1 — System architecture:

Solar PV array sized to meet daily pumping energy (kWh) and power (kW) demand.

Energy-efficient pumps: high-efficiency submersible pumps or surface pumps with direct-coupled motors; use Variable Frequency Drives (VFDs) for flow control and energy optimization.

MPPT solar controllers / inverters that support DC-coupled or AC-coupled architectures depending on BESS choice.

Backup system: diesel genset and/or grid connection and/or battery (BESS) depending on reliability targets and economics.

Control & monitoring: PLC/RTU + IoT gateway + cloud SCADA (real-time telemetry, alarms, predictive maintenance).

Mechanical: well-head piping, discharge mains, filters/strainers, air release valves, check valves, sump/collection works.

2 — How it addresses the problem

Reduces diesel & grid consumption: Primary energy from PV reduces fuel/electricity bills and diesel logistics.

Lowers OPEX volatility: PPA model converts capital cost to predictable operating payments (per kWh or per m^3 pumped).

Improves reliability: Hybrid backup (battery/grid/diesel) maintains pumping under low solar or during outages.

Reduces emissions: Less diesel use → lower CO_2 and particulate emissions (ESG benefit).

Simplifies operations: Vendor-managed O&M reduces in-house maintenance burden and ensures uptime SLAs.

Enables data-driven O&M: IoT + analytics reduce unplanned downtime through condition-based maintenance.

3 — Innovation & uniqueness

OPEX-first deployment for a mine: shifts financial burden away from HCL and aligns incentives — vendor argues to maximize energy yield and uptime.

Smart pumping with VFD + PV forecasting: use solar availability forecasts to modulate pump duty (VFD) and schedule high-flow periods during peak PV.

Hybrid control logic: automated seamless switchover across PV → BESS → Grid/Diesel without manual intervention.

Performance-based SLAs: vendor paid on delivered pumping volume / uptime (not hardware), incentivizing reliability and efficiency.

Modular and scalable design: Prefabricated skids and containerized inverters/pumps for faster deployment and portability between sites.

4 — Sizing & design method (practical steps you can show in PPT)

Quantify dewatering demand

Collect historical inflow (m^3/day) and peak hourly inflow (m^3/h).

Define required continuous pump head (m) and friction losses → calculate required pump power (kW).

Pump hydraulic power = $(\rho \times g \times Q \times H) / \eta_{pump}$.

$\rho = 1000\ kg/m^3$, $g = 9.81\ m/s^2$, Q = flow (m^3/s), H = head (m), η_{pump} = pump efficiency.

Compute energy need

Daily energy (kWh/day) = ∑ [pump power(kW) × hours operating].

Add auxiliary loads (controls, telemetry).

PV sizing

PV array kWp ≈ (Daily energy need kWh/day) / (site average peak sun hours × system efficiency).

System efficiency account: inverter losses, cabling, soiling (~75–85% depending on specifics).

Backup strategy

If 24/7 pump required and PV cannot supply at night, choose either:

Grid/diesel backup for continuous operation (lower battery CAPEX), or

Battery storage (BESS) sized for required night-time pumping hours (more CAPEX but quieter, emission-free).

Use hybrid controllers to manage priority (PV → battery → grid/diesel).

Component selection

Pumps: choose model with best efficiency at site duty point; prefer proven vendors (Grundfos, KSB, Shakti, CRI).

Inverter/MPPT: must support anti-islanding, remote monitoring, and VFD integration.

Telecom: 4G/5G or private LPWAN for telemetry; fallback via satellite if remote.

Protection: lightning, surge, earthing, overcurrent, and isolation switches.

5 — OPEX / Contract model (practical terms)

PPA (Power-for-Service): Vendor owns assets; HCL pays per kWh generated or per m^3 pumped. Typical contract 5–10 years.

Service-level KPIs: uptime %, delivered m^3/month, response time for faults, energy yield guarantee.

Pricing structure: fixed + variable (capacity reservation + usage). Include inflation index and escalation caps.

Vendor obligations: installation, spare parts, scheduled maintenance, remote monitoring, emergency response.

Exit clause: buyout option or asset removal at contract end.

6 — Implementation roadmap (8–12 weeks typical for modular builds)

Week 0–2: Feasibility & site survey

Water inflow study, solar irradiation assessment, geotechnical for mounting, grid/diesel availability.

Week 2–4: Detailed design & vendor selection

Finalize PV, pump, inverter, BESS specs; tender/PPA negotiation.

Week 5–8: Procurement & factory acceptance tests

Week 8–12: Installation, integration & commissioning

Mechanical, electrical, control integration, SCADA setup, FAT & SAT.

Week 12+: Performance testing & handover

Acceptance tests per SLA; begin O&M by vendor.

7 — KPIs & measurable outcomes

Operational: Pumping uptime (%) — target ≥ 98% (hybrid recommended).

Financial: Reduction in OPEX (%) — target 25–45% depending on diesel replacement.

Environmental: Diesel consumption reduction (L/month) and CO_2 savings (tonnes/year).

Performance: Energy yield per kWp (kWh/kWp/year), delivered m^3 per kWh.

Maintenance: Mean time to repair (MTTR), mean time between failures (MTBF).

8 — Risks & mitigations (ready to paste into PPT)

Intermittent solar / low insolation → Mitigation: Hybrid backup + correct PV oversizing + forecasting.

Mechanical pump failure → Mitigation: vendor-managed spares and predictive maintenance sensors (vibration/temperature).

Telemetry loss in remote site → Mitigation: redundant telecom paths, local logging with store-and-forward.

PPA pricing disputes → Mitigation: clear SLAs, independent metering, arbitration clause.

Site security / theft → Mitigation: fencing, CCTV, asset tagging, insurance.

9 — Cost & benefit snapshot (illustrative points to expand with real numbers)

Capital avoided by HCL: 100% (assets owned by vendor under OPEX).

Operating savings: typical solar+hybrid projects report 25–45% reduction in energy/diesel costs — compute using local diesel price and current fuel consumption baseline.

Payback for vendor: PPA revenue stream + potential carbon credits.

(Use your site data to compute exact $/year savings and CO_2 avoided — include a slide with that calculation.)

10 — Next steps I recommend you take now

Gather historical dewatering data (m^3/day, peak flows, pump head, current power/diesel consumption by month).

Get site solar data (PVGIS/IMD or local irradiation) for accurate PV sizing.

Prepare RFP/PPA template with required KPIs and SLA terms.

Shortlist vendors for pilot (small skid) to validate in one dewatering sump before full rollout.