New Energy Times

The Dark Side of ITER

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Summary

Since at least 1993, scientists representing the nuclear fusion community have convinced members of the U.S. Congress that the International Thermonuclear Experimental Reactor (ITER), under construction in Southern France, is designed to produce 500 million Watts of thermal power, ten times more electrical power than the reactor is designed to consume.

This is not true.

Later, other fusion scientists convinced the European Parliament and European Commission to publish similar falsehoods about ITER. In fact, the list of organizations that have, as a result of the fusion scientists' claims, inadvertently published falsehoods about ITER in the last decade is extensive.

As revealed by New Energy Times in 2017 and in a subsequent 2019 statement from the United Kingdom Atomic Energy Authority, if the ITER reactor works according to design, the ITER reactor should produce about as much power from fusion as the electricity required to operate the entire device. A statement by a Japanese government fusion organization also describes the expected overall device power balance accurately: "ITER is about equivalent to a zero (net) power reactor, when the plasma is burning." A German government document uncovered by New Energy Times also reveals that the reactor's overall output will be equivalent to zero net power.

The actual design goal for the ITER reactor is to create a plasma of 500 megawatts (thermal) for around twenty minutes while 50 megawatts of thermal power are injected into the tokamak, resulting in a ten-fold gain of plasma heating power, not reactor power.

The enormity of this false science claim, in terms of involved scientists, expenditure of taxpayer funds from China, the European Union, India, Japan, Korea, Russia, and the United States is unprecedented and is therefore difficult to conceive. Deception and fraud are ugly words that nobody in the scientific world wants to be associated with. Nevertheless, over the course of three decades, it happened.

Much like the perpetual motion frauds from a century ago, which employed hidden mechanical devices to supply power, scientists promoting ITER have hidden the reactor's expected input power through specific wording, omitted facts, undisclosed terminology, and deceit.

Introduction

For any electrical power-generation system, the most fundamental performance measurements are the rate of electrical power going into the system and the rate of electrical power coming out of the system. In chemical and nuclear power-generation systems, output is in the form of heat, which is converted to electricity.

What, therefore, would be the point of building the world's largest experimental fusion reactor if it turns out that the electrical power required to run it is equal to or even greater than the power it produces from fusion?

That is the rhetorical question that author Michel Claessens poses in his new book *ITER: The Giant Fusion Reactor*. He also published a French version of the book, in 2018. Claessens answers this question and informs readers that the International Thermonuclear Experimental Reactor, ITER, under construction now in southern France, is designed to consume only 110 million Watts (megawatts) of electricity while producing 500 megawatts of thermal power from fusion. Readers are thus informed that the reactor is designed to produce 4.5 times more power from fusion than the reactor is expected to consume from the southern France electrical grid.

If we make an apples-to-apples comparison and calculate the output power back to electrical power, using a 40 percent efficiency rate, the gross electrical output would be 200 megawatts, and the net electrical output would be 90 megawatts. This is a highly simplified calculation, but it shows that net power would still result if like terms are compared.

Claessens contacted me in January 2017 regarding one of my early news stories about the ITER reactor. Although his book and his discussions with me represent only his personal views, Claessens is no bystander. He is a key link to the European Commission and works for the commission on ITER policy issues. Perhaps more significant, from 2011 to 2015, he worked for the ITER Organization, which is responsible for building the ITER reactor. Claessens was the head of communications, reporting directly to the ITER organization's current, and third, director-general, Bernard Bigot.

110 Megawatts or 50 Megawatts?

For two decades, promoters of the ITER project have created the impression that the reactor will need only 50 megawatts of power to operate. This number has appeared on the ITER Organization's Web site, in promotional videos produced by the organization, in public talks by its representatives, and in testimony before members of Congress.

Based on Claessens' 110 megawatt number, the projected power amplification of the reactor would have been only half of what its promoters had claimed. Instead of producing 10 times more thermal power from the fusion reactions compared with the electrical input power, the reactor, according to Claessens, will produce less than half that amount.

As the publisher of *New Energy Times* for the past 20 years, I have seen and heard many, claims of new types of energy sources and power producing devices. A number of these claims have involved deception. In claims involving power-production, knowing exactly how much power goes into a system and how much power comes out is essential. Without both of these numbers, any power-production claim is meaningless.

"ITER is expected to embody most of the features of a fusion power plant. ITER is being designed to produce 1,000 megawatts of energy, which is about half of that produced by an average-sized conventional electric power plant. The purpose of ITER is to demonstrate the scientific and technical feasibility of magnetic fusion energy and to prove that a sustained fusion reaction can be maintained at an energy level sufficient to generate electricity in commercial quantities."

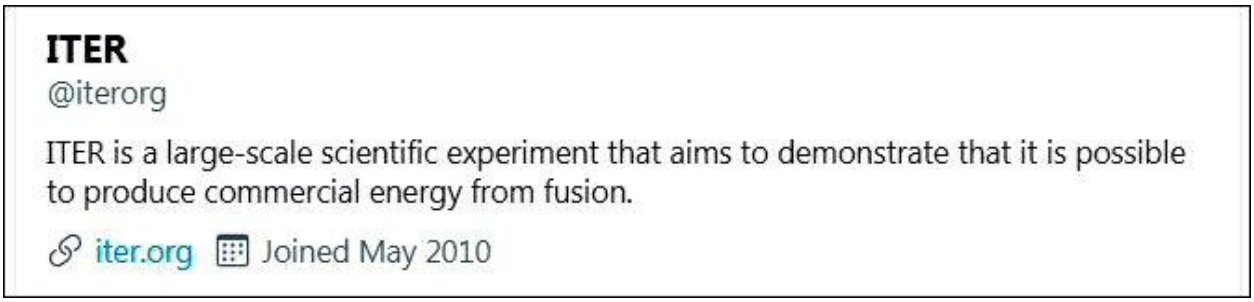
— Senator J. Bennett Johnston (D-LA) / U.S. Senate, March 24, 1993

On the dark side of the energy business, claimants usually exaggerate the output power, making it seem larger than it really is. But the same effect can happen by misrepresenting the input power, making it seem smaller than it really is. This is why the input and output power claims for any fusion reactor, ITER in particular, are crucial to know. This is why clear and transparent disclosure of input and output power values is essential.

Officials responsible for the ITER project have said for more than 15 years that the ITER reactor is designed to consume only 50 megawatts of power. Promoters of the project, in public communications before 2017, rarely listed that value as "50 megawatts of injected thermal power," which is accurate and precise. Instead, they left it vague and allowed non-experts to assume that the "50-megawatt input power" was electrical. The effect resulted in an immense exaggeration unwittingly carried to completion by their associates in industry, government, and the news media.

The ITER reactor is designed to produce fusion particles that have 500 megawatts of thermal power. Along with that output value, ITER promoters used the 50-megawatt input value as the foundation for their claims that the reactor is designed to 1) produce 10

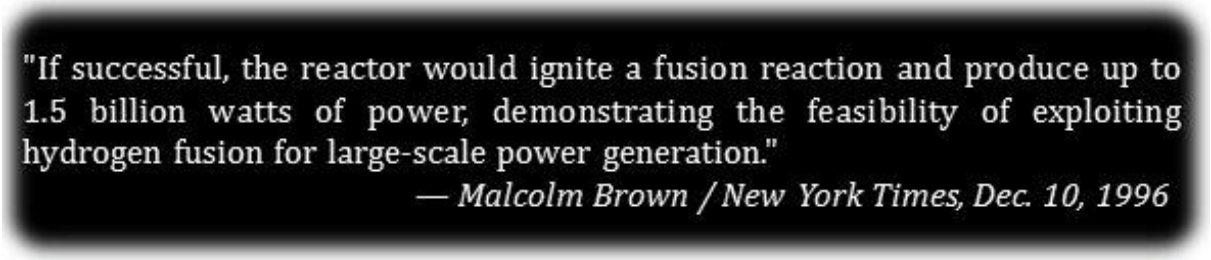
times as much power as it should consume, 2) produce significant amounts of net power, 3) be the first fusion reactor to produce net power, 4) produce, even for just a few seconds, as much power as a small commercial power plant, and 5) demonstrate that it is possible to produce commercial energy from fusion.



Screenshot from ITER Organization Twitter page, retrieved June 5, 2020

Neither 110 Megawatts Nor 50 Megawatts

The actual value for the electrical input power, according to the design, is neither 110 megawatts nor 50 megawatts but 300 megawatts. The ITER organization didn't tell me that value. The ITER organization doesn't publish that value in any obvious place on its Web site. In fact, when I realized that the 50 megawatt value on the ITER organization's Web site wasn't the real electrical input value, I asked Bigot and Laban Coblentz, the head of communications for the ITER Organization, for the electrical input value. Bigot didn't respond. Coblentz said it would be too difficult to figure out despite the access he had to staff at the ITER Organization.



Eventually, through contacts I had in the nuclear science community, I learned about the 300-megawatt electrical input value and published it in October 2017. The 300 megawatts of electricity, according to the design, are required continuously during the projected five-minute experimental run. Even more power, 400 megawatts of electricity, will be needed to start the reaction.

When Claessens was writing his book, he wasn't sure whether the 110-megawatt value he had obtained or the 300-megawatt value I had obtained was correct. To be safe, he cited my number as an alternate value. A few weeks ago, Claessens wrote to me and said he now concurred with my 300-megawatt number.

50 megawatts. 110 megawatts. 300 megawatts. Does it matter? Yes, it does, because it invalidates almost every public claim made about ITER and the perceived purpose of the project.

Nearly every public claim about ITER in the last two decades has created the illusion that the projected results of the ITER experiment apply to the reactor's overall power balance. *Therefore, my comment below directly addresses the power as it applies to the reactor's overall power balance:*

> **When the 300 MW of required input electricity is accounted for, thermal output is normalized to electrical power (to compare apples to apples), and all reasonable power multiplier and conversion assumptions are considered, the ITER reactor, if it works properly, will 1) produce the same amount of power as it should consume, 2) produce no net power, 3) be at least the 100th fusion reactor to fail to produce net power, 4) not produce, even for just a few seconds, power comparable to any size commercial power plant, and 5) fail to demonstrate that producing commercial energy from fusion is possible.** [1]

So Why Build ITER?

Yes, there was and still is a legitimate scientific purpose for the reactor, and it was specified clearly in the 2002 International Atomic Energy Agency ITER Design Specification. But ITER promoters sold the project on false technology claims rather than science.

On Nov. 25, 2017, the English-language Wikipedia page for ITER, as it had for nearly a decade, said this:

> The ITER project aims to make the long-awaited transition from experimental studies of plasma physics to full-scale electricity-producing fusion power stations. The ITER fusion reactor has been designed to produce 500 megawatts of output power for around twenty minutes while needing 50 megawatts to operate.

The next day, I corrected the description on the page. This description has changed very little in 2½ years. It provides a useful and accurate description of the project and what the reactor is supposed to do:

> The ITER thermonuclear fusion reactor has been designed to create a plasma of 500 megawatts (thermal) for around twenty minutes while 50 megawatts of thermal power are injected into the tokamak, resulting in a ten-fold gain of plasma heating power. Thereby, the machine aims to demonstrate the principle of

> producing more thermal power from the fusion process than is used to heat the plasma, something that has not been achieved in any fusion reactor.

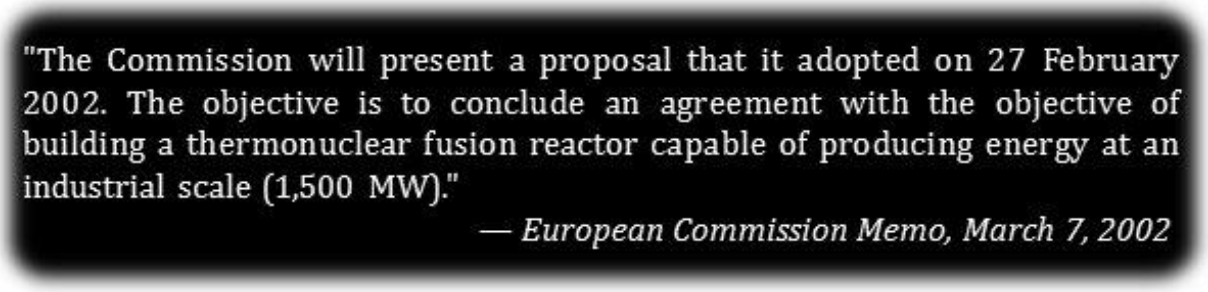
This is a less technical and more concise description of the goal of the project (anyone may feel free to copy it):

> **The ITER reactor is designed to inject 50 megawatts of heating power into the reaction chamber, with the objective of causing fusion reactions that produce 500 megawatts of thermal power. These power values do not reflect the overall input or output of the reactor.**

Systemic Self-Deception?

The French Wikipedia page for ITER had been wrong for a decade, as well. Many of the other-language Wikipedia pages for ITER were also wrong, stating that ITER was designed to produce 500 megawatts of output power while needing 50 megawatts to operate. The German-language page is the only one that was completely correct.

For a whole decade, not one person in the international fusion community noticed that the most popular encyclopedia in the world was promoting a false science claim, and no one made a correction. It wasn't just Wikipedia; the problem existed in almost all news stories and many government documents.



But the Wikipedia error tells us something important: Anybody with the knowledge could have corrected any of these pages at any time, but no one did. Did some people in the fusion science community realize that they were using misleading language when speaking to Congress, when responding to the news media, and while asking for money? Yes, absolutely, and we will get to that. Why, for more than a decade, did knowledgeable experts ignore the false claims about ITER on the French, English, and Chinese Wikipedia Web pages?

Representatives of the fusion scientific community told the public, among other things, that only 50 megawatts of power were needed to sustain the reaction. The public

interpreted this to mean that only 50 megawatts of power were needed to make the reactor work.

Is it likely that well-informed members of the fusion science community who saw the language that the ITER Organization was (and in some cases still is) using didn't see the problem? For fusion scientists who did see the problem, is it likely that they accepted and fostered an underlying cultural construct that it was permissible to discuss the power values that would almost certainly be misinterpreted by non-experts? **These two ideas compose my thesis for the root of the misunderstanding about the power myths about ITER, JET and TFTR.**

How Did We Get Here?

Despite the misleading public claims, ITER is intended to be solely a scientific experiment, to accomplish a scientifically significant gain of power produced by the fuel versus power used to heat the fuel. It was never designed to show any power gain that applied to the overall reactor or a power gain that would indicate any sense of the potential practical output of the reactor.

But when representatives of the fusion science community spoke to the news media and to members of Congress, they told a different story. Here are a few of the many examples from the last two decades.

Norbert Holtkamp

Norbert Holtkamp was the principle deputy director of the ITER Organization from April 2006 to September 2010. He was interviewed and quoted in October 2006 by the U.S. Department of State *eJournal USA.* Here's what he said:

> If ITER is successful, it will be the first fusion reactor device that will create significantly more energy than it uses. ... ITER will be the first fusion reactor to create more energy than it uses. Scientists measure this in terms of a simple factor — they call it Q. If ITER meets all the scientific objectives, it will create 10 times more energy than it is supplied with. The latest device, JET in England, is a smaller prototype that in the final scientific stage reached a Q of nearly 1, which means that it generated as much energy as was put into it. ITER will be the way to go beyond this — a demonstration of creating energy in the fusion process — to a Q of 10. The idea is to put in about 50 megawatts and produce 500 megawatts. So part of the scientific goal of ITER is to first make sure that this Q of 10 can be achieved.

I interviewed Holtkamp on Jan. 17, 2020, in his office at the Stanford Linear Accelerator Laboratory (SLAC). SLAC is a U.S. Department of Energy National Laboratory, and it is operated by Stanford University. I asked Holtkamp about four sets of public claims he had made, all of them significantly and factually incorrect. I began with statements he had made at the Falling Walls Conference in Berlin in 2009:

> What does ITER stand for? Our goal is to demonstrate that it is possible to produce commercial energy from fusion — the process that powers the sun and the stars — to produce at least 10 times more power than we need to operate ITER. ... We will produce 500 megawatts of fusion power, and we need about 50 megawatts to do so; that, for us, is a Q of 10.

By e-mail, in advance of the meeting, I had explained to him that I knew that the reactor was designed to use at least 300 megawatts of electricity. I wanted to make sure he had a few days to think about what he might tell me. I also sent him a link to the Berlin video and direct quotations of his statements. Holtkamp made no attempt to dispute the number with me in advance or in person. After I sat down with him and handed him the quotations from his presentation, I asked him, "So what happened?"

"I had to get the science mission out in 10 minutes. I had no time to get into the details," Holtkamp said.

I moved on to his statements in the Department of State *eJournal USA*, a printout of which I had handed to him. He tried to tell me what he had really meant to say: "It means the power going into the plasma versus the power coming out of the plasma."

But I pointed out that he didn't explain that to the readers, nor mention anything about plasma in his power claim. He said, "No, it doesn't."

I asked Holtkamp why, when he was being interviewed for an article in *European Energy Review*, he allowed the journalist, who clearly misunderstood the project mission and the projected power output of ITER, to continue with his false belief. He implied that he deliberately let the journalist continue his misunderstandings.

"I just chose to respond to the interviewer's question differently," Holtkamp said, "I didn't agree or disagree."

I later looked at a third-party quote of Holtkamp from a former ITER engineer published in a *New Yorker* article written by Raffi Khatchadourian. Based on my direct experience with Holtkamp, I am convinced that what the engineer told Khatchadourian was accurate:

> [Holktamp] once said, "If you spend as much money as you can, after the first billion, no one is going to stop us." So he spent and spent and spent, one former ITER engineer told me.

"If successful, ITER would create the first fusion device capable of producing thermal energy comparable to the output of a power plant, making commercially viable fusion power available as soon as 2050."

— U.S. White House Press Release, Jan. 30, 2003

Kaname Ikeda

I also contacted Kaname Ikeda, who was the first director-general of the ITER Organization, during the years 2006 to 2010. When I asked Ikeda about the misleading public statements he had made about ITER, he did not give me any clear responses.

Neil Calder

The third person from the early period of the ITER Organization whom I interviewed was Neil Calder. He had been the first head of communications for the organization, from 2008 to 2010. Calder is retired now and lives in in Okinawa, Japan, where he enjoys the culture, the food, and the ocean. I found him through his blog and was able to meet him on Feb. 20, 2020, while he was visiting San Francisco.

The energy coming out of ITER will be 10 times greater than the energy going in. Input power 50 MW - output power 500 MW.

Calder's strategy: "Implement consistent message worldwide." (April 1, 2008)

My preconceptions about Calder were not good. I had seen the blatantly false statements that he had instructed his team of international communicators to disseminate and I had seen the very successful results of that outreach program. I had assumed that, because Calder had held such a high-level post in the organization, specifically responsible for public communication, he must have known that he was spinning the truth. I was wrong.

Calder was as jovial in person as in his videos. He had no idea about the brewing controversy or why I wanted to talk with him. I asked from whom he had learned, when he began working at the ITER Organization, that the reactor was supposed to use only 50 megawatts of input electricity. He explained:

> It wasn't just what they were telling me; that was the official word, all over, everywhere. When I got there, I sat down with a lot of people and asked them, "OK, what will we be saying?" We had a brainstorming meeting so I could get a clear idea what they thought ITER was. I spoke with everybody in the senior management at the time, and there were no inconsistencies, as far as I remember. I sat around talking with David Campbell for long, long periods to try and understand the physics.

I said to him, "Based on the actual design, the reactor isn't going to produce 10 times more power than it uses. It's not going to consume just 50 megawatts of electricity." I told him that the overall power reactor power values, normalized to electric, would leave about zero net power. After a moment, he said cautiously, "Well, if you're correct, then that's really interesting."

We talked further, and he encouraged me to look deeper into the story and, if it was correct, publish it. He objected when I used the word "misled." He insisted that he had not been misled but that there must have been a communication failure. Calder had unknowingly initiated a worldwide communications program that propagated a serious and false science claim. Not only did he advise his international communications team how to promote ITER, but he also collaborated with *New Scientist* journalist Valerie Jamieson to publish a major feature article and impressive poster in the magazine in 2009. From then on, the public understanding that ITER would require only 50 megawatts of electricity to operate was set in stone.

Something that Calder had told me helps explain Holtkamp's comment about spending the public's money on science. ITER was initially approved at a budget of $5 billion. The total cost, if you believe the ITER Organization, is $22 billion. Alternatively, if you believe the U.S. Department of Energy, the cost is $65 billion. Before ITER, Calder had been the head of press and publications for CERN, the European Organization for Nuclear Research. CERN, like ITER, is another massive physics project. Calder said that, even though a lot of politicians don't like continuing support of CERN, they have no choice. He said the uproar from scientists would make it nearly impossible for elected officials to stop funding CERN. It appears the same factors apply here and now to the ITER project.

I See a Problem

Holtkamp, Calder, and Ikeda left the ITER Organization in 2010. Four years later, I stumbled on the problem.

In 2014, I was writing a historical trilogy on the new field of nuclear science known as Low-Energy Nuclear Reactions. (It was initially misidentified as a "cold" form of

deuterium-deuterium fusion, but the reactions are actually neutron-based.) In a draft chapter, I had mentioned that the closest any fusion reactor had come to making more power than it had consumed was the Joint European Torus Reactor (JET) in the United Kingdom.

> "[JET] achieved world record results with 16 MW of fusion power in 1997. ...ITER will be capable of generating 400 MW of fusion power for a duration of 6 minutes."
>
> — *European Commission, Oct. 18, 2004*

I was certain, as everyone else seemed to be, that in its record-setting experiment on October 31, 1997, the reactor had produced 16 megawatts of thermal power from fusion while consuming 24 megawatts of electrical power. In other words, I had understood that it had achieved a gain, or an engineering Q-value, of Q-engineering = 0.66 and that it had come close to being the first fusion reactor to produce net power. But one of my technical editors, Mat Nieuwenhoven, asked me some probing questions and encouraged me to dig deeper.

I contacted two people I knew in the fusion research community. The first was Stephen O. Dean, the director of Fusion Power Associates, a nonprofit research and educational foundation. The second was Michael Schaffer, a fusion scientist at General Atomics, in San Diego. I began to realize that I had seriously misunderstood basic assumptions. It resolved when I contacted Nick Holloway, the spokesman for the JET laboratory.

There's a well-known saying that describes the next moment: "It ain’t what you don’t know that gets you into trouble. It’s what you know for sure that just ain’t so." To my amazement, I learned that that JET had not used just 24 megawatts of electrical power to make 16 megawatts of thermal power from fusion for a second. JET had used more than 700 megawatts. I was stunned, and I didn't fully believe it until a few days later after I had conferred with several of my colleagues.

With that information, it became clear to me how I had misunderstood the JET result. The members of the community had used the scientific notation "Q" in their public communications without precision, and that caused the public to think they were talking about Q-engineering rather than Q-fusion values. Q-fusion applies only to the ratio of power produced by the fusion reactions to the thermal power injected into the fusion fuel or, more technically, the plasma.

Even though fusion scientists knew that they meant Q-fusion when they spoke about ITER, the vague manner in which they used "Q" without a notation, as well as the context in which they used "Q" caused many people to think they meant Q-engineering.

They had also done two other things to contribute to my misunderstanding. They had never publicly disclosed the 700 megawatts of electrical power needed to operate JET or the 950 megawatts of electrical input power needed for TFTR. I had to search carefully to find any document that referred to the TFTR value. Eventually, I found an article from the Princeton Alumni Weekly from 1980 with the figure.

On June 8, 2020, I asked Andrew Zwicker, the head of communications for the Princeton Plasma Physics Laboratory, to confirm the value. He didn't have the information but referred me to Dale M. Meade, a retired scientist from the laboratory. Meade spent several hours reviewing his personal records at home and information available online but was unable to find any record, though he told me he would keep searching.

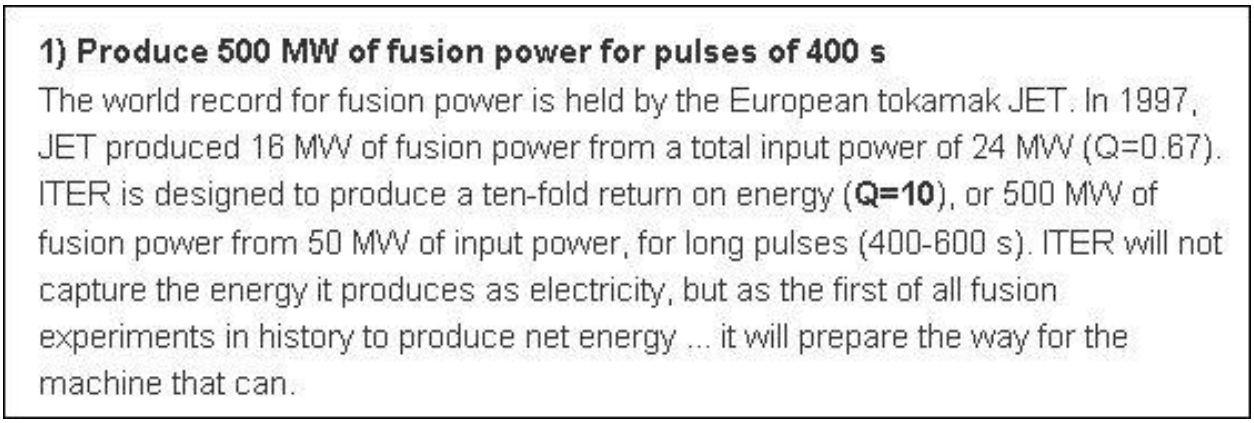
> "If it works, ITER will take in 50 megawatts of power and put out between 500 and 1,000 MW. That's right - it could power itself. ... Although the Joint European Torus project in Abingdon, Oxfordshire, managed to generate 80 percent of the power put into it - falling just short of being self-sustaining - it demonstrated what could be done."
>
> — *Charles Arthur / The Register, July 6, 2005*

An excellent example of the effect of the JET communication failure, if you want to call it that, appears in a book by fusion critic Charles Seife, a journalism professor at New York University and a former science journalist for *Science* and *New Scientist* magazines. In Seife's book, *Sun in a Bottle*, he showed that he thought that JET had consumed a total of 24 megawatts of electrical input power:

> JET got 6 watts out for every 10 it put in. It was a record, and a remarkable achievement, but a net loss of 40 percent of [power] is not the hallmark of a great power plant. Scientists would claim — after twiddling with the definition of the [power] put into the system — that the loss was as little as 10%. This might be so, but it still wasn't breakeven; JET was losing energy, not making it.

Seife is far from alone. For years, the ITER Organization's Web site, in several places, said that "JET produced 16 MW of fusion power from a total input power of 24 MW." They usually showed a Q-value after that but didn't specify whether it was Q-fusion or Q-

engineering. Because they describe the 24 MW as "total input power" rather than "injected thermal power," they implied the Q-engineering value.



1) Produce 500 MW of fusion power for pulses of 400 s

The world record for fusion power is held by the European tokamak JET. In 1997, JET produced 16 MW of fusion power from a total input power of 24 MW (Q=0.67). ITER is designed to produce a ten-fold return on energy (**Q=10**), or 500 MW of fusion power from 50 MW of input power, for long pulses (400-600 s). ITER will not capture the energy it produces as electricity, but as the first of all fusion experiments in history to produce net energy ... it will prepare the way for the machine that can.

Screenshot from ITER Organization Web site "Goals" page, retrieved August 3, 2017

As far as I could tell in 2014, the 700-megawatt value for JET did not appear anywhere on the Internet. Knowing how the fusion science community had caused me — and every other science writer that I knew — to misunderstand the JET result, I began closely examining the ITER claims.

The ITER organization was using the phrase "fusion power" in the same misleading way. Its promoters were being vague about the electrical power that the reactor was designed to consume. The ITER Organization's Web site claimed that the "electricity requirements for the ITER plant and facilities will range from 110 MW to up to 620 MW for peak periods of 30 seconds during plasma operation."

That power range appeared on only one deeply buried page called "Power Supply." Everywhere else, in multiple places on the organization's Web site, and on the homepage, including the page for news media, the organization was consistently saying, "ITER has been designed to produce a tenfold return on energy (Q=10), or 500 MW of output power from 50 MW of input power." Because they said "50 MW of input power" rather than "50 MW of injected thermal power," and because their language implied power for the overall reactor, they created the false impression that their "Q=10" inferred a Q-engineering value.

Waiting for Bigot

On Dec. 19, 2016, I sent a request to Dr. Bigot asking him how much power the reactor is expected to consume during peak plasma production. He never replied. Several days later, I received a response from Laban Coblentz, current head of communications for the ITER Organization. Coblentz told me it would be too difficult for he and his staff to figure out how much electrical power the reactor would consume. But he did tell me, on

Dec. 24, 2016, that the injected thermal power of 50 megawatts would require the consumption of 150 megawatts of electricity.

At that moment, I knew that Coblentz knew that the reactor would require at least three times more input electricity than he and Bigot were telling the public on the organization's Web site. They never specifically claimed that the 50 MW was in the form of electricity. But they also didn't, in every place I saw, say that the 50 MW was thermal.

By leaving the form of the 50 MW value vague, by context and by allowing people to assume the form of power most familiar to them, they misled people into thinking that the 50 megawatts were electrical. This is exactly what had happened with the "total input power of 24 MW" for JET. By saying that "ITER will not capture the energy it produces as electricity," they additionally reinforced the implication that there would be enough thermal output to produce net electricity — if a turbine was connected to the system.

"L'objectif final affiché est de générer une puissance de 500 MW durant plus de six minutes à partir d'une puissance de 50 MW."
— Commission Nationale du Débat Public, June 30, 2006

On May 1, 2017, I sent another letter to Dr. Bigot, encouraging him to make the corrections necessary to avoid misleading the public. He never replied. At that time, I still did not have a ballpark number for the expected electrical power required for the reactor. But I knew that it had to be much higher than 150 megawatts. One week later, Daniel Jassby, a retired principal research physicist from the Princeton Plasma Physics Laboratory, gave me the 300 megawatt value and a very clear understanding of the different power-consuming systems in the ITER reactor.

I sent several other requests to people I knew in the nuclear industry. Independently, two other experts, Hartmut Zohm and Steve Cowley, gave me similar values. Zohm is the head of the Tokamak Scenario Development Division at the Max-Planck-Institute of Plasma Physics. Cowley is the current director of the Princeton Plasma Physics Laboratory and former chief executive officer of the United Kingdom Atomic Energy Authority.

I didn't doubt the value I had received from my three sources, but I still wanted to hear what the ITER Organization had to say. On June 29, 2017, I sent the 300-megawatt input value to David Campbell, who was the ITER organization's chief scientist. He didn't respond. I sent a second e-mail on July 10. He didn't respond.

Campbell retired from the organization several months later. I contacted him by e-mail in June 2020 and asked whether he was willing to talk about some of the ITER history. He responded politely but said, "Since I retired from the ITER Organization more than two years ago, I no longer participate in public discussions of the ITER project."
I sent him a second e-mail with some additional information, and he responded politely but did not engage. I sent him a third e-mail. I told him I respected his wishes but I wanted to at least give him the chance to respond to one question: "Were you instructed to not respond to my June and July 2017 e-mails?"

This time, Campbell did not reply.

Campbell worked for the organization under the direction of all three directors-general. When he joined the organization in 2007, the false idea that "ITER will take in 50 megawatts of power and put out between 500 and 1,000 MW" was established in the public mind.

> "[ITER] will reach industrial size with a capacity of 500 MW. ... The energy consumption will be 50 MW, the output ten times."
> — *Austrian Chamber of Commerce, Dec. 10, 2007*

Then, on the ITER Organization's Web site, they started talking about Q: Q = 0.65, Q = 1, Q = 10. Nobody but a fusion scientist would have understood anything beyond the first sentence in that paragraph. [2] The first sentence served to support the organization's political and financial goals. The rest of the paragraph satisfied the consciences of the scientists, who knew that "ITER should produce more power than it consumes" was deceptive. This is the formula that has been used for two decades to sell, promote and perpetuate public support and funding of the ITER reactor.

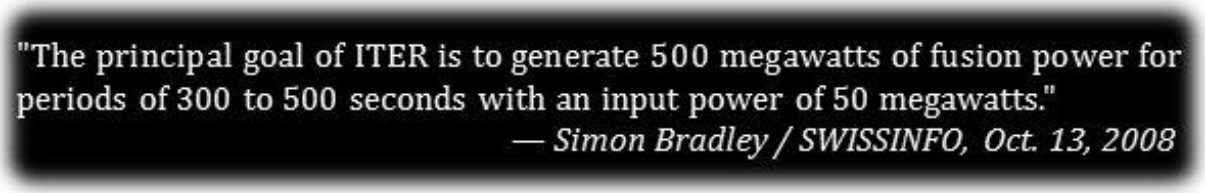
Campbell walked into this messy situation; he didn't create it. But he knew that the claims were being grossly misrepresented. These are the other questions I would like to ask Campbell: Did you encourage the organization to be more honest in its public claims? Whom did you talk to? When? What was the outcome?

A year earlier, on May 26, 2016, journalists Davide Castelvecchi and Jeff Tollefson wrote an article in *Nature*, saying that ITER "is predicted to produce about 500 megawatts of electricity." There's a note at the bottom of the article that says, "Updated: Added comment from ITER Director-General Bernard Bigot." So Bigot read it, corrected some other part of the article, but allowed *Nature* to continue publishing the doubly false

claim that the overall reactor would produce 500 megawatts of power and that it would be in the form of electricity.

After sending my letter to Bigot in May 2017, I waited five months to see whether he and Coblentz would make any corrections on the ITER Organization Web site. They didn't. I published the results of my investigation, as well as the input values on Oct. 6, 2017.

A month after I published my investigation, Bigot and Coblentz made significant corrections to the ITER Organization's Web site. Two months later, they issued a press release. They didn't make the 500-megawatt claim. They didn't claim that ITER would produce 10 times more power than it would use. Instead, they opted for another dishonest claim: "[ITER is] a project to prove that fusion power can be produced on a commercial scale."



I told other science journalists about the matter, but there was little interest in or understanding of the situation and no broader news coverage. As fall 2017 turned into winter, I began contacting major fusion organizations around the world and advising them of the similar false and misleading power claims on their Web sites. One by one, some after just a single letter but most after dozens of letters spanning three years, the organizations made corrections. By now, I think all of them have removed any of their previous outright false claims. Many of them have also corrected their other claims that were misleading.

The organizations included: EUROfusion, the E.U. consortium of fusion research institutions; the U.K. Atomic Energy Association; the ITER Russia domestic agency; the World Nuclear Association; the ITER India domestic agency; IRSN, the French Nuclear Institute, FuseNet; the European Fusion Education Association; the European Commission; Atkins, one of the largest ITER contractors, the International Energy Agency; the ITER U.S domestic agency, and the ITER Korea domestic agency. As far as I could tell, the ITER Japan and China domestic agencies had not made false or misleading claims on their Web sites.

Bigot Goes to Washington

Bigot and Coblentz, however, continued to publish many misleading claims on the central organization's Web site. That spring, Bigot went to Washington, D.C., and lobbied for more money for ITER. He testified before the House Subcommittee on Energy on March 6, 2018. He followed the same formula that had been successful in his and others' previous pitches for fusion, including heavy reliance on the double meaning of "fusion power," which I have placed in bold:

> At JET, we know it could not deliver more than 70 percent of the **fusion power** it received. Because of the size, it is not possible to have net **fusion power**. We had **fusion power**, but not a net outcome. This is why, with ITER, we need a larger tokamak, a larger vacuum vessel, and the expectation is to have 10 times the **fusion power** that we will feed in with the heating system — 500 megawatts of **fusion power**. So everybody in this audience has to understand there is a minimum size if you want to get fusion power.

In all but his final use of "fusion power," what he said and what he meant were two different things. In his first five uses of the phrase, only fusion scientists would have understood that he was talking only about the power of the particles produced by the fusion reaction and that such power did not account for any of the power required to produce those particles.

> "In Cadarache, France, the large international fusion project called ITER is about to begin construction. This experiment is designed to produce five times more energy than it consumes for several consecutive hours."
> — *Congressman Brian Baird / U.S. House of Representatives, Oct. 29, 2009*

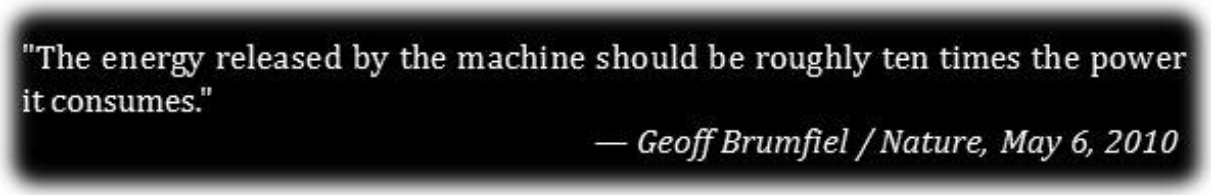
The significance of this meaning is that a fusion reactor can produce 10 megawatts of fusion-produced particles regardless of whether the reactor needs 10 megawatts to operate, 50 megawatts, or 1,000 megawatts. This meaning of "fusion power" has no bearing on the leftover power available for conversion to electricity. Bigot did not explain the hidden meaning of "fusion power" to members of Congress. His first five uses of the phrase did not apply to the output of the reactor as a complete system. He knew that. Unless the members of Congress were fusion experts, they almost certainly heard Bigot say this:

> At JET, we know it could not deliver more than 70 percent of the **power** it received. Because of the size, it is not possible to have net **power**. We had **power**, but not a net outcome. This is why, with ITER, we need a larger tokamak, a larger vacuum vessel, and the expectation is to have 10 times the **power** that we will feed in with the heating system — 500 megawatts of **power**. So everybody in this audience has to understand there is a minimum size if you want to get fusion power.

Only the last use of Bigot's phrase "fusion power" meant the same thing to his audience as it did to him. Only fusion experts knew the difference between the last use and the other five uses of the "fusion power."

But this is nothing new in the fusion funding business. Stewart C. Prager, the director of the Princeton Plasma Physics Laboratory, testified before members of Congress on Oct. 29, 2009. He did the same thing. See if you can spot which meaning is which:

> By any metric, we are far along the road to commercial **fusion power**. In the past 30 years, we have progressed from producing 1 watt of **fusion power** for one-thousandth of a second to 15 million watts for seconds, and ITER will produce 500 million watts for 10 minutes and longer. ... The most recent National Academy study notes remarkable progress in recent years. But my focus today is the future, the remainder of the journey to **fusion power**."



The Holdouts

Almost all the fusion organizations I have contacted have now succeeded or come close to making their public claims honest and transparent for non-experts. Many of the organizations have still refused to relinquish the "500 megawatts fusion power" claim, which assumes that readers understand the difference between the two meanings of fusion power.

Fusion experts can argue that "500 megawatts fusion power" is technically accurate. It is. But public research organizations communicating to the public — without immediately and clearly explaining that the specific use of the phrase means particle energy rather than reactor output — misleads the public. To my knowledge, not one of organizations promoting ITER defines the difference between the ordinary meaning of "fusion power" and the scientific meaning on their Web sites.

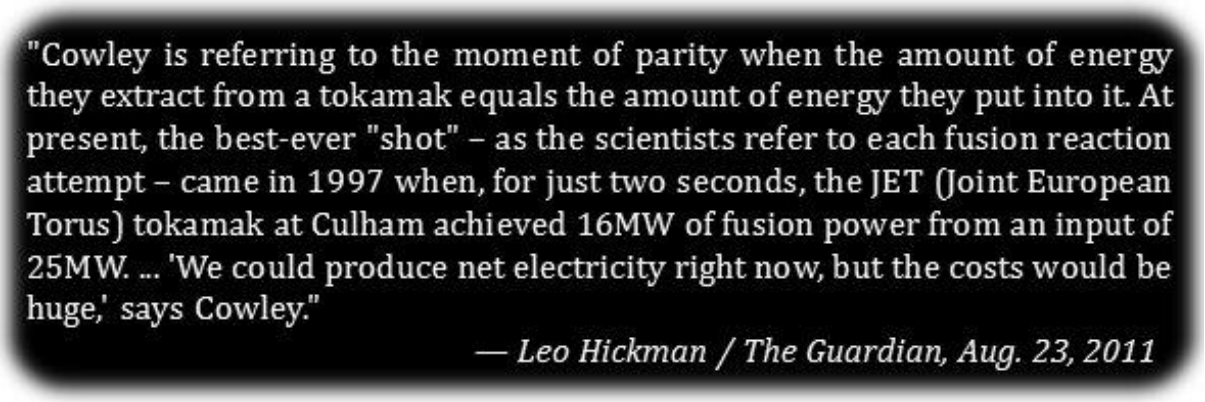
Anatoly V. Krasilnikov, the director of the Russia ITER domestic agency has, after three years and six letters from me, come close to making his public claims more accurate.

Kathy McCarthy, the director of the U.S. ITER domestic agency, has made a significant and almost complete correction to the last (to my knowledge) remaining misleading U.S. ITER document.

Kijung Jung, the director of Korea ITER domestic agency, has come a long way and is close to having fully accurate and transparent claims on his organization's Web site.

To his credit, Shishir P. Deshpande, the ITER India project director, corrected false and misleading claims about the ITER reactor on his organization's ITER Web page only 45 days after receiving a single e-mail from me in 2017.

In Europe and the U.K., although I have successfully encouraged the EUROfusion, FuseNet, U.K. Atomic Energy Agency, and the European Commission to make necessary corrections, the central ITER organization as well as the European ITER domestic agency known by the catchy name "Fusion for Energy" have shown much greater reluctance to make corrections.



Still Waiting for Bigot

On Feb. 8, 2018, four members of the European Parliament — Michèle Rivasi (Verts/ALE) , Bart Staes (Verts/ALE) , Rebecca Harms (Verts/ALE) , José Bové (Verts/ALE) — learned about my investigation and asked the European Commission what was going on. On April 25, 2018, Commissioner Arias Cañete, on behalf of the European Commission, responded.

"The IO Web site," Cañete wrote, "now states unambivalently that the performance of ITER will be assessed by the so-called fusion Q, i.e. by comparing the thermal power output of the plasma with the thermal power input into the plasma."

Cañete's response was interesting because it showed that he understood exactly what the power values were supposed to mean. But he didn't understand that the ITER organization had done an incomplete job. Two years later, as of June 10, 2020, misleading and vague claims were still present on the ITER Organization's Web site. [3]

European ITER Domestic Agency

The other organization that continues to publish significantly misleading ITER claims is the European ITER domestic agency, run by its director, Johannes Schwemmer. I have discussed these matters with him since June 17, 2018.

> "The plan is to use 50 megawatts (in heating the plasma and cooling the reactor), and get 500 MW out ... The JET experiment in the UK, hasn't even managed to break even, energy-wise. Its best ever result, in 1997, achieved a 16 MW output with a 25 MW input."
>
> *— Gaia Vince / BBC, Aug. 13, 2012*

In my early communications with Dr. Schwemmer, from June 2018 to April 2019, I told him about 12 specific Web pages or documents that contained claims that were misleading and exaggerated. By the end of 2019, he had made a partial correction to only one of these items.

In a recent redesign of the Fusion for Energy Web site, eight of the 12 erroneous items were removed. The remaining items with misleading claims include the English-version brochure, the Spanish-version brochure, a Fact Sheet, and a Postcard.

In his last letter to me, Dr. Schwemmer said that he was unwilling to respond to any further letters from me or make further corrections, so I have begun communicating with other people in his organization and in the European Commission.

Most curiously, in his Nov. 9, 2018, letter to me, Dr. Schwemmer said that the accurate way to represent the primary objective and goal of ITER is to "ensure that there is no possible misunderstanding on the ITER energy gain of 10 - [that it is] linked only to the plasma and not to the energy balance of the overall ITER plant." Indeed.

Nevertheless, Schwemmer has not done what he knows is right.

Schwemmer's organization has just published three new inaccurate, misleading, and exaggerated claims (as people who are not experts in fusion would understand them) in three places on the Fusion for Energy ITER Web page. [4]

European Commission

At one point, I wondered whether leaders in the European Commission, who have oversight capacity for "Fusion for Energy," are less concerned about the scientific integrity of the project than the economic benefit of it to Europe. I remembered what Commissioner Arias-Cañete had said on Dec. 4, 2017, at the ITER Industry Day, a trade show for contractors and potential contractors working on ITER:

> Over the last ten years, Fusion for Energy has directly awarded almost 1,000 contracts and grants for a value of approximately EUR 4 billion spread all over Europe. Some 300 companies including SMEs from about 20 different EU Member States and Switzerland, as well as some 60 research organisations, ... have benefited from this investment in ITER. As a result, ITER has already created 3,000 direct jobs on the site of Cadarache.

This one-day business conference was organized by the European Commission "to showcase, discuss and reinforce the benefits of European participation in the ITER project." Both the draft and final programs for the event contained the false ITER claims, with no attempt to use language to make them marginally honest: "By producing 500 MW of power from an input of 50 MW — a gain factor of 10 — ITER will be the stepping-stone for future demonstration of the feasibility of fusion power plants."

> "ITER is planned to generate 500 MW of power using an input of 50 MW, which is spent on heating the plasma and maintaining the magnetic fields."
> *— Zach Herrera / Stanford University Student, April 26, 2013*

In Claessens' book and in my conversations with him, he says that several thousand companies, all over the world, including people working on construction, components, services, transportation, and logistics, are involved in the project.

What I don't know is whether past or present senior members of the European Commission, including Cañete, Dominique Ristori, Gerassimos Thomas, or Massimo Garribba, understood the misrepresentation that was taking place under their command.

Back to Claessens

Claessens had initially contacted me in early 2017 to thank me for shedding light on the ITER power values. I knew then that he had had some uncertainties about the claimed 50-megawatt input power value when he worked for the ITER organization. He also told me that, when he was at the site in Cadarache, he asked his colleagues "to be a little bit more cautious and modest."

I asked Claessens whether he ever attempted to resolve the discrepancy between the ITER organization's published input value of 50 megawatts and their other value, which ranged from "110 MW to up to 620 MW." I also asked him whether he, in his capacity as head of communications, had been responsible for the ITER organization's Web site. He responded:

> Yes, I did control the information on the IO Web site. And this is precisely the reason why I started to ask about the gain factor, the fusion power etc. I was already suspecting at that time that something was wrong. I don't remember when I started asking colleagues about this, but I remember that I raised the issue with David Campbell (and others). I never received a clear and well-argued answer from anyone. I never felt this was considered as important by the IO at the highest level.

One thing Claessens pointed out to me was that, as a former ITER Organization employee, he was required to submit drafts of his books to the ITER Organization for prepublication review, which he did with both the French and English versions.

I was particularly interested in how he got his reactor input value of 110 megawatts. He explained that, on April 3, 2017, he sent an e-mail to Joël Hourtoule, section leader for ITER's Steady State Electrical Network Section. He chose the lower value in the range "110 MW to up to 620 MW" and asked Hourtoule to confirm that it was the total electric power requirement for the reactor.

Rather than reply to Claessens, Hourtoule sent the request to Coblentz to get his approval to answer the question from Claessens. Here is the response Claessens received the following day from Coblentz:

> Sorry to make this inquiry, but your question to Joel Hourtoule – see below – caused a bit of nervousness because of the past issues with the material related to ITER's net engineering energy balance where you were quoted by Mr. Krivit. The immediate question raised to me was to clarify how you would use the answers to these questions. I am confident of your purpose, based on our discussion; but if you could specify that purpose for me (e.g., that the information will be used in an EC presentation), I can provide the needed internal reassurance.

Coblentz, under Bigot's direction, was inappropriately controlling and limiting fundamental scientific information about a publicly funded science project. Two parts about Coblentz' attempt to control the release of the scientific information were ironic. First, earlier that year in my conversations with Coblentz, he had already revealed to me that the systems that create the injected thermal power themselves would consume 150 megawatts of electricity. The other part about Coblentz' attempt to control, which is obvious to readers by now, is that 110 MW wasn't even the correct value.

Claessens replied to Coblentz deferentially and explained that he had given a conference presentation in Paris the previous week, people wanted to know how much power would be consumed, and that he had another conference presentation coming up the following month. Coblentz said that he would approve Hourtoule's request to provide Claessens with the information he had asked for.

By Oct. 6, 2017, Bigot and Coblentz knew that I had published the 300 MW value. Because of my direct communications with the directors of the domestic agencies, all of the top leaders involved in the ITER organization knew the 300 MW value and knew that I had published it.

> *"[ITER] is the biggest attempt so far and is predicted to produce at least 500 megawatts of power from a 50 megawatt input."*
>
> *— Daniel Clery / Science, Nov. 19, 2015*

In early 2018, Claessens followed procedures and sent the manuscript of his French-version book to Bigot and Coblentz. More than six months later, he received some comments from Coblentz and incorporated them in the final text. Nobody from the organization told him the 110 MW input power was wrong. A year later, he sent the English version of his book to Bigot and Coblentz. Again, they allowed him to publish the book knowing full well that the 110-megawatt input value was incorrect.

Claessens' books, to my knowledge, are the only books about the ITER reactor project written so far for a public audience. I only read portions of the English version, where Claessens discusses power. He clearly has the courage to speak forthrightly and, where appropriate, critically, and this is refreshing to see.

There's one place where he fell victim to a common but fallacious practice among fusion advocates. On Page 27, he wrote that "TFTR generated nearly 11 megawatts, an amount that could have powered 1,000 homes for a few seconds if converted into electricity." He failed to mention the 950 megawatts of electrical input power in his analogy. (Claessens has an oral but not written source for the TFTR value as 500 MW, rather than my written source for it as 950 MW.)

An honest analogy would have been "TFTR consumed an amount of electricity that could have powered 86,000 homes and generated an amount of thermal power that could have powered 1,000 homes for a few seconds if converted into electricity." If the fusion community wants any credibility, it must stop the deceptive and misleading claims.

"[ITER] is predicted to produce about 500 megawatts of electricity."
— *Davide Castelvecchi and Jeff Tollefson / Nature, May 26, 2016*

Winning Formula

The communications that have worked to gain support and funding for large tokamak fusion devices have consistently encompassed the following strategies:

1. Stating Q-fusion values by using language expressing Q-engineering values.
2. Describing the thermal power produced by fusion reactions as "fusion power" while also describing power produced by a fusion plant as "fusion power."
3. Keeping quiet about the input power required to operate the reactor.
4. When discussing input power, mentioning only the amount of injected thermal power.
5. When discussing injected thermal power, using vague expressions like "power to heat the fuel," "power to start the reactions," "power to sustain the reactions," and “power required to keep the plasma hot."

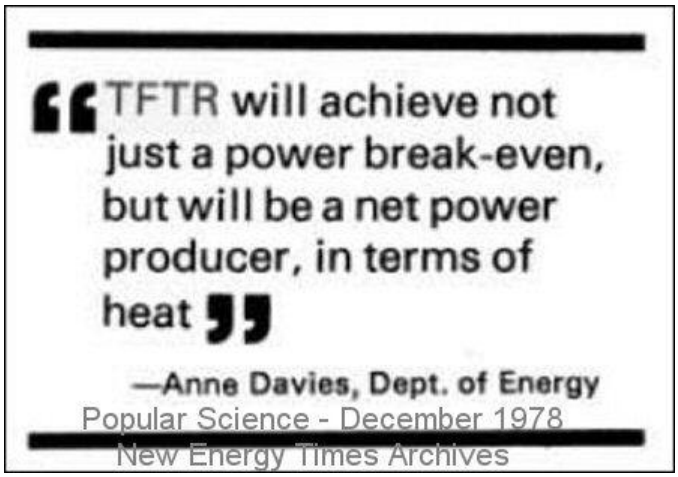
This model, or at least portions of it, was in place as early as 1978 and has been used universally and consistently.

A few years ago, I interviewed Anne Davies, the chief of the Tokamak Systems Branch of the U.S. Department of Energy from that era. I asked Davies how journalist Edward

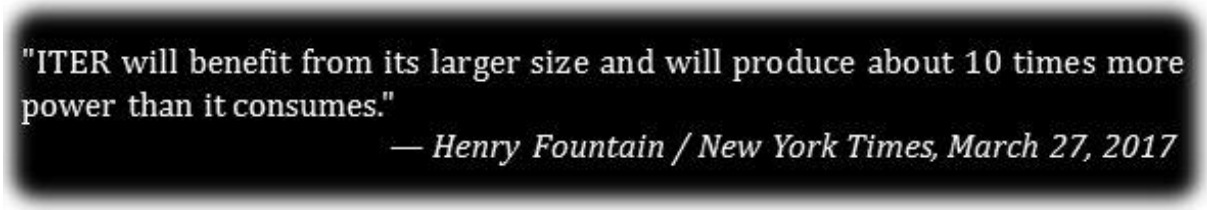
Edelson, writing for *Popular Science*, misunderstood that Davies expected TFTR to demonstrate Q-engineering > 1 rather than Q-fusion > 1. Here's what she told me:

"I'm pretty sure what I was talking about, in terms of heat, I meant the injected neutral beam power input versus the power out," Davies said. "Informed by 40 years of history, I can only speculate that I either assumed the reporter understood what I meant or I actually explained it and he left it out, perhaps to shorten the article. What I am sure of is that none of us ever deliberately misled anyone."

Journalists that Davies spoke with in 1992 and 2003, and members of Congress in 1993, all came away with the same false impression.



Davies' boss at DOE, was Stephen O. Dean, who later left the department and co-founded a fusion advocacy company. In 2002, Dean wrote an article in *Nuclear News* in July 2002 that solidified the effectiveness of the formula.



Dean apparently believed that readers of the flagship magazine, who are experts not in nuclear fusion but in nuclear fission, would know the difference between the two meanings of "fusion power." Without explaining what he really meant by fusion power, he wrote:

> By the mid-1990s, more than 10 MW of fusion power had been produced in TFTR and JET. The facilities were designed to sustain as power for only a few seconds, however. Obviously, for power plants, this power would need to be sustained in steady state. Hence, new facilities are required. ITER (the proposed International Thermonuclear Experimental Reactor) is designed for 1,000-second operation, with upgrade potential to steady state."

He accompanied that text with a graph showing a dramatically vertical line labeled "Fusion power produced (Watts)" and a caption "Fusion power produced in the laboratory has increased 100 million-fold over 20 years to more than 10 million Watts."

> "JET hasn't even managed to break even, energy-wise. Its best ever result, in 1997, remains the gold standard for fusion power – but it achieved just 16 MW of output for 25 MW of input."
>
> — *Editors / The Guardian, March 12, 2018*

I asked Dean, "How you could possibly have imagined that readers of your review would have come to any other conclusion than fusion reactors had produced at least 10 MW of net power?"

"It's very clear," Dean replied. "It does not say electricity. It also says 'in the laboratory' and 'for a few seconds.'"

Members of the fusion community engaged not only in massive deception but also in self-deception, using weak and unsubstantiated arguments to defend their behavior.

But the fusion funding game was not limited to ITER. A 2018 press release from the Massachusetts Institute of Technology about its affiliation with a fusion start-up company called Commonwealth Fusion Systems followed the same deceptive practices when it announced their new fusion reactor concept.

The directors responsible for the press release misled a journalist for *The Guardian,* a journalist for an Oilprice.com article, which was republished on NASDAQ.com, and an MIT student and visiting scientist writing in *Physics World* to describe the new MIT fusion concept as one that would be the first fusion reactor to achieve net energy gain.

By the mid-1990s, more than 10 MW of fusion power had been produced in TFTR and JET. The facilities were designed to sustain this power for only a few seconds, however. Obviously, for power plants, this power would need to be sustained in steady state. Hence, new facilities are required. ITER (the proposed International Thermonuclear Experimental Reactor) is designed for 1000-second operation, with upgrade potential to steady state.

In 1976, the U.S. Energy Research and

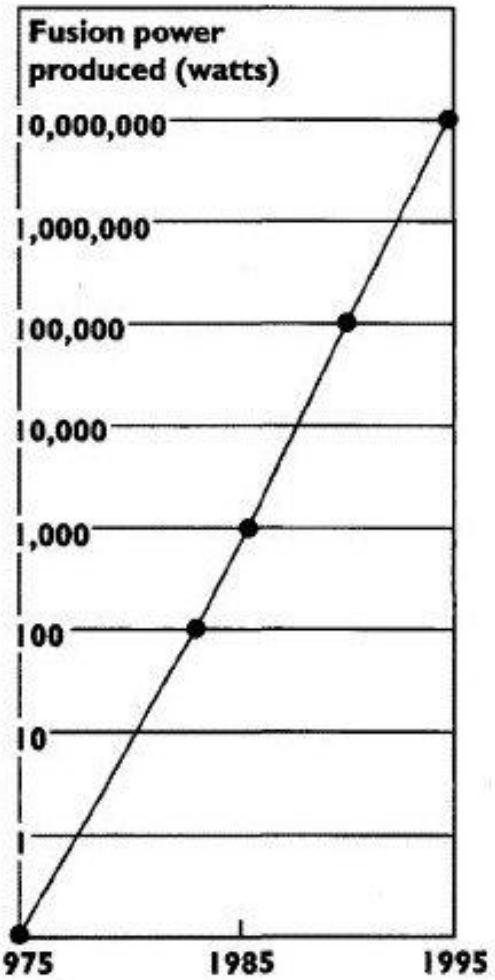


Fig. 1. Fusion power produced in the laboratory has increased 100 million-fold over 20 years to more than 10 million watts.

Excerpt from Dean Article

But a close reading of the press release reveals that the device is designed for Q-fusion > 1 rather than Q-engineering > 1. In English, this means that the MIT/Commonwealth device is not intended to be the first fusion reactor to achieve net energy gain.

In 2018, an umbrella organization called the Fusion Industry Association was founded to be the "voice of a new industry." The organization's members consist of private businesses that hope to commercialize fusion energy. We might assume that the investors funding all of these companies have performed their due diligence and understood the difference between the two meanings of fusion power. We might assume that the scientific advisers for these private companies have transparently explained the difference between Q-fusion >= 1 and Q-engineering >= 1 to their investors. I wouldn't bet on it.

Despite an abundance of "breakthrough" fusion news stories in the past decade, where are the breakthrough experimental results? Fusion looks like vaporware, though it has fostered well-meaning tech and science enthusiasts who, without knowledge of the dark side of fusion, understandably appreciate and regard these magnificent projects as tributes to human ingenuity. The idea of fusion is important, and it should be pursued until it is reasonable to abandon the effort. Regardless of whether fusion succeeds, will it have been worth compromising scientific integrity? Deceiving the public and elected officials?

> "In 1997 Jet set a world record for the highest ratio of energy out to energy in. But that was still just two-thirds of the break-even point where the reactor isn't consuming energy overall. ... [ITER] hopes to conduct its first experimental runs in 2025, and eventually to produce 500 megawatts (MW) of power – 10 times as much as is needed to operate it.
>
> — *Philip Ball / The Guardian, Oct. 27, 2019*

The enormity of this false science claim, in terms of number of participants, international scope, expenditure of funds, and event duration is unprecedented. The magnitude of the deception makes it difficult to recognize. The story it tells of human nature, of scientists whom we hold in high esteem, is harsh. Deception and fraud are ugly words that nobody in the scientific world wants to be associated with. The facts presented here will take some time for the broader scientific community to reckon with.

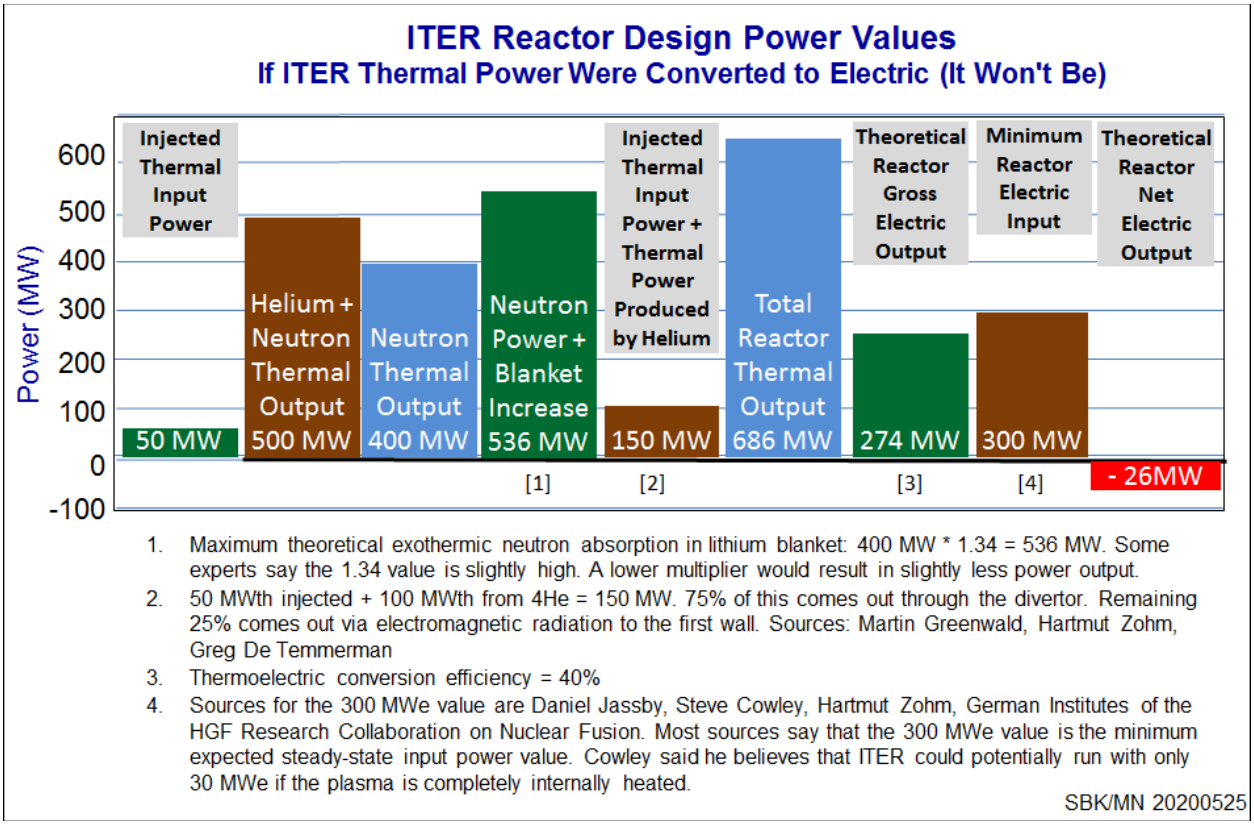
Certainly, the actions of a few people in the fusion science community do not reflect the integrity of everyone in the community. But if everyone has looked the other way for four decades, then it does reflect on the entire community.

The ITER hoax is reminiscent of perpetual motion fraudsters of a century ago. One well-known story is that of Charles Redheffer. The Redheffer perpetual motion hoax ended in 1813 when mechanical engineer Robert Fulton investigated Redheffer's device, removed wooden boards, and found a concealed rope. Fulton followed the rope upstairs to find an old man sitting quietly on a chair. With one hand, the man turned a crank that was attached to the rope, which sent the hidden power to the device. With the other hand, the man was eating a piece of bread.

But rather than hiding input power through mechanical devices, as Redheffer did, scientists promoting these large tokamak fusion reactors have hidden the input power through specific wording, omitted facts, undisclosed terminology, and deceit.

References

1. Link to the spreadsheet with the calculations. Link to a larger image of the graph.

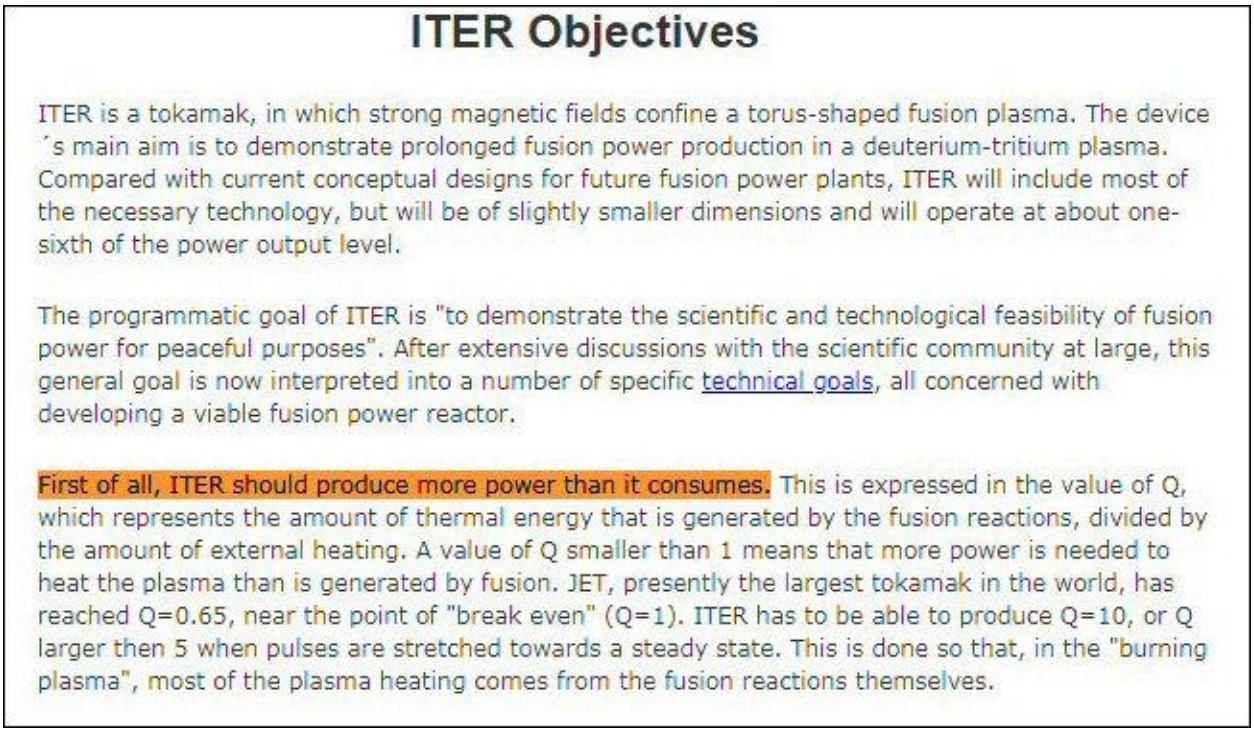


Records of my direct communications with my sources for the 300 MW value, as well as a corroborating document from the German government I later found, are here. This graph has evolved since I published the first version two years ago. Thanks to new sources, Martin Greenwald, deputy director of the Plasma Science and Fusion Center at MIT, and Greg De Temmerman, a coordinating scientist at ITER, the graph has become more precise.

Daniel Jassby is a retired principal research physicist from the Princeton Plasma Physics Laboratory. Hartmut Zohm is the head of the Tokamak Scenario Development Division at the Max-Planck-Institute of Plasma Physics. Steve Cowley is the current director of the Princeton Plasma Physics Laboratory and former chief executive officer of the United Kingdom Atomic Energy Authority. All sources have seen this version of the graph. Only Jassby disputes any data shown in this graph. He thinks that the 150 MW recovery is too optimistic. After seeing the graph, all sources except Jassby asked me not to cite them but instead to cite the values in published literature. I asked them for such citations, but they didn't provide any.

Additional corroboration comes from a Japanese government fusion organization, the first such organization to publicly state the ITER reactor power accurately: "ITER is about equivalent to a zero (net) power reactor, when the plasma is burning." The United Kingdom Atomic Energy Authority was second: "ITER should produce about as much fusion power as the electricity required to run the entire plant."

2. Screenshot of ITER organization's Web site, August 13, 2007



ITER Objectives

ITER is a tokamak, in which strong magnetic fields confine a torus-shaped fusion plasma. The device ´s main aim is to demonstrate prolonged fusion power production in a deuterium-tritium plasma. Compared with current conceptual designs for future fusion power plants, ITER will include most of the necessary technology, but will be of slightly smaller dimensions and will operate at about one-sixth of the power output level.

The programmatic goal of ITER is "to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes". After extensive discussions with the scientific community at large, this general goal is now interpreted into a number of specific technical goals, all concerned with developing a viable fusion power reactor.

First of all, ITER should produce more power than it consumes. This is expressed in the value of Q, which represents the amount of thermal energy that is generated by the fusion reactions, divided by the amount of external heating. A value of Q smaller than 1 means that more power is needed to heat the plasma than is generated by fusion. JET, presently the largest tokamak in the world, has reached Q=0.65, near the point of "break even" (Q=1). ITER has to be able to produce Q=10, or Q larger then 5 when pulses are stretched towards a steady state. This is done so that, in the "burning plasma", most of the plasma heating comes from the fusion reactions themselves.

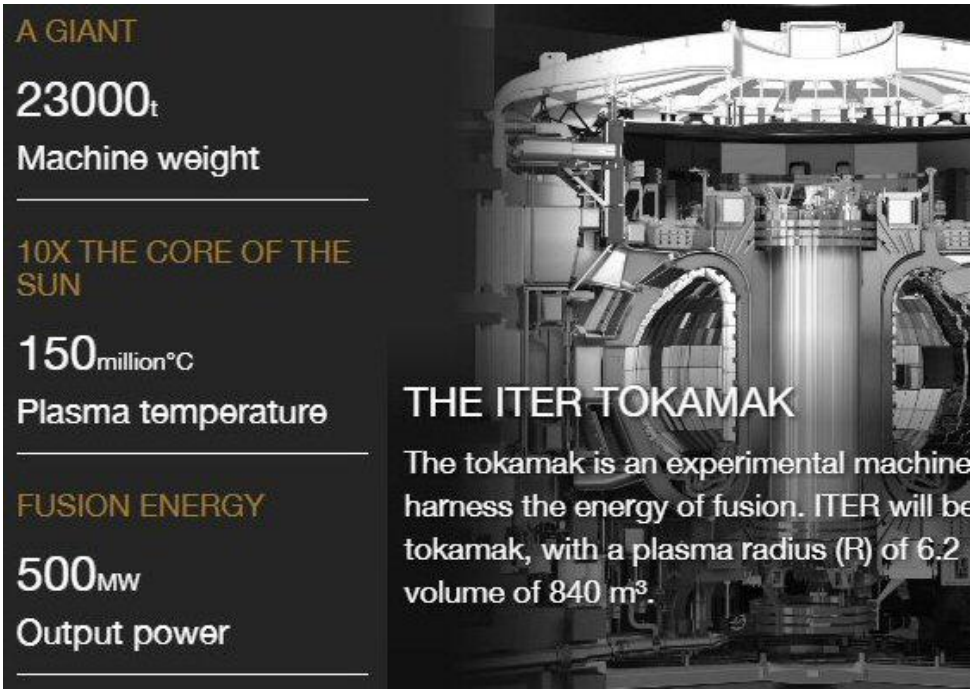
3. As of today, the home page still says that ITER "will take its place in history as the first fusion device to create net energy." The "About ITER" page still says, "ITER will be the first fusion device to produce net energy." Anybody besides an expert in ITER, including power industry experts, would read those sentences and think that the overall reactor is supposed to produce net energy. Bigot and Coblentz know that the claim, at face value, is false, so they have a pop-up message that explains what they *really* mean: "when the total power produced during a fusion plasma pulse surpasses the thermal power injected to heat the plasma." But readers will see this only if they place their mouse over the words.

The "Facts and Figures" page, listed under the "For the Press" menu, still presents a statement that cannot stand alone without being misleading: "For 50 MW of power injected into the Tokamak via the systems that heat the plasma, it will produce 500 MW of fusion power for periods of 400 to 600 seconds." Without understanding the scientific

nuance, non-experts will think that the reactor is designed to produce 500 megawatts of power from an input of 50 megawatts.

Overall, the ITER Organization's Web site creates the overwhelming impression that the ITER reactor is designed to produce 500 megawatts of thermal power from only 50 megawatts of power. Some statements on the site are a little clearer and say that the reactor is supposed to produce 500 megawatts from 50 megawatts injected into the plasma. This is closer to the truth but still not the complete truth. The reactor can't do anything without 300 megawatts needed to operate all of the subsystems. So this continues to be a major lie of omission.

The "Machine" page, which says in large letters "FUSION ENERGY - 500 MW OUTPUT POWER," will cause most readers to think that the reactor will produce a net power output of 500 megawatts, rather than zero megawatts.



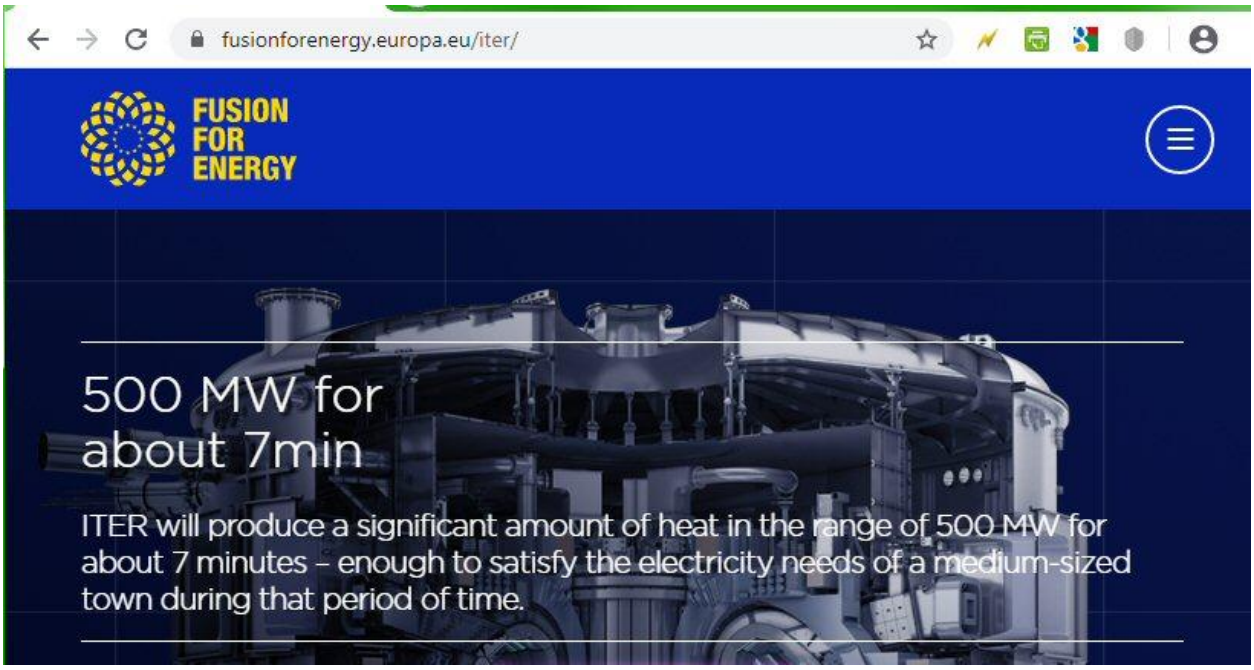
The "Goals" page, among others, says that "ITER will not capture the power it produces as electricity, but as the first of all fusion experiments in history to produce net energy, it will prepare the way for the machine that can." By doing so, it creates the false impression that there would be enough net energy to convert to electricity if the reactor had a turbine. Again, Bigot and Coblentz include a pop-up message in an attempt to make the claim truthful.

The respective pages on the French version of the ITER organization's Web site contain the same misleading statements.

4. Misleading Fusion For Energy claims.

CLAIM #1: "ITER, which in Latin means 'the way,' will be the world's biggest experiment on the path to fusion energy. It will be the first fusion device to generate more energy than that it consumes."

CLAIM #2: "500 MW for about 7 min - ITER will produce a significant amount of heat in the range of 500 MW for about 7 minutes – enough to satisfy the electricity needs of a medium-sized town during that period of time."



CLAIM #3: "10 times more thermal power - ITER will generate 10 times more thermal power than the one received."

Revision History

June 16, 2020
p. 1: replaced "fusion power" with "power from fusion"
p. 18: replaced "meeting" with "meaning"

June 25, 2020
p. 16: Fixed misplaced letter 'I'

July 04, 2020
p. 1 added: "The actual design goal for the ITER reactor is to create a plasma of 500 megawatts (thermal) for around twenty minutes while 50 megawatts of thermal power are injected into the tokamak, resulting in a ten-fold gain of plasma heating power, not reactor power."

July 5, 2020
p. 1 added: "as a result of the fusion scientists' claims"

p1. replaced "The magnitude of the deception, involving scientists whom we hold in high esteem, makes it difficult to recognize and reconcile. Deception and fraud are ugly words that nobody in the scientific world wants to be associated with. Nevertheless, this disturbing matter is one which the fusion community, as well as the broader scientific community, must reckon with."

with "and is therefore difficult to conceive. Deception and fraud are ugly words that nobody in the scientific world wants to be associated with. Nevertheless, over the course of three decades, it happened."

July 17, 2020
p1. replaced "Nevertheless, over the course of three decades, it happened." with " "Nevertheless, over the course of three decades, a serious misunderstanding, whether accidental or intentional, has happened."

July 26, 2020
p1. replaced "specific linguistics, undisclosed terminology, and deceit" with "specific wording and undisclosed terminology. The common thread underlying the activity was not one of malice or greed, but of self-deception and zealotry; a belief that fusion research was so important that breaches of scientific integrity c accuracy, honesty, and transparency — were deemed necceary, were practiced routinely, and were accepted within the field.

7/26/2020
p1. Replaced: "a serious misunderstanding, whether accidental or intentional, has happened." with "it happened."

7/26/2020
p1. Replaced: "Deception and fraud are ugly words that nobody in the scientific world wants to be associated with. Nevertheless, over the course of three decades, a serious misunderstanding happened." with "Over the course of three decades, a serious misunderstanding has happened."

7/27/2020
p1. and p. 29 Replaced: "linguistics" with "wording, omitted facts"