



# Extraordinary Claims require Extraordinary Evidence



Clean

Green

Renewable



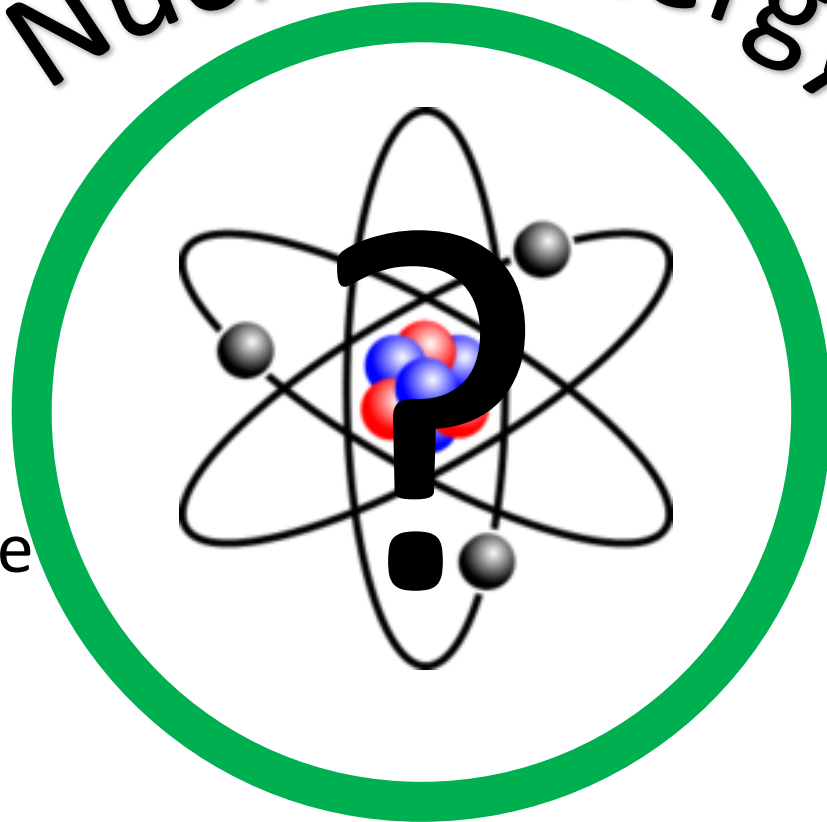
Clean

Green

Renewable



## Nuclear Energy



Reliable 24-7

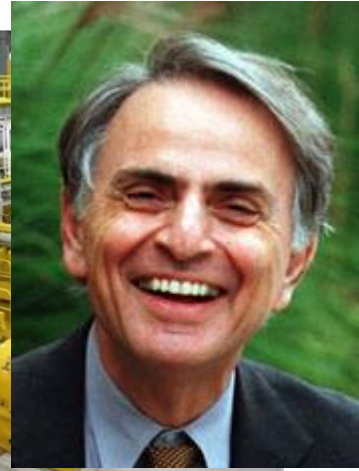
Flexible

Robust

Reliable

Flexible

Robust



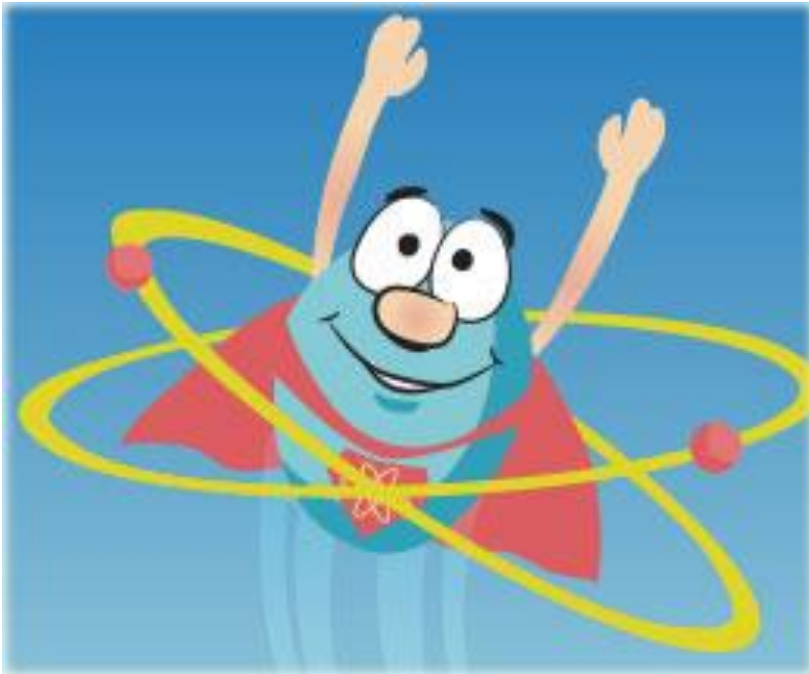
Carl Sagan



# Clean Green Renewable Energy



 **Dunedin**  
Energy Systems Limited.





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## RENEWABLE ENERGY

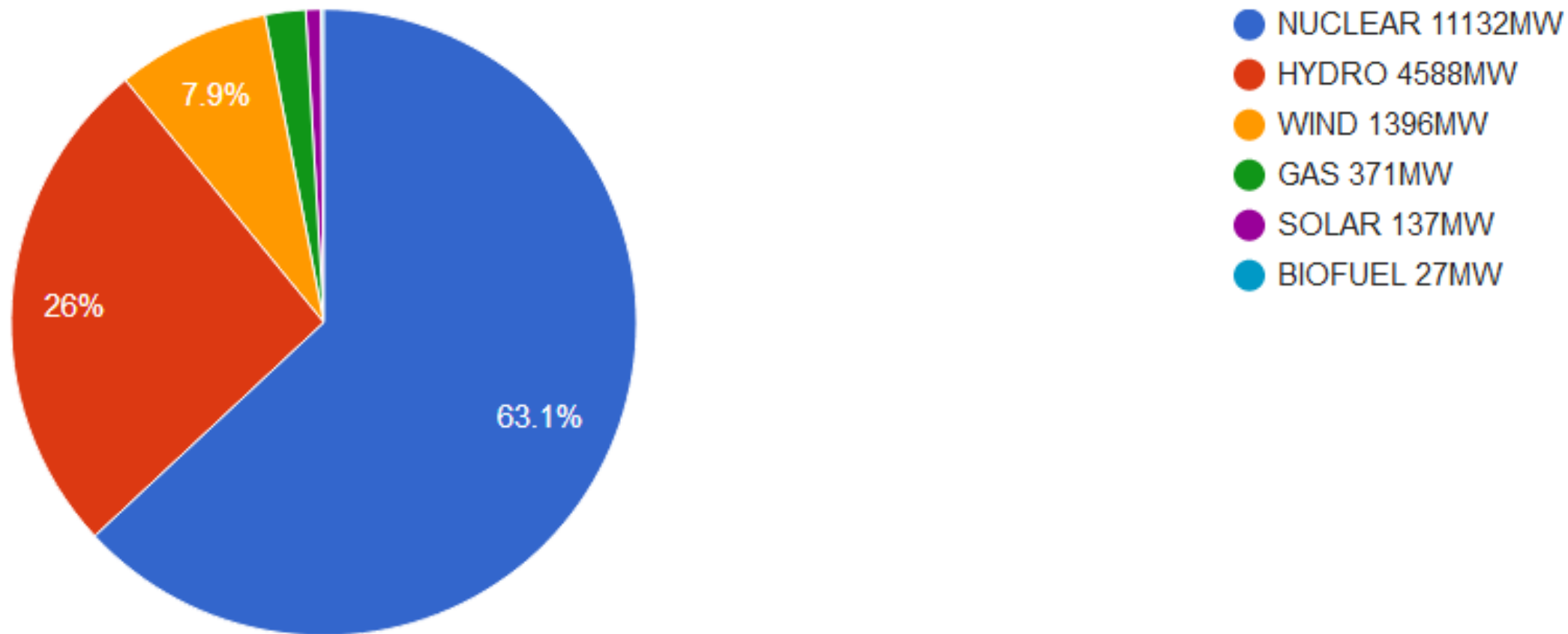
### Nuclear Power

Large-scale nuclear power generation may be suitable for populated areas of southern Canada, but Nunavut's comparatively lower power demands and decentralized habitation patterns could make the use of smaller-scale nuclear reactors (also referred to as "nuclear batteries") more practical.

# Electricity Generated in Ontario

Jun 10 2019 10:45

## Generation Totals



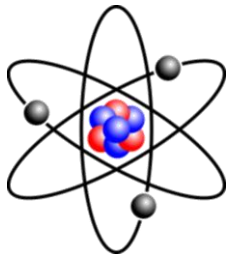
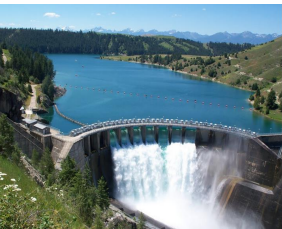
What exactly do we mean when we say **Clean Green** and **Renewable**?



Lets Compare

**Clean** energy means that the energy source gives off little or no noxious emissions, particulates, or greenhouse gasses during its operation.

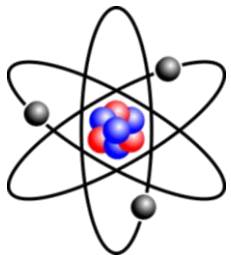
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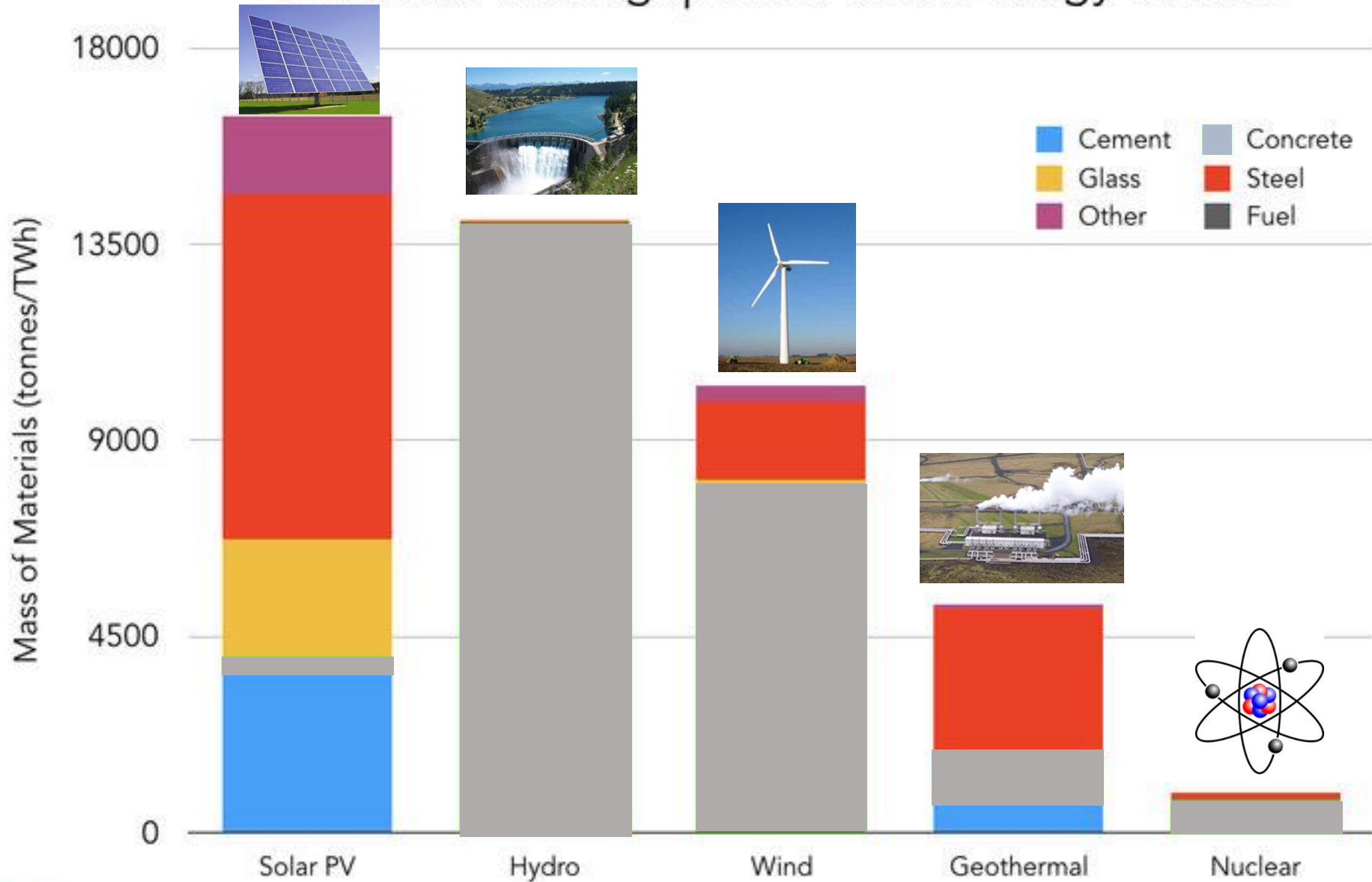
Nuclear energy, like solar panels emit no sound, particulates, gasses or fumes,

By **Green** we mean that the construction and operation & decommissioning of the energy source has minimal impact on the environment. Of course all energy sources have some environmental impact, but less is best.

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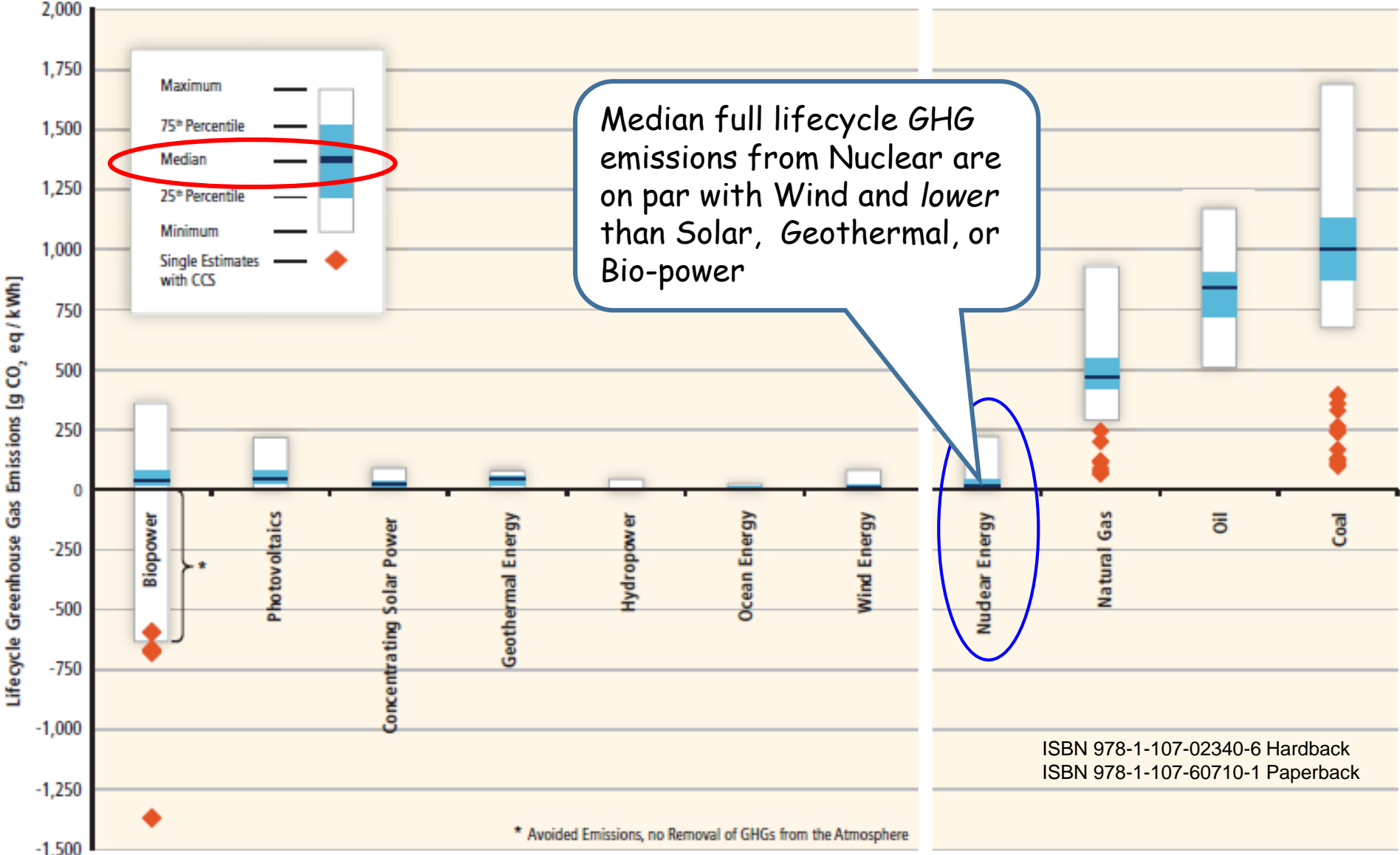
# Materials Throughput for Each Energy Source



Sources: DOE Quadrennial Technology Review, Table 10.4  
 Murray, Raymond L. Holbert, Keith E.. (2015). Nuclear Energy - An Introduction to the Concepts, Systems, and Applications of Nuclear Processes (7th Edition). Elsevier. page 97

# Renewable Energy Sources and Climate Change Mitigation

## Special Report of the Intergovernmental Panel on Climate Change



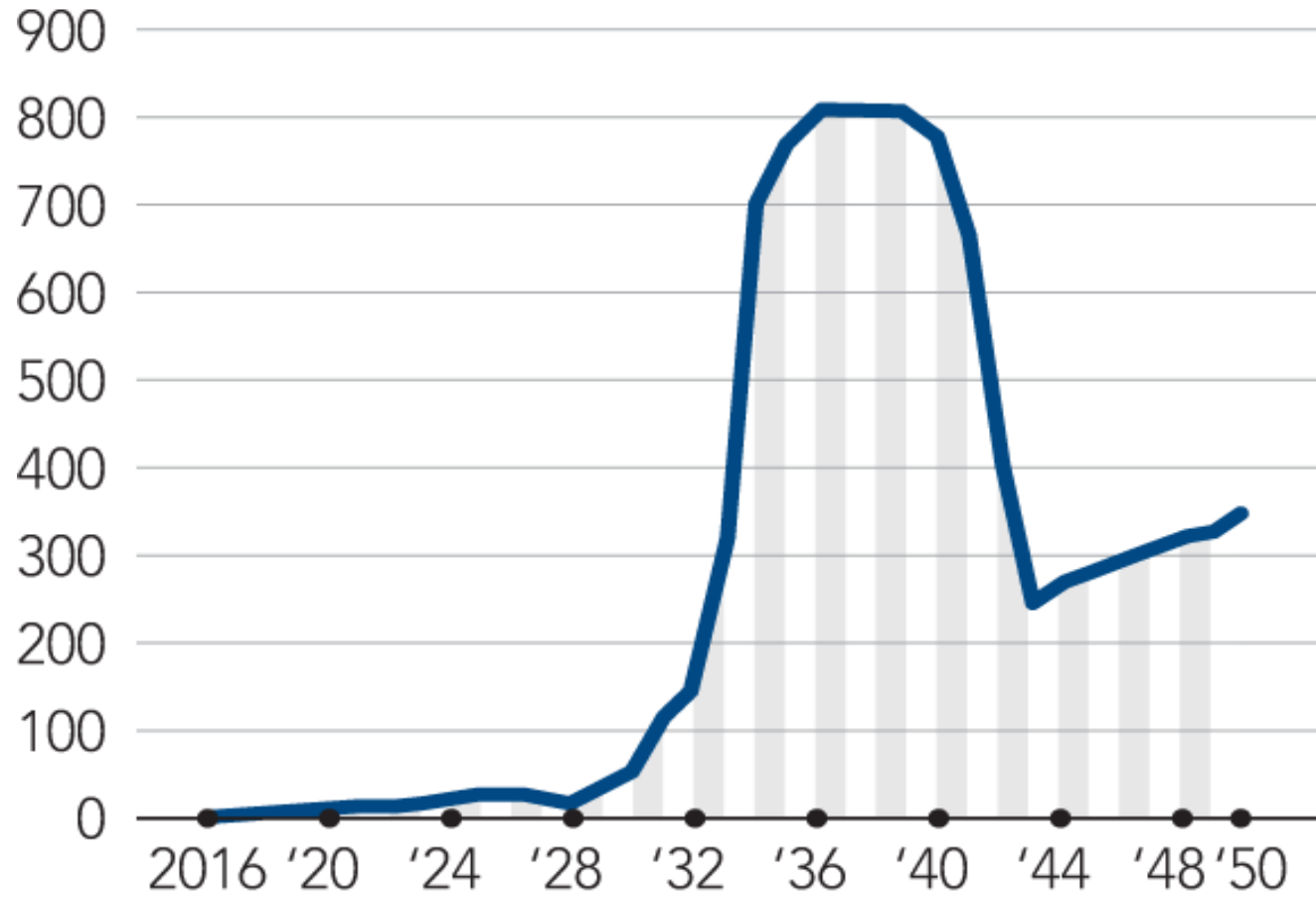
**Greenness** also considers the environmental impact of de-commissioning and waste



428 m<sup>3</sup> = 1,027 tonnes concrete  
+ 30 tonnes steel



# Used solar panels requiring disposal in Japan *(in thousands of tons)*

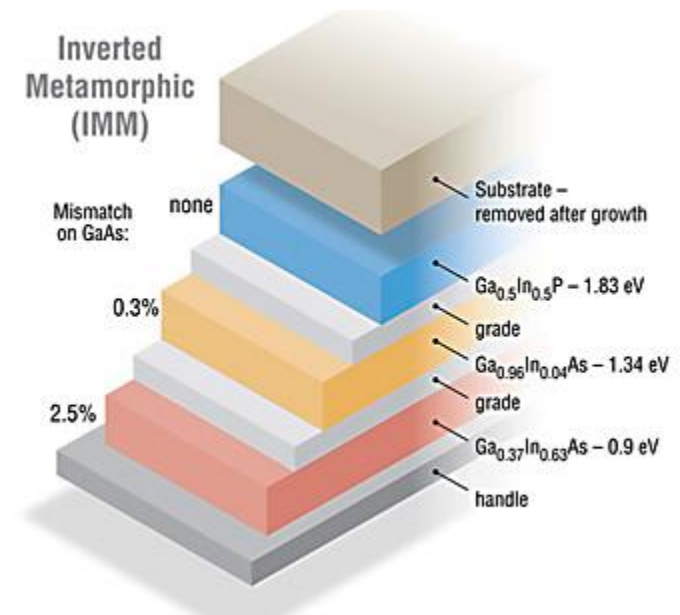


Forecast based on panel lifespan of 20 years  
Source: Japanese Environment Ministry

## Australia's first solar-panel recycler plans to help green the full life cycle of components

South Australian-based company Reclaim PV estimates it will open Australia's first commercial solar-panel recycling plant in mid 2019. Its high-energy founders also have a broader mission — to inform better environmental practices throughout the solar value chain.

JANUARY 18, 2019 NATALIE FILATOFF

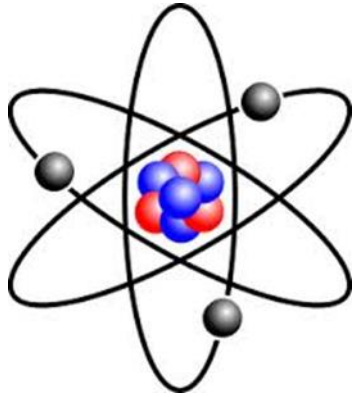


**Greenness** also considers the environmental impact of de-commissioning and waste

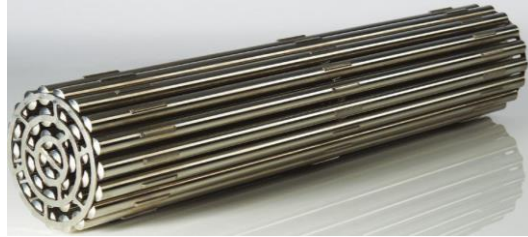
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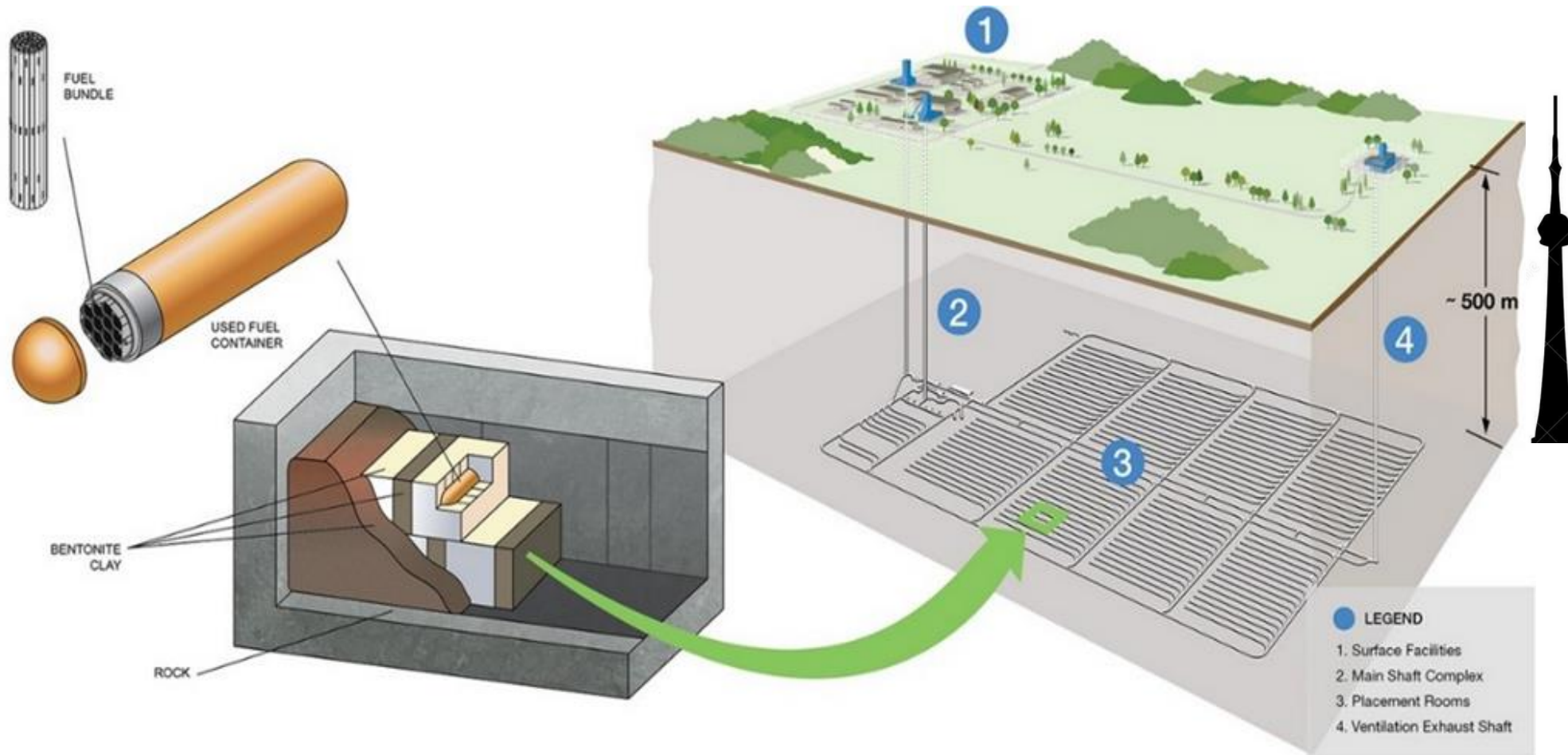


**Greenness** also considers the environmental impact of de-commissioning and waste



# Greenness also considers the environmental impact of de-commissioning and waste



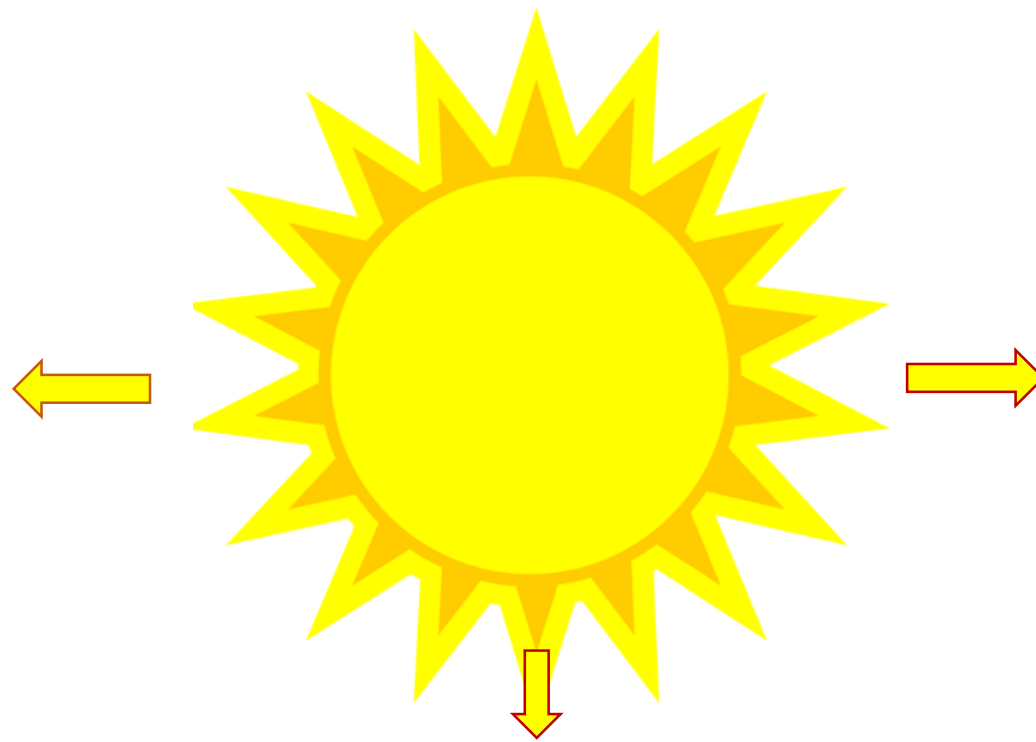




Renewable



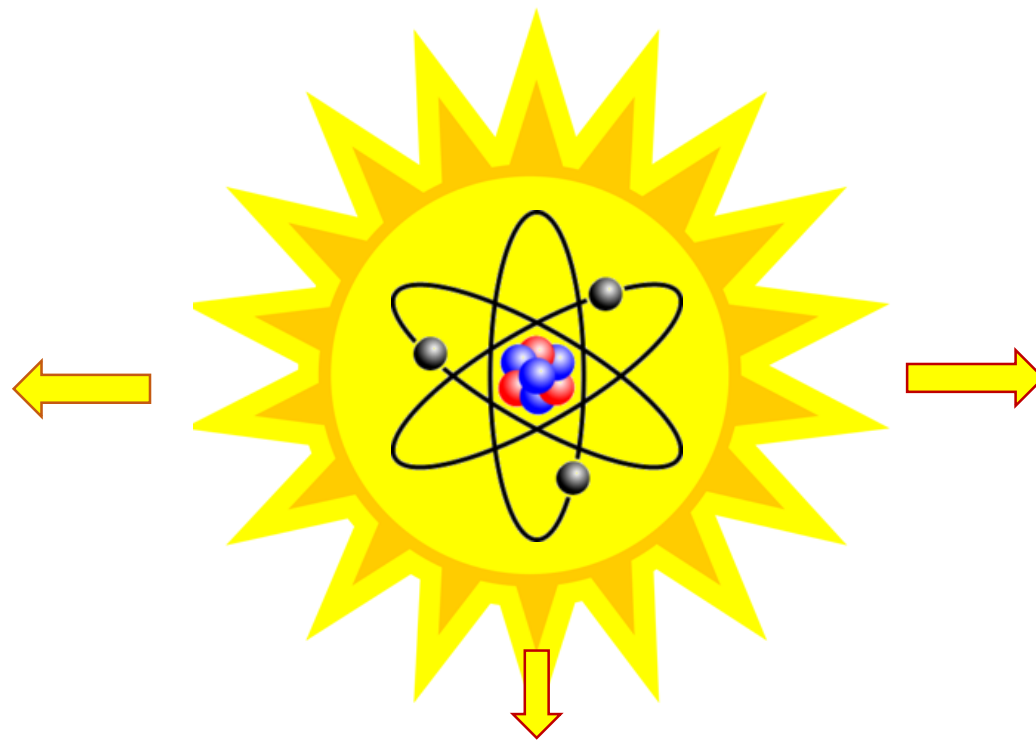
Energy



**Renewable**



**Energy**

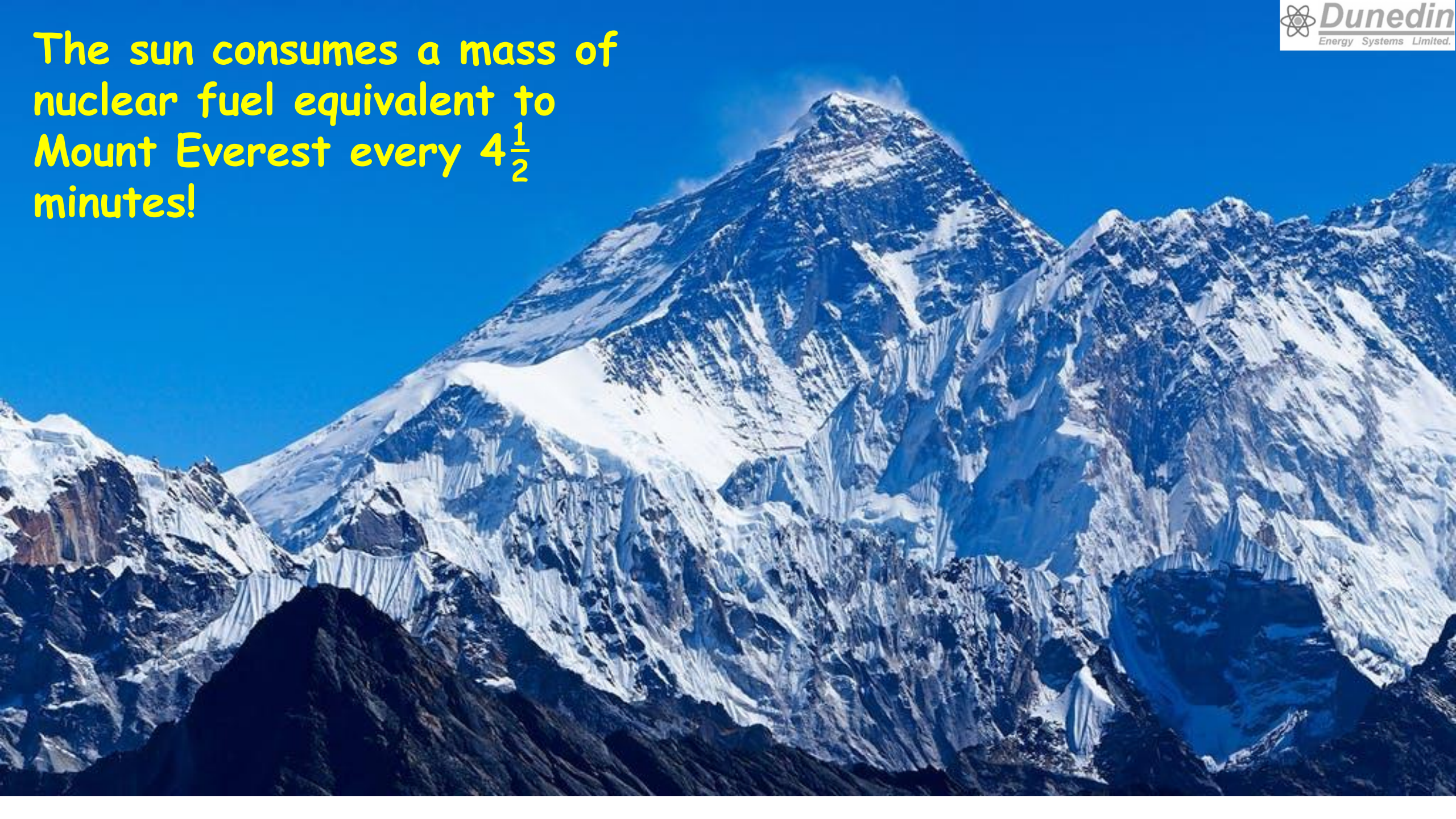


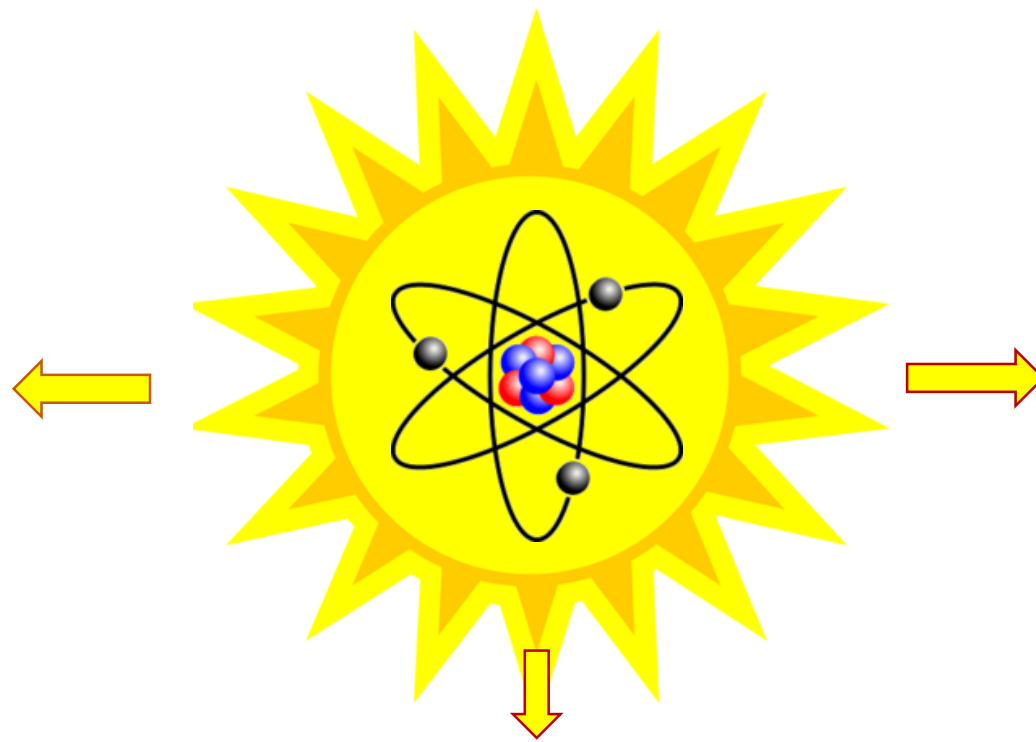
Renewable



Energy

The sun consumes a mass of nuclear fuel equivalent to Mount Everest every  $4\frac{1}{2}$  minutes!





Clean  
Green

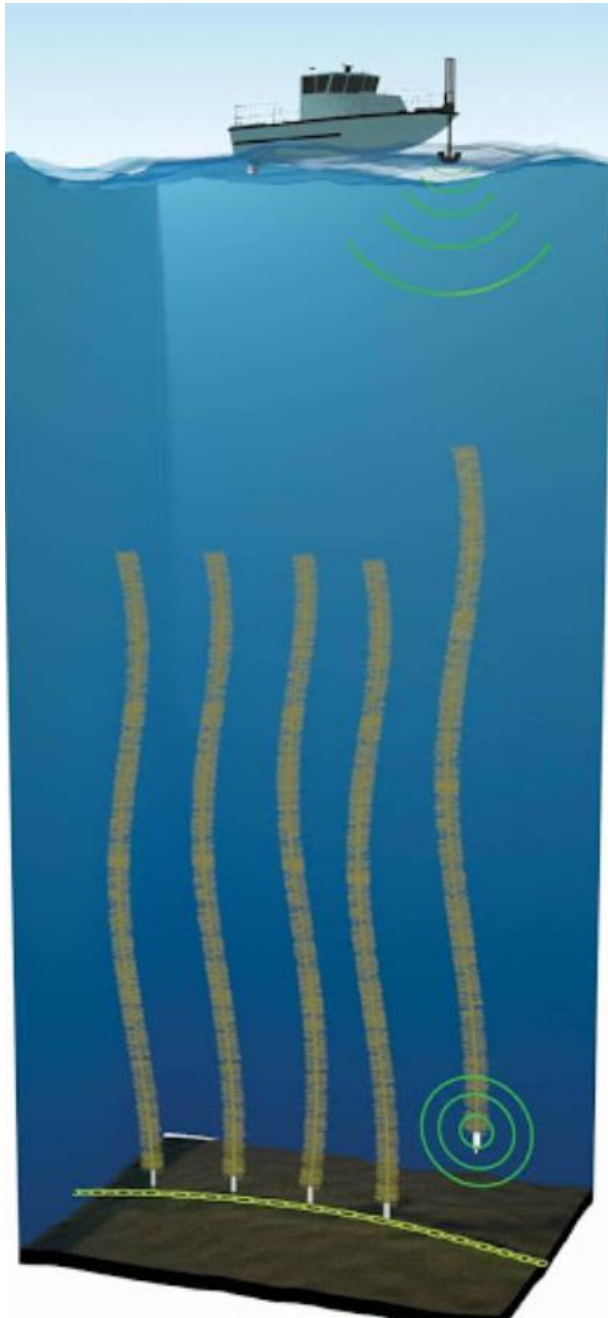


Renewable  
Energy



**4 billion  
tonnes of  
Uranium in  
the ocean**

**100 trillion  
tonnes of  
Uranium in  
the earth's  
crust**



# Cost-effective method of extracting uranium from seawater promises limitless nuclear power



David Szondy | June 13th, 2018



This first gram of yellowcake was produced from uranium captured from seawater with modified yarn (Credit: PNNL)

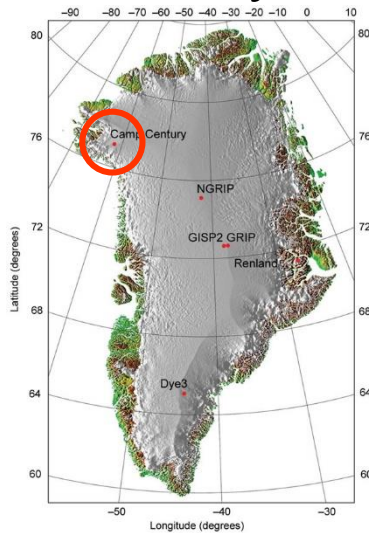
<https://newatlas.com/nuclear-uranium-seawater-fibers/55033/>





Most people think that nuclear only comes in one size - **GIGANTIC** -

# Camp Century

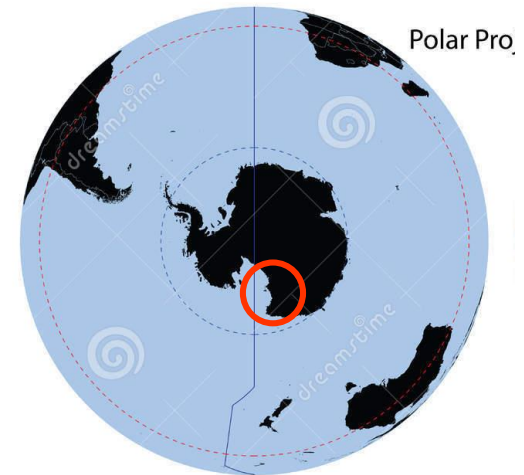


Approximately 1.6 MWe  
+ space heating

# Ft. Greely

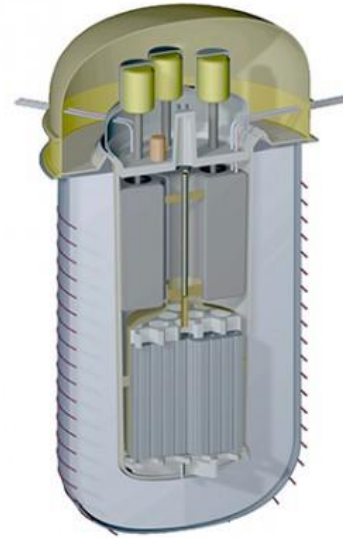
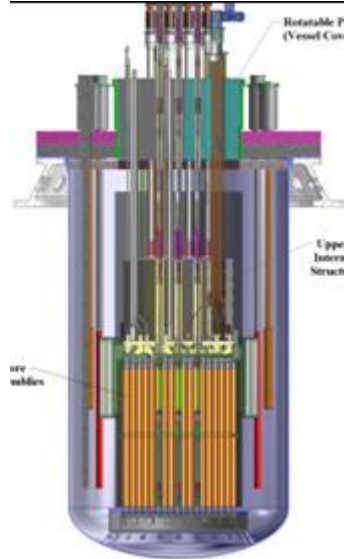
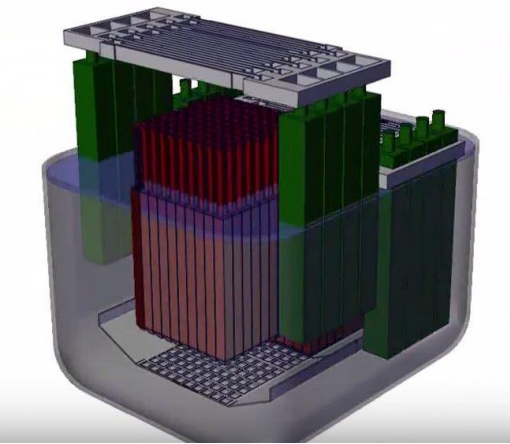
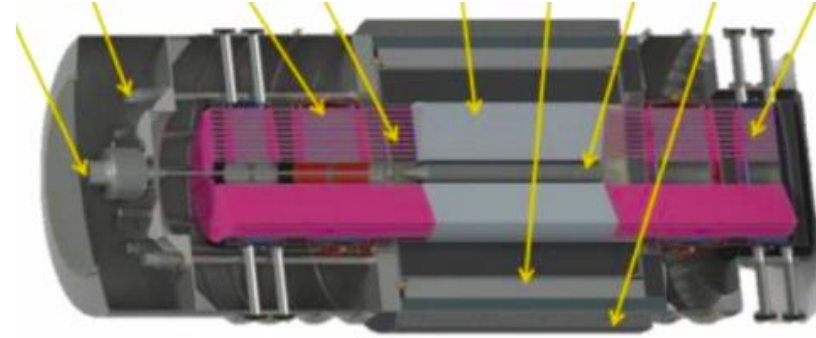
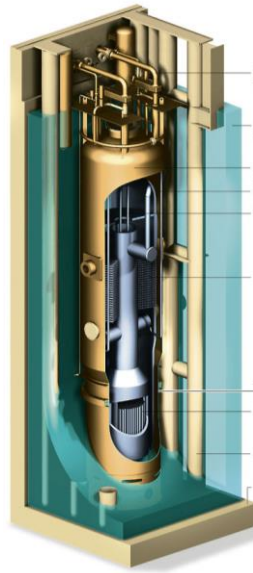


# McMurdo Station

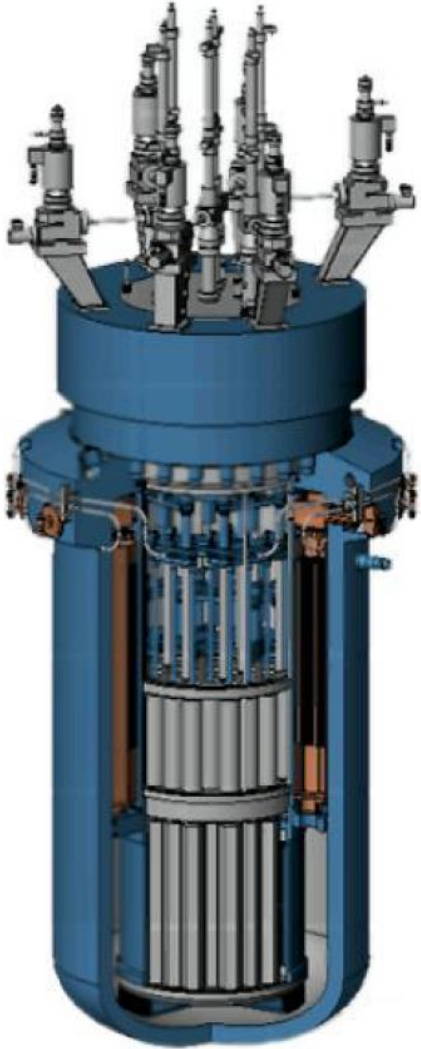




# ULTRA SAFE NUCLEAR CORPORATION







## Generic features of Small Modular Reactors

- ✓ Low power output 500 kWe to 50 MWe
- ✓ Typically 5 to 25 years without refuelling = energy price stability
- ✓ Produce electricity or high-grade heat, or both when operated in a co-generation mode.
- ✓ Zero emissions operation. No SO<sub>x</sub>, NO<sub>x</sub>, VOCs or GHGs
- ✓ Can be located near to the load centre

## Communities

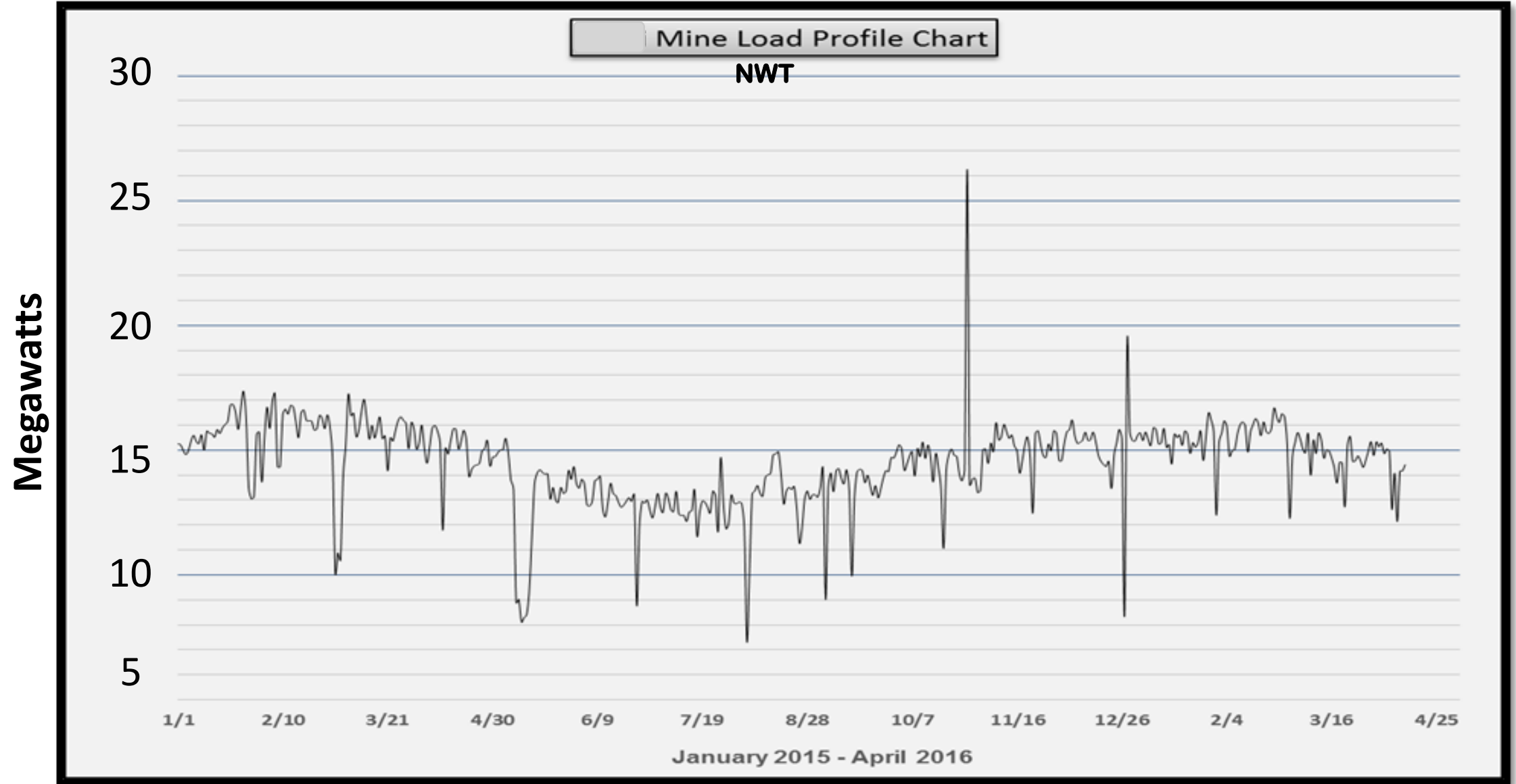


Electrical load < 2MWe

## Mines

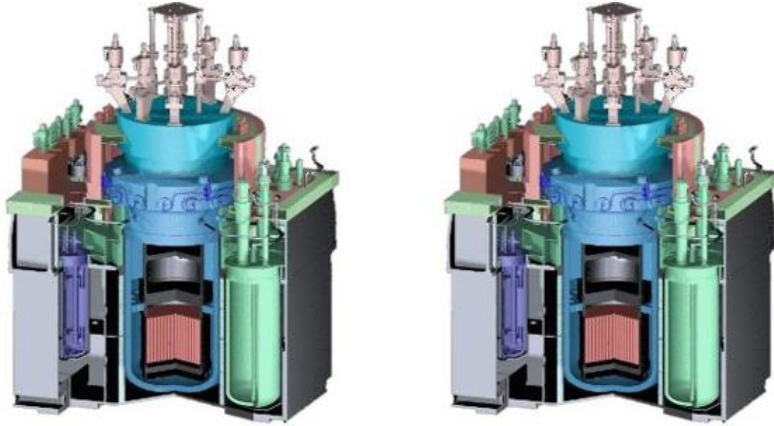


Electric loads 10 to 20 MWe





### 16MWe **ABV-6M** Plant



Annual power production 126,000 MWh

### 16 MWe Diesel Plant



Annual power production 126,000 MWh

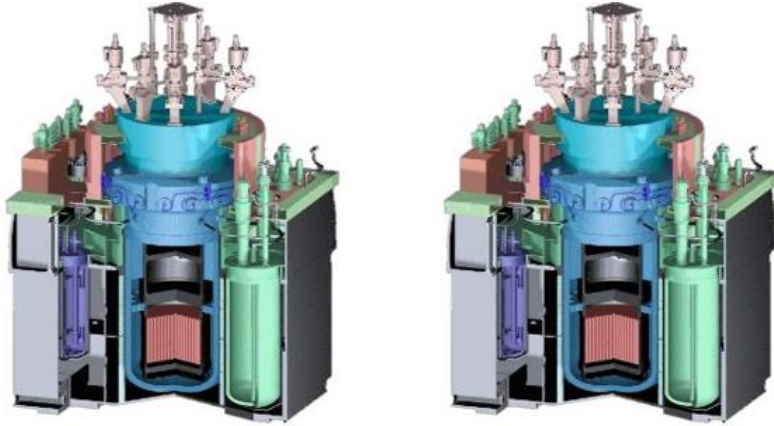
Annual fuel logistics 31,500,000 L



630+ Super B loads



## 16MWe **ABV-6M** Plant



Annual power production 126,000 MWh

Annual fuel logistics **0**

## 16 MWe Diesel Plant



Annual power production 126,000 MWh

Annual fuel logistics 31,500,000 L

Annual GHG production 85,000 t

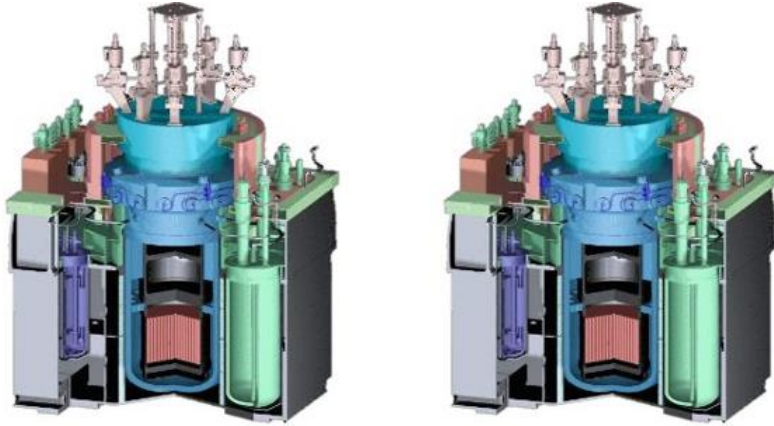


***Whoa !...How much CO<sub>2</sub> did you say??***

**85,000 tonnes**



### 16MWe **ABV-6M** Plant



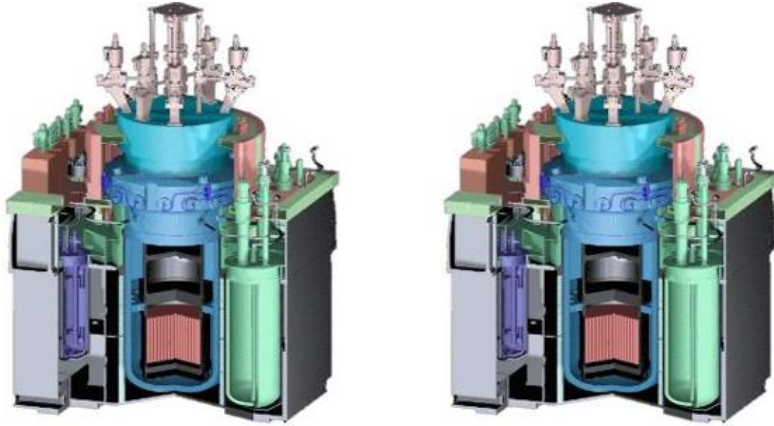
Annual power production	126,000 MWh
Annual fuel logistics	<b>0</b>
Annual GHG production	<b>0</b>

### 16 MWe Diesel Plant



Annual power production	126,000 MWh
Annual fuel logistics	31,500,000 L
Annual GHG production	85,000 t
SOx, NOx, VOC, Black Carbon	YES

### 16MWe **ABV-6M** Plant



Annual power production	126,000 MWh
Annual fuel logistics	<b>0</b>
Annual GHG production	<b>0</b>
Annual SOx, NOx, VOC, Soot	<b>0</b>
Annual Carbon <b>Credit</b> \$	?

### 16 MWe Diesel Plant



Annual power production	126,000 MWh
Annual fuel logistics	31,500,000 L
Annual GHG production	85,000 t
SOx, NOx, VOC, Soot	YES
Annual Carbon <b>Tax</b> \$	?

# CANADA'S DIESEL DEPENDENT COMMUNITIES

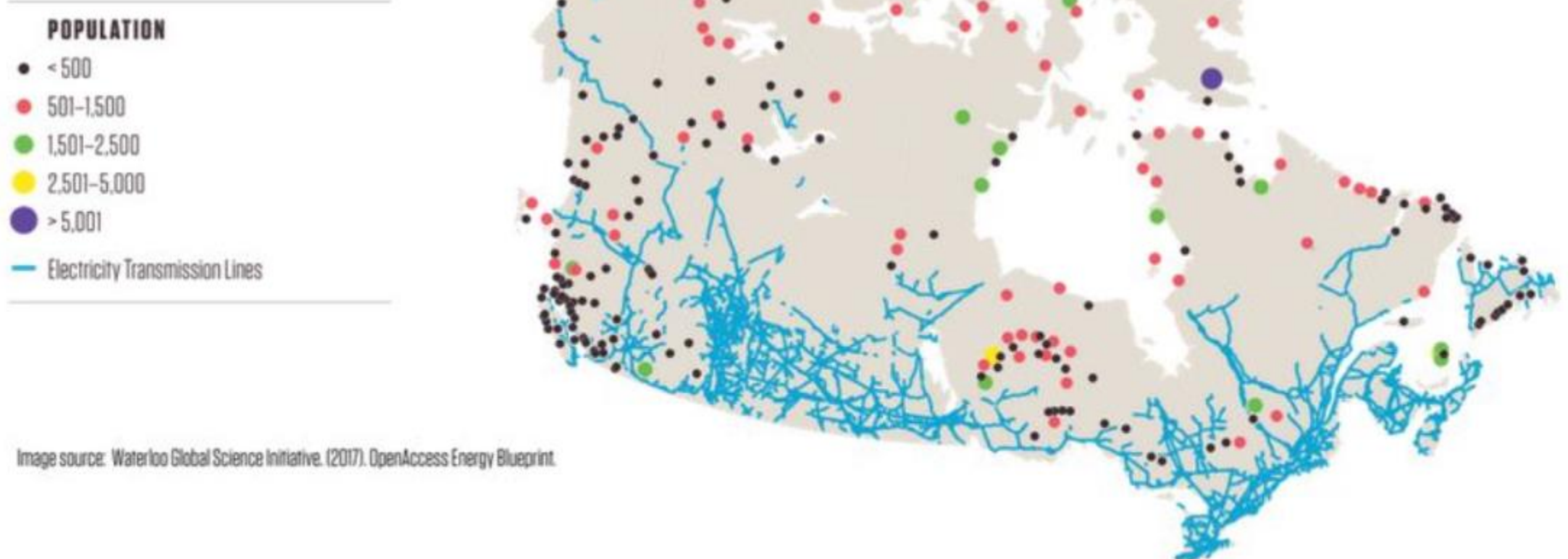
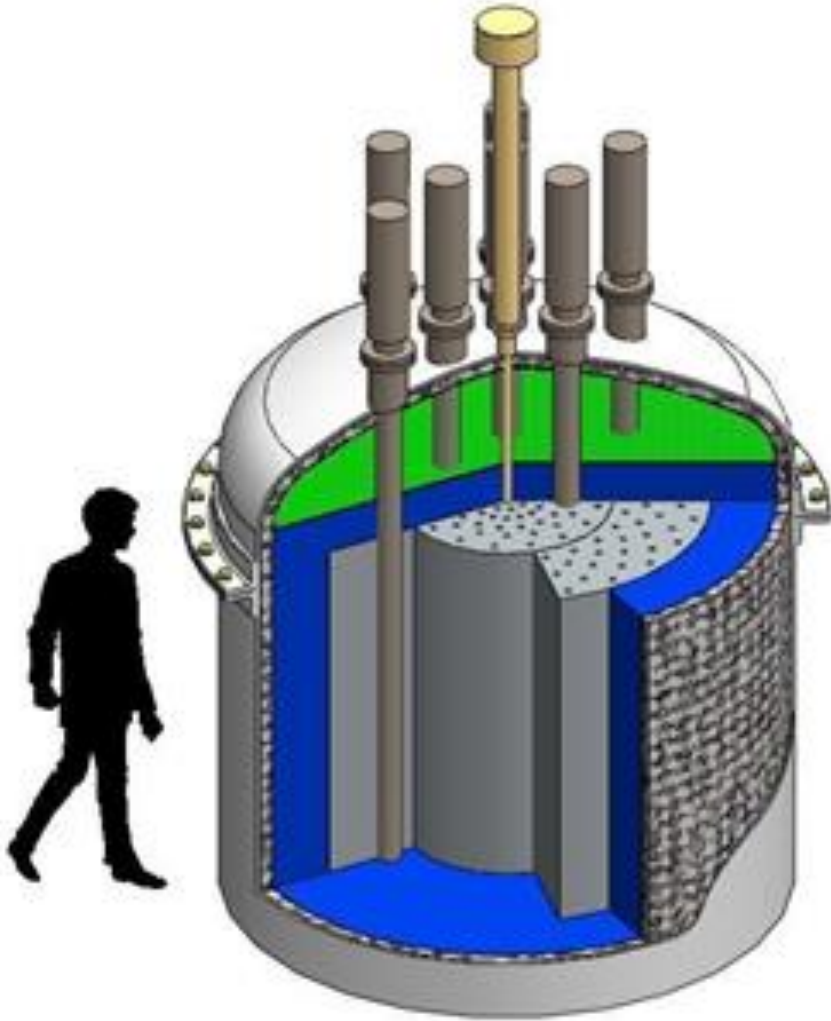


Image source: Waterloo Global Science Initiative. (2017). OpenAccess Energy Blueprint.

# The Canadian Nuclear Battery™

## Key Metrics

- 600 kWe or 2,400 kWt or a combination of both in a co-generation mode
- Will run for up to 20 years on a single fuel load
- Dimensions  $\approx$  3 x 4 metres
- Unit weight  $\approx$  20 tonnes = air transportable
- Operates at atmospheric pressure



### **Each year of operation will:**

- ✓ Produce 5,000 MW hours of electricity
- ✓ Avoid  $\approx$  1.2 million litres of diesel fuel combustion
- ✓ Avoid  $\approx$  3,300 tonnes CO<sub>2</sub>
- ✓ Zero emissions of SO<sub>x</sub>, NO<sub>x</sub>, VOC, Black Carbon

# Summary

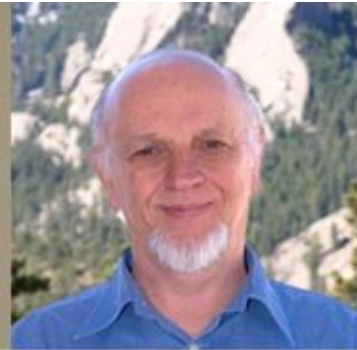
1. Micro Nuclear power plants belong in the family of Clean, Green Renewable energy technologies.
2. Nuclear energy can provide reliable, zero emissions, electricity and heat, 24-7, independent of wind, weather, or insolation.
3. Nuclear energy can dramatically reduce the cost, logistical effort, and environmental impact of providing high quality electricity and heat to northern communities and industries.

# Thoughts on **clean, green, Renewable Energy** from four world leading climate scientists

**"Renewables like wind and solar and biomass will certainly play roles in a future energy economy, but those energy sources cannot scale up fast enough to deliver cheap and reliable power at the scale the global economy requires. While it may be theoretically possible to stabilize the climate without nuclear power, in the real world there is no credible path to climate stabilization that does not include a substantial role for nuclear power"**



**Dr. James Hansen,**  
Climate scientist,  
Columbia University  
Earth Institute



**Dr. Tom Wigley**  
Climate Scientist  
University of Adelaide  
and the National  
Center for  
Atmospheric Research



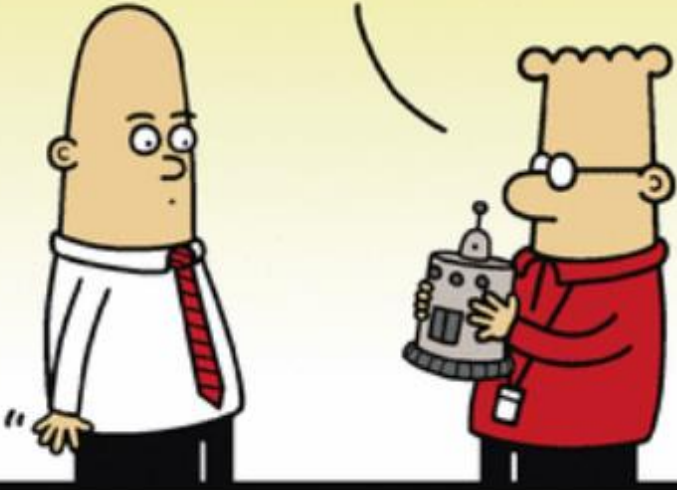
**Dr. Kerry Emanuel**  
Atmospheric  
Scientist,  
Massachusetts  
Institute of  
Technology



**Dr. Ken Caldeira**  
Senior Scientist,  
Dept. of Global  
Ecology, Carnegie  
Institution

# Questions ?

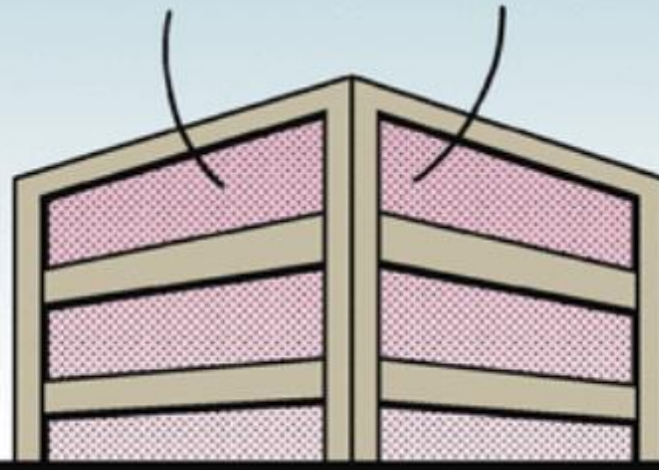
I ENGINEERED A  
TOTALLY SAFE DESIGN  
FOR NUCLEAR POWER  
PLANTS.



DILBERT.COM @SCOTTADAMSSAYS

HOW SURE  
ARE YOU  
THAT IT  
IS SAFE?

ONE  
HUNDRED  
PERCENT.



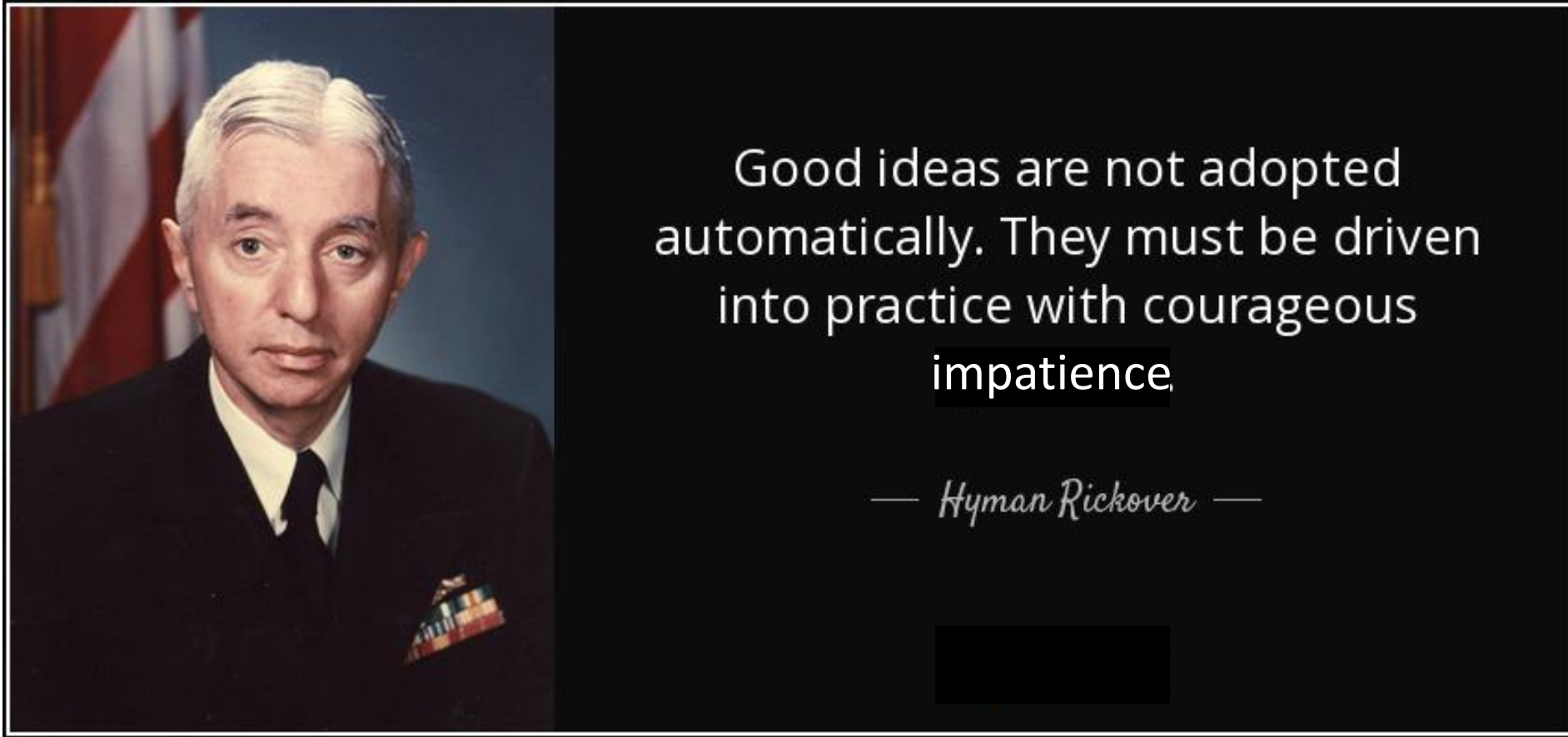
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JUST  
KEEP IT  
AWAY  
FROM MY  
TOWN.



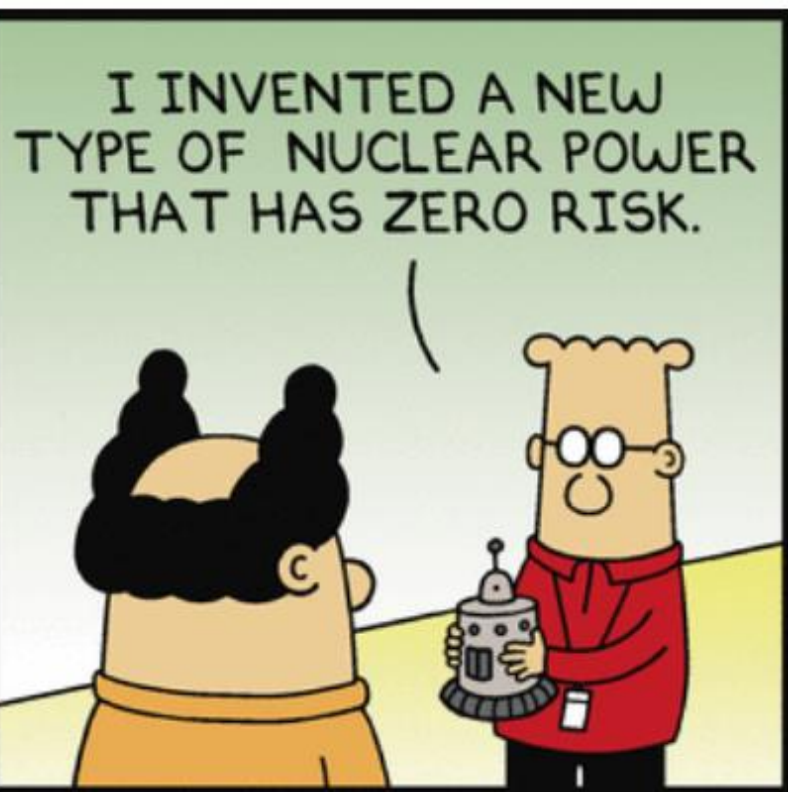
MAYBE  
IT WASN'T  
AN ENGI-  
NEERING  
PROBLEM  
AFTER ALL.



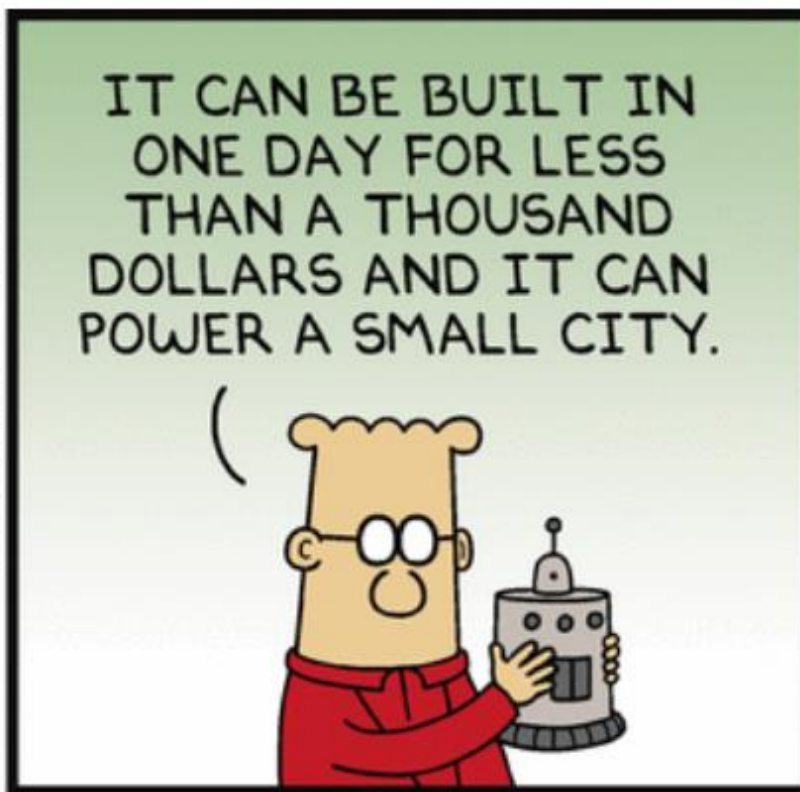


Father of the United States Nuclear Navy

- **500 Reactor Cores**
- **5,400 Reactor years of operation**
- **0 reactor accidents**



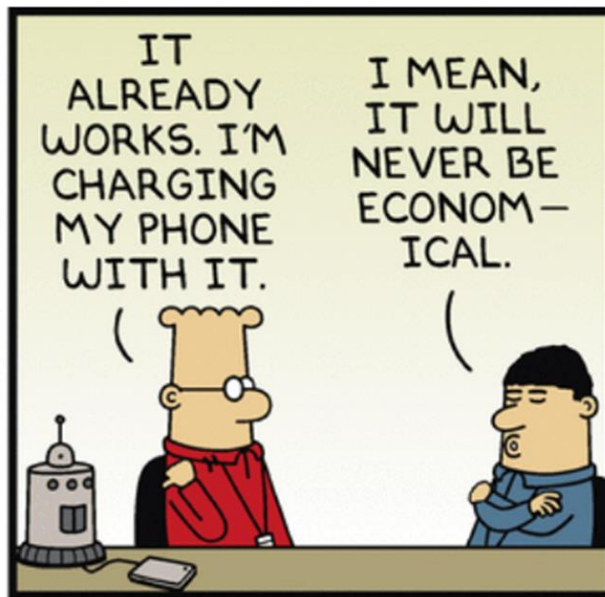
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