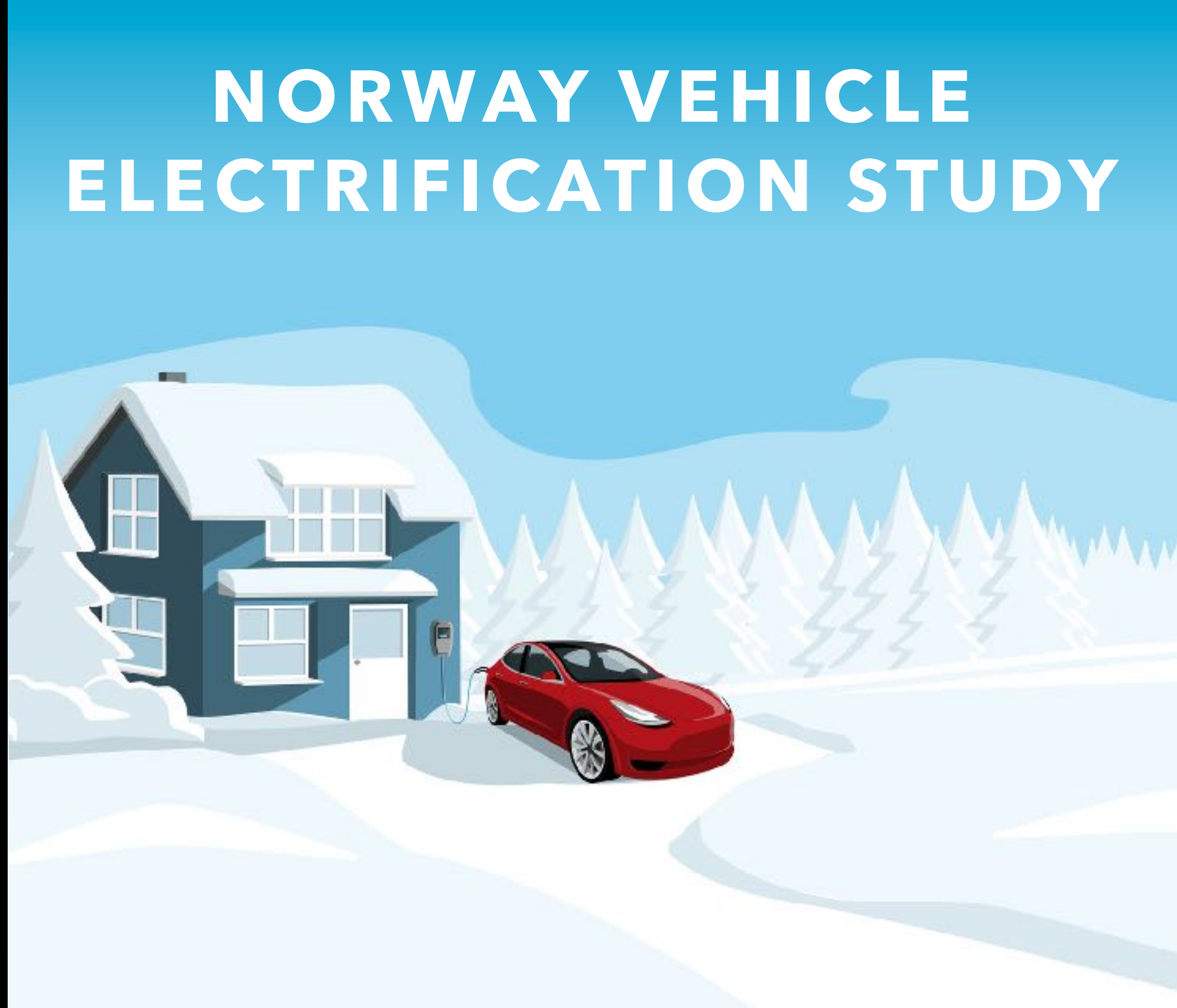


NORWAY VEHICLE ELECTRIFICATION STUDY

**FREE
ABSTRACT**

*A case study on
how to succeed in
electric*



***What all countries should learn from
the global leader***

The report combines the expertise of several experts



Frederic Bruneteau

Managing Director, Brussels

The founder of PTOLEMUS, Frederic has accumulated **25 years of experience of the mobility and transport domains** and 15 years of strategic and financial advisory.

He has become **one of the world's foremost experts of connected mobility** and is interviewed on the subject by publications such as the *Financial Times*, *Forbes*, the *Wall Street Journal* and *The Economist*. He has also spoken at over 40 conferences on the subject.

He has led over 180 consulting projects and helped many world leaders define their strategy and implement it.

Clients he has served include AAA Data, Abertis, AGC Automotive, Allianz, AXA, Baloise, BP, Bridgestone, BRP, Cihon, CNH Industrial, Danlaw, DMP, Europ Assistance, the European Commission, HERE, Hitachi, Kapsch, the Netherlands' Ministry of Transport, Mobile Devices, Octo Telematics, Michelin, OMV, Pioneer, Qualcomm, Scania, Société Générale, Telit, TomTom, Toyota and WEX.

Frederic has led many assignments related to electrification.

Frederic fully reviewed this report.



Lars Godell

Director, Strategic Foresight, Oslo

A Norwegian citizen, Lars has **more than 25 years of experience from strategic and operational work** as a senior analyst, adviser, and executive **in the global telecom industry**. Last year he analysed the Norwegian mobility market for an investor.

He has specialised in techno-economic analyses of infrastructure and services for the purposes of product and business development, strategy, regulatory and public affairs.

Lars has been advising CxO-level clients and colleagues for 25 years, 17 of which with **Telenor**, one of the world's largest mobile operators.

He spent 8 years as a principal European telecom analyst with **Forrester Research**. His hype-busting research on the business case for new technologies as well as advice on industry restructuring resulted in a CEO-level network and almost daily interviews with journalists.

Lars has an MSc degree in political science from the University of Oslo and an **MBA degree from the University of Chicago Booth School of Business**.

Lars led the research, analysis and writing of this report.



Paul Maupin

Marketing Director, Brussels

An American citizen, Paul has 15 years of experience in digital marketing in a range of responsibilities such as website development, copywriting, CRM, analytics, project management, product development, social media management and content strategy.

Paul has worked with a broad range of international clients and brands, large and small, to develop relevant, consistent, and results-oriented digital communication and marketing strategies across channels.

Responsibilities he endorsed over his career include:

- Developed, implemented and supervised the

global content marketing strategy for **Radisson Hotel Group**, including data-driven marketing, communication with key internal and external stakeholders;

- Managed digital channels, social presence and marketing strategy for the Europe region at **UPS**, including implementation of paid campaigns alongside ad agencies and content creation for the pan-European central channels.

Paul reviewed the report and leads our marketing of the report.

Will the world learn from Norway's electrification successes and failures?



Dear reader,

Electrification of transport has taken on a new urgency with the combination of a climate and energy crisis, and the twin negative effects of the pandemic and Ukraine war.

After 25 years in the global telecom industry, of which 11 years abroad, I am used to **comparing my home country of Norway to other countries**. As an analyst, I learnt how to **separate hype from reality on new technologies**. At Telenor, I learnt a few things about **regulatory and government affairs at both EU and national levels**. Finally, as a **Norwegian electric car driver for 4 years**, I personally experienced this ongoing transition.

Norway is 5-10 years ahead of other countries - Does it matter?

The short answer is yes! Although Norway only has a population of 5.4 million and is the third richest country in the world, **there is no need to repeat the errors of the Norwegian model for electrification**. Others have the luxury of **copying what has worked well here since we started our journey in 1990**.

On the surface of it, many are aware of Norway's success. This year, 78% of all new passenger cars are electric and the country is on course to reach its 100% target in 2025.

However, strangely, there appears to be little willingness to dig behind the surface of our electrification success.

Many industry associations, think tanks, and car makers keep discussing how to finance the roll-out of new public charging points for electric vehicles (EVs) **without reflecting on the Norwegian experience and results**.

With a market-led approach and limited national subsidies (€25 million since 2015), the country has achieved the best charging infrastructure in Europe.

Some of the same ignorance appears to have hit European governments when trying to stimulate the adoption of EVs. With the exception of Norway, they have all gone for the complex and costly system of subsidies to EV buyers. The Norwegian model has been to use the car taxation system and other usage benefits (tolling, parking, use of bus

lanes) to make EVs more attractive than fossil fuel cars.

Since 2021, the rapidly escalating fuel prices plus the ambitious climate targets in Europe and elsewhere have started to convince car buyers globally of the benefits of EVs. **Norway is no longer an isolated test market and it becomes even more urgent for all countries to learn from the "Northern Lights" of Norway.**

This report explains what made it succeed but also the pitfalls to avoid.

The deep analysis of Norway's model can bring considerable insights for governments but also for OEMs and charging stations operators. As some are talking about trillion dollar plans to decarbonise their economy, we believe this report will save time and money for many.

As consultants, we look forward to helping you shape your **strategy** in this swiftly evolving landscape.

Sincerely,

Lars Godell, Director, Strategic Foresight

By responding to these questions, the report will help you avoid reinvent the wheel in electrification!

Will Norway succeed with its 100% EV target for new passenger cars in 2025?

What can other countries learn from Norway's approach to electrification? Successes and failures/gaps?

What are the biggest drivers and inhibitors of EV adoption, in Norway and elsewhere?

For how long should government maintain the policy of offering EV purchase benefits?

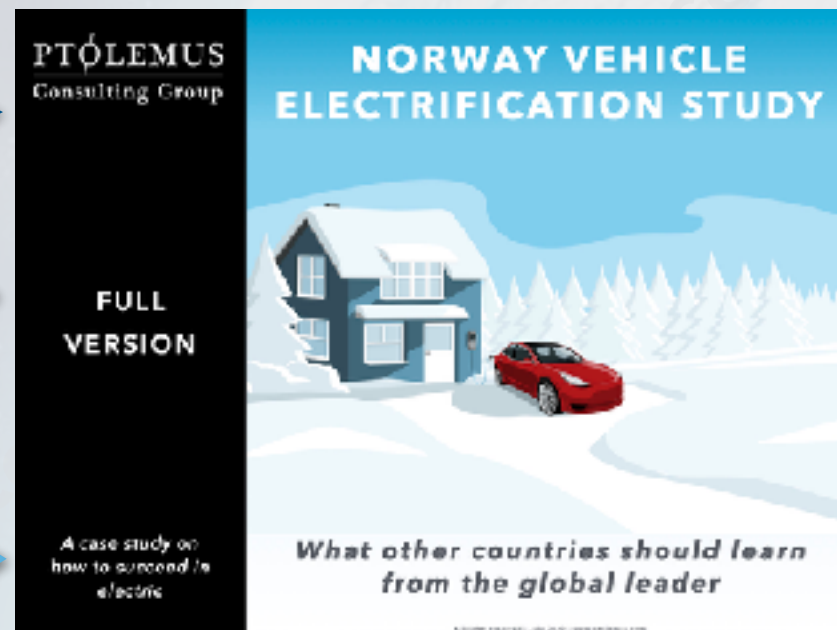
Who will win in the public charging market, Tesla or Ionity?

What should governments, OEMs, and public charging operators do to improve customers' public charging experience?

What should OEMs do to give EV buyers a realistic idea of the range of their EVs?

What should government's role be in making sure there will be enough public chargers?

What is the best way for governments to stimulate the adoption of EVs?



What is the TCO of EVs vs ICEVs, in Norway and Europe?

What will be the impact of EVs on fuel tax revenues, road funding and public transport?

What are the factors holding back a rapid move to full electrification of the car fleet?

The first inside-out report to catch up with the world leader in car electrification, Norway



***The future exists already:
it is in Norway, which is
10 years ahead of any
other country in car
electrification!***

***And no, it is not only
about money!***

***Understanding the
Norwegian paradigm will
allow all stakeholders to
save billions!***

- **A 120-page analysis of Norway's car electrification success** based on:
 - 25 years of direct experience in the field
 - PTOLEMUS EV consulting experience
 - Six months of research & analysis incl. interviews with key stakeholders
- **An examination of the global challenges of electrification**
 - Market drivers and inhibitors
 - Understanding supply chain and battery metal challenges
 - The medium to long-term EV outlook
- **An in-depth assessment of the take-off of the Norwegian EV market** incl.:
 - Key traits of the Norwegian transport market
 - The direct and implicit costs of Norway's support for EVs
 - The role of fuel price and efficiency in the EV TCO analysis
 - The impact on CO₂ emissions
 - How Norway compares with other markets
- **A study of the EV charging market at home and in public venues**
 - Market size and key players
 - The economics of public charging
 - Consumer challenges with EV public charging and driving range
 - The effect of Tesla's charging network
- **A detailed assessment of Norway's EV success stories and their cost:**
 - Purchasing (tax) incentives
 - Usage incentives, from tolling to parking
 - The charging infrastructure and payment strategy that worked
 - And the ecosystem that made it happen
 - **8 policies / best practices to emulate**
- **The 6 major errors to avoid**
 - What did not work even in Norway
 - The negative side effects of EVs
- **15 recommendations for governments worldwide to set their policy**
- **10 recommendations to OEMs**
- **10 recommendations to EV charging point operators (CPOs)**

The report dissects the Norwegian electrification model and brings lessons to all stakeholders

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- E. Norway's transport electrification targets and results, and in comparison with other countries
- F. To support decarbonisation, Norway has also stimulated the adoption of hybrid cars
- G. Norway's EV purchase and usage benefits

H. The direct and implicit cost of Norway's support for EVs

I. Norway's superior EV charging infrastructure

J. Understanding consumers' car purchasing preferences

K. The role of fuel price and fuel efficiency in the EV TCO analysis

L. Forecast until 2030 for the electrification of different vehicle categories

M. Forecast for road traffic until 2030

N. Overview of the EV public charging market

✓ Market size and key players

✓ Understanding consumers' experience with EV public charging and driving range

✓ National government's limited subsidies for EV public charging infrastructure

✓ The economics of public charging

✓ The effect of Tesla opening its charging network

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The report includes over 100 figures (1 of 3)

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The report mentions 70 companies and organisations (1/2)

Company	Country	Type	Company	Country	Type	Company	Country	Type
ABB	Switzerland	Industrial	easee	Norway	Smart EV charging hardware	IEA	France	Energy advisory
ACEA	Belgium	Industry association	Elbil	Norway	News site	imove	Norway	Car subscription
Aftenposten	Norway	Newspaper	Elbil24	Norway	News site	IONITY	Germany	EV charging operator
Agora Verkehrswende	Germany	Think-tank	Energi Norge	Norway	Industry association	ITF	France	Think-tank
Audi	Germany	Automotive	Enova	Norway	Energy innovation advisory	Kinect Energy	US	Energy company
Autobransjens Leverandørforening	Norway	Industry association	Euractiv	Belgium	News site	Kople	Norway	Energy company
Automotive News Europe	US	Magazine	European Commission	Belgium	International organisation	Kruser	Norway	Electric boat sharing
Bloomberg	US	Media company	Eviny	Norway	Energy company	Mer	Norway	EV charging operator
Business Insider	US	News company	Financial Times	UK	Newspaper	Mercedes-Benz	Germany	Automotive
ChargeUp Europe	Belgium	Industry association	Fortune	US	Magazine	Morrow	Norway	EV battery production
CircleK	Canada	Fuel retail	FREYR Battery	Norway	EV battery production	Motor	Norway	Magazine
DNV	Norway	Assurance & risk management	Goldman Sachs	US	Financial services	NAF	Norway	Car owner association
e-on	Germany	Energy company	Hydro	Norway	Aluminum production	NIO	China	Automotive
EAFO	Belgium	Energy information	Hydrovolt	Norway	EV battery recycling	NOBIL	Norway	EV charging database
			ICCT	US	Think-tank			

The report mentions 70 companies and organisations (2/2)

Company	Country	Type
Northvolt	Sweden	EV battery production
Norwegian EV Association	Norway	Car owner association
NRK	Norway	Public broadcaster
NVE	Norway	Electricity regulator
OECD	France	International organisation
OFV	Norway	Automotive information
Plug	Norway	Electric maritime charging
recharge	Norway	EV charging operator
Ruter	Norway	Public transport provider
Siemens	Germany	Industrial
Statens Vegvesen	Norway	National road authority
Statistics Norway	Norway	National statistics agency
Statkraft	Norway	Energy company

Company	Country	Type
Statnett	Norway	National grid operator
Stellantis	France	Automotive
Tesla	US	Automotive
Tibber	Norway	Smart electricity retail provider
TØI	Norway	Think-tank
Transport & Environment	Belgium	NGO
US Geological Survey	US	Government entity
VDA	Germany	Industry association
Volkswagen	Germany	Automotive
Wells Fargo	US	Financial services
Wikipedia	US	Encyclopedia
World Population Database	US	Demographics data provider
Zaptec	Norway	Smart EV charging hardware

Norway Vehicle Electrification Study

A stylized illustration of a winter scene. In the foreground, a red Tesla Model S is parked on a snowy surface, connected to a charging station mounted on a wall. To the left is a two-story house with a snow-covered roof and several windows. In the background, there are snow-covered evergreen trees and rolling hills under a clear blue sky.

Extract from the 120-page report

Electrification is happening for all types of vehicles

Vehicle categories

Passenger cars



Light duty vehicles



Heavy duty vehicles



e-scooters



e-mopeds



e-bikes



Levels of electrification

HEVs

Hybrid Electric Vehicles



PHEVs

Plug-in Hybrid Electric Vehicles



BEVs

Battery Electric Vehicles



FCEVs

Fuel Cell Electric Vehicles



The drivers of EV adoption now outnumber inhibitors

EV market inhibitors

- * High purchase price of vehicles
- * Limited EV charging infrastructure
- * Poor customer charging experience
- * Battery and range limitations, range anxiety
- * Price and supply of metals for batteries
- * Consumer inertia
- * Long waiting list for popular models

EV market drivers

- ✓ Growing regulatory pressure to reduce carbon emissions
- ✓ Strong push by OEMs, fleet operators and leasing companies
- ✓ Growing range of available EV models (450 globally)
- ✓ Battery, driving range and charging speed improvements
- ✓ Increased availability of charging stations
- ✓ Purchase and usage incentives
- ✓ Environmentally conscious customers
- ✓ TCO 1: EV savings vs. ICEVs if including purchase incentives
- ✓ TCO 2: Worsening TCO of ICEVs with rapidly increasing fossil fuel prices (Ukraine effect now, carbon pricing from 2026)

Norway Vehicle Electrification Study

**Extract from the state of the
Norwegian EV market**

Small but resource-rich Norway enjoys its position as a major energy supplier to Europe

How sustainable is Norway's current very comfortable energy position?

- **A small but very rich country**
 - Population of 5.4 million
 - The world's third richest country
 - The world's biggest Sovereign Wealth Fund, worth €1.23 trillion in 2021
 - Est. €120 billion revenues from oil & gas for the government in 2022
- **Nature has made it challenging**
 - Harsh climate, mountainous, long distances, Europe's longest coastline
- **Inside NATO, but formally outside the EU**
 - Member of the European Economic Area (EEA) since 1994 but has no EU voting rights
 - Part of the Common Market for all goods and services (excluding fish and agriculture)
 - Member of Schengen and ACER*
 - Part of EU's carbon trading system
- Aligned with EU's 55% climate emission cut target for 2030
- **Major reliable and friendly energy supplier to Europe**
 - 87% of its vast energy production is exported (2020)
 - 2nd largest natural gas and oil supplier to the EU (covering around 25% of EU's gas consumption)
 - Exporter of approx. 10% of its hydropower production via 17 international power cables
- **Culture focused on trust, egalitarianism, conformity, doing things for the greater good**
- **Thinking about the unthinkable again, new debates are brewing**
 - Full EU membership (again)
 - Nuclear power
 - Securing enough renewable energy (especially wind)

82% of people live on 7% of the land



Land area: 324,000 km²

Norway is a very rich country with many cars

GDP per capita € 76,584

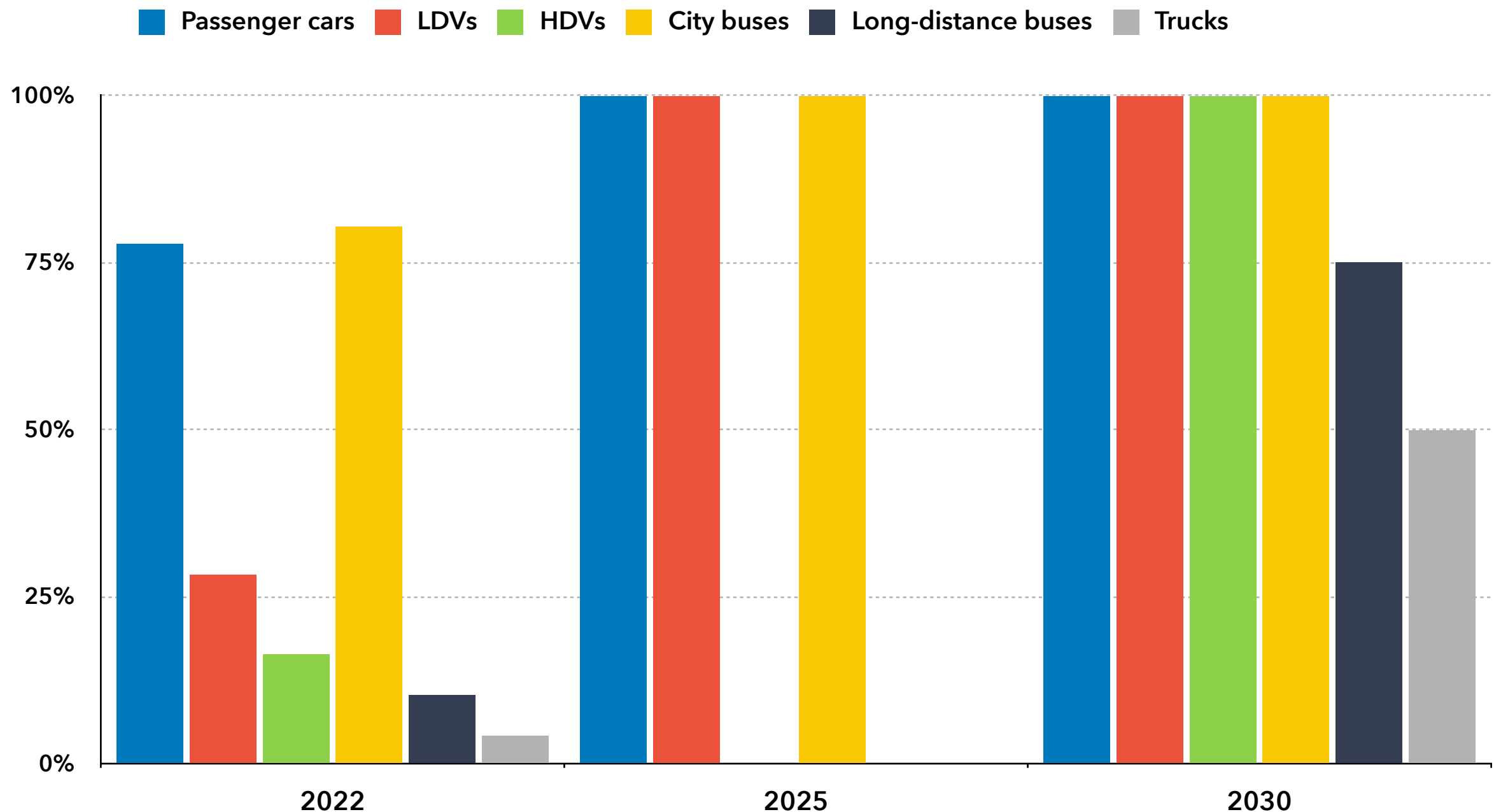


Car ownership 538/1,000 inhabitants



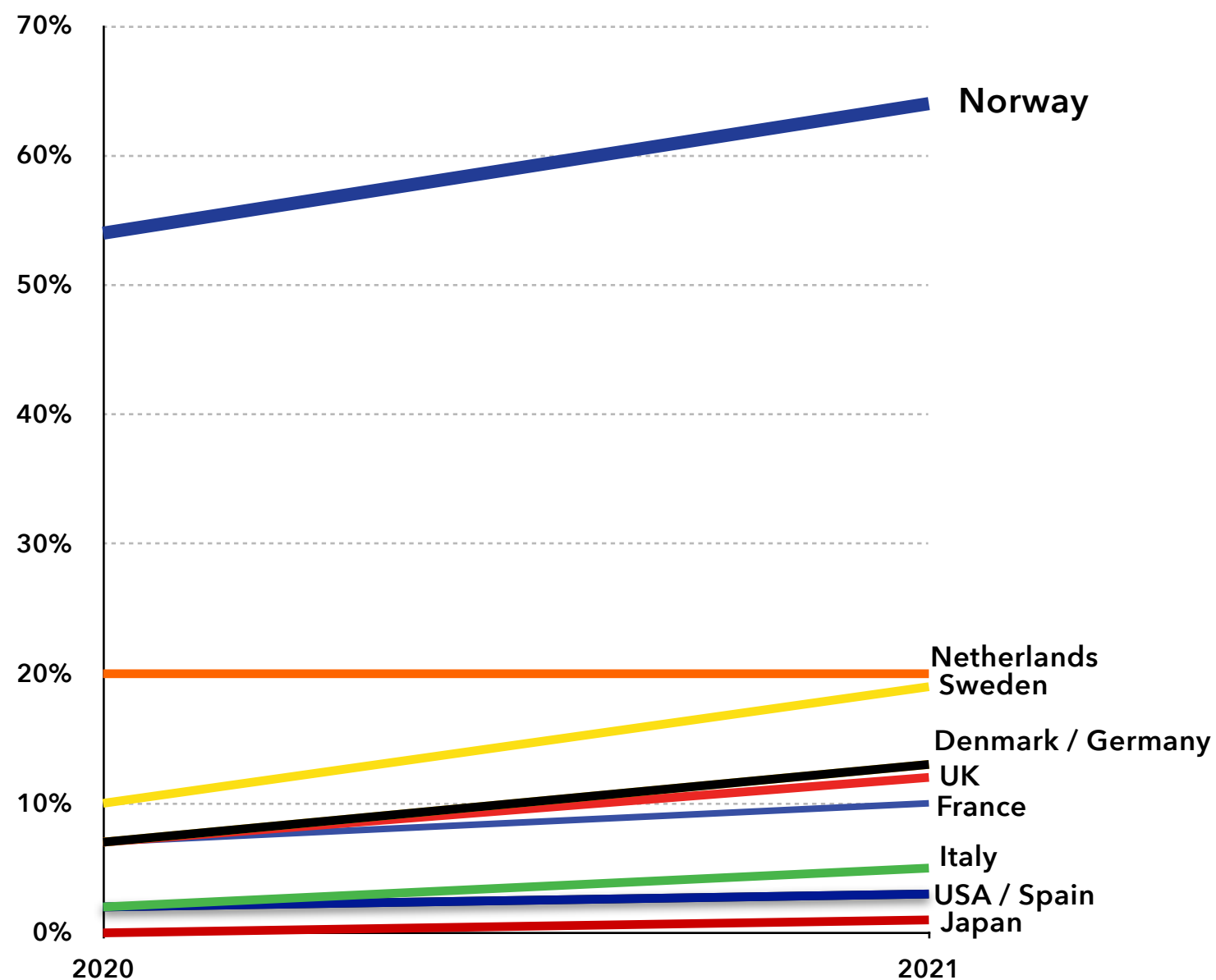
Norway has aggressive targets for the electrification of road transport and is doing well for passenger cars

Norway is struggling in most other vehicle classes (as % of new sales)

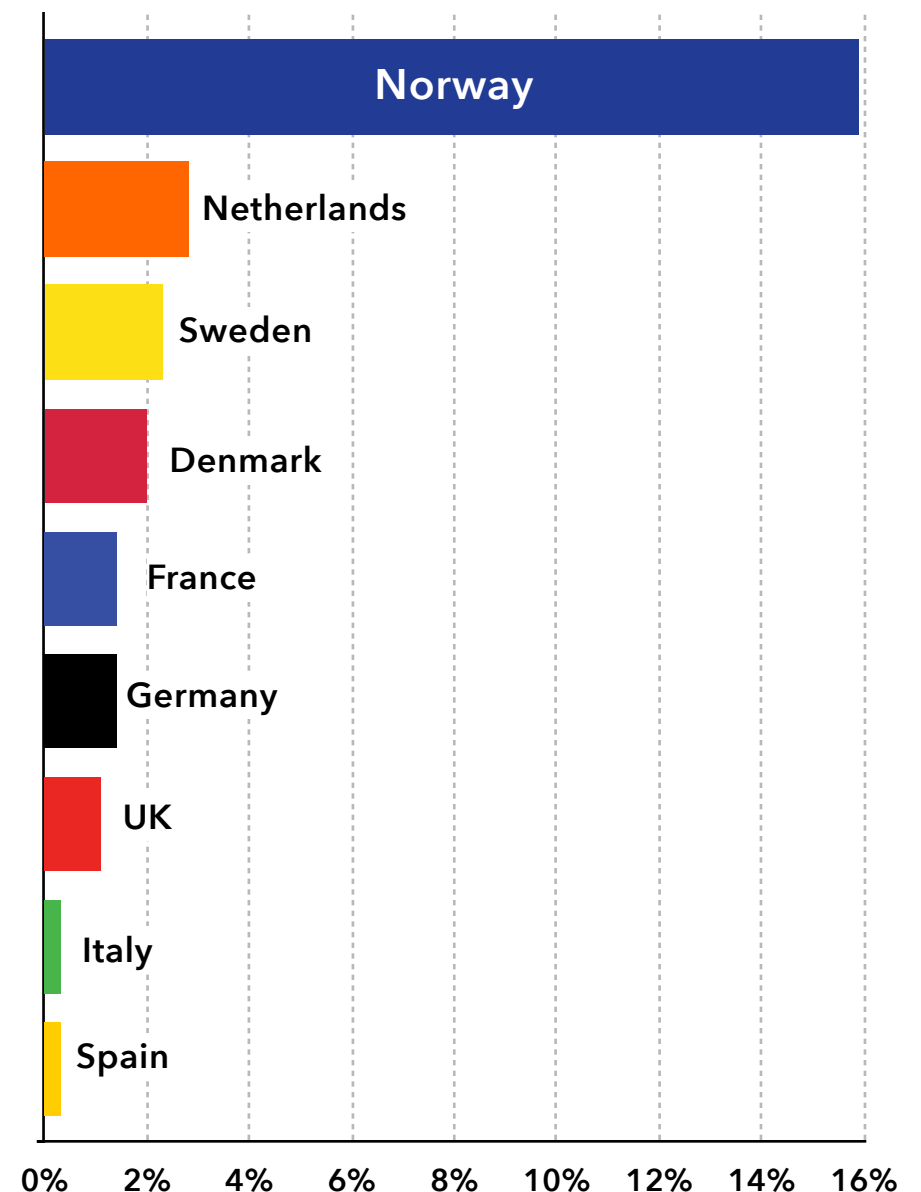


Norway is 5-10 years ahead of all other countries in terms of EV adoption


































EV penetration of new cars sold (%)



EV penetration of all cars in use (% , 2021)

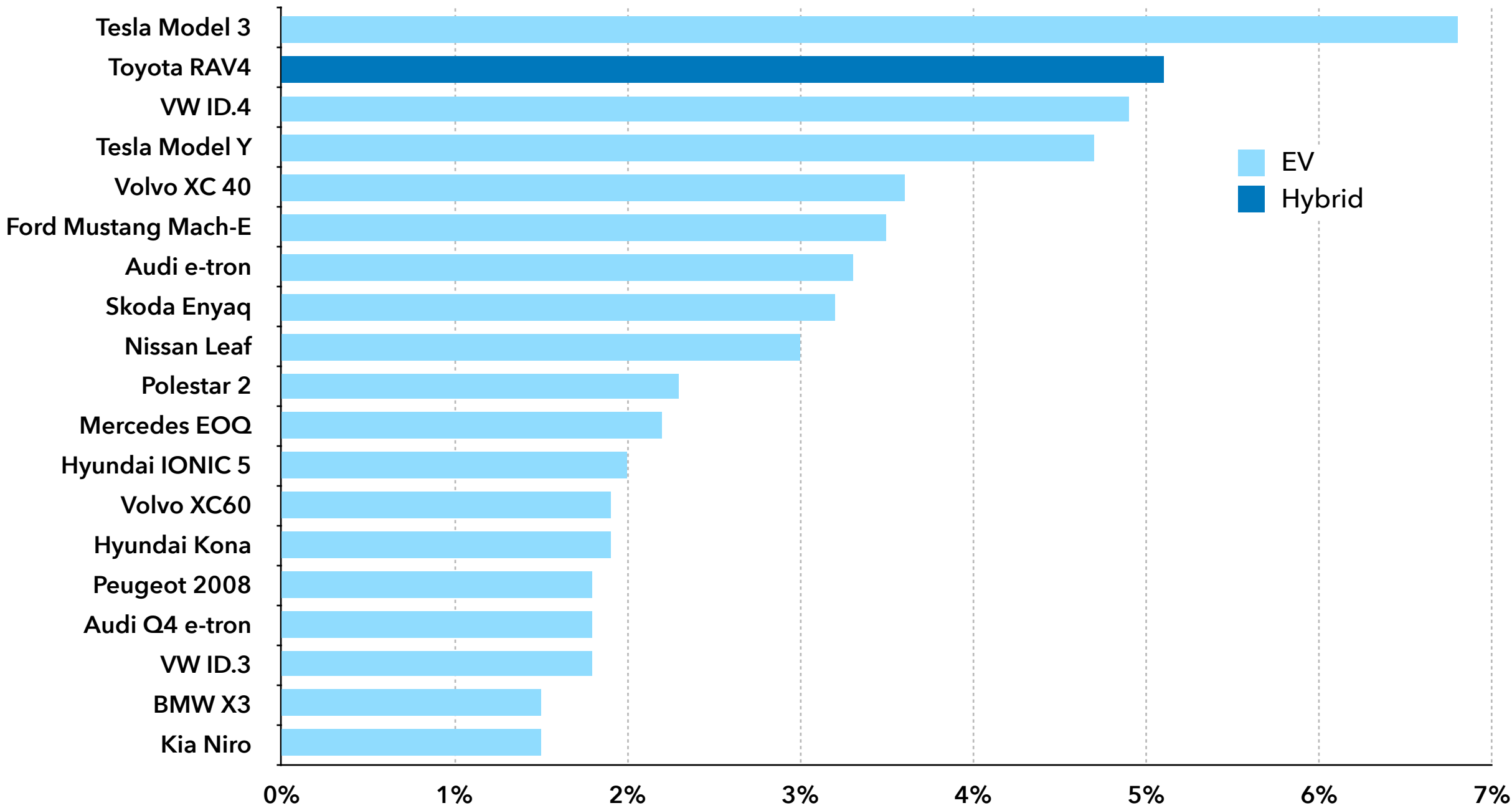


Norway's EV success comes from a combination of dense charging infrastructure and purchase & usage benefits

Country	Public charging infrastructure ⁽¹⁾	EV purchase benefits (government share)	EV usage benefits ⁽²⁾	EV penetration of new cars (% , 2021)
Norway				64%
Netherlands				20%
Sweden				19%
Denmark				13%
Germany				13%
UK				12%
France				10%
Italy				5%
USA				3%
Spain				3%
Japan				1%

In 2021, EVs represented 19 of the top 20 selling new passenger cars in Norway

Norway's top-selling new passenger cars in 2021



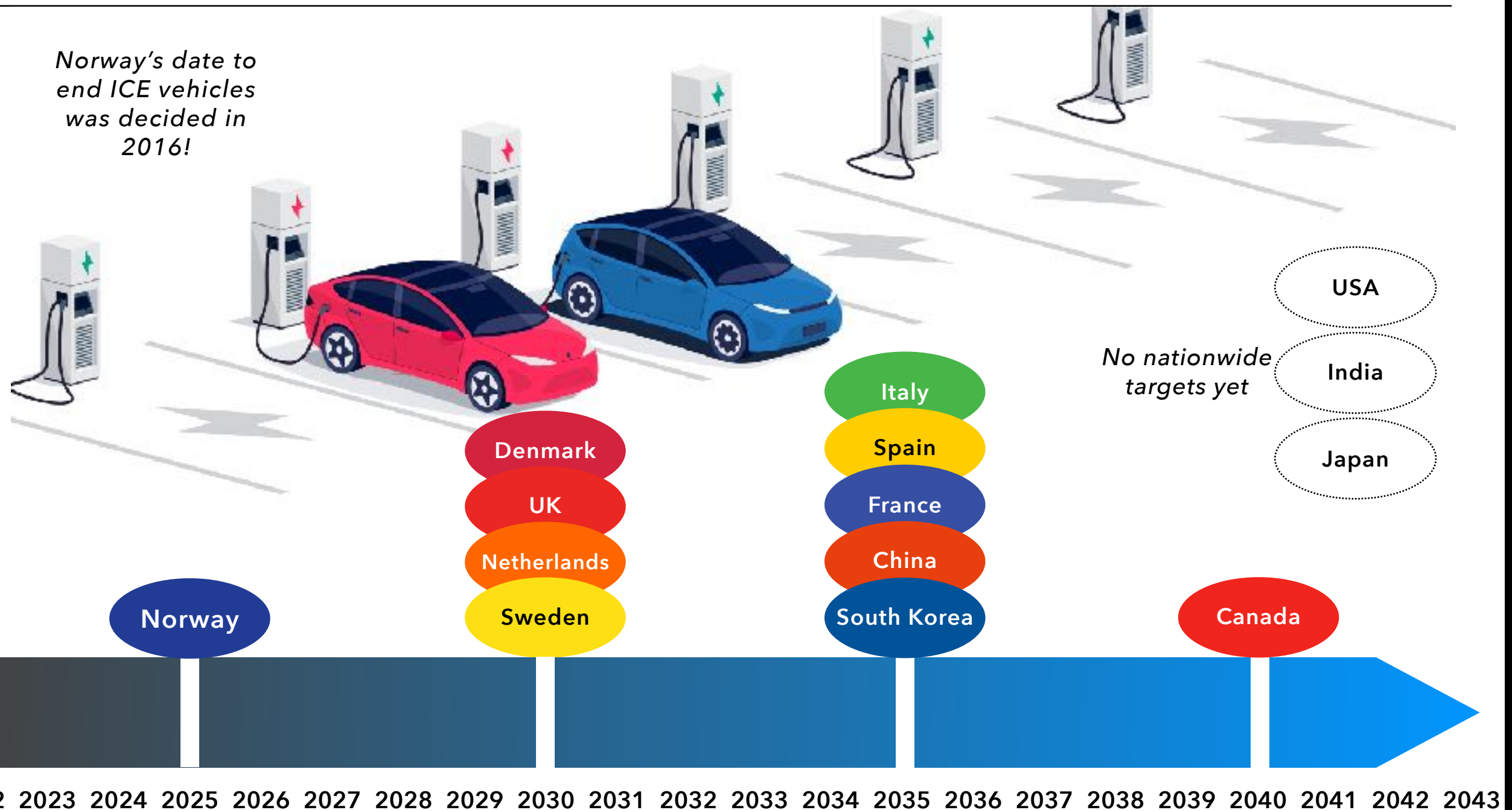
Norway Vehicle Electrification Study

Norway's electrification success stories

Norway is 5-10 years ahead of all other countries in terms of 100% EV sales targets

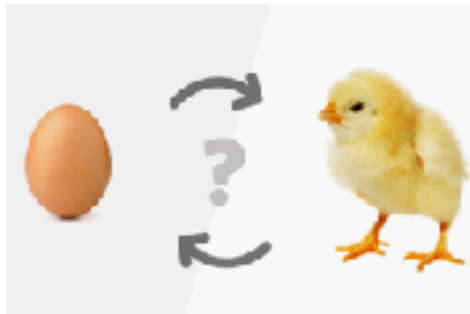
Target year for ban of new fossil fuel cars

Norway's date to end ICE vehicles was decided in 2016!



Fixing home charging first should be governments' #1 priority after sorting out which EV benefits are needed

Enabling home charging is the best way to avoid the chicken and egg problem for EV adoption



- Despite all the hoopla around the need for public chargers, all countries must **solve home charging first**
 - Most early EV adopters are affluent and are likely to live in detached or semi-detached housing owned by themselves
 - **Most EV charging takes place at home because it is cheaper and provides more independence** of potentially congested and hard to find public charging points
- Based on what Norway and countries such as France have done, **local governments need to carefully support and regulate home charging****
 - Establish **the right to plug** in multi-tenant buildings
 - Carefully evaluate whether any financial support is needed to stimulate charging infrastructure deployment within multi-tenant buildings
- Encourage local governments to enable and **set aside dedicated space for kerbside parking in cities** where on-site home charging is not possible
- Evaluate whether local governments should copy the example of Oslo and be **involved in the roll-out and operation of kerbside charging in the first phase of EV adoption** (possibly overcoming an initial market failure and natural monopoly situation)
- Make sure the utilities and the national electric transmission network operator **strengthen the electricity grid**
 - **Invest in more capacity and effect at the edge of the network**
 - **Invest in smart grid technology and load balancing**

Norway Vehicle Electrification Study

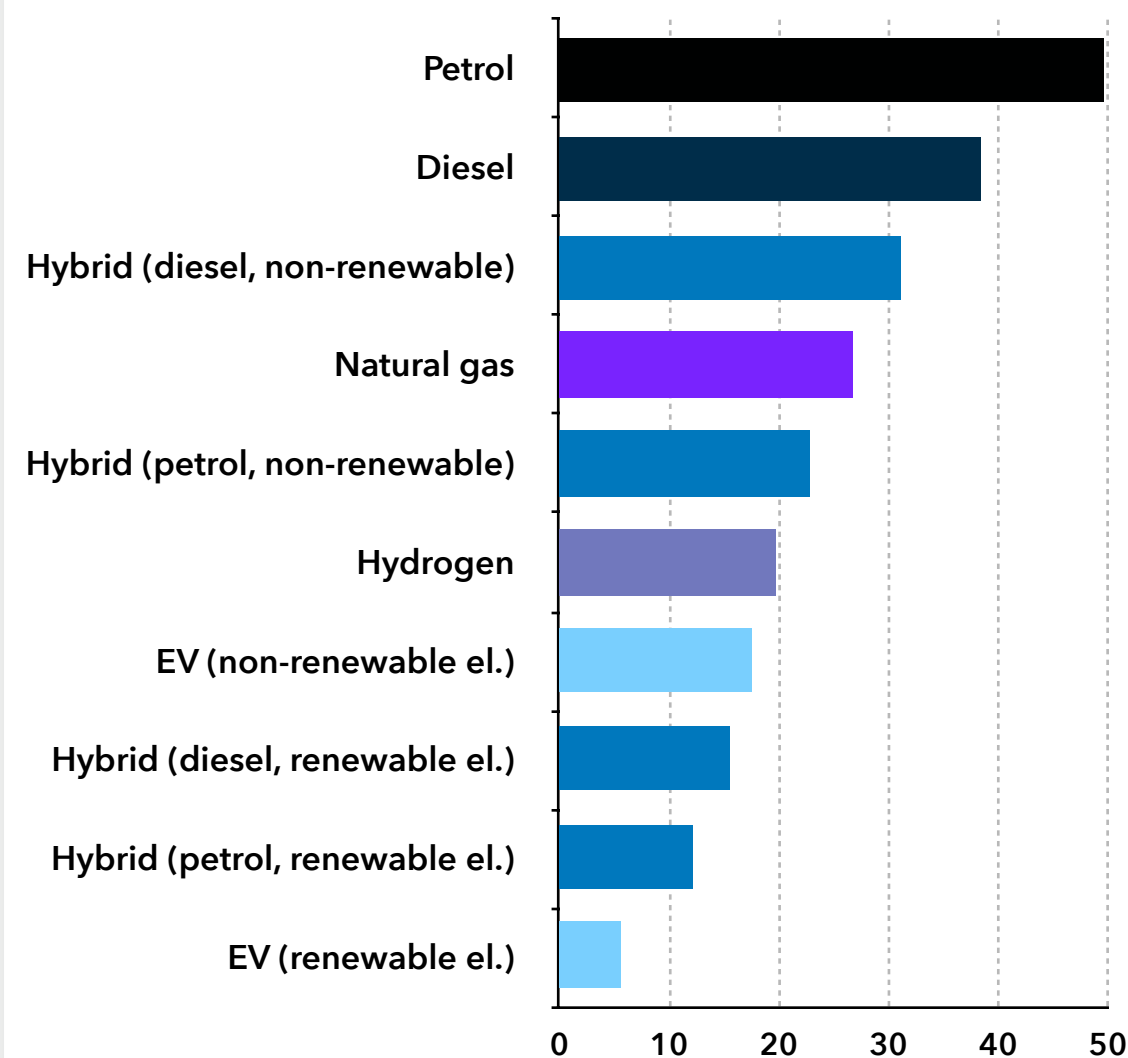
**Extract from pitfalls for other
countries to avoid**

The high lifecycle CO₂ emissions of hybrid cars show why all countries should stop supporting hybrids now

EVs emit as little as a third of the CO₂ of hybrids

- Many studies confirm that **the lifecycle CO₂ emissions of EVs are much lower than any other car**
 - Even when including emissions from battery & car production and usage, and scrapping/recycling
 - EVs running on clean renewable electricity (as in Norway) emit 83-89% less than a petrol car, and 60-70% less than a hybrid**
 - A new Transport & Environment study found that **hybrids in reality only run 38% of km in electric mode**
 - Even in 2030, when taking into account the improved electric range
- of hybrids and a greener European grid into account, BEVs will be 2.7x cleaner than hybrids
- Norway and other European countries still give big car tax advantages to hybrids**
 - These direct or implicit subsidies should be used for EVs and/or public charging infrastructure
 - This report focuses on pure EVs for 3 reasons:
 - Hybrids mean emissions that the planet cannot afford**
 - Hybrids create an additional step towards full electrification**
 - From 2027, the EU will use real-life emissions of PHEVs****

Lifecycle CO₂ emissions by powertrain and type of electricity production (tons) *



Assumptions:

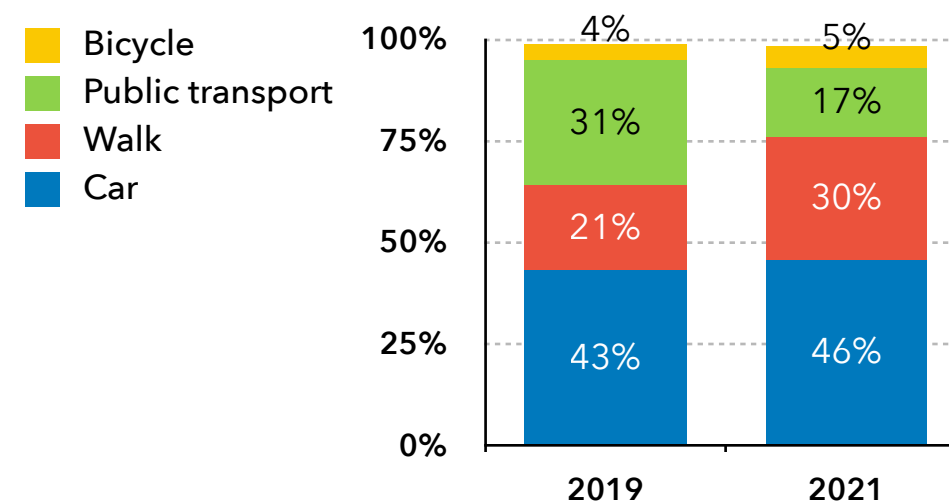
Driving distance of 230 000 km over 15.5 years, across 790 combinations of car models, engine and fuel types

EVs are contributing to changed mobility patterns, to the detriment of public transport

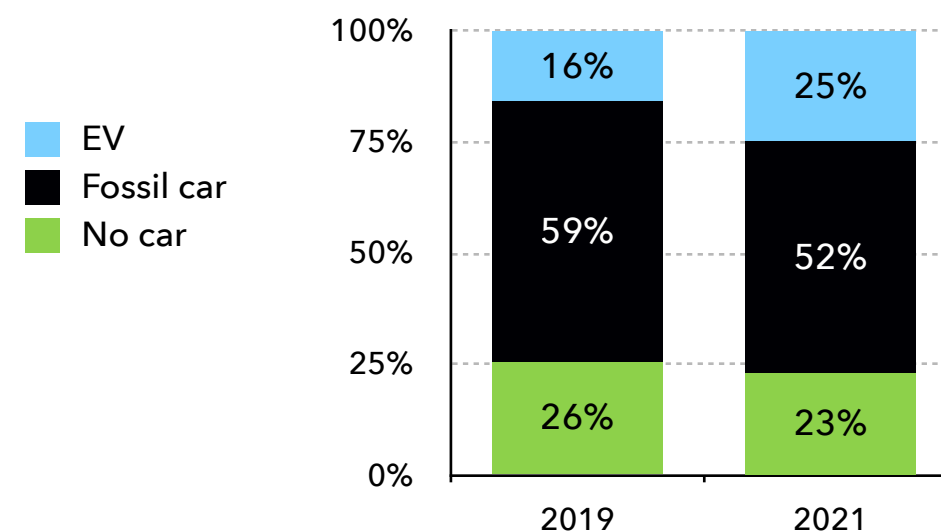
The negative EV effect on public transport will last longer than the pandemic

- Oslo regional statistics (65% of all public transport tickets in Norway) show **the big changes to mobility patterns since 2019:**
 - While cars, walking and biking all increased their share of consumers' mobility needs between 2019 and 2021, **the share of public transport declined from 31 to 17%!**
- More people in and around Oslo now have access to a car**
 - The share of people having access to an EV has gone up from 16% in 2019 to 25% in 2021
- The EV success is contributing to**
 - An increase in overall car usage and traffic** (traffic in the Oslo city toll ring is up 4.7% in 2022 compared to 2019)
 - A reduction in public transport usage**
- Indications are that **the trend toward increased car usage will remain**
 - 34% of Norwegians, and 53% of those in Oslo, said that they will "permanently" increase their car usage*
- A more balanced EV policy should aim at replacing trips previously made by fossil cars, and not replacing trips by public transport, walking and biking**

Norwegians used the car, biked and walked more than before



More people have access to EVs



PTOLEMUS Consulting Group

About PTOLEMUS

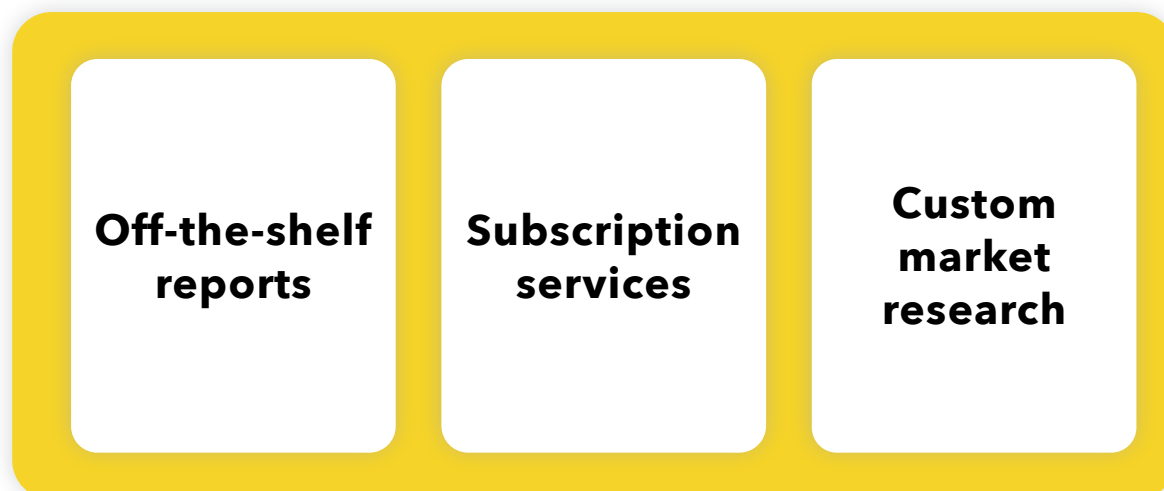


The first strategy consulting & research firm entirely focused on geo-connected mobility & automation

Strategy consulting services



Market research services



Fields of expertise

Mobility services	Car pooling Car sharing MAAS	Micro-mobility Ride hailing Shared mobility	Smart parking Tax refund
Vehicle services	bCall eCall Fleet telematics SVT / SVR	Tracking VRM In-car Wi-Fi Parking	Navigation Speed cameras Traffic information
Energies	BEV EV charging EVaaS	Fuel cards Hydrogen	PHEV Vehicle-to-grid
Usage-based charging	Car As A Service Electronic Toll Collection	Mobility-as-a-Service Road charging	UBI / PAYD Vehicle rental Vehicle leasing
Vehicle data & analytics	AI CAN-bus Crowd-sourcing Data protection	Driving behaviour OBD Predictive analytics	Remote diagnostics xFCD
Vehicle automation	ADAS Autonomous cars	Autonomous trucks	Robo-taxis Shuttles
Enabling technologies	Positioning (GNSS / WiFi / cellular) M2M / connectivity	Smartphones Sensors	Telematics devices V2X

190 consulting assignments in mobility and electrification



Perform a market sizing of the global EV market opportunity

Power grid and power generation systems group



Perform a high level analysis of EV OEMs in North America

Large IT supplier



Help our client make acquisitions in the fleet electrification supply market

Large Asian engineering group



Help the company in defining its 10-year future strategic plan

Global ITS leader



Identify the best practices of EV apps to help it design the app of its new EV

Major outdoor vehicle OEM



Assisted the board of its technology unit in its strategy definition

Global motorway operator



Valuation of a global EV bus & coach fleet telematics solution provider

Charging solution provider



Definition of their future mobility services value proposition, strategy and roadmap

Roadside assistance group



Conduct the due diligence of 2 fleet / EV software companies

Large engineering group



Conducted the strategic review of a major road operator's mobility services business

Major road operator

PTOLEMUS can help your organisation define and achieve its electrification strategy

- **Strategy definition**

- Evolution of strategy towards EVs
- Fleet electrification strategy
- Charging network strategy
- Sustainability strategy
- Emission measurement plan

- **Investment assistance**

- Strategic review
- Commercial due diligence
- Market forecasting

- **Innovation management**

- Integration with fleet telematics
- Vehicle electrification strategy
- Value proposition to EVs
- Value added services (VAS) strategy

- **Procurement**

- Identification of relevant suppliers
- Selection of telematics technology & suppliers

- **Business development**

- Partnership strategy definition
- Partnership strategy implementation

- **Deployment**

- Data privacy strategy
- Analytics, scoring and pricing strategy
- Specifications of telematics-enabled products
- Design & deployment of telematics platform

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Published in July 2022

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Avenue Louise 363

1050 Brussels

Belgium

contact@ptolemus.com

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A case study on
how to succeed in
electric

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Contents	<p>The Norway Vehicle Electrification Study is the first inside-out report bringing insights into the often poorly understood successes and failures from the global car electrification leader – Norway. It shows how countries can use car taxation rather than wasteful subsidies and a mostly market-led approach to build the world’s best public EV charging infrastructure.</p> <p>This study includes:</p> <ul style="list-style-type: none"> • 120-page analysis of the Norway vehicle electrification example • Assessment of the global challenges of electrification • Norway’s electrification success stories • Detailed explanation of the pitfalls for other countries to avoid • 10 recommendations to automotive OEMs • 15 recommendations to governments worldwide • 10 recommendations to charging point operators (CPOs) 	
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For any assistance in your
electrification strategy, please
contact:

Frederic Bruneteau
Managing Director
fbruneteau@ptolemus.com

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