Stable grid operation and cost-efficient scheduling of Heavy Duty Vehicle fleets by dynamic toll and electricity prices

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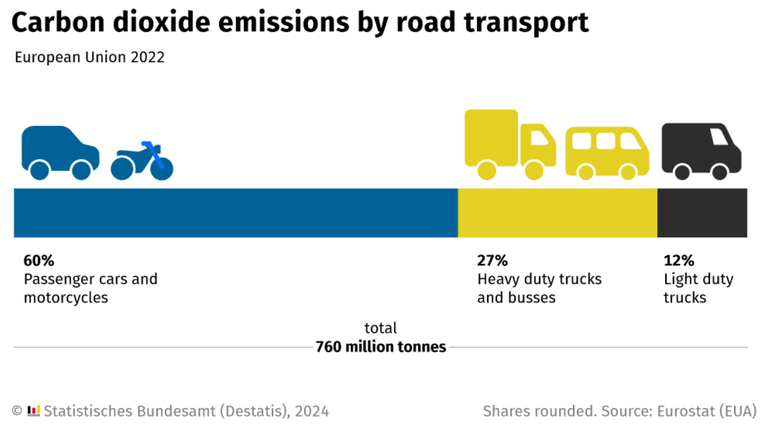
Heavy Duty Vehicle (HDV) Decarbonization Challenges

- High share of GHG emissions by HDV ➔ high need for electrification
- Need for massive expansion of charging infrastructure
- Significant challenges for the power grid



State of the art: Unidirectional Coupling of Transport and Energy System

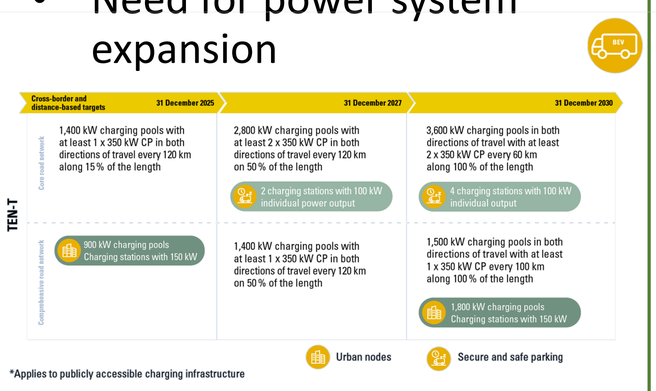
Transport System

Fleet management

- Vehicle mix
- Trip planning

Infrastructure

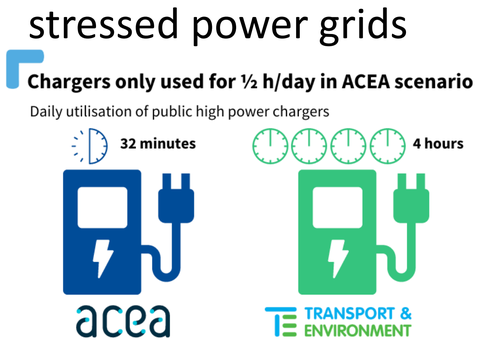
- placement and dimensioning of charging points
- Need for power system expansion



Requirements for public charging stations for electric HDV [1]

Current Scenarios

- over- or under-estimation of charging point needs
- stressed power grids



Demand and Flexibility Potential

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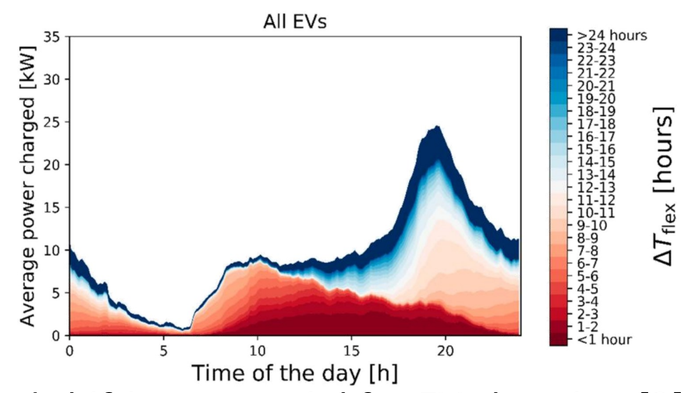
1. Data Parsing
   - Data filtering
   - Data cleaning
   - Variable replacements
   - Travel diary composition
2. Grid Modelling
   - Charging availability assignment
3. Demand and Flexibility Estimation
   - Flow profile calculation (electricity demand, charging power)
   - State profile calculation (maximum and minimum battery level)
4. Time Discretisation
   - Daily time series creation
5. Aggregation
   - Weekly time series creation
   - Fleet aggregation
6. Temporal and Spatial Scaling
   - Annual time series creation
   - Normalisation
   - Scenario-based fleet upscaling

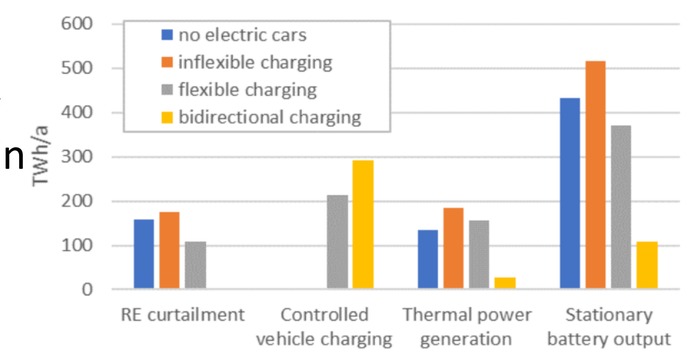


Load shifting potential for EV charging [2]

Energy System Optimization

REMix
Renewable Energy Mix

- Comprehensive modelling of energy networks, storage, and sector couplin
- Impact of power system oriented vs user oriented charging

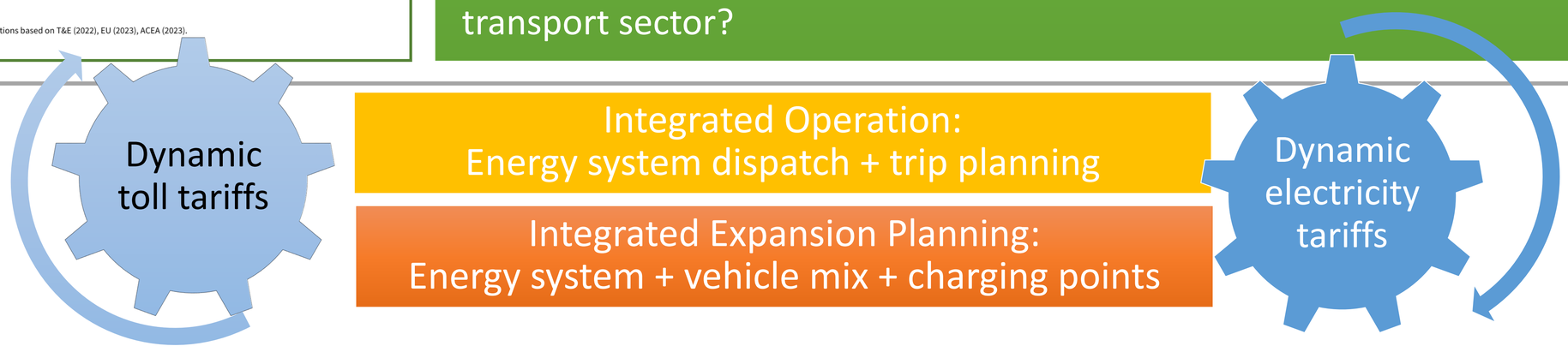


Impact of EV charging strategies on Energy System

Bidirectional Coupling Benefits

- System oriented: optimal utilization of **“fixed”** charging flexibility
- Applications: congestion management, day-ahead, intraday, ancillary services
- Economic benefits for fleet owner

Open Question
How can optimized scheduling of HDV fleets cut grid infrastructure investment needs and accelerate cost-effective decarbonization of the transport sector?



[1] National Centre for Charging Infrastructure based on “Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure”
[2] Wulff et al. (2020) Comparing Power-System and User-Oriented Battery Electric Vehicle Charging Representation and its Implications on Energy System Modeling. Energies, 13(5), 1093. doi: 10.3390/en13051093

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