GREEN ENERGY

TECHNICAL CONCEPT & SYSTEM INTEGRATION REPORT

Core Pillars: Solar PV • Waste-to-Energy • Biogas & Biomass • BESS • Smart Grid • SCADA • Digital Twin

01 | Executive Overview

Green Energy is a core pillar of the ADS ECO Eco-Industrial Complex. The system combines multiple renewable and recovery-based energy sources to reduce carbon emissions, strengthen energy security and support long-term sustainability. The concept integrates generation, conversion, storage, distribution and intelligent control under a single EMS. This 12-page landscape report expands the original PDF into a modern technical document with 3D visuals, tables and implementation framework. All figures are indicative and require validation via resource studies, feedstock characterization, grid analysis, ESIA and FEED.

Dimension	Objective	Concept Indicator
Generation	Increase renewable & recovered energy	Multi-source hybrid: PV + WtE + Biogas + Biomass
Decarburization	Reduce GHG Scope 1,2,3	Carbon accounting, MRV, ESG assurance
Resilience	Improve self-sufficiency & uptime	BESS, islanding, black-start, thermal storage
Circularity	Waste-to-resource	RDF/SRF, organics, digestate, heat cascade
Digital	AI-optimized dispatch	EMS/SCADA/Digital Twin + forecasting

Integration Logic: Safety and reliability first; then optimize cost, carbon, self-consumption, recovered heat, storage value and grid services.

02 | Vision, Objectives & Design Principles

A low-carbon, resilient and digitally managed industrial energy ecosystem.

#	Principle	Description
01	Integrated	Electricity, heat, fuel, storage and grid interaction designed as one coordinated system
02	Modular	Generation and storage blocks phased and expanded as demand and feedstock increase
03	Efficient	Priority to energy recovery, heat utilization, low parasitic consumption and demand management
04	Digital	SCADA, EMS, IoT, Digital Twin and AI support monitoring, forecasting, optimization and reporting
05	Resilient	Critical loads, black-start strategy, redundancy and islanding considered from design
06	ESG-Aligned	Carbon accounting, environmental monitoring, audit trails and performance assurance embedded

Strategic Objectives: Increase renewable generation • Reduce direct/indirect GHG • Improve energy independence and resilience • Support circular economy • Enhance ESG performance, transparency and compliance

03 | Integrated Energy System Architecture

Primary resources (Solar PV, Residual Waste RDF/SRF, Organic Waste, Biomass) → Conversion (PV inverters, WtE/Pyrolysis, AD+Upgrading, CHP/ORC) → Flexibility (BESS Fast balancing, Thermal Storage Heat shifting, Smart Grid Optimal dispatch) → End uses (Industrial Loads, District Heat, EV Charging, Grid Export). AI/EMS optimizes cost, carbon, reliability and self-consumption in real time; SCADA and Digital Twin provide monitoring, simulation and predictive control.

04 | Renewable Energy Portfolio

Technology	Primary Input	Principal Output	Key Integration Requirements
Solar PV	Sunlight	Electricity	Inverters, MV transformers, protection, weather station, EMS forecasting
Waste-to-Energy	Residual non-recyclable waste / RDF-SRF	Electricity, steam, hot water	Feedstock control, emissions treatment, residue management, heat offtake
Biogas / Bio methane	Organics, sludge, bio-residues	Biogas, bio methane, CHP electricity & heat	AD, gas cleaning/upgrading, dig estate management
Biomass Energy	Sustainable biomass & by-products	Heat, steam and/or electricity	Fuel spec, drying/storage, combustion controls
BESS	Electrical energy	Dispatch able power, reserves, backup	PCS, EMS, fire safety, HVAC, protection, degradation mgmt.
Hybrid System	All generation & flexible loads	Optimized electricity & thermal	Smart grid, forecasting, demand response, digital twin

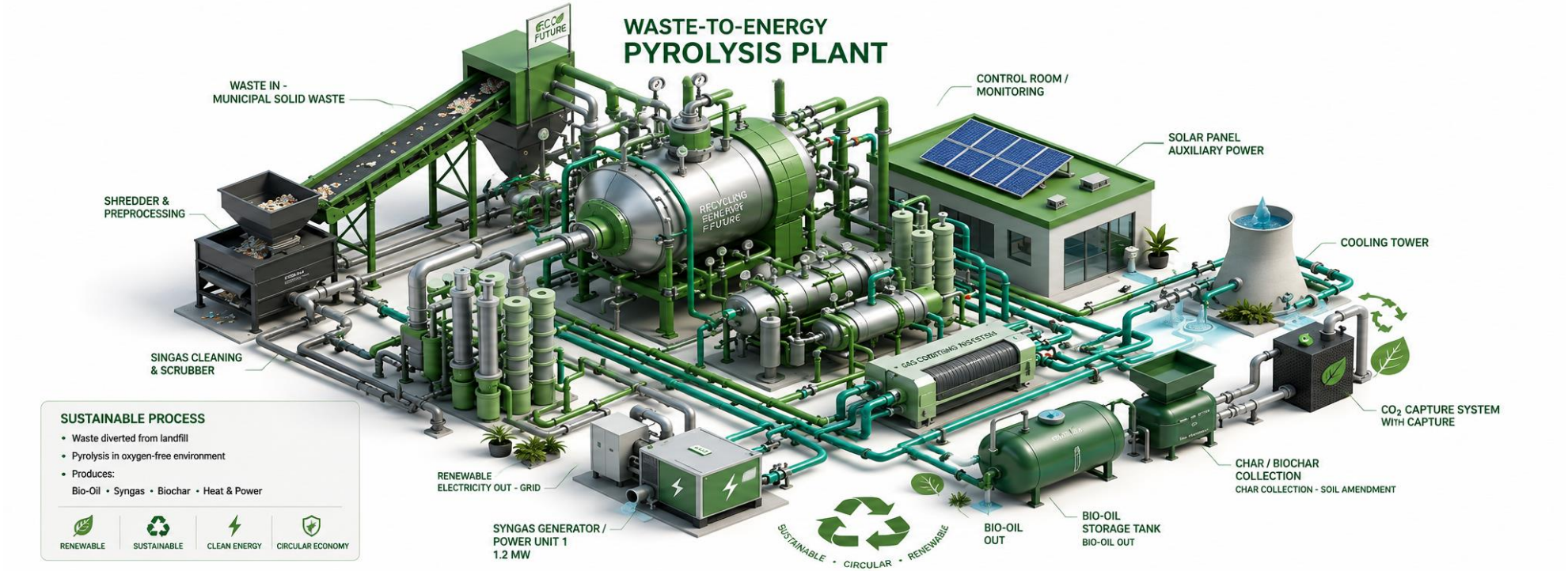
05 | Solar Photovoltaic Systems

Clean electricity from rooftop and ground-mounted PV fields. System Configuration: High-efficiency PV modules on industrial roofs, carports and/or ground-mounted fixed-tilt. String or central inverters by size, maintainability, redundancy and grid-code. DC combiner boxes, surge protection, isolators, earthing, lightning protection and safe-access routes. MV transformers, switchgear, protection relays, revenue meters and POC equipment. Weather station: irradiance, module temperature, ambient temperature, wind and soiling. SCADA for performance, alarms, curtailment, forecasting and maintenance.

Design Area	Technical Requirement
Yield Assessment	Use bankable solar-resource data, shading model, losses and availability assumption
Inverter Sizing	Optimize clipping, inverter loading and annual yield; project-specific calculation required
Structural	Verify roof loading, wind, snow, seismic and waterproofing interfaces
Electrical	Confirm voltage rise, harmonics, fault levels, protection coordination and export limits
O&M	Provide safe cleaning, access, monitoring, spares and vegetation/soiling management

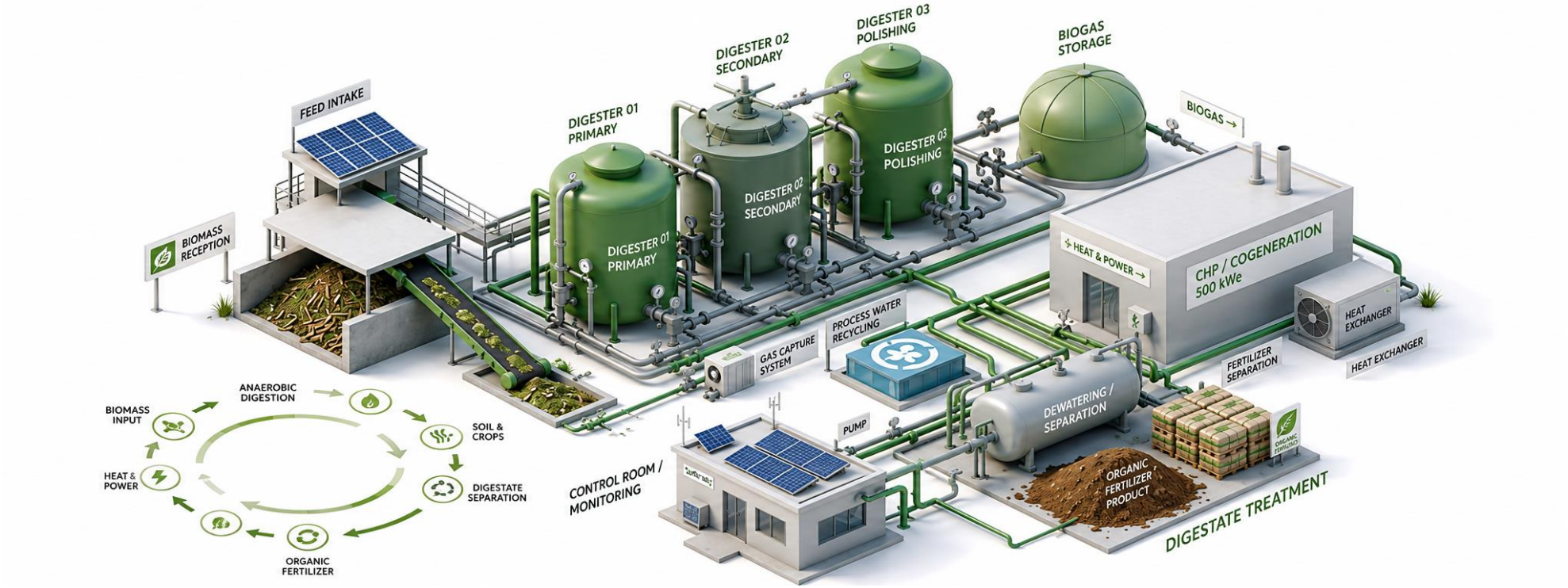
06 | Waste-to-Energy Systems

Recovery of electricity and thermal energy from non-recyclable residual waste. Mandatory evidence: representative feedstock sampling, mass and energy balance, emissions model and guaranteed net efficiency, APC system and CEMS concept, residue classification and heat offtake study.



Technology Route	Description	Key Outputs
Moving-grate / Fluidized-bed combustion	Proven residual-waste energy recovery with robust emission control	Electricity, steam, bottom ash, metals
Pyrolysis	Thermal decomposition into gas, oil and char under oxygen-limited conditions	Syngas, pyrolysis oil, char, heat
Gasification incl. Plasma	High-temp syngas generation and vitrified/mineral residues	Syngas, slag, recyclable metals
ORC Waste Heat Recovery	Electricity from lower-temp recovered heat	Electricity, low-grade heat

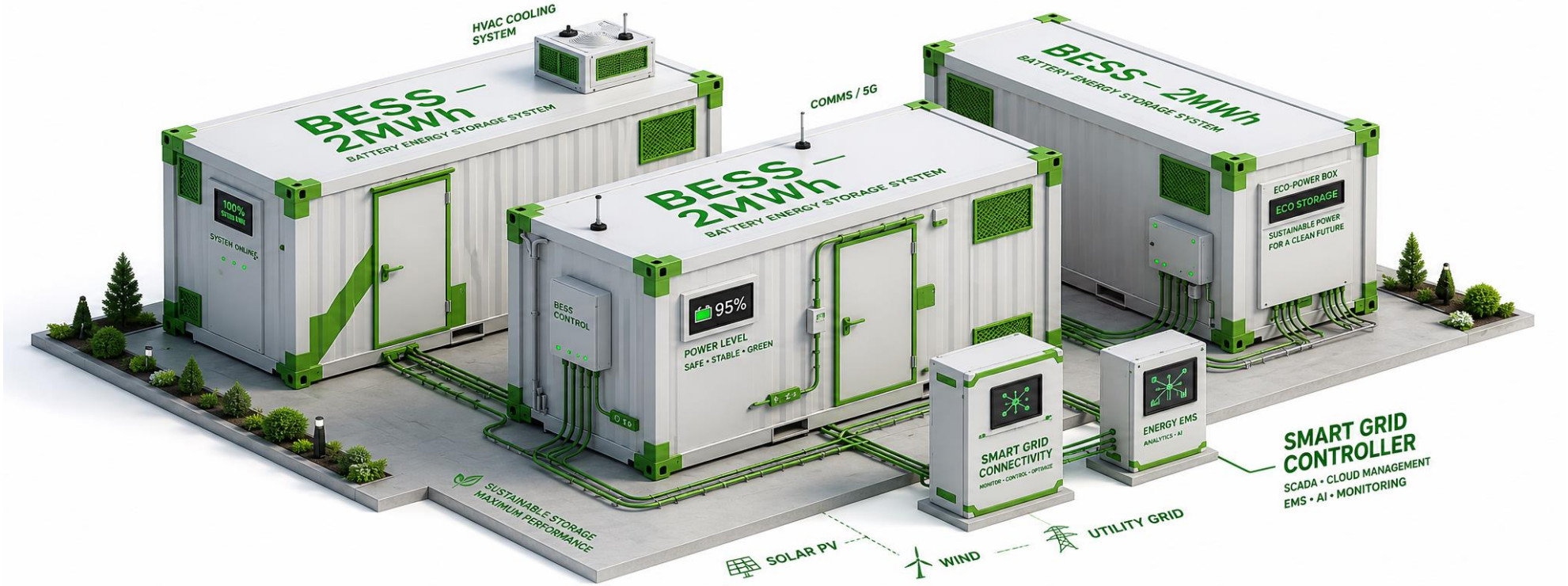
07 | Biogas, Biomethane & Biomass



Anaerobic Digestion: Feed reception, contaminant removal, shredding/pulping and blending. Mesophilic or thermophilic digestion with monitored temperature, pH, loading rate, mixing and retention time. Biogas collection, moisture removal, H2S control, compression and gas-quality measurement. CHP utilization or upgrading to biomethane via membrane, PSA, water scrubbing. Digestate dewatering, nutrient recovery, composting or fertilizer production. Biomass: Sustainable feedstock spec covering moisture, ash, particle size, contaminants, bulk density and seasonality. Covered reception, fire-safe storage, drying, screening and metered feeding. CHP integration with steam, hot-water or thermal-oil networks.

Instrumentation	Purpose
Gas flow, methane and oxygen analyzers	Safety, efficiency and compliance
Digester pressure, level, temp and pH	Process stability and biological health
Leak detection and ATEX zoning	Explosion prevention
CHP efficiency and heat recovery metering	Energy balance and guarantees
Digestate mass balance	Circular economy compliance

08 | Battery Energy Storage & Hybrid Systems



Use Cases	Sizing Inputs	Safety & Lifecycle
PV shifting & self-consumption	15-min & sub-min load profile	Container spacing & fire-access
Peak shaving	PV/WtE/CHP production profiles	Thermal runaway detection
Frequency & voltage support	Grid limits & tariff structure	Emergency shutdown zones
Reserve & backup	Critical-load autonomy	Warranty, augmentation, recycling
Ramp-rate control	Cycles per day & temp	Cybersecure remote access
Black-start support	Availability, degradation, EOL	Commissioning & capacity verification

09 | Smart Grid, SCADA, EMS & Digital Twin

Unified data and control platform. Layers: Field (inverters, meters, sensors, relays, PLCs) → Communication (fiber, Ethernet, 4G/5G redundant, IEC 61850, Modbus TCP, OPC UA) → SCADA/EMS (real-time monitoring, AI forecasting, dispatch optimization, alarm management) → Digital Twin (simulation, predictive maintenance, scenario analysis, AR/VR training). Functions: demand forecasting, generation forecasting, price optimization, self-consumption maximization, carbon minimization, peak shaving, AGC.

10 | Energy Applications & Distribution

Application	Typical Loads	Integration Controls
Industrial Operations	Process equipment, motors, pumps, sorting lines	Power-quality monitoring, load prioritization, demand response
Facility Power	Buildings, lighting, HVAC, labs	Efficiency controls, sub-metering, backup priorities
District Heating / Process Heat	Hot water, steam, thermal oil	Heat exchangers, insulated network, return-temp optimization
EV Charging	Fleet, staff and public	Smart charging, demand limiting, RFID, PV/BESS coordination
Grid Export	Surplus renewable electricity	Grid-code compliance, revenue metering, forecasting
Backup Systems	Critical control, safety, comms	UPS, BESS, standby gen, black-start

11 | Grid Interconnection & Power Quality

Study / Requirement	Purpose
Load Flow	Normal, N-1 and expansion; import/export limits; transformer and cable loading
Short-Circuit Study	Fault contribution from grid, generators and inverters; equipment ratings
Protection Coordination	Relay settings, selectivity, anti-islanding, synch-check, intertripping
Power Quality	Harmonics, flicker, voltage variation, unbalance, power factor
Dynamic / Stability	Ride-through, frequency response, voltage control, IBR interaction
Earthing & Lightning	Touch/step voltage, grounding grid, surge protection, lightning risk
Metering & Settlement	Import/export revenue meters, generation meters, loss allocation, time sync
Grid Code Compliance	Reactive power, ramp rates, curtailment, comms, forecasting obligations

12 | ESG & Carbon Management

Environmental: Define baseline for grid electricity, fossil fuel, landfill and transport emissions. Quantify Scope 1,2 and relevant Scope 3 using auditable methods. Monitor air emissions, water use, wastewater, noise, residues and biodiversity. Apply waste hierarchy: prevention, reuse, recycling, recovery, compliant disposal. ESG Governance: Clear ownership for energy, carbon, environmental and safety data. Role-based approval, audit trails, calibrated meters and controlled methodologies. Align with lender, investor and EU CSRD/ESG. Track incidents, corrective actions, stakeholder concerns and community benefits.

13 | Safety, Resilience & Cybersecurity

Domain	Controls
Electrical safety	Arc flash, LOTO, energized work, PPE, training
BESS fire safety	Gas detection, thermal runaway prevention, isolation, fire suppression
Biogas safety	ATEX zoning, leak detection, explosion protection, ventilation
Waste & biomass	Fire prevention, dust control, safe storage, temp monitoring
Cybersecurity	IT/OT segmentation, MFA, least-privilege, secure remote access, backups, patch governance, SOC monitoring

14 | Operations, Maintenance & Asset Management – KPIs – Roadmap

Management Element	Required Practice
Operations Control	24/7 monitoring where required; shift logs, alarm management, permits, dispatch and production planning
Preventive Maintenance	Time-based inspections, lubrication, calibration, cleaning, filter changes and statutory testing
Predictive Maintenance	Condition monitoring, vibration, thermography, oil analysis, IV-curve analysis and AI anomaly detection
Corrective Maintenance	Prioritized work orders, root-cause analysis, safe isolation, repair and return-to-service verification
Spare Parts	Critical-spares analysis, vendor lead times, preservation and minimum stock levels
Performance Management	Daily/weekly/monthly KPI review, loss analysis, heat balance, degradation and improvement actions
Training	Role-based qualification, simulator/AR-VR training, emergency drills and OEM knowledge transfer
Documentation	Controlled drawings, operating manuals, settings, software backups, maintenance history and change control

Operational Rhythm & Performance Guarantees

Real-time: alarms, dispatch, safety and equipment status • Daily: energy balance, production, availability and major losses • Weekly: maintenance backlog, forecast and constraint review • Monthly: KPI assurance, carbon/ESG reporting and commercial reconciliation • Quarterly: reliability review, risk register and improvement portfolio • Annual: capacity tests, statutory inspections and lifecycle plan update

KPI Category	Examples
Technical	Net electrical output, heat delivery, availability, Performance Ratio, BESS usable capacity and round-trip efficiency, specific auxiliary consumption
Environmental	CO2e avoided, air emissions compliance, water use, residue recovery rate
Economic	Self-consumption ratio, peak demand reduction, export revenue, O&M cost per MWh
Safety & Compliance	LTI, near-miss closure, permit compliance, cybersecurity incidents

Phase	Key Deliverables
Concept (Current)	Energy demand baseline, solar resource study, waste and biomass feedstock characterization, grid capacity options
Pre-Feasibility	Technology-neutral requirements, heat demand map, ESG baseline and permitting roadmap
Feasibility & ESIA	Bankable feasibility study, ESIA, grid connection agreement
FEED & Procurement	Technology guarantees, EPC/O&M strategy, feedstock and offtake contracts, data room
Construction & Commissioning	FAT/SAT, protection injection, metering verification, grid-code tests, as-built docs
Operations Optimization	Daily/weekly/monthly KPI review, AI dispatch tuning, lifecycle planning