CWIEME BERLIN | 14-16 MAY 2024 MESSE BERLIN

By Hyve

Welcome to CWIEME Tech Talk:

EV Range: Optimisation in the Pursuit of Consumer Acceptance

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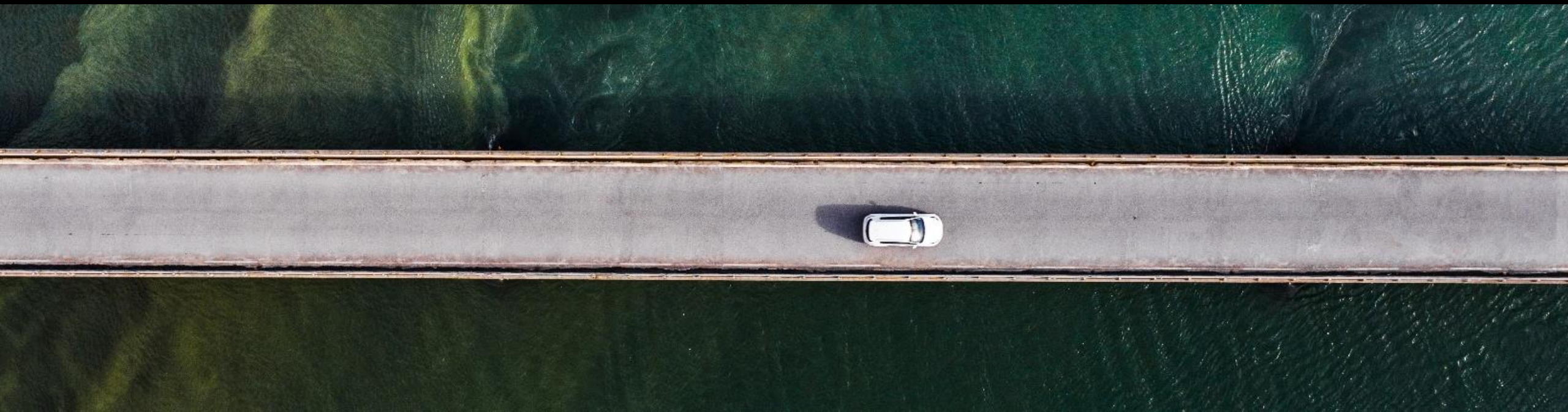
S&P Global
Mobility

EV Range: optimization in the pursuit of consumer acceptance

Matteo Martini, Associate Director

Supply Chain and Technology, Thermal Vehicle Domain

March 13, 2024



Presenter

Matteo has overseen the Thermal Vehicle Domain within Supply Chain and Technology, S&P Global Mobility since February 2020.

He has more than 15 years of experience in the automotive business, having previously worked with a major automotive supplier within the thermal division in Italy and the US.

Matteo graduated from Politecnico di Torino, Italy with a master's degree in Automotive Engineering. He is a chartered member of the Institution of Industrial Engineers in Torino, Italy.

Matteo Martini

Associate Director, S&P Global Mobility

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Our five divisions focus on distinct markets-and together, they deliver unmatched breadth and depth.

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Indices
A Division of S&P Global

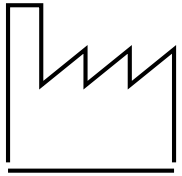
S&P Global
Commodity Insights

Supply Chain and Technology

90+

Analysts

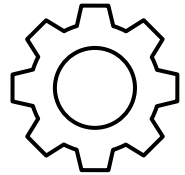
in 18 offices, with dedicated data scientists and data architects



5,000+

Suppliers

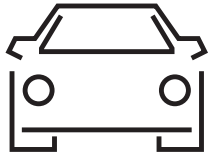
tracked at model/nameplate level



300+

Technologies

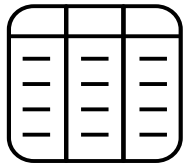
tracked and mapped against 150+ vehicle, engine and transmission subsystems



15

Vehicle domains

Autonomy, battery, charging, chassis, connected car, consumer insights, E/E & semi, interior, lighting, materials, OEM strategy, propulsion, software, thermal and UI/UX



30 million

Number of rows

updated monthly

Agenda

- Why driving range matters
- Why cabin comfort has relevant implication on driving range
- Initial findings on climatic conditions, cabin comfort and driving range implications

Why driving range matters

According to the **2023** iteration of the S&P Global Mobility Consumer Survey, only

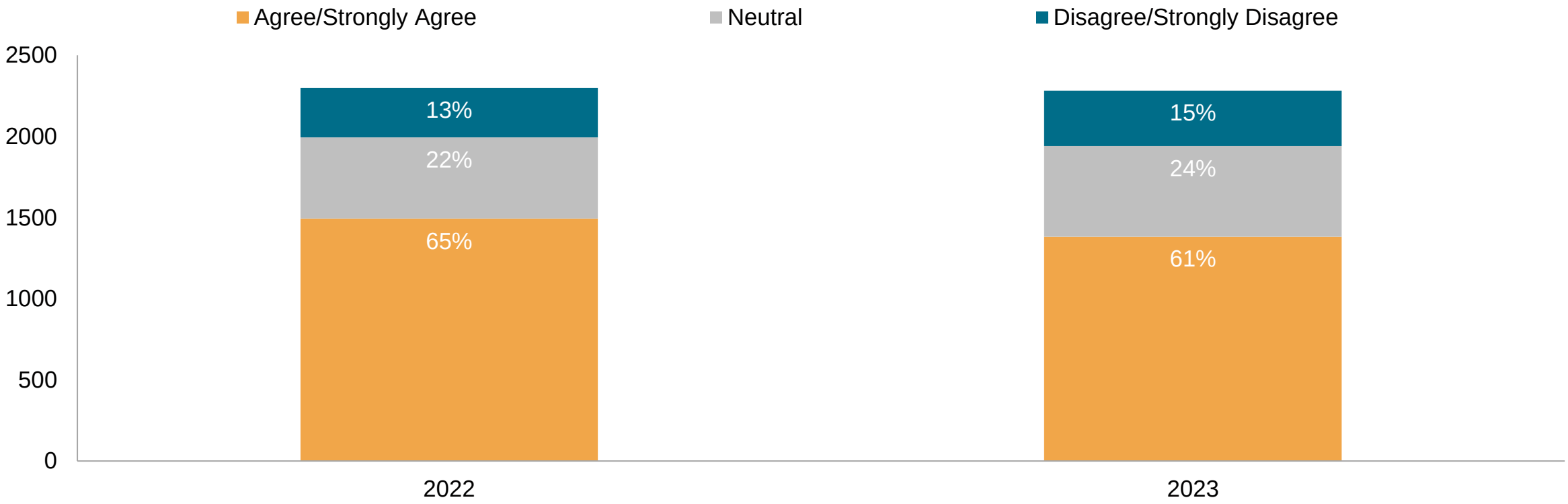
15%

of **EV owners** think taking a **trip does not require** careful **planning** of charging stops.

Note: SCT 2023 Consumer Survey
Source: S&P Global Mobility. Supply Chain & Technology proprietary research.

Consumer survey details

Taking a trip requires careful planning of charging stops (EV owners)



Data compiled January 2024.
Source: S&P Global Mobility.

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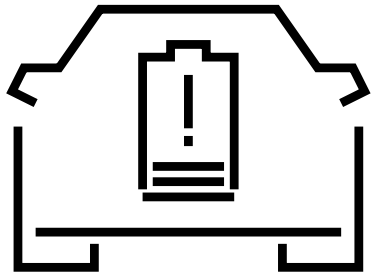
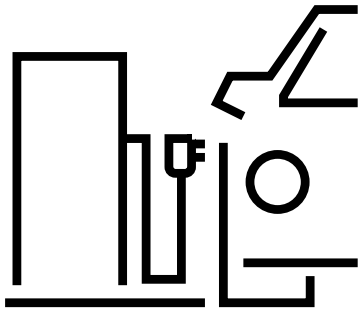
What does careful planning mean?



How far I can drive



How long it takes to charge

How is all-electric range reported?

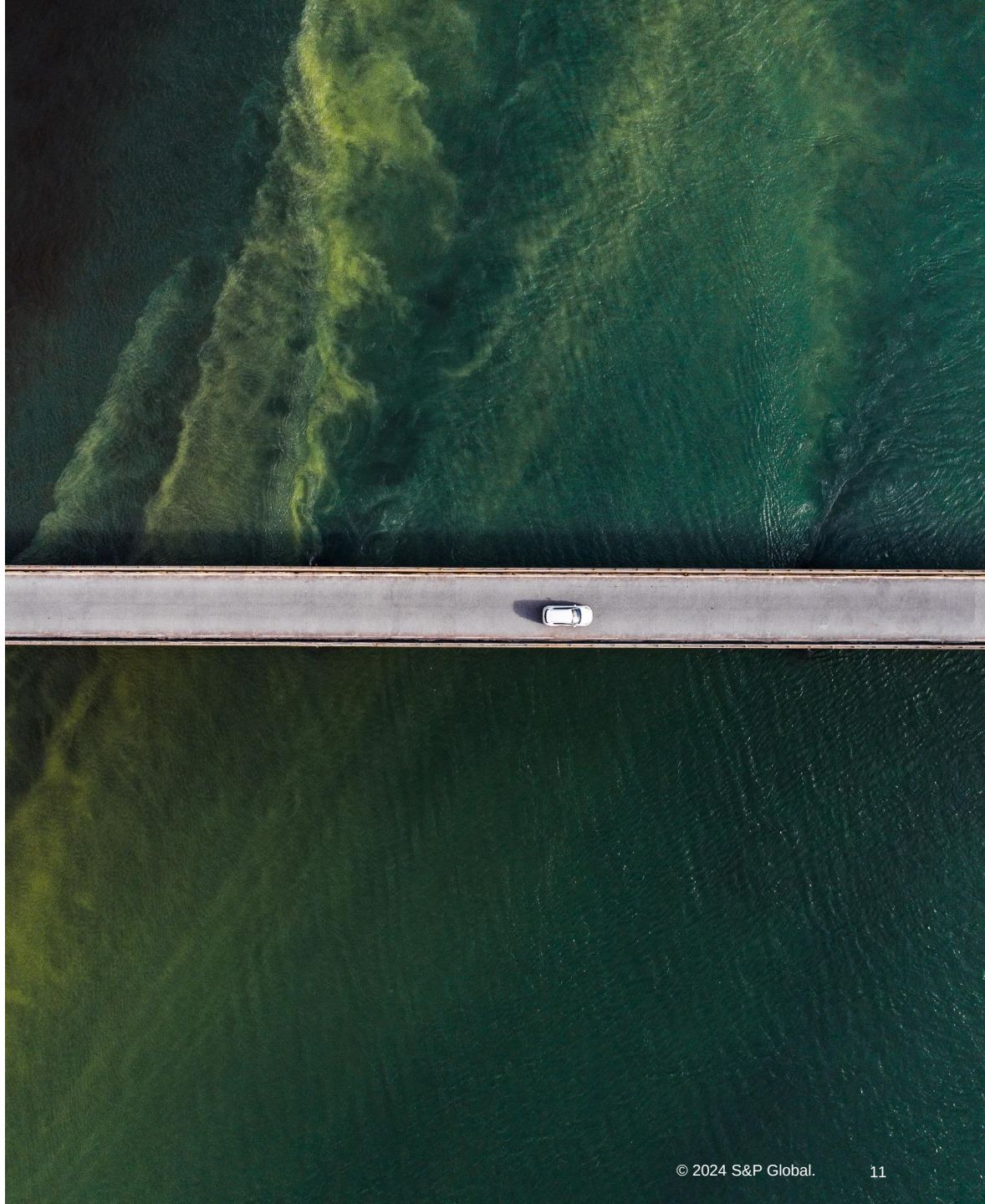
Volkswagen ID.3: 266 miles (combined WLTP)

Tesla Model 3: 333 miles (EPA)

Xpeng P7: 706 km (NEDC)

Nio EC6: 935 km (CLTC)

Porsche Taycan: 23.5~19.6 kWh/100 km (WLTP)



Note: UK and US websites use miles, EU websites use km as distance unit.

WLTP = Worldwide harmonized Light-vehicle Test Procedure; EPA = US Environmental Protection Agency; NEDC = New European Driving Cycle; CLTC = China Light-duty Vehicle Test Cycle

Source: https://www.volkswagen.co.uk/en/electric-and-hybrid/electric-cars/id3.html, https://www.porsche.com/uk/models/taycan/taycan-models/taycan/, https://www.tesla.com/model3, https://www.heyxpeng.com/p7, https://www.nio.com/ec6.

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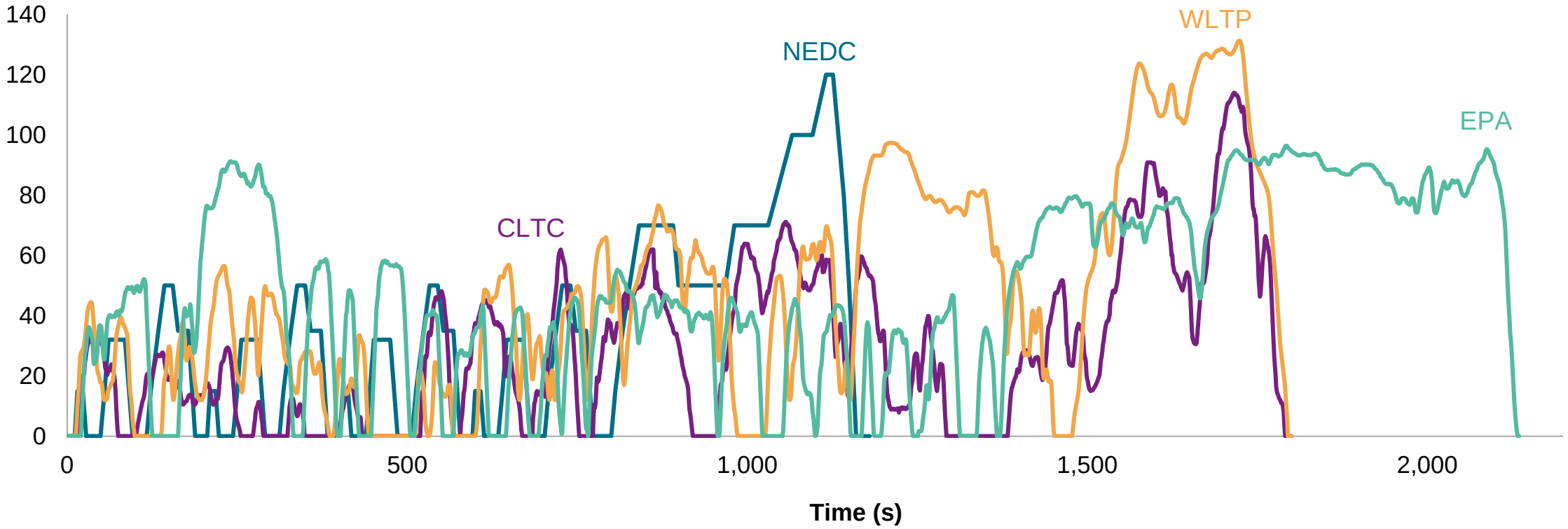
Are these test cycles comparable?

WLTP, EPA, CLTC, NEDC driving profile (km/h)



Data compiled October 2023
Note: WLTP = Worldwide harmonized Light-vehicle Test Procedure; NEDC = New European Driving Cycle; CLTC = China Light-duty Vehicle Test Cycle; EPA = US Environmental Protection Agency emission and fuel consumption calculation procedure.
Source: S&P Global Mobility

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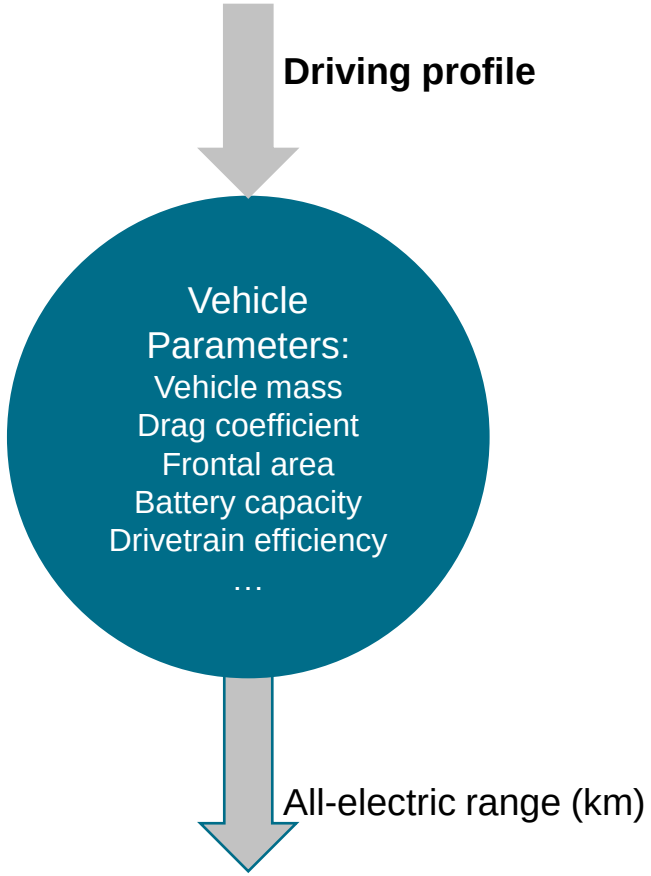
We developed a model to calculate range according to different test cycles



Test cycles:

- **WLTP —** Worldwide harmonized Light-vehicle Test Procedure,
- **CLTC —** China Light-duty vehicle Test Cycle,
- **NEDC —** New European Driving Cycle,
- **EPA —** Environmental Protection Agency emission and fuel consumption calculation procedure.

Additional calculation:

Constant speed range @ 30, 50, 70, 90, 110, 130 km/h.

For existing **vehicles** and new ones **up to 2029**

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Use case to evaluate different standards

		D-Sedan
Vehicle parameters	Drag area, C_dA (m^2)	0.54
	Mass (kg)	2,222
	Usable battery capacity (kWh)	61
		All-electric range (km)
Standard	WLTP	414
	NEDC	476
	CLTC	510
	EPA	325

CdA = Coefficient of aerodynamic drag (Cd) x frontal area (A)
Source: S&P Global Mobility

How does it compare to actual use?

		D-Sedan
Vehicle parameters	Drag area, C_dA (m^2)	0.54
	Mass (kg)	2,222
	Usable battery capacity (kWh)	61
		All-electric range (km)
Standard	WLTP	414
	NEDC	476
	CLTC	510
	EPA	325
Custom	Highway driving @ 90 km/h	305
	Highway driving @ 130 km/h	**203**

CdA = Coefficient of aerodynamic drag (Cd) x frontal area (A)
Source: S&P Global Mobility

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How do different body shapes affect range?

		D-Sedan	Van	
Vehicle parameters	Drag area, C_dA (m^2)	0.54	**1.12**	+107%
	Mass (kg)	2,222	2,222	
	Usable battery capacity (kWh)	61	61	
		All-electric range (km)		
Standard	WLTP	414	293	
	NEDC	476	386	
	CLTC	510	424	
	EPA	325	240	
Custom	Highway driving @ 90 km/h	305	222	
	Highway driving @ 130 km/h	203	**130**	

CdA = Coefficient of aerodynamic drag (Cd) x frontal area (A)
Source: S&P Global Mobility

How do different weights affect range?

		D-Sedan		Sport
Vehicle parameters	Drag area, C_dA (m^2)	0.54		0.54
	Mass (kg)	2,222	-32%	**1,500**
	Usable battery capacity (kWh)	61		61
		All-electric range (km)		
Standard	WLTP	414		506
	NEDC	476		614
Custom	CLTC	510		661
	EPA	325		406
	Highway driving @ 90 km/h	305		347
	Highway driving @ 130 km/h	203		**221**

CdA = Coefficient of aerodynamic drag (Cd) x frontal area (A)
Source: S&P Global Mobility

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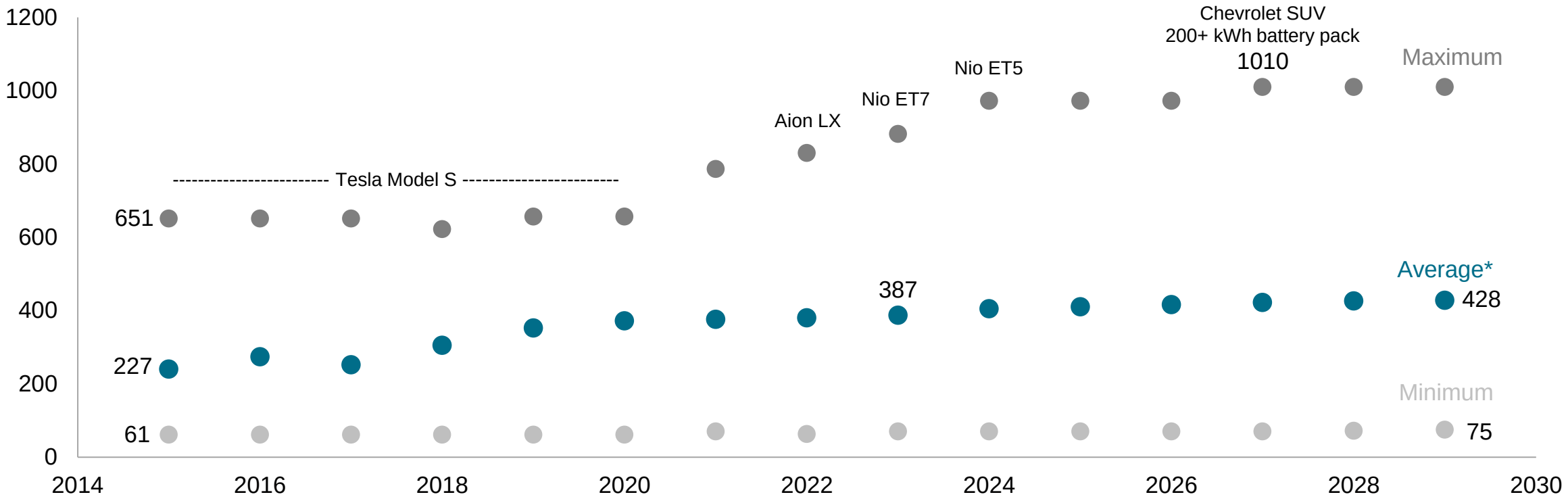
How is driving range evolving?

WLTP all-electric range (km)



Data compiled January 2024.
Note: BEV only. *Average is weighted by production volume.
Source: S&P Global Mobility.

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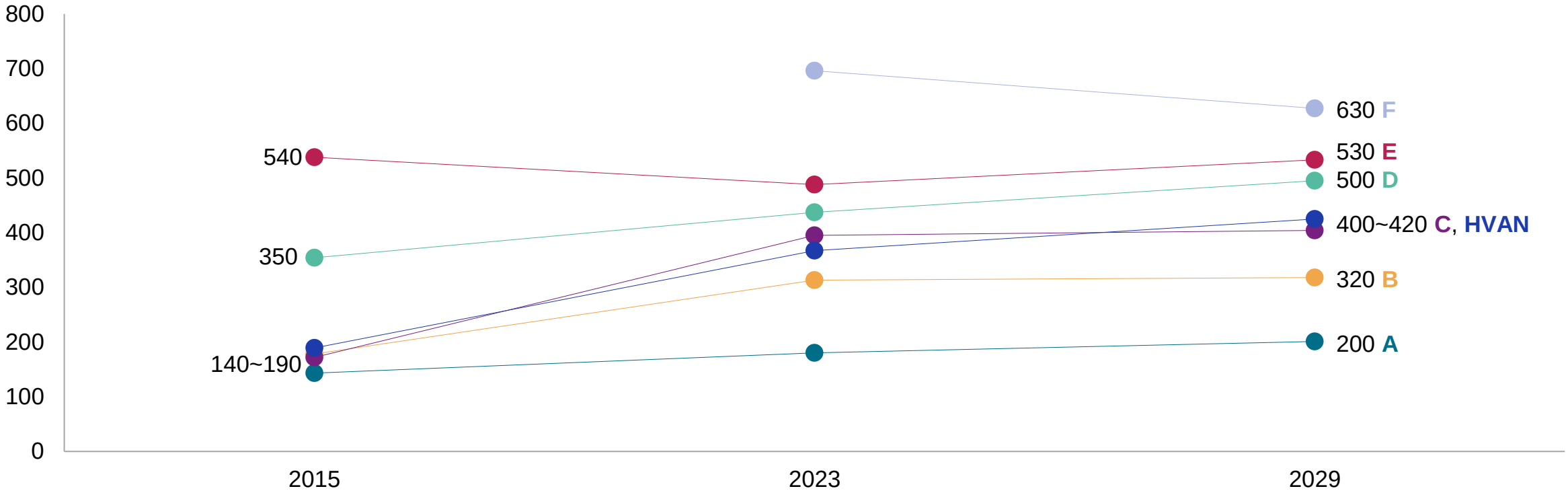
How is driving range evolving by segment?

Average* WLTP all-electric range by global sale segment (km)



Data compiled January 2024.
Note: BEV only. *Average is weighted by production volume.
Source: S&P Global Mobility.

Why cabin comfort has relevant implication on driving range

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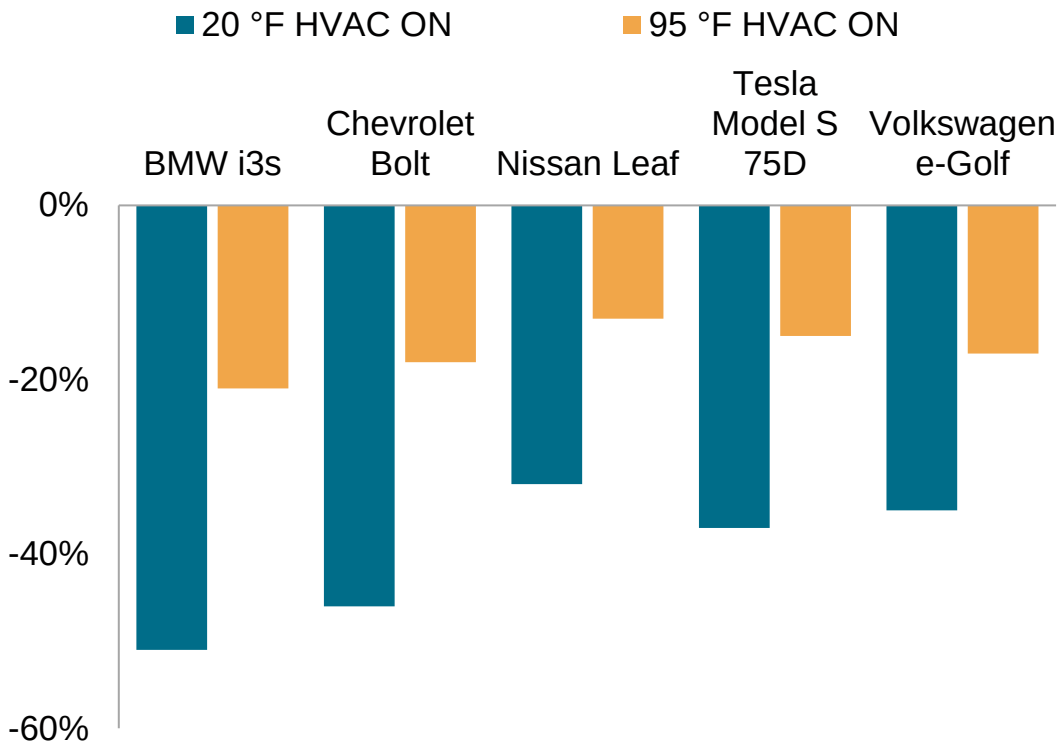
Driving range in extreme climate conditions gets worse

- The test cycles simulated using a dynamometer at **ambient** temperatures of 75 F (24 °C, baseline), 20 F (-7 °C, extreme **cold**) and 95 F (35 °C, extreme **hot**).
- EPA rated range:
  - BMW i3s: 152 miles,
  - Chevrolet Bolt: 258 miles,
  - Nissan Leaf: 215 miles,
  - Tesla Model S 75D: 259 miles,
  - Volkswagen e-Golf: 123 miles.

Change in combined range

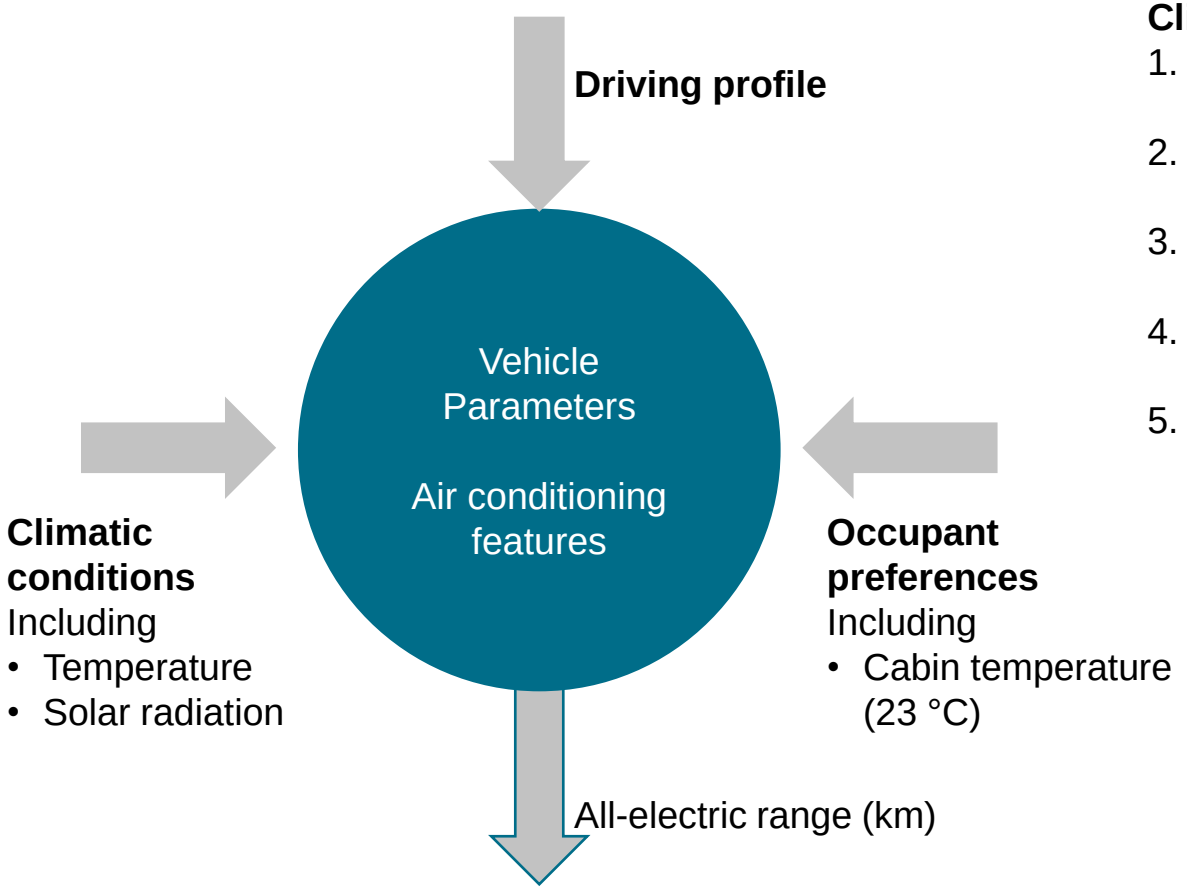


Data compiled in 2019

Note: Test conducted by the American Automobile Association (AAA) in partnership with the Automotive Club of Southern California's Automotive Research Center as per the guidelines established in SAE International standard J1634, Battery-Electric Vehicle Energy Consumption and Range Test Procedure.

Source: AAA

Our model has been updated accordingly



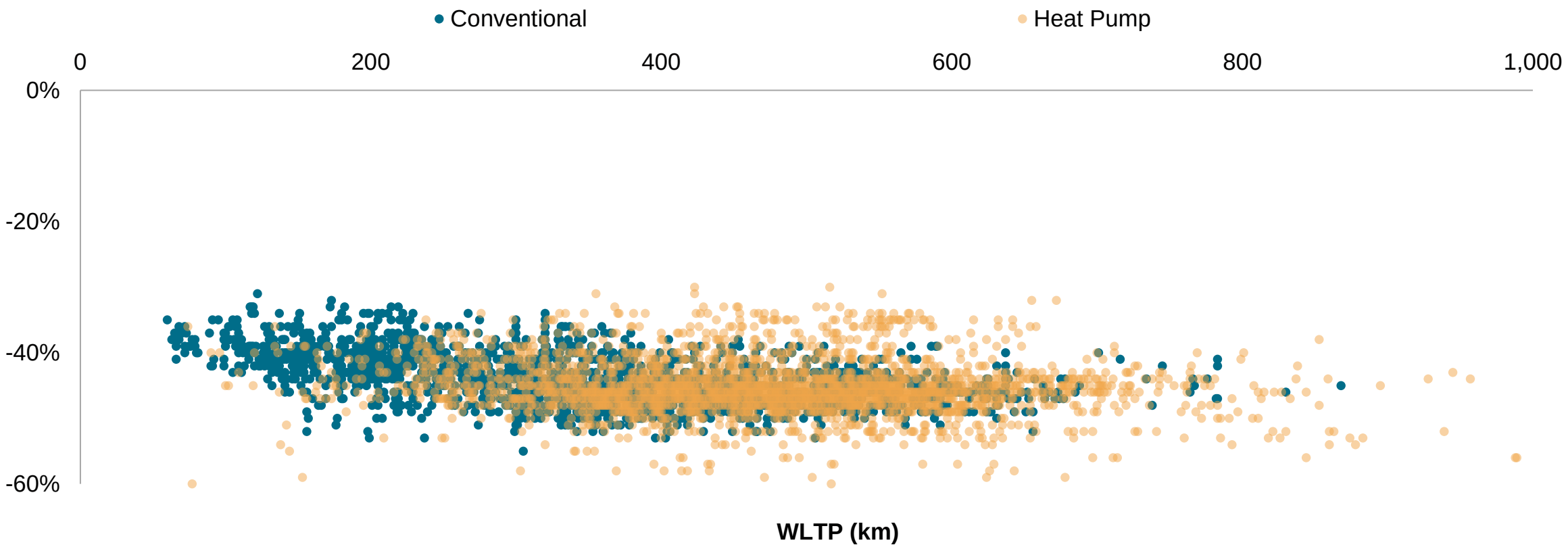
Climatic conditions

1. Extreme cold: -16 °C (3 F),
2. Extreme hot: 41 °C (106 F),
3. Average annual range, Mediterranean climate (Barcelona, Spain),
4. Average annual range, Continental climate (Oslo, Norway),
5. Average annual range, Hot Desert climate (Dubai, UAE).

Initial findings

Initial findings: Heat pump does not outperform coolant heater in extreme cold

WLTP range reduction at -16 °C



As of September 2023.
Source: S&P Global Mobility

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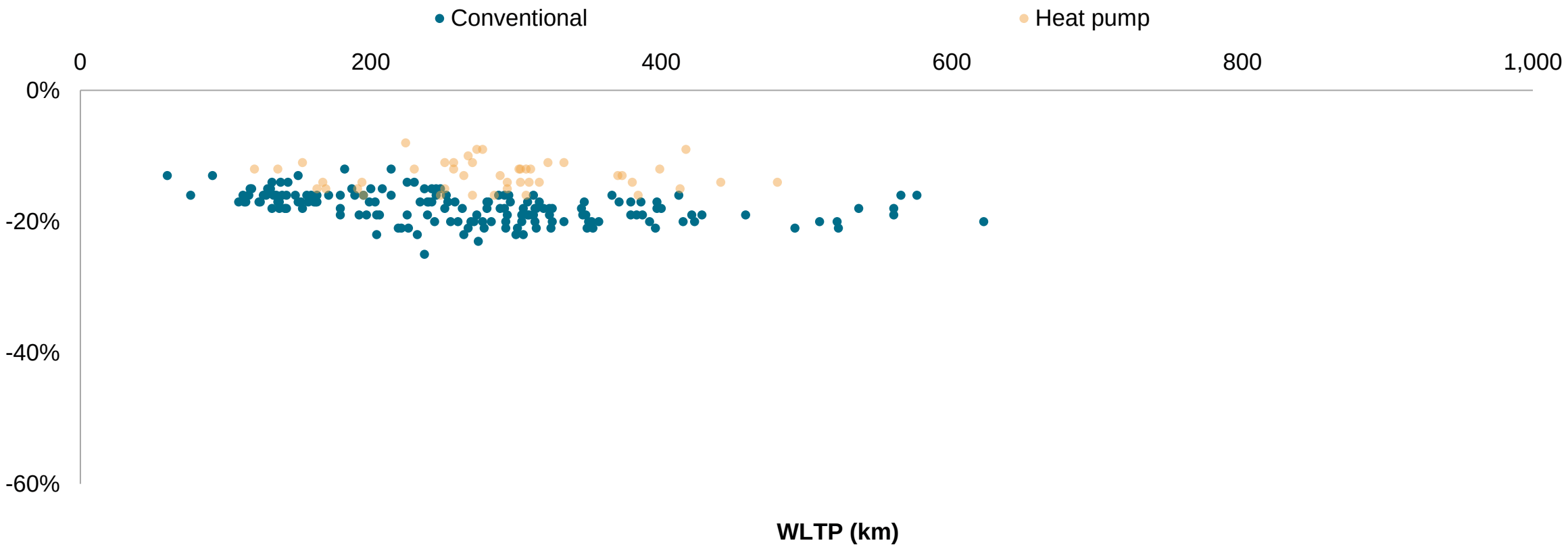
Initial findings: Heat pump is better than coolant heater on average

Average WLTP range reduction in cold climate, 2018



As of September 2023.
Source: S&P Global Mobility

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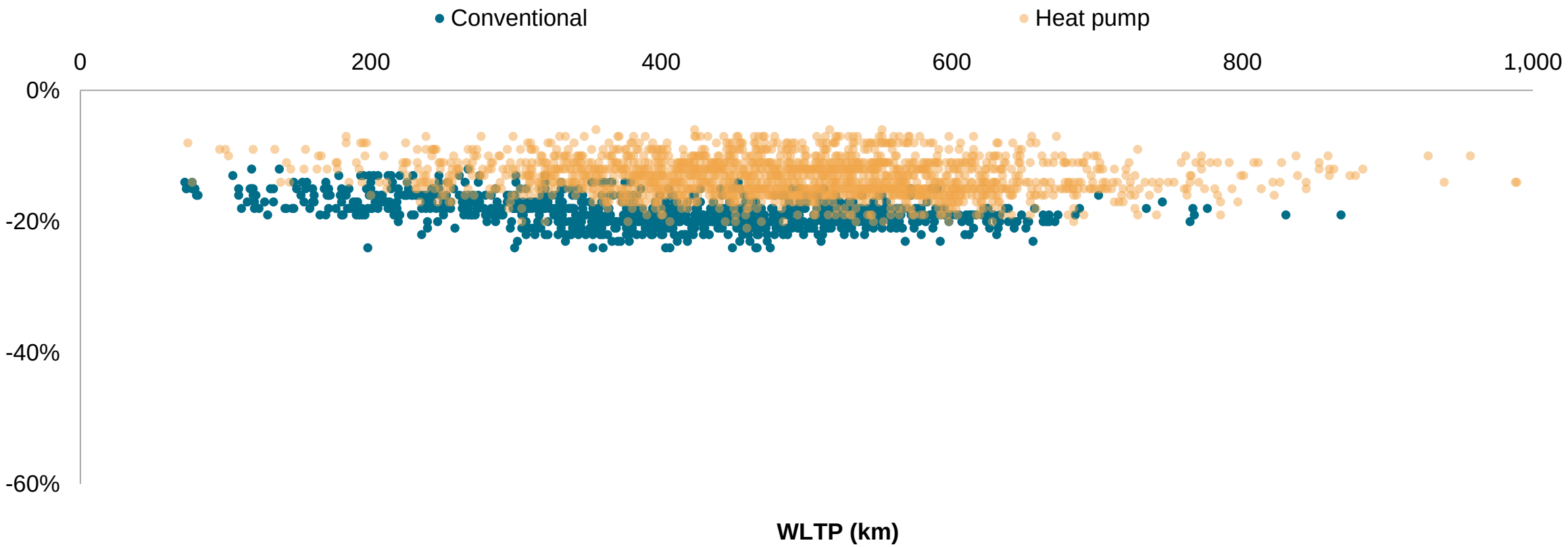
Initial findings: Heat pump will be largely adopted

Average WLTP range reduction in cold climate, 2028



As of September 2023.
Source: S&P Global Mobility

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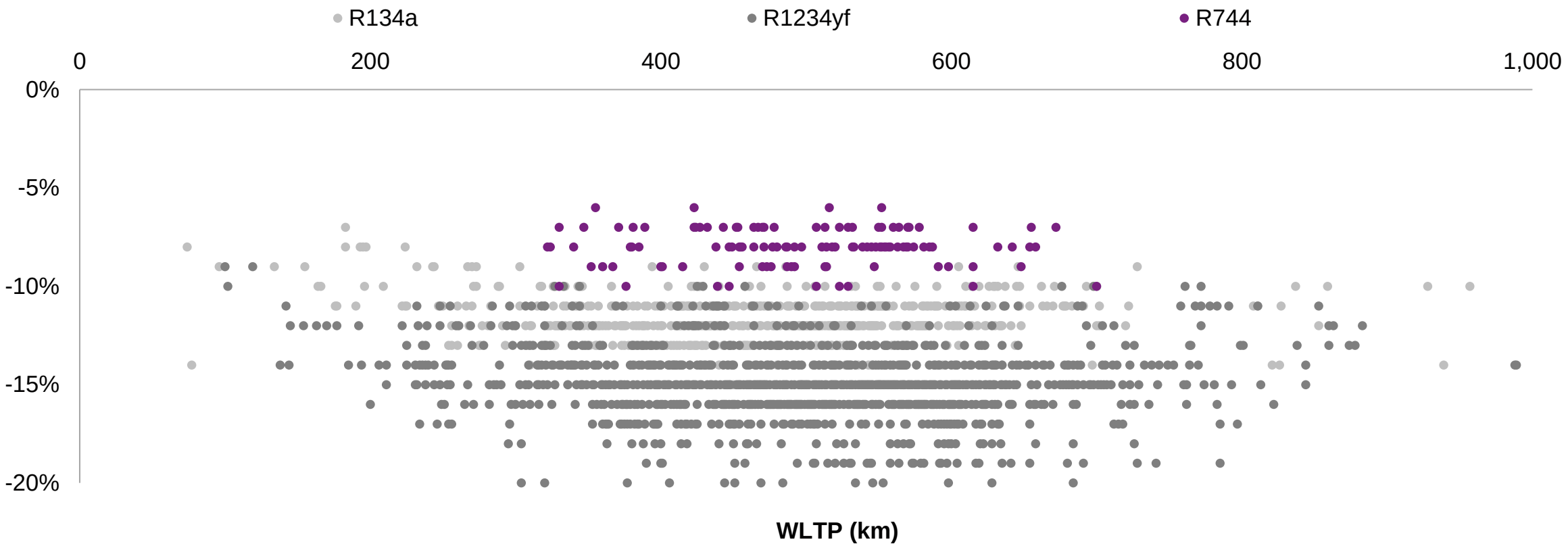
Initial findings: Heat pump performance is affected by refrigerant

Average WLTP range reduction in cold climate, vehicles with heat pump, 2028



As of September 2023.
Source: S&P Global Mobility

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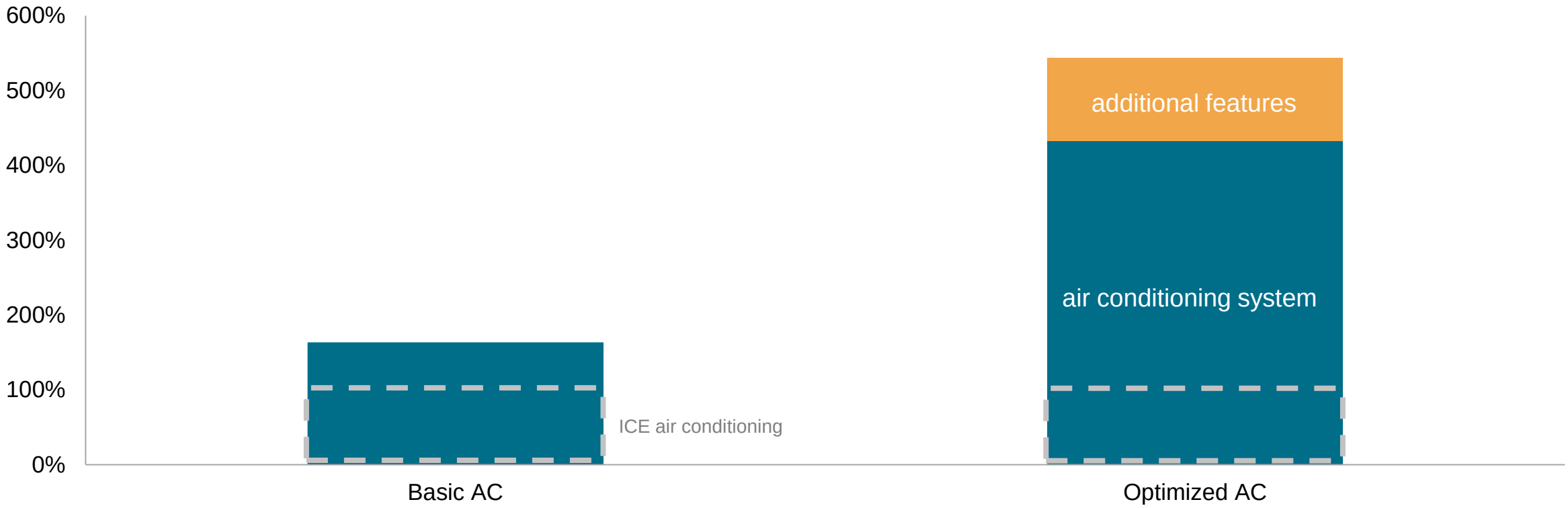
Price implication: complex and efficient heat pump can cost up to 2.5 times more than a basic air conditioning system but only achieve 30% more range

Estimated BEV AC system price (-)



Data compiled Feb 2024
Note: Internal combustion engine vehicle value sets arbitrarily equal to 100%.
Source: S&P Global Mobility.

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As the world shifts toward electric mobility, the importance of **real-life driving range is invaluable**.

Understanding the impact of vehicle **thermal management** will generate significant **opportunities**.

Contact us

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Q&A Session

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