

# **CIBO Environmental & Energy/Sustainability Committee Meeting**

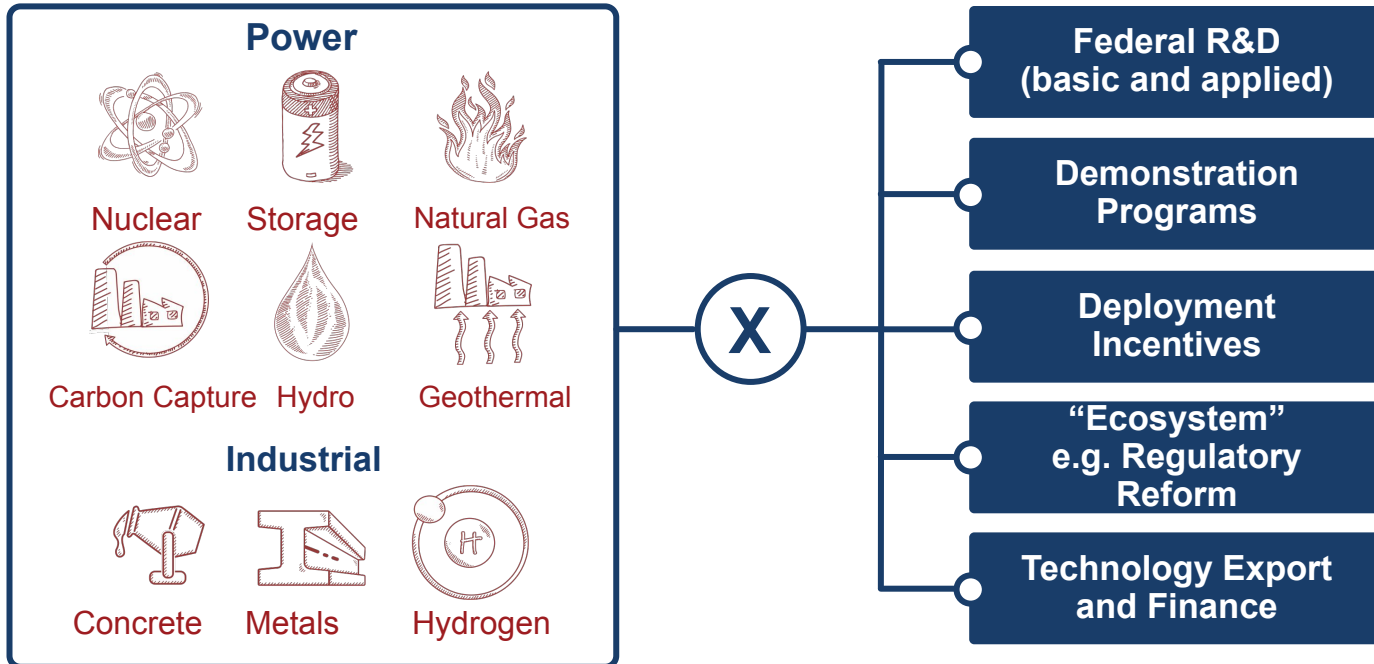
**Small Modular Nuclear Reactors – Industrial:  
New Technologies/NRC Licensing**

March 7, 2023

**CLEARPATH**

# CLEARPATH

## Key technologies and policy areas



**Mission: Develop and advance policies that accelerate innovations to reduce and remove global energy emissions.**



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## Current Nuclear Landscape and NRC History

- Current nuclear landscape
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- Simple hierarchy of regulations

## Reactor Licensing

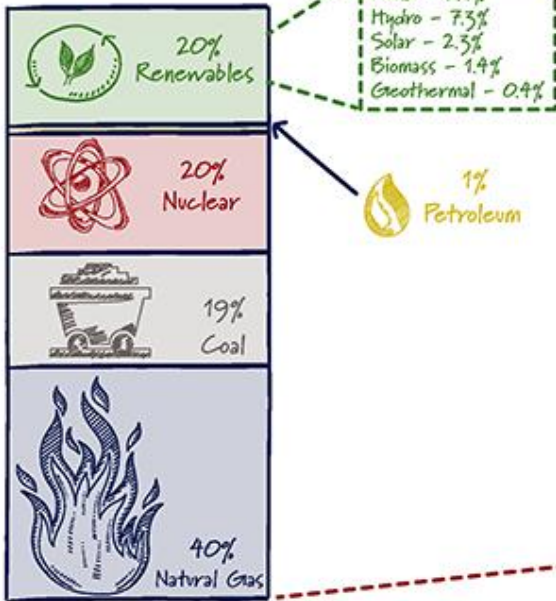
- Technical requirements vs licensing processes
- Part 50, Part 52, and more

## Case Studies

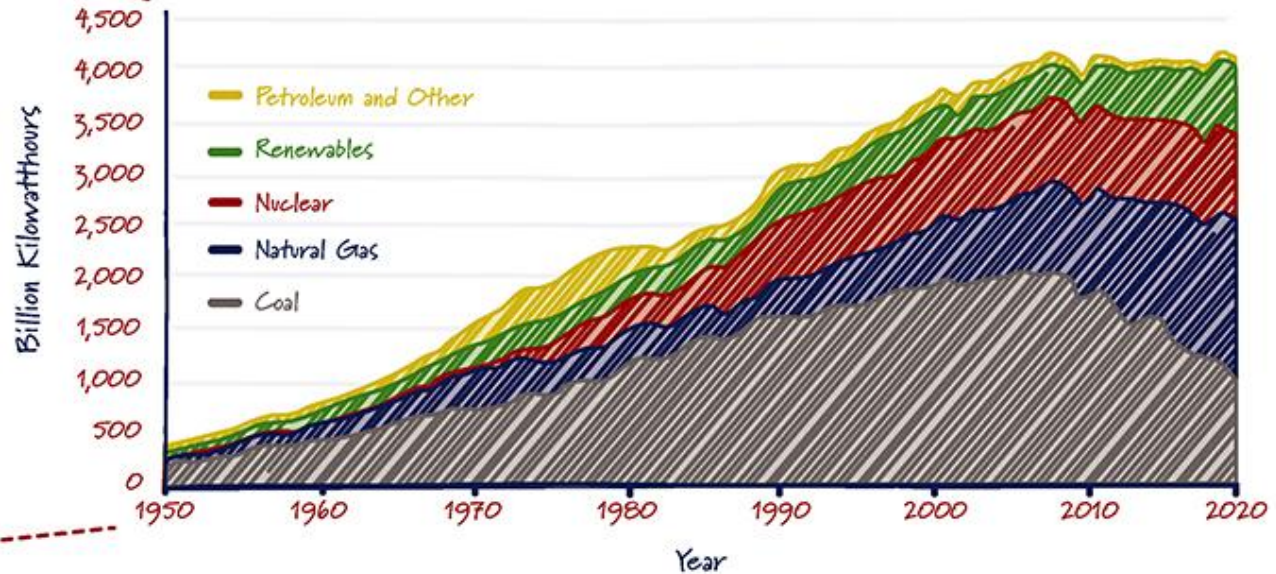
- X-energy, NuScale, and Oklo
- Q+A

# Sources of power in the U.S. have evolved over time

Sources of U.S. Electricity Generation, 2020



U.S. Electricity Generation by Major Energy Source, 1950-2020



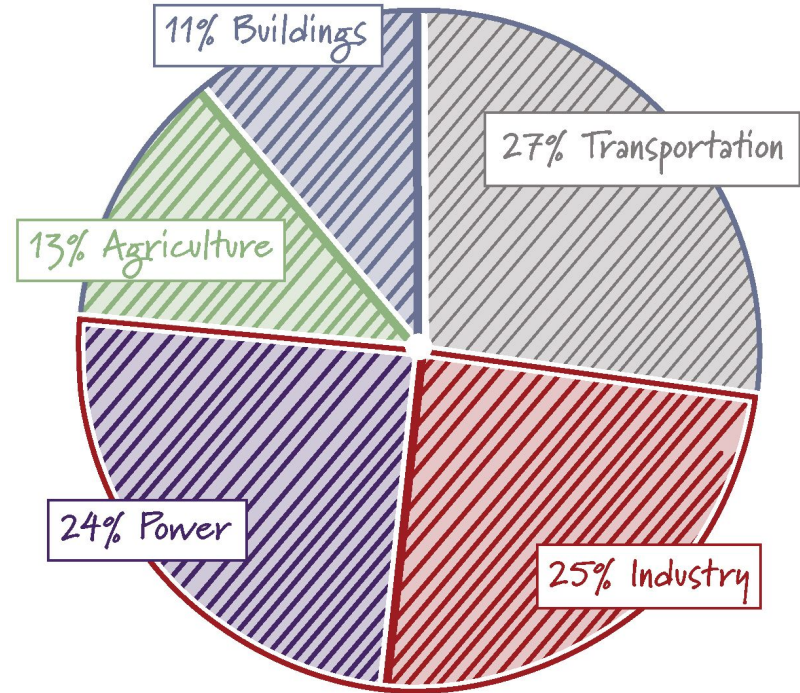
# Opportunity for Industrial Sector Decarbonization

## Why Industrial

Industrial emissions account for 25% of total U.S. emissions, driven by heavy industrial sub-sectors including steel, cement, and chemicals.

## More Policy is Needed

Without policy changes, industrial emissions are set to be the top source of emissions by 2030, surpassing the electric power and transportation sectors.



# Nuclear: Recently Enacted Policies

## Energy Act 2020

- Comprehensive reauthorization of nuclear energy research and development programs
- Advanced Reactor Demonstration Program Authorization
- HALEU Fuel Authorization
- Russian Suspension Agreement Extension
- Fusion R&D reauthorization (five years)

## IJA

- Advanced Reactor Demonstration Program, partial funding, only for 2 big demos - \$2.5 billion (direct funding)
- Authorized siting studies for isolated communities
- Civil nuclear credit program - \$6 billion (direct funding)

## CHIPS+

- Fission for the Future, DOE supports AdvR deployment with prioritization of fossil closure communities - \$800 million (auth 2023-27)
- National Nuclear University Research Infrastructure Reinvestment - \$15 million (auth)
- DOE-SC Fusion research - \$250 million (auth 2023-27)

## Tax Bill

- HALEU Approps - \$700 million
- 45U - Existing-nuclear PTC, dynamic and based on plant revenue
- 45Y&48E - Clean Electricity PTC/ITC
- 45V - Hydrogen PTC credit stacking with 45U. ITC option
- 48C - Advanced Energy Projects ITC extension - \$10 billion
- Office of Nuclear Energy national lab infrastructure - \$150 million
- LPO: Loan Guarantee expansion to \$80 billion & \$250B loan authority for energy repowering generation
- Advanced Industrial Facilities Deployment program - \$5.8 billion

# A Brief History of the NRC

## The AEC and the NRC

- Congress created the Atomic Energy Commission (AEC) in the Atomic Energy Act of 1946, later amended in 1954
- The Energy Reorganization Act of 1974 created the Nuclear Regulatory Commission (NRC)
- The NRC regulates reactors, nuclear materials, and waste through licensing, inspection, and enforcement.

## The Mission of the NRC

“The NRC licenses and regulates the Nation's civilian use of radioactive materials to provide reasonable assurance of adequate protection of public health and safety and to promote the common defense and security and to protect the environment”

## The Commission

- Led by a five member Commission, which are appointed by the President and confirmed by the Senate. No more than three Commissioners can be from one political party.
- Five year terms. One member is designated the Chair by the President.
- “Collegial body”

## The NRC

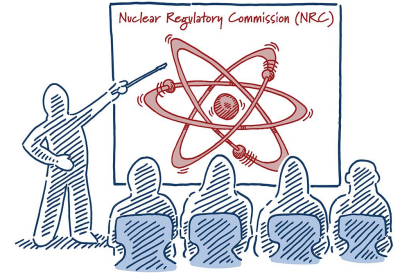
- Independent Agency
- HQ in DC and four Regional offices
- FY23 budget is \$927.2 million; 100% fee recoverable
- 1,672 mission direct FTE
- Multiple Offices - NRR, Research, NMSS



# A Simple Hierarchy of Regulation

## The Law

- The statutory authority for the NRC
- The Atomic Energy Act of 1954
- The Energy Reorganization Act of 1974
- And more! (APA, NEPA)



## Code of Federal Regulations (CFR)

- Title 10, Energy — the “rules” or “regulations,” which have the “force of law”
- Compliance “provides reasonable assurance of adequate protection of public health and safety and promotes the common defense and security and to protect the environment”
- In short, compliance with the regulations is how the NRC determines safety

## Regulatory Guidance

- Regulatory Guides (RGs) are NRC approved methods of meeting the regulations
- Usually developed along with new regulations
- Regulations are mandatory. Guidance is optional.

# What is in 10 CFR?

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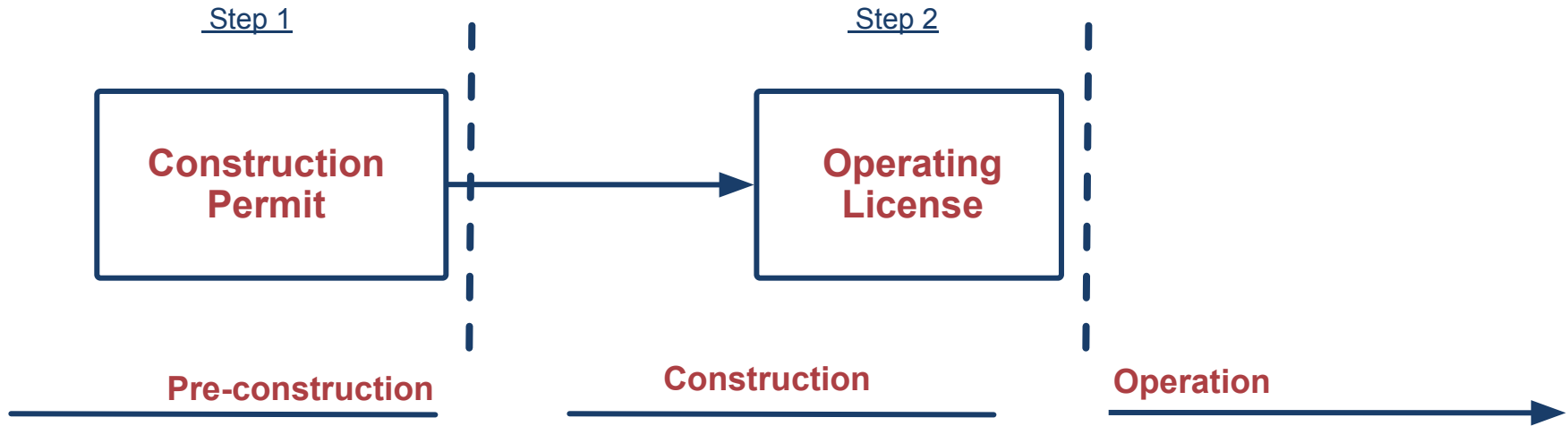
## Technical Requirements

- Specific requirements that must be met by license holders
- Can be performance-based, or prescriptive
- Some examples include dose limits, QA requirements, types and number of safety systems, and LWR fuel limits

## Licensing Processes

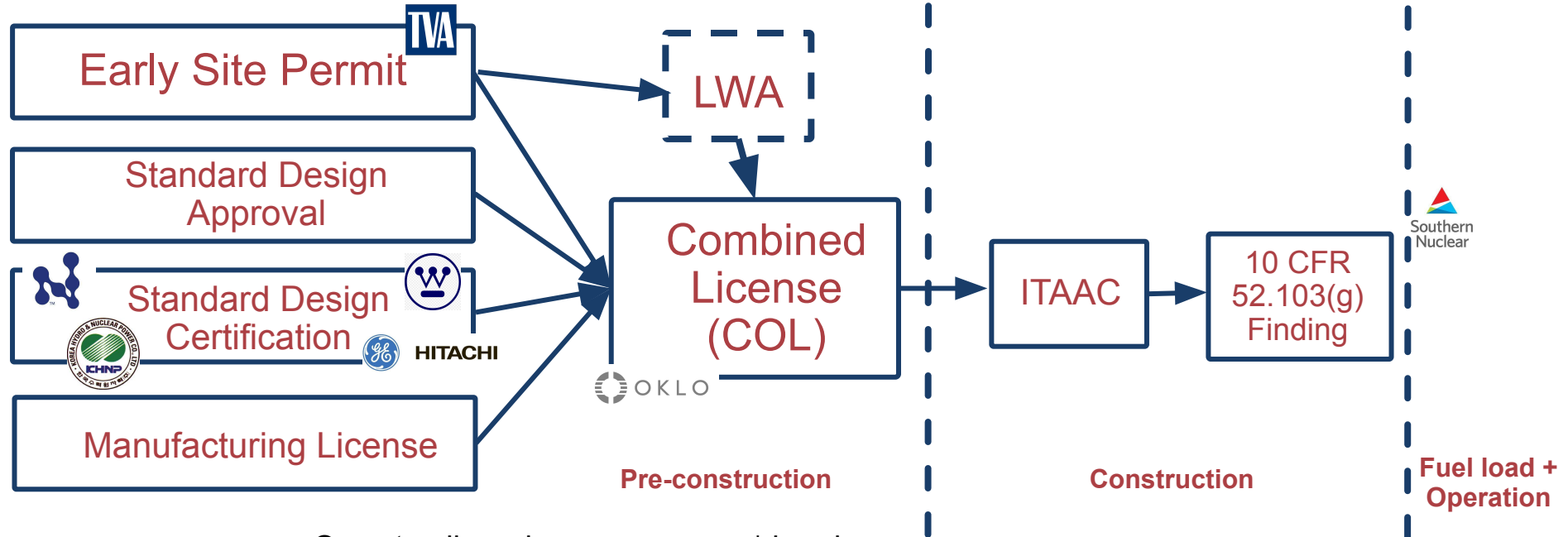
- Specific outcomes, usually a type of license, that an applicant can receive from the NRC
- Need to meet safety (Parts 50/52/53) and/or environmental requirements (Part 51)
- Cite other parts of the CFR

# 10 CFR Part 50



- Two step licensing process; two hearings
- Preliminary design details are allowed for the construction permit review
- All operating reactors are licensed under Part 50 (until hopefully this year!)
- Also considered by multiple advanced reactor vendors

# 10 CFR Part 52



- One step licensing process; one\* hearing
- Only need a combined license (COL); everything else is optional
- 7 approved DCs; 14 issued COLs (Vogtle Units 3+4 under construction)

**Part 52**

# Why develop a new Part 53?

## Parts 50 & 52

- Parts 50 and 52 are written for light water reactors (LWRs), specifically large LWRs
- Future reactors will be very different (fuels, coolants, temperatures, systems)
- Congressional direction from NEIMA

### LWR centric

- Safety is defined by LWR fuel
- Thus, rules are written for large LWR
- Safety is addressed through active methods

### Prescriptive

- Due to long LWR history, rules are written for large LWRs
- Incorporate operating experience
- TMI, Davis Besse, Browns Ferry, Fukushima

### Guidance

- Associated guidance is also written for large LWRs
- Future reactors will be a variety of sizes, coolants, and rely on passive and inherent safety features

### Uncertainty

- NRC has made progress reviewing different designs (AP1000, ESBWR, NuScale)
- But future designs are much different, and more numerous
- Part 53 must create predictability

### Historical Experience

- Lessons learned from AP1000 and NuScale reviews
- PRISM, NGNP
- LMP, TICAP, ARCAP
- Non-LWR pre-application interactions

# Development of Part 53

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## NEIMA

- NEIMA directed the NRC to develop a “technology-inclusive, regulatory framework for optional use by commercial advanced nuclear reactor applicants for new reactor license applications”
- Defined “advanced nuclear reactor” and “regulatory framework”

## SECY-20-0032

- May 2020, Senate EPW sent a letter telling the NRC to accelerate the rulemaking
- NRC Commission voted to publish the final rule by October 2024
- NRC staff asked the Commission for a short delay (which was approved)

## Rulemaking

- Draft Proposed Rule was sent to the Commission March 6, 2023
- Extensive public outreach and public comments
- Additional activities include developing guidance documents and fusion

# Case Studies



- 1.5 MWe fast reactor which uses heat pipes; future interest in larger reactors and fuel recycling
- DOE Site Use Permit at INL; initial focus on micro-grid applications
- 2020 - first non-light water Submitted NRC Combined License (COL) application
- 2022 - COL was denied by NRC “without prejudice”
- Future - Oklo plans to resubmit license application



- 77 MWe light-water small modular reactor; 4, 6, or 12 modules per site
- 2017 - Submit Design Certification (DC) to NRC for 12 module, 50 MWe reactor; certified by NRC in 2020
- Jan 2023 - submitted Standard Design Approval for 77 MW module
- 2024 - UAMPS will submit COL to NRC; target approval and start construction in 2025/2026, expected operation in 2029



- High-temperature, pebble-bed, gas-cooled reactor (200 MWth / 80 MWe); 4 modules
- 2020 - selected for ARDP; announced in March 2023 that will build at an industrial site with Dow in Gulf region
- Using Part 50, and will submit a Construction Permit (CP)
- 2022 - Submitted license application for TRISO-X fuel fabrication facility in Oak Ridge, TN

# Licensing and Non-Electric Applications

## Moving ahead

- There are no restrictions to licensing a nuclear plant at an industrial site, or for non-electric purposes
- Additional research is ongoing at EPRI, INL, and elsewhere
- The following resources just scratch the surface



### Analysis

- INL, "[Establishing Jurisdictional Boundaries at Collocated Advanced-Reactor Facilities.](#)" August 2020
- EPRI historical review and tritium migration



### Demos

- MARVEL reactor
- INL webpage on Integrated Energy Systems, <https://ies.inl.gov/SitePages/Home.aspx>
- Ongoing H2 demonstrations at commercial nuclear plants



### Licensing

- NRC, "[A Regulatory Review Roadmap For Non-Light Water Reactors.](#)" December 2017 (ML17312B567)
- The American Nuclear Infrastructure Act (ANIA), Sec. 202., Unique licensing considerations for non-electric applications.



### International

- Multiple nuclear district heat (CHP) projects in Switzerland, China, and Russia
- Interest in Finland, France, and South Korea



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