

SMART OPERATIONS

INTEGRATED DIGITAL INTELLIGENCE, AUTOMATION, DIGITAL TWIN & ESG



Smart Operations is the digital intelligence and operational-management platform of ADS ECO Eco-Industrial Complex. It connects six zones through common automation, data, cybersecurity, analytics and governance standards. Objective: one reliable operating picture, improve safety and resource efficiency, convert plant data into timely decisions and auditable ESG evidence. All capacities, performance targets, cybersecurity classifications, reporting boundaries and system specifications require validation through project-specific engineering, risk assessment, permitting, supplier guarantees and formal acceptance testing.

01 | VISION, OBJECTIVES & DESIGN PRINCIPLES

Capability	Technical Scope	Primary Outcome
Integrated control	SCADA, alarms, historians, video, access, utilities and zone status	Coordinated operation and faster response
Operational intelligence	AI, predictive analytics, Digital Twin and optimization models	Higher availability, yield and energy efficiency
Digital execution	MES/MOM, WMS/TMS, CMMS/EAM, LIMS/QMS and electronic workflows	Traceable production, maintenance, quality and logistics
ESG intelligence	Mass/energy/water/carbon accounting and evidence management	Decision-grade sustainability and investor reporting
Cyber resilience	Segmented OT architecture, identity, monitoring, backup and recovery	Protected continuous operations and controlled change

Vision: One digital platform connecting six operational zones, real-time situational awareness from field assets to executive dashboards, AI-supported decisions with clear human accountability, transparent material, energy, carbon and ESG traceability, safe, resilient and continuously improving operations. Objectives: Standardize automation and data architecture, integrate operational, maintenance, quality, energy and logistics workflows, reduce downtime, waste, energy intensity and operational risk, enable predictive control and condition-based maintenance, provide auditable ESG and investor information, develop a skilled Industry 4.0 workforce. Core Design Principles: Safety and environmental protection override production optimization; Local control remains capable of safe operation if higher-level systems or communications unavailable; Platform is modular, vendor-neutral and based on open, documented interfaces; Every critical KPI must have defined source, calculation method, owner, frequency, target and evidence trail; AI recommendations operate inside approved constraints and subject to role-based approval; Cybersecurity, data governance, backup and recovery engineered from beginning.

Operating Principles – Verification

Operating Principle	Required Technical Feature	Verification
Single source of operational truth	Common tag naming, historian, time sync and master-data rules	Cross-system reconciliation and dashboard acceptance tests
Traceable decisions	Electronic approvals, audit trail and event history	User/role logs and change-management records
Fail-safe operation	Local PLC/Safety PLC logic, fallback modes and controlled restart	Cause-and-effect tests and loss-of-comms tests
Scalable integration	API, OPC UA, MQTT and standard data models	Interface tests and future capacity review

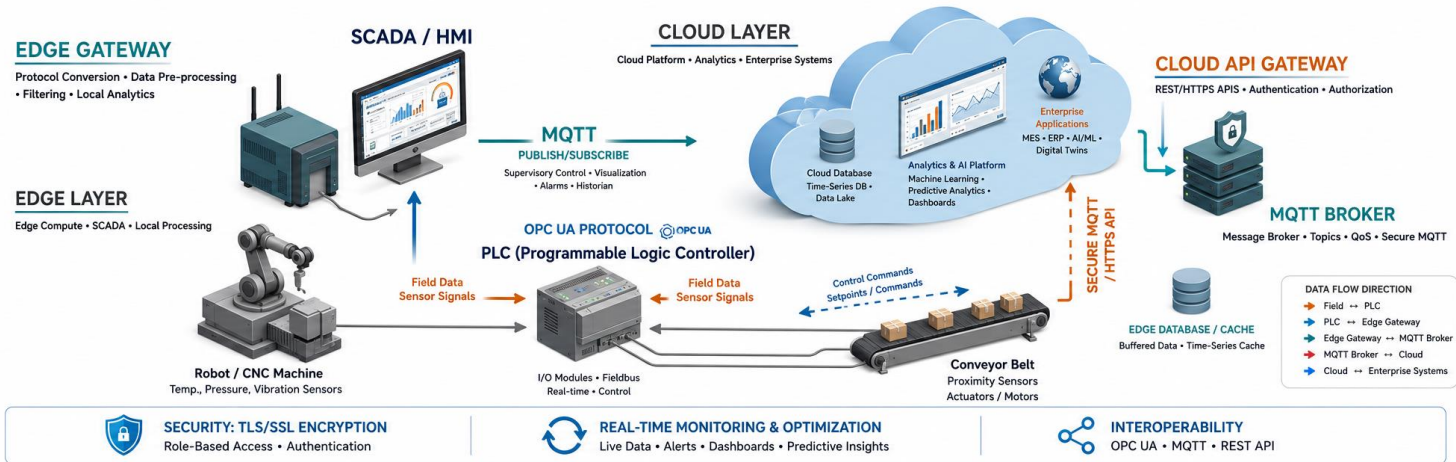
02 | SIX-ZONE INTEGRATED OPERATING MODEL

Every zone retains dedicated process control while sharing one common digital, operational and ESG framework. Central platform does not replace local process safety or machine control. It coordinates information, workflows, optimization and governance. Each zone publishes approved operational data and receives authorized schedules, recipes, work orders, logistics instructions and performance targets.

Zone	Digital Function	Key Outcome
1. Waste Reception & Intelligent Sorting	Digital reception, inspection, AI sorting, material separation and complete chain-of-custody	Fast auditable check-in, higher recovery and purity
2. Waste-to-Energy Production	Feedstock recipe, calorific-value management, combustion/pyrolysis control, CEMS, energy dispatch	Stable conversion, emissions compliance, max heat recovery
3. Advanced Recycling & Circular Manufacturing	MES batch, spectroscopy quality, robotics coordination, product genealogy	Premium secondary raw materials, full traceability
4. Agro-Industrial & Bio-Resource Valorization	Biological process control, smart farming, nutrient recovery, lab release	Stable digestion/fermentation, efficient water/nutrient use
5. Logistics, Warehousing & Support	WMS, TMS, AS/RS, AGV/AMR, RFID/GPS, yard/dock management	Accurate inventory, lower waiting time, secure dispatch
6. Innovation, Education & Community	AR/VR simulator, Digital Twin sandbox, R&D lab integration, ESG reporting	Safer commissioning, faster tech validation, transparent ESG

INDUSTRIAL AUTOMATION ARCHITECTURE

Industry 4.0 • PLC • SCADA • EDGE • CLOUD • OPC UA • MQTT • API DATA FLOW



03 | WASTE RECEPTION & INTELLIGENT SORTING – ENERGY – RECYCLING ZONES

Digital / Automation Function	Technical Implementation	Operational Value
Digital reception	ANPR/RFID, weighbridge, driver kiosk, document scan, geofenced queue and camera record	Fast, auditable check-in and reduced manual error
Sorting control	PLC/SCADA conveyor control, NIR/VIS/XRT classification and robot coordination	Higher recovery, purity and stable throughput
Material tracking	Bin/stockpile ID, scale data, barcode/QR and WMS integration	End-to-end chain of custody and inventory accuracy
Quality analytics	Composition trends, purity tests and supplier scorecards	Better contracts, routing and process protection
Safety monitoring	Fire/thermal cameras, gas/radiation detection, interlocks and access control	Early hazard detection and controlled response

Energy Zone Function	Technical Implementation	Operational Value
Feedstock & conversion	Online moisture/calorific indicators, feeder control, furnace/reactor SCADA and model-based optimization	Stable conversion and lower auxiliary fuel demand
Energy management	EMS, smart meters, load forecast, CHP/ORC dispatch and BESS controller	Maximum internal use and controlled grid exchange
Emissions & environment	CEMS, alarm limits, reagent inventory and compliance reporting	Transparent environmental performance
Asset reliability	Vibration, temperature, oil and electrical condition monitoring	Reduced forced outages and planned intervention
Heat integration	Steam/thermal network metering, pressure/temperature optimization and consumer scheduling	Higher overall efficiency and useful heat recovery

Recycling Zone Function	Technical Implementation	Operational Value
Production execution	MES/MOM schedules, recipes, electronic work instructions and batch records	Consistent production and full traceability
Smart quality	NIR/XRT/LIBS/vision analytics, laboratory interface and SPC	Premium purity and faster release
Robotics & automation	Robot cell coordination, safety zoning, conveyor synchronization and changeover control	Higher productivity and safer handling
Material genealogy	Lot/bale/box ID, transformation record and warehouse location	Customer confidence and recall readiness
Resource efficiency	Energy, water, additives, reject and yield accounting by line/product	Lower cost and improved circular performance

04 | BIO-RESOURCE, LOGISTICS & INNOVATION ZONES

DIGITAL TWIN & AI PREDICTIVE ANALYTICS

Eco-Industrial Complex • Recycling & Energy Plant • AI Optimization • Real-Time Monitoring



Bio-Resource Function	Technical Implementation	Operational Value
Biological process control	pH, ORP, temperature, gas quality, mixing and feed-rate control	Stable digestion/fermentation and higher yield
Smart farming	IoT soil/climate sensors, GIS, crop imaging and AI decision support	Efficient water/nutrient use and improved production
Product quality	LIMS, batch genealogy, microbiology/chemistry tests and release workflow	Safe market-ready fertilizer, feed and bio-products
Circular utilities	Recovered water, low-grade heat, CO2 and nutrient integration	Lower external resource demand
Biosecurity & EHS	Hygiene zoning, gas detection, odor monitoring and incident procedures	Protected workers, products and environment

Logistics Function	Technical Implementation	Operational Value
Warehouse management	WMS locations, stock status, FEFO/FIFO, AS/RS and cycle counting	Accurate inventory and efficient space use
Transport management	TMS routing, appointment windows, carrier status and delivery confirmation	Lower waiting time and transport cost
Autonomous movement	AGV/AMR fleet manager, map, mission queue, safety scanner and charging logic	Reliable internal flow and reduced manual handling
Tracking & security	RFID/QR, GPS, geofencing, seal control, CCTV and access rights	Secure, traceable material movement
Supply-chain analytics	Demand forecast, dock utilization, vehicle turnaround and service-level KPIs	Improved planning and customer performance

Innovation Function	Technical Implementation	Operational Value
Training & simulation	AR/VR, operator-training simulator, e-learning and competency matrix	Safer commissioning and stronger workforce performance
R&D integration	Pilot equipment data, LIMS, experiment plans and model management	Faster technology validation and scale-up
Knowledge management	Controlled procedures, lessons learned, search and role-based access	Consistent execution and retained knowledge
ESG management	Carbon accounting, evidence repository, KPI approval and disclosure workflow	Transparent compliance and investor confidence
Innovation governance	Idea pipeline, stage gates, benefits tracking and cybersecurity review	Controlled adoption of useful technologies

05 | CENTRALIZED OPERATIONS CONTROL CENTER (OCC)

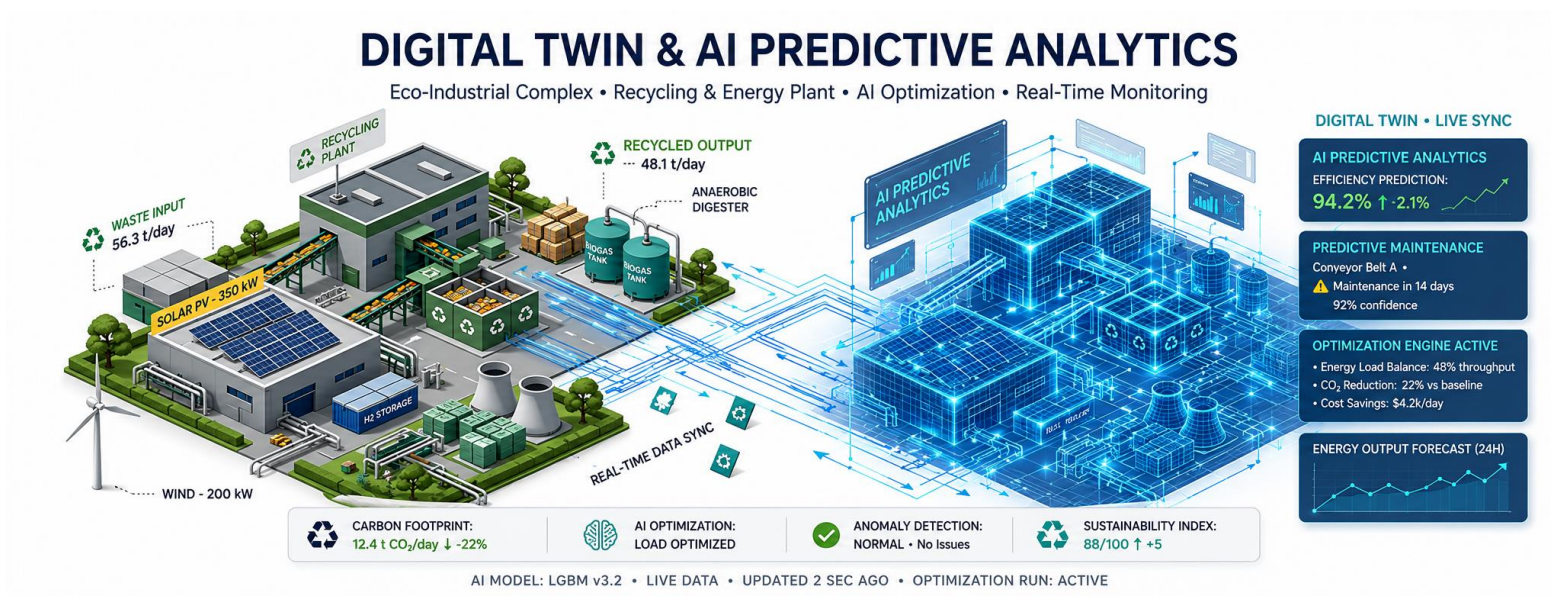


Console / Role	Primary Responsibilities	Required Information
Shift operations supervisor	Coordinate zones, manage priorities, authorize response and handover	Plant overview, alarms, production plan, constraints and incidents
Zone operators	Control process, execute procedures and confirm field conditions	Local HMI/SCADA, trends, interlocks, work permits and cameras
Maintenance & reliability	Plan work, monitor health and restore availability	CMMS, condition data, criticality, spares and isolation status
EHS / security	Monitor people, environment, fire/gas, access and emergencies	CCTV, access, detectors, weather, muster and response plans
Energy manager	Balance generation, storage, demand, heat and grid	EMS, meters, forecasts, prices and grid limits
Management / ESG	Review performance, risks, targets and evidence	KPI dashboard, carbon/water/material balances and action status

06 | INDUSTRIAL AUTOMATION, DATA & INTEROPERABILITY

Interface / Standard	Typical Use	Engineering Requirement
OPC UA	Secure structured exchange between PLC/SCADA, historians and applications	Defined namespace, certificates, redundancy and data-quality flags
MQTT / Sparkplug	Edge-to-platform telemetry and event distribution	Store-and-forward, topic governance, TLS and retained-state rules
Modbus TCP / vendor protocols	Legacy meters, drives and packaged equipment	Gateway isolation, polling limits and documented register maps
REST / API / database	MES, WMS, CMMS, LIMS, ERP and ESG platforms	Versioned interfaces, authentication, error handling and audit trail
Time synchronization	Consistent sequence of events and mass/energy reconciliation	Redundant NTP/PTP strategy and clock-health monitoring
Master data model	Equipment, materials, locations, users, suppliers and products	Unique IDs, ownership, change control and lifecycle governance

07 | DIGITAL TWIN, AI & ADVANCED ANALYTICS



Use Case	Inputs	Model / Method	Output and Control Boundary
Waste composition forecast	Supplier history, cameras, NIR, seasonality and schedule	Computer vision + time-series model	Expected composition, route and staffing recommendation
Energy optimization	Feed quality, process state, demand, BESS, weather and grid constraints	Hybrid physics + optimization model	Dispatch and set-point recommendations within approved limits
Predictive maintenance	Vibration, temp, electrical signature, alarms and work history	Anomaly detection and remaining-life estimation	Risk score, inspection/work recommendation and spare demand
Quality prediction	Process parameters, material sensors and lab results	Multivariate regression / classification	Early quality warning and sampling priority
Logistics forecast	Orders, inventory, production plan, vehicle/rail data and travel time	Demand and route optimization	Dock plan, fleet plan and delivery-risk alert
ESG forecasting	Mass, energy, water, emissions, production and project assumptions	Scenario model and controlled calculation engine	Expected carbon/water/waste performance and target gap

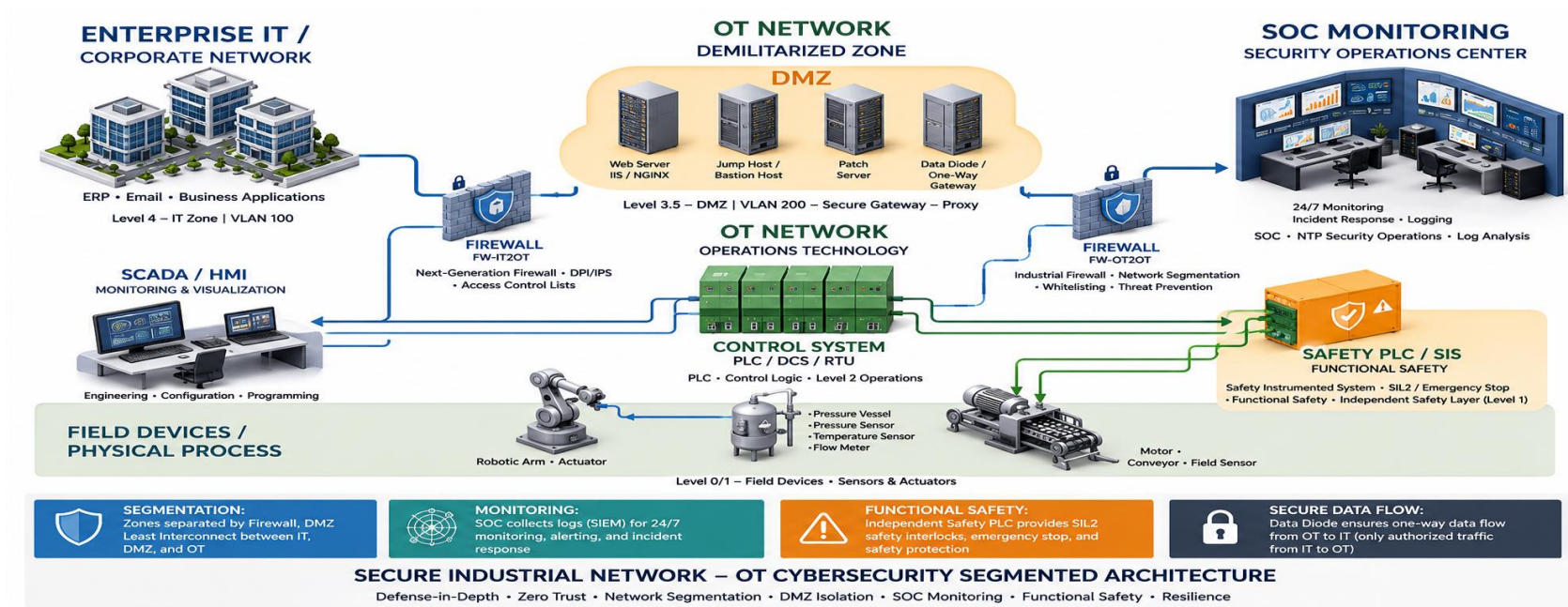
Model governance must document purpose, training data, owner, approved operating range, performance tests, retraining triggers, cybersecurity controls and human approval requirements. Models that affect safety or critical protection functions must not bypass certified safety logic.

08 | DATA PLATFORM, HISTORIAN & GOVERNANCE

Data Domain	Examples	Quality / Governance Controls	Retention / Use
Time-series process data	Temperature, flow, pressure, motor current, gas quality	Timestamp, engineering units, range, quality flag, calibration status	Operations, analysis, performance and investigations
Events and alarms	Alarms, trips, acknowledgements, operator actions	Priority rules, shelving policy, rationalization and sequence-of-events	Incident review and alarm-performance management
Transactions	Loads, batches, work orders, inventory, shipments, tests	Unique IDs, approval, completeness and reconciliation	Traceability, accounting and customer evidence
Master data	Asset hierarchy, material codes, suppliers, products, locations	Owner, version, effective date and change-control workflow	Cross-system consistency
Documents and evidence	Procedures, certificates, photos, permits, inspection records	Controlled revision, role access, signature and audit trail	Compliance, quality, training and ESG assurance
Models and analytics	Algorithms, parameters, training datasets and performance results	Model registry, validation, approval and monitoring	AI governance and repeatability

Edge-First Operating Rules: Safety and machine control remain local; Critical HMI and alarms remain available without cloud connectivity; Gateways buffer data during communication loss; Remote changes require authorization and traceable deployment. Data Governance Rules: Every KPI has an owner and approved calculation; Raw, validated and reported values distinguishable; Manual adjustments require reason and approval; Retention and access reflect legal, operational and commercial needs.

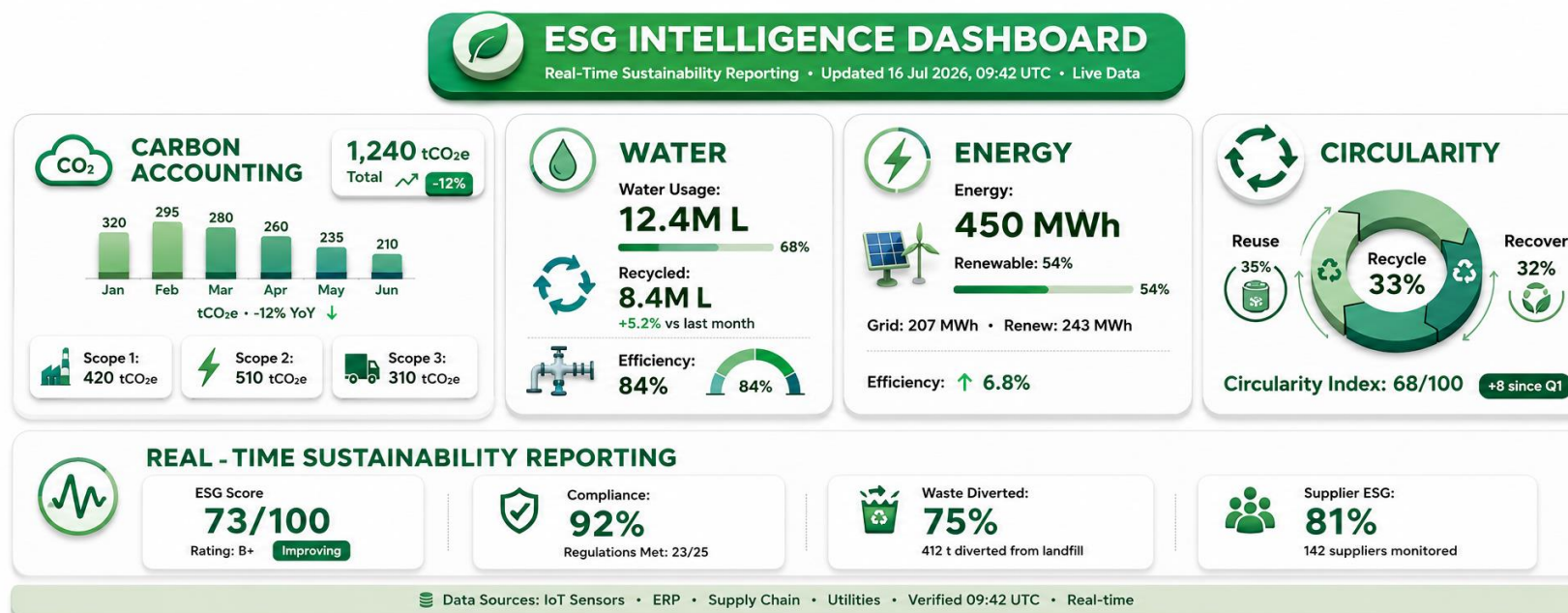
09 | OT CYBERSECURITY, FUNCTIONAL SAFETY & RESILIENCE



Cybersecurity and functional safety are related but independent disciplines. Cyber controls must not impair protective functions, and safety-system modifications require dedicated engineering, testing and authorization.

Resilience Test	Minimum Acceptance Objective
Loss of enterprise/cloud connection	Local process control, alarms and essential operator functions remain available
Loss of one network path or server	Redundant architecture transfers without uncontrolled process impact
Credential compromise scenario	Least privilege, rapid revocation and segmented access limit lateral movement
Backup restoration	Configuration, historian, application and critical records restored to defined recovery objectives
Remote vendor access	Time-limited approval, MFA, jump host, recording/logging and immediate disable capability
Cyber incident exercise	Operations, IT/OT, management, legal/communications and recovery teams demonstrate coordinated response

10 | ESG INTELLIGENCE, CARBON ACCOUNTING & SUSTAINABILITY REPORTING



ESG Topic	Primary Operational Data	Example Calculations / Evidence
Waste and circularity	Incoming mass, recovered products, rejects, disposal and stock changes	Diversion rate, recovery yield, material circularity and mass-balance reconciliation
Energy and climate	Fuel, electricity, renewable generation, exported energy, heat and refrigerants	Scope 1/2 inventory, avoided emissions, energy intensity and renewable share
Water	Abstraction, purchased water, process use, recovered water, discharge and quality	Water intensity, reuse rate, discharge compliance and site water balance
Air and environment	CEMS, odor, dust, noise, incidents and environmental inspections	Limit compliance, excursion management and corrective-action evidence
People and safety	Hours worked, training, incidents, exposure, permits and competency	TRIR/LTIFR, training completion and critical-control verification
Governance	Approvals, audits, complaints, supplier due diligence and model/change records	Compliance score, action closure, evidence completeness and accountability

CSRD/ESG outputs should be generated from controlled calculation methods, approved organizational boundaries and traceable source records. Framework supports internal management, lender/investor due diligence and independent assurance without duplicate manual reporting.

11 | INTEGRATED WORKFLOWS, KPIs & IMPLEMENTATION

Common workflows use same role model, severity definitions, electronic evidence and action tracking across all zones. Integration prevents alarms, work orders, quality deviations, environmental events and logistics disruptions from being managed in disconnected systems.

KPI Family	Examples	Required Context
Safety & environment	Critical alarms, permit deviations, emissions excursions, spill/odor incidents	Severity, exposure, response time, root cause and action status
Production & quality	Throughput, yield, purity, product release, rejects and rework	Material/product, shift, supplier, line and operating mode
Reliability	Availability, OEE, MTBF, MTTR, condition risk and maintenance backlog	Asset criticality, cause, work type and production impact
Energy & utilities	Specific energy, generation, heat recovery, BESS cycles and water reuse	Zone, process, product, tariff and weather/operating conditions
Logistics & inventory	Turnaround, stock accuracy, dock utilization and delivery service	Carrier, route, customer, material and constraint
ESG & governance	Carbon, diversion, water, jobs, training, audit actions and evidence completeness	Boundary, method, period, approver and assurance status

Test / Deliverable	Scope	Acceptance Evidence
Control philosophy and cause/effect	Operating modes, interlocks, trips, fallback and restart	Approved documents and witnessed functional tests
Interface and data tests	Tags, units, timestamps, IDs, API behavior, errors and reconciliation	Interface test records and signed data-quality results
FAT / SAT	Hardware, software, HMI, alarms, historian, reports and redundancy	Witnessed test scripts, punch list and closure
Cybersecurity verification	Segmentation, identity, remote access, logging, backup and recovery	Configuration baseline, vulnerability review and restoration test
Performance and load test	Data volumes, concurrent users, latency and retention	Measured results against approved requirements
Training and competency	Operators, maintenance, engineers, administrators, management and emergency roles	Attendance, assessment, simulator results and authorization
Cutover and stabilization	Migration, parallel run, rollback, issue control and model tuning	Approved cutover plan, daily review and stable KPI trend

Workstream	Minimum Information Required Before FEED
Process and operations	Zone process descriptions, operating modes, material/energy balances, control narratives and production schedules
Assets and instrumentation	Equipment list, criticality, instrument index, I/O, packaged-unit interfaces and calibration strategy
Automation and networks	Control-system architecture, tag naming, network topology, redundancy, time sync and remote-access requirements
Applications and workflows	MES/WMS/TMS/CMMS/LIMS/ERP scope, roles, approvals, master data and retention
Data and analytics	KPI dictionary, historian rates, data ownership, models, cloud/edge boundary and reporting needs
Cybersecurity and safety	Risk assessment, zones/conduits, identity, backup/recovery, safety lifecycle and emergency response
ESG and compliance	Organizational boundary, calculation methods, meters/evidence, reporting standards and assurance requirements
Commissioning and operations	FAT/SAT plan, simulator/training needs, cutover strategy, staffing, support model and service levels