



Ruter's transition to zero emission

76 ebuses by summer 2019 – all zero emission by 2028

Snorre Lægran, planning director Ruter As

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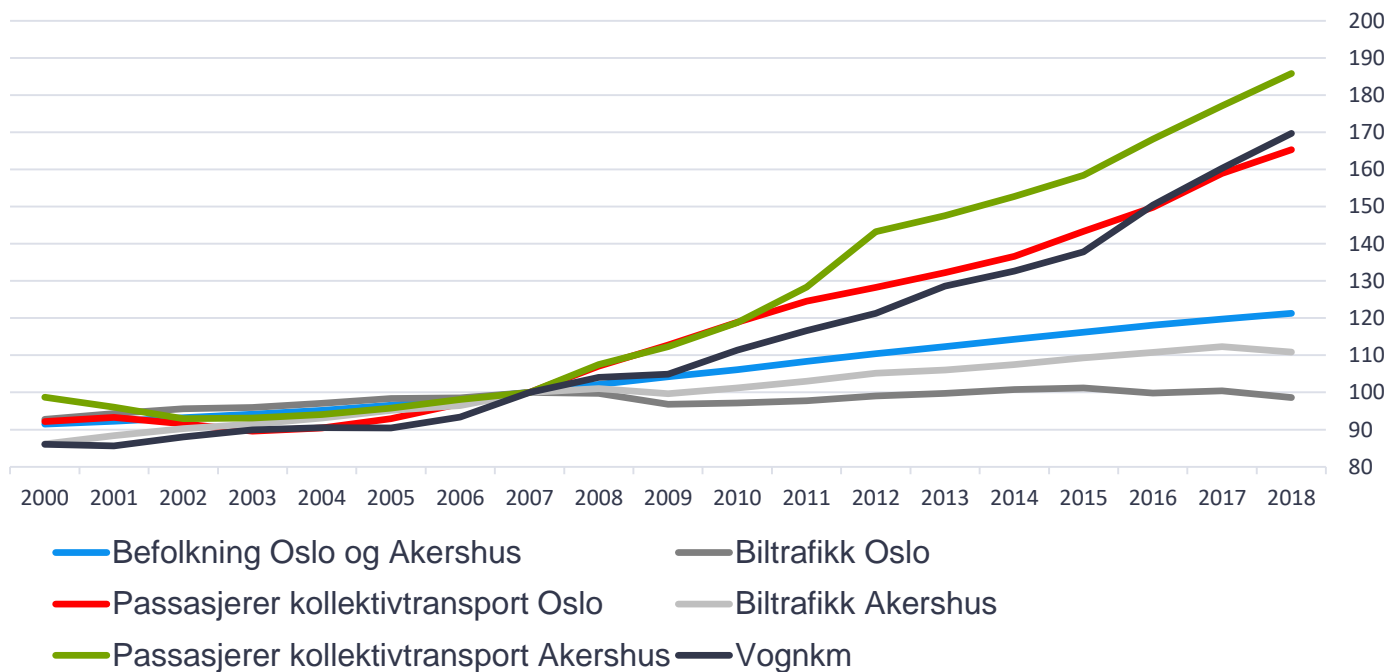
A photograph of two women sitting on a tram at night, looking out the window and smiling. The woman on the left is wearing a light-colored coat and a headscarf. The woman on the right is wearing a dark coat and a plaid scarf. The background shows a city street at night with blurred lights and other passengers on the tram.

387 million
boardings

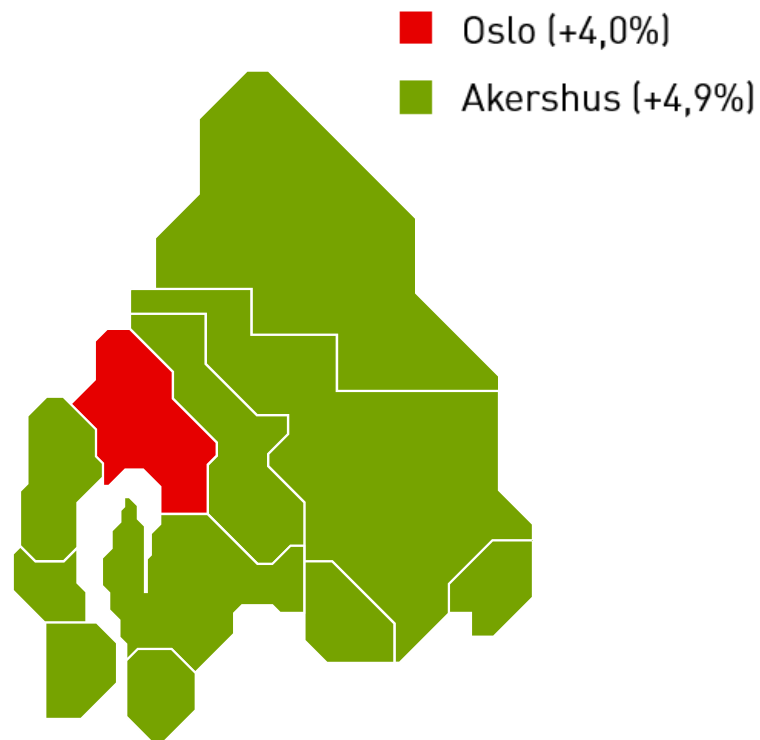
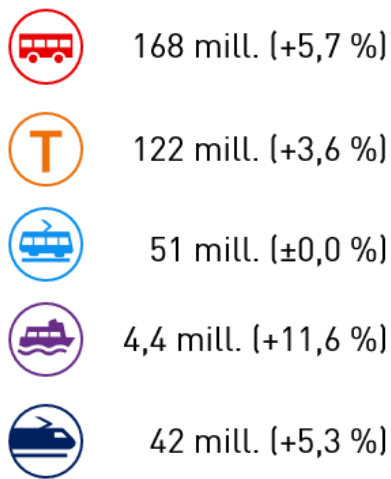
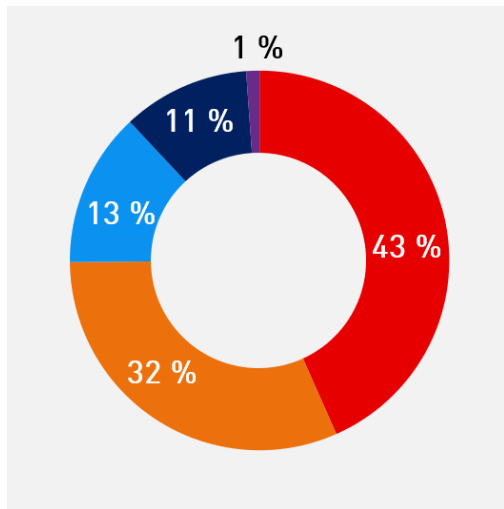
4,2% growth

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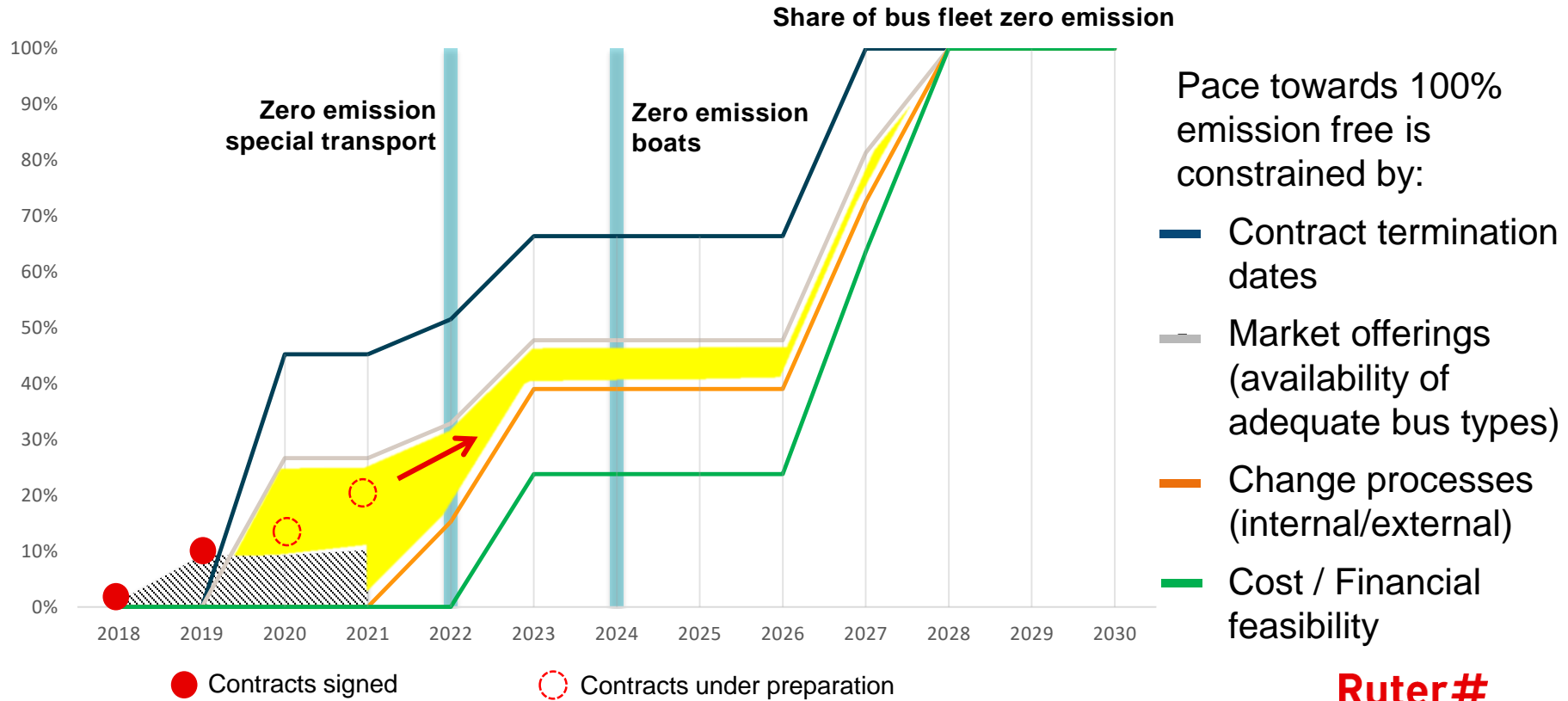
Development 2000-2018



Boardings: Distribution



Our target: emission free by 2028



Electric status

E-bus test started 30.11.2017

- 6 e-buses
- 3 operators
- 3 charging solutions
 - Slow charging on depot
 - Fast opportunity charging
 - Bus mounted pantograph
 - Pole-mounted pantograph

Phase in 70 e-buses in existing Oslo service contracts in 2019

- 70 e-buses
- 3 operators
- 4th charging solution
 - Fast charging on depot
- Operations start May 2019

E-buses included in the new Romerike service contract in 2019

- 39 e-buses
- 2 operators
- Operations start July 2019



Going electric for city buses – the current e-bus test

Line 60
Charging at Vippetangen



Fast charging
400kW – 8 mins
Charging in one end of
2x12km route

Line 74
Charging at Mortensrud T



Fast charging
300kW – 12 mins
Charging in one end of
14km route

Line 31 / 31E
Charging at depot Jernkroken



Slow charging
80kW – 3 hrs
Charging at depot, close to 24km route

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70 E-buses in existing Oslo service contracts



Mercedes



BYD



VDL

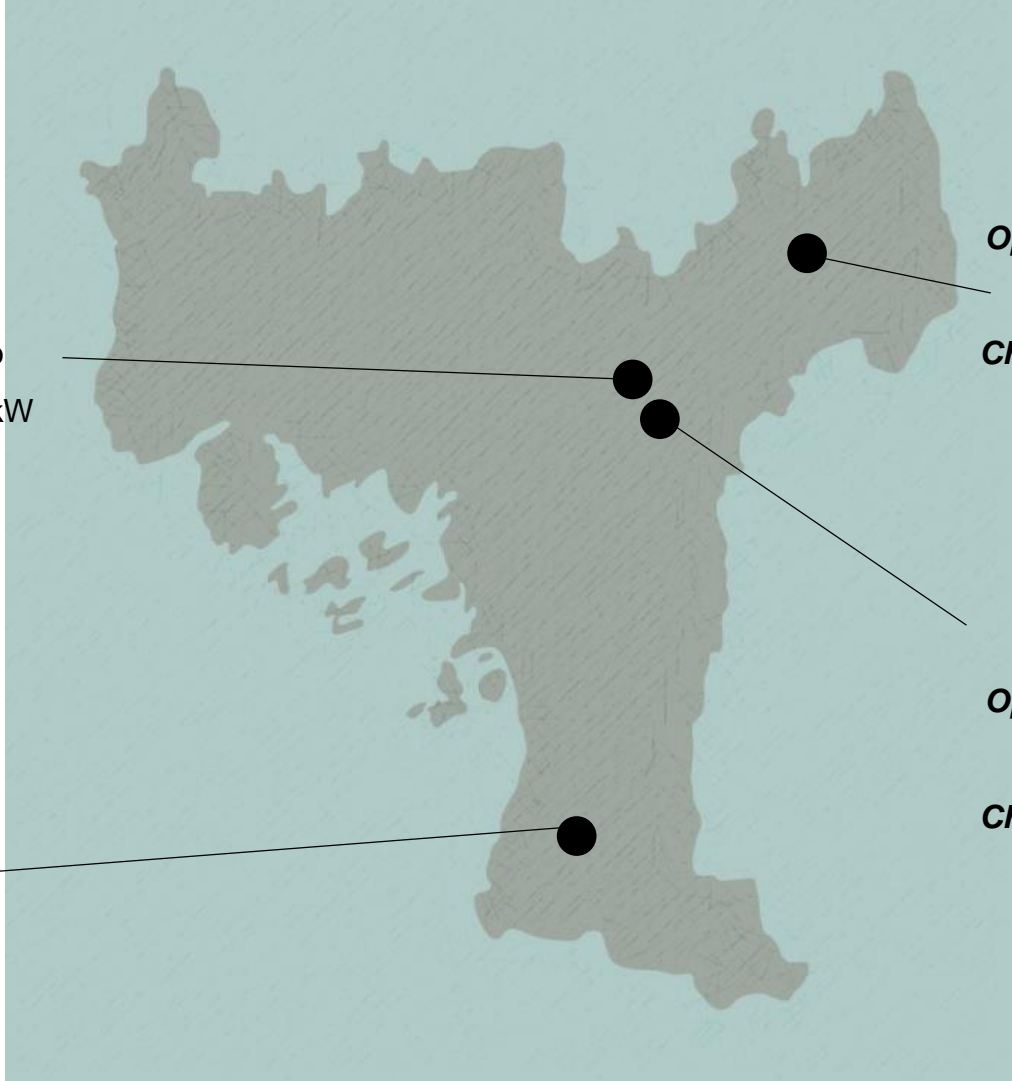


VDL

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Depot Persveien
Operator Norgesbuss
Buses 4 Solaris solo
6 Mercedes solo
Charging Medcom 1x600kW

Depot Klemetsrud
Operator Unibuss
Buses 10 VDL solo
Charging Heliox 10x50kW



Depot Jernkroken
Operator Nobina
Buses 20 BYD articulated
Charging Heliox, 8x300kW and
20x80kW

Depot Alnabru
Operator Unibuss
Buses 30 VDL articulated
Charging Heliox 12x300kW and
18x50kW

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39 E-buses included in the new Romerike service contract in 2019

Depot Brubakkveien

Operator Norgesbuss

Buses 17 Volvo solo

Charging ABB



Depot Leiraveien

Operator Nobina

Buses 22 BYD articulated

Charging Heliox



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**We have to listen,
test, fail, and learn**

Lessons learned – feedback from operators

- Change of work pattern, new logistics, new routines, uncertainty
- Problems related to prototype / early production models
 - IT issues, door issues
 - replacement of battery pack
 - rear axle broken (new in-hub motor design)
 - depot charger problems → lack of battery balancing every 2-3 days
- Lower mileage than expected
- No special challenges with buses in winter conditions, even with range or pantograph
- Two operators have selected drivers (pantograph charging)
- One operator trained all drivers (plugin charging on depot)

Lessons learned – Ruter

- The market has learned and matured
- The operator handle the e-bus risks in the tenders Romerike 2018 and West Region 2019
- Demanding to establish fast charging infrastructure
 - many players - good collaboration, but takes time
- Area requirements - both for end stop fast charging, and increased number of buses
- What is the optimal (or practical) business model for charging – grid owner, depot owner, operator, any new e-infrastructure operator...

In 2019 Ruter will expand to 115 electric buses



