ACCELERATING THE ADAPTATION OF EV'S FOR LOGISTIC VEHICLES

SHOWCASES AND LEARNINGS FROM THE DUTCH DKTI PROGRAMM | R. DE GROOT MSC

OUTLINE

ACCELERATING THE ADAPTATION OF EV'S FOR LOGISTIC VEHICLES

01. INTRODUCTION
02. THE DKTI PROGRAM
03. EXAMPLES FROM LEARNINGS
04. ZERO EMISSION ZONES IN AMSTERDAM
05. CLOSURE

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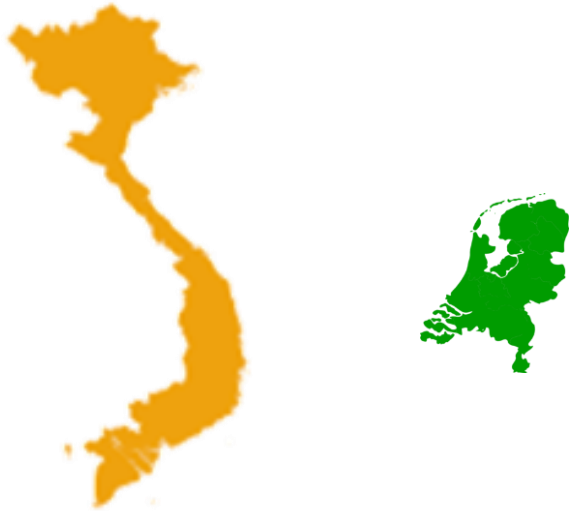
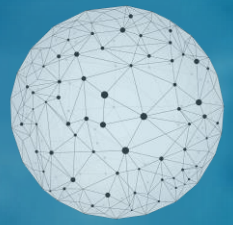
RELATIONSHIPS
VIETNAM AND THE NETHERLANDS

- Two wheelers are very popular
- River delta's are a special concern related to climate change
- NL is the 5th largest investor in Vietnam globally
- In 2023 we will celebrate 50 years of diplomatic relationships
- **Minister of trade** Liesje Schreinemacher is visiting Vietnam this week!
- First Vinfast EV is expected in NL in 2023



ROADMAPS

SUSTAINABLE



SUSTAINABLE VEHICLES

- Electrified Power Solutions
- Hydrogen Fuel-Cell Solutions
- Flex Fuel Combustion Technologies
- H_2-ICE
- Powertrain Performance Validation Centre

SUSTAINABLE LOGISTICS

- Sustainable Logistics

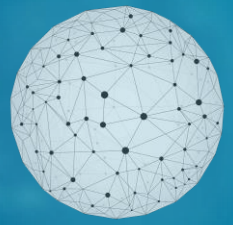
SUSTAINABLE MOBILITY

- Real-World Emission Policy and Strategy
- Towards Zero CO_2 Mobility
- Green Maritime Performance

SUSTAINABLE SOCIETAL IMPACT

- Urban Mobility and Environment
- Zero Emission Mobility System

SMART & SAFE



SMART VEHICLES

- Automated Yards
- Connected & Cooperative
- Streetproof
- Streetwise
- Simplexity

SMART LOGISTICS

- Automated Logistics
- Self organizing Logistics

SMART MOBILITY

- V2V & V2X Communication
- Smart Intersections

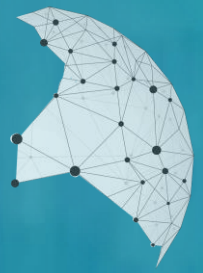
SMART SOCIETAL IMPACT

- Connected Mobility
- Impact of new mobility
- Traffic Safety
- Urban mobility and environment

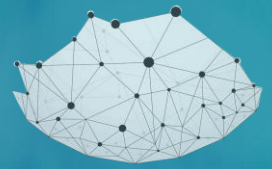
GOALS

ZERO EMISSION

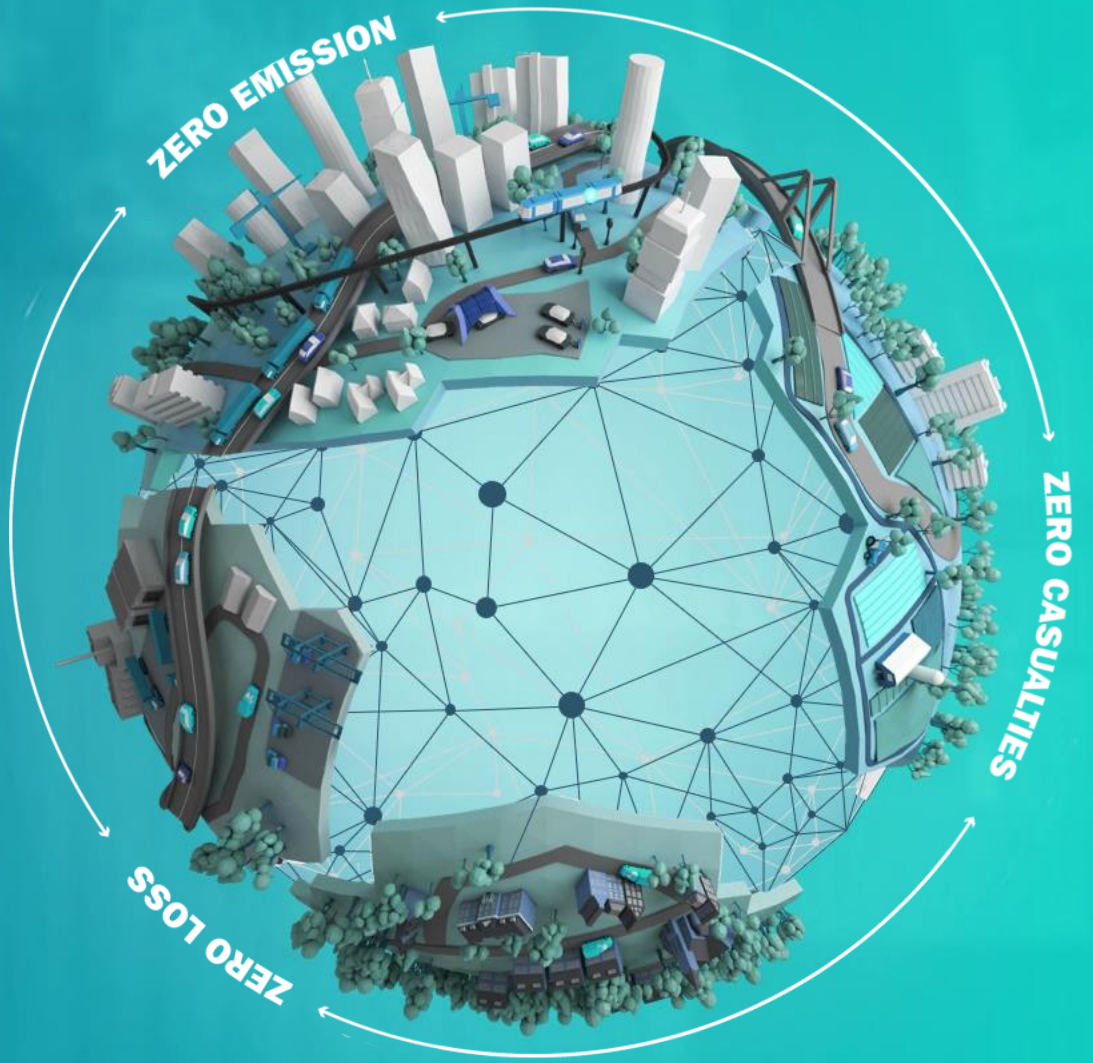
ZERO CASUALTIES



ZERO LOSS



3 ZERO'S

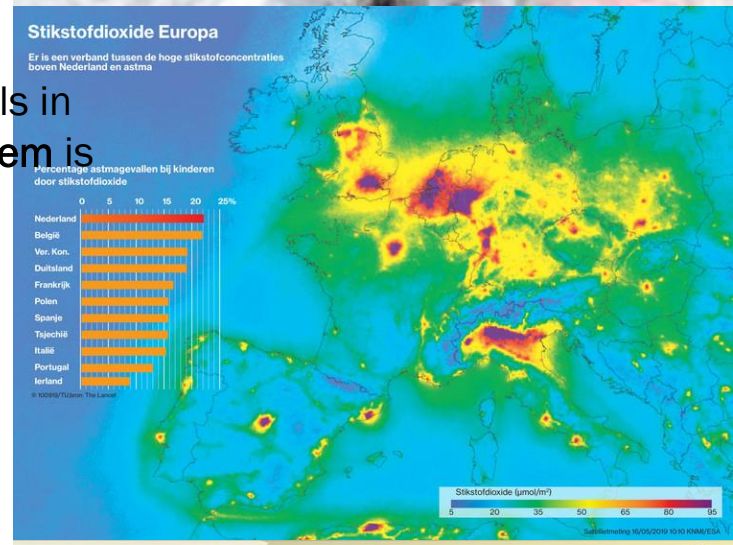


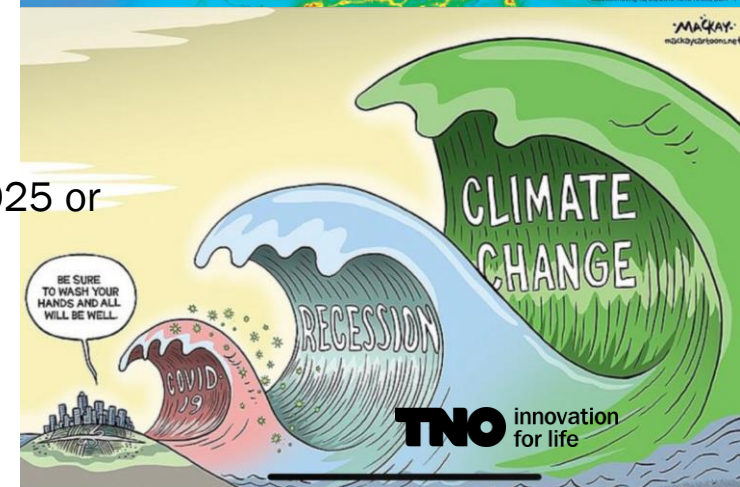
ELECTRIFICATION IN THE NETHERLANDS
HOW IT STARTED

INTRODUCTION

The main driver to start the transition towards zero-emission vehicles is that **air pollution** levels in cities exceed legal limits enforced by EU legislation. Also the **decarbonizing the transport system** is one of the main policy objectives.

- A quick adaptation of passenger cars
  - Tax incentives helped to initialize the transition
  - In June 25% of each new car was electric (9% hybrids).
  - The mild climate and almost no mountains easy the transition
  - In an early stage a decent charger network was established
- Today most cities have announced legislation that will ban ICE from their city centers by 2025 or 2030





ELECTRIFICATION IN THE NETHERLANDS
PUBLIC TRANSPORT BUSSES WERE NEXT

STATE OF THE ART BUS SYSTEMS IN EUROPE

Public transport busses in the Netherlands is still partially government funded, but works by giving concessions to the bus operators. This empowers them to steer towards a **zero emission** operation.

- By 2030 each public transport bus in the Netherlands should be zero emission
- In 2016 the first entire ZE operation with 43 busses was launched in Eindhoven
- Zero emission busses are now the standard, as they operate at lower costs!
- Factors for success were:
  - Collaboration between operators, authorities, cities and industry
  - TNO's role was to develop tooling for planning the charge moments in the operation and identify risks

ZERO EMISSION CITY LOGISTICS

THE NEXT STEP

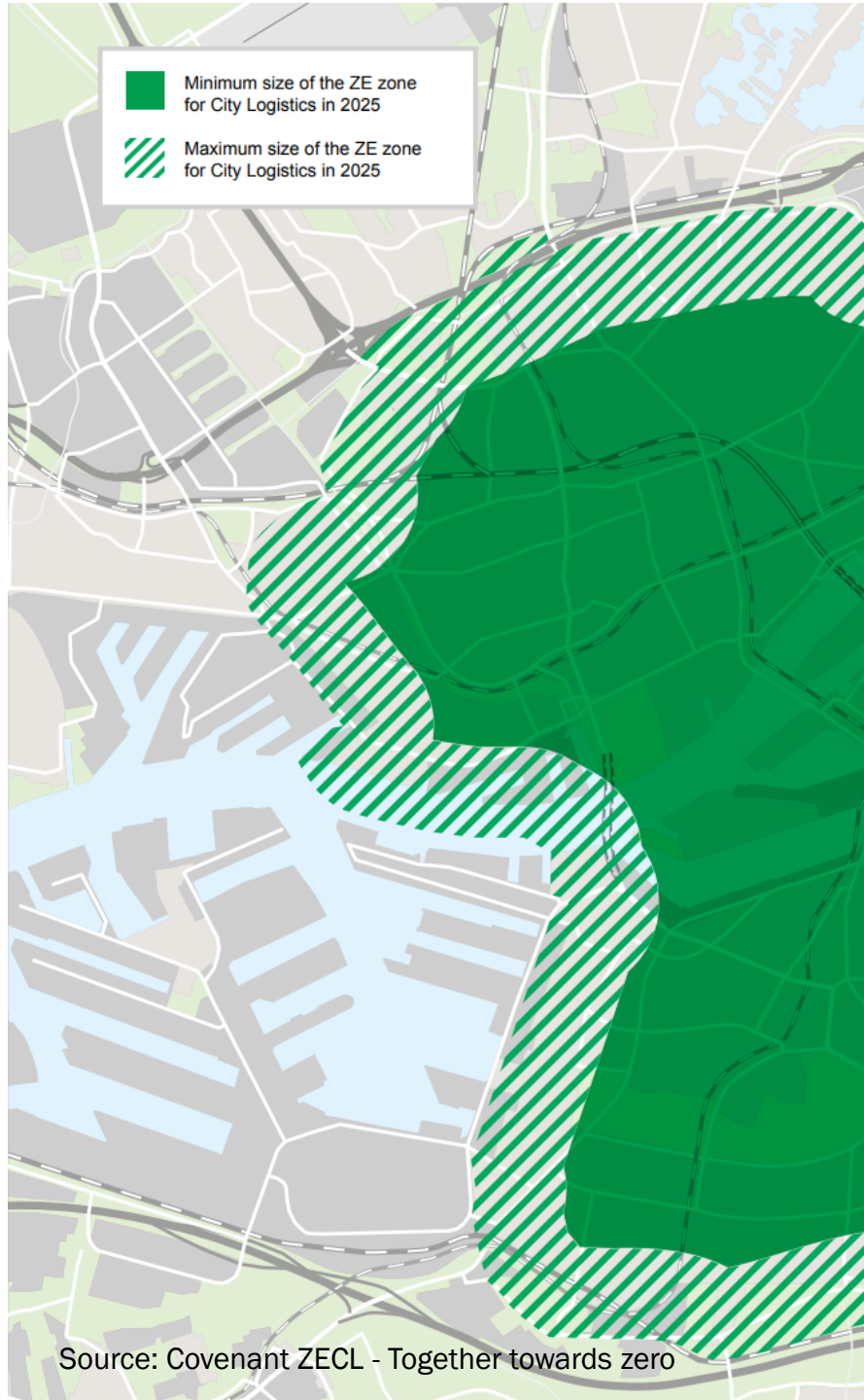
In Rotterdam, the Convenant Zero Emission City Logistics is an agreement with the logistics sector about zero emission city logistics.

For the rules regarding access to the Zero Emission Zone for City Logistics (ZECL zone) shall follow the starting principles of the National Climate Agreement and the implementation agenda for city logistics that follows from this.

Amsterdam (and other cities) will follow the same principles.

This creates a uniform access regulation for all ZECL zones in the Netherlands.

The definition of zero emissions is no exhaust emissions. At the moment, these are only battery-electric and hydrogen-electric vehicles.



Source: Covenant ZECL - Together towards zero

ZERO EMISSION CITY LOGISTICS

STARTING PRINCIPLES

- Municipalities shall announce the location and extent of the ZECL zone at least 4 years before its introduction.
- All new delivery vans and lorries registered after 1 January 2025 must be emission-free in the ZECL zone.
- Plug-in hybrid lorries will have temporary access to the ZECL zone, until 1 January 2030, if their driving emission-free within the ZECL zone can be demonstrated and enforced. Ongoing debate whether plug-in hybrid vehicles (if enforceable) should also be allowed after 2030.
- All delivery vans and lorries must be emission-free in the ZECL zone by 1 January 2030.
- The municipality can grant an exemption. This can be used for cases where an early investment is not proportionate.

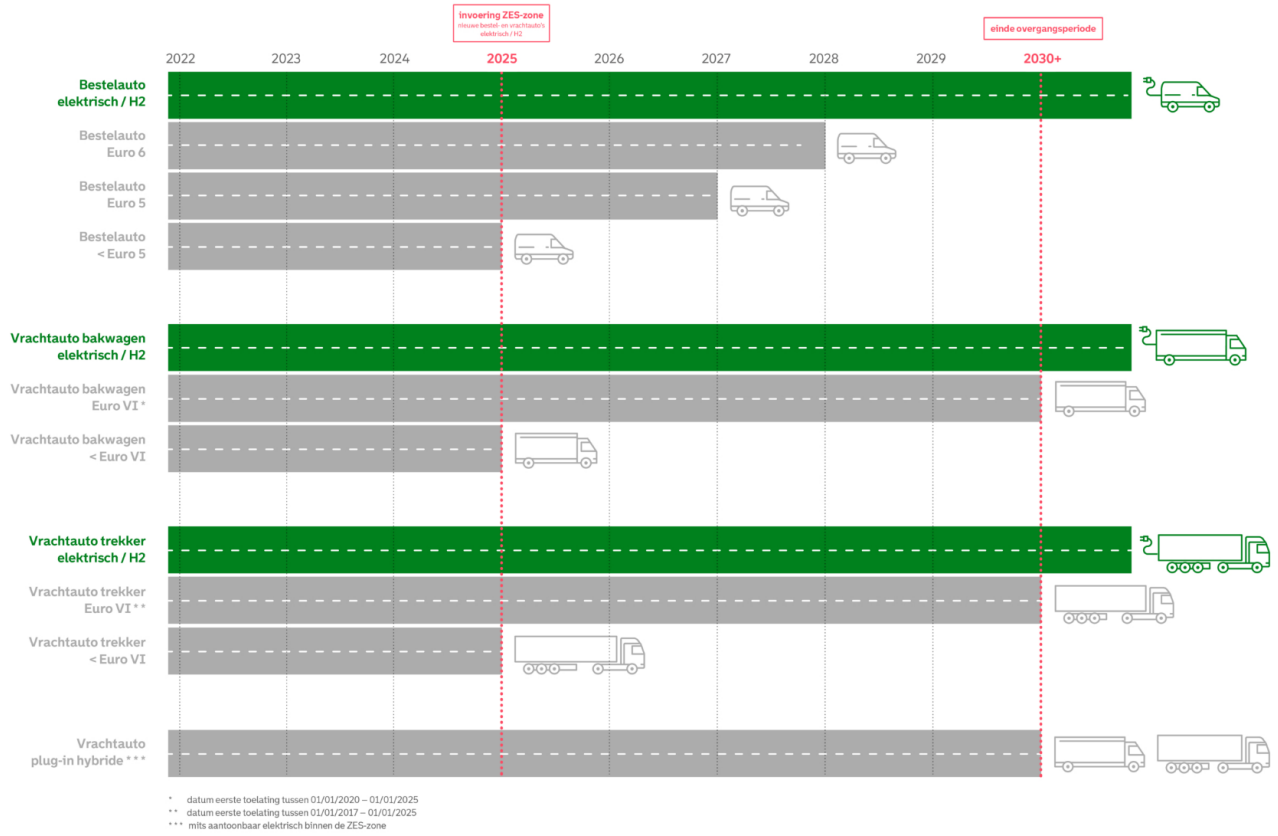
ZERO EMISSION CITY LOGISTICS

SMALL COMPANIES

To ensure that the introduction of the ZECL zone will not lead to disproportionate investments for both small and large companies and is feasible for every business, the State Secretary has announced a transitional scheme for delivery vans and lorries registered before 1 January 2025.

This transitional scheme is based on depreciation periods and natural investment moments:

- Euro-VI box trucks registered after 1 January 2020 and Euro-VI tractors registered after 1 January 2017 have access to the ZECL zone until 1 January 2030.
- Euro Class 5 delivery vans will have access to the ZECL zone until 1 January 2027.
- Euro Class 6 delivery vans will have access to the ZECL zone until 1 January 2028.



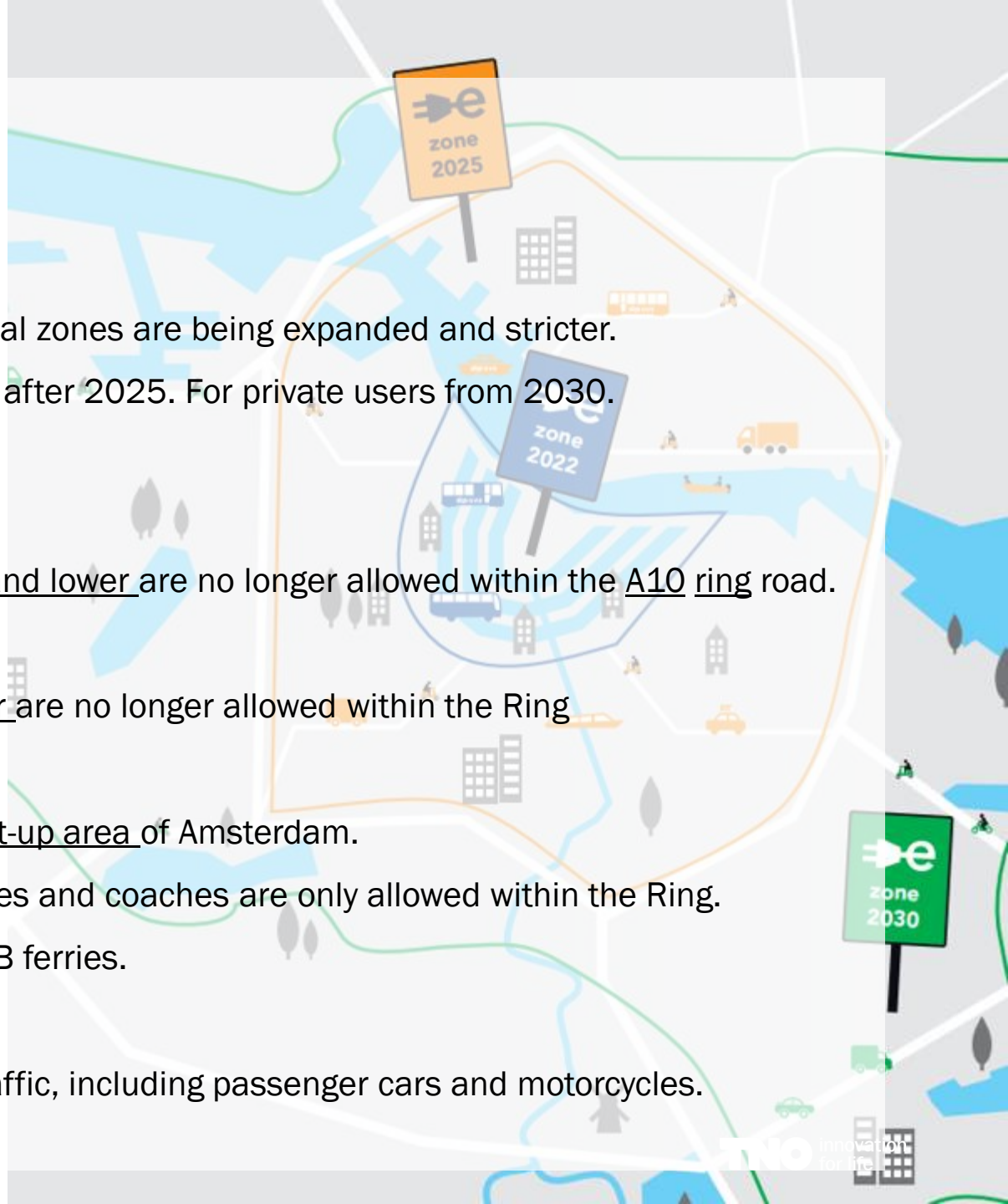
AMSTERDAM
EMISSION-FREE TRAFFIC IN 2030

Amsterdam currently has 6 environmental zones. The environmental zones are being expanded and stricter.

In general: for new commercial vehicles: need to be Zero Emission after 2025. For private users from 2030.

The most important milestones are:

- In 2020:
  - diesel cars and diesel delivery vans with an emission class 3 and lower are no longer allowed within the A10 ring road.
- In 2022 :
  - diesel trucks and diesel buses with emission class 5 and lower are no longer allowed within the Ring
- In 2025:
  - only electric mopeds will be allowed to drive around in the built-up area of Amsterdam.
  - only emission-free lorries and vans, taxis, public transport buses and coaches are only allowed within the Ring.
  - this also applies to passenger shipping, pleasure craft and GVB ferries.
- By 2030:
  - The entire built-up area will be emission-free for all types of traffic, including passenger cars and motorcycles.



ZERO EMISSION ZONES
MOTOR CYCLES IN EUROPE

- Amsterdam (The Netherlands)
  - From 2030, wants to allow only motorcycles with an electric drive within the A10 ring. Mopeds with a combustion engine will no longer be welcome from 2025.
- Barcelona (Spain)
  - From January 2022, no longer allowed to enter Barcelona with a motorbike or scooter of 20 years or older. With a younger motorcycle, this is only allowed with an environmental sticker.
- London (UK)
  - Since April 2019, London has only allowed motorcycles that meet at least the Euro 3 emission standard. The municipality wants to introduce day tickets for vehicles with a combustion engine.
- Paris (France):
  - In Paris, since July 2019, only motorcycles may enter the city center that have been registered since January 1, 2007 (Euro 3). It concerns a driving ban between 8 a.m. and 8 p.m. In 2030, Paris is also aiming for a complete driving ban for vehicles with combustion engines.
- Italy:
  - Many Italian cities will ban two-stroke motorcycles in the coming years and have plans ready to phase out the emission standard for motorcycles and scooters, just like in Paris.

ELECTRIFICATION IN THE NETHERLANDS

VEHICLES USED FOR CITY LOGISTICS ARE THE NEXT CHALLENGE

DKTI PROGRAMM TO ACCELERATE

Municipalities are tightening the requirements for **environmental zones.** In Amsterdam by 2025 no ICE trucks are allowed in the city centre anymore. Logistic operators have to find solutions as electric trucks are not widely available yet. And the industry is waiting to industrialize the manufacturing of electric trucks.

Rijksdienst voor Ondernemend Nederland

- The DKTI program is a **subsidy scheme** from the Dutch government (2017, 2019, 2021
- Objectives : accelerate the transition towards zero emission fleets
  - ‘learn by doing’
  - ‘share knowledge’
- It brings together INDUSTRY, LOGISTIC OPERATORS, END USERS, DSO’s and so on
- … and it was a SUCCES!

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ACTIVE OR RECENTLY FINISHED DKTI PROJECTS
@ TNO POWERTRAINS

AH – Simon Loos – DAF

5x BEV+PHEV

Jumbo

BEV

MAD-ET Manders – DHL

BEV

E-Waste

5x BEV

Elevate – Diverto H2 multi-functional machine

Deliver-E – Domino's e-scooter

Fleetlife - Amber

HYLOAD: GINAF – H2 Truck

FCEV

ZEBRH – 13x N3 BEV trucks

DreamH2aul – Total – Vos – BCTN - ZEPP – 2 FCEV trucks

Reload (successor of E-Waste)

BEV

CH2ART – Air products – Schenk – FCEV's

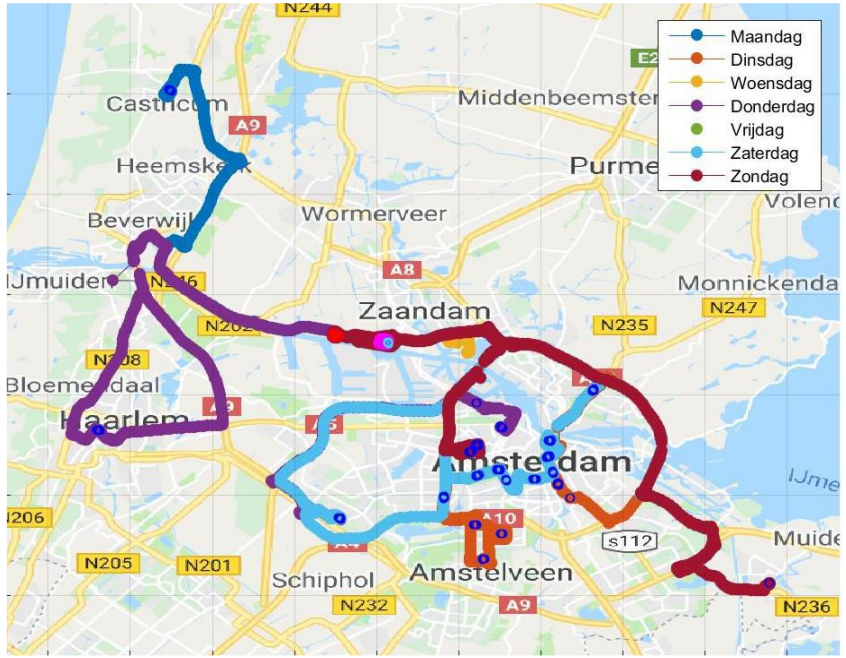
Sterke Lekdijk

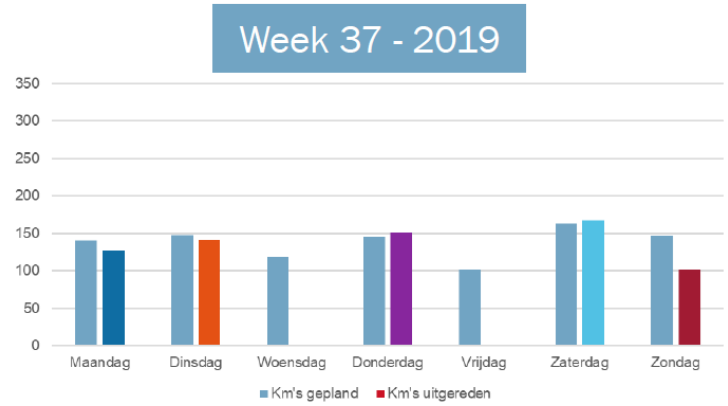
H2 construction equipment

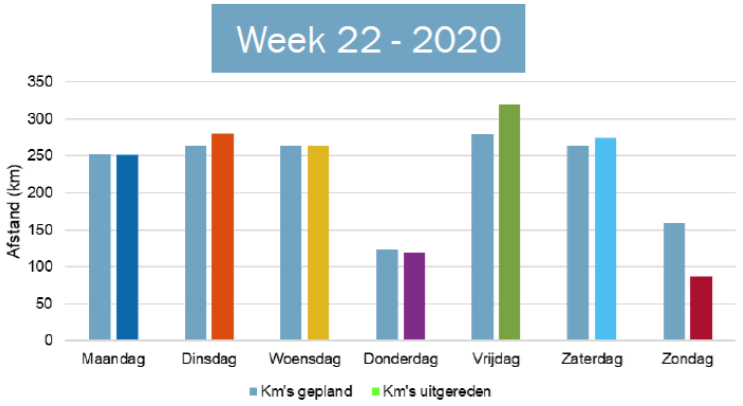
VITALISE – ViriCiti – Heliox - Arriva

LEARNING CURVE OPERATING A BEV TRUCK

EXAMPLE OF ONE YEAR OF USING

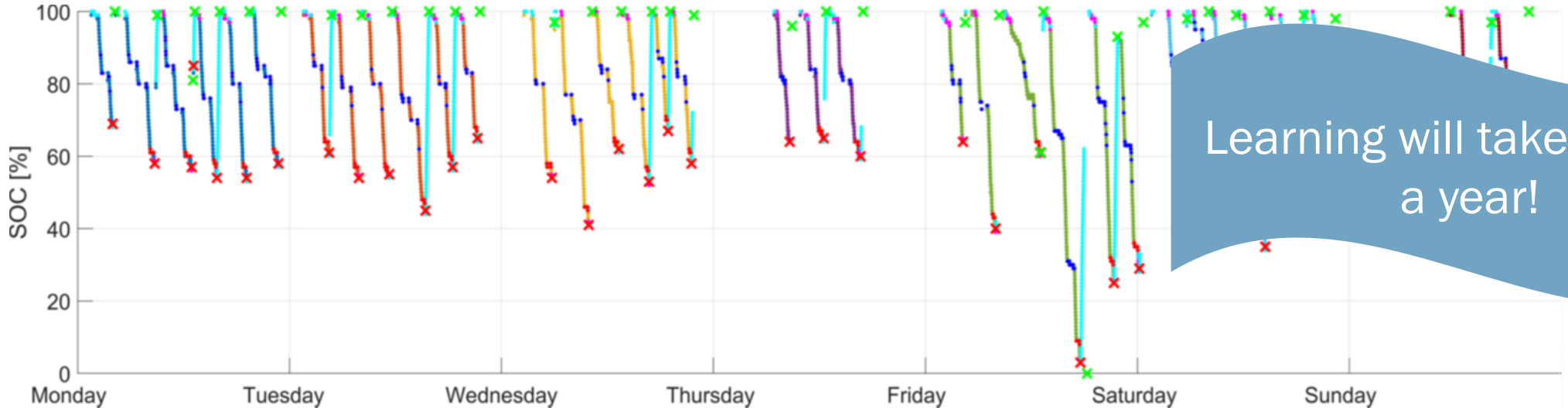






LEARNING CURVE OPERATING A BEV TRUCK
WHY HAS THE USE INTENSIFIED?

- Higher power **chargers** were introduced (150 → 300kWh), nearly halfed to time needed
- **Drivers** got used to vehicles, shorter trips and the chargers, they adapted their driving style
- Logistic planner learn which trips are possible to drive with an eTruck
- The technology proofed to be reliable during the operation
- **Collection of data** appreard essential to understand operational margins and optimize. Also driver experience is essential to improve acceptance,

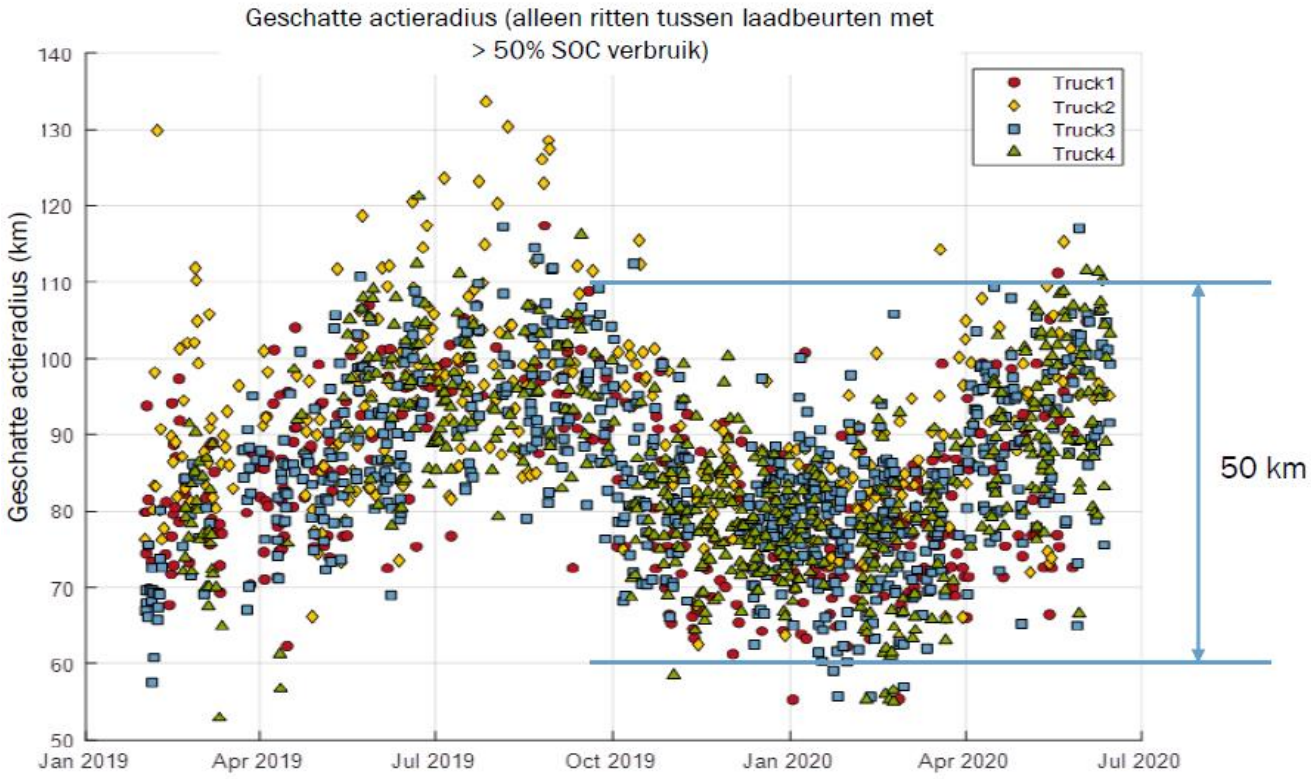


Learning will take at least a year!

RANGE IN PRACTICE
LARGE VARIATIONS IN ENERGY CONSUMPTION

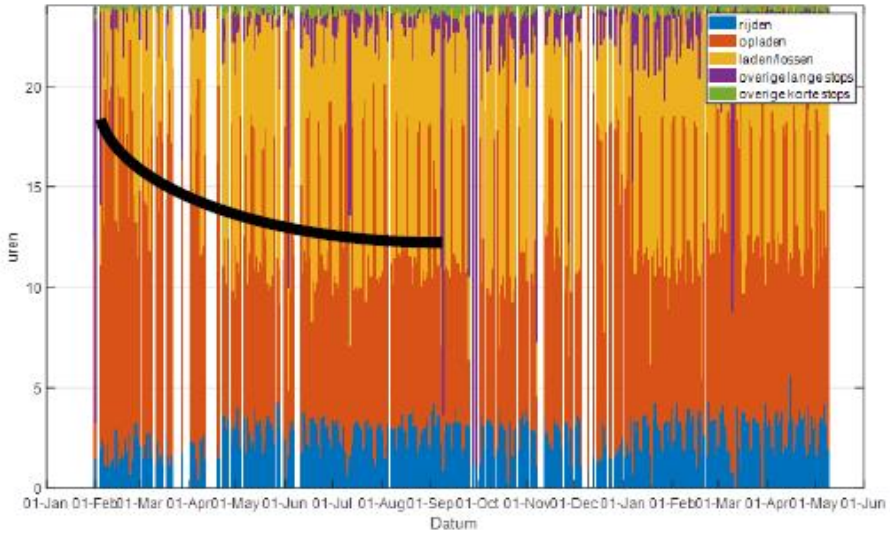
- Clear seasonal influences
- Energy consumption can vary a factor of 2
- Main influencing factors
  - Temperature
  - Weight of the payload
  - Distribution city – highway driving

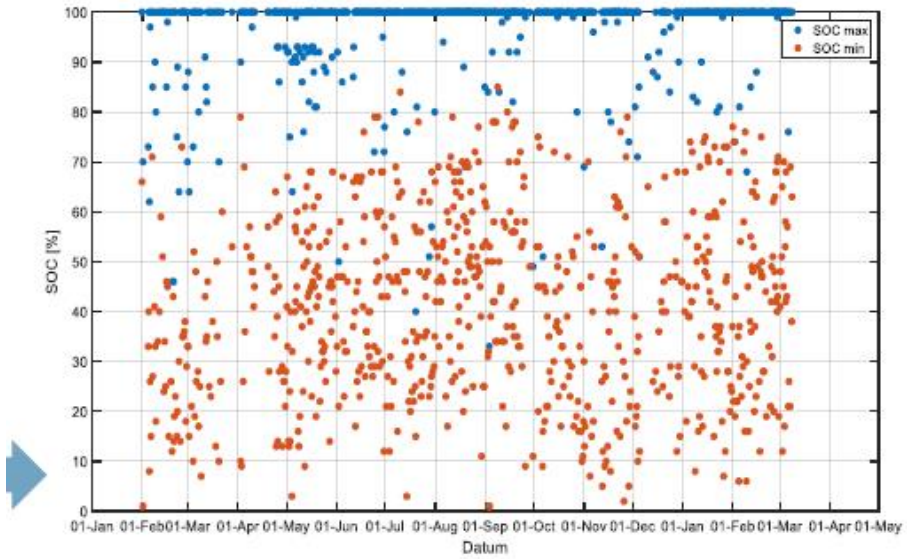
Stranded vehicles due to depleted batteries are unacceptable, Therefore planning is done conservatively. This means that there is a lot of potential for optimization.

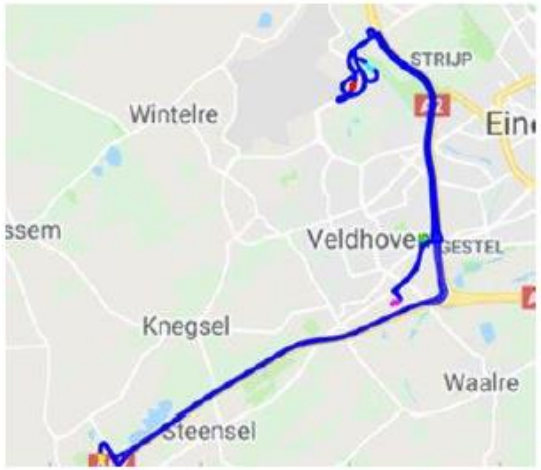


THE SAME ETRUCK WITH A DIFFERENT OPERATION
WHAT HAPPENS IF THE OPERATION IS SHORT

- Also here perceived a learning curve
- >50,000km, 7 days a week
- No differences with a Diesel truck in this operation
- The planning allows deeper discharing
  - Vehicles charge at the dock, so no time is lost
  - Only regular and short trips!
  - Small fleets > lower risks
  - Drivers were already used to short trips







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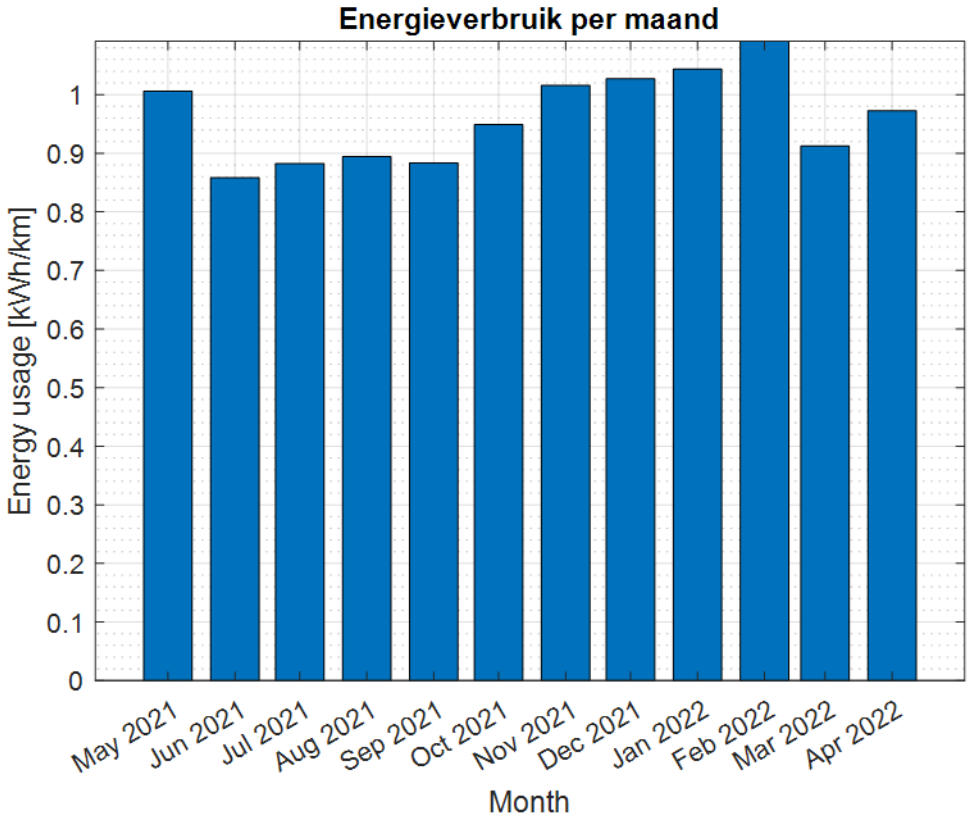
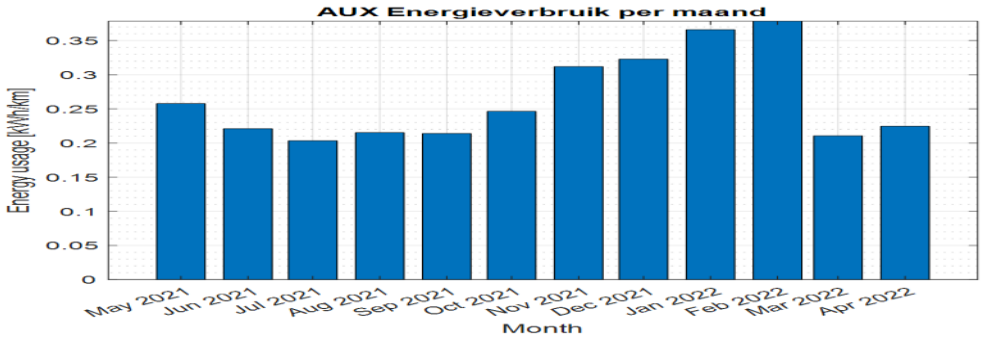
ANOTHER EXAMPLE OF SEASONAL INFLUENCES (1 VEHICLE)
AND THE DOMINANT ROLE OF AUXILIARIES

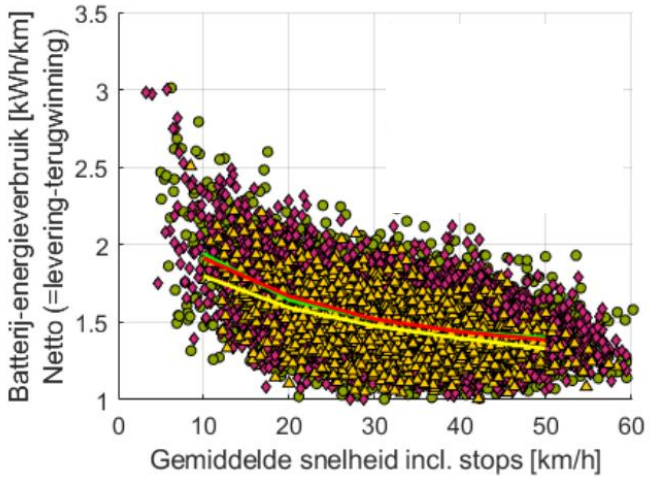


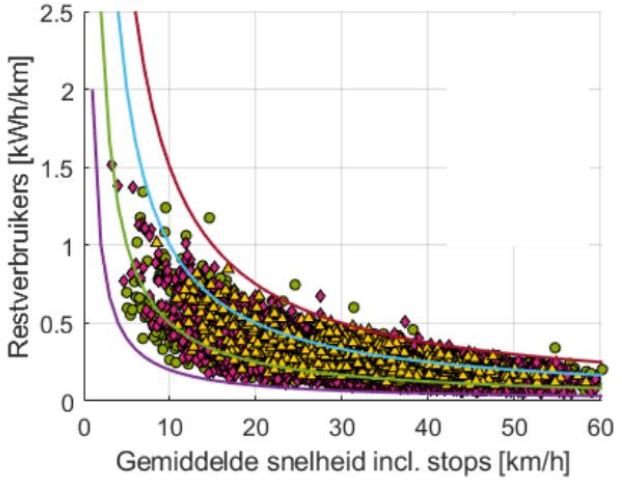


THE INFLUENCE OF AVERAGE SPEED OF AN E-TRUCK
LOW SPEED IS NOT NECESSARILY MOST EFFICIENT

- One would guess that driving in cities with a lot of start-stop is most efficient
- However, in the tests there is no big difference between highway driving and city-driving
- One of the explanations is the influence of auxiliaries (cabin heating, cabin airco, cargo conditioning): the contribution of auxiliaries increases with decreasing speed
- Driver behaviour versus energy efficiency is of increasing importance in city traffic

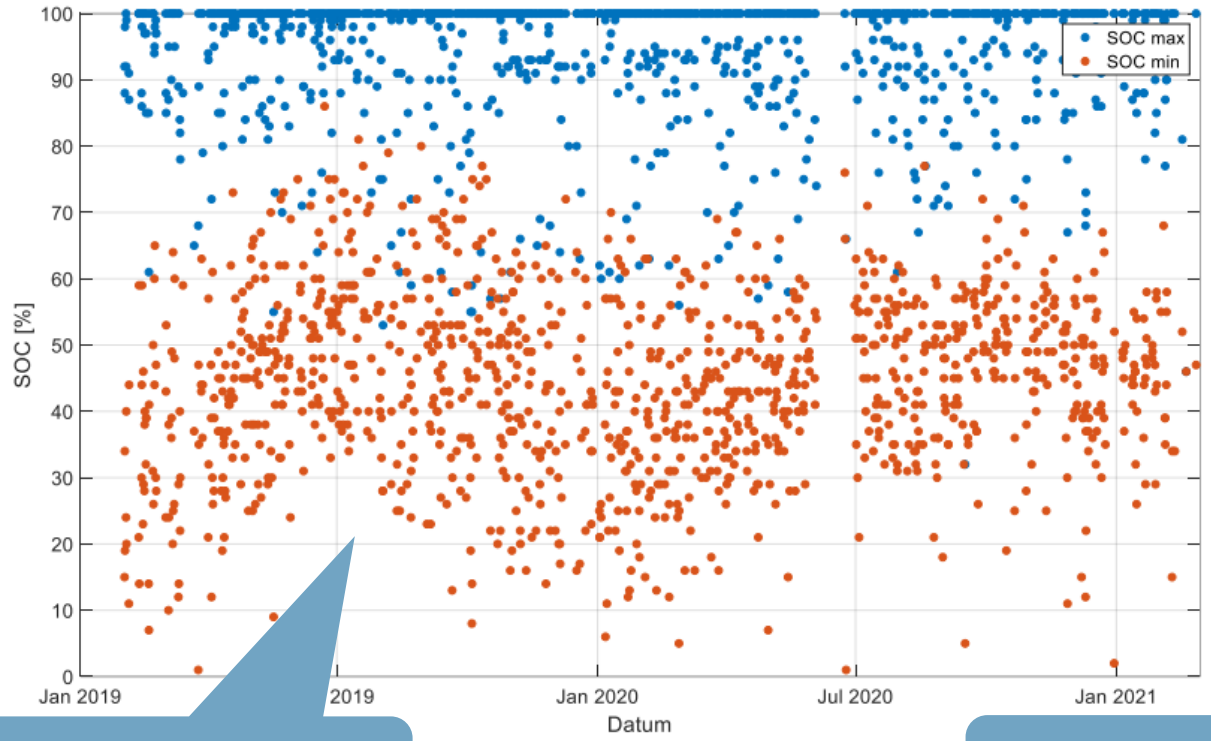
- More research needed in DKTI projects: influence of route on efficiency → needed to predict range in fleet management



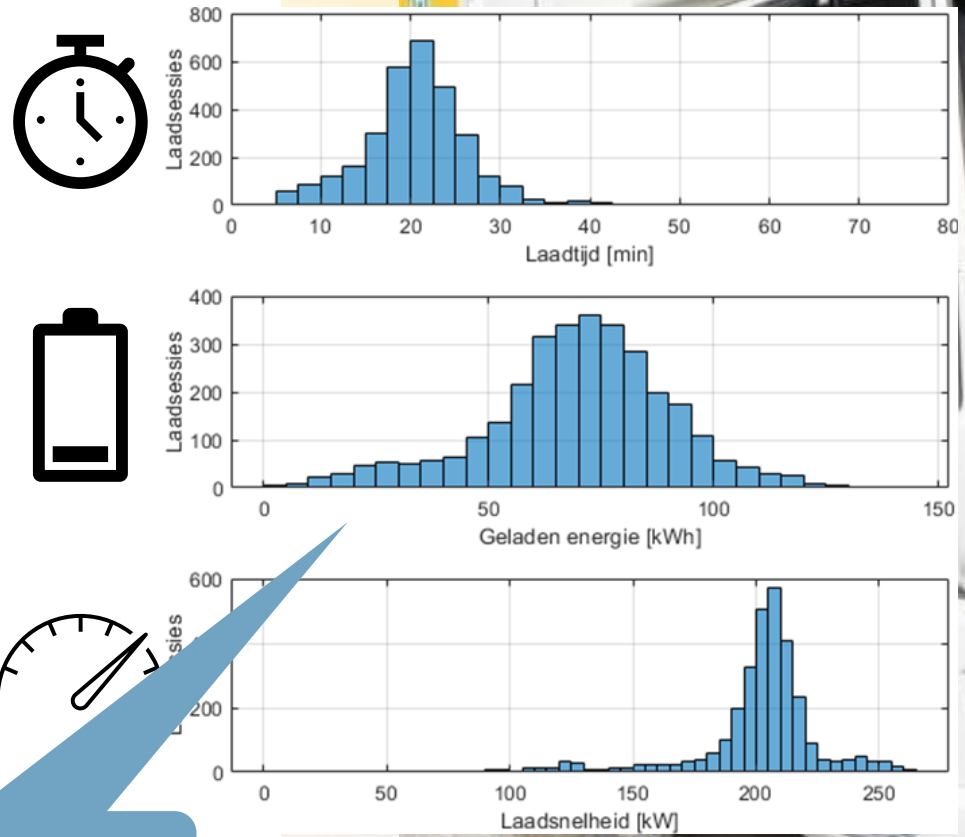


CHARGING AN E-TRUCK IN PRACTICE
TOWARDS “CHARGING WHAT YOU NEED”

- Depleting the battery below 10% SOC is rare
- On the contrary: charged energy is often below half the battery capacity



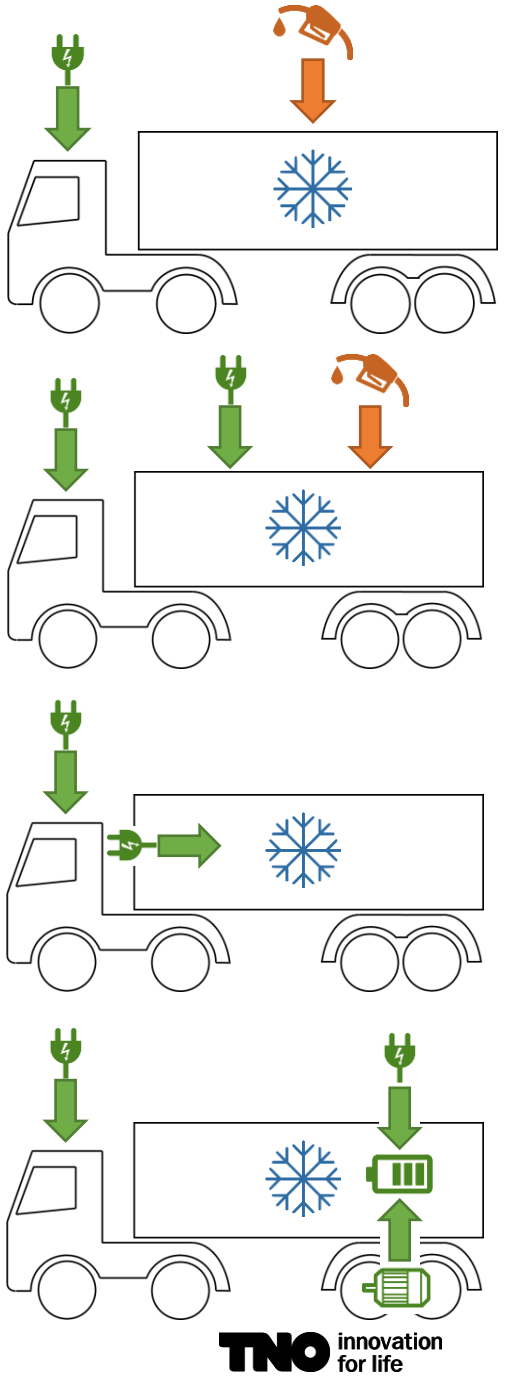
Note the seasonal influence in this graph too



Average charged energy not even half of max battery capacity

CARGO CONDITIONING IN A ZE COMBINATION
MULTIPLE SOLUTIONS

- 2 solutions for completely ZE combinations followed in DKTI projects: E-PTO versus regenerating trailer incl. battery
- Both obviously cost energy and range. Either by using the truck battery or by losses of the trailer while regenerating. It seems that the level of increased energy consumption and decreased range is pretty comparable between both solutions.
- All variants tested in DKTI projects (see first results in next slides). More research required in currently active DKTI projects. Trailer data gathering could be a challenge.
- Important questions from logistic operators (partly addressed in DKTI so far):
  - Impact on range in daily practice for various truck types
  - Possibilities for plug-in while e.g. at dock or customer
  - Cost-benefit for the various solutions
  - Flexibility to use the trailers for other purposes



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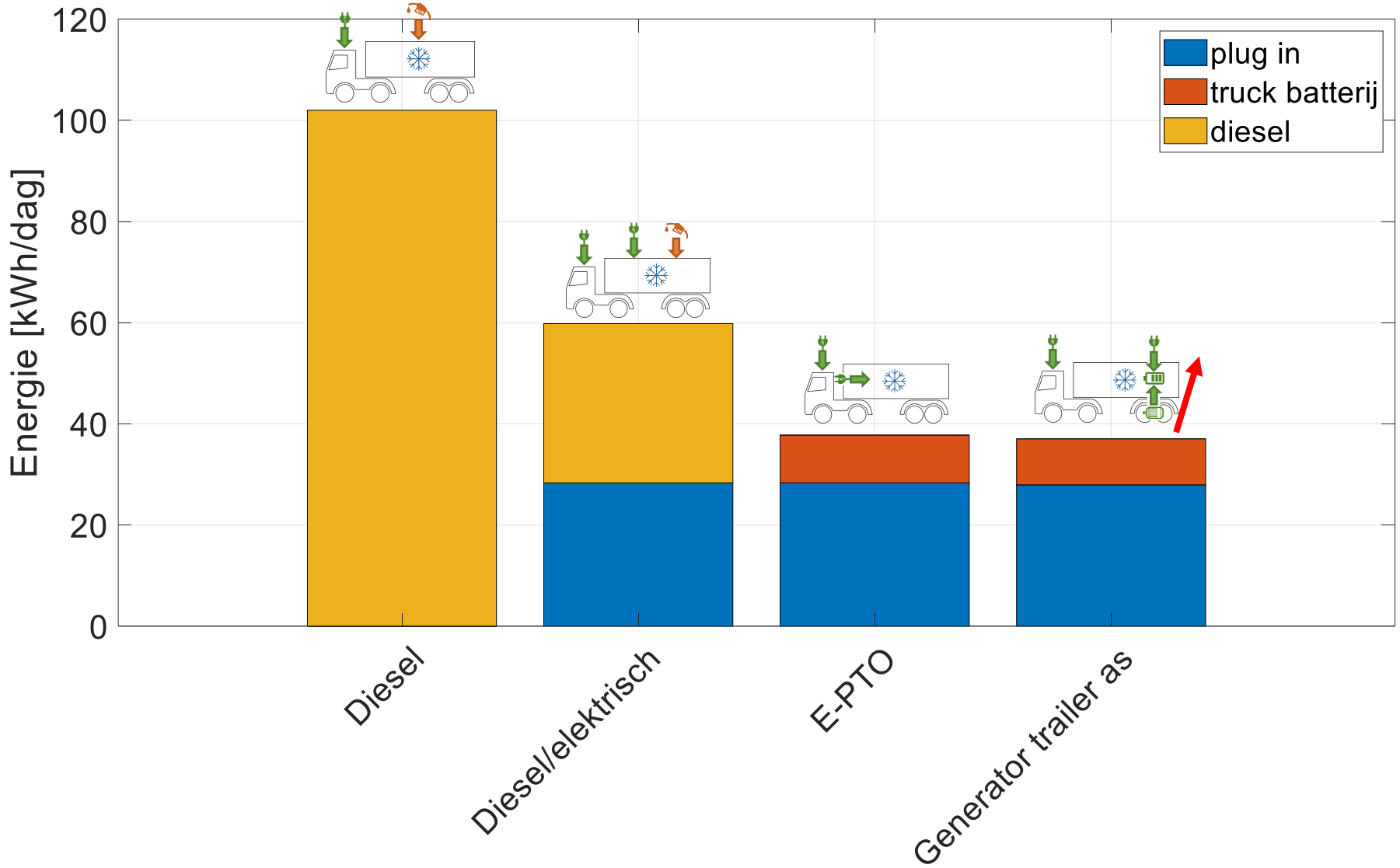
INFLUENCE ON RANGE IN DKTI-1 PROJECTS

E-PTO AND BATTERY-TRAILER SHOW COMPARABLE RESULTS

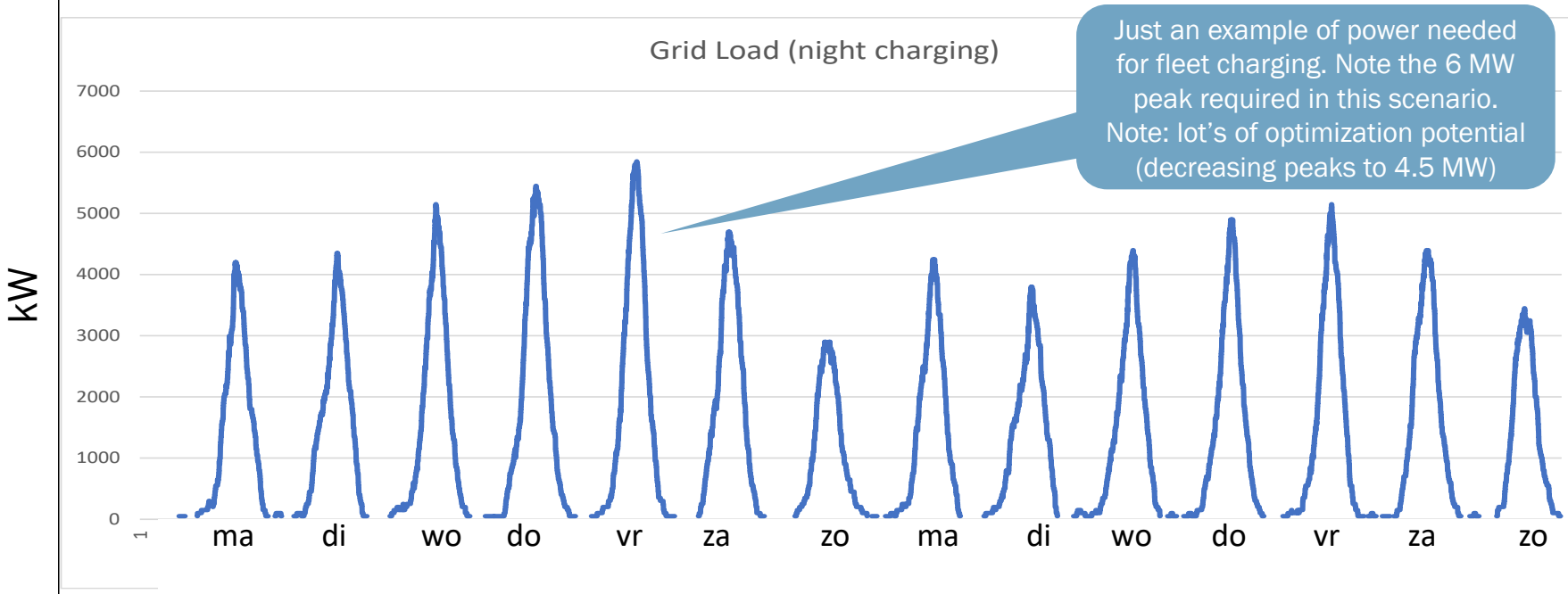


THE ROLE OF THE DRIVER
IN THE TRANSITION TO ZERO EMISSION

- Significant differences project to project in driver acceptation, e.g. due to:
  - Change in character of the job yes/no: e.g. shorter trips due to range → more loading/unloading
  - Waiting times during charging influence working schedule yes/no
  - Fixed pool of willing drivers or large pool of drivers
  - Pressure of operational planning towards drivers, e.g. while charging
  - Failures of vehicle and/or charging equipment
- Reactions noted by drivers:
  - Driveability better than diesel, especially in city driving / up-hill driving worse than diesel
  - Less driving / more loading-unloading is rewarded negatively / waiting is unpleasant
  - More detailed instructions for drivers needed
  - Being part of a pilot is rewarded positively, including flexibility of planners

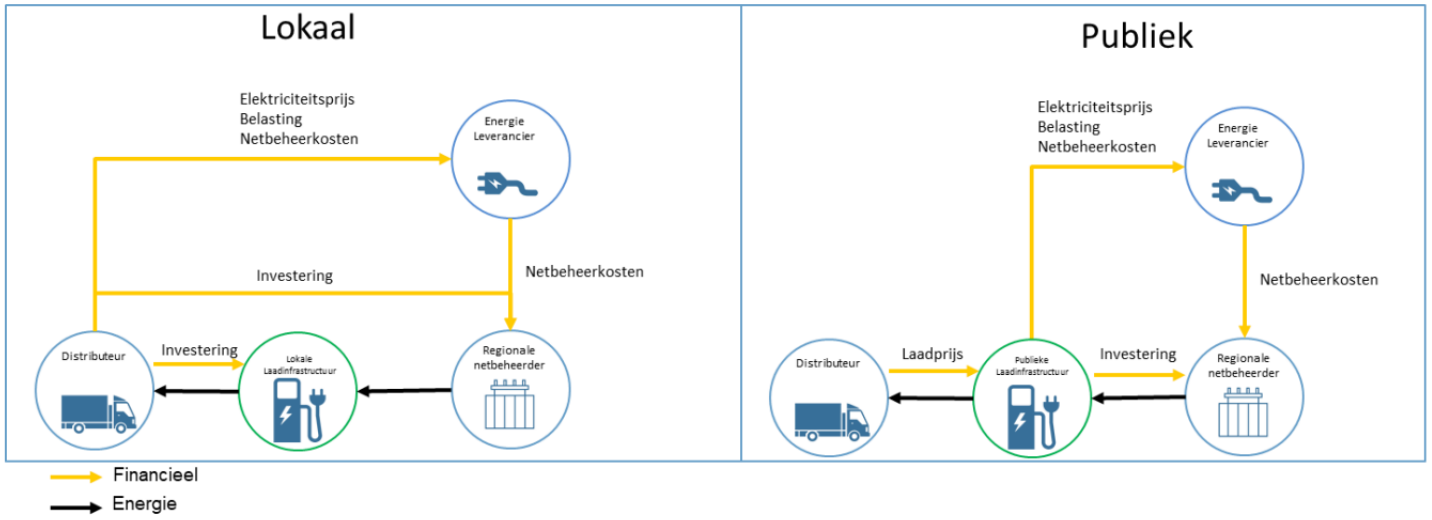
ELECTRICITY SUPPLY WHEN SCALING UP
THE LIMITS ARE FELT BY EVERYONE

- In every project fleet operators have serious concerns on the required grid connection when scaling up.
- Calculations in DKTI project show required energy and peak power when charging fleets in various scenario's.
- Huge waiting times for grid connection reinforcement require solutions, in order not to slow down the transition to ZE logistics.



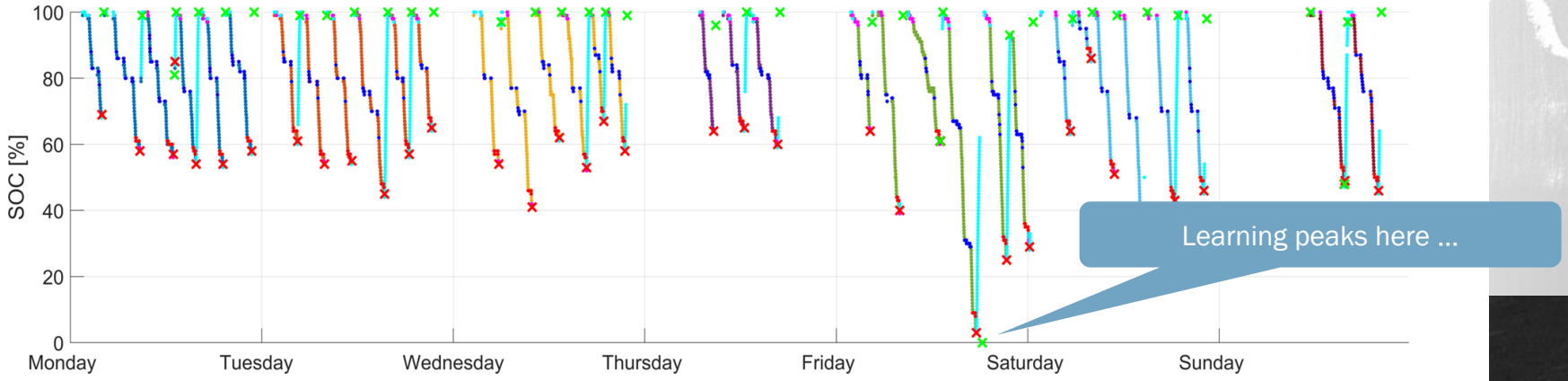
THE IMPACT ON THE ENERGY SYSTEM
PUBLIC/PRIVATE CHARGING

- TNO report 2021 R11613: Naar 100% elektrisch distributievervoer: de impact op het energiesysteem
- Analysis of the impact of private versus public charging
- The role of storage systems: only in specific cases this could pay off.
- However: storage systems might be of crucial importance in cases where increasing the grid connection is not possible



SOME THOUGHTS ON LEARNING IN DKTI
KEY WORDS: TOGETHER & TRANSPARANCY

- Learning starts in setting up the project: e.g. what is the real motivation to join? Under what conditions do partners wish to join?
- Learning is investing time together
- Learning is sharing facts (data and analysis) and experience
- Learning requires an open attitude towards each other
- Learning peaks when things go wrong (and especially why)
- Learning means looking at the whole ecosystem, not only at the truck



WHAT COULD HOLD THE TRANSITION BACK
AS OBSERVED IN DKTI PROJECTS

- Lack of grid connection and/or grid power
- Lack of public ultra-fast charging locations for logistics
- Insufficient integration options for electric trucks in fleet management
- Uncertainty what solution works best for what application (e.g. FCEV vs. BEV)
- Uncertainty of price developments (truck, fuel, maintenance, …)
- Uncertainty of long term battery behaviour including effect on truck residual value
- Reliability of e-truck + charger not on level of dieseltruck + dieselpump (yet)
- …

LESSONS LEARNT

IN A NUTSHELL

LEARN TOGETHER

INVOLVE ALL THE STAKEHOLDERS

DON'T FORGET THE DRIVER

PUSH TO THE LIMITS

THINK AHEAD

BE PATIENT...

TNO'S MISSION IS TO MAXIMIZE THE
LEARNINGS IN ALL IT'S FACETS AND ACROSS ALL DOMAINS

THANK YOU FOR
YOUR TIME

FOR QUESTIONS, SUGGESTION, KNOWLEDGE SHARING & COLLABORATION

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