Q&A on nuclear fusion and the ITER project with Michel Claessens

Interviewer: Gareth Byatt – Principal Consultant, Risk Insight Consulting
Interviewee: Michel Claessens (@M_Claessens) – ITER Policy Officer and Teacher in Science Communication

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Michel,

Thank you for making the time to talk with me about nuclear fusion, and the ITER project. I'd like to start by asking you about what you do, and your background and relationship with ITER.

Michel: *My background is in physical chemistry. I have a PhD in this subject, and after a number of years carrying out research at university and in the private sector, I moved into science journalism. It was this move that led to me being recruited by the European Commission, to develop their information and communications strategy for the large research programme that the European Union (the EU) has in place.*
In 2011, I was recruited by ITER as Head of Communication and External Relations. I had been following this project for a long time, and it was a terrific role to hold for five years, from 2011 to 2016. I am now in Brussels, where I still work for / with the ITER project, and I am a civil servant helping with the EU (which is one of the project's biggest funders).

(for general information about ITER and nuclear fusion, refer to the links provided at the end of this interview)

Gareth: Your book, ITER: The Giant Fusion Reactor: Bringing a Sun to Earth offers us a fascinating glimpse into this totemic energy project – covering the events and research over several decades that led to the project's formation, the technical details of the construction and technology involved, and what ITER could mean for humankind. What inspired you to write the book, and what do you hope that readers can gain from it?

Michel: *Partly it is down to my love of writing (which is what led me to move into science journalism, as I mentioned earlier). The book I have written about ITER is my fourteenth book – writing is one of my hobbies. I continue to contribute to media and magazines as well, and it is a pleasure for me to put together a body of work like this. And, since I have had the honour of being part of ITER for a good few years, the book was an opportunity for me to put into words some of the key aspects of the project and its endeavours, which I still find quite breathtaking.*

I hope that through the book I can encourage more people to know about ITER in a rounded way.

A linked reason for writing the books is that, in welcoming hundreds of groups to Cadarache (the site of the ITER project), I consistently found (which is no criticism, I hasten to add – just an observation) that very few people know about the existence of ITER, and the magnitude and scale of its ambitions for humankind.

Since publishing the book in 2019, I have been very pleased to receive good feedback about it. I have sought to cover a broad range of aspects. I feel it is a requirement to look at the overall spectrum of such a project, which includes appreciating differing viewpoints about it. This is very much my "ligne rouge", as we say in French – to be open and honest about things, and to state facts and welcome a rounded debate. We have to address the problems, difficulties and the errors that have been made on a project like this, as well as the significant achievements and further opportunities that exist.

People can also follow me on Twitter.

An aerial view of the ITER worksite in Cadarache (close to Marseille), taken in May 2020 (courtesy of M Claessens). The site has a total area of 181 hectares. Top left, the main warehouse which is used for the storage of the reactor parts delivered by the seven ITER members. In the foreground, the personnel car park and the headquarters of the international organisation (the building which is bent and has a dark façade). The reactor will be located in the tallest building on the centre of the platform. Nearly three thousand people are currently working on the site.

Gareth: Thanks for that context, Michel. I'd like to build upon what you just said, about being open to address problems, difficulties and also errors, as well as the good things that have happened, and are happening. One of the criticisms of the project is the cost of it. For example, why not use the money for other research, other renewable energy options, etc, the alternatives, then people tend to see it.

Michel: *Yes, we need to address the matter of costs, and to unpack it completely to understand it, and also to see what it represents in view of overall costs of energy production and use. Dialogue is key. One of the things I want to stress is that, through writing about ITER, I am not seeking to influence people, rather to provide them with facts and information about the project so that they can make their own assessment.*
Indeed, I remember welcoming some opponents of nuclear power to the site whilst I was based in Cadarache. Whilst some people were a bit nervous about it, we had a good dialogue. We can work together when we are open and ready to listen to each other's views.
To come back to your question on the cost, it is up to each country to decide upon the breakdown of the research budget; it is therefore a political decision. At the EU level, the ITER budget line is a specific element which does not conflict with the research done on renewables, etc.

Gareth: You've got me thinking about a "key tenet" of good risk management – to listen to people in an unbiased way, and not be closed to views. I wrote about this a while ago for the Institute of Risk Management (the IRM) as it happens, in an article for their magazine.

Before we return to the subject of costs and the project itself, could we outline for people the main difference between "traditional" nuclear power, which is based on nuclear fission, and nuclear fusion (which ITER is designed to harness), and the advantages (if that's the right way of putting it) that nuclear fusion has over nuclear fission? Do you foresee that both nuclear technologies have a role to play moving forward, as part of an overall energy picture? (chapter 2 of your book covers this in good detail, I would like to add).

Michel: *Yes, this is a critical point to outline and explain. Fission is common across the world, fusion is not. From a physics point of view, they are pretty much the opposite. Fission splits atoms apart, whereas fusion is about combining them. For fusion to take place you need to achieve very high temperatures – some 150 million degrees Celsius, and this is extremely challenging to achieve outside of the stars that light up our night sky, which spend their lives furiously doing this.*

Gareth: I have read about "cold fusion" research that was being undertaken some time ago. Is that still being progressed?

Michel: *Yes, there is some research being done into cold fusion, for example at MIT, but I'm not sure where it will head. I don't think that since the late 1980's there has been any particular scientific update. However, it's good that people are examining different options for nuclear fusion.*

Gareth: You describe at the start of the book two aspects which are generally agreed upon if we are to meet our present and future energy needs: first, we must reduce or rationalise our energy expenditure and second, we must develop solutions that are as safe and environmentally friendly as possible, based on sustainable and universally available sources.
The formation and early activities towards ITER go back many years, before many renewable energy sources became as popular as they have. There is, of course, a lot of discussion all around the world about how sustainable energy sources are critical for the future of our planet, and to help us combat climate change. Is nuclear fusion getting enough coverage as being part of a sustainable energy future?
For example, I note that the IEA briefly mentions it in their assessment of nuclear energy's role in a Sustainable Development Scenario, whilst stating that a large increase in nuclear power capacity is required to sustainably meet future energy demands. I don't see much about nuclear fusion being covered in the press in comparison to what we see about solar, wind, hydrogen and hydro-electric, apart from recent news about ITER and occasional feature articles in the business press about start-ups.

Michel: *I think this is a fair question, about whether nuclear fusion is getting enough media coverage. We have certainly seen a much greater coverage about renewable energy over the last decade or two – which is all positive for driving sustainable energy policy and strategy. ITER doesn't tend to make international headlines too often – or indeed national ones, in the country where it is being built. As you know, ITER is based in France (in Cadarache, in the south) and the French media do not cover it too much. Big milestones make the news, mostly.*

The publicity about ITER is linked to the way that the media want to cover it. It can be hard to get headlines sometimes, for various reasons. The fact also is that ITER is very complex. Perhaps people struggle with the complexity. From all the visitor groups I have welcomed at ITER, they tend to ask us why we are not talking more about it.

When it comes to general coverage of all energy needs, there are some people in the global community who say: "we don't need fusion, renewables can cover our needs." To that, I would say that we still don't know the answer to how we meet our future energy needs.

Nuclear fusion is much cleaner than conventional fossil fuel energy sources and is much safer than nuclear fission. Fusion energy should allow the construction of large "clean" power plants, and thus guarantee the supply of baseload power to the electricity networks with a stable minimum level of production at any time, regardless of weather conditions, which is essential to provide for the growing energy needs of our global economy. However, technological progress and the emergence of 'smart' electricity networks have also shown in recent years that it appears to be possible to have stable electricity production without 'centralised' power plants.

Gareth: I wonder whether the relative lack of media coverage about ITER might at least in part be associated with the fact that, given everything about the project (which I'll come onto in a moment), it is being managed pretty well, so far.
It is hugely ambitious. Its perhaps interesting to look at the cost, complexity and timescales of it in comparison with other major energy projects (for example, the Flamanville-3 reactor in France may cost €12.4bn, the Hinckley Point C nuclear power station is forecast to cost more than £20bn / €22.2bn), and also other infrastructure projects (for example, Crossrail in London is currently forecast to cost £18.7bn / €20.8bn).

Michel: *That's a good point. Plus, when we look at, say the US$37bn cost of the Three Gorges Dam in China, or the spending for the next World Cup in Qatar (estimated by some to be around US$220bn), we can appreciate size and scale. The International Space Station (a terrific example of international cooperation, I want to add) was also quite costly.*

In its particular "segment" of infrastructure and scientific advancement, I would say that roughly speaking, the cost and timescales of ITER are comparable to other projects. The first CERN Large Hadron Collider project in Geneva was lower, but the next generation of accelerators (a Future Circular Collider) look to be of a similar cost to ITER. Projects like ITER, the LHC, the FCC and others further our understanding and capabilities for the long-term.

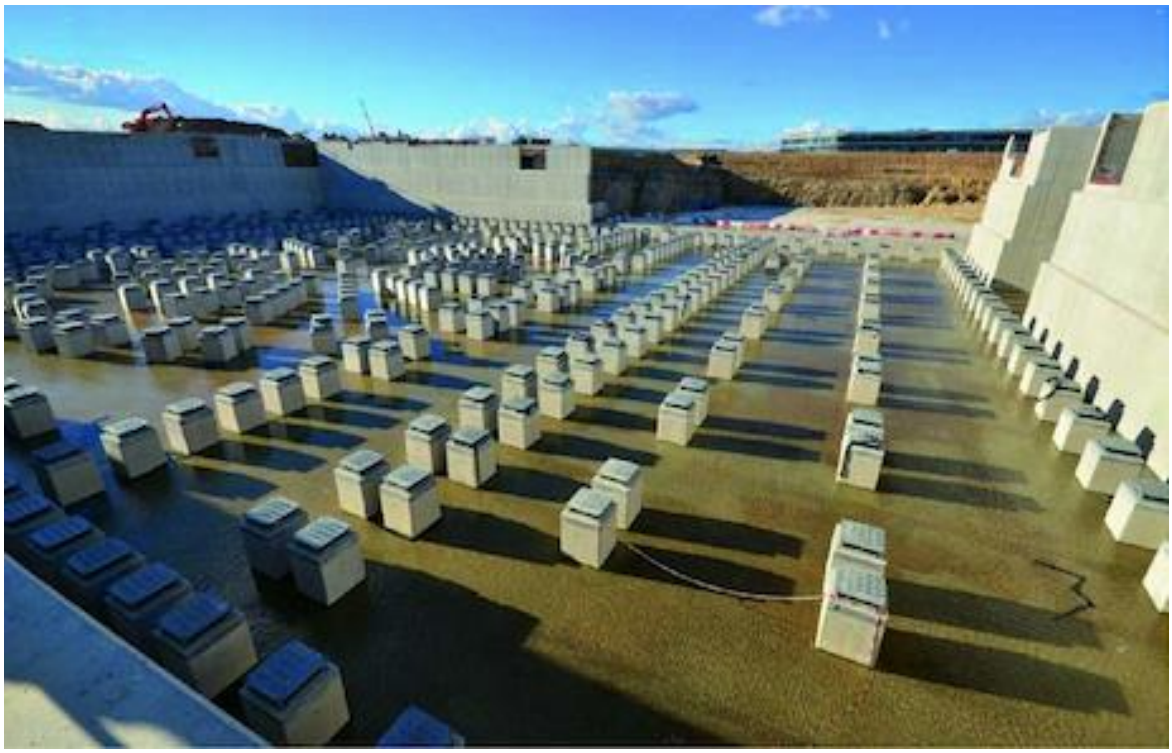
In terms of "the long-term", we used to say that, based on our plans for ITER, fusion energy may not be fully realised before the second half of this century.

Some people say that this is too late – too late to tackle climate change "in time and in a strong way", and too late to see the cost-benefit from the project. Realistically, our technology advancement may mean we have to wait this long.

Gareth: As a Risk and Resilience Consultant who works in the infrastructure sector and other heavy industry sectors, I am always interested in hearing about the way that major infrastructure teams manage risk as they work towards achieving their objectives. I know and appreciate how challenging major infrastructure projects are, especially ones like ITER that have many "FOAKs" (first-of-a-kinds) and novel (new) risks to tackle.
How does the ITER project team stitch risk management into its project activities? From reading your book, I can see that there are a great many "novel risks" and "unknown unknowns" to building the tokamak and all the other equipment and facilities that constitute the project. I am sure there were some risks and issues that are common to many large infrastructure projects (for example, I noted your point in your book about the preparatory work for the site, and the challenging community liaison during the destruction of large trees as part of the site clearance).
One point you raise in your book is the importance of addressing programme-specific issues and risks at all stages of production, and that in hindsight this could have been done better early in the project's life. I wonder whether we could unpack this a little? First-class risk management must be stitched into how a project team and its entire supply chain operates. Is there a particular approach, or framework, that is adopted by the ITER project team?

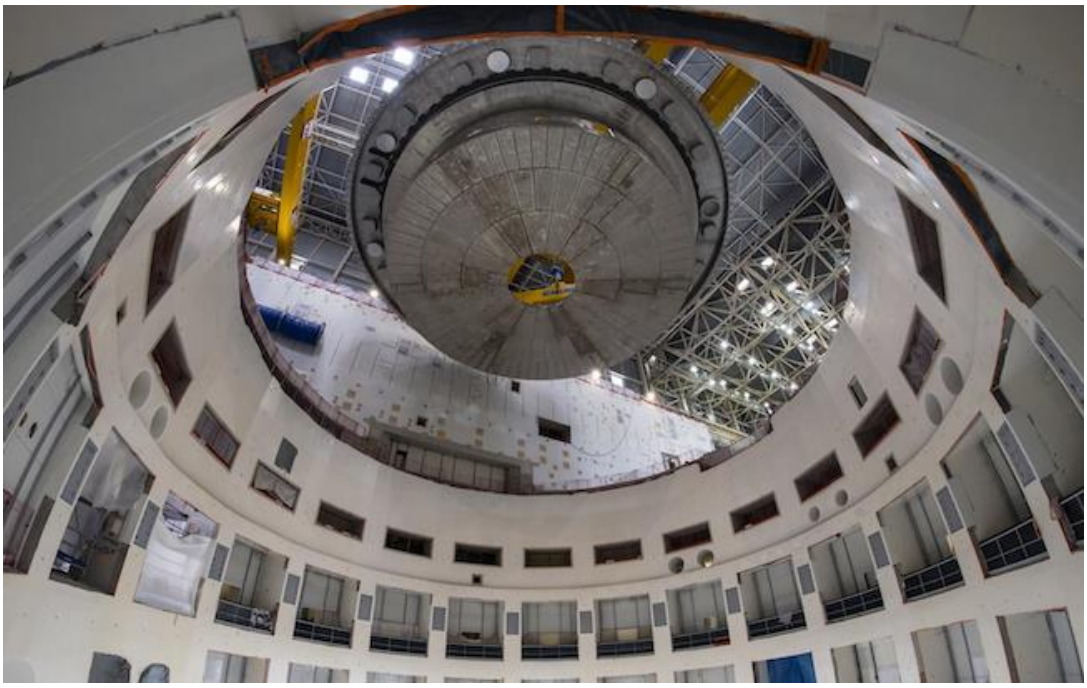
Michel: *As you say, the project has a lot of risk associated with it, in all sorts of ways. In my time working on and with ITER, I have seen examples of where the project has handled risks very well, and some where it has proven challenging.*
In terms of risks that have in my view been managed well, the "known site risks" have been handled well. By this, I mean the threats of natural and external events and disasters, such as floods, seismic risk, terrorist attacks etc. These threats have been taken into account very early in the project's life. ITER had to demonstrate to its stakeholders that the facility will be safe and secure, and also that it will not pose a threat for the local community (i.e. on health, safety and environmental grounds).

To give you one example of planning for such risks, the tokamak building is resting on 493 piles below ground (part of the foundation) which have anti-seismic parts built into them:



ITER's ground support structure (photo courtesy of M Claessens, taken in 2012)

Cross-party and program-level risks took a little while to be integrated properly. Perhaps this was inevitable due to the many stakeholders involved. At the beginning of the project the cross-party risks were managed separately by ITER and the 7 separate agencies. Now, the ITER organisation has a professional, serious and comprehensive risk management framework in place which integrates the risks of all stakeholders.



Installation of the cryostat base of the reactor in the building. The cryostat will contain the fusion reactor and provide an ultra-cool high-vacuum environment (courtesy of M Claessens).

View of a toroidal field (TF) superconducting coil manufactured in Japan. The ITER reactor will contain 18 TF coils, each 17 metres high and weighing 310 tonnes. Half are manufactured in Japan, half in Europe (courtesy of M Claessens).

Gareth: These points that you have raised make me think about "business continuity planning" and business / operational resilience. This is something that I am sure other projects could learn from. Going through continuity risks and thinking through ranges of outcomes, with scenario analysis, can be a good way to look at the risk in a rounded way. I also think that, when we are looking at novel risks and "unknown unknowns", expressing potential outcomes in ranges can be worthwhile. In terms of embedding a structure for dealing with cross-party risks, sometimes this takes time as parties learn to work together and share information, especially when different cultures are involved.

Michel: *Yes, I agree that using ranges of outcomes to look at risks where it is difficult to quantify or know specific outcomes can help.*

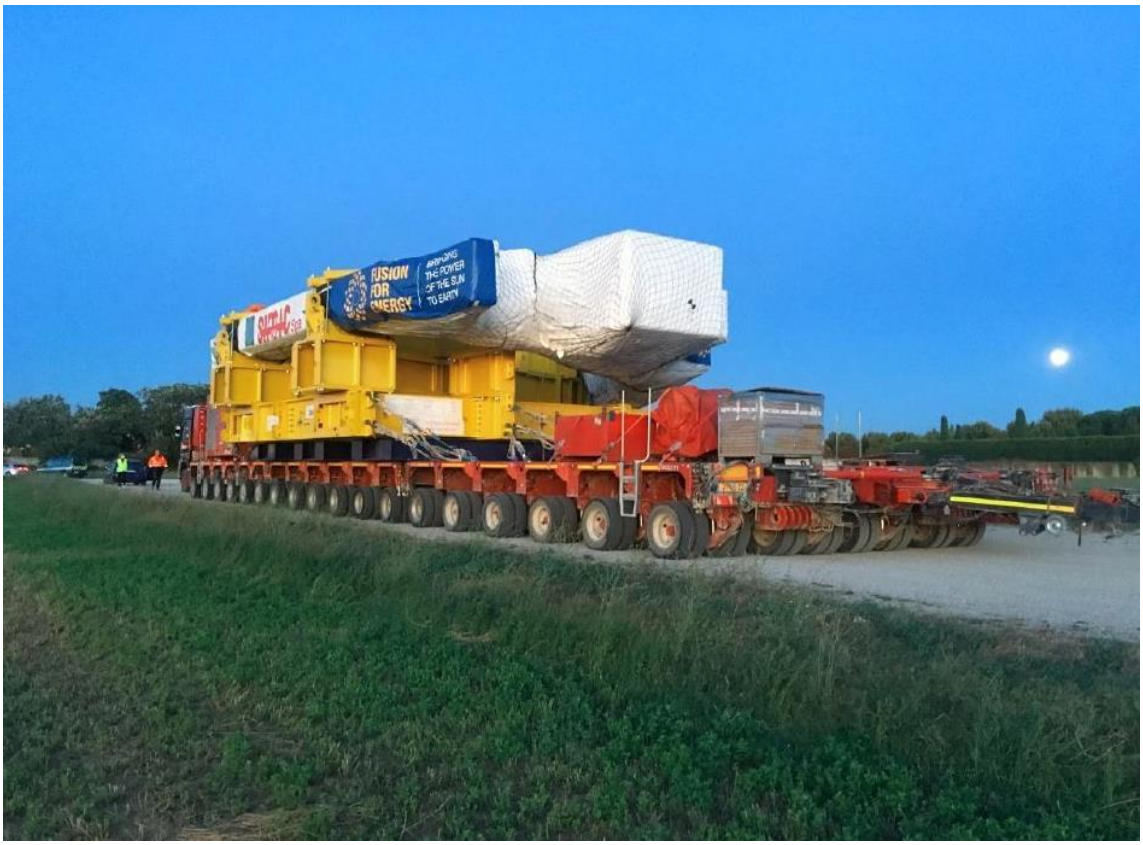
For sure, managing risk at ITER is strongly linked to appreciating culture. We have to remember that ITER is multi-cultural. By this, I do not "just" mean that it is made up of people from 35 countries, and countless languages, but also the backgrounds and expertise that people have. Some have a background in the nuclear industry, some in physics, some in research and some in building and construction. It is a source of richness, but it can also create difficulties because some people may not initially understand an overall decision or direction that is being taken.

There are also certain risks, such as international political risks, about which we cannot influence – for example, if one of the members decides to change their minds. For example, India has not been fulfilling its cash contribution to ITER since 2017, and the US has altered its contributions in recent years. The COVID-19 situation is another example of international risk.

Gareth: Just continuing on the "business continuity and resilience" point, I do quite a bit of work in resilience and business continuity in the private sector, and I have written for various institutes and industry leaders about the need to demonstrate what I call "purposeful resilience" – to be resilient to change and disruption in a way that puts people and the environment first, and achieves sustainable outcomes. Building resilience into ITER, including what must be many back-up measures and fail-over mechanisms (e.g. to incorporate back-up / fail-over plant and equipment, from pumps to the special vacuum vessel bricks to the complex magnets required, as well as backing up design information and data), must be part and parcel of the project.
I wonder what learnings businesses could take from the approach to resilience being taken by the team building ITER. Resilience across the whole value chain has always been important, and it continues to be the case during the COVID-19 pandemic.

Michel: *Yes, resilience measures have certainly been integrated into the ITER project. As just one example, you mentioned the magnets being used in the tokamak. There will be 18 very large magnets inside it. Nine are coming from Japan, nine are being made in Europe. They are complex and a "new one" cannot be manufactured and shipped to site quickly. The ITER consortium agreed that, as part of its resilience measures, there is benefit of having one additional magnet fabricated, whilst the 18 are being produced (i.e. whilst work is already being undertaken to fabricate and then ship them to site), to be a back-up in case there is a problem with one of the 18 magnets in the tokomak. This is just one example.*

This mindset and approach to resilience and "critical components" has been followed for most of the major systems and components. This decision was, of course, agreed by the ITER Council, the primary governance body.



Delivery of one of the large magnets to the ITER site (photo courtesy of M Claessens)

Gareth: Thanks for this example, Michel. You have reminded me of a piece in The Economist published in June 2020, titled "The world should think better about catastrophic and existential risks". They give the example of large transformers in electricity grids, which, if they experience a problem, may cause major problems.

Also, I imagine that there must be a lot of work being done to protect the technology of ITER against cyber threats (which, of course, are constantly evolving). I know that the Cyber threat to critical infrastructure mean that governments stipulate stringent controls to guard against it.

Michel: *Yes, the IP value of ITER is huge, and certainly, a detailed approach to cyber security is in place.*

Gareth: You mention in your book that ITER may be the most complex (and most expansive) machine ever built by humankind (your description about the technical aspects across the book chapters, the computerised images of the ITER reactor and the various photos of parts of ITER throughout the book are fascinating, I must say).

I know that Bill Gates is an advocate of nuclear fusion, through the Breakthrough Energy organisation and its backing of new energy initiatives. For nuclear fusion to be an important, reliable, safe and cost-effective part of the global energy mix of the future, do we need a blend of large facilities like ITER and smaller, nimbler nuclear fusion businesses such as those being developed by the likes of start-ups such as Commonwealth Fusion Systems, First Light Fusion, General Fusion, TAE Technologies, and Tokamak Energy that are also working to make nuclear fusion become a commercial reality (and that are managing to raise capital from sources around the world to do so)?

Michel: *Yes, I would say that ITER and the smaller fusion companies co-exist, and it is healthy competition. I would not say that there is real collaboration going on, but everyone benefits from the advances in technology that different teams continue to achieve – the superconducting magnets, the IT et cetera. In a way, they are all 'travelling in the same direction'. I remember a meeting with the scientific directors at ITER some 5 years ago, when the U.S. company Lockheed Martin was launching a new fusion initiative, and our team was at pains to say that this is good to see, because we need various initiatives to succeed with the big picture for fusion energy.*

There are, I think, currently over 20 private funded projects on fusion. Some are backed by well-known names such as Bill Gates, Jeff Bezos, the late Paul Allen and Peter Thiel, others are lesser known. I think this shows that there is global confidence in this technology for the future. Also, the Chinese government is independently building "their own version" of ITER.

Gareth: With 35 countries involved in ITER (and 35 countries contributing towards the tokamak), it is clearly a project with incredible international cooperation. What learnings about how things have progressed so far, and how the project continues to progress, can be taken on board by other supranational organisations?
One organisation that comes to my mind is the UN, for example. Another organisation I think of in terms of learnings about international cooperation is the World Trade Organisation.

Michel: *That's an interesting point. We always need to consider the particular context for each supranational organisation – they are all different, with their different challenges. When you work in such an organisation for a decent period of time, you tend to appreciate the cultural richness that they have. However, it is true that not everyone in such organisations gets to work in positions where they regularly see this.*

It certainly requires some effort to openly and consistently maintain cooperation. For sure, these exchanges are a strength and a richness. We also need to accept that it does create challenges. One obvious one is the variety of languages that are spoken in such organisations (and ITER is a case in point). English is the common language used, but the percentage of native English speakers in most supranational organisations will not be large. Plus, cultural traits need to be carefully appreciated by everyone. Then, there are related cultural aspects of nations.

For example, something I noticed at ITER is the way you have to adapt when living in another country. The way people in different nations respond to different matters differs with their culture. Healthcare is just one example. Another example is the specific geography where you live, within the country. In the vicinity of ITER, the level of spoken English amongst the public is not as high as it is in, say, Paris. Whilst this isn't specific to ITER (and it certainly isn't a criticism, just an observation), it does show that mixing lots of cultures together in a particular location means that a great deal of awareness, openness and patience is required by everyone – including their families. The willingness to learn from others is important, too.

Gareth: Regarding the UN, I wonder whether we could briefly discuss the Sustainable Development Goals (SDGs), particularly SDG 7 – Affordable and Clean Energy. The UN has a drive for a "decade of action" to achieve the SDGs by 2030. I tried to find some information about the SDGs and ITER, but I couldn't find out any information about it. Does the ITER team define its contribution towards the SDGs as part of its work?

Michel: *For sure, ITER subscribes de facto to the initiative of the SDGs, and especially for developing clean and affordable energy, but you are right, the SDGs are not explicitly mentioned by ITER. Perhaps this is because ITER was conceived many years ago. Plus, we should bear in mind that ITER is looking at the long-term for energy needs, way past 2030. There is an inherent link to the SDGs, I would say.*

Gareth: Continuing on the theme of the drive to achieve sustainable energy for the world, does nuclear fusion have the potential to be used to help store and distribute energy (using various "energy storer" solutions) to various parts of the world, include developing and remote parts, as well as to be used to power large metropolises and the developed world? Sustainable Energy for All (SEforALL), which focuses on SDG 7, estimates that 789 million people – predominantly in sub-Saharan Africa – are living without access to electricity, and hundreds of millions more only have access to very limited or unreliable electricity.

Michel: *For me, the two points are separate. There is the fusion process to create the energy, and then there is the storage of energy and its distribution. If we can continue to find improved solutions to store electricity, that would be good (there are lots of initiatives underway for this).*

Gareth: Governments around the world still talk about the importance of having a "base load" of power, and that renewable energy might struggle to meet base load demand (whether that is really true is a matter for debate). Rather than talking about "base load", should we be talking about dynamic energy use and storage to dynamically manage energy loads? I am wondering if nuclear fusion can play a valuable role in helping us to store energy in an appropriate way, integrating with technologies such as batteries and hydrogen fuel cell technology.

Michel: *Yes, I think it is about finding a blend of solutions to provide us with what we need. Base load is an issue and should be handled properly.*

Fusion may be part of the answer to this challenge. There are some experts claiming that we will not need to use base load in future, with "smart networks" taking its place. It's possible that this may happen, but we need to do further work to see how the future energy needs can best be managed. We are all using more and more energy around the world for many things (computers, internet, air conditioning, transport etc.) We all know that the climate is warming up and this has an impact on our energy needs.

Gareth: As the IEA and other agencies and analysts have noted, there continues to be a lot of traditional power station construction taking place around the world. Should governments be thinking about how to "turn this oil tanker around" and invest in new ways of doing things? I am particularly thinking about some of the large, emerging economies such as China and India.

Michel: *We should be continuing the research on various technologies for energy. We need to remember, per my point earlier, that fusion will take time to come to fruition. We need to invest in research and innovation in other technologies as well. It's not only about the budgetary capacity and what to spend money on for research, it is about our capacity to organise new work and the involvement of industry and the private sector. On this point, the EU is, for example, well organised (ITER is a specific budget line for the EU, for example, and other budget lines exist for other types of green energy, as we mentioned earlier).*

Gareth: You devote a chapter in your book to "those who are against ITER" – people and groups ranging from trade union groups and anti-capitalist groups, as well as respected scientists. We briefly touched upon it earlier in this interview. It is always good to welcome diverse views, and to listen fully to people's arguments.

Michel: *Yes, there is certainly opposition to ITER, in various ways. I think that with major new initiatives like ITER, there are always going to be differing views and differing opinions on whether they should be proceeding, and how they should be approached (similar to probably all large infrastructure and developmental projects).*

Rounded criticism and different viewpoints should always be welcomed. We can all learn from different perspectives.

Gareth: You have reminded me of a piece that I wrote a few years ago, Michel, about the importance of understanding perspectives of many stakeholder groups on large infrastructure projects.

Michel: *I agree. I would categorise the opposition to ITER into three categories: firstly, there are technical concerns and criticism. Second, there are ideological concerns and, third, there are concerns about the potential for things to go wrong on the project.*

Taking the technical opposition and criticism first, there are various points made. Some people say that because the design of the ITER reactor dates back 20 years, it will only confirm what we already know. Some say that ITER will not bring the very latest new technology, even though it is not yet ready to be used, but this is not true.

With regard to other technical criticisms, people say that the materials to withstand the pressures and temperatures required for fusion to be successful may not be good enough. Other technical concerns are also related to commercial matters. For example, that it is too early to say if ITER will "open the door" to commercial sources of fusion energy (noting that there are already fusion start-ups in existence, as we discussed earlier). There are other criticisms that ITER will not produce any "net" energy. We need to remember that it is a proof of concept (an important one, but still a proof of concept).

Second, there is the form of criticism, which is ideological in nature, by people who are against nuclear power in general – both fission and fusion. Fission is of course our current nuclear energy power, and it comes with very large plant construction costs, dangerous waste products that have a long-lasting effect and people's memories of large-scale accidents in the past. There is a growing understanding of how fusion is different to fission – that it is a much greener alternative with no radioactive waste products that the fission process creates, so perhaps this type of criticism about nuclear fusion may change over time.

The third criticism I see is from scientists, and also the general public, which is related to worries about ITER because of the sheer size and scale of it. There are concerns that it could be uncontrollable, that it could be dangerous. I remember taking groups around the project, and some people find it to be a dangerous concept, when they see what we are seeking to achieve. Also, some scientists are concerned that ITER could consume too much of the budget for new energy research and development.

I think it's important to understand people's concerns, relate to them and respond to them as best we can. As I mentioned earlier, dialogue is key.

Gareth: The last criticism point you mention is, I think, a direct linkage to "novel risks" – that is to say, risks that arise from unforeseen challenges and/or complex combinations of how things could occur.

Should businesses in different sectors be doing more to help to speed up the reality of nuclear fusion being part of our global energy mix? I'll split this question into two parts.
First, the Energy giants such as Exxon Mobil, Chevron, Shell, BP, Total and others, and national electricity providers. Most say they are investing in "green energy initiatives", including a certain amount of investment in nuclear fusion.
Second, businesses in other sectors (from agriculture to concrete production, mining, shipping and steelmaking) that are investing in and implementing renewable energy sources for their energy needs.

Are there actions that business can undertake now to contribute towards, and benefit from nuclear fusion initiatives, or is this something that will have to wait till more progress on fusion development is seen?

Michel: *Based on my experience, I would say that, overall, the private sector businesses are participating in making new forms of energy real. For fusion, I think we always need to remember that it is a long-term goal, that we cannot immediately achieve it. Businesses have certainly "come to the party" for ITER. The companies that have signed contracts for ITER (large and small) took a risk in doing so – in technology and financial risk (you mentioned that ITER has lots of "first of a kind" earlier). I see a lot of interest in fusion from the private sector. For me, I see a growing awareness and interest in various aspects of what fusion can represent. I am also contacted by financial investors. Many large fund management businesses are supporting start-ups in fusion. Making it clear that it is a long-term mission is key.*

Thank you very much for your time, Michel. As we move forward in a world that is currently dominated by the COVID-19 pandemic, there is much discussion about whether we will have a "genuine reset" of our world – including for a truly sustainable energy mix to power our future energy demands. I look forward to seeing how the ITER project continues to progress, as part of the work towards nuclear fusion.

I enjoyed listening to your interview on the BBC 5 Live Science podcast recently, by the way. Keep up the great work!

Michel: *My pleasure, It is possible to visit the ITER project in Cadarache (when times are normal) – you can book a date and time and be treated to a tour.*

Further suggested reading and watching about nuclear fusion

ITER, The Giant Fusion Reactor

The ITER project has an excellent website, for those who are interested in finding out general details about it.

Find out about the ITER Tokamak (toroidalnya kamera ee magnetnaya katushka – torus-shaped magnetic chamber) machine here.

What will ITER do? Read this information to find out.

A good source of general information about nuclear fusion power by the World Nuclear Agency is their website, here.

Examples of start-ups and businesses involved in fusion work

Commonwealth Fusion Systems

First Light Fusion

General Fusion

TAE Technologies

Tokamak Energy

Sample articles about nuclear fusion

Breakthrough at the ITER Fusion Reactor Paves Way for Energy Source That May Alter the Course of Civilization | Opinion (Newsweek May 2019)

Two British companies confident of nuclear fusion breakthrough (FT Dec 2019)
(access restrictions may apply to this article)

Bloomberg Moonshot interview on fusion energy (Oct 2019)

Nuclear Fusion Start-up Gets $84 Million to Enter Next Phase (Bloomberg May 2020)

Oil giant joins Bill Gates-backed nuclear fusion plan for 'game-changing zero-carbon energy' (May 2020)

Nuclear power for sustainable development (a paper by the IAEA)