



Electric buses: Who's in charge?

A proposed roll-out methodology for public e-buses charging infra

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10 October, 2017



- EVConsult & our work
- Electric plug-in buses in the Netherlands
- Charging solutions for public electric buses
- Infrastructure: key stakeholders
- The triple layered model





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EVConsult & our work



- A team of 15 consultants with various academic backgrounds
- Founded 8 years ago by Roland Steinmetz and Tim van Beek
- Head Office in Amsterdam, The Netherlands
- Strategy consultancy, project management research & innovation
- National and Global clients





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E-buses in the Netherlands

Plug-in e-buses are past pilot phase



Schiermonnikoog

- Bus fleet: 6, full electric
- Start of operation: 2013

Eindhoven

- Bus fleet: 43, full electric, city transport
 - Start of operation: start 2017

Schiphol

- Bus fleet: 35 buses for gate transport
 - Start of operation: June 2015

Utrecht

- Bus fleet: 10, full electric, city transport
 - Start of operation: September 2017



E-buses in the Netherlands

All new e-buses electric by 2025



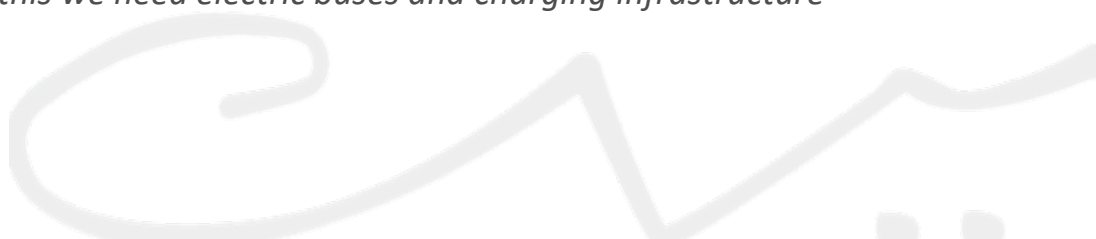
Zero Emission Bus Agreement

2025 all new buses in public transport to be Zero Emission

2030 all buses Zero-Emission



To realise this we need electric buses and charging infrastructure





- EVConsult & our work
- Public transport in the Netherlands: electric bus adoption and prospects
- Charging solutions for public electric buses
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Charging solutions for public e-buses

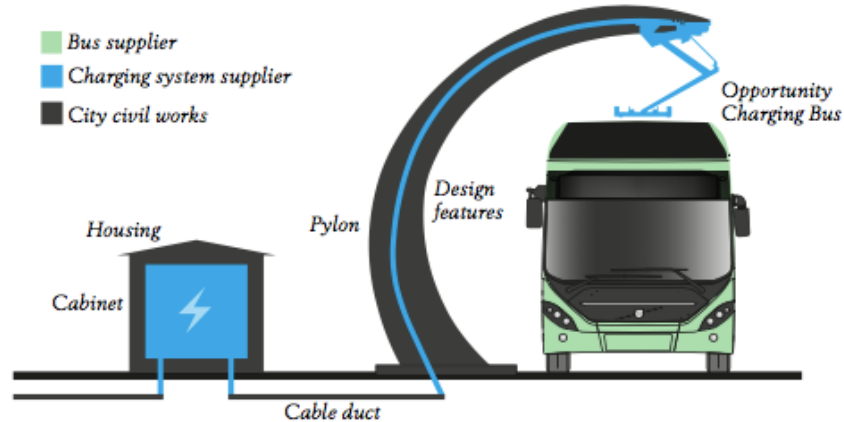
A quick overview



Charging solutions

1. Opportunity charging

2. Overnight charging



Source: Volvo

Charging solutions for public e-buses

A quick overview



Charging solutions

1. Opportunity charging



Depot charging at Eindhoven bus depot

2. Overnight charging

Charging solutions for public e-buses

A quick overview



Charging solutions

1. Opportunity charging



Plug charging BYD

2. Overnight charging



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Infrastructure: key stakeholders

Impact of charging solution for electric buses



Charging solution

Transport

Chargers

Public space

Costs & benefits

- PTO
- PTA
- City

- PTO
- Grid operator

- City





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Current approach

Charging is part of the tender for public transport



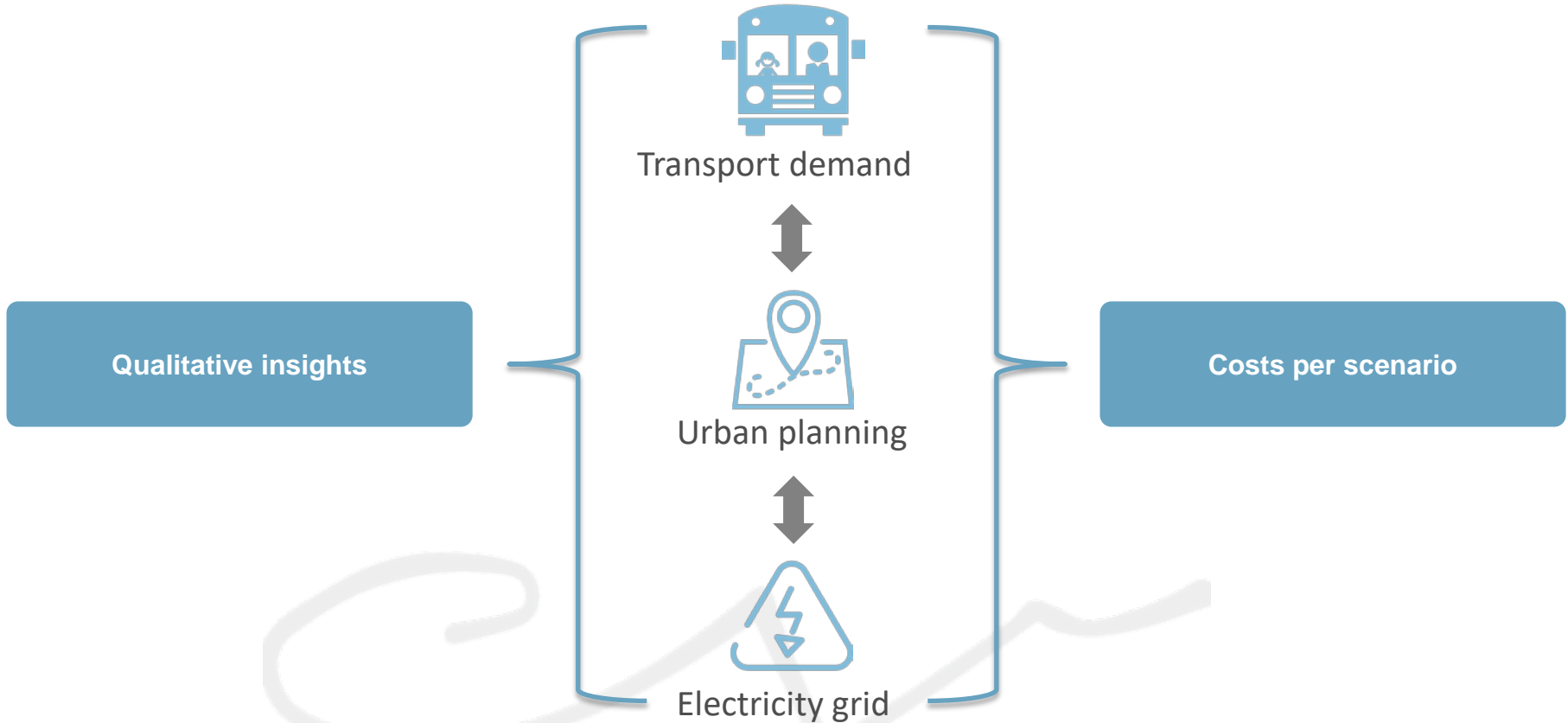
- Decision on technology and location lie primarily at the PTO
- *Advantages*
 - Responsibilities transport and timetable lie entirely at the PTO
 - Charging solution & choice of buses is connected → PTO can design its own most efficient transport model
- *Disadvantages*
 - First PTO decides on charging planning in cities
 - PTA has no influence on charging technology
 - Charging configuration is only known after award of the concession
 - Coordination with cities / municipalities start
 - Long realisation term charging infrastructure
 - Use of multiple PTOs or other electric vehicles is more difficult



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The triple layered model



Triple layered model



Develop charging scenarios: technology decision

Charging solutions		E-buses
1. Opportunity charging	With bus exchange	--
	At key locations	-+
	At end-stops	-+
	At the depot	-
	At most bus stops	++
2. Overnight charging	At the depot	-+

Distinguish:

 Scenario's possible today

 Future scenarios

 City lines

 Transit lines

Triple layered model

Layer 1. Transport requirements



Charging solutions		# E-buses	Chargers
1. Opportunity charging	With bus exchange	--	100-350 kW
	At key locations	-+	100-350 kW
	At end-stops	-+	100-350 kW
	At the depot	-	100-350 kW
	At most bus stops	++	350+ kW
2. Overnight charging	At the depot	+	30-150 kW

Depends on local conditions:

- Bus routes
- Lay over times
- Frequency of rides
- Driving speed
- Etc..

Triple layered model

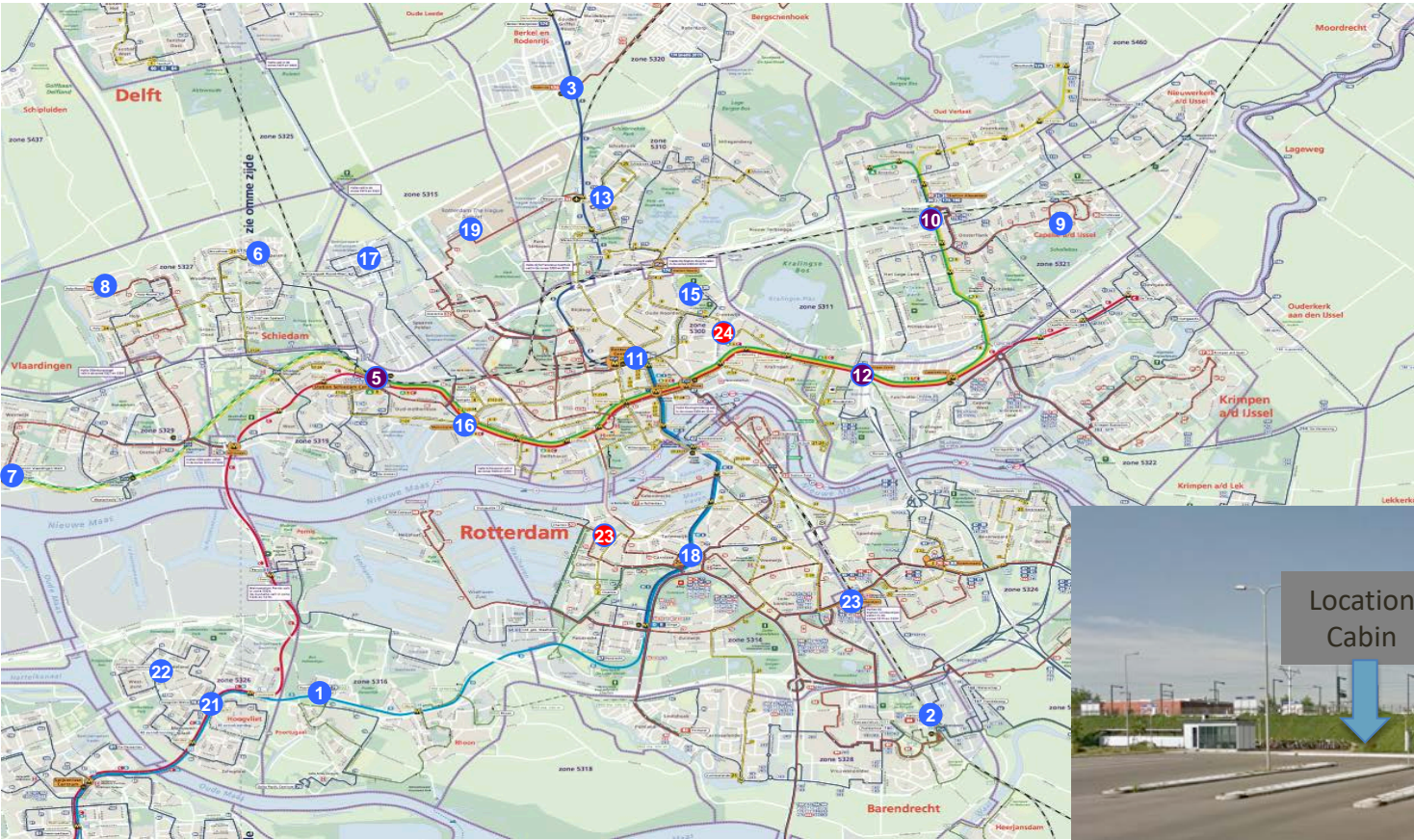
Layer 2. Urban planning



Charging solutions		# E-buses	Chargers	Public space
1. Opportunity charging	<i>With bus exchange</i>	--	100-350 kW	-
	<i>At key locations</i>	++	100-350 kW	-
	<i>At end-stops</i>	++	100-350 kW	++
	<i>At the depot</i>	-	100-350 kW	++
	<i>At most bus stops</i>	++	350+ kW	--
2. Overnight charging	<i>At the depot</i>	+	30-150 kW	++

Triple layered model

Layer 2. Urban planning – *example Rotterdam*



- Room in public space
- Bus route
- Landscaping
- 1 or multiple PTOs
- Scalability..



Triple layered model

Layer 3. Electricity grid

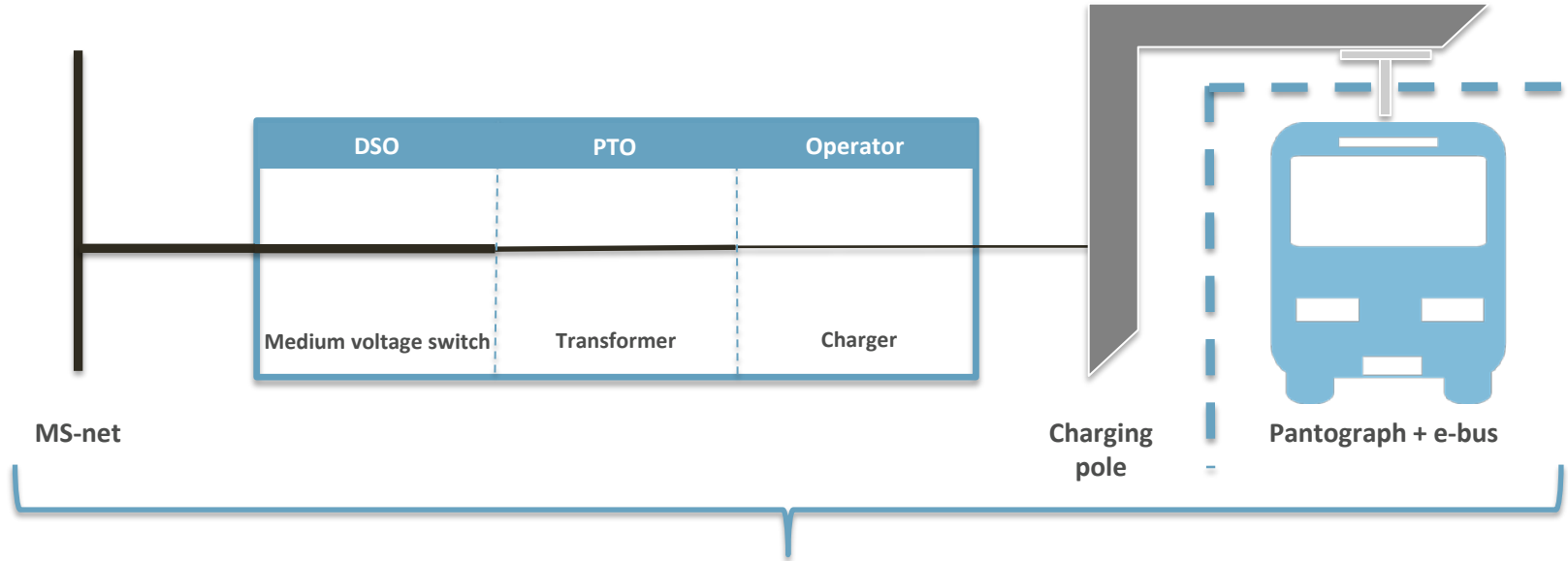


Charging solutions		# E-buses	Chargers	Public space	Grid impact
1. Opportunity charging	<i>With bus exchange</i>	--	100-350 kW	-	--
	<i>At key locations</i>	+-	100-350 kW	-	--
	<i>At end-stops</i>	+-	100-350 kW	+-	--
	<i>At the depot</i>	-	100-350 kW	++	-
	<i>At most bus stops</i>	++	350+ kW	--	--
2. Overnight charging	<i>At the depot</i>	+	30-150 kW	++	++

 Depending on local grid

Triple layered model

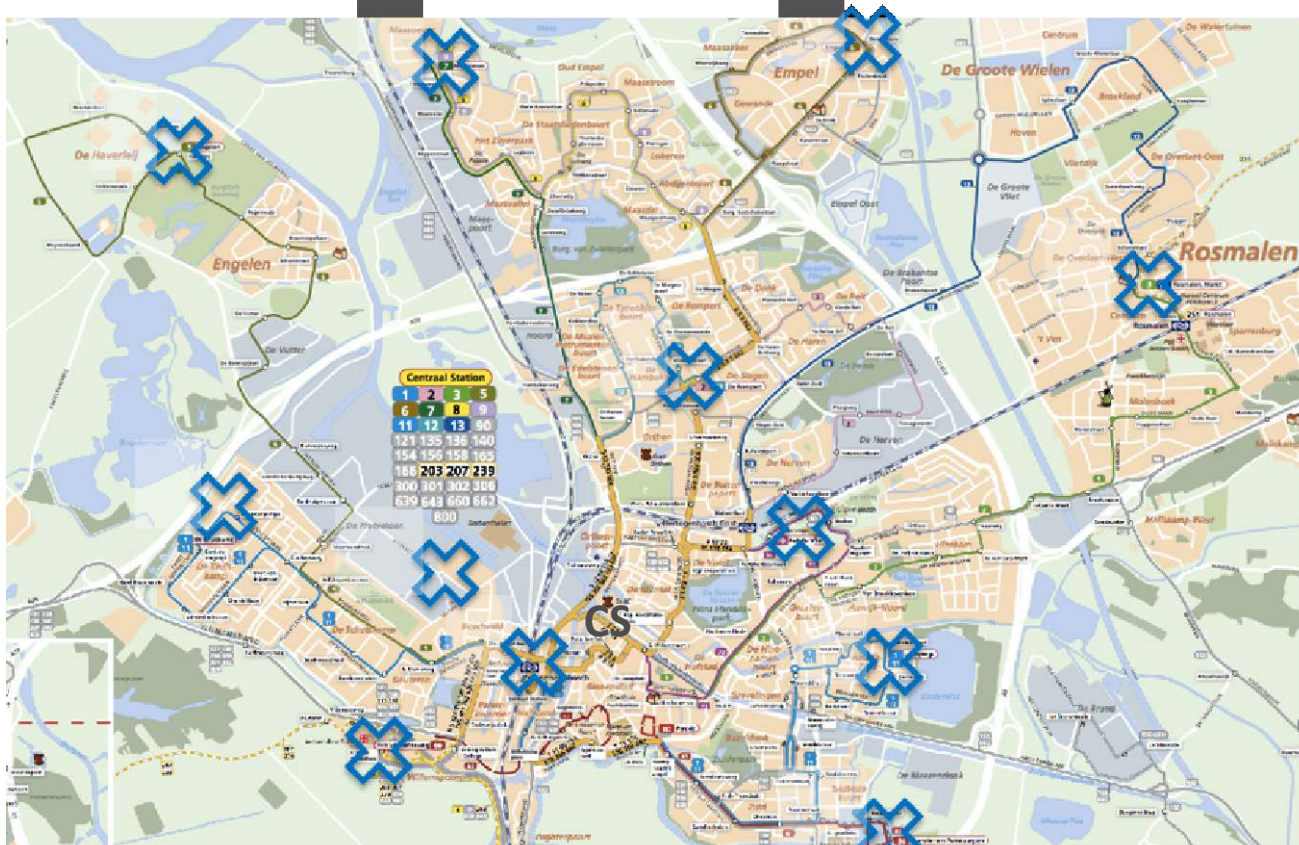
Cost comparison over the entire value chain



Cost comparison over the entire value chain

Triple layered model

Results Triple Layered Model



Insight in:

- Charging configuration
- Potential locations
- Grid impact
- Costs
- Feasibility



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