

Advanced Nuclear Technology

A presentation on SMRs to Kahramaa (Qatar)

Hasan Charkas
Program Manager

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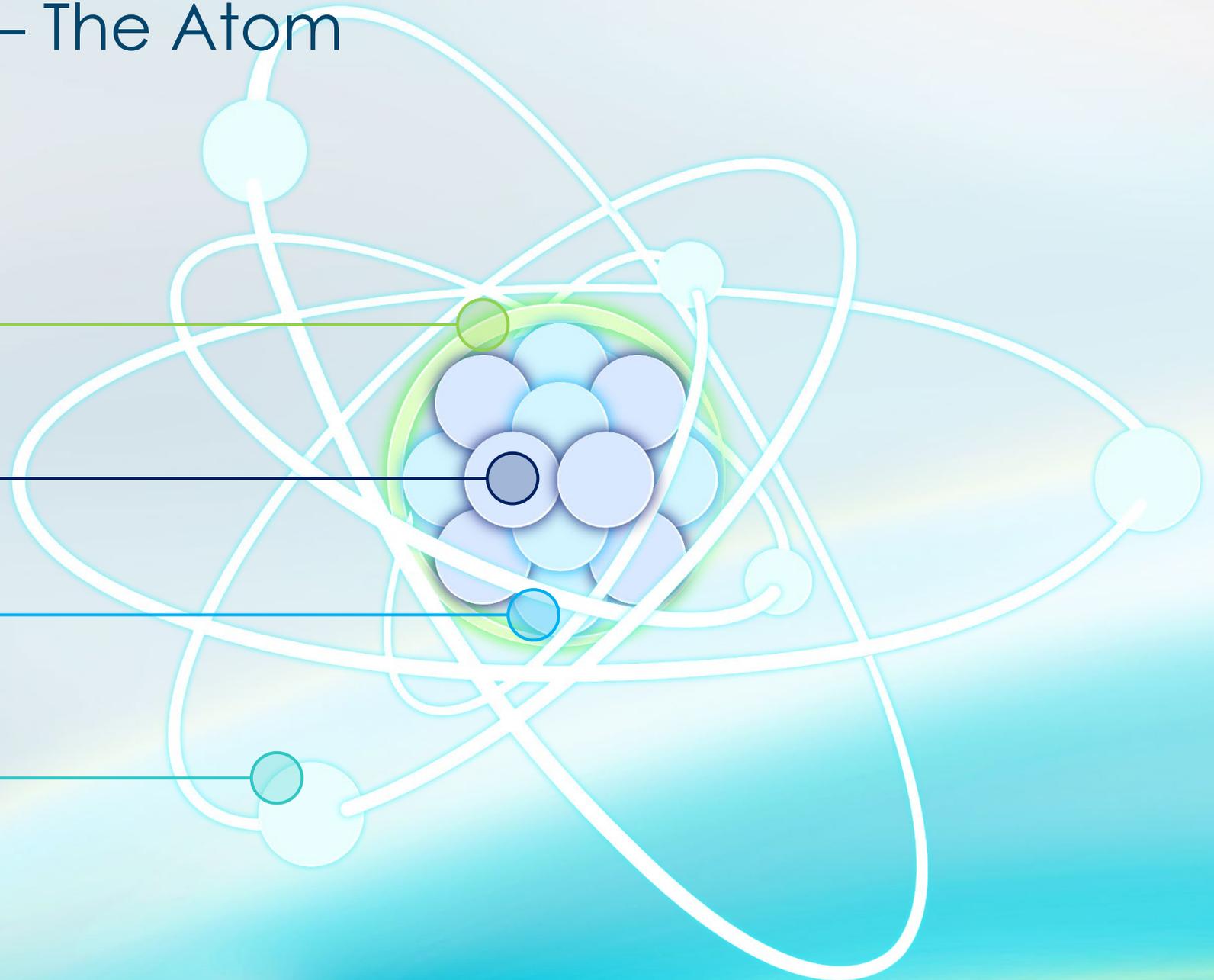
Nuclear Physics – The Atom

NUCLEUS

NEUTRON

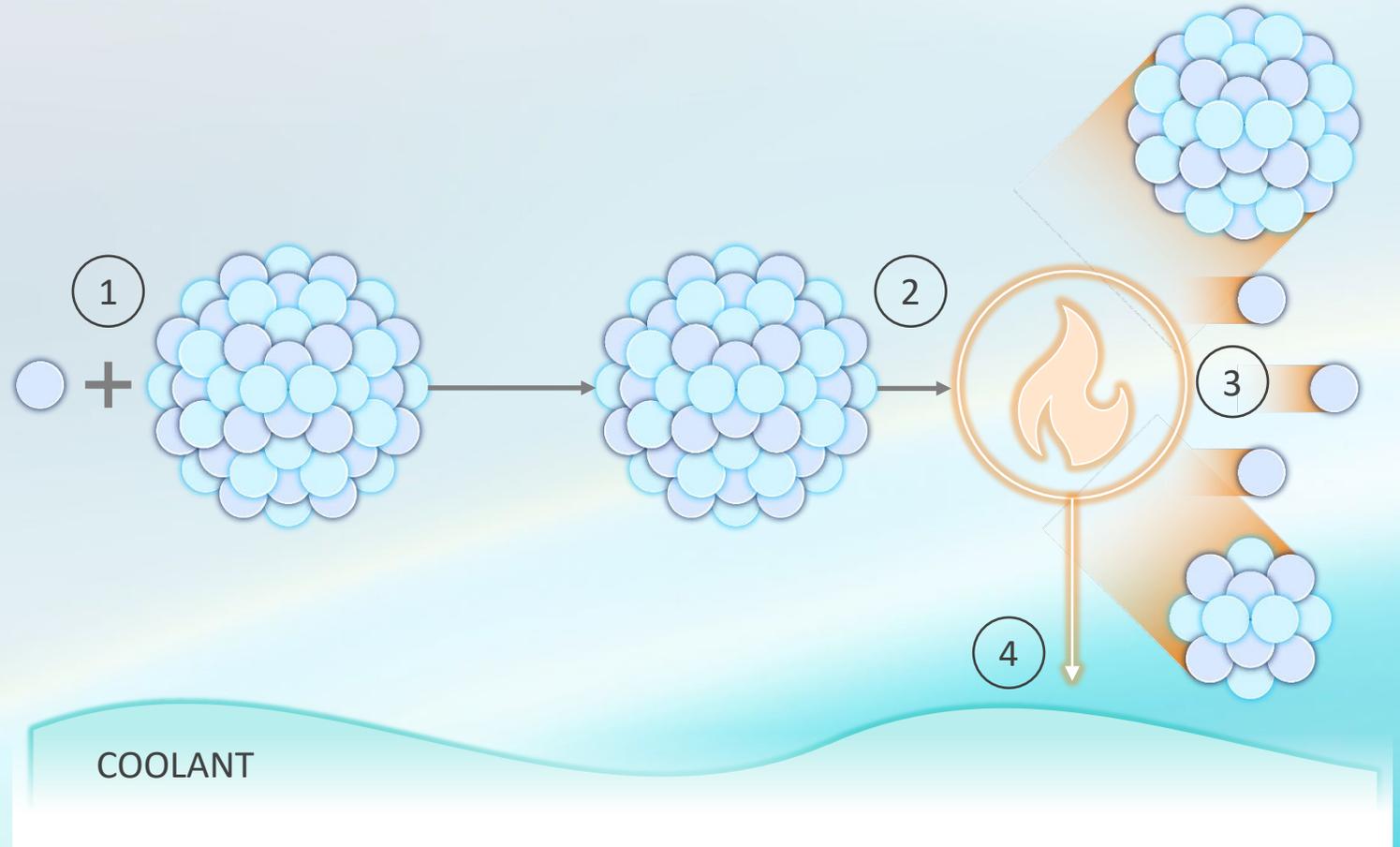
PROTON

ELECTRON

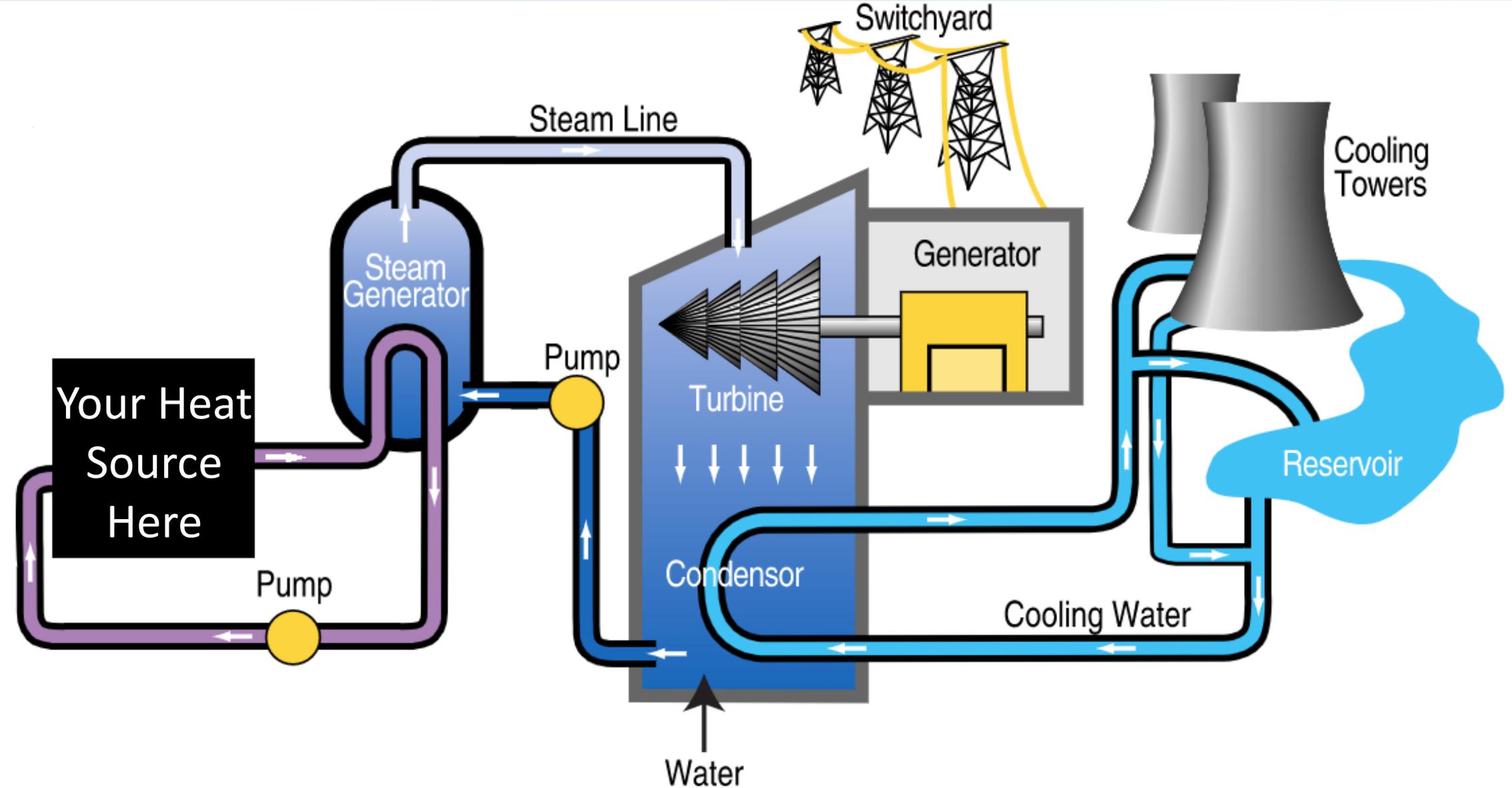


Nuclear Physics – Nuclear Fission

- ① Neutron absorbed by target nucleus
- ② Nucleus becomes unstable and splits (fissions)
- ③ Fission products and neutrons are released with high kinetic energy which creates heat
- ④ Heat is transferred to coolant



Generating Electricity



Fundamental Design Choices

Coolant

Temperature

Pressure

Corrosivity, Reactivity

Gas

Salt

Liquid
Metal

Water

Dissolved

Metal

Oxide

Carbide

Nitride,
Silicide,...

F
Salt

Cl
Salt

TRISO-based

Prismatic

Pebble

Fuel

Fuel Cycle

Solid vs. Liquid

Circulating vs. Fixed

Enrichment

n^0 Energy

Fast

Thermal

n^0 Moderation

C

H₂O

ZrH

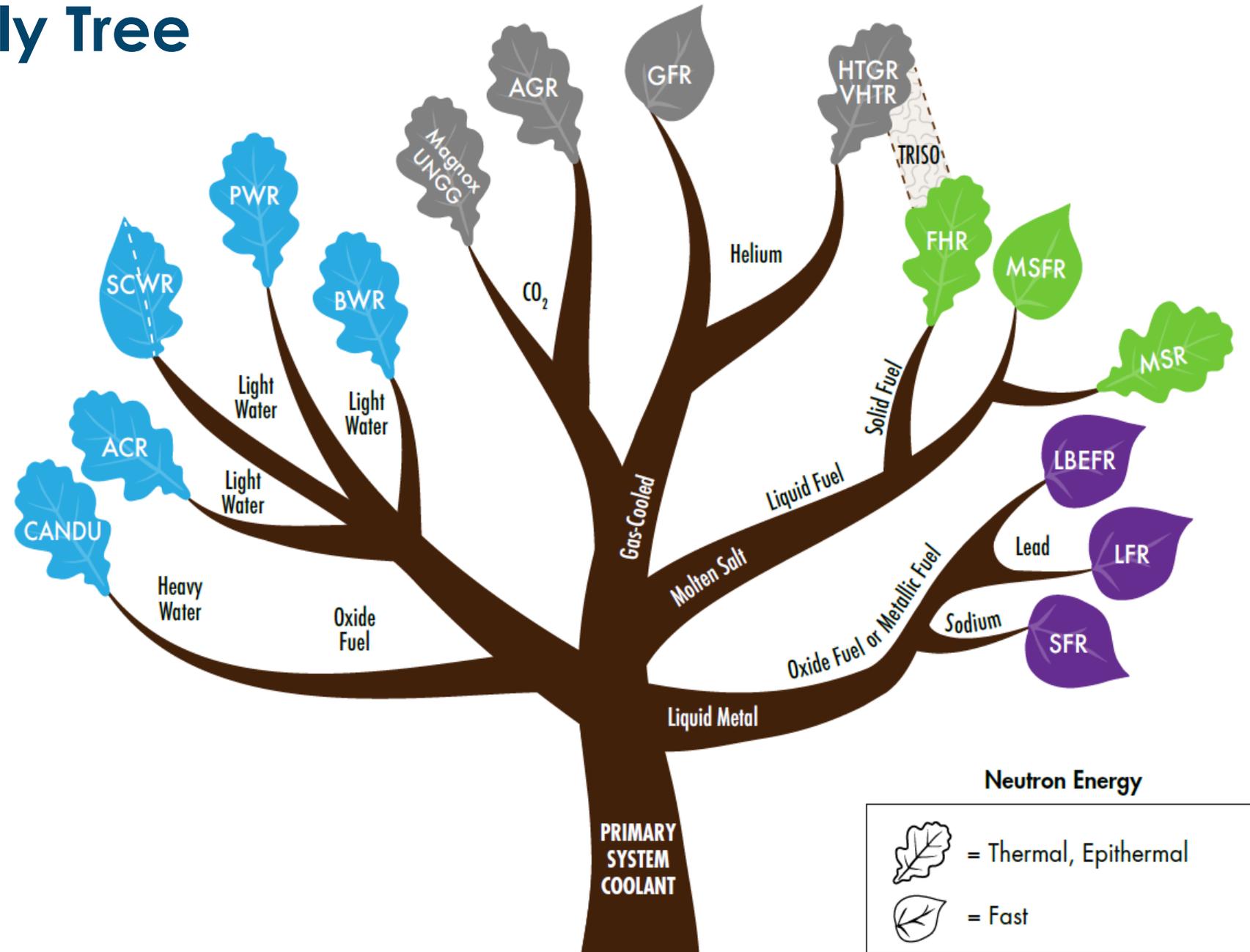
D₂O

BeO

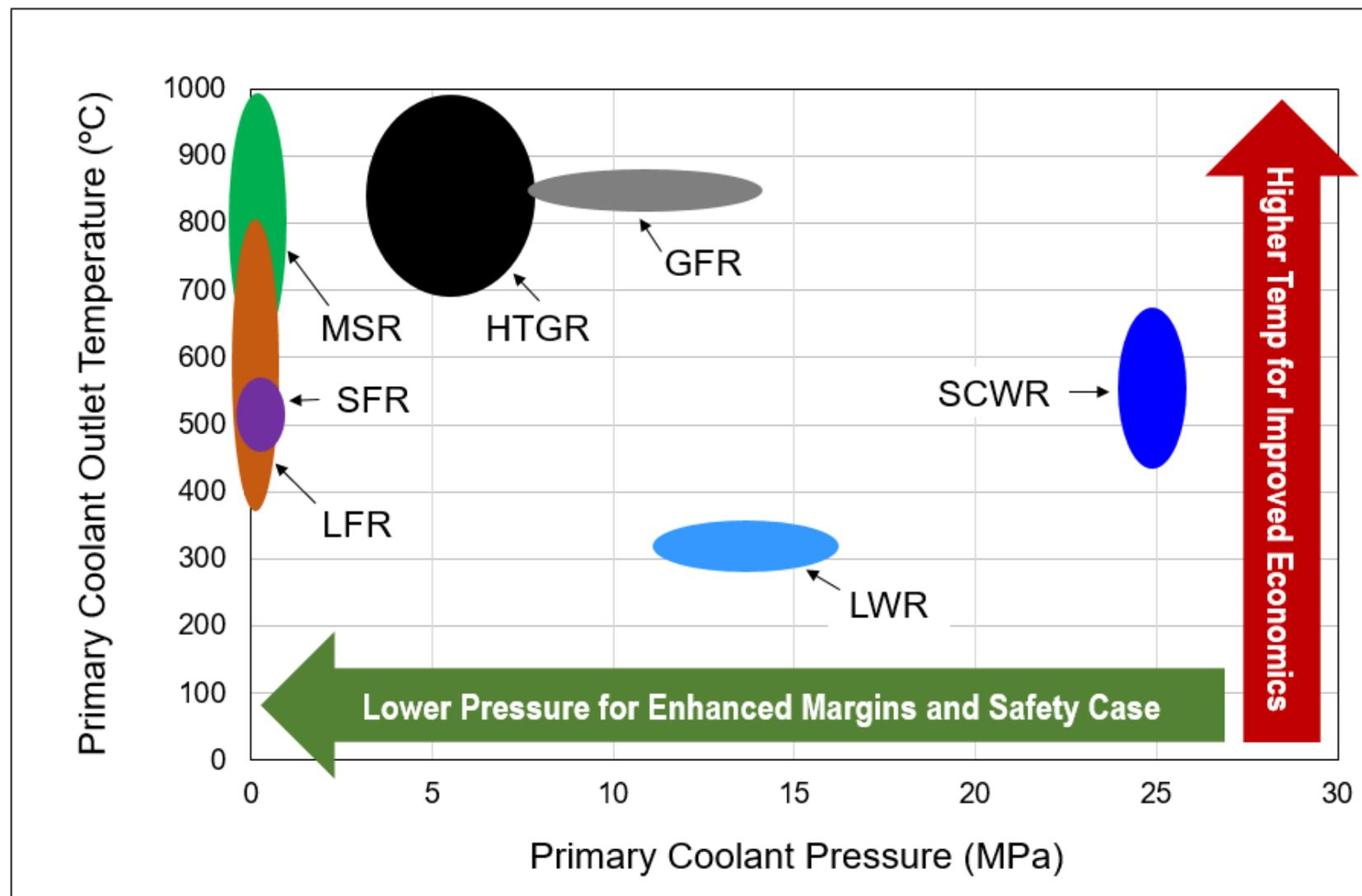
The Nuclear Family Tree

Advanced Reactors

- Small Modular Light Water Reactor (SMR)
- Microreactors
- Gas-cooled Fast Reactor (GFR)
- Lead-cooled Fast Reactor (LFR)
- Sodium Fast Reactor (SFR)
- Supercritical-water-cooled Reactor (SCWR)
- Molten Salt Reactor (MSR)
- High-temperature Gas-cooled Reactor (HTGR)
- Fluoride High-temperature Reactor (FHR)
- Lead-Bismuth Fast Reactor (LBEFR)



Importance of Coolant Choice



Economics and flexibility are tied to fundamental properties (T, P)

ANT Technology User's Groups

Purpose

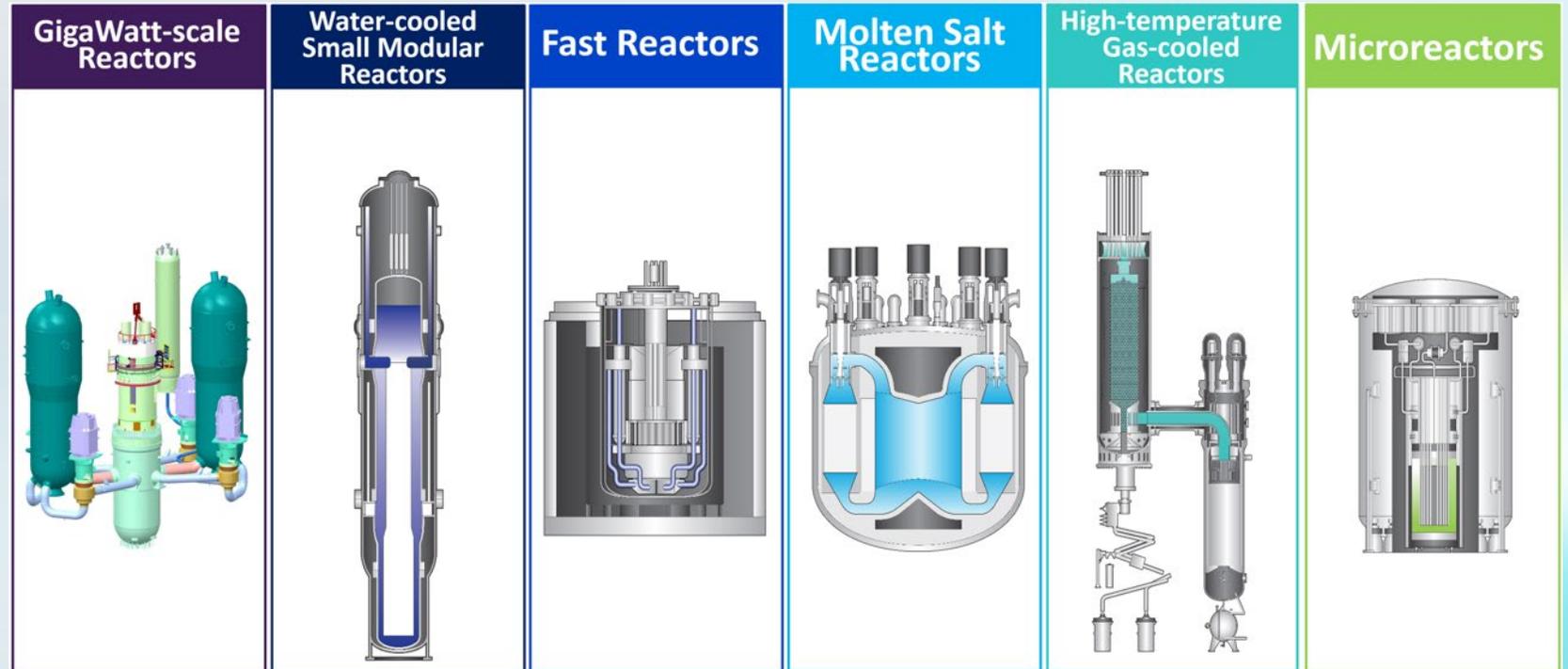
Information Exchange

- Technology Overviews
- Forum for technology specific discussions

Issue Identification & Resolution

Research & Guidance Development

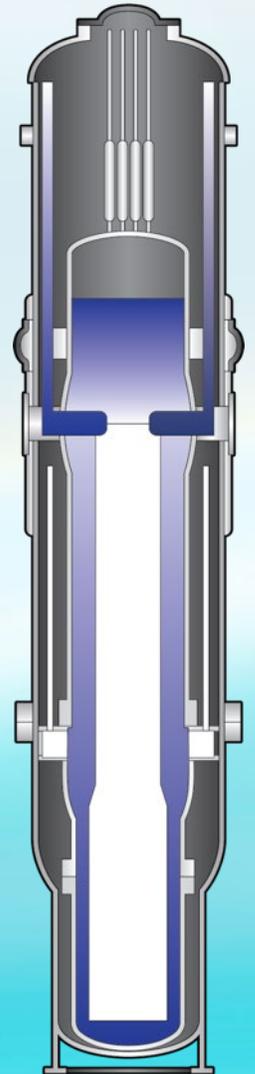
- Develop technology specific resources



Light-water Small Modular Reactor (lwSMR)

FAVORABLE ATTRIBUTES OF LIGHT-WATER SMALL MODULAR REACTORS

- 1 High design maturity, building on decades of experience with the operating fleet
- 2 Mature uranium oxide fuel form, taking advantage of an existing supply chain
- 3 Skilled workforce of trained operation and maintenance staff
- 4 Novel deployment to reduce risk to owners and operators that can scale to demand
- 5 Familiar regulators to license the technology without a challenging learning curve



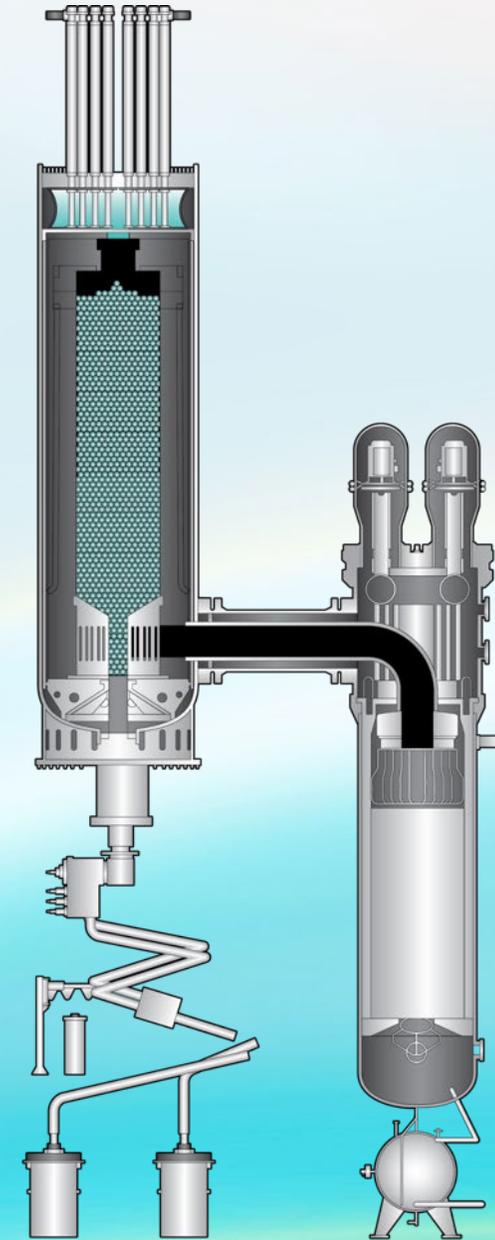
Light Water Small Modular Reactors

COUNTRY	VENDOR	REACTOR	NEUTRON SPECTRUM	MODERATOR	COOLANT	OUTPUT (MW)	STATUS
Argentina	CNEA	CAREM-25	Thermal	Water	Water	32	In construction
UK	Rolls Royce	UK SMR	Thermal	Water	Water	470	In development
US	GE-Hitachi	BWRX-300	Thermal	Water	Water	300	Selected by OPG and TVA
US	Holtec	SMR-160	Thermal	Water	Water	160	In development; US ARDP
US	NuScale	NuScale Module	Thermal	Water	Water	77	Design certification approved; selected by UAMPS
US	Westinghouse	AP-300	Thermal	Water	Water	300	In development Based on AP-1000

High Temperature Gas Reactor (HTGR)

FAVORABLE ATTRIBUTES OF HIGH-TEMPERATURE GAS REACTORS

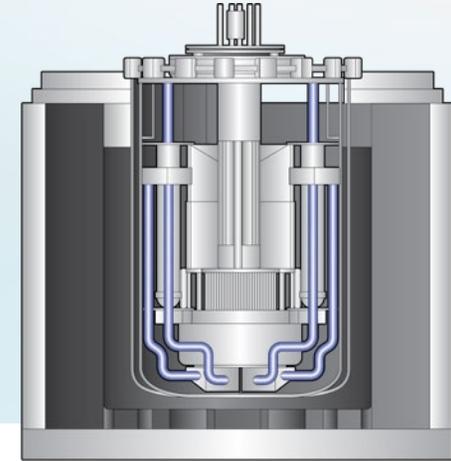
- 1 High temperature for decarbonizing non-electric industries
- 2 Utilization of TRISO fuel for fission product retention
- 3 Potential for online refueling, eliminating refueling outages
- 4 Inert helium coolant reducing chemistry challenges



High Temperature Gas Reactors

COUNTRY	VENDOR	REACTOR	NEUTRON SPECTRUM	MODERATOR	COOLANT	OUTPUT (MW)	STATUS
China	CNNC	HTR-PM	Thermal	Graphite	Helium Gas	200 MWth	In commercial operation
US	Framatome	SC-HTGR	Thermal	Graphite	Helium Gas	272	No active work
US	X-Energy	XE-100	Thermal	Graphite	Helium Gas	80	Demonstration project US ARDP
US	General Atomics	Fast Modular Reactor	Fast	N/A	Helium Gas	50	In development; US ARDP
US	General Atomics	Energy Multiplier Module	Fast	N/A	Helium Gas	265	In development

Liquid Metal Fast Reactors



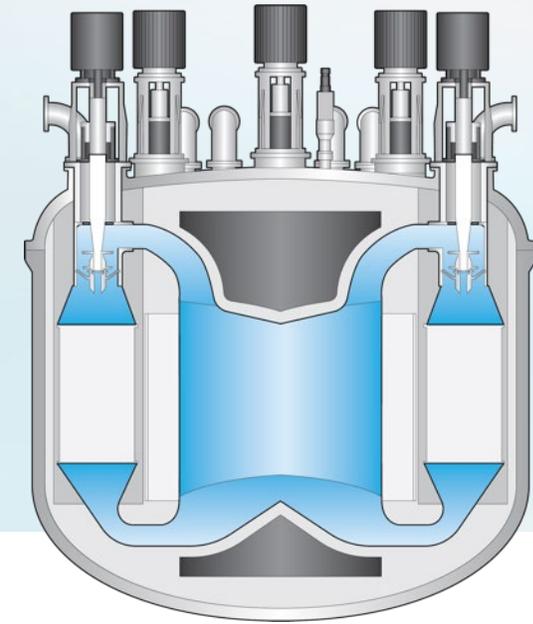
FAVORABLE ATTRIBUTES OF METAL-COOLED FAST REACTORS

- 1 Low pressure operations, to improve safety
- 2 Fast neutron speed to improve fuel utilization by up to 200x
- 3 Utilization of multiple fuel form options, creating flexibility in supply chain
- 4 Mature design and operating experience for some variants
- 5 Industrial experience working with some coolant options
- 6 Highly efficient thermal transfer from fuel to coolant to power conversion

Liquid Metal Fast Reactors

COUNTRY	VENDOR	REACTOR	NEUTRON SPECTRUM	MODERATOR	COOLANT	OUTPUT (MW)	STATUS
Canada	Advanced Reactor Concepts	ARC 100	Fast	N/A	Liquid Sodium	100	In development
US	TerraPower	Natrium	Fast	N/A	Liquid Sodium	345	Demonstration project scheduled; US ARDP

Molten Salt Reactors (MSRs)



FAVORABLE ATTRIBUTES OF MOLTEN SALT REACTORS

- 1 High temperature operation, for improved efficiency
- 2 Low pressure operation, for improved safety
- 3 Utilization of fast or thermal neutrons for fuel recycling
- 4 Utilization of up to 20% U-235 enriched fuel salt
- 5 Use liquid fuel, eliminating fuel damage or failure
- 6 Online refueling, eliminating refueling outages

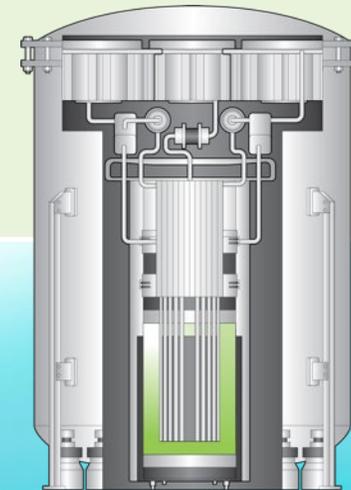
Molten Salt Reactors

COUNTRY	VENDOR	REACTOR	NEUTRON SPECTRUM	MODERATOR	COOLANT	OUTPUT (MW)	STATUS
Canada	Terrestrial Energy	Integral Molten Salt Reactor	Thermal	Graphite	Molten Fluoride Salt	195	In development
UK	Moltex	Stable Salt Reactor	Fast	N/A	Molten Chloride Salt	300-500	In development
US	TerraPower/ Southern Company	Molten Chloride Fast Reactor	Fast	N/A	Molten Chloride Salt	780	US ARDP
US	Kairos Power	KP-FHR	Thermal	Graphite	Molten Fluoride Salt	140	Demonstration project online, US ARDP

Microreactors

POTENTIAL END USES OF MICROREACTORS

- 1 Combined heat and power production for district energy networks
- 2 Process industrial uses
- 3 Production of low carbon fuels such as hydrogen and ammonia
- 4 Off-grid electricity generation for remote communities or industries like mining
- 5 Data centers
- 6 Mobile deployment for forward military operating bases
- 7 Mobile deployment for emergency disaster response



Read more in this
public technology brief

Advanced Nuclear Technology (ANT) Program Focus

MISSION: Accelerating the deployment of nuclear power around the world



Informing
Resource
Planning



Technology
Development



Reducing
Deployment
Costs



Supporting
Plant Startup



Training



Siting & Owner
Requirements



Energy
Economics



Design &
Engineering



Technical
Basis



Construction
Optimization



Advanced
Manufacturing



Commissioning



Initial
Operations



More than
90 companies



200+ Past
Products



Dozens of
Ongoing Projects

From project initiation through initial operation,
ANT is an extension of your team.

VISIT [ANT.EPRI.COM](https://ant.epri.com)

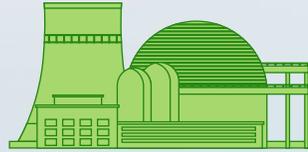
2025 ANT Membership

ANT Participation Extended to Over 90 Companies

NUCLEAR SECTOR BASE MEMBERS



52 Global Members



>83%
of the world's commercial
nuclear units



>340
reactors worldwide

FULL ANT SUPPLEMENTAL MEMBERS



ADVANCED REACTOR INITIATIVE MEMBERS



ANT Research Structure

Engineering &
Construction
Innovation



Project
Development
& Execution



Advanced
Manufacturing
& Materials
Qualification



Advanced
Reactor Materials
Reliability



Nuclear Design
& Fuel Cycle



Commissioning,
Initial Operations
& Maintenance

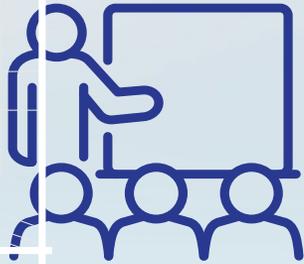
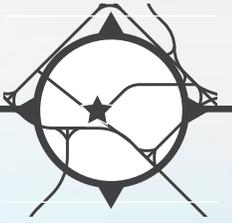


Nuclear Beyond
Electricity



Advanced Reactor Roadmap

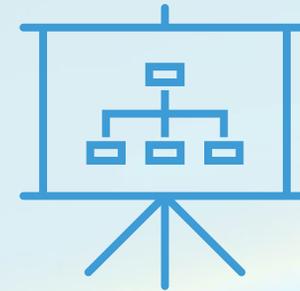
A shared strategy to ensure success at scale



Serving government, academic, industrial, and public **stakeholders**



Almost 100 GWe of **new nuclear** will be needed by 2050. This means around **300 ARs** in the next **30 years**



7 Enablers and **46 key actions** chart our path towards a **net-zero future**



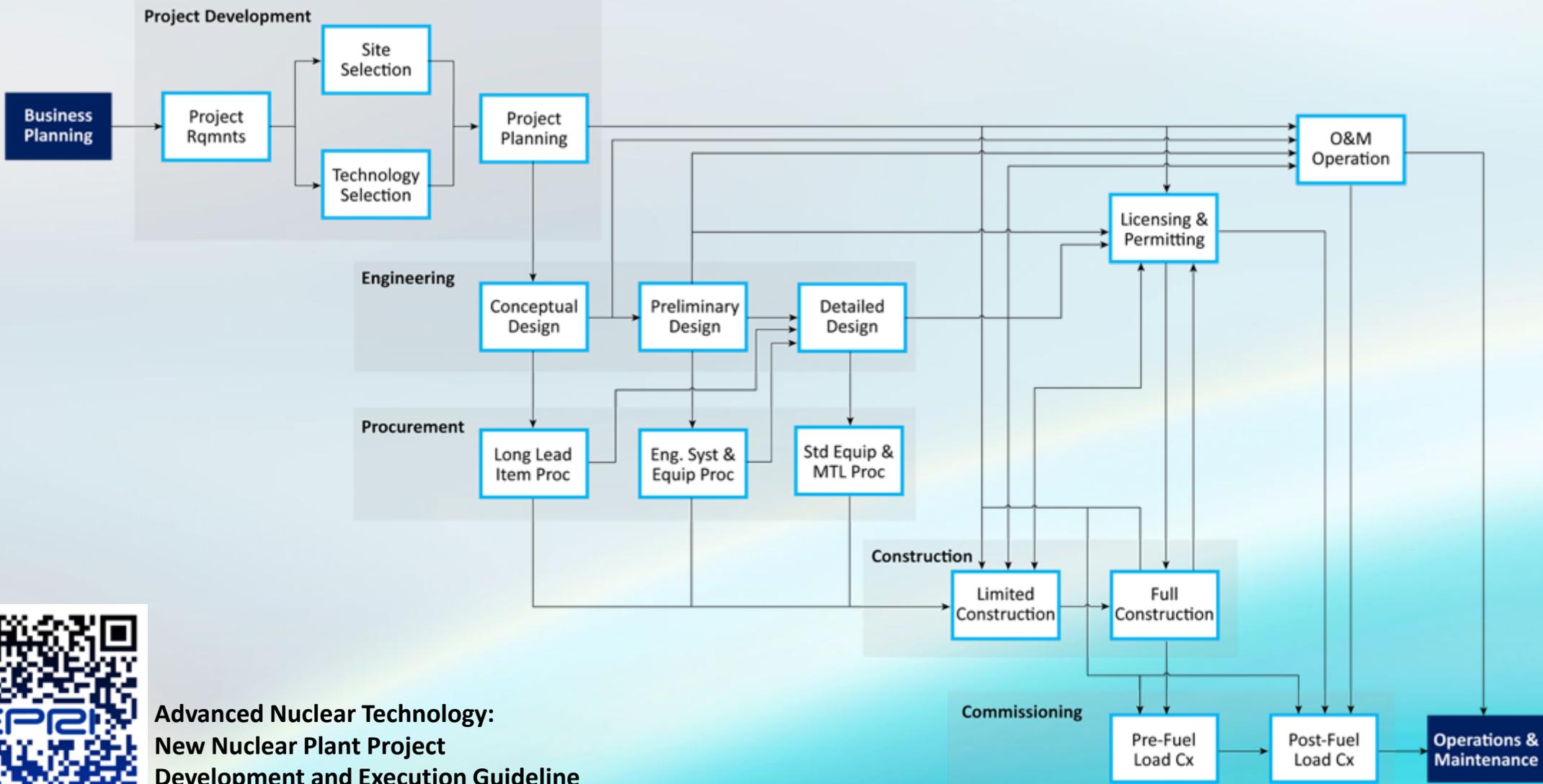
Convening the industry for **strategic action**

Industry's roadmap to the future fleet

ARRoadmap.com

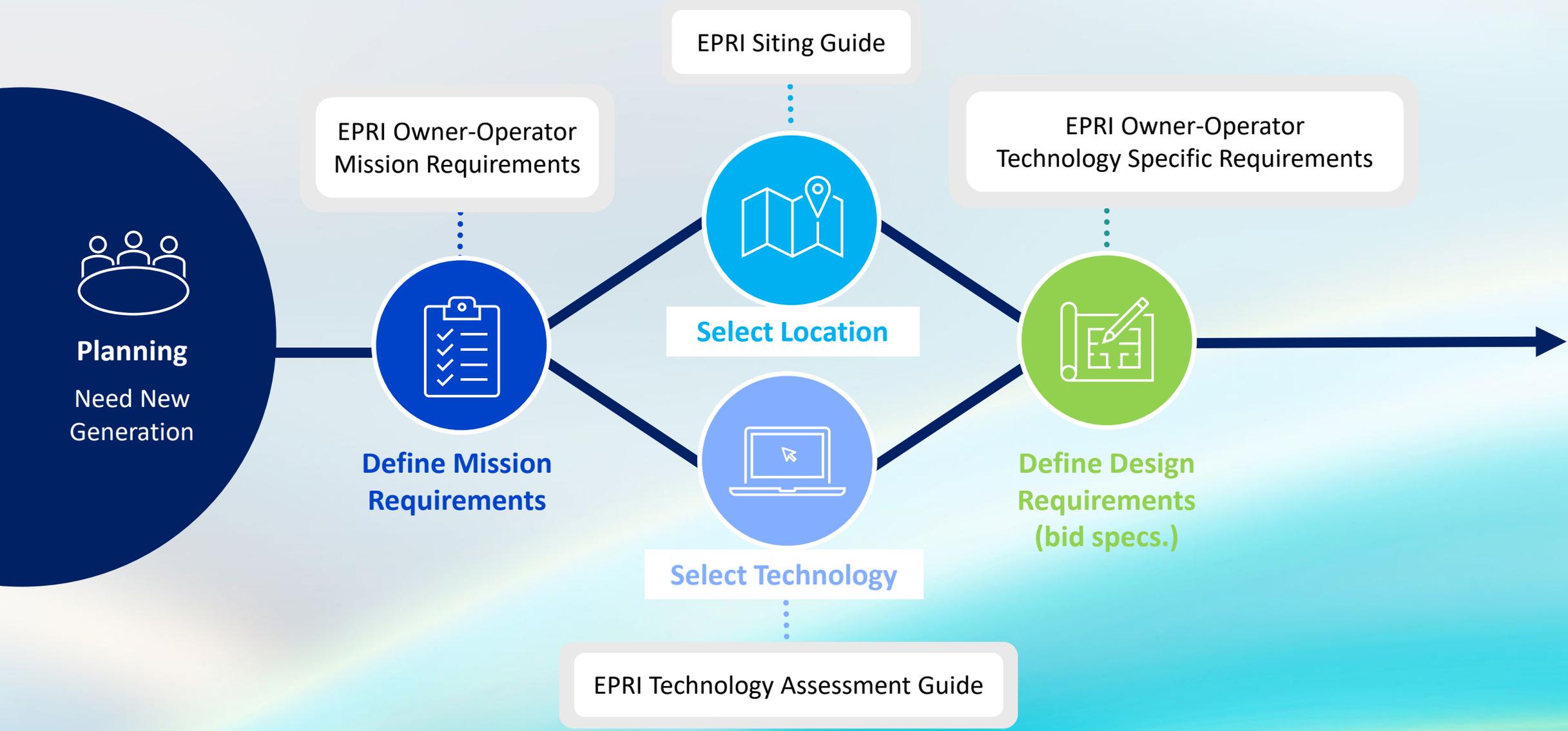


New Nuclear Project Development & Execution Framework



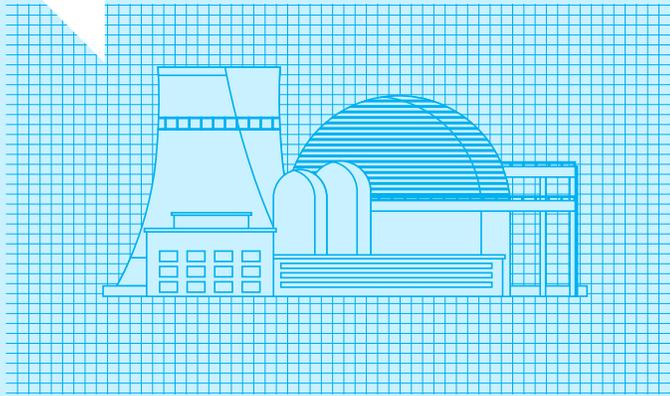
Advanced Nuclear Technology:
 New Nuclear Plant Project
 Development and Execution Guideline
[3002026494](https://www.epri.com/standards/3002026494)

Project Development



New Plant Technical Assistance

EPRI Technology Transfer



Project Initiation

New to Nuclear Training

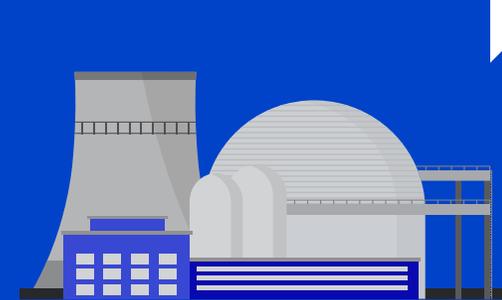
- ✓ Siting
- ✓ Utility and Owner Requirements
- ✓ Design



Pre-Construction

Construction Readiness Review

- ✓ Engineering
- ✓ Optimization
- ✓ Advanced Manufacturing



Commissioning and Initial Operations

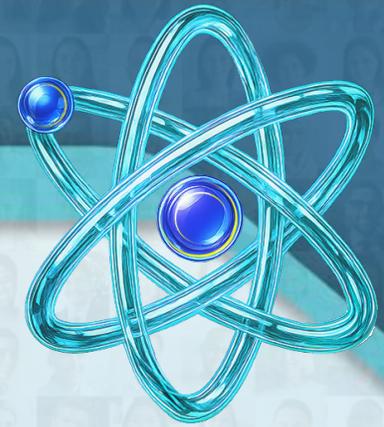
Technical Readiness Review

- ✓ EPRI Program Implementation
- ✓ Startup and Testing



Guide to EPRI New Build Resources
[3002025692](#)

EPRI



TOGETHER...SHAPING THE FUTURE OF ENERGY®