DEBATE ON THE FUTURE OF FISSION

WHEN WILL CASK-HUGGING BECOME A NATIONAL SPORT?

MARCH 23, 2023 BY RICHARD STEEVES, MD, PHD

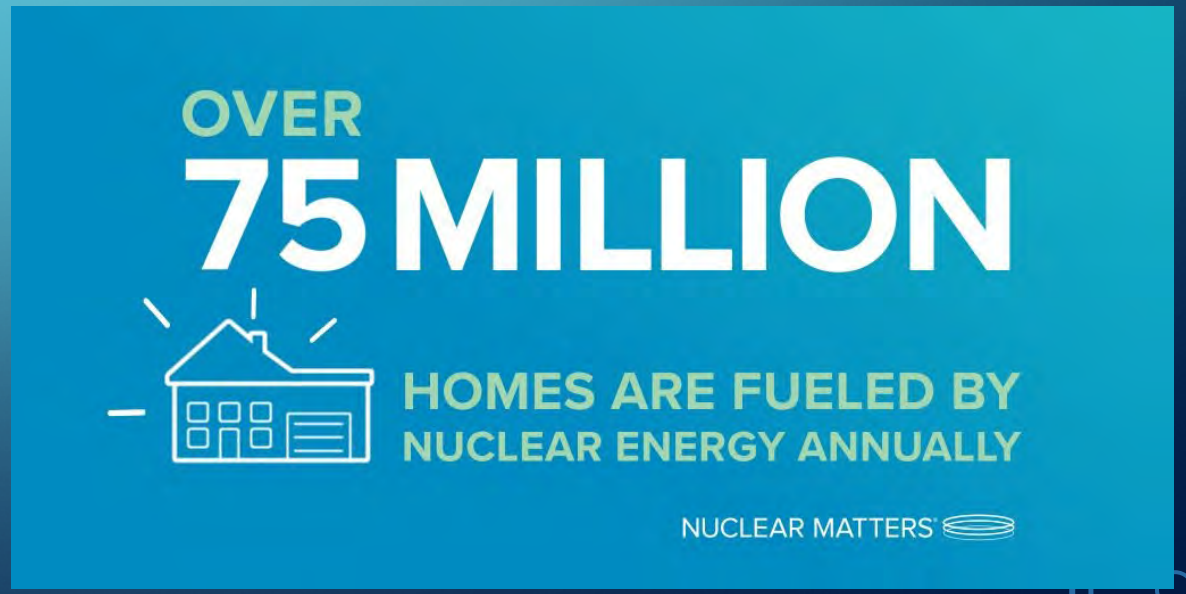
- Drums made of steel and concrete have safely stored SUNF (Slightly Used Nuclear Fuel) at power plants across USA, ready for future development of advanced reactors.
- Rigorously tested prior to use, they have not leaked or injured anyone.

WHY AM I HERE? WHY DO I CARE?

- Medical training (Albert Einstein College of Medicine): radiation oncology, a subspecialty of radiology in which linear accelerators and radioactive isotopes are used to treat cancer in all parts of the body.
- Graduate training (Ph D, University of Toronto): medical biophysics, during which I used radiation to study the causes of leukemia in mice.
- The PV solar system (on my garage roof for > 15 years) records cumulative and instant volt-hours generated every day.
- I drive and fly electrically, so I regret our grid dependence on coal.

LET'S START WITH SOME FACTS

- Nuclear (fission) plants in USA produce more CLEAN energy, 24/7, than all other carbon-free sources combined. Our 93 reactors generate nearly 19% of our total electricity, and they operate at over 90% of their capacity.
- Nuclear adds diversity and reliable power to our grid in any weather, giving us crucial energy security.



The New York Times

Opinion

We Need More Than Solar and Wind to Power the Green New Deal

We're also going to need nuclear, geothermal and fossil-fuel plants that capture and store their emissions.

By Jesse Jenkins and Samuel Thernstrom

Dr. Jenkins and Mr. Thernstrom are co-authors of a recent study reviewing pathways to decarbonize electricity systems.

Jan. 17, 2019

https://www.nytimes.com/2019/01/17/opinion/

Nuclear's Environmental Value

Will Siri, Sierra Club Director, 1966

"Nuclear power is one of the chief long-term hopes for conservation…Cheap energy in unlimited quantities is one of the chief factors in allowing a large rapidly growing population to preserve wildlands, open space, and lands of high scenic value… With energy we can afford the luxury of setting aside lands from productive uses."

The Sierra Club's motto was wisely: "Atoms, not dams", and Ansel Adams said: ***"Nuclear energy is the only practical alternative that we have to destroying the environment with oil and coal."*** And, now we know, all 'renewables' require oil, coal, or gas to make up for more energy than they deliver.

THE SIERRA CLUB'S DIVISIVE HISTORY

- Most environmental organizations still copy the Sierra Club in opposing nuclear.
- My thesis today is that people who advocate 100% Renewables harm our planet more than climate-deniers do.

THERE'S NO FREE LUNCH FOR ANY ENERGY SOURCE

- Most people think solar power is FREE, once you own (or rent) the panels.
- Of course, minerals, electricity and heat are required to make panels; and the UN reports that only 20% of e-waste is recycled, while 80% goes to landfills or gets shipped to developing countries.

NUCLEAR MATTERS LOOKS BACK AT 2022 AS AN OUTSTANDING YEAR FOR FISSION

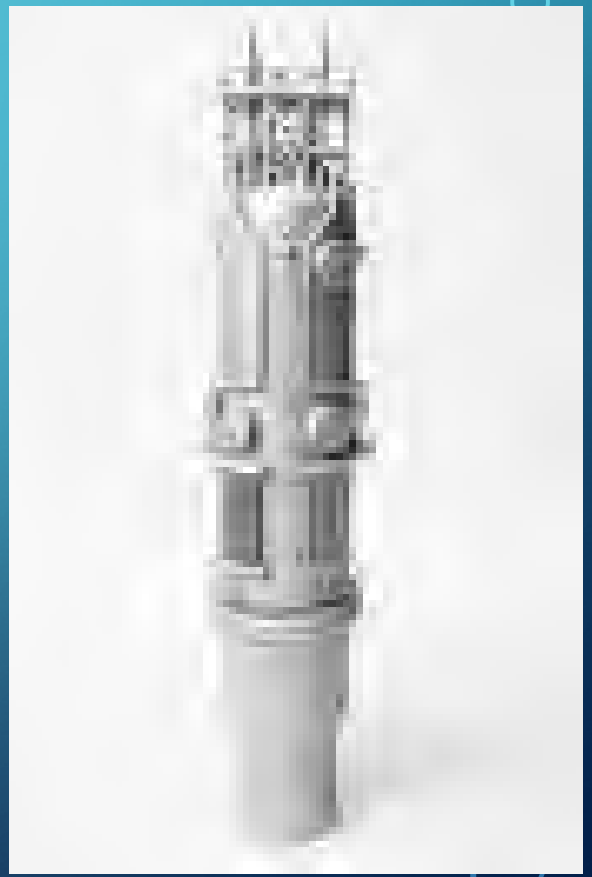
- The anticipated nuclear energy renaissance surpassed expectations.
- Advocates, communities and legislators have increased their support for this carbon-free, 24/7 source of electricity.
- The Inflation Reduction Act provided crucial support for maintaining our current fleet of Light Water Reactors, and for building newer, safer Small Modular Reactors, with which factory-built components can be more quickly assembled on sites of existing coal plants.
- COP27 conversations moved our fission technology forward.

KATHRYN HUFF'S STATEMENT TO THE PRESS

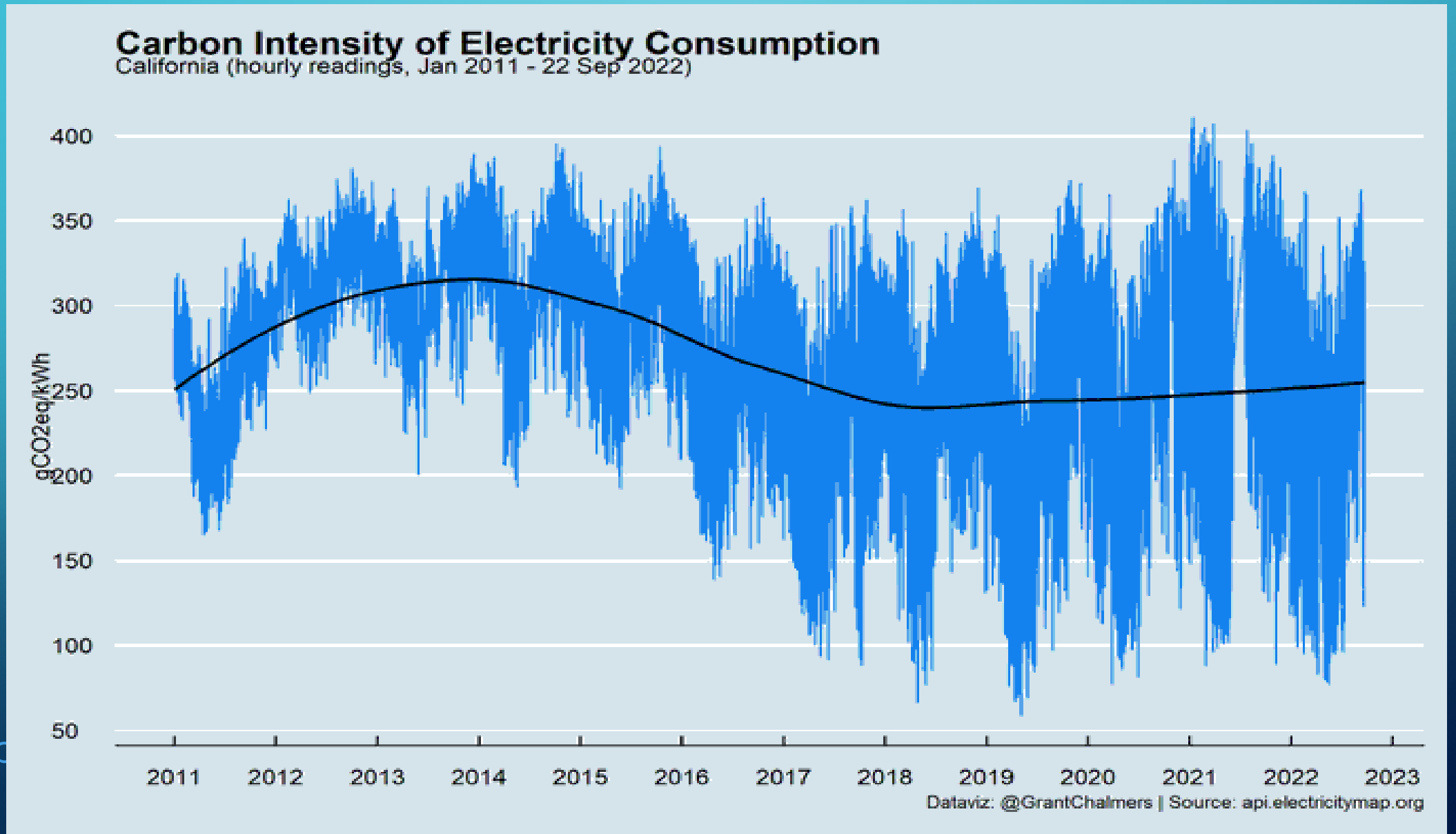
- "It would be more costly and more dangerous NOT to utilize nuclear fission as we build a greener future."
- "This is my opinion, and that of the Dept. of Energy, and that of the Biden administration."

PRESIDENT BIDEN'S POLICY

- Goals set by the Biden-Harris Administration include: 50% reduction in carbon emissions by 2030…and 100% clean power grid by 2035 ……and a net-zero energy economy by 2050 that will require help from new fission plants like this one →
- Federal agencies and the International Energy Agency claim that our national carbon mitigation targets can only be achieved by doubling our nuclear power capacity by 2050.



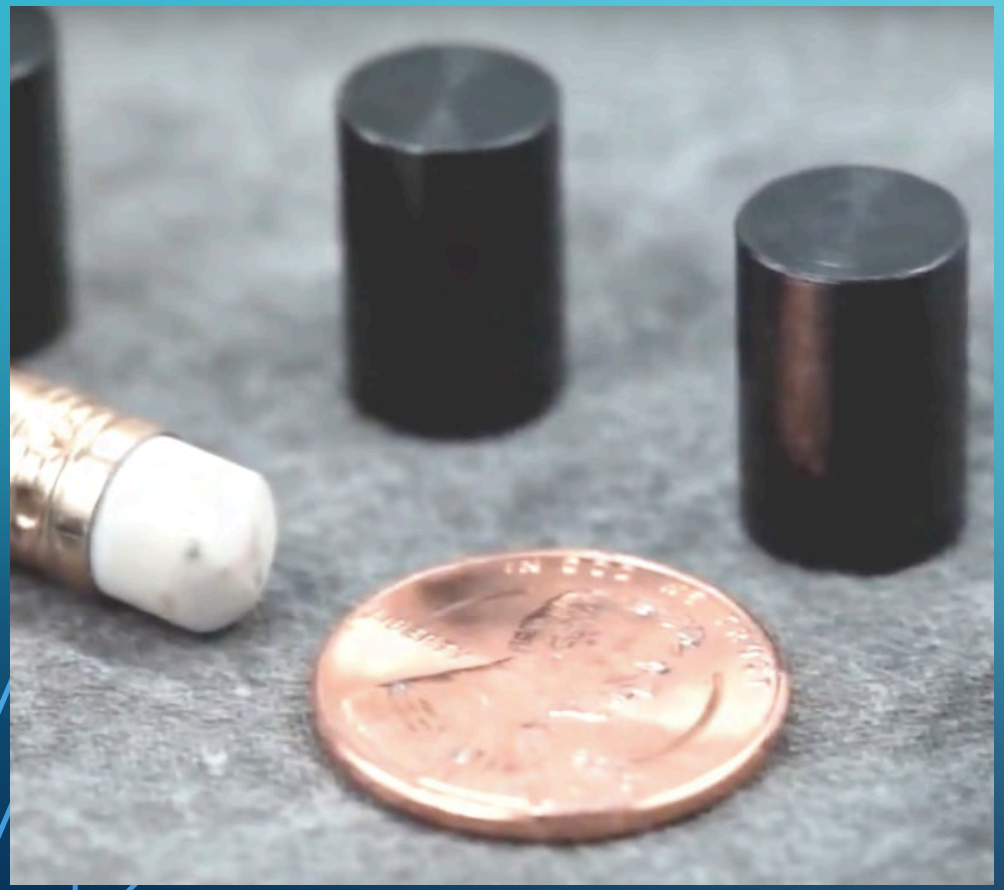
WHAT DID SUN AND WIND DO FOR CALIFORNIA ?

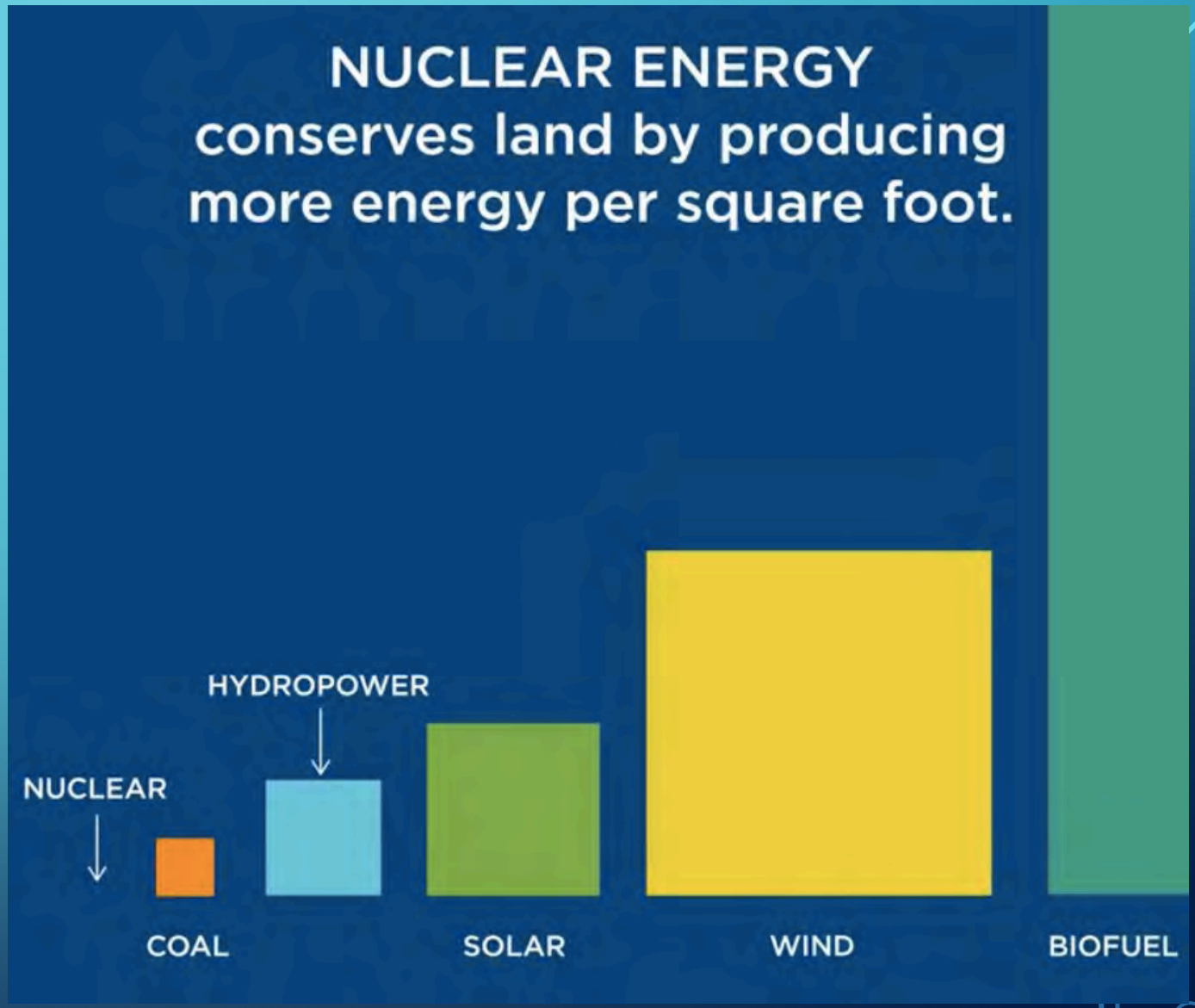


COMPACT FISSION

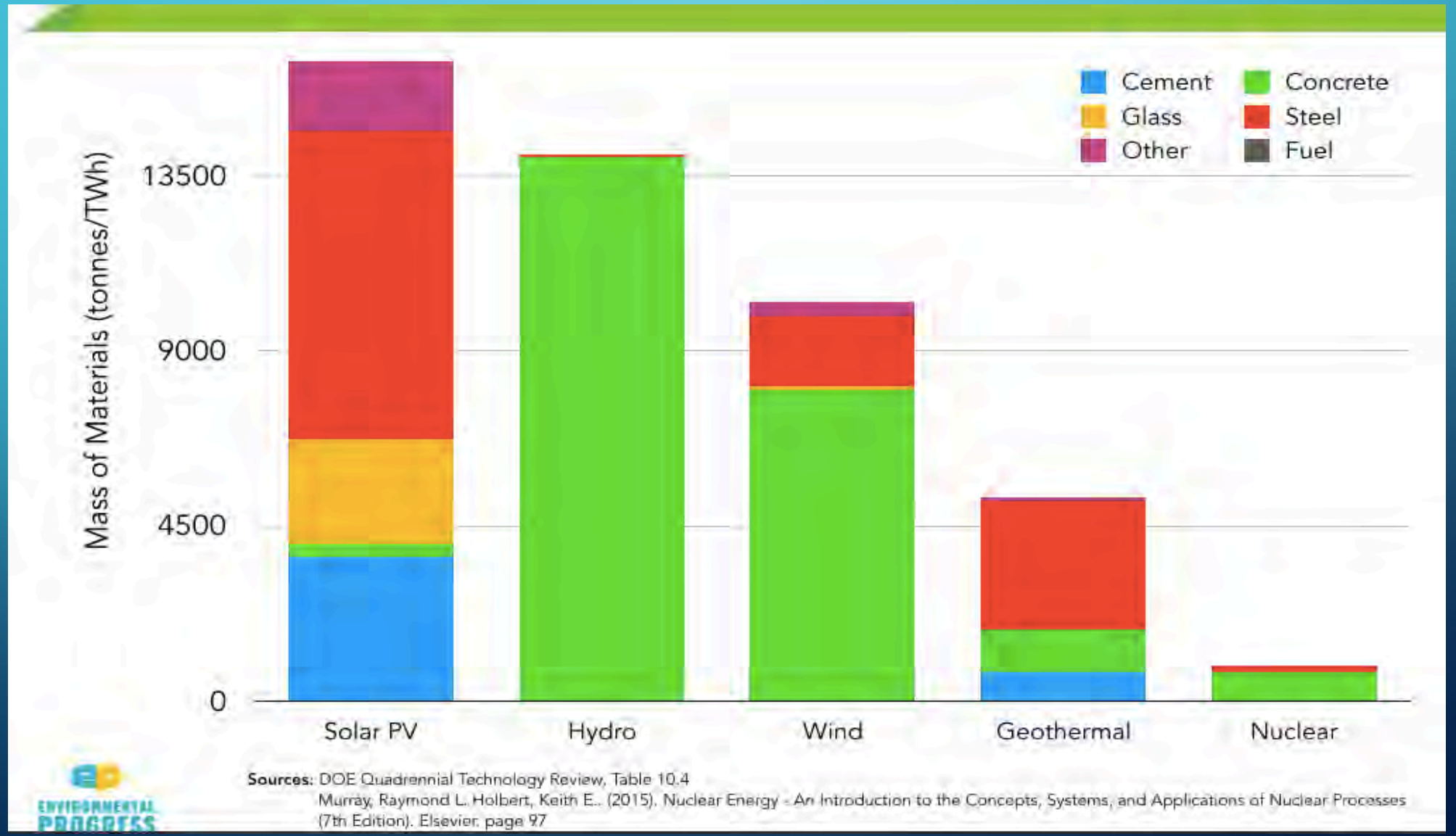
PELLET SIZE = 1 CM D X 1 CM L.

20 GM U EQUIV TO 400 KG COAL



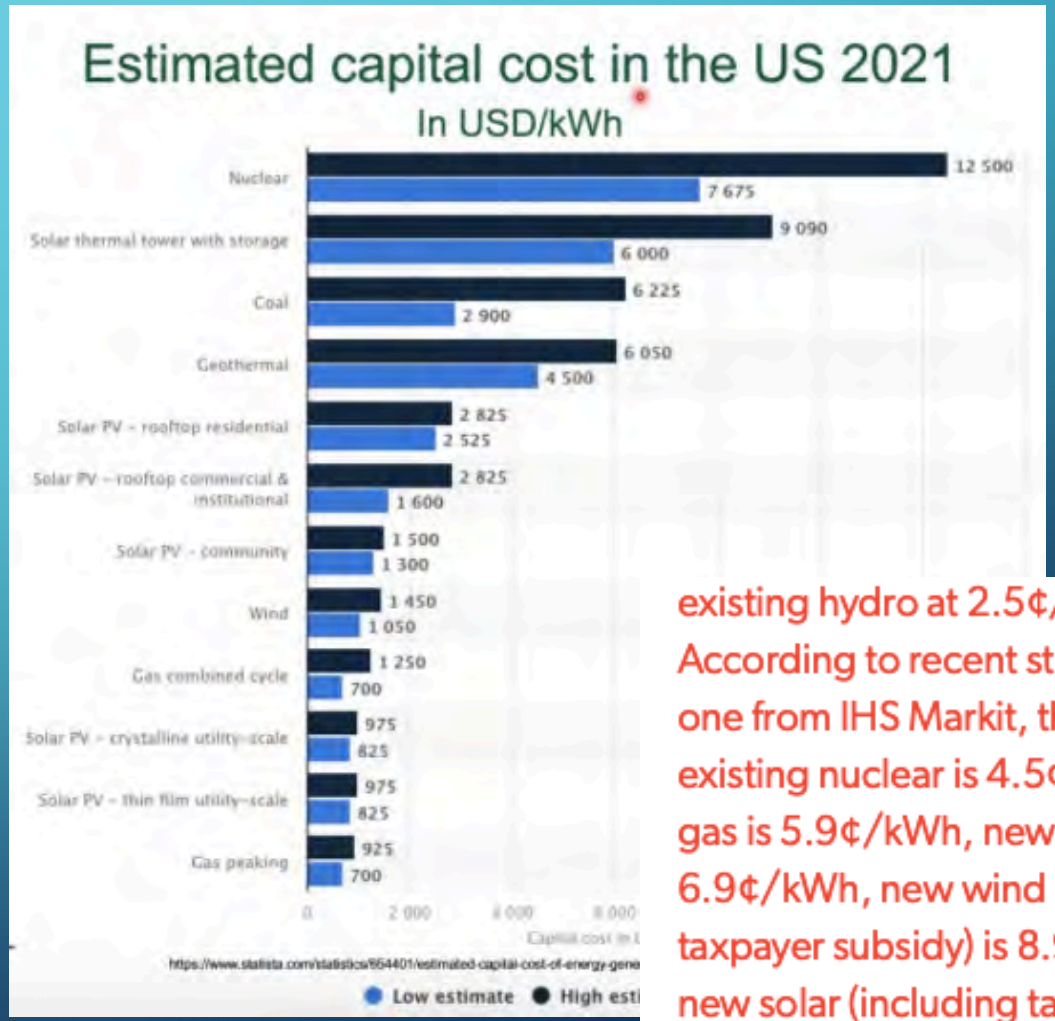


MASS OF MATERIALS NEEDED TO GENERATE A TERAWATT-HOUR



YES, FISSION PLANTS COST MORE TO BUILD… BUT WHAT ABOUT CONSTANCY & DURABILITY?

- Most planners think only about the up-front costs →
- Others include the "Levelized" or operating costs →
- But few include the capacity factor, cost of gas back-up, batteries, life span, replacement or recycling (next slide).



existing hydro at 2.5¢/kWh. According to recent studies, including one from IHS Markit, the cost for existing nuclear is 4.5¢/kWh, new gas is 5.9¢/kWh, new nuclear is 6.9¢/kWh, new wind (including taxpayer subsidy) is 8.9¢/kWh, and new solar (including taxpayer subsidy) is 9.8¢/kWh.

TO BE FAIR, COSTS SHOULD CONSIDER DURABILITY, AS WELL AS CAPACITY FACTOR→

- Data taken from Thoughtscapism.com.

Building-costs of low-carbon electricity

We can't afford to only think short-term.

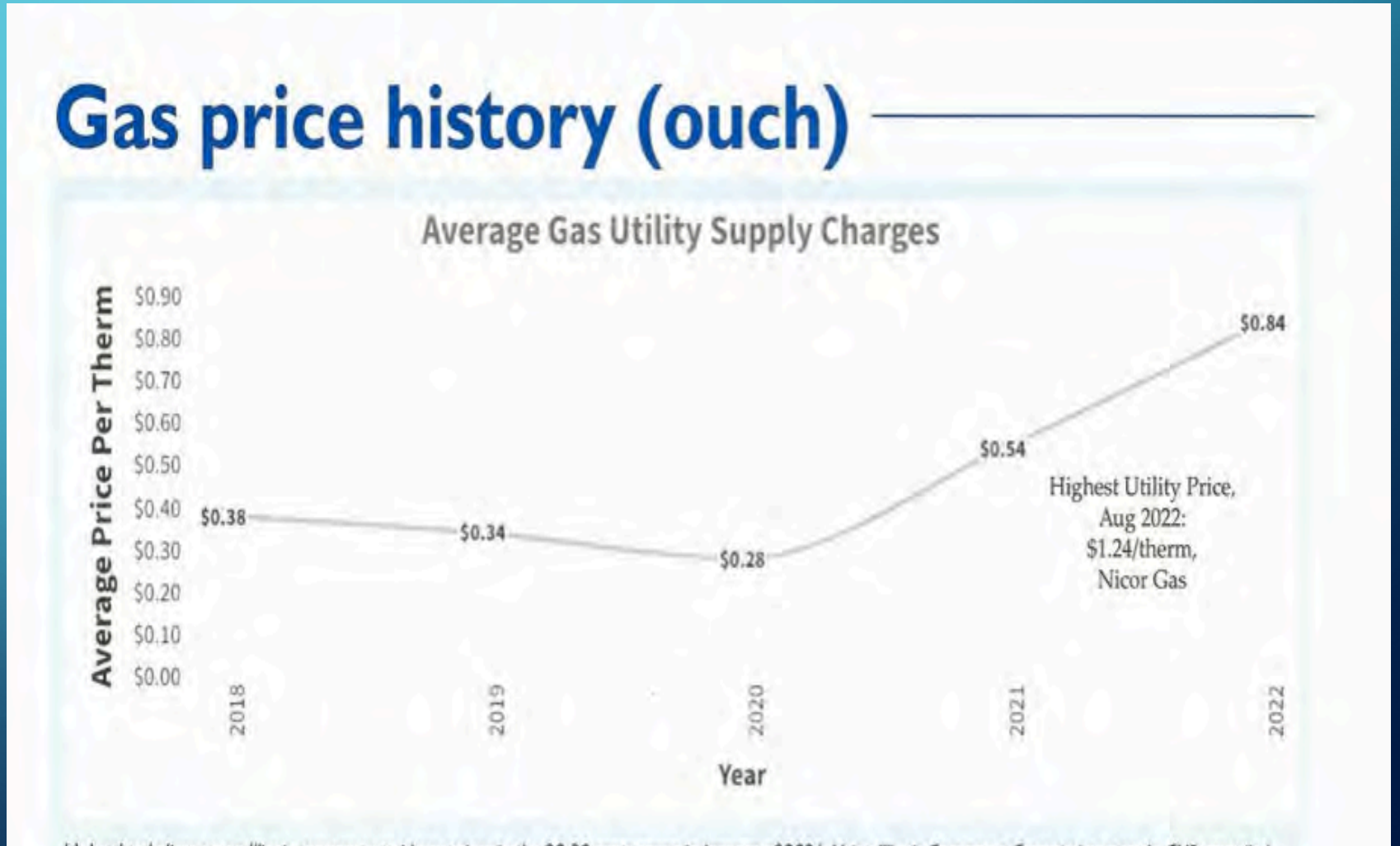
€ ⚡ 🕒	Nuclear Korea	Nuclear Finland	Wind EU Onshore	Wind EU Offshore	Solar PV Germany
Capital, billion €/GWe	1.7	5.3	1.6	3.3	1.4
Capacity factor	90%	90%	25%	40%	10%
Lifetime (years)	60	60	20	20	25
Capital, cents/kWh	**0.4**	**1.1**	**3.7**	**4.7**	**6.2**

We can't dismiss nuclear.

Best lifetime investment (**cents/kWh**) is one that will keep providing clean energy for our kids and grandkids.

4-YEAR PRICE RANGE FOR BACK-UP GAS

- Costs for fission power are stable, in contrast to the high price-volatility for gas (methane) that backs up solar intermittency.



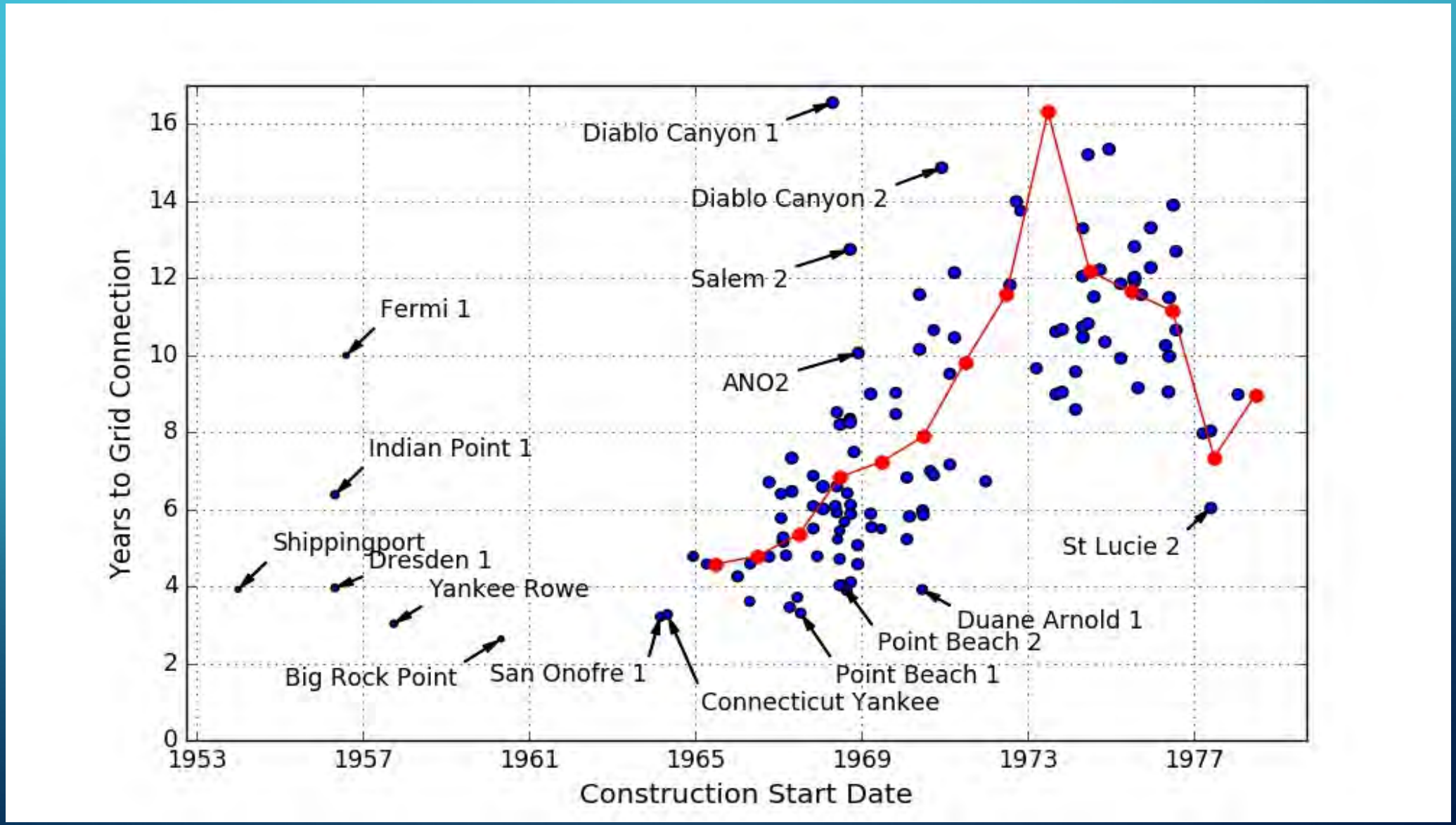
YES, NPPs DO TAKE A LONG TIME TO BUILD

THAT IS, IN RECENT NEWS …. AS SHOWN HERE…

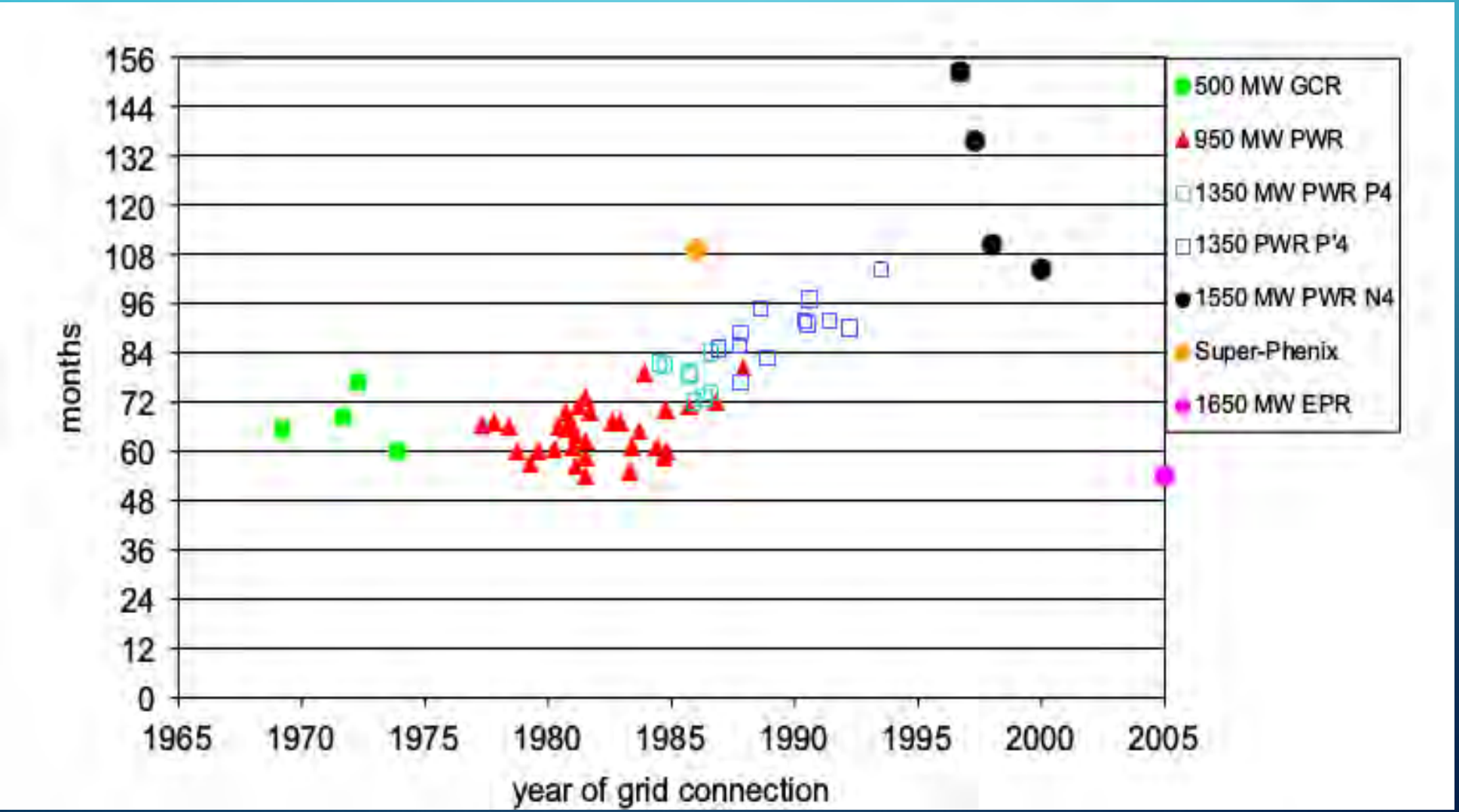
RECENT NUCLEAR PLANT COSTS & YEARS TO BUILD

	INITIAL		LATEST	
PLANT	**$/kW**	**YEARS**	**$/kW**	**YEARS**
Vogtle ¾ USA	4500	5	9000+	10+
Flamanville 3 France	2000	5	8000+	15+
Olkioluto Finland	2000	5	8000	16

BUILDING TIMES IN USA DID NOT START HIGH

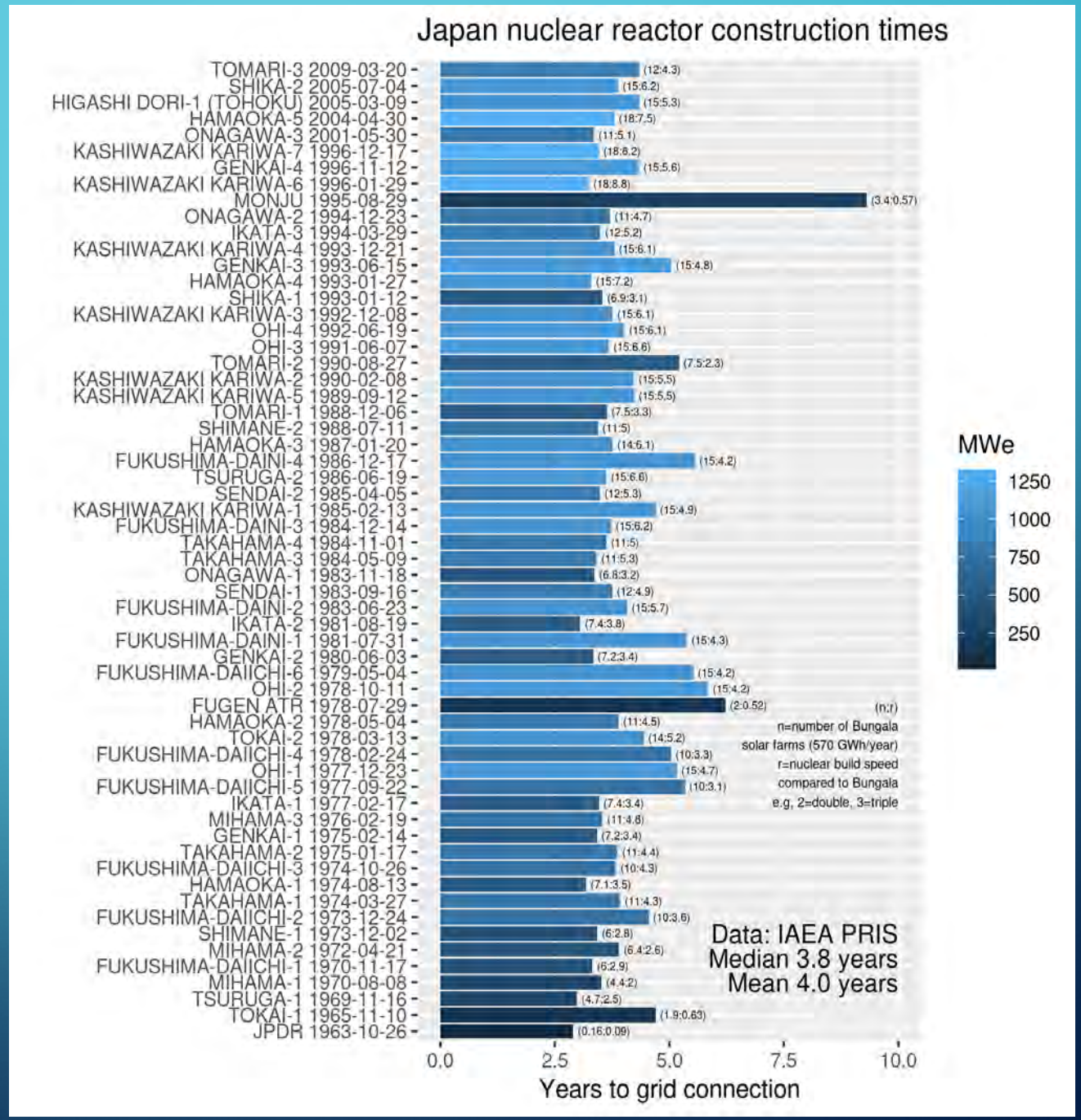


NOT SO MANY MONTHS TO BUILD IN FRANCE

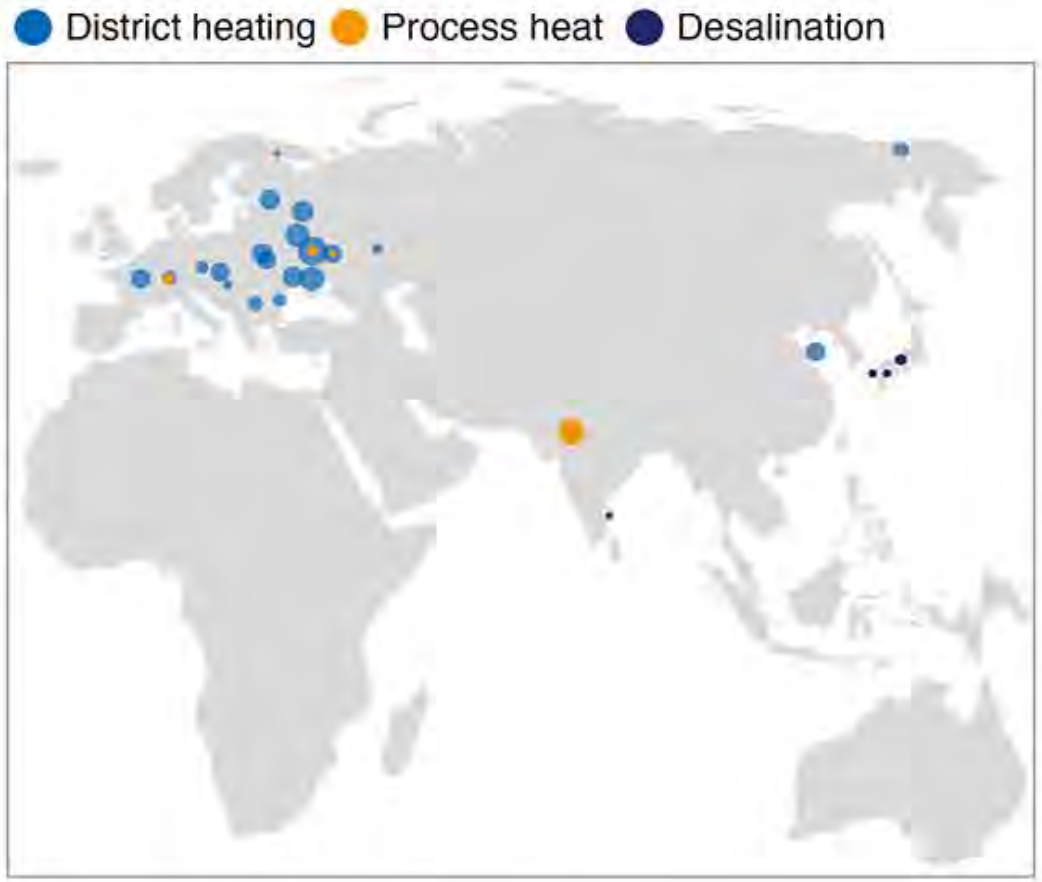


CONSTRUCTION TIMES IN JAPAN ARE CONSISTENTLY LESS THAN 5 YEARS

JAPAN PLANS TO BUILD 150 MORE PLANTS OVER THE NEXT 10 YEARS

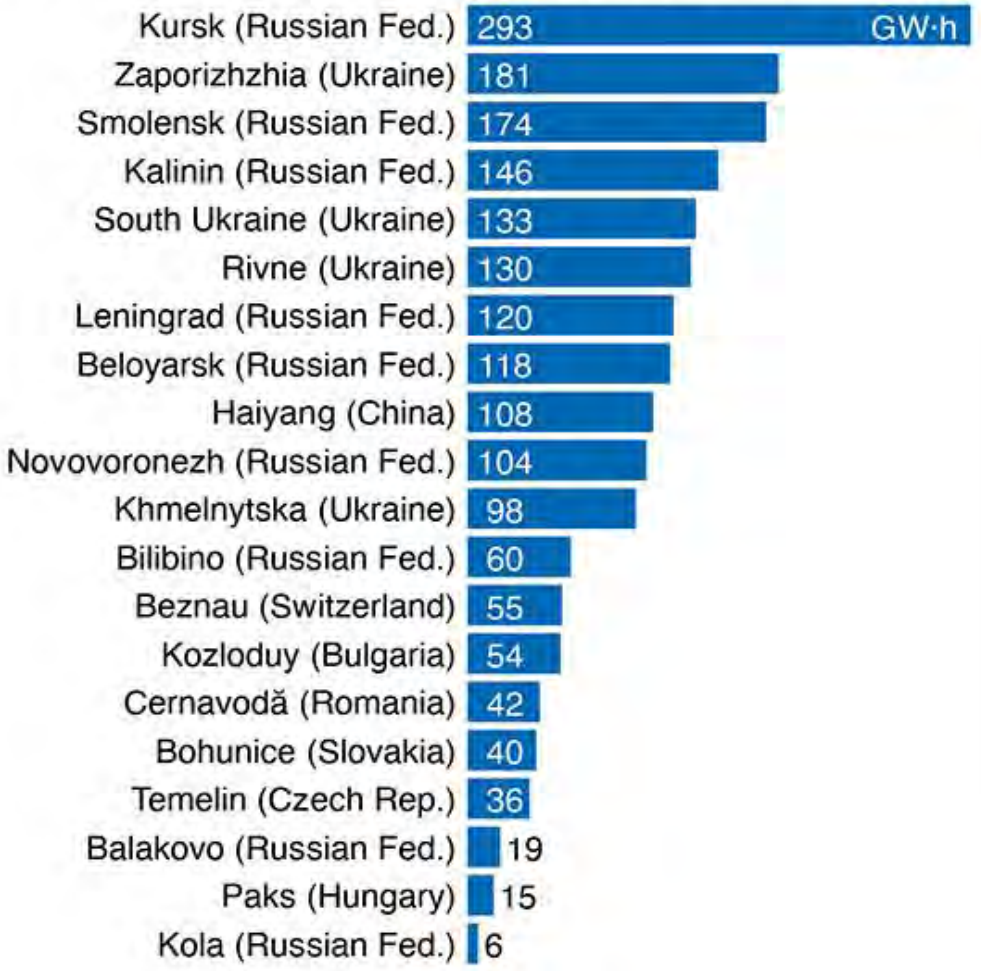


FISSION IS USED FOR MORE THAN ELECTRICITY



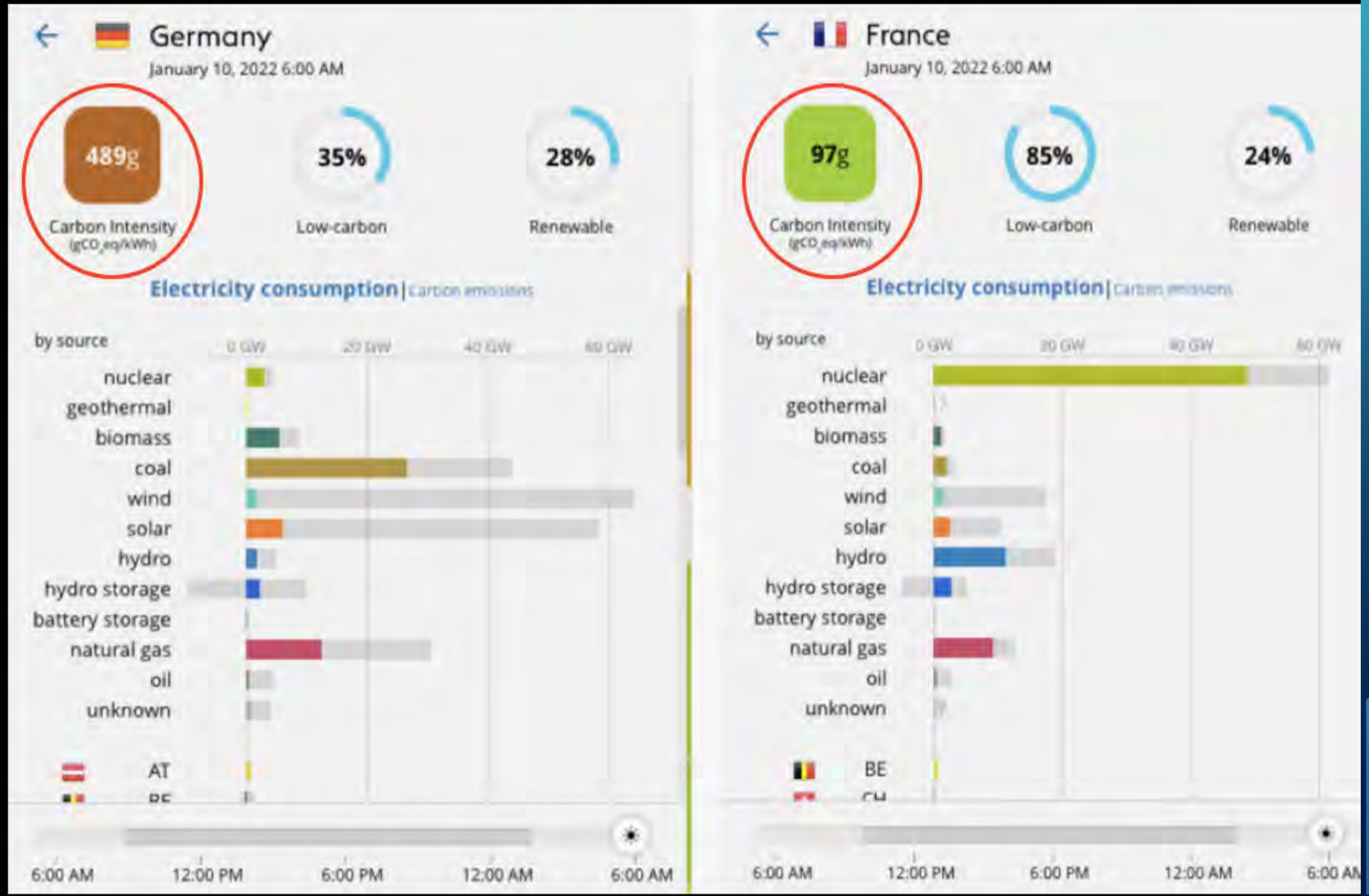
Capacity (only non-electric uses)

Nuclear power plants providing district heating:



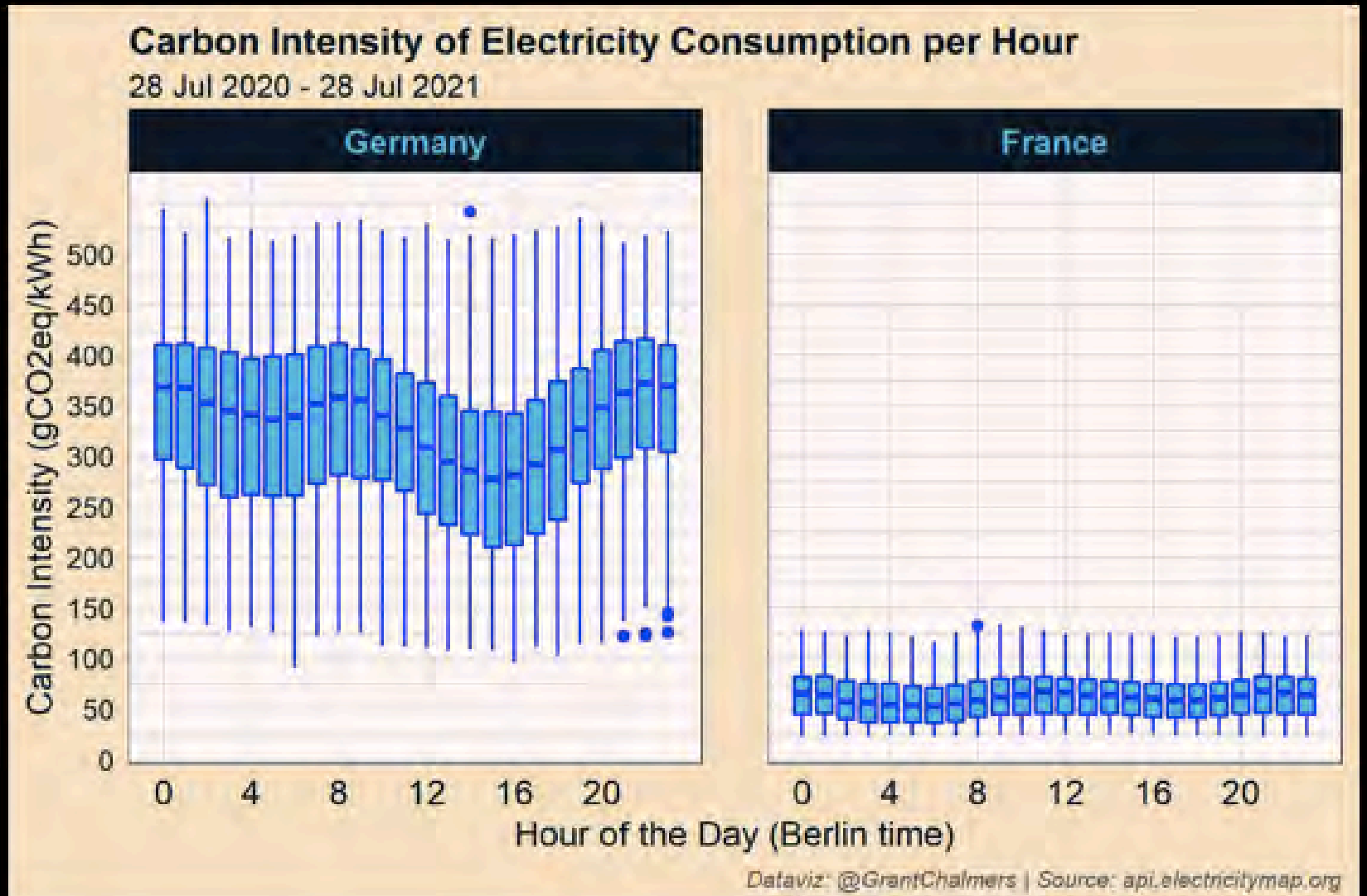
GENERATING ELECTRICITY IN GERMANY VS. FRANCE

- Compare the low-carbon → levels and the green bars → (nuclear) and brown bars → (coal) for generating electricity in Germany vs. France on Jan. 10, 2022.



CONSISTENT DIFFERENCES PERSISTED FOR A YEAR

- Germany's carbon emissions are 5 – 10 times higher than those in France.
- Germans paid 1.5X as much as the French for their electricity in 2021: 0.30 $/kWh (G) vs. 0.20 $/kWh (F).



OTHER COUNTRIES IN EUROPE ?

- **Slovakia** has embraced nuclear enthusiastically.
- To be fair, only 13/27 countries in Europe are pro-nuclear.
- 60% in Slovakia are keen, while 70% of Austrians are opposed.

The Mochovce nuclear power plant in Slovakia. PHOTOGRAPH: STEFAN SUTKA/GETTY IMAGES

DR. A. CARO'S CONCLUSIONS

Will nuclear save the green transition?

Very probably, water cooled SMR will prosper in a time scale useful to contribute to the energy transition

Generation IV SMR have great prospects, but need years to become a worldwide reality

Without funding schemes involving Governments and 'Contract for Differences', large reactors will face difficulties

Without promoting permanent repositories, many countries will probably not give the social license needed

Alfredo Caro a George Washington University Research Professor, was the Director of the Atomic Center and Balseiro Institute in Bariloche, Argentina; he worked for the European Fusion Program at the Paul Scherrer Institute in Switzerland and the DOE Fusion Program at Lawrence Livermore National labs and

JACK DEVANNEY SAYS:

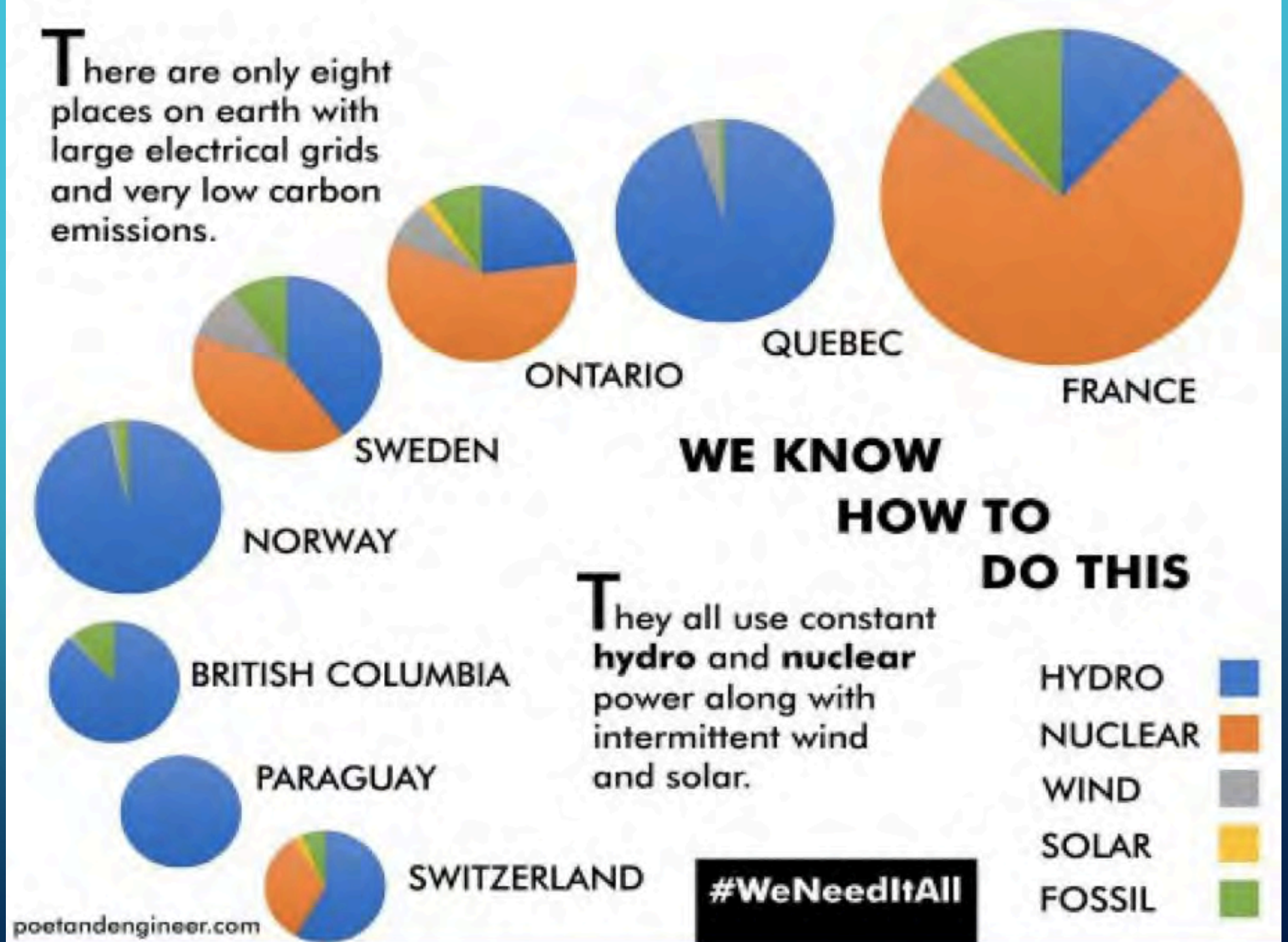
If it is true that we only have 20 or 30 years to drastically cut CO2 emissions, then, as we shall see:

1) we are not going to make it, and

2) we will impoverish and kill billions trying.

As Greta points out, all we can do is panic.

If on the other hand a gradual reduction in CO2 emissions over the next 100 years will suffice, then, if we can avoid our usual stupidities, there is a chance that we can pull it off.


There are only eight places on earth with large electrical grids and very low carbon emissions.
ONTARIO
QUEBEC
FRANCE
SWEDEN
NORWAY
BRITISH COLUMBIA
PARAGUAY
SWITZERLAND
WE KNOW HOW TO DO THIS
They all use constant hydro and nuclear power along with intermittent wind and solar.
HYDRO
NUCLEAR
WIND
SOLAR
FOSSIL
#WeNeedItAll
poetandengineer.com