

# Sustainability Intelligence Platform – Documentation (for Development & Simulation)

## 1. Project Context

- **Event:** JunctionX Vaasa 2025 – Hack the Future of Energy & Tech
  - **Challenge Partner:** Wärtsilä
  - **Theme:** Sustainability Intelligence Platform
  - **Objective:** Build a prototype tool that simulates real-time power sector metrics, hosted on Supabase, with a dashboard for sustainability intelligence.
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## 2. Problem Statement

The power sector produces ~36% of global CO<sub>2</sub> emissions. Current reporting is fragmented and retrospective.

**Our solution:** A real-time simulation of key sustainability KPIs stored in **Supabase** and visualized in a dashboard, helping companies measure progress toward **net zero 2050** and comply with reporting standards.

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## 3. Core KPIs (Chosen for Simulation)

1. **CO<sub>2</sub> Intensity of Electricity (gCO<sub>2</sub>/kWh)**
  - Formula:  $\text{Emissions} \div \text{Total Electricity Generated}$ .
  - Simulated range: 100–300 gCO<sub>2</sub>/kWh (depending on renewables share).
2. **Renewable Share of Generation (%)**

- Formula:  $(\text{Renewable Generation} \div \text{Total Generation}) \times 100$ .
- Renewables include hydro, wind, solar.
- Simulated range: 30–60%.

### 3. Net Zero Trajectory Alignment (%)

- Formula:  $(\text{Reduction achieved} \div \text{Required reduction path to 2050}) \times 100$ .
- Requires historical baseline (2020 = 30 Mt CO<sub>2</sub>) and yearly target path.
- Simulated as a percentage showing if we are **ahead / on track / behind**.

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## 4. Database Schema (Supabase)

We will simulate and store the KPI data in Supabase.

Tables:

**Table 1: co2\_intensity**

| id | timestamp           | co2_intensity_g_per_kw<br>h |
|----|---------------------|-----------------------------|
| 1  | 2025-09-27 09:00:00 | 145                         |
| 2  | 2025-09-27 09:15:00 | 138                         |
| 3  | 2025-09-27 09:30:00 | 150                         |
| 4  | 2025-09-27 09:45:00 | 132                         |
| 5  | 2025-09-27 10:00:00 | 128                         |

**Table 2: generation\_mix**

| i<br>d | time<br>mp | hydro_<br>mw | wind_<br>mw | solar_<br>mw | nuclear_<br>mw | fossil_<br>mw | total_<br>mw | renewable_shar<br>e_pct |
|--------|------------|--------------|-------------|--------------|----------------|---------------|--------------|-------------------------|
|--------|------------|--------------|-------------|--------------|----------------|---------------|--------------|-------------------------|

|   |                     |     |      |     |      |      |      |      |
|---|---------------------|-----|------|-----|------|------|------|------|
| 1 | 2025-09-27 09:00:00 | 950 | 1800 | 150 | 2700 | 1400 | 6950 | 40.9 |
| 2 | 2025-09-27 09:15:00 | 940 | 1820 | 160 | 2700 | 1350 | 6970 | 42.0 |
| 3 | 2025-09-27 09:30:00 | 930 | 1750 | 170 | 2700 | 1500 | 7050 | 40.0 |
| 4 | 2025-09-27 09:45:00 | 920 | 1700 | 180 | 2700 | 1550 | 7050 | 39.2 |
| 5 | 2025-09-27 10:00:00 | 910 | 1650 | 200 | 2700 | 1600 | 7060 | 38.3 |

**Table 3: netzero\_alignment**

| year | actual_emissions_mt | target_emissions_mt | alignment_pct |
|------|---------------------|---------------------|---------------|
| 2020 | 30                  | 30                  | 100           |
| 2021 | 28                  | 29                  | 110           |
| 2022 | 27                  | 28                  | 110           |
| 2023 | 26                  | 27                  | 106           |
| 2024 | 26                  | 26                  | 100           |
| 2025 | 27                  | 25                  | 83            |

## 5. Architecture

- **Supabase:** stores simulated data tables.
  - **Backend:** Python Flask / Node.js → fetch data from Supabase and serve via API endpoints.
  - **Frontend:** React + Chart.js/Plotly → fetch from backend and render dashboard.
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## 6. Dashboard Features

- **KPI Cards:** show current CO<sub>2</sub> Intensity, Renewable Share, Alignment % in real time.
  - **Time Series Graphs:** trends of emissions and renewable share.
  - **Trajectory Chart:** actual vs target emissions (net zero path).
  - **Simulation Updates:** script inserts new rows into Supabase every few minutes to mimic real-time feed.
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## 7. Team Roles

- **Data Scientist (you):** build simulation logic for KPIs, insert into Supabase.
  - **Web Developer:** connect frontend to Supabase API, design dashboard.
  - **Business/Finance Student:** prepare business case, market potential, compliance value.
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## 8. Development Roadmap

- Step 1: Define schema in Supabase (done .

- Step 2: Write Python script to simulate & insert data periodically.
  - Step 3: Build backend endpoints to query Supabase.
  - Step 4: Build frontend dashboard (React) to show KPIs & charts.
  - Step 5: Integrate and polish for demo.
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## **9. Deliverables**

- Working dashboard with live simulated data.
- Documentation of KPI logic.
- Business presentation linking solution to net zero goals.