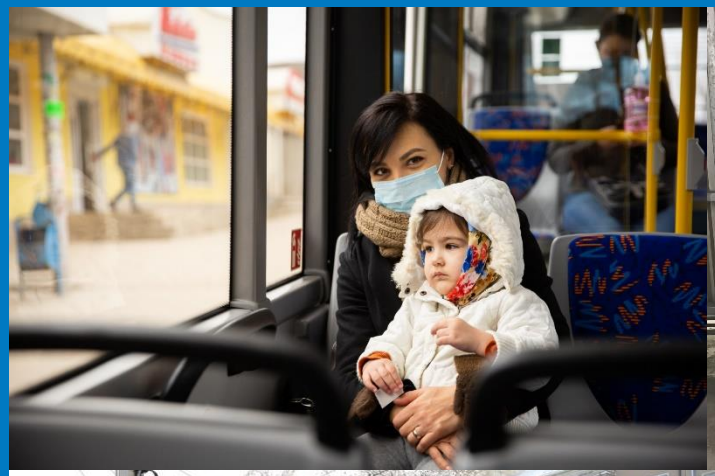




# Going Electric – A Pathway to zero emission buses

MobiliseYourCity Global Forum
25 June 2021

UITP

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

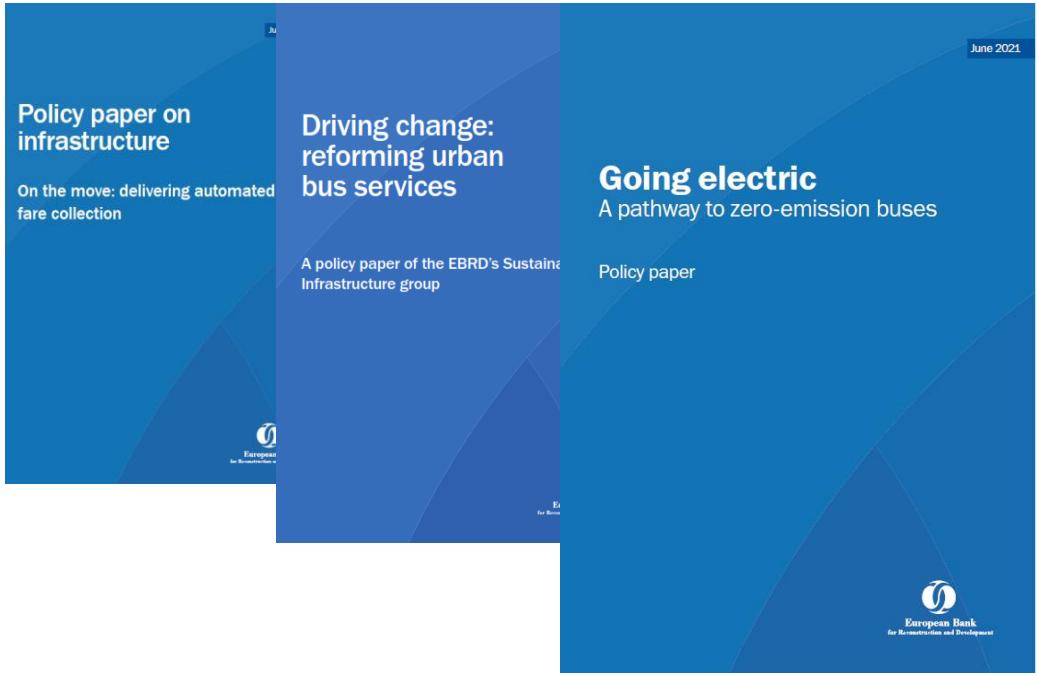
European Bank for Reconstruction and Development

Setting the stage for electric

*Ian Jennings, EBRD*

# Policies to support cities

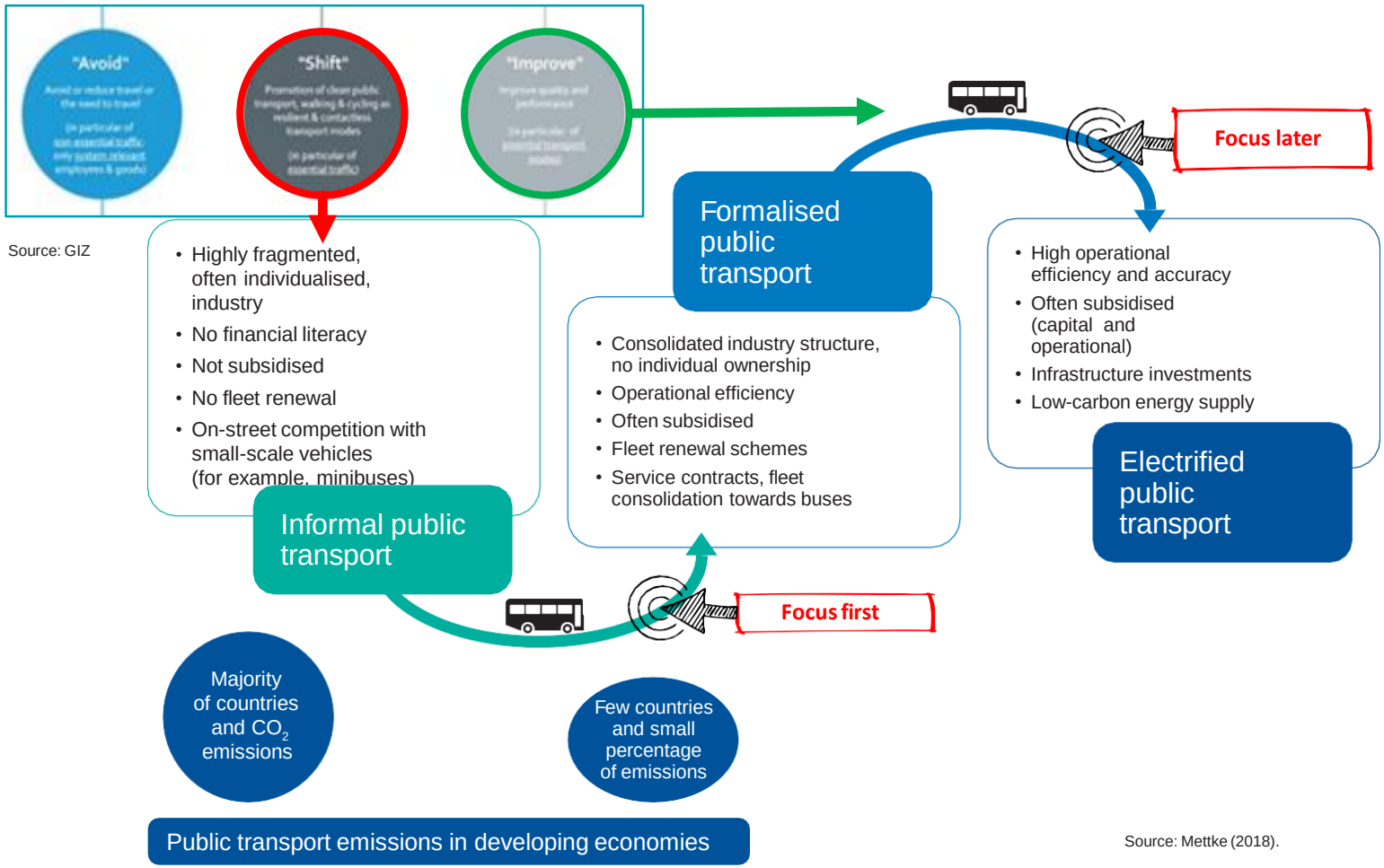
*..advance solutions for sustainable urban mobility systems*




## *Available at:*

EBRD infrastructure policy series (Going Electric- #16)
https://www.ebrd.com/infrastructure/infrastructure-client-support.html
Policy paper "*Going Electric- A Pathway to Zero Emission Buses*"
https://www.ebrd.com/infrastructure/going-electric.pdf
Policy paper "*Going Electric- A Pathway to Zero Emission Buses*"
*https://www.ebrd.com/documents/municipal-infrastructure/driving-change-reforming-urban-bus-services.pdf*

# ..on a pathway to electric




*"Policy is what you spend your money on"*

# E-bus from wire to battery
## *Policy to investment support*



**Policy paper "Going electric"**

| Diesel or clean gas (CNG) | Hybrid diesel or CNG | Plug-in hybrid | Battery electric bus | Hybrid or battery trolleybus | Trolleybus | Fuel cell hydrogen |
|---|---|---|---|---|---|---|
| Meets latest Euro VI standards<br><br>CNG bus as mature alternative technology (biogas compatible) | On-board diesel generator battery pack to allow balancing of engine load<br><br>No plug-in capability | Able to operate on battery for substantial period<br><br>Can be recharged externally as well as by on-board diesel engine | No on-board generator All power sourced from on-board batteries | Battery bus charged by trolley wires | No or limited battery pack<br><br>Batteries used for short distance manoeuvring in depots and at terminals only | Electric bus with power generated on board by fuel cell<br><br>Unconstrained daily range |

**Skopje, North Macedonia (in service 2020)**

- **35 low entry CNG buses**
- Supplier: MAN (Germany)
- Bus Rapid Transit (BRT) system under development

**Batumi, Georgia (delivered Dec 2020)**

- **8 low-entry battery electric midi-buses, depot charging**
- Grant support from E5P (Eastern Europe Energy Efficiency and Environment Partnership (E5P) fund
- Supplier: Belkommunash (Belarus)

**Sofia, Bulgaria (delivered 2020)**

- **15 low-floor electric buses with fast-chargers** (ultra-capacitor), 6 charging stations
- Concessional loan with support from Green Energy Special Fund (GESF), Taipei-China
- Supplier Higer-Aowei (Bulgaria/China)

**Dushanbe, Tajikistan (in service May 2019)**

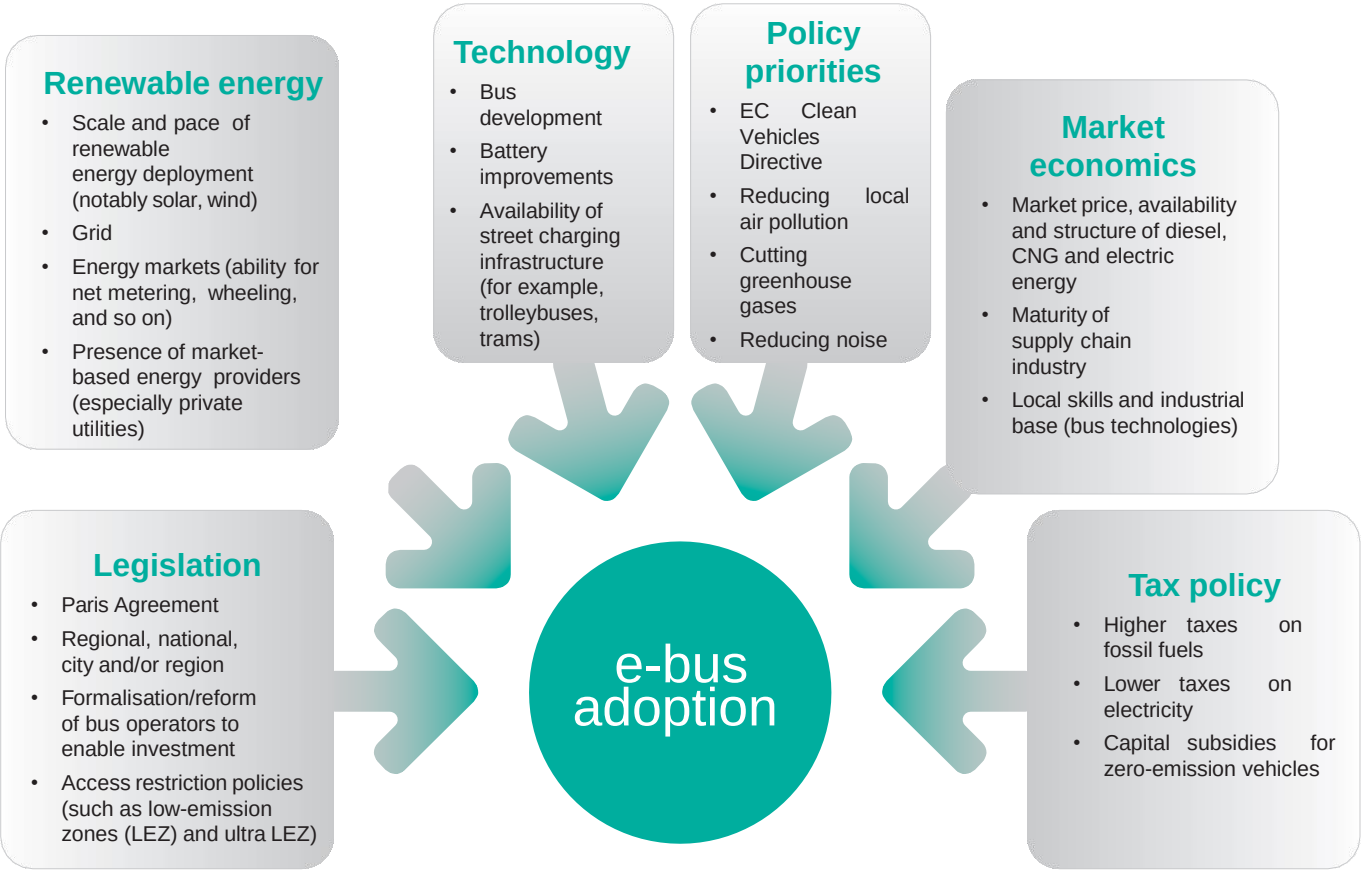
- **4 low-floor extended range, battery trolleybus**
- Investment grant from EBRD (early transition country)
- Supplier Belkommunash (Belarus)

**Balti, Moldova (in service April 2021)**

- **11 extended range, battery trolleybus**
- Grant support from E5P (Eastern Europe Energy Efficiency and Environment Partnership (E5P) fund
- Supplier TORHOVYI DIM «LITAN» (Ukraine)

# Why choose e-bus?

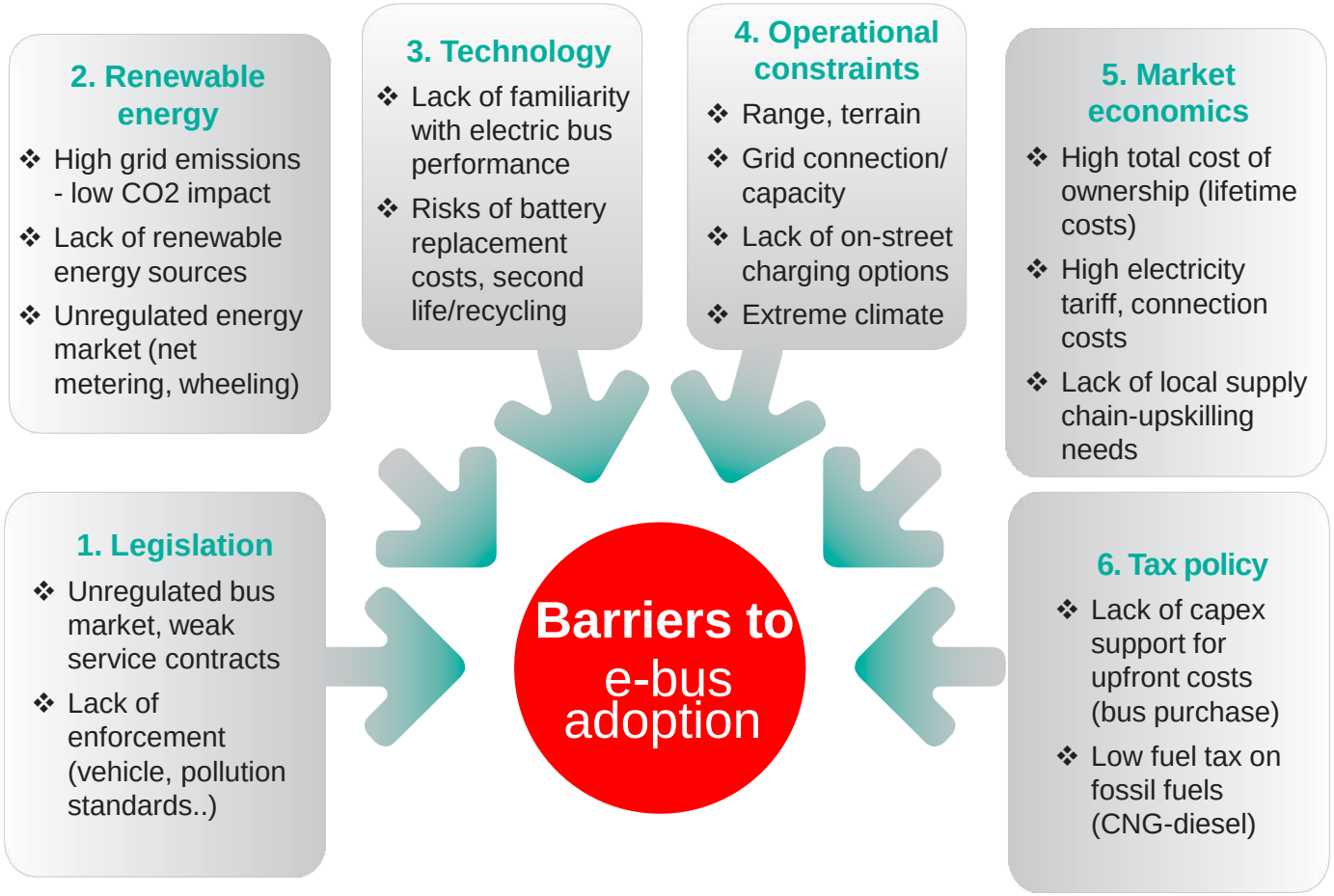





Source: TIL analysis for the EBRD. Note: Schematic shows motivations and enablers for the use of e-buses, in schemes studied by TIL.

# POLL #1 - what are the main barriers to e-bus deployment?






For the poll- select your **top 3 choices** for your city-country-business sector

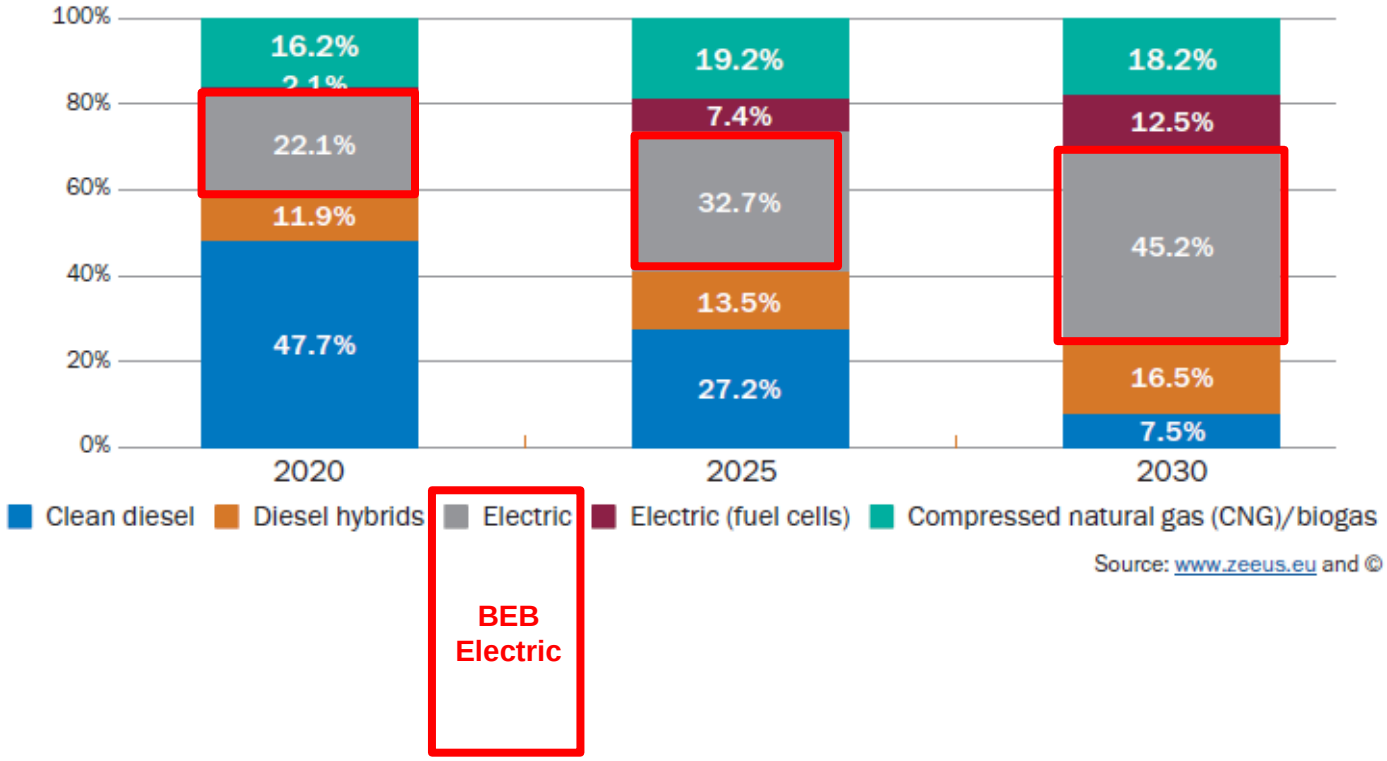
# Choosing the right e-bus

*Arno Kerkhof, UITP*

UITP ADVANCING PUBLIC TRANSPORT

# State of the market

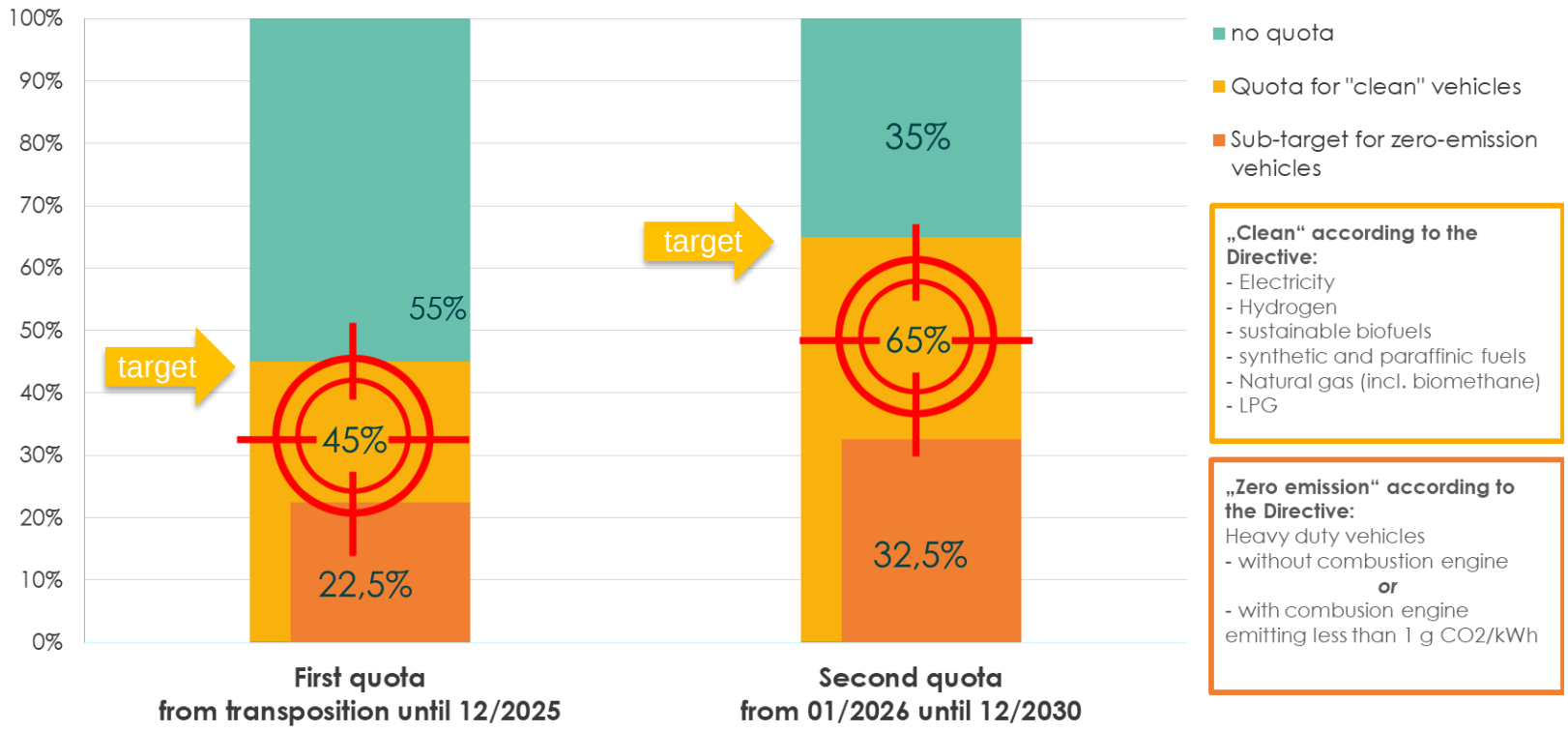
Figure 1. Propulsion systems by year – UITP forecast (European markets)




Source: www.zeeus.eu and © UITP VEI Committee.

# Clean Vehicles Directive: Mandatory quotas for public procurement






Source: UITP based on CVD

► *Illustration of the maximum mandatory procurement quotas (applicable for: LU, SE, DK, DE, NL, AT, BE, IT, IE, ES, CY, MT; lower quotas apply for remaining Member States)*

# EU Clean Bus Deployment Initiative



Launched in 2017 to speed up the introduction of clean buses across Europe.

Elements for the scale up:

- Policy framework
- Financial & funding framework
- Exchange of best practices and knowledge

The Clean Bus Europe Platform is the strategic line of action to develop, implement and support the transition towards clean bus fleets.


House of the Regions, Brussels (BE)

# The Clean Bus Europe Platform: enabling e-bus fleet upscale

UITP

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

European Bank for Reconstruction and Development

CLEAN BUS EUROPE PLATFORM


The Clean Bus Europe Platform is financed by the European Union.

www.cleanbusplatform.eu

# Factors to consider for e-bus selection



Table 13. Factors to consider in defining the organisational framework and financing regime for e-buses

| | Issue | Commentary |
|---|---|---|
|  | Power and charging | The deployment of electric buses will require large scale investments in infrastructure for bus charging, power distribution and bus depot reconstruction, as well as new bus fleets. A well-planned, scalable roll out programme, delivered via project management, will be needed and cities should make or act on commitments to transition to e-buses. |
| 15 > 20 > 25 years? | Asset life uncertainty | Electric buses may have longer economic lives than the diesel buses they replace, as will some power equipment. This life may not be aligned to the operating concession period. |
|  | Battery replacement funding | Bus batteries will require repeated replacement during the life cycle of the bus and charging assets. (In 2020, battery life was typically 5-8 years and bus life 15+ years.) Given the rapid development of this technology, it is possible that battery life and efficiency will continue to improve significantly in terms of weight, range, life and cost. |
|  | Operating transition costs | Investment in operating expenditure (opex) will be needed for a smooth transition from diesel, covering staff training, retraining and familiarisation for drivers, bus maintenance teams and other staff. |
| | Governance and funding structure | For all these reasons, it is desirable that any investment in electric buses is undertaken within the context of a strong and contractualised governance structure, with market stakeholders that are capable of delivering policy objectives and ensure the sustainability of the investment. |
| 15 > 20 > 25 years? | Strategy<br>Contractualisation<br>Funding | This is likely to embrace:<br>• setting defined transport policy and financial objectives for the transport authority<br>• defining operational and contractual obligations of the PTO(s) (which may be a division of the PTA) and/or private operators<br>• defining the duration of the operating rights, which should be consistent with the investment proposed in the electric bus fleet and the conversion works that may be funded. |
|  | Political framework<br>Long-term funding<br>Stable operating regime | The reformed structure is likely to cover topics such as:<br>• exclusive operating rights<br>• regulation of timetables and bus network<br>• vehicles required – number, capacity, emissions standard, average or maximum age, and so on<br>• asset lives and replacement obligations<br>• subsidies and subventions payable<br>• asset ownership and charging regimes<br>• who holds vehicle and equipment RV and on which balance sheet do they sit.<br>Contractual models should, therefore, clearly define the responsibilities and roles of each party, allocating risks where handled best and reinforcing cooperation amongst the parties. When possible, early involvement of different parties is strongly recommended. |

Source: TIL analysis for the EBRD.

# Charging infrastructure aspects



line end



hub

Diesel bus parking plan (12 buses)

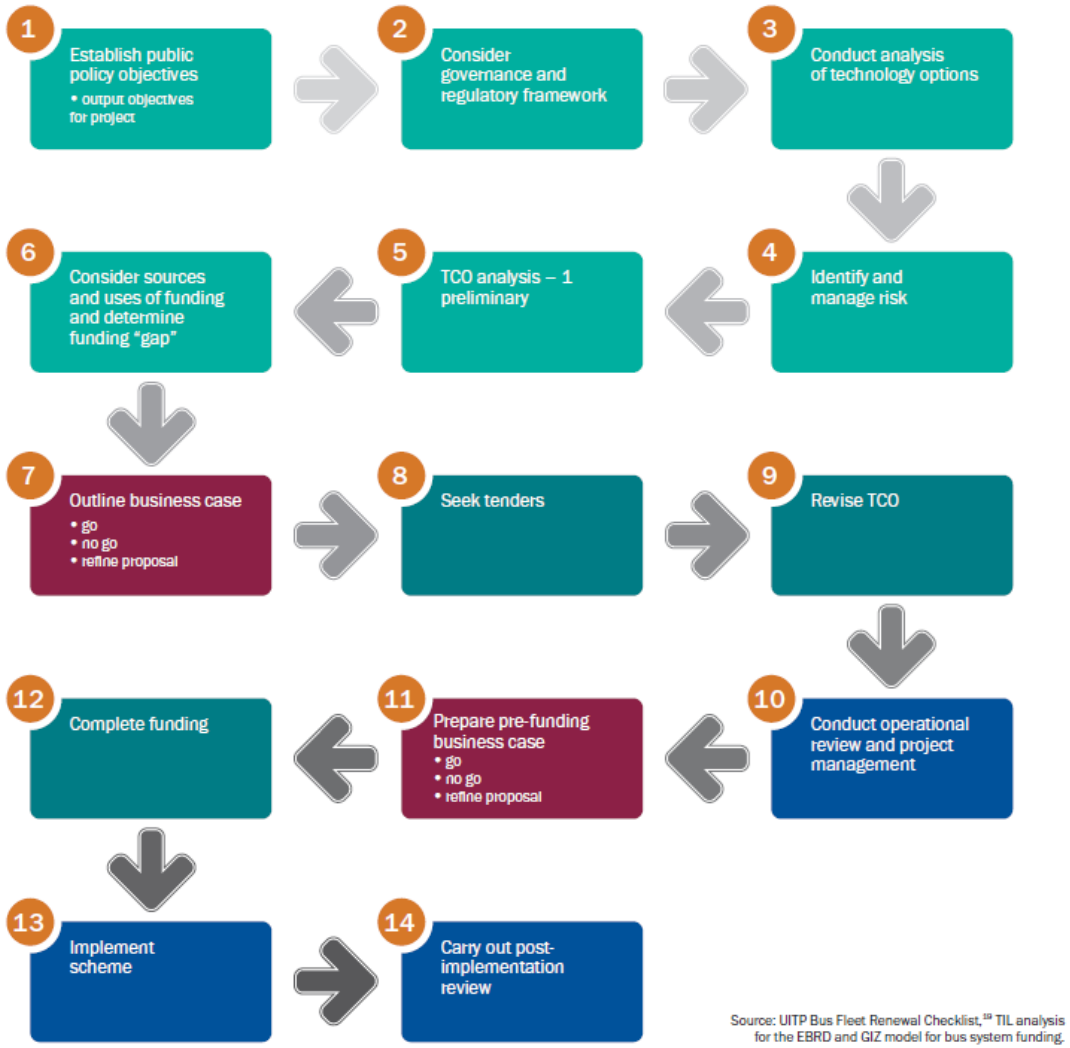
shared concept

Electric bus parking plan (same area only takes nine buses – assuming depot charging)

depot

# Developing e-bus project

Figure 8. A step-wise model for developing an e-bus project




Source: UITP Bus Fleet Renewal Checklist,[19] TIL analysis for the EBRD and GIZ model for bus system funding.

# POLL #2 – Topics you need for future webinars ?

## WHICH TOPICS DO YOU FIND MOST RELEVANT FOR FUTURE WEBINARS?

- Current state of e-bus deployment and market watch e-bus product
- Setting scheme objectives for e-bus projects
- Choosing the right e-bus technology option- planning, development and procurement
- e-Bus operations and total cost of ownership
- Battery chemistry and battery technology – market, behaviour, circularity
- Funding models- from battery lifecycle to green funds

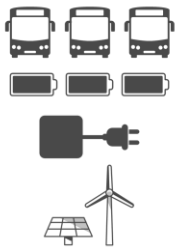
# E-bus lifetime costs

*David Leeder, Partner – TIL*

*Transport Investment Ltd*

# e-buses have large economic impacts and high up-front costs







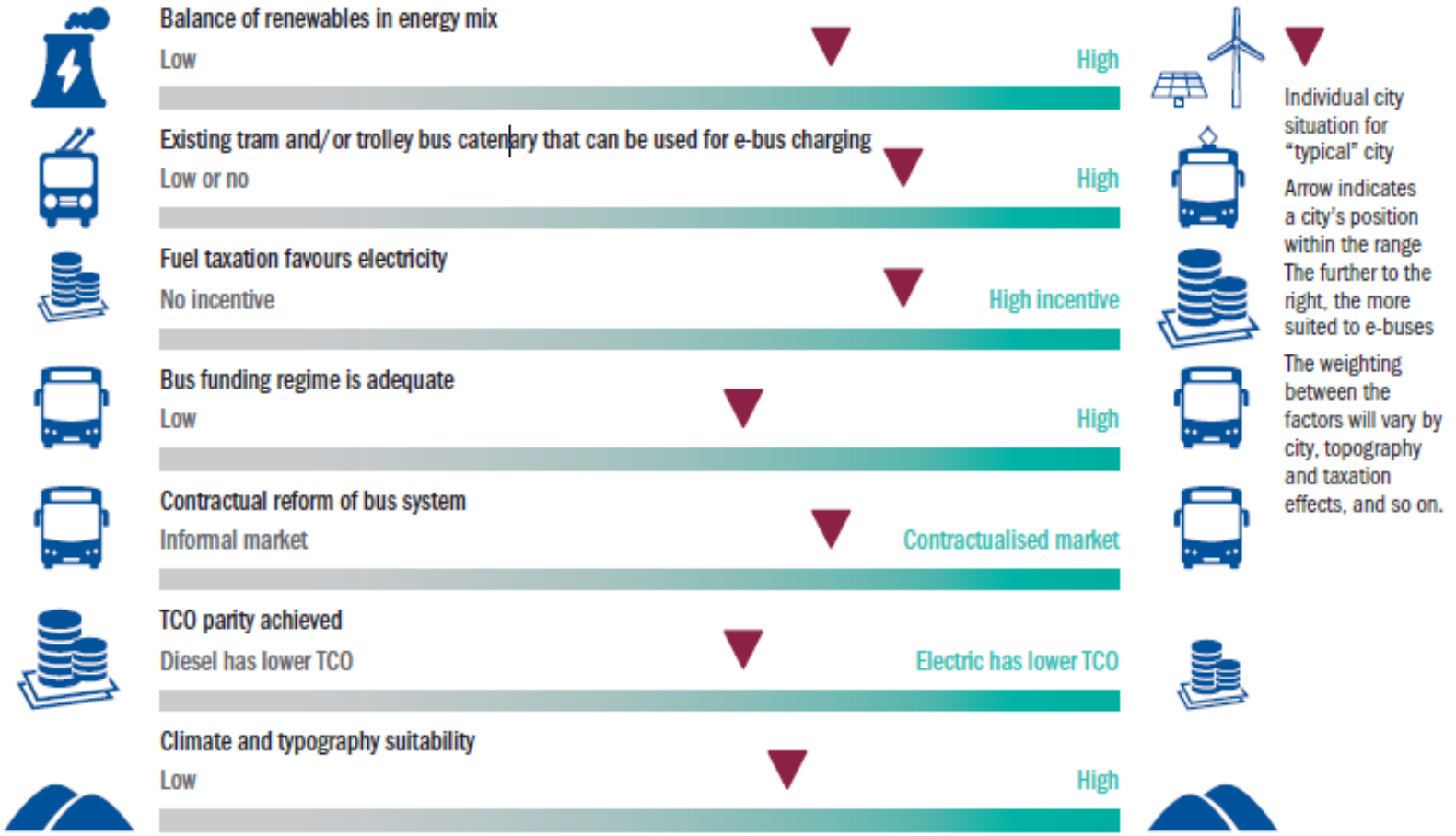


| **Upfront capital costs x2 – x3 higher** | **Total cost of Ownership approaching parity with diesel** | **Assets may last longer** | **Are batteries a capital item or revenue item?** |
|---|---|---|---|
| Buses | Fiscal regime | Less vibration | Allocate risk |
| Batteries | Capital grants | Fewer moving parts in drivetrain | P&L and balance sheet |
| Chargers | Operating grants | Experience with trolleybuses | Disposal and recycling |
| Grid connections | Asset life | | Life |
| (transition costs – eg training + redundancy) | Operating costs | | Replacement cost |

Biggest economic change in bus technology since end of horse buses in 1910

# Factors affecting TCO

Figure 10. Factors favouring e-bus TCO outcomes




Source: TIL analysis for the EBRD.

# UK like for like diesel vs e-bus achieves TCO parity



Figure 12. Comparison of TCO between Euro VI diesel and e-bus (UK assumptions)[21]

Electric power costs are likely to be lower than diesel costs and must be adjusted for fuel taxes and electric vehicle incentives.

Consumption rates will be heavily affected by local topography and heating/ cooling requirements.

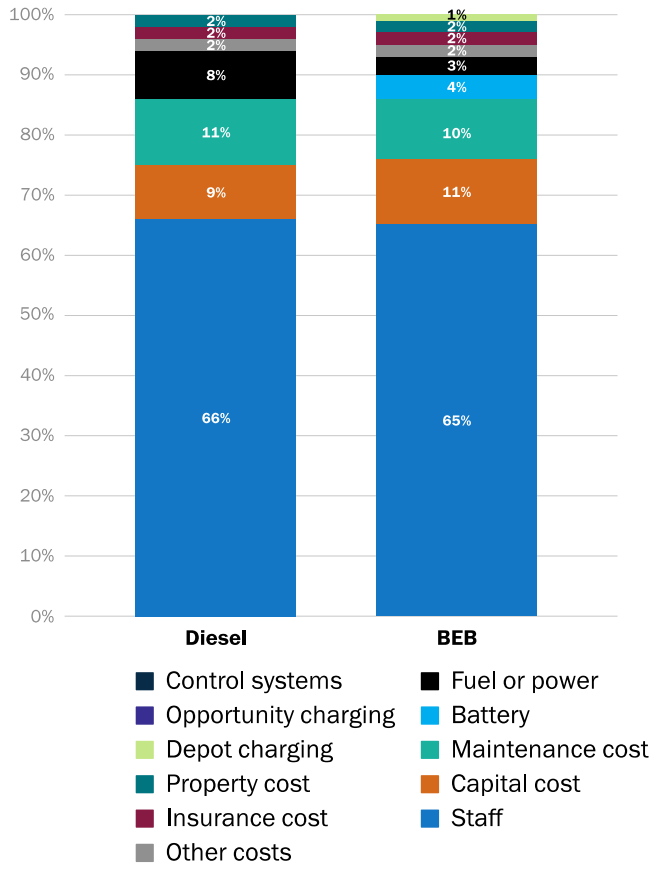
Maintenance costs for e-buses can be 5-30 per cent lower, depending on local assumptions.

E-bus capital costs are higher for e-buses, because of the higher unit costs of the buses and equipment. These costs reduce if asset lives can be extended.

Labour costs remain the dominant cost element.

These costs are affected by the potential impact of charging time on driver labour costs.

However, they may benefit from reductions in engineering labour hours.




Source: TIL analysis for the EBRD.

E-bus has lower fuel / power cost

E-bus has lower maintenance

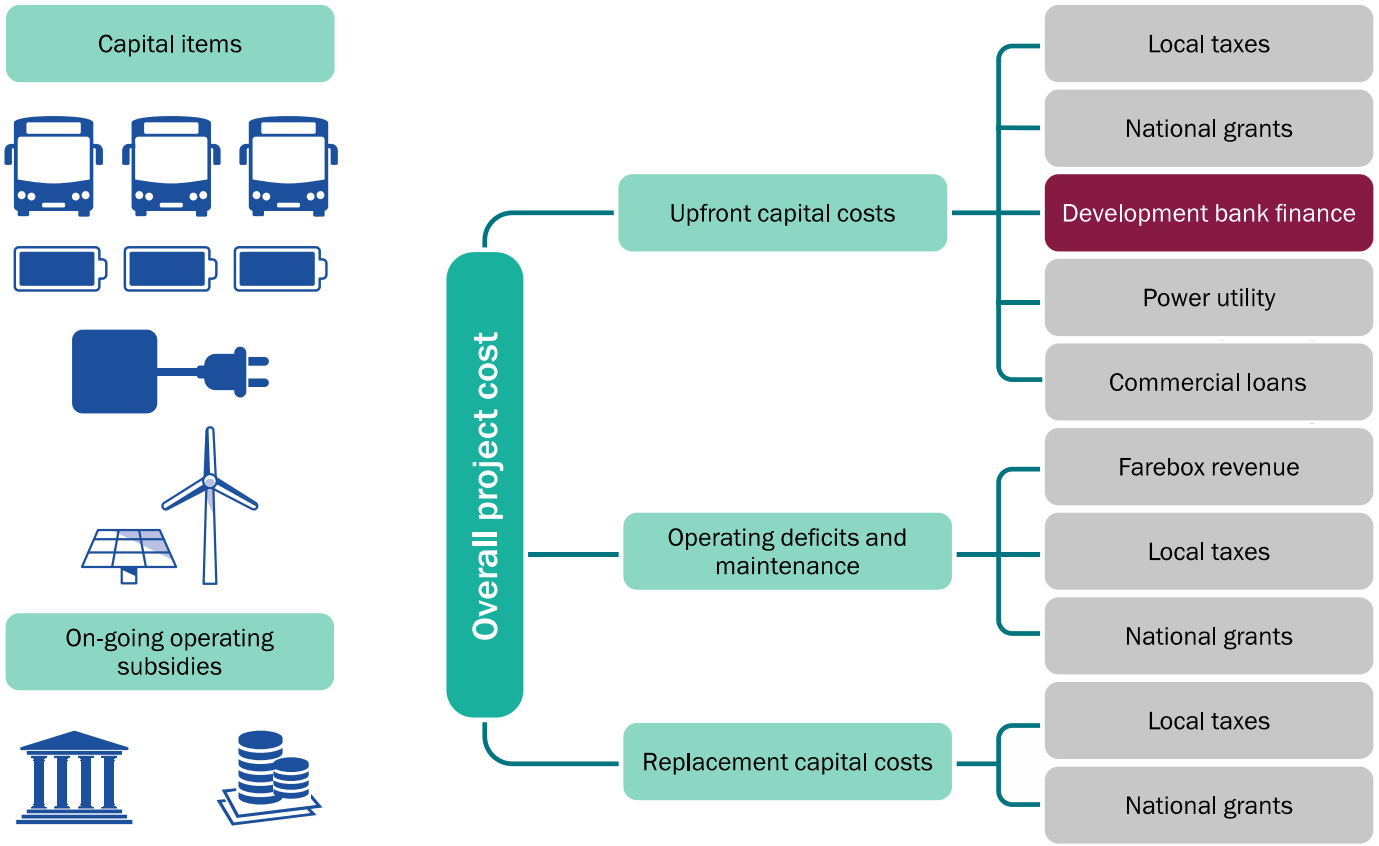
E-bus has higher capital

Small changes in labour costs - Driven by charging strategy

UK subsidy regime assists e-bus, and power costs much lower than diesel post tax

# e-bus schemes require a 'sources and uses of funds' approach

Figure 13. Sources and use-of-funds analysis

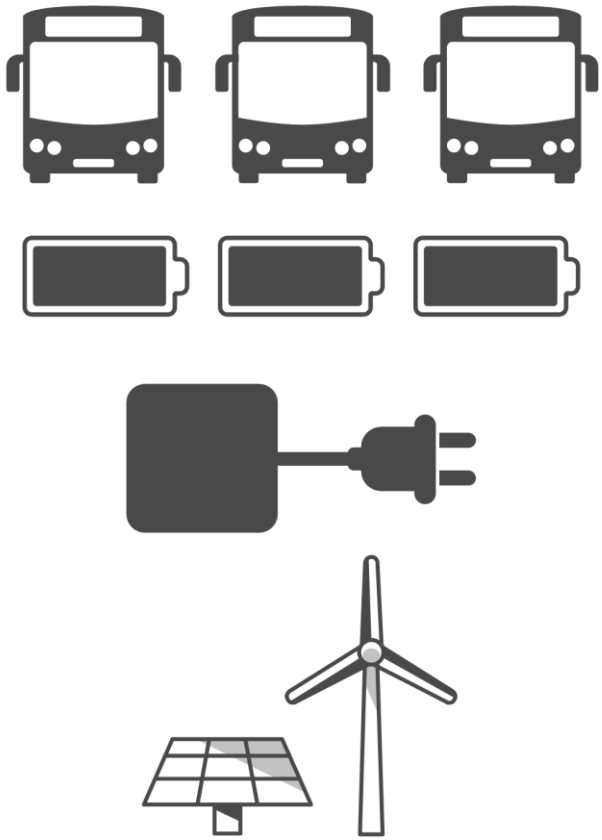



Source: TIL analysis for the EBRD.

Scheme funding must consider whole life of assets which can be 15-20 years

# Financing and warranties must be considered for all asset classes





15-20 year life
Manufacturers and banks offering RV guarantees
May require contract maintenance
And or long warranties
RV guarantees ?

5-8 year life
Extending life
Must be safely recycled and disposed
Second life opportunity

Charging equipment
Long life
High and variable cost
May require contract maintenance
And or long warranties

Incremental renewable capacity

Long warranties and ‘battery as a service’ are key considerations and becoming available

# Future funding models for ebus

*Ian Jennings, EBRD*

# What role for future funding models?



**New funding models are emerging..**

**Why should they be considered?**

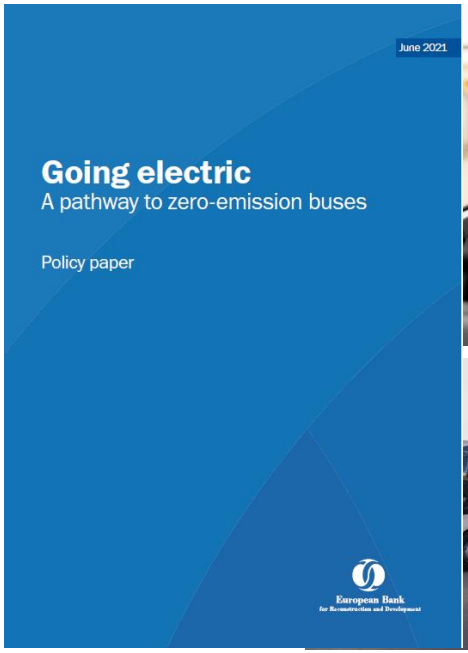
- **High upfront cost** of electric vehicles, charging infrastructure
- Current **battery-related c**osts up to 30%-50% of the bus lifecycle costs, including battery replacement cost during bus life
- Electric battery operation requires **optimisation of electricity supply**, smart charging and use of renewables, on and off-site
- Lifecycle approach enables better **risk allocation** and management by the party best able to manage risks, costs and uncertainties
- Capture of **asset residual values** (battery second life, recycling)

# POLL# 3: Which funding models will be dominant in 10 years time?



| Component | | Standard purchase | Standard purchase + extended warranty | Standard purchase + service agreement | Battery as a Service (BaaS) | Utility funded |
|---|---|---|---|---|---|---|
| Purchaser | | PTO | PTO | PTO | PTO | Utility |
| | Bus supply | | | | | |
| | Battery supply | | | | | |
| | Charging supply | Possibly, separate supplier | | | | |
| | Battery replacement | | | Possibly, separate service contract | | |
| | Battery service | | | | | |
| | Charging service | | | | | |
| | Legend | Main supplier | Optional | Leasing contract | | |

# Thank you






Policy paper "*Going Electric- A Pathway to Zero Emission Buses*" https://www.ebrd.com/infrastructure/going-electric.pdf

European Bank for Reconstruction and Development (EBRD) - Ian Jennings - Senior Specialist / Urban Transport – Xiaolu Wang- Associate Banker, Infra Europe

International Association of Public Transport (UITP) – Arno Kerkhof- Head of Bus Transport Unit / Aida Abdulah- Senior Manager – Knowledge & Innovation

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH – Christian Mettke – Project Manager, Climate Change, Environment, Infra dept

Transport Investment Limited (TIL) – David Leeder - Managing Partner / Alok Jain Managing Director, TransConsult Asia (TCA)