OBSERVATIONS ON 21ST CENTURY NUCLEAR ENERGY

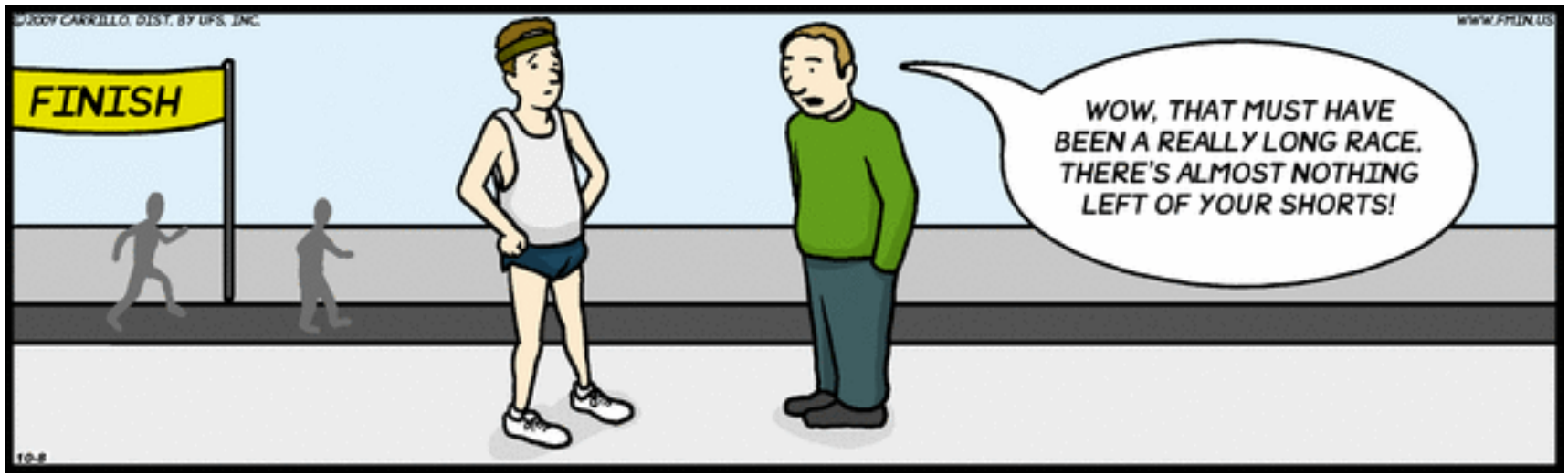
AUGUST 2017, TODD ALLEN, PROFESSOR & SENIOR FELLOW

POWERPOINT 1

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

third way
fresh thinking

NUCLEAR ENERGY IS A LONG RACE



WHAT MATTERS?

Technology

Policy

Communications

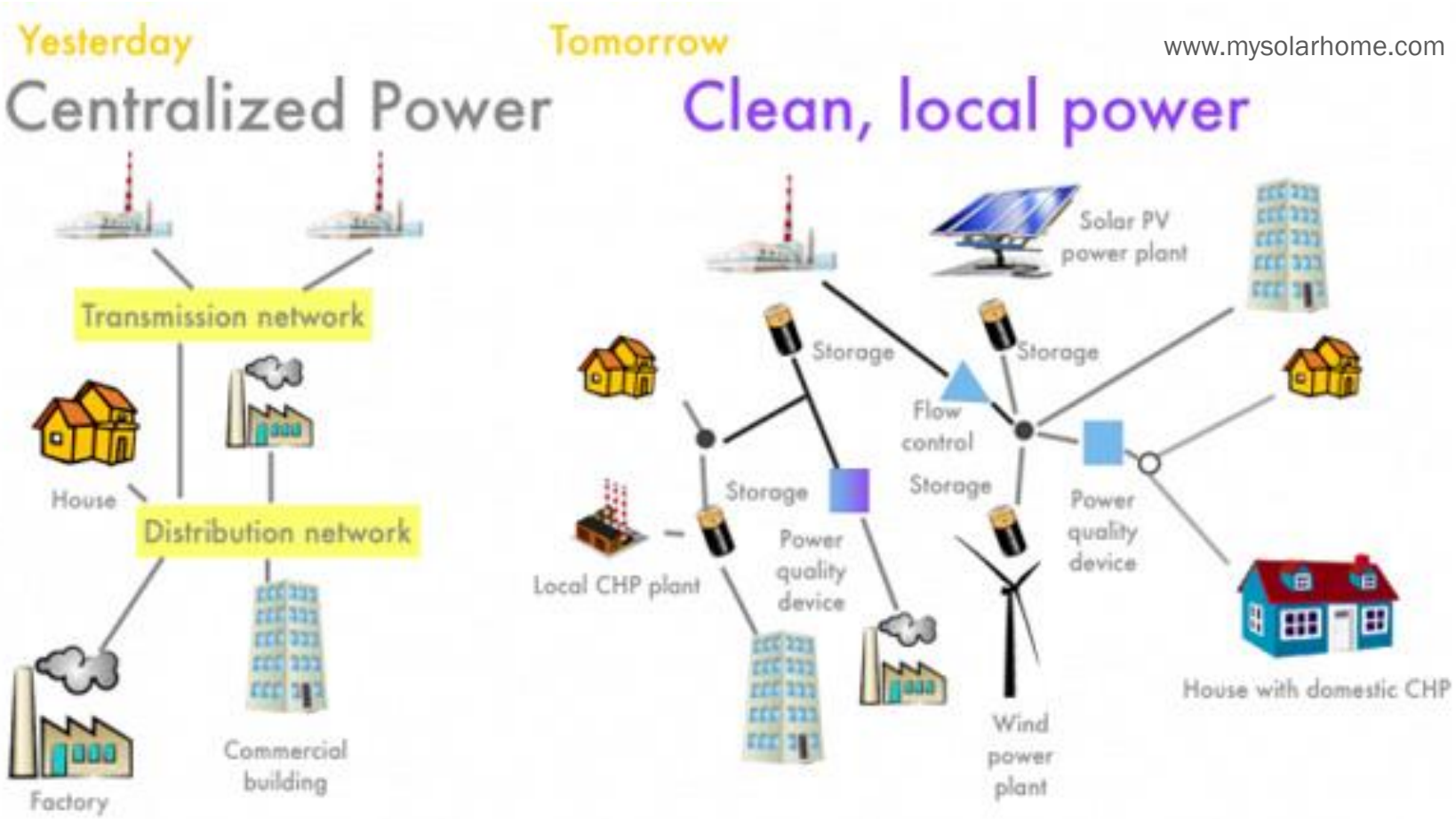
TECHNOLOGY

WHAT DO WE WANT IN OUR FUTURE?

VS.

- Water purification
- Sanitation
- Irrigation
- Heating & air conditioning
- Vaccinations
- Pharmaceuticals
- Homes

THE ENERGY SYSTEM



OPTIMIZED SYSTEMS

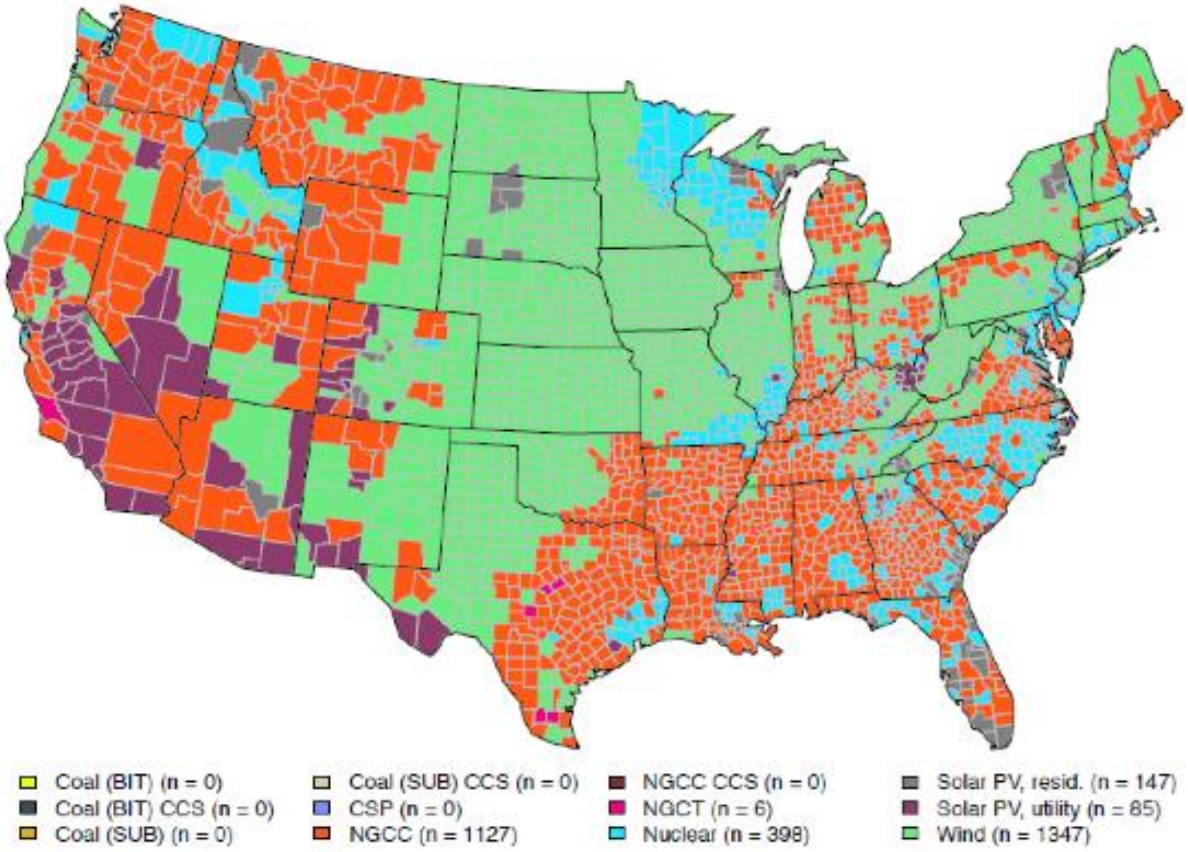
Figure 4.13. Mapping Reliability Attributes Against Resources[iii] 301

● = Exhibits Attribute
◒ = Partially Exhibits Attribute
○ = Does Not Exhibit Attribute

Resource Type	Essential Reliability Services (Frequency, Voltage, Ramp Capability)					Fuel Assurance		Flexibility			Other		
	Frequency Response (Inertia & Primary)	Voltage Control	Ramp			Not Fuel Limited (> 72 hours at Eco. Max Output)	On-site Fuel Inventory	Cycle	Short Min. Run Time (< 2 hrs.)/ Multiple Starts Per Day	Startup/ Notification Time < 30 Minutes	Black Start Capable	No Environmental Restrictions (That Would Limit Run Hours)	Equivalent Availability Factor
			Regulation	Contingency Reserve	Load Following								
Hydro	●	●	●	●	●	○	◒	●	●	●	●	◒	●
Natural Gas - Combustion Turbine	●	●	◒	●	◒	●	○	●	●	●	●	◒	◒
Oil -Steam	●	●	●	●	●	●	●	●	○	○	○	○	◒
Coal - Steam	●	●	●	●	●	●	●	◒	○	○	○	◒	◒
Natural Gas - Steam	●	●	●	●	●	●	○	●	○	○	●	◒	◒
Oil/ Diesel - Combustion Turbine	●	●	○	●	○	○	●	●	●	●	●	○	◒
Nuclear	◒	●	○	○	◒	●	●	○	○	○	○	◒	●
Battery/ Storage	◒	◒	●	●	○	○	○	●	●	●	◒	●	●
Demand Response	○	○	◒	◒	◒	◒	◒	●	●	◒	○	●	●
Solar	◒	◒	○	○	◒	○	○	●	●	●	○	●	●
Wind	◒	◒	○	○	◒	○	○	●	●	●	○	◒	●

COST OF ELECTRICITY

Map of the lowest-cost electricity generation technology in every U.S. county



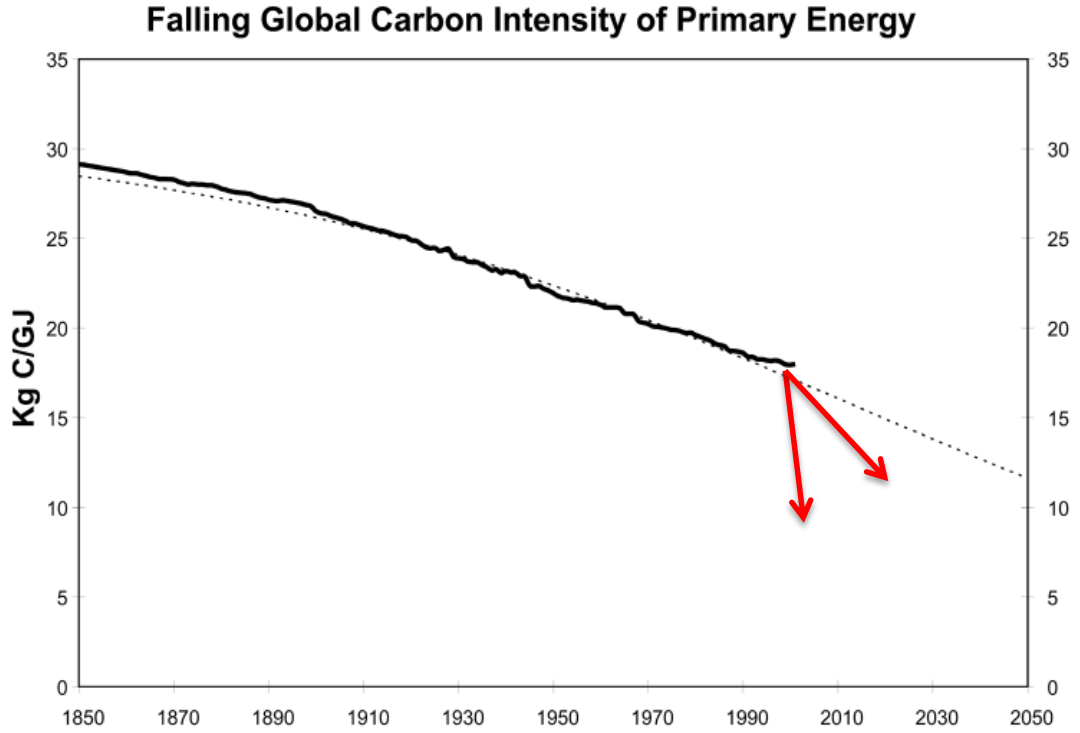
RESILIENCE

Houston, 22 December 2016 (Argus)-The North American Electric Reliability Corporation (NERC) wants to make sure utilities, power grid operators and federal and state policymakers understand the increased risk that reliance on a single fuel presents to dependable electric service. Because of limitations in how it is delivered, gas provides "just-in-time" fuel, meaning firm transportation and dual-fuel capability may be needed to reduce widespread reliability problems.

Pressure from low gas prices is also driving the premature retirement of US nuclear plants. That trend is also a concern to NERC, along with the rapid penetration of distributed energy resources, such as rooftop solar, because such resources are not under the control of grid operators.

DECARBONIZATION

Figure 1 Decarbonisation as falling global carbon intensity of total world primary energy

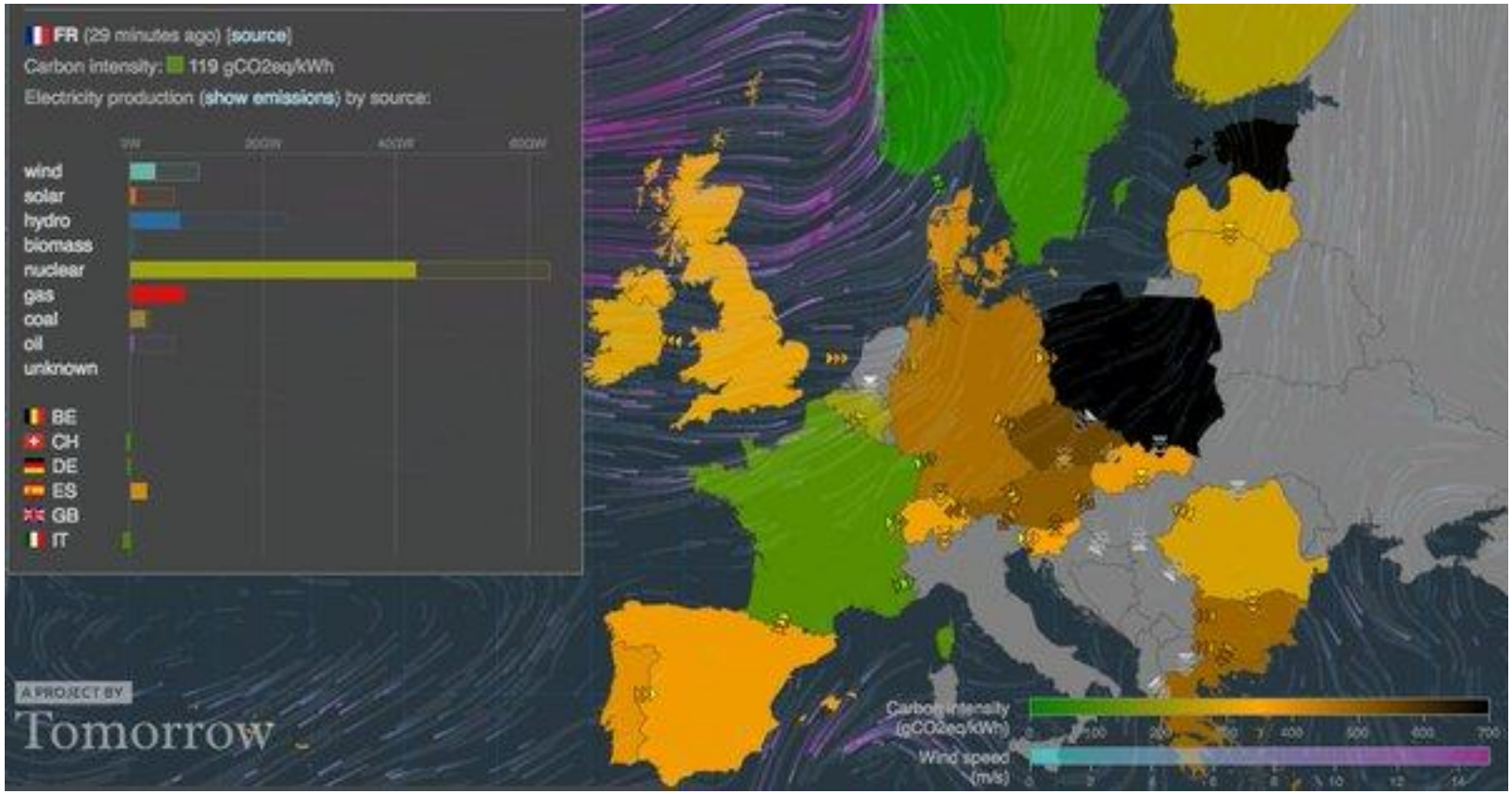


Data sources: IIASA, BP (1965–2001), CDIAC, http://cdiac.esd.ornl.gov/trends/emis/em_cont.htm

Source: N.M. Victor and J.H. Ausubel

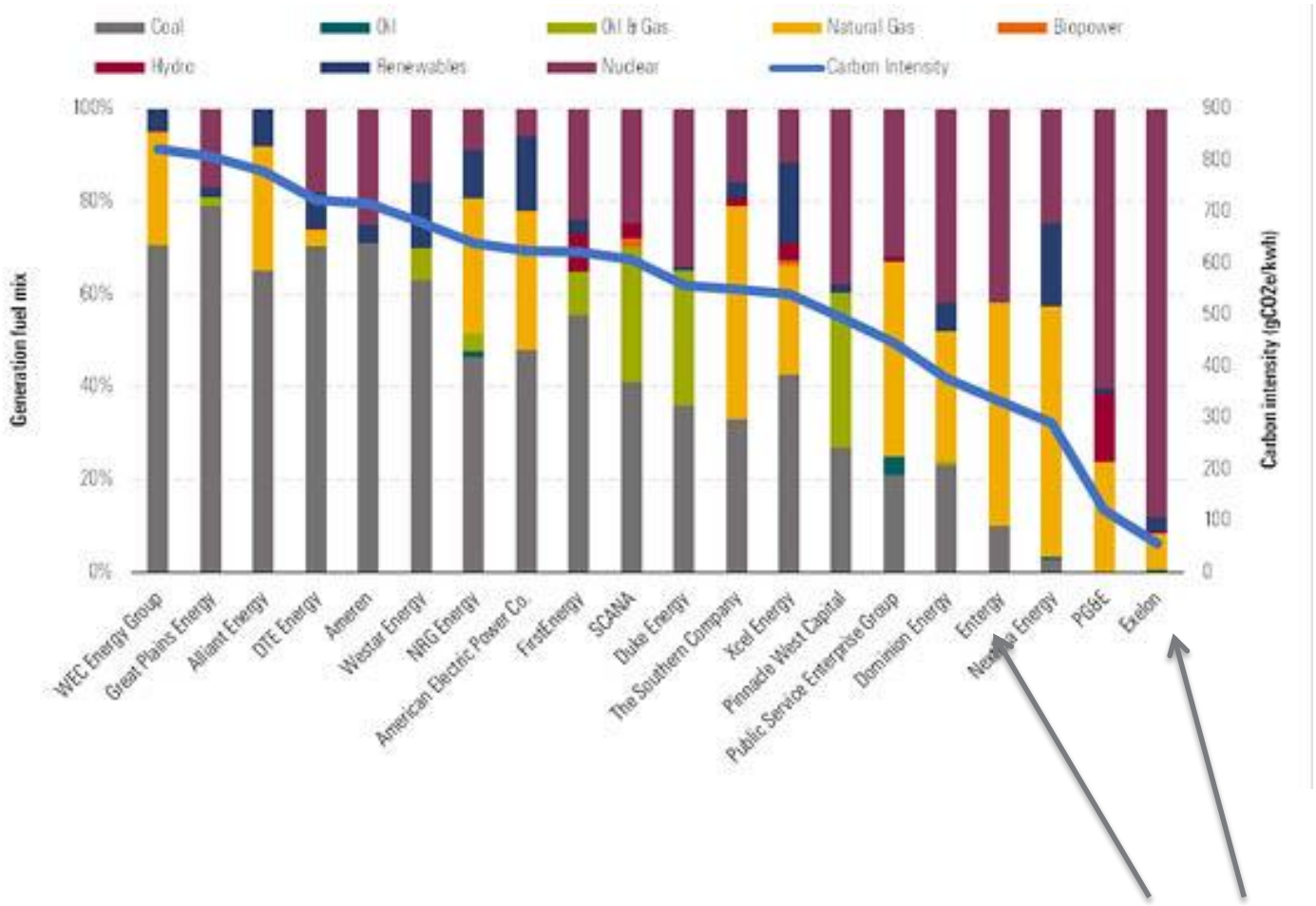
EMISSIONS

Live CO2 emissions of the European electricity consumption



http://electricitymap.tmrow.co

CARBON



Exelon & Entergy: Clean Energy Heroes

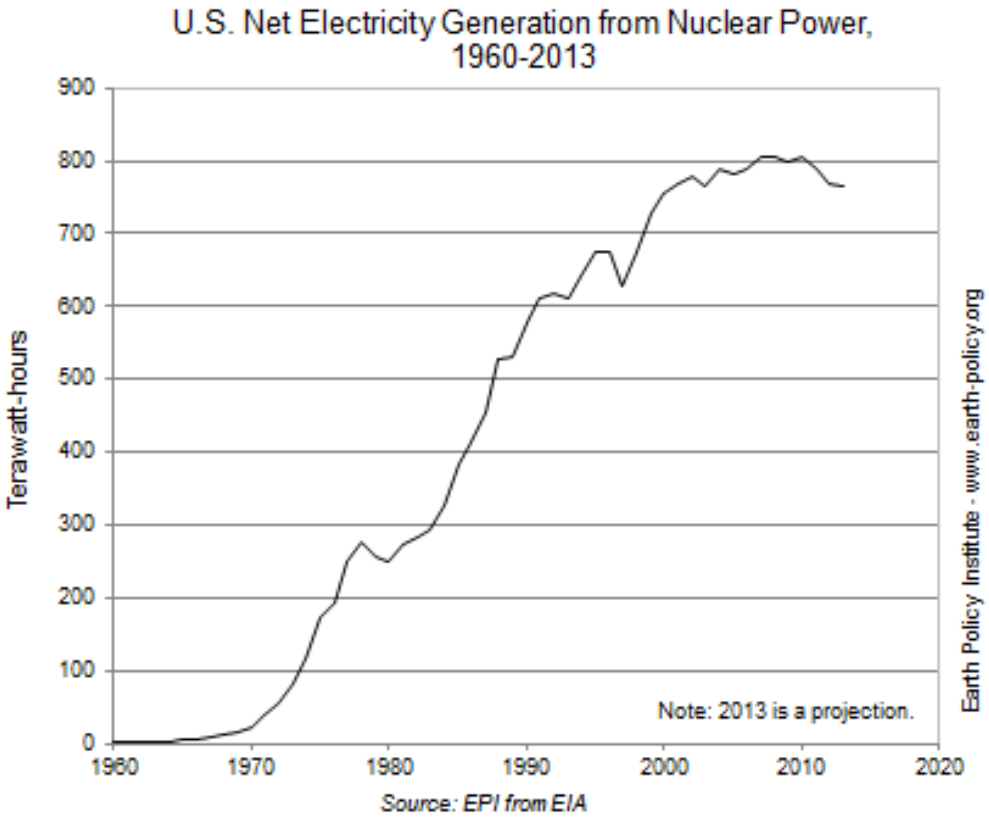
WHAT ABOUT NUCLEAR?

OPINIONS

CONFIDENT EXPERTS

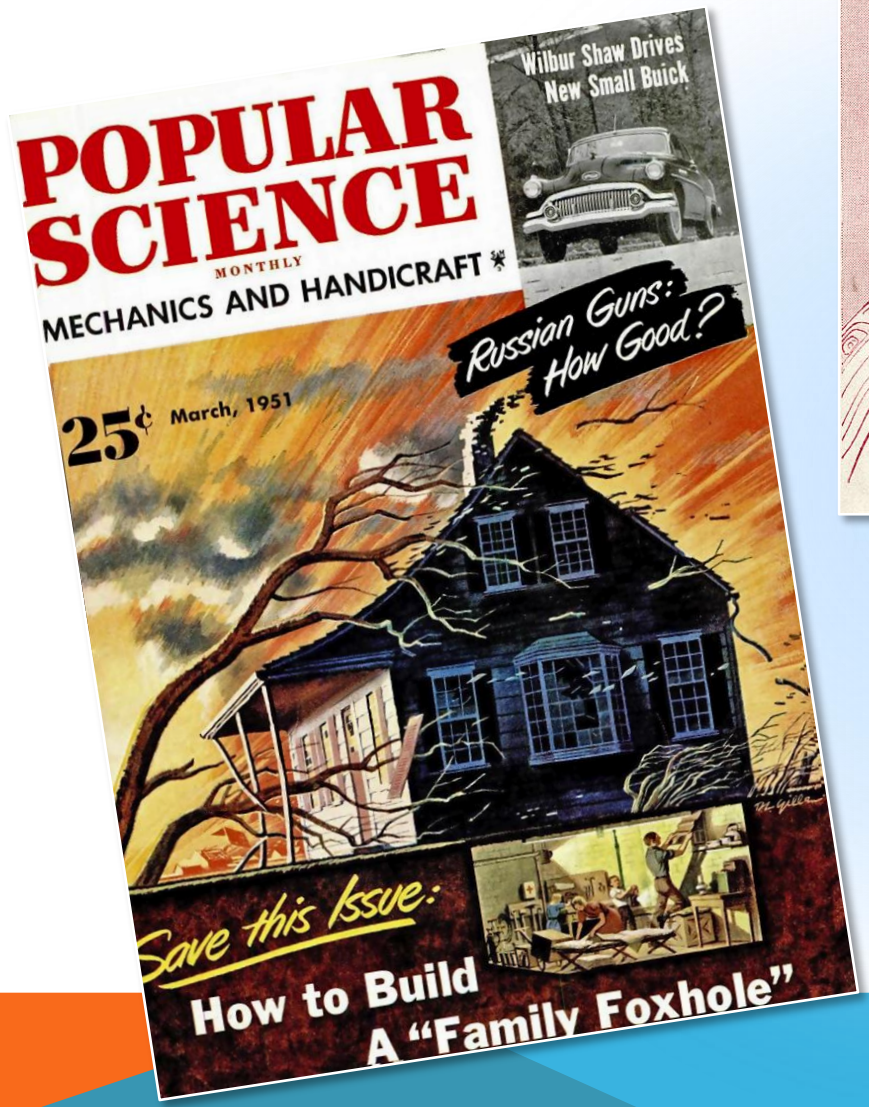
Lewis Strauss

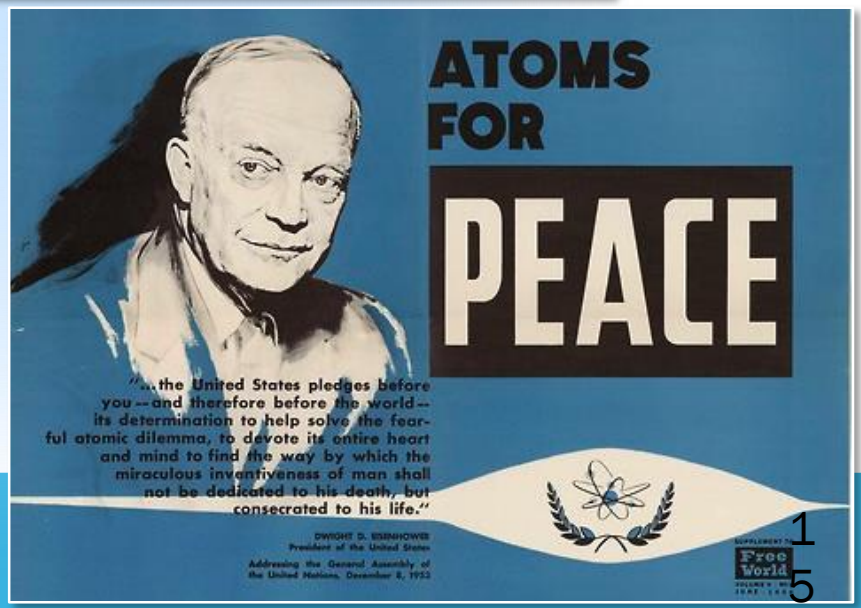
*"It is not too much to expect that our children will enjoy in their homes electrical **energy too cheap to meter**, will know of great periodic regional famines in the world only as matters of history, will travel effortlessly over the seas and under them and through the air with a minimum of danger and at great speeds, and will experience a lifespan far longer than ours as disease yields and man comes to understand what causes him to age."*



http://www.earth-policy.org/plan_b_updates/2013/update116

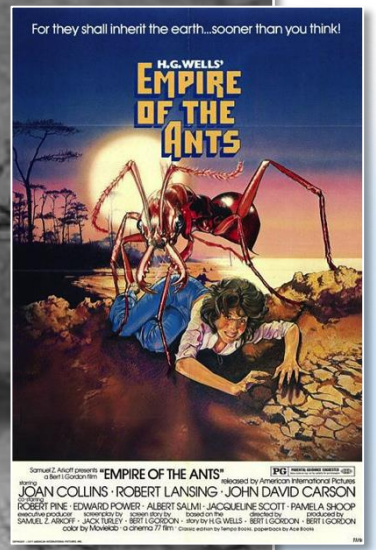
EARLY MESSAGING



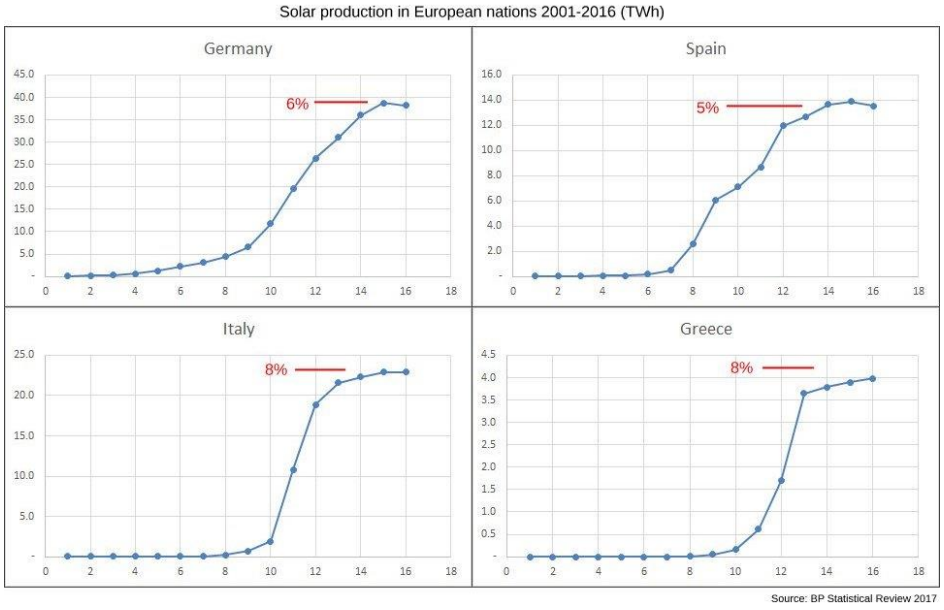


THEM: GIANT MUTANT ANTS (1950S)

A first entertainment use of radiation-induced mutant creatures



CONFIDENT EXPERTS

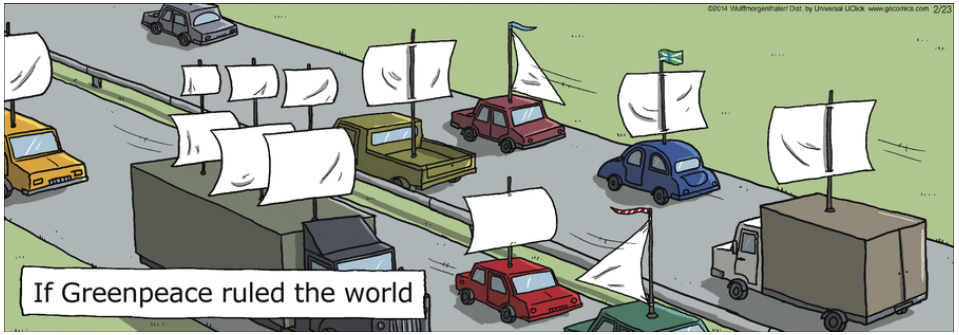


Paul Krugman

"Recently Bill Gates declared, … that we need an "energy miracle"…. But we've already had that miracle: the cost of electricity generated by wind and sun has dropped dramatically, while costs of storage, crucial to making renewables fully competitive with conventional energy, are plunging as we speak.

The result is that we're only a few years from a world in which carbon-neutral sources of energy could replace much of our consumption of fossil fuels at quite modest cost. ."

THE FEEDBACK FROM POP CULTURE



Charles Sheeler

France

Japan

Still Graceful?

View from the Back

QUOTES

John Kerry, Senator, Congressional Record of the Energy And Water Development Appropriations Act of 1995 The reality of the Advanced Liquid Metal Reactor (ALMR), the advanced liquid metal reactor, is that it is a waste and that it is a danger, that it is fiscally irresponsible, scientifically irresponsible, and irresponsible with respect to arms control and nuclear waste.

John Kerry, U.S. Secretary of State, Jan 2017 speech at MIT: "Given this challenge we face today, and given the progress of fourth generation nuclear: go for it," he said. "No other alternative, zero emissions."

Translation: ALMR is a fourth generation reactor

QUOTES

Sting, Rolling Stone December 2016, "What we know about power, I would say my position has shifted," he says. "I think if we're going to tackle global warming, I think nuclear power is the only way you can create massive amounts of power."

David Duchovny and Jigar Shah, Huffington Post, November 2016, "could we make faster progress on emissions reductions if renewable energy advocates and the nuclear energy industry work together? We believe they not only can, they must."

WHAT ABOUT NUCLEAR?

TECHNOLOGY

NUCLEAR PRODUCTS

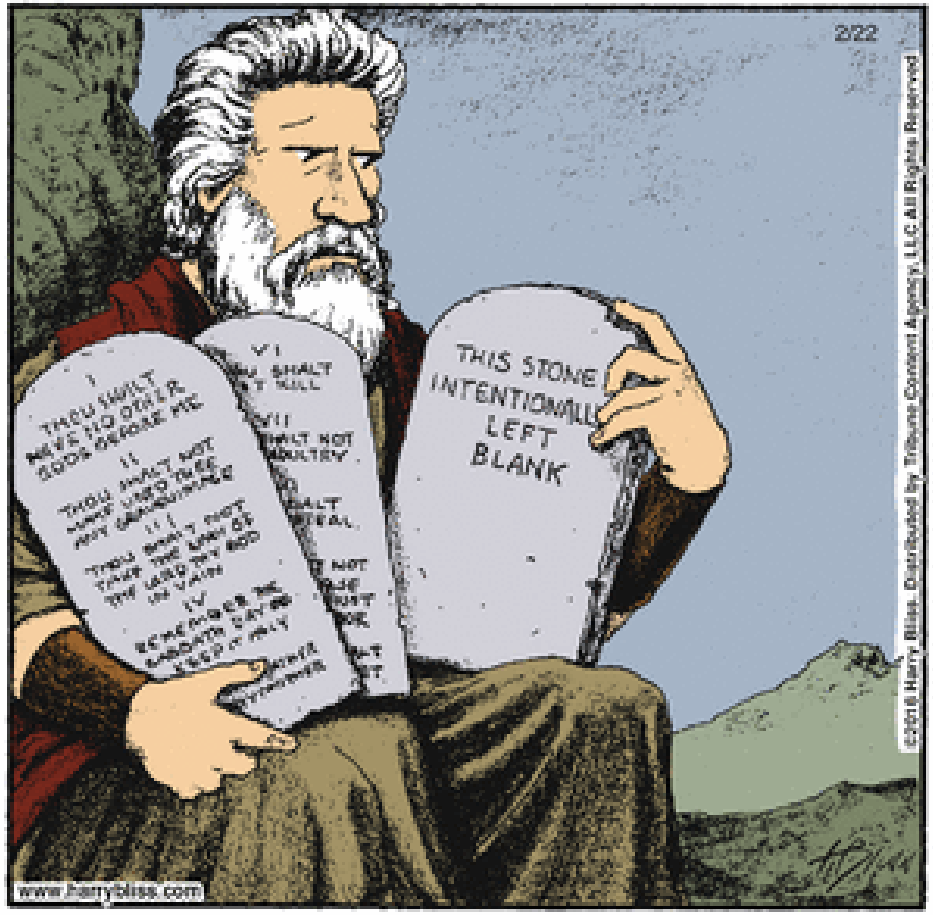
Soviet Trabant

Gigawatt-scale electricity

Detroit Auto Show

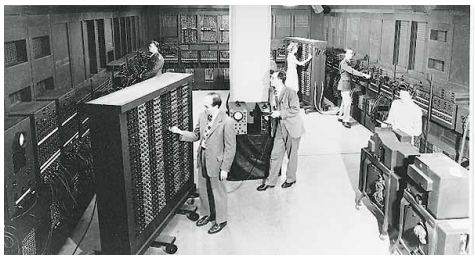
The customer won't buy your Trabant if they can buy a Camry

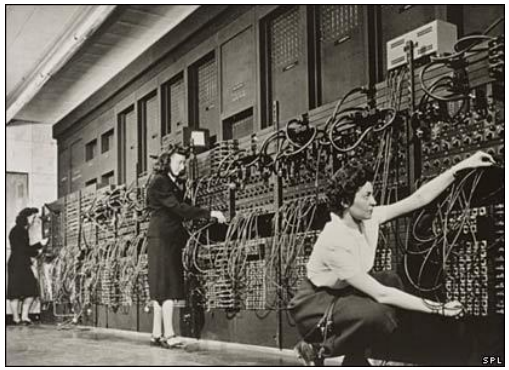
IMAGE OF NUCLEAR ENERGY CREATIVITY



PERSONAL COMPUTERS

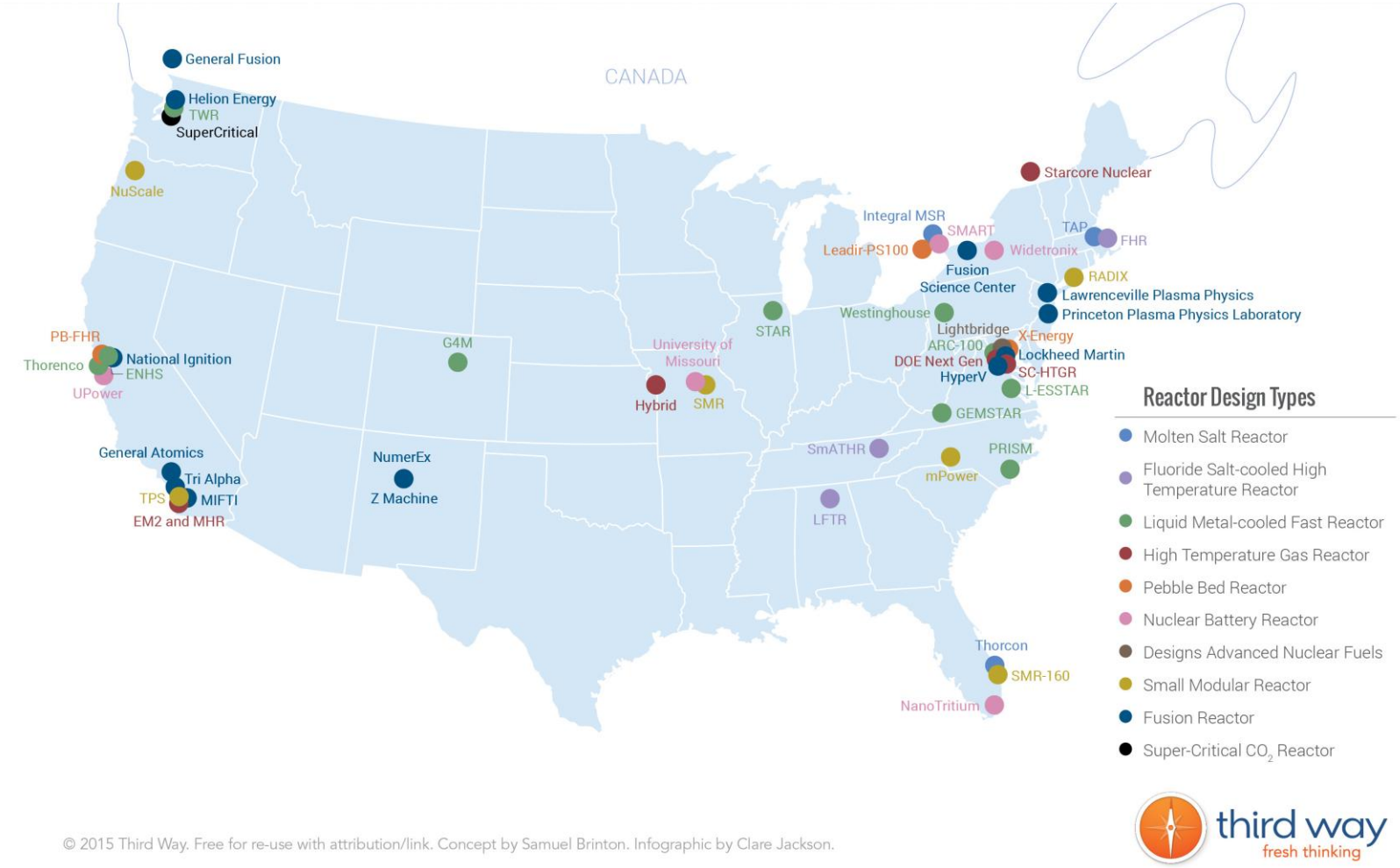
- Before the introduction of the microprocessor in the early 1970s, computers were generally large, costly systems owned by large corporations, universities, government agencies, and similar-sized institutions. End users generally did not directly interact with the machine, but instead would prepare tasks for the computer on off-line equipment, such as card punches.
- A different model of computer use was foreshadowed by the way in which early, pre-commercial, experimental computers were used, where one user had exclusive use of a processor.





From: Wikipedia

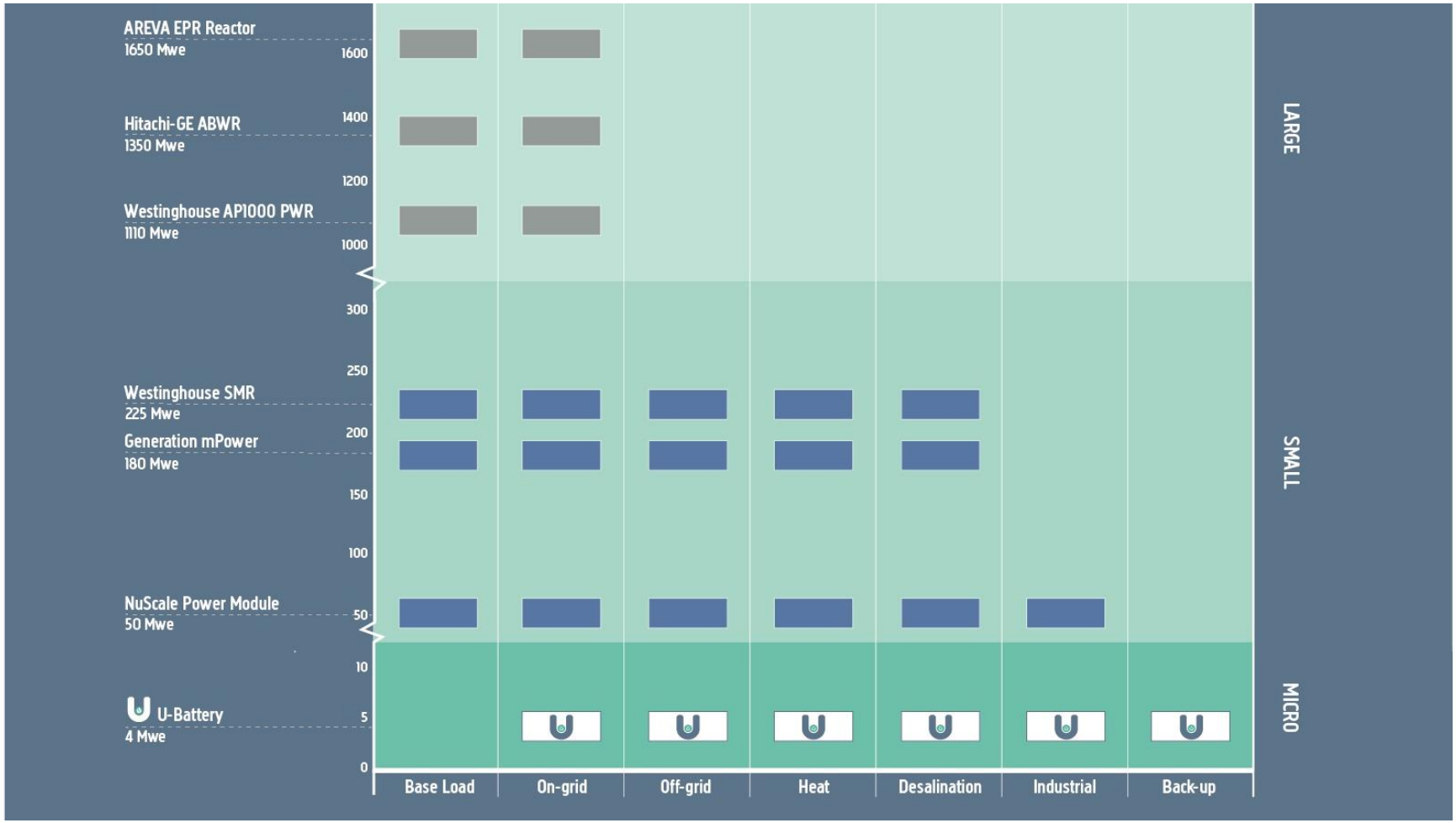
THE ADVANCED NUCLEAR INDUSTRY



third way
fresh thinking

~50 companies
~$1.5B of private capital

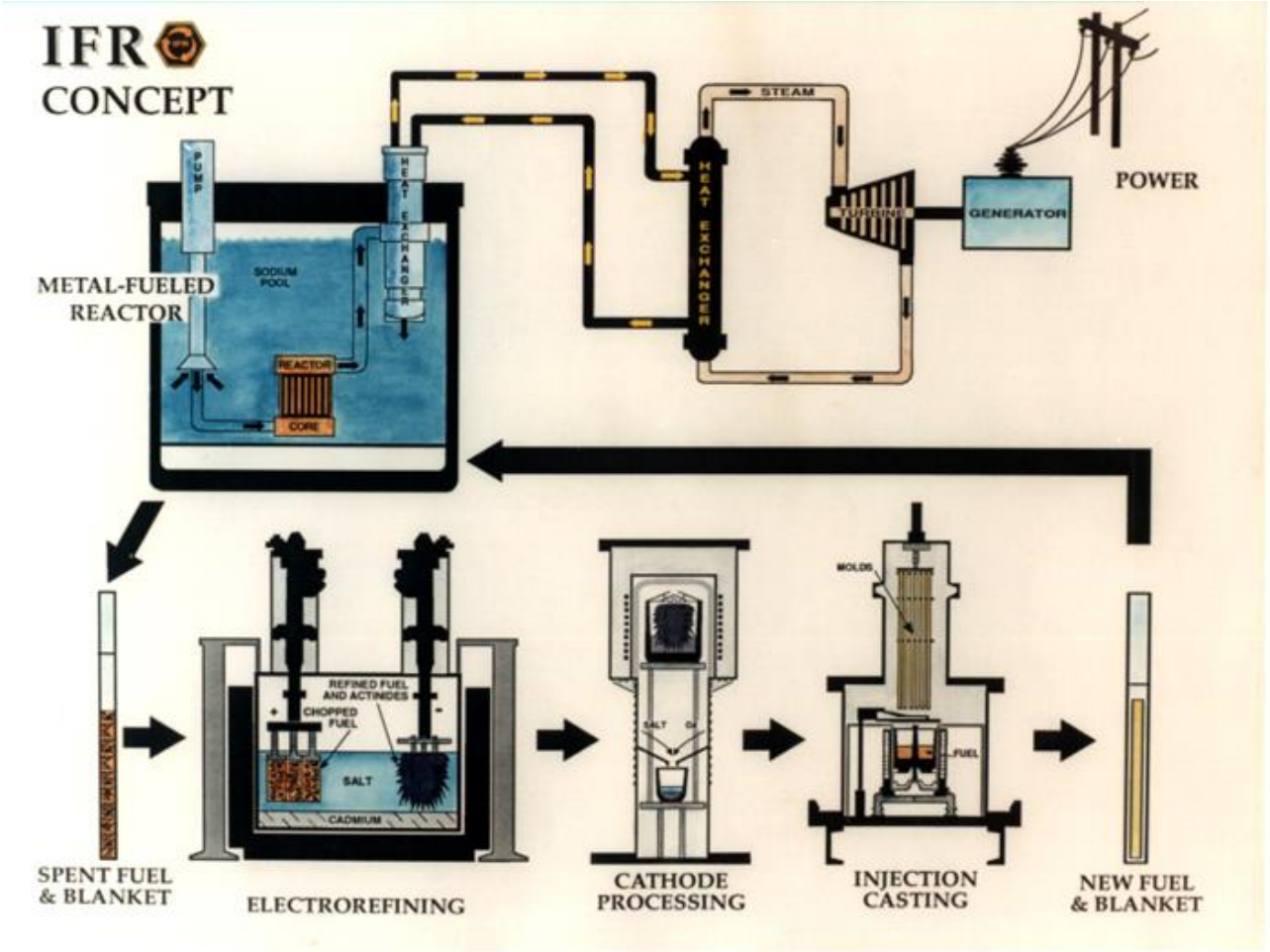
A MODERN NUCLEAR APPROACH



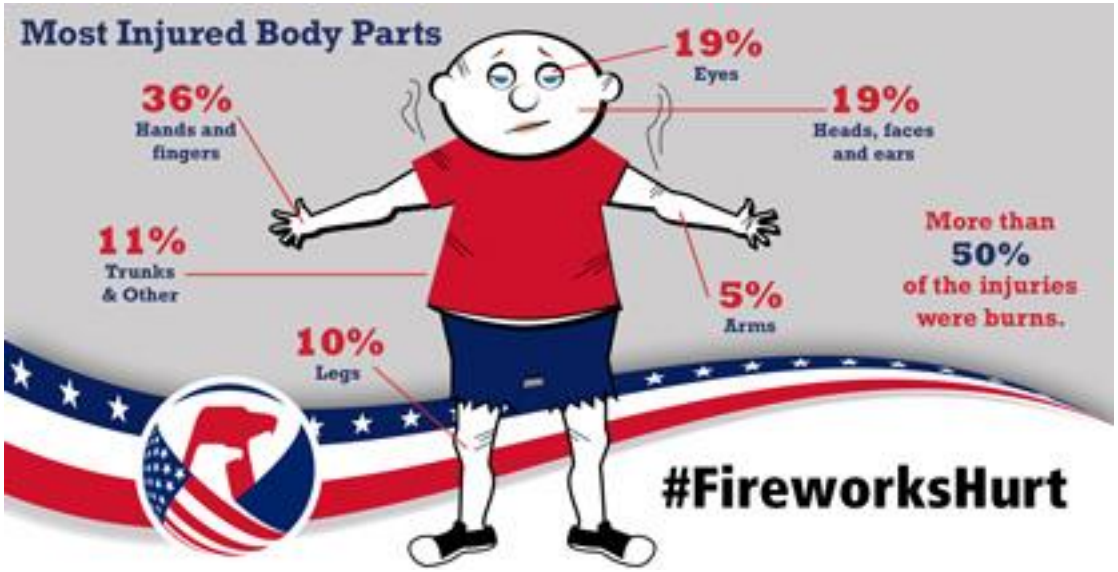
Courtesy Urenco

The Product Must Make Sense

Before its time?



The Product Must Make Sense



Consumers must want it

It can't have fatal flaws

Do 80 year designs make sense?

Greater value to community in jobs, skills, and tax base

- Partner with other industries (fueling stations, sustainable dairy, energy storage)
- Growth in technical skills (Korea example)
- National partnerships (interim storage plans in Texas and New Mexico)

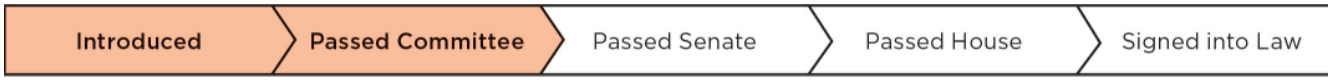
CAR VERSUS HORSE

People would not have switched to cars to eliminate horse crap if they didn’t go faster

THE POLICY ENVIRONMENT

FEDERAL LEGISLATION

S. 97, the Nuclear Energy Innovation Capabilities Act (NEICA)



H.R. 431, the Nuclear Energy Innovation Capabilities Act (NEICA)

H.R. 590, the Advanced Nuclear Technology Development Act

S. 512, the Nuclear Energy Innovation and Modernization Act (NEIMA)

H.R. 1551, To amend the Internal Revenue Code of 1986 to modify the credit for production from advanced nuclear power facilities

S. 666, To amend the Internal Revenue Code of 1986 to modify the credit for production fron advanced nuclear power facilities

INCENTIVES

Exhibit 1 – Summary of Federal Energy Incentives, 1950–2016

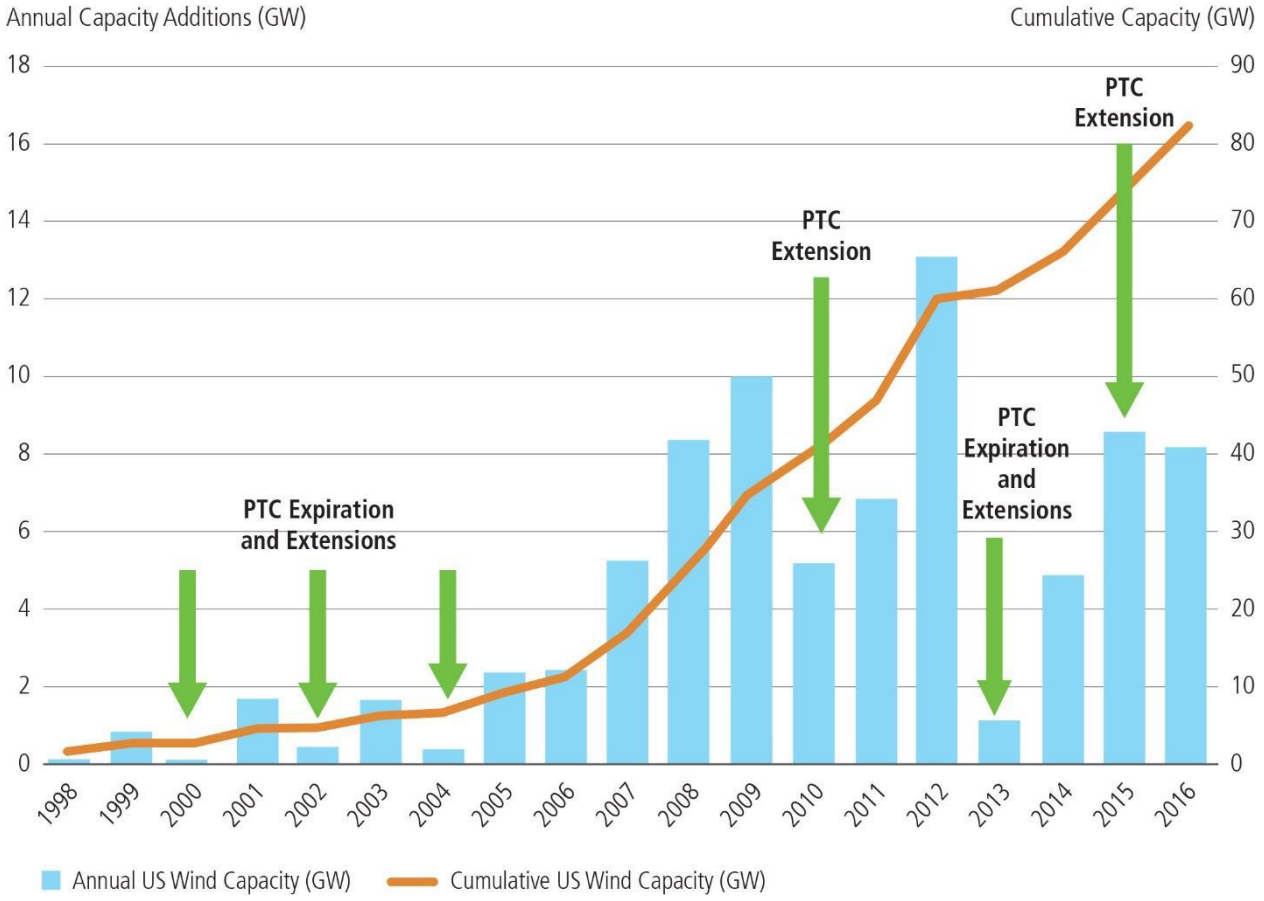
(Billions of 2015 Dollars[1])

TYPE OF INCENTIVE	ENERGY SOURCE							SUMMARY	
	Oil	Natural Gas	Coal	Hydro	Nuclear	Renewables[2]	Geothermal	Total	Share
Tax Policy	218	122	40	14	-	84	2	**479**	47%
Regulation	138	5	11	6	18	1	-	**179**	18%
R&D	9	8	43	2	85	32	6	**185**	18%
Market Activity	8	3	3	78	-	4	2	**98**	10%
Gov't Services	38	2	19	2	2	3	-	**66**	6%
Disbursements	3	-	-4	3	–27	34	1	**10**	1%
Total	**414**	**140**	**112**	**105**	**78**	**158**	**11**	**1,018**	
Share	40%	14%	11%	10%	8%	16%	1%		100%

Balanced Approach?

INCENTIVES

Figure 3.27. Relationship between the PTC and Annual Wind Capacity Additions



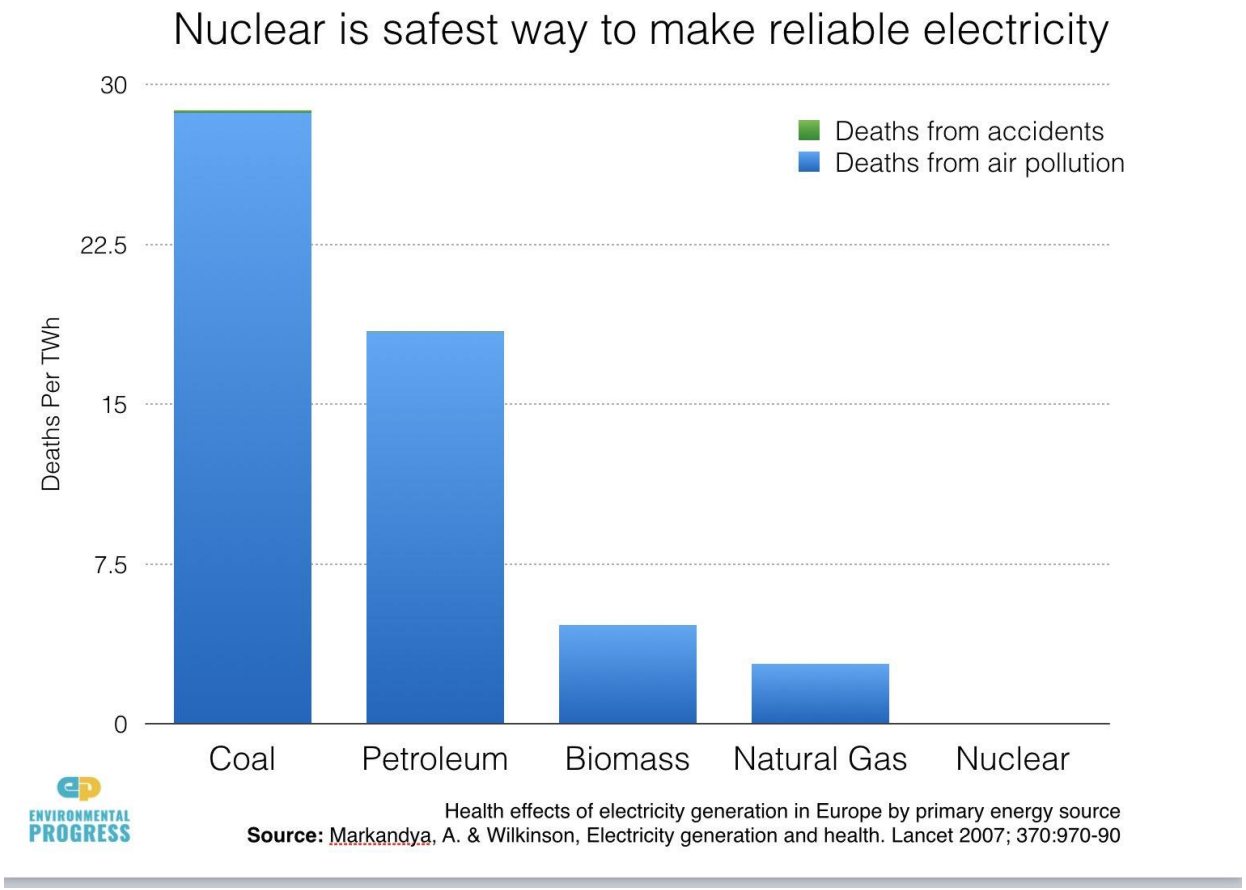
COMMUNICATIONS

QUOTES FROM ADVANCED ENERGY APRIL 2016

- **Focus on NY Reforming the Energy Vision. :**
  - REV and the announced $150M Green Bank must:
    - Transform while protecting jobs to support people (e.g., fossil jobs become solar jobs)
    - Incredible ideas coming out of the university community
    - Need wave after wave of demo projects
    - Community led projects
    - All New Yorkers must participate. This must support low and moderate income families
    - Resilience is a foundation
    - Start with the customer
    - Think Big. Start Small. Scale Fast.

Thinkstock

WHY NUCLEAR ENGINEERS LIKE NUCLEAR



"We kill less people than you think"

PROPOSING MARRIAGE

Would you try the Following? Please be my spouse because compared to your last offer, I am:

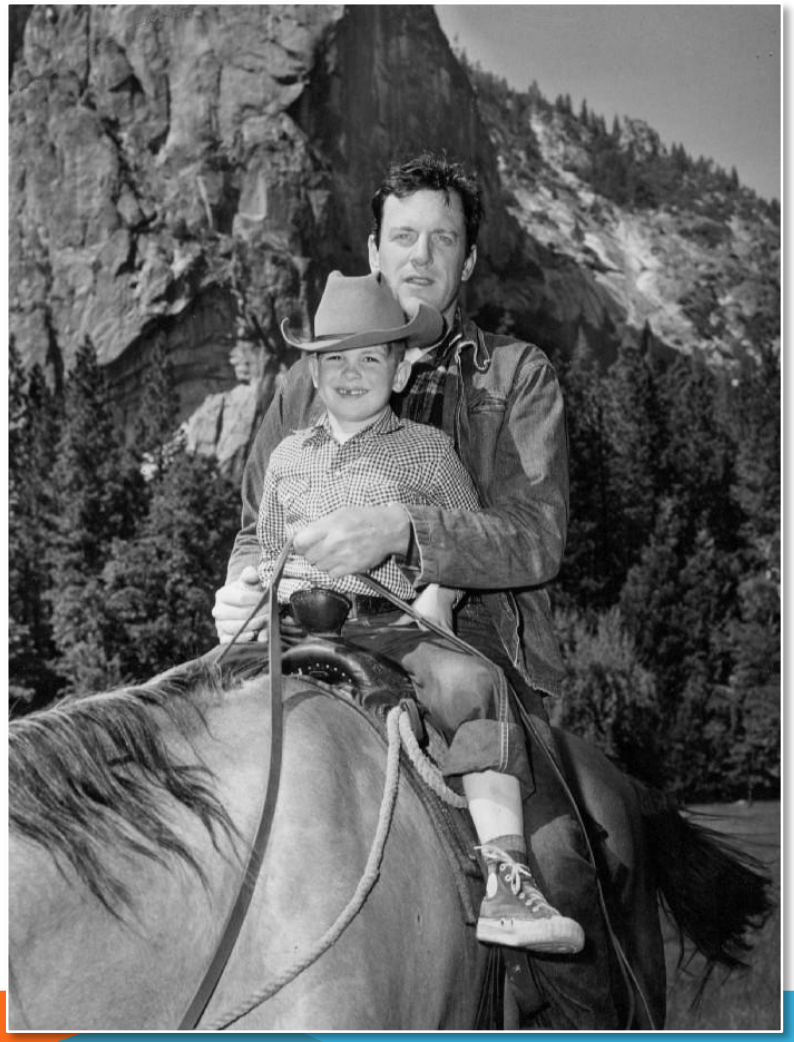
- Not as Dumb
- Not as Cheap
- Not as Ugly
- Not as Smelly

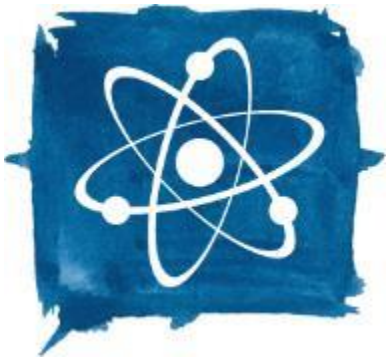
If no, then why talk about your new nuclear technology as:

- Not as Dangerous
- Not as Expensive
- Not such a Big Waste Problem
- Not as Big a Proliferation Risk

THE MERCIFUL END

BACK TO JAMES ARNESS





ADVANCED NUCLEAR CAMPAIGN

Todd Allen

Senior Fellow, Third Way

tallen@thirdway.org

Community Resolution

Goal for nuclear innovation companies is to get community support

IN THE COMMISSIONERS COURT
OF
ANDREWS COUNTY, TEXAS

A resolution in support of establishing a site in Andrews County for consolidated interim storage of spent nuclear fuel and high-level radioactive waste.

WHEREAS, Andrews County, Texas, as host to two low-level radioactive waste disposal facilities operated by Waste Control Specialists LLC ("WCS"), greatly benefits directly and indirectly from the economic activity associated with disposal of radioactive materials; and

NOW, THEREFORE, BE IT RESOLVED AND ORDERED that the Commissioners Court of Andrews County, Texas, meeting in open session, believes that the construction and operation of a consolidated SNF and HLW interim storage facility in Andrews County (the "Facility"), licensed by the Nuclear Regulatory Commission and developed by WCS, will enhance the health, safety, and welfare of the citizens of Andrews County; and

WHAT DO WE WANT IN OUR FUTURE?

Louise Jopling, English

"Hey Sis, Remind Me Again How We Can Live on a Multi-Million Dollar English Country Estate and Not Have a Fing Dishwasher,"*** 1896

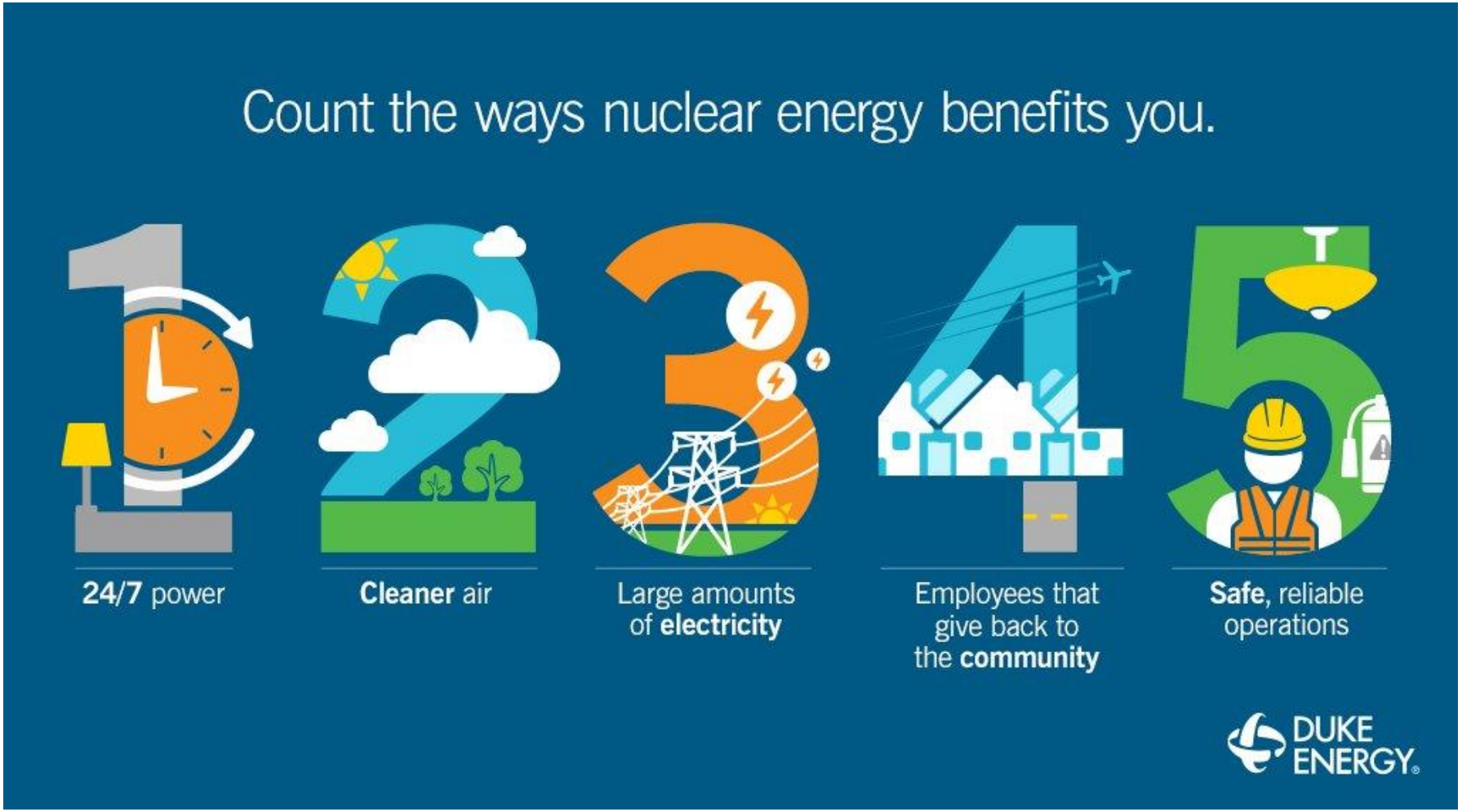
Oil on canvas

on

ls

- Homes

BETTER


Count the ways nuclear energy benefits you.
1
24/7 power
2
Cleaner air
3
Large amounts of electricity
4
Employees that give back to the community
5
Safe, reliable operations
DUKE ENERGY.

“MARKETS”-RENT SEEKING OPPORTUNITIES GALORE AND WHO ARE YOUR CUSTOMERS

Electricity Supply

Capacity

Ancillary Services

Minimum Offer Price Rules

Energy Imbalance Markets

Demand Response

Process Heat

Federal Tax Credits

State Renewable or Clean Energy Mandates or other Dictates (and associated negative pricing)

Carbon price

Power Purchase Agreements

Suggesting Reading:

https://americanaffairsjournal.org/2017/05/no-free-market-electricity-can-ever/

THE CLOSING QUOTE

Why Nuclear in Africa? Why Not!

Joseph Odhiambo, Kenya Nuclear electricity board

GATEWAY FOR ACCELERATED INNOVATION IN NUCLEAR (GAIN)

NuScale Power

NuScale/WIN/ UAMPS desire to build first reactors at INL

DOE Programs

NRC

Transatomic Power

Transatomic etc. want to retire risk and move up in TRL

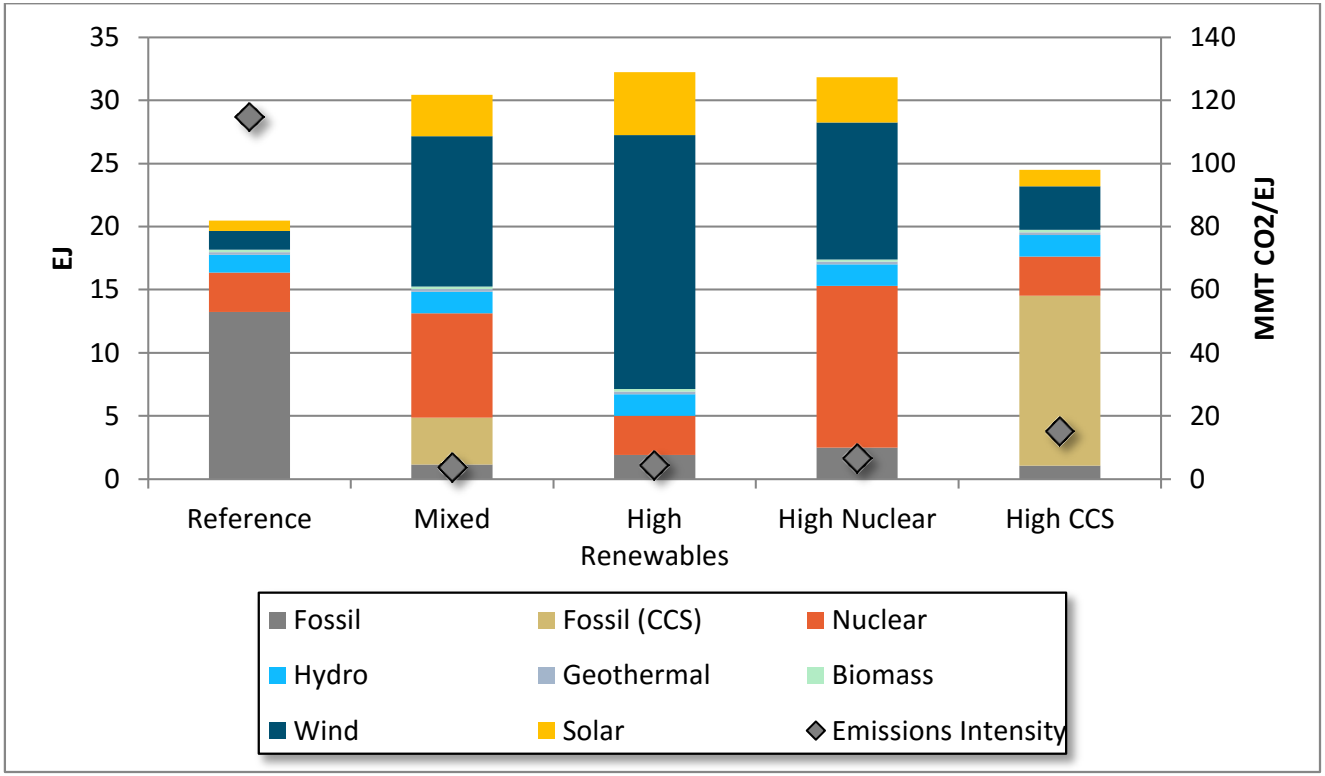
DOE Programs

NRC

OPTIMIZED SYSTEMS

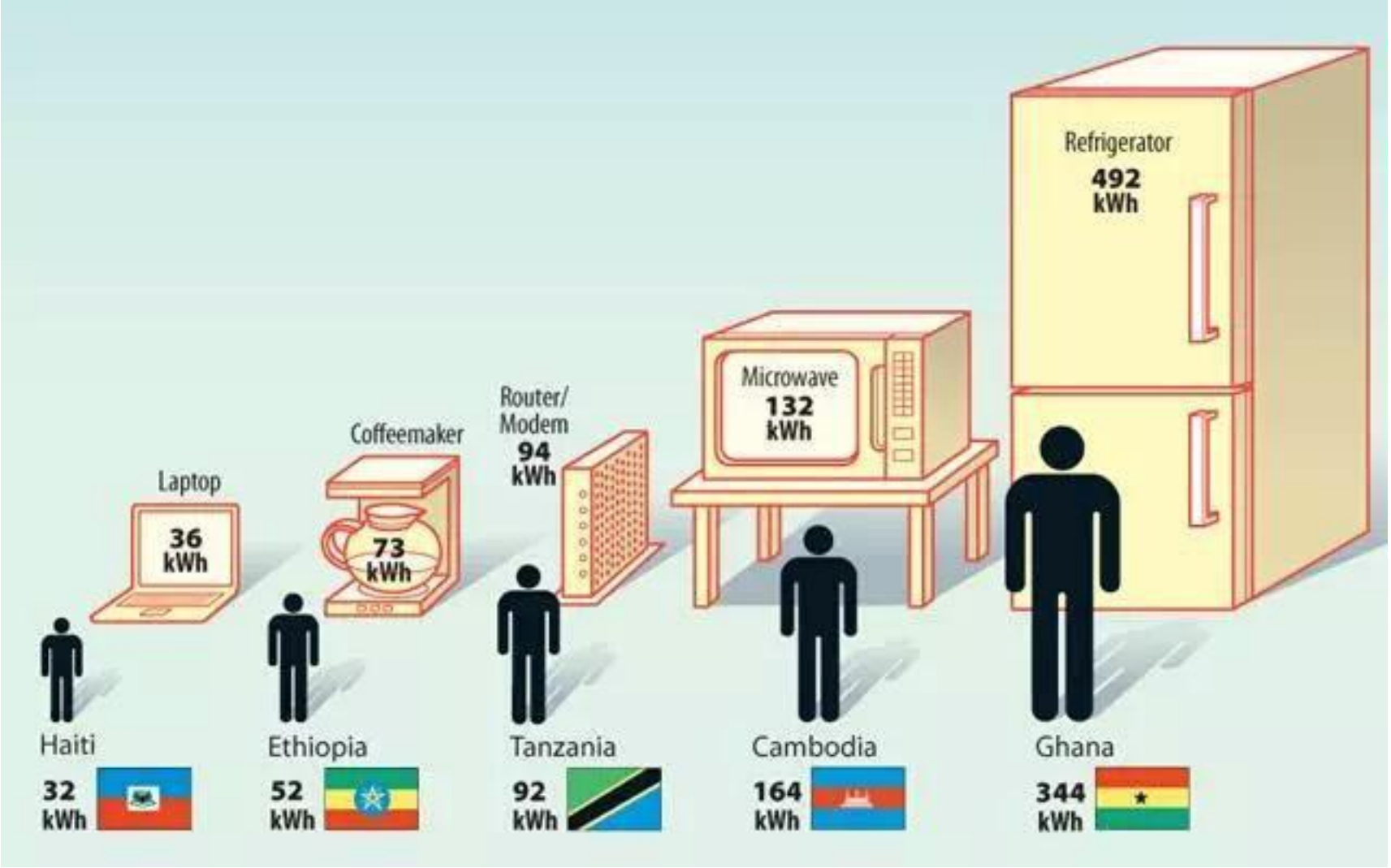
U.S. Deep Decarbonization Pathways

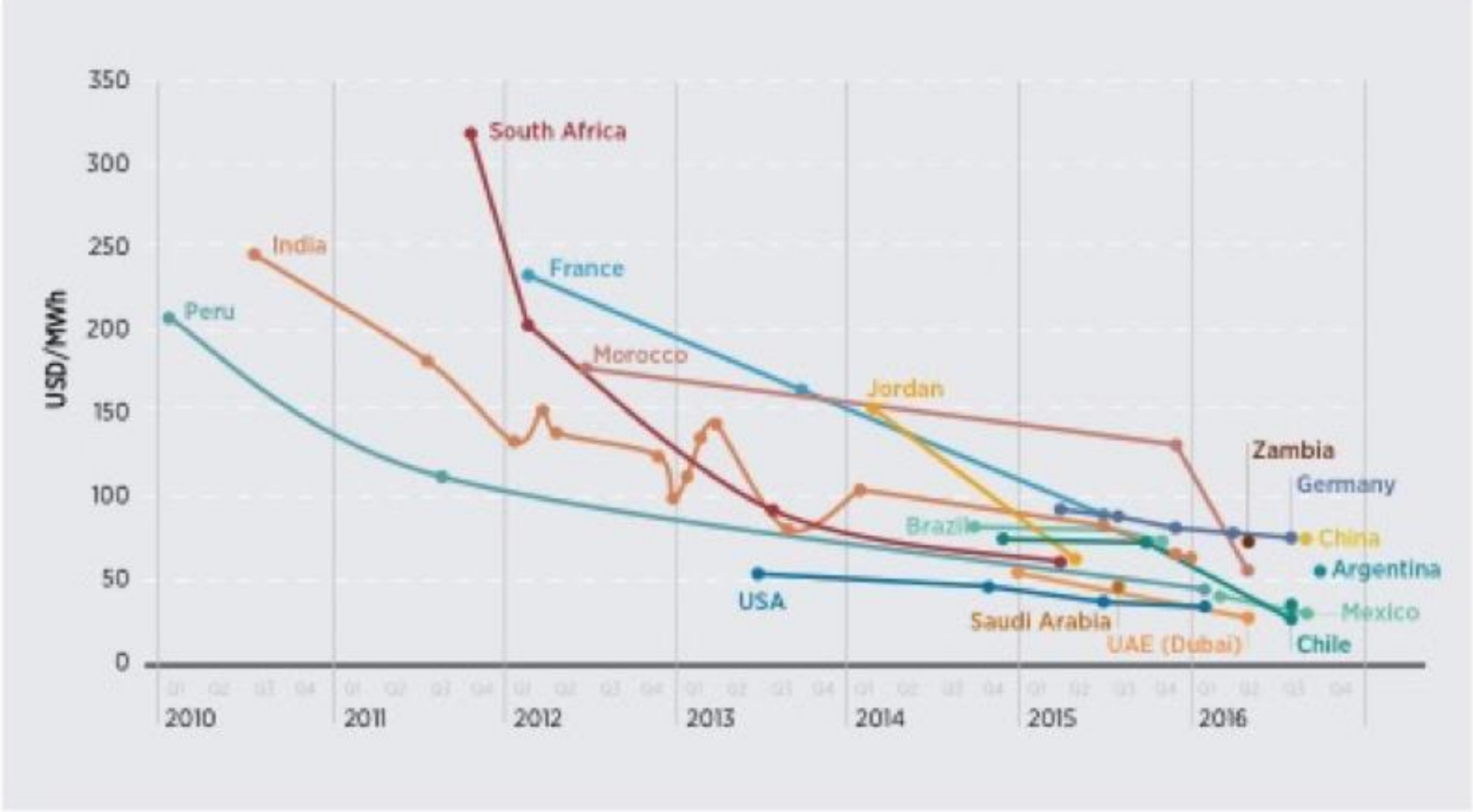
Figure 29. 2050 Electric Generation by Resource Type



If some communities achieve 100% renewables, which communities provide the balance (Energy Imbalance Markets?)

NOT ALL MARKETS ARE THE SAME





IRENA, 2017 (forthcoming).

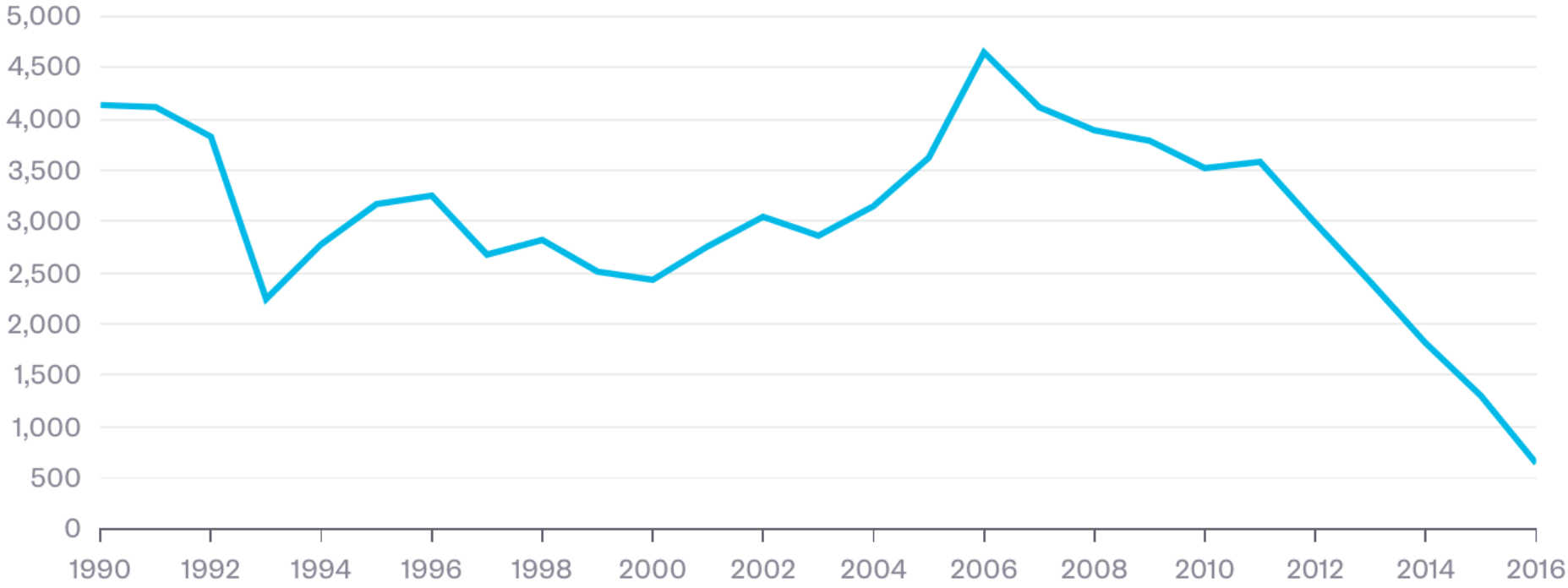
The graph shows auction prices for solar PV

Source: International Renewable Energy Agency (IRENA) 2017.

OPPORTUNITIES

One County's Coal Jobs

Payroll employment in coal mining in Boone County, West Virginia



Sources: West Virginia Office of Miners' Health, Safety and Training (1990-2008), U.S. Bureau of Labor Statistics (2009-2016)