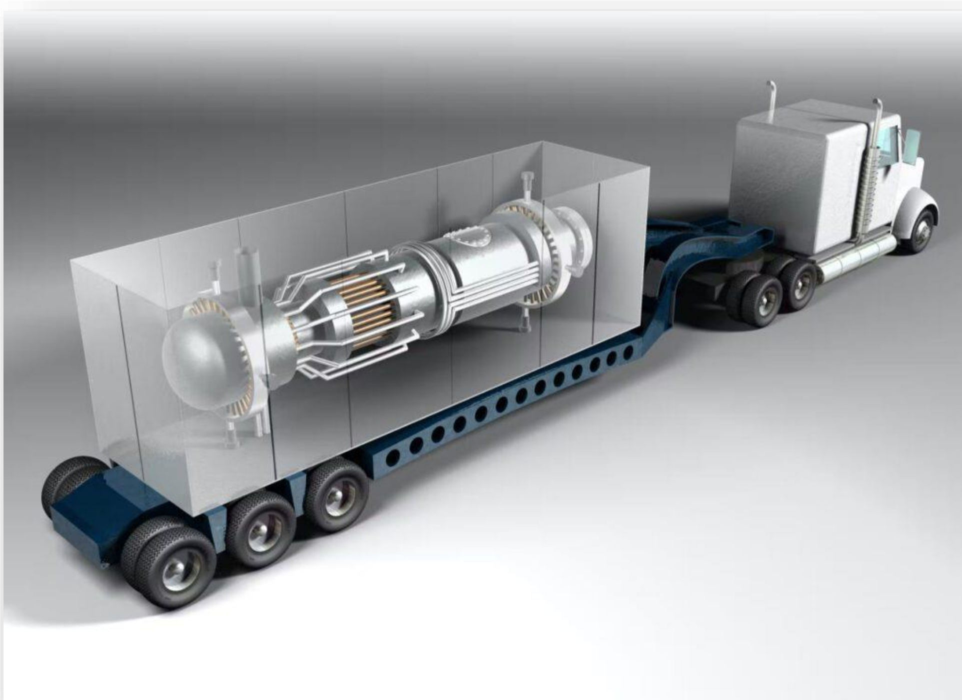
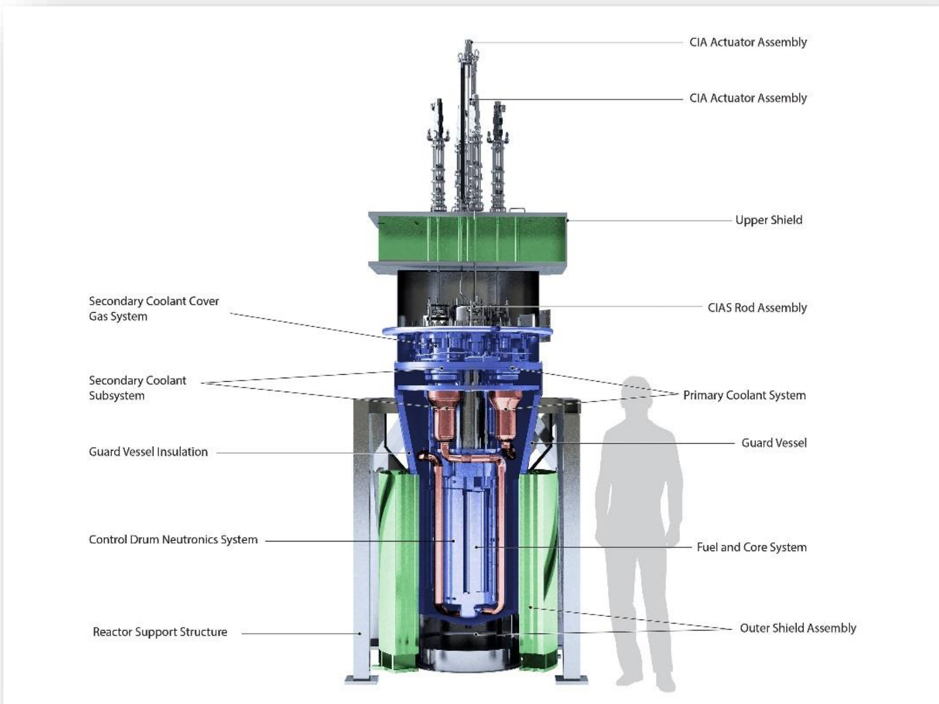
Introducing: Vortex Energy Group LLC's Nuclear Energy Division

Microreactors

Nuclear Microreactors Integrated with WtE Applications

Nuclear **microreactors** are one of those “quietly revolutionary” technologies DOE has been nurturing for years, and they’re finally moving from concept → deployment. Let’s dig in and learn all about these new marvels.





1. What *is* a Nuclear Microreactor?

A **nuclear microreactor** is a **very small, factory-fabricated fission reactor**, typically:

- **1–20 megawatts electric (MWe)**
- **5–50 megawatts thermal (MWth)**
- Designed to run **5–20+ years without refueling**
- Transportable by **truck, rail, ship, or aircraft**
- Operated with **minimal on-site staffing**
- Intended for **remote, resilient, or mission-critical power**

The DOE Office of Nuclear Energy sees them as **"energy batteries"**: long-duration, carbon-free, weather-proof baseload power.

2. What We are Seeing in the First Image

The device in this image resembles a **heat-pipe–cooled fast-spectrum microreactor** (similar to designs from BWXT, Westinghouse eVinci, or Oklo concepts):

Key Visual Clues

- Cylindrical, sealed pressure vessel
- Internal fuel rods or monolith fuel blocks
- Radial heat extraction (often **heat pipes**, not water loops)
- No large pumps, no cooling towers

This class of reactor emphasizes:

- **Passive safety**
- **No moving parts in the core**
- **Walk-away safe physics**

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3. Are Microreactors Available *Now*?

Short answer: Pre-commercial, but real deployments are imminent

Status	Reality
Fully commercial mass-market	❌ Not yet
Government & defense pilots	✅ Yes
First-of-a-kind civil deployments	🔜 2026–2030
Factory production lines	🔄 Being built now

DOE Programs Driving Deployment

- **Project Pele** (DoD + DOE): mobile reactor for military bases
- **MARVEL** (INL): 100 kWe test microreactor (under construction)
- **DOME / NRIC**: licensing and demonstration pathways

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4. Typical Microreactor Sizes

🔷 Power Output Classes

Class	Electrical Output	Typical Use
Nano-reactor	0.1–1 MWe	Research, sensors, small bases
Microreactor	1–5 MWe	Villages, mines, islands, bases
Large microreactor	5–20 MWe	Data centers, cities, industrial hubs

🔷 **Physical Scale**

- Roughly **shipping-container sized**
- 10–40 tons depending on shielding
- Often **fully sealed for life**

For perspective:
A **5 MWe microreactor** ≈ continuous power for **4,000–5,000 U.S. homes**
With **no fuel deliveries for a decade**

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5. Fuel & Reactor Types

Common Designs

- **HALEU fuel** (High-Assay Low-Enriched Uranium, <20%)
- **Fast spectrum reactors**
- **TRISO or metallic fuel**
- **Helium, sodium, or heat-pipe cooling**

Why This Matters

- Higher burnup
- Smaller core
- Longer life
- Passive shutdown physics

If power is lost, the reactor **naturally cools itself**.

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6. Lead Time Once Ordered

This is the big practical question.

🔷 **TODAY (First Movers)**

Step	Timeline
Site selection & feasibility	6–12 months
Licensing & safety review	18–36 months
Factory fabrication	12–24 months
Transport & install	1–3 months

Total (today): ~4–6 years

🔷 **FUTURE (Post-Standardization, ~2030)**

Once designs are licensed and factories are running:
~18–36 months from order to power
That's where DOE is pushing hard.

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7. Why DOE Is Excited About Microreactors

From DOE’s perspective, microreactors solve problems that **solar, wind, and even SMRs can’t**:

Strategic Advantages

- Works in **Arctic, islands, deserts, war zones**
- Immune to fuel supply disruptions
- No dependence on weather
- Tiny land footprint
- Perfect for **microgrids & hardened infrastructure**

Typical Target Users

- Military bases
- Remote communities
- Mining operations
- Data centers
- Disaster-prone regions (👀 Puerto Rico…)

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8. Limitations & Real Talk

They are **not** magic bullets.

Issue	Reality
Cost per MWh	High at first
Licensing	Still slow
Public perception	Mixed
Waste handling	Centralized but required
HALEU fuel supply	Bottleneck today

Microreactors shine where **resilience > lowest cost**.

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9. How This Intersects With *Our* WtE Work

Here’s the fun crossover:

- Microreactors = **ultra-reliable baseload**
- WtE = **dispatchable, waste-destroying generation**

Together?
A **nuclear-anchored + WtE-buffered microgrid**
Zero landfill growth, zero blackout risk, minimal fuel logistics

We’ve basically been designing the **thermal cousin** to this nuclear concept — just with trash instead of uranium.

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10. Bottom Line

- ✅ Microreactors are **real**
- ⏳ Commercial availability: **late 2020s**
- 📦 Sizes: **0.1–20+ MWe**
- 🕒 Lead time today: **4–6 years**, shrinking fast
- 🎯 Best use: **remote, resilient, mission-critical power**

A closer look: **(1) microreactors vs SMRs vs WtE**, **(2) a Puerto Rico/island use case**, and **(3) a map-style overview of the key DOE programs + the most visible vendors and where they sit on the timeline**.

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1) Microreactors vs SMRs vs WtE (side-by-side)

What each one *really* is

- **Microreactor**: very small, usually **~1–20 MWe**, often "containerizable," factory-built, meant for **remote / resilient / microgrid** power. DOE's DOME test bed is designed for fueled experiments up to **20 MWth** (thermal).
- **SMR**: small modular reactor, typically **tens to a few hundred MWe** per module, aimed more at **grid-scale** power and/or industrial steam; usually less "portable" than microreactors.
- **WtE (our lane)**: dispatchable power from waste destruction + heat recovery; permitting tends to be environmental/air-quality driven vs nuclear regulatory driven.

Practical comparison (the "hearing-room" version)

Attribute	Microreactor	SMR	WtE (Thermal Vortex + HRSG + STG)
Typical electric size	~1–20 MWe (some vendors talk larger "families")	~20–300+ MWe/module	Often modular blocks (we commonly frame **~6 MW blocks**)
Best fit	Remote bases, mines, islands, data centers needing hardened baseload	Grid support, retiring coal, large industrial heat/power	Cities/regions with waste liability + local power need
Fuel logistics	Refuel every **~5–10+ years** depending design (often sealed-core concepts)	Refuel periodically (site operations)	Continuous waste feed supply chain (local)
Siting & approvals	Nuclear licensing + security + emergency planning (varies by design/site)	Nuclear licensing + big civil works	Air permit + solid waste + ash handling + interconnect

Attribute	Microreactor	SMR	WtE (Thermal Vortex + HRSG + STG)
Construction pattern	Factory build → ship → install	Heavy civil, modular but still big builds	Conventional industrial construction + permitting
"Lead time today"	Often **multi-year** due to first-of-kind + licensing	Multi-year	Often multi-year but usually less than nuclear once permitted and financed
Biggest bottleneck	Licensing path + fuel supply chain (e.g., HALEU/TRISO) + first-of-kind learning	Financing + schedule risk + supply chain	Permitting politics + feedstock contracts + community perception
Grid value	High: resilient baseload for microgrids	High: large clean firm power	High: dispatchable + waste destruction + local resiliency

Quick synthesis:

- Microreactors are the "**nuclear battery**" for places where *resilience is worth paying for.*
- SMRs are the "**grid modules**" for larger-scale clean firm power.
- WtE is the "**trash-to-turbine workhorse**" that also solves a waste problem (two birds, one vortex).

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2) Puerto Rico / Island Microgrid Use Case (what makes sense and what doesn't)

Think of Puerto Rico (or any island grid) as a **three-layer cake**:

1. **Critical loads** (hospitals, water pumping, comms, emergency ops, shelters)
2. **Economic anchors** (ports, industrial parks, data hubs, cold-chain, wastewater plants)
3. **General grid loads** (residential/commercial)

A realistic island architecture

A) "Nuclear microreactor" role (if used):

- Best as a **hardened baseload anchor** for **critical loads**, ideally **behind-the-meter** or in a controlled industrial/port zone.
- Microreactors are being developed explicitly for decentralized civilian/defense sectors, and DOE's test infrastructure (DOME) is meant to accelerate actual fueled demonstrations.

B) "WtE role (our strongest fit):"

- Best as **dispatchable firm power** + **waste destruction** + **grid-stabilizing generation** near load centers.
- Provides local fuel security using waste streams already on-island (MSW, biomass blends, sargassum handling where applicable).

C) The hybrid (where the magic is):

- Microreactor = steady "heartbeat" power for critical loads
- WtE = dispatchable "muscle" that follows demand, handles waste, supports black-start and resilience
- Storage/solar = "fast twitch" and cost optimization

Where microreactors are strongest for PR

- **Critical infrastructure microgrids** where "no power" is not an option.
- **Industrial/port microgrids** where land footprint is tight and security is manageable.
- **Remote/isolated nodes** where diesel logistics are brutal.

What *doesn't* pencil as well (early on)

- Using microreactors as a general public "everywhere solution" immediately. Early units will likely be expensive, and the regulatory + security wrapper is substantial.

Bottom line for PR:
If PR were a ship in a storm, a microreactor is the **keel** (stability), while WtE is the **engine room** (power + waste removal). Together they make the grid much harder to "capsize."

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3) DOE programs + vendor landscape (who's doing what, and "when")

The DOE infrastructure that matters (the "map legend")

- **DOME (INL / NRIC)**: DOE is repurposing the EBR-II containment to create the **world's first microreactor test bed**, supporting fueled experiments up to **20 MWth**.
- **MARVEL (INL/DOE-NE)**: a DOE microreactor project producing **~85 kWth / ~10 kWe**, meant as an R&D/test platform (not itself a commercial product).
- **DOE Microreactor Program (GAIN/INL)**: umbrella program supporting R&D, demonstration, and deployment of very small, transportable reactors.

Defense pull-through (often accelerates timelines)

- **Project Pele (DoD + DOE/INL support)**: a **1.5 MWe** demonstration microreactor; DOE notes planned transport to INL for safety reviews/testing in the **2026 timeframe**, and BWXT has discussed testing as early as **2027** with electricity production expectation around **2028**.

Vendor "map" (by size class and maturity)

A) ~1 MWe class (portable generator concept)

- **Radiant – Kaleidos**: DOE describes it as designed for **~1.2 MWe** and **5+ years** before refueling. Radiant has stated first test in **2026** and initial deployments beginning **2028**.

B) ~5 MWe class ("microgrid baseload" sweet spot)

- **Westinghouse – eVinci**: described as a heat-pipe microreactor producing up to **~5 MWe** with a **15 MWth** core design; progress includes DOE/DOME-related safety documentation for a scaled test reactor and reporting that the commercial concept is designed for **8+ full-power years** before refueling.
- **USNC / Global First Power – MMR** (Canada-focused demo pathway): often cited around **~15 MWth / ~5 MWe** class, with Chalk River plans described by CNL/partners.

C) 10–20 MWe class ("bigger microreactor / small town / industrial")

- Many concepts exist, but near-term reality tends to concentrate in the 1–5 MWe range first because it's easier to site, finance, and demonstrate.

D) "Microreactor lineage that's scaling upward" (data-center talk)

- **Oklo – Aurora**: NRC notes pre-application activity and indicates proposed reactors up to **75 MWe** (note: that's beyond what many people would call a "microreactor," but it's often discussed in the same family because of compact fast-reactor design goals).

Lead time: what we can responsibly say today

For first customer deployments (today's reality):

- Demonstration/test-bed readiness: DOME is positioned as the first microreactor test bed (DOE), with industry activity building toward the **late-2020s** for operational first-of-a-kind deployments.
- Project Pele signals a realistic cadence: "module to INL" planning in **2026**, testing around **2027**, electricity around **2028** (per DOE/BWXT statements).

Once designs are standardized (the "future steady state"):

- The industry thesis is **18–36 months** order-to-power for repeat builds, but that assumes: licensed design, fuel supply, factory throughput, and a repeatable siting template. (That's an inference; the sources above show the *current* cadence is still longer.)

Below are two **concept-level architectures** to use as "talking schematics" for stakeholders—each one pairs a **microreactor (optional/limited in scenario 1)** and **WtE** as firm generation, with controls designed for **resilience, islanding, and black-start**.

1) Puerto Rico microgrid concept: Microreactor + WtE "Resilience Hub"

Design intent
Create a **hurricane-hardened microgrid** that can:

- Run **indefinitely in island mode**
- Keep **critical loads** powered even if the island grid collapses
- Convert local waste liabilities into dispatchable power (WtE)
- Use the microreactor as the **steady "keel"** and WtE as the **dispatch "engine"**

Concept single-line (electrical)
Microreactor (firm baseload) + **WtE STG (dispatchable)** + **BESS (fast grid-forming)** + **PV (optional)** → **Medium Voltage (MV) microgrid bus** → critical feeders + industrial feeders + (optional) PCC to PREPA/LUMA grid.
Recommended "modular" sizing (example)
We can scale in blocks, but here's a realistic anchor:

- **Microreactor:** 5 MWe (steady baseload, N-1 philosophy depends on use case)
- **WtE:** 6 MWe block (our familiar unit), dispatchable with ramping
- **Battery (BESS):** 10–30 MW / 20–60 MWh (fast frequency support + black start + ride-through)
- **PV (optional):** 5–20 MWp (cost reducer, not resilience anchor)

This gives us:

- **Firm power:** 11 MWe (reactor + WtE)
- **Fast stabilization:** BESS
- **Fuel security:** nuclear long-cycle + local waste feedstock

Physical layout (what goes where) -"Resilience campus" zoning

1. **Generation block A:** Microreactor in a secure, controlled zone
2. **Generation block B:** WtE in an industrial zone (waste receiving, preprocessing, combustor, HRSG, turbine, emissions control)
3. **Energy buffer block:** BESS + MV switchgear + microgrid controller/SCADA
4. **Critical load ring:** hospitals, water/wastewater pumping, emergency ops, telecom, shelters
5. **Optional export intertie:** PCC with synch-check relay to island grid

How it runs (operational modes)

Mode 1 — Normal (grid-connected)

- Microreactor runs near steady output (best for nuclear economics/operations)
- WtE follows load + waste availability (dispatchable)
- BESS does fast support and arbitrage (frequency/voltage, peak shaving)
- PCC imports/exports as desired

Mode 2 — Islanding event (hurricane / grid failure)

- **Grid-forming BESS** holds frequency/voltage instantly (milliseconds)
- WtE and microreactor re-synchronize to the microgrid bus (seconds–minutes depending on design)
- Loads shed by priority (critical → essential → deferrable)

Mode 3 — Black start

- BESS energizes MV bus ("electrical heartbeat")
- Start WtE auxiliaries (feed handling, draft fans, controls)
- Bring STG online and take over bulk power
- Microreactor comes online per its startup sequence (varies by design; think "slow and steady" compared to battery)

Thermal integration options (high value in PR)

Even if we don't do district heating, PR has **thermal loads** that matter:

- **Desalination / water treatment** (RO is electric-heavy; thermal desal is heat-heavy)
- **Absorption chilling** (microreactor/WtE waste heat → chilled water loop for critical facilities)
- **Industrial steam** for nearby facilities

Key point

Keep nuclear and WtE thermal loops **separate** (safety + licensing simplicity). Couple at the **electrical bus** and optionally via **secondary district loops**.

Control philosophy (what makes it "microgrid grade")

- **Grid-forming inverters (BESS)** are the "metronome"
- **Droop control** for WtE generator
- **Microreactor setpoint** steady with limited load-following (depends on vendor/design)
- **Load management**: priority tiers + automatic UFLS/UVLS (under-frequency/under-voltage load shedding)
- **Cyber segmentation**: nuclear zone controls physically/logically segmented from WtE/utility networks

Why this pairing is compelling for PR

- Microreactor provides **long-duration firm power**
- WtE provides **dispatch + waste destruction + local fuel**
- BESS provides **instant stability + black start**
- Together, the microgrid is harder to "knock over" than any single technology alone

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2) AI data center concept: WtE + "Firm Power Spine" (with optional microreactor)

For data centers, the priority stack is slightly different:

1. **Power quality & uptime** (Tier III/IV expectations)
2. **Predictable energy cost**
3. **On-site generation that reduces interconnection risk**
4. **Heat management (cooling), not steam**

Two viable configurations

A) Most practical near-term: WtE + Gas backup + BESS (grid-forming)

WtE becomes our **baseload + waste solution**, while data center UPS and gensets cover instantaneous ride-through.

Typical architecture

- **WtE STG (6–20 MWe)** → MV bus → data center substation
- **BESS (20–100 MW / 10–50 MWh)** grid-forming + peak support + ramp smoothing
- **UPS at IT load** (seconds) + **diesel/natural gas gensets** (minutes–hours) for Tier compliance
- **Optional grid tie** sized for import/export and redundancy

Why this works

- WtE is steady, dispatchable, and predictable
- Batteries handle step loads and improve power quality
- Gensets satisfy traditional reliability narratives (and permits are well-understood)

B) Longer-term "headline" architecture: Microreactor + WtE + BESS

Here the microreactor is the **firm spine**, WtE is the **dispatch + circular economy anchor**, and BESS is the **shock absorber**.

Example sizing for a mid-sized AI campus

Data centers vary wildly; a simple concept case:

- **IT load:** 50 MW (common campus-scale order of magnitude)
- **Total facility power:** 65–80 MW (depends heavily on PUE and cooling strategy)

A workable firm mix might be:

- **Microreactor:** 20 MWe (steady)
- **WtE:** 12 MWe (two 6 MW blocks)
- **Grid import:** 30–50 MW (capacity reservation)
- **BESS:** 50–150 MW / 25–75 MWh (grid-forming + ride-through + ramping)
- **Backup gensets:** sized to our tier target, often N+1

Key message for hearings:

We're not trying to "replace the grid." We're trying to **avoid becoming a grid problem** by self-supplying a large fraction of firm load.

Cooling integration: where WtE helps more than people think

Data centers don't want steam—they want **reliable cooling**.

WtE (and/or reactor) can support:

- **Absorption chillers** (waste heat → chilled water)
- **District chilled water loop** (thermal storage tank can shift cooling peaks)
- **Heat recovery** for nearby industrial or municipal uses (where feasible)

Important practical note
We still need conventional electric chillers for redundancy and response speed, but thermal-driven chilling can cut peak demand and improve PUE economics in the right climate/conditions.
Power-quality details (what a data center cares about)

- **Grid-forming BESS** stabilizes voltage/frequency and handles fast transients
- **Static transfer switches** can shift feeds without IT interruption
- **Harmonics & flicker control** via inverter-based resources and filters
- **Protection coordination** (distance relays, differential protection on critical buses)

Dispatch strategy (data center version)

- Microreactor: steady output (economic optimum)
- WtE: follow facility load and/or waste availability; can be tuned to peak periods
- BESS: instantaneous response + peak shaving + contingency reserve
- Grid: used as backup + flexible import/export; avoids stressing the local utility

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“Glue” that makes both scenarios credible: a shared core blueprint
If we want one common diagram language for both:

1. **Firm generation spine:** microreactor and/or WtE
2. **Fast stabilizer:** grid-forming BESS
3. **Critical-load ring:** prioritized feeders with automatic shedding
4. **Intertie/PCC:** grid-connected when available, islanding when needed
5. **Operations layer:** microgrid controller + SCADA + cybersecurity segmentation

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A little wordplay to help see the “big picture”

- Microreactor = **keel**
- WtE = **engine room**
- BESS = **flywheel**
- Microgrid controller = **captain**

🔷 **HRSG — *Heat Recovery Steam Generator***

An **HRSG** is a **boiler system that captures heat from another process and converts it into steam**, which is then used to drive a **Steam Turbine Generator (STG)** or supply industrial/process heat.
How it works (plain English)

1. A hot source produces exhaust or radiant heat
    - WtE combustor
    - Gas turbine exhaust
    - Nuclear reactor secondary loop
    - Industrial process heat
2. That heat flows across boiler tubes inside the HRSG
3. Water inside the tubes turns into high-pressure steam
4. Steam is sent to:
    - An **STG** (for electricity), and/or
    - Process users (district heating, absorption chillers, industry)

Why HRSGs matter (especially in *our* systems)

- They **unlock electricity from heat** that would otherwise be wasted
- They enable **combined-cycle efficiency**
- They are the **thermal interface** between:
    - WtE ↔ STG
    - Nuclear ↔ STG
    - Gas turbine ↔ STG

In our familiar system language:
Thermal Vortex Combustor → HRSG → STG → Electricity
No HRSG = no steam = no turbine power.

Typical HRSG characteristics

- Can be **water-tube or fire-tube** (water-tube most common at utility scale)
- Designed for specific:
    - Inlet temperature
    - Gas composition
    - Steam pressure and temperature
- Often includes:
    - Economizer (preheats feedwater)
    - Evaporator (boils water)
    - Superheater (raises steam temperature)

Where HRSGs are used

- Waste-to-Energy plants
- Combined-cycle gas plants
- Nuclear power plants (secondary loop)
- Biomass and geothermal facilities
- Industrial cogeneration (CHP)

How HRSGs differ from "ordinary boilers"

Feature	HRSG	Conventional Boiler
Heat source	Waste or recovered heat	Dedicated fuel firing
Primary role	Energy recovery	Steam production
Fuel burned inside boiler	Usually none	Yes
Efficiency role	Increases system efficiency	Standalone

Relationship to STGs and reactors (the chain)

- **Reactor / Combustor** → produces heat
- **HRSG** → captures heat and makes steam
- **STG** → converts steam into electricity

Think of it this way:

- **Reactor / Combustor = fire**
- **HRSG = kettle**
- **STG = generator**

Why HRSGs are strategic in hearings and designs

- They **increase efficiency without increasing fuel**
- They reduce emissions per MWh
- They are mature, bankable, and well-understood
- They let us add **electric output without adding combustion**

That makes them politically and technically "quiet heroes."

Clean glossary summary (drop-in ready)

HRSG (Heat Recovery Steam Generator)
A boiler that captures waste heat from combustion, nuclear, or industrial processes and converts it into steam for electricity generation (via an STG) or for direct thermal use.

🔷 **STG — *Steam Turbine Generator***
An **STG** is the **electric power block** that converts **steam energy into electricity**.

How it works (plain English)

1. Heat (from WtE, nuclear, biomass, geothermal, etc.) boils water
2. Steam spins a turbine
3. The turbine turns a generator
4. Electricity comes out

Why STGs matter in our work

- They are **fuel-agnostic** (trash, nuclear heat, biomass, industrial waste heat)
- Extremely **durable and well-understood**
- Ideal for **baseload and dispatchable generation**
- Central to **WtE plants** and **thermal nuclear plants**

In our familiar language (current WtE or Energy Recovery):
Thermal Vortex → HRSG → STG = electricity

🔷 **SMR — *Small Modular Reactor***

An **SMR** is a **scaled-down nuclear power reactor**, built in modules rather than as a massive custom plant.

Typical characteristics

- **50–300+ MWe** per module
- Factory-fabricated components
- Installed on-site in multiples (1, 2, 4, 6 modules, etc.)
- Grid-scale power, not usually portable

How SMRs differ from microreactors

Feature	SMR	Microreactor
Electrical size	~50–300+ MWe	~0.1–20 MWe
Portability	Low	High
Target use	Grid replacement, coal retirements	Remote sites, microgrids
Refueling	Periodic	Often sealed for years
Complexity	Moderate–high	Lower (by design)

In short:

SMRs replace power plants.

Microreactors replace diesel fleets.

Glossary of typical terminology in the nuclear energy industry:

🔌 **Power Generation & Conversion**

STG (Steam Turbine Generator)

A system where steam drives a turbine connected to an electrical generator.

HRSG (Heat Recovery Steam Generator)

A boiler that captures waste heat (from combustion or reactors) to produce steam for an STG.

MW / MWe / MWth

- **MW**: megawatts (generic)
- **MWe**: electrical output
- **MWth**: thermal (heat) output

Baseload Power

Generation designed to run continuously at a steady output.

Dispatchable Power

Generation that can be increased or decreased on demand.

SMR (Small Modular Reactor)
A modular nuclear reactor smaller than traditional gigawatt-scale plants.

Microreactor
Very small nuclear reactor (typically 1–20 MWe), often transportable and sealed for long life.

Fast Spectrum Reactor
A reactor that uses fast (high-energy) neutrons, allowing smaller cores and higher fuel efficiency.

HALEU (High-Assay Low-Enriched Uranium)
Uranium enriched between 5% and 20% U-235, used in many advanced reactors.

TRISO Fuel
Ceramic-coated fuel particles that retain fission products even at very high temperatures.

Passive Safety
Safety features that rely on physics (gravity, heat dissipation) rather than pumps or operator action.

🔋 Grid & Microgrid Terms

Microgrid
A localized electrical system that can operate independently from the main grid.

Islanding
When a microgrid disconnects from the main grid and operates on its own.

Black Start
The ability to restart a power system without external electricity.

BESS (Battery Energy Storage System)
Large-scale batteries used for frequency control, black start, and fast response.

Grid-Forming Inverter
An inverter that establishes voltage and frequency rather than following the grid.

Grid-Following Inverter
An inverter that synchronizes to an existing grid signal.

🏭 Waste-to-Energy (WtE) & Thermal Systems

WtE (Waste-to-Energy)
Conversion of waste materials into usable heat and/or electricity.

Thermal Vortex Combustion
A high-temperature, swirling combustion method that improves destruction efficiency and mixing.

Feedstock
Material used as fuel (MSW, biomass, sargassum, tires, etc.).

Auxiliary Loads (Parasitic Load)
Electricity used internally by a facility (fans, pumps, conveyors).

Ash Handling System
Equipment that manages solid residue after combustion.

❄️ Data Center & Cooling Terms

PUE (Power Usage Effectiveness)
Ratio of total facility power to IT equipment power (lower is better).

UPS (Uninterruptible Power Supply)
Battery-based system providing instantaneous power during outages.

Absorption Chiller
Uses heat (instead of electricity) to produce chilled water.

District Cooling
Centralized chilled-water system serving multiple buildings.

🧠 Control, Protection & Operations

SCADA (Supervisory Control and Data Acquisition)
Monitoring and control system for industrial facilities.

Droop Control
Method for sharing load among generators based on frequency/voltage changes.
UFLS / UVLS

- **UFLS**: Under-Frequency Load Shedding
- **UVLS**: Under-Voltage Load Shedding

PCC (Point of Common Coupling)
Electrical connection point between a microgrid and the utility grid.

🧩 Regulatory & Planning

N+1 Redundancy
System design with one extra unit beyond minimum required.

Capacity Factor
Actual energy produced divided by maximum possible energy.

Interconnection Agreement
Contract defining how a facility connects to the grid.

Cost Allocation / Tariff Rider
Mechanism to assign infrastructure costs to specific users rather than general ratepayers.