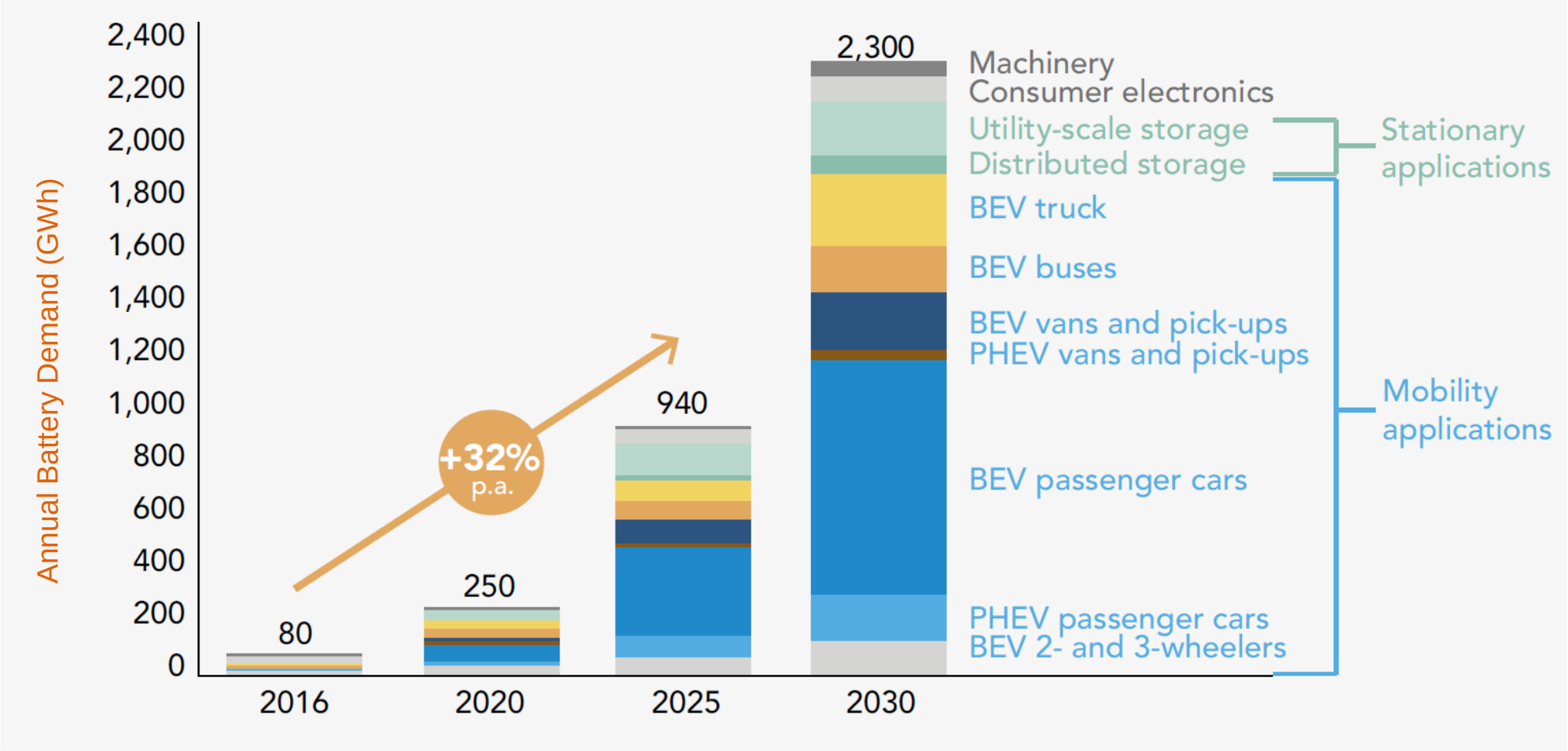
Kuorma-autoliikenteen sähköistyminen ja vedyn mahdollisuudet

Kuljetus 2023, Jyväskylä 25.5.2023

Mikko Pihlatie

Forecasted evolution of battery market demand



Source: BATT4EU / SRIA, - September 2021

Zero-Emission Trucks: Trends & Barriers

Top Transformational Shifts Shaping the Future of Electric Trucks

Low Emission Zones (LEZs)
Regulation of air quality in urban areas by the levying of a fee on vehicles causing pollution

Fuel Price Volatility
Driving fleet owners toward alternate powertrains

Energy Storage Research
Rapid technological advancements

Regulatory Environment
Legislation making green transport solutions mandatory

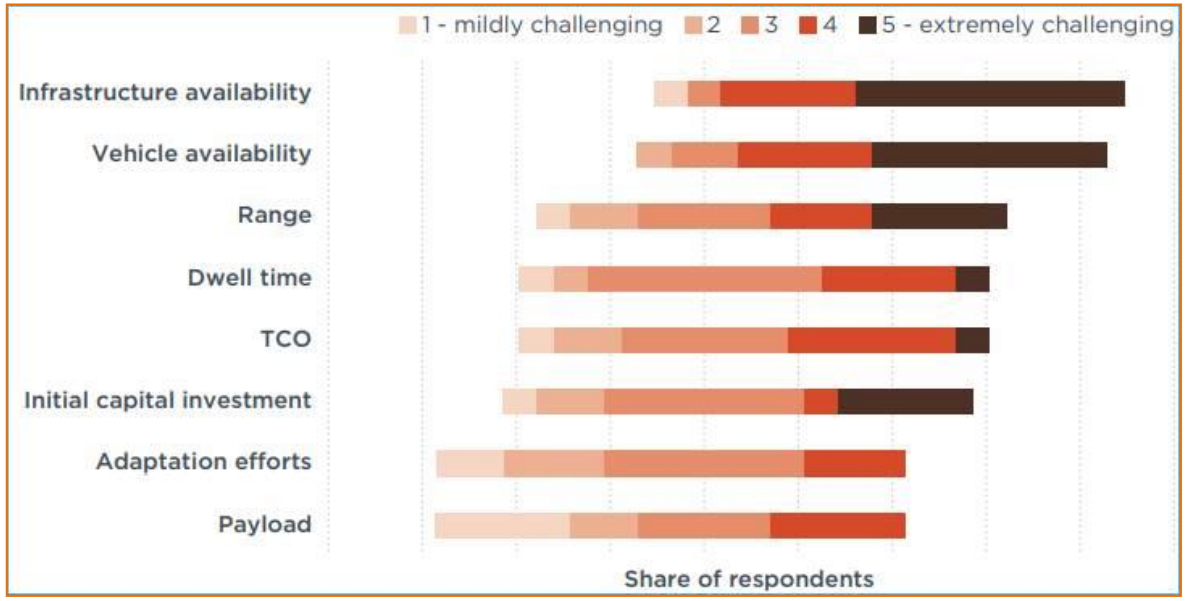
Energy Security
Reducing energy import through the adoption of renewable energy

Infrastructure Barriers
The least pressure on the existing energy infrastructure

Global Supply Chain
Technology licensing and economies of scale because of the increasing adoption of EVs

Government Support
Incentives for new vehicle purchases and subsidies for hybrid electric R&D

Importance of Key Barriers to the Transition to Zero-Emission Freight Vehicles

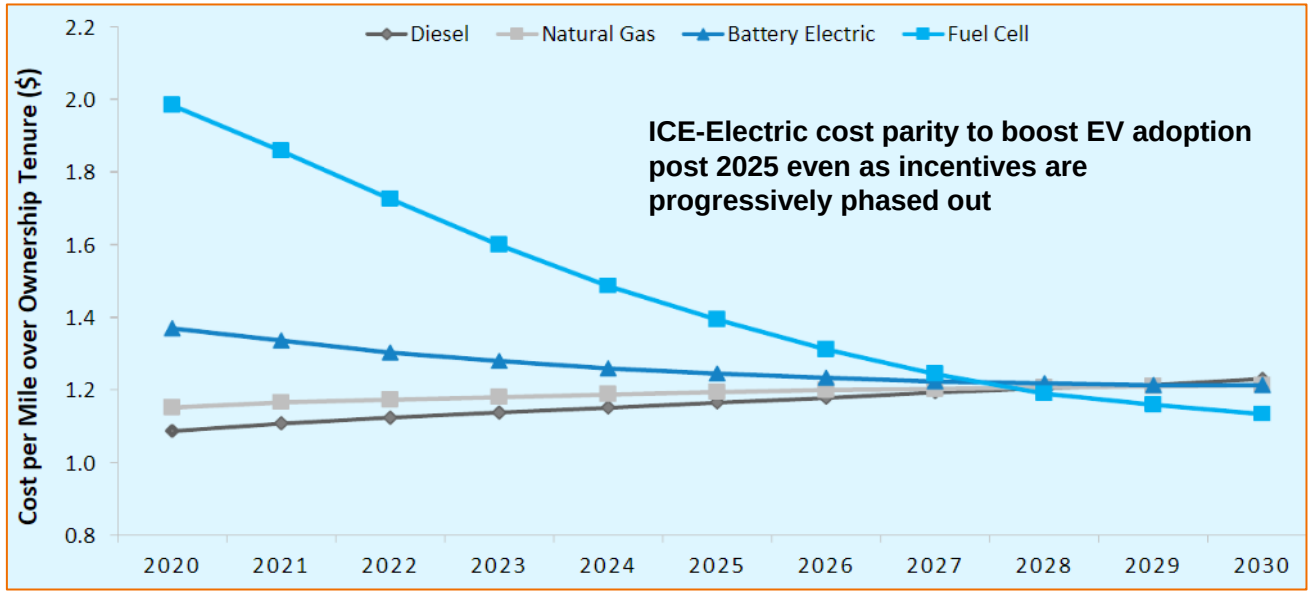


There is little publicly accessible electric charging and hydrogen refueling infrastructure dedicated to heavy-duty vehicles in Europe, which is perceived by ECTA (European Clean Trucking Alliance) members as the most important barrier hindering the transition to zero-emission trucking

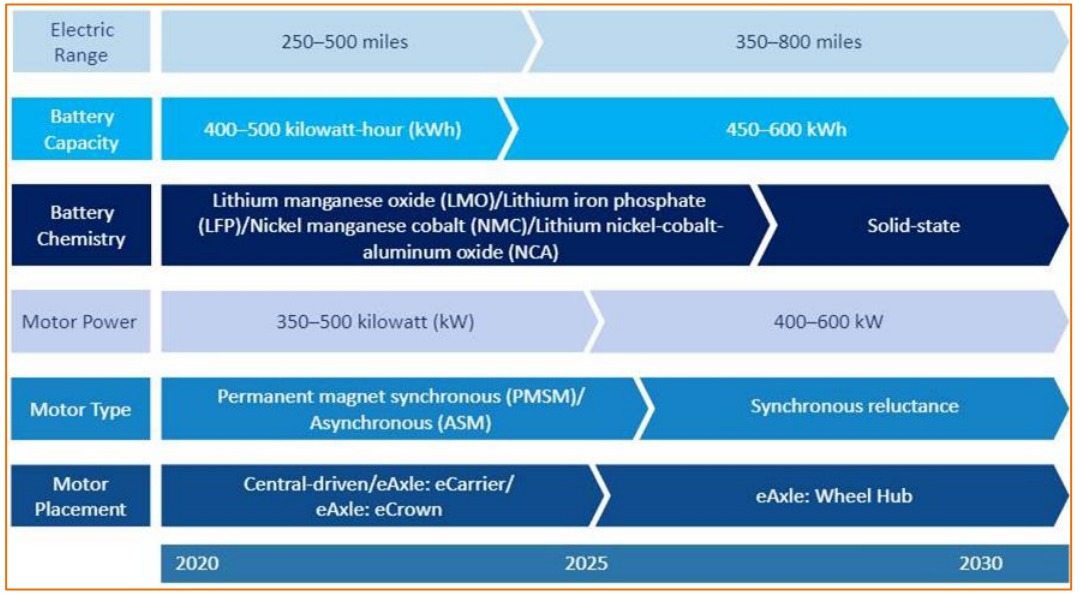
SOURCES: Frost & Sullivan (Dec 2021): European Medium-duty and Heavy-duty Electric Trucks Growth Opportunities ; ICCT (Sep 2022): Road freight decarbonization in Europe - readiness of the European fleets for zero-emission trucking

Trucks: Cost Parity to Boost EV Adoption Post 2025

Electric Trucks: HD Long Haul Total Cost of Ownership (TCO) Forecast in Europe*



Main Platform Component Technology Roadmap: Heavy-Duty Trucks



The 4 Mega Trends driving transformation in the trucking industry are connected, shared, autonomous, and electric (CASE) mobility:

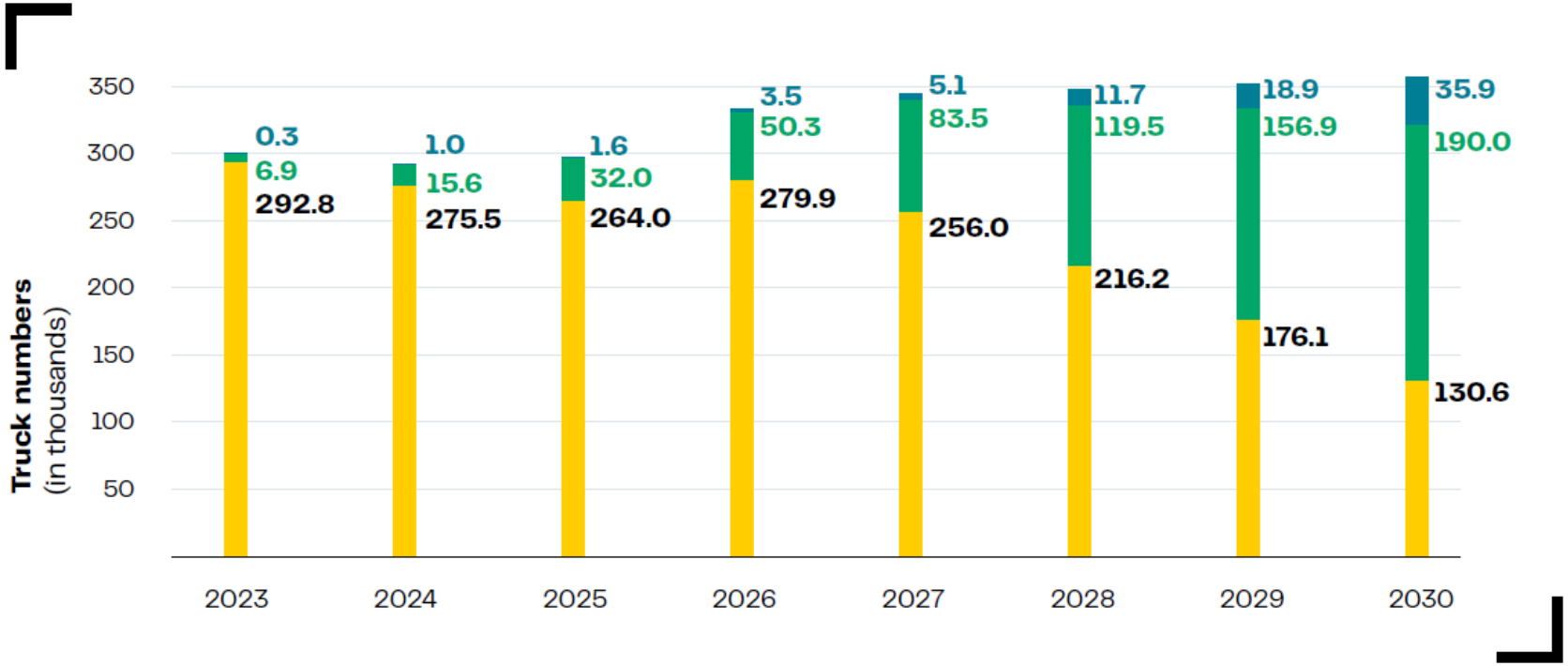
- Connected and shared, in the form of telematics and digital freight brokerage, are in the nascent stage of technology development but already underway
- This decade will see the proliferation of electric trucks
- Autonomous driving is 5–10 years away, depending on the level of autonomy

SOURCE: Frost & Sullivan (Oct 2022)*: 14th Annual Intelligent Mobility Summit, 2022 ; Frost & Sullivan (Nov 2022): Global OEM Strategies for Electric Medium- and Heavy-Duty Truck Platforms

Forecast manufacturer data sales figures in Europe for heavy-duty vehicles (> 12 t)

Three key drivers towards reaching toal cost parity

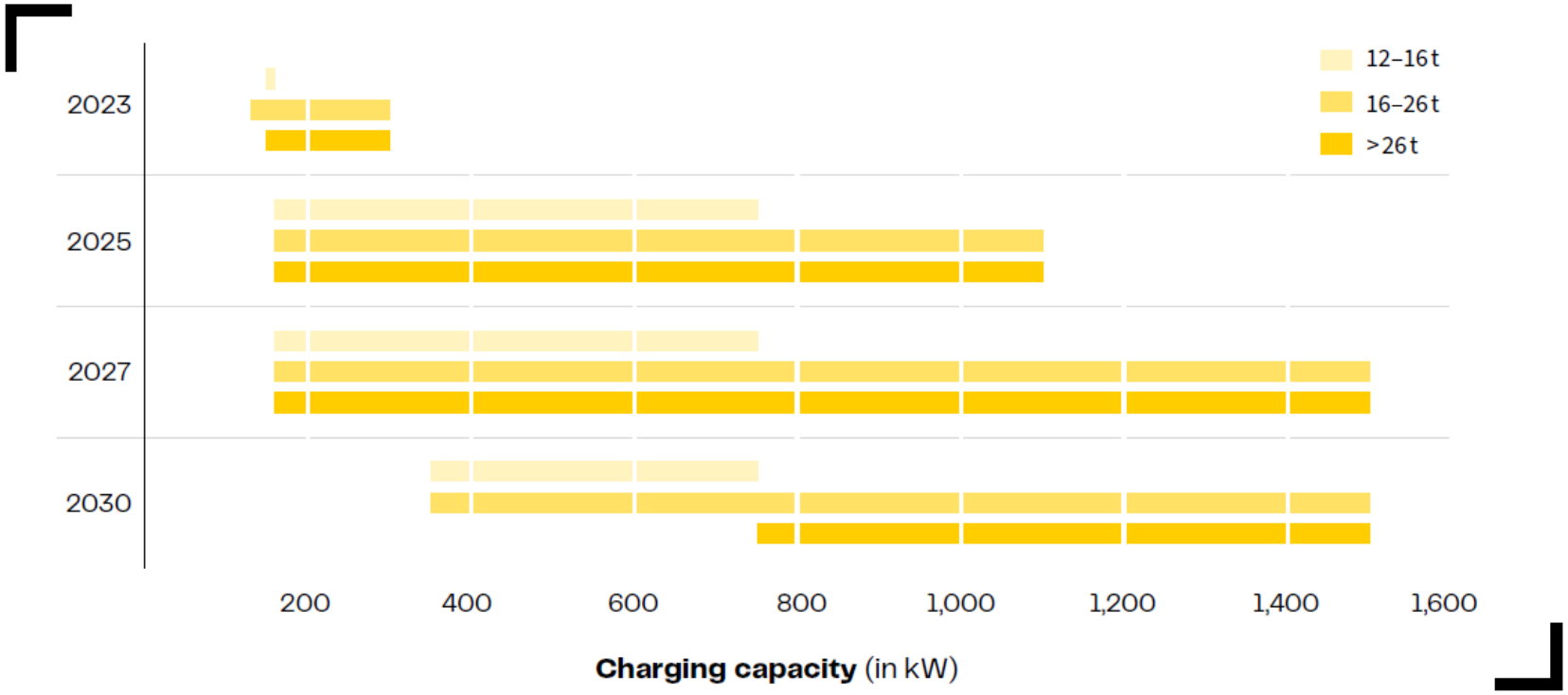
- Early incentives for vehicles and infrastructure (can also be e.g. CO2 dependent road tolls)
- Regulatory framework e.g. CO2 limits for manufacturers
- Energy costs: electricity and hydrogen vs diesel



Source: Market development of climate-friendly technologies in heavy-duty road freight transport in Germany and Europe, NOW GmbH, May 2023

Anticipated development of the charging capacity of battery trucks (> 12 t) by GVW

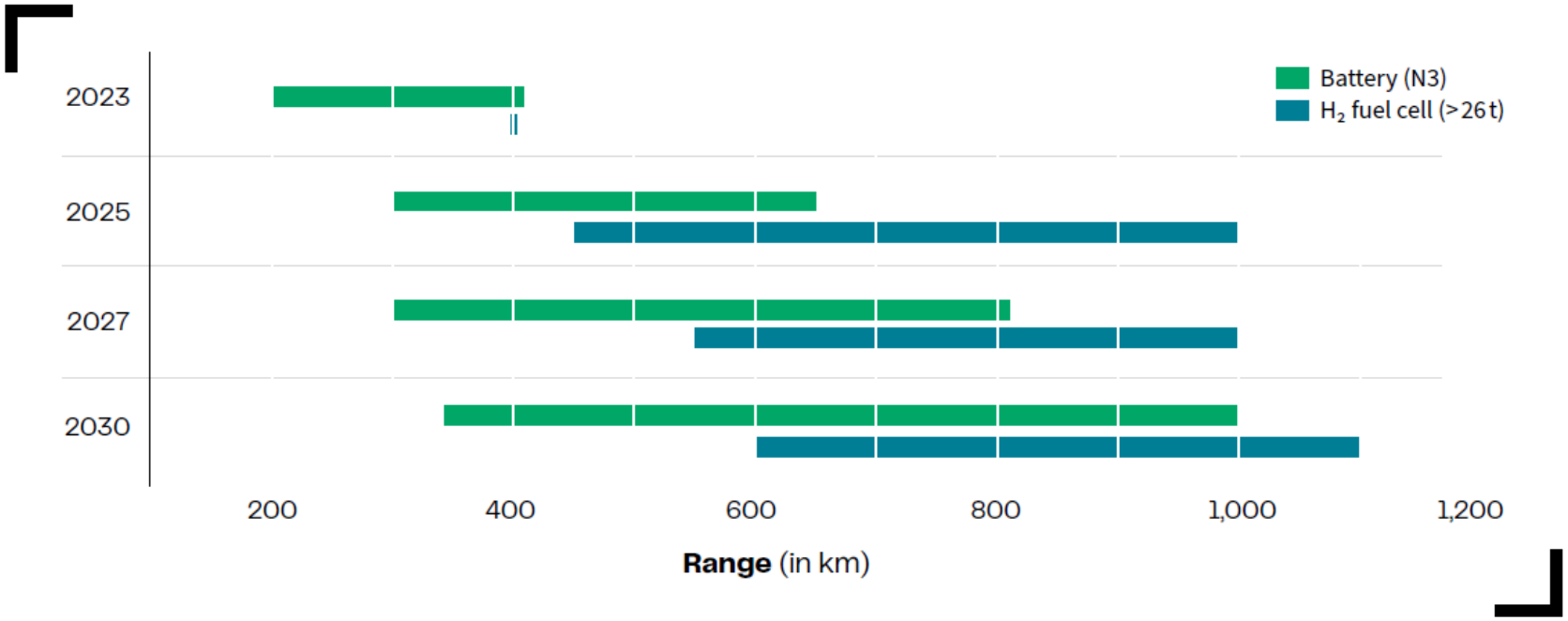
- Suitable alternative fuel infrastructures is imperative for ZE-HDV
- AFIR regulation will require deployment of both charging and H2 refilling
- Both charger capacity and battery charge acceptance will be increasing
- Megawatt charging is a key requirement for battery electric trucks



Source: Market development of climate-friendly technologies in heavy-duty road freight transport in Germany and Europe, NOW GmbH, May 2023

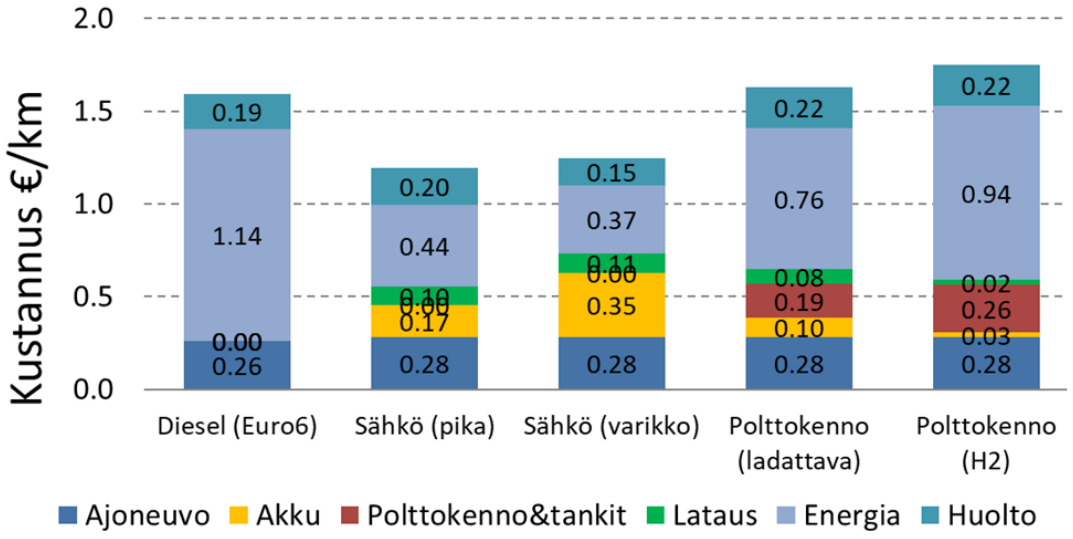
Anticipated development of the range of battery and fuel cell trucks

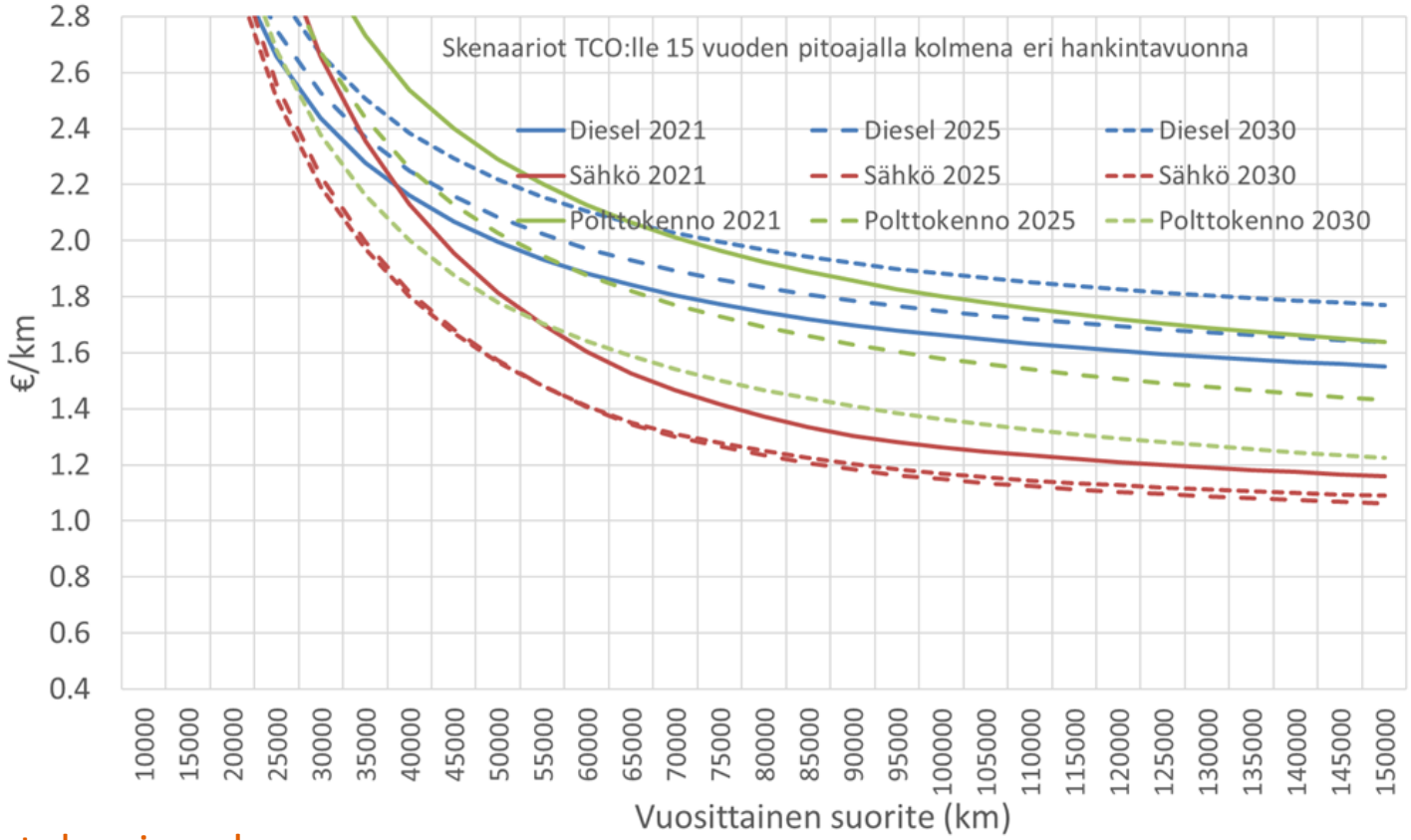
- Fuel cell trucks are currently behind battery electric trucks in market development
- Availability and price of green hydrogen for transportation not solved yet
- Hydrogen refilling infrastructure only in planning
- Increase in battery size and range in electric trucks expected



Source: Market development of climate-friendly technologies in heavy-duty road freight transport in Germany and Europe, NOW GmbH, May 2023

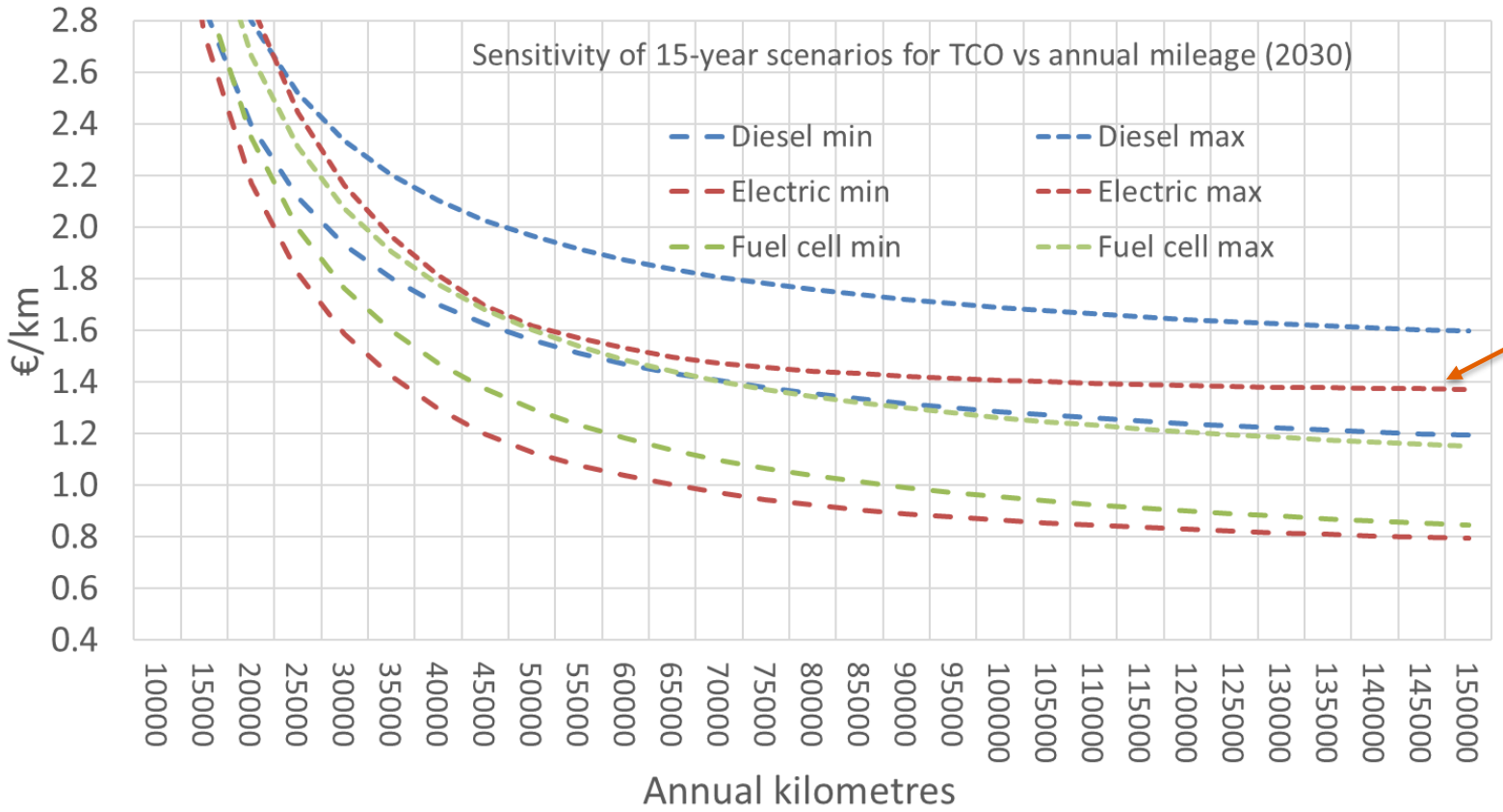
Total cost of ownership scenarios: urban bus trunk line (126000 km/a nominal)





VTT: Paikallisliikenteen puhtaat käyttövoimat nyt ja tulevaisuudessa:
https://cris.vtt.fi/en/publications/paikallisliikenteen-puhtaat-käyttövoimat-nyt-ja-tulevaisuudessa?utm_source=email

Example: Sensitivity analysis TCO vs km: urban bus year 2030 diesel vs electric vs H2



Huom: Sähköbussille oletettu 50% korkeampi energiankulutus matkustamon lämmityksen vuoksi

VTT: Paikallisliikenteen puhtaat käyttövoimat nyt ja tulevaisuudessa:
https://cris.vtt.fi/en/publications/paikallisliikenteen-puhtaat-käyttövoimat-nyt-ja-tulevaisuudessa?utm_source=email

ESCALATE

Powering European Union Net Zero Future by Escalating
Zero Emission HDVs and Logistic Intelligence

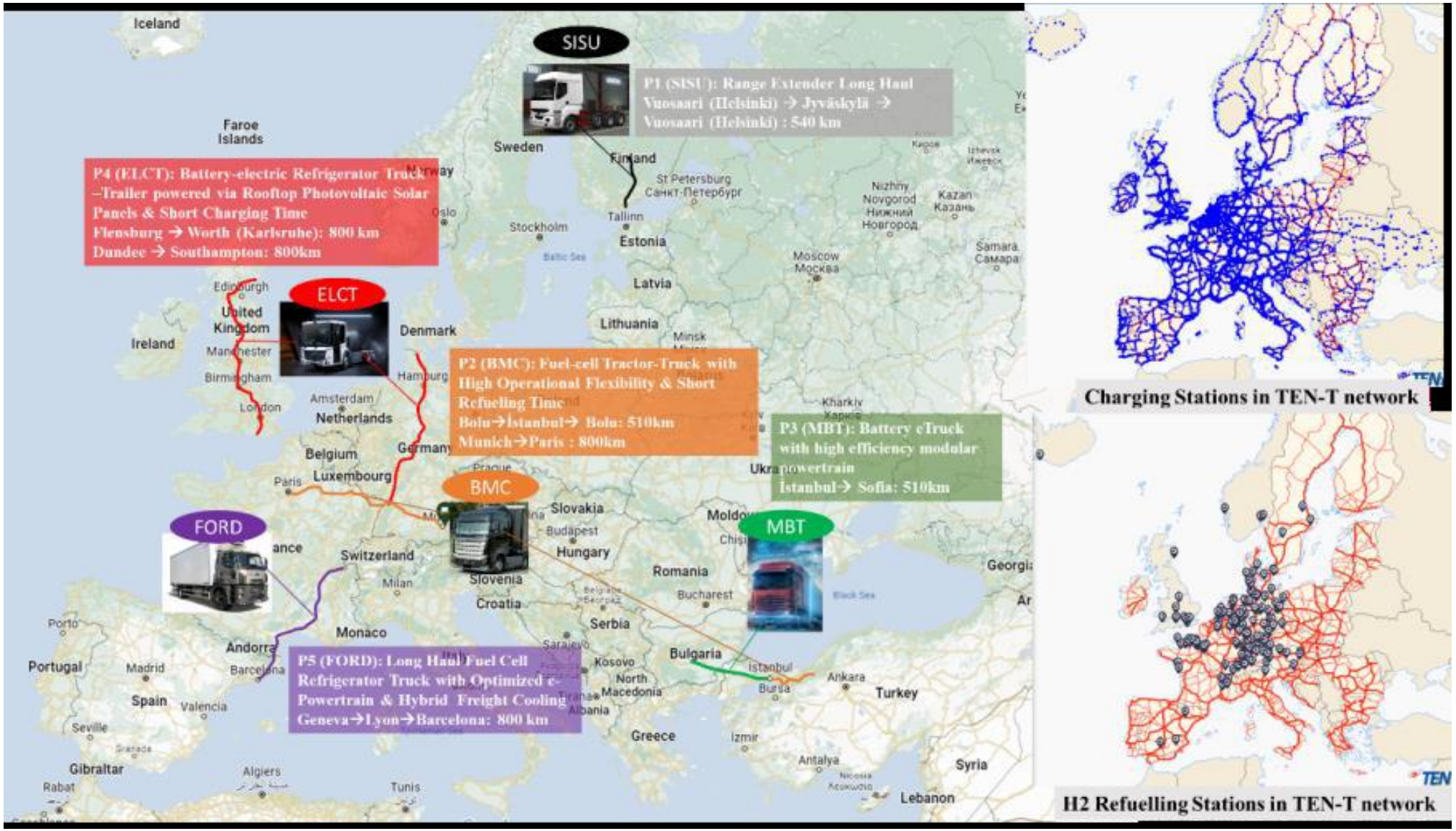
ESCALATE zero emission trucks for regional and long haul

SIX HOVE Kick-off meeting, Espoo, Finland, 23rd March 2023

Mikko Pihlatie, VTT

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101096598.

Overview of real life demonstrations of zero-emission trucks



5+3 PILOTS

1 MW
Fast Charger

KEM

Green fix
multi-fuel
station

ENGIE

Mobile-modular
H2 Filling Station

TEKFEN

Range Extender
Long-Haul Truck
(R)

SISU

Fuel Cell
Long -Haul Truck
(R)

BMC

Battery
Electric
RegionalTruck
(R)

MBT

Refrigerator Solar
Battery Truck
(R)

ELCT

Refrigerator
Fuel Cell Long-
Haul Truck
(V)

FORD

PILOTS

Pilot 1 key Innovations

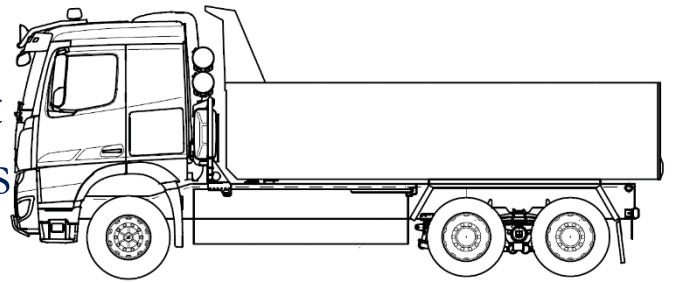
- Modular and scalable HD powertrain with battery, FC and H2 tanks
- Serve different mission and driving profile within one vehicle platform
  - Hybrid power source flexible design through modularity and scalability: battery-FC-H2 tanks (performance, energy, components lifetime)
  - Prototype: Pure BEV with hydrogen FC range extended for long haul use case
- Flexible vehicle platform based on 3-axle tractor (Vecto 10/12)
  - Traction power ~350 kW (VECTO 12 and beyond (40 – 76t)
  - Multi-use chassis with extra space for various configurations (superstructures)
  - Modularity of hybrid powertrain battery/FC power and capacity combinations and hybridisation degrees (virtual design, prototyping, operation optimisation with DT)
  - Hybrid BE-FC powertrain control, energy management and operation optimisation
  - Fast charging up to 1 MW and H2 refilling with user-friendly interfaces

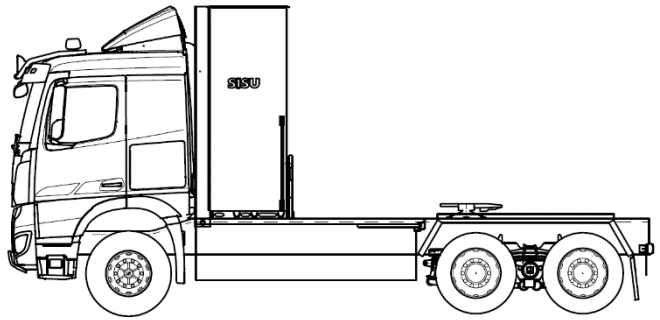
ESCALATE Sisu demonstration

- Sisu (vehicle integrator and OEM) with Tier 1 providers
  - Battery system: battery specification 500-600 kWh/1-2C charge
  - Fuel cell: Ballard 140-200 kW, H_2 storage: 40-80 kg H_2
  - Powertrain and integration: Sisu subcontracting
- Fast charging solution, interface, plugs: Kempower
  - Charging specification for pilot use case: 800-1000 kW in Vuosaari, piloting MCS
  - ~200-300 kW in Kokkola and Jyväskylä
  - Enables fully electric operation of most missions including long haul
- H_2 refuelling infrastructure: local partners for pilots
  - H_2 refilling station from market in Vuosaari/Jyväskylä/Lahti
  - additional H_2 provision e.g. in Kokkola
- End user piloting partners:
  - Rauanheimo (industrial product validation proto 1 phase)
  - O. Jylhä Oy (long haul and regional use case in freight logistics)
- VTT Technical Research Centre of Finland
  - R&I partner: design, modelling, simulation, validation, analysis, standardisation

Pilot 1 Operational scenarios for P1

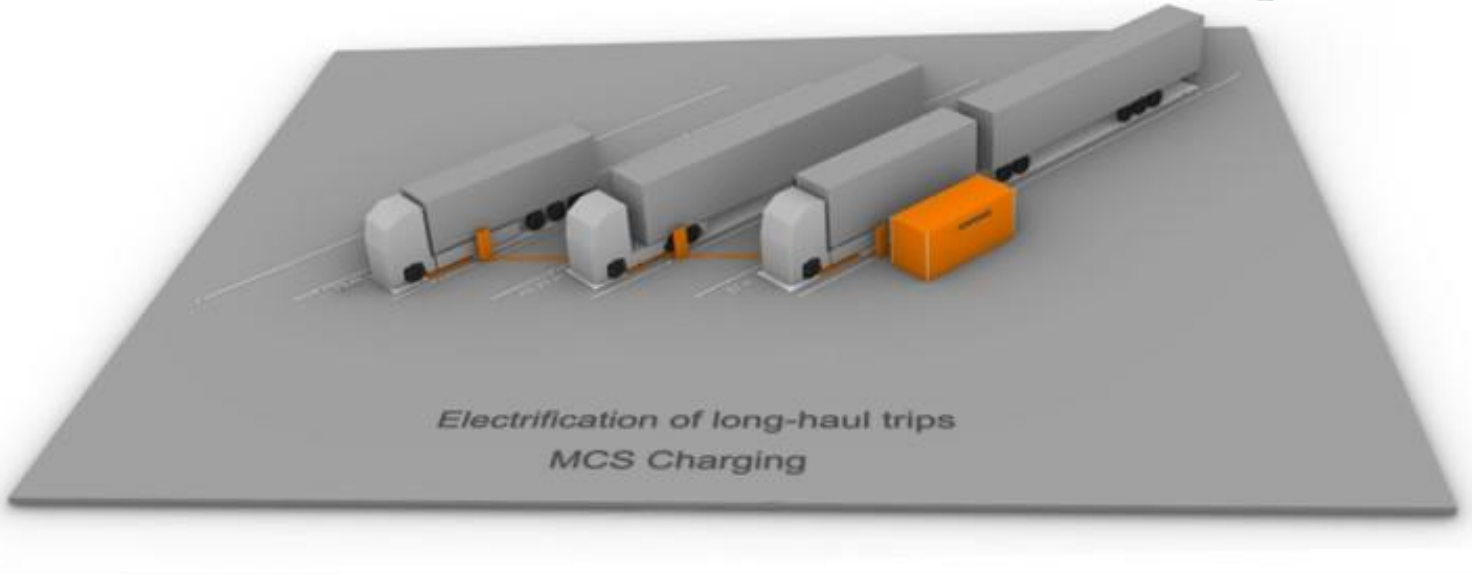
- Phase 1 industrial (BEV): Port of Kokkola Industrial Park (KIP) internal operations
  - BEV mode, short operations supporting prototype development and charging interface. Temporary superstructure with hydraulics
- Phase 2a regional missions (full BEV-FCRE)
  - Regional Port of Vuosaari (B2) – Helsinki area / O.Jylhä (40 t)
  - Regional Port of Kokkola – Kaustinen / KWH Logistics (~52 t)
  - Operations with a 40-52 t semi-trailer from the port logistics terminal and deliveries to customers in Helsinki region;
- Phase 2b long haul missions (full BEV-FCRE):
  - Port of Helsinki – Jyväskylä (long haul)
  - Long haul use case with 520 km round trip
  - Primarily 76t combination, validation also for the nominal 40 t





Pilot 1 Demonstration of MW charging capacity

- MW level charging plug/cable management, end-user viewpoint i.e. VoC
- System scalability for different power levels
- Grid monitoring (friendliness aspect) and waste heat management
- Location of MCS demo: Port of Helsinki, Pilot 1 phase 2b



SIX HOVE electric heavy-duty vehicles innovation cluster

Strategy

National workgroup for battery strategy implementation (TEM)

Tactical activity coordination

Playmaking body for RDI-activities in heavy-duty eTransport

Individual activities

SIX Sustainable Industry X MOBILE WORK MACHINES

SIX Sustainable Industry X HEAVY ON-ROAD VEHICLES

LVM: National research programme for near-zero-emission transport 2022 -2026?

Machine of the Future (2030)

- Electrified
- Autonomous operations & driving
- Enabling new value from data

1. Commercial and utility vehicles in cities
2. Heavy-duty regional and long haul transport
3. Industrial transports
4. Purpose-serving charging infrastructures (cross-cutting)

End-user pilots, Testbeds & Living Labs

Mining testbed

Port testbed

Forestry testbed

HD trucking: O-D and corridors

Local transport fleets / testbeds

Multi-user port/ industrial testbed

Multi-operator charging testbed (ZEMHUB)

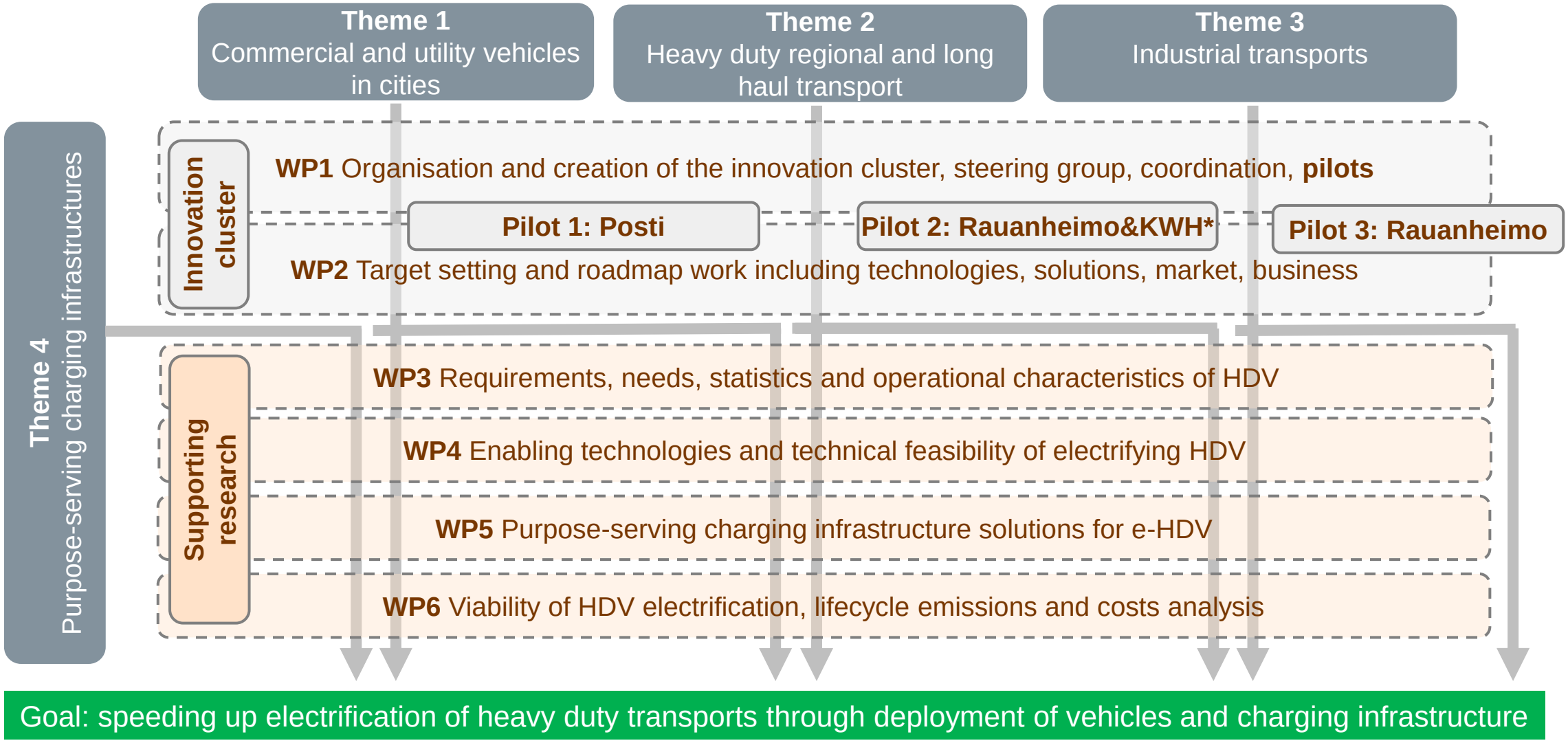
Private/Public Innovative Purchases

Industrial site 2 | Industrial site 1 | LH corridor 1 (AFIR) | City 1 | City 2 | Regional

City/regional transports: Planning, specification, validations & market dialogue, public procurement

SIX Sustainable Industry X HEAVY ON-ROAD VEHICLES

SIX HOVE cluster and project structure



Goal: speeding up electrification of heavy duty transports through deployment of vehicles and charging infrastructure

* Pilot 2: The 1st part of the pilot is done in EU project ESCALATE. Scale-up in Finland through SIX HOVE

Kiitos!

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