**Leo Electric — Intellectual Property Brief  
  
‘EV → Smart‑Grid → Analytics → Carbon Credits → Valuation → Predictions’**

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# 0) Executive Summary — Leo Climate Intelligence Stack (LCIS)

Leo Electric’s defensible edge is a vertically integrated pipeline that combines field‑proven EV and charging/swapping hardware, proprietary supply‑chain and certification know‑how, and cross‑border data stewardship. This brief formalizes intellectual property across digital MRV for carbon, degradation‑aware crediting, blended asset valuation, and predictive control of fleets and microgrids. [1][2]

# 1) Reference System Architecture (Patentable Implementation)

[Vehicle/Battery/BMS] --CAN/RS-485--> [Telematics Edge]  
 | |  
 | BLE/UART | MQTT/TCP  
 v v  
 [Swap/Charge Station: 8/10‑bay] <----> [Local Gateway]  
 (TCP/IP, RS-485, IP54, safety) | OCPP/OCPI\*  
 | \   
 | \ HTTPS+TLS  
 v v  
 [Microgrid EMS/PCS] <----> [Grid/Utility APIs] [External MRV/Registry]  
 | | (credits issuance)  
 | | ^  
 v v |  
 [LCIS Cloud Data Plane] |  
 ┌─────────┬─────────┬───────────┬─────────┐ |  
 | Ingest | Store | Model | Serve |---------+  
 | | (Lake) | (MRV/ML) | (APIs) |  
 └─────────┴─────────┴───────────┴─────────┘  
  
\*Standards gateways map to OCPP/OCPI where applicable. Stations support TCP/IP, RS‑485, per‑bay safety, and 48/60/72 V outputs. [1]

# 2) Data Model (Core to Claims & Trade Secrets)

2.1 Telemetry (vehicle/BMS): { device\_id, vin, ts\_utc, lat, lon, soc, soh, v\_pack, i\_pack, temp\_cell\_max, temp\_cell\_min, dod, cycles, fault\_flags, speed, odo\_km }

2.2 Station/Swap event (8/10‑bay models): { station\_id, bay\_id, ts\_in, ts\_out, kWh\_in, kWh\_out, v\_out, i\_out, battery\_id, firmware\_hash, safety\_aerosol\_status, fan\_status } [1]

2.3 Microgrid/Utility: { site\_id, ts\_utc, pv\_gen\_kWh, grid\_import\_kWh, grid\_export\_kWh, tariff\_block, freq, outage\_flag }

2.4 Emission Factors (EF): { country, grid\_zone, ts\_utc\_window, EF\_avg\_kgCO2e\_kWh, EF\_marg\_kgCO2e\_kWh, source }

2.5 Credit MRV ledger lifecycle: observed → computed → attested → verified → issued → retired; each with { hash, signature, verifier\_id }.

2.6 Valuation inputs: { asset\_id, capex, opex, uptime, km\_day, swap\_events\_day, energy\_cost, credit\_price\_scenario, default\_rate, residual\_curve, WACC }.

# 3) Carbon Accounting — Methods & Integrity Controls (Patentable)

Per‑trip CO₂e avoided (2W/3W): CO2e\_avoided = d\_km \* EF\_ICE,km − ((kWh\_consumed/η\_charger) \* EF\_grid). Charger efficiency and station losses are measured from station telemetry. [1]

Battery‑degradation adjustment: Δ = (kWh\_in − kWh\_to\_pack) \* EF\_grid, where Δ is derived from SOH, pack V/I, and thermal spread. [1]

Anti‑fraud & attestation: edge signatures per event; redundant sensing (BMS vs station energy); route plausibility (odo vs GPS); station safety telemetry as data quality gates. [1]

# 4) Credit Pathways (Designs to Claim)

• Mini‑bundles per campus/city (e.g., university towns in PH) for pooled verification and lower MRV costs. [2]

• Microgrid‑coupled credits: PV‑aligned swaps when EF is high; grid when low; MRV records dispatch intent and actual EF.

• Battery passport ↔ credit uplift: SOH‑driven multipliers; degraded packs routed to daytime PV charging.

# 5) Valuation & Finance Models (Blended Cashflows)

Asset cashflow for a vehicle a: CF\_a(t) = R\_ops(t) + R\_swap(t) + R\_credit(t) − (C\_energy(t) + C\_maint(t)); NPV = Σ CF(t)/(1+WACC)^t. Inputs backed by station specs and quality processes. [1]

Scenario engine: credit price paths (P10/P50/P90), grid EF trajectories, and SOH decay curves by chemistry (Li‑ion vs sodium‑ion). [2]

# 6) Predictions & Optimization

• Demand & energy forecasting: hierarchical time‑series for swaps/kWh/day; tariff‑aware load shifting to meet SLA.

• Battery SOH & failure: survival models and Gaussian Processes; dispatch policy assigns PV‑prefer charging to high‑IR packs.

• Credit yield prediction: E[CO2e\_avoided] × E[credit\_price] with uncertainty bands.

• Grid‑aware swapping: reinforcement learning over station queues and EMS state to trade off wait time vs EF vs tariff.

# 7) Inventions to File (Claims Scaffold)

A) Telemetry‑attested micro‑mobility MRV — Independent claim: method combining attested swap/charge events, time/location‑specific EF, and degradation‑adjusted losses to generate a verifiable credit ledger. [1]

B) Degradation‑aware charging orchestration — Assign batteries to PV vs grid using SOH/thermal metrics to maximize lifetime credits/throughput.

C) Swap‑station integrity & quality‑gate MRV — Use station safety states and certification process checks (e.g., TÜV) as admissibility gates. [1]

D) Battery‑passport → credit uplift mapping — Compute dynamic multipliers from chemistry, SOH, cycles with audit trail.

E) Blended asset valuation for EV portfolios — Price EV assets using operations + energy arbitrage + carbon; output securitizable cashflows.

F) Cross‑border data stewarding for climate credits — Privacy‑preserving aggregation in a SG data steward emitting attested aggregates to registries/G2G programs. [1]

G) Swap‑aware OCPP/OCPI gateway for 2W/3W — Protocol extension modeling the battery as a session with per‑bay attestation and EF annotations.

H) Sodium‑ion integration policy — Chemistry‑aware swap/charge policies when Na‑ion co‑exists with Li‑ion; optimize safety, SOH, and credit yield. [2]

# 8) What to Patent vs Keep Trade‑Secret

Patent now: A, B, C, E, F (MRV + valuation + data stewarding + station integrity).

Trade‑secret: calibration tables for charger/battery losses by SKU & climate, swap queue heuristics, supplier quality recipes, TÜV playbooks. [1]

# 9) Implementation Plan (90–180 days)

Phase 1 (0–45 days): finalize data schemas; deploy firmware fields for signatures; stand up ingest/lake/feature store; connect first pilot site (e.g., PH campus or NG city cluster). [2]

Phase 2 (46–120 days): compute v1 MRV (hourly EF); run shadow credits; train forecasting & SOH models; implement PV‑prefer scheduling at microgrids.

Phase 3 (121–180 days): third‑party attestation; registry submission pack; valuation console for financiers; lease term‑sheets backed by credit yield.

# 10) Technical Artifacts (for Engineering)

10.1 MRV Edge→Cloud Pseudocode

# Edge (station)  
evt = collect\_swap\_event() # energy in/out, bay\_id, battery\_id, temps  
evt['fw\_hash'] = firmware\_hash()  
evt['sig'] = sign(evt, EDGE\_PRIVATE\_KEY)  
publish\_mqtt('swap/events', evt)  
  
# Cloud  
def process\_event(evt):  
 assert verify\_sig(evt)  
 trip = join\_trip(evt['battery\_id'], window=24\*3600)  
 kwh = compute\_energy(evt, trip)  
 ef = lookup\_ef(trip.latlon, trip.time\_bucket) # time/location matched  
 loss = loss\_model(evt, trip.bms, station\_id=evt['station\_id'])  
 co2\_avoided = trip.baseline\_ice\_kg - (kwh + loss) \* ef  
 ledger\_entry = attest(evt, trip, co2\_avoided)  
 write\_ledger(ledger\_entry)

10.2 Valuation Function

def asset\_npv(cashflows, wacc):  
 return sum(cf / ((1+wacc)\*\*t) for t, cf in enumerate(cashflows, start=1))

# 11) Evidence & Enablement (from Leo Materials)

Hardware readiness: 8/10‑bay stations with TCP/IP, RS‑485, IP54, per‑bay aerosol fire suppression; 48/60/72 V outputs. [1]

Certification moat: TÜV SÜD process maturity; claim that supplier lists alone cannot replicate the quality system. [1]

Track record: Deployments for SP Group underground facilities and Singapore military. [1]

Global pipelines: Philippines university accelerator, Nigeria MoU/government route, Saudi platform collaboration. [1][2]

Chemistry optionality: intent/partners for sodium‑ion alongside Li‑ion. [2]

# 12) Filing Strategy

• File 3–4 SG provisionals now (MRV core, valuation, station integrity, data stewarding); proceed to PCT within 12 months.

• Consider defensive publication for swap‑aware OCPP/OCPI extensions (if standardization is preferred).

• Use NDAs and invention assignments with factories/partners (China, PH, NG).

• Prioritize territories: SG, PH, NG, SA, IN, EU — aligned to go‑to‑market lanes. [2]

## Annex A — Sample Invention Disclosure Outline

Title: Degradation‑aware MRV for 2W/3W swap ecosystems

Problem: Existing EV MRV ignores small‑vehicle swap dynamics and time‑varying EF.

Detailed Description: Data model, algorithms, integrity checks.

Claims: As per section 7 (A–H).

Enablement: Refer to station specs, TÜV processes, deployment pilots. [1][2]

## Annex B — Architecture Diagram (Monospace)

[Vehicle/Battery/BMS] --CAN/RS-485--> [Telematics Edge]  
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# References

[1] Leo Electric — SG Gov Presentation (Jun 25), compressed. Internal document.

[2] Leo Electric Explainer Document. Internal document.