Southern Company

Energy Systems of the Future

Research & Development

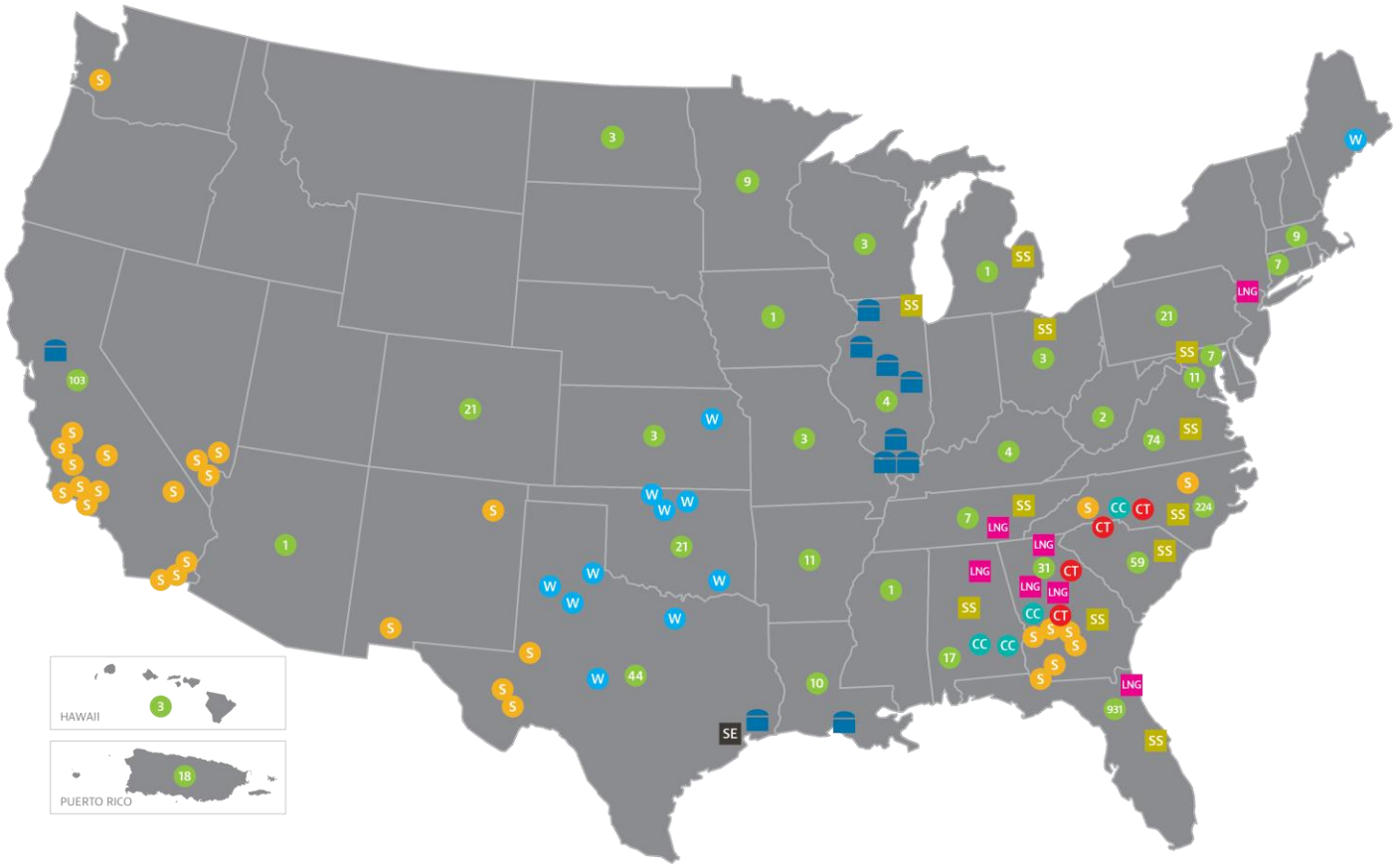
Southern Company provides clean, safe, reliable, affordable energy and customized solutions.

Service territories

- Electric
- Gas

Gas pipelines

- Southern Natural Gas
- Southern Company Gas
- Pipeline projects



Southern Power

- Combined-cycle facility[1]
- Peaking facility
- Biomass facility
- Solar facility
- Wind facility

Southern Company Gas

- LNG facilities
- Sequent Energy Management
- SouthStar
- Natural gas storage

PowerSecure

- Owned and managed sites per state

[1]In November 2018, Southern Power agreed to sell its combined-cycle facility in Mankato, Minnesota.

Capabilities in
50 States

7
Electric & Natural Gas Utilities

9 Million
Customers

Approximately
29,000
Employees

Approximately
44,000 MW
of Generating Capacity

We have committed to net zero operation by 2050.

DIVERSE PORTFOLIO

→ just transition
→ zero carbon resources
→ energy efficiency
→ negative carbon strategies

RESEARCH & DEVELOPMENT

→ deliver affordable, reliable, net zero energy
→ optimize delivery systems

ENGAGE STAKEHOLDERS

→ employees
→ community
→ customers
→ governance

2007 → **2019** → **2030** → **2050**

Baseline

Reduced 44%

50% Reduction

Net Zero

Nuclear Energy

- Constructing the only two new nuclear units in the U.S. in more than three decades through Georgia Power and Southern Nuclear
- Gen IV nuclear developed & operating at NGCC costs with superior safety benefits & operational flexibility

Gas & Hydrogen

- Natural gas suppliers committed to GHG reductions in their own businesses have a competitive edge in our bid selection process
- New utility business models for hydrogen production, delivery & use technologies

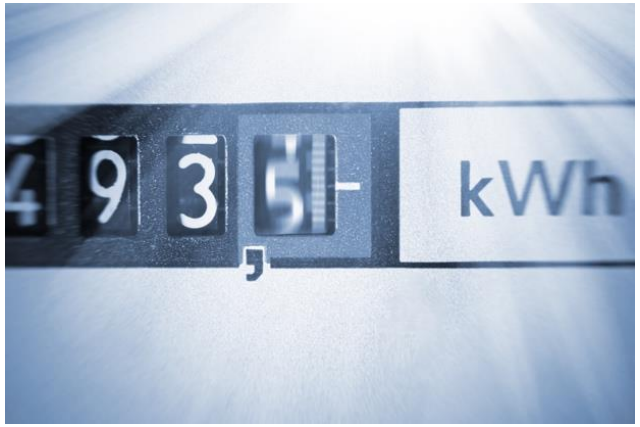
Renewable Energy

- Southern Company is the second-largest owner of solar capacity outside China, with more than 2.6 gigawatts
- More than 14,000 MW of renewables expected online by 2024

Carbon Capture

- Manage the DOE's National Carbon Capture Center – a neutral research facility working to accelerate the development of advanced technologies to reduce greenhouse gas emissions from both natural gas and coal power plants
- Expanding to include CO_2 utilization and direct air capture

Energy Efficiency



- Since 2000, programs have helped reduce peak demand for electricity by more than 4,800 MW and avoid more than 2 billion kWh of energy use
- Newly developed ubiquitous behind-the-meter technologies for transportation, buildings, food production, industrial processes & smart city applications

Distributed Resources

- PowerSecure is a leading provider of utility and energy technologies to electric utilities and industrial, institutional and commercial customers
- Dispatchable solar, wind, storage & other distributed resources developed & operating in microgrid & centralized configurations as low-cost energy sources

R&D objectives are focused on providing the best value to customers.

RIGHT TECHNOLOGY

→net zero enabling

→address safety & sustainability

→maximize flexibility – integrate well with renewables

RIGHT TIMELINE

→support post-2030 deep decarbonization

→replace potential retirements

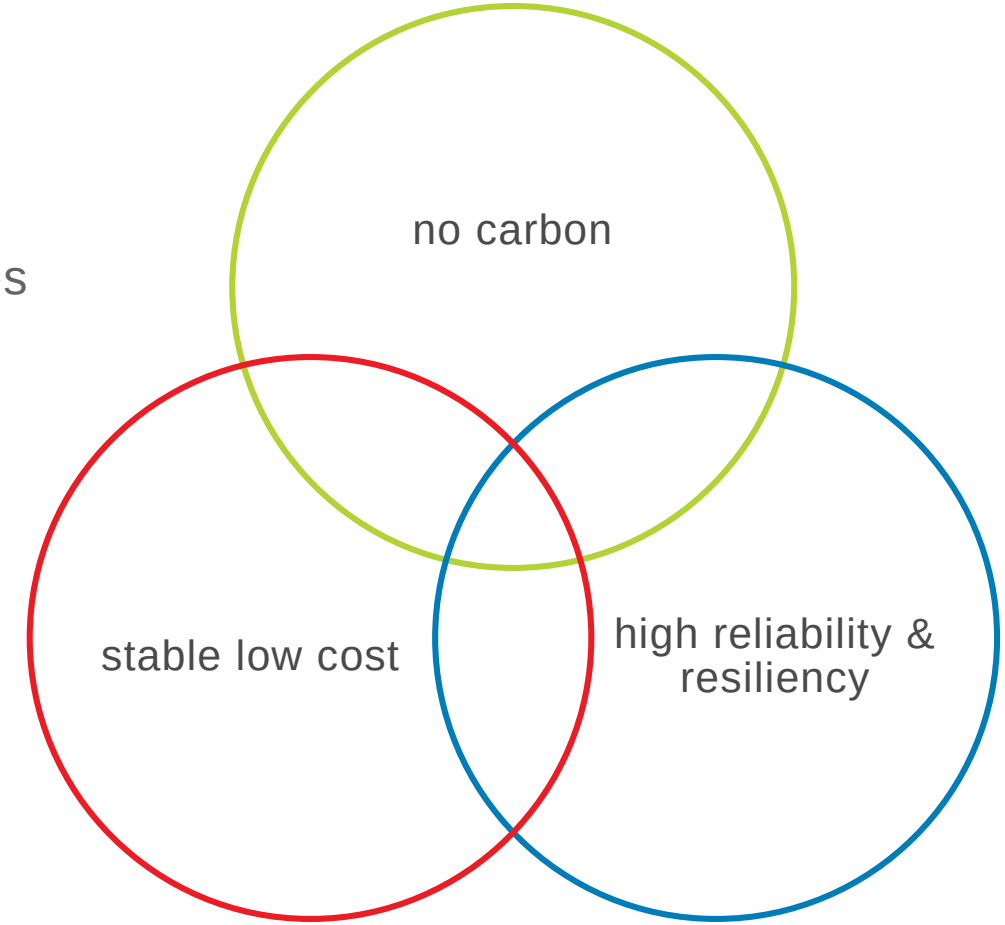
RIGHT COST

→competitive with ngcc+pcc and solar+battery

BEST VALUE

→fixing long-term energy production cost

→be options positive – expand the market past electricity



Fast	vs	Thermal
Breeder		Burner
Liquid Fuel		Solid Fuel
Thorium		Uranium

COOLANT CHOICE

Salt, Water, Gas, Metal

Fast	vs	Thermal
Breeder		Burner
Liquid Fuel		Solid Fuel
Thorium		Uranium

COOLANT CHOICE

Salt, Water, Gas, Metal

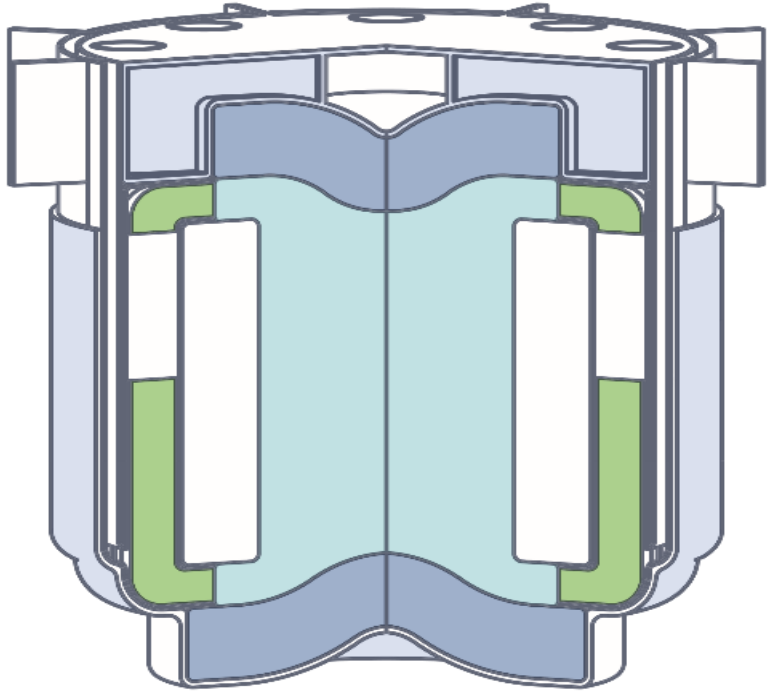
Molten Chloride Fast Reactor selected as a high potential option worth pursuing.

SUPERIOR OPERATION

→ low pressure system
→ inherent & passive safety
→ high availability
→ high thermal efficiency

BROAD APPLICATION

→ high-grade heat
→ load following or 24/7
→ flexible capacity
→ compact size



LONG-TERM SUSTAINABILITY

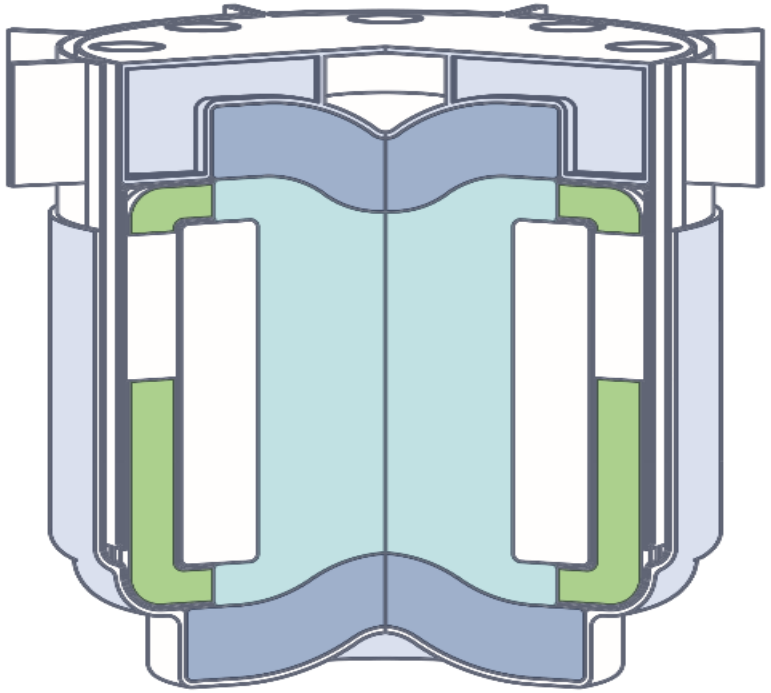
→ high fuel utilization
→ proliferation resistant
→ fuel flexibility
→ low used fuel yields
→ high power density

COST COMPETITIVE

→ competitive cost of electricity
→ capital investment opportunity
→ stable fuel price
→ minimizes need for negative emissions technology

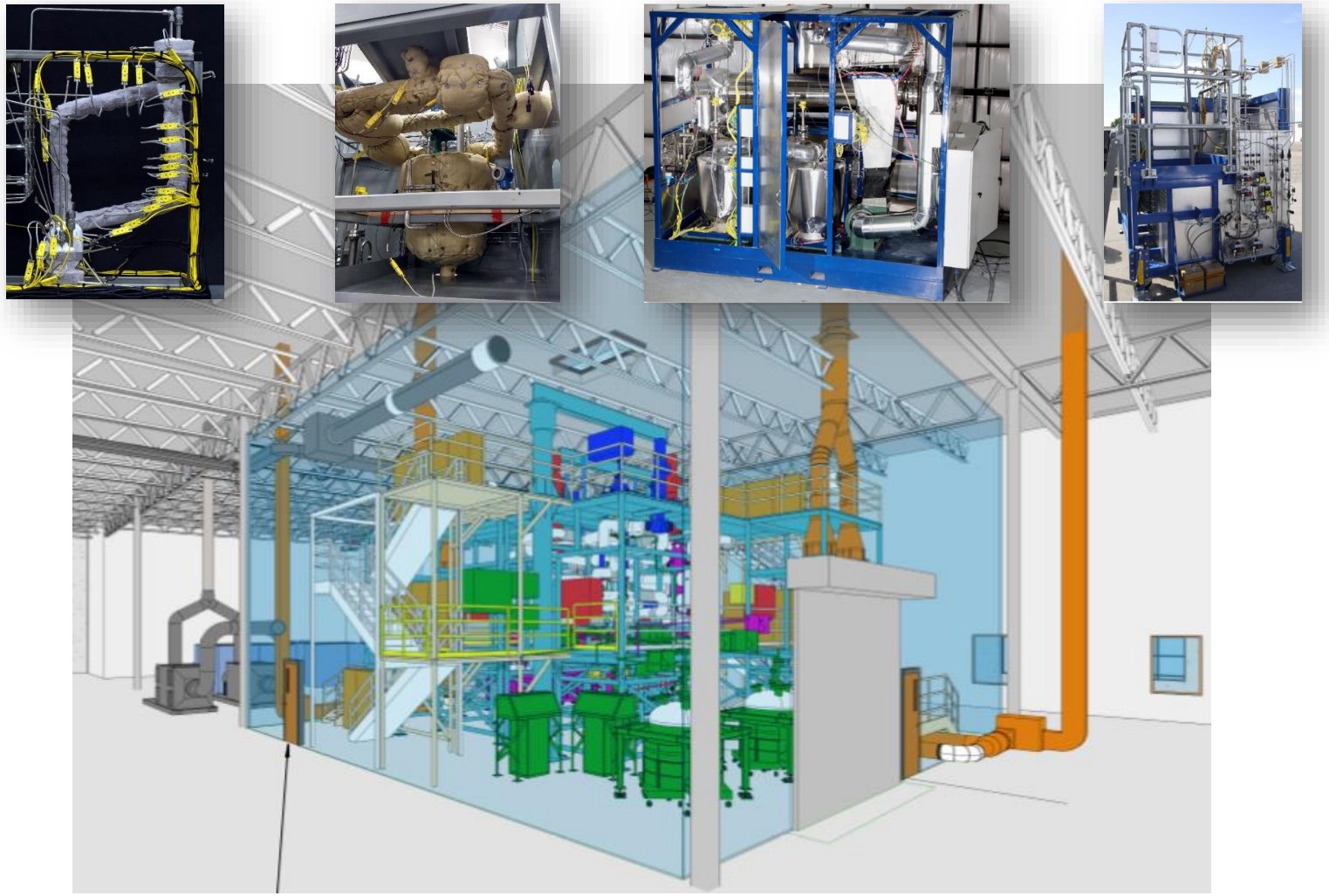
TerraPower's History & Mission

- In 2007 TerraPower was established by visionary investors and led by Bill Gates
  - All forms of energy were initially considered
  - **Carbon-free, Scalability** and **energy density** consideration led TerraPower to innovate in nuclear energy
- Todays nuclear industry faces challenges
  - **Social, economic and technological challenges** have limited nuclear
  - Next generation nuclear technology offers the potential to solve many of these limitations
- Focus on next generation nuclear that excel in economics, safety, resource utilization, waste, and proliferation resistance
  - Resulted first in the Traveling Wave Reactor (TWR) development starting in 2008
  - And then the Molten Chloride Fast Reactor (MCFR) development beginning in 2013



Significant Molten Chloride Fast Reactor (MCFR) development has been made under ARC'15.

- $40M DOE Award - $68M total project
- Final design of IET complete
- Long lead components ordered
- Civil construction underway
- Microloops operated for over 10,000 hours
- Larger-scale pumped loop operated over 1,000 hours



R+D

TerraPower

OAK RIDGE National Laboratory

EPRI

VANDERBILT UNIVERSITY

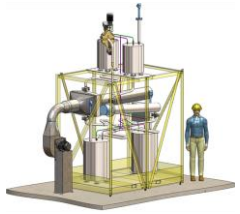
INL Idaho National Laboratory

separate effects tests

7+ loop-years of microloop operation

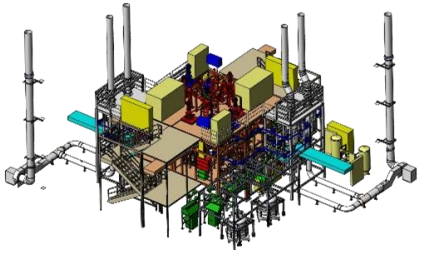
isothermal loop – ***world's largest pumped chloride salt system***

polythermal loop



integrated effects test

<1 mw electrically heated, multi-loop system



non-nuclear

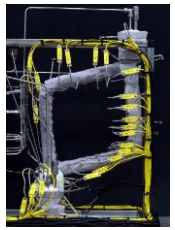
nuclear

2020

separate effects tests

10,000+ hours uranium chloride microloop operation

plutonium fueled microloop



separate effects tests

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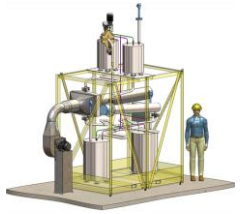
polythermal loop



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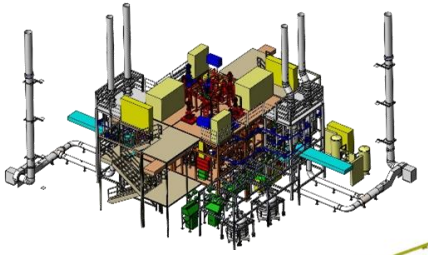
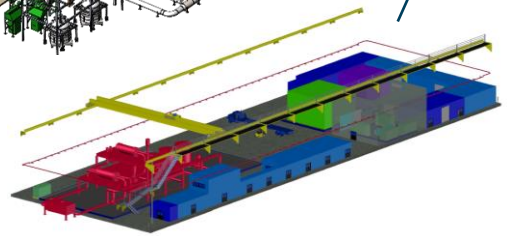


mastif (molten salt test facility)

demo reactor scale components

remote maintenance equipment



product offerings

thermal energy storage / transfer

bulk storage

high-grade heat (refining, etc.)

non-nuclear

nuclear

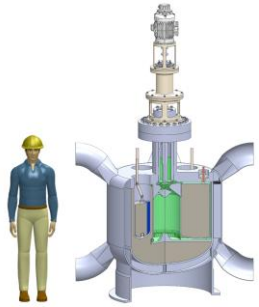
2020

2030

mcre (molten chloride reactor experiment)

300 kw_{th} critical reactor

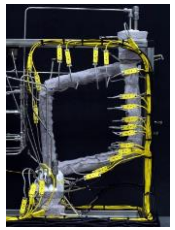
doe authorized at inl



separate effects tests

10,000+ hours uranium chloride microloop operation

plutonium fueled microloop



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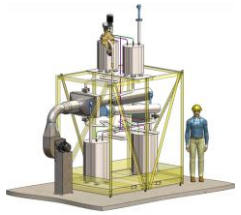

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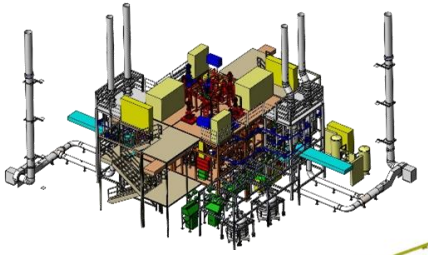

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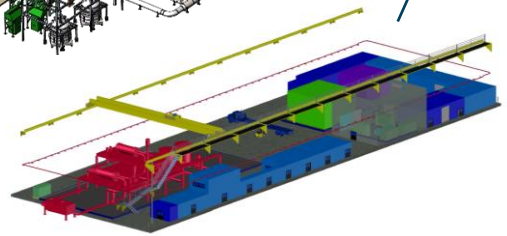


product offerings

thermal energy storage / transfer

bulk storage

high-grade heat (refining, etc.)

small-scale electric

90-360 mw_{th} applications

maritime transportation

onboard power production

non-nuclear

nuclear

2020

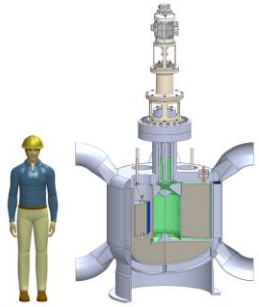
2030

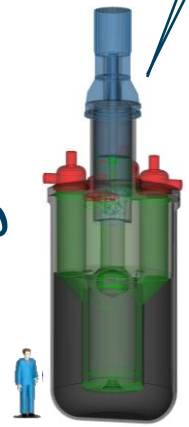
2035

mcre (molten chloride reactor experiment)

300 kw_{th} critical reactor

doe authorized at inl

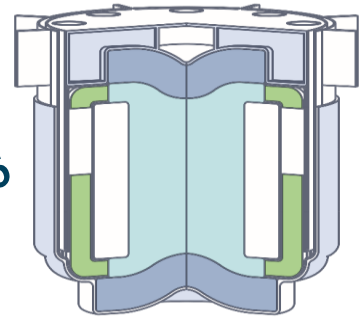




demonstration reactor

30 mw_{th} start-up

180 mw_{th} full power operation



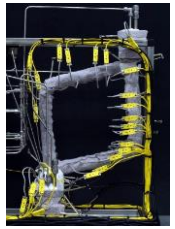
commercial reactor

300-800 mw_e applications

separate effects tests

10,000+ hours uranium chloride microloop operation

plutonium fueled microloop



ADVANCED REACTOR DEMONSTRATION PROGRAM

RISK REDUCTION

$400 MILLION

80/20 FUNDING

5 YEARS

DEMO RXR 10-12 YEARS

DECEMBER 2020 SELECTION ANTICIPATED

An unparalleled team is pursuing the development and demonstration of TerraPower's MCFR.

Southern Company

TerraPower

orano

EPRI
ELECTRIC POWER RESEARCH INSTITUTE

BECHTEL

CORE-POWER

3M

Centrus
Fueling the Future of Nuclear Power

MITSUBISHI HEAVY INDUSTRIES, LTD.

TELEDYNE BROWN ENGINEERING
Everywhereyoulook™

PAR SYSTEMS

NRIC
National Reactor Innovation Center

INL
Idaho National Laboratory

Pacific Northwest
NATIONAL LABORATORY

OAK RIDGE
National Laboratory

SRNL
SAVANNAH RIVER NATIONAL LABORATORY
OPERATED BY SAVANNAH RIVER NUCLEAR SOLUTIONS

Los Alamos
NATIONAL LABORATORY

Argonne
NATIONAL LABORATORY

VANDERBILT UNIVERSITY

THE UNIVERSITY OF TENNESSEE KNOXVILLE

WISCONSIN
UNIVERSITY OF WISCONSIN-MADISON

UNIVERSITY OF MICHIGAN

THE UNIVERSITY OF UTAH®

R+D

Molten Salt Reactor TWG →

ONE

Terra Power

Fast
Breeder
Liquid Fuel
Salt Cooled
Uranium
(Could use Th)

TWO

Thorcon

Thermal
Burner
Liquid Fuel
Salt Cooled
Thorium

THREE

Terrestrial Energy

Thermal
Burner
Liquid Fuel
Salt Cooled
Uranium
(Could use Th)

FOUR

Flibe Energy

Thermal
Breeder
Liquid Fuel
Salt Cooled
Thorium

FIVE

Muons Inc.

Accelerator Driven
Subcritical
Liquid Fuel
Spent Nuclear Fuel
(U and Pu
Fluorides)

SIX

Elysium Industries

Fast
Breeder
Liquid Fuel
Salt Cooled
Uranium

SEVEN

Alpha Technology Corporation

Thermal
Breeder
Liquid Fuel
Salt Cooled
Thorium

Exelon.

NEI
NUCLEAR ENERGY INSTITUTE

DUKE ENERGY.

EPRI

MSR TWG

COLLABORATE ON TECHNOLOGY NEUTRAL TOPICS

- SALT PROPERTY MEASUREMENT
- FUEL QUALIFICATION
- MODELING AND SIMULATION TOOL DEVELOPMENT

EDUCATE AND BUILD RELATIONSHIPS

- MEET QUARTERLY
- PARTICIPATION NOT EXCLUSIVE TO MEMBERS

Investing in an agile and efficient regulatory framework

- *SO is leading a DOE supported project to formalize a risk informed, performance based licensing process (RIPB)*
- *NRC has endorsed LMP approach (NEI 18-04) and provided guidance (RG 1.233)*
- *LMP methodology tabletop demonstrations successful on various non-LWR designs (Xe-100, PRISM, Kairos-FHR, MSRE, eVinci, VTR)*
- *TICAP underway to develop material to guide applicants through submission of licensing application*