AI MPC + Hydraulic Optimisation Layer

Investment Committee Feasibility Analysis — 6,600 TR Central Chilled Water Plant

Prepared 4 November 2026

> **Recommendation: Approve.** Structure as a performance-based contract and commission during the current low-load window (Nov–Feb) so the system is fully closed-loop before the March peak.

4.13 GWh	₹5.17 cr	3.6 months	₹39.7 cr	2,200 TR
annual energy saved (15.6%)	gross saving / yr (≈ $587k)	all-in payback (average)	GAV uplift @ 12.5% cap	trapped capacity unlocked

Net of the annual subscription, savings are **₹4.97 crore a year** against an all-in capex of **≈ ₹1.5 crore**. Unlocking the trapped capacity defers roughly **₹33 crore** of auxiliary plant expansion.

Underwriting assumptions (to be confirmed)

- **0.70 kW/TR is whole-plant efficiency** at peak (chillers, pumps and towers), held flat across seasons.
- **The operating profile runs 24×7** at the stated load factors; a 14 h/day sensitivity is shown in Section 2.
- **Exchange rate:** planning rate of ₹88/US$ — update to spot.
- **The landlord retains the savings** (chilled water billed per TRh or as fixed CAM) — see caveat in Section 4.

1. Thermodynamic Power Breakdown (peak design condition, 6,600 TR)

Baseline split of 0.70 kW/TR

Sub-system	kW/TR	Peak kW
Chillers	0.54	3,564
Primary CHW pumps	0.03	198
Secondary CHW pumps	0.05	330
Condenser water pumps	0.05	330
Cooling tower fans	0.03	198
Total plant	**0.70**	**4,620**

Chiller compressor savings (−12%)

- **Lift minimisation (−6%):** condenser water supply moves from a fixed setpoint to tracking wet-bulb plus approach — about 2°C lower on average, at ~3% compressor power per °C of lift.
- **Asymmetric part-load staging (−6%):** staging driven by plant kW/TR rather than supply temperature; chillers held in their 50–80% efficiency band, and the standby/overflow chillers forced online by low ΔT are shut down.
- **Effect:** chiller efficiency improves from 0.54 to ≈ 0.475 kW/TR.

Secondary pumping savings (cubic affinity law)

- **Flow reduction:** restoring ΔT from 5.2°C to 8.2°C gives Q_2/Q_1 = 5.2/8.2 = **0.634**.
- **Cubic law:** power scales by 0.634^3 = **0.255** → 330 kW falls to 84 kW.
- **Critical-zone DP reset:** trim-and-respond on the most-open valve removes a further 10% → **76 kW**.
- **Cooling tower fans rise at peak** — the deliberate trade-off that buys lower lift. MPC optimises total plant kW, not each sub-system.

Sub-System	Baseline kW	AI-Optimised kW	Power Saved (kW)	% Reduction
Chillers (compressors)	3,564	3,136	428	12.0%
Primary CHW pumps (fewer chillers staged)	198	158	40	20.2%
Secondary CHW pumps (ΔT + DP reset)	330	76	254	77.0%
Condenser water pumps (staging / VFD)	330	297	33	10.0%
Cooling tower fans (lift trade-off)	198	218	−20	−10.1%
Total plant	**4,620**	**3,885**	**735**	**15.9%**

Plant efficiency: **0.700 → 0.589 kW/TR**.

IC caveat on the cubic law: it holds only if DP reset fully removes fixed-setpoint head. Systems with static head behave closer to an exponent of ~2.2, giving secondary power of ≈ 121 kW and peak savings of ≈ 690 kW. The conservative case in Section 2 covers this.

2. Financial & NOI Model

Annual energy by operating regime

Regime	Hours	Load (TR)	Baseline kW	Saving %	kWh saved	₹ saved
Mar–Aug (100%)	4,416	6,600	4,620	15.9%	3,245,760	₹4.06 cr
Sep–Oct (60%)	1,464	3,960	2,772	15.0%	608,731	₹0.76 cr
Nov–Feb (15%)	2,880	990	693	14.0%	279,418	₹0.35 cr
Total	**8,760**		**26.46 GWh/yr**	**15.6%**	**4,133,909**	**₹5.17 cr**

- **Current annual chilled-water electricity bill:** ₹33.07 crore (26.46 GWh × ₹12.50/kWh).
- **Gross saving:** ₹5.17 crore a year ≈ **$587k**.

Investment

Item	₹
AI MPC software + IoT edge gateways (top of ₹50–80 L benchmark, multi-building)	80 L
Enabling instrumentation (calibrated flow meters, per-building ΔT sensors, power meters)	25 L
Hydraulic remediation allowance (bypasses, 3-way valves, stuck valves, fouled coils)	45 L
All-in capex	**₹1.50 cr (≈ $170k)**

Annual SaaS / support opex: **₹20 L/yr**. The remediation line matters: software alone will not move ΔT from 5.2°C to 8.2°C — low ΔT is usually a physical coil and valve problem. Do not accept a vendor quote limited to the ₹80 L.

Payback (net saving ₹4.97 cr/yr ≈ ₹41.4 L/month average)

Basis	Payback
Software-only benchmark (₹80 L)	1.9 months
All-in (₹1.5 cr), average month	3.6 months
All-in, live by 1 March (peak months earn ≈ ₹66 L/month net)	≈ 2.3 months
All-in, live now in November (winter months earn only ≈ ₹7 L/month)	≈ 6 calendar months (late April)

Savings are highly seasonal, so timing is the key value lever: tune during low load, capture savings in the peak months.

Sensitivities

Case	Net saving / yr	All-in payback	GAV uplift
Base	₹4.97 cr	3.6 months	₹39.7 cr
Conservative (70% realisation: persistence, M&V, sub-cubic pump law)	₹3.42 cr	5.3 months	₹27.4 cr
14 h/day operation instead of 24×7	≈ ₹2.8 cr	≈ 6.4 months	≈ ₹22.5 cr

Every case clears the hurdle comfortably.

3. Hydraulic Capacity & CapEx Deferral

Chiller evaporators, pumps and pipes are all sized for design flow at 9°C ΔT. Within that flow, deliverable capacity scales with ΔT:

ΔT	Deliverable capacity at design flow
9.0°C (design)	6,600 TR
5.2°C (current)	3,813 TR (57.8%)
8.2°C (target)	6,013 TR

- **Capacity unlocked: ≈ 2,200 TR** — 33% of the plant (≈ 7.7 MW thermal). About 587 TR remains trapped against design.
- **How the plant copes today:** delivering 6,600 TR at 5.2°C needs ≈ 1,066 L/s against ≈ 616 L/s at design — about 73% overflow, met by running standby chillers and pumps beyond design flow. This is the staging penalty removed in Section 1.

Deferred capex

- **Avoided auxiliary chiller plant:** 2,200 TR × ≈ ₹1.5 lakh/TR all-in (chillers, towers, pumps, HT/LT electrical, plant room, piping) = **≈ ₹33 crore** (range ₹27.5–38.5 crore).
- **Avoided electrical infrastructure:** ≈ 1.5 MW of connected load (≈ 1.8 MVA of transformer / sanctioned demand).
- **A parallel pipeline is not a substitute:** low ΔT traps capacity at the chiller evaporators as well as in distribution, so new pipe alone does not recover chiller capacity.
- **Present it at present value:** deferring ₹33 crore by 5 years at 12.5% is worth **≈ ₹14.7 crore**. Count it only if an expansion or new tower is actually in the capex plan; otherwise treat the 2,200 TR as restored N+1 redundancy and lease-up headroom.

4. Asset Valuation Expansion

Case	Net NOI uplift	GAV uplift @ 12.5% cap	Net of capex
Base	₹4.97 cr	₹39.7 cr (≈ $4.5M)	₹38.2 cr
Conservative (70%)	₹3.42 cr	₹27.4 cr	₹25.9 cr

Roughly **26× value creation on capital deployed** in the base case.

Two caveats for the IC

- **Lease structure decides who captures the savings.** If chilled water is passed through at cost plus a markup, most of the saving flows to tenants and NOI can actually fall as the markup shrinks with the bill. Confirm the billing basis before booking the GAV uplift.
- **Buyers will haircut unverified savings.** Expect a valuer to capitalise only savings backed by 12+ months of IPMVP-verified data. Build the M&V from day one.

5. Executive 3-Step Action Plan (issue tomorrow morning)

1

ΔT forensics — due in 10 days (FM contractor)

- Export 12 months of BMS trends: CHWS/CHWR per building, secondary and decoupler flow, chiller kW and amps, DP setpoint.
- Verify calibration of plant flow meters and temperature sensors.
- Walk the top 20 AHUs by flow for open bypasses, 3-way valves, valves stuck at 100%, fouled coils and low setpoints.
- Expect a Pareto pattern — 10–20% of coils usually cause most of the degradation. Fix those first; this is the remediation scope.

2

No-cost control resets — this week (FM contractor)

- Move condenser water supply from a fixed setpoint to wet-bulb + ≈ 3°C, floored at chiller minimum.
- Reset secondary DP setpoint by trim-and-respond on the most-open valve.
- Stop running standby chillers; stage on plant kW/TR rather than supply temperature.
- Log plant kW/TR daily. The 15% winter load is the safest tuning window of the year; this alone typically captures a third of the savings.

3

Performance-based MPC tender — live by 15 February (MEP consultant)

- IPMVP Option B/C M&V plan, with the baseline locked during Nov–Jan.
- Guaranteed or shared savings with clawback.
- 4–6 weeks in shadow mode, then closed-loop control.
- BACnet/Modbus points list; OT cybersecurity through edge gateways with no inbound internet path.
- Add ΔT ≥ 7.5°C and a plant kW/TR target to the FM contractor's KPIs so the gains persist.