

ITER Forum website Update 7/15

B.J.Green (19/7/15)

1. Scientists propose an enhanced new model of the source of a mysterious barrier to fusion known as the “density limit”

June 29, 2015

<http://www.pppl.gov/news/2015/06/scientists-propose-enhanced-new-model-source-mysterious-barrier-fusion-known-“density”>

Researchers at the U.S. Department of Energy’s (DOE) Princeton Plasma Physics Laboratory (PPPL) have developed a detailed model of the source of a puzzling limitation on fusion reactions. The findings, published in June in *Physics of Plasmas*, complete and confirm previous PPPL research and could lead to steps to overcome the barrier if the model proves consistent with experimental data. “We used to have correlation,” said physicist David Gates, first author of the paper. “Now we believe we have causation.” This work was supported by the DOE Office of Science.

At issue is a problem known as the “density limit” that keeps donut-shaped fusion facilities called tokamaks from operating at peak efficiency. This limit occurs when the superhot, charged plasma gas that fuels fusion reactions reaches a certain density and spirals apart in a flash of light, shutting down the reaction. Overcoming the limit could facilitate the development of fusion as a safe, clean and abundant source of energy for generating electricity.

Bubble-like islands

The key to this barrier lies in the runaway growth of bubble-like islands that form within the magnetically confined plasma and cool it, according to the paper. While physicists had long suspected that this cooling effect was linked to the density limit — also known as the “Greenwald limit” after MIT physicist Martin Greenwald, who derived an empirical rule for it — they lacked insight into the mechanics.

The apparent breakthrough came when Gates and coauthors studied the process by which the islands are cooled by impurities that stray plasma particles kick up from the walls of the tokamak. Countering this cooling is heating that researchers pump into the plasma. But the scientists found that even a tiny bit of net cooling in the interior of the islands can cause them to grow exponentially, leading to disruption of the crucial current that runs

through the plasma and completes the magnetic field that holds the hot gas together.

Reaching this finding called for rethinking some long-held ideas about the growth of the islands. These included a 1977 paper on the stability of islands by theorist Roscoe White of PPPL that extended the analysis of a 1973 paper by British physicist Paul Harding Rutherford. The 1977 work showed a stabilizing effect that appeared to override the impact of a later effect by French physicist Paul-Henri Rebut that attempted to demonstrate runaway growth of the islands.

Tipping the balance

Ironically, it was White himself who showed that his 1977 paper was not really the last word on the subject. In a new paper published in *Physics of Plasmas* last February, White demonstrated that when the thermal balance in an island tips from heating to cooling, the island also becomes asymmetric. The asymmetry cancelled the effect of the 1977 equation that indicated island stability and caused the Rebut model of island growth to be dominant. "I don't know why we didn't think of the thermal balance in the island before," White said.

His discovery grew out of conversations with Gates, a coauthor with PPPL physicist Dylan Brennan of White's February paper. Gates had reviewed data on the evolution of islands in fusion experiments and noticed that they became asymmetric at the density limit. After consulting with White, Gates hypothesized that the development might be important. He and White then added the effect of this asymmetry to the Rutherford/White and Rebut equations to complete a revised model of the source of the density limit. Still to come are papers on a numerical simulation of the model by Brennan and the impact of different mixtures of impurities on the density limit by physicist Luis Delgado-Aparicio of PPPL. Both had joined White in coauthoring the Gates paper. Also ahead are comparisons of the new model with past experiments that disrupted at the density limit. Graduate student Qian Teng is to make these comparisons. "So far we've shown that in principle the full equation works," said White. "Now we must check it against detailed disruption cases."

PPPL, on Princeton University's Forrestal Campus in Plainsboro, N.J., is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for the creation of fusion energy. Results of PPPL research have ranged from a portable nuclear materials detector for anti-terrorist use to universally employed computer codes for analyzing and predicting the outcome of fusion experiments. The Laboratory is managed by the University for the U.S. Department of Energy's Office of Science, which is the largest single supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time. For more information, please visit

2. X marks the spot: Researchers confirm novel method for controlling plasma rotation to improve fusion performance

By Raphael Rosen

June 23, 2015

<http://www.pppl.gov/news/2015/06/x-marks-spot-researchers-confirm-novel-method-controlling-plasma-rotation-improve>

Rotation is key to the performance of salad spinners, toy tops, and centrifuges, but recent research suggests a way to harness rotation for the future of mankind's energy supply. In papers published in *Physics of Plasmas* in May and *Physical Review Letters* this month, Timothy Stoltzfus-Dueck, a physicist at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL), demonstrated a novel method that scientists can use to manipulate the intrinsic – or self-generated – rotation of hot, charged plasma gas within fusion facilities called tokamaks. This work was supported by the DOE Office of Science.

Such a method could prove important for future facilities like ITER, the huge international tokamak under construction in France that will demonstrate the feasibility of fusion as a source of energy for generating electricity. ITER's massive size will make it difficult for the facility to provide sufficient rotation through external means.

Rotation is essential to the performance of all tokamaks. Rotation can stabilize instabilities in plasma, and sheared rotation – the difference in velocities between two bands of rotating plasma – can suppress plasma turbulence, making it possible to maintain the gas's high temperature with less power and reduced operating costs.

Today's tokamaks produce rotation mainly by heating the plasma with neutral beams, which cause it to spin. In intrinsic rotation, however, rotating particles that leak from the edge of the plasma accelerate the plasma in the opposite direction, just as the expulsion of propellant drives a rocket forward. Stoltzfus-Dueck and his team influenced intrinsic rotation by moving the so-called X-point – the dividing point between magnetically confined plasma and plasma that has leaked from confinement – on the Tokamak à Configuration Variable (TCV) in Lausanne, Switzerland. The experiments marked the first time that researchers had moved the X-point horizontally to study plasma rotation. The results confirmed calculations that Stoltzfus-Dueck had

published in a 2012 paper showing that moving the X-point would cause the confined plasma to either halt its intrinsic rotation or begin rotating in the opposite direction. "The edge rotation behaved just as the theory predicted," said Stoltzfus-Dueck.

A surprise also lay in store: Moving the X-point not only altered the edge rotation, but modified rotation within the superhot core of the plasma where fusion reactions occur. The results indicate that scientists can use the X-point as a "control knob" to adjust the inner workings of fusion plasmas, much like changing the settings on iTunes or a stereo lets one explore the behavior of music. This discovery gives fusion researchers a tool to access different intrinsic rotation profiles and learn more about intrinsic rotation itself and its effect on confinement.

The overall findings provided a "perfect example of a success story for theory-experiment collaboration," said Olivier Sauter, senior scientist at École Polytechnique Fédérale de Lausanne and co-author of the paper.

Along with the practical applications of his research, Stoltzfus-Dueck enjoys the purely intellectual aspect of his work. "It's just interesting," he said. "Why do plasmas rotate in the way they do? It's a puzzle."

PPPL, on Princeton University's Forrestal Campus in Plainsboro, N.J., is devoted to creating new knowledge about the physics of plasmas — ultra-hot, charged gases — and to developing practical solutions for the creation of fusion energy. Results of PPPL research have ranged from a portable nuclear materials detector for anti-terrorist use to universally employed computer codes for analyzing and predicting the outcome of fusion experiments. The Laboratory is managed by the University for the U.S. Department of Energy's Office of Science, which is the largest single supporter of basic research in the physical sciences in the United States, and is working to address some of the most pressing challenges of our time. For more information, please visit science.energy.gov.

3. ITER: on the path to change

22 June 2015 [Caroline Peachey](#)

<http://www.neimagazine.com/features/featureiter-on-the-path-to-change-4605964/>

Despite being one of the most complex scientific projects in the world, management is the main challenge facing ITER, says the project's recently appointed director general, Dr. Bernard Bigot.

Generated by XStandard version 3.0.0.0 on 2015-06-22T09:53:21
The ITER site in Cadarache, Southern France was bathed in sun when it opened its doors to journalists in mid May. Construction was progressing on the tokamak building, the canteen was bustling and the site was gearing up for the arrival of three US-procured electrical transformers.

But the huge poloidal field coils winding facility told a different story. Despite being completed more than three years ago, it stood empty, except for a few boxes containing the niobium-titanium conductor that will be used to build some of the largest, most powerful magnets in the world.

Winding operations for assembly of the four (of six) ITER poloidal field coils that are too large to be transported to the site should have been underway by now. But the project has faced a multitude of delays and cost overruns exacerbated by protracted decision-making and ineffective leadership.

Now, it is time for change. "It was a learning process," said Bernard Bigot, who took charge in March with the mandate to 'fix' the ITER Organization. "The time has come to set up a proper, project-minded organization."

It will be no easy task for a project that involves 35 nations, and represents half of the world's population and more than 80% of global gross domestic product. Plus, right from the outset the ITER project has been facing a significant organisational challenge.

For political reasons, when the project was launched each of the parties wanted to have its own domestic agency that could contribute equipment 'in-kind'. This meant that they would provide the components themselves, rather than the financing for them, leading to a very complex procurement situation.

For example, four different parties are supplying parts for the 5000t vacuum vessel, which needs to fit together with millimetre precision. Europe is responsible for supplying seven of the nine sectors of the vessel, and South Korea the remaining two. The in-wall shielding that will be bolted inside the vessel's walls will be delivered by India, with Russia and Korea sharing supply of the ports that will be welded on the D-shape sectors.

Bigot says that while this model was a good idea in principle, not enough consideration was given to integration.

In addition, poor management and inefficient decision-making has contributed to project delays and soaring costs.

Part of the reason for the slow progress is down to the way the project is structured. The European Union, as host party, will contribute up to about 50% of the costs and the other parties 10% each. However, technical decisions require consensus and because those relating to the design of components will inevitably impact some parties more than

others, it is difficult to reach. In one case discussions dragged on for six years without a definitive answer, Bigot said. Without that decision work did not progress.

The ITER Organization is now gearing up to take a more decisive role in the project.

"What was plaguing the project before is that there was confusion between the best technical solution and sharing of the cost," said Bigot. "Now I want just the best technical decision. The cost will be covered according to the share of the parties, reflecting the spirit of the ITER agreement."

With this in mind, Bigot, who took up the role of ITER director general three months ago, is hoping for two key changes to the project: the setup of a reserve fund; and more power for the director general to take technical decisions. In March the extraordinary council agreed in principle to these two changes, which need to be approved in November.

"In any large project... according to the cost of the procurement you need 15-20% contingencies," said Bigot, who has had a long and distinguished career in research, higher education and government.

"You also need somebody that is trusted by the parties to take the decision and who has the power to implement it," he added.

In a situation where each 12 month delay adds around €200 million to the overall project cost (and that is based simply on the costs of running the 2000 person ITER Organization), the time has come to become more 'project-minded,' he said.

A new schedule

One of Bernard Bigot's first priorities since his appointment has been to provide a new cost, schedule and scope 'baseline' for the ITER project. Bigot would not disclose any details of the new schedule (also due to be released in November), but he admitted that the baseline accepted in 2010, which expected first plasma by 2019, is "clearly not feasible" and that the project has run into many delays.

Still, Bigot stressed that the first plasma is 'not the real end of the story,' and that deuterium-tritium plasma (previously planned for March 2027), is more significant.

"We are now considering the best way to move on from the first plasma and rush as much as possible to the DT plasma, which will please the scientific community," Bigot said.

The new baseline is expected to be realistic, but aggressive, and needs to be accepted by all parties involved.

If some parties face difficulties complying with the schedule for delivery of equipment, the ITER Organization has to put the interests of the project first, which could see it step in and redistribute tasks.

The Organization has already taken charge of procurement of some components on behalf of domestic agencies, although they still remain responsible for the costs.

No backup plan

Despite changes to the timing, Bigot does not anticipate any changes in the scope or ambition of the project.

"This project started in 1985. Since then many scientists and engineers have been considering the scope of the project and the necessity to have the ITER facility to demonstrate the best conditions for the delivery of fusion technology."

"I do believe as it has been worked out from the beginning that the size and scope of the facility is the right one," Bigot said.

"You cannot demonstrate fusion with a facility that is half the size."

Bigot said that even if technical changes are needed to optimise the ITER design, his primary concern is coming into difficulty with financing, which will reduce the capacity to demonstrate.

The project is too far advanced for design changes, with more than €7 billion of procurement contracts in place and over 1000 companies at work, Bigot said.

"You could not just change [the scope] in the middle...you have to go, or stop."

He concluded: "The time has come for the ITER Organization to demonstrate it is serious. The biggest risk is that we lose trust of the political leaders and public opinion, then the project would be dead."

About the author

Caroline Peachey is editor of Nuclear Engineering International. She visited the ITER site as part of a press trip on 18-19 May.

4. A 'mini ice age' is coming in the next 15 years

Solar activity is predicted to drop by 60 percent in 2030.

<http://www.sciencealert.com/a-mini-ice-age-is-coming-in-the-next-15-years>

A new model that predicts the solar cycles more accurately than ever before has suggested that solar activity will drop by 60 percent between 2030 and 2040, which means in just 15 years' time, Earth could sink into what researchers are calling a mini ice age.

Such low solar activity has not been seen since the

last mini ice age, called the Maunder Minimum, which plunged the northern hemisphere in particular into a series of bitterly cold winters between 1645 and 1715.

The prediction is based on what's known as the Sun's '11-year heartbeat'. The Sun's activity is not the same year in year out, it fluctuates over a cycle that lasts between 10 and 12 years. Ever since this was discovered 172 years ago, scientists have struggled to predict what each cycle will look like. But just last week at the National Astronomy Meeting in Wales, mathematics professor Valentina Zharkova from Northumbria University in the UK has presented a new model that can forecast what these solar cycles will look like based on the dynamo effects at play in two layers of the Sun. [Zharkova says](#) she can predict their influence with an accuracy of 97 percent.

What exactly are these so-called dynamo effects? They're part of a [geophysical theory](#) that explains how the motion of Earth's outer core moves conducting material, such as liquid iron, across a weak magnetic field to create an electric current. This electric current also interacts with the fluid motion below the surface of Earth to create two magnetic fields along the axis of its rotation.

When Zharkova's model applied this theory to the Sun, it drew its predictions assuming that there are dynamo effects in two subterranean layers - one deep down in the convection zone, and another up near the surface, each fluctuating between the northern and southern hemispheres.

[Zharkova explained her findings at the conference:](#)

"We found magnetic wave components appearing in pairs, originating in two different layers in the Sun's interior. They both have a frequency of approximately 11 years, although this frequency is slightly different, and they are offset in time.

Combining both waves together and comparing to real data for the current solar cycle, we found that our predictions showed an accuracy of 97 percent."

Looking at these magnetic wave patterns, the model predicted that there would be few sunspots over the next two 11-year heartbeats - called Cycle 25, [which peaks in 2022](#), and Cycle 26, which runs from 2030 to 2040.

"In cycle 26, the two waves exactly mirror each other - peaking at the same time but in opposite hemispheres of the Sun. Their interaction will be disruptive, or they will nearly cancel each other. We predict that this will lead to the properties of a 'Maunder minimum'," [said Zharkova](#).

During the original Maunder Minimum, the entire River Thames froze over in England. So I guess time to get your skates ready?

5. NuGen acquires land for Moorside project

14 July 2015

<http://www.world-nuclear-news.org/NN-NuGen-acquires-land-for-Moorside-project-1407155.html>

NuGeneration Limited (NuGen) and the UK's Nuclear Decommissioning Authority (NDA) have signed a contract to transfer land near the Sellafield site in Cumbria for NuGen's planned Moorside nuclear power plant.

NuGen announced today that the signing of the land contract had been approved by its board at a meeting in Tokyo. The contract was

signed by NuGen CEO Tom Samson and NDA CEO John Clarke. The signing of the contract follows successful completion of site suitability studies at Moorside by NuGen, which it said confirmed the site - to the north and west of Sellafield - as being suitable for the construction of three Westinghouse AP1000 pressurized water reactors. NuGen will now take responsibility for the land following payment of an "undisclosed sum" to the NDA, it said.

In October 2009, NuGen secured an option to purchase land on the West Cumbrian coast from the NDA for a total cash consideration of £70 million (\$109 million). The site is approximately 200 hectares, of which the company will select the most suitable 100 hectares for the nuclear power plant. In May 2014, NuGen extended its option to purchase the land until after the European Commission ruling on the legality of the UK's electricity market reforms that support nuclear power. The original option to purchase the land was due to expire last October.

Samson said, "This is a key moment in our Moorside project journey. Our board reached a decision of significance which confirms Moorside is suitable, against criteria at this stage of the development. NuGen, our vendors and our expert partners are all confident we can build three reactors on the site."

He added, "This is great news for the North-West, and particularly West Cumbria, the UK's nuclear heartland. We are delighted to be taking forward Moorside, a massive development which will supply some 7% of the UK's future electricity."

Clarke said, "The completion of this stage of the land sale brings a range of benefits both nationally and locally. It supports the initiative to have West Cumbria recognized as a centre for nuclear excellence, building on over six decades of nuclear expertise in the area, whilst delivering value for money for the taxpayer and the national economy."

NuGen - a 60%/40% joint venture between Toshiba and GDF Suez - confirmed plans last year to build three Westinghouse AP1000 reactors at Moorside by the end of 2026 with a total capacity of 3.4 GWe. The first unit is expected to begin operating by the end of 2024. A final investment decision is expected to be taken by the end of 2018.

*Researched and written
by World Nuclear News*

6. EDF Energy completes safety upgrades at UK plants

14 July 2015

<http://www.world-nuclear-news.org/RS-EDF-Energy-completes-safety-upgrades-at-UK->

[plants-1407156.html](#)

EDF Energy announced today that it has completed post-Fukushima safety upgrades at its UK nuclear power plants within the time agreed with the regulator and to budget. The upgrades include a new emergency response centre near Sizewell B.

According to the company, "no fundamental weaknesses" were found at the UK's nuclear facilities in a review by the Office for Nuclear Regulation (ONR) following the March 2011 accident at Japan's Fukushima Daiichi plant.

However, the ONR made a number of recommendations to enhance safety and resilience of the UK facilities. EDF Energy said it immediately started a plan to meet those recommendations at its eight nuclear power plants.

A key part of the enhancements, it said, was establishing a new emergency response centre near the Sizewell B plant, the UK's sole pressurized water reactor. This, EDF Energy said, "provides robust back-up for the multiple safety systems already in place at the station".

The company has also established three regional facilities to service its other nuclear power plants which use a different technology. The plan also included additional training for key technical staff, enhancements to back-up equipment for cooling systems, and emergency command and control facilities.

Stuart Crooks, managing director of EDF Energy's generation business, said: "In the immediate aftermath of Fukushima we satisfied ourselves and the regulator that our plants were safe to continue operation."

He added, "At the same time we conducted a detailed review to ensure we had learned the lessons from the event and make recommendations to improve our safety margins even more."

Crooks said that EDF Energy will "continue to learn and ensure we achieve safe reliable generation of low-carbon electricity over the life of our nuclear stations."

*Researched and written
by World Nuclear News*

7. USA's first big commercial reactor segmentation completed

14 July 2015

EnergySolutions announced yesterday the successful completion of the first large commercial reactor vessel segmentation in the USA. ZionSolutions, a wholly owned subsidiary of EnergySolutions, completed the segmentation of the reactor vessel of unit 2 of Zion nuclear power plant in late June.

<http://www.world-nuclear-news.org/WR-USAs-first-big-commercial-reactor-segmentation-completed-14071501.html>

After more than 20 years of operation, Zion's two reactors were permanently shut down on 15 January 1998. Commonwealth Edison (ComEd), owner of the plant at the time, concluded that the continued operation of Zion Station was not financially feasible and the plant was removed from service.

In 2010, the Nuclear Regulatory Commission approved the transfer of ComEd parent company Exelon's licence to EnergySolutions, which in September of that year began the ten-year process of dismantling the site, and which will eventually move away parts of the plant to its property in Utah.

Carol Peterson, Exelon's senior vice president of strategy and planning and lead liaison for the Zion decommissioning project, said completion of the segmentation was a significant milestone in the decommissioning of the Zion plant. "The innovative process is another example of how EnergySolutions continually looks for ways to apply technology to improve safety and efficiency and to protect the environment," she added.

Salt Lake City-headquartered EnergySolutions said the cutting process started on 26 May, with the first of 17 segments of the reactor vessel cut with an oxy-propone torch connected to a robotic fixture external to the vessel. The final cut was completed on 26 June.

This "first-of-its-kind application" for the US nuclear industry required specialized rigging and lifting equipment that were used "safely without incident", John Sauger, executive vice president for ZionSolutions, said in the same statement. "Extensive design, analysis, mockup testing and planning resulted in a fast cutting sequence with no release of radiation to the environment," he added.

David Lockwood, CEO and president of EnergySolutions, said the company was pleased to have completed three major milestones in the Zion Nuclear Power Plant Decommissioning Project in 2015, including used fuel transfer, B and C level radioactive waste removal and vessel segmentation.

Differing from other reactor disposal projects completed in the past, the Zion vessel is shipped in traditional railcars that require no additional actions such as heavy load analysis and custom railcar availability and scheduling.

Zion was the third dual-reactor nuclear power plant in the ComEd network and served Chicago and the northern quarter of Illinois. The first unit of the plant started producing power in December 1973 and the second unit came online in September 1974. Although it was withdrawn from service in early 1998, it had not been in

operation since February 1997. The plant is located on the western shore of Lake Michigan shoreline, in the city of Zion, which is in Lake County, Illinois.

The used nuclear fuel was placed in the plant's onsite storage pool and remains there today in safe and controlled storage.

The \$1 billion decommissioning project has required an average of 200 skilled workers each year, most of them local, and a peak workforce of 400.

*Researched and written
by World Nuclear New*

8. **Austrian nuclear objection undermines right of energy choice**

World Nuclear Association Press Release

Issue Date: 06 July 2015

<http://world-nuclear.org/Press-and-Events/Press-Statements/Austrian-nuclear-objection-undermines-right-of-energy-choice/>

It is one thing to have an opinion, it is quite another to try and force your opinion on someone else." - said Agneta Rising Director General of the World Nuclear Association in response to the action launched today by the Austrian government against the UK nuclear programme.

"The UK public, indeed people in all countries, have the right to choose nuclear to meet their energy needs and to help address climate concerns if they so wish. It is a pity that the Austrian government has decided not to respect that right."

The action claims to challenge the legality of the subsidy arrangement agreed for Hinkley Point C nuclear power plant, as approved by the European Commission. However, media statements from Austrian officials make it clear that they are pursuing this action because of their own anti-nuclear agenda. The action is profoundly misinformed and damaging to global efforts to address climate change¹.

"The countries that are leading on decarbonisation are using nuclear energy. Not all countries are in Austria's position - lucky enough to be able to count on hydro power built decades ago to provide roughly 65% of their electricity today. Most others have to make pragmatic choices," continued Rising.

"Nuclear power plants are one of a handful of technologies capable of

generating low-carbon energy 24/7 and are the foundation of a healthy, modern electrical system in countries lucky enough to have them."

¹The IPCC unequivocally recognises that nuclear energy is a low-carbon generating technology with life-cycle emissions "[comparable to most renewables](#)". For more background on the Austrian objection please [see our briefing](#).

The World Nuclear Association is the international organisation that represents the global nuclear industry. Its mission is to promote a wider understanding of nuclear energy among key international influencers by producing authoritative information, developing common industry positions, and contributing to the energy debate, as well as to pave the way for expanding nuclear business.

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9. Federal Government Wants Big Solar?

Here's A Project

July 15, 2015 Energy Matters

<http://www.energymatters.com.au/renewable-news/port-augusta-solar-em4925/>

It's an ill wind that blows nobody any good they say. Repower Port Augusta has seized on recent Federal Government comments and renewed its push for support for the construction of a solar thermal power plant.

Two coal-fired power stations in Port Augusta are to be replaced with a combined cycle gas plant; or if Repower Port Augusta has its way, with Australia's first solar thermal plants.

A [blueprint](#) for replacing the coal plants with solar and wind was launched in 2012. Last year, Alinta Energy said it would [investigate the viability](#) of a solar thermal facility; but a study found the cost of the projected \$577 million project to be too much for Alinta Energy to go it alone – there was a gap of \$150 million.

The Australian Federal Government recently stated it would like to see the CEFC focus more on investing in large scale solar – and Repower Port Augusta says it has just the project.

“We will be reaching out and not just to the Clean Energy

Finance Corporation but to the Federal Government and the State Government and saying, ‘Look if you guys are wanting to invest in large-scale solar, here’s one that could really help a community’,” [said](#) Repower Port Augusta spokesman Dan Spencer.

However, the CEFC isn’t about handouts or interest free loans – it’s about low risk investments providing rapid and substantial returns. While the benefits of a solar thermal project in Port Augusta are many, that criteria could pose a challenge. Even so, the current situation has enabled the group to bring its very worthy project back into the spotlight again.

The Repower Port Augusta Alliance will be holding an [evening discussion](#) on Wednesday, August 5. Among those attending the event will be Dr Keith Lovegrove, a solar thermal expert with the Climate Change Institute at ANU (Canberra).

10. [Can you actually hear 'inaudible' sound?](#)

Limits of human hearing (infrasound and ultrasound) examined

Date:

July 10, 2015

Source:

Physikalisch-Technische Bundesanstalt (PTB)

Summary:

Are wind farms harmful to humans? This controversial topic makes emotions run high. To give the debate more objectivity, an international team of experts dealt with the fundamentals of hearing in the lower limit range of the audible frequency range (i.e., infrasound), but also in the upper limit range (i.e., ultrasound).

http://www.sciencedaily.com/releases/2015/07/150710123506.htm?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+sciencedaily%2Fmatter_energy%2Fwind_energy+%28Wind+Energy+News+--+ScienceDaily%29

Are wind farms harmful to humans?

Some believe so, others refute this; this controversial topic makes emotions run high. To give the debate more objectivity, an international team of experts dealt with the fundamentals of hearing in the lower limit range of the audible frequency range (i.e. infrasound), but also in the upper limit range (i.e. ultrasound). The project, which is part of the European Metrology Research Programme (EMRP), was coordinated by the Physikalisch-Technische Bundesanstalt (PTB). At PTB, not only acoustics experts, but also experts from

the fields of biomagnetism (MEG) and functional magnetic resonance imaging (fMRI) were involved in the research activities. They have found out that humans can hear sounds lower than had previously been assumed. And the mechanisms of sound perception are much more complex than previously thought. Another vast field of research opens up here in which psychology also has to be taken into account. And there is definitely a need for further research.

If there is a plan to erect a wind turbine in front of someone's property, many an eager supporter of the "energy transition" quickly turns into a wind energy opponent. Fear soon starts spreading: the infrasound generated by the rotor blades and by the wind flow might make someone ill. Many people living in the vicinity of such wind farms do indeed experience sleep disturbances, a decline in performance, and other negative effects. Infrasound designates very low sounds, below the limit of hearing, which is around 16 hertz. The wind energy sector and the authorities often try to appease the situation, declaring

that the sounds generated are inaudible and much too weak to be the source of health problems.

Christian Koch knows for sure, "Neither scaremongering nor refuting everything is of any help in this situation. Instead, we must try to find out more about how sounds in the limit range of hearing are perceived." This expert in acoustics from PTB is the manager of the international project in which metrology experts from several metrology institutes and scientists from the Max Planck Institute for Human Development in Berlin investigated the fundamentals of the hearing of "inaudible" sounds for 3 years. Very low sounds (i.e. infrasound, below approx. 16 hertz) or very high sounds (i.e. ultrasound, above approx. 16,000 hertz) occur in numerous situations of daily life: infrasound is not only produced by wind turbines, but also sometimes when a truck thunders past a house, or when a home owner installs a power generator in his basement. Ultrasound can, for example, originate from commercial ultrasonic cleaning baths that are sometimes used, e.g., to thoroughly clean a pair of glasses. It can also be generated by a device used as a deterrent against martens (to keep them from gnawing on the wiring of cars). A particular variant of such devices has been developed to keep young people away from certain places -- an internationally controversial topic from an ethical viewpoint. These devices, which produce very high-pitched sounds that can only be heard by children and young people, are sometimes used by adults who want to enjoy some peace and quiet. "In all these areas, we have to deal with considerable levels of loudness in some cases," Christian Koch

adds.

An audible loud sound may damage hearing -- as well as getting on your nerves. But what exactly is an "audible" sound? And what does a human being really hear? In order to find out more, an infrasonic source which is able to generate sounds that are completely free from harmonics (which is not as trivial as it may sound!) was constructed within the scope of this project. Test persons were asked about their subjective hearing experience, and these (also quantitative) statements were then compared by means of imaging procedures, namely by magnetoencephalography (MEG) and functional magnetic resonance imaging (fMRI). The results have shown that humans hear lower sounds -- namely from 8 hertz on -- which, after all, is a whole octave than had previously been assumed: an excitation of the primary auditory cortex could be detected down to this frequency. All persons concerned explicitly stated that they had heard something -- whereby this perception had not always been tonal. In addition, the observations showed a reaction in certain parts of the brain which play a role in emotions. "This means that a human being has a rather diffuse perception, saying that something is there and that this might involve danger," Christian Koch says. "But we're actually at the very beginning of our investigations. Further research is urgently needed." An application for a follow-up project has already been filed. In this project, the investigations will be focused on the question why some persons feel disturbed by "inaudible" sound, whereas others are not even bothered: many a home owner is left cold by having a wind turbine next to their homes.

And we need to take another effect into account: namely, that some people become really ill because they imagine risks which, in reality, might not even exist. This is the reason why it makes sense to involve psychologists as well.

But the researchers see a great need for further research also in the other extreme -- the ultrasound. Although the measuring instruments used are among the most precise in the world (PTB is the world leader, especially for MEG), the researchers were not able to measure whether humans can hear above the previously assumed upper threshold of hearing, and if they can, what they then perceive. Since, however, what applies to other ranges, also applies to high-pitched sounds -- namely that a very loud sound may damage the hearing -- here too, there is a need for further research.

The results of the international research project might lead to the introduction of uniform -- and binding -- protection provisions for these limit ranges of hearing within Europe, since there have been none to date.

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