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Power History, current And Future Part Two

knut@Kenmark.us

Knut S-C Öjermark

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Power
Agenda

1. Home power
2. Power outage considerations
3. Atomic bombs
4. Fission
5. Fusion
6. Future

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Power

Power Outage

Power Outage

Home considerations

- Generator?
- Batteries?

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Power

Home Generators

Portable

Battery

1800W

Ok for camping and small houses?

Diesel

20Kw

Propane/Natural Gas 200A

$6,872.99

Transfer switch a few Seconds

Large house, no Pool running

1 – 2 Kw

Pool filter & cleaner 2 – 3 Kw

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Home Solar with batteries

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Solar panels

Solar Shingles

Solar panels with Battery

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Considerations

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All need installation costs

One battery system for each Sub-panel. Each +/- $15k. No running cost.

No PG&E cost

200A

One system for the house. $7000.

Cost of gas

Large house

200A main breaker

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Considerations

With or without Battery

Without battery, all Surplus over generated get sold to PG&E at the market rate.
Of peak rate the rate is lower.
Power lost NO solar power!

Year end surplus energy is returned to the energy grid when your system creates more energy than your have used.
PG&E adjust to $.03/KWh on 12 months surplus usage.
You may owe over $1,500.

Need to balance usage.

With Battery (ies) not

Typical usage:

- Charging EV 12 Kw
  - 240v and 50Amp
- Pool pump 2.4Kw

Net Energy Metering (NEM) is very complicated
NEM 2.0, save about 60% more over 20 years.
NEM 3.0 much lower export rate

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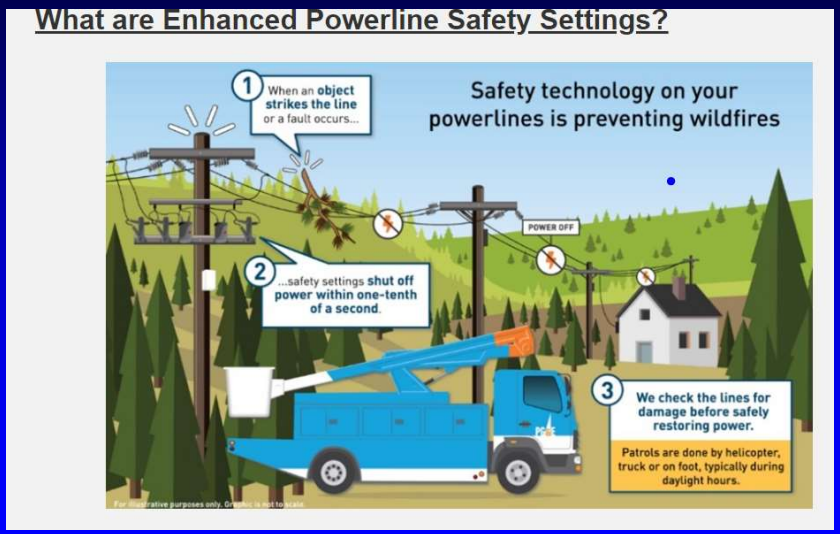
PG&E Safety shut off 1/10 sec



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Power
Atomic Energy

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Power
Bombs

Why talk about bombs?

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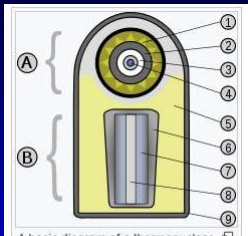
A primary Fission

B secondary Fusion



A basic diagram of a thermonuclear weapon.
Note: some designs use spherical secondaries.
A. fission primary stage
B. fusion secondary stage
1. High-explosive lenses
2. Uranium-238 ("tamper") lined with beryllium reflector
3. Vacuum ("levitated core")
4. Tritium "boost" gas (blue) within plutonium or uranium hollow core
5. Radiation channel filled with polystyrene foam
6. Uranium ("pusher/tamper")
7. Lithium-6 deuteride (fusion fuel)
8. Plutonium ("spark plug")
9. Radiation case (confines thermal X-rays by reflection)

Fusion design

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Fission and Fusion Bombs: What is the Difference?

Hiroshima Fission atomic bomb

15 kilotons of TNT

Fusion (H- bomb) atomic bomb
Much more powerful.

Russian TSAR Bomba (50 megatons) test
3,800 stronger than Hiroshima.
Cut back from 100 megatons

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Hiroshima Fission Bomb

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Fusion Bombs

A **thermonuclear weapon**, **fusion weapon** or **hydrogen bomb** (**H bomb**) is a second-generation nuclear weapon design

Heavy isotopes of hydrogen (deuterium and tritium

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Fission Small Modular Reactors

Small modular reactors (SMRs) are a class of small nuclear fission reactors, designed to be built in a factory, shipped to operational sites for installation and then used to power buildings or other commercial operations.

- As of 2023, there are more than eighty modular reactor designs under development in 19 countries. The ability to bypass financial and safety barriers that inhibit the construction of conventional reactors
- The first SMR units are in operation in Russia and China

https://en.wikipedia.org/wiki/Small_modular_reactor

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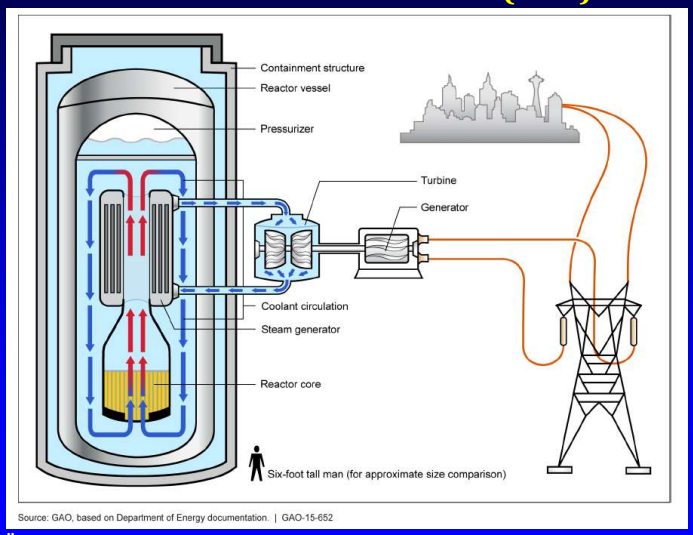
Power
Future and current
Small Modular Reactor (SMR)



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Future
Fission Reactor types

- **Nuclear fission reactors**
  - Is a device used to initiate and control a fission nuclear chain reaction or nuclear fusion reactions.
- **Thermal-neutron reactors**
  - reduce the speed of the neutrons to low-velocity, thermal neutrons
- **Fast-neutron reactors**
  - fission chain reaction is sustained by fast neutrons
- **Molten salt**
  - A class of nuclear fission reactor in which the primary nuclear reactor coolant and/or the fuel is a mixture of molten salt with a fissionable material.
  - See next chart
- **Gas cooled reactor**
  - A nuclear reactor that uses graphite as a neutron moderator and a gas (carbon dioxide or helium in extant designs) as coolant.[1] Although there are many other types of reactor cooled by gas,

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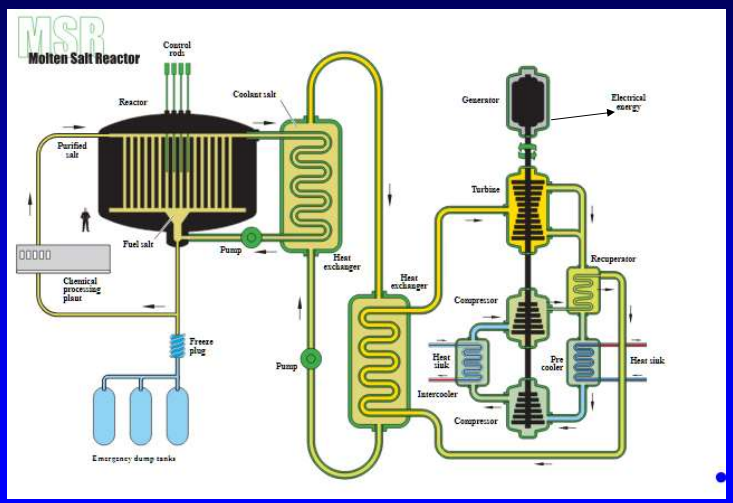
Power
Future and current
Molten Salt Fission Reactor



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Small Modular Fission Reactor (SMR)

Nuclear-powered aircraft carriers
Ten *Nimitz*-class carriers

Nuclear-powered submarines
The United States Navy operates the largest fleet of nuclear submarines

Nuclear-powered cruisers
All scrapped 2012

https://en.wikipedia.org/wiki/Nuclear_navy

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Power

Future ?

Small Modular Reactor (SMR) Fission

Design | Licensing | Under construction | Operational | Cancelled | Retired

Name	Gross power (MW_e)	Type	Producer	Country	Status
4S	10–50	SFR	Toshiba	Japan	Detailed design
ABV-6	6–9	PWR	OKBM Afrikantov	Russia	Detailed design
ACP100 Linglong One	125	PWR	China National Nuclear Corporation	China	Under construction[70]
TMSR-LF1	10[71]	MSR	China National Nuclear Corporation	China	Under construction
AP300[72]	300	PWR	Westinghouse Electric Company	United States	Detailed design
ARC-100	100	SFR	ARC Nuclear	Canada	Design: Vendor design review.[73] One unit planned for construction at Point Lepreau Nuclear Generating Station in December 2019.[74]
MMR	5-15	HTGR	Ultra Safe Nuclear Corporation (USNC)	United States/Canada	Licensing stage[75]
ANGSTREM[76]	6	LFR	OKB Gidropress	Russia	Conceptual design
B&W mPower	195	PWR	Babcock & Wilcox	United States	Cancelled in March 2017
BANDI-60	60	PWR	KEPCO	South Korea	Detailed design[77]
BREST-OD-300[78]	300	LFR	Atomenergoprom	Russia	Under construction[79]
BWRX-300[80]	300	BWR	GE Hitachi Nuclear Energy	United States/Japan	Licensing stage
CAREM	27–30	PWR	CNEA	Argentina	Under construction
Copenhagen Atomics Waste Burner	50	MSR	Copenhagen Atomics	Denmark	Conceptual design
HTMR-100	35	GTMHR	Stratek Global	South Africa	Conceptual design[70]

Many more pages of this

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Fission

Small Modular Reactor (SMR) Economics factors

- SMRs is the claimed economies of scale in production, due to volume manufacture in an offsite factory.
- Some studies instead find the capital cost of SMRs to be equivalent to larger reactors.
- Substantial capital is needed to construct the factory - ameliorating that cost requires significant volume, estimated to be 40–70 units.
- SMR staff operating costs per unit output can be as much as 190% higher than the fixed operating cost of fewer large reactors.

To ameliorate is to step in and make a bad situation better.

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Future Fusion

Fusion

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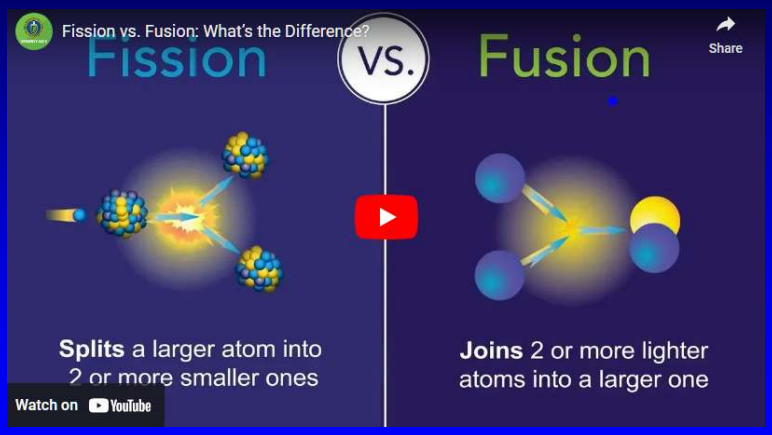
Fission vs Fusion

Fission and Fusion: What is the Difference?



https://www.youtube.com/watch?v=2W-GEE6YU4M

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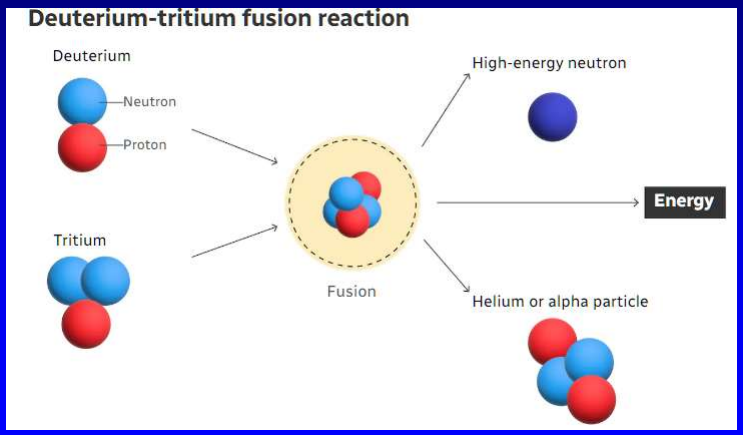
Smashing atoms together — Essentially the opposite of the atom-splitting fission

No Uranium – No Meltdown – No waste. Why?



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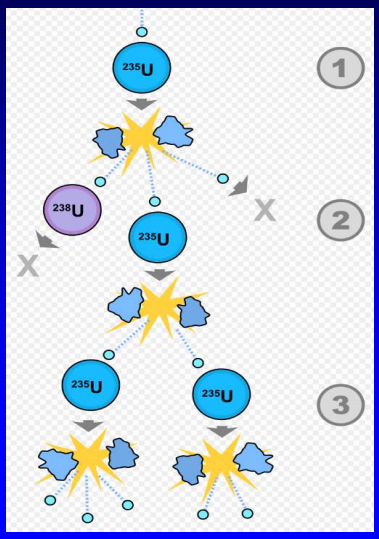

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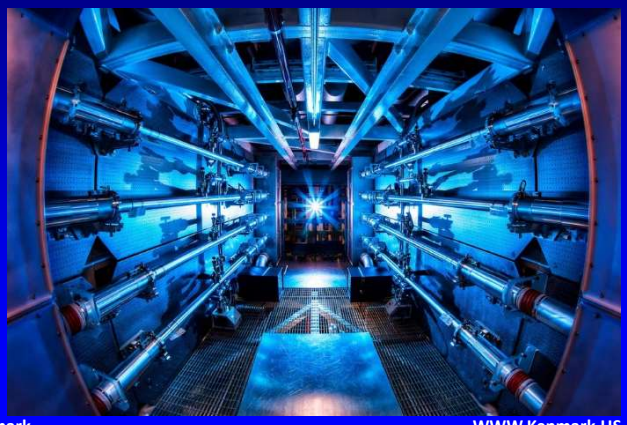
US scientists repeat fusion ignition **breakthrough for 2nd time.**
Lawrence Livermore National Lab (LLNL) achieved a net energy gain in a fusion experiment us
lasers on Dec. 5, 2022.



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The target chamber of LLNL's National Ignition Facility, where 192 laser beams delivered more than 2 million joules of ultraviolet energy to a tiny fuel capsule to create fusion ignition on Dec. 5, 2022.

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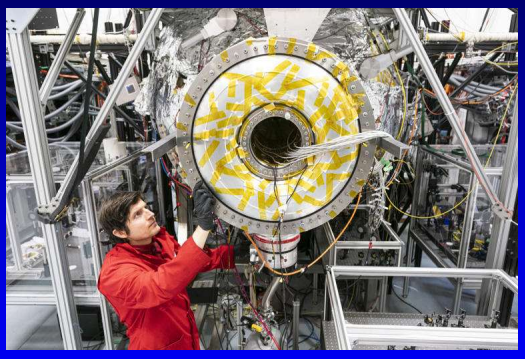
Fusion fever: A reality check on the multibillion-dollar race to reinvent energy and save the planet



The nuclear fusion sector is **hot**.
Maybe not 100 million degrees
Celsius that is needed

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Helion employees working on a component of its Polaris device, a seventh-generation fusion prototype that it expects to produce electricity.

Helion Energy, Inc. is an American fusion research company, located in Everett, Washington

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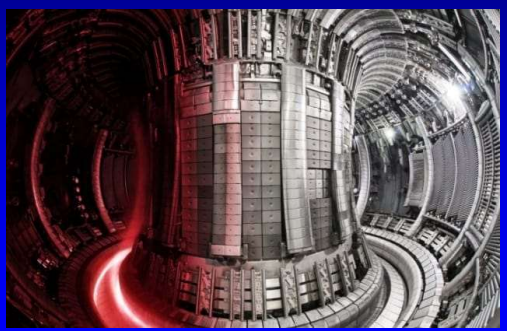
Future Fusion

For over the past decade, JET has been carrying out "ITER relevant" experiments, in anticipation of the opening of giant **fusion reactor in Cadarache, France**

ITER (initially the **International Thermonuclear Experimental Reactor)**
https://en.wikipedia.org/wiki/ITER



Feb 21, 2024 · **ITER, the world's largest science project with the collaboration of 35 nations,** is under construction for the demonstration of a tokamak reactor 12.

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Future Fusion

Challenge Conclusions:

- No waste comparison to Fission
- No melt downs
- Maybe many years before achieving to sustain power
- As of now achieved over 3 Millions Joules output with 2 millions input
- More than 100 million degrees Celsius.

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