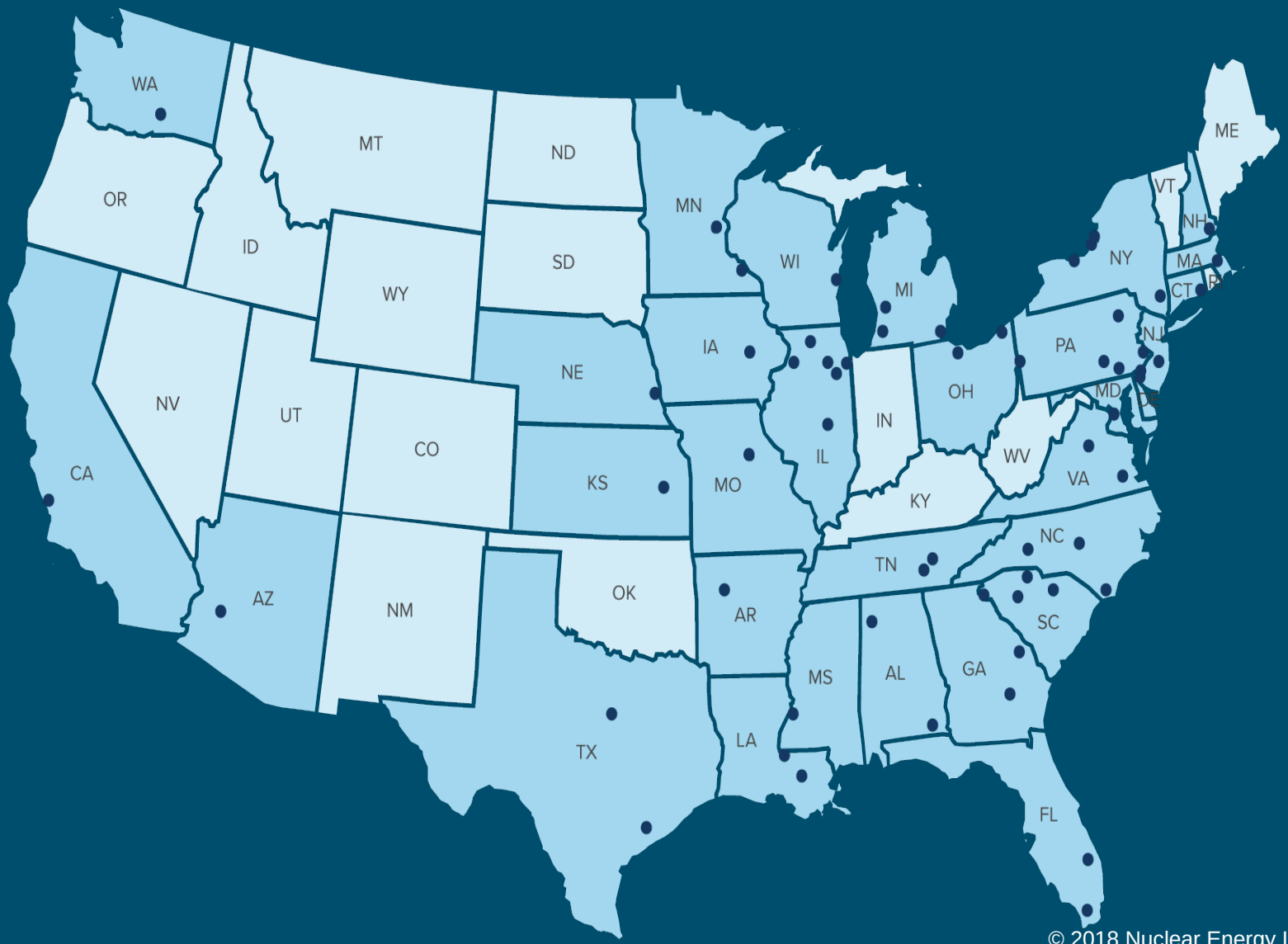
Key Regulatory and Policy Factors for Safe and Sustainable Operation of Nuclear Power Plants

John F. Kotek
Nuclear Energy Institute

February 14, 2019

NUCLEAR ENERGY IN THE U.S.



Nuclear Energy in the U.S.

- 98 reactors at 59 sites, in 30 states
- 99,010 MWe of baseload capacity
- Oyster Creek Nuclear Generating Station retired in September 2018 after 49 years of operation

Source: U.S. Energy Information Administration
Updated: September 2018

UNPRECEDENTED INDUSTRY PERFORMANCE

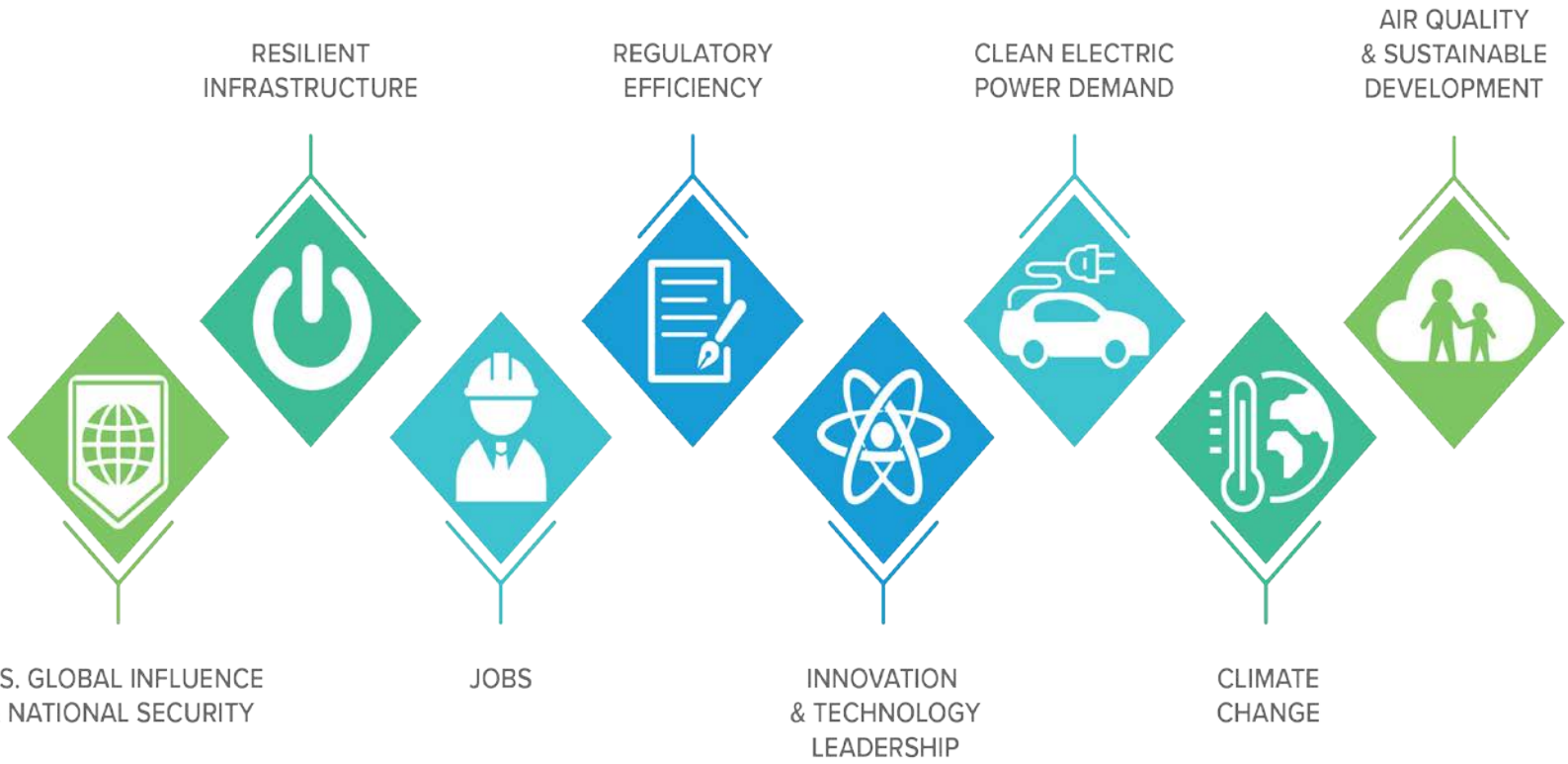
NEI Regulatory Efforts

Enable meaningful reductions in costs associated with existing regulatory requirements

Minimize the burden associated with any new/evolving challenges and regulatory requirements

Reduce the total costs associated with industry-controlled activities

NUCLEAR IMPERATIVES



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

anies taking serious action to tackle greenhouse gas
hains has doubled, according to research by an

ing Rolls-Royce, Nestlé and Panasonic were among
ith taking an "industry-leading" approach on the
ofit that collected data on behalf of 99 of the world's
ations.

THE WALL STREET JOURNAL.

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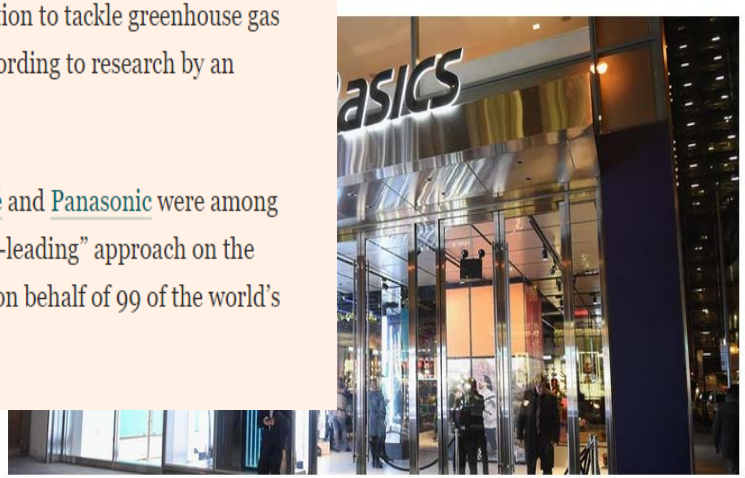
Levi's Plans to Slash Emissions in Global Supply Chain by 2025

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.

CONTENT

How to Provide
Part 1



BRIEF

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

ADVANCING THE NUCLEAR NARRATIVE

The Nuclear Power Dilemma

Declining Profits, Plant Closu
of Rising Carbon Emissions

Steve Clemmer
Jeremy Richardson
Sandra Sattler
Dave Lochbaum

November 2018

Union of Concerned Scientists

Google

Moving toward 24x7 Carbon-Free Energy at Google Data Centers: Progress and Insights

Introduction

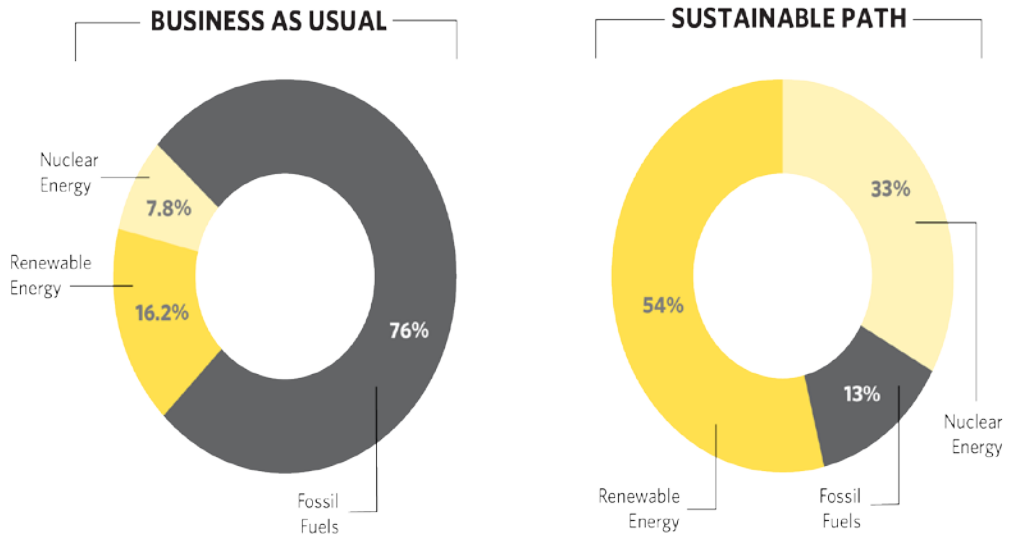
In recent years, Google has become the world's largest corporate buyer of renewable energy. In 2017 alone, we purchased more than seven billion kilowatt-hours of electricity (roughly as much as is used yearly by the state of Rhode Island[1]) from solar and wind farms that uilt specifically for Google. This enabled us to match 100% of nual electricity consumption through direct purchases of able energy; we are the first company of our size to do so.

ng our 100% renewable energy purchasing goal was an ant milestone, and we will continue to increase our purchases ewable energy as our operations grow. However, it is also just ginning. It represents a head start toward achieving a much r, longer-term challenge: **sourcing carbon-free energy for our ions on a 24x7 basis.**

g this challenge requires sourcing enough carbon-free energy ch our electricity consumption *in all places, at all times*. Such roach looks markedly different from the status quo, which, e our large-scale procurement of renewables, still involves -based power. Each Google facility is connected to its regional grid just like any other electricity consumer; the power mix in egion usually includes some carbon-free resources (e.g. wind, ydro, nuclear), but also carbon-based resources like coal, l gas, and oil. Accordingly, we rely on those carbon-based ces — particularly when wind speeds or sunlight fade, and also es where there is limited access to carbon-free energy. Carbon- not, around-the-clock electricity is the fuel that enables us to uously deliver Google search results, YouTube video plays, e Cloud Platform services, and much more without interruption.

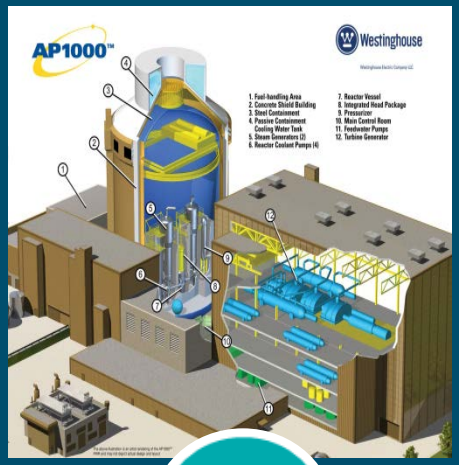
A Changing Energy Portfolio

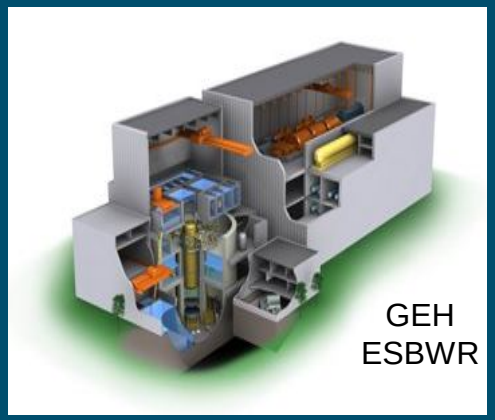
In order to both meet increased energy demand and keep the climate in safe boundaries, we'll need to alter our energy makeup to curtail emissions of carbon and other harmful chemicals.



Source: The Nature Conservancy, The Science of Sustainability, 2018

Continuum of Innovations



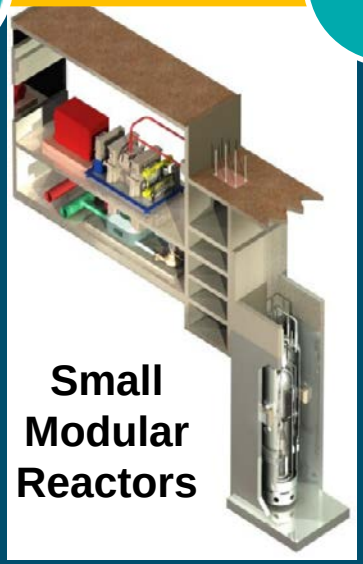


Advanced Non-LWRs

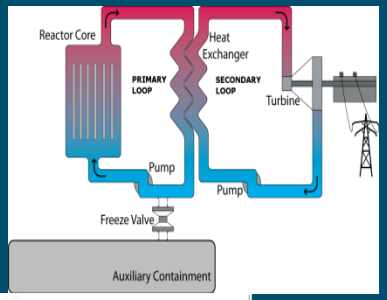
- Hi-temp gas
- Liquid metal
- Molten salt

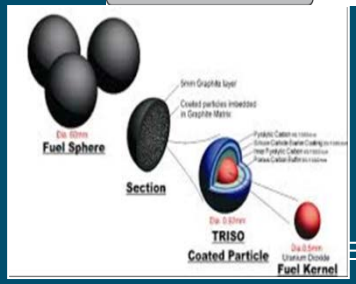
2016 — 2020 — 2025 — 2030

NuScale Power Module



Small Modular Reactors





SMR LICENSING

- TVA Clinch River Early Site Permit Application, May 2016; Approval Q1 2020
- NuScale Design Certification Application, January 2017; Approval Q1 2021
- NRC agrees NuScale can safely operate without safety grade power source; Jan 2018
- UAMPS Construction Operating License Application, To Be Determined

NuScale Power Module

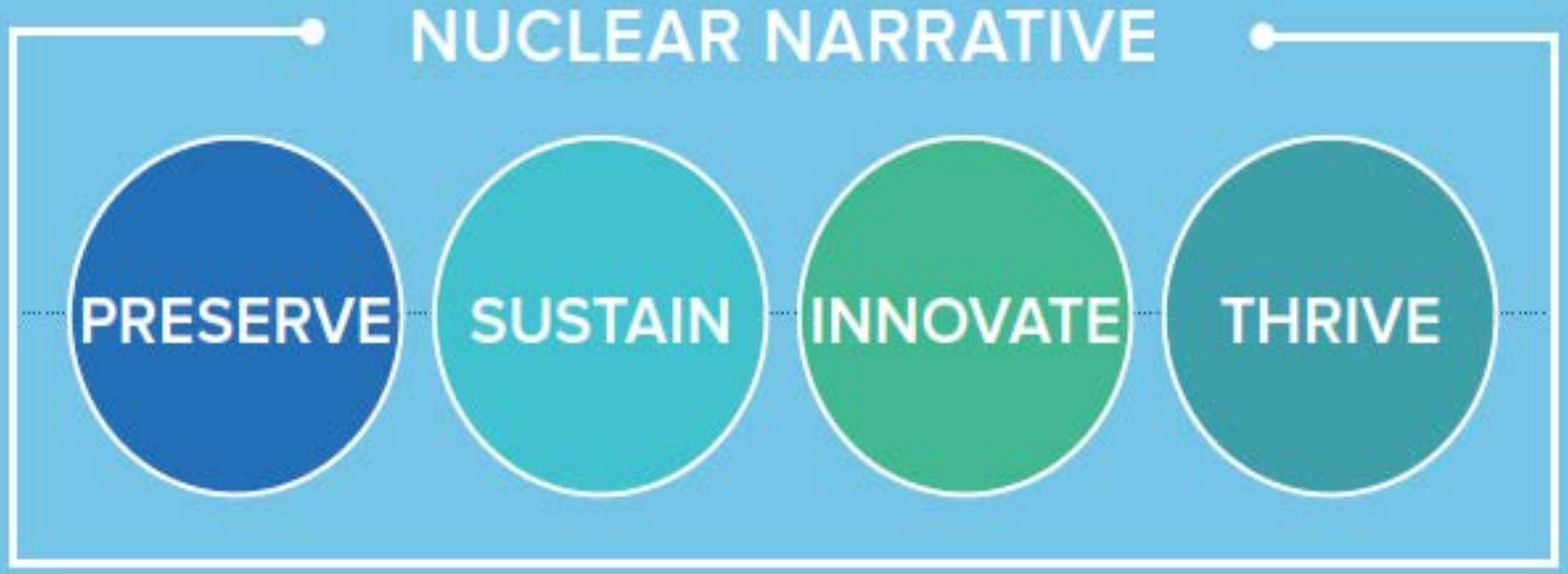
UAMPS = Utah Associated Municipal Power Systems

THANK YOU FOR YOUR KIND ATTENTION

Backup Slides

NATIONAL NUCLEAR ENERGY STRATEGY

create the nuclear imperative



BEST-IN-CLASS

NUCLEAR CONTRIBUTIONS

AVOIDS **547.5 MILLION** METRIC TONS OF **CARBON** EMISSIONS EACH YEAR

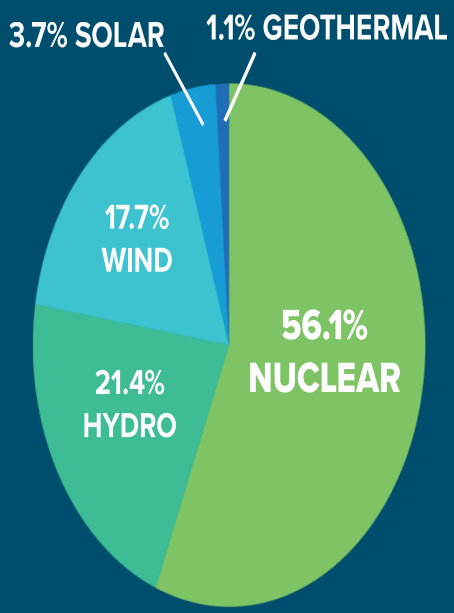
+

PREVENTS **315,000** SHORT TONS OF **NOx**

AND

374,000 SHORT TONS OF **SO_2** EMISSIONS

—AVERAGE— **CAP FACTOR >90% SINCE 1999**



SUPPORTS **475,000** JOBS

SAVES CONSUMERS AN AVERAGE OF **6%** ON ELECTRICITY BILLS

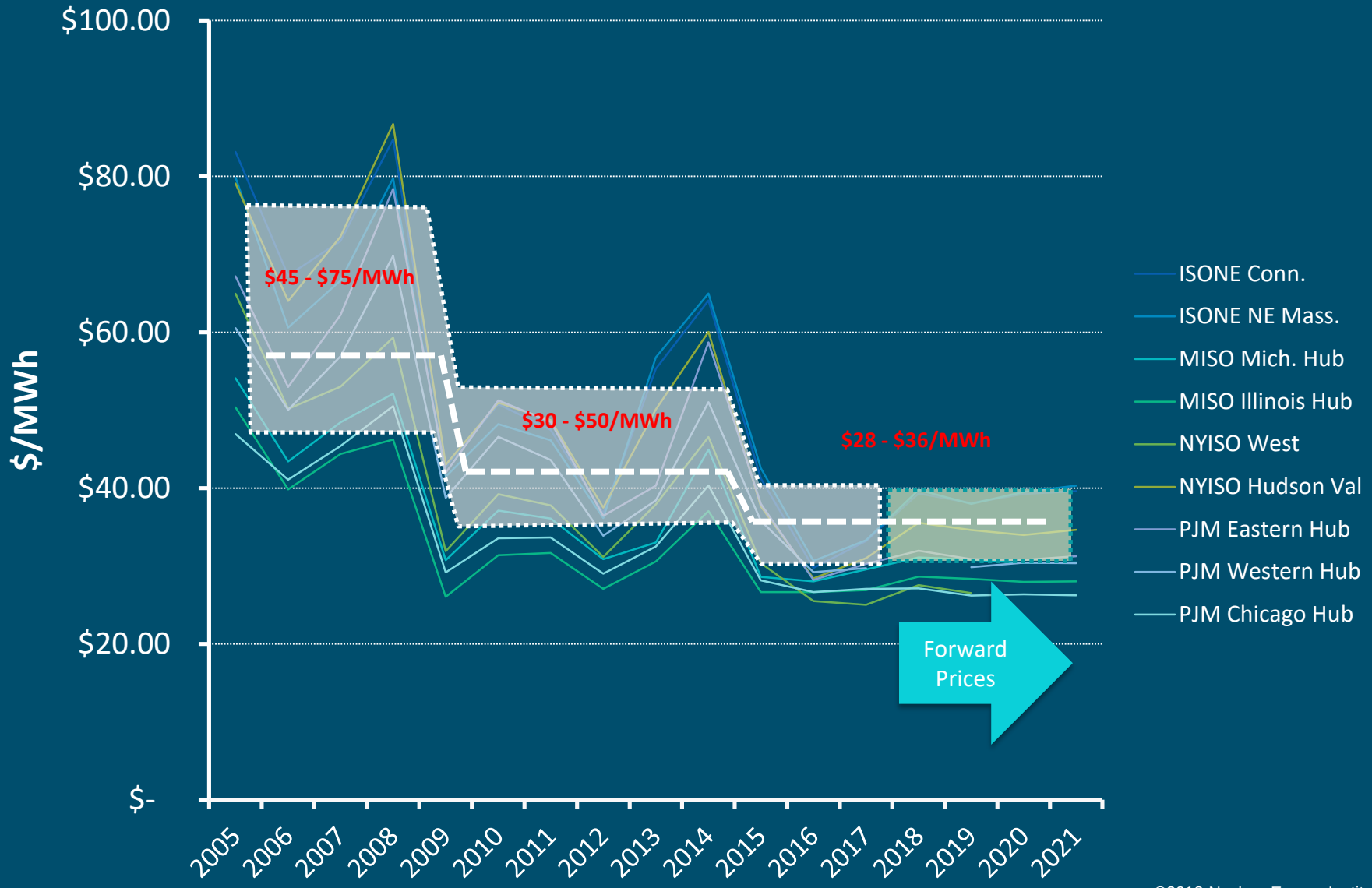
ADDS **$60 BILLION** TO THE COUNTRY'S **GDP**

Premature Nuclear Power Plant Closures and Announced Shutdowns

Plant	MWe	Closure Year	Reason	Final Year Generation (billion kWh per year)	Final Year CO2 Avoided (M tons/year)
Crystal River 3	860	2013	Mechanical	7.0	3.8
San Onofre 2 & 3	2,150	2013	Mechanical	18.1	8.0
Kewaunee	566	2013	Market	4.5	3.8
Vermont Yankee	620	2014	Market	5.1	2.4
Fort Calhoun	478	2016	Market	3.4	3.3
Oyster Creek	625	2018	Policy	5.4	4.0
TOTAL	**5,299**			**43.5**	**25.3**
Three Mile Island 1	803	2019	Market	6.9	5.0
Pilgrim	678	2019	Market	5.1	2.3
Davis-Besse	908	2020	Market	7.9	5.7
Duane Arnold	619	2020	Market	5.2	5.0
Indian Point 2 & 3	2,061	2020-2021	Market & Policy	15.3	7.1
Beaver Valley 1 & 2	1,872	2021	Market	15.3	11.1
Perry	1,268	2021	Market	9.8	7.1
Palisades	789	2022	Market	6.1	5.3
Diablo Canyon 1 & 2	2,240	2024-2025	Policy	17.9	6.9
TOTAL	**11,238**			**89.5**	**55.5**

Source: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the **U.S. Environmental Protection Agency** and latest plant generation data from the **U.S. Energy Information Administration**. Updated: September 2018.

DECLINING ELECTRICITY PRICES



STATES RECOGNIZE NUCLEAR'S VALUE

$1.6 Billion
In Economic Benefits in New York

$1.5 Billion
Economic Activity in Connecticut

$1.2 Billion
Economic Activity in Illinois

$800 Million
Economic Activity in New Jersey

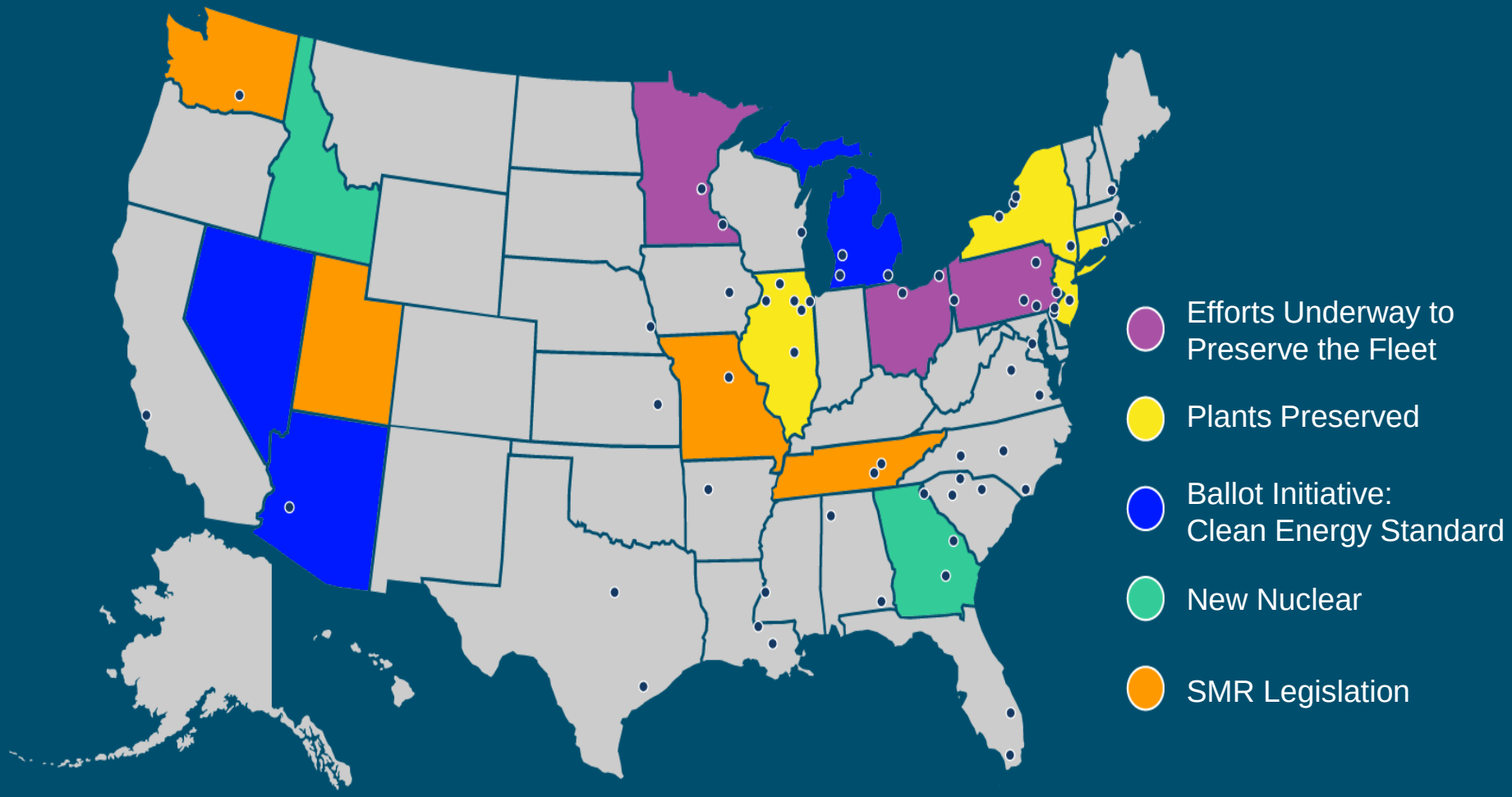
Nuclear Plants Saved from Premature Closures

Plant	MWe	Projected Closure Year	Reason for Potential Shutdown	Electricity Generated in 2017 (billion kWh per year)	CO_2 Emissions Avoided in 2017 (Million metric tons/year)
Clinton	1,065	2017	Market	8.3	8.1
Fitzpatrick	852	2017	Market	6.2	2.9
Ginna	582	2017	Market	4.7	2.2
Hope Creek	1,172	~2020	Market	10.6	7.7
Millstone 2 & 3	2,096	~2020	Market	16.5	7.4
Nine Mile Point 1 & 2	1,770	2017-2018	Market	16.0	7.4
Quad Cities 1 & 2	1,819	2018	Market	15.4	11.2
Salem 1 & 2	2,328	~2020-2021	Market	18.0	13.1
TOTAL	**11,683**			**95.7**	**60.0**

- 11,683 MWe baseload capacity
- More than 7,400 direct jobs saved
- More electricity generation than all U.S. utility solar in 2017
- 60.0 million metric tons of CO_2 avoided

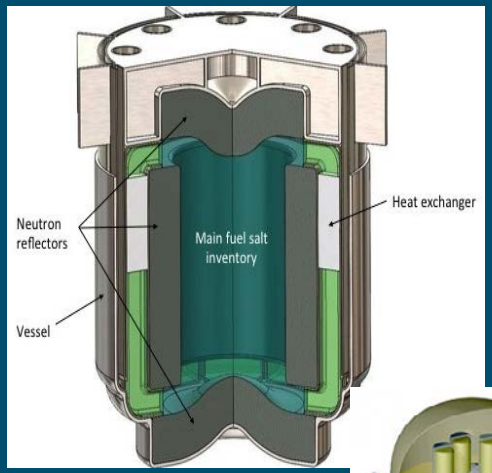
Source: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the **U.S. Environmental Protection Agency** and latest plant generation data from the **U.S. Energy Information Administration**. Updated: August 2018.

STATE OF THE STATES



NON-WATER COOLED REACTORS

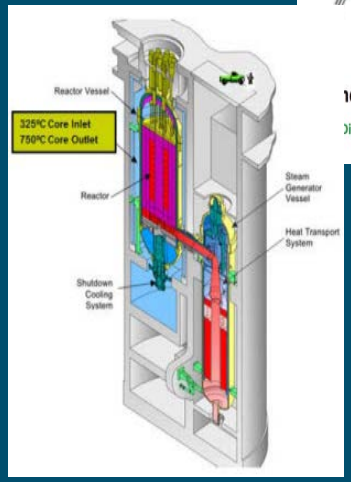
Molten Salt Reactors



TerraPower

Terrestrial Energy

High Temperature Gas Reactors



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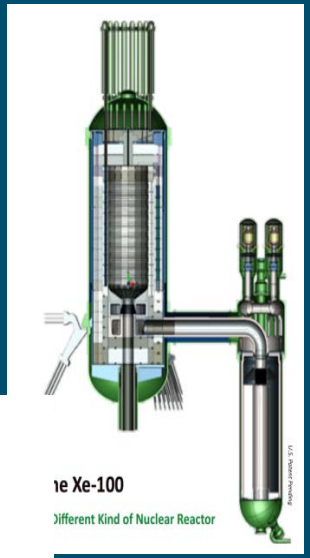
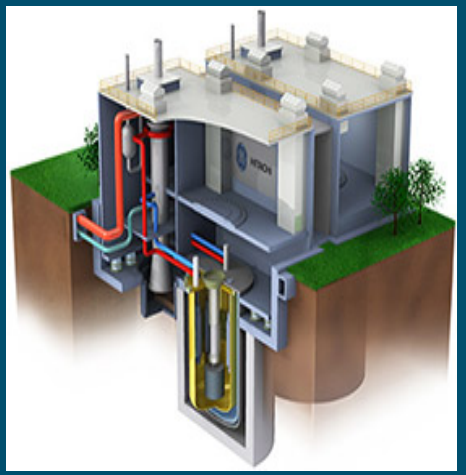


X-energy

Micro Reactors

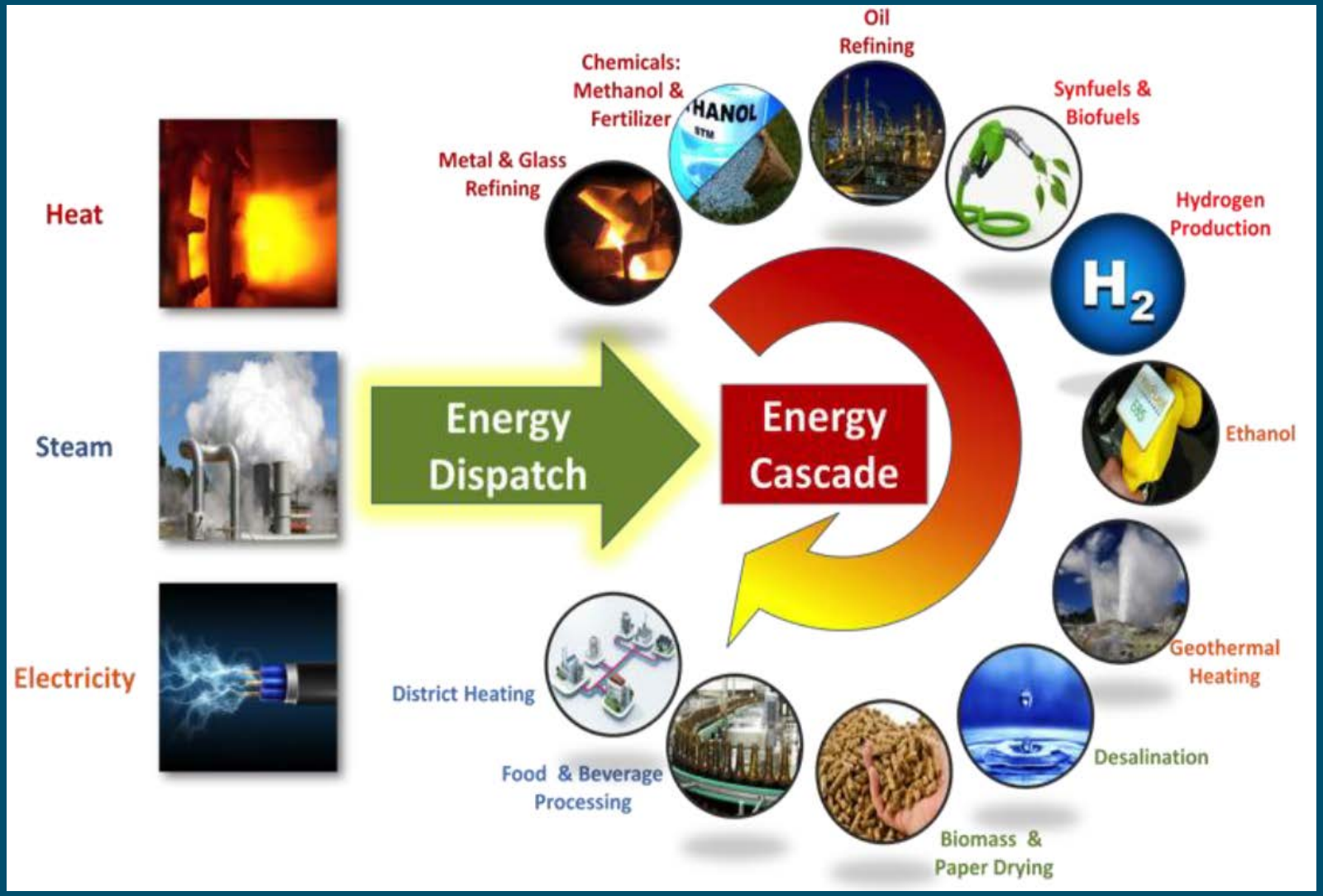
Westinghouse eVinci

Liquid Metal Reactors



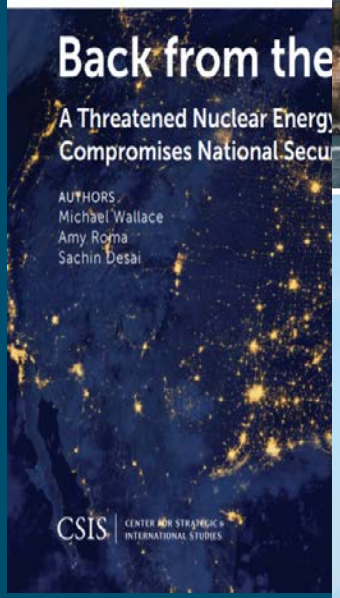
GE PRISM

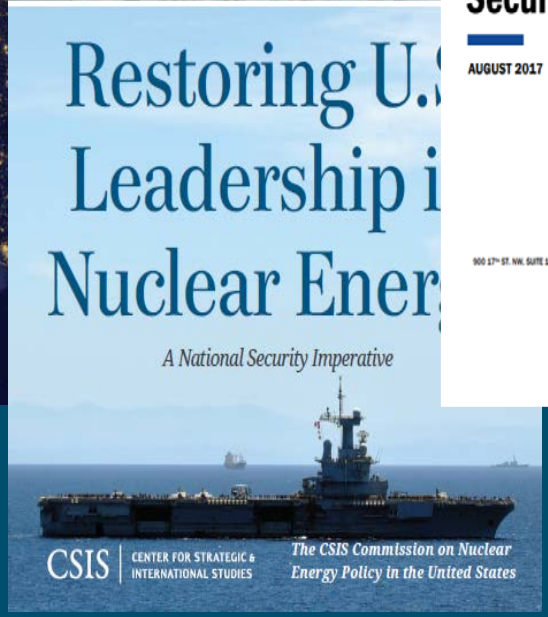
New Applications

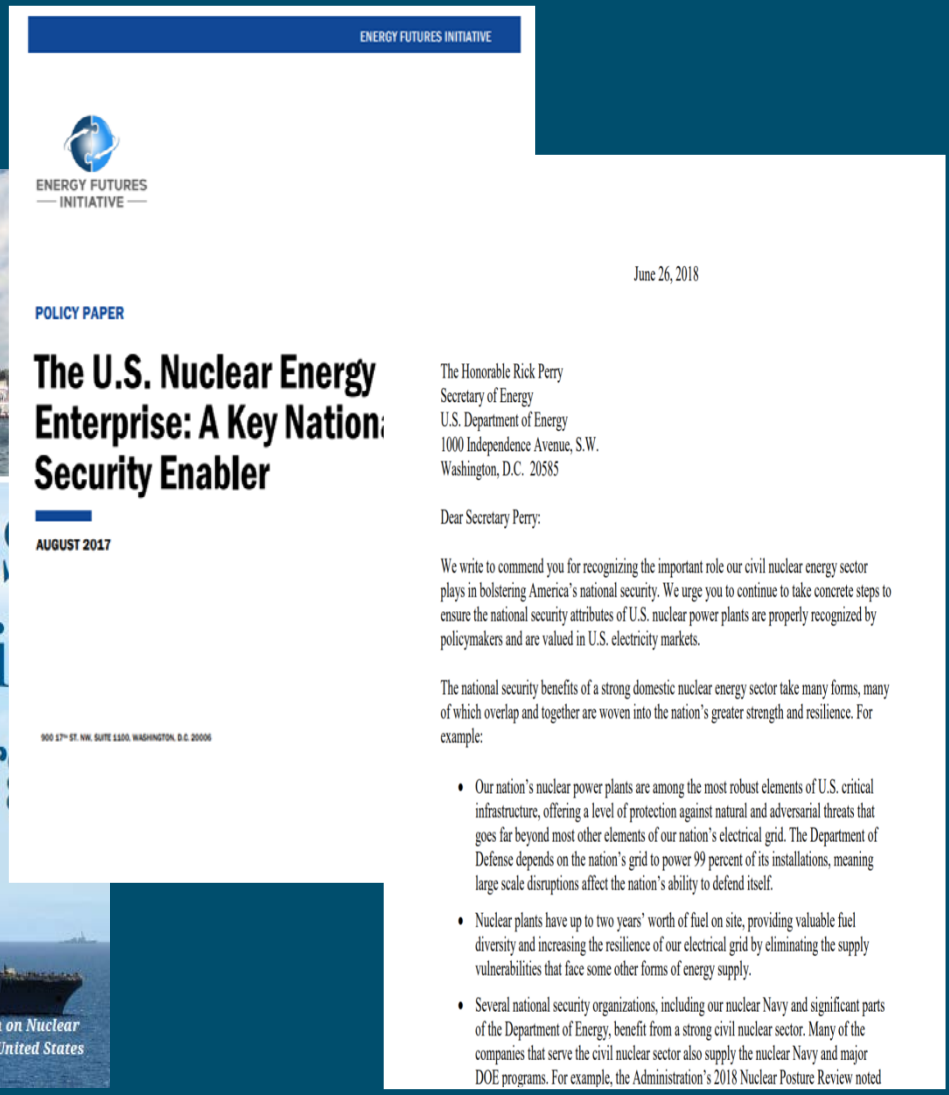


Source: Idaho National Laboratory

THE NATIONAL SECURITY IMPERATIVE

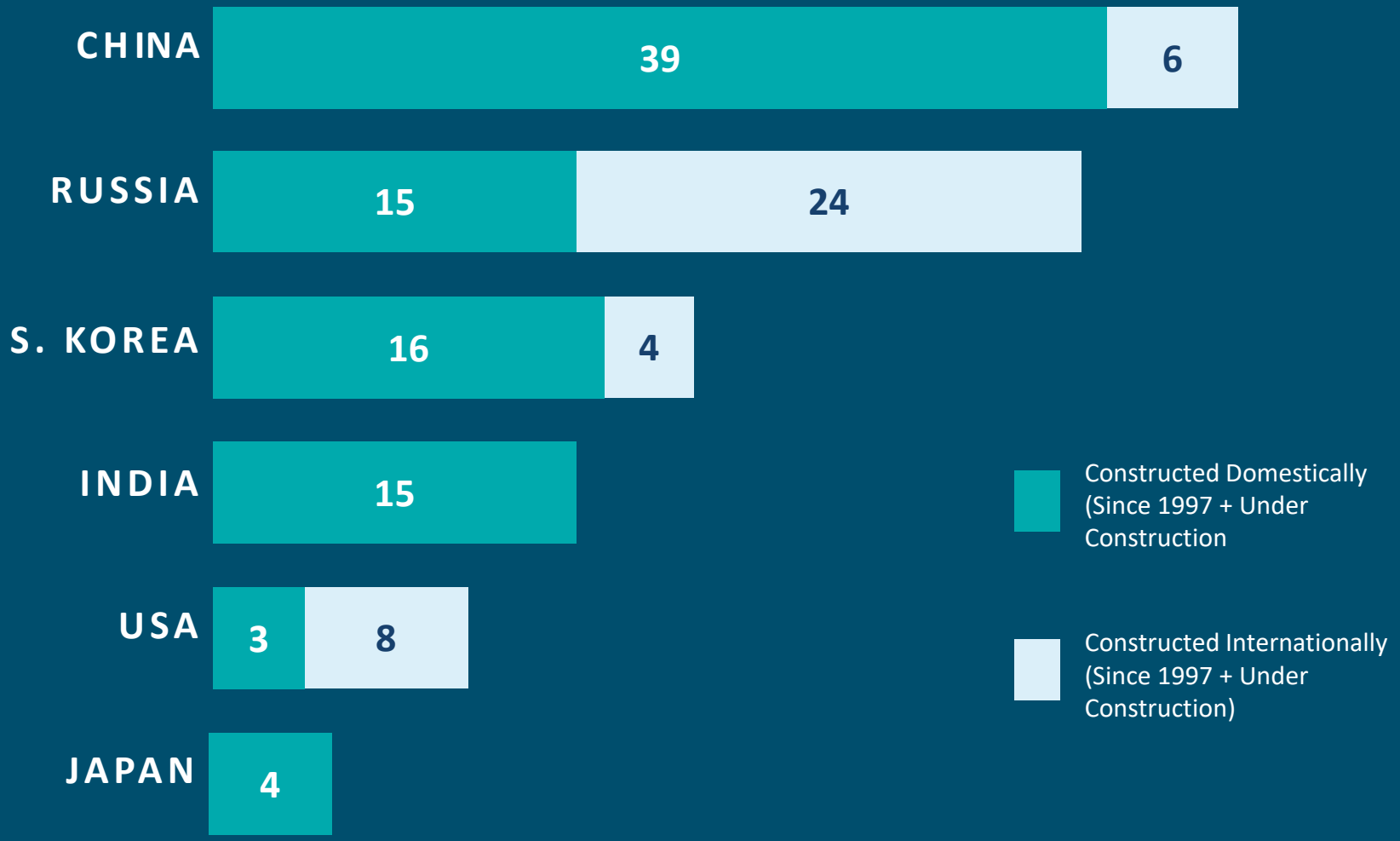






International Nuclear Influence

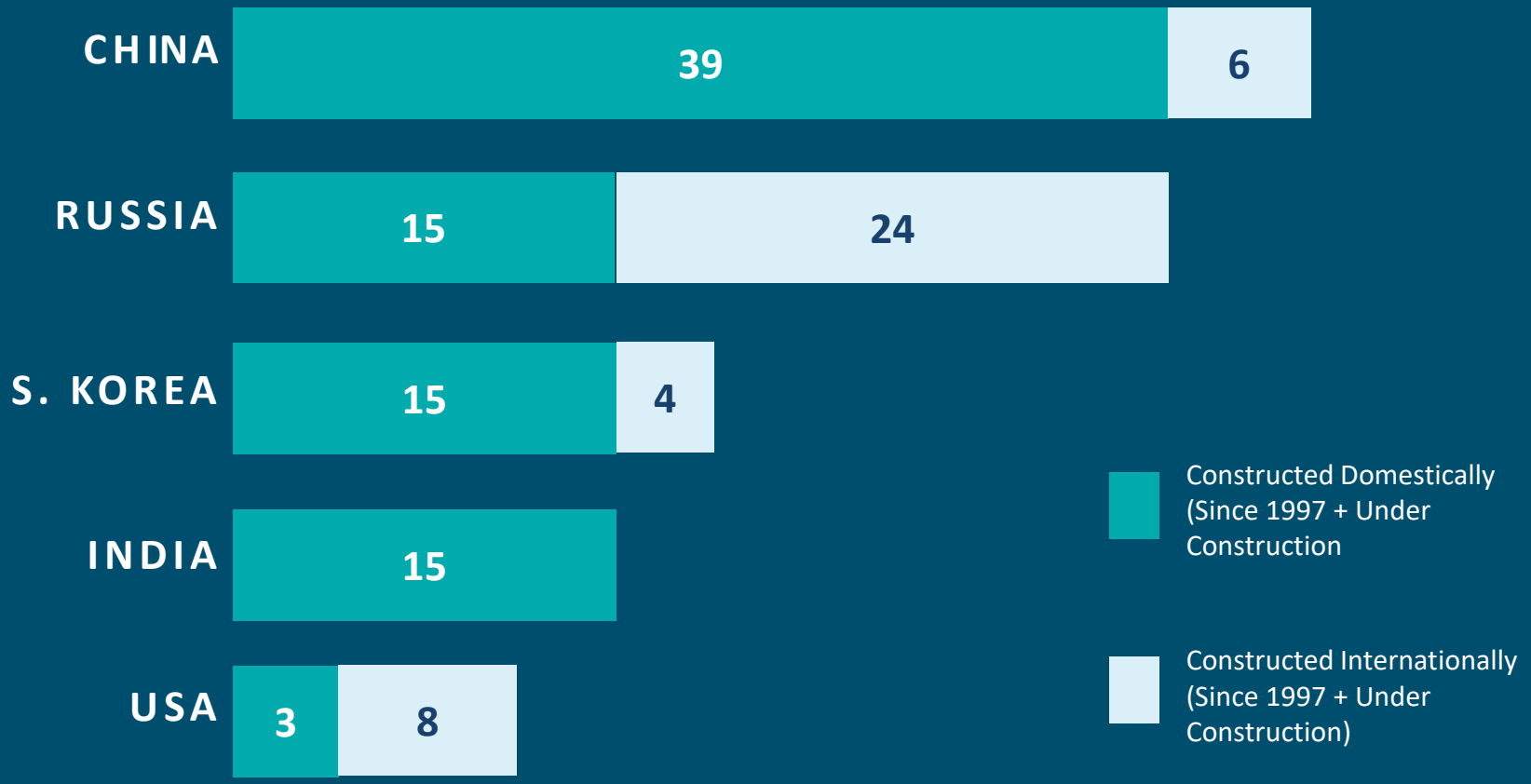
China and Russia are leading in constructing their domestic designs



Source: International Atomic Energy Agency: PRIS Database
Updated: February 2019

RUSSIA AND CHINA ARE WINNING

China and Russia are leading in constructing their domestic designs



Source: International Atomic Energy Agency: PRIS Database
Updated: September 2018

GROWING GLOBAL INFLUENCE

UNITED STATES

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The Great Debate

Russia building nuclear reactors – and influence – around the globe

By Hannah Thoburn | April 29, 2015

Russian President Vladimir Putin (2nd L), his Egyptian counterpart Abdel Fattah al-Sisi (2nd R) and Russia's Defense Minister Sergei Shoigu (L) meet onboard a guided missile cruiser at the port of Sochi, August 12, 2014. REUTERS/Alexei Druzhinin/RIA Novosti/Kremlin

Russia has been notoriously brazen in using state-owned companies as instruments of national power. President Vladimir Putin's natural-gas wars with Belarus and Ukraine made headlines and sometimes left substantial parts of Europe in the cold. But Moscow's exploits in other energy-related areas have been less noticed.

WHY? A CENTURY-LONG RELATIONSHIP

Cooperation on:

Reactor system procurement

Operator training

Regulatory capacity

Construction quality & safety

Environmental protection

Cooperation on:

Physical security
Cybersecurity
Nuclear material protection & accountability
Nuclear nonproliferation
Supply of fuel & services
Research & development
Workforce development
Nuclear materials transportation
Operational safety & performance
Safety regulation

Cooperation on:

Decommissioning services

Decontamination technologies

Nuclear waste management

Environmental protection

Creating a Brighter Nuclear Future: The Essentials

- Markets and policies that fully value what nuclear delivers
  - Current plants
  - New build
- Sustained successful operating of existing plants
  - Safe operations
  - Continually increasing operational efficiency
- Continued movement toward more risk-informed regulation

Creating a Brighter Nuclear Future: The Essentials

- Investment in RDD&D that preserves U.S. status as leading innovator
  - Cost-effective, flexible new designs
  - Advanced fuels, I&C, materials, construction/fab techniques, etc.
  - Preserve existing & add new capabilities
- Success in export markets
- Increased public acceptance/social license
  - Resolve back-end of the fuel cycle
  - New approaches to siting, public engagement

Partners in Advocacy

Ohio Clean Energy Jobs Alliance

Prevent The Loss of $500 Million to Ohio's Economy

Here's how you can help:

NEI

ANS Center for Nuclear Science and Technology Information

NAVIGATING™ NUCLEAR

Energizing Our World

An ANS Center for Nuclear Science and Technology Information's Education Initiative in Collaboration with Discovery Education

CLEARPATH

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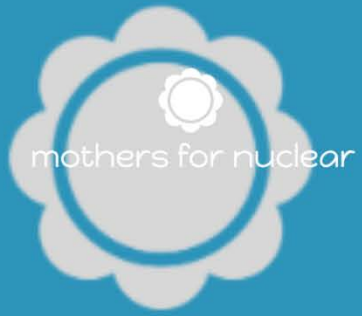
Nuclear

Nuclear power is the largest source of clean energy in the United States. In 2014, nuclear plants made 19% of all the electricity made in America. That's 4 times as much clean power as wind and solar combined.

Download Policy Overview

NEI



mothers for nuclear

"As mothers, we feel a responsibility to protect our children, and the planet they'll inherit."

I am Kristin Zaitz

I am a co-founder of Mothers for Nuclear and mom to Oliver and Kate. I am an outdoors woman, civil engineer, project manager, and

I am Heather Matteson

I am a co-founder of Mothers for Nuclear, and Zoe's mom. I am a materials scientist, nuclear reactor operator and lifelong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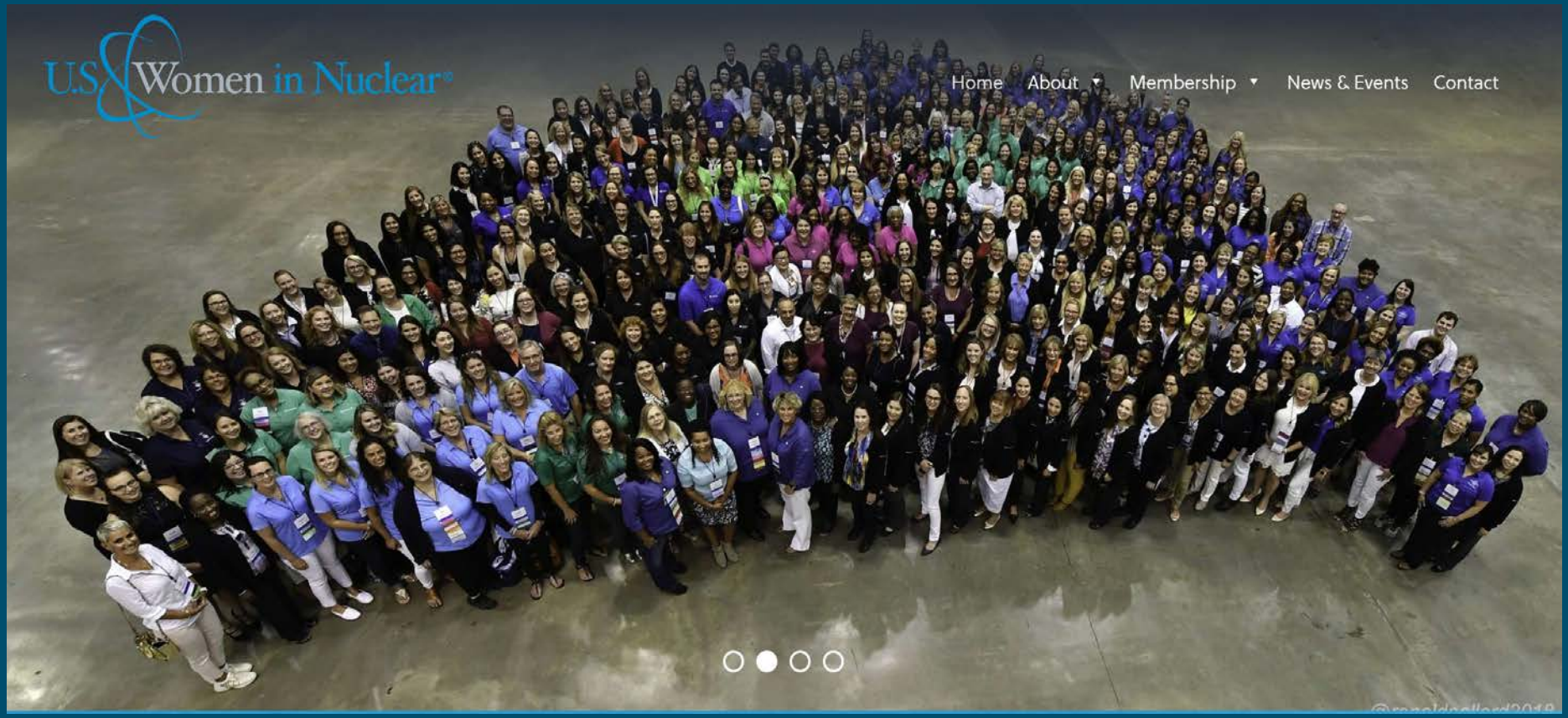
Our Mission
NAYGN provides opportunities for a young generation of nuclear enthusiasts to develop leadership and professional skills, create life-long connections, engage and inform the public, and inspire today's nuclear technology professionals to meet the challenges of the 21st century.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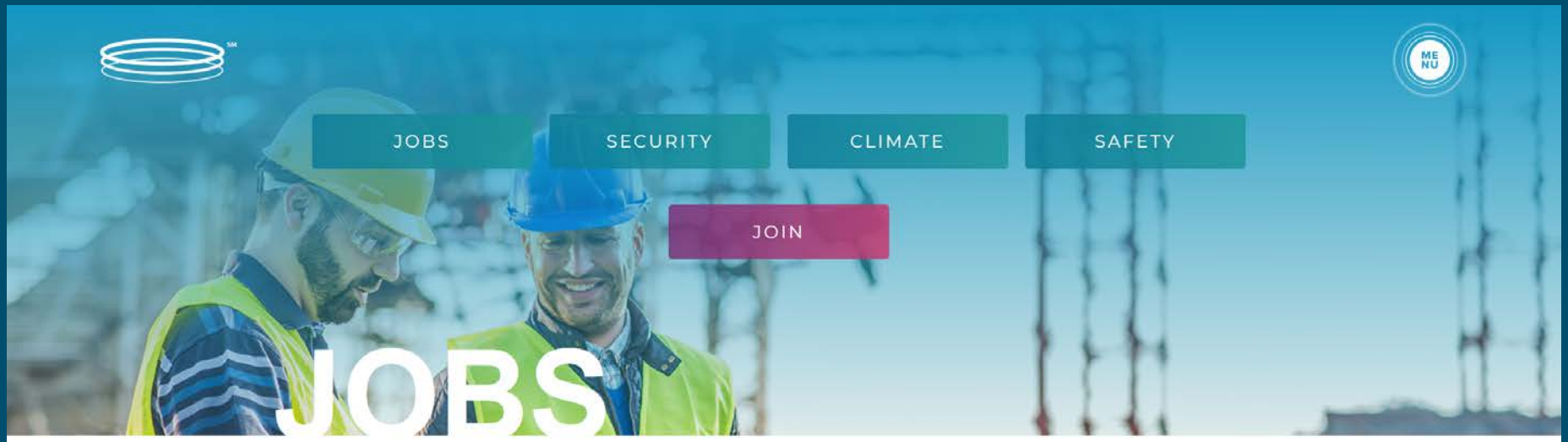

Nuclear plants are important economic engines for both our country and in the communities where they operate. They provide hundreds of thousands of

SIGN YOUR NAME TO SHOW YOU SUPPORT THIS