Holos Generators: Distributable, Integral very-Small Modular Reactors (v-SMRs) Competitive and Synergetic with Renewable Energy Sources

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Atlanta

Transportable Generators via Balance of Plant Elimination

- Trasformative
- Advanced with modest investment
- Shortened construction time
- Tested at full-scale
- DBA, BDBA performance validation
- Autonomous & “walkaway” safe
- Extremely low capital cost
- Fast commissioning
- Decommissioning-ready
- Reliant on proven technologies
- Disruptive in the market place

http://www.hologsen.com/neutron-coupling-decoupling/ Video Link

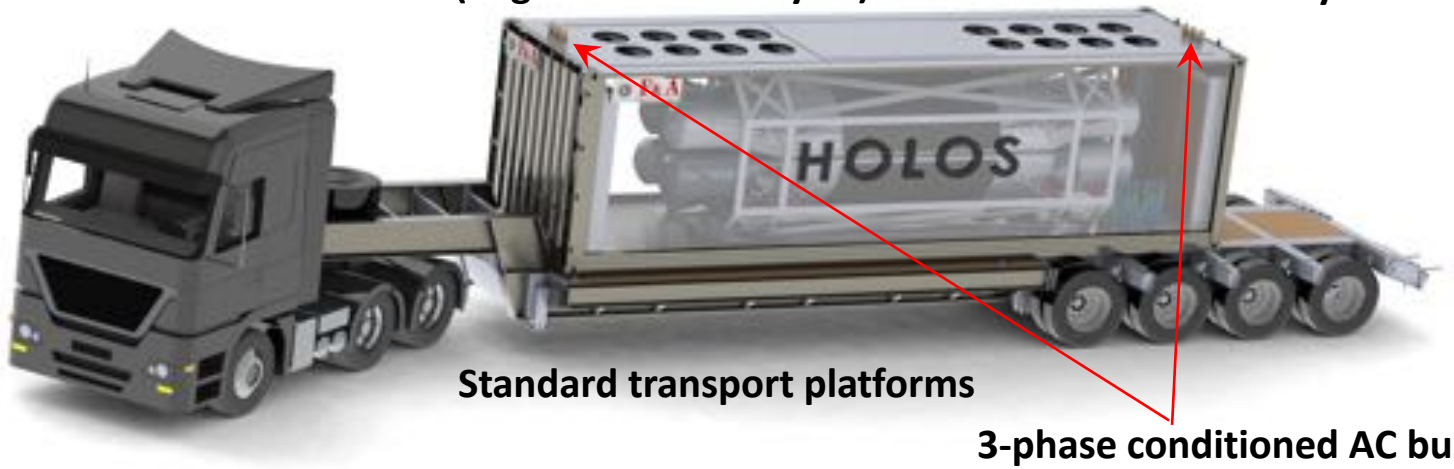
Main Features & Requirements

Independent of Site-specific Stressors

- Electric-island immediately operational
- Station Black Out (SBO) immune
- Loss Of Coolant Accident (LOCA) immune
- Sabotage and design basis attack resistant
- Air-cooled, passive decay heat removal
- Near-real time load following (MW/sec)
- Process Heat Standard via separation heat exchanger
- Sealed fuel cartridges from factory to repository
- Factory certifiable (as for aviation turbojet engines)
- 97% capacity factor

3 MWe ORC (Organic Rankine Cycle)

10 MWe Brayton



Standard transport platforms

3-phase conditioned AC buses

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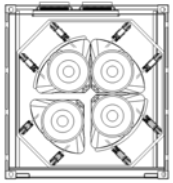
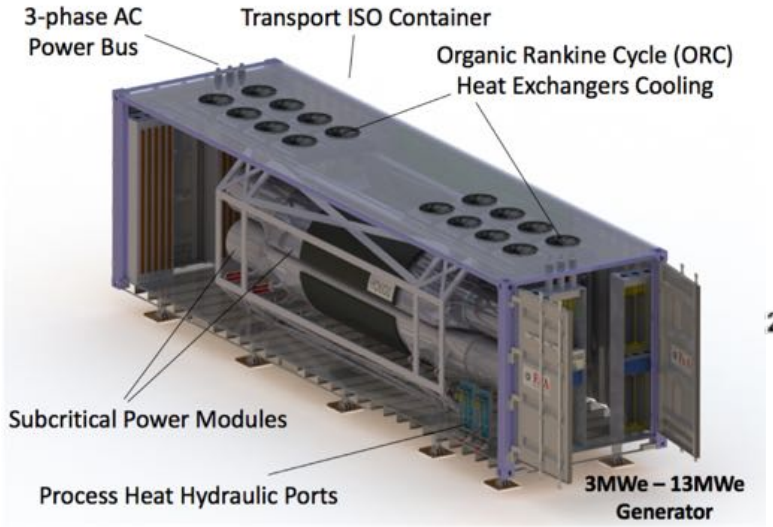
Factory-certified Rapidly Deployable Configurations

Single ISO container

Electric Island
Immediately Operational
Min 3 MWe – 13 MWe Max





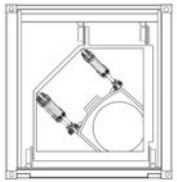
61 MWe
SCALED UP FOUR SUBCRITICAL TITAN POWER MODULES
INSIDE 4 ISO CONTAINERS

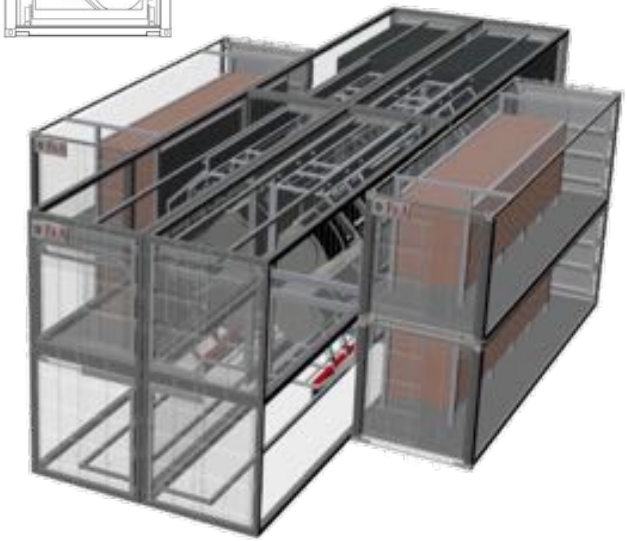
AUXILIARY POWER COMPONENTS
INSIDE 4 ISO CONTAINERS

ORC MODULES
INSIDE 4 ISO CONTAINERS
20 MWe ADDITIONAL POWER

81 MWe
TOTAL POWER GENERATION

Clusterable ISO containers





http://www.hologsen.com/holos-quad/

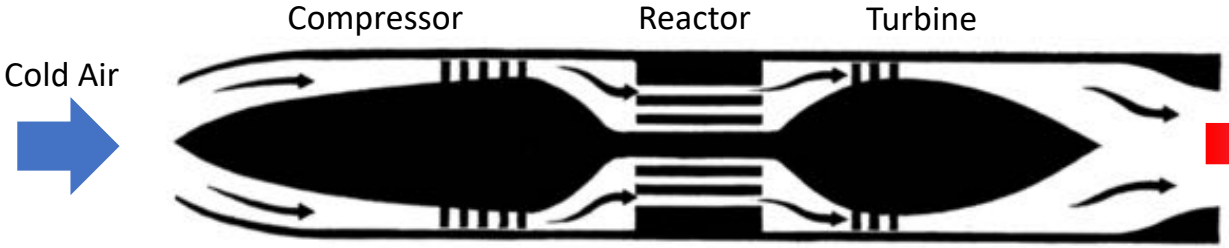
Video Links

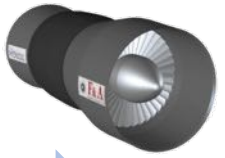
http://www.hologsen.com/holos-titan-generator/

Holos Thermal-hydraulic Feasibility

OPEN TO CLOSED LOOP
TURBOJET TECHNOLOGY

Video Link: http://www.hologsen.com/open-to-closed-loop-technology/

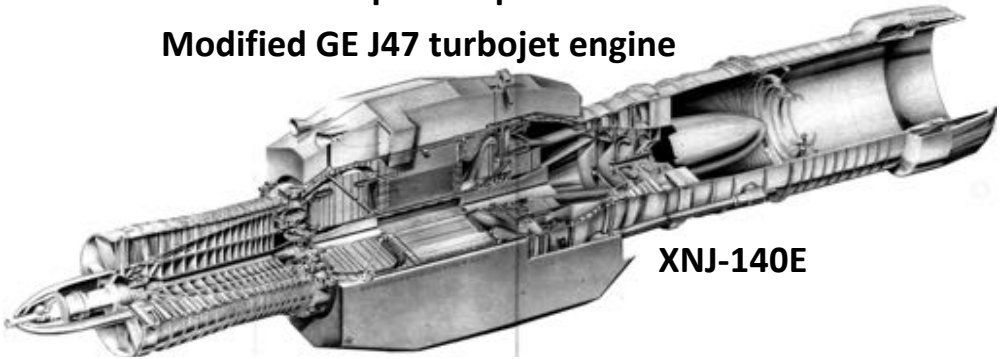




Closed-loop with HTRE-3

Open-loop

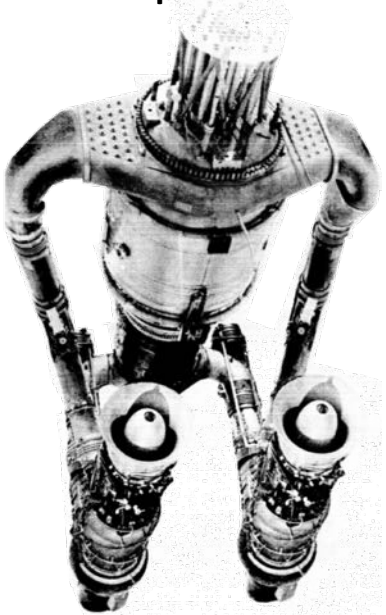
Modified GE J47 turbojet engine



XNJ-140E

The 1st aircraft engine based on nuclear energy operated January 31, 1956

TORY II-A Testing Prototype



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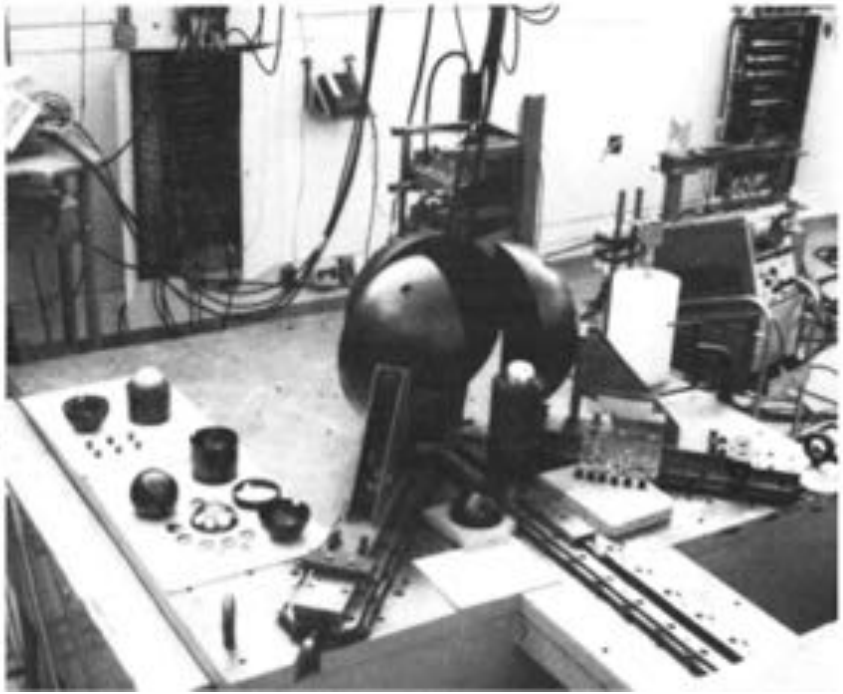
Holos Neutronic Feasibility

KIWI-TNT & Parka reactors



Flattop mobile reflectors

16 Rover “flyable” reactors were proof tested by LANL

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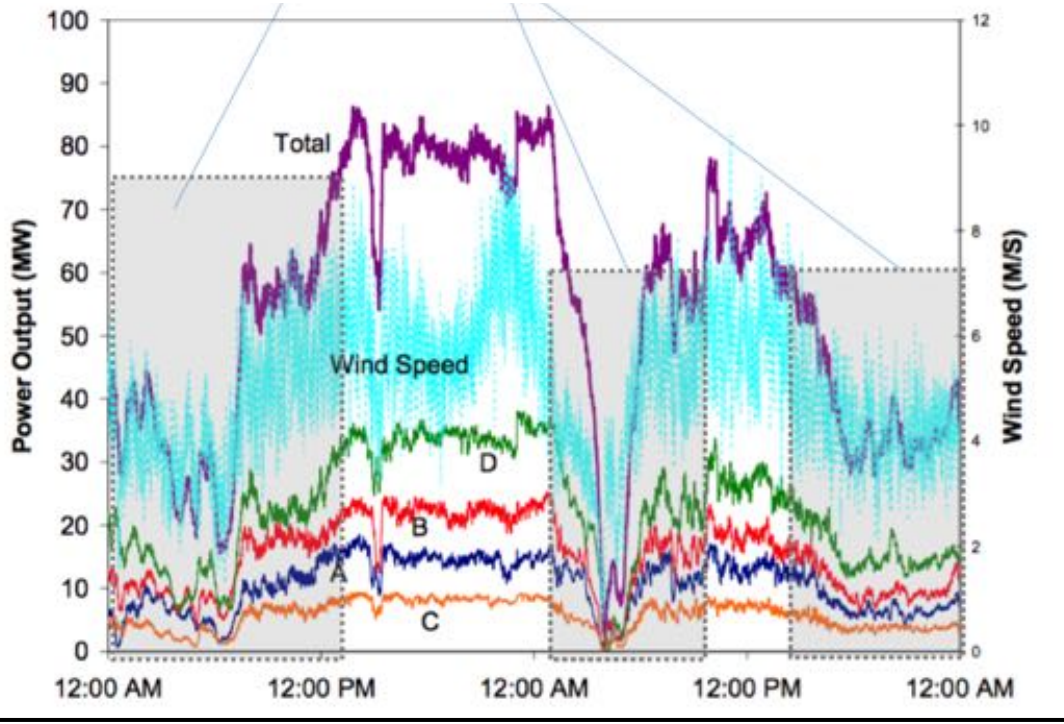
Applications: ~~non~~-Dispatchable Renewables

EV Charging Stations at non-electrified locations

Holos high-fidelity load following supports contingency power at the request of power grid operators



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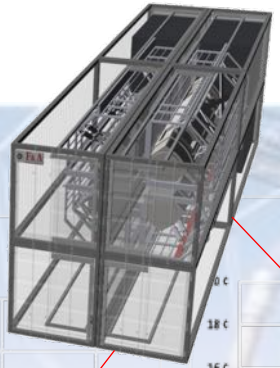
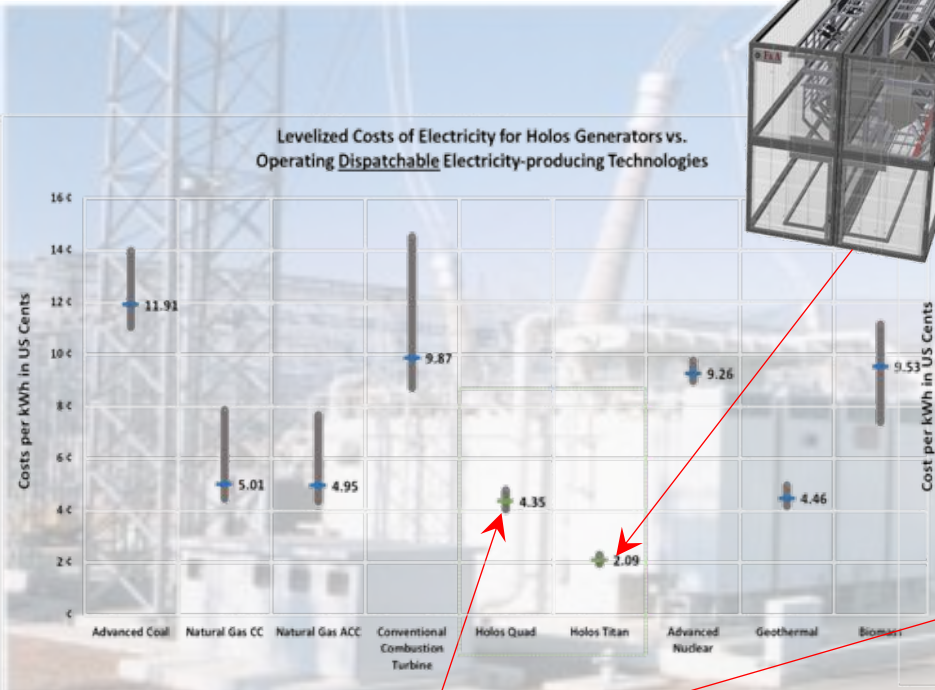
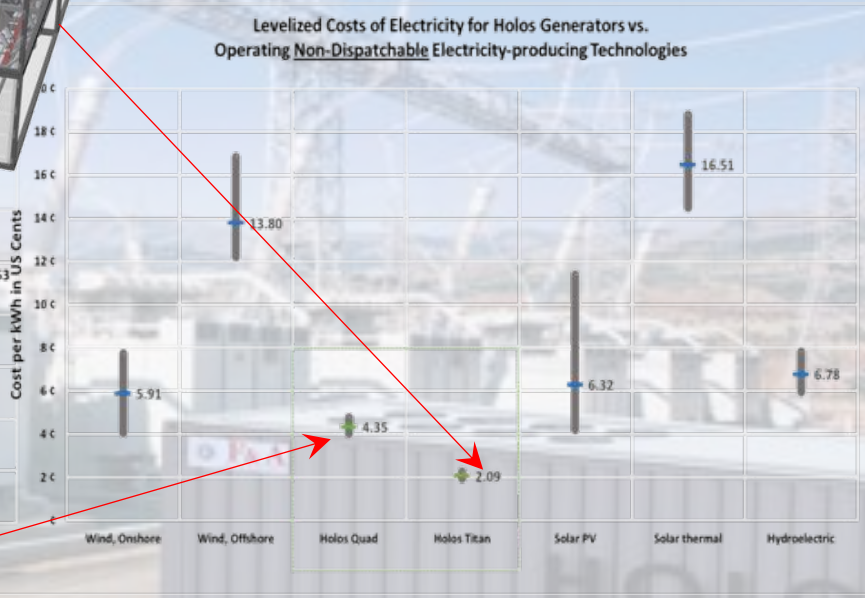
Competitive



81 MWe





13 MWe

Based on 2018 EIA data

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Emergency Power

03-01-18, 15% of power customers still in the dark

Immediately Operational Electric Island

Fukushima Daiichi Station

Preventing severe accidents induced by prolonged Station Black Out

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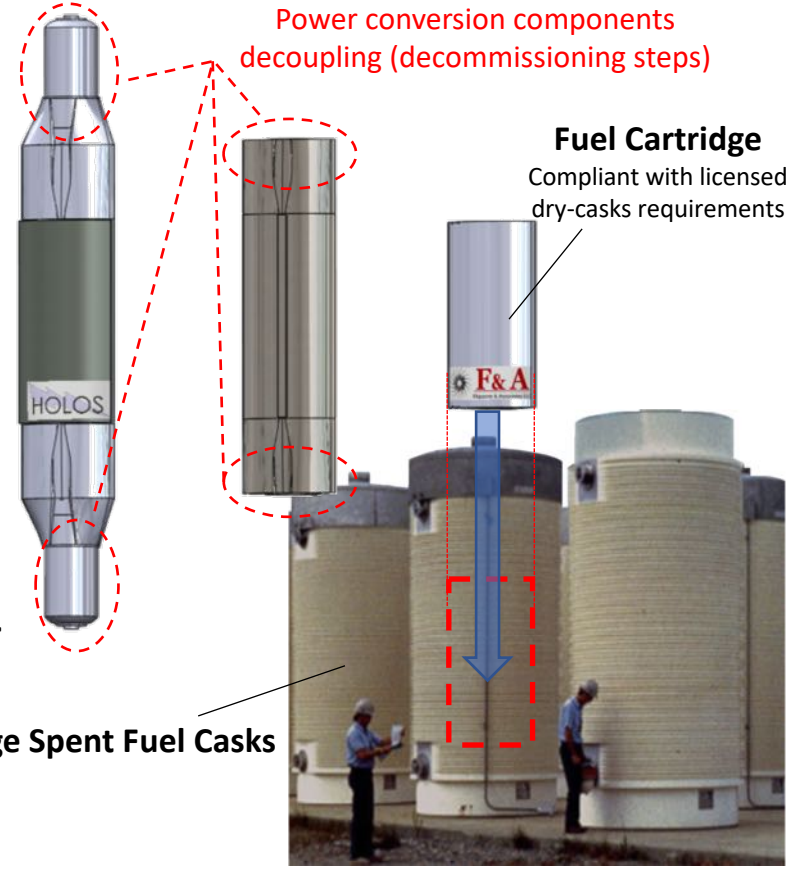
Mass Production allows for True Economies of Scale

FOAK = 135M
NOAK = 65M

Holos Architecture Enables Substantial Design Simplifications and Cost Reductions

- ~~Nuclear Island~~, ~~Turbine Island~~, ~~Condenser~~, ~~BoP~~ coupling multiple ~~Reinforced Concrete Buildings~~ → SSCs reduction
- Fully autonomous, no on-site operators, 4 FTE off-site operators supporting simultaneous monitoring of multiple units
- Each unit is formed by multiple mass-produced components (e.g., turbo-generators, fuel cartridges) → reduced FOAK
- 1x Holos Generator Unit = 4x identical components → NOAK achieved with a few units

Simplified and expedited decommissioning



LWRs vs. Holos

Holos Systems, Structure and Components (SSCs) substantially reduced, inducing lower decommissioning costs

Decommissioning Sub-categories	LWRs	Holos
Staffing	✓	
LLW Burial	✓	
Equipment Removal	✓	✓
LLW Packaging & Shipping	✓	
Decontamination Activities	✓	✓
Decommissioning Planning Activities	✓	
Other Costs	✓	✓
Spent Fuel Management	✓	✓
Planning & Preparation	✓	✓
Dormancy w/Wet Fuel Storage	✓	
Dormancy w/Dry Fuel Storage	✓	✓
Dormancy w/No Fuel Storage	✓	
Site Reactivation	✓	
Decommissioning Preparation	✓	
Large Component Removal	✓	✓
Plant Systems Removal & Building Remediation	✓	
License Termination	✓	✓
Site Restoration	✓	

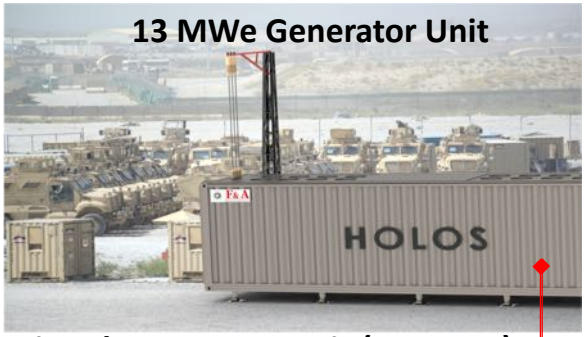
LWRs: Light Water Reactors

Research, Development, and Deployment

R&D and Deployment Schedule

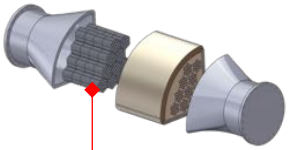
- $3M scaled prototype: Feasibility and Fuel Cartridge Ballistic Testing
- $79M full-scale deployable system via execution of 5 Main tasks over 3 years

Task	Description	T+1y		T+2y		T+3y	
1	Holos Core and Reactivity Control Optimization						
2	Thermal-hydraulic & Neutronic Models Verification						
3	Design and Manufacturing of Operational s-SPM and Test-rig						
4	Active Magnetic Bearings (AMB) Design & Manufacturing						
5	Worst-case Scenario Simulation & Testing						

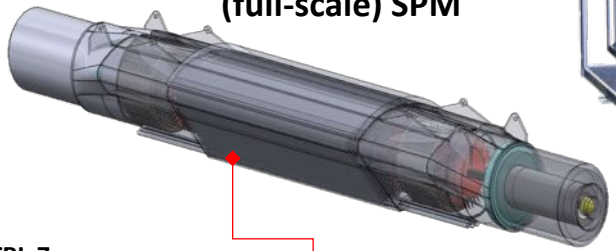


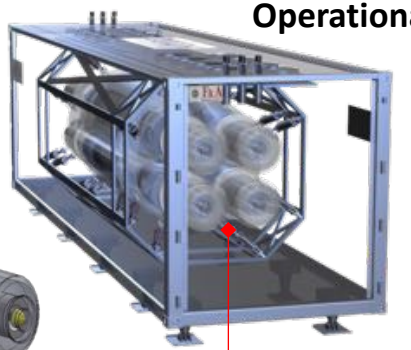
Operational Generator Unit (4x SPMs)

Prototype scaled-SPM



Subcritical Power Module (full-scale) SPM





Safety

- Melt resistant fuels
- No volatiles release
- Fuel at atmospheric pressure
- EMP and ballistic strike resistant
- Decay heat passive removal
- Factory certified

TRL-7 $3M → TRL-8 $25M → TRL-9 $51M

FOAK $79M - licensing & fuel not included — 3 year

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Leveraging Operational Waste Heat Recovery Test-rig

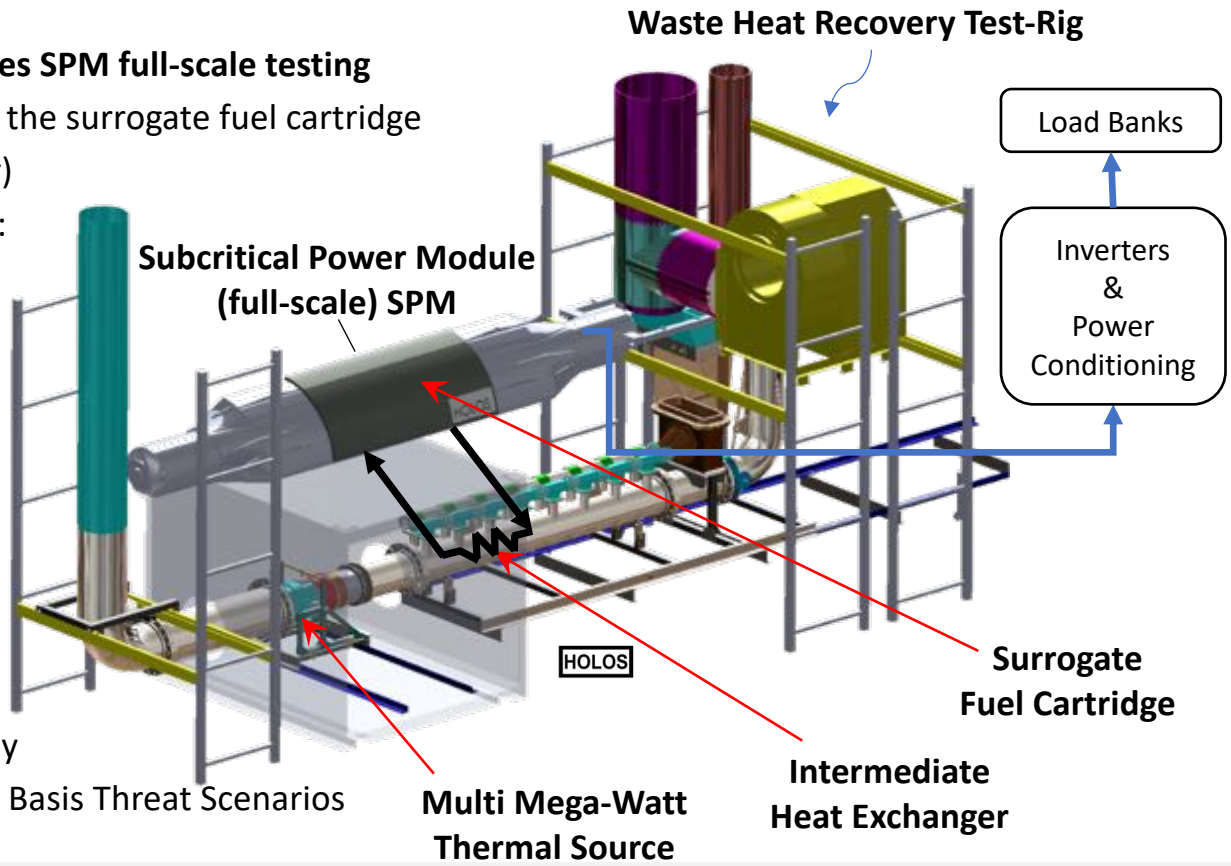
Multi Mega-Watt thermal source enables SPM full-scale testing

- Intermediate HEX thermally coupling the surrogate fuel cartridge
- Surrogate fuel cartridge (non-nuclear)
- Full-scale SPM system fully equipped:
  - ✓ Integral turbo-machinery
  - ✓ Inverters & load banks
  - ✓ Dynamic load simulator

Accelerated R&D and Deployment

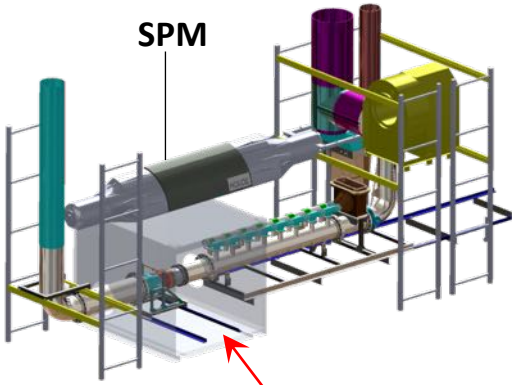
Full-scale testing accelerates:

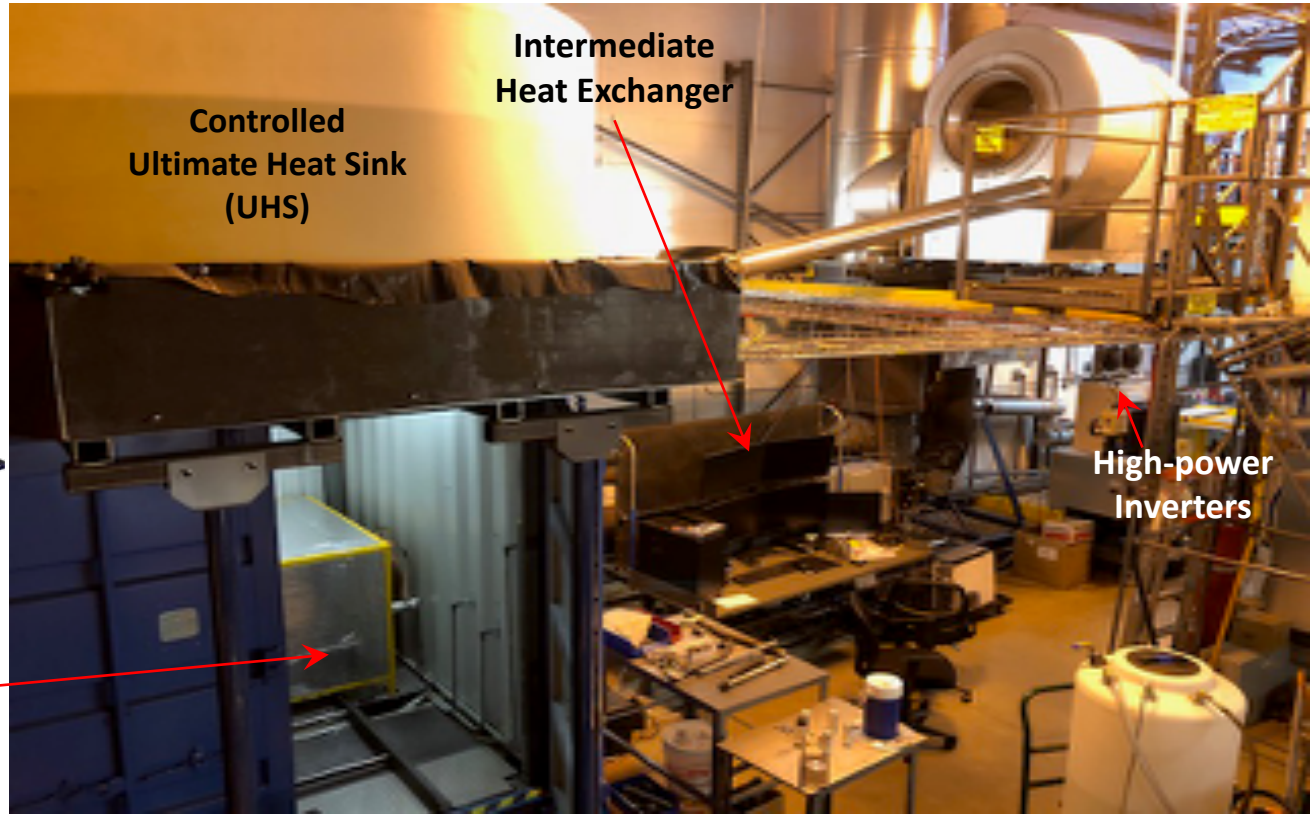
- Safety performance validation
- Licensing processes
- Supports factory-certification pathway
- Performance validation under Design Basis Threat Scenarios



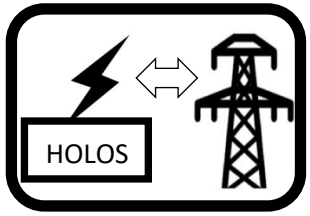
Low-cost Operational Waste Heat Recovery Test-rig

- Testing at full-scale conditions
- Low-cost safety and technical performance validation
- Accelerated development

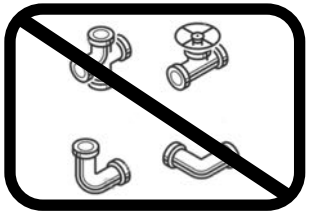




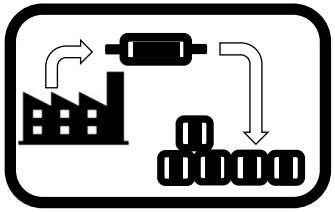
Summary



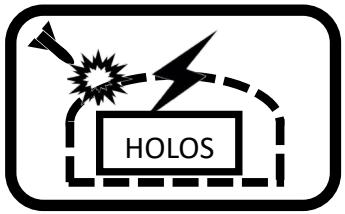
Power-demand Matching (load-following)



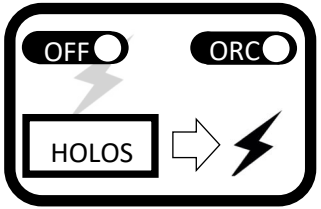
BoP Elimination Integral Power Conversion



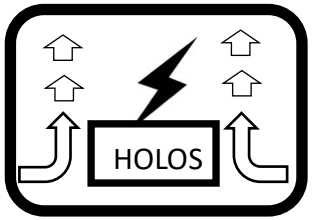
Sealed From Factory to Repository



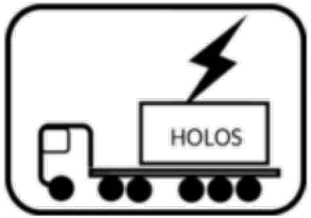
Sabotage Coping Capability, inherent, passive and active



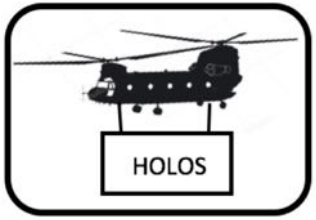
Electricity Production after Shutdown



Passive Air-cooling



Distributable



Emergency Power

Case Studies

Marine Propulsion

Mining Operations

Detailed Technical & Economic Information available at: www.holosgen.com

Questions?