ASSURED Final Conference: Electric Fleets for Green Cities

21st March 2022

Autoworld, Brussels

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769850.

Welcome!

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Your moderators today…

Maitane Berecibar, VUB

Aida Abdulah, UITP

Keynotes

Keynote

Mr Patrick Mercier-Handisyde
DG Research and Innovation
European Commission

Keynote

Prof. Joeri van Mierlo

Director MOBI-VUB and ASSURED Project Coordinator

Keynote

Umberto Guida

Senior Director K&I, UITP

ASSURED

Meet the ASSURED Family!

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VTT

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ENGIE Laborelec
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ENEXIS NETBEHEER
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TMB Transports Metropolitans de Barcelona
Stadtwerke Osnabrück

ASSURED Family

Video

Agenda

Innovative energy storage systems and smart charging strategies

- Martin Brigenzu, FEV: Assessment advanced energy storage systems with respect to architecture & technology, considering super-fast charging
- Felix Lehfuß, AIT: Grid integration and stability in conjunction with Hi-Power charging
- Omar Hegazy, VUB: Smart tools for fleet management and fleet optimisation
- Questions for the audience

Ensuring standardisation and interoperability of charging solutions

- Mehrnaz Farzam Far, VTT
  ASSURED Standardisation & Interoperability support
- Joan Carles Artigau & Santi Obiols, Idiada
  ASSURED Interoperability & conformance tests of (super) fast charging solutions
- Questions for the audience
- Coffee break

From the lab to real operation: enabling real fleet upscale

- Aida Abdulah, UITP: Ensuring user acceptance: ASSURED Demonstrations
- Stamatis Manganiaris, ICCS: ASSURED Light Duty Van: Inductive High Power Charging Systems
- Roel de Groot, TNO: Research questions addressed in ASSURED
- Fabrizio Camisetti, Rina-C: Business Modelling and Deployment Strategies
- Questions round

Round Table: What has ASSURED delivered and what challenges lie ahead? End user perspective

- Maurizio Maggiore, DG RTD, EC
- Maitane Berecibar, VUB
- Mario Canet, TMB
- Joachim Kossow, Stadtwerke Osnabrück
- Sergio Fernández Balaguer, EMT Madrid
- Gerard Hellburg, Vervoerregio Amsterdam

Results

Presentation Results I

Innovative energy storage systems and smart charging strategies

Martin Brigenzu, FEV

Assessment on advanced energy storage systems with respect to architecture and technology, considering super-fast charging

Assessment on advanced energy storage systems with respect to architecture and technology, considering super-fast charging

Final Event – Brussels – 21.03.2022

Martin Bringezu, FEV

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Agenda

- Operational requirements and boundaries
- Design approach of different RESS chemistries
- Modelling of the RESS
- Hybrid topology approaches
- Conclusion

Operational requirements & boundaries

“Understanding the requirements to the vehicles and their battery systems requires knowledge of the performance targets, which are requested by working every day on the route and the existing constraints from the topography and charging infrastructure.” *

*D2.5 (RINA)

Operational requirements and boundaries

D2.1 – Specification of city & PT stakeholder strategies and needs
- Effective and coherent Electrification Deployment Strategies
- Compliant charging infrastructure and route topology

D2.3 – Specification of operational requirements
- Vehicle and battery performance targets of weight, vehicle speed, electric driving range, charge time
- Power and energy demands towards the supply grid

D2.5 – Final requirement compilation and KPI's
- Fully compiled relations at KPI tree
- Definition of KPI measurement plan and performance targets

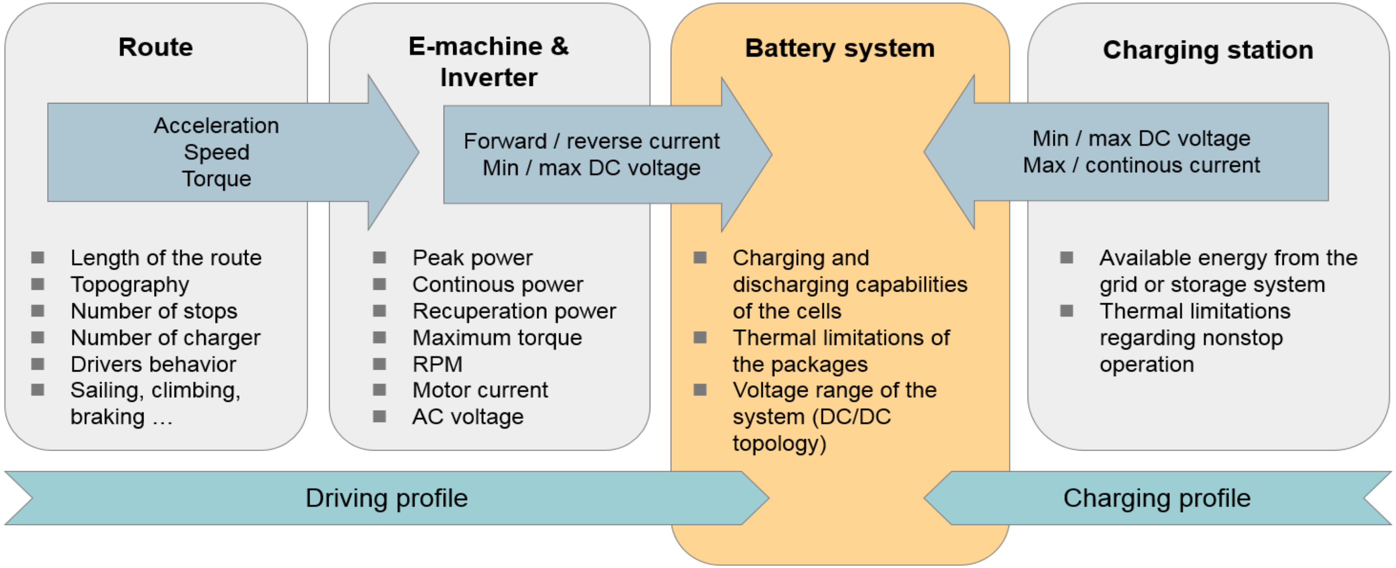
D2.2 Specification of grid constraints
- Smart regulation and tariffs to activate smart charging
- Suitable standards to reduce power quality issues are needed

D2.4 – Specification of Charging Infrastructure
- Energy efficiency of grid connection and charging stations
- Energy request regarding fleet applications
- Interoperability of different EVSE and contact system supplier

Martin Bringezu (FEV)

Operational requirements and boundaries

Multiple interfaces to the RESS (Rechargeable Energy Storage System) influencing the requirements towards the layout.



Martin Bringezu (FEV)

Operational requirements and boundaries

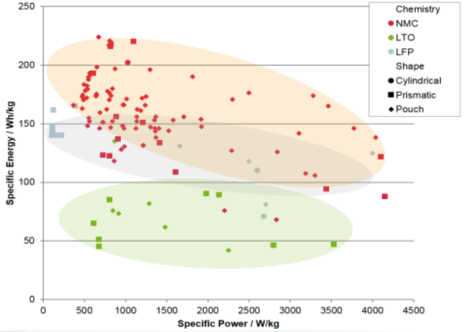
High level: Requirements are developed in WP2. They have been extracted from different sources (ZeEUS database, use cases, other sources) in order to comply with the different approaches for range and charging strategies.

Parameter	Required values
Battery energy content	• ASSURED use cases vary between 60 – 250 kWh. • Busses in European cities have batteries from 30 kWh – 450 kWh.
Charging power	• parallel stacked batteries and huge HVAC charging power with pantograph-contact system goes up to 500 kW (future target super-fast charging 600 kW). • Over-night in the depot with power up to 150 kW
Voltage range	• conductive charging stations: 480 – 800V • powertrain and DC-link design: 500 – 720V In the past not every powertrain layout of commercial covered 800V technologies!
Ambient temperature	• Overall ambient temperature conditions (non-operational) without critical safety event: -40 – 85°C • Operational range LTO (-30 – 55°C) / NMC (-20 – 60°C) / LiCap (-30 – 60°C)

Design approach of different RESS chemistries

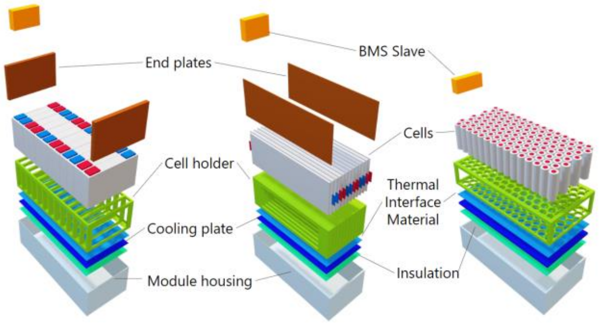
Cell selection

- Selection of cell according to the operational requirements of commercial vehicle.
- Cell data base analysis of target cells: LTO, NMC, LiCaps



Battery design approach

- Composition of cells, modules and packs according to the boundaries.
- Verification by MATLAB battery concept design tool



Pack model evaluation

- Selection of "best fit" battery packs to cover the demands:
  - High energy for long range
  - High performance for acceleration and recuperation
  - Super-fast opportunity charging

LTO		Unit	Pack 1	Pack 2	Pack 3
1. assum[illegible] P_BattRecC[illegible] 120k[illegible]	N_CellParMin	#	1	3	2
	I_PackContDCH	A	210	270	360
	N_CellTotal	[illegible]	[illegible]	[illegible]	[illegible]
2. assum[illegible] P_BattMaxC[illegible] 450k[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NMC		Unit	Pack 1	Pack 2	Pack 3
1. assumption Power_BattRecContDCH = 80kW	N_CellParMin	#	2	2	2
	Current_PackContDCH	A	180	230	126
	N_CellTotal	#	344,0	344,0	344,0
	Weight_Pack	kg	595,12	901,28	331,96
	Volume_Pack	l	252	390	180
	Power_PackCont	kW	114,6	146,4	75,9
	Energy_PackCont	kWh	129,8	194,7	75,9
2. assumption Power_BattMaxContCHG = 100kW	N_CellParMin	#	2	1	3
	Current_PackContDCH	A	240,0	160,0	180,0
	N_CellTotal	#	344	172	516
	Weight_Pack	kg	595,1	450,6	497,9
	Volume_Pack	l	251,5	195,1	269,7
	Power_PackCont	kW	152,7	101,8	108,4
	Energy_PackCont	kWh	129,8	97,4	113,8

Martin Bringezu (FEV)

Modelling of the RESS

Integration of the scalable design approach into battery model

- **Interfacing to Electric Vehicle (EV) powertrain model, DC-DC converter, auxiliary electrical system, electric motor and gearbox, and the Energy Management System (EMS)**
- **Definition of pack specific parameter to achieve a scalable RESS in energy content and power**

Integration of a battery thermal system model

- **Interfacing to electrical model + cooling circuit model + thermal battery model**

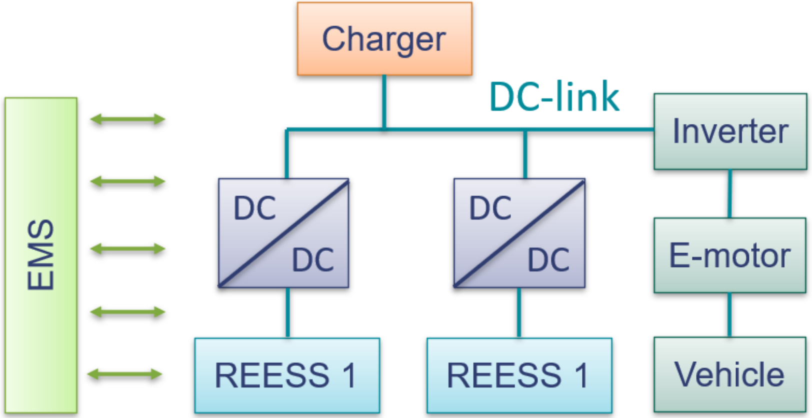
Verification of scalability via “SORT” cycles

- **First simulation with different battery pack sizes: small (~60kWh), medium (~120kWh) and large (~180kWh)**

Hybrid topology approaches

Modelling approach to investigate in efficiency and cost optimized configurations.

- Different configurations have been considered in order to compose the benefit of the different RESS-characteristics (LTO, NMC, LiCap).
- To couple the RESS's into the DC-link also different DC/DC topologies have been used.
- Components are connected to the EMS (Energy Management Strategy).



Example configuration

Conclusion

Efficiency and cost evaluation

- Single RESS topology
  - LTO provides the best performance regarding super-fast charging
  - LFP still the best mix in charging performance and range
  - NMC is the “best in cost” approach with over-night charging strategy
- Hybrid RESS topologies
  - LiCap in conjunction with NMC and DC-DC converter has good performance in peak performance and range.
- Single- and hybrid comparison
  - For most of the common commercial vehicle applications single topologies have their benefit in efficiency and cost, because of reduction of additional electrical efficiency loss, component weight or CapEx.

Thank you!!!

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Felix Lehfuß, AIT

Grid integration and stability in conjunction with Hi-Power charging

(remote)

Grid stability and safety in conjunction with Hi-Power charging

Final Conference, 21st March, Brussels

Lehfuß Felix (AIT)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769850.

Grid integration and stability in conjunction with Hi-power charging – The Challenge

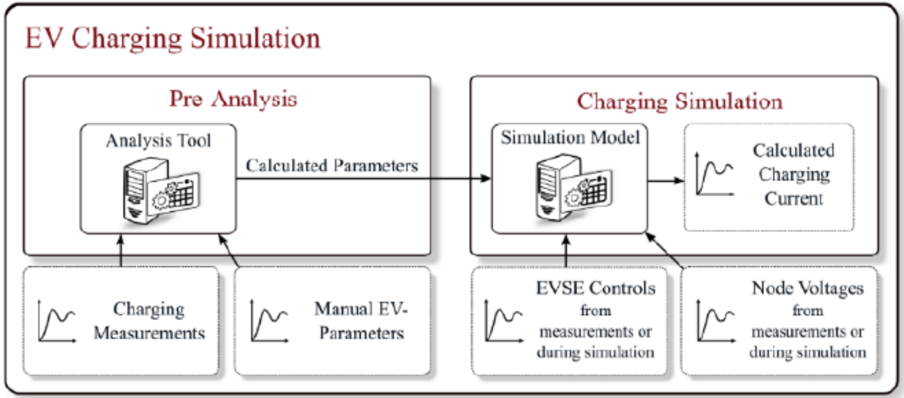
Embedded in WP3 Task 3.3 aimed to investigate

- Necessary bi-directional information between systems and providers
- The interaction between charging infrastructure and the electricity grid
- The impact of electric busses/trucks on urban distribution grids

Addressing power ratings of 300kW to 600kW and charging durations of <30s, <5min and 30-50min.

Applied Methodology:

- Specific Location Scenarios:
  - Eindhoven Bus depot
  - Eindhoven end of line
  - Veghel Distribution Centre
- Large Scale Scenario

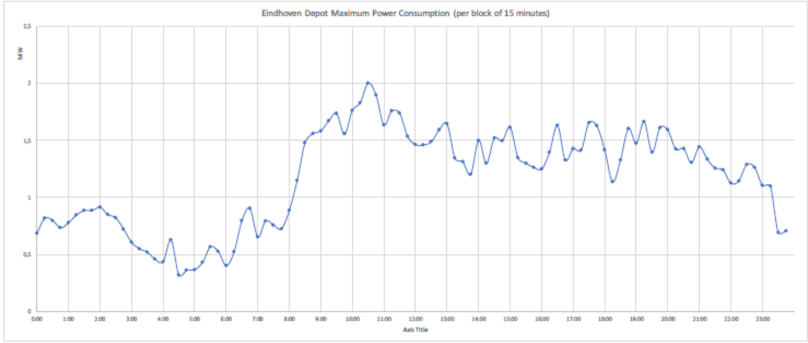


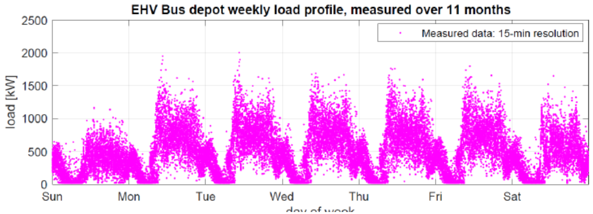
Local Scenario: Eindhoven Bus Depot

Charging Equipment/Environment:

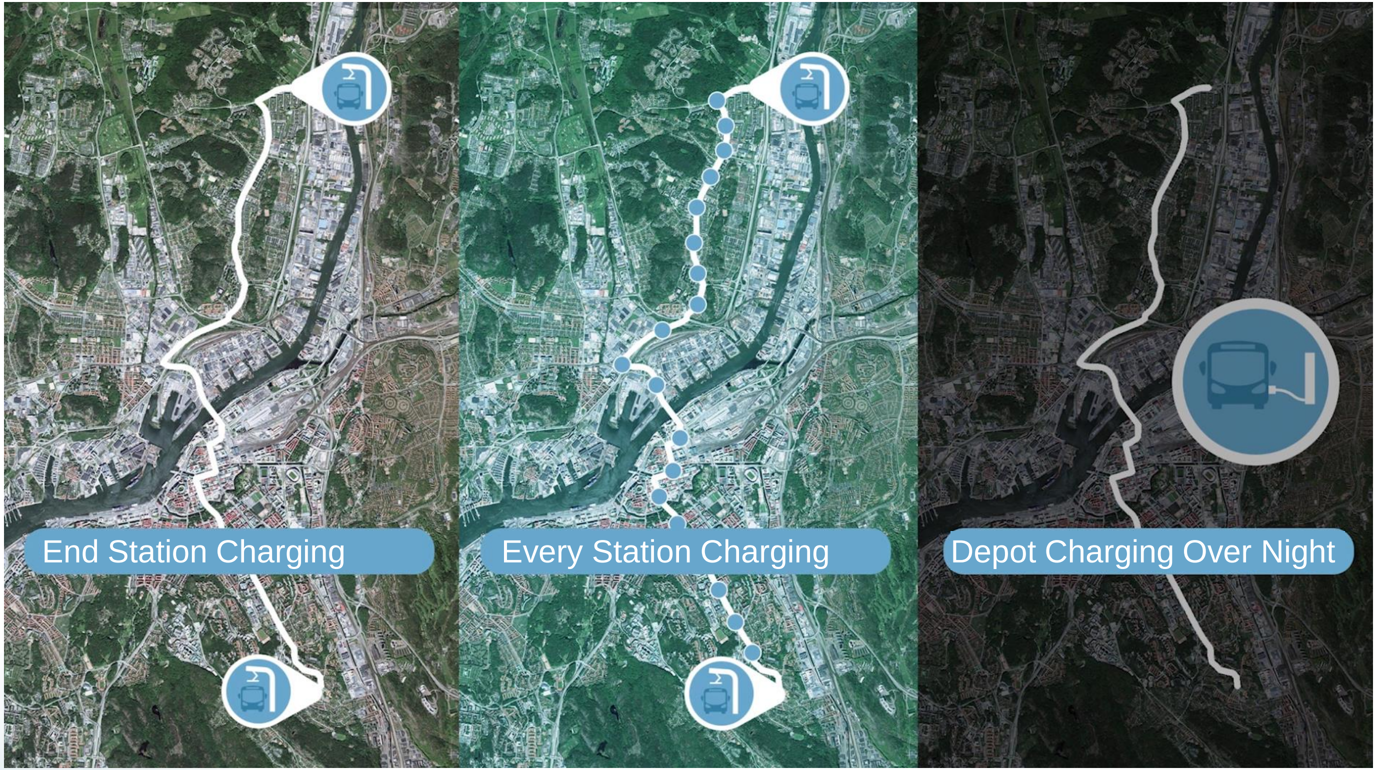
- 10x 300kW „fast“ chargers
- 22x 30kW „slow“ chargers
- 3x 1600kVA Transformers

Around 40 e-buses operated in rush moments

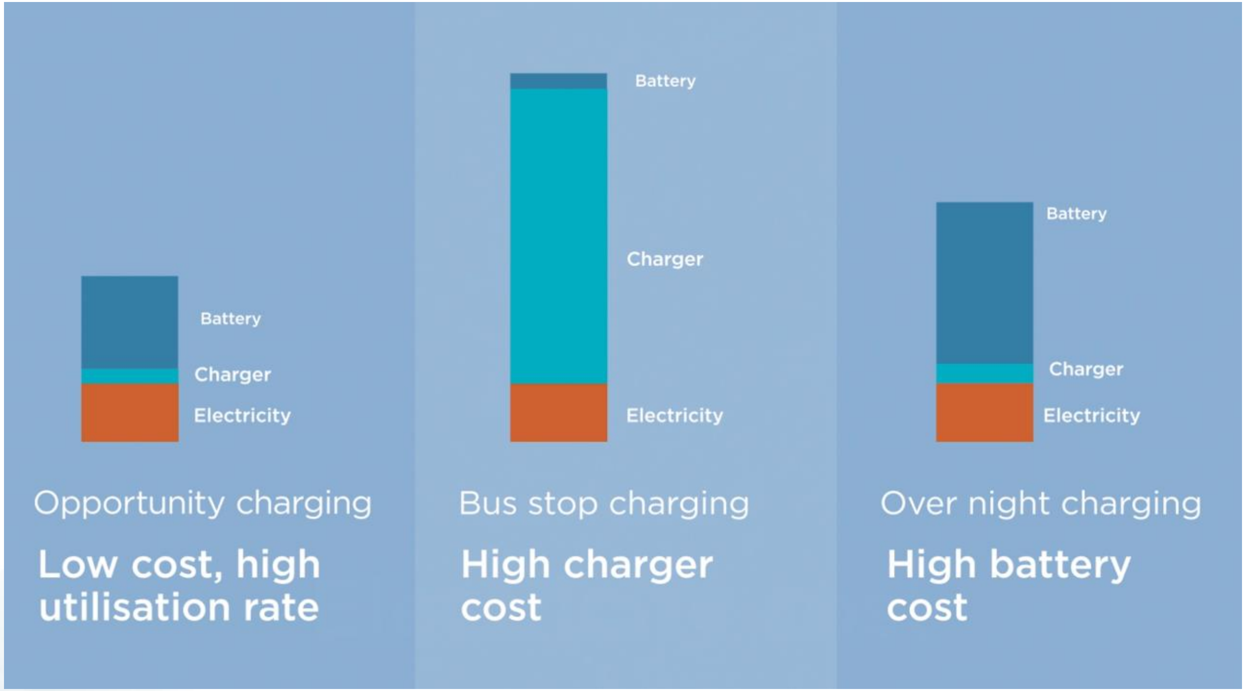




Large Scale Scenario - Definition



Large Scale Scenario -Definition



Large Scale Scenario Definition

Every station charging

- 20 active charging stations
- 8-13 seconds charging time per stop, depending on charging power

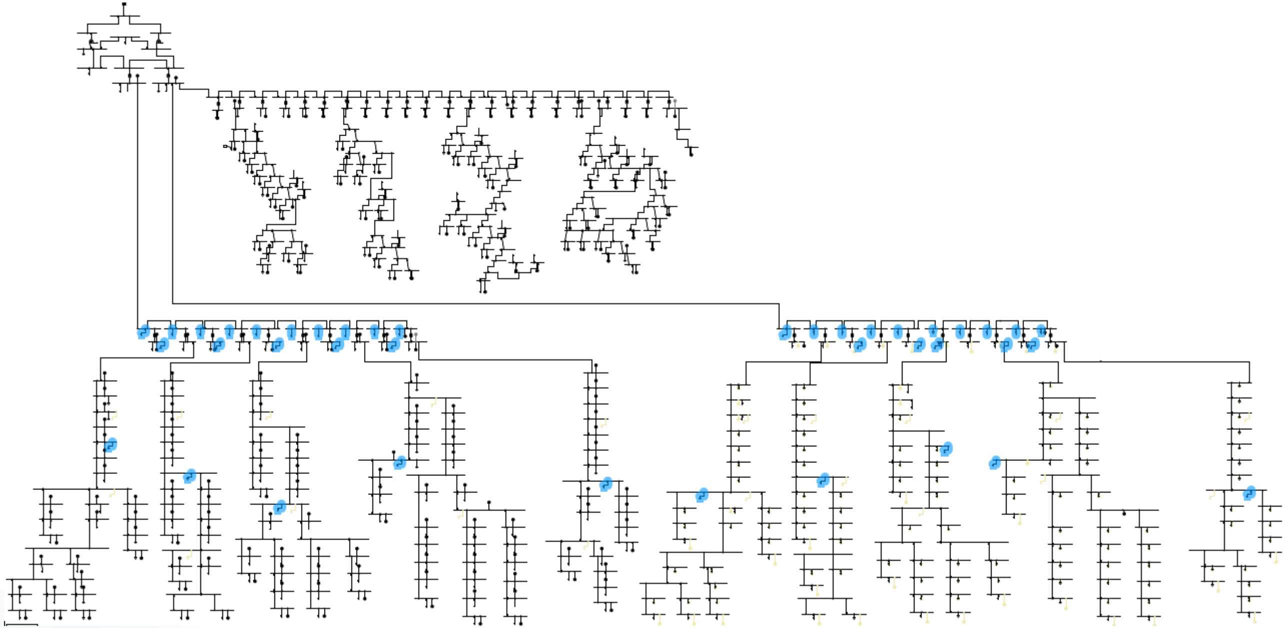
Every second station charging

- 10 active charging stations
- 13-23 seconds charging time per stop, depending on charging power

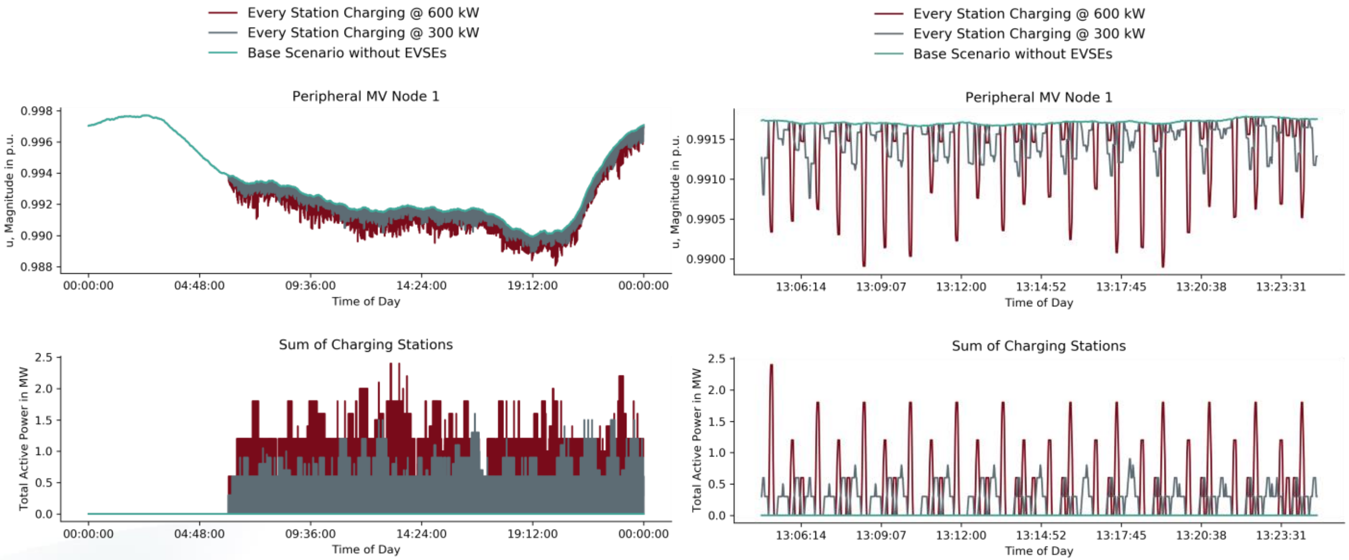
End station charging

- 2 active charging stations
- 90-170 seconds charging time at stop, depending on charging power
- 1 active charging station at night (0 a.m. to appr. 8 a.m.)

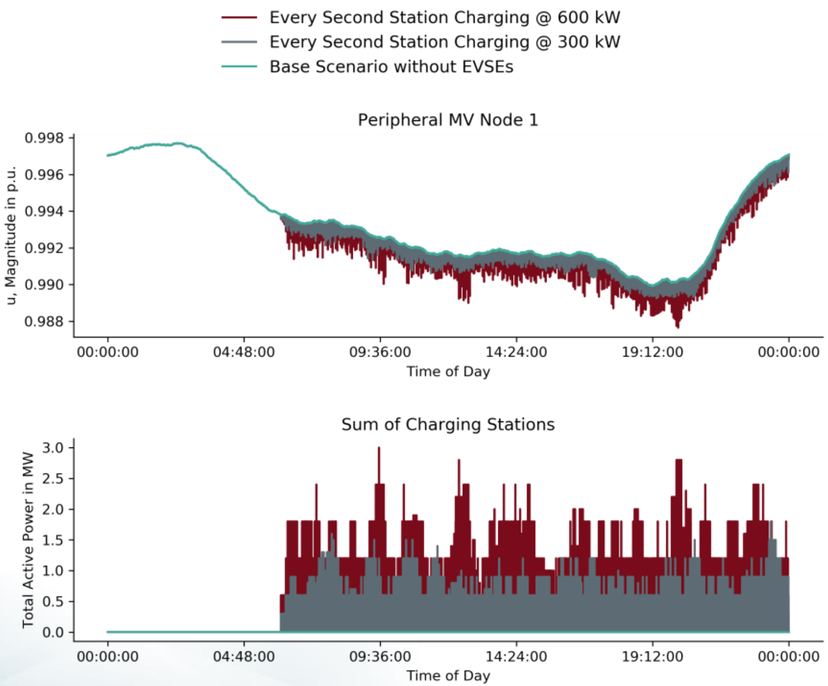
Large Scale Scenario - Grid Model Overview

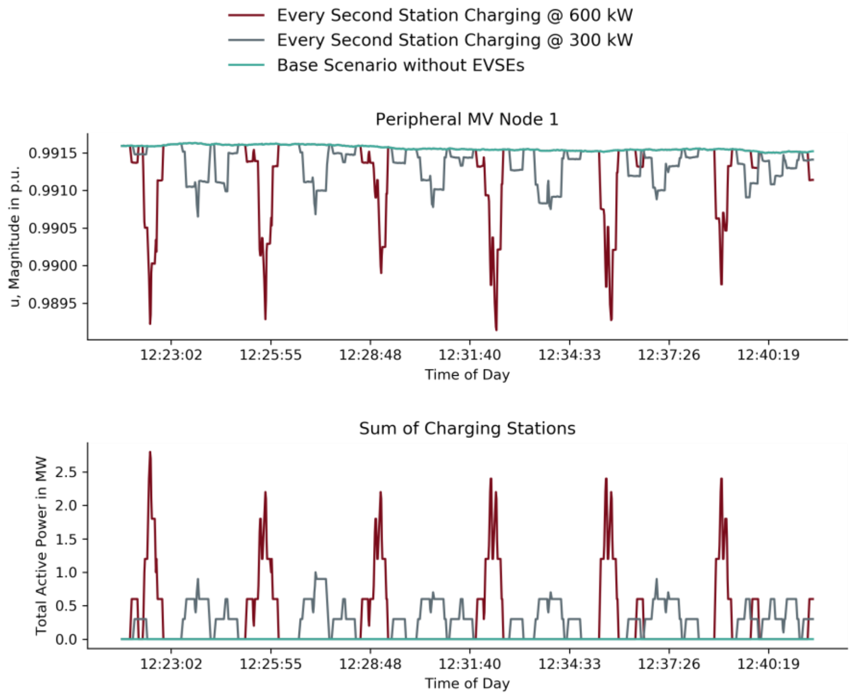


Every Station Charging

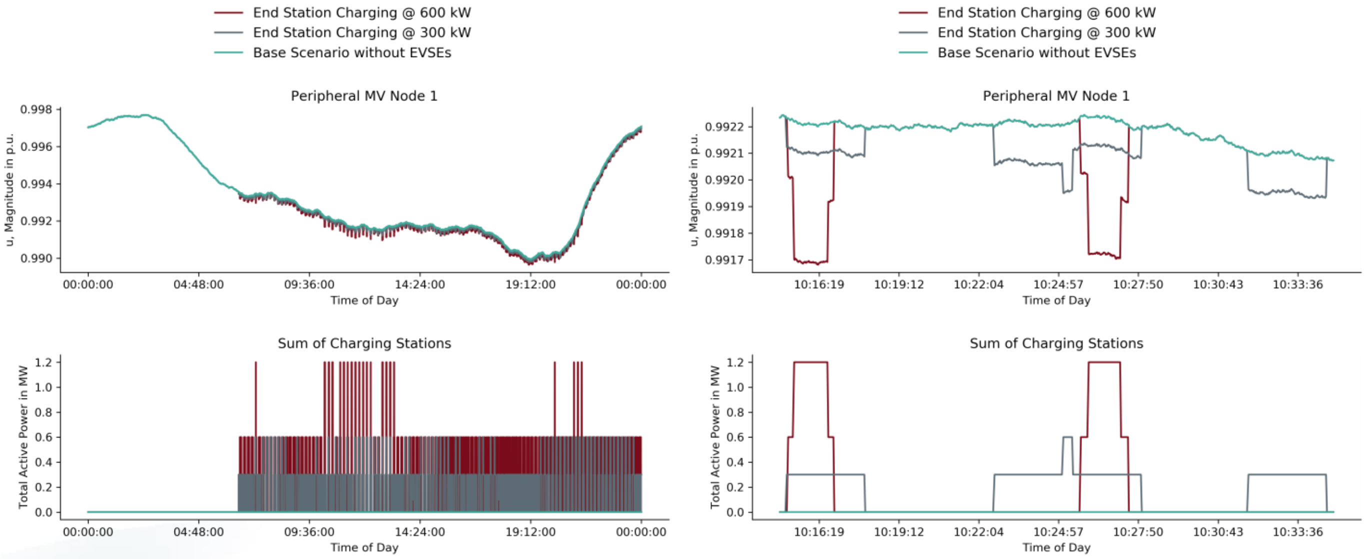


Every Second Station Charging

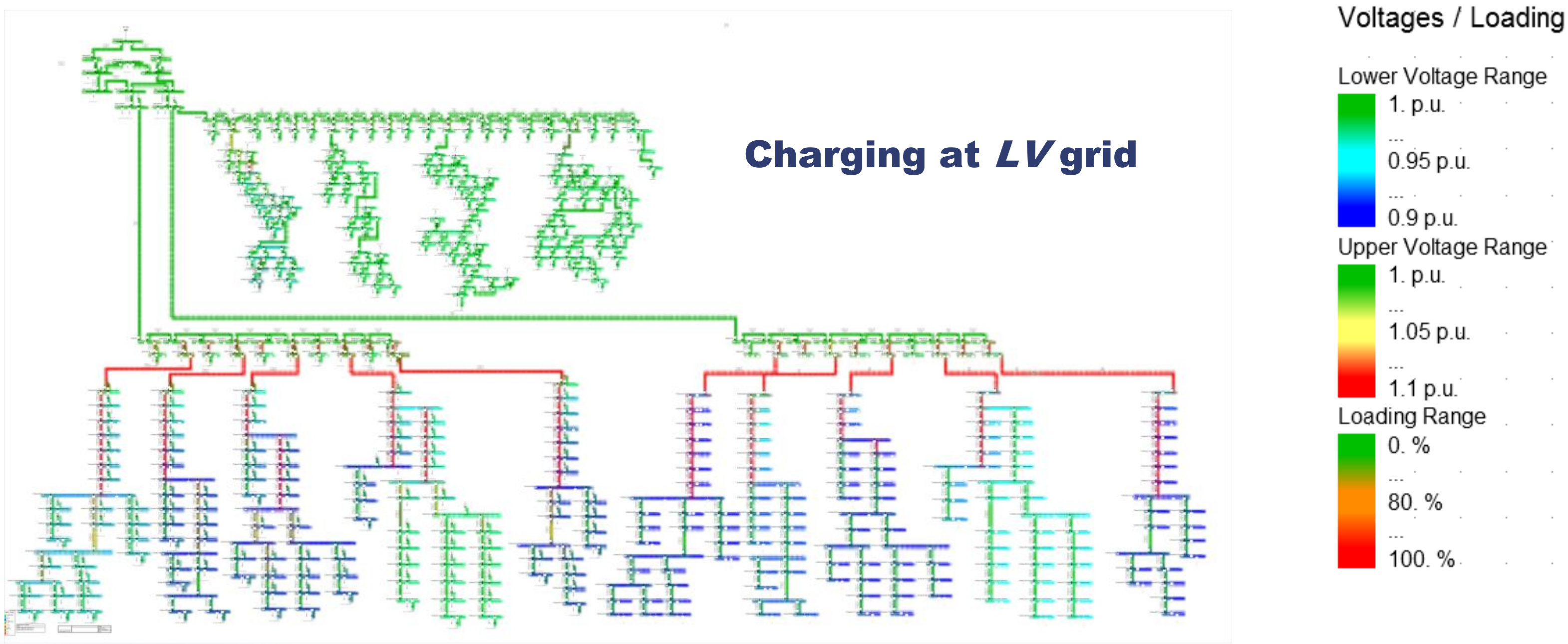




End Station Charging

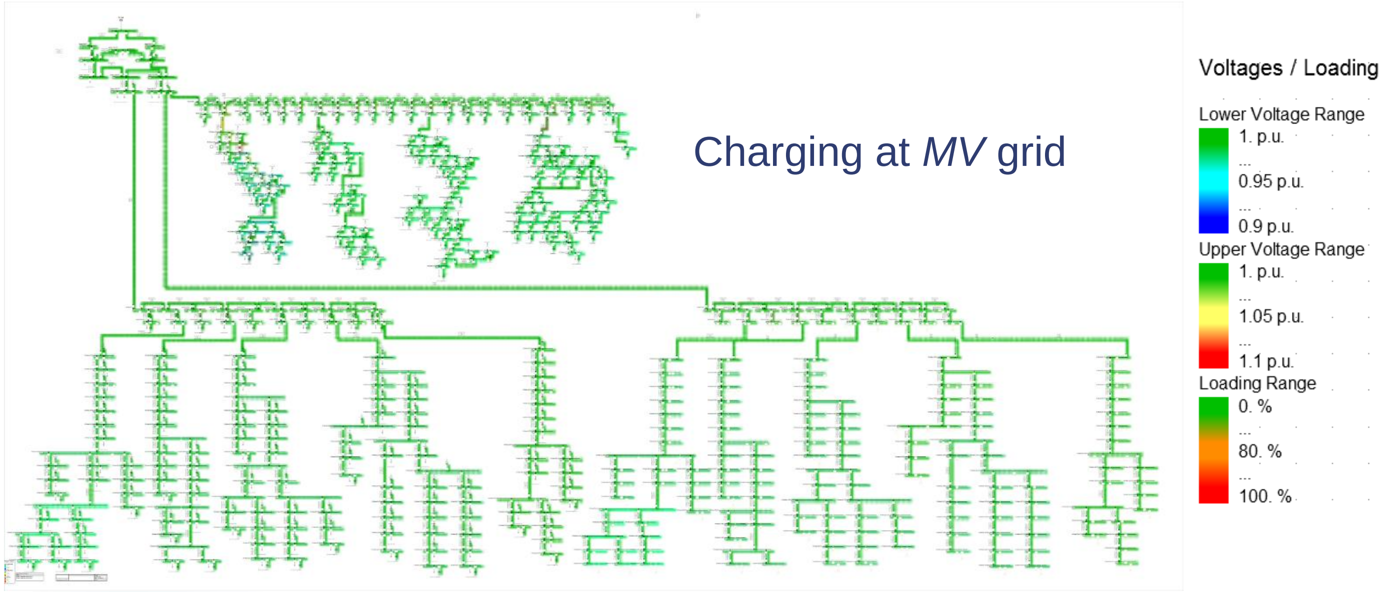


Charging: LV- vs MV-grid



Heatmap of 300 kW LV Charging at Every Station

Charging: LV- vs MV-grid



Heatmap of 300 kW LV Charging at Every Station

Strategies for the mitigation of grid failure due to high power charging EV-fleets

Opportunity Charging:

- Short charging duration results in spiked load behaviour. Resulting spikes did not violate the voltage band (if EVSE is connected to MV levels)
- For real field implementation an additional communication layer enabling an „emergency opt out“ is recommended
- Opportunity charging as additional measure since battery sizes of busses suffice to reach depot (for the majority of cases and scenarios).

Depot Charging:

- Congestion can be avoided through thorough planning.
- Use technologies as controlled charging, load shifting, load balancing and Energy Management Systems to reduce or flatten the required grid interconnection.

Results of executed simulations in the framework of ASSURED provide a positive outlook

I am happy to answer questions!
Write them on the chat!

Omar Hegazy, VUB

Smart tools for fleet management and fleet optimisation

Smart Tools and Fleet Management on Fleet Optimization

GA Final, March 21, 2022

Omar Hegazy

Professor and Head of EPOWERS

(Efficient Power Electronics Powertrain and Energy Solutions)

MOBI, ETEC, VUB

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769850.

Main Topics

- Energy Storage Systems Hybridization Design Tool (D6.1)
- Electric Bus Simulation Framework (D6.2)
- Energy and Charging Management Strategy (D6.3)
- Evaluation of Use Case in Cities (D6.3, D6.4)

PR1: ESS Hybridization Design Tool

Objectives

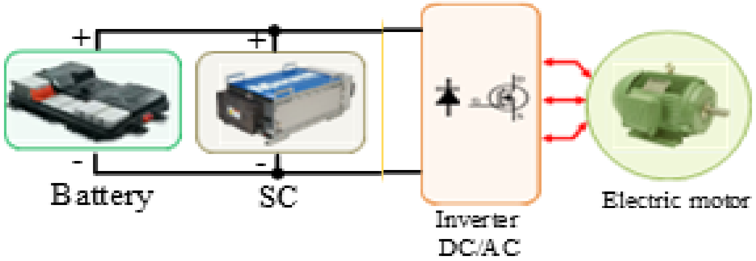
- Determine the most cost-effective ESS configuration
- Determine the most energy efficient ESS configuration
- Design of the thermal, cooling, and ageing model of the ESS

Battery Pack

Supercapacitor Bank

Power Electronics Module

PR1: ESS Hybridization Design Tool



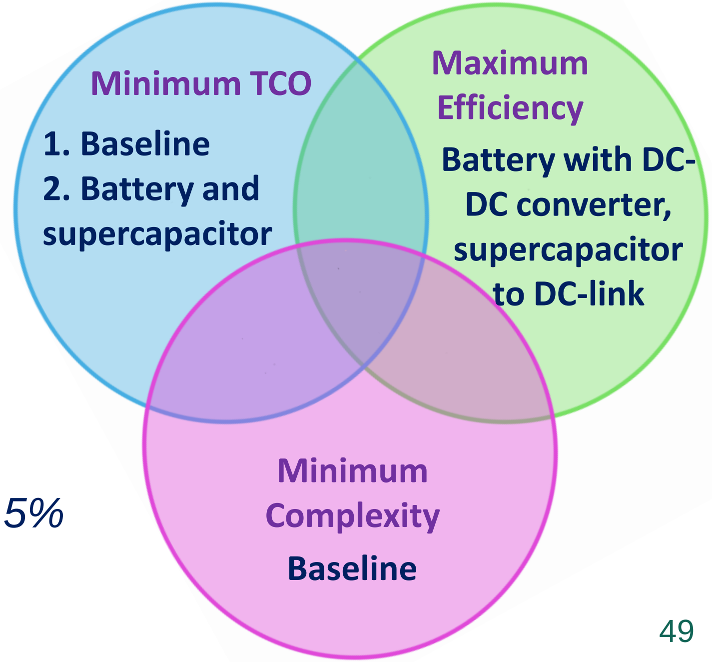
Six Topologies Researched

- Battery connected to DC-link bus
- Battery connected to DC-DC converter
- Both battery and supercapacitor connected to DC-link bus
- Battery connected to DC-DC converter, while supercapacitor connected to DC-link bus
- Battery connected to DC-link bus, while supercapacitor connected to DC-DC converter
- Both battery and supercapacitor connected to DC-DC converter

PR1: ESS Hybridization Design Tool

Results and Findings

- Baseline
  - Battery directly connected to DC Link
  - Least complex, lowest cost
  - Requires inverter with a wide voltage operating range, least efficient, requires a larger sized in battery



Significant findings:

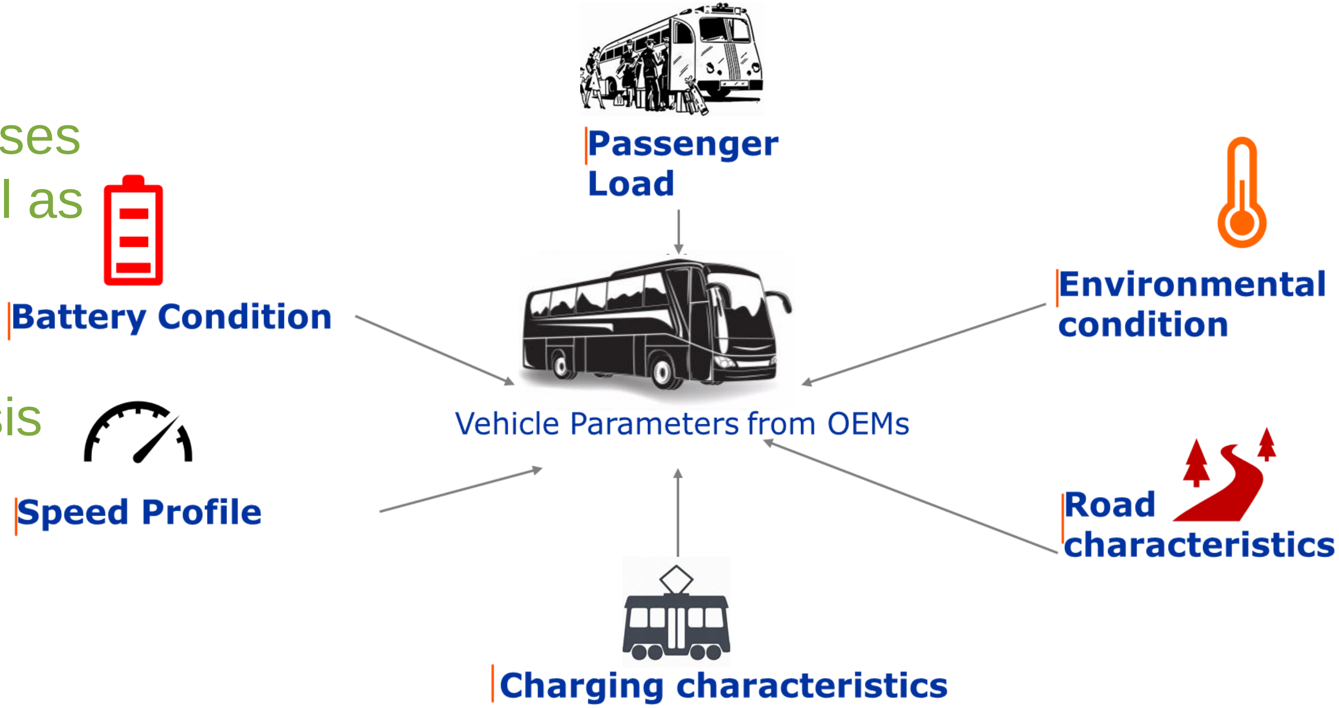
Adding supercapacitor improved performance by 3%

Adding DC-DC converter improved performance by 3.5%

PR2: E-Bus Simulation Framework

Objectives

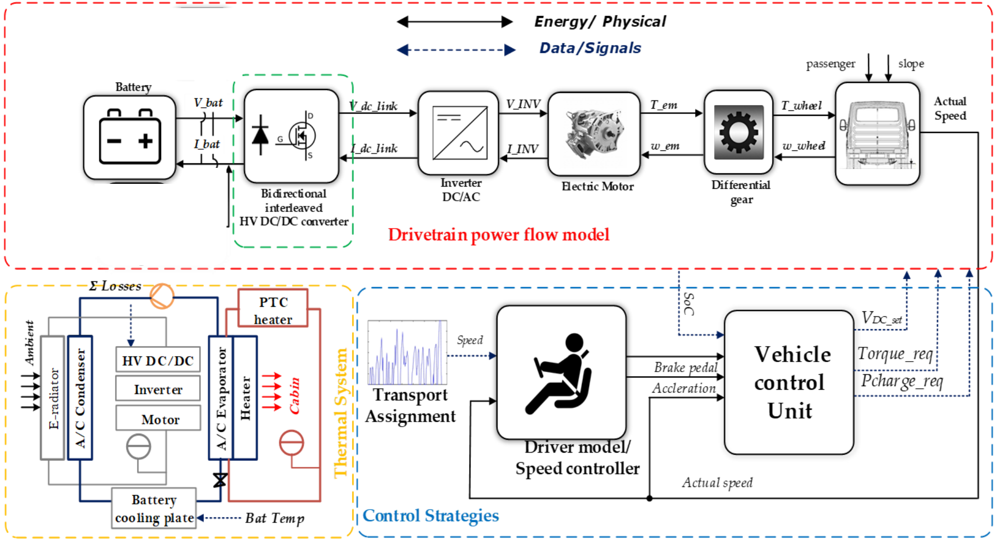
- Simulate use cases for single as well as fleets of buses
- TCO analysis
- Grid load analysis



PR2: E-Bus Simulation Framework

Features

- Up to ***100 buses*** in fleet
- Multiple bus routes in city
- Enhanced TCO analysis
- Energy usage analysis
- Grid electricity demand
- Energy management analysis using the triple ECO-features



Forward facing model of electric vehicle powertrain

PR2: E-Bus Simulation Framework

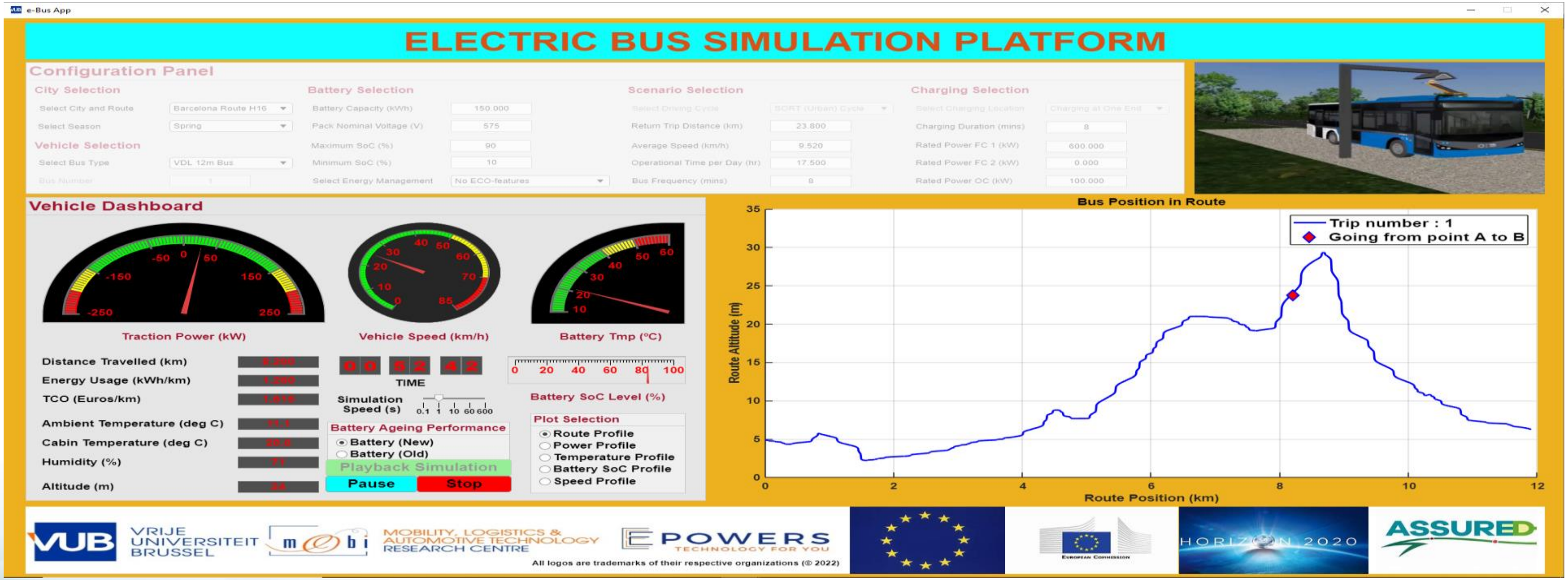
User Interfaces

Using GUI Application

- 👍 Easy of use, visually appealing, do not require MATLAB license
- 👎 Less flexible, require vendor support to configure new functionality

Using MATLAB/Simulink

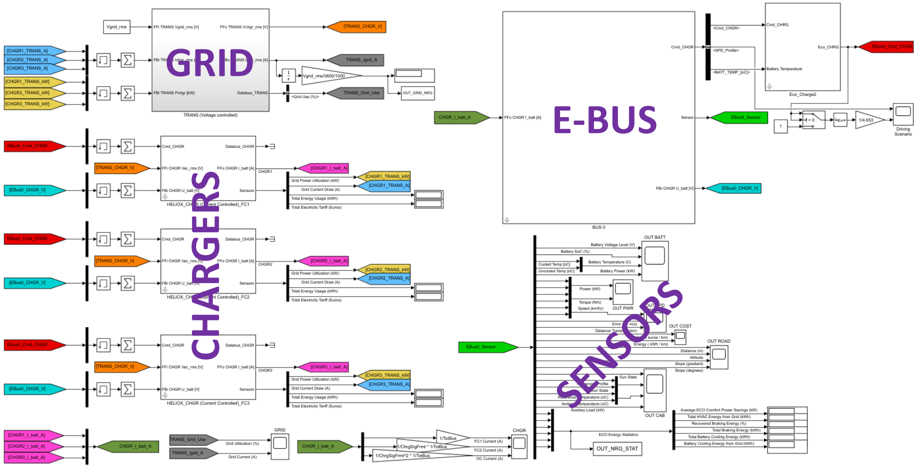
- 👍 Highly flexible and configurable in-house
- 👎 Require MATLAB license, requires know-how in Simulink

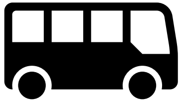


PR2: E-Bus Simulation Framework

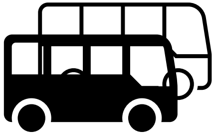
Achievements

- More than 500 single bus Use Case (UC) simulations of 18m and 12m buses in cities
  - Barcelona (routes H16, L33)
  - Osnabruck (route N5)
  - Gothenburg (routes R55, EL16)
  - 4 seasons, new & aged battery
- 30 fleet simulations of Barcelona, Osnabruck, Gothenburg
- 8 optimization of charging infrastructure for bus fleets

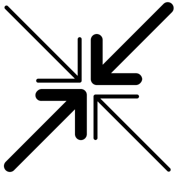




\> 500 single bus simulations



30 fleet simulations

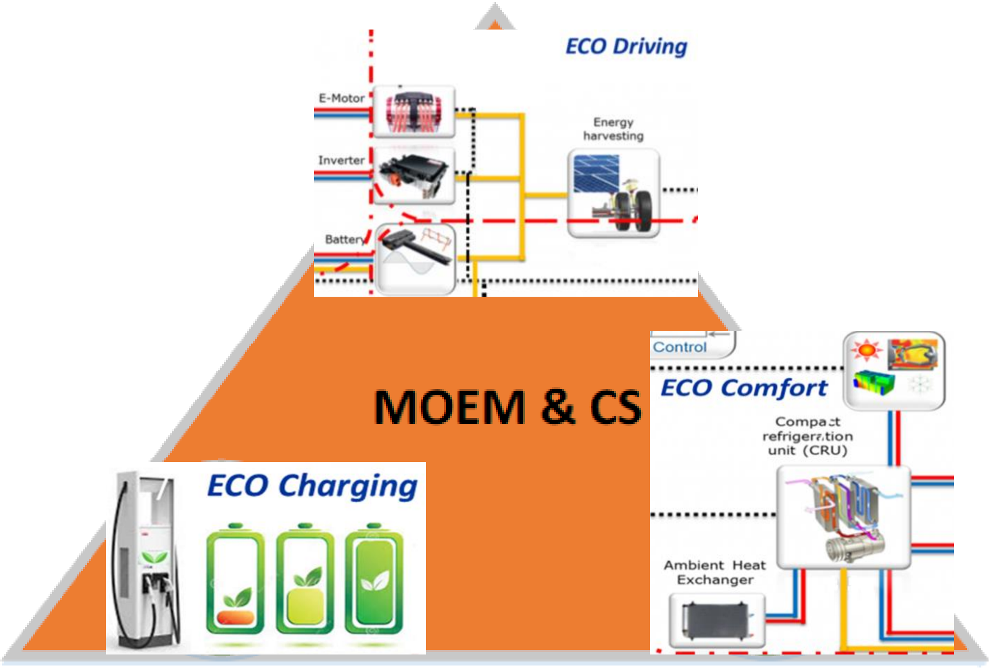


8 optimization simulations

PR3: Energy & Charging Management

Objectives

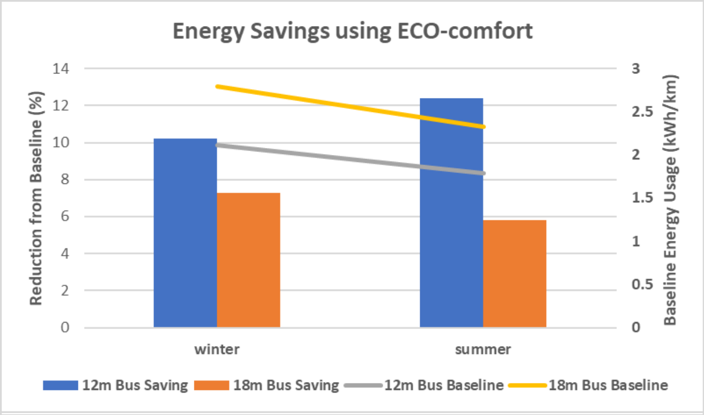
- Reduce bus energy consumption using:
  - Energy management
  - Thermal management
  - Charging management
- Lower the TCO
- Extend the driving range
- Extend the battery life
- Lower the impact on grid



PR3: Energy & Charging Management

Features

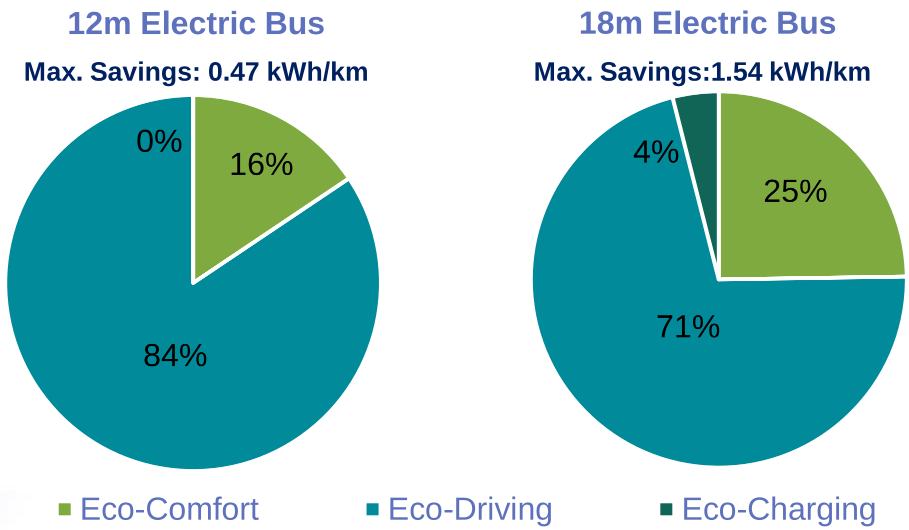
- ECO-driving
  - Optimize driving cycle
  - Optimize regenerative braking
- ECO-comfort
  - Dynamic temperature setpoint
  - Preconditioning of cabin & battery
- ECO-charging
  - Optimization of charging schedule
  - Pulsed charging



NOTE: The [illegible]

PR3: Energy & Charging Management

Achievements



Energy savings due to ECO-feature

Evaluation of Use Cases in Cities

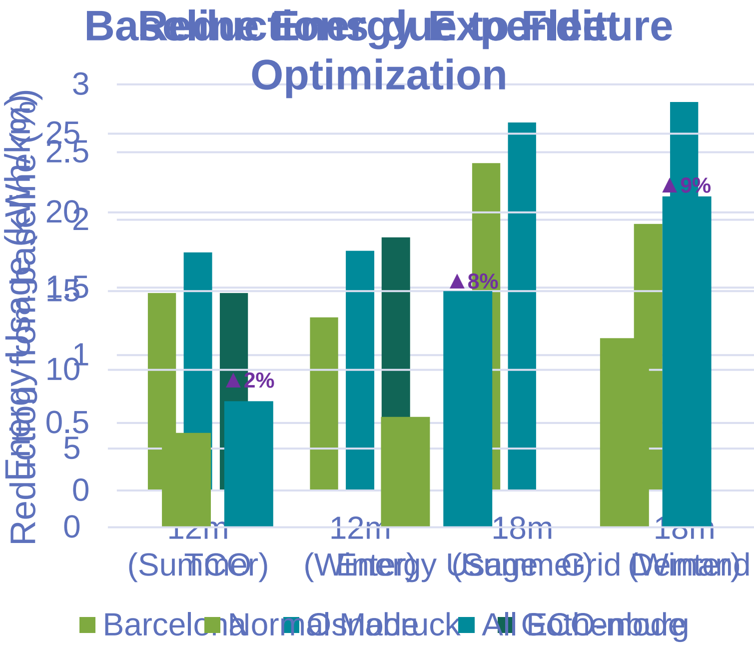
Objectives

- For City Bus Operators
    - Determine the energy requirements for different bus sizes based on Use Case scenario
    - Determine the possible reduction in energy utilization through application of ECO energy management techniques
- For Distribution Service Operators
    - Determine the impact on the electricity grid during fleet charging
    - Determine the possible reduction in load on grid through charging scheduling

Evaluation of Use Cases in Cities

Results and Findings

- Baseline energy usage
- Factors affecting energy usage
  - Passenger load, route elevation, driving scenario, and climate
- Reduction in key objective compared to baseline after optimization of the charging infrastructure



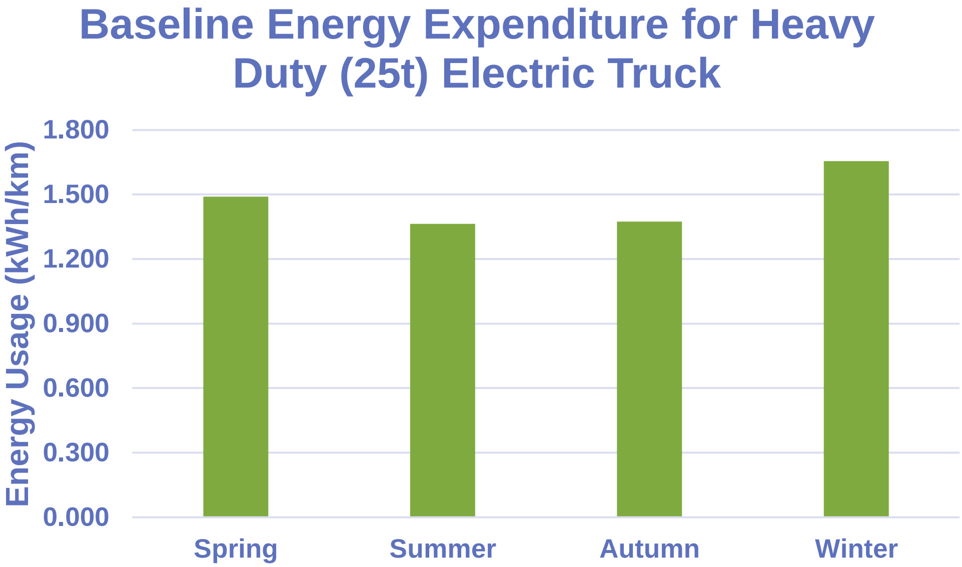
NOTE: The energy expenditure reflects the bus being subjected to a hybrid SORT driving cycle

NOTE: Average velocity in Barcelona is 11.64 km/h, in Osnabruck is 19.78 km/h, in Gothenburg is 18.24 km/h

Evaluation of Use Cases in Cities

Results and Findings

- Use Case of Heavy Urban Vehicle such as Electric Truck
- ECO-comfort leads to minimal energy savings (~2%) due to small cabin size
- ECO-driving leads up to 30% energy savings from baseline due to high average velocity



Note: The energy values reflects for the driving scenario with average speed of 50 km/h

Thank you for your attention

SLIDO 1st round!

https://app.sli.do/event/w8P7hj7yq8qewLH8oXbr74

www.slido.com
code #297014

1

How can battery development optimise driving range and efficiency?

a) Build batteries as big as you can!
b) Arrange the battery needs according to the required range and charging profiles (best-fit strategy)

2

What has high impact on battery aging for the Rechargeable Electrical Energy Storage System?

a) High charging currents produce stress and extreme self-heating inside cells
b) Low continuous current during overnight charging damages the cells extremely
c) Ambient conditions lower than -30°C and above 60°C are critical for cells during charging and discharging

3

Which energy management strategy has a significant impact on the energy consumption (kWh/km) of electric buses & trucks?

a) ECO-comfort
b) ECO-charging
c) ECO-routing
d) ECO-driving

Presentation Results II

Ensuring the standardisation and interoperability of charging solutions

Mehrnaz Farzam Far, VTT

ASSURED Standardisation & Interoperability Support

ASSURED Standardisation and Interoperability Support

ASSURED Final Conference 21st March

Mehrnaz Farzam Far (VTT, Finland)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769850.

Standardisation and interoperability: what they are and why they matter?

Standardisation and interoperability of e-bus charging is key to enable the upscale of HD-EVs fleets.

- It provides an indispensable basis for wider market penetration and enables the flexibility and optimisation of bus operations and higher rest value.
- It contributes to cost reduction of charge infrastructure by assuring functionality, compatibility, and interoperability.
- It does not bind the product choice to one solution or supplier.

Agreed standards encourage innovation, boost confidence and create suitable market conditions for further technological development, reducing deployment barriers and facilitating competition.

- Reliable, functioning interoperability between vehicles and chargers (of different vendors) is instrumental
- A standardized common test protocol secures compliance

Development of European Electric Bus Standardisation

2013
- ZeEUS project

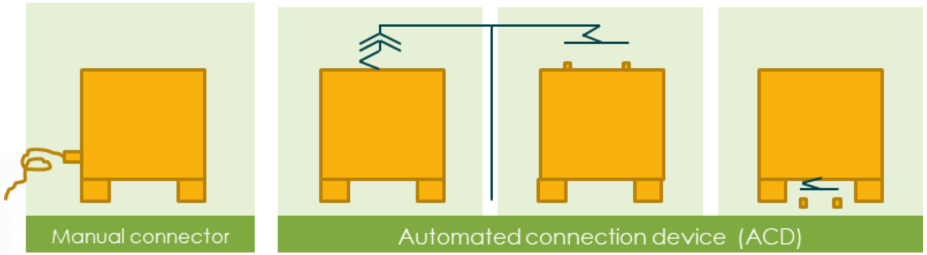
2014
- AFI directive

2015
- EC Mandate 533

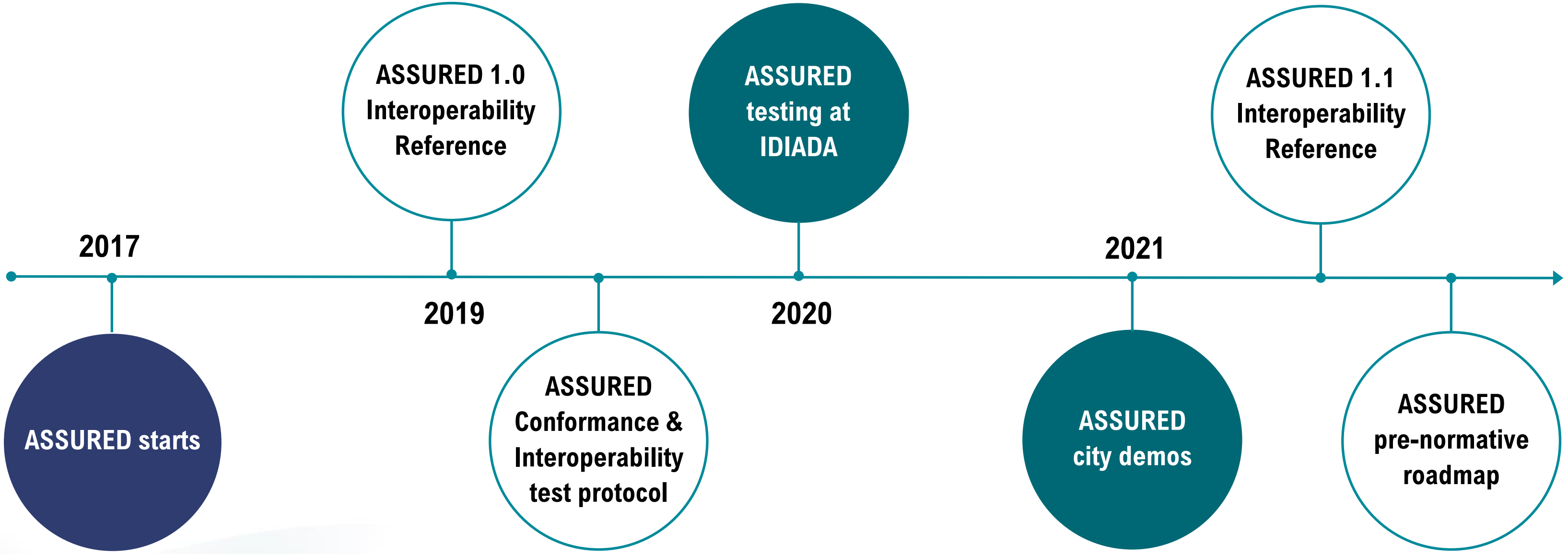
2016
- ZeEUS e-bus standardisat-ion group

2017
- ASSURED starts

2018
- ZeEUS ends
- CEN-CENELEC recommendation



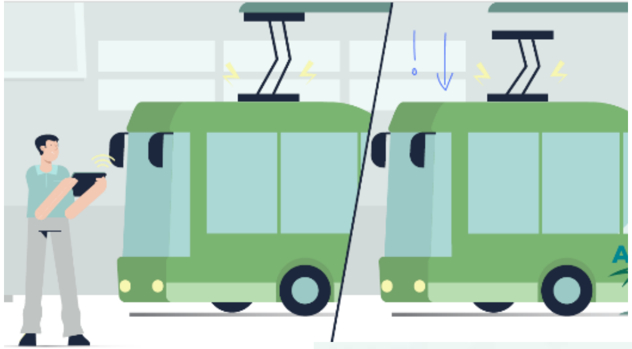
ASSURED activities on STD and INT



ASSURED 1.1 Interoperability Reference Available Online

SCAN ME

- **Describes standards and definitions used in ASSURED**
  - Mechanical interface
  - Electrical interface
  - Communication
  - Deviations & additional specifications



ASSURED Pre-normative technology roadmap Available Online

The roadmap supports:

- future standardisation effort by providing the evolvement of various charging technologies aspects and their future requirements
- end users in selecting their charging technologies by familiarising them with the charging technologies and concepts, and their perceived potential.

SCAN ME

INDEX

Thank You!

More info:

www.assured-project.eu

Joan Carles Artigau &
Santiago Obiols, Idiada

ASSURED Interoperability and conformance tests of (super) fast charging solutions

ASSURED Interoperability and conformance tests of (super) fast charging solutions

ASSURED Final Conference 21st March

Joan Carles Artigau Benítez (Applus+ IDIADA)
Santiago Obiols Pascual-Trenor (Applus+ IDIADA)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769850.

Overview of ASSURED testing activities

Background of HD-EVs

- Missing specifications and definitions of standards for electric heavy-duty vehicles prompted the urge to create a new standard.
- Innovation, electromobility expertise, knowledge and industrial thinking were necessary to cover the key points in order to achieve effective interoperability of super fast charging systems.

ASSURED main goal

- Ensure the interoperability of super-fast charging solutions for reducing costs and supporting the standardization of the infrastructure elements.
- For this purpose, IDIADA has led the validation activities of the ACD charging interfaces, together with the strong cooperation of the reference industry partners.

Overview of ASSURED testing activities

Testing activities outcomes

- Integration of ACD solutions with IDIADA's EV and EVSE simulators to carry out the conformance and interoperability testing procedure outlined in the ASSURED 1.0 interoperability reference document (ASR 1.0)
- All the new and smart electric mobility solutions provided by all the partners have ended up been validated with encouraging and promising results.

Conformance testing – Overview and testing tools

What is Conformance for eHD charging and why is important?

- Conformance testing consists of dedicated tests for an electric vehicle or charger against a test system emulating the counterpart.
- Basic charging assessment for IEC61851 & ISO15118
- Readiness to Interoperability testing

IDIADA Conformance testing tools:

- Electrical installation capable to support super-fast chargers up to 600kW
- 1MW AC Grid capability
- IDIADAs EV & EVSE Simulator
- Tests under real power up to 500kW (1000V)
- ACD test station with ACD systems Type A and Type B installed and control system
- PLC and Wireless communication interfaces

ASSURED

Interoperability testing – Overview and solutions provided

What is Interoperability for eHD charging and why is important?

"Interoperability is the ability of vehicles, chargers, networks and management systems to interact and manage data, to ensure:"

- Safety
- Compatibility of equipment and protocols
- Functionality
- System reliability
- System Availability

Partners solutions provided:

- Inverted pantograph (panto down):
    - ABB, HELIOX, HEULIEZ, IRIZAR, VDL, VOLVO
- Roof-mounted pantograph (panto up):
    - ABB, HELIOX, JEMA, IRIZAR, VDL
- Demo cities:
    → Barcelona, Spain (Panto up technology)
    → Osnabrück, Germany (Panto down technology)

ABB | heliox | Jema Irizar Group innovative energy | Irizar | HeuliezBus | VDL Bus & Coach | Volvo | Applus IDIADA | TMB Transports Metropolitans de Barcelona | Stadtwerke Osnabrück

Interested in hearing more?

- **Parallel session 1: Standardisation and Interoperability of e-vehicle charging**
- **When: Today @ 14.30-16.30**
- **What: more details on:**
    - Charging trends, technologies, & standards
    - ASR 1.1 Interoperability Reference
    - ASR pre-normative technical roadmap
    - ASR Interoperability testing & results

Thank You!

More info:

www.assured-project.eu

SLIDO 2nd round!

https://app.sli.do/event/w8P7hj7yq8qewLH8oXbr74

www.slido.com
code #297014

4

In your opinion, what is the best way to achieve full interoperability in the context of EV charging ecosystem?

a) Using same technologies in different brands of chargers and vehicles.
b) Testing the chargers and vehicles of different brands against interoperability test protocol and specifications.

5

How would you rate the importance of interoperability between chargers and different vehicle types (e.g. buses and trucks)?

a) Very important
b) Moderately important
c) Not important

Coffee break!

See you in 10 minutes!

Presentation Results III

From the lab to real operation: enabling real fleet upscale

Aida Abdulah, UITP

Ensuring user acceptance: ASSURED Demonstrations

Ensuring user acceptance: ASSURED Demonstrations

Final Conference, 21st March

Aida Abdulah, UITP

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769850.

Innovation makes sense only if end users can extract value from it, i.e. accept and deploy the innovation

At the lab…

- Vehicles were adapted and modified based on the developed charging solutions and the needs of the demo cities.
- The vehicles were also verified at controlled sites as a pre-test before the real operation demos

Pillar I: e-Buses

Iveco – Heuliez Bus
Rorthais

Volvo
Gothenburg

Irizar
Bayonne

VDL
Helmond

Pillars II & II: e-truck & e-van

MAN

Brussels

Volvo

Gothenburg

Tofas

Torino

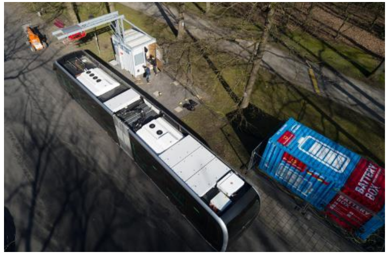
ASSURED

Demonstrators for User Acceptance

Barcelona & Osnabruck	• Interoperability between buses and chargers of different brands
Gothenburg	• Interoperability between bus, urban truck, vans
Eindhoven & Jaworzno	• Smart charging for fleet upscale • Energy storage systems, energy efficiency

Barcelona: Roof mounted pantograph

Osnabruck: Infrastructure mounted pantograph

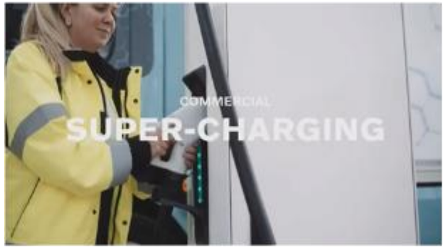


Gothenburg: Interoperability bus-truck-van

Flexible, interoperable charging

Goal: to showcase different vehicles using the same charging technology and standards:

- Indoor bus charging
- Infrastructure-mounted pantograph up to 450 kW
- High power CCS2 charging for trucks and cars
- Roof-mounted pantograph



Eindhoven: From 43 to 100 e-buses

- **Goal: designing the fleet upscale in a smart and cost-effective way**
  - ensuring that power supply is guaranteed!
  - without supersizing the grid connection!
- **How: balancing supply and demand by advanced system capabilities, making mobility more intelligent.**

“From E-mobility to I-mobility”

Jaworzno: Smart charging management & efficiency

Public bus fleet of 23 e-buses

Goal: transition to zero-emissions fleet to reduce CO_2 emissions.

- Impact on grid & battery lifetime
- Optimisation of TCO

Thank You!

aida.abdulah@uitp.org

Stamatis Manganiaris, ICCS

ASSURED Light Duty Van: Inductive High Power Charging Systems

A visit to the Power Electronic Innovation Center, Turin

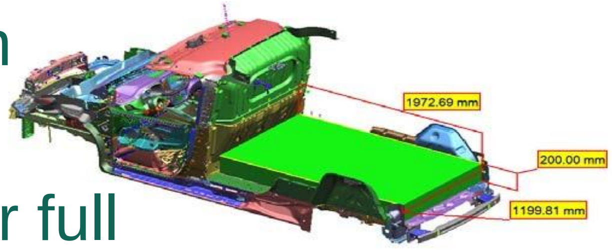
ASSURED wireless power transfer system

POLITECNICO
DI TORINO

UC9: Fast wireless charging of Light Duty electric VAN

Mechanical Activities

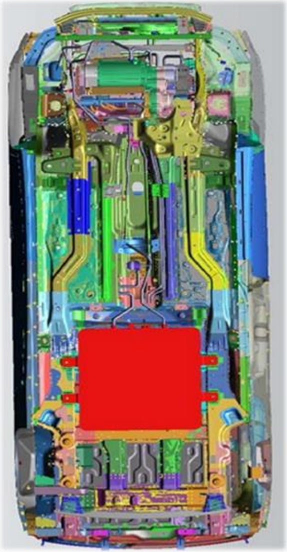
- Thermal system architecture definition
- Thermal system mechanical design
- Producing prototype parts
- Support, holder, bracket designs for full scale prototype vehicle
- Proto vehicle mechanical integration



UC9: Fast wireless charging of Light Duty electric VAN

Electric & Electronical Activities

- EE architecture design
- Network design
- Wireless Power Transfer Module (WPT) communication protocol definition
- LV/HV Harness Design
- Proto Vehicle Electrical Integration



UC9: Fast wireless charging of Light Duty electric VAN

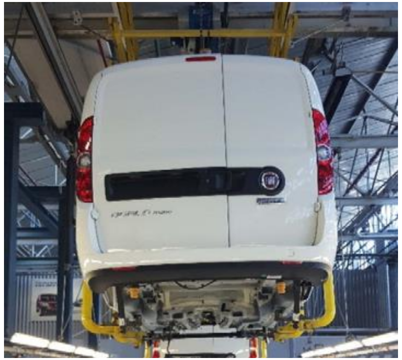
Virtual Integration Activities

- Virtual feasibility for WPT system
- Virtual integration activities for WPT system
- Thermal system virtual integration activities
- Geometric integration of components
- Prototype vehicle mechanical & electrical & electronic integration

UC9: Build-up the Vehicle

HV – components

- Battery
- E-Machine and Inverter
- Auxiliary Components (On Board Charger, DC/DC, Heater, AC Compressor)
- Power Distribution Box
- WPT Unit



UC9: Build-up the Vehicle

LV Electrical System & Software Activities

- LV Components and Harness
- Energy Management & Vehicle Control Algorithms Development
- Vehicle2Ground Unit Wireless Communication System
- WPT System - Vehicle Communication Interface (CANBUS & WI-FI)
- SW Functions and Algorithms Development
- Vehicle Control SW Implementation
- SW Optimizations
- E&E Functional Integration

UC9: Build-up the Vehicle

Demonstration Tests

- System initialization
- Basic functionality
- WPT Mechanical and Electrical Integration
- Thermal Management System Performance
- Activation / Deactivation / Alignment Status
- Error Handling, Self-Diagnostics and Recovery Strategy Functionality
- WPT Static Charging System Functional and Performance

UC9: Build-up the Vehicle

Vehicle Platform	Doblo Cargo Maxi
Curb weight	1,917 kg
Full loaded weight	2,450 kg
EM Power	30 kW Nominal / 83 kW Peak
EM Torque	100 Nm Nominal / 240 Nm Peak
Battery Pack Capacity / Weight	~40 kWh / 485 kg
Maximum speed	135 km/h Electronically Limited
Nominal Voltage	355,2 V
Autonomy @full load/no load	185 km / 225km
Acceleration 0-50 km/h @full load/no load	5,5 s / 5,1 s
Acceleration 0-100 km/h @full load/no load	16 s / 13,5 s

UC9 TOFAS VAN Final vehicle specifications

Power Tools and measurements bench

Power bench

- DC power supply unit: SM15K-SERIES, in series configuration to act as DC grid

DC Measurement bench

- Power Meter Analyzer: LMG-500
- 3 current probes (2xPSU600 and PSU200)

AC Measurement bench

- 8-Channel Oscilloscope (HDO8000)
- 4 voltages probes (HD3220) also to sense output voltage at battery side

Power Tools and measurements bench

EMC Measurements

- Exposure Level Tester: ELT-400
- Exposure Probe: ELT 100cm^2(1-400kHz)

Battery Emulator: 100kW (I-TS-3870-300)

Data collection measurements

The aim was to verify the capability of the WPT system to transfer 100kW with an efficiency above the 90% and verify the safety, of the users, with EMC/EMF tests

WPT system ASSURED Final Evaluation	Value
Resonance Frequency (Testing condition)	83 kHz
Nominal Input Voltage	580.49 V
Nominal Input Current (Testing condition)	192.12A
Nominal Input Power (Testing condition)	111.52 kW
Nominal Battery Voltage (Testing condition)	378.87 V
Maximum Battery Current (Testing condition)	277.19A
Maximum Battery Power (Testing condition)	104.96 kW
Efficiency Input Line – Output battery side	94.12%

Data collection measurements

The test was applied in

- hot scenario: 35 °C: vehicle charged with 100 kW of power for up to 10 minutes
- ideal scenario: 22 °C: vehicle charged with 100 kW of power for up to 12,5 minutes

The ASSURED electric vehicle has an energy consumption 66.6% lower than the diesel vehicle

Thank you for your time

Stamatis Manganiaris
ICCS

Roel de Groot, TNO

Research questions addressed in ASSURED

Research questions in ASSURED

Final Event – Brussel – 21 March 2021

R. de Groot

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769850.

Research Questions & KPI’s

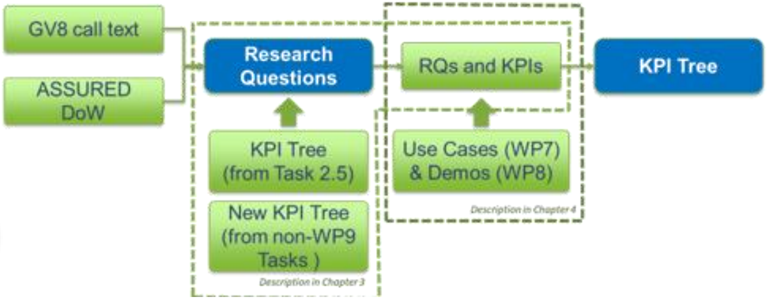
- **Research questions as the driving paradigm**
- **Report 1: D 2.5 – Final requirement compilation and KPI’s**
- **Report 2: D 9.1 – KPI update and focus on Use-Cases and Demonstrators (RINA)**

in what way do we understand the **impact** of fast charging on battery lifetime?

?

What is the impact of **fast charging** on power grid quality, stability and reliability?

?



Data gathering & measurements

- Evidence based, multiple sources, organized in pillars
- D9.2 - Report on operational load measurements

Use cases & Demonstrations

Simulation for
fleet upscaling & TCO

Vehicle
- Components
- Bus Truck, Van
- Energy efficiency
- Noise
- EMC

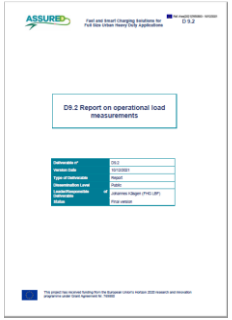
Charger
- Energy efficiency
- interoperability

Grid
- Frequency
- Power quality

DATA COLLECTION

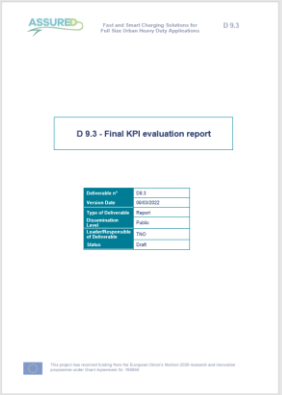
Interviews

Outcomes
other WP's



High lighted results

Answers to research questions, conclusions and recommendations available in Public report D9.3 – Final KPI Evaluation Report


ASSURED Fast and Smart Charging Solutions for Full Size Urban Heavy Duty Applications D 9.3

D 9.3 - Final KPI evaluation report

Deliverable n°	D9.3
Version Date	08/03/2022
Type of Deliverable	Report
Dissemination Level	Public
Leader/Responsible of Deliverable	TNO
Status	Draft

Interoperability

- Test protocols and test infrastructure were developed and successfully implemented
- Interoperability test successfully tested in use case setting and in demonstrations
- Recommendations provided to **standardization** committees
- Interoperability guidelines available in ASSURED 1.1 (freely available)

Highlighted results

Energy efficiency

- Fast charging is not favourable for the charging energy efficiency
- Mainly due to energy losses in the battery pack and required cooling
- For a standard 12m bus the energy consumption was **1.09-2.11 Kwh/km** depending mostly on the type of operation and weather conditions.
- Significant savings can be achieved with operational measures on ECO-driving and to a lesser extend on ECO-comfort.

Fleet upscaling results

Lessons learnt from the Eindhoven (NL) eBus operation

- Operational constraints haven't changed since **2016!**
- **Today** more robust operation due to technology advancements
- > 10 Million km driven electrically!
- Reliability on par with conventional diesel bus
- Transition from **e-mobility** to **i-mobility** is to be made, thereby saving costs on infrastructure and vehicles.
- Continuous innovation needed to meet never ending pressure on TCO reduction: flexibility and connectivity.
- D 9.4 – Report for upscaling to a fleet of 100 vehicles in Eindhoven


ASSURED
Fast and Smart Charging Solutions for Full Size Urban Heavy Duty Applications
D 9.4

Eindhoven Electric Bus Fleet Upscaling aspects growing intelligently to 100 Vehicles

D 9.4 – Report for upscaling to a fleet of 100 vehicles in Eindhoven

Deliverable n°	D9.4
Version Date	16/03/2022
Type of Deliverable	Report
Dissemination Level	Public
Leader/Responsible of Deliverable	Jan van Meijl (VDL)
Status	Issued

Acknowledgements

Thanks to ALL ASSURED partners!!!

Special thanks to:

- **Sara Fozza** from Rina for all the ground work on KPI’s
- **Manuel and Johannes** for the data collection
- **Nikos and Robert** for the conclusions
- **Jan and Peter** for sharing insights based in practical experience

Acquisition of proposal
April 2016 - Turin
CNH MUSEUM

Final Event
March 2022 – Brussel
AutoWorld MUSEUM

Acquisition of proposal
April 2016

Final Event
March 2022
Brussel

Fabrizio Camisetti, Rina-C

Business Modelling and Deployment Strategies

Business Modeling and Deployment Strategies

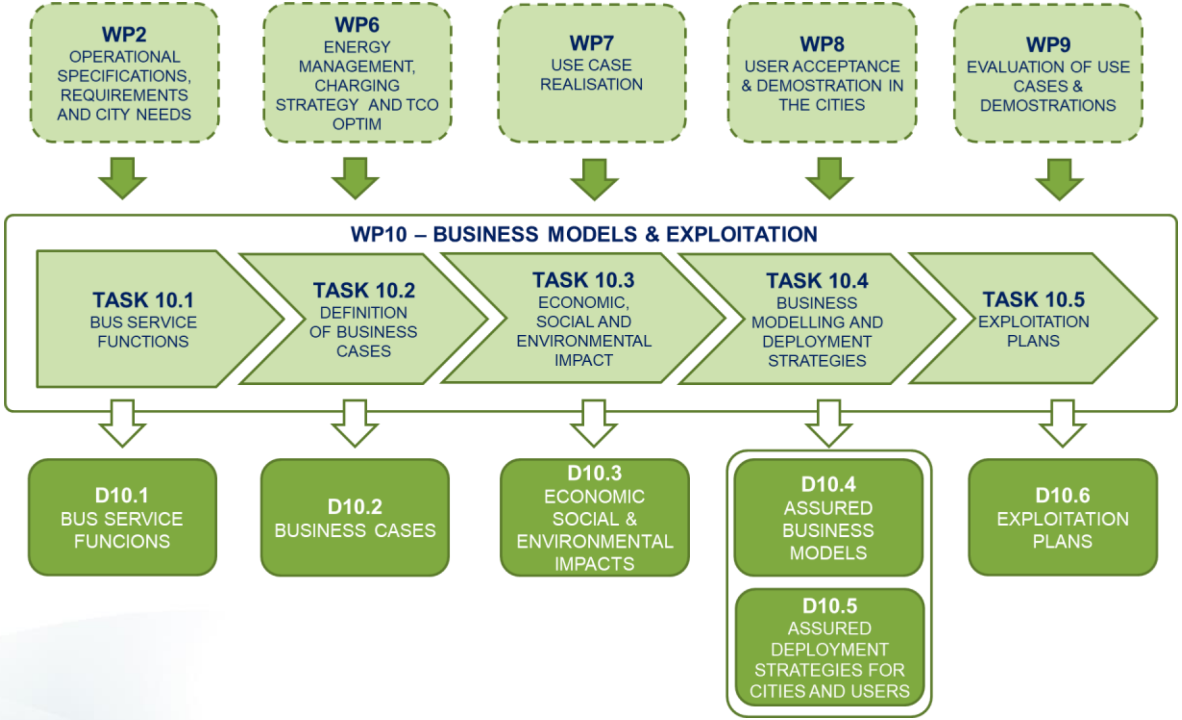
Final Conference
"Electric Fleets for Green Cities"
Brussels 21 March 2022

Fabrizio Camisetti – RINA C

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 769850.

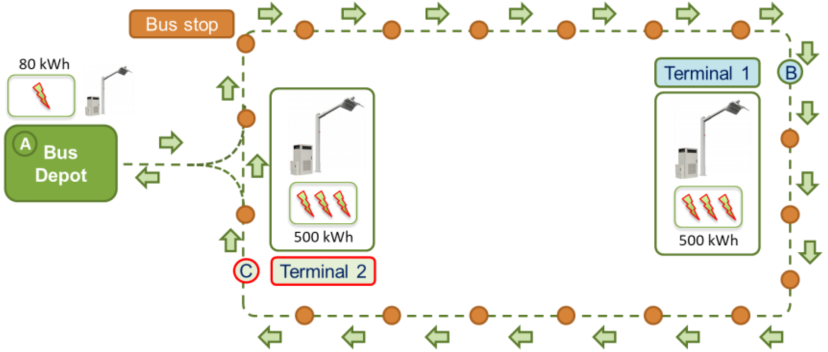
![ASSURED logo]

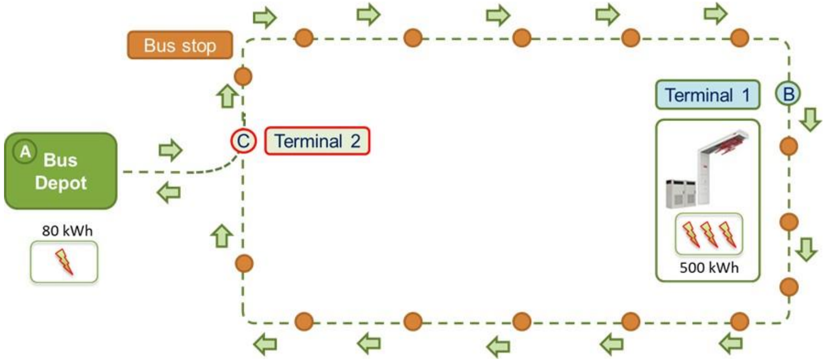
Workflow



Business Cases

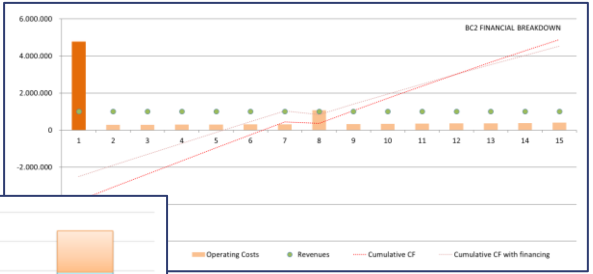
- BCs build considering improvements showed in Use Cases and Demo Cities and key results highlighted through the evaluations made in the other work-packages
- BCs set up considering main elements positively tested in real operation and showing both economic & financial aspects and social & environmental aspects
- Several parameters (elements, assets composition, operational needs, ….) and were considered and evaluated

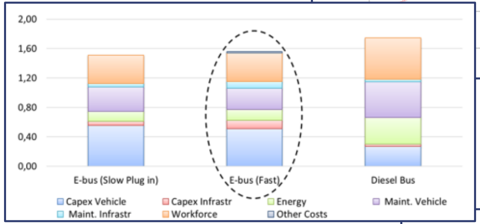


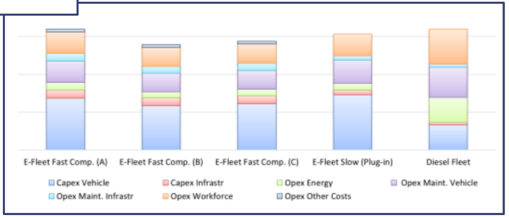


Economic impacts

- Financial and economic analysis were done for each BCs to evaluate their performances and suitability
  - Results (cash flow, NPV and IRR) collected and analyzed
  - Performance evaluated (also using Sensitivity Analysis)
  - Comparison of results with other possible solutions using electric vehicles with similar characteristics but charged with slow charging plug-in solutions or diesel vehicles
  - Comparison with different fleet composition

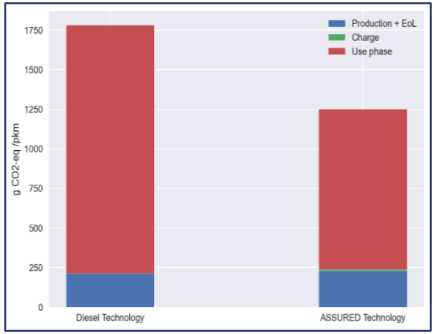


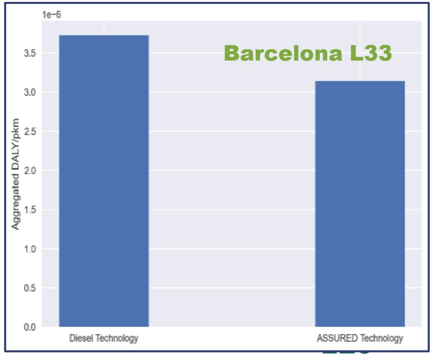




Environmental and Social impacts

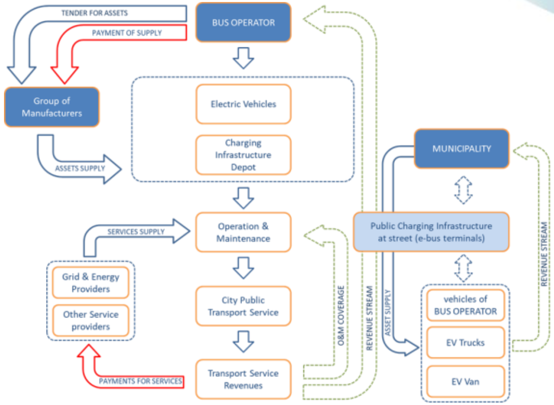
- Environmental impact was done using Life Cycle Assessment (LCA) methodology and social impact was assessed by calculating the Disability Adjusted Life Year (DALY)
    - ASSURED technology performed generally better than diesel
    - Charging infrastructure’s contribution to emission is negligible considering the lifetime of a bus
    - Using clean energy to charge the ASSURED bus will further reduce the environmental impact
    - Social impacts are different according to the specific line
    - All the impact of diesel has a local impact. For ASSURED social impacts are not local. The impacts are upstream, where electricity is produced

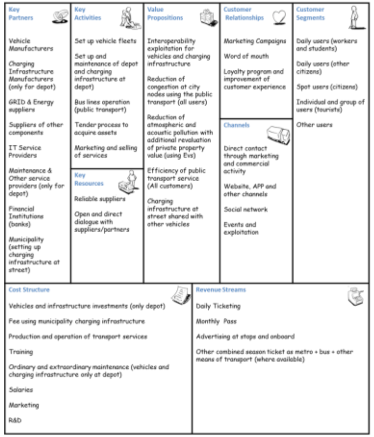




Business Modeling

- The activity included in the first part a value system, market overview, competitor analysis and potential business opportunities
- Business models for further exploitation of project results were developed, using a common methodology (Canvas) for definition and evaluation. In particular:
  - Business models description, including key characteristics, links, role of entities and cost and revenue streams
  - Additional elements and insights from business models
  - Technical and not technical barriers and regulatory restrictions



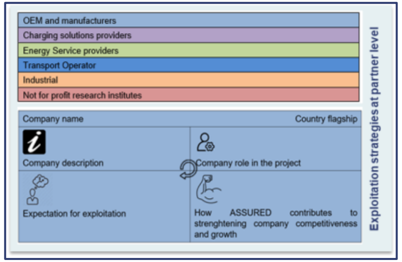


Deployment Strategies

- Deployment strategies developed serve as a guiding report to cities and public transport authorities/operators to plan their electrification journey driven by the vision of ASSURED
- The work related to deployment strategies aims to simplify the process of deployment using SUMP methodology
- Interviews were conducted with city officials and PTO/PTA representatives among ASSURED's cities
- The analysis of driving forces and barriers under different categories (technology, operational,…) , answers how far projects as ASSURED has come in order to support electrification as well as points to the work that is still ahead to reach faster deployment to achieve clean air and climate action goals set out by cities, regions and nations in Europe

Exploitation plan

- The objective of the activity was the definition of the exploitation strategies to ensure the impact of the project, including measures and methodologies managing and protecting the project IP and generated foregrounds. The results achieved are:
  - Identification of ASSURED Exploitable Results (ERs)
  - Vehicles related exploitable results and related exploitation strategies
  - Fleet management and charging system technologies related Characterization and exploitation strategies
  - Prioritization and Risk Assessment Analysis of Fleet Management and Charging System Technologies related Exploitable Results
  - Exploitation strategies at partner level
  - IPR management approach and plan – BFMULO analysis



Project Result General description	**Project Result # / Title**				
	Project Result Short description/Service Description	*Short description of the component and of the related service provided*			
	Innovation content/ Competitive advantage/Benefits	*Added value of the project result/service provided from the end-user point of view*			
	Type of Result	*e.g., Product/Tool, Model, Algorithm, Method, Software, Platform, Knowledge, Other to be specified*			
	TRL	Before ASSURED		After ASSURED	
Market	Targeted Market	*Example of application or scenario for the project result/service B2B or B2C market Sector of application*			
	Customer segments and whom to address (inside the clients' organization)				
	Benefit to customers				
	Potential competitors				
IPR	Owner(s) of Result				
	Other Partners involved	*If there are other partners involved, we will involve them in the exploitation call*			
	Joint ownership (Need of agreement before the end of the project?)	Yes/No			
Exploitation Strategy	Exploitation claim	**Consultancy service**	**Academic exploitation**	**Commercial exploitation (E.g. selling licenses)**	**Other**
		Yes/No	Yes/No	Yes/No	Yes/No
	Revenue streams associated to the above exploitation claim	€	€	€	€
	Estimated yearly selling price (if already considered)				
	Estimated effort to bring the Project Result to the market (yearly)	Activities	Cost	Time	

Some outputs & points for discussion

- No one-size-fits-all solution when it comes to deployment of electric fleets in cities
- Vehicles related ERs were developed in a very prompt and efficient manner, going faster that the time scheduled within the project.
- Strong effort to be spent in the next years with the aim to improve competitiveness, by overcoming bottlenecks towards the expansion of the e-bus fleet all over Europe (e.g., vehicles and infrastructure costs, interpretation of standards, local laws and regulations per member states and between member states to be standardized as far as possible, etc…)
- The work performed within the project has been really valuable, or in any case, relevant since helped to allow a European market where standards and test methods are accepted and reliable
- Considering the increase of e-fleets in cities and the corresponding demand for energy, it has to be accounted that exploring innovative deployment strategies such as charging hubs allowing the use of shared charging infrastructure among not only different vehicle and charger manufacturers but also across sectors should be a proactive step towards tomorrow's cities with large electric fleets

…. and finally ….

A special thanks to all Partners for the fruitful collaboration!

Thanks for the attention

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What are the advantages of using Wireless Power Transfer for EVs?

a) No exposed wires
b) Charging convenience
c) Power transmission during adverse weather
d) All the above

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Were you aware of the ASSURED 1.1 Interoperability Reference?

a) Yes
b) No

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“What do you consider as most valuable result from the ASSURED Use Cases and Demonstrators?

a) Developments on standardisation leading to interoperable solutions
b) Implementing, testing and comparing fast charging solutions against conventional solutions
c) Learning more about the impact of the fast charging on grid, battery, TCO

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In your view, what steps should be taken in the short and medium term, to further advance the electrification of urban transport?

a) To continue the technological development process and at the same time implement the interoperability level;

b) To decrease the significative investment costs of vehicles and charging infrastructures for a wider electrification in the cities;

c) To create new innovative business models shared between public and private entities involved in local public transport.

Announcement

ASSURED Clean Bus Report

Inspiring cities to be part of the clean bus movement

125+

CITIES, OEMs & SUPPLIERS

ASSURED Clean Bus Report

Register now via QR-code to be receive your copy!

Round table

Remote speaker

What has ASSURED delivered and what are the challenges ahead?

Moderator

Aida Abdulah & Arno Kerkhof

Bus Unit, K&I, UITP

UITP

Maurizio Maggiore

DG Research and Innovation
European Commission

Maitane Berecibar

Head of Battery Innovation Centre, MOBI-VUB

Mario Canet Sabate

New Developments Manager
TMB, Barcelona

Transports Metropolitans de Barcelona

Benjamin Roelands

Electric Buses Program Manager
STIB-MIVB Brussels

Sergio Fernández Balaguer

EMT Madrid

Gerard Hellburg

Vervoerregio Amsterdam

Joachim Kossow

Stadtwerke Osnabrück, Osnabruck (remote)

Participants

Maurizio Maggiore, DG RTD EC
Maitane Berecibar, VUB
Mario Canet, TMB Barcelona
Benjamin Roelands, STIB Brussels
Sergio Fernández, EMT Madrid
Gerard Hellburg, Vervoerregio Amsterdam
Joachim Kossow, Stadtwerke Osnabrück

Closure

Maitane Berecibar

Aida Abdulah

Parallel Sessions start 14.30!

- **PS1 “Standardisation & interoperability of e-vehicle charging”**
- **PS2 “Looking into full electrification: Shared charging infrastructure for urban fleets”**
- **PS3 “Design optimization tool and simulation platform to ensure modularity and fleet upscale”**

Lunch break

See you at 14.30!

Thank You!

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