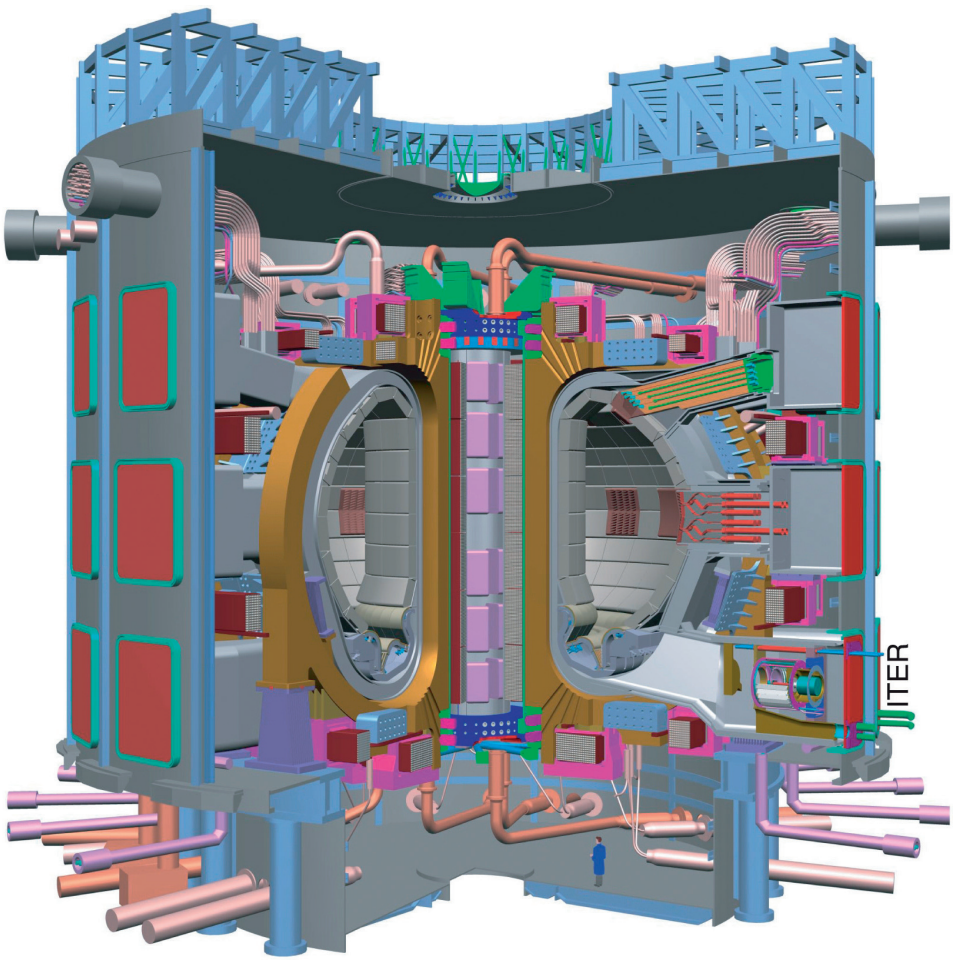
Fusion energy is a clean and powerful energy, reliant on a process compared to creating an artificial sun. Swedish research is contributing to the development of ITER, a new giant fusion reactor being built in France but, **Professor Jan Scheffel** states, Sweden is in danger of losing the initiative

Fund fusion for the sustainable future



ITER, the largest fusion experiment, is the focus for Swedish fusion research

It is widely accepted by international science bodies, politicians and the public who elect them that we are all at a critical juncture in terms of industry and environment. Our perception of these two currently clashing areas has to change as must our view of the energies on which we rely. We need emission free and pollution free, sustainable, safe and cheap energy sources to fuel a growing and ever-more demanding society. Although there are many renewable energies proven in Europe's energy mix there is one energy type that is still in the experimental stages and yet has the most potential to take our energy future in exactly the place we need to go. That energy is fusion energy.

"The importance of fusion lies in that there is no other sustainable energy source that has potential to replace fossil

fuels economically on a large scale within regions such as Europe," says Prof. Jan Scheffel of the Royal Institute of Technology in Sweden.

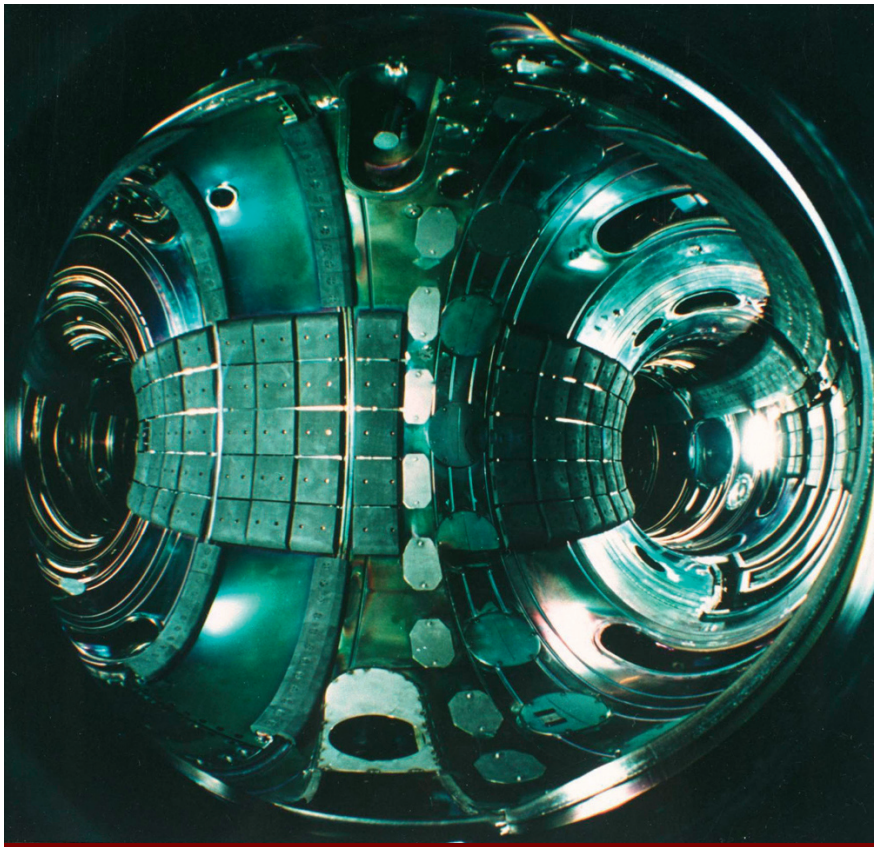
"The European Commission finds in a major study that renewable energy can only, when fully developed, supply about 50 per cent of the energy needed for Europe. It is imperative to find out, as soon as possible, to what extent fusion can fill the void."

Sweden's fusion projects

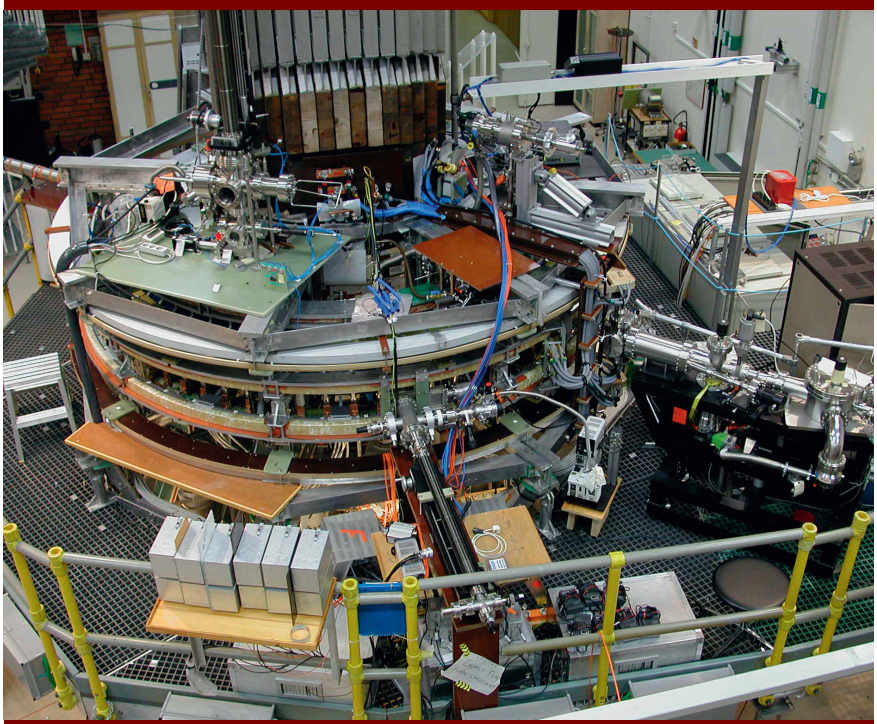
The largest experimental so called 'tokamak' fusion reactor to date is in Abingdon in the UK, called JET, but a new larger fusion reactor, ITER, is currently being created in France. Many new technologies need to be tested out in JET before they go to ITER and ITER will call on a great many scientists from around Europe and the world to converge their findings and innovations collaboratively to make the new reactor a success. Swedish scientists play essential roles in both JET and the development ITER. The JET project has been a huge success, achieving plasma temperatures and confinement that provide the understanding for defining the mission for ITER which is 500 MW fusion power at reactor conditions. The organisation of work units from different countries within EFDA (the European Fusion Development Agreement that forms part of the Euratom-Fusion Programme) has been very effective. Sweden here plays important roles in the fields of plasma control, plasma heating, plasma-wall interaction, neutron diagnostics, spectroscopy, and theoretical and numerical modelling of stability and transport.

The Swedish Fusion Research Unit is one of the Associates in the Euratom fusion programme – a European research and development effort co-ordinated by the European Commission – and is driving innovations for inclusion in ITER.

The Swedish unit is comprised of University groups at Chalmers University of Technology (CTH), Uppsala University (UU) and the Royal Institute of Technology (KTH) together with Studsvik Energy AB, a company with a long experience in nuclear power technology. This Swedish network is responsible for R&D activity that focuses on both the physical technology that needs development and the physics that will make fusion viable as an energy source. Each research group



This is a fish-eye lens wide-angle view of the doughnut shaped reactor core of the JET fusion reactor in Oxford, UK. Large magnets curl the heated plasma around on itself so it does not touch and vaporise any parts of the reactor in its incredible heat which reaches 200 million Kelvin – hotter than the core of the sun



The EXTRAP T2R experiment located at the Royal Institute of Technology, KTH, in Stockholm

is working on specialist areas toward the goal of sustainable fusion.

At Studsvik Energy AB, they are conducting important materials and power plant safety studies. The university groups in the unit focus on computer modelling of the plasma confinement and heating physics (CTH and KTH), development of neutron diagnostics for power plants (UU), materials studies of the interaction of the plasma with the first wall of the confinement vessel (KTH and UU) and finally development of active control techniques for improvement of plasma stability (KTH). In this last regard, the in-house experiment at KTH, EXTRAP T2R, is used for basic development experiments of advanced automatic control techniques.

"The work in general is now very much focused on support for the development of the ITER final design and in preparation for effective exploitation of ITER when it comes into operation," confirms Professor Scheffel.

researchers that at a time when increased funding would make a difference the investment seems to be grinding to a halt. Scheffel explains the frustrations: "It is vital to abandon fossil fuels, providing 80 per cent of the global energy production, as soon as possible in order to reduce carbon dioxide outlet and thus diminish global warming. Fusion has, during its development, received a very limited budget given its potential to become the new, but sustainable, baseload energy source replacing the fossil fuels. As an example the Apollo project, with the much simpler task of placing a man on the moon, was given more money than what has been spent on fusion globally since the research started in the 1950's. Within fusion, a plan for development named 'fast track' has nevertheless been designed. With moderate spending, a fusion demonstration reactor DEMO, providing electricity for the grid, is expected within 35 years. The first step is ITER. The construction of DEMO could, however, be hastened if political decisions and budgetary limits would be less strict. A major economical problem for fusion research in some European countries, like Sweden, is the freezing of the budget that has been prevalent for a decade and a half."

> "The time is over for governments to rely on catch 22, claiming that funding will be alotted to fusion when it appears more realistic and immediate. Scientific and technological research now shows that fusion is around the corner if we are willing to pay for it"

Funding fusion

As with many R&D projects funding has become an issue but in the case of fusion the potential gains from increased financial commitment are potentially world-changing, and at a critical time when the world needs changing.

"Global warming tells us that Mankind must forcefully explore the possibilities for replacing the fossil fuels as soon as possible," states Scheffel. "The Stern report showed us that any hesitation in developing baseline, sustainable energy sources will require enormous economical spending when trying to recover in the middle of the century. The time is over for governments to rely on catch 22, claiming that funding will be alotted to fusion when it appears more realistic and immediate. Scientific and technological research now shows that fusion is around the corner if we are willing to pay for it."

There is a real concern amongst fusion researchers that at a time when increased funding would make a difference the investment seems to be grinding to a halt. Scheffel explains the frustrations: "It is vital to abandon fossil fuels, providing 80 per cent of the global energy production, as soon as possible in order to reduce carbon dioxide outlet and thus diminish global warming. Fusion has, during its development, received a very limited budget given its potential to become the new, but sustainable, baseload energy source replacing the fossil fuels. As an example the Apollo project, with the much simpler task of placing a man on the moon, was given more money than what has been spent on fusion globally since the research started in the 1950's. Within fusion, a plan for development named 'fast track' has nevertheless been designed. With moderate spending, a fusion demonstration reactor DEMO, providing electricity for the grid, is expected within 35 years. The first step is ITER. The construction of DEMO could, however, be hastened if political decisions and budgetary limits would be less strict. A major economical problem for fusion research in some European countries, like Sweden, is the freezing of the budget that has been prevalent for a decade and a half."

For Europe renewable energy will, when fully developed, only be able to provide about half of the energy required. It is limited by the need for large land areas, its intermittency and associated storage problems and for economical reasons. Therefore fusion is vital for the energy future primarily because there presently is no other sustainable energy source that has potential to replace fossil fuels economically, on a large scale. It is this point that fusion scientists in Sweden and around the world want to underline, the answer can be fusion but the problem is funding it. ★

At a glance

Full Project Title
EURATOM Fusion Research Programme Association (EURATOM-VR)

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European Fusion Development Agreement (EFDA)

Project Funding
Seventh Framework Programme of the European Atomic Energy Community (EURATOM) for nuclear research and training activities

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Jan Scheffel is professor in Theoretical Fusion Physics at the Royal Institute of Technology in Stockholm, Sweden. He is also the public information officer within the Swedish fusion association and the Director of undergraduate and graduate studies at the Alfvén Laboratory (Fusion Plasma Physics) KTH. His other activities include pedagogical leadership of two master programmes and work in the field of epistemology.

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