Power Plant Flexibility Vietnam

Workshop on: Operational Flexibility of Thermal Power Plants in Viet Nam

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Findings, Improvements and Indicative Costs

Insights from full-scale testing at Vinh Tan unit 3 and Quang Ninh unit 2

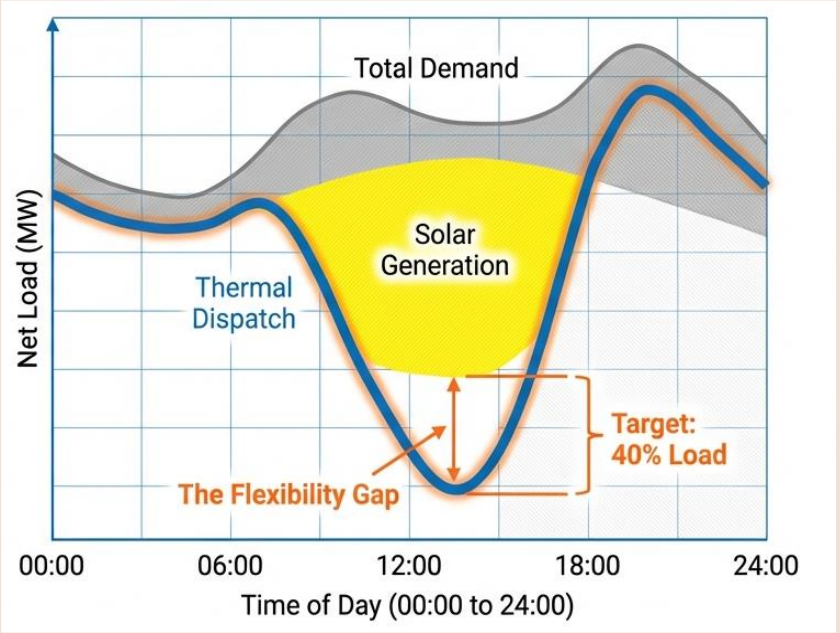
The Driver: Rising renewable penetration requires thermal baseload to stabilize the grid

The Goal: Validate the technical feasibility of reducing the minimum stable load

Targets:

Vinh Tan 4 (Benson, Sub-bituminous)	300 MW → 240 MW
Quang Ninh 2 (Drum, Anthracite)	225 MW → 180 MW

Scope: Combustion stability, thermal stress, controls, emissions



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Methodology: A Rigorous Diagnostic Approach



Approach

- Stepwise load reduction
- Defined stabilization periods

Configuration

- E.g. mill combination
- CCS vs. turbine following modes

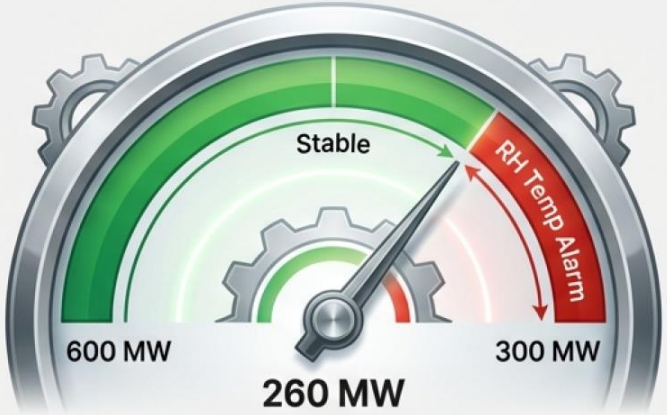
Data & safety

- High frequency data logging
- No safety limits overridden

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Key Results: The Edge for Minimum Load

Vinh Tan 4 (Unit 3)



- **Result:** 300 MW stable (oil-free). 260 MW unstable.
- **Failure Mode:** Reheater Temp alarms + Oil required.
- **Primary Limit:** Thermal asymmetry (A/B imbalance) & RH metal temps.

Quang Ninh (Unit 2)

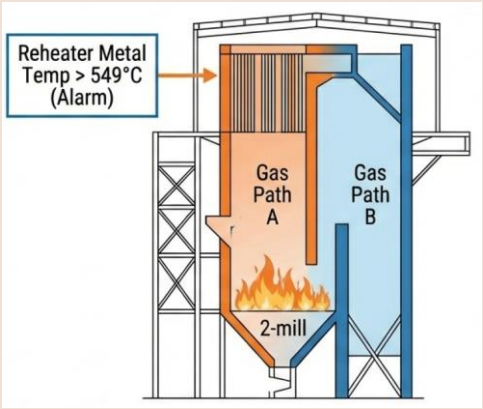


- **Result:** Reached 180 MW only with continuous oil support.
- **Primary Limit:** Furnace draft instability & combustion asymmetry.
- **Status:** Not commercially ready for oil-free low load < 225 MW.

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Case Study: Vinh Tan 4 Unit 3 Findings

Thermal Asymmetry is the Primary Constraint



Achieved Load: 300 MW (~50%) stable
260 MW triggered alarms

Practical limit: 300 MW to protect component life

Root Causes:

- **Asymmetry:** Persistent gas-path temperature split (steam temperature difference 30-40°C)
  Air-side maldistribution – inadequate damper bias
  Unknown PF distribution – static classifiers and uneven pipe resistance
- **Configuration:** 2 mill operation concentrates heat in lower furnace (loss of vertical staging)
- **Control:** SH/RH spray attemperators lack gain scheduling for low load
  Mill load limited to 85%

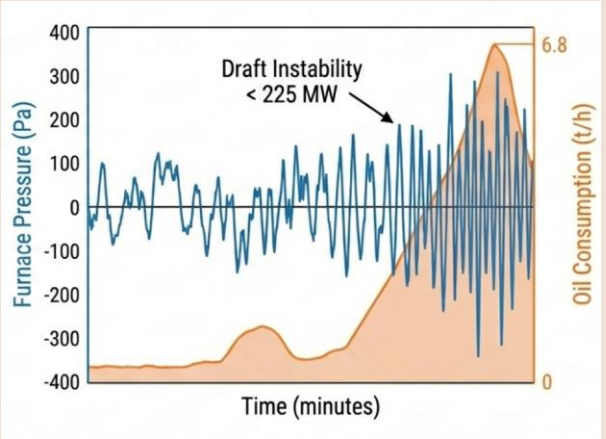
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Case Study: Quang Ninh Unit 2 Findings

Furnace Pressure Stability is Primary Constraint

Achieved Load: 225 MW (~60%) stable
Lower loads reachable ***only*** with oil support

Practical limit: 225 MW without upgrades



Root Causes:

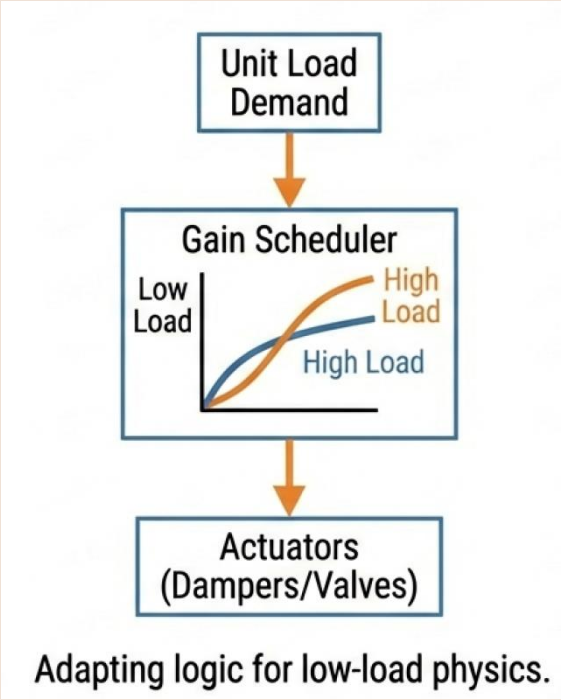
- **Control:** Binary on/off Secondary Air dampers cause uneven flow steps
  Non-coordinated control hierarchy between fuel, ID, FD and secondary air
  Unknown PF distribution – static classifiers and uneven pipe resistance
- **Firing:** Bin firing halts active coal drying; stored coal cools
- **Fans:** Uncoordinated ID fans create pressure asymmetry

Common Findings

- Low-load limit is set by stability margins, not by rated hardware limits
- Side-to-side air and flue-gas maldistribution becomes the governing low-load constraint
- PF distribution is a critical uncertainty and likely contributor to asymmetric firing
- Control strategy and tuning are not adapted for low-load dynamics
- Oil support becomes necessary at low load as stability margin collapses

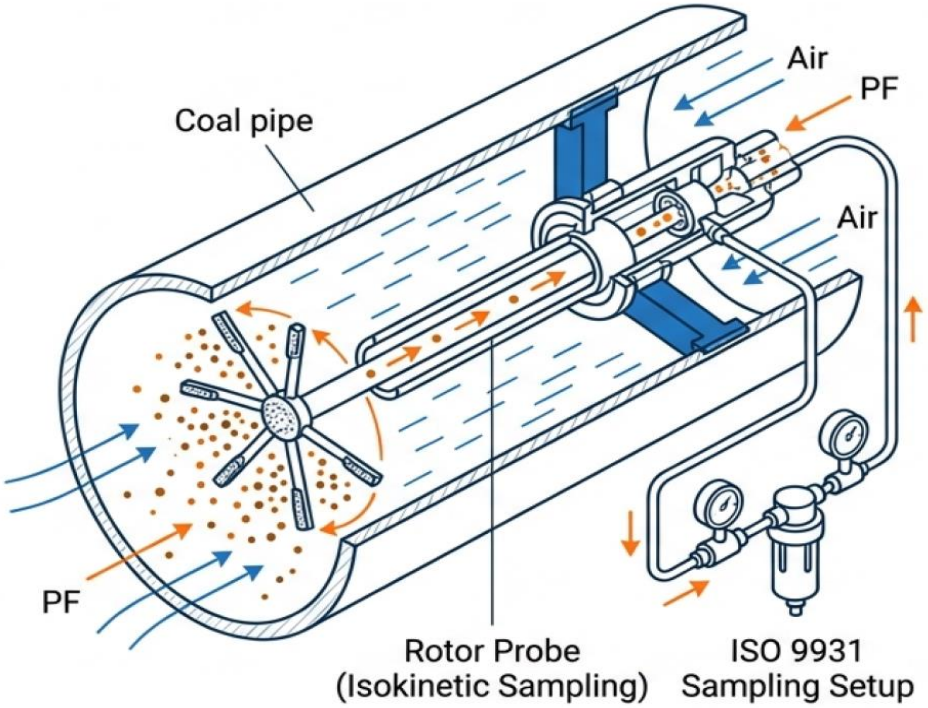
Immediate Recommendations: Operational Tuning

1. **Control Logic (Both Plants):**
   - Retune PID loops with with fuel–ID–FD–SA hierarchy
   - Implement optimized and feedforward controls
   - Implement ‘Turbine Following’ mode for low load hold
   - **Vinh Tan**: Implement dynamic, pressure-linked metal temperature limits
2. **Procedural Changes:**
   - **Vinh Tan**: Mandate 3-mill operation where possible
     Quang Ninh: Strict ‘bin firing’ momentum floors
3. **Maintenance**
   - Targeted soot-blowing to manage heat flux asymmetry
   - ISO 9931 sampling



Adapting logic for low-load physics.

Closing the Gap: ISO 9931 sampling



The "Black Box" of PF Distribution:

- Neither plant currently measures PF mass flow per burner line.
- Consequence: Cannot distinguish between bad tuning and physical blockage.

Required Action:

- Mandatory **ISO 9931** isokinetic sampling campaign.

Secondary Checks:

- Primary Air (PA) velocity at burner tips.
- Air Preheater (APH) Cold-End temperature (Corrosion Risk).

Warning: Low load reduces APH gas temperature, increasing Acid Dew Point corrosion risk.

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Medium-Term Upgrades: Hardware investments

QUANG NINH	Scope summary	Indicative CAPEX	Outage need	Timeframe Weeks
Coordinated control-loop tuning	Establish clear fuel–ID–FD–SA hierarchy, implement feed-forward chains, define low-load or bin-firing state, perform structured step tests and tuning	< 0.20 (M.USD)	Mainly online with short test holds	2 – 6
Modulating secondary-air dampers	Replace binary SA dampers with modulating dampers, add position feedback and enable A/B trim in DCS	< 2.4 (M.USD)	Planned short outage per boiler side	8 – 22
PF diagnostics and PF balancing	ISO 9931 PF sampling, dirty-air traverses and installation or adjustment of PF balancing dampers	< 2.6 (M.USD)	Short outages and mill stoppages	8 – 16
Furnace water-cannon system	Install automated water-cannon cleaning system including access, protection and drainage modifications	< 3.5 (M.USD)	Major planned outage	16 – 32
Flame scanner and BMS upgrade	Replace legacy flame scanners with modern dual-spectrum units, integrate 4–20 mA / digital signals in DCS, update burner-management logic, voting and diagnostics for low-load coal-flame detection	< 1.9 (M.USD)	Short boiler outage or staged burner outages	4 – 16

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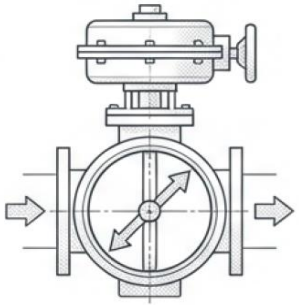
Medium-Term Upgrades: Hardware investments

VINH TAN	Scope summary	Indicative CAPEX	Outage need	Timeframe Weeks
Unit Master ramp coordination	Jump and gradient limiters for fuel, air, feedwater, RH setpoint. Feed-forward wiring. Scripted tests	< 0.16 (M.USD)	Mainly online with short test holds	2 – 6
Mills and PF	Mill debottleneck and PF line upgrades. PF distribution balancing hardware and selected PF monitoring tie-in	< 6.0 (M.USD)	During unit shutdown	4 – 6
Furnace water cannon system	Install automated water-cannon cleaning system including access, protection and drainage modifications	< 3.5 (M.USD)	Short outage per cannon	12 – 24
Dynamic classifiers	Retrofit one mill with variable-speed classifier and VFD integration	< 6.4 (M.USD)	Major unit outage about 6 weeks	12 – 24
Flame scanners and BMS upgrade	Replace legacy flame scanners with modern dual-spectrum units, integrate 4–20 mA / digital signals in DCS, update burner-management logic, voting and diagnostics for low-load coal-flame detection	< 1.5 (M.USD)	Short on-load window	12 – 24

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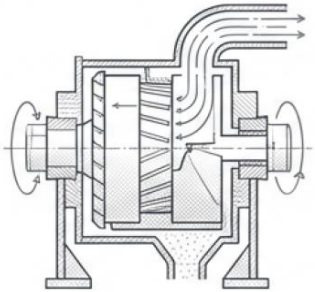
Improvement Pathway: Targeted Hardware Upgrades

Quang Ninh (Draft & Air)



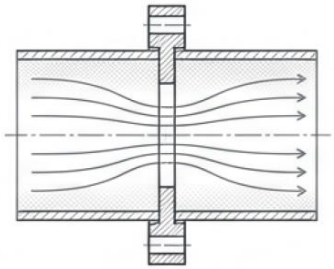
- Replace Binary SA Dampers with **Modulating Dampers** (position feedback).
- Upgrade to Dual-Spectrum Flame Scanners.

Vinh Tan 4 (Mills & Thermal)



- **Dynamic Classifiers**: To decouple PF fineness from mill load.
- **Mill Debottlenecking**: Restore clearances to allow >85%.
- **Water Cannons**: Automated cleaning for front-wall.

Common Measures



- PF Line Balancing hardware (Orifices/Riffle boxes) based on ISO 9931 data.

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Next Steps for the Vietnamese Power Plant Fleet

A. Objective and principle

- Implement a fleet-wide Project "**Flexibility Diagnostic and Upgrade Package**"

B. Fleet programme structure

1. Set up a focused Project on updating and optimize control loops
2. Fleet screening and standard low-load diagnostic protocol
3. Close the common data gaps before major CAPEX decisions
4. Implement "Package A" across the fleet: controls and operating rules (quickest, lowest outage)
5. Implement "Package B" where diagnostics confirm need: air-side and PF balancing upgrades
6. Targeted "Package C" hardware upgrades only for units where remaining limits justify it
7. Define governance, KPIs, and acceptance criteria that are measurable

C. Indicative budgeting approach using the two reports as planning anchors

D. Governance and replication logic

Next Steps for the Vietnamese Power Plant Fleet

Unit size	Package A Controls and rules	Package B Air and PF balancing	Package C Hardware upgrades	Total if all applied
300 MW	0.3–0.5 MUSD	0.4–0.7 MUSD	0.8–1.2 MUSD	1.5–2.4 MUSD
450 MW	0.35–0.6 MUSD	0.6–1.0 MUSD	1.2–1.8 MUSD	2.2–3.4 MUSD
600 MW	0.4–0.7 MUSD	0.8–1.3 MUSD	1.8–2.8 MUSD	3.0–4.8 MUSD
700 MW	0.45–0.8 MUSD	1.0–1.6 MUSD	2.2–3.5 MUSD	3.7–5.9 MUSD

Governance structure
Define decision authority and technical accountability

- **Fleet steering group**
  EVN, plant owner, regulator, technical advisor. Owns targets, budget gates, and replication decisions.
- **Technical authority**
  Defines diagnostic methods, KPIs, acceptance criteria. Confirms whether limits are operational or hardware-driven.
- **Plant implementation teams**
  Execute tests, tuning, and upgrades. Provide validated data back to fleet level.

Measurable KPIs for acceptance
Decisions based on data, not judgement.

- Minimum stable load MW without emergency oil support
- Furnace draft stability and oscillation amplitude
- A–B path air and temperature symmetry
- Oil firing rate at target low load
- Operator intervention frequency

Replication logic across the fleet
Scale only what works.

- If Package A delivers target KPIs on one unit, **replicate directly** to similar units.
- If Package B is required on one unit, apply only to units with **same limiting mechanism**.
- Package C is **never auto-replicated**. Each unit requires independent justification.

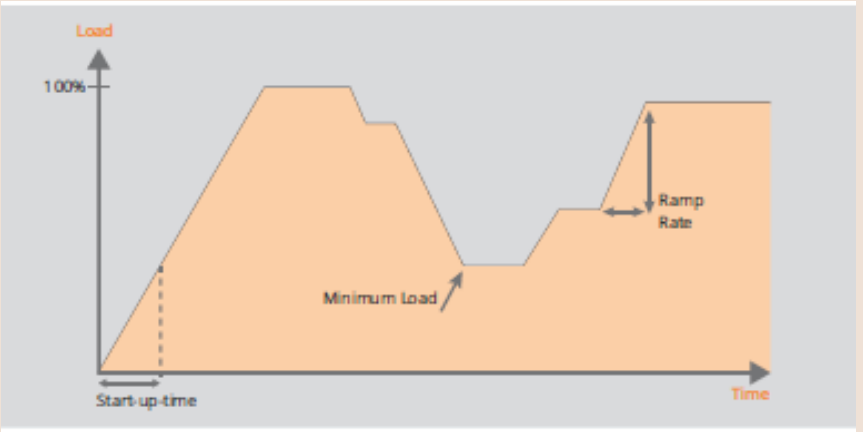
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Flexibility is more than Low Load

- **Definition IEA 2008:**
  “The ability to operate reliably with significant shares of variable renewable electricity”

- **Ramping**
  Flexibility is turndown plus the ability to change load and configuration without trips, alarms, or damage accumulation.

- **Startup and shutdown time**
  Both reduce system costs by reducing must-run hours and part-load fuel penalty.



- **Overload capability**
  Overload capability is typically a time-limited operating mode, for example short duration uplift for contingency reserve, frequency response, or peak support.

Thank you

Quang Ninh **Vinh Tan 4**

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