NEWS IN REVIEW

FEBRUARY 2018

IN THIS ISSUE

TOMORROW'S ENERGY: The Race for Fusion Power

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The production of electricity remains an expensive and often dirty industry. Just think of fossil fuels or nuclear reactors. But nuclear fusion may hold the key to the world's energy problems. It's clean and sustainable. The only thing is, nobody's been able to create it yet. So, the race is on. Frédéric Zalac of CBC/Radio-Canada's Découverte looks at companies in California and British Columbia that are trying to develop technology to create nuclear fusion. And he visits France, where the largest nuclear fusion project is being built.

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News in Review is produced by CBC NEWS and Curio.ca

GUIDE
Writer/Editor: Sean Dolan
Additional Editing: Michaël Elbaz

VIDEO
Host: Michael Serapio
Senior producer: Jordanna Lake
Packaging Producer: Marie-Hélène Savard
Associate Producer: Francine Laprotte

Supervising Manager: Laraine Bone

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Video Review

Before Viewing

The world continues to struggle to find clean energy solutions to stem the rise in global temperatures. While wind and solar energy are an important step in the right direction, something more efficient and powerful is needed if we hope to meet our energy needs in the long term. If only we could replicate the way the sun creates energy, then our problems could be solved. The sun manages to hold gases in its gravitational field and fuse atoms together to release enough energy to sustain a solar system. That same gravitational field holds the planets in orbit.

Imagine if we could replicate this technology on a small scale. Imagine a town powered by a kind of mini-star power station (not much bigger than a pickup truck) that performs a minor variation on what the sun has been doing for our planet and the rest of the solar system for 4.5 billion years.

Is this too far-fetched or is this the kind of creative scientific thinking that we need to employ if we hope to survive as a planet?

Viewing

1. Why are scientists so anxious to find a way to generate power through nuclear fusion? What is the appeal of this energy source?

2. Where is the headquarters of General Fusion?

   ❒ Victoria ❒ Calgary

   ❒ Toronto ❒ Burnaby

3. Who is Michel Laberge and what is he hoping to do?

4. How long have scientists been trying to generate fusion power?

5. a) Describe Michel Laberge's idea for creating fusion power?

   b) What does Ken Fowler think of Laberge's idea?

   c) What did Fowler do to help Laberge raise money for his project?

6. What strategy are scientists at the National Ignition Facility (NIF) using to try to generate fusion power?

7. What is the key problem with the temperature of the plasma that fusion scientists are trying to heat up?

8. In which country is the largest, most ambitious fusion project located:

   ❒ France

   ❒ Great Britain

   ❒ Canada

   ❒ The U.S.A.

9. How many countries are taking part in the ITER fusion project?

10. Nobel prize-winning Russian physicist Andrei Sakharov invented a machine called the tokamak designed to trap very hot plasma using magnetic fields.

    ❒ True ❒ False

11. ITER construction began in 2007 and will continue until 2025. When do scientists

expect ITER to produce its first fusion plasma?

12. a) How successful was General Fusion's container test?

    b) How soon does Michel Laberge expect his company to generate fusion power?

After Viewing

Renowned fusion scientist Ken Fowler says,

> "Fusion is accused of being 30 years away no matter when you ask. I think that we know that it can work. What we don't know is just how long and how hard the combined financial/technical path is to get it there."

Should the Canadian government funnel money, resources and scholarly expertise to fusion projects like General Fusion? Should they also attempt to join the ITER cooperative? What are the potential consequences if Canada does not invest in this technology while other nations continue to develop it?

THE STORY

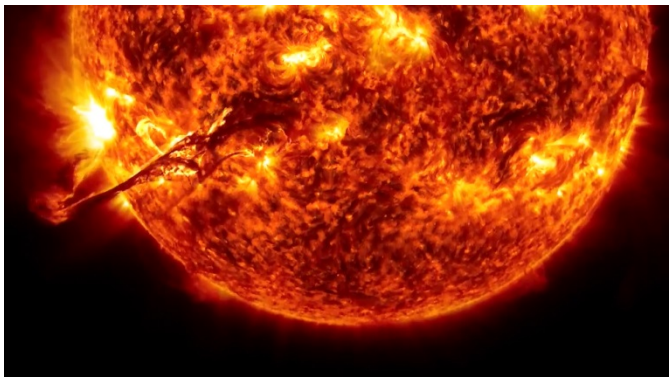
Minds On

Currently Canada's nuclear power grid relies on fission. Nuclear fission occurs when atoms are split. The ensuing release of energy is then harnessed and used to produce electricity. Unfortunately, fission results in toxic, radioactive waste that, if not disposed of properly, can cause devastating illnesses. This is what has prompted some scientists to make a major push away from fission and toward fusion — a clean but as yet unproven technology. Keep in mind that scientists think that humanity could achieve fusion power by the middle of this century.

Review the following videos to learn about fusion:

1. Go to YouTube and search for Michel Laberge's video "Nuclear fusion within reach." The video is from a TED talk that Laberge made in August 2014 in Kansas City.
2. Check out Andrew Zwicker's St. Peter's University lecture called "Fusion energy: utopian or practical?" — another TED talk available on YouTube.

Summary question: What is nuclear fusion?



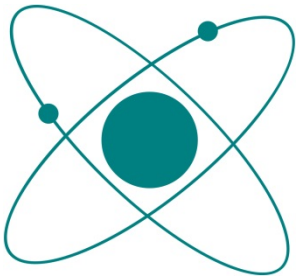
Michel Laberge, physicist and founder of General Fusion

What powers the sun?

Scientists have long imagined, "If we could only harness the technology that powers the sun, we could power the world." It's a fanciful, inspiring idea that has captivated the scientific community since the dawn of the nuclear age. If we could just create a mini-star, we could have enough energy to power a town, a city, a nation and even a planet. But how? How can we achieve this vaulting technological feat?

Well, believe it or not, we are on the cusp of doing just that. Scientists are very close to making "star power" a reality as nuclear fusion is on the verge of becoming a workable technology here on Earth.

TOMORROW'S ENERGY: The Race for Fusion Power



What is nuclear fusion?

Which begs the question: what is nuclear fusion? Bob McDonald, the host of CBC's weekly science show Quirks and Quarks, explains it this way, "Fusion is the process of forcing elements, such as hydrogen, to fuse together into helium, which is a lower energy element. The leftover energy is given off and available for us to make electricity." This all sounds simple enough, but McDonald explains that this is easier said than done because the atomic bonds of hydrogen are incredibly powerful. Fusing atoms requires tremendous force and unbelievably high temperatures. To put things in perspective, McDonald likens creating fusion as being as simple as building a snowman out of ball bearings — not an easy task unless you melt the ball bearings and mold the snowman. Applying the same principle to hydrogen, scientists believe if they can smash this element's atoms together hard enough and heat them to 100 million degrees Celsius (seven to ten times hotter than the sun's core), fusion is possible. The problem: generating that kind of heat for a sustained period of time.

After reading the previous paragraph, one might assume that humanity can't be that close to achieving fusion. The old physicists joke about fusion technology is that achieving fusion is 30 years away (or 50 or 100 depending on who's telling the joke) no matter when you ask. To date, fusion has been elusive, but humanity seems to be investing in the idea and promising results are closer than ever. Take a look at these projects:

ITER

A cooperative of 35 nations has been formed to build the world's largest tokamak, a magnetic fusion device first conceptualized by Russian physicists in the 1950s. The project is called ITER (which means "the way" in Latin). It is a massive 43-hectare facility currently under construction in France. ITER is by far the largest fusion project in the world. Once the tokamak is operational, scientists hope to demonstrate that nuclear fusion can be achieved before the project moves on to building fusion reactors. The price tag for ITER is approaching $20 billion, causing many cooperating nations to wonder if they can continue footing the bill for such a costly experiment.

NIF

Another large-scale operation is the National Ignition Facility (NIF) in Livermore, California. This research centre is looking at using lasers to heat and compress hydrogen in an effort to trigger a fusion reaction. Scientists like the concept of using lasers as a heating option but, to date, the idea still only exists on the theoretical level. In other words, NIF scientists have a good idea, and have achieved some success during their experiments, but they still have work to do to win the race to create a workable fusion reactor.

Wendelstein 7-X and ST40

Other efforts in Germany and Britain have also advanced the study of fusion. Recently, Germany unveiled the stellerator, Wendelstein 7-X, which many see as a serious rival to the tokamak technology of ITER (and can be built for a fraction of the cost). Meanwhile, Britain's Tokamak Energy has developed the ST40, a

device that the company's CEO believes will accelerate the emergence of fusion as a viable power source. Both the Wendelstein 7-X and ST40 are private sector initiatives in the race to achieve fusion.

General Fusion

Not to be outdone, Canada has its own fusion innovator. Physicist Michel Laberge founded his company, General Fusion, in 2002. Since then, Laberge has attracted investors and scholars to his practical approach to nuclear fusion. He believes fusion can be achieved by using pistons to create the conditions for fusion — namely the extremely high temperatures needed to cause a reaction. His concept includes a process that demonstrates how the fusion reaction will be converted into power and shared with the electrical grid for commercial purposes. Laberge and his team have managed to draw private investors and government grants into his framework. To the scientists at General Fusion, nuclear fusion will be the technology that saves humanity.

Michel Laberge is a plasma physicist from Quebec. He earned his Master of Science degree at Laval University and his Ph.D. in physics at the University of British Columbia

The holy grail

And this is what has kept scientists both in the public and private sector motivated. Not only will fusion power result in safe, clean and economical power that flies in the face of fossil fuels and climate change, fusion power also stands to change the entire planet's understanding of how to generate power. There may come a day when people look back from a fusion powered world and wonder how we lived on such a dirty, fuel-burning planet. In the end, the winner of the fusion power race will not only be able to lay claim to saving the planet from pollution and climate change, they will also win perhaps the greatest payday in human history as global power generators make the shift to the clean and efficient power of fusion. This is what makes fusion power the holy grail of our planet's future.

When we say fusion power is **"the holy grail of our planet's future"** we are making reference to the medieval stories and folklore of King Arthur of England. According to legend, King Arthur led the Knights of the Round Table on a quest to find the Holy Grail. Some Christian traditions believe Joseph of Arimathea preserved the cup Jesus used at The Last Supper. The cup was believed to possess magical powers and this is what led to the quest — a quest that ultimately ended in failure. To call fusion power a "holy grail" is to suggest that what it will provide will be so transforming that we will have problems understanding what we did without it.

To Consider

1. What is fusion power?
2. Why is fusion power so difficult to achieve?
3. What companies and projects are leading the charge in the race to develop fusion power?
4. Why are investors willing to support General Fusion?
5. What is the payday for the winner of the race to generate fusion power?

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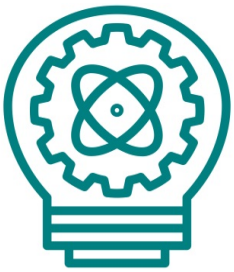
THE INNOVATORS



So, how close are we to achieving fusion power? Who is going to win the race? Perhaps this activity will help you find out.

Task:

- Form a group of three or four.
- Pick one of the companies or projects listed on the right. Clear your choice with your teacher so that no two groups present on the same company/project.
- Prepare a PowerPoint slide, a PREZI, or a Padlet that provides the following information (preferably on one page but a few pages works well too):
  - A company profile
  - A description of the company's most promising fusion project
  - A picture/graph/chart that demonstrates graphically what the company is up to
- Why you think the company you are profiling is going to win the race to create fusion power.
- Present your page(s) to the class. Make sure everyone in the group gets the opportunity to speak.

The Companies & Projects

1. Energy/Matter Conversion Corporation
2. General Fusion
3. Helion Energy
4. ITER (International Thermonuclear Experimental Reactor)
5. Max Planck Institute of Plasma Physics (IPP)
6. National Ignition Facility
7. TAE Technologies
8. Tokamak Energy
9. Tri-alpha Energy

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