Cisneros says he uses a soft touch when speaking to real estate groups, so that people don’t feel lectured to. “I say, ‘This has not been my highest priority either, but it’s got my attention, and I want to share it with you,’ ” he said. He warns audiences to budget for spiraling insurance premiums in coastal states like Florida, and to keep in mind that in drought-prone regions like California’s Central Valley, water permits may become hard to acquire. Mr. Page treads especially lightly when addressing farmers’ groups, as he says they have been conditioned to think of global warming as a liberal euphemism for more regulation. Instead of coming right at the issue, he takes a circuitous route. “I ask simple questions: ‘Would you like universities to suspend research on seeds that grow in higher temperatures? Of course not! That’s all I’m saying!’ ” he said, raising his hands defensively. “You get people to acknowledge that they, too, have anxieties. It’s a micro-acknowledgment, not a macro-acknowledgment.” Through this kind of education, several committee members hope to recruit business leaders to the side that

helps, not hinders, the fight against climate change. “The whole point of all of this is that it can be mitigated,” Mr. Paulson said. “The enemies of what we’re trying to do are short-termism and a sense of hopelessness. But if we act soon we can avoid the worst outcomes and adapt.”

Even so, the committee members seem to have a long road ahead of them.

After meeting with Mr. Page, Jon Doggett, executive vice president of the National Corn Growers Association, said he was skeptical that the report would influence farmers much. His members need near-term incentives to cut greenhouse gases — immediate cost savings, government incentives and so forth, he said.

“Are we going to reduce greenhouse gas emissions today because we believe there’s an economic benefit 15 years from now? That’s way too hypothetical for a family-owned and operated business that has to make a payment this year,” Mr. Doggett said. “The banker doesn’t get paid in hypothetical dollars.”

Dale Moore, executive director of public policy for the American Farm Bureau Federation, which lobbies in Washington on behalf of farmers and ranchers, said he agreed with Mr. Page that climate seemed to be in a “more extreme cycle” and that agribusiness would do well to develop hardier seed strains. But the group’s members remain skeptical that humans cause climate change. They are part of a consortium opposing the Environmental Protection Agency’s new proposed rule limiting coal-fired power plants.

But not all business groups feel this way. The Seattle Metropolitan Chamber of Commerce parted ways with the national Chamber of Commerce in 2011 specifically because the views of Seattle members on climate change differed so drastically with the sort of climate-denying statements the national group was making. “We were hosting clean technology conferences,” said Maud Daudon, president of the group, “and they were issuing statements that came from an entirely different place.”

Bit by bit, the Risky Business Project's committee members hope to turn the tide, bringing Congress around to the way that a majority of Americans feels. "We've made progress on things like civil rights, smoking, gay marriage and other things that seemed impossible to move when businesspeople joined the silent majority," said Mr. Cisneros. "Congress tends not to act until the broad mainstream, including business, is aboard."

And if business feels the pain in its wallet, it will feel the heat to act, even on the coldest of days.

10. Cape Bridgewater wind farm operator Pacific Hydro rejects noise study

Posted Tue at 7:55am

<http://www.abc.net.au/news/2015-02-17/business-as-usual-for-wind-farm-operator-despite/6126018>

Renewable energy company Pacific Hydro has ruled out any changes to its operations at a wind farm in south-west Victoria, after a study into impacts on nearby residents.

Pacific Hydro last month released a report that linked sensations reported by residents near its Cape Bridgewater wind farm to low-frequency noise.

The study's Steven Cooper addressed more than 150 people in Portland last night.

Pacific Hydro's Lane Crockett said no causal link had been proven between the frequencies and residents' observations and the company would not change its Cape Bridgewater operations.

"There's nothing that came out of the report that suggests that we should," he said.

"There's an unverified hypothesis that Steven Cooper's come up with."

Study participant Sonia Trist is disgusted by the response.

"I found it cold and hateful really," she said.

Pacific Hydro also announced it was closing complaints that led to the commissioning of the report and said the study did not justify compensation.

11. **US targets novel fusion research**

Sep 30, 2014

<http://physicsworld.com/cws/article/news/2014/sep/30/us-targets-novel-fusion-research>

A US government agency has launched a new \$30m programme to support alternative approaches to generating energy from nuclear fusion. The initiative has been created by the **Advanced Research Projects Agency – Energy** (ARPA-E), which falls under the auspices of the Department of Energy (DOE). In August, the DOE invited researchers to "develop and demonstrate low-cost tools to aid in the development of fusion power". Research teams need to outline their proposals by 14 October with three-year grants ranging from \$250,000 to \$10m up for grabs.

Fusion researchers have welcomed the new programme, which comes as fusion research in the US faces severe budget constraints. As one of seven partners in the €16bn **ITER** fusion project, the country has to provide 9% of the reactor's components – at a cost of \$3.9bn – despite a flat overall national fusion budget, which has put a squeeze on domestic fusion facilities. Next year's budget is also far from certain after the White House recommended static spending, the House of Representatives called for an increase and the Senate even voted to kill the US contribution to ITER.

Budget casualty

One of the casualties of this ongoing budget squeeze was a DOE project called High Energy Density Plasma (HEDP), which was cancelled in 2013. This programme had supported projects lying between the low-density, long-duration approach of magnetically confined fusion – like ITER – and the very fast, very high density of inertial-confinement fusion, as carried out at the US's National Ignition Facility. The demise of HEDP ended projects at several US national laboratories that used electrical pulses, magnetic fields, lasers and even high explosives to achieve fusion.

The new programme from ARPA-E will tap into this middle ground, focusing both on "targets" (methods for containing plasmas) and "drivers" (systems for heating and compressing plasmas). "I have long advocated that the parameter space in-between conventional [magnetic-fusion and inertial-fusion] regimes is clearly where the advantages of [both] can be combined, while eliminating some of the disadvantages," says plasma physicist **Glen Wurden** of the Los Alamos

National Laboratory in New Mexico, who works on magnetized plasmas. "Members of the HEDP fusion community, especially those previously working in the area of magneto-inertial fusion before the funding was cut, were thrilled to finally see the ARPA-E funding opportunity announced," he adds.

The Canadian company General Fusion is taking a similar approach to fusion and is profiled in the article "[Firm takes middle ground to fusion](#)"

About the author

Daniel Clery is a science writer based in the UK

12. US EPA's Clean Power Plan achievable, study says

20 February 2015

<http://www.world-nuclear-news.org/EE-US-EPAs-Clean-Power-Plan-achievable-study-says-2002155.html>

The US Environmental Protection Agency's (EPA's) proposed Clean Power Plan is achievable without jeopardizing the reliability of the country's power system, a study by the Analysis Group has concluded.

EPA proposed the Clean Power Plan - which would reduce carbon dioxide emissions from power generation by 30% from 2005 levels by 2030 - in June 2014. It claims the plan "will lead to climate and health benefits worth an estimated \$55 billion to \$93 billion in 2030, including avoiding 2700 to 6600 premature deaths and 140,000 to 150,000 asthma attacks in children."

The Analysis Group's report - entitled *Electric System Reliability and EPA's Clean Power Plan: Tools and Practices* - addresses the impact of ongoing changes in the energy industry for stakeholders and offers recommendations to ensure reliability.

The group - which provides economic, financial and business strategy consulting - said its report demonstrates that "the industry, its reliability regulators, and the states have a wide variety of existing and modified tools at their disposal to help as they develop, formalize, and implement their respective State Plans." In particular, it notes, "These two responsibilities - assuring electric system reliability while taking the actions required under law to reduce CO2 emissions from existing power plants - are compatible, and need not be in tension with each other as long as parties act in timely ways."

The report says, "In the end, because there are such fundamental shifts already underway in the electric industry, inaction is the real threat to good reliability planning." It added, "There are continuously evolving ways to address electric reliability that build off of strong standard operating procedures in the industry."

The Analysis Group noted that, in evaluating potential concerns related to the plan, "a recent survey of more than 400 utility executives nationwide found that more than 60% felt optimistic about the Clean Power Plan and felt that EPA should either hold to its current emissions reductions targets or make them more aggressive."

Testifying before the Federal Energy Regulatory Commission (FERC) at a technical conference on 19 February to discuss the plan, Exelon's senior vice president for regulatory affairs and wholesale market policy, Kathleen Barrón, said that well-designed carbon reduction rules can be a driving force to modernize the USA's ageing electric system, maximize the use of clean energy and support economic growth.

Exelon - America's largest generator of nuclear power - said it "supports the call of a number of organizations ... for EPA to give states a way to comply with the Clean Power Plan by imposing a cost on carbon emissions." The so-called Reliability Dispatch proposal, it said, "would treat all low-carbon power equally, increasing the competitiveness of existing sources, including nuclear and hydropower."

It said, "These resources are essential to FERC's mandate to ensure consumers have access to reliable power 24/7 and in all weather conditions, while meeting EPA's carbon-reduction obligation."

*Researched and written
by World Nuclear News*

13. **US nuclear utilities beat emissions goals**

24 July 2009

http://www.world-nuclear-news.org/EE-US_nuclear_utilities_exceed_emission_goals-2407094.html

Two of the three companies recognized by the US Environmental Protection Agency (EPA) for reducing their greenhouse gas emissions under its Climate Leaders program are nuclear utilities.

The EPA said that Exelon and Public Service Enterprise Group (PSEG), together with Raytheon, "have found cleaner sources of energy, reduced energy consumption, increased production of renewable energy and retired old equipment, all in an effort to reduce their contribution to climate change."

Climate Leaders is an EPA industry-government partnership that works with companies to develop comprehensive climate change strategies. Partner companies commit to reducing their impact on the global environment by completing a corporate-wide inventory of

their greenhouse gas emissions based on a quality management system, setting aggressive reduction goals, and annually reporting their progress to EPA.

Exelon - one of the largest electric and gas utilities in the USA - joined the Climate Leaders program in 2003 and set a goal of reducing its total greenhouse gas emissions by 8% between 2001 and 2008. The EPA said that Exelon far surpassed this goal by reducing its emissions by 38% as of the end of 2008.

Among the measures taken by Exelon to reduce its emissions were to retire higher-emitting and less efficient fossil fuel plants and increase energy efficiency in its buildings. It has also increased the fuel efficiency of its vehicle fleet by adding hybrid and electric vehicles.

The company operates the largest nuclear fleet in the USA and the third largest fleet in the world. Exelon's ten plants, with 17 reactors, represent some 20% of the US nuclear industry's power capacity and so about 4% of all the USA's electricity.

Exelon continues to work toward the goal of *Exelon 2020 - A Low-Carbon Roadmap* - its comprehensive strategy to reduce, offset or displace more than 15 million tonnes of greenhouse gas emissions annually by 2020.

More nuclear helps PSEG

Meanwhile, PSEG pledged to reduce its carbon emissions by 18% between 2000 and 2008. The EPA said that the company exceeded its goal, achieving a 31% reduction.

The company said that it reduced its emissions by expanding nuclear output and building new, cleaner natural gas plants. PSEG said the reduction was also due to a drop in coal output from 2007 to 2008. "Nuclear plants emit no carbon, and natural gas combined-cycle plants emit significantly less carbon than coal plants," the company said. It added that it did not purchase renewable energy credits or greenhouse gas offsets to help meet the target.

Eric Svenson, PSEG's vice president of environment, health and safety, said: "We've met and exceeded a number of carbon reduction goals over the last 15 years, and in the process, become one of the nation's leading low-carbon energy companies."

Among its power plants, PSEG operates the Salem and Hope Creek nuclear power plants in New Jersey and is a part owner of the Peach

Bottom plant in Delta, Pennsylvania. It owns 100% of Hope Creek, 57% of Salem and 50% of Peach Bottom. Exelon owns the other 50% of Peach Bottom.

EPA Administrator Lisa Jackson commented: "We congratulate the members of the partnership upon meeting their goals to confront climate change. EPA's Climate Leaders are some of the largest and most competitive companies in manufacturing, finance, information technology and other major sectors of the economy." She added, "They're proving that they can be both industry leaders, and leaders in the fight against climate change."

14. **Atucha 2 reaches 100% rated power**

19 February 2015

<http://www.world-nuclear-news.org/NN-Atucha-2-reaches-100-percent-rated-power-19021502.html>

The second unit of the Atucha nuclear power plant in Argentina today reached 100% of its rated power, completing an increase in the share of nuclear power in the country's electricity mix from 7% to 10%.

The plant is located in the town of Lima, Zárate, Buenos Aires. Today's milestone for the unit - named after former President Néstor Carlos Kirchner - was witnessed by Argentina's President Cristina Fernandez.

Fernandez said during the unit's inauguration ceremony that, in revitalizing the country's nuclear power program, Kirchner had proved himself to be the kind of leader "who makes history", like his predecessor President Juan Domingo Perón, the namesake of Atucha 1.

Now, the National Atomic Energy Commission is attracting "new young blood" to its workforce at the uranium enrichment plant at Pilcaniyeu, Fernandez said, stressing that Argentina is a leader in nuclear nonproliferation. Today, Argentina has 129 companies in the nuclear power sector and 5220 specialists.

Atucha 1 began operating in 1974 and in 1979 construction of Atucha 2 was ordered following a government decision to have four more units coming into operation in 1987-1997. Then in August 2006, the government announced a \$3.5 billion strategic plan for the country's nuclear power sector. This involved completing Atucha 2 and extending the operating lifetimes of Atucha 1 and Embalse.

As well as generating electricity, Embalse also produces cobalt-60 for uses in medicine, industry and food irradiation worldwide.

Atucha 2's rated power is 692 MWe and together with Atucha 1 and

the reactor at Embalse it establishes Argentina's total nuclear generating capacity at around 1627 MWe. The Carem small reactor project should add a further 27 MWe by 2018. The country's next two reactors planned are likely to be built by China National Nuclear Corporation.

In February, Argentina and China ratified an agreement signed last year to work jointly on a project to build a fourth nuclear power reactor in the Latin American country.

"We went to China to seek investment to incorporate two new plants, one of 700 megawatts and another 1000 megawatts," Fernandez said. "No one needs to panic," she said, because the first will be 70% owned by Argentina and ownership of the second will be split 50:50.

Hydro and nuclear power have to be "absolutely complementary" in the country, she said, "but we must place much more emphasis on nuclear energy, which is cheap and clean generation technology." In addition, nuclear power is vital to the country's medical sector, she said.

Argentina produces 5% of the world's molybdenum-99 and one-third of the global supply of cobalt-60. she said. The country has also "returned to the select club of 11 countries" that can produce enriched uranium.

*Researched and written
by World Nuclear News*

15. **Watts Bar 2 gets licensing nod from NRC committee**

16 February 2015

<http://www.world-nuclear-news.org/NN-Watts-Bar-2-gets-licensing-nod-from-NRC-committee-16021502.html>

The Tennessee Valley Authority (TVA) has reached a "critical regulatory step" towards the start up of the USA's first new nuclear power reactor in 20 years.

An independent body within the Nuclear Regulatory Commission (NRC) has recommended proceeding with the licensing process for Watts Bar Unit 2, near Spring City, Tennessee. Its recommendation is part of the information NRC commissioners will consider when making a final decision on issuing an operating license for the reactor.

In a letter to the NRC chairman, the Advisory Committee on Reactor Safeguards noted that "there is reasonable assurance" that a second unit can operate at the Watts Bar plant "without undue risk to the health and safety of the public".

Joe Grime, TVA's chief nuclear officer, said in a statement on 13 February that the committee's conclusion on TVA's preparedness and ability to operate a dual-unit station is the result of six years of discussions, interactions and meetings through which TVA has

demonstrated that unit 2 "is being completed the right way - safely, with quality, and in a manner to protect the general public."

The unit is about 95% complete and remains on target to begin commercial operations between September 2015 and June 2016 at a total cost of between \$4.0 billion to \$4.5 billion. When online, it will produce 1150 megawatts of carbon-free electricity - enough to meet the needs of 650,000 homes, TVA said.

Work on Watts Bar 2 was suspended in 1985 when the unit was about 55% completed, 12 years after construction began. TVA decided in 2007 to resume the project, initially estimating a cost of \$2.5 billion and a completion date of 2012. TVA revised both the cost and the completion date in April 2012.

TVA, which currently has six operational nuclear units, has nine million customers in parts of seven southeastern states.

*Researched and written
by World Nuclear News*

16. **Terms of Paks project 'are in order', says Hungarian prime minister**

20 February 2015

<http://www.world-nuclear-news.org/NN-Terms-of-Paks-project-are-in-order-says-Hungarian-prime-minister-20021502.html>

Hungary and Russia are "already in the implementation phase" of their project to build two new Russian-designed units at Paks, Hungary's Prime Minister Viktor Orbán said in an interview with Russian newspaper *Kommersant*. The article was published on the Hungarian government's website today, two days after Russian President Vladimir Putin made an official visit to the country.

According to the newspaper, Putin talked during his visit about a Russian state loan for the project of between €10 billion (\$11.4 billion) and €12 billion (\$13.6 billion). Asked to which currency the loan would be tied to, Orbán said, "Luckily, it is not tied to the rouble, or to the forint. This is good news for everyone." He would not state that it would be linked to the euro, saying merely that "the financial terms and conditions are in order."

He added: "If we implement everything the way we have planned, we shall have struck one of the best deals in the history of Hungary. We only have to keep firmly to the agreement. We Hungarians are innovative, and always come up with new and better ideas; it is not easy to stay on the chosen path. But if we are disciplined, we shall succeed."

Paks currently comprises four Russian-supplied VVER-440 pressurized water reactors, which started up between 1982 and

1987. Though originally 440 MWe gross, the units have been upgraded and will be modified further to give 500-510 MWe gross. In early 2014, Hungary and Russia signed a cooperation agreement which included the construction of two new VVER reactors of up to 1200 MWe each at Paks. The first new unit is to be commissioned in 2023, with the second following about two years later. During Putin's visit to Hungary this week, Russia's Rosatom and Hungary's ministry of human capacities signed a memorandum of understanding on cooperation in the training of nuclear energy personnel.

Hungarian online news agency *Portfolio.hu* today cited Orbán as saying that nuclear energy remains "necessary" in Europe. Orbán also said it was time to admit "the especially inconvenient truth" that competitive energy prices could not be created in the region without having Russia as part of Europe's energy market. The most important factor in the energy sector today is price, he said, and "climate is only second."

The Paks extension project is expected to cost nearly €12 billion (\$13.6 billion), according to *Portfolio.hu*. Of that, 80% will be provided by Russia in the form of a "highly preferential" 30-year loan.

*Researched and written
by World Nuclear News*

17. Japan leading charge for cleaner coal

Updated: 12:23 pm, Thursday, 19 February 2015

<http://www.skynews.com.au/news/world/asiapacific/2015/02/19/japan-leading-charge-for-cleaner-coal.html>

Japan is leading innovation in clean coal technology, in a move that could have significant ramifications for Australia.

As one of the world's biggest coal exporters, there's much at stake for Australia in the intensifying negotiations ahead of the UN climate change summit in Paris in December.

While some countries want coal-fired power to be phased out by

the middle of the century, Japan is at the fore of the fight to ensure it stays a prominent part of the global energy mix. It argues billions of dollars being poured into fighting climate change should be used to invest in more efficient coal-fired power technology as well as renewables.

The Isago power plant near Yokohama uses technology known as 'Ultra Supercritical' and is the most efficient power plant of its kind in the world.

The technology superheats the steam used to drive turbines and generate power to 620 degrees Celsius, more than twice that of normal coal-fired stations.

Using the Ultra Supercritical method dramatically cuts the amount of pollutants including nitrous oxide and sulphur oxide. It also reduces carbon emissions by 25 per cent compared to other coal-fired plants around the world, though overall emissions levels are still higher than gas-fired power plants and other sources, including nuclear, solar and wind power.

But in Japan, as in much of the world, coal is considered the cheapest and most reliable energy source despite its environmental footprint.

The Director of the Japanese Climate Change Division, Junya Nakano, says his country thinks cleaning up fossil fuel use should be a priority.

'We think the promotion of high efficiency in coal fired power plants should be promoted, but the green climate fund...is a matter for the Green Climate Fund board,' he told Sky News Political Editor David Speers.

This is just one of the key sticking points which could make or break a global agreement at the Paris climate summit in December.

Opinion is divided on whether the billions being pumped into the Green Climate Fund should be used to help developing countries build only renewable energy, or also to invest in cleaner technology for fossil fuels.

Japan has committed \$1.5 billion to the fund and says public funding should be used to support more efficient coal-fired power, saying it's the only realistic way to bring down emissions

in developing countries.

'We expect developing countries will use public financing to reduce the cost of highly efficient coal-fired power plant,' said Katsuhisa Shimakura Coal Policy Director, Japanese Economy Ministry.

Carbon capture and storage (CCS) could potentially make significant cuts to coal's atmospheric footprint and has been tested with some success.

Underground storage in a country as seismically active as Japan is not currently an attractive option.

'I think another 10 years or 20 years...I think CCS now is not commercially viable,' Mr Shimakura said.

Japan will not necessarily slow down its coal imports from Australia, especially as its is only just starting to recover and the government doesn't want to push energy costs any higher.

But it is mindful of the need to cut emissions, and coal is likely to play a significant role Japan and the world's energy mix in the decades to come.

Sky News Political Editor David Speers visited Isago power plant as a guest of the Japanese Oil, Gas and Metals Corporation.