Experiences from trials with battery electric buses in Norway

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32nd Electric Vehicle Symposium (EVS32)
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Contents

- Battery electric trials in Norway
- User Experiences
- Costs of operations

Photo: Ruter

Photo: Nobina

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Ruter - 60 % of bus fleet full electric in 2025

2015 Stavanger
2 x city (Ebusco/Boreal),
Kolumbus

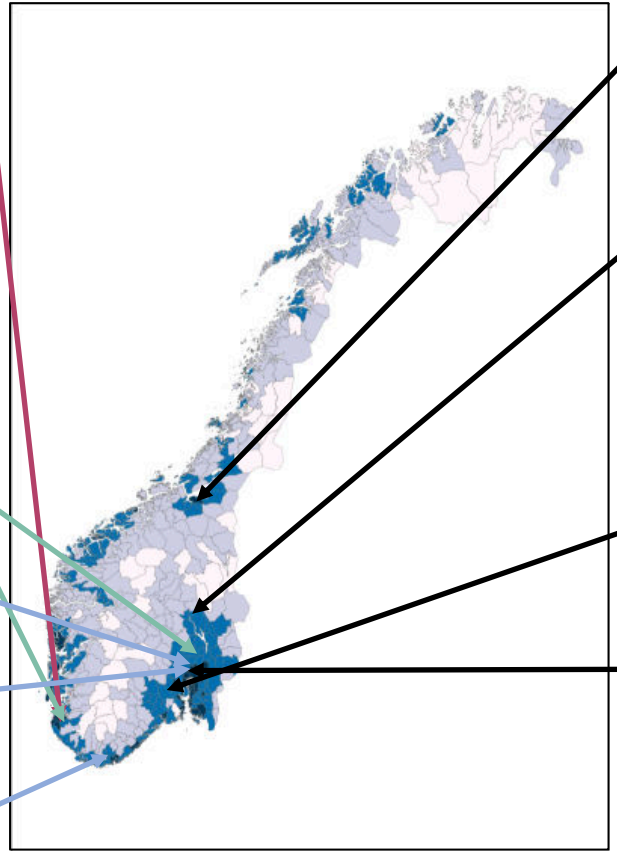
2017 Stavanger
3 x city (Ebusco/Norgesbuss)
Kolumbus

2017 Lillestrøm/Jessheim
10 x mini (IVECO/Taxus)
Ruter

2017/2018 Oslo
2 x articulated (BYD/Nobina)
2 x city (Solaris/Norgesbuss)
2 x city (Solaris/Unibuss)
Ruter

2018 Oslo
4 x mini (IVECO/Oslo Taxibuss)

2018 Kristiansand
5 x city (Solaris/Boreal)
Kolumbus



2019 Trondheim
25 x city (Volvo 7900/Tide
10 x city (Heuliez/Tide)
AtB

2019 Lillehammer
2 x city (Volvo 7900/Unibuss)
Opplandstraffik

2019 Drammen
6 x city (Volvo 7900/Nettbuss)
Brakar

2019 Oslo area
42 x articulated (BYD/Nobina)
30 x articulated (VDL Citeas/Unibuss)
10 x 12m (VDL Citeas/Unibuss)
17 x city (Volvo 7900/Norgebuss)
Ruter

$\sum = 172$ ++

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User experiences

- **Case study** based on semi-structured interviews of
  - Enterprises with **experience in operating battery-electric buses** in Norway
  - Sample based on the **project list of ENOVA** (the Norwegian Government Agency for the transition towards a low-emission society), and the **Norwegian Public Road Administration's vehicle registry Autosys, as of Apr 2018**
- Interviews with people **closely involved in vehicle purchase in each firm**
- **Interview questions** were related to **purchase process**, **technology, performance**, service/maintenance, charging infrastructure, use of the existing fleet, **investment and operation costs and** incentives for enforced in-phasing of zero-emission vehicles

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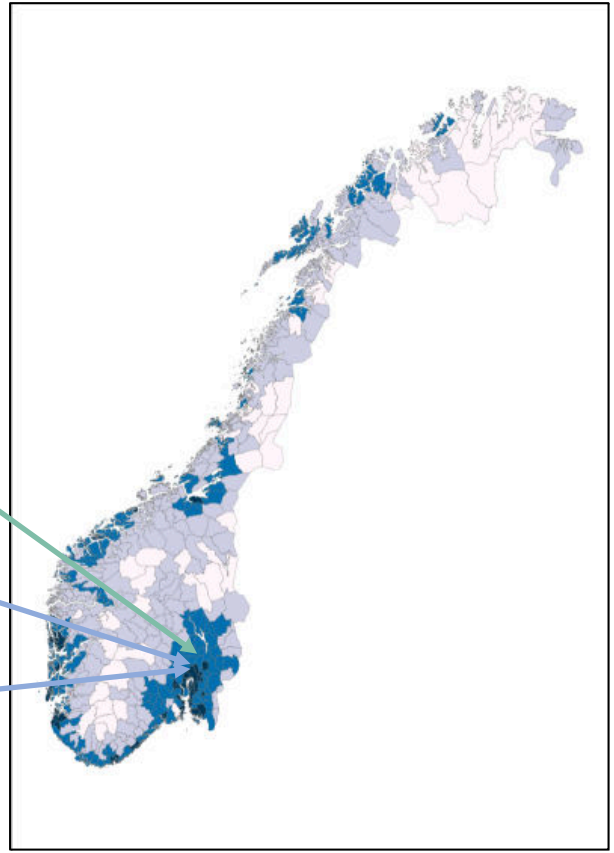

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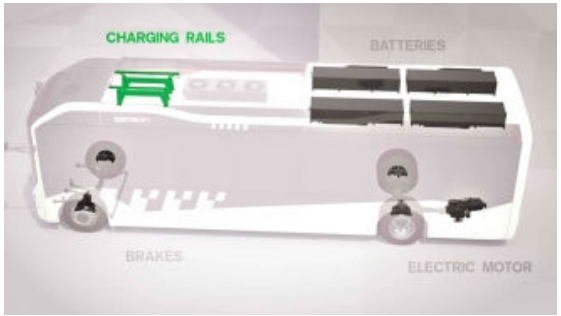
Busses used in the Oslo region trials

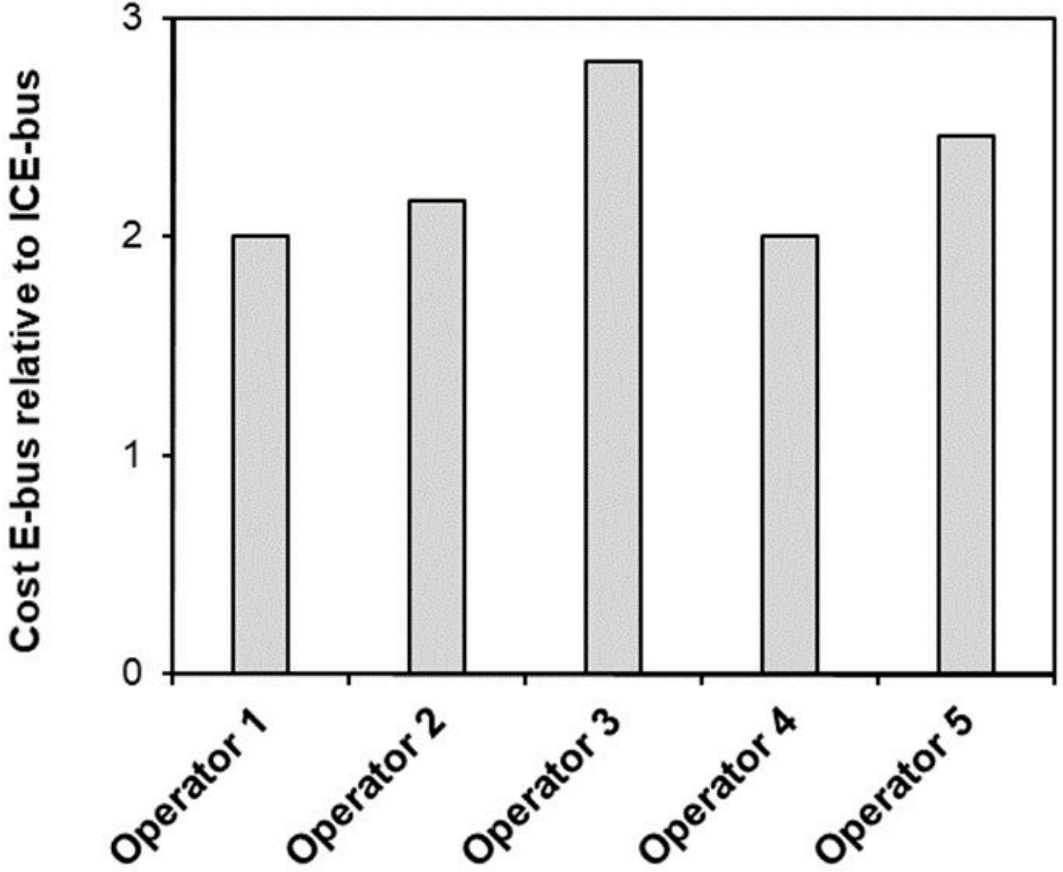
Opererator	Technology employed		Range (km)	Manufacturer	Depot charging	Opportunity charging	Charge time (hours)
Taxus	Mini bus	Na-NiCl2 (90 kWh)	160	Iveco	11 kW		4
Oslo Taxibus	Mini bus	Na-NiCl2 (82 kWh)	150	Iveco	22 kW (public chargers for mini buses)		2
Nobina	Articulated bus	Lithium iron phosphate (300 kWh)	180	BYD	80 kW 300 kW planned		3.5
Norges-buss	City bus	Lithium-titanate (127 kWh)	240	Solaris	80 kW 250 kW pantograph/150 kW charger planned	Fast charger at endstation (pantograph)	1/0.1
Unibuss	City bus	Lithium-titanate (75 kWh)	45-50	Solaris	80 kW	300 kW (pantograph) at endstations planned	6/0.1

Experience from operatio

	Operator 1
Design (3.4.1)	Some heigh
Owners/drivers/passengers (3.4.2)	Low sound/
Energy use (3.4.3)	Extra energ
Range (3.4.4)	Affected by
Vehicle performance (3.4.5)	Technical p
Charging performance (3.4.6)	Some techr



Volvo 7900 Electric Volvo.se



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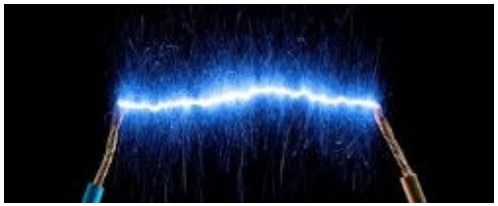
Total cost of ownership

Costs normalised (per functional unit)

Vehicle investment

Operation



Bbc.com

Charging infrastructure investment

Heliox.nl

Maintenance and repair

Herberts-travel.co.uk

Model assumptions

+

+ Interviews

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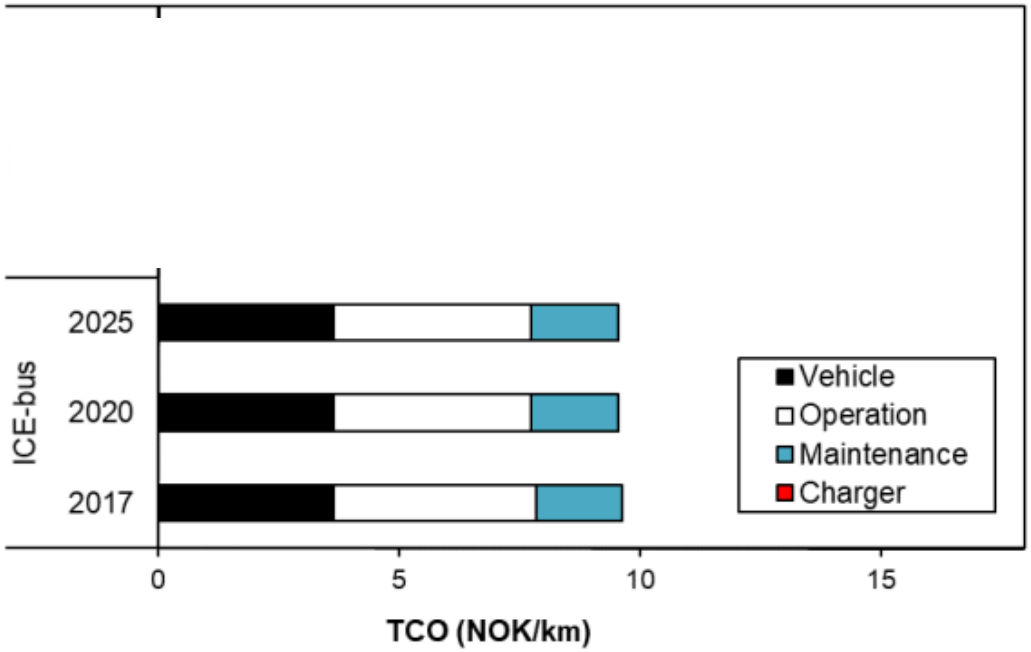
Total cost of ownership City bus (12 meter)



Current ICE-bus TCO compares well with other studies (8-10 NOK/km)

By 2025 E-bus TCO is comparable

Other studies find E-bus TCO favourable to ICE-buses by 2025, or is already favourable

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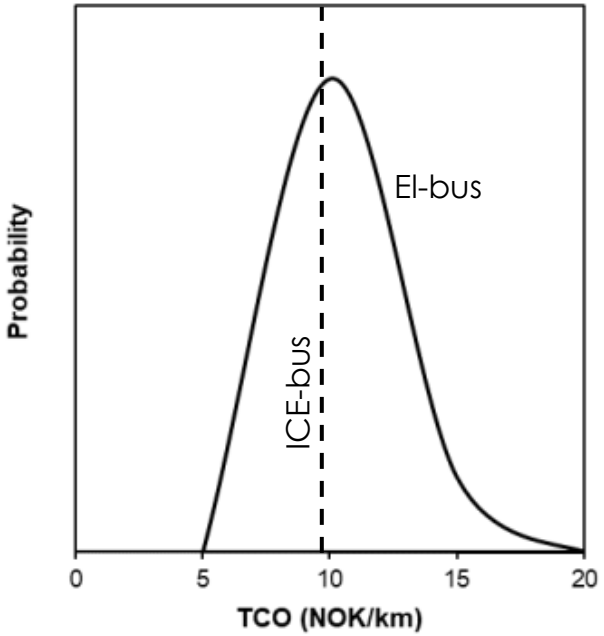
High TCO uncertainty

- Vehicle investment 2.5-3.5 MNOK.
- Max 10 % extra vehicle requirements
- Charger cost 0.4-1.25 MNOK, shared between 5 buses
- Maintenance 1.2 – 2.0 NOK/km
- Electricity costs 1.8-2.3 NOK/km



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Summary

- Market almost in place: Electric buses expected to be mass produced by 2020
- Generally good practical experience, where working correctly
  - Main issues related to engine power, charging and batteries
- Expected to be cost competitive by 2025.
  - Importance of accounting for uncertainties
- Future work
  - Refine cost model and assumptions, streamline with LCA

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Thanks for your attention!

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Photo: Øystein Dahl Johansen/Ruter

Photo: Odd Richard Valmot

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