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norden
Energy & Transport

“the RekkEVidde”

Assessing Range and Performance of Electric Vehicles in Nordic Driving Conditions

“the RekkEVidde” Objectives

- Produce realistic performance figures for EVs attributed to Nordic driving and weather conditions
- Agree what kind of additional testing is done for EV’s apart from the regulatory test (ECER No. 101)

Create market acceptance for EV´s

Consortium

Coordination

greennet FINLAND

Laboratory testing

VTT

Field testing

TSS
Test Site Sweden

toi
Transportøkonomisk institutt
Stiftelsen Norsk senter for samferdselsforskning

STOCKHOLMS STAD

ÍSLENSK NÝORKA ehf
ICELANDIC NEW ENERGY Ltd.

In-laboratory Testing Activities at VTT

EVs Tested at

Battery-Electric Vehicles

Citroën C-Zero

Nissan Leaf ('12 & '13)

Renault Kangoo

Extended-Range Electric Vehicles

Plug-in Hybrid EVs

Chevrolet Volt

Opel Ampera

Toyota Prius PHEV

Not yet supported by the RekkEVidde protocol: Next Phase!

Citroën C-Zero in climatic test cell at VTT
Blower duct frontal size
1.0m x 1.2 m
Blower's air speed max 100 km/h
Ambient temperature range from +25 down to -30 ˚C

Test Conditions

Normal ambient temperature: +23 ˚C

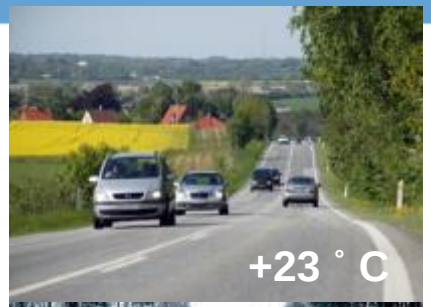
- Air resistance for normal temperature
- Road load for normal asphalt

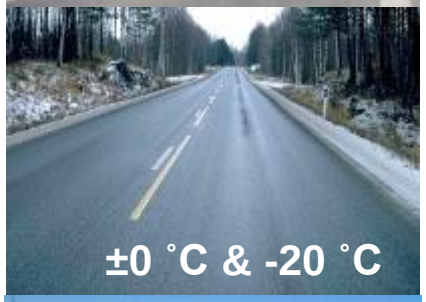
Intermediate ambient temperature: ±0 ˚C

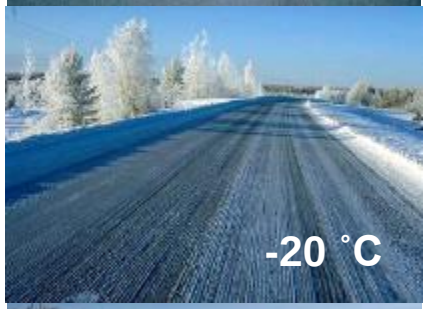
- Air resistance for intermediate temperature
- Road load for normal asphalt

Low ambient temperature: -20 ˚C

- Air resistance for low temperature (+16%)
- Road load for normal asphalt
- Road load for old snow (+ 6% rolling resistance)
- Road load for new snow (+ 9% rolling resistance)







Energy Consumption (kWh) – Grid Electricity Uptake

cycle	energy use (grid) +23 °C kWh/km	energy use (grid) -20 °C kWh/km	asphalt +23 °C kWh/km	asphalt 0 °C kWh/km	asphalt -20 °C kWh/km	old snow -20 °C kWh/km	new snow -20 °C kWh/km
NEDC	0.142	0.200	0.142	0.159	0.192	0.196	0.201
Helsinki City	0.141	0.195	0.137	0.148	0.173	0.211	0.207
Artemis Urban	0.178	0.239					
Road, FIN	0.193	0.251	0.190	0.212	0.233	0.231	0.235
Artemis Road, EV*	0.157	0.195					
Artemis Motorway, EV*	0.244	0.329					
average, three cycles	0.159	0.216	0.156	0.173	0.199	0.212	0.214
average, all cycles	0.176	0.235					

*EV denotes that warm-up part of the cycle is omitted

Energy Consumption (%) Ambient Temp & Road Surface

	energy use (grid)		asphalt	asphalt	asphalt	old snow	new snow
	+23 °C	-20 °C	+23 °C	0 °C	-20 °C	-20 °C	-20 °C
cycle	%	%	%	%	%	%	%
NEDC	100 %	141 %	100 %	112 %	135 %	138 %	141 %
Helsinki City	100 %	138 %	100 %	108 %	126 %	154 %	**151 %**
Road, FIN	100 %	130 %	100 %	112 %	123 %	122 %	**124 %**
average, three cycles	**100 %**	**136 %**	**100 %**	**110 %**	**128 %**	**138 %**	**139 %**

Estimated Range (km)

cycle	estimated range +23 °C km	estimated range -20 °C km	asphalt +23 °C km	asphalt ±0 °C km	asphalt -20 °C km	old snow -20 °C km	new snow -20 °C km
NEDC	**124**	88	124	111	92	90	87
Helsinki City	125	90	128	119	102	83	85
Artemis Urban	99	74					
Road, FIN	91	70	93	83	75	76	75
Artemis Road, EV*	113	90					
Artemis Motorway, EV*	72	53					
average, three cycles	113	83	115	104	90	83	82
average, all cycles	104	77					

Estimated Range (±%)

cycle	estimated range +23 °C %	estimated range -20 °C %	asphalt +23 °C %	asphalt ±0 °C %	asphalt -20 °C %	old snow -20 °C %	new snow -20 °C %
NEDC	**100 %**	-29 %	0 %	-10 %	-26 %	-28 %	-30 %
Helsinki City	1 %	-27 %	4 %	-4 %	-18 %	-33 %	-32 %
Artemis Urban	-20 %	-41 %					
Road, FIN	-26 %	-44 %	-25 %	-33 %	-39 %	-39 %	-40 %
Artemis Road, EV*	-9 %	-27 %					
Artemis Motorway, EV*	-42 %	-57 %					
average, three cycles	-9 %	-33 %	-7 %	-16 %	-28 %	-33 %	-34 %
average, all cycles	-16 %	-38 %					

The impact of heating and ventilation

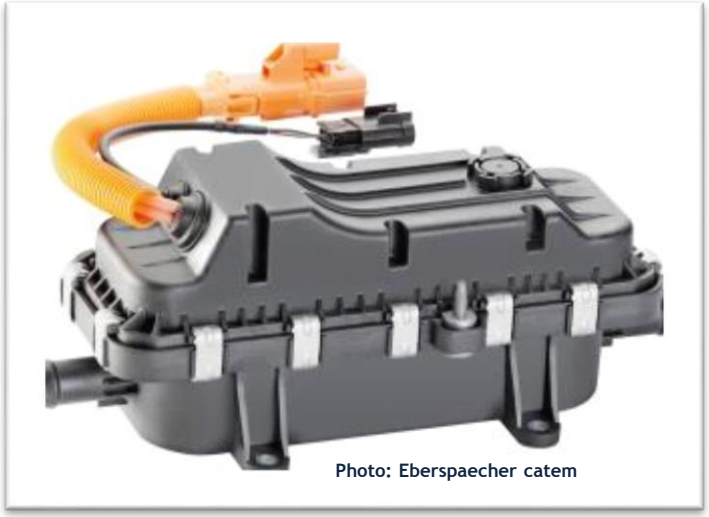
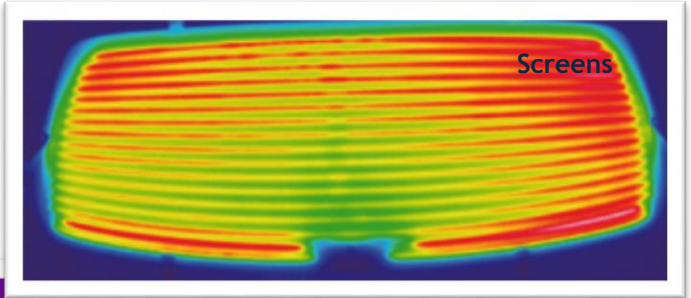
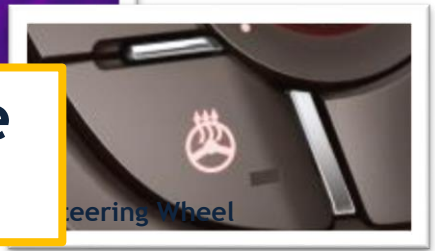


Photo: Eberspaecher catem

Electric (PTC) Heater of Coolant for Cabin Heating

Direct Electric Heating Imposed on Critical Components





Both Systems Use Primary Energy from the Battery, as no Waste Heat is Available!

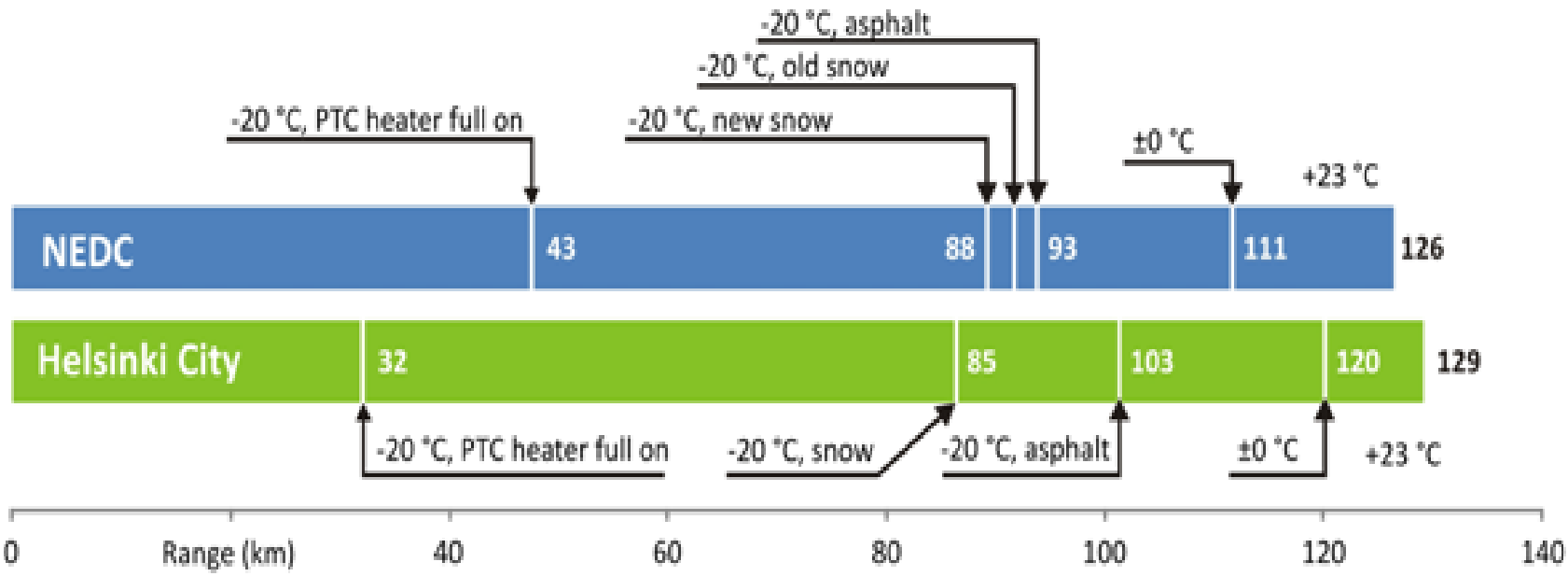
The impact of heating and ventilation

Citroën C-Zero - Simulated Heater Effect

	+23 °C		-20 °C w/o and with **PTC heater (4.5 kW)**					
cycle	driving energy* kWh/km	est. range km	driving energy* kWh/km	est. range km	heater energy** kWh/km	total energy kWh/km	est. range km	relative impact %
NEDC	0.121	124	0.129	88	0.134	0.263	43	-51 %
Helsinki City	0.116	130	0.118	96	0.236	0.354	32	**-67 %**
Artemis Urban	0.143	105	0.145	78	0.256	0.400	28	**-64 %**
Road, FIN	0.169	89	0.184	62	0.055	0.239	47	-23 %
Artemis Road	0.129	117	0.137	83	0.075	0.211	54	-35 %
Artemis Motorway	0.205	73	0.224	51	0.043	0.266	43	**-16 %**

*theoretical road load +10% **calculated

Cold temperature range shortening depents on the cabin heating



Fuel fired heating adds the range

ambient	-20 °C		
	heater		
	electric	fuel-fired	gain
cycle	km	km	km
NEDC	58	98	40
Helsinki City	48	113	65
Road, FIN	74	85	10

Nissan Leaf 2012 range with electric cabin heater and fuel-fired heater

Field Testing Activities by TSS

Test Site Sweden

Photo: Erika Brokvist, Gröna Bilister, SWE

RekkEVidde Field Test Codes

Two test codes:
Basic Field Test (BFT)
Advanced Field Test (AFT)

Photo: Robert Granström, TSS

Photo: Robert Granström, TSS

Photo: Erika Brokvist, Gröna Bilister, SWE

Field-Testing of EVs

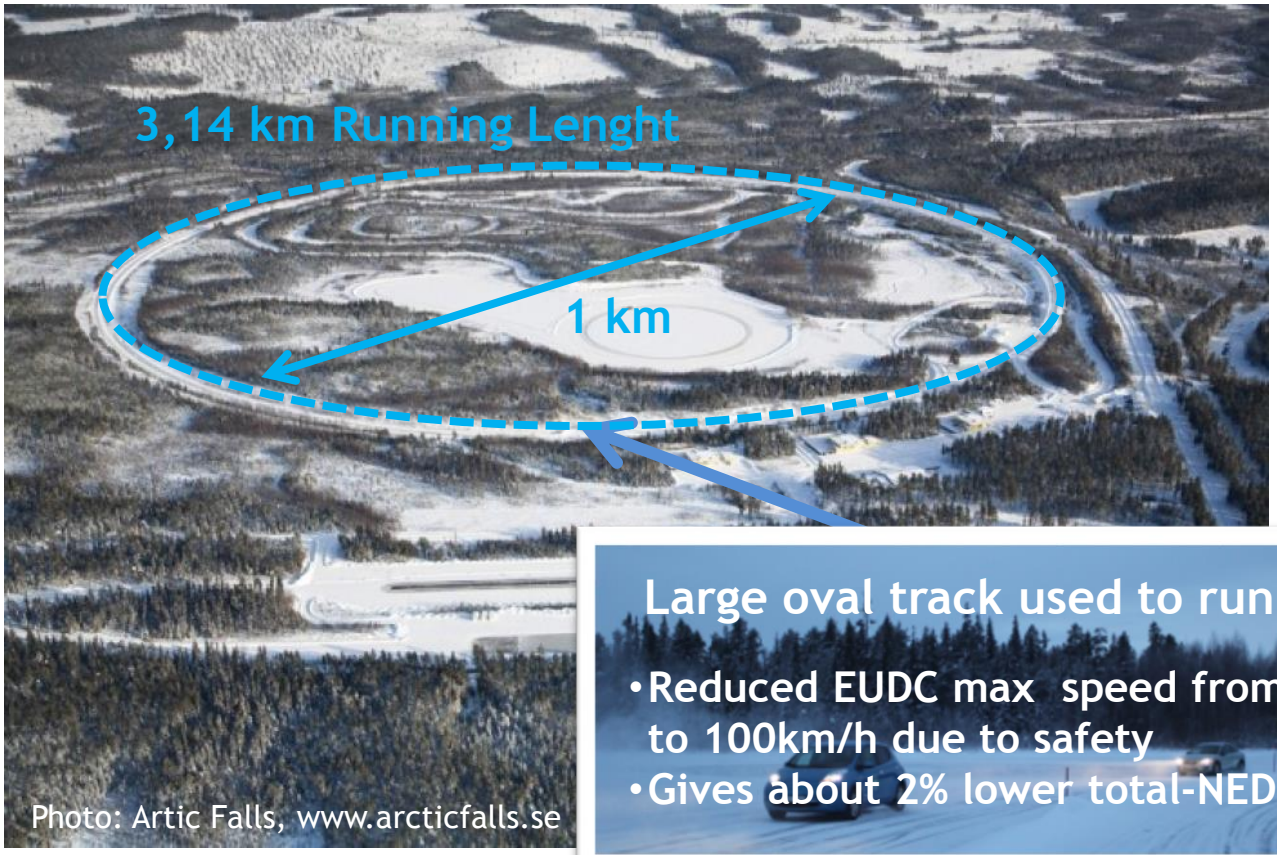


Photo: Artic Falls, www.arcticfalls.se

Large oval track used to run NEDC cyc

- Reduced EUDC max speed from 120 km/h to 100km/h due to safety
- Gives about 2% lower total-NEDC workload

RekkEVidde Field Test Codes - BFT

Basic Field Test (BFT)

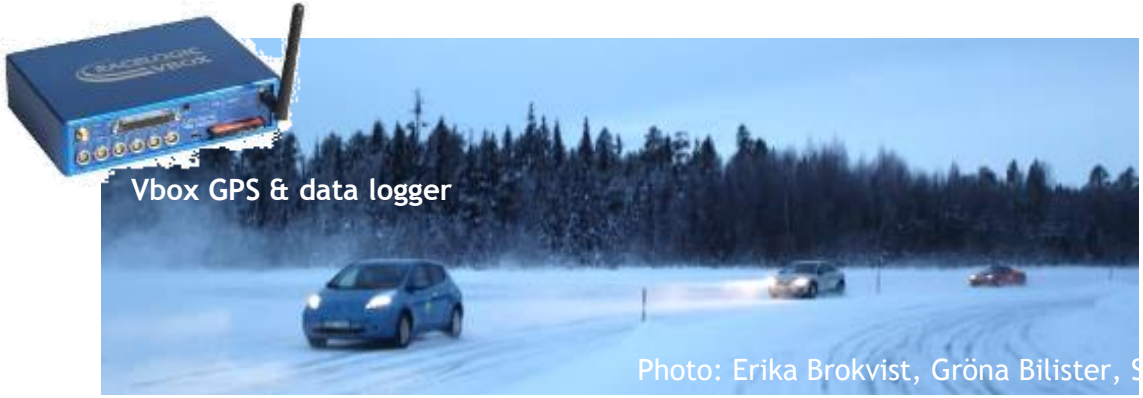
3 x NEDC on track (or road)

Vbox to verify speed & distance

Re-charging with ChargeAlyzer

Test time max 24 hours

Heating & ventilation not tested



RekkEVidde Field Test Codes - AFT

Advanced Field Test (AFT)

3 x NEDC on track (or road)

Vbox to verify speed & distance

Kvaser CAN-logger (for power & SOC)

Re-charging with ChargeAlyzer

Test time 2 x 24 hours for heater tests

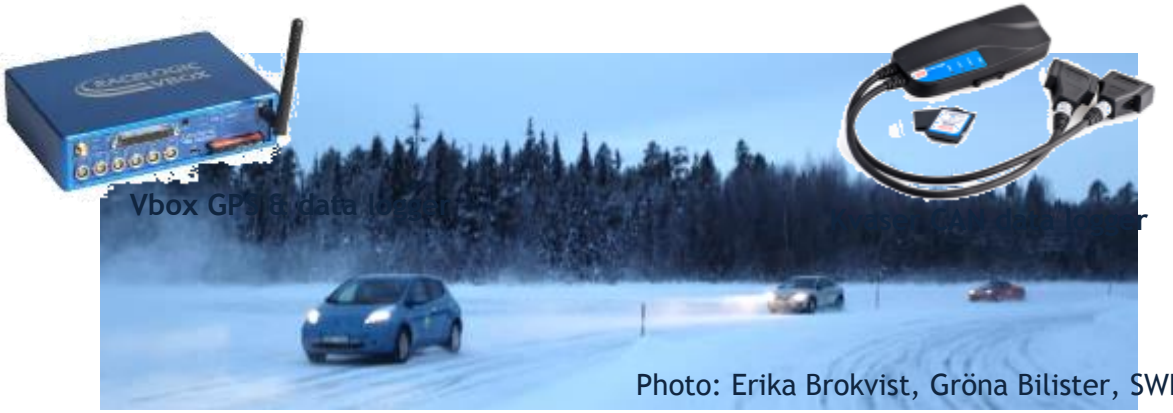
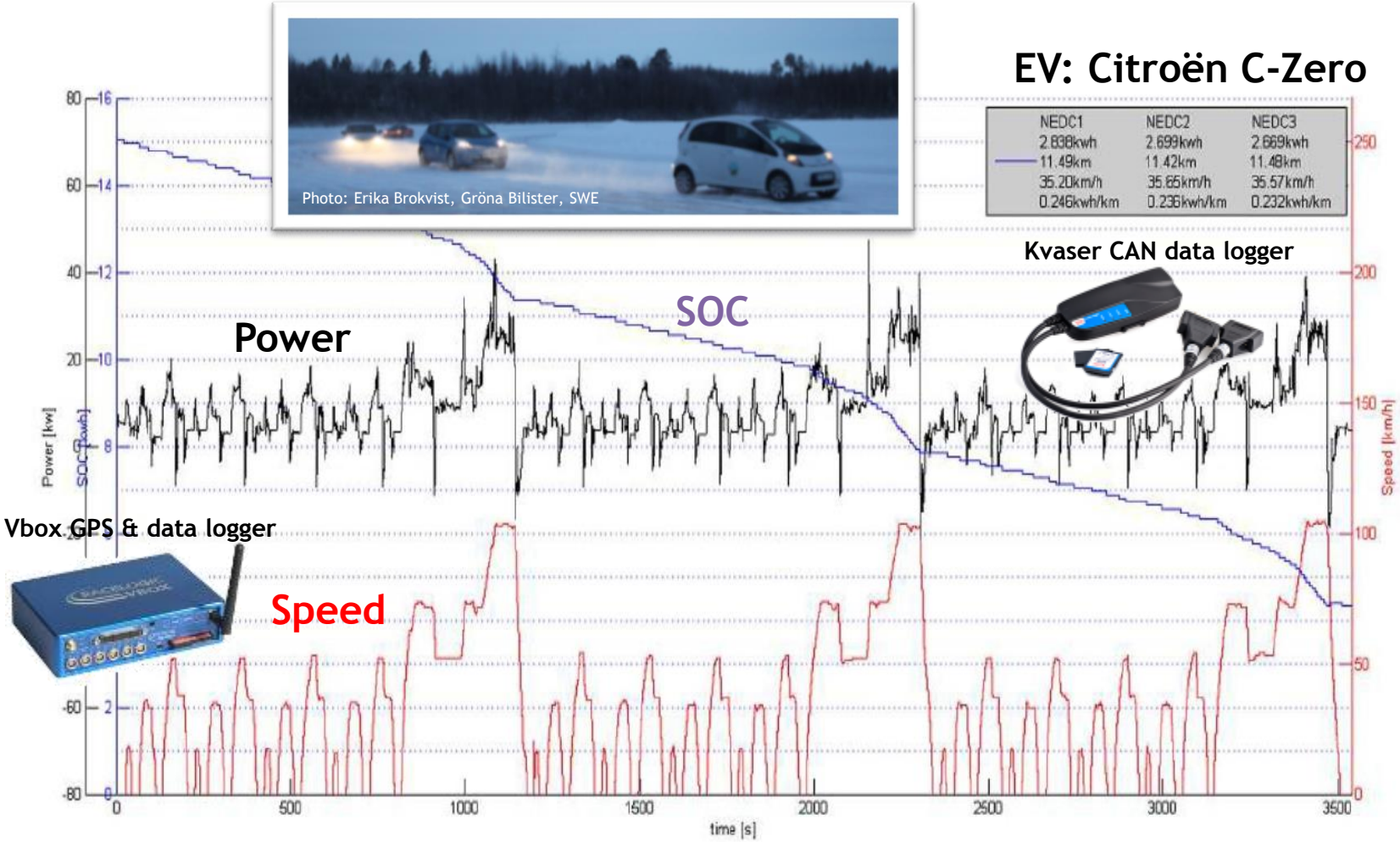


Photo: Erika Brokvist, Gröna Bilister, SWE

AFT: 3xNEDC Run on a Track

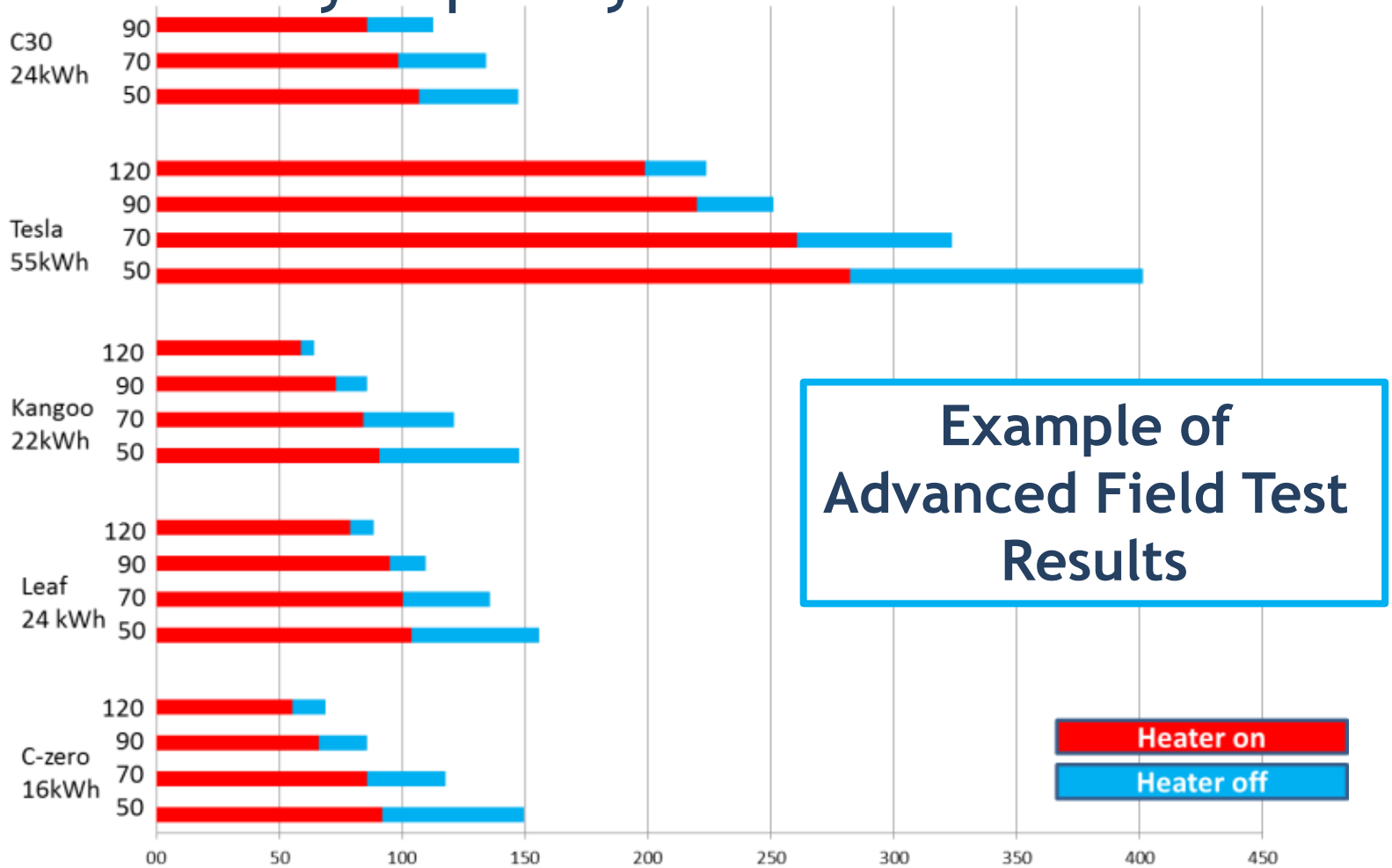


Test Fleet - January 2013

Photo: Erika Brokvist, Gröna Bilister, SWE

www.testsitesweden.com

Range estimate based on CAN-info (SOC) and nominal battery capacity



Example of Advanced Field Test Results

Energy Labelling

Charge mode and temp limit

Testing or Calculations?

NEDC or ext-NEDC?

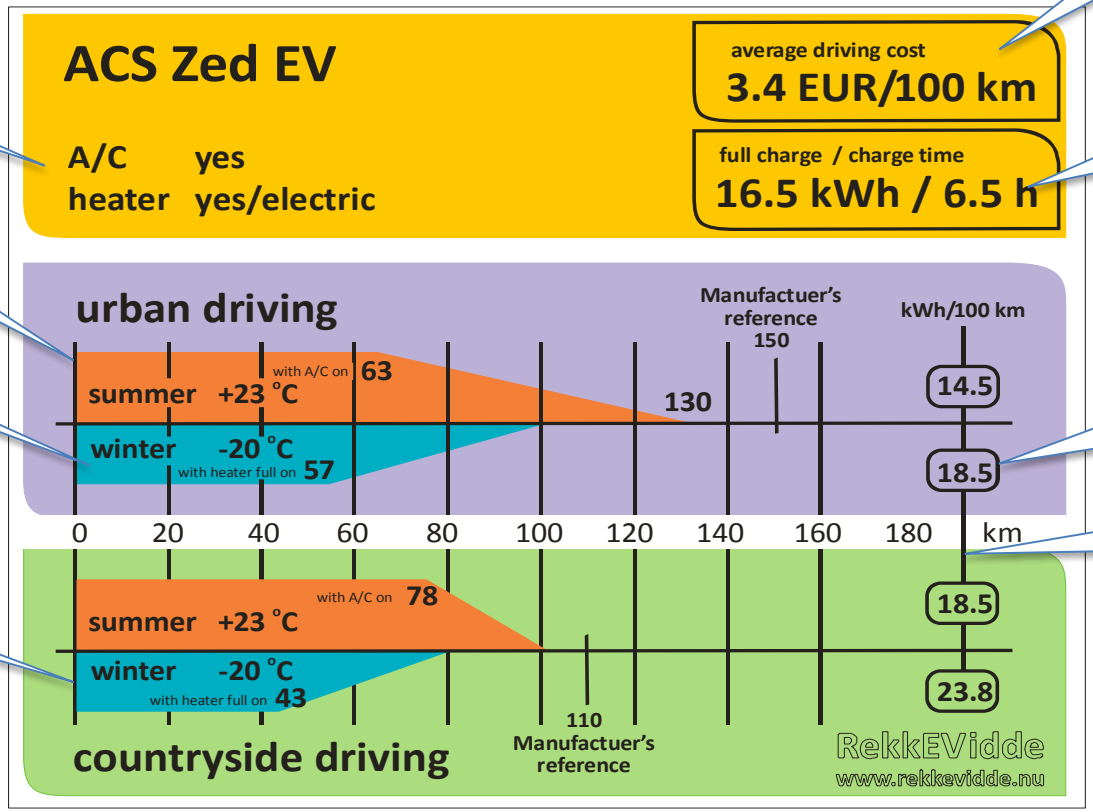
More than one speed?

Cabin temperature

Charge mode dependent

With/without pre-heating

Tesla S as the norm?



Summary & Conclusions

Cold weather and adverse road conditions increase driving resistances >> range becomes shorter

Electric heating consume high amounts of prime battery energy >> range is adversely affected especially if avarage speed is low

Cabin preheating before driving and use of a fuel heater and permission to use bus lanes increases the range

The RekkEVidde project has produced

Methodology for the EV cold temperature testing

Proposal for the EV Energy label

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