IMSR® Commercialization before 2030

GAIN Molten Salt Reactor Workshop 2020

Oak Ridge National Laboratory

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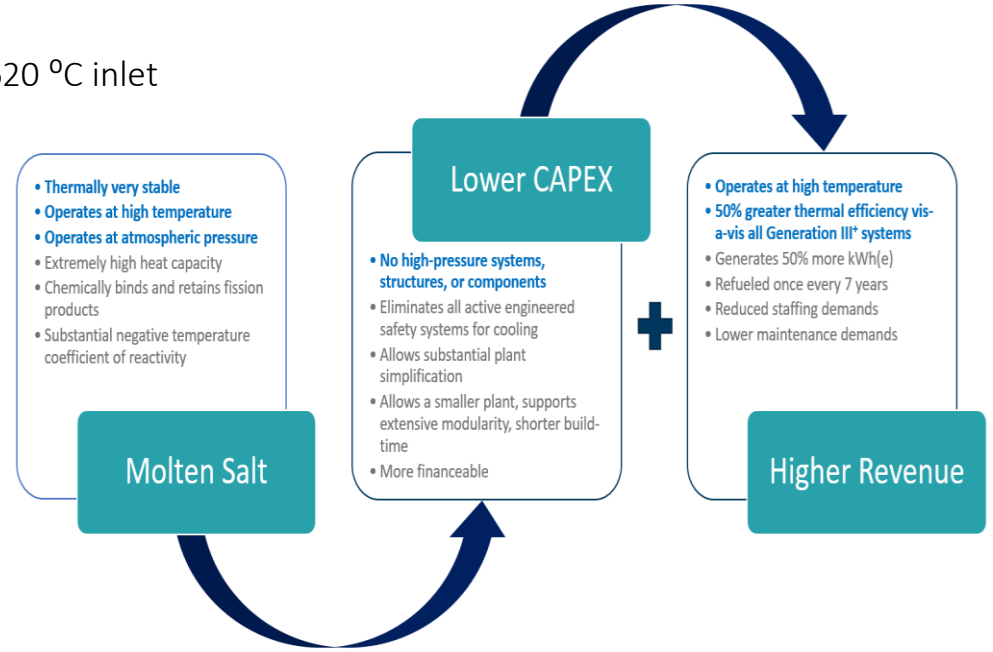
Dave Hill

Chief Technology Officer

Terrestrial Energy USA

IMSR® Technology Summary

- 442 MWth liquid fueled and cooled, thermal spectrum, graphite moderated, pool-type, molten fluoride salt reactor
- Hydrostatic operating pressure, 700 ^{o}C outlet, 620 ^{o}C inlet
- 195 MWe/44% thermal efficiency
- 600 °C liquid salt industrial heat supply
- Fuel enrichment <5%
- 7-year fuel cycle length
- 56-year plant design life
- 17-acre site layout
- Plant boundary EPZ
- Black start capable



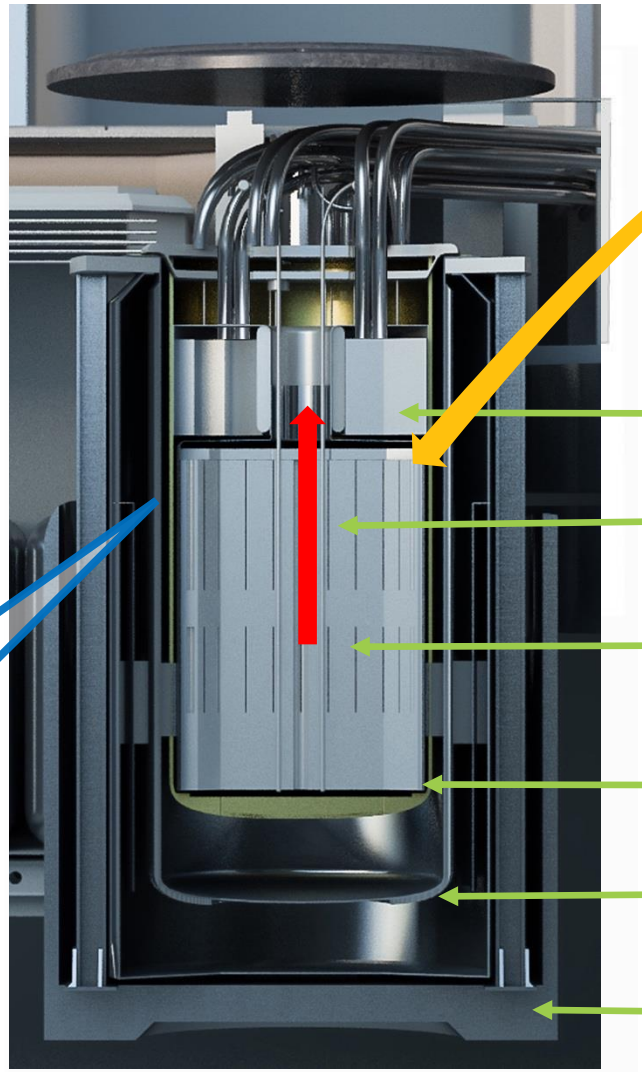
- Inherent and passive decay heat removal, indefinite coping time, no operator action required
- Capable of 10% per minute from 100% to 50% to 100% load following ramp rate

IMSR® technology provides a solution to the current unaffordable and uncompetitive nuclear new build market problem

IMSR® – Key innovation

- Key innovation is integration of primary reactor components
  - *Reactor core*
  - *Primary heat exchanger*
  - *Pumps*
- A sealed reactor vessel within a compact replaceable unit
  - *7-year operation*
- **Integral design captures full commercial value**
  - *Inherent safety*
  - *Operational simplicity*
  - *High capital recovery*
- Patents pending and granted

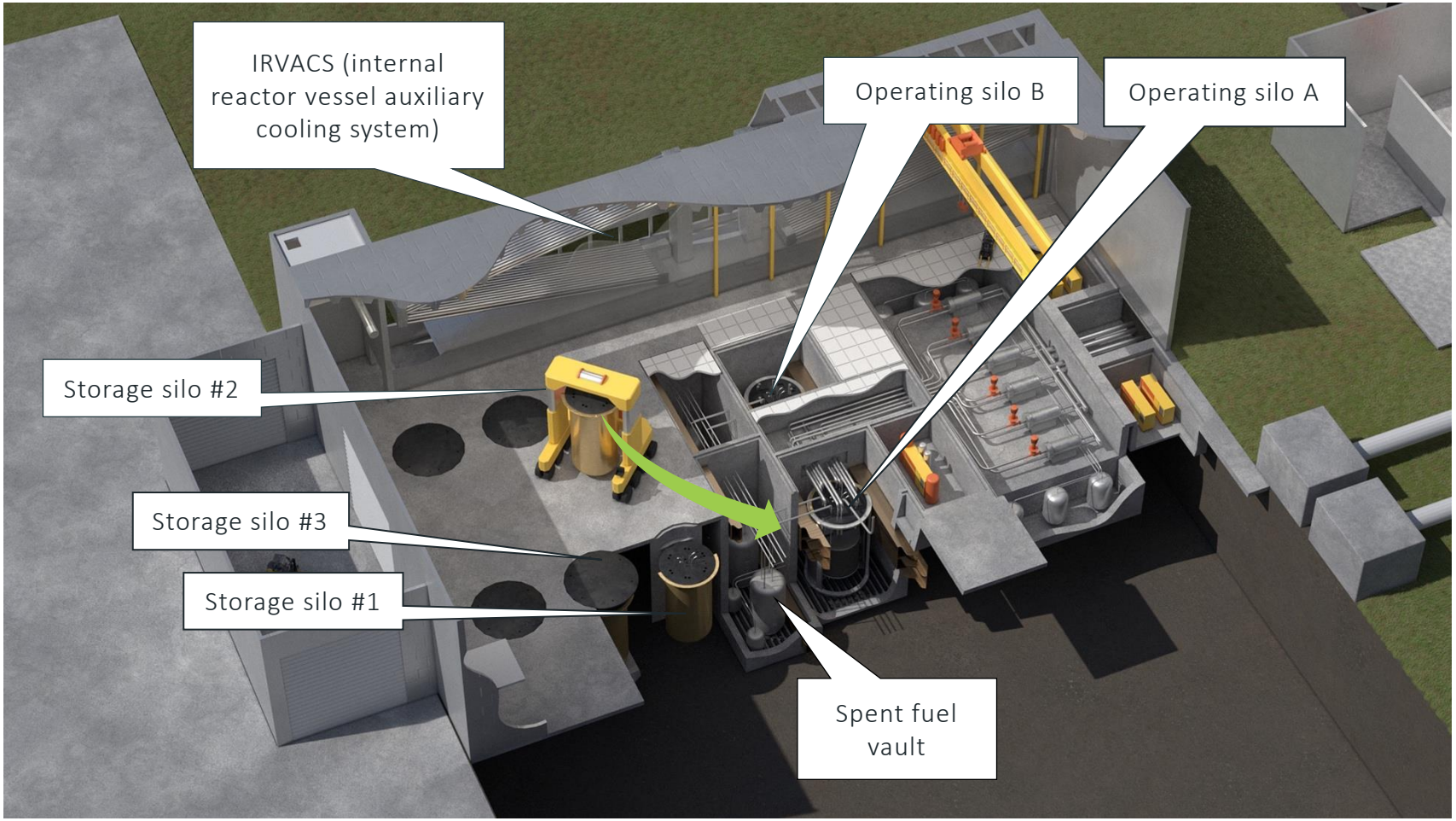
The reactor core is replaced every 7 years



IMSR® size:
3.7 m x 12 m

IMSR® Core-unit in Containment and Silo

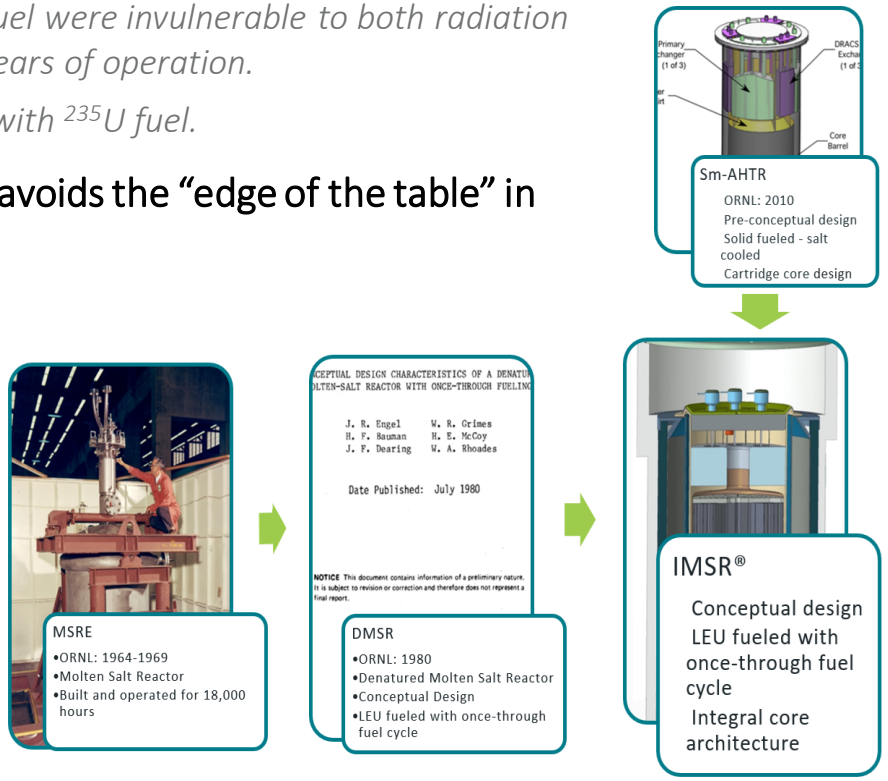
Sealed and replaceable IMSR® Core-unit



IMSR® is simpler and safer by design

IMSR® Technology Readiness

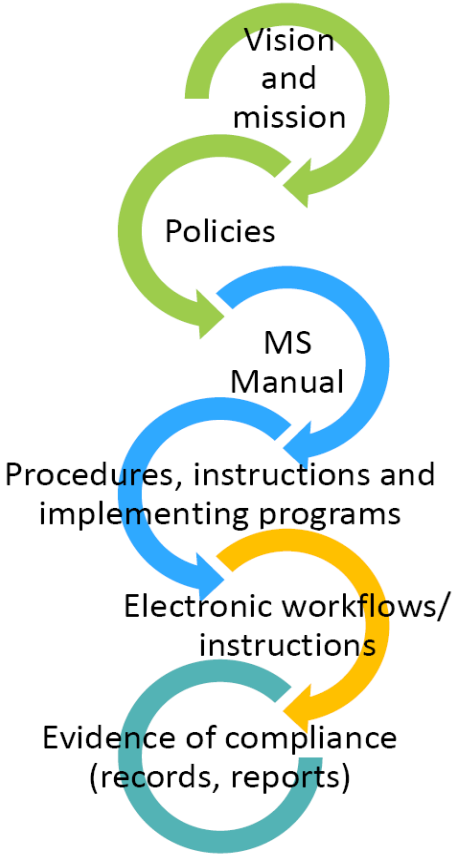
- IMSR® is fueled by a fluoride-based homogeneous liquid fuel salt
  - *The MSRE proved that fluoride salts in a liquid fuel were invulnerable to both radiation and high temperatures during more than four years of operation.*
  - *9,000 equivalent full-power hours of operation with ^{235}U fuel.*
- **IMSR® development is based on pragmatism, avoids the "edge of the table" in terms of risk**
  - *Risk = Cost*
  - *Reduced Risk = Reduced Cost*
- All major SSCs at a TRL level of 6-7
  - ***Construction testing and start-up will confirm technology readiness.***
  - *No reliance on High Assay LEU*
  - *2-3% ^{235}U for startup*
  - *4.95% ^{235}U for periodic fuel additions*



No fundamentally new technologies are required to design, build, evaluate, operate, regulate, or decommission the IMSR®

IMSR® Engineering

- Comprehensive advanced reactor design process.
  - *Defines the entire IMSR® technology development program.*
  - *Encompasses all research, development, analysis, engineering, licensing, and testing.*
  - *Will lead to a fully designed, engineered, and licensed IMSR® nuclear power plant.*
- Basic Engineering phase for the IMSR® plant is on schedule for completion in 2021.
  - *Establishes the system level technical details to enable detailed engineering.*
- A "buy vs make" focused R&D program of validation and verification will be completed by 2024.
  - *Physics*
  - *Thermal Hydraulics*
  - *Materials*
  - *Chemistry*



Engineering is on pace to meet the principal business objective to develop, license, construct, commission, and demonstrate a commercial plant IMSR® in the 2020's

IMSR® Regulatory Progress

- IMSR® has successfully completed the Canadian CNSC Vendor Design Review (VDR) Phase I.
  - *VDR Phase II is on schedule to complete in 2021*
- US NRC regulatory engagement is underway.
  - *10CFR Part 52 Standard Design Approval of the IMSR® Core-unit*
  - *Prerequisite to 10CFR Part 50 Construction Permit Application*
- IMSR® is the subject of a joint CNSC/USNRC collaborative regulatory review by both agencies.
- Successful completion of regulatory reviews will be catalytic
  - *Domestic regulatory approvals are required for deployment to international markets*
  - *Green light for first electric utilities to start deployment of first IMSR® power plants*
  - *Nuclear supply chain commitment to IMSR® development*
  - *Broader private capital involvement*

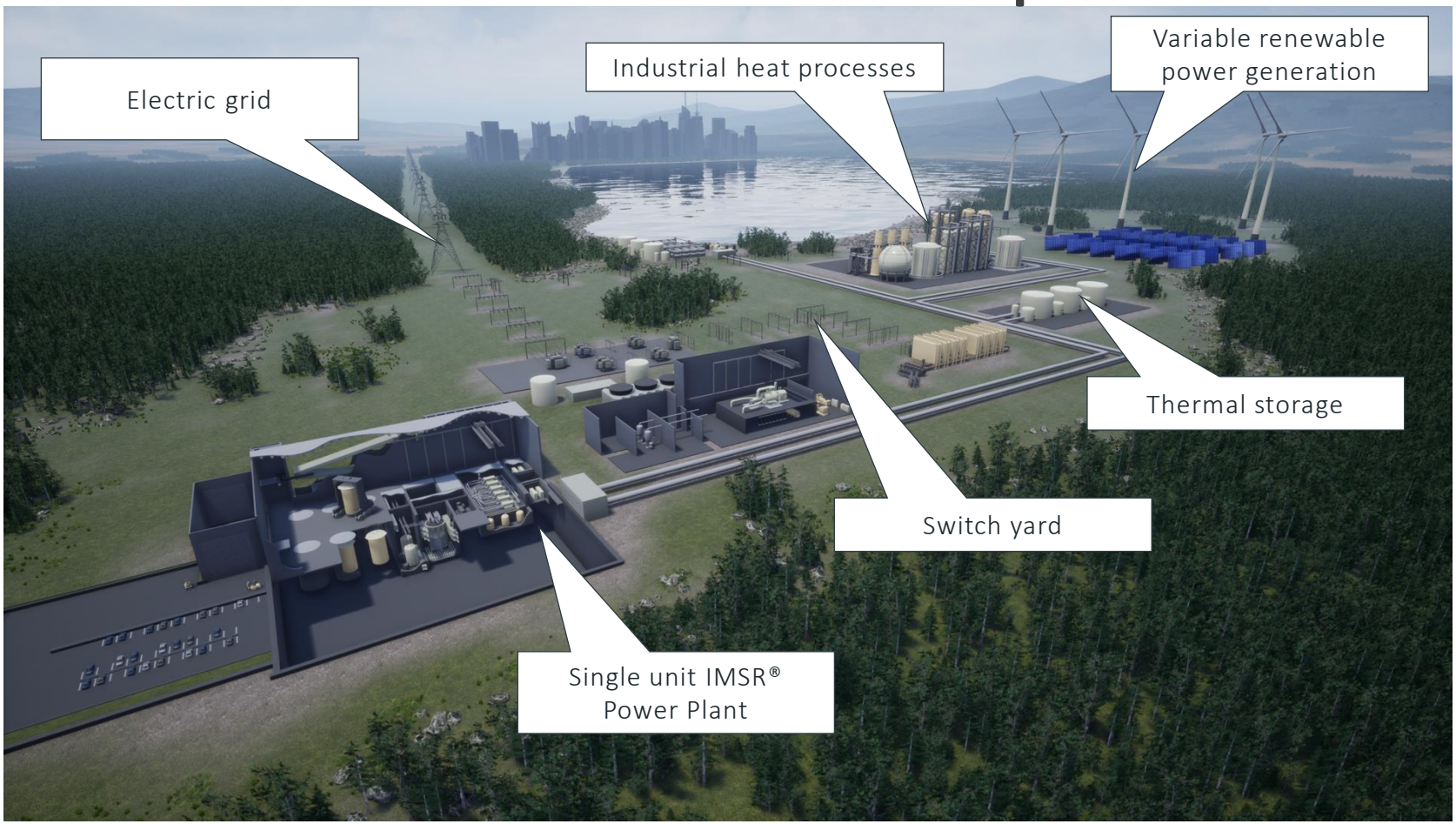
IMSR® licensing progress is key to continued private investment and commercial success

IMSR® Deployment Before 2030

- Progress in engineering and supplier engagement supports the established deployment schedule
- **Early stage supplier agreements in place**
  - *Graphite, pumps, fuel supply, simulator*
  - *BOP – Steam generators, turbine equipment*
- **IMSR® is one of three designs selected by Ontario Power Generation to advance SMR deployment in Ontario**
- Internationally renowned nuclear industry suppliers and utilities are supporting development and deployment of IMSR® through a Nuclear Innovation Working Group
  - *Ontario Power Generation, Bruce Power, Burns & McDonnell, SNC-Lavalin, Corporate Risk Associates Limited, Kinectrics, Laker Energy Products, Promation, and Sargent & Lundy*
- **Business case drives private capital investment support**
  - *CAPEX < $1 billion, superior thermal efficiency (~44%), LCOE of $50/MWh*

Engineering, technology, and supply chain development is focused on early deployment and commercial success of IMSR®

IMSR® is ideal for providing industrial heat and electric power



IMSR® 600°C heat can be coupled to many industrial activities in an industrial park – it is not just for electric-grid power provision

Questions

Terrestrial Energy USA, Inc.
537 Steamboat Road, Suite 200
Greenwich, CT 06830

Phone: 646-687-8212
Email: info@terrestrialusa.com