evs 27
The 27th INTERNATIONAL ELECTRIC VEHICLE SYMPOSIUM & EXHIBITION
BARCELONA
17th-20th November 2013

Extended Range Electric Vehicles components preliminary sizing based on real mission profiles

Filippo Colzi

Organized by Fira Barcelona avele
Hosted by AVERE mea Ajuntament de Barcelona
In collaboration with EVAAP EDTA
Supported by European Commission

The context: EVs hurdles

COSTS AND RANGE

21.850* €
210 km

24.790* €
199 km

31.950 €
150 km

36.499 €
190 km

79.440 €
502 km

MID-LEVEL **FUEL CAR**
20.000 €
800 km

* Not including the battery pack

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Mid-term solutions

SERIES HYBRIDS

Extended Range Electric Vehicles - EREVs

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EREVs powertrain: actual situation

MANUFACTURERS DIFFERENT CHOICES

Car Model	BP capacity [kWh]	RE Power [kW]	RE type
Chevrolet Volt / Opel Ampera	16	63	1.400 cc – 4 cylinders
Fisker Karma	20,1	175	2.000 cc – 4 cylinders
Suzuki Swift Erev	2,66	-	660 cc – 3 cylinders
Audi A1 e-tron	12	15	254 cc - Wankel
Volvo C30	24	45	nd – 3 cylinders
Hyundai i-oniq	-	45	1.000 cc – 3 cylinders
BMW i3 Rex*	18,8	25	647 cc – 2 cylinders
Lotus/Proton Emas	11,5	35	1.200 cc – 3 cylinders
Tata Megapixel	13	22	325 cc – 1 cylinder

Research opportunities

OBJECTIVE

Preliminary define **a rational sizing** for Battery Pack capacity and Range Extender power.

MEANS

- **Real Mission** profiles data
- Vehicle **dynamic model**
- EREV behaviour **simulation model**

EREV requirements

- **Pure electric** everyday-life usage
- Coeherence between **battery life-span** and **vehicle life-span**

Minima requirements

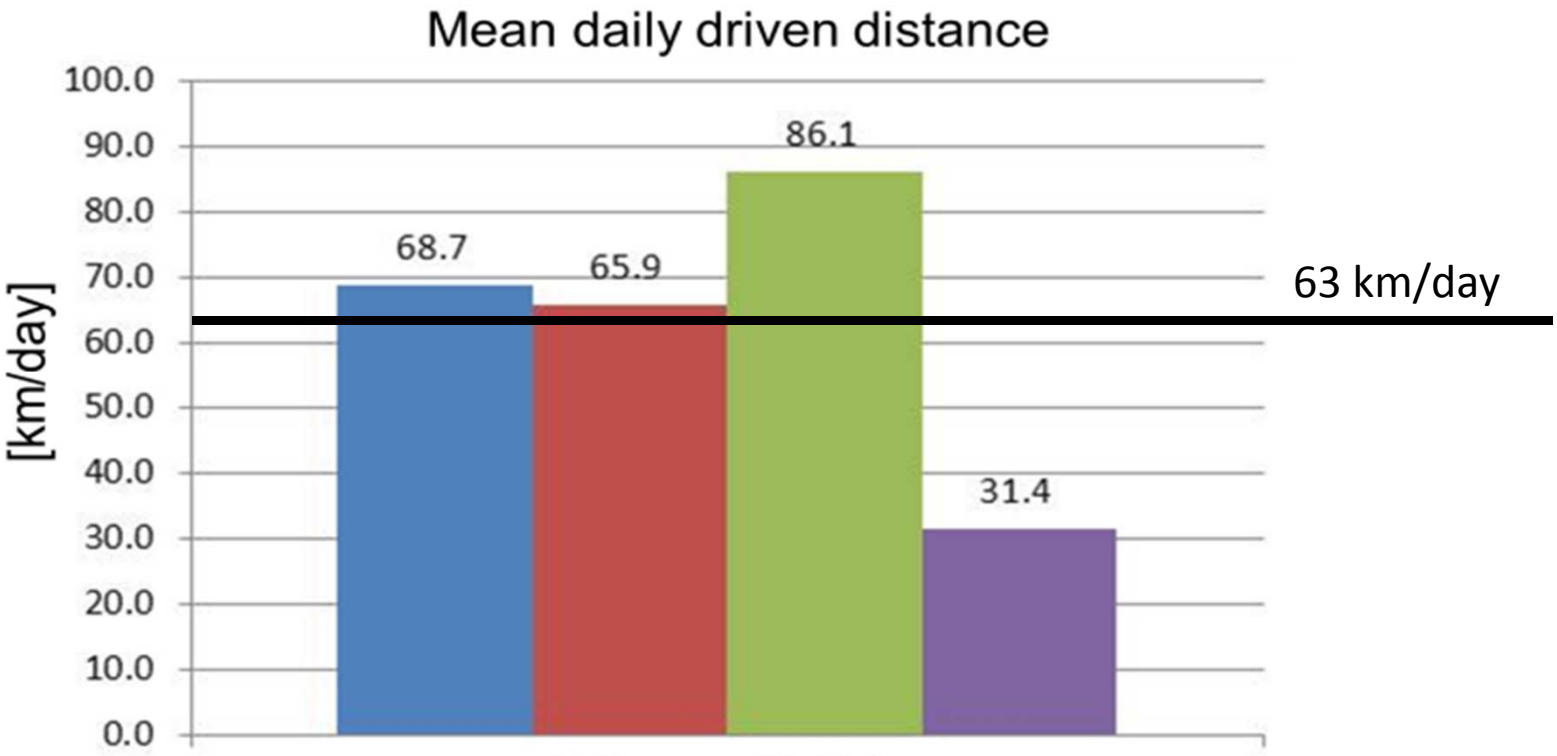
- No forced changes in **driving habits**

Worst-case Analysis

Every-day usage

Real missions data

- **4 cars**
- **5 months** of data acquisition



Battery/car life-span

- Common **car life**: 150.000 km
- Declared **Battery Life**: 2.000 cycles.
- **Objective: 2.000 cycles have to cover minimum 150.000 km**

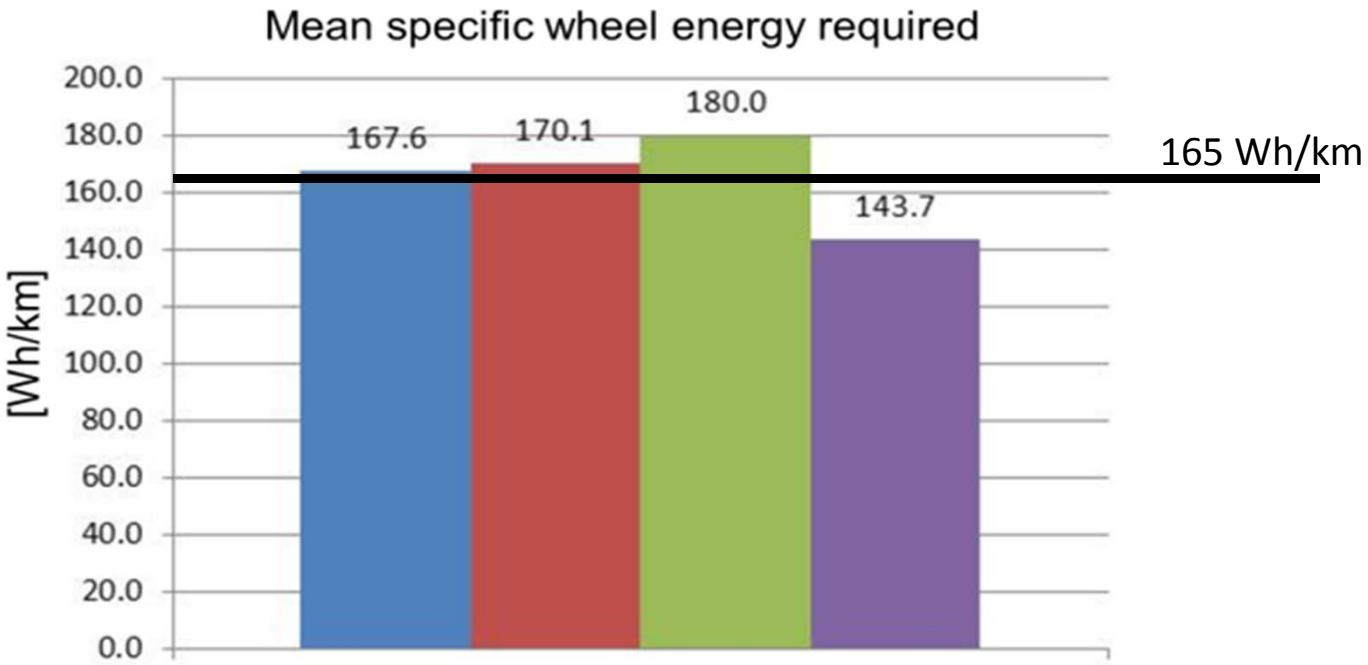
1 cycle = 150.000/2.000 = **75 km**

Minima requirements choice

- **Everyday-life** range: miminum **63 km/day**
- **Battery life-span** required: minimum **75 km/day**

--> 75 km/day

Minimum Battery capacity

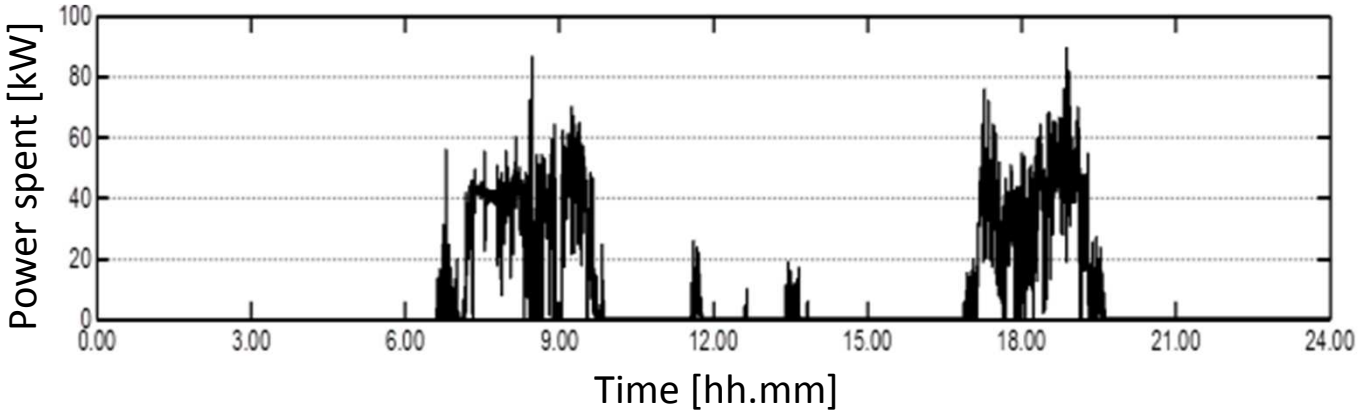


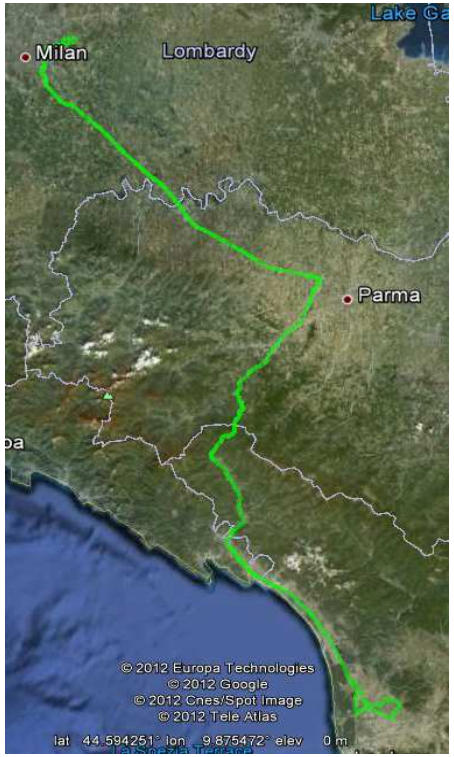
75 km/day --> 15,47 kWh

Worst-case satisfaction

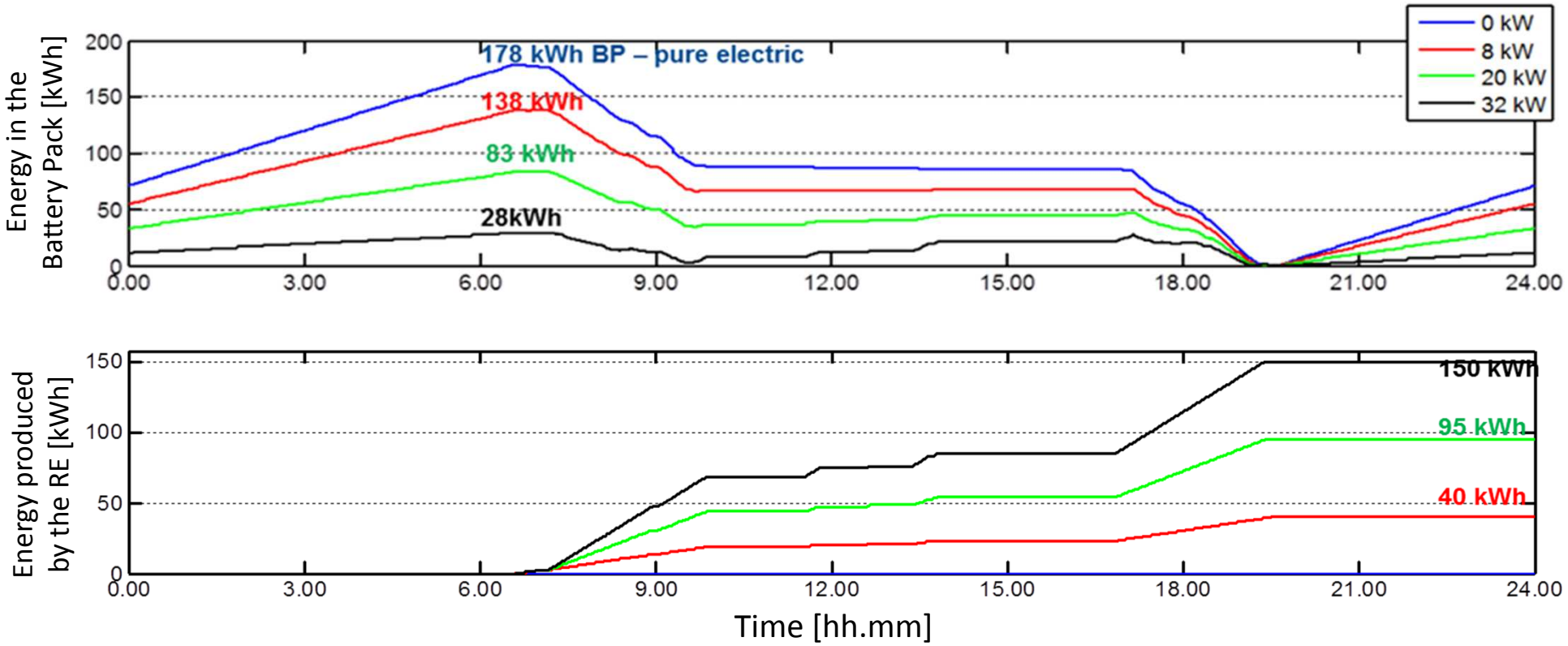
January, 10th 2012

- Distance covered: **601 km**
- Mean speed: appr. 100 km/h
- Maximum speed: >150 km/h
- Energy consumption: **178 kWh**

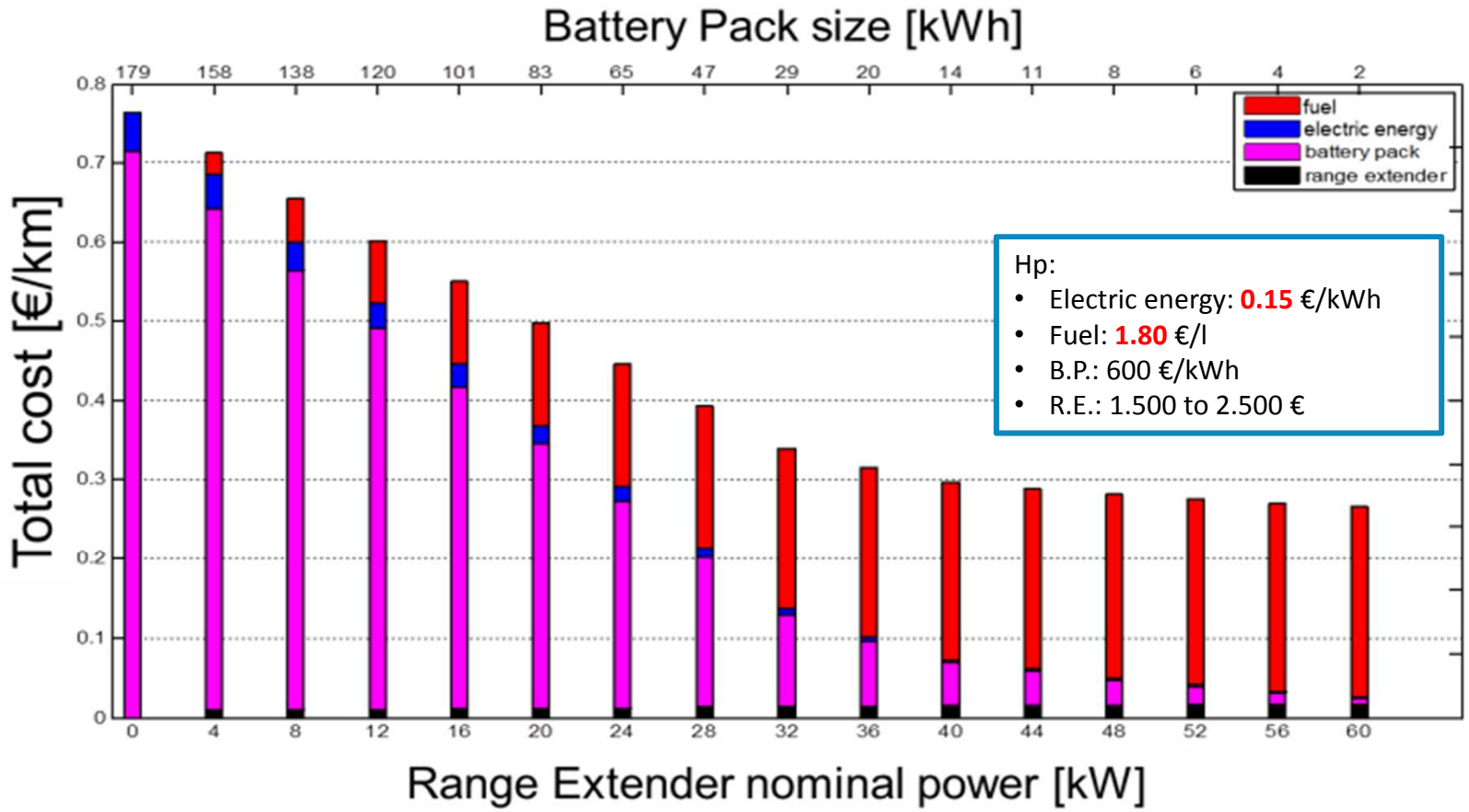




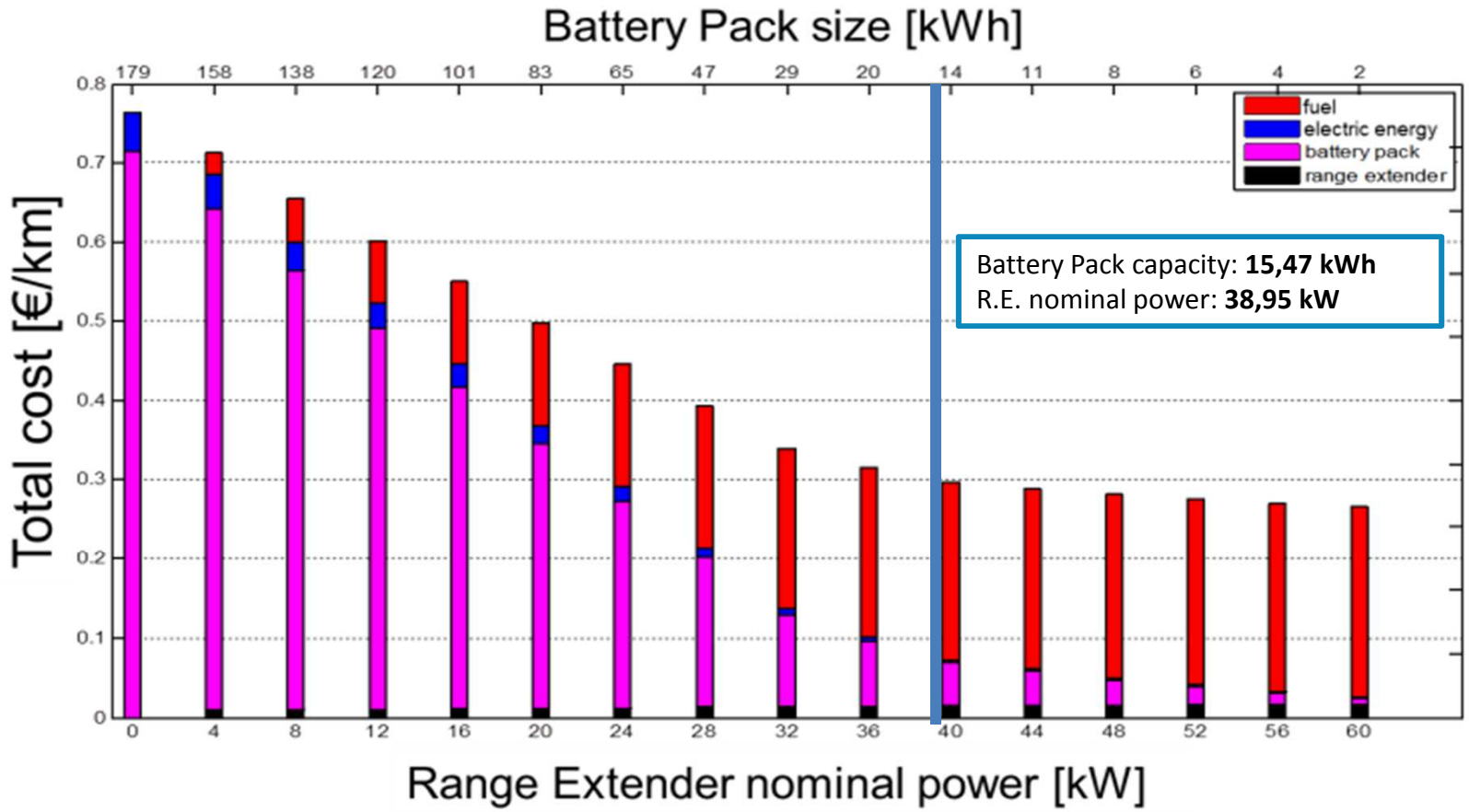
How much hybrid? - Power



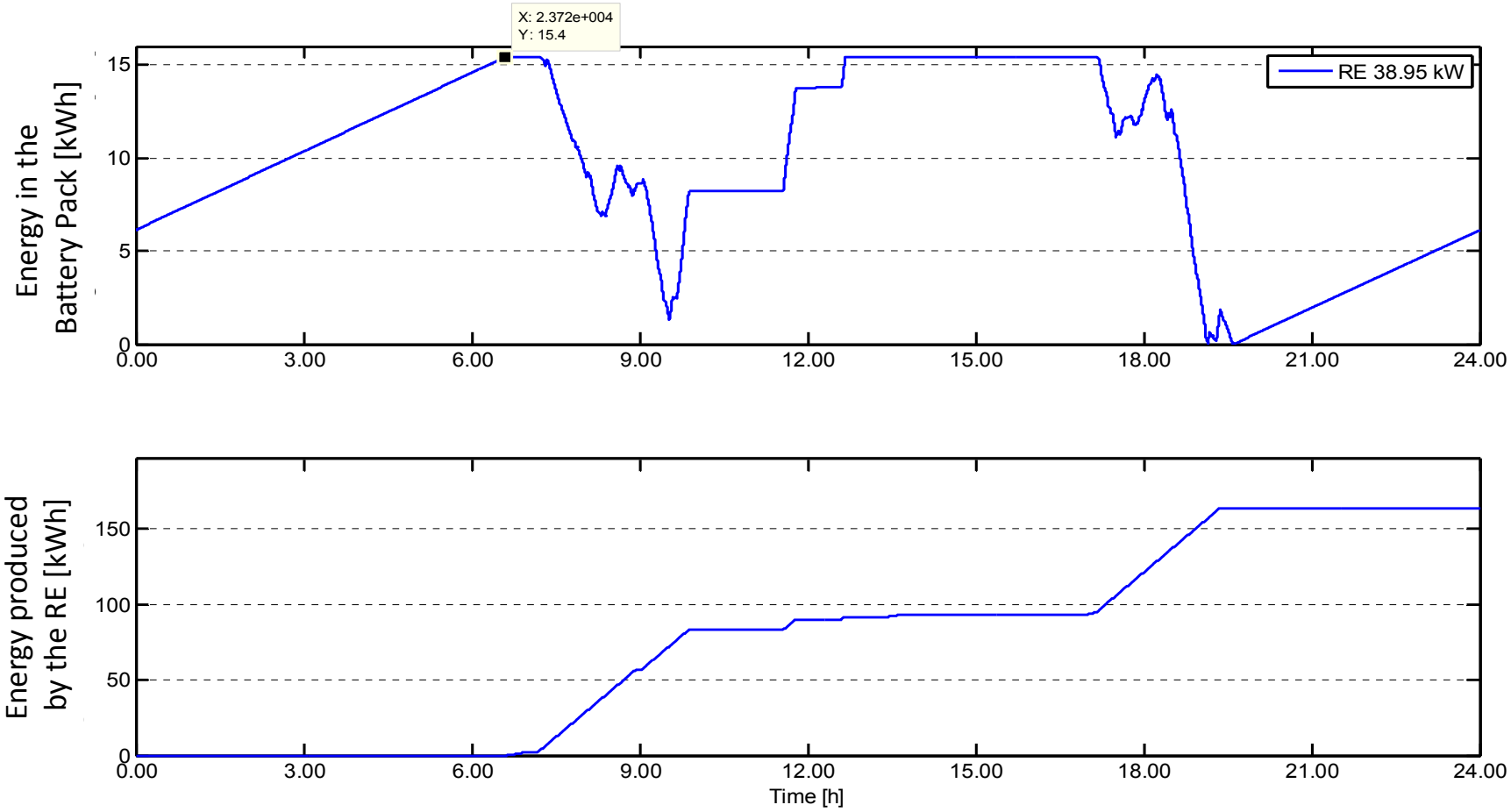
How much hybrid? - Costs



How much hybrid? – Choice



How much hybrid? – Choice



Additional analyses

1. **Natural gas** instead of gasoline
   - **Lower fuel cost**
   - **Same sizing**

2. Economic comparison with traditional vehicle for the 5 months-use
   - **No significant differences: + 2,1%**

3. Speed limitations
   - **120 km/h**
   - **90 km/h**

	RE Power [kW]	B.P. capacity [kWh]
No limits	38.95	15.4
Limit 120km/h	31.65	15.4
Limit 90km/h	17.92	15.4

Conclusions

- Simple process but identification of a preliminary sizing
  - **Rational requirements**
  - **Close to final users** (real missions data)

- **Battery pack** sizing → **everyday-life** usage
- **Thermal engine** sizing → performances and **exceptional routes**

- Work composed by **many parts**, each one wants to be **discussed and improved**

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