



Breaking Down Regulatory and Implementation Barriers for Digital Applications

**11th International Workshop on
Application of FPGAs in Nuclear Plants**

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S. Jason Remer, P.E.

Director, Life Extension and New Tech
Nuclear Energy Institute



Nuclear Contributions



AVOIDS
547.5
MILLION
METRIC TONS OF
CARBON
EMISSIONS
EACH YEAR

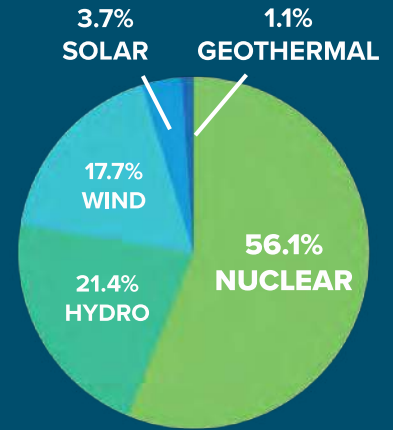
+

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

AND

374,000
SHORT TONS
OF **SO2**
EMISSIONS

—AVERAGE—
CAP FACTOR
>90%
SINCE 1999



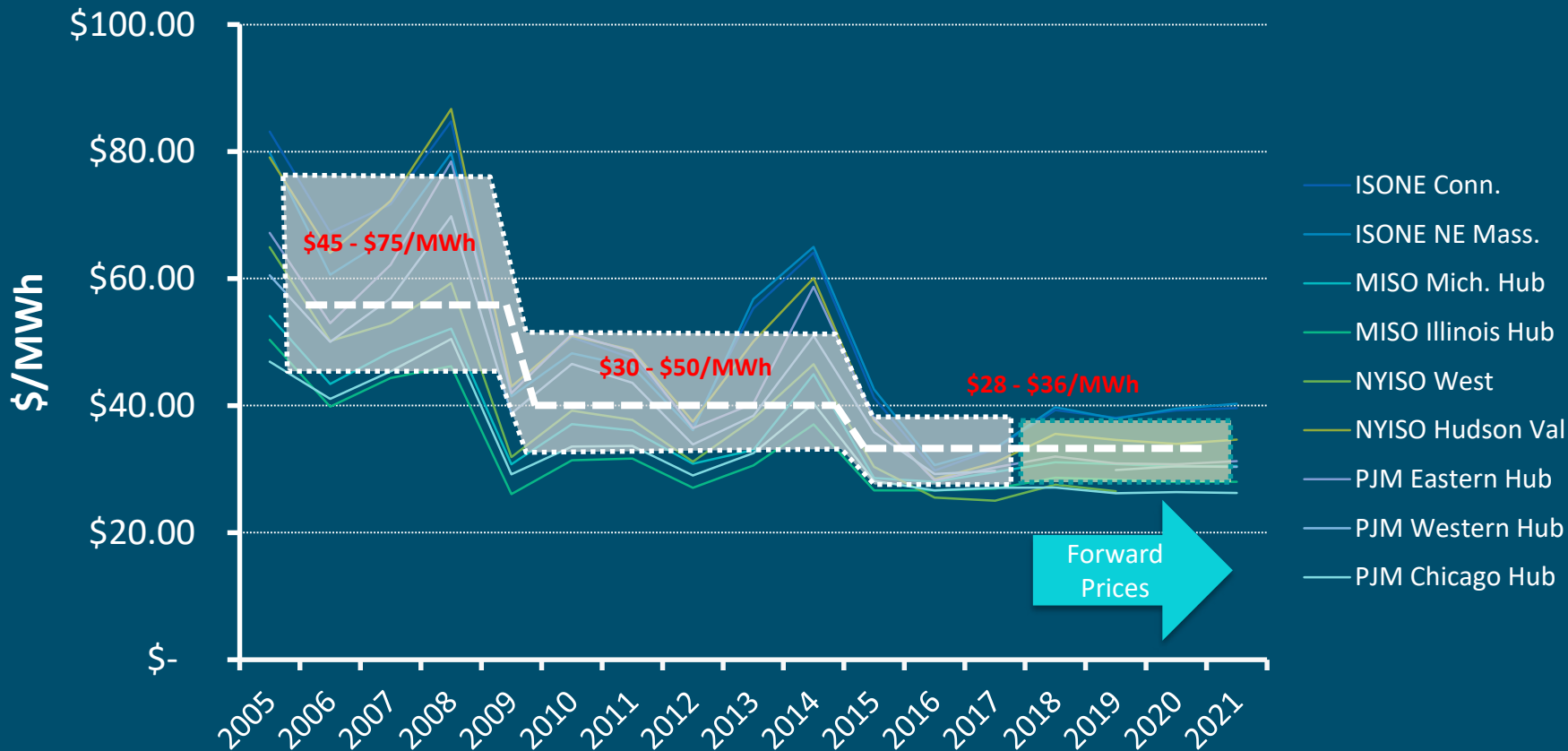
CONTRIBUTES
\$10 BILLION IN FEDERAL
AND **\$2.2 BILLION** IN STATE
TAXES EACH YEAR

SUPPORTS
475,000
JOBS

SAVES CONSUMERS
AN AVERAGE OF
 6%
ON ELECTRICITY BILLS

ADDS
\$60
BILLION
TO THE COUNTRY'S
GDP

Declining Electricity Prices



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
TOTAL	4,674			38.1	21.3
Oyster Creek	610	2018	Policy	5.4	4.0
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	11,848			94.9	59.5

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: July 2018.

NATIONAL NUCLEAR ENERGY STRATEGY

CREATE THE NUCLEAR IMPERATIVE



PRESERVE

Appropriately value
nuclear generation

SUSTAIN

Create sustainability
via improved
regulatory framework
and reduced burden

INNOVATE

Innovate,
commercialize,
and deploy
new nuclear

THRIVE

Compete globally

Preserve Deliverables



PRESERVE

**Appropriately
value nuclear
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SUSTAIN

Create sustainability
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THRIVE

Compete globally

1. Significantly impact conversation around proper valuation of nuclear generation
2. Advance state-level policy actions (Zero Emission Credits - ZEC, etc.)
3. Pursue market reforms at ISOs and FERC that recognize the attributes provided by nuclear plants

Nuclear Plants Saved from Premature Closure



Plant	MWe	Projected Closure Year	Reason for Potential Shutdown	Electricity Generated in 2017 (BkWh/year)	CO₂ Emissions Avoided in 2017 (Million MT/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
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
TOTAL	8,184			67.1	39.2

Sustain Deliverables



PRESERVE

Appropriately value
nuclear generation

SUSTAIN

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

INNOVATE

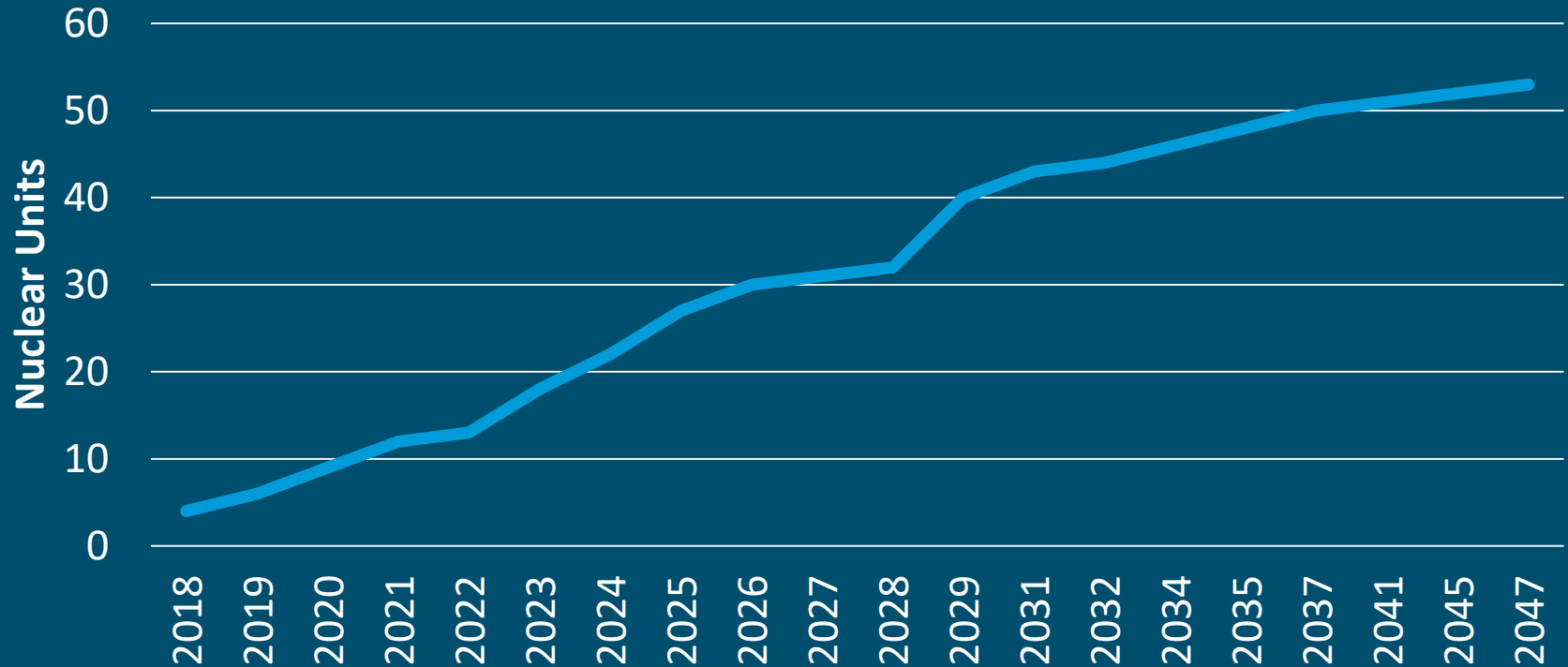
Innovate,
commercialize,
and deploy
new nuclear

THRIVE

Compete globally

1. Modernize NRC regulatory requirements and oversight
 1. Eliminate Regulatory burden for applying Digital Systems
2. Reduce the financial burden on nuclear operators
 1. Digital Control and Safety Systems
3. Advance new and used fuel regulations

Cumulative SLR Applications



- Make improvements to plant **Efficiency –Cost Savings**
- Improve long-term **Reliability** of critical I&C systems
- Manage component obsolescence
- Helps support the Business Case for 2nd License Renewal (**>60 Years**)
- Improve overall nuclear plant **Safety**
- **OE** – Industry in the US has been implementing digital upgrades for the past 25 years improving plant safety with significant success driven by plant availability and trip reduction modifications

I Love Old Pickup Trucks...



1978 Ford F150

351CI V8, modified

Front Disc Brakes, Analog Ignition Control

AM Radio

Brake light comes on after attempting stop

F150 - best selling truck in US

2016 Ford Flex

3.5L V6

ABS Brakes, Adaptive cruise control

Digital Engine/transmission control

Digital Traction Control

Front, side and top air bags

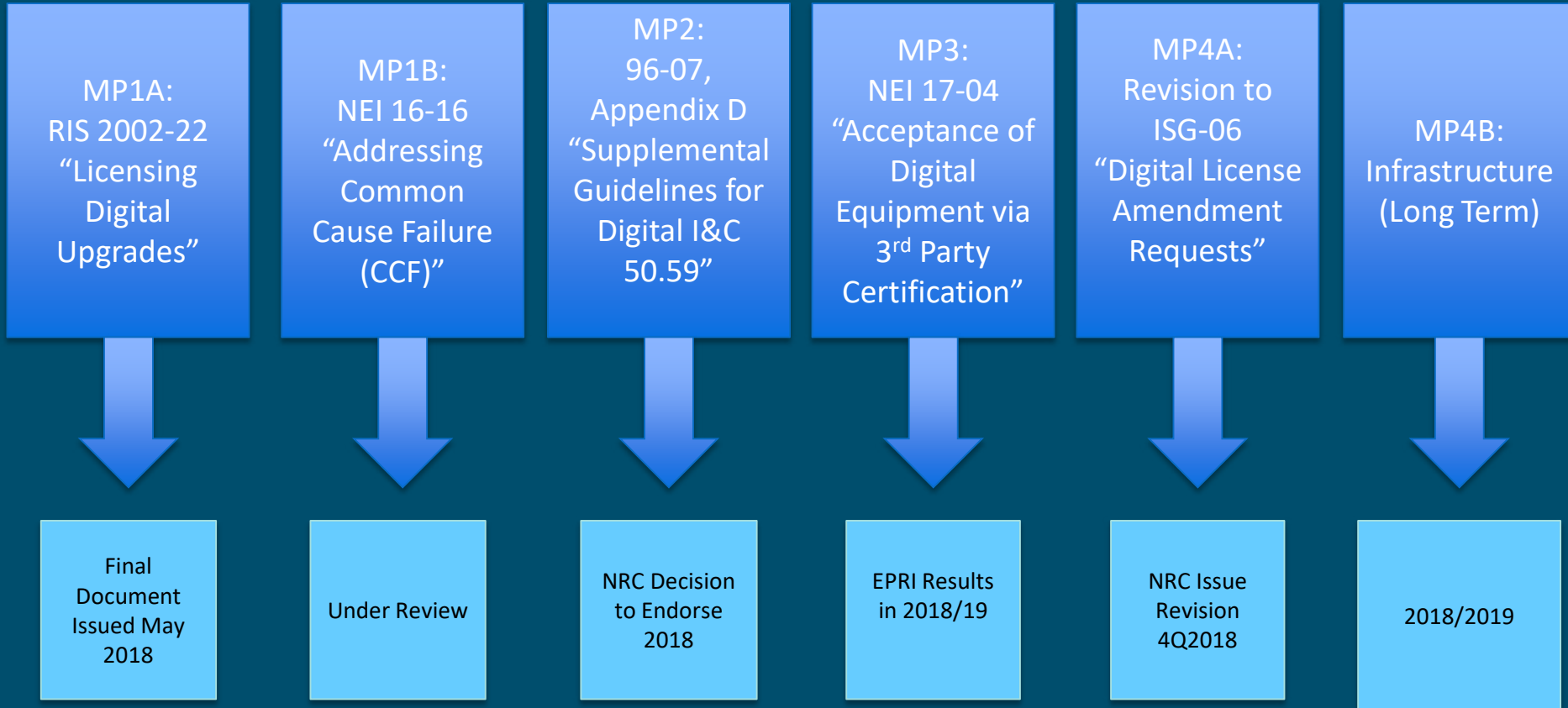
Sends vehicle health report to email

Bluetooth, driver assist, integrated entertainment system, etc.



- Industry Chief Nuclear Officers commissioned the Digital I&C Working Group to break down barriers to full plant application of digital systems
- NRC Commissioners instructed staff to establish a plan to “modernize the NRC regulatory infrastructure” - NRC Digital I&C Integrated Action Plan (IAP)
- U.S. Nuclear Industry, as led by the Nuclear Energy Institute (NEI), are working with NRC staff to identify key opportunities and develop a plan to resolve digital issues
- **This must be a step change and not a minor adjustment to current policy to be successful**

Digital I&C Modernization Plan (MP) Schedule



NEI Sponsored RIS Workshops

Date	Hosting Utility	Location	Classroom Capacity
August 15	TVA	Chattanooga, TN	50
August 21	Duke Energy	Kings Mountain, NC	30
August 23	Exelon	Oswego, NY (Lisle Point)	35
August 28	Exelon	Kennett Square, PA	45
September 5	APS	Tonopah, AZ (PacifiCorp)	45
September 12	Duke Energy	Kings Mountain, NC	30
September 17	Dominion Energy	Innsbrook, VA	50
October 10	Exelon	Warrenville, IL (Cantera)	30
October 22	Duke Energy	Kings Mountain, NC	30
October 24	Duke Energy	Kings Mountain, NC	30
October 30	Southern Nuclear Co.	Birmingham, AL	25
November 6	DTE Energy	Newport, MI (Fermi 2)	20

“Excellent Workshop”
“One of the best training experiences at the site ever”

Workshops led by NEI and Industry Experts and NRC HQ, Site and Region staff



- Over 50 safety-related and non-safety-related system and component upgrades planned as a result of guidance in RIS 2002-22 Supplement 1 identified so far
 - Control room chiller controls
 - Emergency Diesel Generator controls
 - Control room indicators and recorders
 - Main Feedwater, Emergency Feedwater and turbine controls
- Leading utilities in discussion to implement major digital upgrades to control room, Reactor Protection Systems and Engineered Safety Features Actuation Systems
 - Plans subject to revision of DI&C ISG-06 by 2018
 - Second License Renewal providing opportunities for major capital investments



- NRC not prepared for new technologies including Digital I&C, Advanced Reactors and Big Data
 - Commissioned a study now before the Commission
- Industry identified areas where radical transformation is needed
 - Utilize qualitative and quantitative risk insights to guide all regulatory decision making processes
 - Recognize the current inherent safety margins in all licensing activities
 - Utilize Digital I&C to gain operating efficiencies and reduce maintenance and surveillance activities
 - Allow use of international standards not specifically approved by NRC (IAEA, etc.)

DELIVERING THE
NUCLEAR PROMISE



FUTURE PLANT INITIATIVE



Process and
Program
Redesign



Risk-Informed
Decision Making



Regulatory
Transformation

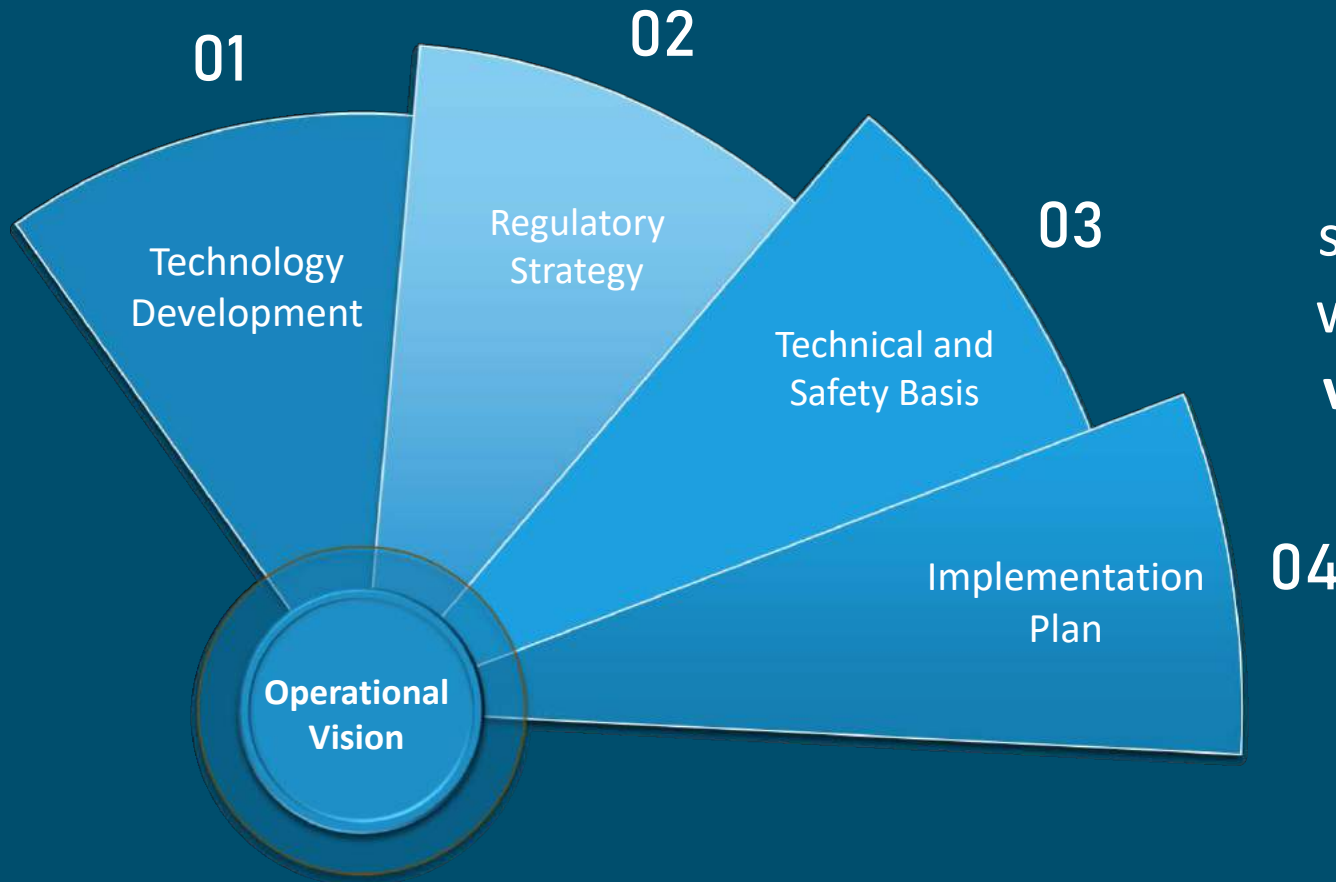


Digital
Technology



Research and
Development

The road to future plant operations must build off of and go deeper than process improvements with application of risk insights and digital I&C systems



A comprehensive strategy must begin with an **operational vision** of the future plant

Coordination and collaboration is essential for industry success

EPRI

ELECTRIC POWER
RESEARCH INSTITUTE

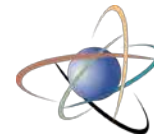


U.S. DEPARTMENT OF
ENERGY



NUCLEAR ENERGY INSTITUTE

INPO[®]



U.S. NRC

A nighttime photograph of the Washington Monument, Lincoln Memorial, and US Capitol building in Washington, D.C. The sky is a deep orange and red, suggesting sunset or sunrise. The Lincoln Memorial is illuminated from below, and the Washington Monument is lit up. The US Capitol building is also lit up, and its dome is prominent. The foreground shows some trees and streetlights.

Questions?