SMAR3TS

Staff Mobility to Action Resilient, Restorative, and Regenerative Transitions & Societies

Funded by
the European Union

Innovate3X (I3X) at Kempower

Shaping the future of Heavy Electric Traffic Ecosystem (HETE)

Kempower Electric Mobility Research Center – EMRC

Presented by: Ville Naumanen & Prof. Marko Torkkeli

Funded by the European Union

Kempower in a nutshell

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Finnish electric vehicle fast charging equipment manufacturer

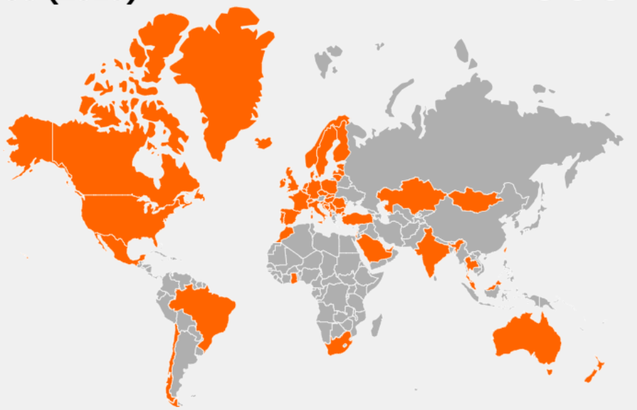
- Power range: 40 kW – 4 MW+
- Suitable for all electric vehicle types, like electric cars, buses, trucks, boats, and machines
- Listed in Nasdaq First North Growth Market since December 2021

New company with a strong history

- Charging business as own company since 2017
- 70 years of experience in DC-power sources (Kemppi Group)

Powering Planet Cool.

COUNTRIES WITH KEMPOWER CHARGERS
65 (2025)



TOTAL CHARGING SESSIONS
+ 30 M

TOTAL ENERGY DELIVERED
+ 1.2 TWh

CHARGER AVAILABILITY
+ >99%

We charge our planet for the better by powering the electric movement. We enable quick and scalable EV charging solutions for everyone, everywhere.

Kempower Heavy Electric Traffic Ecosystem (HETE)

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OUR GOALS

Develop

•Charging technology for electric trucks
•A software platform to support charging
•A testing platform for charging infrastructure

Study

•Future charging models
•The effects of charging infrastructure on electric grids

The **Heavy Electric Traffic Ecosystem (HETE)** is an R&D program that aims to develop charging technology suitable for truck traffic. It includes a supporting software platform and testing infrastructure for charging systems.

The ecosystem will **study future charging models** and **analyze the impacts of charging infrastructure** on electric grids. Kempower will launch R&D projects across all areas of the program and invites other future-oriented businesses with R&D expertise to join.

RESEARCH FIELDS

EV charging technologies

How can we increase the **power capacity of charging systems**? This field includes the development of power converter technology, advanced system cooling, charger operation with battery energy storage systems and optimal grid use, among others.

Digital solutions and platforms

How can we find **new ways of using data and create data-based business opportunities**? This field involves the development of cloud-based platforms that ensure interoperability with partner platforms.

Customer applications

How can we support overnight, destination and on-the-move charging? This field includes the **development of real-life testing environments** and optimal route and charging planning software – nationally and internationally.

Future DC fast charging

How can we improve long-term business with novel charging technologies? This field covers various research areas, incl. advancement of charging power into the multimegawatt range, the integration of autonomous vehicles into logistics operations, wireless charging and the effects on the electricity grid.

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Kempower HETE: on SMAR3TS mission towards resilient, regenerative and restorative future of mobility

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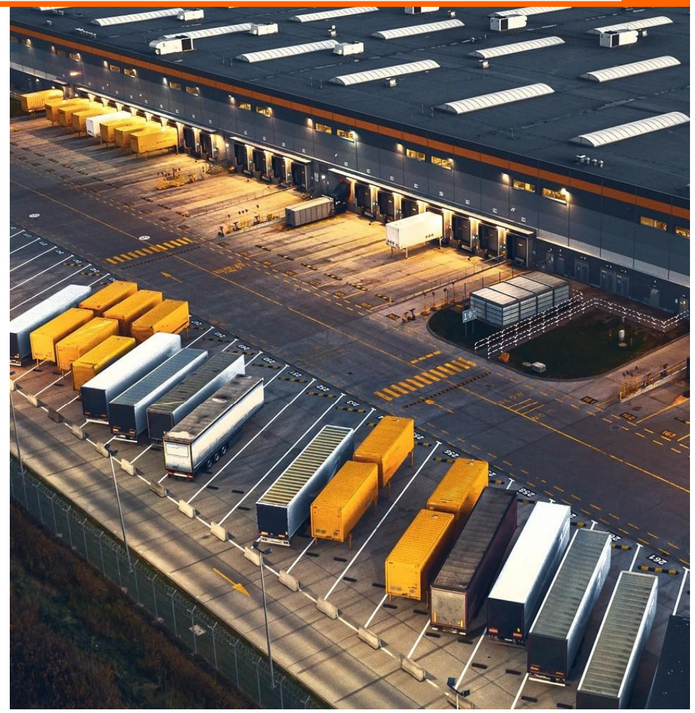
HETE 2024-2029

Mission: To electrify heavy traffic sustainably!

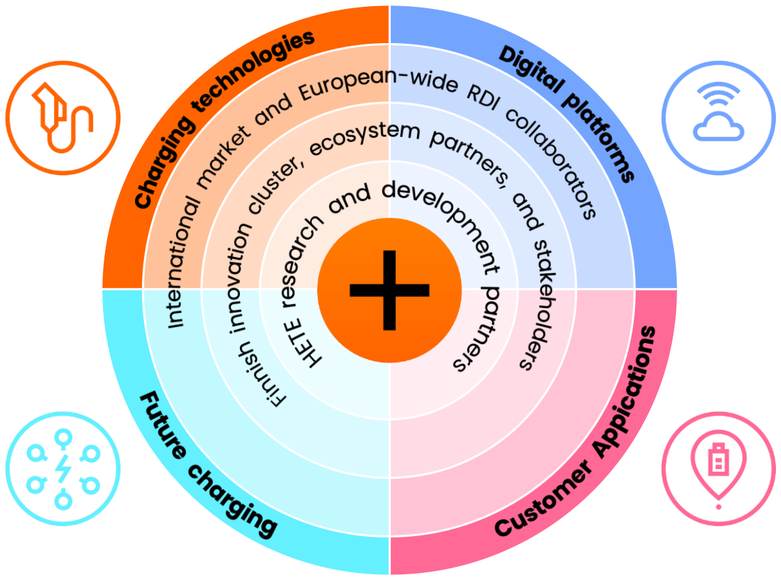
Enabling the ecosystem to **research and develop new technologies and business models** around energy flow and logistics related to the electrification of the heavy traffic industry

HETE aims to build a leading global eTruck charging ecosystem by 2030

- >50 partners involved in the ecosystem
- $ 1 bn+ in revenues from heavy traffic charging systems for the ecosystem companies



The HETE ecosystem layers



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Kempower: HETE Roadmap

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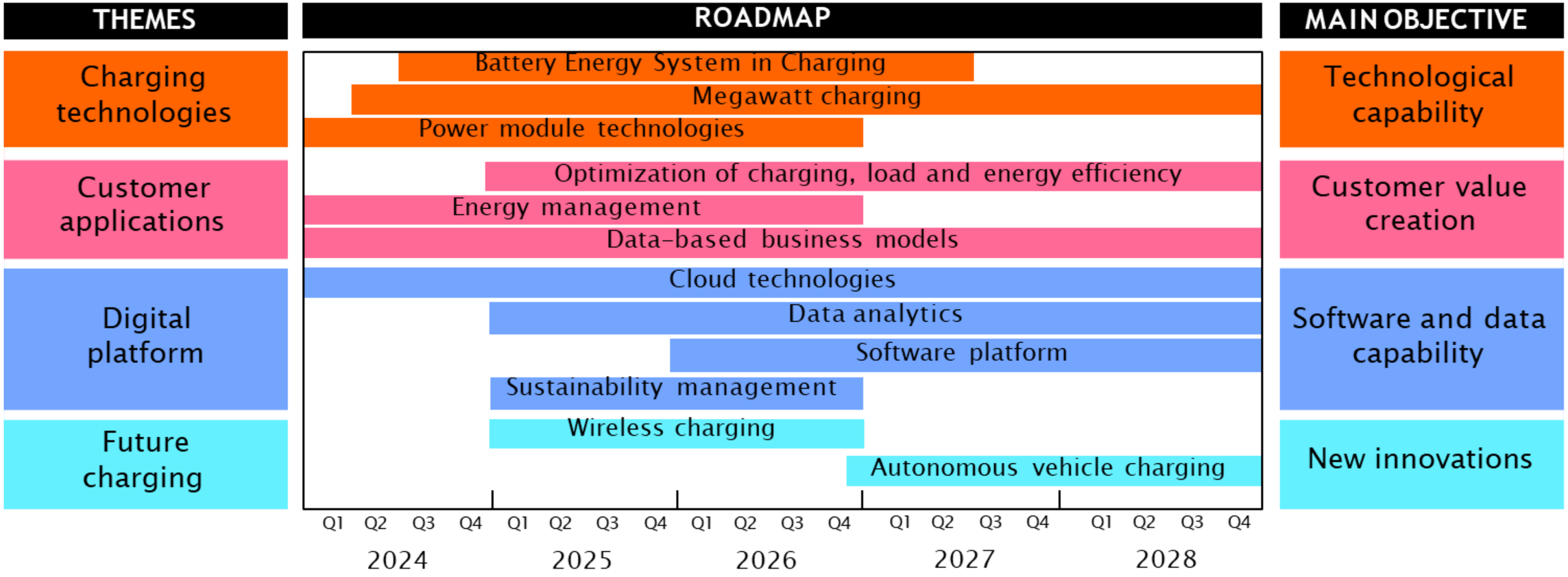

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I3X at Kempower

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Opportunities to identify new I3X within multi-disciplinary R&I-driven secondments at Kempower Electric Mobility Research Center

Business, management and social sciences

- New digital services and digital value creation
- Decision-making – drivers and uncertainties
- Corporate collaborations and innovation ecosystems
- Organizational business analytics capability
- Responsible business: legal and sustainability aspects
- Predictive analytics and maintenance
- Social user profiles, regional characteristics
- Sustainable business models

Software engineering and computational engineering

- Bi-directional charging, systems and technology
- Control of new semiconductor technologies
- Engineering and testing of embedded software
- Software processes, large-scale Agile, hybrid work and global software engineering
- Cloud services, IoT, machine learning, data analytics, inverse problems, and AI
- Technical data analytics, battery/device condition

Electrical engineering and energy technology

- Grid system resilience and design evolution drivers
- System and device reliability, component technologies
- Electrical efficiency and standard development
- Network harmonics and electromagnetic compatibility
- DC distribution technologies and system expertise
- Energy storage supply for high-power charging
- Thermal management, device and system level

Industry 5.0 visionary concepts

- User-centric design and the human–machine interface, digital accessibility
- Analytically augmented design practices and extended reality
- Heavy vehicle charging and battery systems, robotics and automation, megawatt charging technology
- Manufacturability: industrial design, modeling and simulation, composites and metals
- Life cycle assessment, circularity, sustainability, EU Digital Passport

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I3X at Kempower – About the initiator

Name of Organization: Kempower
Research Group/Department: Electric Mobility Research Center – EMRC
Country: Finland

1. Background info

Kempower is a Finnish company specializing in DC fast-charging solutions for electric vehicles, with a strong focus on scalability, modularity, and reliability. We focus on all areas of electric mobility, from electric cars to trucks and buses, as well as construction machinery and marine. Recently, the company has been ranked 8th in the Financial Times FT1000 list of Europe's fastest-growing companies in 2025. *Website*: https://kempower.com/

2. Research Group/Company Department

Short description: **Electric Mobility Research Center (EMRC)** - research platform co-hosted by Kempower and LUT
Link to the website: https://www.lut.fi/en/research/partnerships-and-cooperation/kempower-electric-mobility-research-center-emrc
Contact info: **Ville Naumanen**, Research Director at EMRC
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3. Expertise and available technologies within SMAR3TS project

*1. **Expertise** of your research group/department and available technologies:*

- **EV CHARGING DATASET**
- **Technological expertise**
- **Energy- and mobility-related research**

*2. **Current status:** technology readiness level (TRL)/ solution development (**SRL**) and expected level to reach:*

Currently: EV-charging products are available
Expected: scaling to markets

*3. Examples of engagement in **Research, Development & Innovation (RDI) partnerships and industry partnerships:***

- SMAR3TS
- Business Finland Veturi – ecosystem program for HETE

4. Examples of strategically relevant Innovate3X (I3X) Initiatives

Provide a preliminary description of work that needs to be done, which will be further refined and shaped throughout the secondments.

Examples:

- Raw Materials & Component Supply study for HETE
- Battery Manufacturing & Digital Supply Chains
- Insights on EV Truck & Charger Production across markets globally
- Grid & Power Infrastructure globally
- Charging Infrastructure Deployment across countries
- Fleet Operations & Logistics across countries
- End-User Adoption – data-driven evidence
- Recycling & Circular Economy solutions for HETE
- Business and marketing: Competitor analysis and benchmarking (market and/or technological level)

I3X at Kempower – Alignment to R3 and to WPs

SMAR3TS domains:

1) Specify here: *one or several* ***SMAR3TS domains*** *that are* ***relevant to the work of your organization/research and innovation team****.*

<u>Mobility</u> domain:

- Kempower's EV charging solutions **accelerate the transition to sustainable transport and low-carbon heavy logistics**.
- Secondments **could support market analysis to understand how Kempower could scale the development of (HETE)**: e.g., cross-country analysis to anticipate the market needs, infrastructure, and trends related to charging heavy-duty vehicles; leveraging global EV-charging infrastructure data for innovation pilot/software development/other solutions that could support HETE.

2) Specify here: <u>alignment</u> *of the work of your organization/research and innovation team with one or several <u>SMAR3TS focus areas</u> on <u>Resilience</u>, <u>Restoration</u>, and <u>Regeneration</u>. Share examples.*

- **<u>Enabler of resilience</u>**: Electrified mobility is dependent on the availability of charging infrastructure. Kempower's modular, flexible, and grid-friendly charging systems strengthen transport networks' resilience and continuity, especially in heavy logistics. Modular, scalable DC fast charging systems ensure **flexibility and redundancy in transport infrastructure** and enhance **energy and transport resilience during grid disruptions**.
- **<u>Link to restoration and regeneration</u>**: By shifting mobility away from fossil fuels, Kempower **EV-charging solutions support sustainable mobility** (cleaner air, reduced noise, and lower carbon emissions). **Collaborations with renewable microgrid providers** and **smart energy management systems** provide **opportunities for regeneration** of **heavy truck mobility infrastructures** into self-sustaining, low-impact systems.

I3X – Kempower EV Charging Dataset: Exploring data-driven opportunities for new business

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(1) I3X:

1. Description of Current Stage

Specify here: *What is your research group/department currently working on? Which initiatives/projects are underway under I3X? How does this work contribute to resilience, restoration, and regeneration?*

☐ **Early Implementation – analysis of Passenger EV Charging Dataset, which includes the following info:**

- **Charging metrics** from various EV models across different regions and environments
- Aggregated and anonymized **charging data** to fully protect customer and end-user identity
- Provides an **unbiased view of EV-side charging behavior**
- Accompanied by thorough **documentation and usage guides**
- Ensures **ease of use and encourages innovation**
- **Hosted on an accessible platform with built-in access control**
- **Ready for scalable public distribution, supporting wide research adoption**
- Power and energy center has been working on EU / US behavior, treating large data sets

2. Necessary skills and capabilities, across disciplines:

Specify here: *What gaps or barriers need to be addressed to move forward? Which new skills, knowledge, expertise, interdisciplinary approaches or collaborations are required?*

EMRC (Electric Mobility Research Center) and the HETE (Heavy Electric Traffic Ecosystem) program will run a **pilot of the EV Charging Dataset for Research** during Autumn 2025 (starting in the beginning of Sep 2025).

Examples of necessary skills and knowledge:

- Background in **energy research / automotive industry** (work with EV, heavy EV, charging infrastructures)
- Strong **data analytics skills**
- **Business analytics** experience
- Work with **large data sets and AI tools**
- End-user flexibility and optimization requires end-user data
- Use of charging audits fraud detection or infringement to carbon green loan requirements
- Mobility analytics for city planning and route optimization and road infrastructure

3. Examples of challenges that need to be addressed

Specify here: *Please outline which challenges remain unresolved. You may answer in bullet points.*

1) Need to capture evidence of real-world EV charging behavior
2) Analysis of **EV-charging and infrastructure data**
3) PILOT CASE: EV CHARGING DATASET* TO IDENTIFY NEW BUSINESS OPPORTUNITIES FROM DATA *(*The EV charging dataset will be shared during the secondment)*

- Get insights from the dataset and **map potential scenarios** for its applicability
- **Validate** the tools, practices, and conditions for using the dataset
- **Get feedback from pilot users** and offer possibilities to demonstrate and showcase their work with the data
- The pilot will run 9-12/2025. Kempower will evaluate the results from the pilot and decide on expanding the usage in 2026.
- Unique Value Proposition; - Real time information on charger in vehicles and infrastructure – app that provides this info to users.

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I3X: Exploring the applicability of Kempower solutions in Heavy Electric Traffic - Market analysis for scaling

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(2) I3X:

1. Description of Current Stage

Specify here: *What is your research group/department currently working on? Which initiatives/projects are underway under I3X? How does this work contribute to resilience, restoration, and regeneration?*

Current work: Kempower's EMRC and HETE program are developing megawatt-level charging solutions for heavy electric trucks, buses, and off-highway vehicles, with pilots underway. Focus areas include charger hardware, modular power distribution, and software for smart energy management.

Next steps for impact: Scale from technology pilots to market adoption, requiring analysis of business models, policy frameworks, user acceptance, and logistics ecosystem integration.

Potential areas for secondments:

- **Market analysis for scaling heavy EV charging** (EU/Nordic logistics corridors).Innovation in business models (CaaS, BaaS, leasing models).
- **Policy and regulatory mapping** (EU, Nordic, Finnish incentives for e-trucks).
- **Engagement with logistics operators, SMEs, and municipalities for pilots**.
- **Sustainability assessments** (LCA, circular design, second-life battery use).

2. Necessary skills and capabilities, across disciplines:

Specify here: *What gaps or barriers need to be addressed to move forward? Which new skills, knowledge, expertise, interdisciplinary approaches or collaborations are required?*

- Business case modelling & scenario analysis (TCO, ROI for fleets & infrastructure).
- Techno-economic assessment & lifecycle sustainability analysis.
- Development of industrial, policy, and community pilots. Cross-disciplinary methods (engineering + economics + social sciences).
- Stakeholder & ecosystem engagement (logistics firms, energy providers, policymakers).
- Market intelligence and competitor benchmarking.
- Impact measurement & evaluation methods.
- Knowledge of EU transport, battery, and charging regulations.

3. Examples of challenges that need to be addressed

Specify here: *Please outline which challenges remain unresolved. You may answer in bullet points.*

(1) Market & Business Models:

- Lack of proven cost models for megawatt charging hubs.
- High upfront investment costs for SMEs in logistics sector.
- Limited clarity on viable business models (CaaS, BaaS, leasing).
- Market analysis and competition benchmarking; designing new business models for sustainable mobility

(2) Technology Adoption:

- Slow standardization of megawatt charging (MCS).
- Interoperability gaps between truck OEMs, chargers, and grid operators.
- What to do about charging of autonomous vehicles (automation 2030)?

(3) Sustainability & Circularity:

- Recycling and second-life use of large truck batteries.
- Integration of renewable energy and storage with charging hubs.

(4) Data & Analysis:

- Limited insights from real-world data on heavy EV truck charging behavior.
- Gaps in predictive modelling for grid impact and logistics routing.

(5) Ecosystem Development:

- Coordination needed among logistics firms, energy providers, municipalities, and policymakers.
- Scaling the ecosystem and applicability of Kempower solutions in other countries

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I3X – Battery Recycling Strategy and Second-Life Battery Scale-up

(3) I3X

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1. Description of Current Stage

Specify here: *What is your research group/department currently working on? Which initiatives/projects are underway under I3X? How does this work contribute to resilience, restoration, and regeneration?*

Kempower's EMRC and partners are exploring battery end-of-life management for heavy-duty EVs.

Stage: ☐ Pilot / Proof of Concept → Early Implementation.

Next steps for impact: Move from small pilots and conceptual studies to validated business models, scalable second-life applications, and harmonized recycling processes in line with EU Battery Regulation.

2. Necessary skills and capabilities, across disciplines:

Specify here: *What gaps or barriers need to be addressed to move forward? Which new skills, knowledge, expertise, interdisciplinary approaches or collaborations are required?*

- Techno-economic analysis of recycling and second-life applications.
- Policy & regulation expertise (EU Battery Regulation, Critical Raw Materials Act).
- Circular design & engineering (design-for-disassembly, remanufacturing).
- Data science & digital solutions (blockchain, digital product passports, traceability).
- Cross-sector pilot development & stakeholder engagement.
- Impact measurement (CO_2 reduction, resource recovery rates, cost savings).
- Interdisciplinary methods: combining engineering, economics, sustainability science, and social sciences.

3. Examples of challenges that need to be addressed

Specify here: *Please outline which challenges remain unresolved. You may answer in bullet points.*

- **Market & Adoption**
- **Sustainability & Assessment**
- **Ecosystem & Community Development**:

- Coordination gaps between recyclers, OEMs, energy providers, and policymakers
- Pilot projects

- **Impact**:

- Difficulty in demonstrating long-term benefits (resource recovery %, CO_2 savings, economic viability) in early pilots

Potential areas for secondments:

- Techno-economic & environmental assessments of recycling methods in Nordics/Europe/globally.
- Scaling roadmaps for second-life battery applications (e.g., logistics depots, microgrids, ports).
- Analysis of Policy/regulations of EU Battery Regulation & Digital Product Passports.
- Cross-sector engagement with recyclers, energy utilities, municipalities, and logistics operators to strengthen co-innovation in HETE.
- Development of ecosystem-driven circular design solutions for EV batteries
- Market analysis and value proposition design
- Analysis of sustainable business models for recycling different types of batteries
- Market report/trends analysis

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Examples of research questions for I3X-research-driven SMAR3TS secondments

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Raw Materials & Component Supply

- How can Finland leverage domestic and EU-critical raw material strategies to reduce dependency on non-EU sources for EV battery materials? (Addressing resiliency through the whole supply chain)
- What role can circular mining and urban mining play in securing sustainable lithium and cobalt supplies in the Nordic region?
- What are the main barriers and benefits in reducing battery dependency on non-EU sources for EV battery materials?
- What are the key technologies in reducing battery dependency on non-EU sources for EV battery materials?
- In the case of decision-making techniques and game theory analysis, which strategy can secure the importing material from non-EU with low risk?

Battery Manufacturing & Digital Supply Chains

- How can digital twins, AI and other Industry 4.0 & 5.0 technologies be integrated into EV battery manufacturing to predict, mitigate, reduce production bottlenecks, and increase efficiency across the EU? -
- What are the economic, environmental and social trade-offs of localizing battery production in Finland compared to importing from other EU nations?
- What strategies can be adopted to reduce Finland's dependency on semiconductors imported from non-EU countries for EV charging and battery control systems?
- What are the key drivers of cost reduction in battery cell manufacturing, and how can Finnish companies accelerate along the learning curve?
- What are the techno-economic benefits of nearshoring critical EV components (e.g., BMS chips, power electronics) to Nordic countries within the EU industrial strategy?
- How can collaborative manufacturing platforms among EU nations reduce the cost and lead time of producing EV-related components under global market uncertainties?

EV Truck & Charger Production

- How can predictive analytics and AI-based quality control improve the reliability of EV truck powertrain and charger assembly lines?
- What are the barriers to harmonizing charger interfaces, protocols, and software across different EV truck brands, and how can EU standards help overcome them?
- What materials innovation is needed to enhance the durability and weather resistance of EV truck chargers, especially for deployment in Arctic and sub-Arctic conditions?
- What business models (e.g., leasing, charging-as-a-service, Battery-as-a-Service) can make EV trucks and chargers more affordable for small and medium logistics firms?
- What strategies can be used to optimize heat management in EV truck charger production for improved safety and performance in high-power applications?
- What role can Finland's machine-building and electronics industries play in developing a vertically integrated EV truck-charger ecosystem within the EU framework?

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Examples of research questions for I3X-research-driven SMAR3TS secondments

Grid & Power Infrastructure

- How can large-scale deployment of EV trucks be aligned with Finland’s renewable energy goals without destabilizing the grid?
- Can vehicle-to-grid (V2G) solutions using EV trucks enhance Finland’s national grid flexibility and resilience against energy shocks?
- How can Finland's electricity grid accommodate large-scale EV truck charging without compromising grid stability, particularly in rural or industrial logistics corridors?
- What grid infrastructure upgrades are necessary to support megawatt-level charging hubs for long-haul EV trucks?

Fleet Operations & Logistics

- What are the carbon and cost-saving potentials of AI-driven route and fleet optimization in electric truck operations in Nordic logistics networks?
- How can predictive battery maintenance extend EV truck lifespan and reduce total cost of ownership in cold climate conditions like Finland?
- How can AI-based fleet routing and scheduling algorithms reduce energy consumption and range anxiety in electric truck operations under Finland’s cold climate conditions?
- What logistics strategies can optimize vehicle utilization while accounting for charging downtime and limited range in multi-stop delivery scenarios?

Charging Infrastructure Deployment

- What are the optimal spatial locations for EV truck charging stations in Finland based on transport corridors, logistic hubs, and grid accessibility?
- How can Finland's electricity grid accommodate large-scale EV truck charging without compromising grid stability, particularly in rural or industrial logistics corridors?
- How can smart charging algorithms and demand response mechanisms be designed to align EV truck charging with periods of renewable energy surplus in Finland?
- To what extent can decentralized renewable energy sources (e.g., solar, wind, biogas) be co-located with EV truck charging depots to reduce peak loads and improve grid independence?

End-User Adoption

- Which policy and incentive schemes are most effective in accelerating EV truck adoption among small and medium Finnish logistics firms?
- How does market awareness and digital literacy affect EV truck adoption among end-users in remote and rural regions of Finland and Lapland?
- What are the key behavioral, economic, and informational barriers preventing logistics operators—especially SMEs—in Finland from adopting electric trucks?
- To what extent does digital literacy and access to fleet management technology affect the willingness of rural or small-scale logistics operators to adopt electric trucks in Finland?
- What role do early adopters and peer networks play in accelerating the social acceptance and normalization of electric trucks in regional freight markets?

Recycling & Circular Economy

- What are the most cost-effective and environmentally sound strategies for recycling EV truck batteries in Finland, considering local infrastructure and EU regulatory requirements?
- How can second-life battery applications (e.g., stationary energy storage) be scaled up in the Nordic region to extend the value of decommissioned EV truck batteries?
- What design-for-disassembly practices can be integrated into EV truck and charger manufacturing to facilitate efficient recycling and remanufacturing at end-of-life?
- How can blockchain or digital product passports enhance traceability and circularity of EV truck components across the EU supply chain?
- What role can Finland play in developing a circular ecosystem for EV truck materials—including batteries, rare earth elements, and electronic components—to reduce dependency on virgin raw materials?

Business and marketing

- Competitor analysis and benchmarking (market and/or technological level)

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Innovate3X at Kempower

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