NET ZERO ECONOMY: WHAT'S UP WITH THAT (AND NUCLEAR)

JUNE 2025, TODD ALLEN, PROFESSOR & SENIOR FELLOW

FASTEST PATH TO ZERO
UNIVERSITY OF MICHIGAN

WHAT DO NUCLEAR ENGINEERS DO?

1

Clean, Affordable, and Reliable Nuclear-inclusive Energy Systems

We will lead in the innovation of nuclear technology to support the deployment of a next generation of nuclear-inclusive energy systems.

2

Nuclear Security and Homeland Defense

We will lead to ensure the safe and secure deployment of nuclear, radiological, and plasma technologies.

3

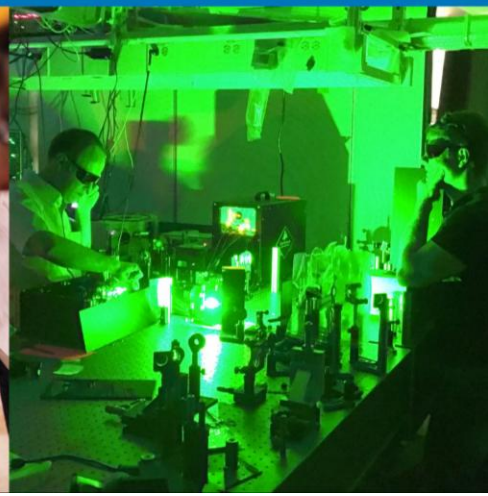
Environment and Health

We will lead in establishing approaches to using nuclear, radiological, and plasma technologies to better the human condition.

4

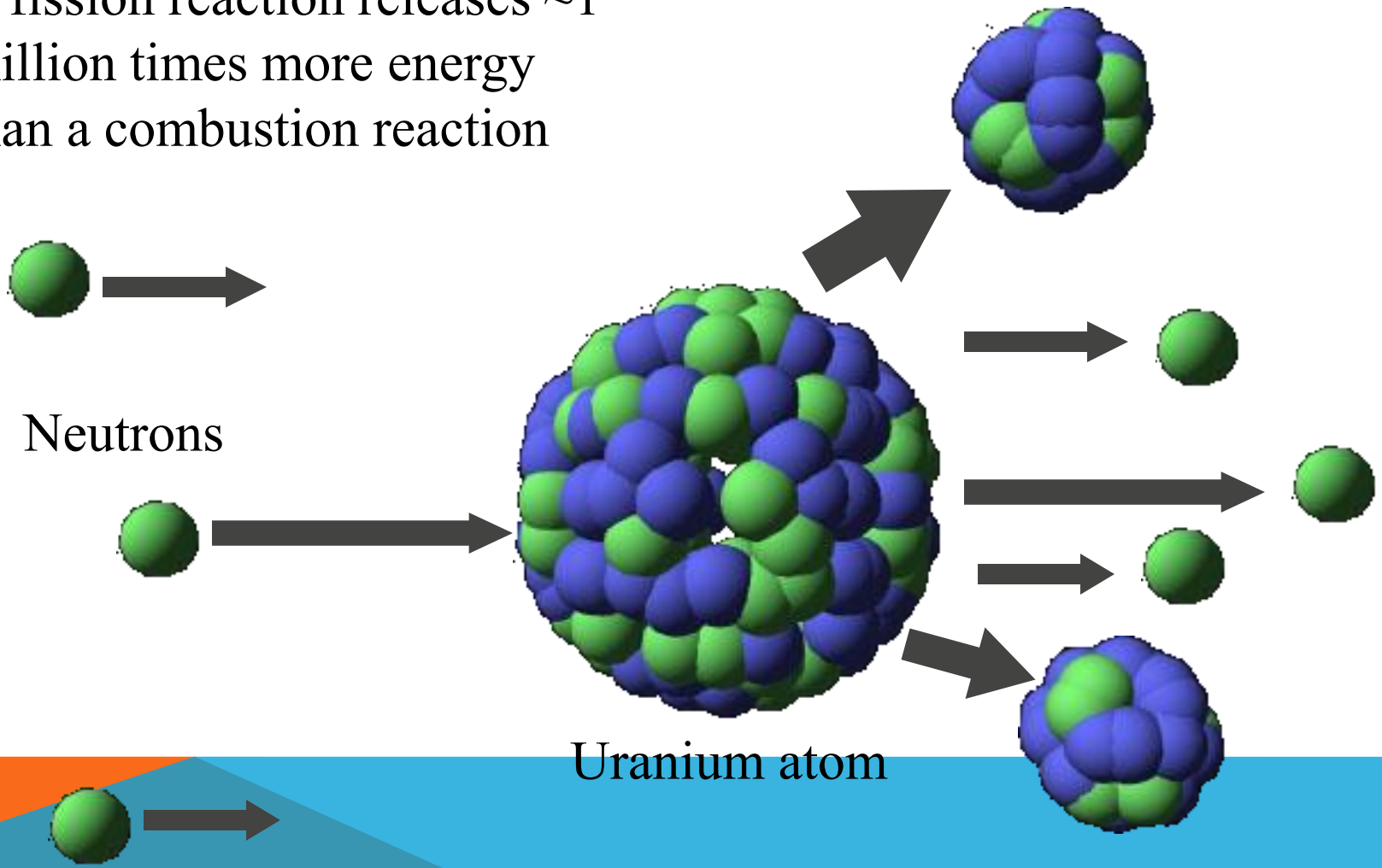
Scientific Discovery

We will lead in applying nuclear, radiological, and plasma processes to advance discovery across the solid, liquid, vapor, and plasma phases.

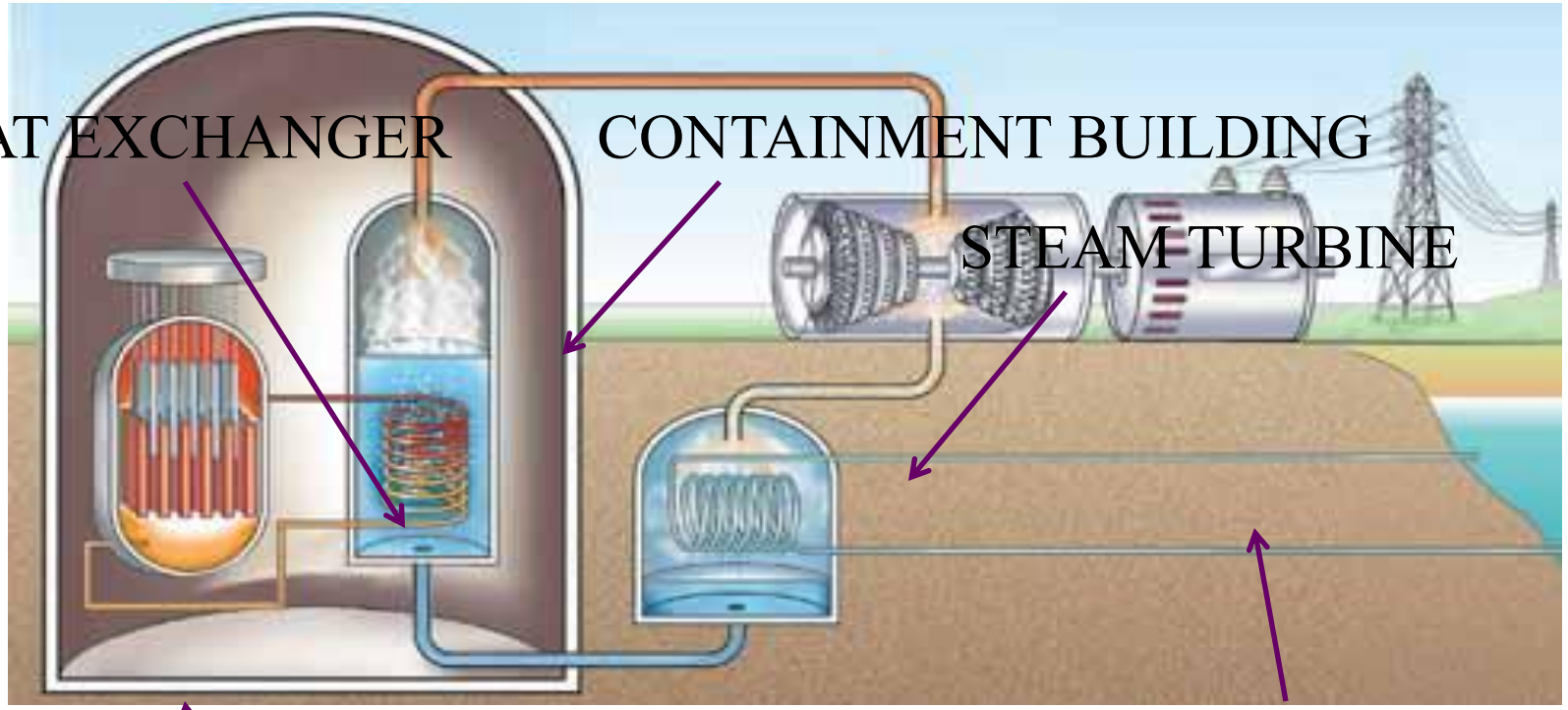


NUCLEAR ENERGY COMES FROM FISSION

A fission reaction releases ~1 million times more energy than a combustion reaction



A NUCLEAR POWER PLANT



ENERGY CONTEXT

WHAT DO WE WANT IN OUR FUTURE?

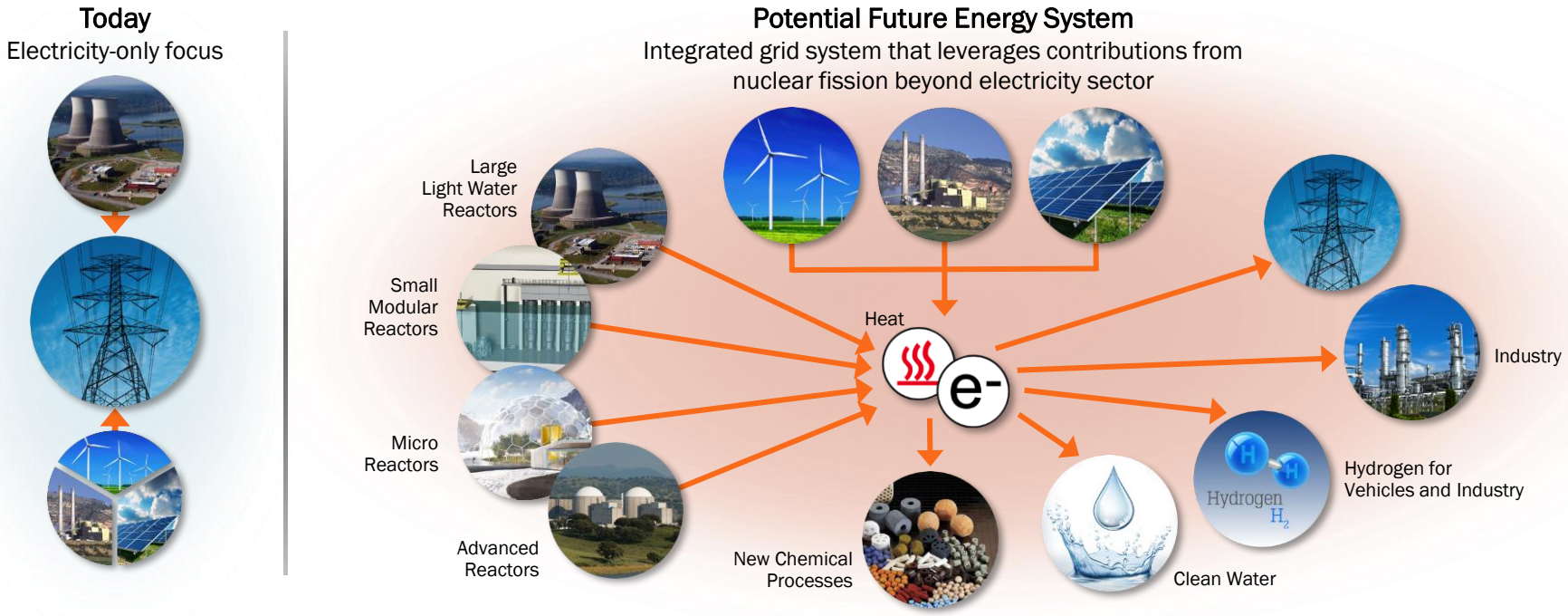
VS.

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

- Clean
- Affordable
- Resilient
- Equitable

ENERGY REIMAGINED

Maximizing energy utilization, generator profitability, and grid reliability and resilience through novel systems integration and process design



Flexible Generators ❖ Advanced Processes ❖ Revolutionary Design

Courtesy Shannon Bragg-Sitton, Ph.D., Idaho National Laboratory

TRANSITIONS

Inspired by Calestous Juma, Innovation and Its Enemies

EXPERTS

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. ."

https://www.nytimes.com/2016/02/29/opinion/planet-on-the-ballot.html

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

CONFIDENT EXPERTS

William Stanley Jevons

"[Coal] is the material energy of the country, the universal aid the factor in everything we do. It can be matter of surprise that year by year we make draughts upon a material of such myriad of such miraculous powers…All things considered it is not reasonable to suppose or expect that the power of coal will ever be superseded by anything better. It is the naturally best source of power as air and water and gold and iron are each for its own purposes the most useful of substances and such as will never be superseded."


Humility

THE IMPERATIVES FOR NUCLEAR ENERGY

THE EMISSIONS REDUCTION IMPERATIVE

Supply chains + Add to myFT

Blue chips act to cut supply chain greenhouse gas emissions

Rolls-Royce, Nestlé and Panasonic among larger companies taking action

Michael Pooler JANUARY 29, 2018 2

npanies taking serious action to tackle greenhouse gas
y chains has doubled, according to research by an

luding Rolls-Royce, Nestlé and Panasonic were among
d with taking an "industry-leading" approach on the
profit that collected data on behalf of 99 of the world's
nisations.

THE WALL STREET JOURNAL.

Home World U.S. Politics Economy **Business** Tech Markets Opinion Life & Arts Real Estate WSJ. Magazine

BUSINESS | LOGISTICS REPORT | WSJ LOGISTICS REPORT

Levi's Plans to Slash Emissions in Global Supply Chain by 2025

The apparel giant aims to reduce greenhouse gas emissions at a sprawling set of factories and mills in 39 countries, sta
suppliers

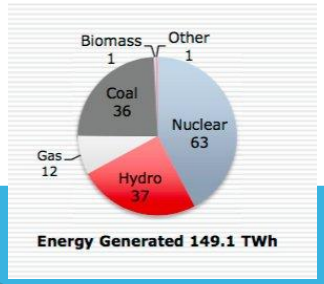
Levi's will start its effort to cut greenhouse gas emissions through energy-efficiency programs at factories run by vendors in the first tier of its supply chain, such as this supplier facility in Mexico. PHOTO: PHOTO COURTESY OF LEVI STRAUSS & CO.

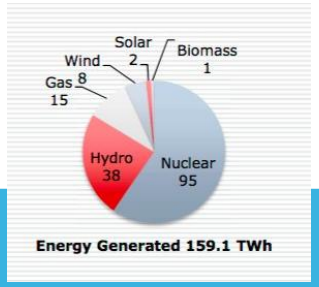
How to Provide F
Part 1

BRIEF

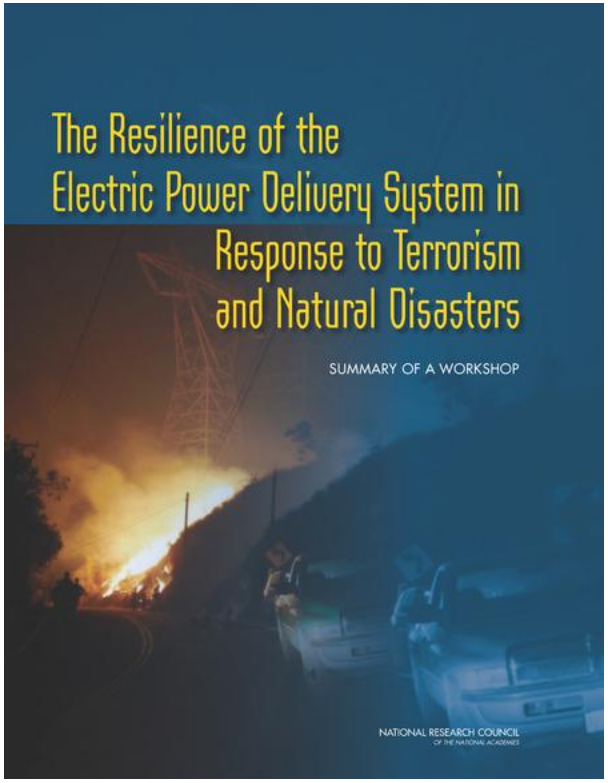
Asics plans to cut 55% of its supply chain carbon emissions

Ontario Transition from Coal





THE RESILIENCE IMPERATIVE



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:

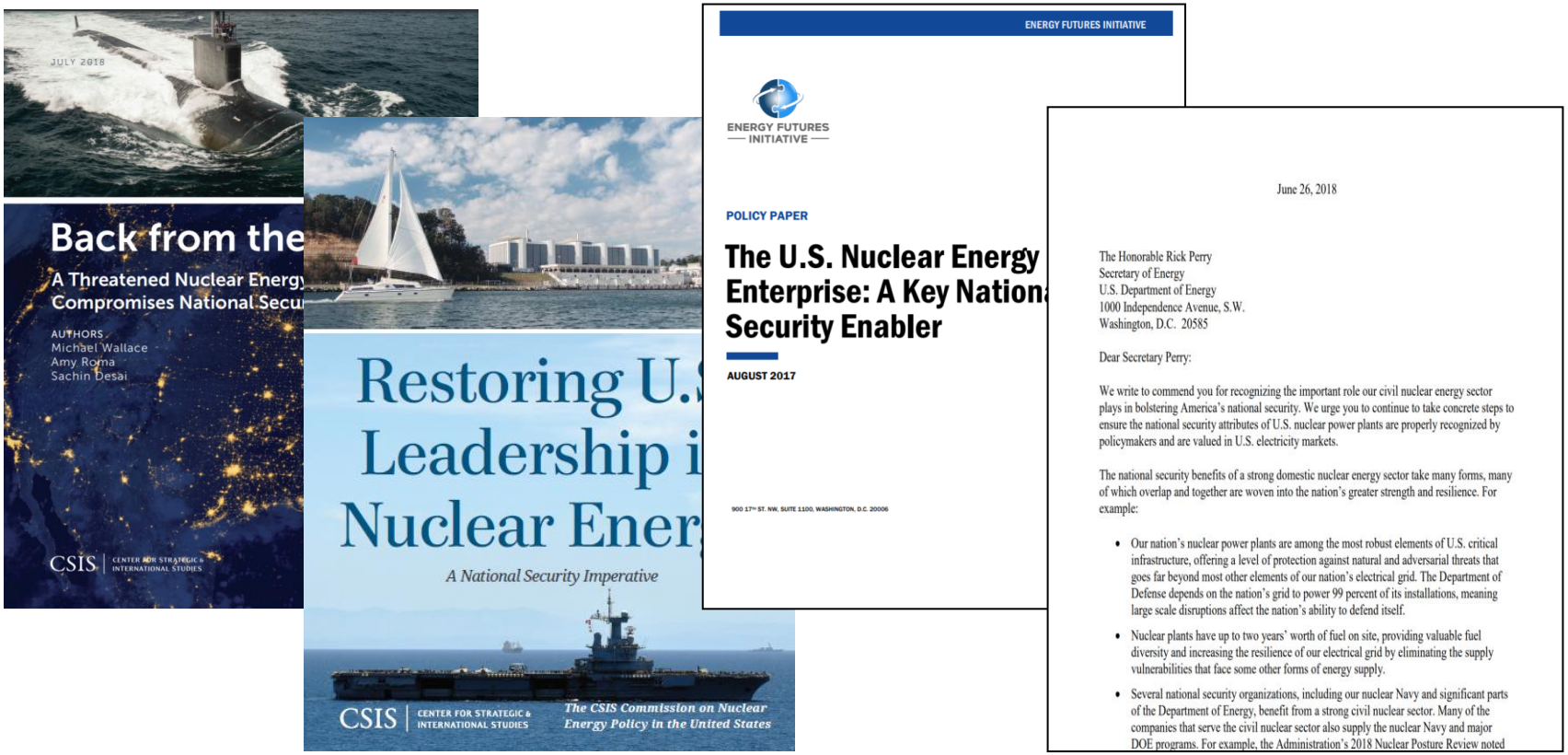
- Increased risk that reliance on a single fuel presents to dependable electric service.
- Firm transportation and dual-fuel capability may be needed to reduce widespread reliability problems.

A Call to Action:

A Canadian Roadmap for Small Modular Reactors

SUMMARY OF KEY FINDINGS

THE NATIONAL & INTERNATIONAL SECURITY IMPERATIVE



PRAGUE (Reuters, 14 Nov 2018) - Czech Prime Minister Andrej Babis said on Wednesday geopolitics should be a factor when the NATO and EU member country decides future nuclear power investments as the country mulls whether to build new reactors.

THE SUPPLY CHAIN IMPERATIVE

£1 trillion international new-build and decommissioning market over the next 10 years

The WNA estimates that the value of global investment in new reactor build will be of the order US$1.5 trillion (£0.93 trillion), with significant international procurement expected to be approximately US$530bn (£330bn), US$40bn (£25bn) per year through 2025.

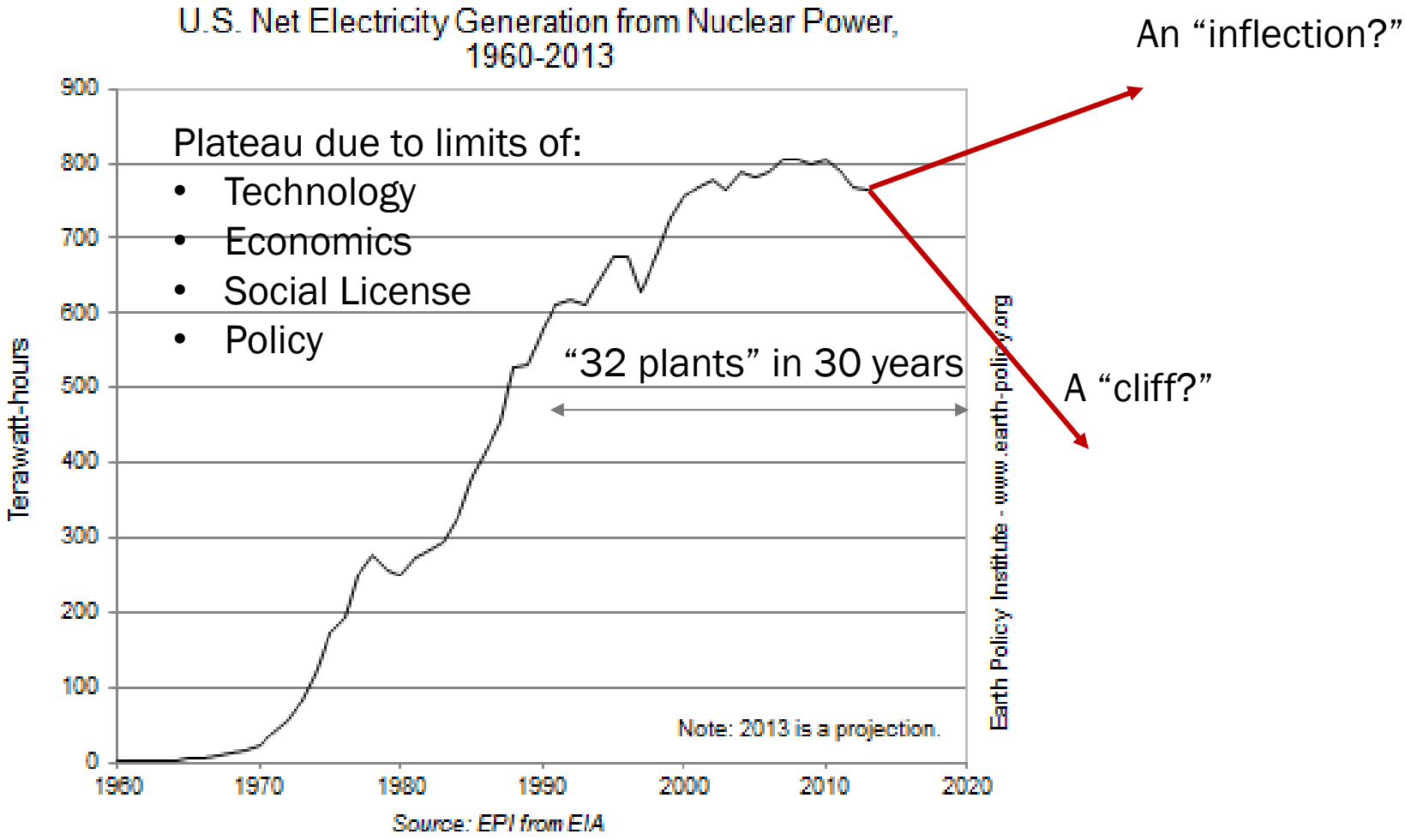
"We need to be clear where we own the value, understand our value proposition in nuclear and where the supply chain can improve competitiveness."

CEO, Manufacturing organisation

Ernst & Young LLP, "Creating confident investors and competitive advantage for the UK nuclear supply chain" November 2017

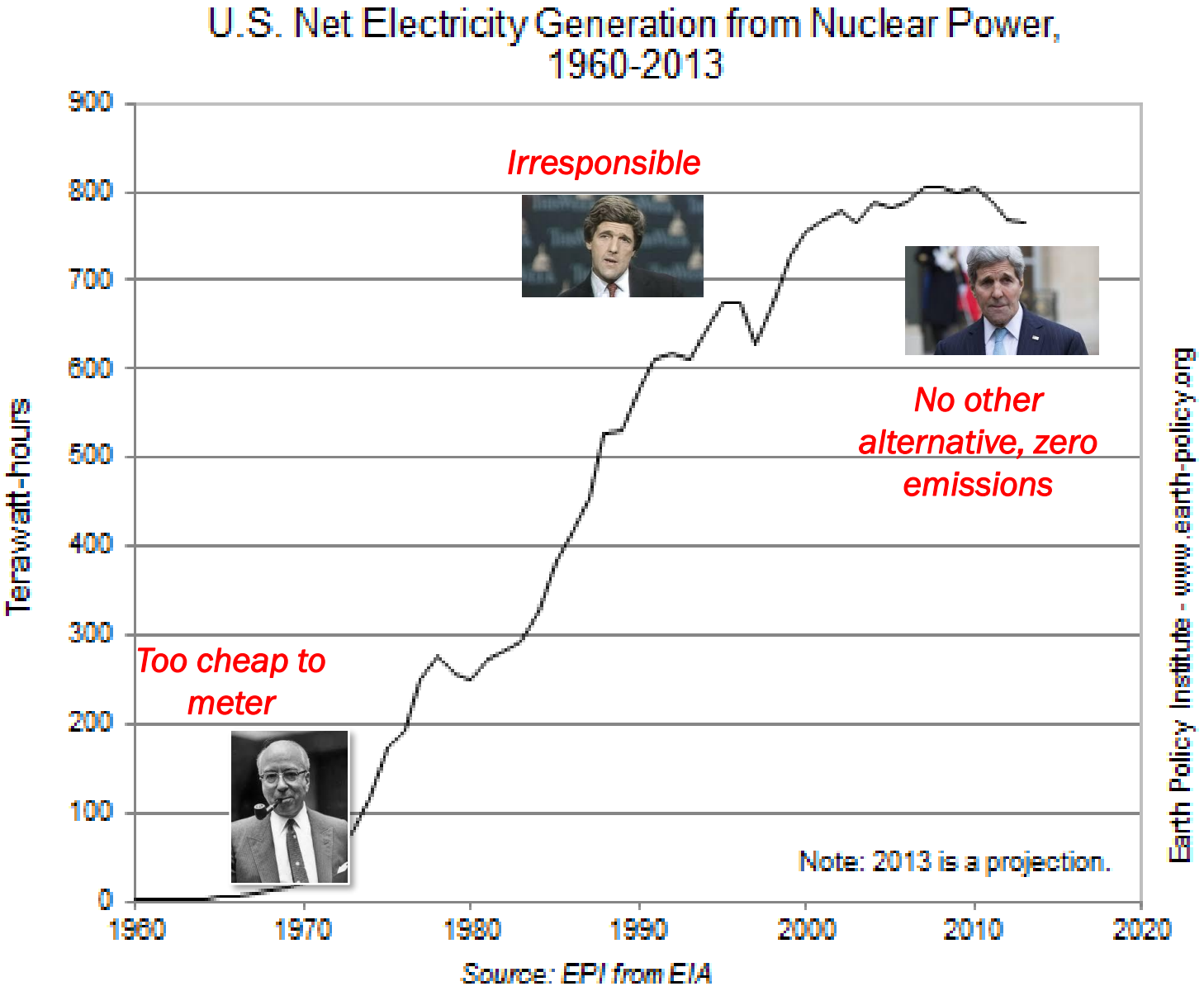
NUCLEAR ENERGY CONTEXT

TRAJECTORY OF ATOMS FOR PEACE GENERATION



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

THE ONGOING CONVERSATION

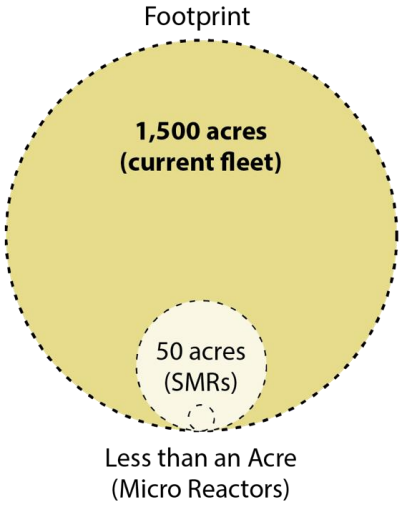


FISSION TECHNOLOGY

EXISTING NUCLEAR REACTORS

Number in operation:	**98 in U.S.**
Timeframe:	**Built in the 1950s-1980s**
Products:	**Electricity**
Megawatts:	**1,000+ megawatts**
Customers:	**Large utilities**
Emergency zone:	**10 miles**
Construction:	**Custom built on site**
Scalability:	**Difficult due to size and cost**

Applications:
Baseload electricity; 24/7



Did you know? In November 2018, the Union of Concerned Scientists recommended federal and state governments adopt policies to preserve the low-carbon electricity the current fleet of nuclear reactors provides.

Courtesy Shannon Bragg-Sitton, Ph.D., Idaho National Laboratory

March 17, 2022
11:19 AM EDT
Last Updated 9 days ago

Europe

Belgium on verge of delaying 2025 nuclear power exit

Reuters

Johnson announces aim for UK to get 25% of electricity from nuclear power

The Guardian

Jasper Jolly *and* Rob Davies

▶ Mon 21 Mar 2022 15.25 EDT

Japan's nuclear revival in a race against time

PM Kishida signals nuclear policy shift just as the shuttered industry's manufacturing and technical expertise is slipping away

By SCOTT FOSTER AUGUST 30, 2022

Asia Times

Korea Pares Back Renewables as It Taps Nuclear for Climate Goal

•Renewable energy share will fall to 21.5% under revised plan

•Nuclear share set to increase to almost one-third by 2030

By Heesu Lee

August 30, 2022, 2:48 AM EDT

Bloomberg

US Edition

September 1, 2022 6:38 AM EDT

Last Updated 3 hours ago

United States

California lawmakers vote to keep state's only nuclear plant running

Reuters

NUCLEAR REPURPOSING

Amazon just bought a 100% nuclear-powered data center

electrek

Michelle Lewis | Mar 5 2024 - 8:06 am PT

Power Engineering

Palisades nuclear plant could restart in August 2025

The latest update came during a Congressional hearing this week.

By Kevin Clark

NPR

NATIONAL

Three Mile Island nuclear plant will reopen to power Microsoft data centers

SEPTEMBER 20, 20241:40 PM ET

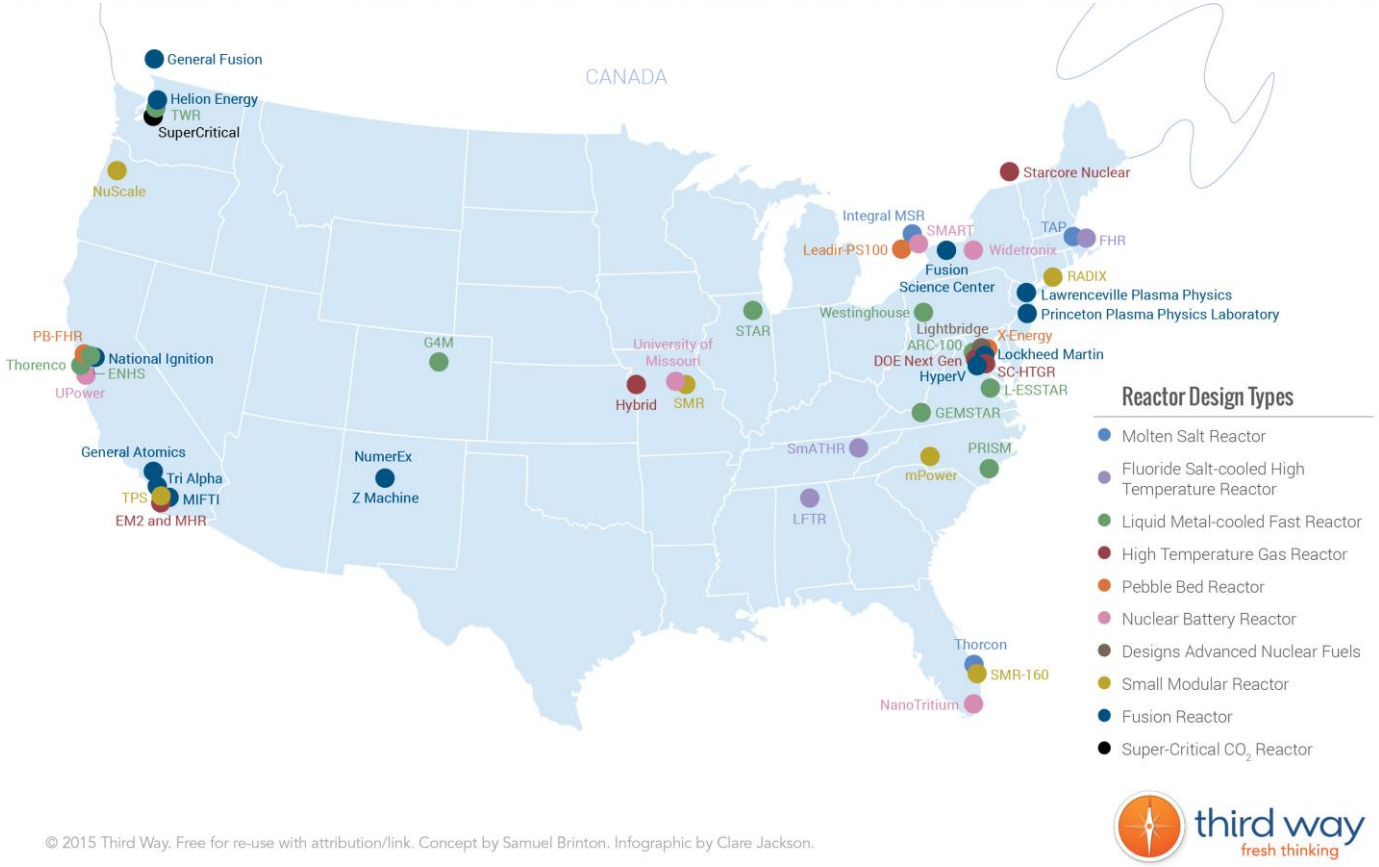
Constellation Energy launches 1-MW nuclear-powered hydrogen production facility at Nine Mile Point

Utility Dive

Published March 7, 2023

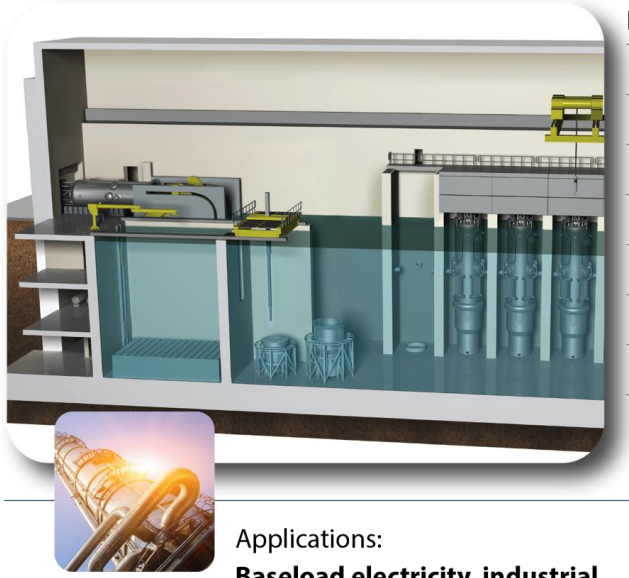
By Diana DiGangi Reporter

U.S. ADVANCED NUCLEAR

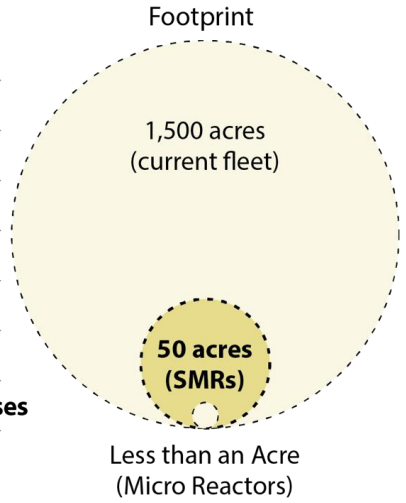


Advanced Reactor Companies

SMALL MODULAR REACTORS



Number in operation:	**None***
Timeframe:	**first reactors expected by 2024**
Products:	**Electricity, heat, and steam**
Megawatts:	**60-300 megawatts per module**
Customers:	**Large utilities; municipalities; industry**
Emergency zone:	**.19 miles**
Construction:	**Factory built; assembled on site**
Scalability:	**Reactor modules added as demand increases**

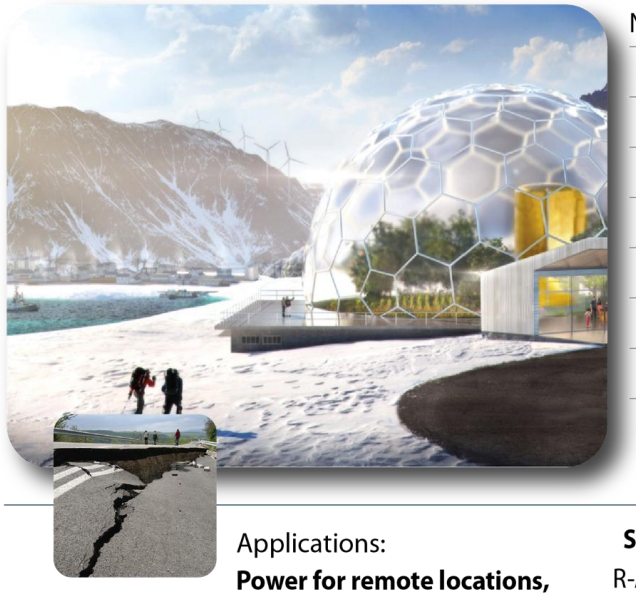


Applications:
Baseload electricity, industrial electricity, industrial processes such as hydrogen production

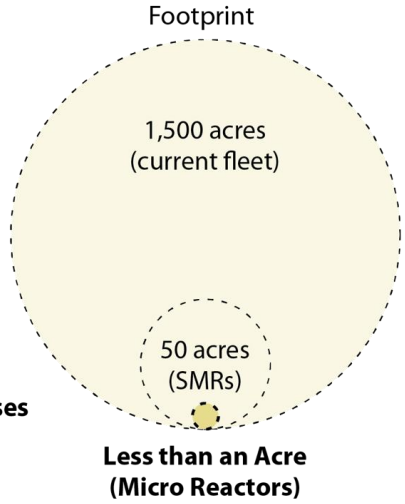
**First SMR in U.S. is currently going through regulatory approval and siting process; UAMPS proposing 12-module SMR in Idaho using NuScale technology.*

Courtesy Shannon Bragg-Sitton, Ph.D., Idaho National Laboratory

MICROREACTORS



Number in operation:	**None in the U.S.**
Timeframe:	**first reactors expected by 2025**
Products:	**Electricity, heat, and steam**
Megawatts:	**20 megawatts or less**
Customers:	**Military; municipalities; industry**
Emergency zone:	**less than .19 miles**
Construction:	**Factory built; assembled on site**
Scalability:	**Reactor modules added as demand increases**



Applications:
Power for remote locations, maritime shipping, military installations, mining, space missions, desalination, disaster relief

Sen. Lisa Murkowski, R-Alaska, April 14, 2019 Op-Ed in the Anchorage Daily News.

Improvements in nuclear technology "are enabling the emergence of so-called "microreactors" that could be a perfect fit throughout our state. As the name suggests, these smaller reactors can be right-sized for dozens of Alaska communities and will have off-grid capability that could solve the challenge of providing clean, affordable energy in our remote areas."

Courtesy Shannon Bragg-Sitton, Ph.D., Idaho National Laboratory

ADVANCED NUCLEAR PROGRESS

Kemmerer 1 Breaks Ground: A Look at TerraPower's Natrium Fast Reactor Nuclear Power Plant

Power

Jun 13, 2024
by Sonal Patel

Kairos Power begins construction on Hermes reactor

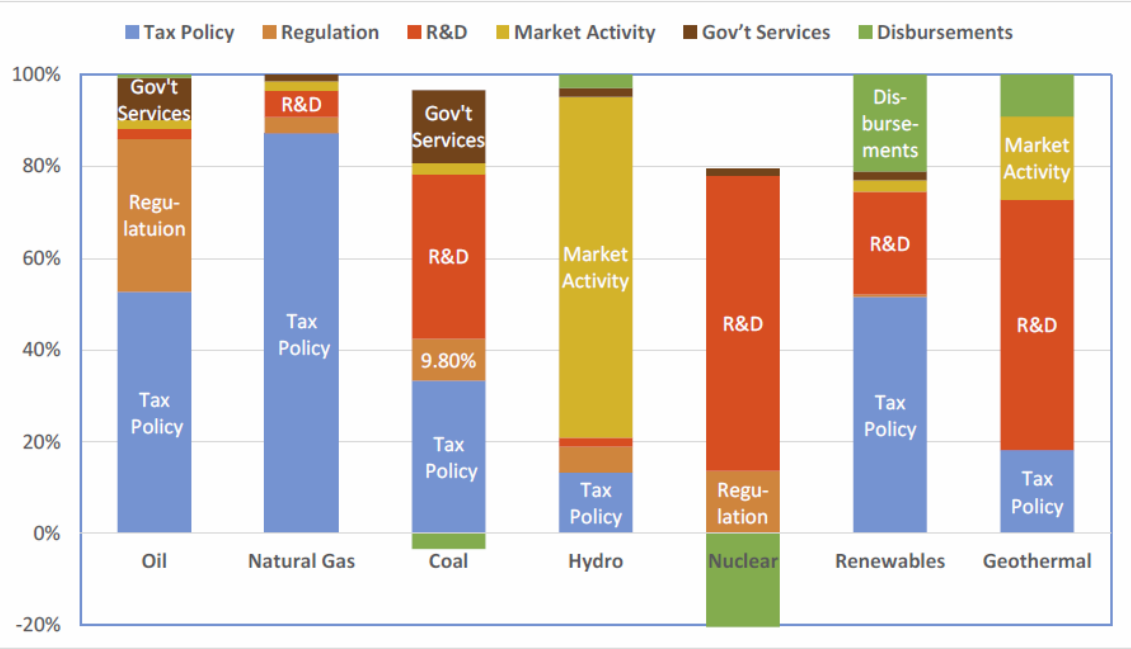
Site work began earlier this month at the Hermes site in Oak Ridge, Tennessee.

Power Engineering
Kevin Clark*7.30.2024*

POLICY AND SOCIETAL ENGAGEMENT

INCENTIVES

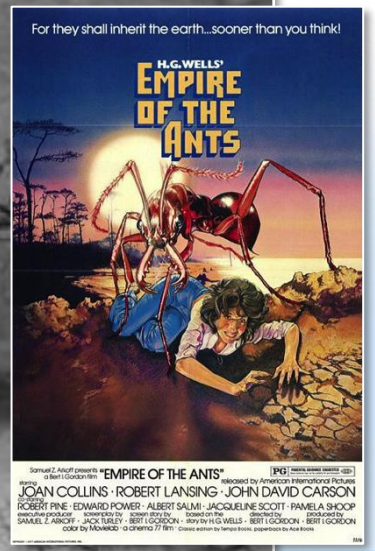
Exhibit 4 – Mix of Federal Expenditures for Each Energy Source



Expenditures for nuclear need better balance between R&D and tax policy

COMMUNITY APPROPRIATENESS

A first entertainment use of radiation-induced mutant creatures

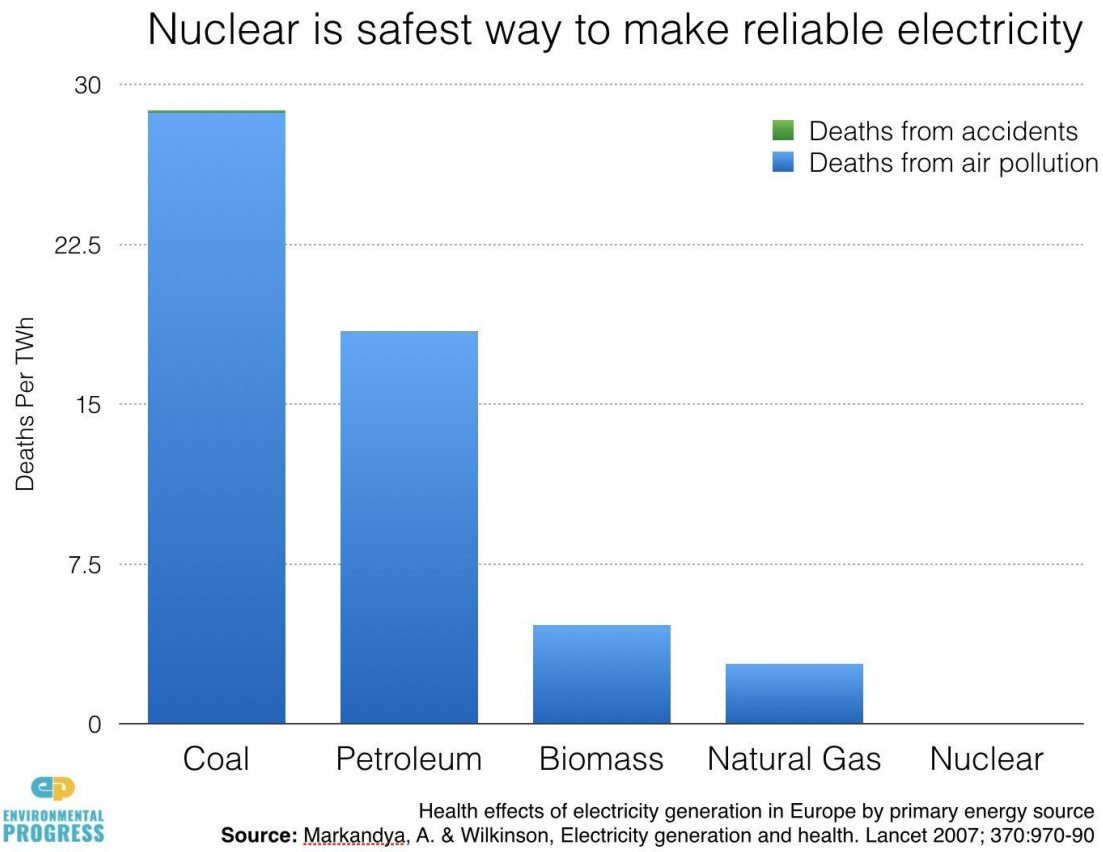


QUOTES FROM ADVANCED ENERGY APRIL 2016

- **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"

WHEN DO YOU ENGAGE WITH COMMUNITIES

Always

Design-airplane windows

Siting-consent based siting

Operations-pumps

END