28/11/2024

Session 5: The promotion, procurement and commissioning process to complement clean energy vehicles

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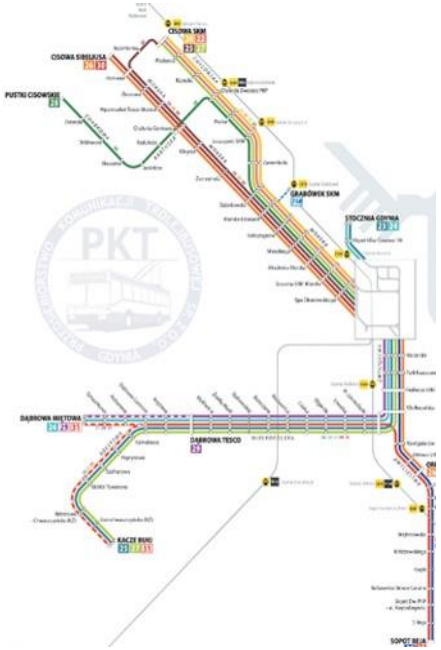
Session AGENDA

- How to sell the idea to the decision makers / lessons learned from previous trails of introduction (type of city, route structure and topography, etc.)
- Summary of experiences when introducing new In Motion Charging lines
- Inclusion of In Motion Charging in planning and feasibility studies in early stage
- Design of an explanatory campaign for the public, gaining public support
- Promotion of high efficiency of In Motion Charging solution, positive effects on reducing the carbon footprint
- Accordance with EU Clean Vehicle Directives (or other national legislation) in inclusion of the National quotas of the member states

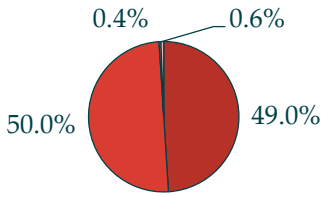
IS IT WORTH IT? YES! BUT HOW TO DO IT?

The promotion, procurement and commissioning process to complement clean energy vehicles on the example of Gdynia (PL) trolleybus system



GDYNIA PUBLIC TRANSPORT IN NUMBERS

- **250,000** inhabitants (**1 million** in Tricity)
- Length of public roads: ca. **400 km**
- Length of public transport routes: **ca. 250 km**
- Motorization rate: **500 cars/1000 inhabitants**
- Transport modes market share: **50/50**
  individual transport
  and public transport:



- **77%** of all Gdynia inhabitants live within a **5 min**. walk from a bus/trolleybus stop

Only 3 trolleybus cities in Poland – Gdynia, Lublin and Tychy - 15 in the past!

UITP

CURRENT GDYNIA TROLLEYBUS OPERATION

18 day lines (9 of them extended) + complementary operation on 3 bus lines

105 trolleybuses

90 km of trolleybus traction (both ways)

10 traction substations

over 5 milion vehicle km a year

410 employees (265 drivers – 2.5 driver per vehic.)

25% of drivers are women

ELECTRIC vs DIESEL PT MARKET SHARE

Trolleybus transport covers ca. **30%** of the whole public transport in Gdynia and neighbouring spa resort city Sopot (which does not have public transport of its own), mainly in central areas of both cities.

GDYNIA TROLLEYBUS SYSTEM STARTED ITS OPERATION IN 1943. LAST YEAR IT CELEBRATED ITS 80TH ANNIVERSARY

PASSENGER INFORMATION

In 1990s - the threat of closing down the trolleybus system in Gdynia

2005 -2007 – 1st EU project to modernize and revive Gdynia trolleybus transport:
new depot, 10.5 km of new grid, new low floor fleet of 10 trolleybuses, 13.5 milion EUR – 50% cofinancing from ERDF

2014 REGIOSTARS EUROPEAN COMMISSION AWARD for the best investment project in sustainable public transport

2010 -2013 – 2nd EU project to stregthen the quality of trolleybus transport:
modernization of existing wired infrastructure, new substations, centralised power distribution, new fleet of 30 trolleybuses
25 milion EUR – 70% cofinancing from ERDF

Development of pro-ecological public transport in Gdynia

Project I - co-financed from European Regional Development Fund (2004-2006 programming period)

Increasing the access to ecological trolleybus public transport and raising the efficiency of its functioning

- building new trolleybus depot
- constructing new trolleybus lines (10.6 km of trolleybus traction single line)
- purchase of 10 new low-floor trolleybuses

Total cost of the project: 14 m Euro
Co-financing from ERDF: 5.6 m Euro (50%)
Implementation: 2005-2007

ZPORR
Zintegrowany Program Operacyjny Rozwoju Regionalnego


PRZEDSIĘBIORSTWO KOMUNIKACJI TROLEJBUSOWEJ

Development of pro-ecological public transport in Tricity Metropolitan Area

Project II complementary to Project I - co-financed from European Regional Development Fund (2007-2013 programming period)

Further increasing the efficiency trolleybus transport functioning

- modernization of the traction network along the main streets of Gdynia and Sopot (11.5 km of trolleybus traction single line) with the reconstruction of 1 trolleybus loop
- construction of 4 new and modernization of 5 existing traction substations
- construction of Substations Remote Control Centre for enhanced and decentralized power management
- purchase of 28 new state-of-the-art low floor trolleybuses with alternative drive (Ni-CD battery) and regenerative braking system

Total cost of the project: 24.5 m Euro
Co-financing from ERDF: 13.6 m Euro (70%)
Implementation: 2010-2013

PROGRAM REGIONALNY
NARODOWA STRATEGIA SPÓJNOŚCI


7:36
sestor


PKT GDYNIA
3086
PKT
GA 4031


WYJŚCIE


PKT GDYNIA
70 LAT KOMUNALNEJ KOLEI TROLEJOWEJ W GDYNI
TRADYCJA I NOWOCZESNOŚĆ
3071
PKT
SOLARIS
GA 7815L

Gdynia trolleybus network after two major upgrade projects

Project

ZPORR
Zintegrowany Program Operacyjny Rozwoju Regionalnego

Project II

PROGRAM REGIONALNY
NARODOWA STRATEGIA SPÓJNOŚCI

2ND UPGRADE PROJECT ECOLOGICAL GAINS

BEFORE THE PROJECT:
yearly traction electric energy consumption: **13 GWh**

AFTER THE PROJECT:
yearly traction electric energy consumption: **10.5 GWh**

ECOLOGICAL BENEFITS:

- **reduction of yearly energy consumption** (**by ca. 20 %**)
  resulting from **yearly electric energy saving** **of 2.5 GWh**
- **reduction of transport pollution emission**
- **reduction of yearly CO_2 emission** **by 2.25 Gg = 2 250 tons**

2 250 TONS OF CO_2 LESS

GDYNIA
moje miasto

2014 REGIOSTARS EUROPEAN COMMISSION AWARD FOR GDYNIA PUBLIC TRANSPORT OPERATOR FOR THE EU BEST INVESTMENT PROJECT IN SUSTAINABLE PUBLIC TRANSPORT

LINK TO REGIOSTARS VIDEO: GDYNIA TROLLEYBUSES (PKT GDYNIA) - WINNER REGIOSTARS 2014 (presentation 31/3/2014 EN)

Gdynia trolleybus transport development through complementary EU projects

ZPORR Zintegrowany Program Operacyjny Rozwoju Regionalnego

Pomorskie w Unii URZĄD MARSZAŁKOWSKI WOJEWÓDZTWA POMORSKIEGO www.woj-pomorskie.pl

PROGRAM REGIONALNY NARODOWA STRATEGIA SPÓJNOŚCI

UNIA EUROPEJSKA EUROPEJSKI FUNDUSZ ROZWOJU REGIONALNEGO

actuate

INTELLIGENT ENERGY EUROPE FOR A SUSTAINABLE FUTURE

CENTRAL EUROPE COOPERATING FOR SUCCESS. EUROPEAN UNION EUROPEAN REGIONAL DEVELOPMENT FUND

Trolley Promoting electric public transport

- training programmes in safe eco-driving

- dual power supply system on the network
- feasibility studies on further public transport electrification in Gdynia by IMC trolleybuses

eLIPTIC

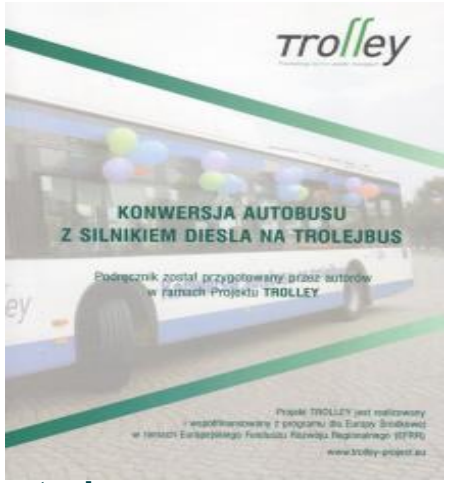
Innovative solutions:

- new technology battery IMC trolleys
- supercaps on substations

2020 CiViTAS Cleaner and better transport in cities DYN@MO

THE CIVITAS INITIATIVE IS CO-FINANCED BY THE EUROPEAN UNION

- published handbook on conversion of a diesel bus into a trolleybus



- study on areas predisposed for supercapacitor recuperation energy storage installation

ORIGINS OF IMC TROLLEYBUSES IN GDYNIA

In 2009 - preparation for the fleet modernization co-financed by EU funds

Basic requirement for the new fleet – auxiliary drive allowing for autonomous operation of trolleybuses

Diesel drive

- long distatance
- flexibility
- popular solution

Battery

- promising technology
- zero emission
- easy maintenance („all electric")

Decision makers

CIVITAS DYN@MO

THE CIVITAS INITIATIVE IS CO-FINANCED BY THE EUROPEAN UNION

- Tendering and purchase of **2 new hybrid trolleybuses** (from SOLARIS Bus and Coach) **with an alternative power source – a new type of a battery from Lithium batteries family (Lithium-ion)**
- in **2015** - choice of a new schedule trolleybus line to be serviced by hybrid trolleybuses with a new battery (**line 21**) – 2 trolleybuses getting off the traction in the central area of Gdynia and going for 2 km solely on the battery as the power source
- purchase of **a supercapacitor for storing braking energy** (20% energy savings) – installed in one of the substations placed in the hilly area where there is a lot of braking

BATTERIES IN GDYNIA TROLLEYBUSES

Ni-Cd battery

- capacity: **6-16 kWh**
- range: **3-5 km**
- length: **12 M**

Li-Ion battery

- capacity: **27 & 69 kWh**
- range: **ca.15 & 30 km**
- length: **12 M**

LiFePO4 battery

- capacity: **40 kWh**
- range: **ca. 20 km**
- length: **12M**

LTO battery

- capacity: **58 & 87 kWh**
- range: **ca. 35 km**
- length : **12M + 18M**

+ 6 12M trolleybuses with LTO batteries (75 kWh) – GEPARD PROGRAMME

IMC IN USE - REGULAR OFF WIRE OPERATION

Line 21 – line extended by 2 km off wire section; landmark street of Gdynia Skwer Kościuszki; on since 2015

Line 29 – line extended by 4 km off wire section; highly populated Fikakowo residential area; on since 2016

Automatic lowering and raising of current collectors due to special devices – docking stations placed on the overhead grid

FURTHER TROLLEYBUS LINES EXTENSIONS AND DIESEL BUS LINES REPLACEMENT

► line 31 – extension by 5 km to ERGO ARENA sports stadium in Gdansk
► several new trolley lines extensions as well as replacement of diesel bus lines - 34 to Demptowo and replacement of diesel buses by IMC trolleys on lines 181, X and on a night line N30

IMC IN USE - REGULAR OFF WIRE OPERATION IN GDYNIA
2015: FIRST OFF WIRE LINE GDYNIA TROLLEYBUS LINE
2024: 50 % OF THE LINES ARE EXTENDED (9 OF 18)

PROCUREMENT AND COMMISSIONING

The tendering proces for IMC trolleybus operations must be very throroughly structured to ensure the selection of reliable and qualified service providers suitable for the specific service conditions.

Tender documents should specify:

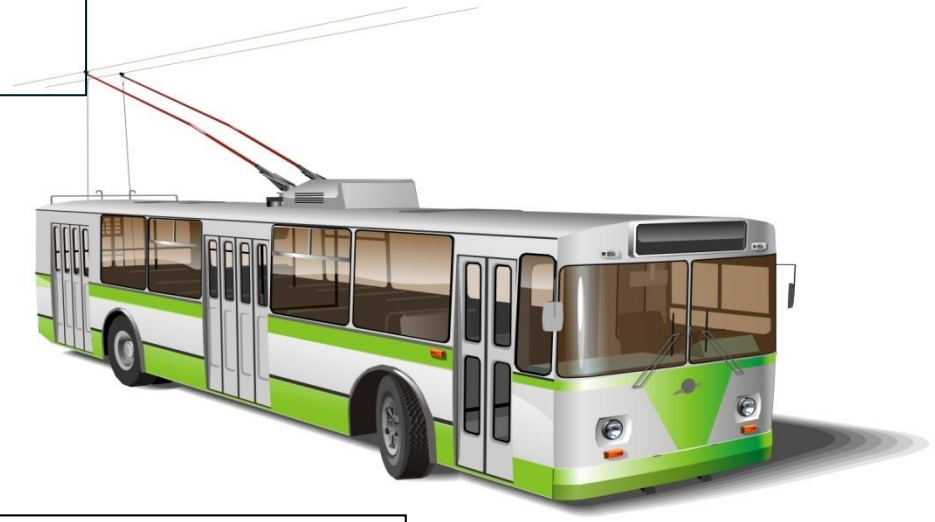
- detailed functional requirements incl. battery performance & capacity
- vehicle compatibility standards
- energy efficiency benchmarks
- service details (eg. route profile, schedule and demand)
- guarantees
- after sales customer service

PROCUREMENT - VERY EXACT TECHNICAL SPECIFICATIONS FOR THE VEHICLES

Automatic pantographs enabling automatic raising and lowering of the collector

Asynchronous drive with energy recovery system

Alternative energy source – a customized capacity battery enabling regular off-wire operation



Internal and extrenal monitoring system

Air conditioning in the whole vehicle

RAISING AWARENESS AND GAINING ACCEPTANCE

GAINING PUBLIC SUPPORT

Design of an explanatory campaign for the public

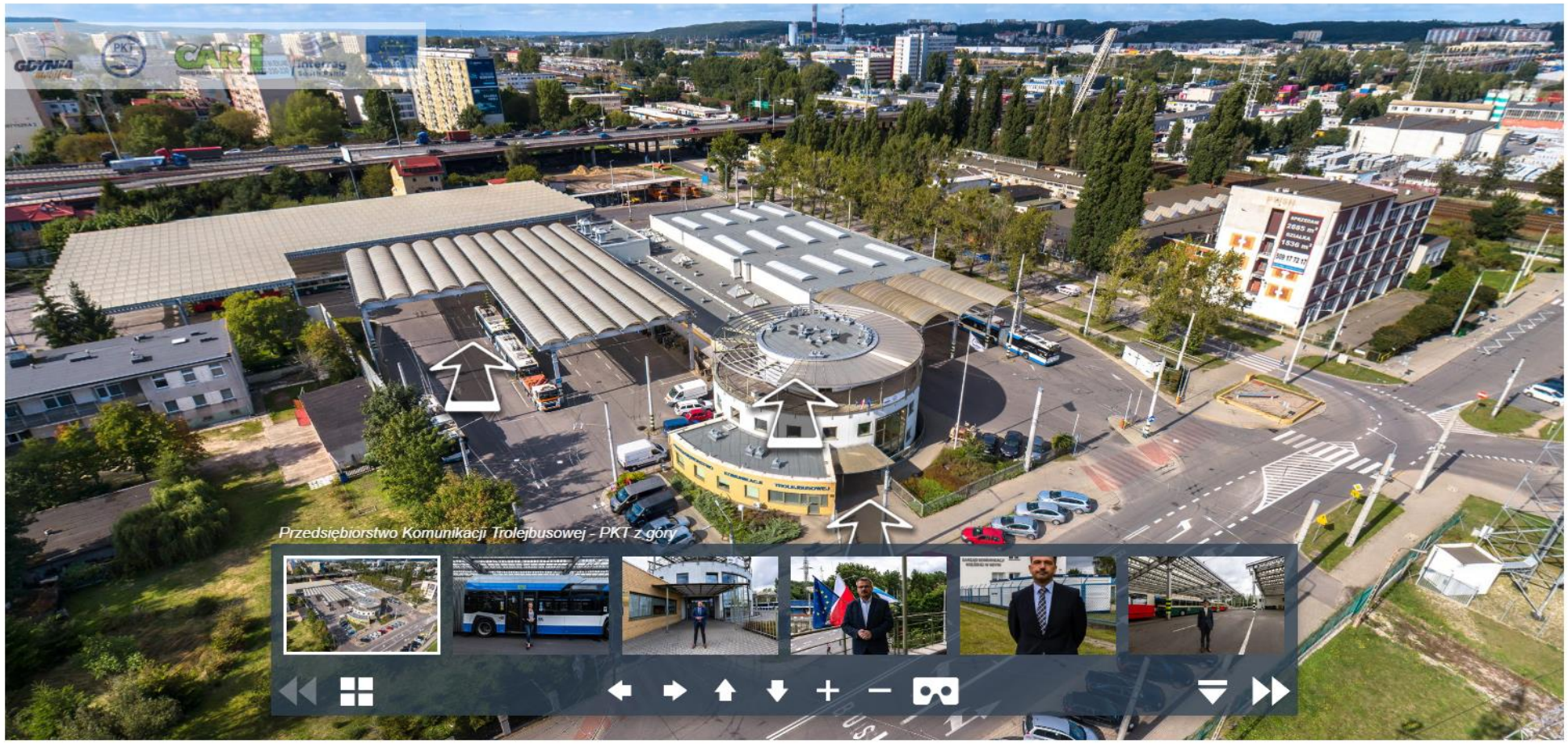
GAINING PUBLIC SUPPORT

GAINING PUBLIC SUPPORT

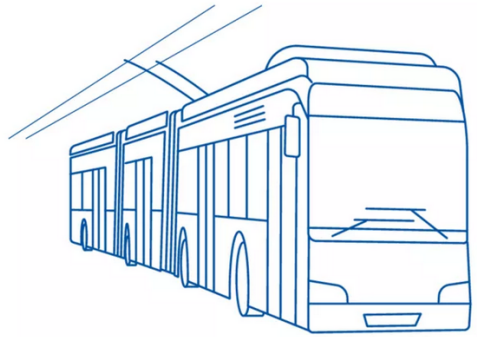
OPEN THE DEPOT TO THE PUBLIC

Niezabezpieczona | pktgdynia.pl/index.php/filmy/

WIRTUALNY SPACER PO ZAJEZDNI TROLEJBUSOWEJ!



RAISE AWARENESS – CITIZENS ENGAGEMENT



DAS BATTERIE-OBERLEITUNGSBUS-PROJEKT

Der BOB fährt rein elektrisch und bezieht seinen Energiebedarf aus einer Oberleitungsanlage. Durch eine zusätzliche kleine Batterie ist er flexibel und kann auch Strecken ohne Oberleitungskontakt fahren. Somit ist der BOB emissionsfrei unterwegs. Ziel ist es, bis zum Jahr 2030 die Stadtbuslinien 7 und 27 auf Teilstrecken mit Oberleitungen auszurüsten und den regulären Betrieb mit dem BOB aufzunehmen.

Die batteriebetriebenen Oberleitungsbusse bieten einen echten Mehrwert für Marburg!

- **Klimaschutz**: Die Umstellung auf batteriebetriebene Oberleitungsbusse auf den Linien 7 und 27 ist aufgrund des hohen Wirkungsgrades ein wichtiger Baustein für einen klimaneutralen ÖPNV und zur Erreichung der Klimaziele.
- **Effektivität**: Mit dem BOB können dank des Einsatzes von 24 m langen Doppel-Gelenkbussen auch höhere Beförderungskapazitäten von und zu den Lahnbergen bei der großen Höhendifferenz dargestellt werden.
- **Lebensqualität**: Batteriebetriebene Oberleitungsbusse verursachen keine lokalen Emissionen im Vergleich zu Bussen mit Verbrennungsmotoren, sie sind im Straßenverkehr auch deutlich leiser und steigern somit die Lebensqualität in der Stadt.

Mehr erfahren

DIALOG UND INFORMATIONEN

Sie haben weitere Fragen oder möchten die Planungsunterlagen einsehen? Dann sind Sie hier genau richtig.

- Stellen Sie Fragen zu dem Projekt unter "MarburgMachtMit"
- Alle Downloads und Materialien des BOB-Projekts auf einen Blick

FAQ, Downloads & mehr...

Ein BOB für Marburg

Infomarkt zum batteriebetriebenen Oberleitungsbus (BOB) für Marburg

Was ist ein **BOB**? Der BOB – ein batteriebetriebener Oberleitungsbus – fährt rein elektrisch und bezieht seinen Energiebedarf aus Oberleitungen. Durch eine Batterie ist er flexibel und kann auch Strecken ohne Oberleitungskontakt fahren. Somit ist der BOB emissionsfrei unterwegs und leistet einen wichtigen Beitrag zu Marburgs ehrgeizigem Ziel: **Klimaneutralität bis 2030.**

Weitere Informationen unter
www.bob-marburg.de

STADTWERKE MARBURG

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Bundesministerium für Digitales und Verkehr

UITP

https://www.bob-marburg.de/

RAISE AWARENESS – CHAMPION CITIES

Historic Centre of the City of Salzburg: UNESCO World Heritage

IMC TROLLEY LIGHTHOUSE EXAMPLES

- Biel, Switzerland
- Zurich, Switzerland
- Solingen, Germany
- Cagliari, Italy
- Prague, the Czech Republic
- Arnhem, the Netherlands
- Landscrona, Sweden
- Tallin, Estonia
- San Francisco, the USA (BRT)
- Rimini, Italy (BRT)

INTRODUCING IN MOTION CHARGING LINES

eBRT trolleybus line Rimini, IT

double-articulated trolleybus, Hess

UITP

INTRODUCING NEW IN MOTION CHARGING LINES

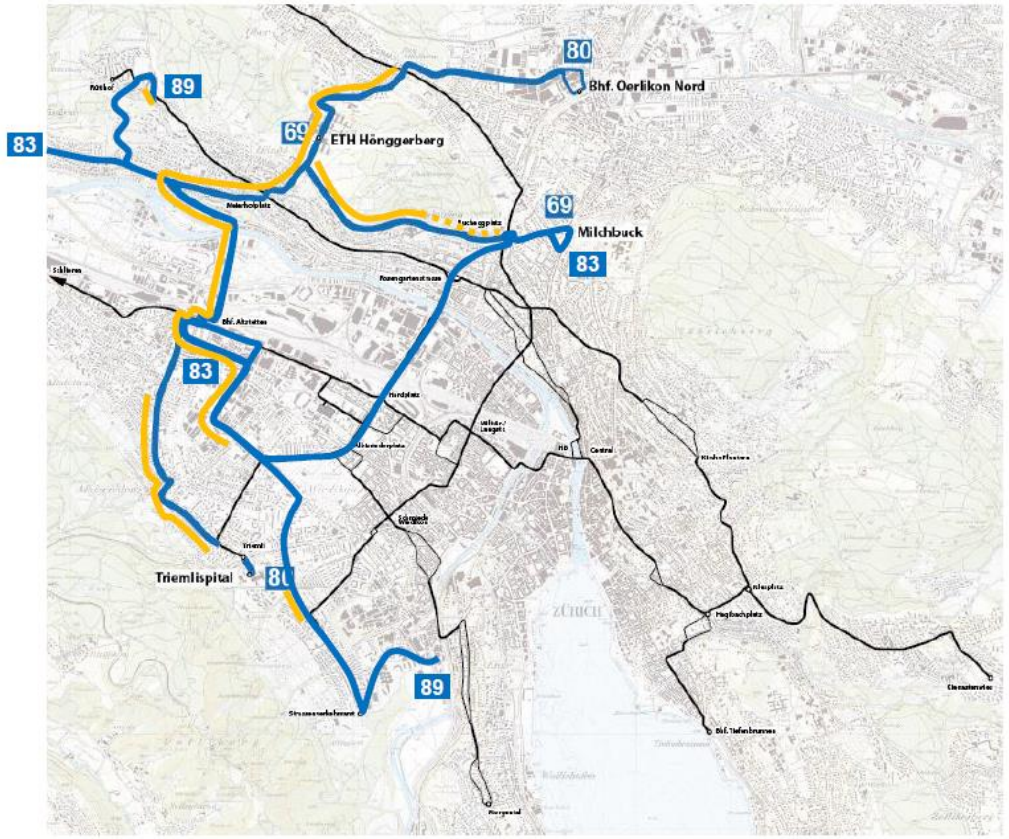
VanHool 24m Trolley in Linz, AT

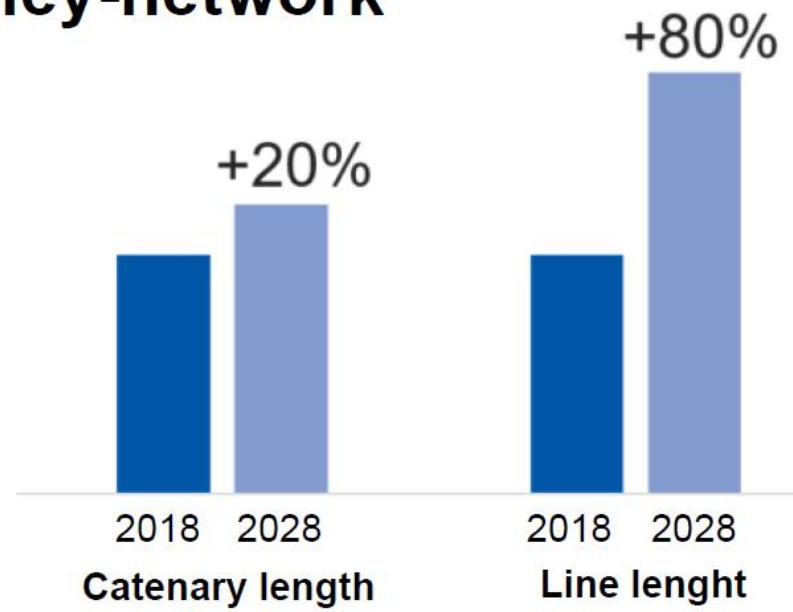
Solaris 24m Trolley

INTRODUCING IN MOTION CHARGING LINES

Upcoming extention of the trolley-network

Lines 69, 80, 83 and 89





Existing trolleybus network

New battery-trolley lines

Additional catenary lines 69, 80, 83 and 89

VBZ Zürich Linie

Ein Unternehmen der Stadt Zürich

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TESTING PHASE | 2010-2020 – Prague (DPP)

2011 – 2020 | electric battery buses

- Bi-polar charging technology, opportunity charging (short wire section)
- Synergies with tram grid / infrastucture (energy supply)

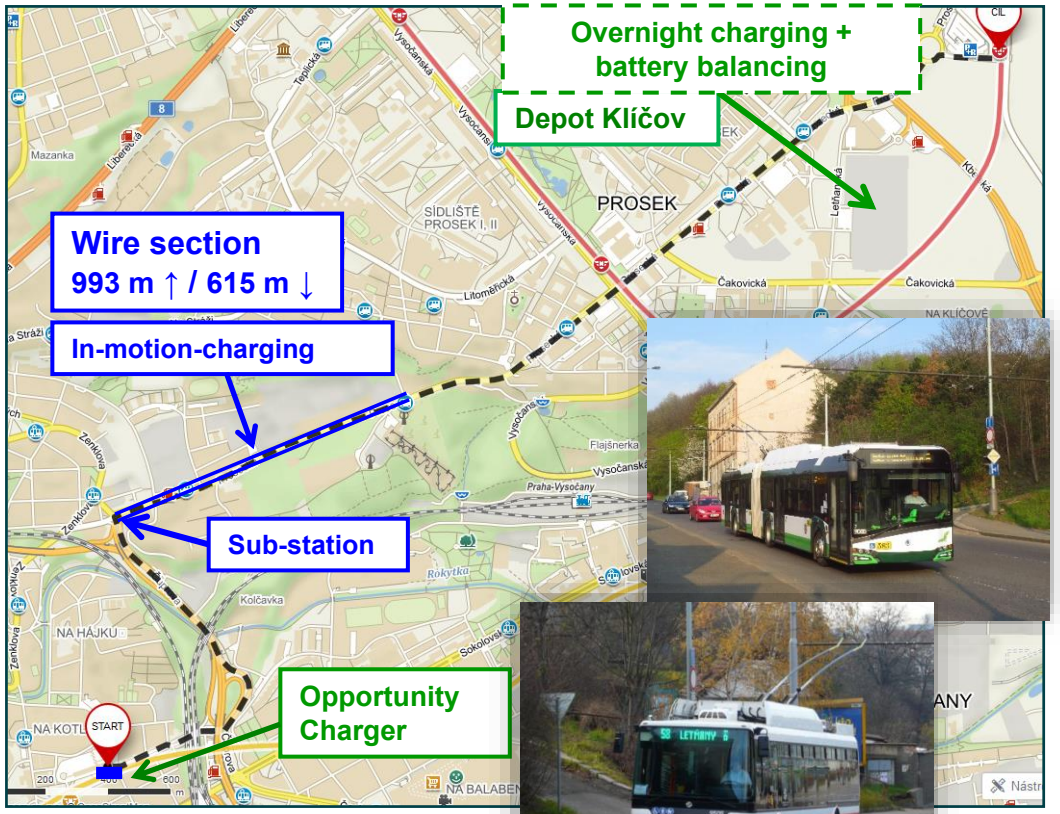
Since 2/2022 |electric buses

14x E-Busse Škoda 36BB (12 m)

- B-ipolar charging technology
- Energy supply (660 V) – from tram network
- EU-funding

2017 – 2020 | in-motion charging

- Pilot project Prosecká street, in-motion-charging
- Line 58 (Palmovka – Letňany)



RAISE AWARENESS – SHARE BEST PRACTICES

https://cleanbusplatform.eu/toolkit/cbep-matching-tool

Clean Bus Matchmaking Tool

Geographical Location / Climate Zone

None

Powertrain Technology

Battery Electric

Topography

Flat

HVAC

Fully electric heating

Line Type

City Centre

Line Length (km)

15

Bus Size

Solo (12m-15m)

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RAISE AWARENESS – STUDY TRIPS

CLEAN BUS EUROPE PLATFORM

The road to s

ABOUT JOIN TH

← BACK

Clean Bus Europ

9 May 2023

**In spring 2023, the Cl
concluded its Study T
months facilitated inv
on clean bus deploym
across Europe. After
Eindhoven (June 202
Paris (February 2023
Germany, Scandinavi**

Italy: Cagliari

The last CBEP Study Tour head to Cagliari (Sardinia) and was kindly hosted by operator CTM Cagliari. The Tour happened in conjunction with the UITP Trolleybus Committee and focused on battery trolleybuses and the integration of electric buses, charged with the trolleybus catenary.

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RAISE AWARENESS – STUDY TRIPS

User Forum to foster knowledge exchange (**workshops with 20-25 stakeholders & site visits**)

Example:
Eberswalde, DE

trolley:2.0 for smart cities

Electric Mobility Europe

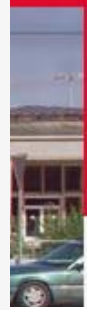
European Commission

UITP

City News (archive)

Seek...

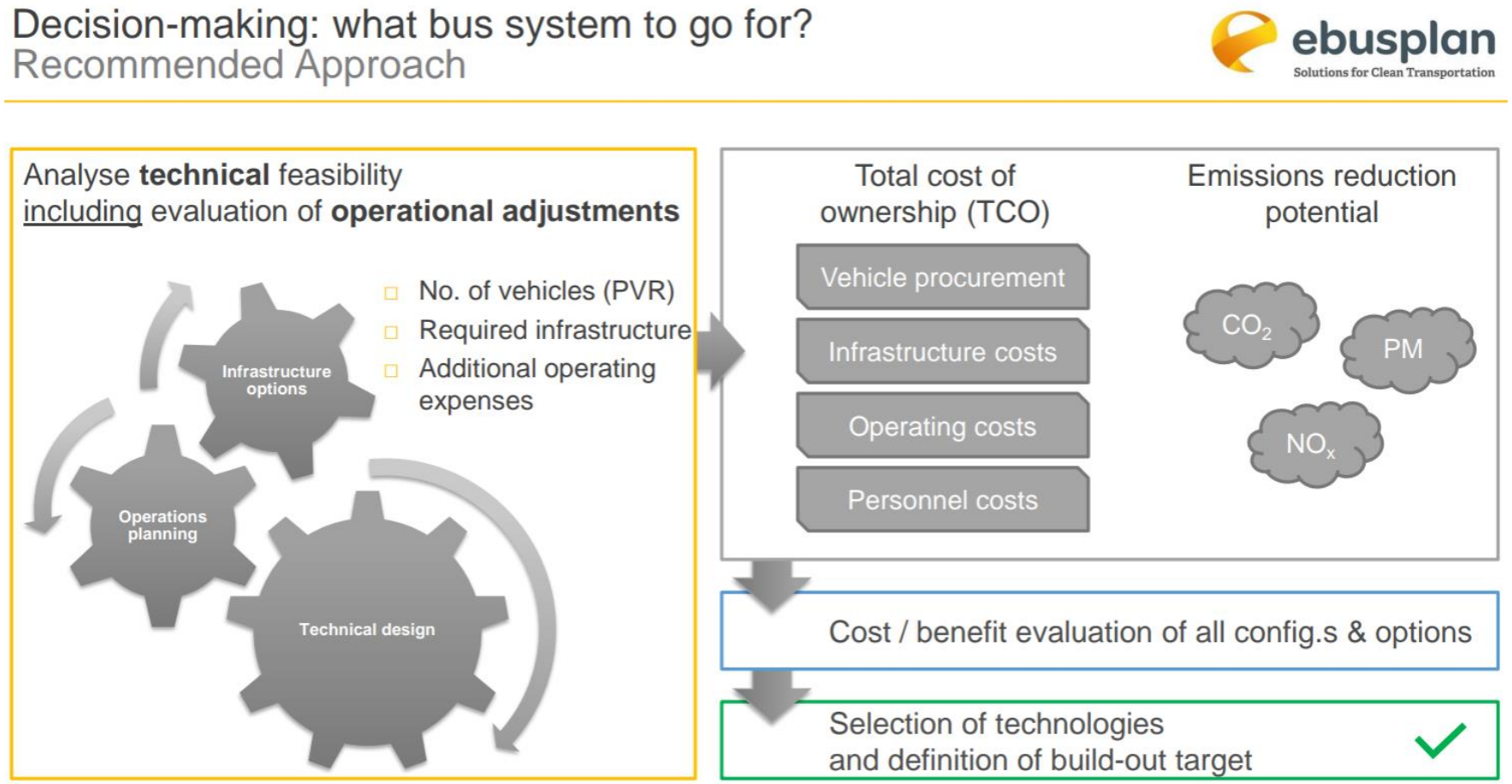
DATE	CATEGORY	HEADLINE
06/06/2023	Jinan [CN]	84 new cars and significant expansion plans
05/25/2023	St Etienne [FR]	Catenary for line M6 is completely renewed
05/24/2023	Lyon [FR]	Lines C1 and C2 end again at Gare Part Dieu
05/22/2023	Limoges [FR]	Conversion of Rue Jean Jaurès to a pedestrian zone
05/16/2023	Lublin [PL]	Cycle times on the trolleybus lines extended and fleet reduced
05/15/2023	Vilnius [LT]	Skoda delivers 91 32-tr solo cars
05/12/2023	Biel/Bienne [CH]	18 new trolleybuses are to be procured
05/11/2023	Marburg [DE]	Information market for battery-powered trolleybuses (BOB) on May 11, 2023
05/10/2023	Kherson/Cherson [UA]	Trolleybus service resumed
05/09/2023	trolley:planning	Foxton in New Zealand: dismantling of the plant
05/05/2023	Bucharest [RO]	Delivery of the 100 trolleybuses is brought forward
05/04/2023	Lucerne [CH]	Ordering of battery articulated trolleybuses for the expansion of electric operation was slowed down by the transport association
05/03/2023	Esslingen [DE]	Return after 11 years - duo bus 327 back in SVE ownership
04/28/2023	Neuchatel [CH]	First battery trolleybus delivered
04/27/2023	La Spezia 2 [IT]	First new Solaris trolleybuses put into operation



Anmelden

CREATE FACTS AND FIGURES

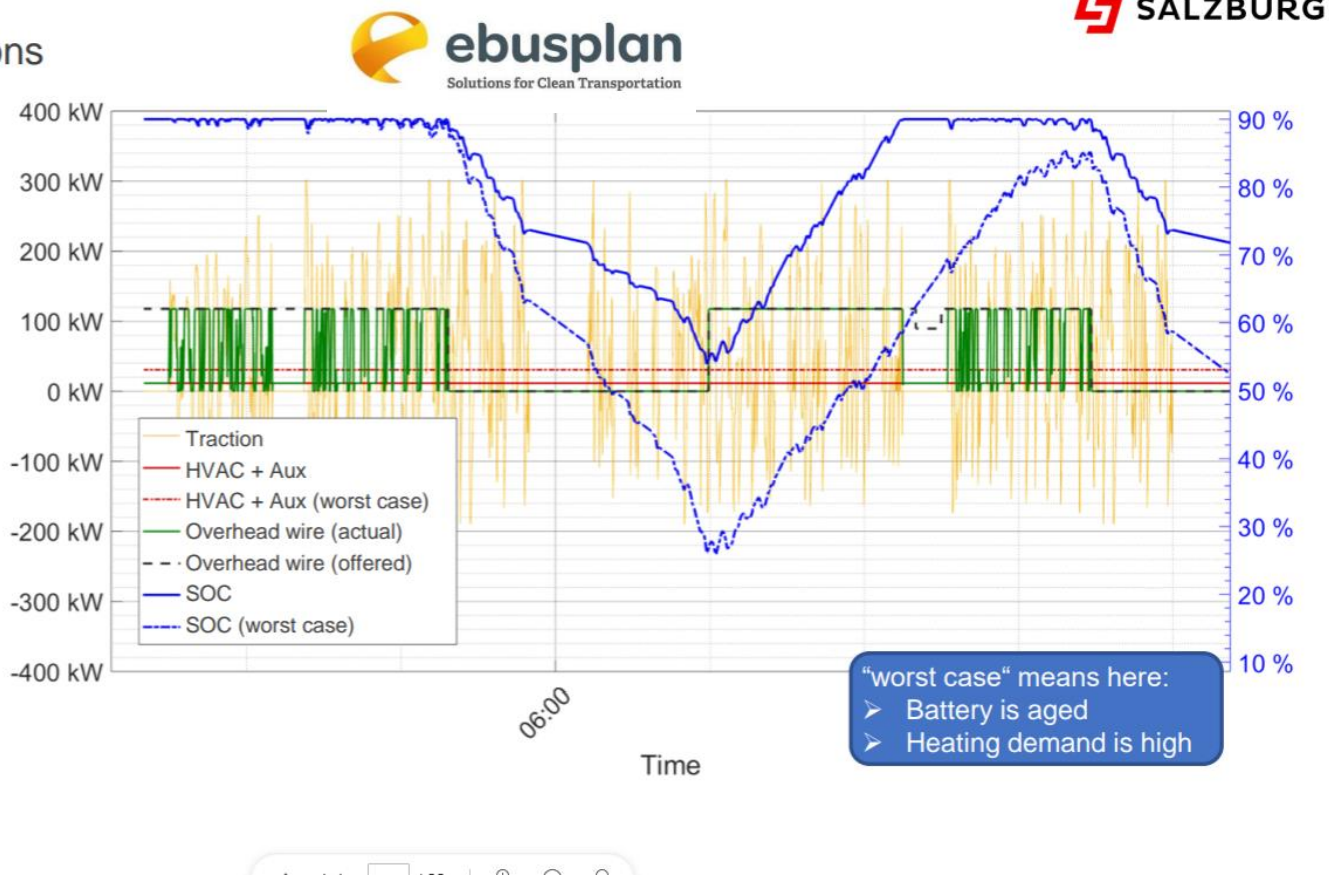
- Inclusion of In Motion Charging in planning and feasibility studies in early stage



CREATE FACTS AND FIGURES

- Inclusion of In Motion Charging in planning and feasibility studies in early stage

- Simulation of operations



CREATE FACTS AND FIGURES

- Inclusion of In Motion Charging in planning and feasibility studies in early stage, Berlin case

The trolley-battery-hybrid technology enables the electric operation of double-articulated buses and might reduce operating costs

BVG

Main results

- The trolley-battery-hybrid technology enables the electric operation of **double-articulated** buses
- The Spandau network can be operated with **approx. 60% catenary**
- The **initial investment costs** are about 50% higher than the ones for other e-bus technologies
- From a **30 years-perspective** the anual **total costs are similar**. However with the operation of double-articulated buses the total costs per passenger can be reduced
- If necessary the infrastructure can be used for **future tramway projects**

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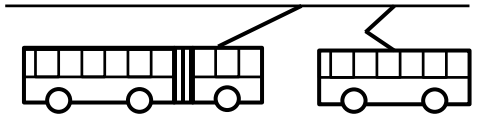
TROLLEYBUS + E-BUS SYNERGY



Cagliari (IT)

Prague (CZ)

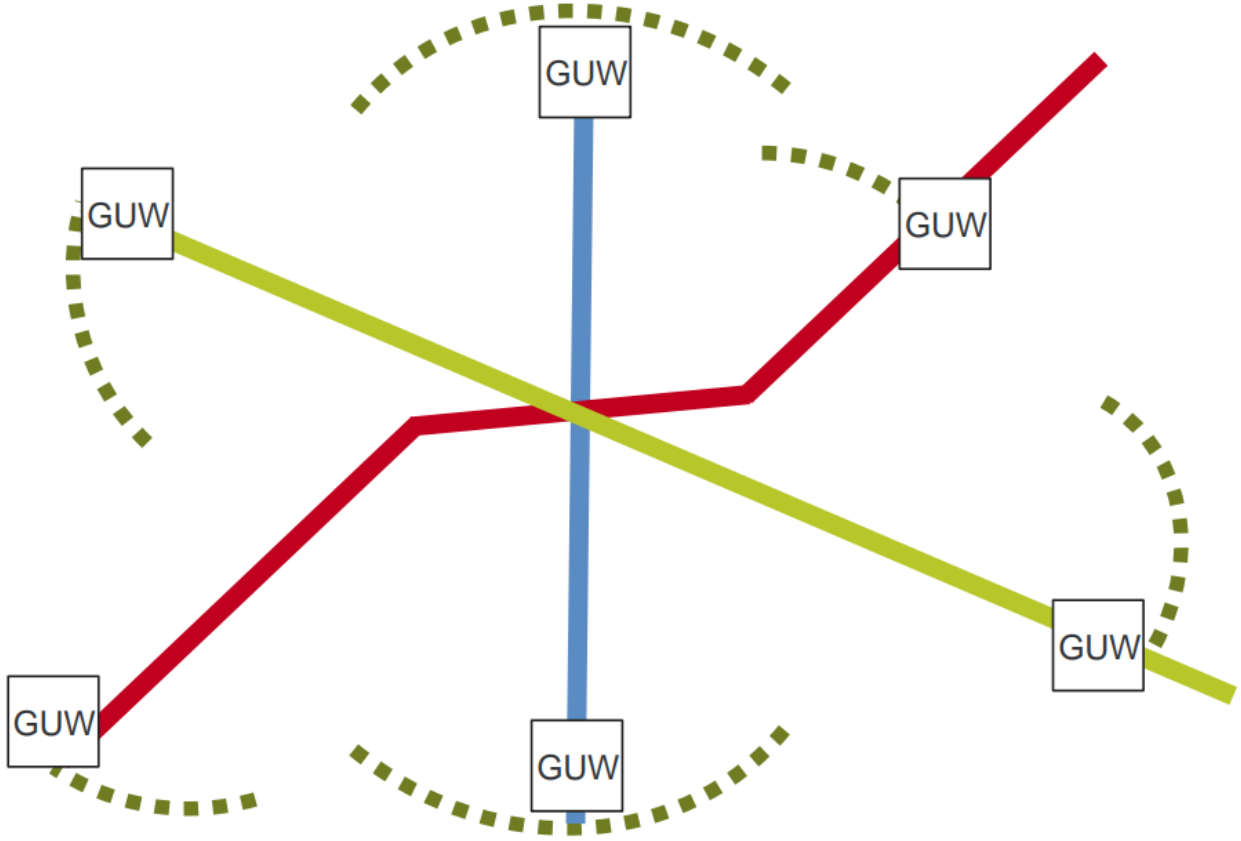
TRAM + TROLLEYBUS SYNERGY

Extending a tramway network

Tramway network

IMC bus line under trolleybus overhead contact line

GUW Rectifier substation



RPS Rail Power Systems

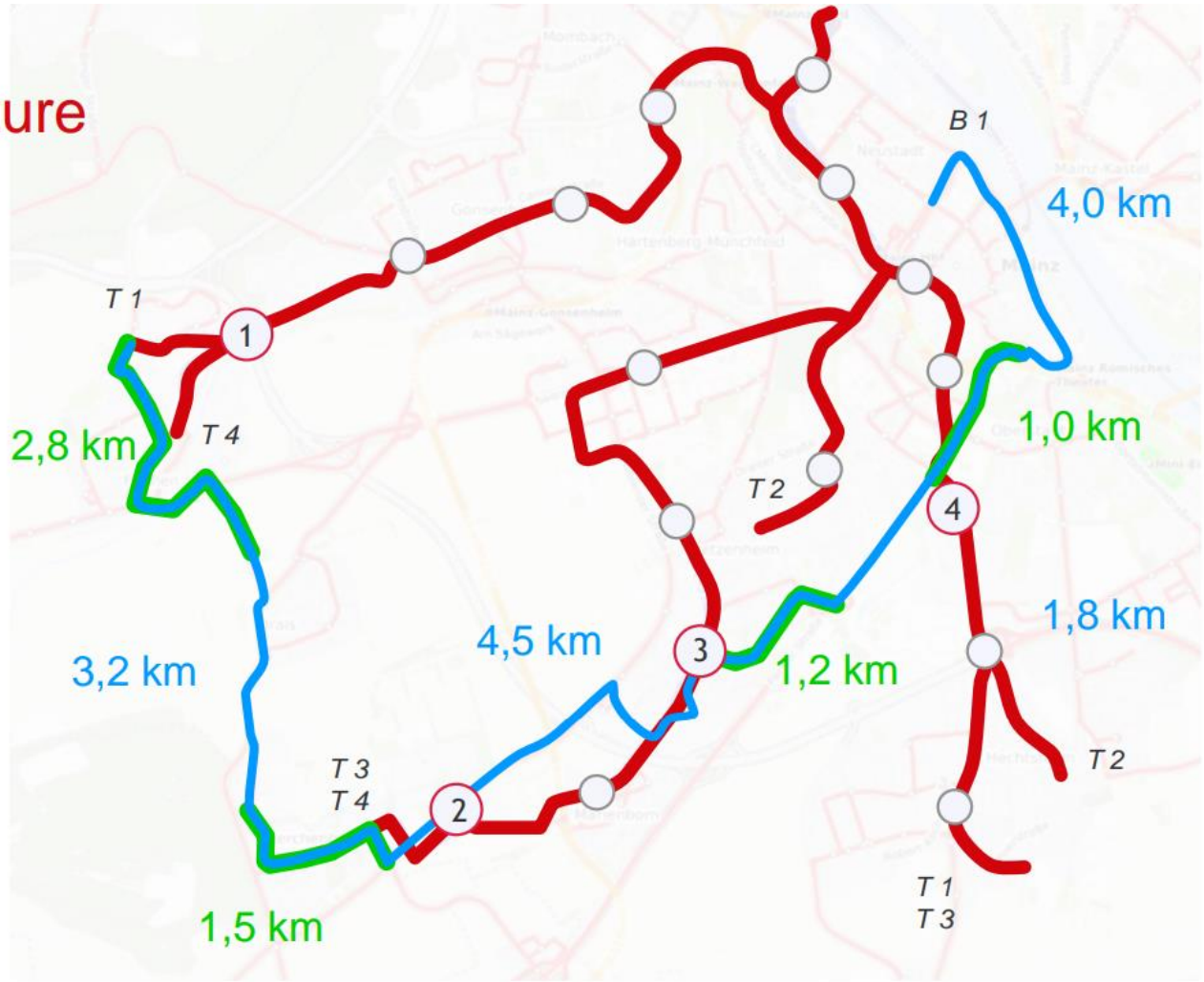
UITP

TRAM + TROLLEYBUS SYNERGY

Example – Network structure

- Tramway network
- IMC®-Bus-route
- Trolleybus catenary
- Rectifier substation

Overhead contact line needed for around 32 % of IMC®-Bus-route



RPS Rail Power Systems

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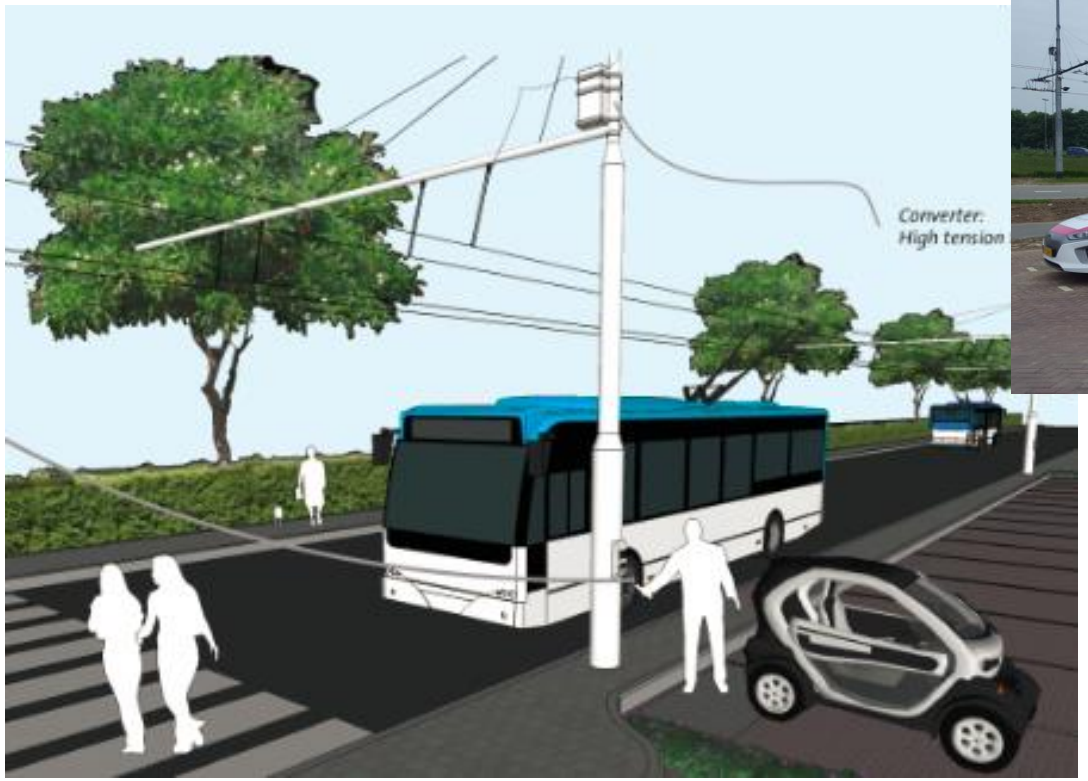
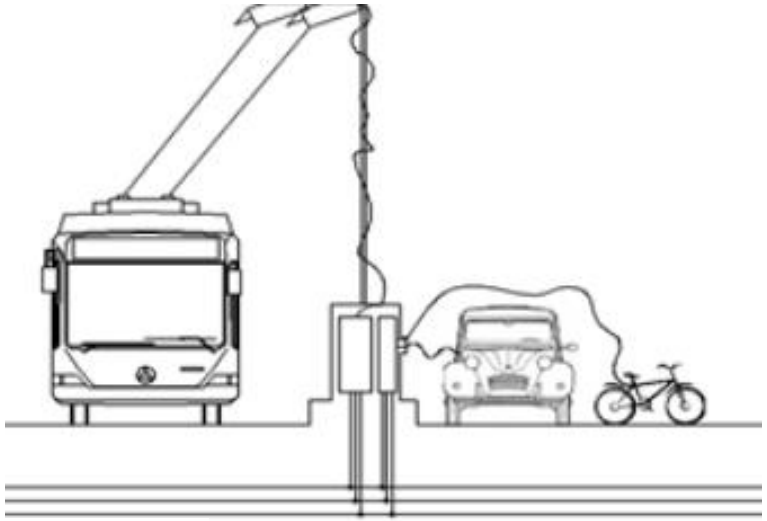
TROLLEYBUS + E-MOBILITY SYNERGY

Multi-purpose trolley charging infrastructure in Arnhem, NL





http://www.omroepgelderland.nl/nieuws/2134955/Autorijden-op-energie-van-remmende-trolleybussen

trolley:2.0 for smart cities

Electric Mobility Europe

European Commission

UITP

TROLLEYBUS + E-MOBILITY SYNERGY

Multi-purpose trolleybus infrastructure usage in Arnhem, NL

DC-DC Charge solutions for E-Mobility: e-car fast charger from the overhead contact line in Arnhem, NL

DC-AC catenary solutions, power solutions for charging machines for public transport cards, WiFi access points and dynamic travel information that's powered by the overhead contact line in Arnhem, NL

GEMEENTE Arnhem

VENEMA Venema Technisch Bedrijf BV

connexxion

Quick facts

- Saving cost in dealing with local power suppliers
- Input DC Voltage: DC Voltage 600 - 840V / peak power 1600 W
- No digging to connect to the local power grid
- No problems, time and costs requesting a power connection
- Better use power capacity of the trolley network

UITP

TROLLEYBUS + E-MOBILITY SYNERGY

Multi-purpose trolleybus infrastructure usage in Arnhem, NL

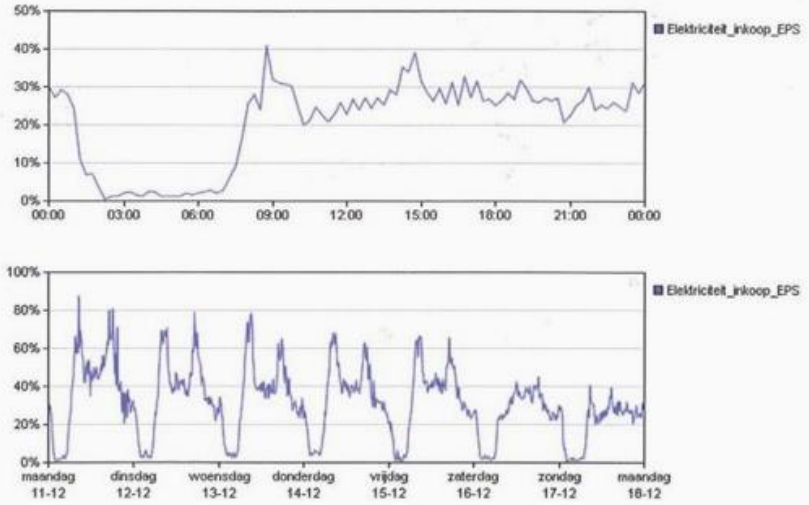
DC-DC Fast Charging from the catenary

Why choose DC Fast Charging from the catenary?

VENEMA
Venema Technisch Bedrijf BV

Business case:

- 50 % lower investment cost for charger deployment
- low fuel cost
- Better use power capacity of the trolley-tram network



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TROLLEYBUS + E-MOBILITY SYNERGY

Smart trolleybus system Solingen, DE

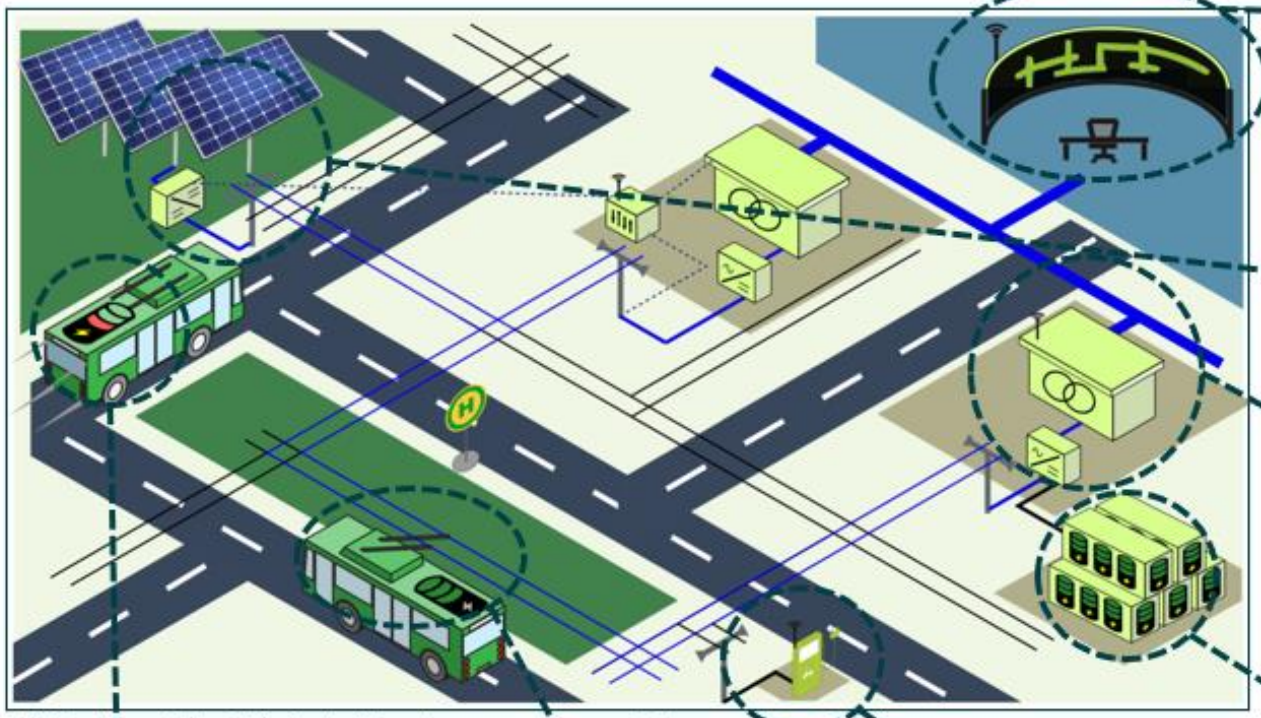
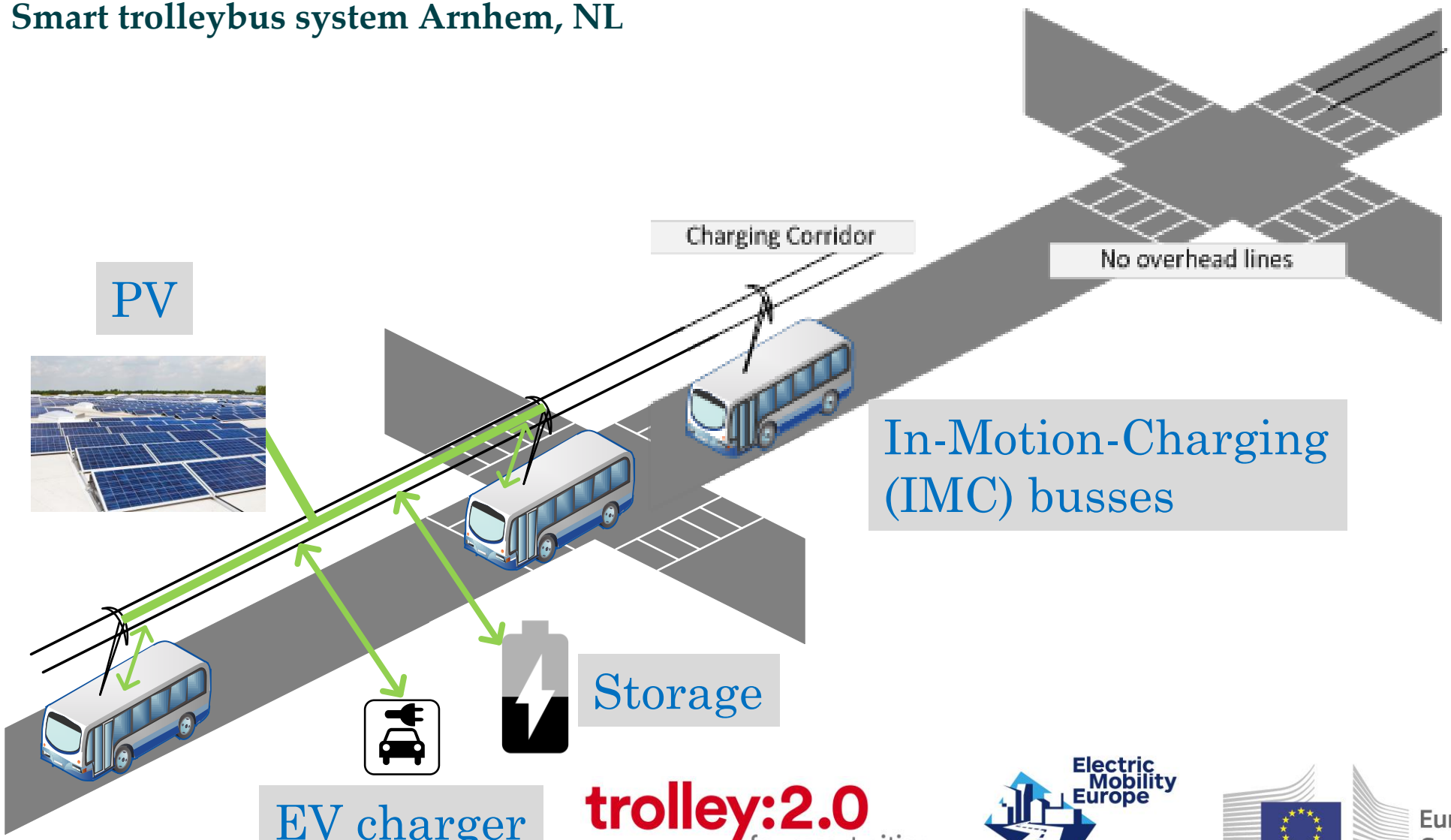


Bild: Lehrstuhl für Elektrische Energieversorgungstechnik, Bergische Universität Wuppertal

- Automated monitoring and control
- PV systems integration
- Substation (bidirectional)
- Stationary Battery storage
- Battery trolleybus – discharging
- Battery trolleybus – charging
- Charging stations for EVs and pedelecs

TROLLEYBUS + RENEWABLE ENERGY

Smart trolleybus system Arnhem, NL



trolley:2.0 for smart cities

Electric Mobility Europe

European Commission

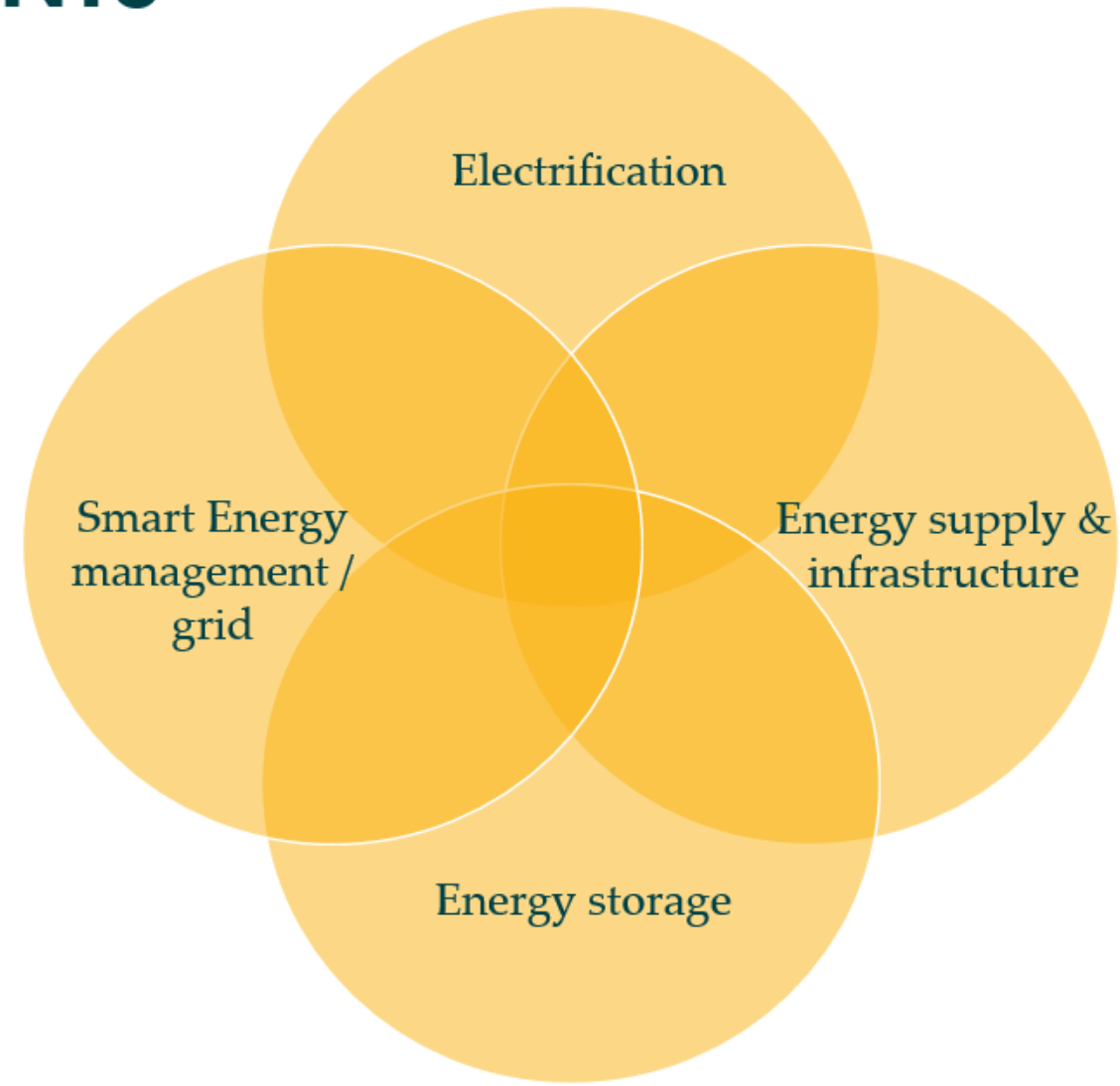
UITP

POLITICAL CONTEXT

CURRENT DEVELOPMENTS

Need for Action
&
Political Will!

Consider a smart trolley system!



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POLITICAL CONTEXT

ACCORDANCE WITH EU CLEAN VEHICLE DIRECTIVES (OR OTHER NATIONAL LEGISLATION) IN INCLUSION OF THE NATIONAL QUOTAS OF THE MEMBER STATES

TROLLEYBUSES IN THE CVD

- Trolley buses are considered to be zero-emission buses, provided that they run only on electricity; or
- They use only a zero-emission auxiliary drive when they are not connected to the grid
- Otherwise they still count as clean vehicles
- Opportunity for trolleybus countries in Europe

UITP

POLITICAL CONTEXT

5 CTM ENERGY TRANSITION STRATEGY

The lines of action for a Clean Fleet

Fleet renewal

- Purchase of clean vehicles to reaching an average fleet age of less than 7 years

Trolleybus system

- Extension and integration of existing trolley network with trolley-hybrids and ebuses

BRT

- Implementation of electrical BRT systems with fast charging solutions

POLITICAL CONTEXT

SALZBURG AG

ONE KEY TO SUCCESS

- With the implementation of the project, standard components are used for all purposes and this is also reflected in the high availability of the vehicles and in interaction between infrastructure and vehicles.
- Regarding to the implementation of the Clean Vehicle Directive (CVD) in Salzburg, the trolleybus with dynamic charging could be the key to success to for a pure electric public transport using well developed components combined with innovative battery technology.

More 80% of passengers in Salzburg city region use all electric public transport.

Electric energy is in case of Salzburg AG 100% renewable energy.

Introduction of trolleybuses with dynamic charging in case of line 5.

Strategy to fullfill the Clean Vehicle Directive and national law regarding urban bus lines (today Diesel and CNG).

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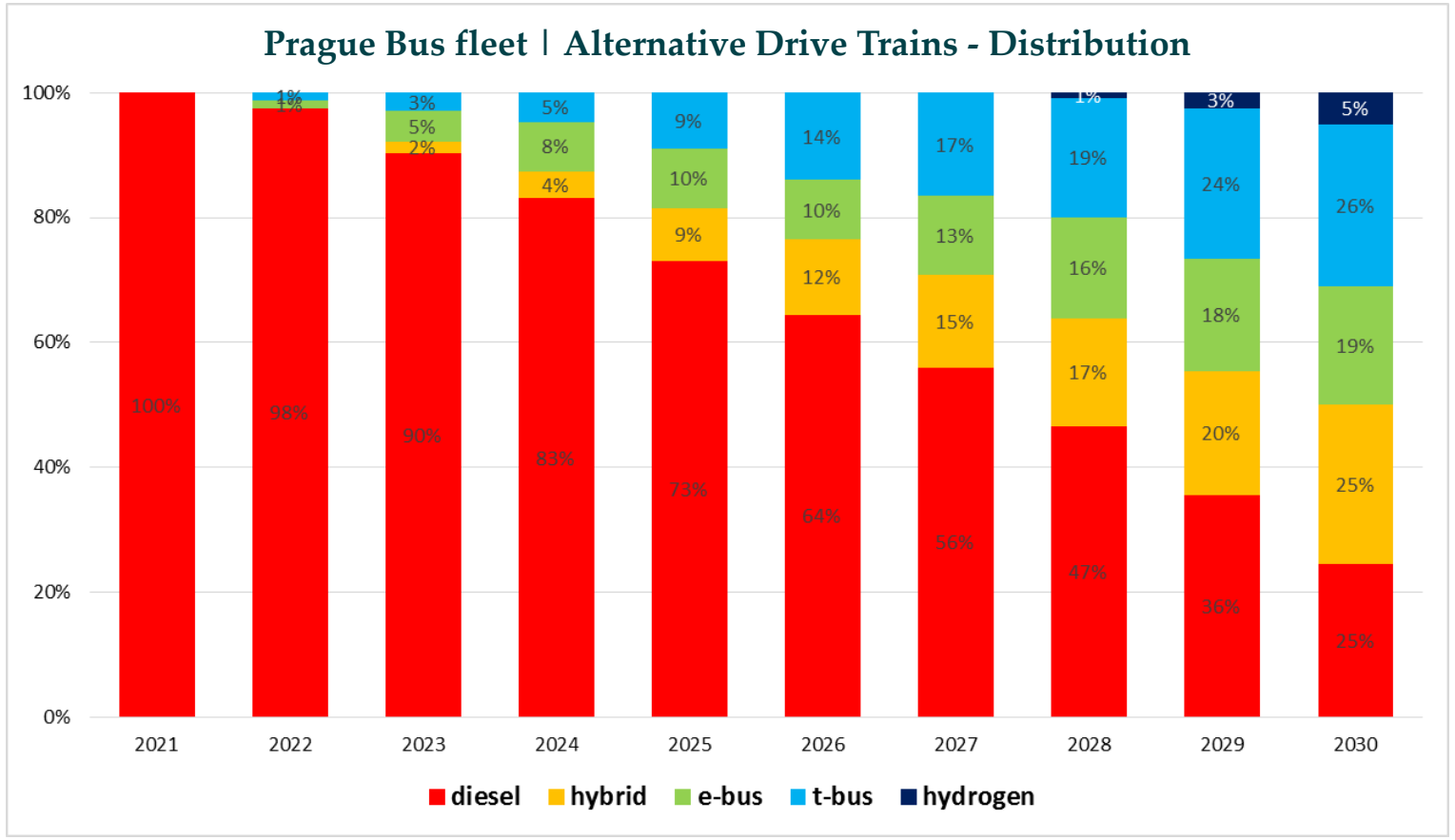
DECARBONISATION PLAN | Prague Bus Fleet



Clean Vehicle Directive (2009/33/EU) Revision 2019
Quota for CZ: 41% by 2025 and 60% by 2030 (1/2 must be zero-emission)

Climate Declaration of the capital Prague (2019)
Reduction of CO2–emissions by 45% until 2030 (compared to 2010)

Climate Plan for Prague (2021)
2030 – 50% buses emission-free + 25% buses (partly clean)

RAISE AWARENESS – BEST PRACTICES

UITP ADVANCING PUBLIC TRANSPORT

POLICY BRIEF

IN MOTION CHARGING TROLLEYBUS SYSTEMS

SEPTEMBER | 2024

INTRODUCTION

The transition to zero-emission bus fleets is a critical component of the global effort to combat climate change and reduce urban air pollution. Governments and cities worldwide are increasingly setting ambitious targets to eliminate fossil fuel use in public transport, which, in turn, offers an opportunity to enhance the passenger experience, increase safety, optimise operations, and improve fuel economy.

Sustainable and efficient public transport systems are instrumental to achieving broader carbon-neutral goals, as they include renewable energy sources and sustainable practices and eliminate emissions generated by other public transport modes with higher negative externalities.

By adopting zero-emission bus fleets, cities and regions can significantly lower their carbon footprint and contribute to a cleaner, healthier and more energy-efficient environment, leveraging renewable energy sources to power public transport networks. There is a wide array of zero-emission bus technologies to consider when planning and implementing the energy transition, including hydrogen buses, battery electric buses (BEBs), and trolleybuses, just to mention the most popular applications.

Several hundred cities around the world operate conventional trolleybuses. They have electric powertrains and are zero-emission buses. Their power networks consist of substations, power cables, and overhead wires. In many cases, major parts of the electric feeding infrastructure can be shared by electric buses (e-buses) with different charging technologies or even rail modes, as these modes are often operated under the same public ownership. This makes this infrastructure a public asset of strategic importance.

Many cities nowadays are actively implementing zero-emission buses, but, unfortunately, in some cases, they are simultaneously dismantling existing operational trolleybus systems. A couple of the main arguments against conventional trolleybuses are that the overhead wire network is a form of visual pollution and trolleybuses have various disadvantages like

In motion charging trolleybus (Cagliari)

Efficiency for Electric Buses Toolkit[4] to support operators and authorities tackling this challenge.

Although heating, ventilation, and air conditioning (HVAC) systems are increasingly being installed in e-buses, regardless of the charging technology, the connection to overhead wires enables the use of smaller batteries and greater use of onboard cooling and heating devices, even when dealing with extreme hot or cold temperatures. Trolleybuses are already in operation in a wide range of climates around the world.

3. DEPOT SPECIFICATIONS

The construction or adaptation of depots to accommodate zero-emission bus technologies is a crucial component of the overall strategy and an increasingly important issue for operators and authorities. In 2022 and 2023, the UITP Bus Committee released a series of factsheets for depot adaptations[5] to electric and hydrogen (H2) buses. Some of the considerations are applicable for IMC trolleybuses, such as safety recommendations, maintenance staff training requirements, location, and power supply, among others.

Because of the mix of technologies, depots should be suitable for storage, charging, maintenance, and all other routine activities of all vehicles in the fleet. The optimal depot layout and setup to accommodate the charging infrastructure for all technologies need to be determined.

IMC trolleybuses enable zero-emission operations to/from and within the depot without overhead wires, which reduces the infrastructure complexity—wires, crossings, and switches—and, thus, the depot setup and maintenance costs. Furthermore, they do not to rely on auxiliary combustion engines. IMC trolleybuses simply require short sections of electrified overhead wires or bars on top of the parking spots, equivalent to plugs or pantograph infrastructure for conventional BEBs.

Van Ness BRT - San Fransisco

4 UITP Tender Structure Document 2023 – Annex VII on Sustainability and Circularity for Buses
5 Depot adaptions for clean bus technologies

IMC SYSTEM PROMOTION, PROCUREMENT, AND COMMISSIONING

Empirical evidence from cities that have implemented IMC systems provides valuable insights into the associated operational benefits and challenges. For instance, IMC technology deployment in Solingen, Germany and Zurich, Switzerland reportedly led to significant improvements in public transport reliability and efficiency. Public opinion has been predominantly positive in such cases, particularly when the environmental benefits and noise reduction advantages have been effectively communicated. The cases highlighted the importance of detailed planning, robust financial backing, and flexible management strategies that allow for iterative monitoring and optimisation.

INCLUSION OF IMC IN EARLY-STAGE PLANNING AND FEASIBILITY STUDIES

The integration of IMC technology into the early stages of public transport planning is critical. Feasibility studies are required to maximise the efficiency of this mode within the overall public transport system and enhance sustainability.

The energy source is always a crucial aspect in electrifying fleets. BEBs typically require more power from the electric grid at a single point, especially those charged overnight.

In the case of opportunity charging or flash charging, there is quite high demand for reserve power, which often makes up the most significant fraction of energy costs. In contrast, power networks designed for IMC can be cross-used with other electric modes such as light rail. Furthermore, in locations where overhead wires are available, a trolleybus network can be used as a power grid for electric vehicle charging stations. At the same time, it should be noted that such cross-use requires strong leadersWhip and political will to overcome any regulatory challenges.

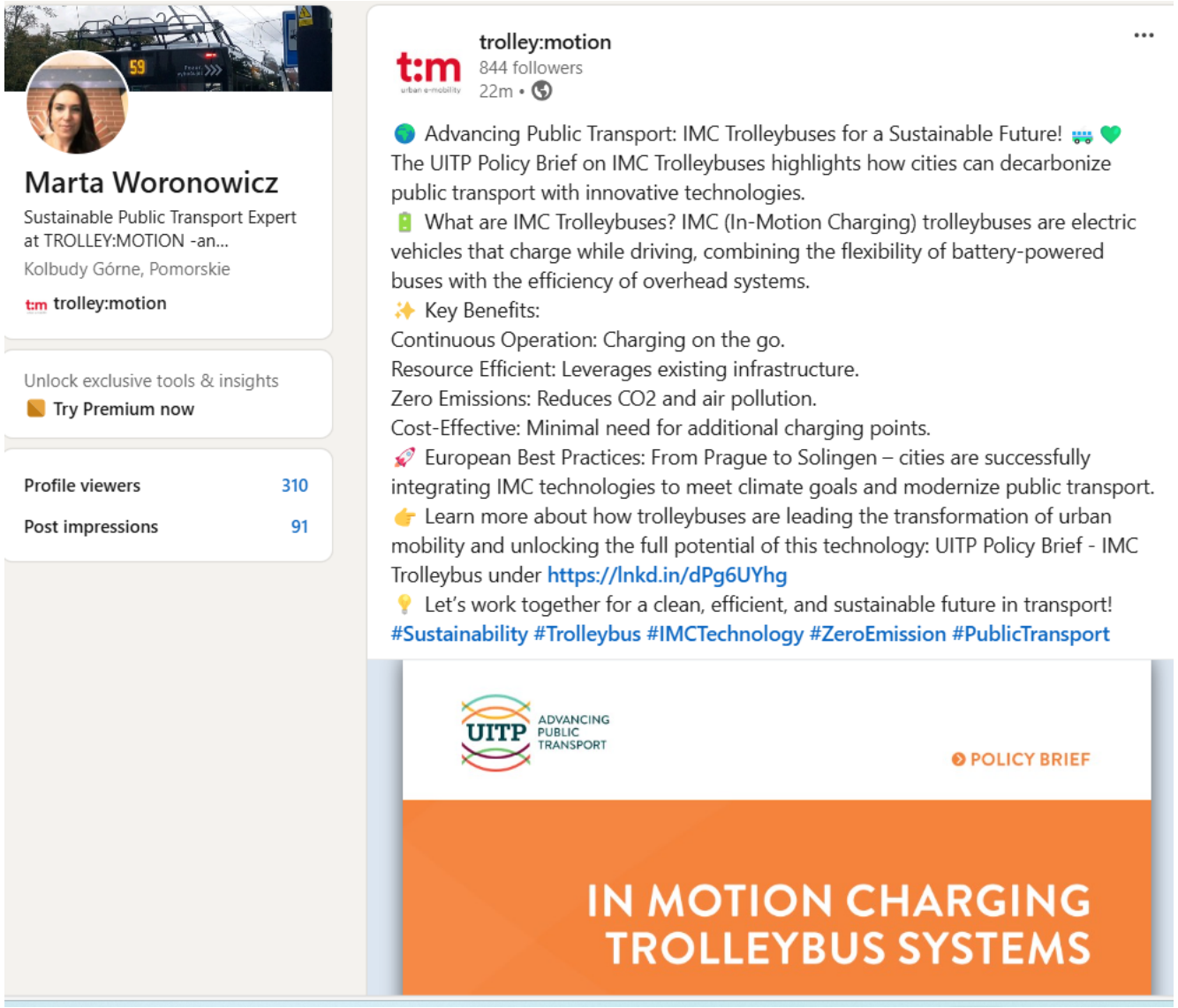
Comprehensive assessment of technical requirements can enable the project team to strike a balance between building new infrastructure and ensuring interoperability with existing infrastructure, taking into account the electric grid's capacity and stability and the feasibility of incorporating renewable energy sources.

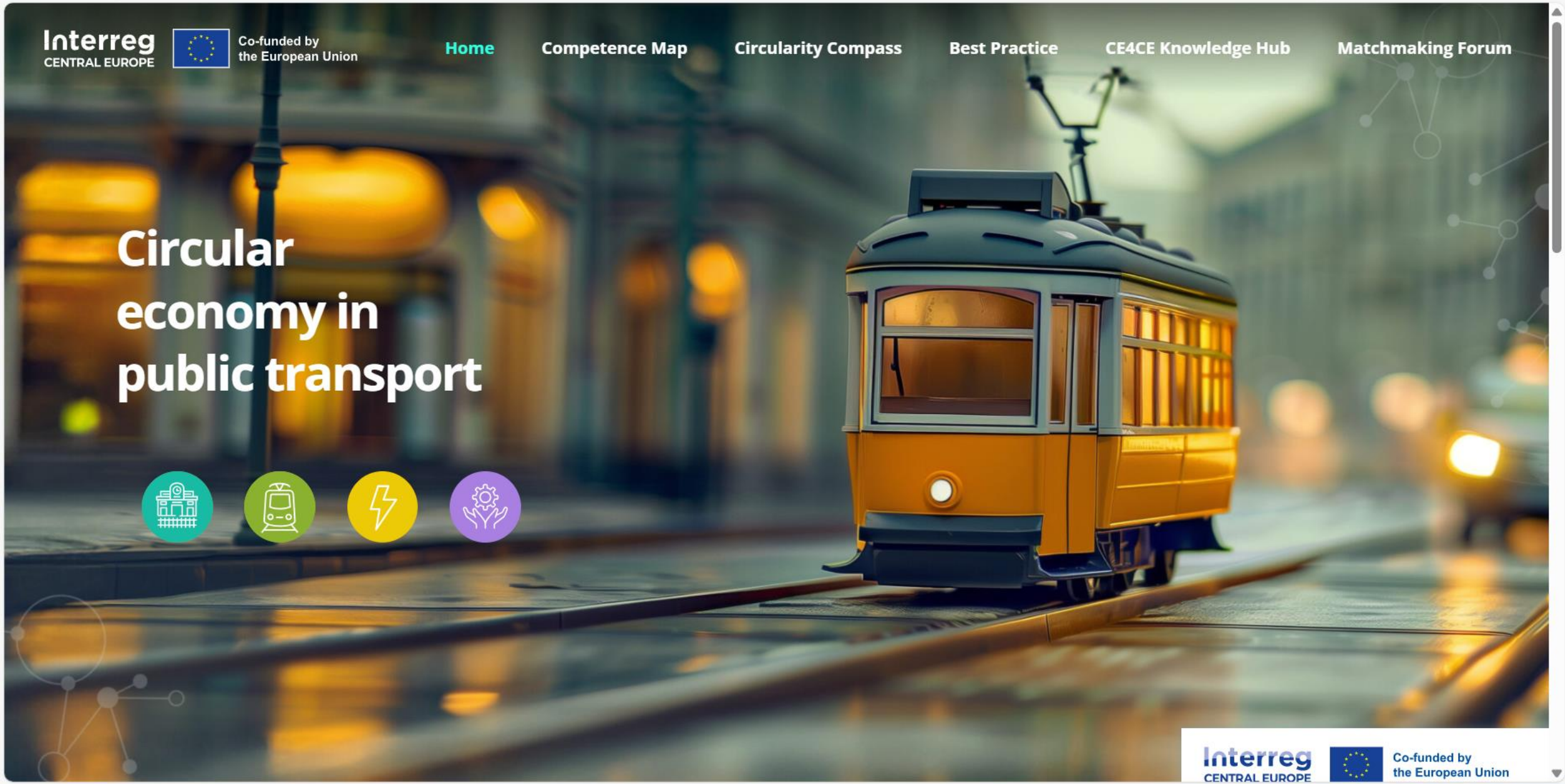
It is crucial to address all potential technical, environmental, and social concerns in the early stages, while simultaneously garnering support from municipal authorities, public transport operators, and the community. Infrastructure cross-use among different modes can enhance both community and authority support. Advanced simulation and modelling tools are available to predict system performance, optimise service design, and evaluate the proposed project's economic and environmental impact.

The implementation process often involves several challenges, especially when dealing with existing trolleybus systems.

UITP

RAISE AWARENESS – BEST PRACTICES




Interreg
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Home
Competence Map
Circularity Compass
Best Practice
CE4CE Knowledge Hub
Matchmaking Forum
Circular
economy in
public transport
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CE4CE PUBLIC TRANSPORT CIRCULARITY KNOWLEDGE PLATFORM

Objective:

1. To identify and represent the skills and knowledge required for the successful introduction and implementation of circular economy principles in public transport (PT)
2. To increase knowledge and capacities of stakeholders in public transport to identify circularity gaps
3. To provide tools and best practices to close these gaps in own organizations through co-creation (circularity compass) and training

Target groups:

- all PT life-cycle actors
- decision takers
- general public

CE4CE (circularity4publictransport.eu)

CIRCULARITY KNOWLEDGE PLATFORM

CIRCULARITY KNOWLEDGE PLATFORM

Home

About the platform

General aspects on circularity

The 4 main knowledge topics

Competence map

Competence mind map

Competence Areas

Theoretical background

Governance

Best Practices

Tools and resources

Circularity compass

Survey

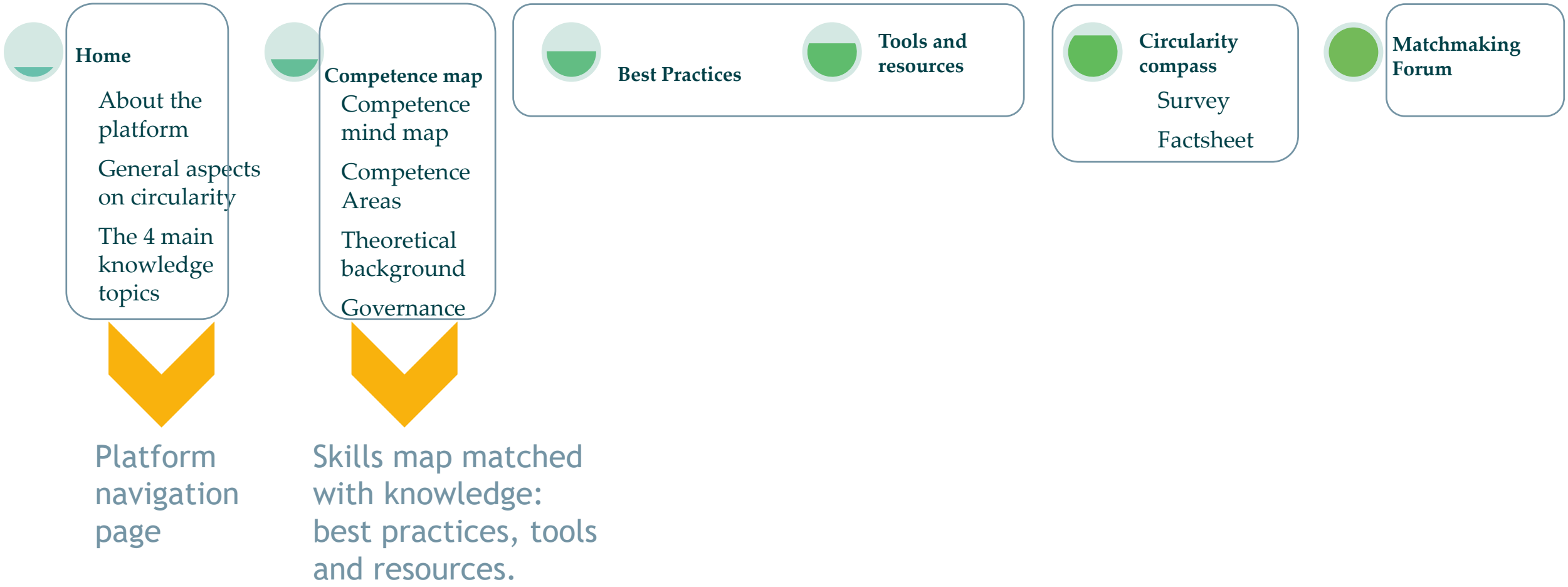
Factsheet

Matchmaking Forum

Platform navigation page

CIRCULARITY KNOWLEDGE PLATFORM

LINK: https://circularity4publictransport.eu/



CIRCULARITY KNOWLEDGE PLATFORM

LINK: https://circularity4publictransport.eu/

Platform navigation page

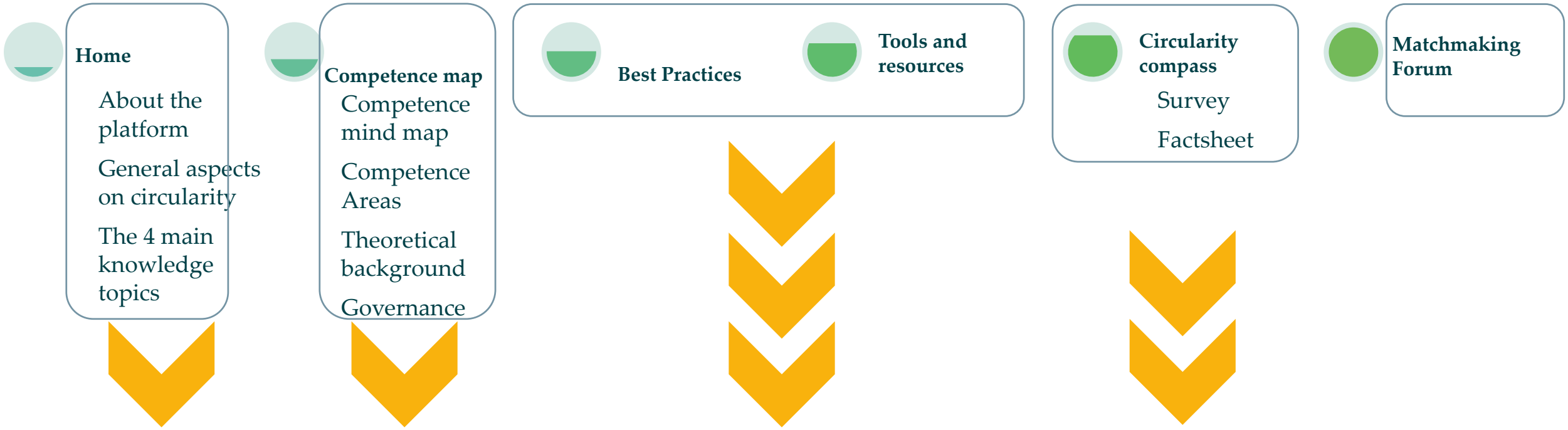
Skills map matched with knowledge: best practices, tools and resources.

Organised by:

1. Competence area (vehicles, infrastructure, energy)
2. Resource type
3. Country

CIRCULARITY KNOWLEDGE PLATFORM

LINK: https://circularity4publictransport.eu/



Platform navigation page

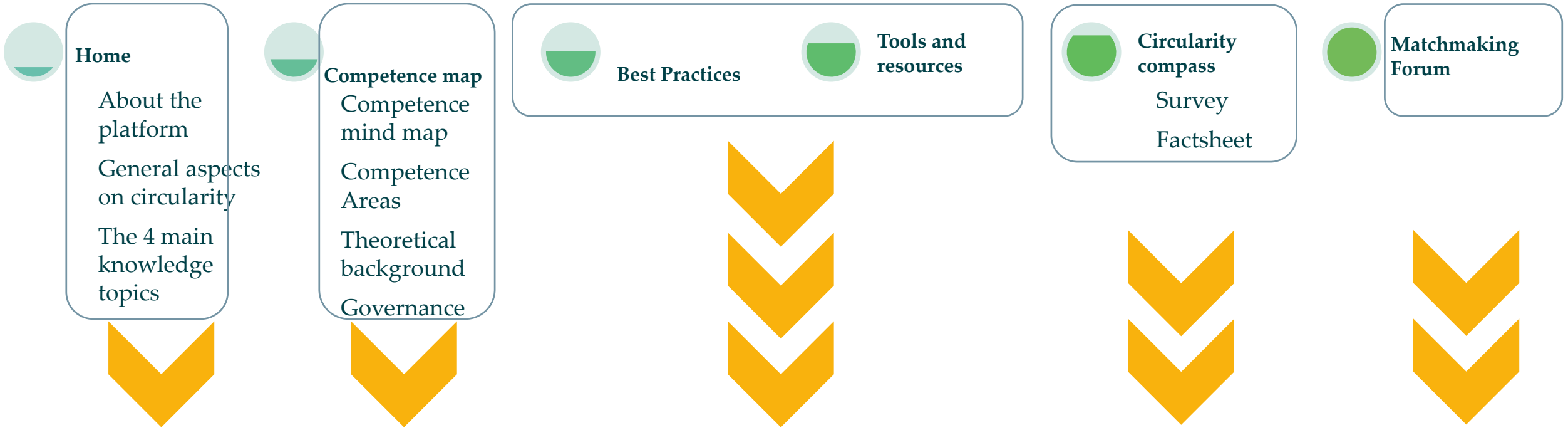
Skills map matched with knowledge: best practices, tools and resources.

Organised by:

1. Competence area
2. Resource type
3. Country

Link to survey

CIRCULARITY KNOWLEDGE PLATFORM



Platform navigation page

Skills map matched with knowledge: best practices, tools and resources.

Organised by:

1. Competence area
2. Resource type
3. Country

Link to survey

Concept in progress

CIRCULARITY KNOWLEDGE PLATFORM

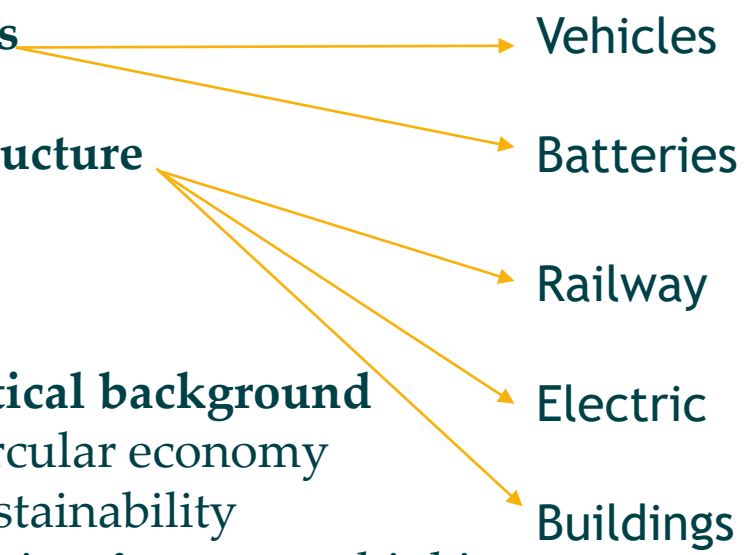
Organisation of best practices, tools and resources

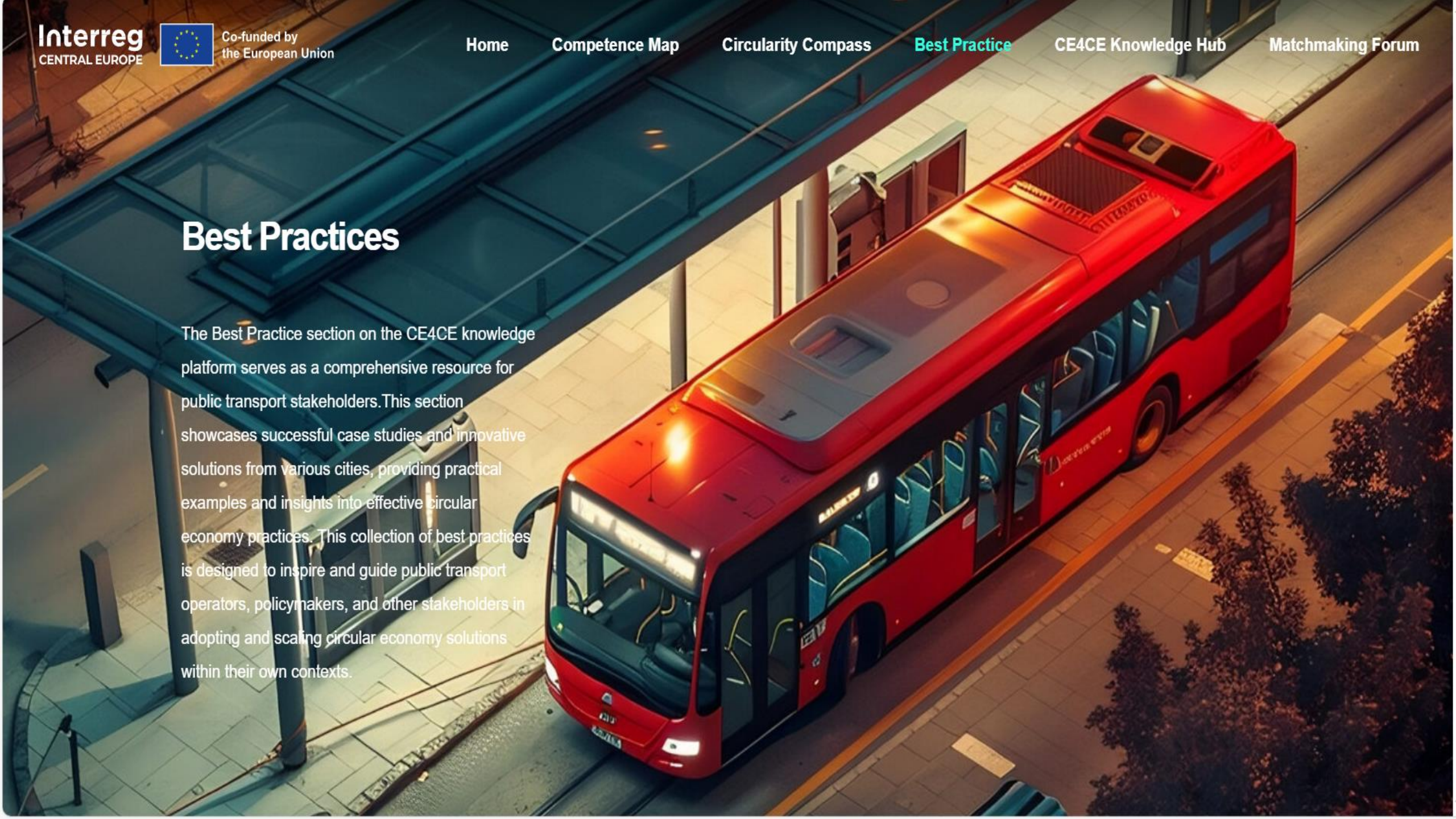
Resource type:

- Guideline
- Tool
- Method
- Software
- Online training
- Best practice
- Report
- Study
- Other

Competence areas:

- **Vehicles**
- **Infrastructure**
- **Energy**
- **Theoretical background**
  - Circular economy
  - Sustainability
  - Design & systems thinking
- **Governance**
  - Policy & regulation
  - Green finance & economics
  - Circular business models
  - Participative project management
  - Stakeholder engagement
  - Communication





Best Practices

The Best Practice section on the CE4CE knowledge platform serves as a comprehensive resource for public transport stakeholders.This section showcases successful case studies and innovative solutions from various cities, providing practical examples and insights into effective circular economy practices. This collection of best practices is designed to inspire and guide public transport operators, policymakers, and other stakeholders in adopting and scaling circular economy solutions within their own contexts.


KOMUNIKACJI
TROLEJBUSOWEJ


GALERIA
MEBLI

HOW TO CONVINCE STAKEHOLDERS

- How to sell the idea to the politicians / lessons learned from previous trails of introduction (type of city, route structure and topography, etc.)
  - Is it something for my city?
  - What are "good" context conditions for the in-motion-charging introduction?
  - What are the arguments (pro in-motion-charging):
    - Economy
    - Energy
    - CO2 emissions
    - Infrastructure assets
    - Capacity
    - …
  - Who needs to be convinced (target groups of communication)?

How to sell the idea to stakeholders (decision makers, the public)? / lessons learned from previous trails of introduction (type of city, route structure and topography, etc.)?

What are the main advantages of an in-motion charging trolleybus system?

AN INTERACTIVE EXERCISE - IMAGINE …

You are to convince decision makers in your city to deploy or expand IMC trolleybus system.

What arguments would you use to support it:

- ……
- ……
- ……
- ……
- ……
- ……

KEY TAKEWAYS

IMC trolleybus advantages

- in accordance with EU Clean Vehicle Directives
- one to one diesel bus replacement as opposed to electric bus (electric bus system needs ca. 20% more vehicles to replace diesel)
- energy efficient as it requires considerably less energy compared to electric bus system
- just unbeatable when going uphill, thus great for hilly cities
- grid can be enhanced by energy saving installations such as solar power plants with energy fed directly to the traction network with no transmission losses, or energy storage supercapacitors for recovering and storing braking energy

KEY TAKEWAYS

IMC trolleybus advantages

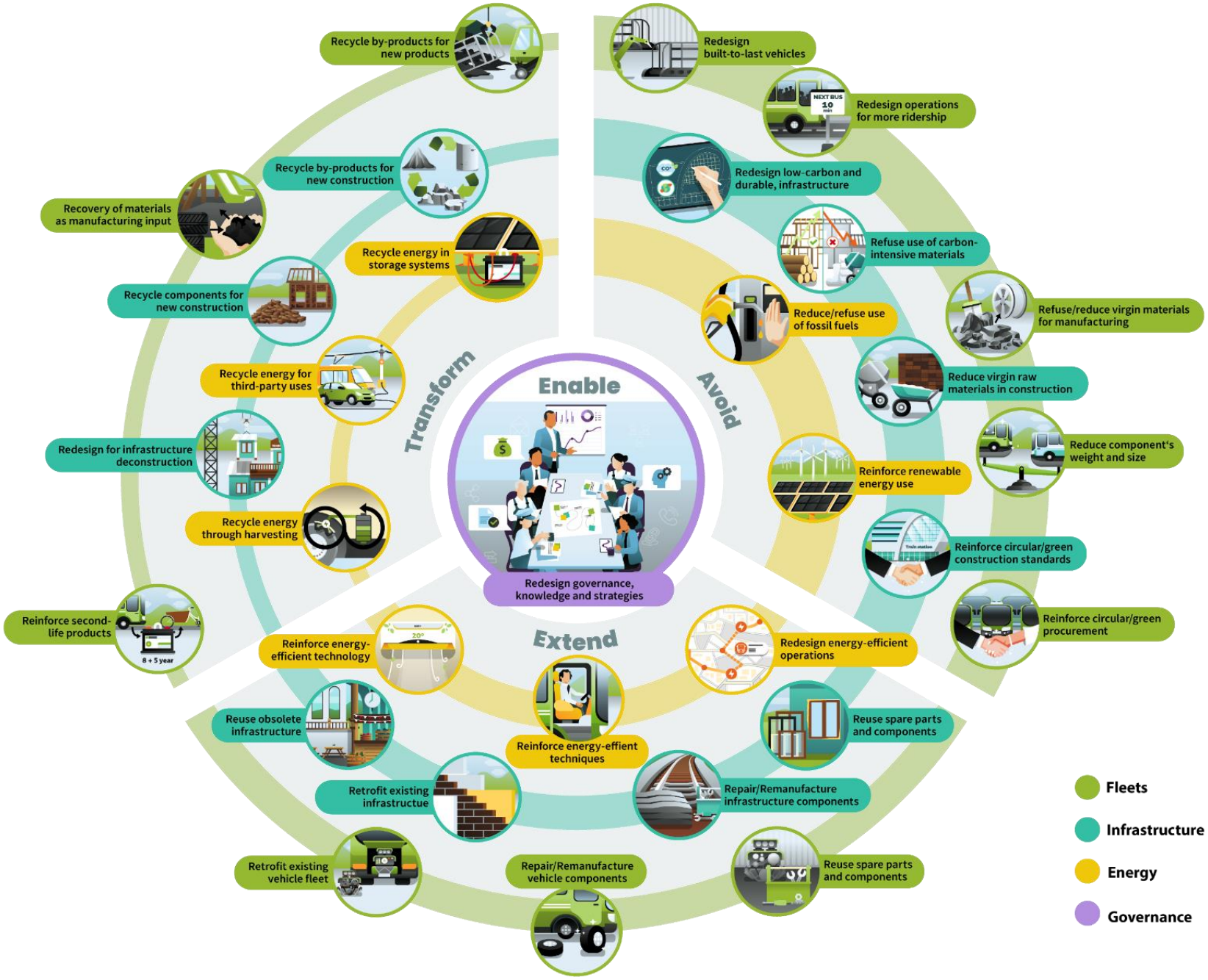
- durable infrastructure; it can serve for 40 years
- a durable vehicle; it is possible to exchange just the battery, no need to scrap down the whole vehicle which can serve for ca. 20 years
- grid is flexible and intermodal – other electric vehicles can easily charged from it; network posts are also city lamp posts
- power networks designed for IMC can be cross-used with other electric modes such as light rail
- very high percentage of charging infrastructure utilization(75%) compared to overnight (19%) and opportunity charging (37%)
- smallest possible parking/depot area of high fire safety
- simple yet tested and resilient technology

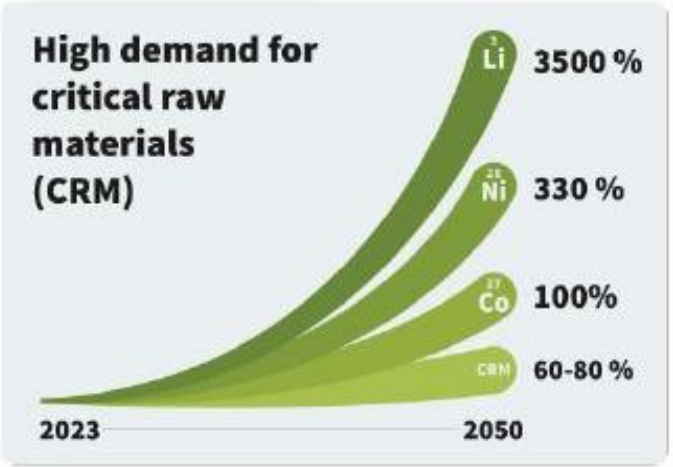
KEY TAKEWAYS

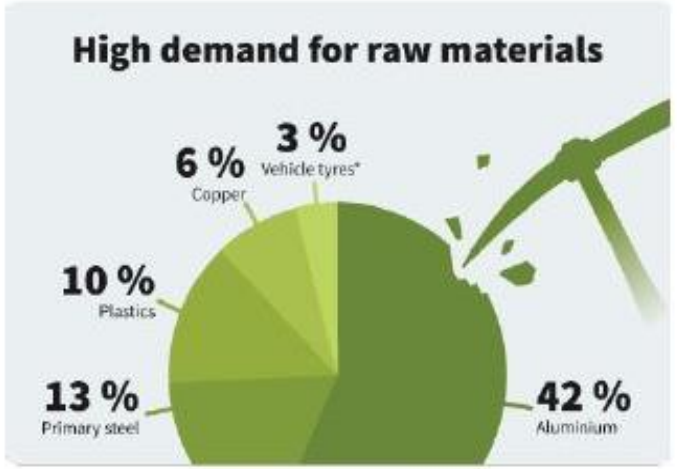
IMC trolleybus advantages

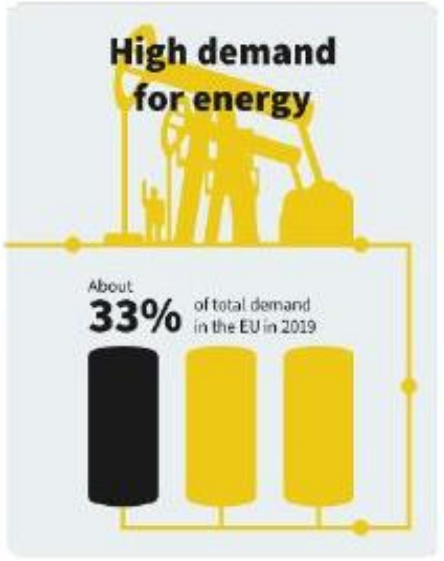
- smallest possible batteries suited to route demands
- 20-30% of wired infrastructure, 80%-70% off wire
- possibility of a shared PV system between residential and traction grids
- environmental benefits and noise reduction
- high usage of regenerative braking energy going into overhead line and onboard (battery and auxiliary)

- **IMC trolleybuses represent a notable example of a circular economy solution in public transport**









The real ecological footprint of the road transport sector

Tailpipe emissions are not the whole story

Electrification is **no silver bullet**

We have to do it smartly and efficiently!

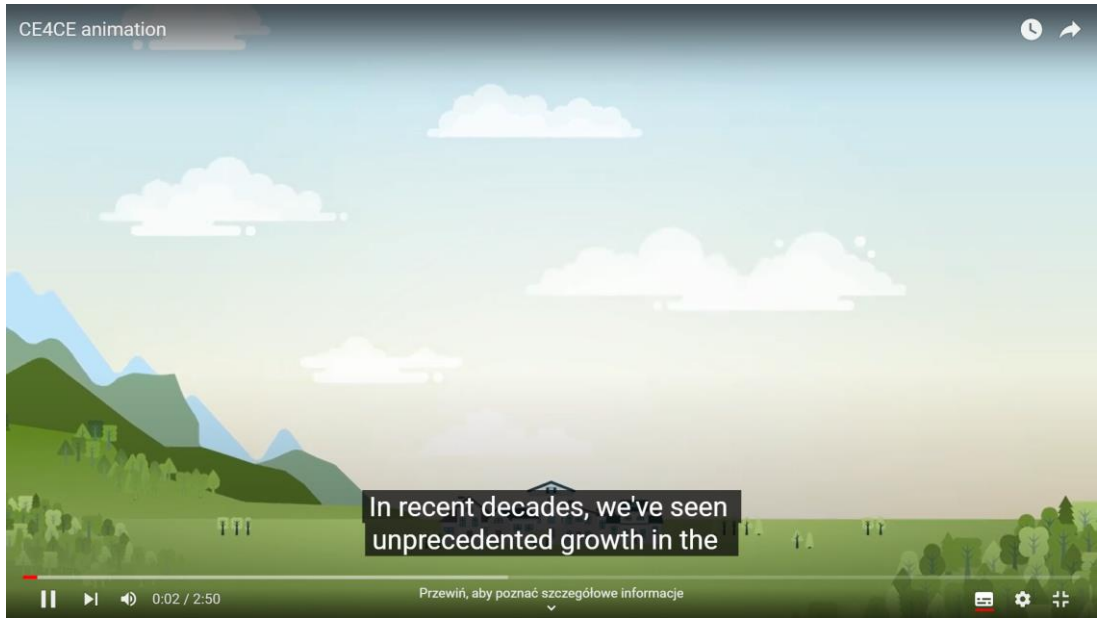
Embedded GHG emissions:
50-60% of an EV's
Compared to
10% for combustion cars (T&E).

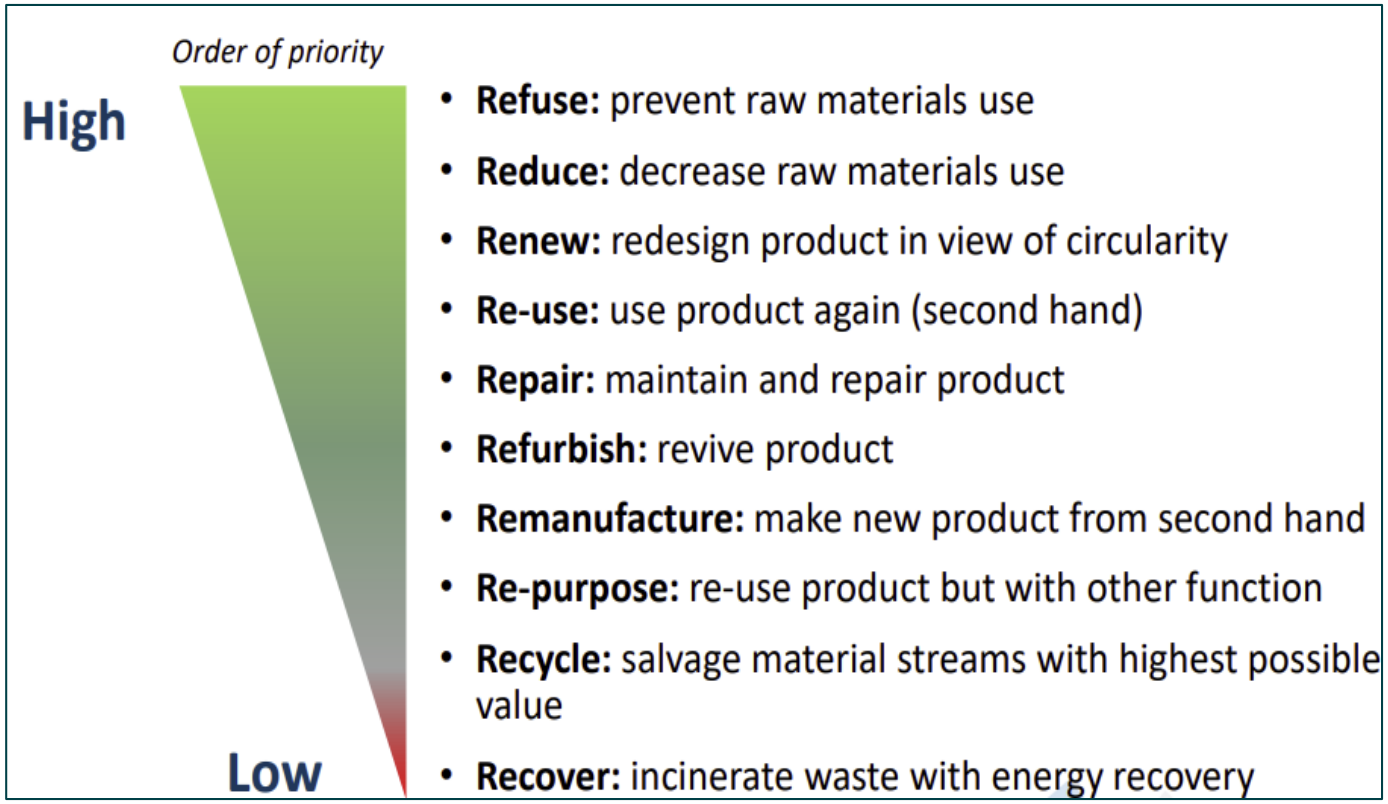
Embedded emissions are becoming the **next frontier in our battle against climate change**

A SHORT VIDEO ABOUT UPTAKING CIRCULAR ECONOMY PRINCIPLES IN PUBLIC TRANSPORT

YOUTUBE LINK TO THE VIDEO:

https://youtu.be/lbCKKBCudzk





In motion charging trolleybus (Cagliari)

RECOMMENDATIONS

IMC trolleybuses offer a highly efficient and effective solution for urban public transport, particularly when combined with existing trolleybus or light rail infrastructure and other e-bus technologies. They provide continuous service, reduce the need for extensive new infrastructure, and offer environmental benefits through reduced emissions and resource reuse. Their successful implementation in several cities highlights the potential for broader adoption of this technology.

POLICY RECOMMENDATIONS

- **Upgrade existing trolleybus systems:** Cities with existing trolleybus networks should consider keeping them and plan the needed updates to implement IMC technology to enhance efficiency and reduce costs.
- **Integrate IMC trolleybuses with eBRT systems:** Combining IMC trolleybuses with demanding routes such as eBRT routes can further optimise public transport operations, with infrastructure investment enabling high-capacity and continuous service.
- **Promote pilot projects:** Encourage pilot projects in cities drafting their fleet decarbonisation plans to evaluate the benefits of IMC technology in real-world conditions.
- **Fleet decarbonisation studies:** IMC trolleybus technology should be considered, along with other zero-emission technologies, in all fleet decarbonisation studies. Such studies must take into consideration all local constraints and specificities to objectively identify the optimal solution in technical, economic, and sustainability-related terms.
- **Urban design and infrastructure:** The design of the poles supporting the trolleybus infrastructure can be integrated into the urban landscape. If needed, an architecture competition for a city-specific design can reveal attractive ideas and improve community acceptance of the project.

IMC trolleybus systems support cities in advancing in their decarbonisation goals by contributing to zero-emission, energy-efficient, and reliable public transport.

KEY TAKEWAYS

POLICY RECOMMENDATIONS FOR IN MOTION CHARGING TROLLEYBUS SYSTEMS

UITP

IMC T-BUS – AN ELEPHANT IN THE ROOM?

IMC trolleybuses well deserve to be taken into consideration and be present at the table at cities PT decarbonization discussion, alongside electric and hydrogen buses. They shouldn't definetely be an omitted option.

QUESTIONS?

THANK YOU!

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