eco4impact – Digital Twin for Predictive Fleet Decarbonization and Scenario-Based Planning

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Physical Twin description

- The physical twin is the **real logistics transport system** , encompassing **heavy-duty trucks** (ICE, BEV, FCEV), transport processes, and multimodal routes.
- It includes the actual vehicles, telematics sensors, and operational logistics processes that generate data for simulations.
- The system is **highly dynamic**, evolving under interactions between vehicles, drivers, infrastructure, and the **environmental context** (traffic, weather, topography).

Digital Twin usages

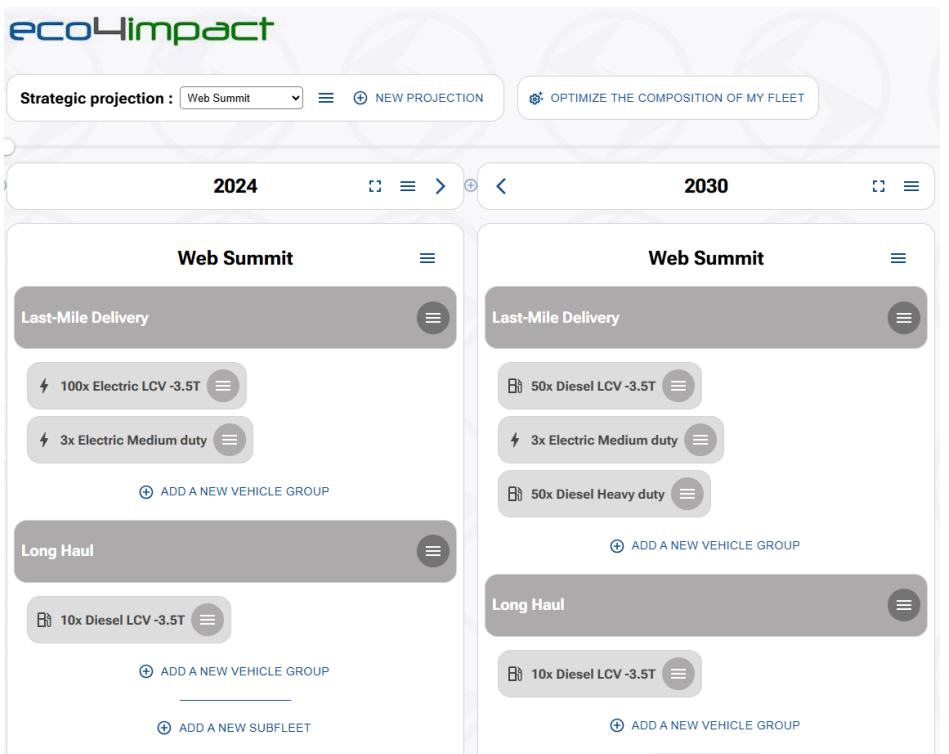
- **Strategic Planning:** Support long-term decision-making by simulating 2030–2050 fleet transition scenarios, making technology choices, and assessing infrastructure needs.
- **Tactical/Daily Planning:** Optimize short-term operations, such as generating optimal tours and energy use schedules, and accounting for constraints like traffic and weather impacts.
- **Evaluation and Simulation:** Evaluate cost–risk trade-offs and sustainability KPIs; and enable fleet managers to simulate the impacts of regulations, subsidies, and CO2 pricing.

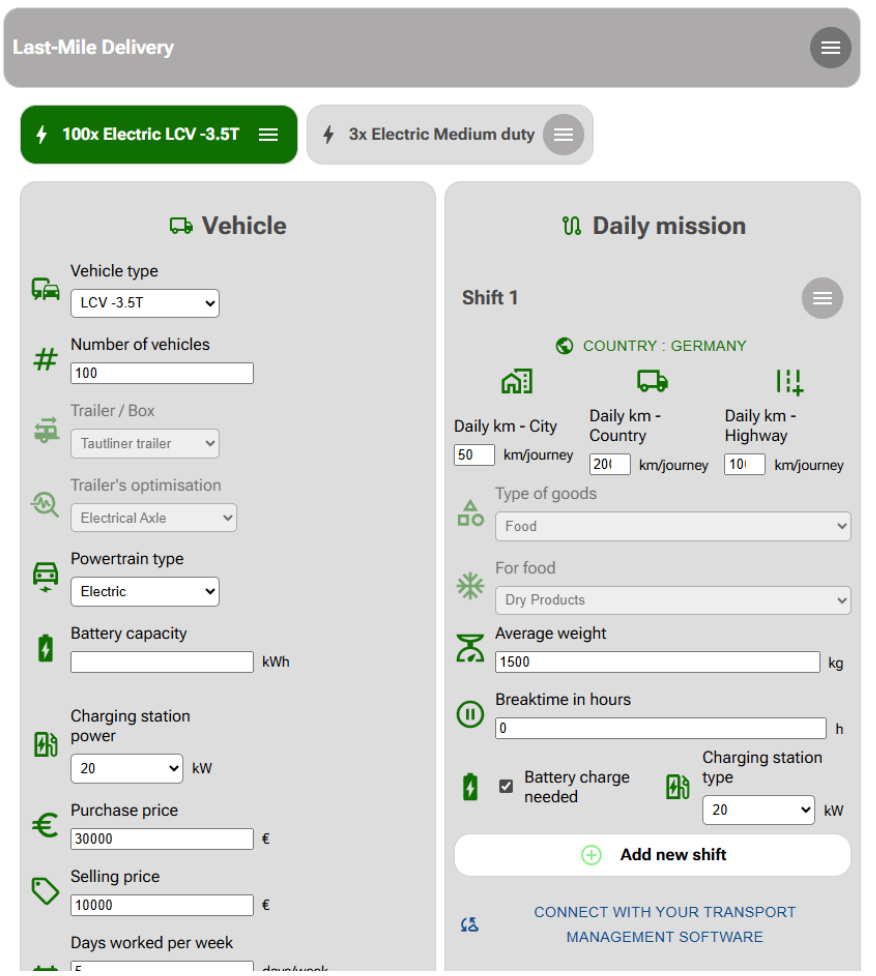
Digital Twin Description

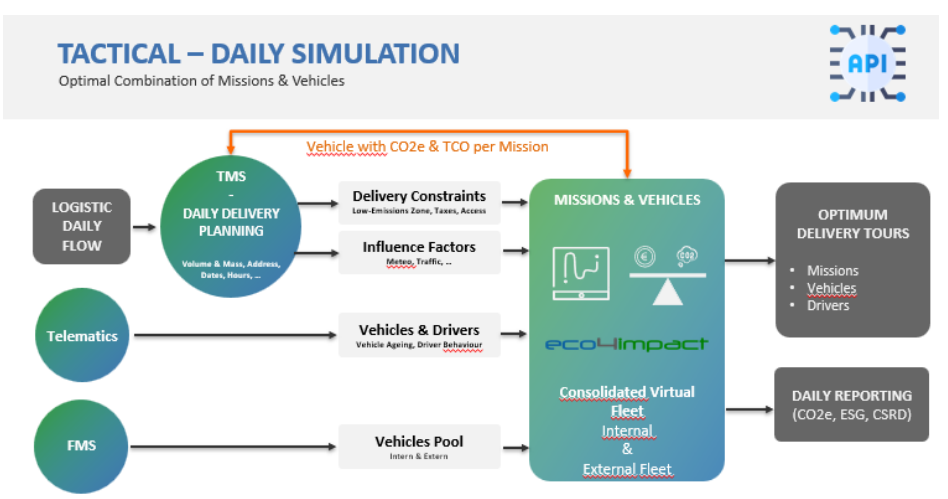
- **Predictive SaaS platform** for modeling and optimizing long-term fleet decarbonization and daily operation
- integrates **Digital Truck Twins** (physics/data models) with a **Scenario Generator** to predict TCO, LCA, CO2-impacts
- It is connected to the **physical twin via continuous ingestion of real transport data** (telematics, usage, infrastructure)

Engineering Digital Twin challenges

- **Automated Scenario Generation:** The most critical challenge, involving creating realistic and diverse scenarios for strategic and tactical planning using Sequence Building Blocks
- **Data Integration:** Merging and cleaning data from numerous heterogeneous and uncertain sources (telematics, infrastructure, market trends) while ensuring consistent formats and semantics
- **Multi-Model Coupling**: Aligning and integrating complex models, specifically Machine Learning (ML), physics-based Digital Truck Twins, predictive cost, and Life Cycle Assessment
- **Predictive Modeling under High Uncertainty:** Forecasting future Total Cost of Ownershipfor emerging powertrains and conducting under uncertainties like future energy mixes, prices, and regulatory.







- **EcoRoadLog Consortium** under construction with logisticians, Federations and Universities in France and Germany.
- **Eco4Impact-Offroad** for Off-Highway Applications is under development in a project with the UNICEM and FNTP.