# Advanced Nuclear Reactors

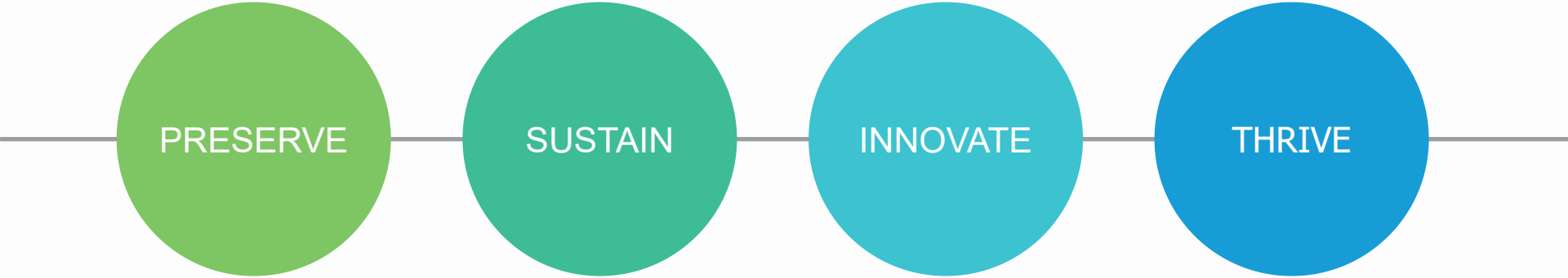
Presentation to Southern States Energy Board

John Kotek, Vice President, Policy & Public Affairs

September 25, 2019

NUCLEAR ENERGY INSTITUTE

# National Nuclear Energy Strategy




**Appropriately value nuclear generation**

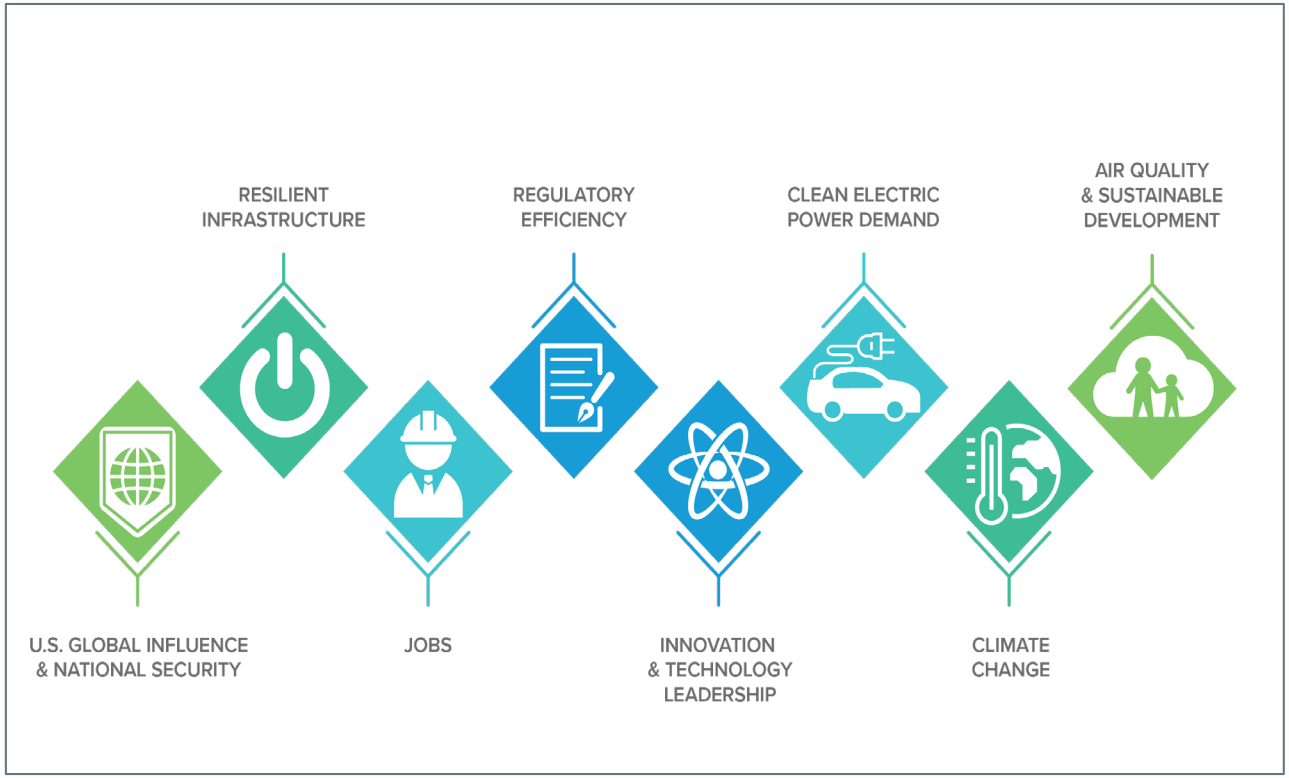
**Create sustainability via improved regulatory framework and reduced burden**

**Innovate, commercialize, and deploy new nuclear**

**Compete globally**

# Nuclear Energy Imperatives



# The Emissions Reduction Imperative

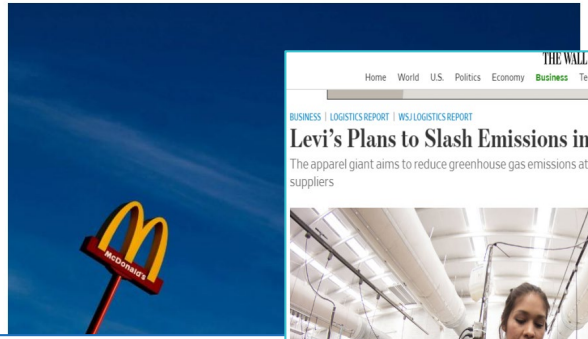
ENVIRONMENT MARCH 20, 2018 / 10:29 AM / A YEAR AGO

REUTERS

## McDonald's sets greenhouse gas reduction targets

Lisa Baertlein 3 MIN READ

(Reuters) - McDonald's Corp on Tuesday announced an approved, science based target to cut greenhouse gas emissions and battle climate change, saying it is the first restaurant company to do so.




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

The number of large companies taking serious action to tackle greenhouse gas emissions in their supply chains has doubled, according to research by an

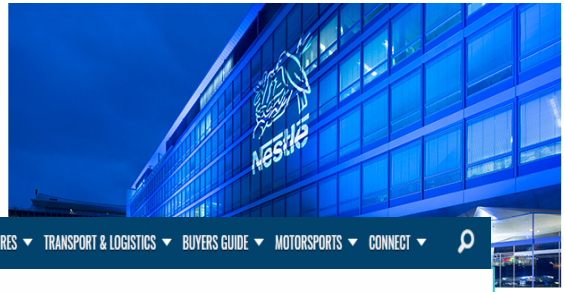
CLIMATE

## Nestlé commits to net-zero target by 2050

E&E NEWS PM

Haley Weiss, E&E News reporter

*Published: Monday, September 16, 2019*

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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.

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## Toyota wants zero carbon emissions in all factories by 2050

Marcus De Guzman

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*Clean, zero emission Toyota factories may soon be a reality*

Toyota

May 31, 2019 09:41

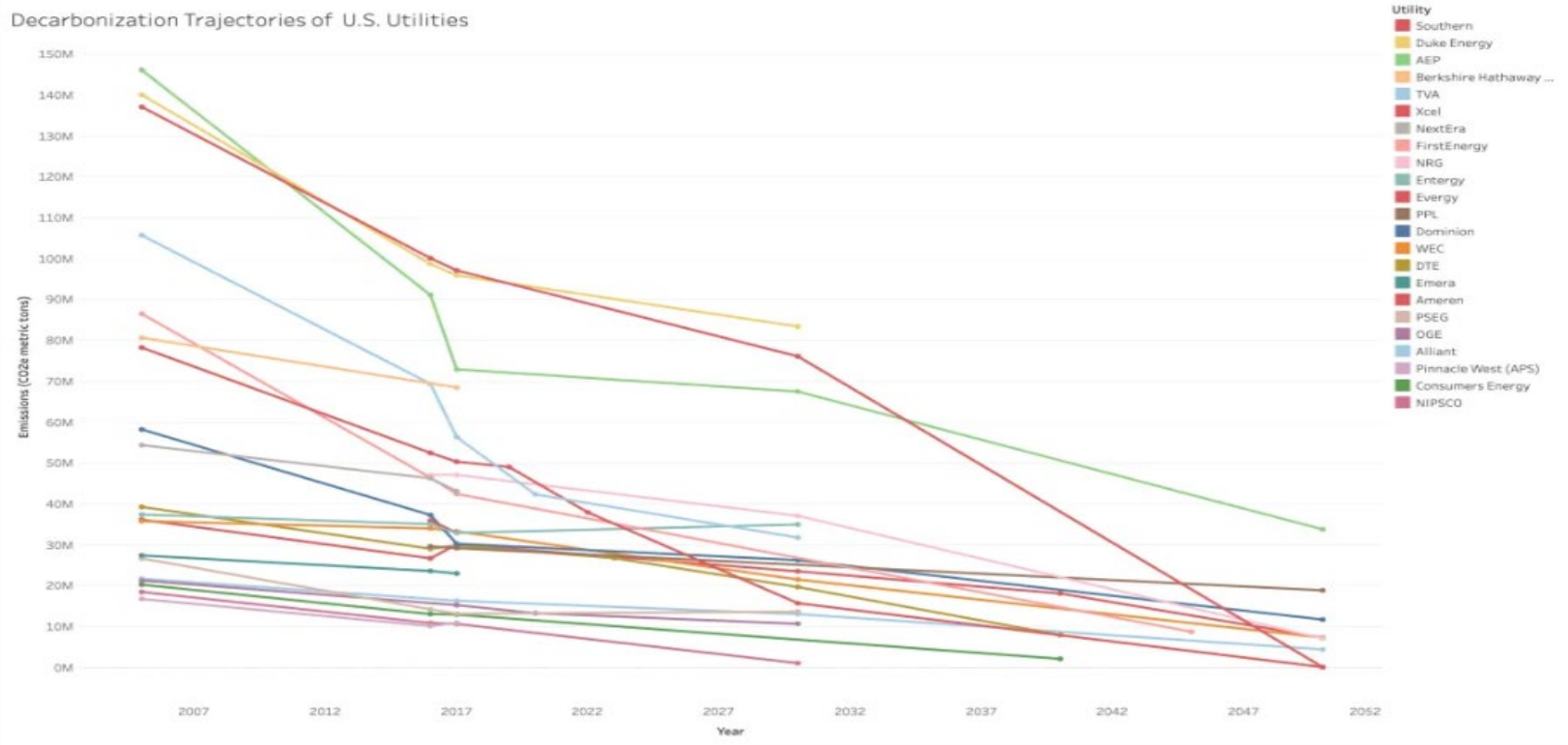
Let's face it, manufacturing cars is no easy feat. Aside from the fact that you have to build a whole fleet of them, you'll also need plenty of resources and energy to manufacture batches of them. But using energy means you're also producing $CO_2$ emissions, which is never good.

That's right, aside from automobiles, car factories also use plenty of energy that result in more $CO_2$ emissions that harm the environment and add more greenhouse gases that pollute the air. So how does Toyota plan to combat that? By setting a goal of achieving 35% reduced $CO_2$ emissions in global plants worldwide by 2030, and having zero $Co_2$ emissions in all manufacturing plants by 2050.

Part of the "Toyota Environmental Challenge 2050", the automaker is looking at not just reducing their carbon footprint from their cars, but also from their manufacturing facilities. To do this, Toyota has been finding ways of recycling and using alternative means of generating energy.

Advertisement

# Utility Decarbonization Commitments

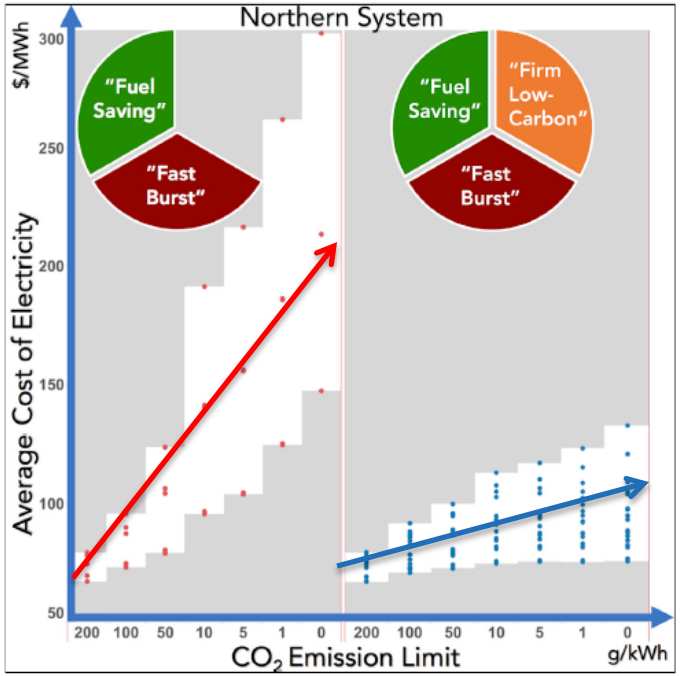



Decarbonization pathways of the nation's largest investor-owned utilities, according to their carbon targets

Source: https://www.energyandpolicy.org/utility-carbon-targets/

# Firm, Low-carbon Generation Enables Affordable Decarbonization





Nestor A. Sepulveda, Jesse D. Jenkins, Fernando J. de Sisternes, Richard K. Lester

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rklester@mit.edu (R.K.L.)


HIGHLIGHTS

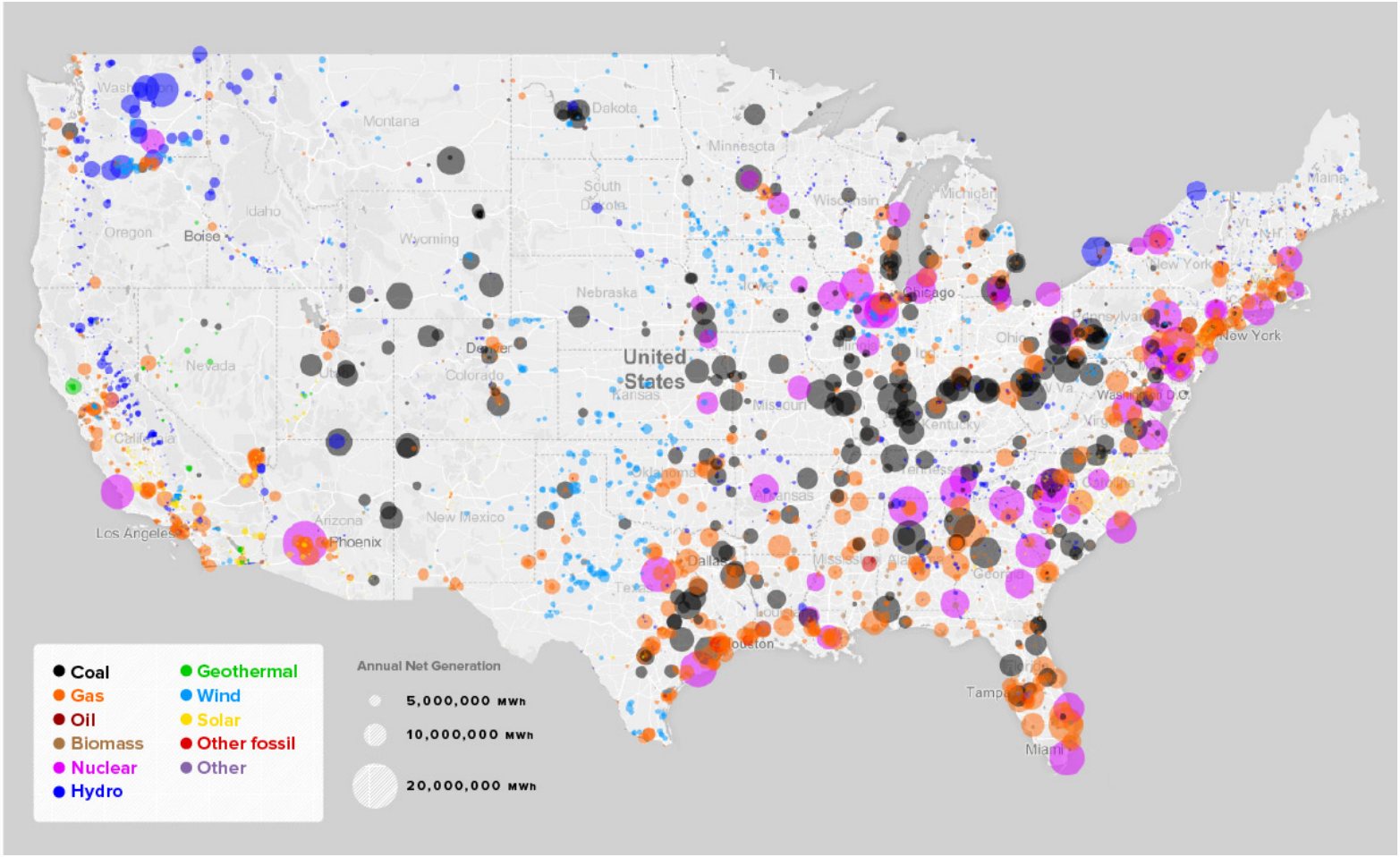
Firm low-carbon resources consistently lower decarbonized electricity system costs

Availability of firm low-carbon resources reduces costs 10%–62% in zero-$CO_2$ cases

Without these resources, electricity costs rise rapidly as $CO_2$ limits near zero

Batteries and demand flexibility do not substitute for firm low-carbon resources

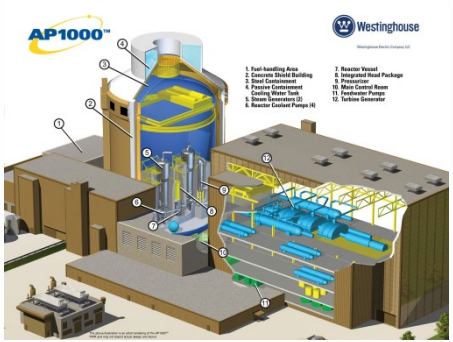
 



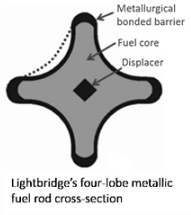

Source: https://www.visualcapitalist.com/mapped-every-power-plant-in-the-united-states/

# Continuum of Innovation




## Evolutionary LWR Fuels



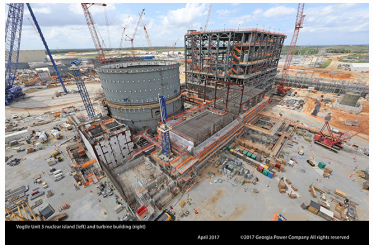
Lightbridge's four-lobe metallic fuel rod cross-section

## Advanced Non-LWRs

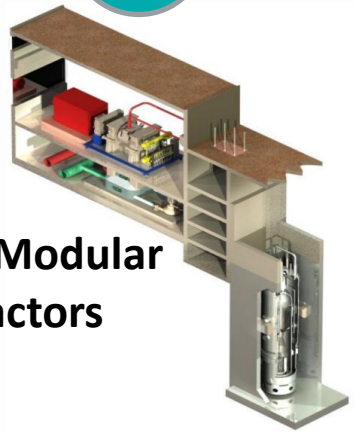
- Hi-temp gas
- Liquid metal
- Molten salt
- Micro-reactors

2016 2020 2025 2030

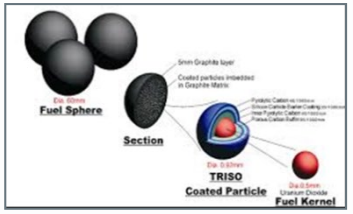

## Large LWRs



NuScale Power Module

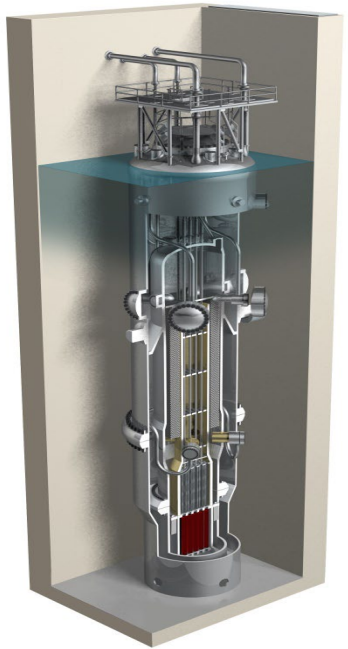


## Small Modular Reactors



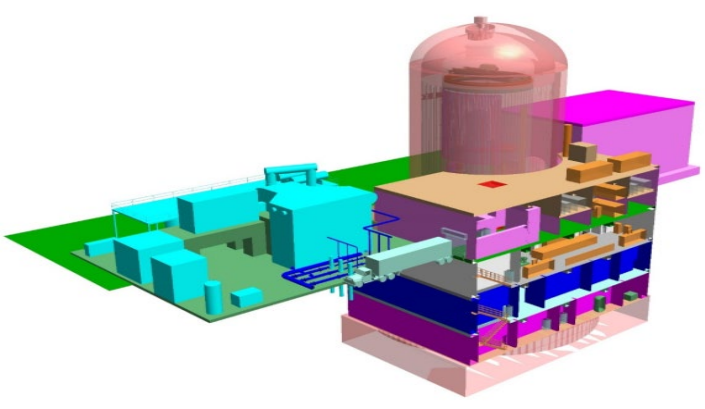

 

# Small Modular LWRs



NuScale Power Module

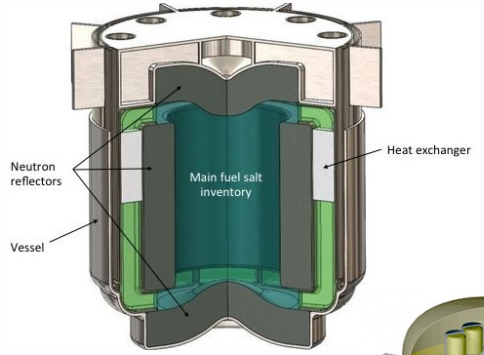
GEH BWRX-300



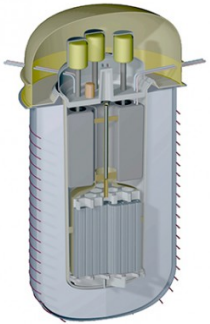
Holtec SMR-160

# Non-Water Cooled Reactors

## Molten Salt Reactors

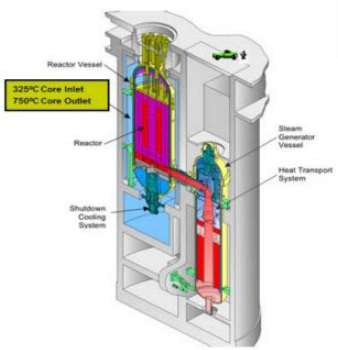



TerraPower

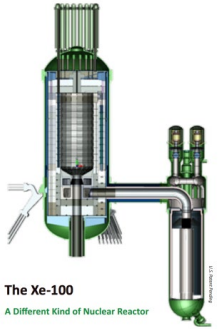


Terrestrial Energy

## High Temperature Gas Reactors




Framatome

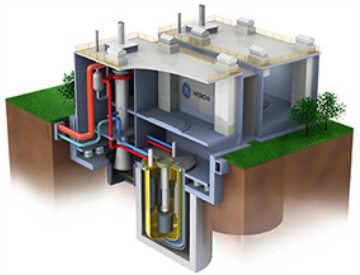



X-energy

## Micro Reactors

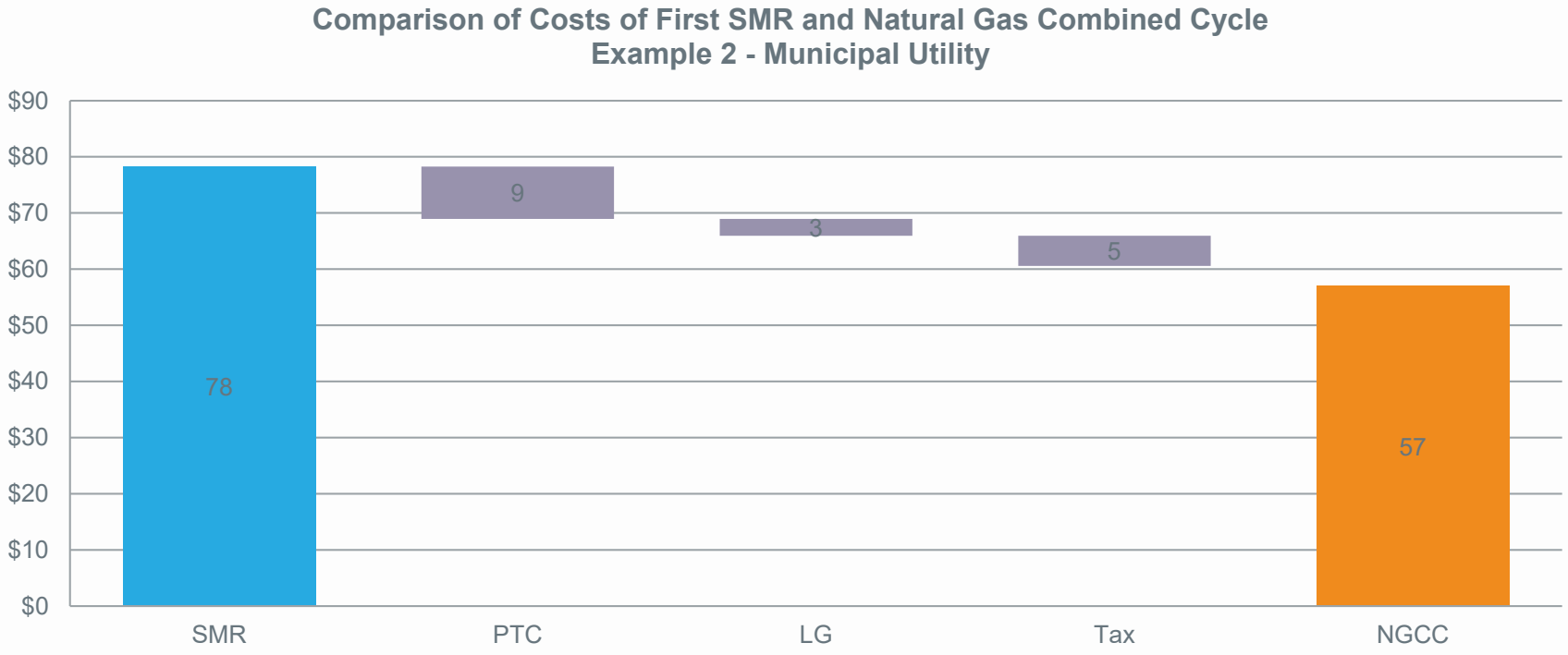
Westinghouse eVinci

## Liquid Metal Reactors



GE PRISM

# Need for Federal and State Policy Support



# Micro-Reactors

Features

- 1 MWe to 10 MWe (typical)
- 10 year fuel life (typical)
- Operates independent of grid


HolosGen


OKLO
2 MWe

Westinghouse eVinci
200 kWe to 25 MWe

Others (not all inclusive)

- Elysium
- General Atomics
- Hydromine
- NuGen
- NuScale
- X-Energy

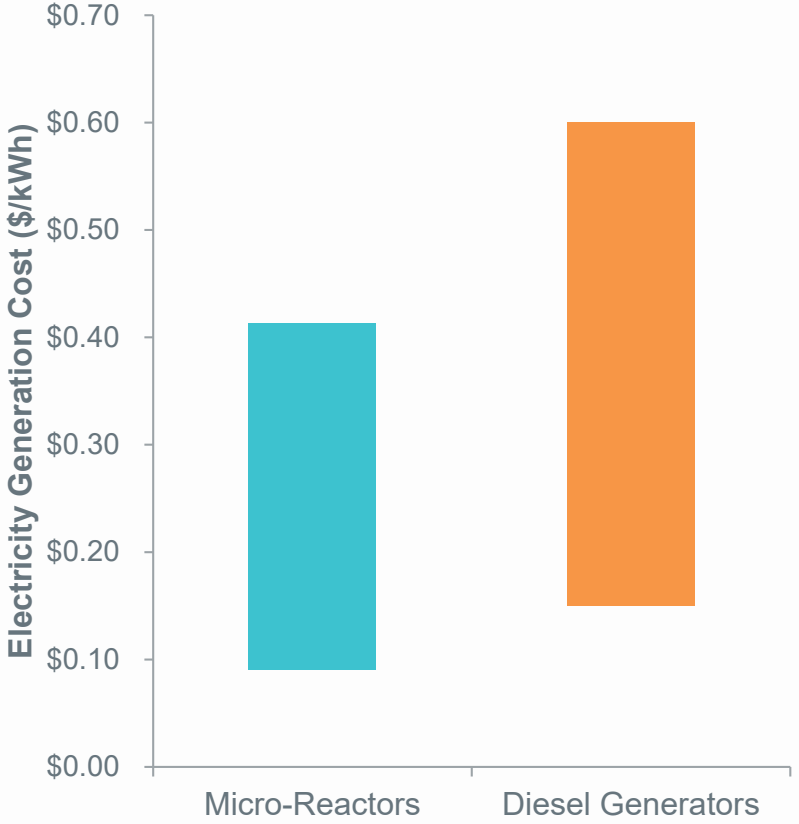
# An Emerging Customer?



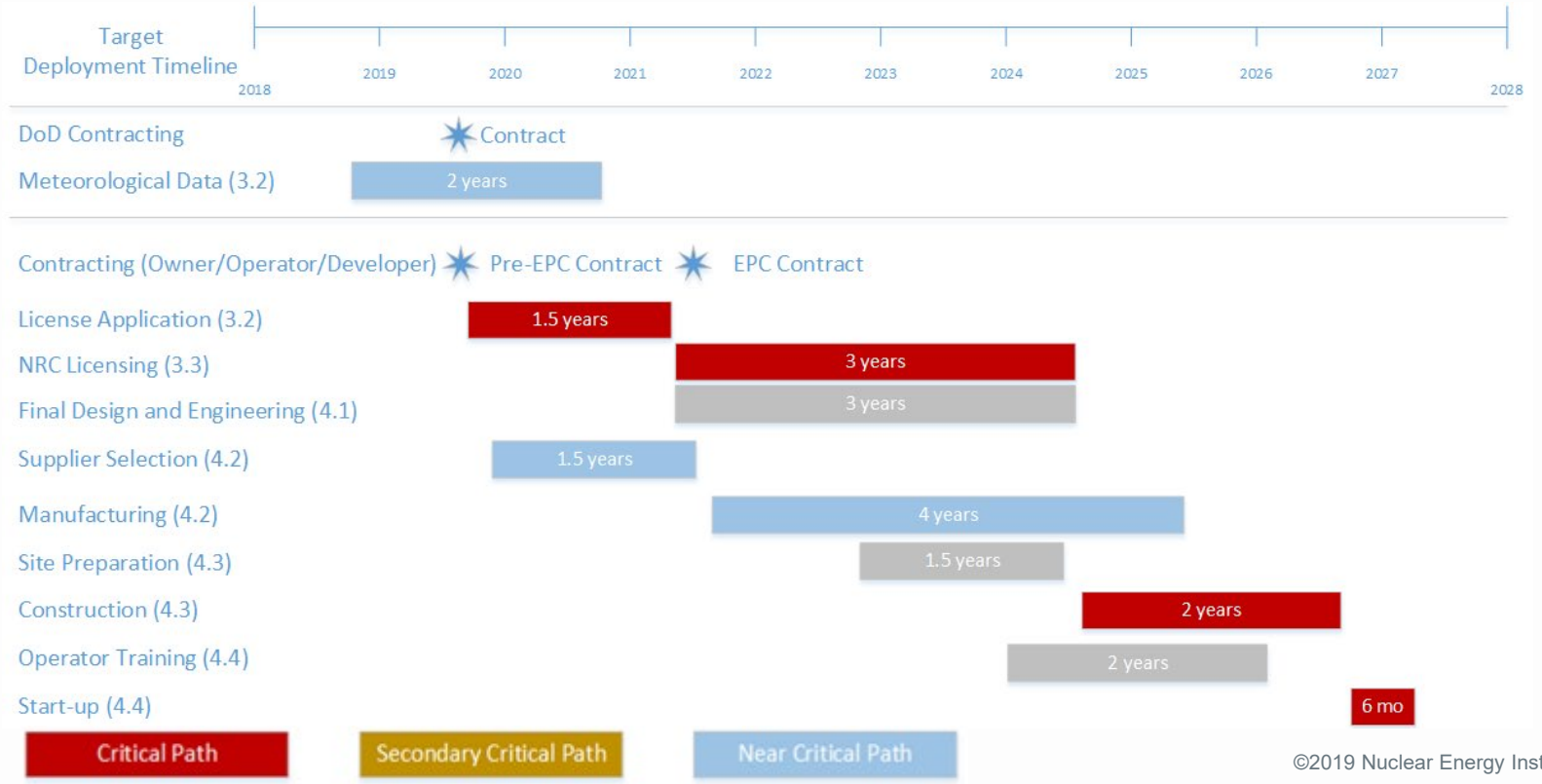

 

# Estimated Costs

- Diesel generator costs
  - Primarily fuel costs
  - Fuel from $2.86/gallon to $4.89/gallon
- Micro-reactor costs
  - Include used fuel disposal and decommissioning
  - 10 year fuel life
  - 40 year plant life
  - 95% capacity factor



# Deployment Timeline

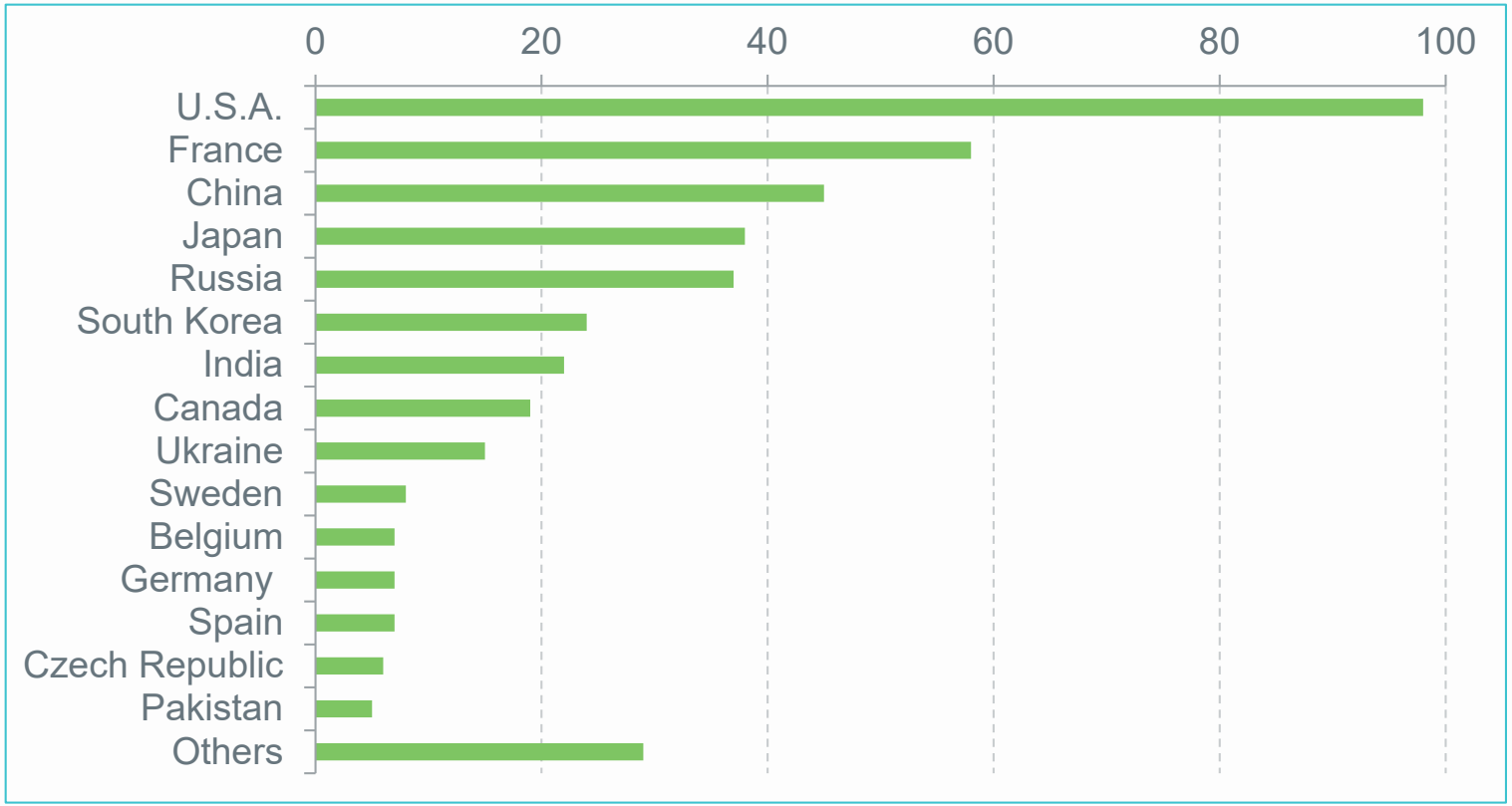


# Market Opportunities

# The National Security Imperative

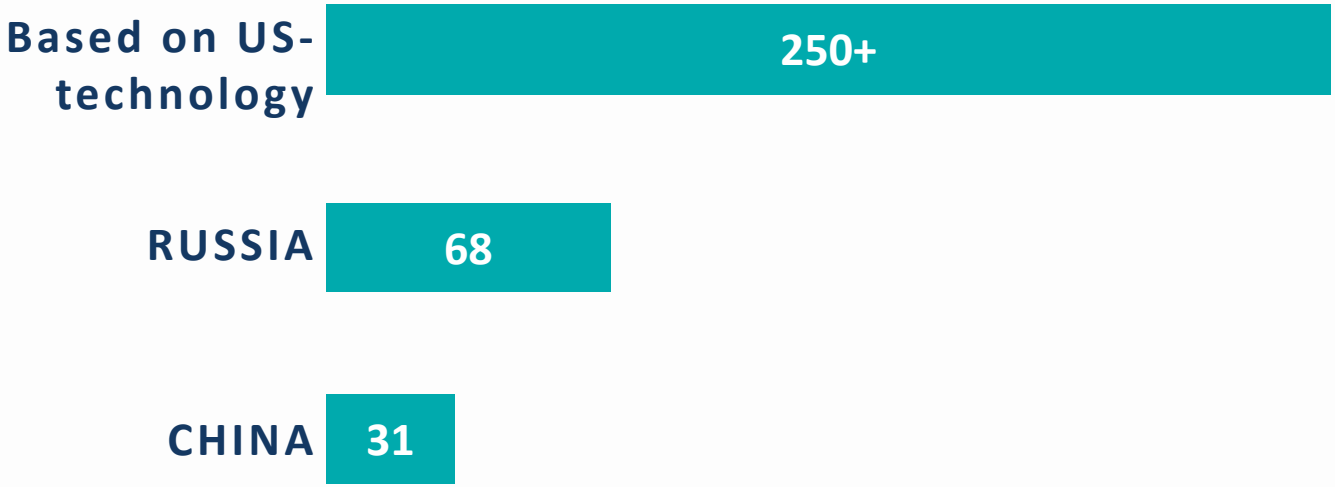



**NEARLY 450 OPERATIONAL REACTORS AROUND THE WORLD**

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

# Us Nuclear Energy Technology Once Led…

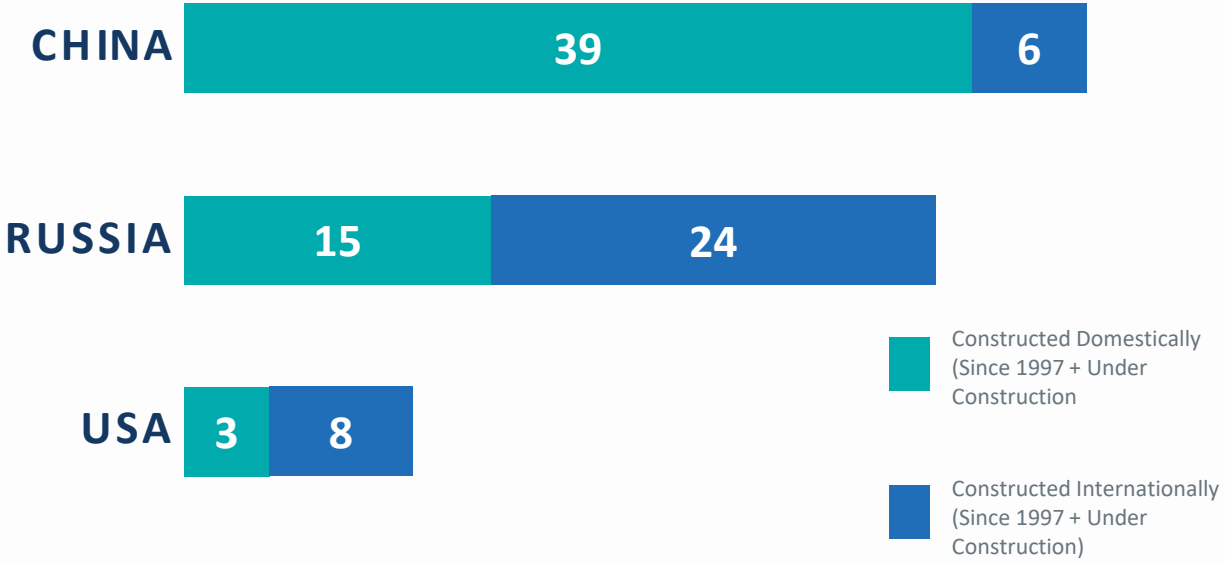
**U.S. technology is the basis for most of the world's operating nuclear reactors**




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

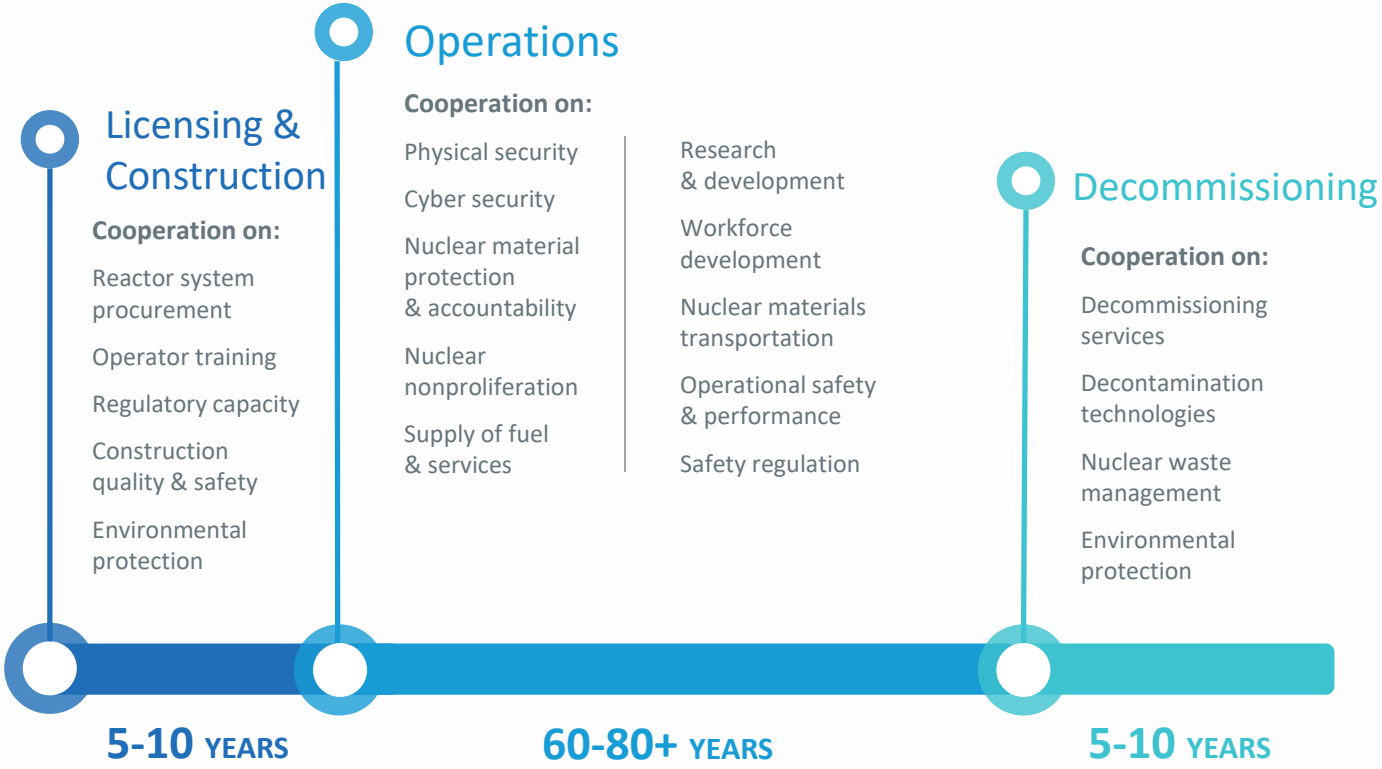
# …Today, Russia And China Are Winning

**China and Russia are leading in constructing their domestic designs**




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

# A Century-long Relationship



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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
R) and Russia's Defense Minister Sergei Shoigu (L) meet onboard a guided miss
at the port of Sochi, August 12, 2014. REUTERS/Alexei Druzhinin/RIA Novosti/K

Russia has been notoriously brazen in using state-owned compa
national power. President Vladimir Putin's natural-gas wars with
headlines and sometimes left substantial parts of Europe in the c
in other energy-related areas have been less noticed.

## Modi, Putin agree to expand nuclear power plant, push defence ties

India and Russia signed five pacts, including a crucial agreement on setting up two more atomic power plants at Kudankulam

Last Published: Thu, Jun 01 2017. 11 33 PM IST

Elizabeth Roche

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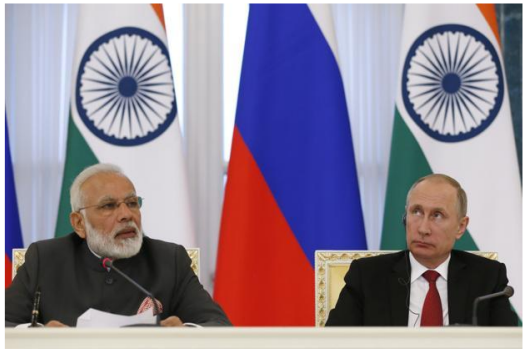

The pact is seen as a major outcome of the talks between Prime Minister Narendra Modi and Russian President Vladimir Putin. Photo: Grigory Dukor/Reuters

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## Pakistan PM Nawaz Sharif Inaugurates Chinese-Assisted Nuclear Power Plant

World | Press Trust of India | Updated: December 28, 2016 16:25 IST

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hanked China for extending cooperation in nuclear field. (File)

arved Pakistan today received a major boost as a China-backed 340
nt, Chasma-III, in its Punjab province was inaugurated by Prime
who termed it as a milestone in the government's efforts to end the
ng. The Chashma-III plant is located at Chashma in Mianwali district

# Creating A Brighter Nuclear Energy Future: The Essentials

- Markets and policies (e.g. CES) that fully value what nuclear delivers and stimulate new build
  - Current plants - ITC
  - New reactors – ITC or PTC
- Sustained successful operating of existing plants
  - Safe operations
  - Continually increasing operational efficiency
- Continued movement toward more risk-informed regulation

# Creating A Brighter Nuclear Energy 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
  - Ex-Im Bank
  - Administration advocacy
- Increased public acceptance/social license
  - Resolve back-end of the fuel cycle
  - New approaches to siting, public engagement

# QUESTIONS?