RANGE EXTENDING AS A SERVICE (RATHER THAN A FIXED COST)

Jean-Baptiste Segard, EP Tender

ATIONAL

EP Tender

iversal choice…

Peak range

Daily range

ow does it compare to an EV?

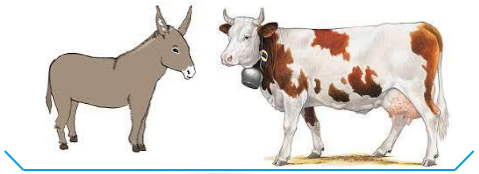
Daily range

main issue…

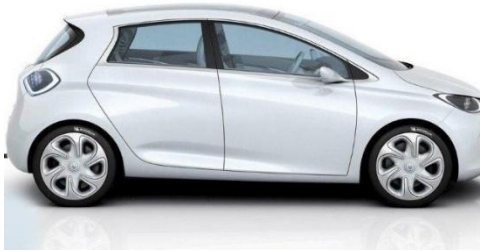
d its consequences for the mass market!

Daily usage (98%)

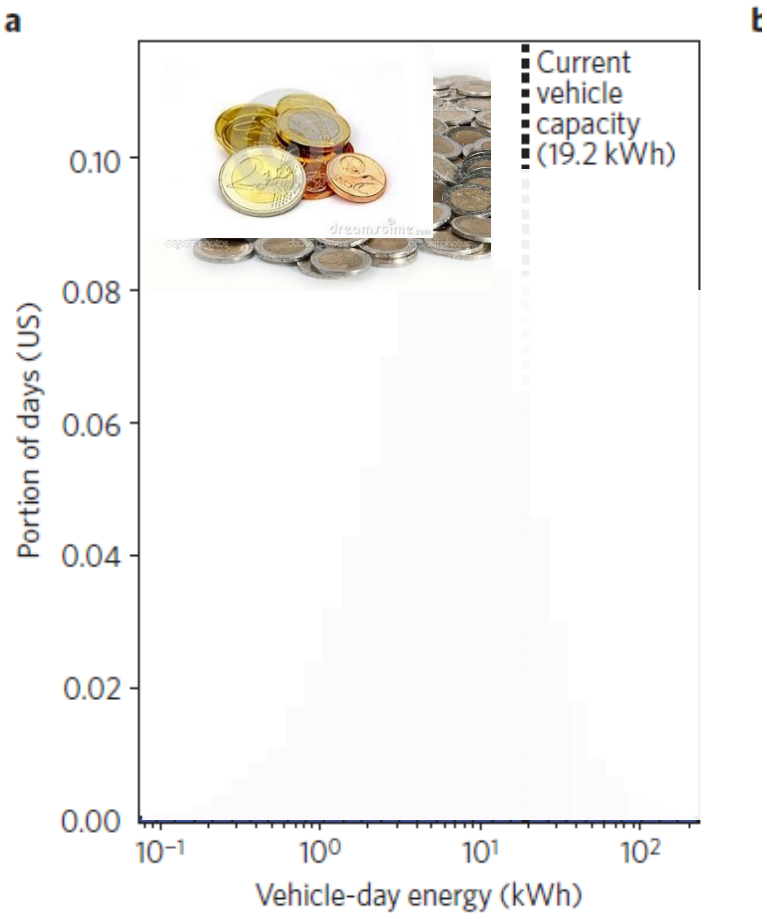
Peak us
(2%)



100 kWh battery



much battery is required ?



'otential for widespread electrification of personal vehicle travel in the United States, Zachary ۱. Needell, James McNerney, Michael T. Chang and Jessika E. Trancik, MIT ,Nature Energy 5 August 2016

Battery utility:

- 0-20 kWh : 87 % of all daily usage
- +20 kWh: +9%
- +20 kWh: +1,5%
- +20kWh: +0,5%

If 20 kWh has a « cost » (or impact) of 1unit per day of usage:

- +20kWh costs 11+1=12 / day
- +20kWh costs 12 + 67= 79 /day
- +20 kWh costs 79+200 = 279 /day
- …

The long term limit to battery size isn't technology, it's the marginal utility.

ying Mathematics

Two variables:

- Battery capacity
- Charging power

Seven equations:

- Profitable car = small battery
- Non subsidized = small battery
- Price competitive = small battery
- Convenient = very large battery
- Convenient = ultra rapid charging
- Charging from renewables = slow demand-response residential charging
- Minimized life cycle footprint = small battery

And with premium autonomous cars :

- Non stop trips = very, very large battery
- No time wasted = hyper rapid charging

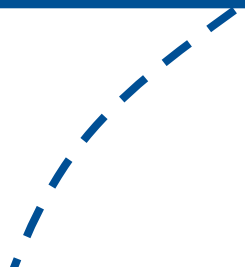
7 equations, 2 variables : no solution. This isn't a technological problem.

ssic solution: two independent sub problems

bank for occasional long distance
ex, battery, fuel cell, inductive charging
n demand rental

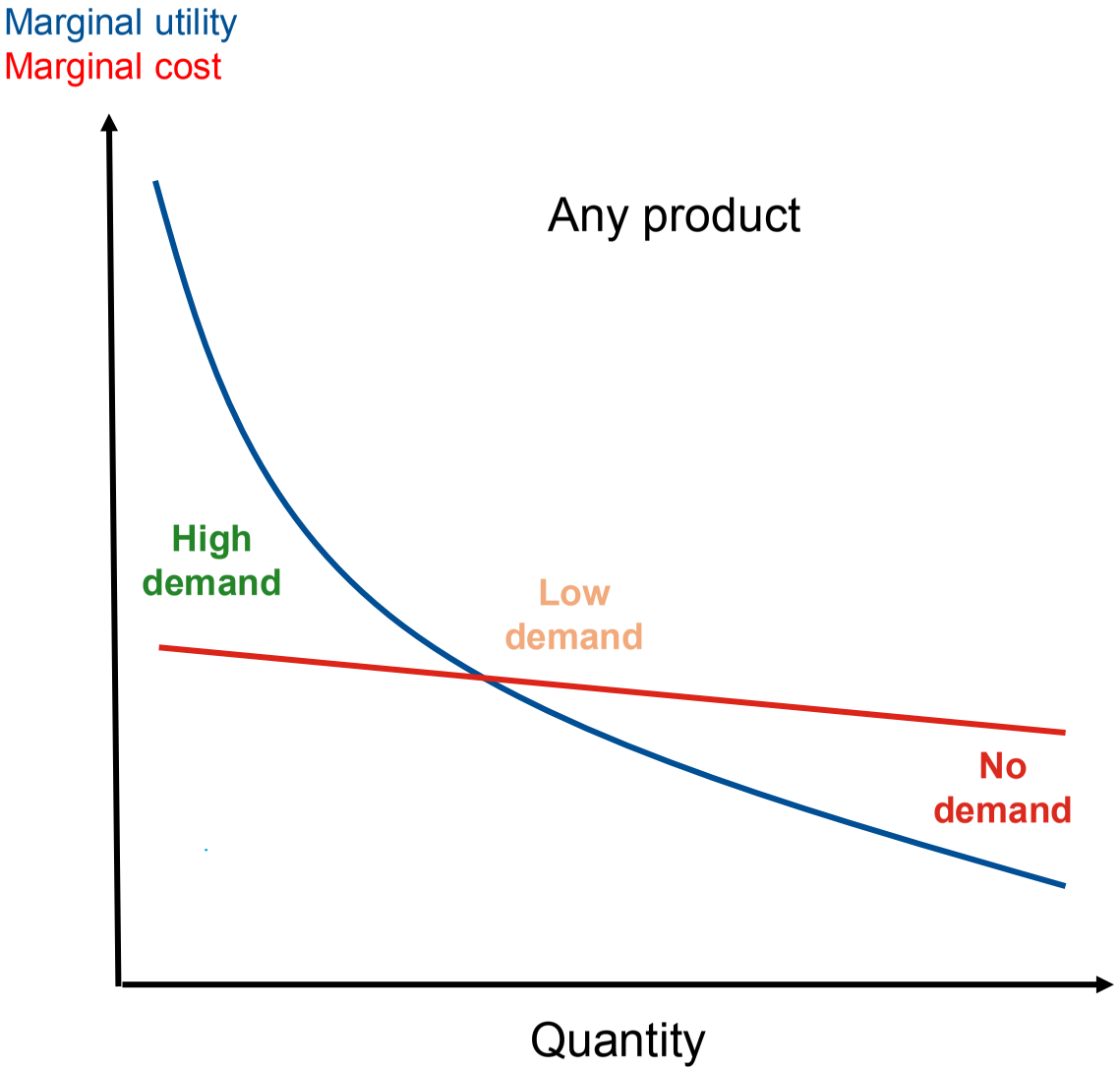
Vehicle optimized for 98% of usage

- 15-60 kWh battery depending on segm
- Mostly residential charging

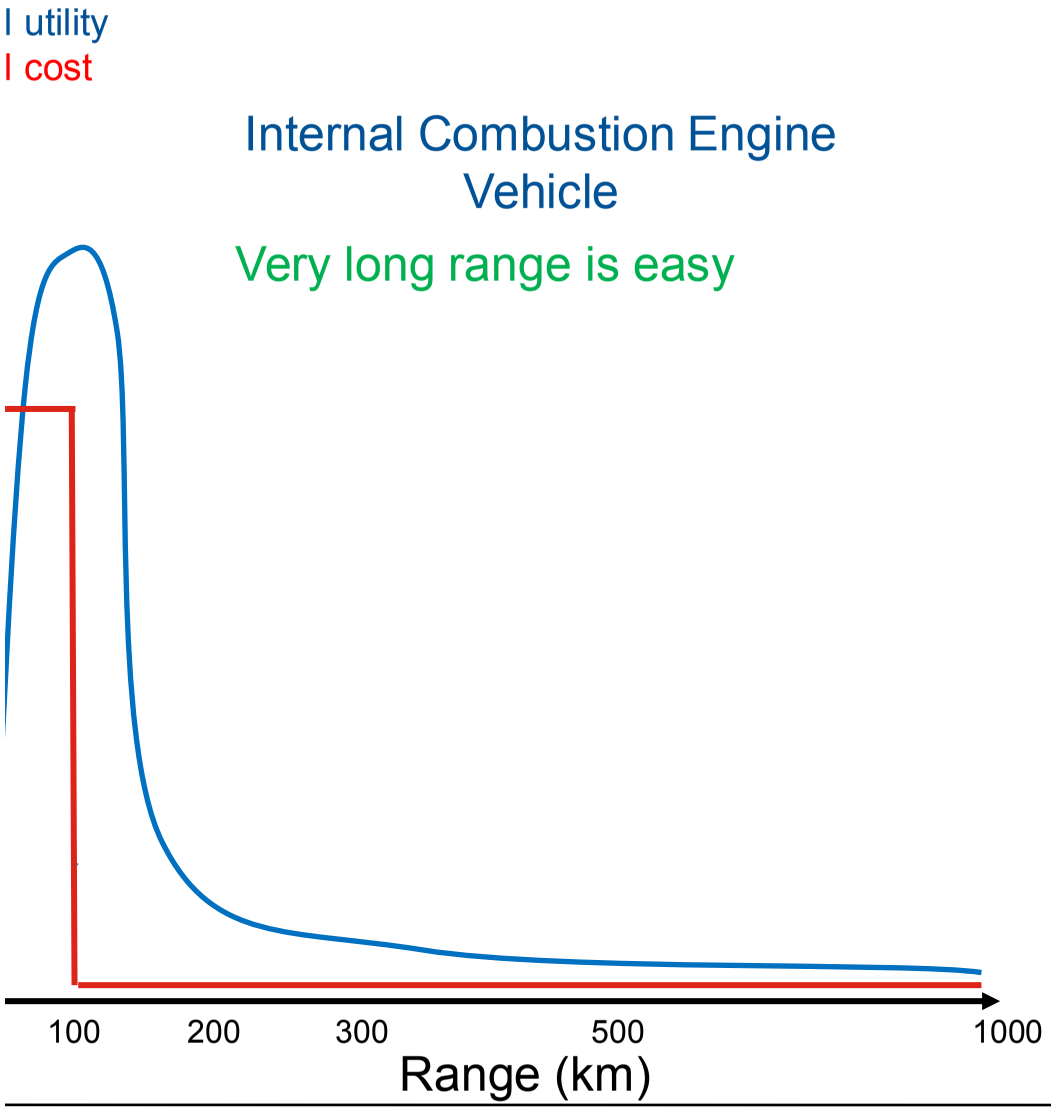


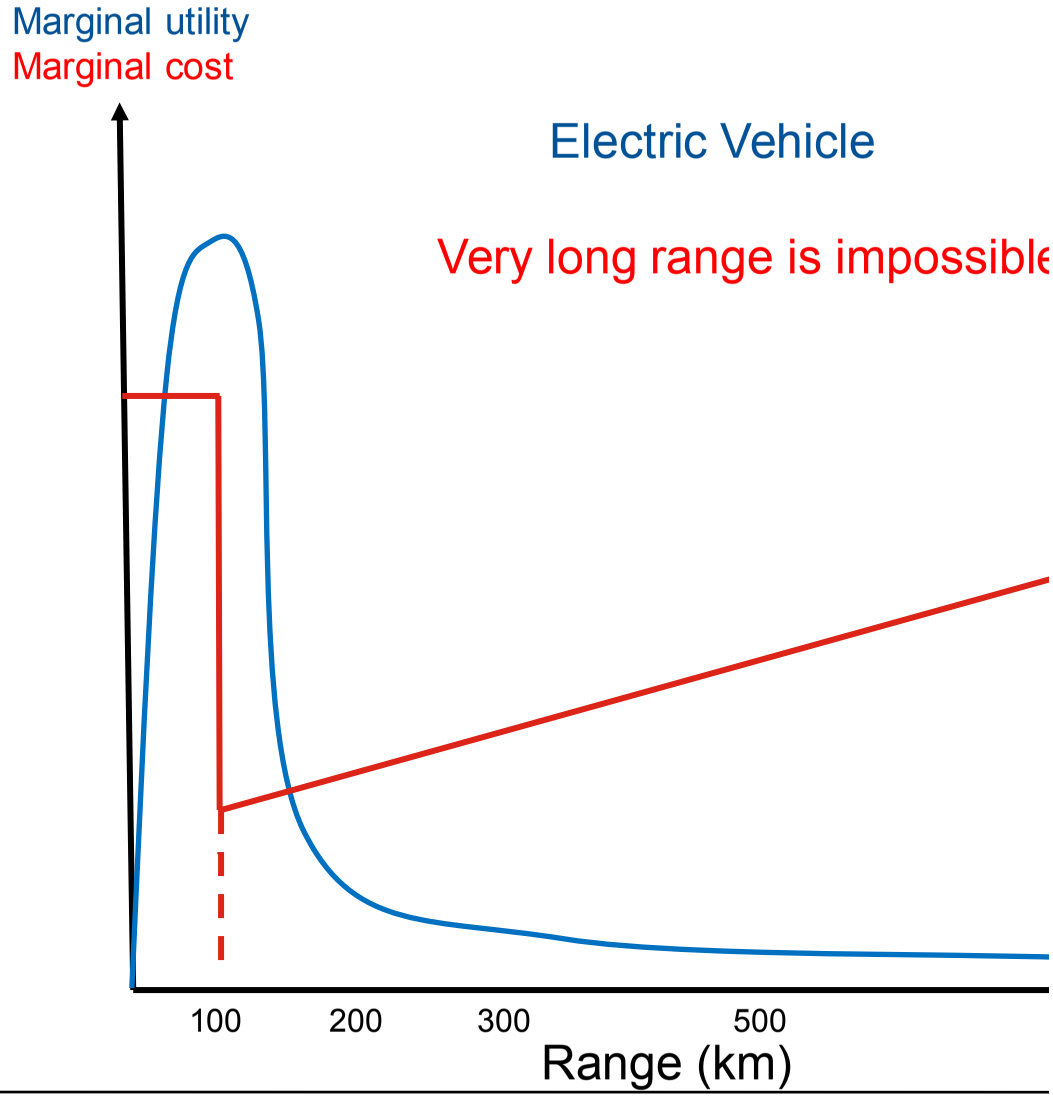
Daily range

ying Economics: decreasing marginal utility

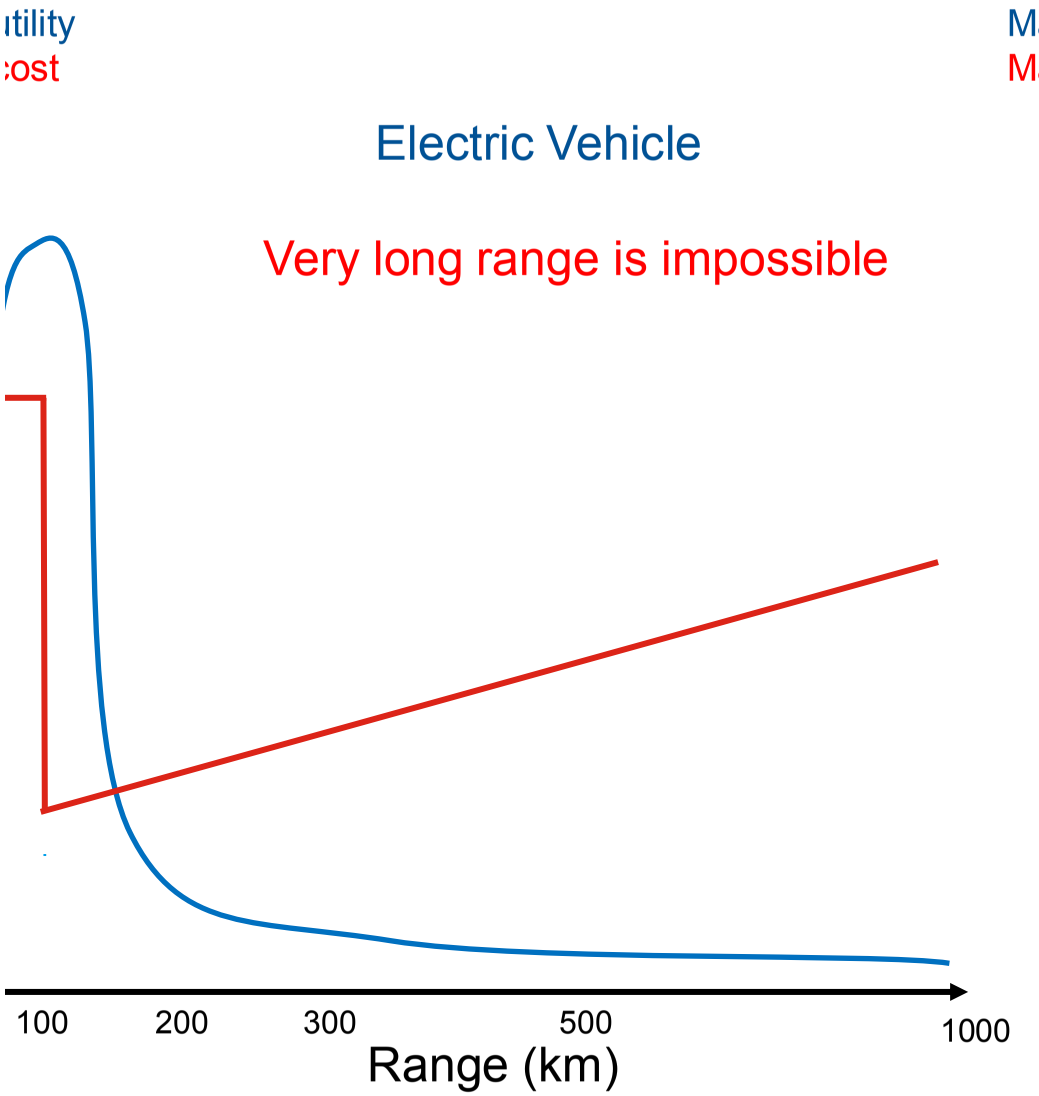


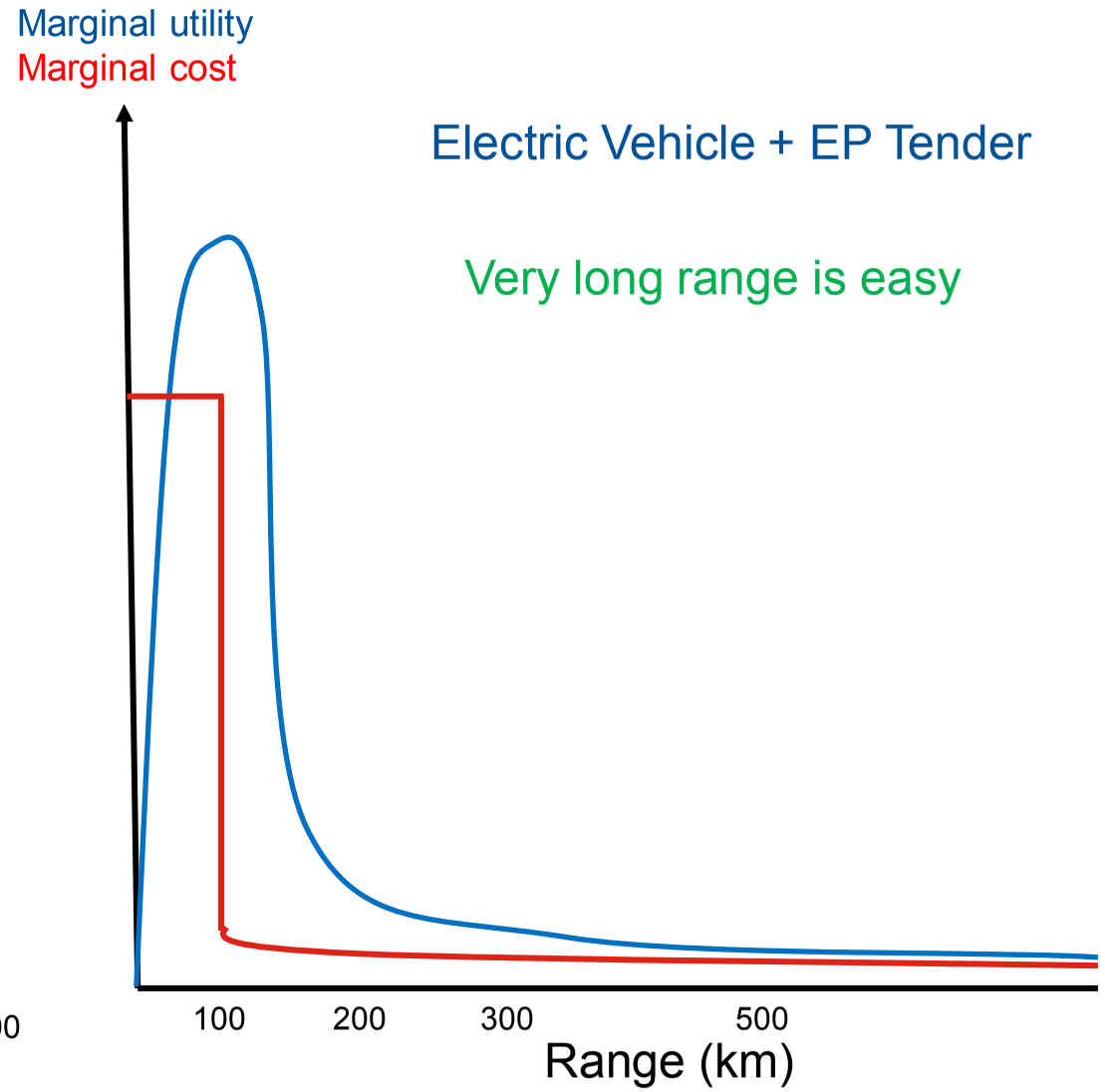
ying Economics: decreasing marginal utility of more vehicle range





ying Economics: decreasing marginal utility





ser experience angle

EV emotions: feel good, great comfort.

But peace of mind is missing during travelling, with risks of:

- Charger out of order,
- Charger busy,
- Missed exit,
- Detour,
- Underestimating of declivity or wether conditions,
- Traffic jam in cold or very hot weather.

Such « russian roulette » is furthermore a very poor fit with autonomous cars, which on the opposite, will provide the ideal conditions for a relaxing trip, without load interruptions, loss of time and stress.

EP Tender user experience

- EV emotions: feel good, great comfort.
- With a modular range extender: travel with peace of mind, and save time
- 2 key conditions:
  - Convenience
  - Safety

venience

Watch 50” demo:
https://www.youtube.com/watch?v=uU7d83_9xOM

venience: the backing system

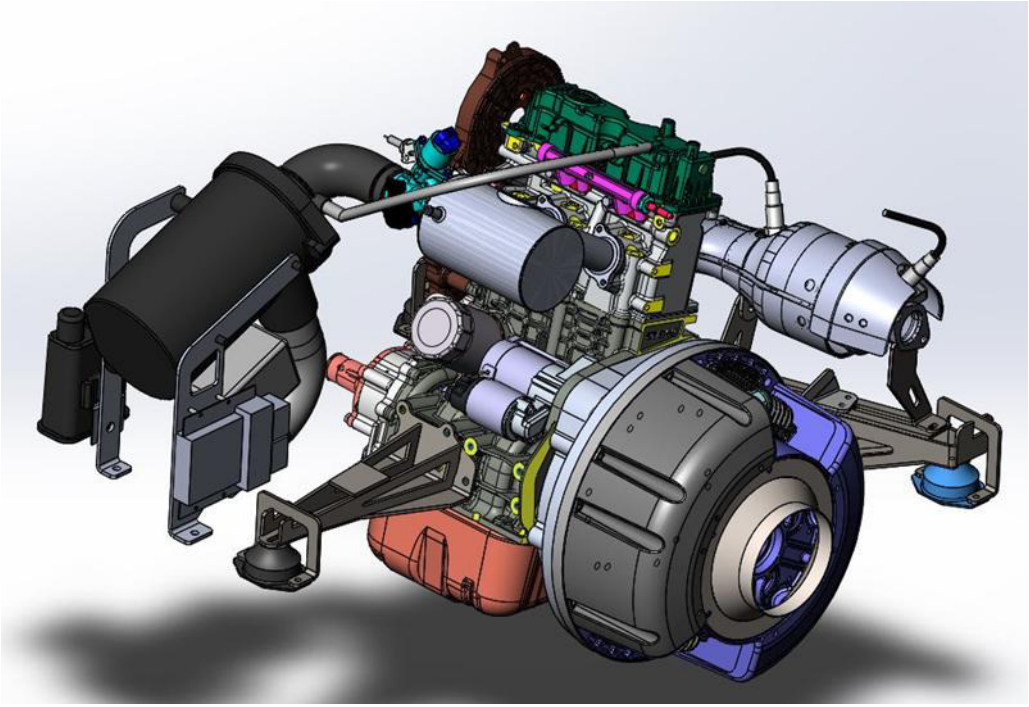
Watch the platform:
https://www.youtube.com/watch?v=jnHX_L06Thk

Open the FMVSS301R crash simulation

https://www.dropbox.com/preview/Reporting%20H2020/PGG.R.P.16.040_EP%20TENDER_COMPILATION_RESULTATS_Calculs-Crash_WITH_LIQUID.ppsx

CE range extender

:
a Nano
4 cc
ylinder
ter cooled
el tank: 35 l



Electric machine:

- NSM (Italy)
- Synchroneous, permanent magnets
- 3 phase, 22 poles
- 2 windings
- Redressor bridge (no invert
- Parallel mode: 360 V at 4 7
- Series mode: 360 V at 2 35
- Air cooled

Range extender:

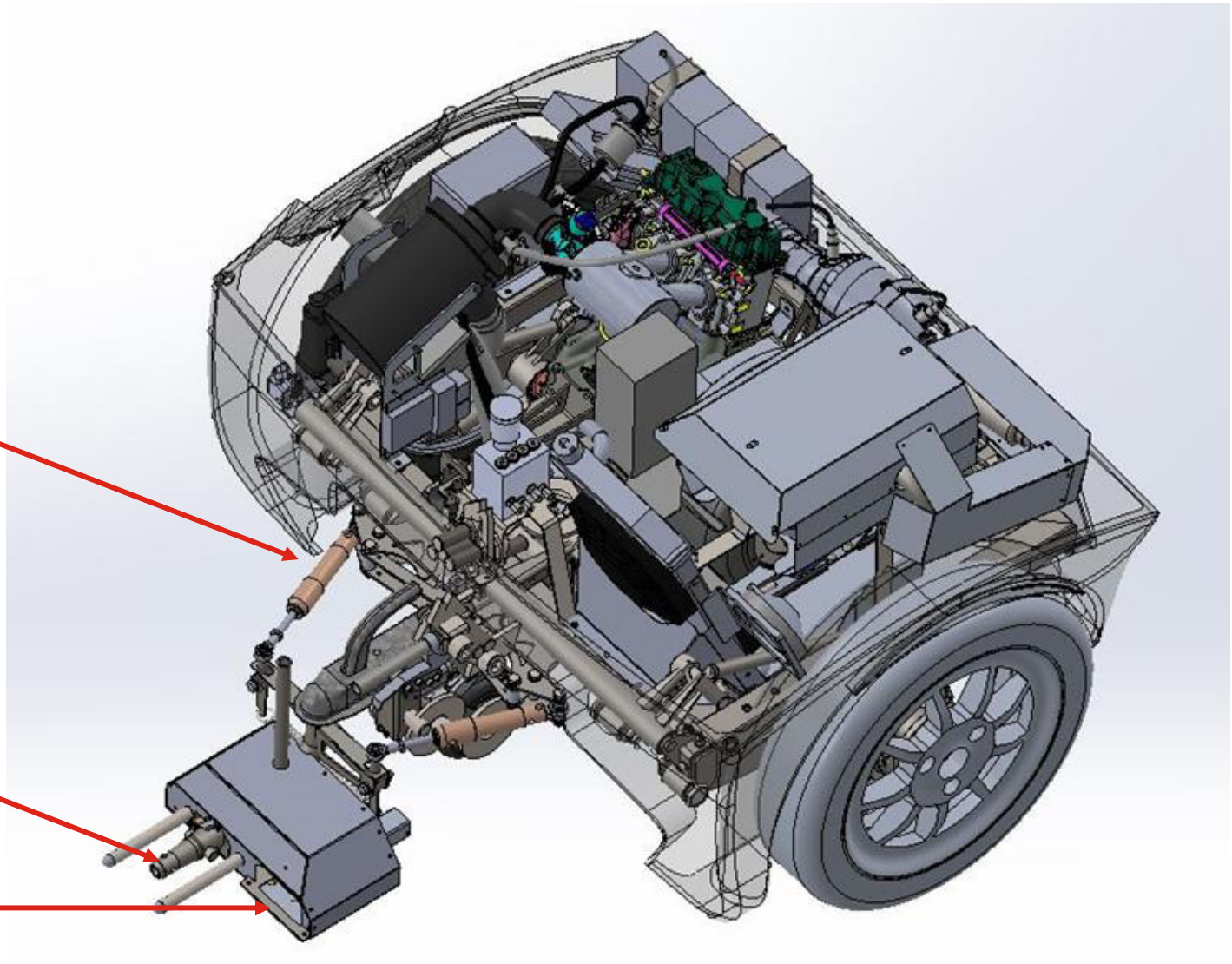
- 22 kW
- 80 kWh
- 2MW « charging »

CE Range extender

steering and
y hydraulic
inders

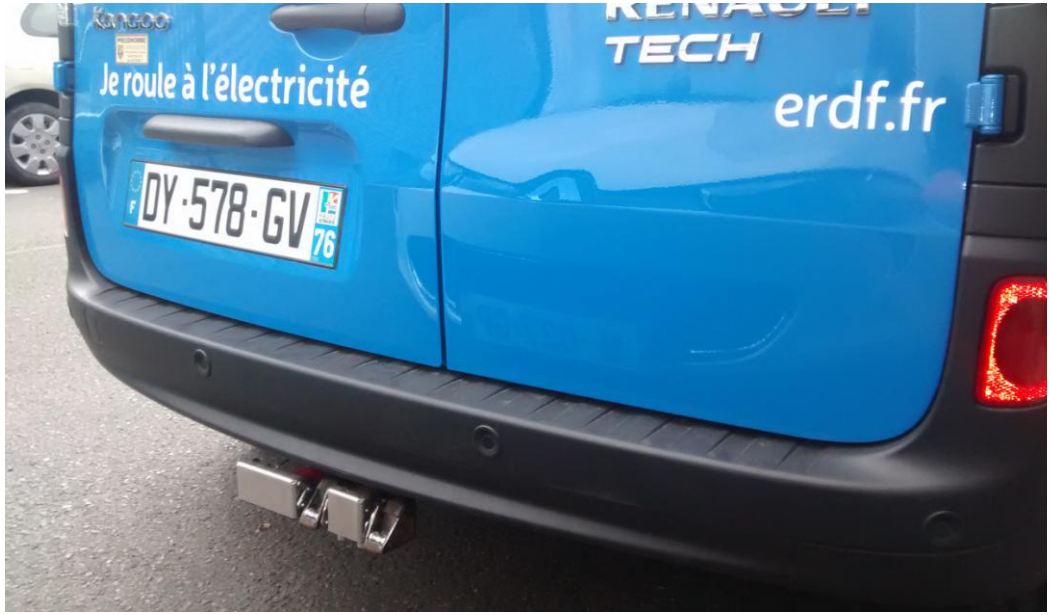
ar

d plug



mounted with tow bar and receiver

Renault Zoe



Renault Kangoo

Cycle impact (Vrije Univertsiteit Brussels)

oals & scope

- Environmental assessment of in-life modularity
- Benchmarking 40 kWh EV + REx (generator/battery)

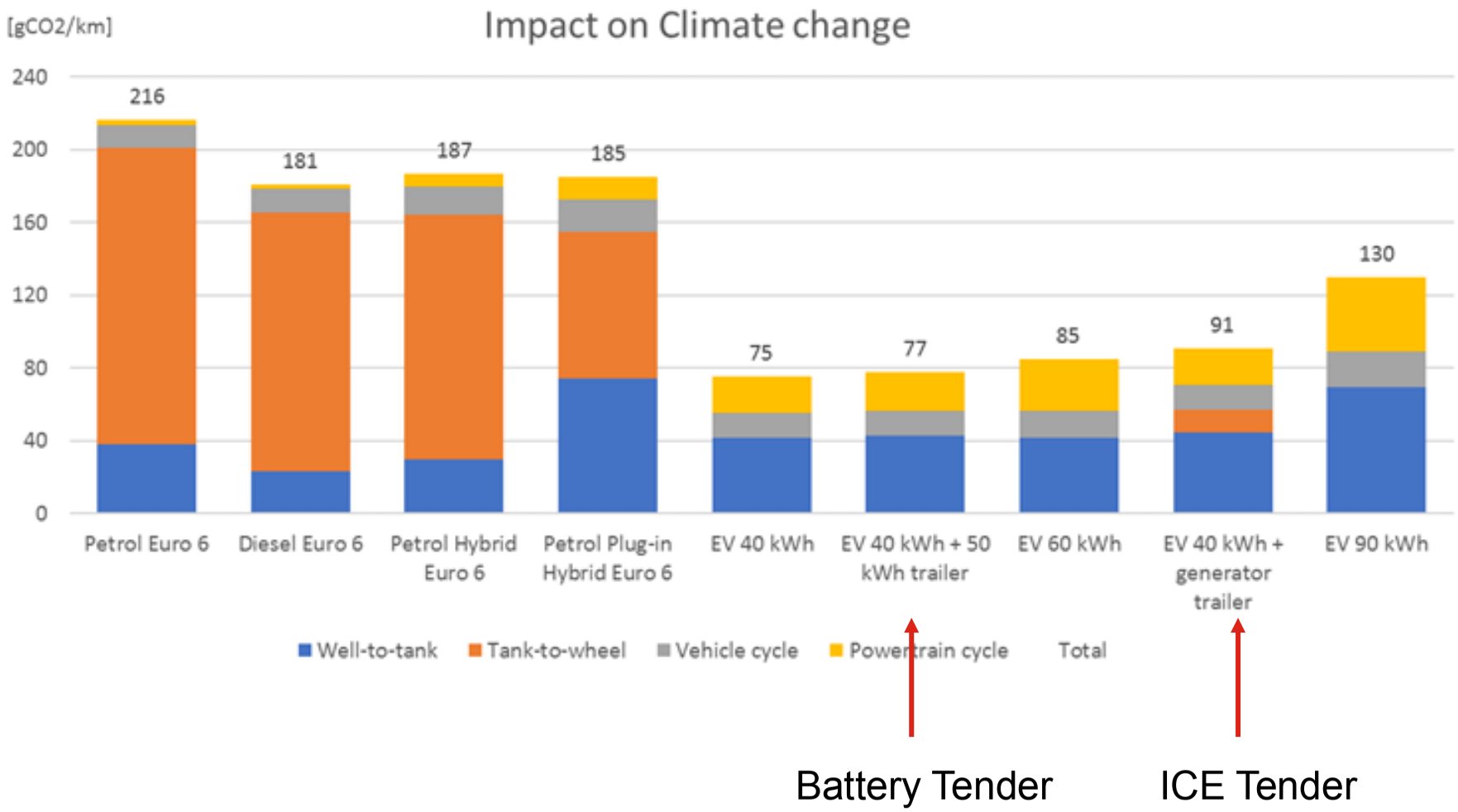
ethodology

- Life-cycle assessment for impact on climate change
- Life-cycle inventory assessment for REx trailer
- Functional unit = 1 kilometre

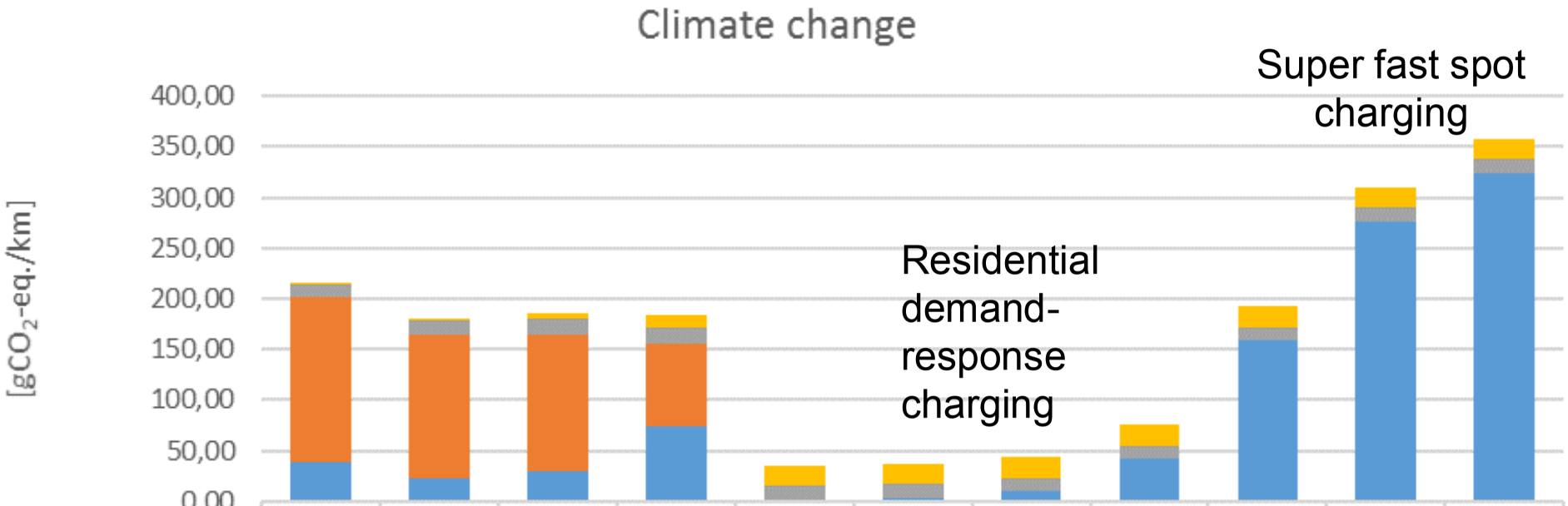
sumptions

- REx shared by 15 users
- Lifetime 209.460 km
- EU electricity mix (29,5% renew., 27,9% nuclear, 25,3% coal, 15,5% gas, 2% oil) = 276 gCO_2/kWh
- Real-world driving emissions

Cycle impact (Vrije Univertsiteit Brussels)



ct of the energy production mix in grams per kilometre

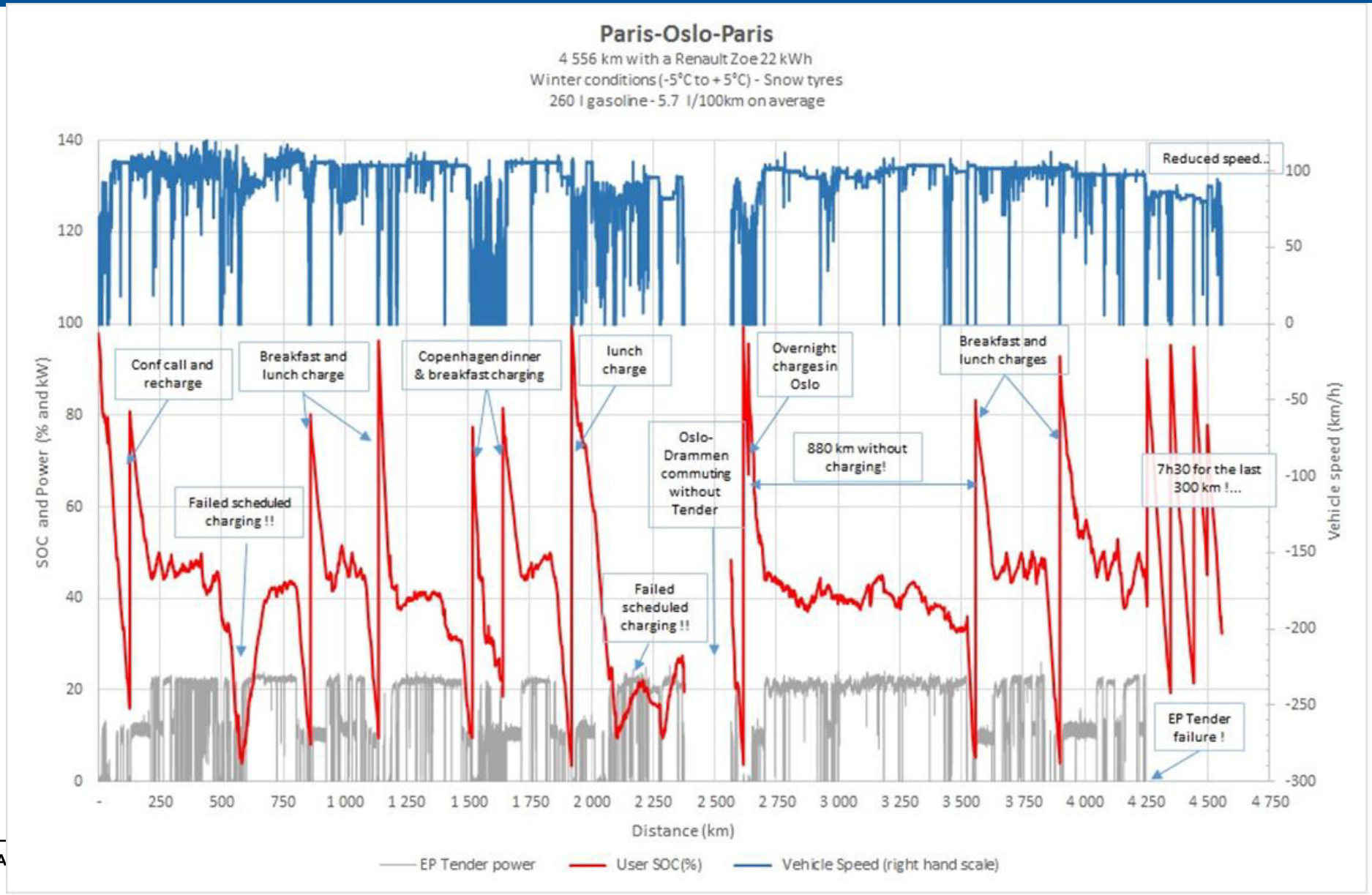


	Petrol Euro 6	Diesel Euro 6	Hybrid Euro 6	Plug-in Hybrid Euro 6	EV 40 kWh Nuclear	EV 40 kWh Wind	EV 40 kWh Hydro	EV 40 kWh EU Mix	EV 40 kWh Gas	EV 40 kWh Oil	EV 40 kWh Coal
Powertrain cycle	2,65	2,65	6,72	12,35	20,04	20,04	20,04	20,04	20,04	20,04	20,04
Vehicle cycle	12,33	12,81	15,54	17,61	13,46	13,46	13,46	13,46	13,46	13,46	13,46
TTW	163,19	142,29	134,89	80,82	0,00	0,00	0,00	0,00	0,00	0,00	0,00
WTT	38,04	23,26	29,49	74,20	2,37	3,48	9,98	41,69	159,00	276,67	325,00

sagie, F.-S. Boureima, T. Coosemans, C. Macharis, and J. Mierlo, “A Range-Based Vehicle Life Cycle Assessment Incorporating Variability in the Environmental Assessment of nt Vehicle Technologies and Fuels,” *Energies*, vol. 7, no. 3, pp. 1467–1482, Mar. 2014.

life results

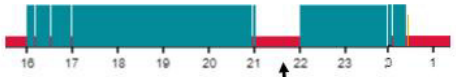
life results



life results

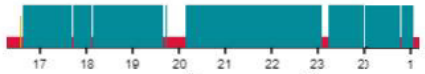
Paris—Stuttgart with a Zoe 22 + EP Tender

Sunday 8 october 667 km from 4.00pm to 0.20 am

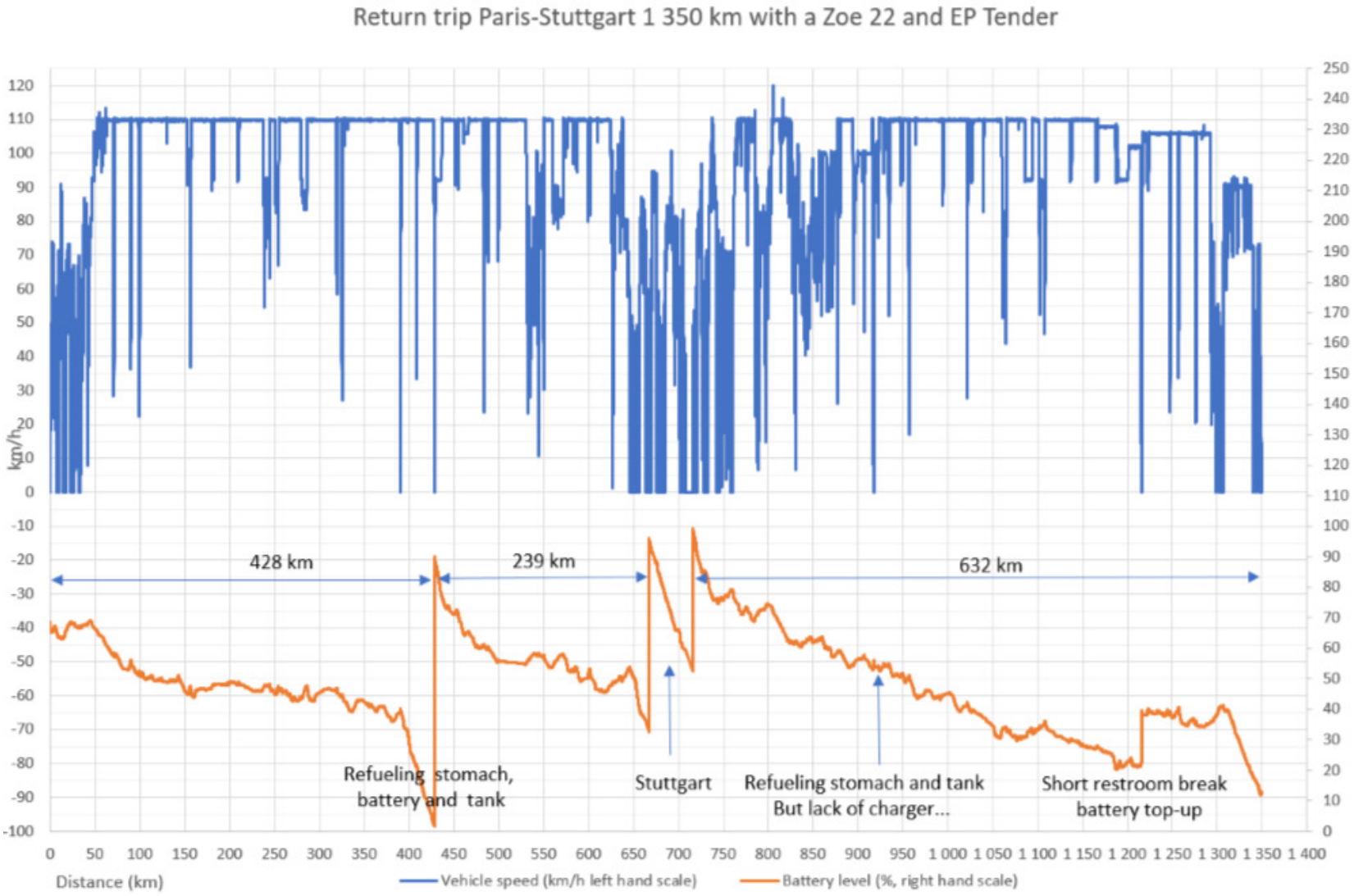


Stuttgart—Paris with a Zoe 22 + EP Tender

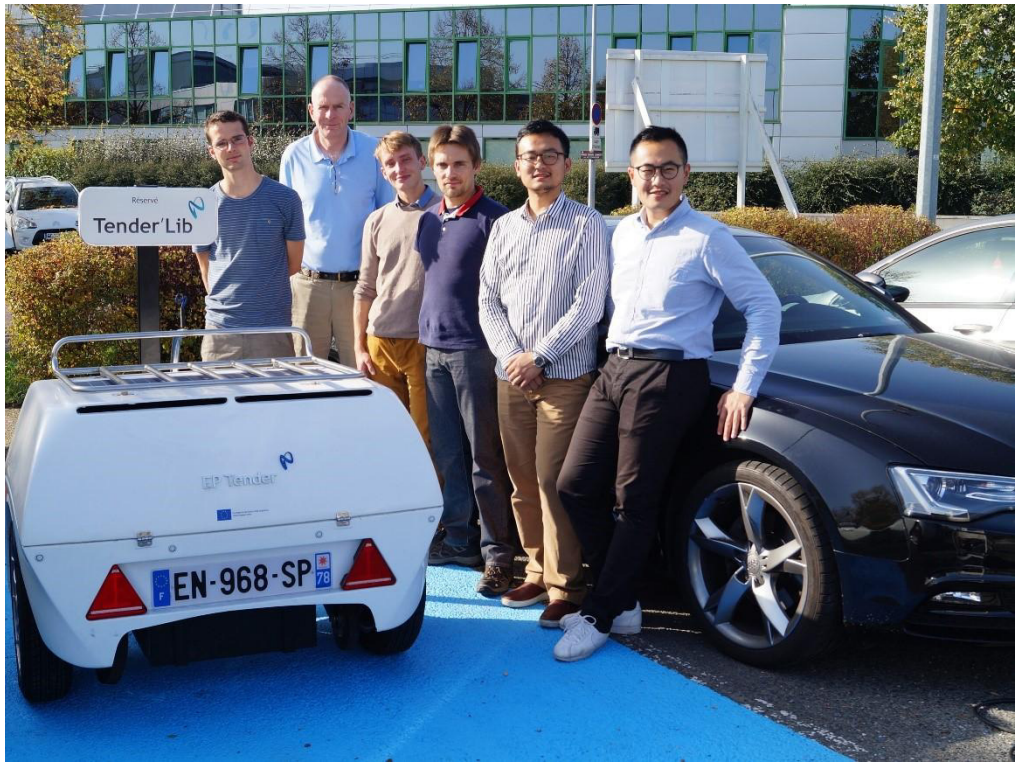
Thursday 12 october 632 km from 4.37pm to 1.03 am



life results



nples of rental points



proposed service (looking for partners !)

On demand rental

Travelling with peace of mind !

Optimal carbon impact

London example:

- 17 rental points
- 9 million people

Paris, Oslo, etc.

500 km additional range

cell version (looking for partners!)

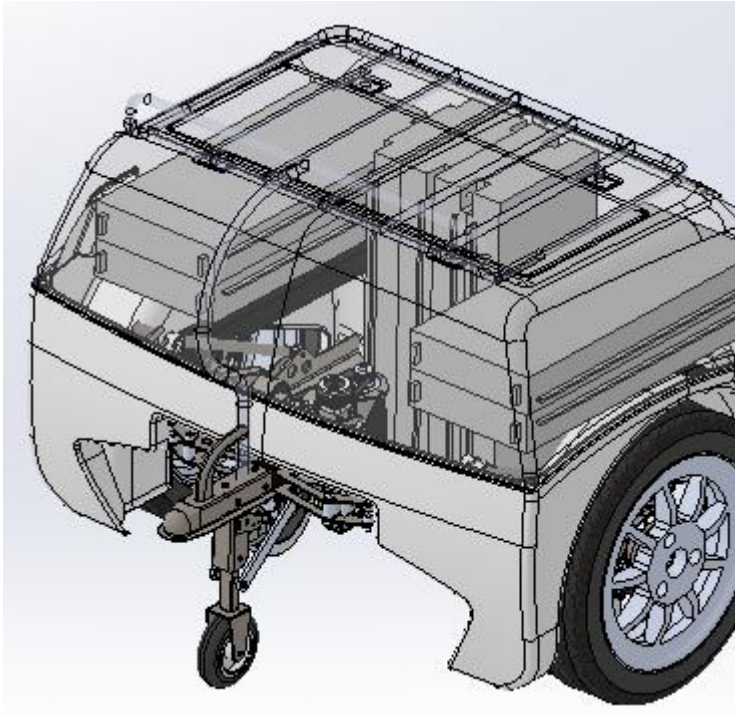
-20 kW
g H2 @ 700 bar
shared by 15 affordable EVs
becomes multienergy
ogressive deployment of H2 infrastructure
arging stations are loaded (used by affordable EVs)

e required investment from FC industry to reach critical mass is reduced by 2 to 3 orders of
gnitude

ery version (looking for partners !)

re looking to develop a 35-40 kWh version
et is 60 kWh in 5-10 years
20/80, Leaf 40/100, Bolt 60/120, Model 3 50/110 and
35 !
er will self mate with the [autonomous] EV
er will be swapped when depleted
ged at night from renewables
as a buffer near fast chargers
mes part of the grid, and located where demand is moving
Powerwall on wheels, if owned

sset which provides value at all times !!



EP Tender with 8 Tesla module

vision

icles are clean, connected, autonomous
ean.

ir range is adequate for daily usage.

ng long distance trips, a self hitching
gy module (a Tender) complements their
nal energy storage.

business model

Range extending service for EVs

Revenues

- High client value
- Margin protected by patents
- Recurring business (“sticky” business)

Distribution

- Low client acquisition cost (via car dealers)

Growth

- Scalable business (wireless rental management, passive docking stations)
- Variable costs
- Global market
- Growth >20% for decades

facts and figures

Targeting 6m€ turnover in 2021

2
Intl. patents granted

Launch client
ENEDIS
L'ELECTRICITE EN RESEAU

Clients are impatient !

Strong fundamentals

3 M$
funding

H2020 SME Phase 2

Field test 50 cars, 5 Tenders

Team of
6

Low burn rate

ignal: two of our clients meet by chance on a French motorway !

ou

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