Leading the Way to A Bright Energy Future

Bringing GenIV to Market: A Vendor's Perspective

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The value of molten salts – IMSR® safety case

Central challenge is heat dissipation in all circumstances
Central pillar of Safety Case

CONTROL

- Strong negative reactivity coefficient of temperature
- Passive shutdown Safety Case

COOL

- Assures heat dissipation in all circumstances
- Fuel is a molten salt and also the coolant
- Enables convective and natural circulation cooling to move heat internally
- Vessel wall at ~600 °C
  - Extremely effective radiative cooling

CONTAIN

- Chemical containment
  - Salts chemically bind volatile fission products, Cs, I etc…
- No chemical driving forces
- Zirconium Metal-Water reactions absent
- No physical driving forces
  - Operates at one atmosphere

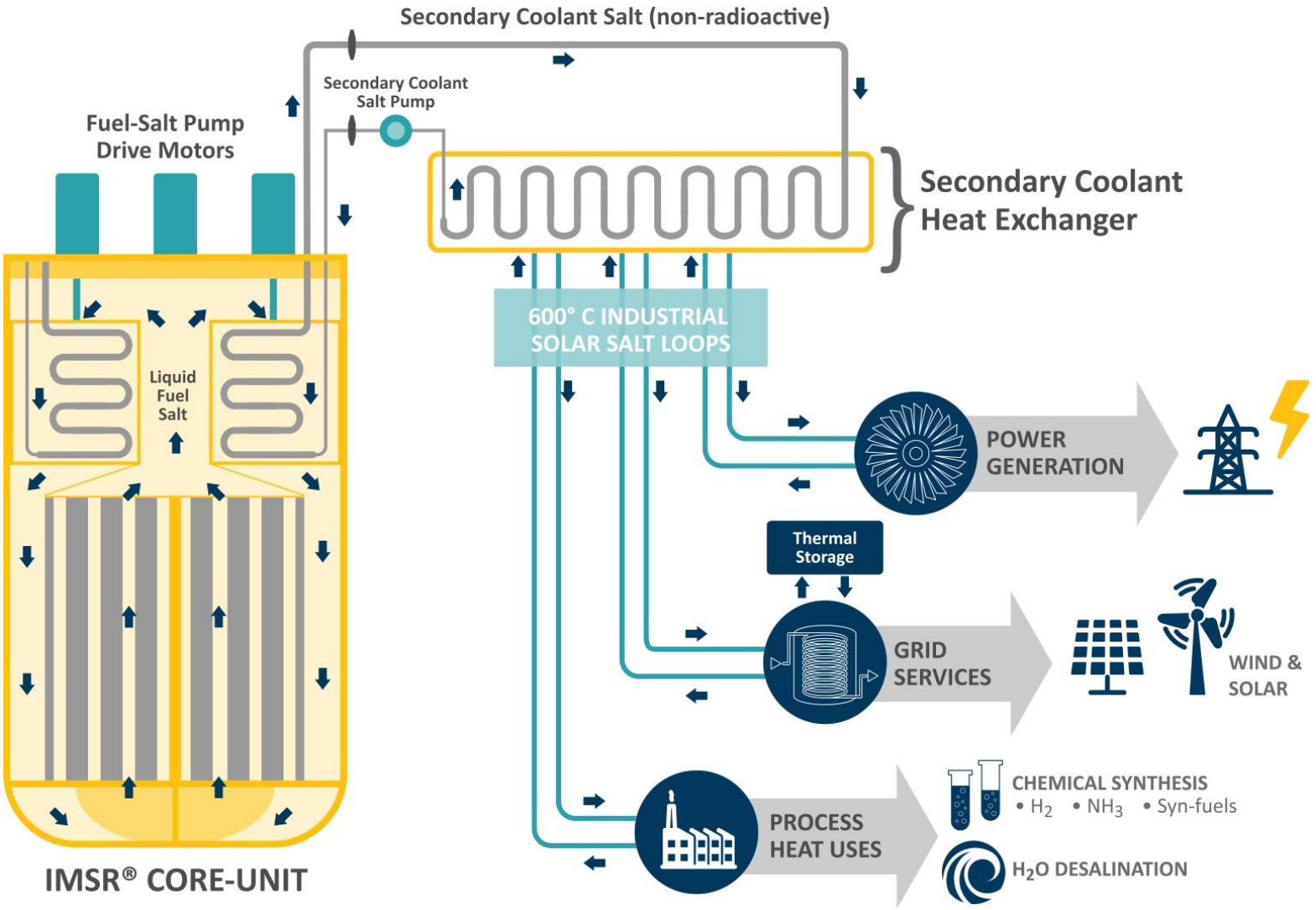
IMSR® Safety Case achieved with simple, natural and passive mechanisms that are secure and robust

IMSR® has a Safety Case to drive cost reduction

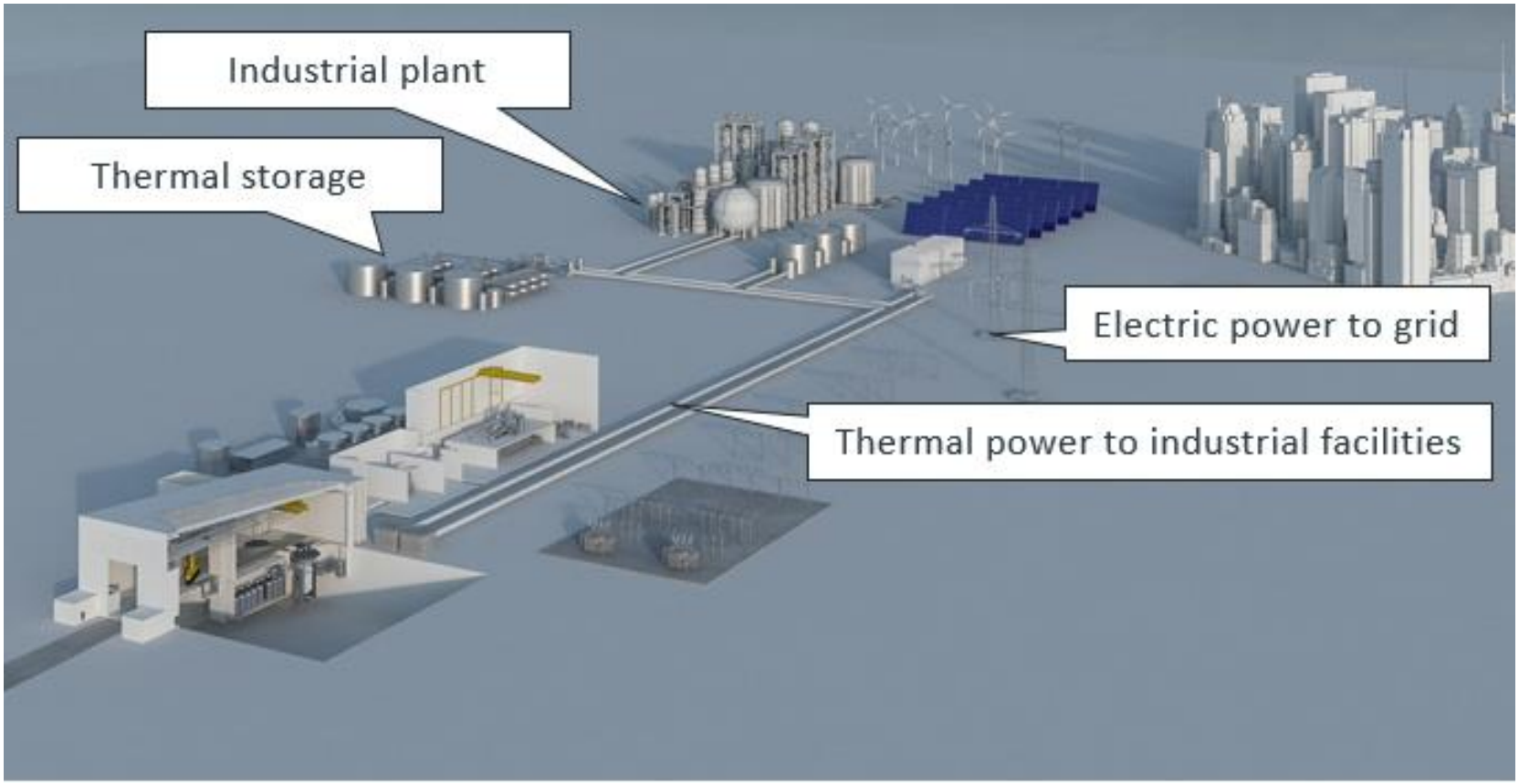
What is Terrestrial Energy's IMSR®?

- Integral Molten Salt Reactor
- MSR-Burner design, ~2% LEU startup and <5% LEU makeup
- Integrates all primary systems into a sealed reactor vessel
- 7 year Core unit "Seal and Swap" approach to graphite lifetime
- Planned as 400 MWth (~ 190 MWe)
- 3.6 m wide Core-unit for eased transportability
- Safety at forefront which leads to cost innovation
- 2020's deployment the goal

How an IMSR® power plant works



IMSR® is for industrial heat use and electric power provision



IMSR® Nuclear Island produces 600 °C industrial heat. Balance-of-Plant can be a broad range of industrial applications – not just power provision

IMSR® - Pragmatic Design Decisions

- 7 year Core-unit replacement
  - *Allows advantages of graphite moderation*
  - *simplifies vessel and heat exchanger code qualification*
- Soft spectrum
  - *very low enrichment startup and 4.95% makeup*
- Inexpensive carrier salt
  - *avoids tritium production of ^{7}LiF or BeF_2*
- Strongly negative temperature coefficients
  - *inherent load following & passive shutdown…control rods not needed*
- Large reduction in Pu waste production while avoiding any salt processing
- Greatly simplified Off-Gas management
- Passive decay heat removal
  - *Innovative closed cycle gas (similar to RVACS)*

VDR Phase II on the critical path to commercialization

- Demonstrating design licensability is key to commercial progress in the nuclear industry
  - *IMSR® has successfully completed CNSC Vendor Design Review Phase 1*
  - *A nuclear industry first for a Generation IV reactor*
- Process has been very beneficial to TEI, much learned on both sides
- Terrestrial Energy has recently started VDR Phase 2
  - *For now, only GenIV system at this stage*
- Terrestrial Energy's successful completion of VDR Phase 2 will be catalytic
  - *Regulatory statement of "No fundamental barriers to licensing" viewed by TEI as key to Utility confidence*

A free market response to the need for advanced nuclear (Vendors with Pre-Licensing activities in Canada as of Oct 2018)

Vendor	Name of design and cooling type	Review start date	Status
Terrestrial Energy Inc.	IMSR Integral Molten Salt Reactor	April 2016	Phase 1 complete
		December 2018	Phase 2 assessment in progress
NuScale Power, LLC	NuScale Integral Pressurized Water Reactor	Pending early 2019	Service agreement under development
Ultra Safe Nuclear Corporation / Global First Power	MMR-5 and MMR-10 High Temperature Gas	December 2016	Completion expected October 2018
		Pending late 2018	PHASE 2 Service Agreement in place – Project start pending
Westinghouse Electric Company, LLC	eVinci Micro Reactor Solid core and heat pipes	Pending early 2019	Service agreement under development
LeadCold Nuclear Inc.	SEALER Molten Lead	January 2017	Phase 1 on hold at vendor's request
Advanced Reactor Concepts Ltd.	ARC-100 Liquid Sodium	Fall 2017	Phase I assessment in progress
URENCO	U-Battery High-Temperature Gas	To be determined	Service agreement under development
Moltex Energy	Moltex Energy Stable Salt Reactor	December 2017	Phase 1 assessment in progress
SMR, LLC. (A Holtec International Company)	SMR-160 Pressurized Light Water	July 2018	Phase I assessment in progress
StarCore Nuclear	StarCore Module High-Temperature Gas	To be determined	Service agreement under development

Why the influx to Canada?

- Canada only moderate future energy expansion but generally favorable views on nuclear power and the need for greenhouse gas reduction
- Regulatory environment sees favorable aspects
- At risk of oversimplification;
  - *Canadian and UK systems more Performance or Principles based*
  - *US NRC more Prescriptive based on 60 years of LWR experience*
- CNSC's Pre-licensing process is also more a staged gate approach
  - *Aligned better to milestone based investment of the private sector*
- Appears to be a healthy world cooperation between regulators to assure the safe and timely arrival of GenIV systems to a world in need of clean, cost competitive and scalable energy.

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