IES
Integrated Energy Systems

# IES Experimental Systems Overview

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INL
Idaho National Laboratory

# Integrated Energy Systems – changing the energy paradigm

**Nuclear Energy Generation**

(Light water reactors, high temperature advanced reactors, small modular reactors, etc.)

**Other Energy Generation**

(Variable renewables, municipal waste, fossil with carbon capture, etc)


*Integrated energy systems (IES) leverage the contributions from nuclear fission beyond electricity*

Biofuel, transportation fuels | Hydrogen for transportation | New chemical processes | Polymers, chemicals | Industrial heat & fuels | Fertilizer, ammonia | Iron, steel, metals | Wood products, cardboard, paper | Clean Water | District heating | Flexible electricity

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# Integrated Energy Systems (IES) Experimental Systems

- Experimental systems within the Dynamic Energy Transport and Integration Laboratory (DETAIL) provide a platform to demonstrate a flexible integrated energy system
  - Non-nuclear microreactor test bed thermal energy source
  - Thermal energy distribution system – backbone of integrated energy system
    - Solid oxide electrolysis
    - MAGNET
  - Power conversion unit (closed loop Brayton cycle)
    - Microgrid load bank
  - Validate modeling on component and system levels
- Capability overlap with NREL's Advanced Research on Integrated Energy Systems (ARIES) – DETAIL adds thermal component (MAGNET, TEDS)
- Additional experimental system demonstration units in design to couple with advanced reactors at INL

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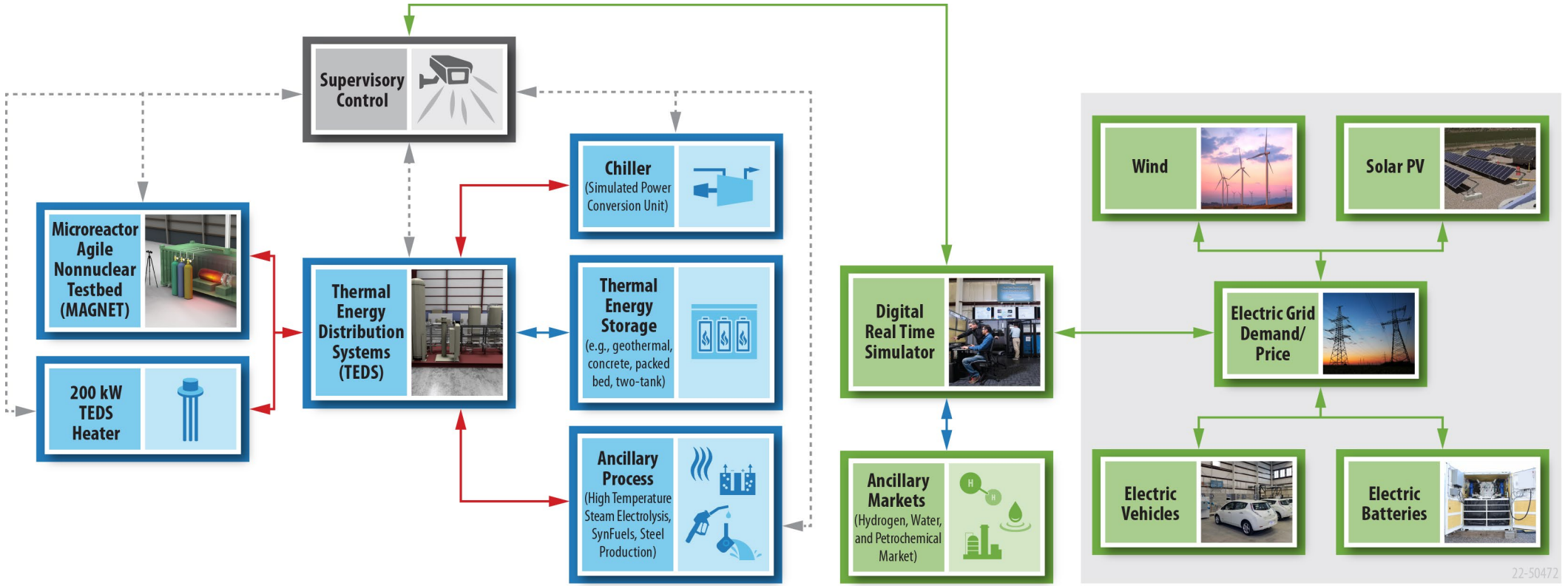
# Dynamic Energy Transport and Integration Laboratory (DETAIL)

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# Thermal Energy Distribution System (TEDS)

- Demonstrate thermal energy distribution components: valves, flanges, gaskets, etc.
- Examine performance and operation of thermal energy storage in an integrated system
- Develop and test instrumentation and control strategies/systems for thermal energy distribution and storage
- Validate computational models that can support scale up of integrated energy systems (e.g., Modelica, RELAP)
- Study thermal energy transport/transmission characteristics and performance
- Provide a test platform for regional grid operations that may include significant renewable penetration
- Provide a platform to experimentally demonstrate grid stressors that may not otherwise be simulated and how those stressors impact electricity generators
- Support cyber-informed engineering of controls and hardware

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# Microreactor Agile Non-Nuclear Experimental Test Bed (MAGNET)

- Provide a general-purpose, non-nuclear demonstration capability to evaluate microreactor, and microreactor component, designs
- Examine thermal-hydraulic performance for demonstrator test articles
- Integrate a power conversion unit
- Demonstrate applicability of advanced manufacturing techniques, e.g., additive manufacturing and diffusion bonding for core and heat removal section designs
- Identify and develop advanced sensors and power conversion equipment for potential autonomous operation
- Enhance readiness of public stakeholders, e.g., DOE laboratories and US NRC, to design, operate, and test high-temperature reactor components

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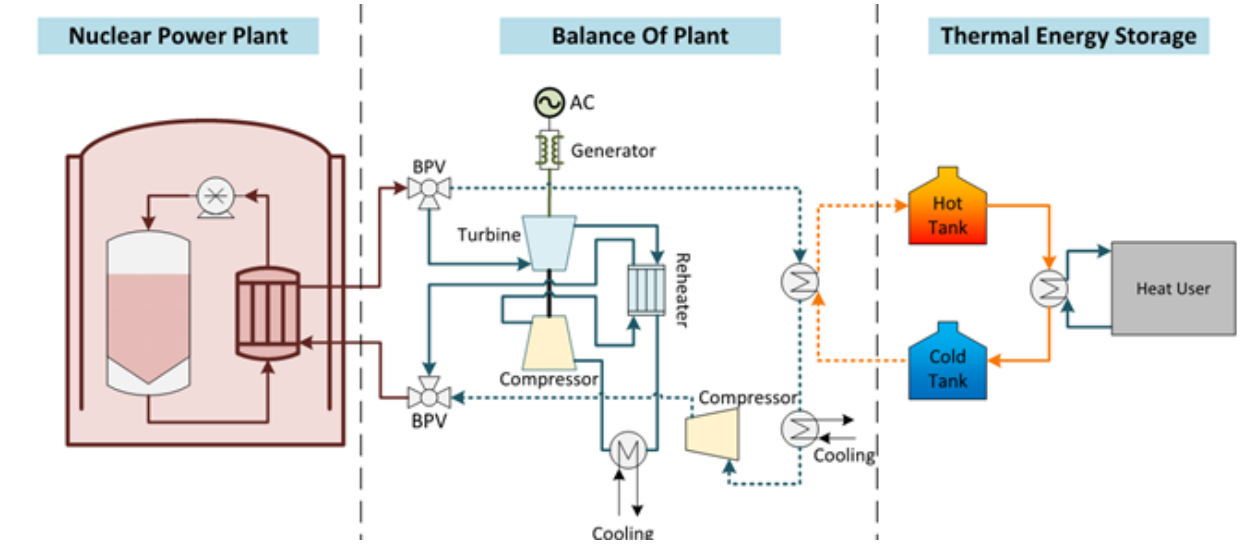
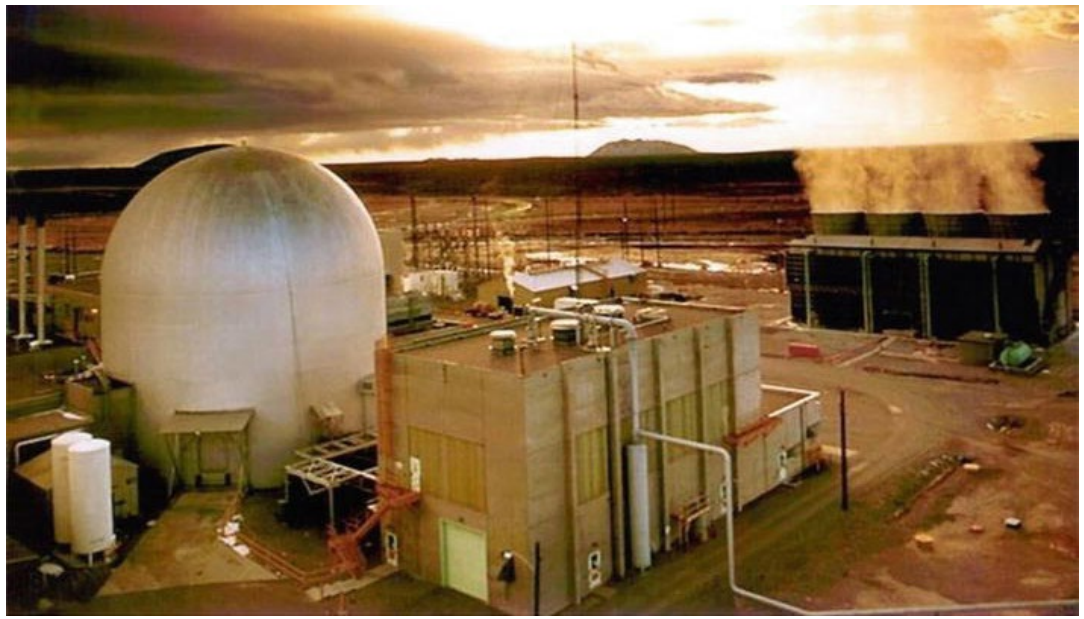
# Advanced Reactor Integrated Energy System (AR-IES) Demonstration



## Overall objectives:

- In collaboration with National Reactor Innovation Center (NRIC), design and construct an advanced reactor integrated energy system (AR-IES) demonstration
- Incorporate a TES study/facility to enable understanding and coupling with various thermal loads/users

## Background:

- Location: EBR-II Dome Testbed
- Demonstration platform to couple the thermal output from an advanced reactor to a controllable load and TES system.

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# Near-Term Plans

- Thermally integrate TEDS and MAGNET
  - Construction in progress – scheduled for completion March 2023
  - Will allow first thermally integrated demonstration in DETAIL
- Demonstrated integrated systems operation
  - Supply heat from TEDS to SOEC
  - Scheduled for ~August 2023
- Integrate power conversion unit for MAGNET (closed loop Brayton cycle)
- TEDS modifications/upgrades
  - Industrial PLC (controls)
  - Drain/vent/fill piping modifications for operational convenience
- Complete detailed design of AR-IES demonstration and make plans for construction and deployment at DOME

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