VECEPT
ELECTRIC VEHICLE WITH COST EFFICIENT POWERTRAIN

eMPROVE
Innovative solutions for the industrialization of electrified vehicles

E.-Mobility Lighthouse Projects - Results of VECEPT and outlook on eMPROVE

Dr. Theodor SAMS (AVL), Dr. Michael NÖST (IESTA)

10. Nov. 2015, A3PS Conference Vienna

klima+ energie fonds

E.-Mobility Flagship Project VECEPT

VECEPT – Vehicle with **C**ost **E**fficient **P**ower**t**rain

Targets:

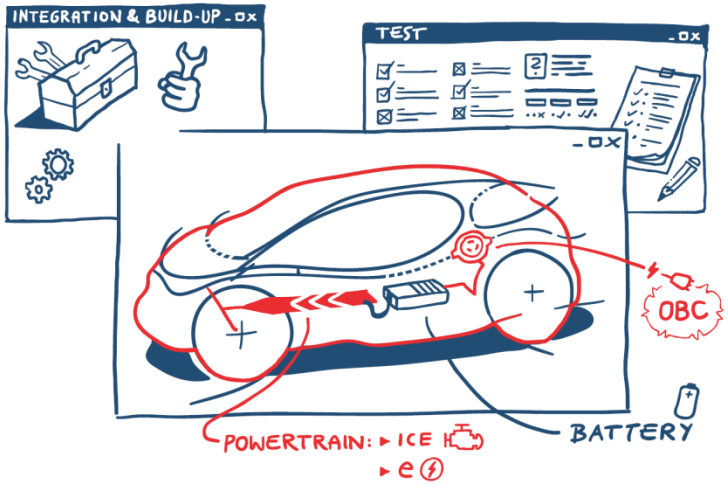
- **Development and testing of a PHEV demonstrator (volume model concept for the global market):**
  - All-purpose ability of the vehicle,
  - Competitive performance, production cost and CO_2 reduction
  - Equipped with a newly developed drivetrain system, cost-efficient charger,
  - Next generation of battery technology,
  - Optimized thermal management incl. HVAC strategy,
  - Minimum AER of 30km and highest efficiency in all operation modes
- **Investigation of BEV and PHEV in mixed fleets:**
  - Novel and sustainable mobility concept for mixed fleets
  - Generic algorithmic toolset for strategic fleet management
- **Installation and operation of charging systems with focus on PHEV**

E.-Mobility Flagship Project VECEPT

VECEPT – Vehicle with **C**ost **E**fficient **P**ower**t**rain

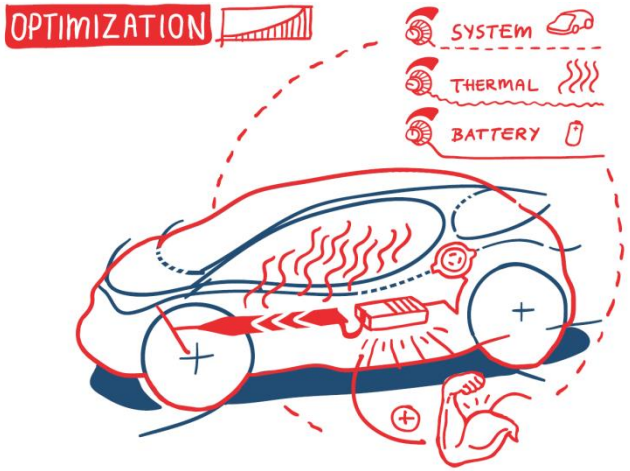
- **Budget**: 7.042.549,- EUR, Funding: 2.803.800,- EUR
- **Duration:** 02.07.2012 – 01.12.2015
- **Management:** Konsortialleiter: AVL List GmbH, Projektmanagement: IESTA
- **Partner:**

Flagship Project VECEPT
All Purpose Cost Efficient Plug-In Hybridized EV



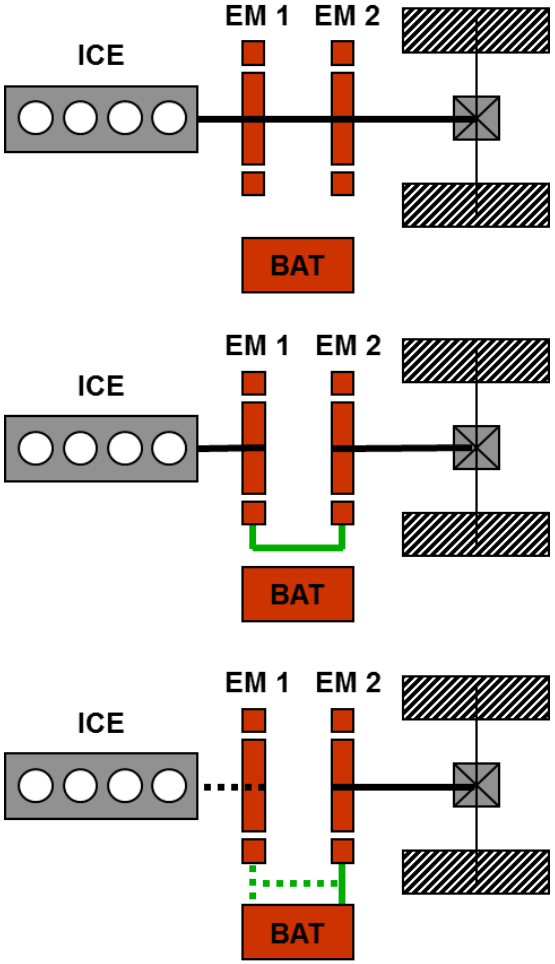
Work package 1

Vehicle Components & Integration

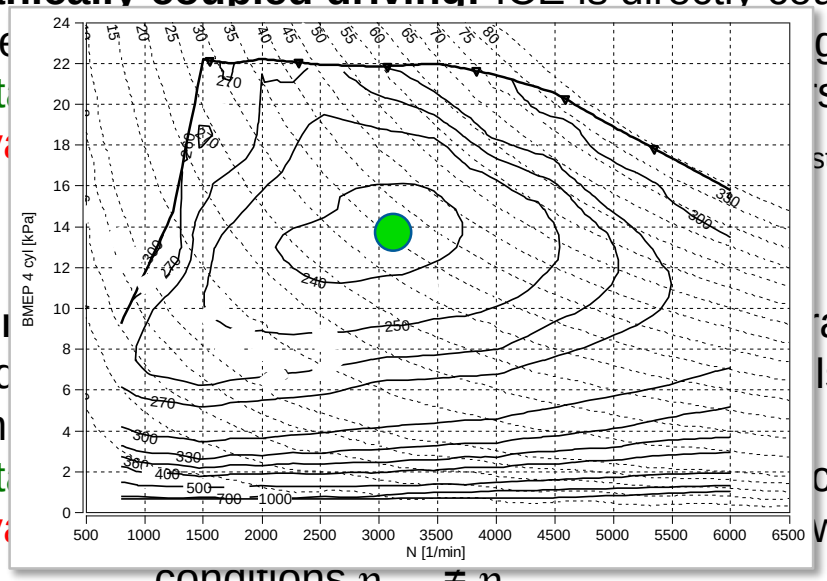


Work package 2

Enhancement of Energy Efficiency



Mechanically coupled driving: ICE is directly coupled to the whe guration
Advant sion
Disadv st point



Serial ator
which c lsion
system
Advant cle load
Disadv w-load
conditions $\eta_{ICE} \neq \eta_{ICE\text{-best point}}$

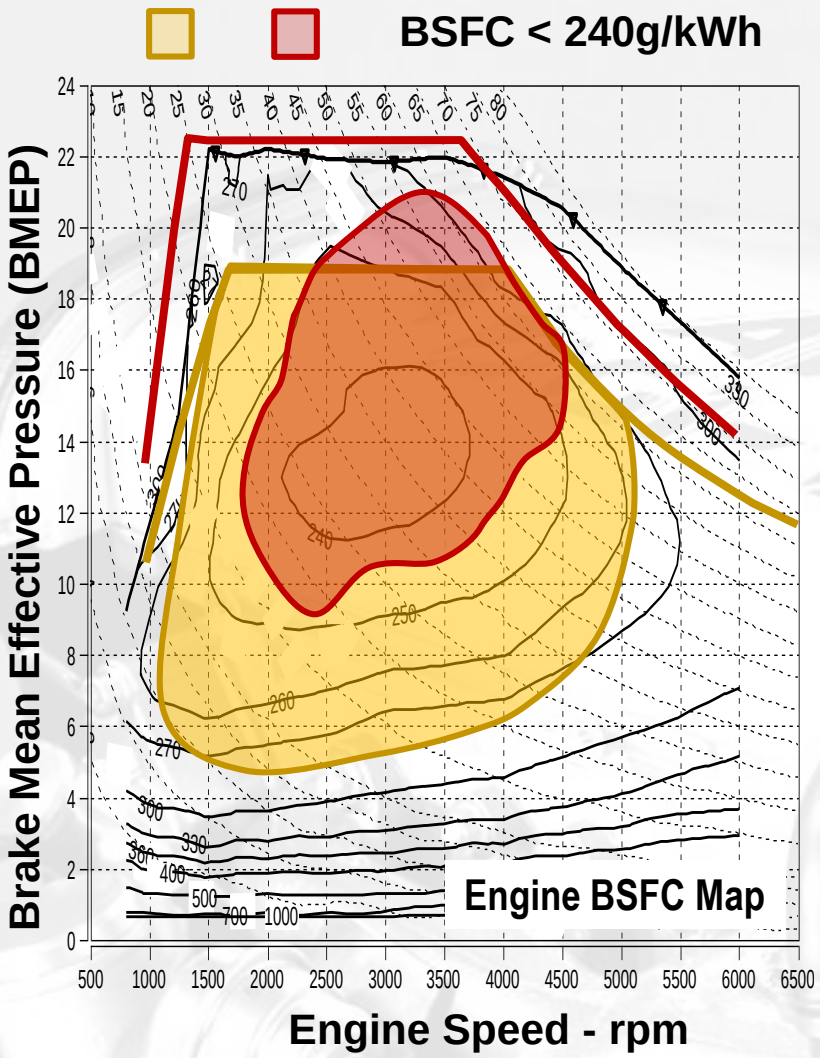
Serial mode (best point): battery and generator deliver energy for electric propulsion system, ICE and generator deliver average required energy by an alternating operation (on/off) and are always operated in best efficiency point

Advantage: ICE operation best efficiency, low complex.

Disadvantage: energy conversion losses plus battery charge /discharge losses. Constant ICE operation (NVH)

Source: AVL

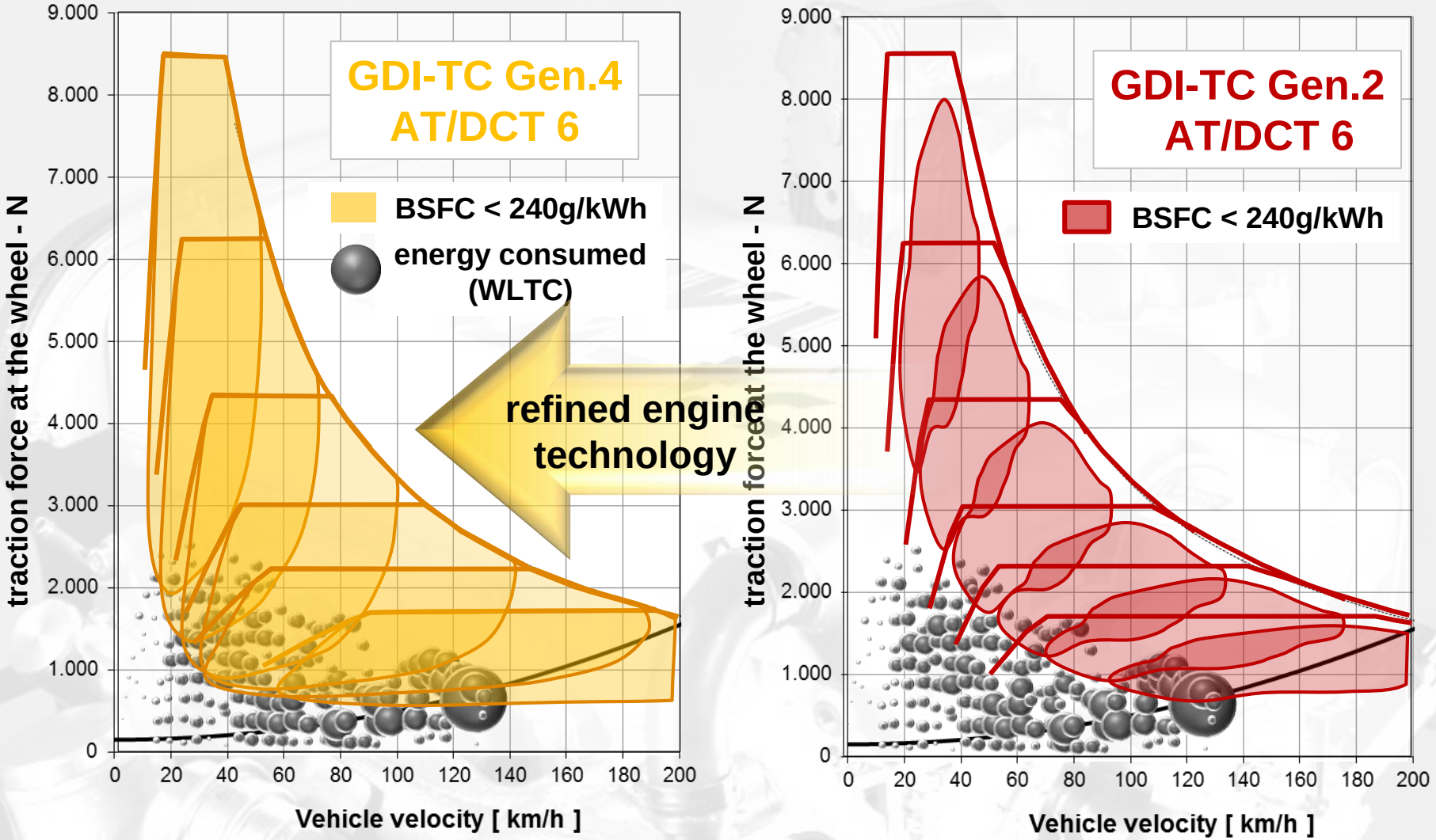
VECEPT
Engine development for low CO2 Emissions



200g/kWh Demonstrator

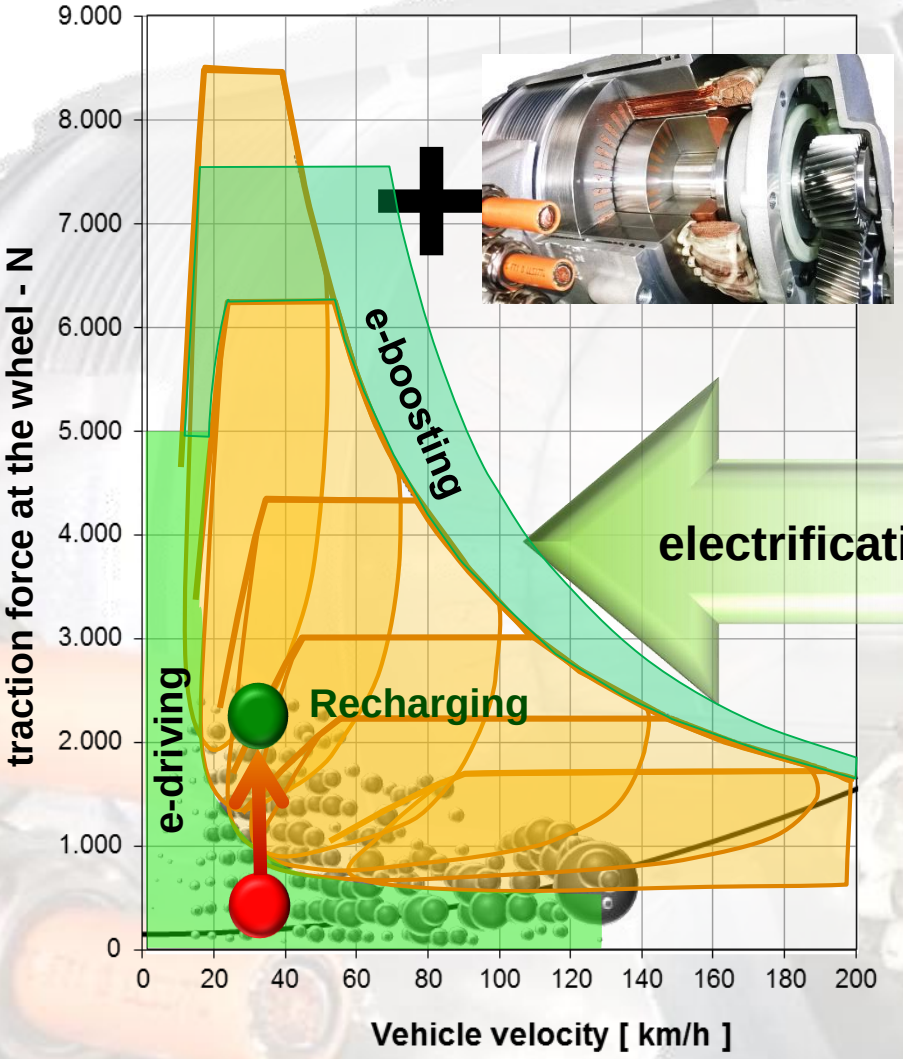
Source: AVL

VECEPT
Engine development for low CO2 Emissions



Source: AVL

VECEPT
Engine development for low CO2 Emissions



electrification

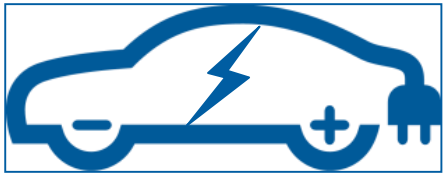
- **Electricfication reduces ineffective ICE operation**
- **ICE advances plus electrification reduce advantage of long overdrive ratios and small ratio steps → reduce gear number**

Source: AVL

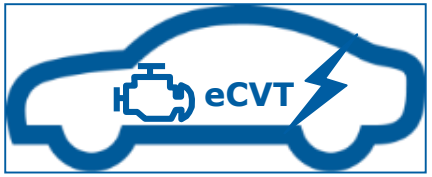
Source: AVL

FUNCTIONAL REQUIREMENTS

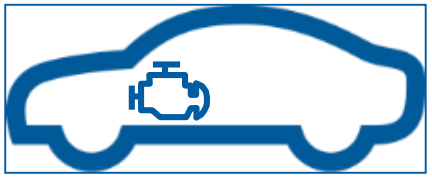
- Pure battery electric driving forward and reverse using the integrated e-motor.
- Electric vehicle launch in conventional operation mode



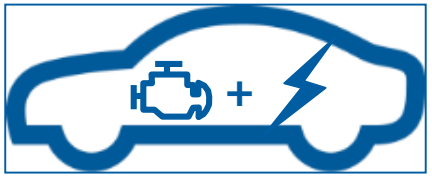
- Torque-split eCVT (electric continuously variable transmission) modes to enable the ICE to be operated at minimum vehicle speed and provide a charging power of minimum 3.5kW to the vehicle's high voltage (HV) system



- 3 Transmission speeds for direct propulsion by the ICE with power shifts between each for best drivetrain efficiency at medium and elevated vehicle speed

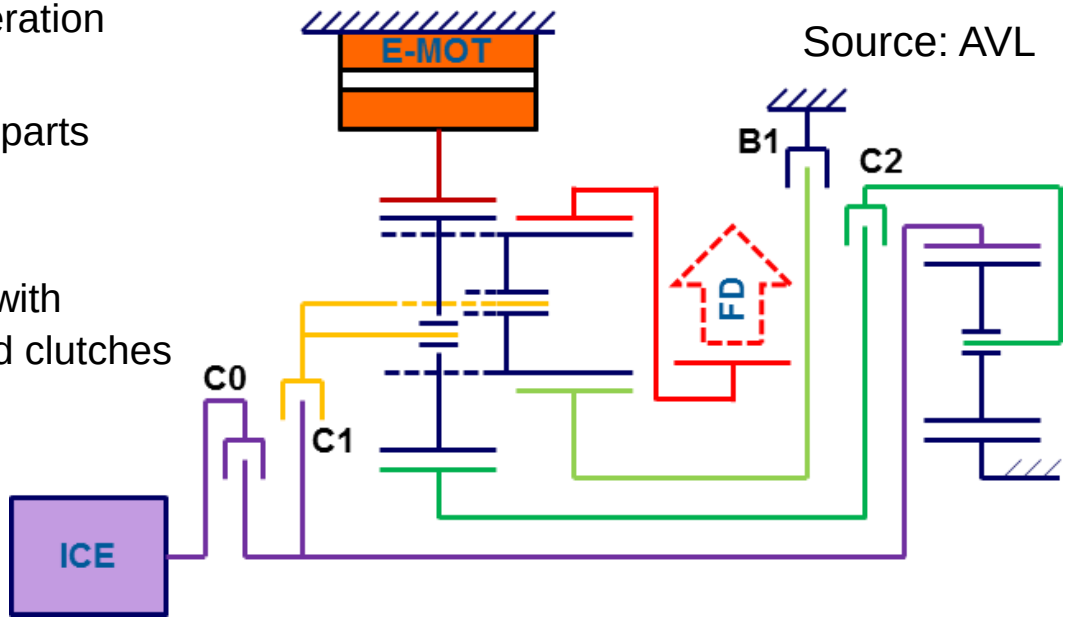


- Electric boost & Recuperation to support the ICE and transmission shifting.
- Impulse start functionality for the ICE (for vehicle standstill / very low speed an additional conventional 12V starter needed)



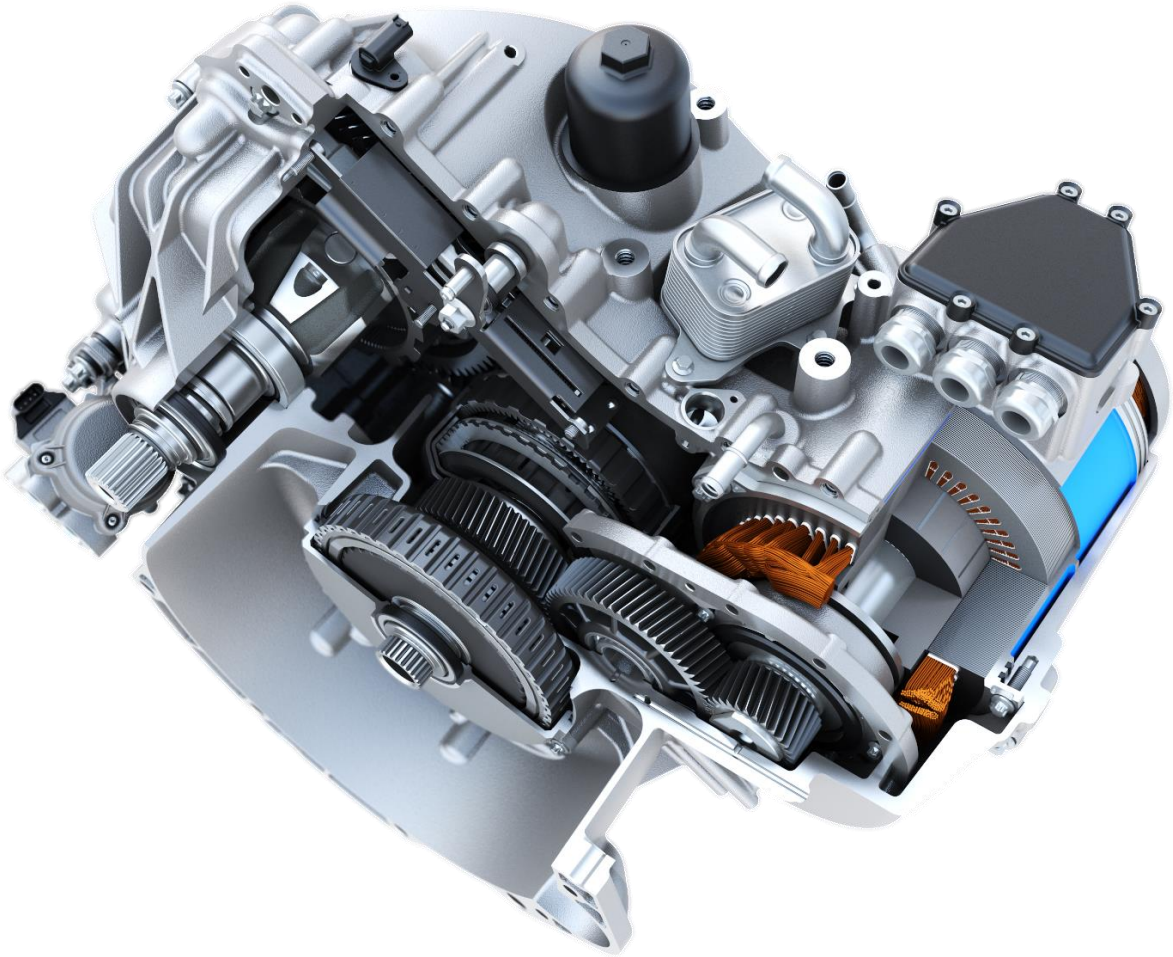
Lepelletier planetary gear set with the e-motor linked to an additional ring gear of the modified Ravigneaux gear set

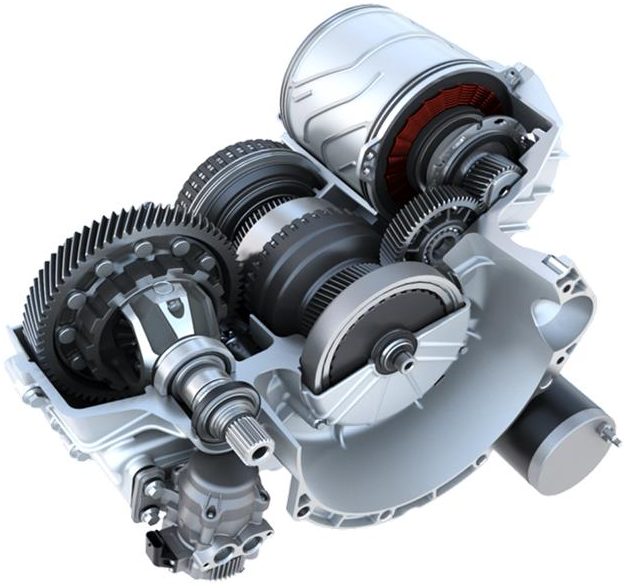
- 7 transmission operation modes
  - 2 torque-split eCVT modes
  - 2 transmission speeds for electric driving
  - 3 transmission speeds for ICE operation
- compact design and low number of parts
  l = 350mm, m = 90kg (with EM)
- three shift elements plus C0 clutch with multiple functionalities of brakes and clutches
- Major interface specification:
  - ICE: 1.2L IL3 TGDI
    P_{max} = 66kW@3500min-1
  - E-motor: induction machine
    P_{10sec} = 65kW, M_{10sec} = 140Nm



Source: AVL

VECEPT
Drivetrain Quick View





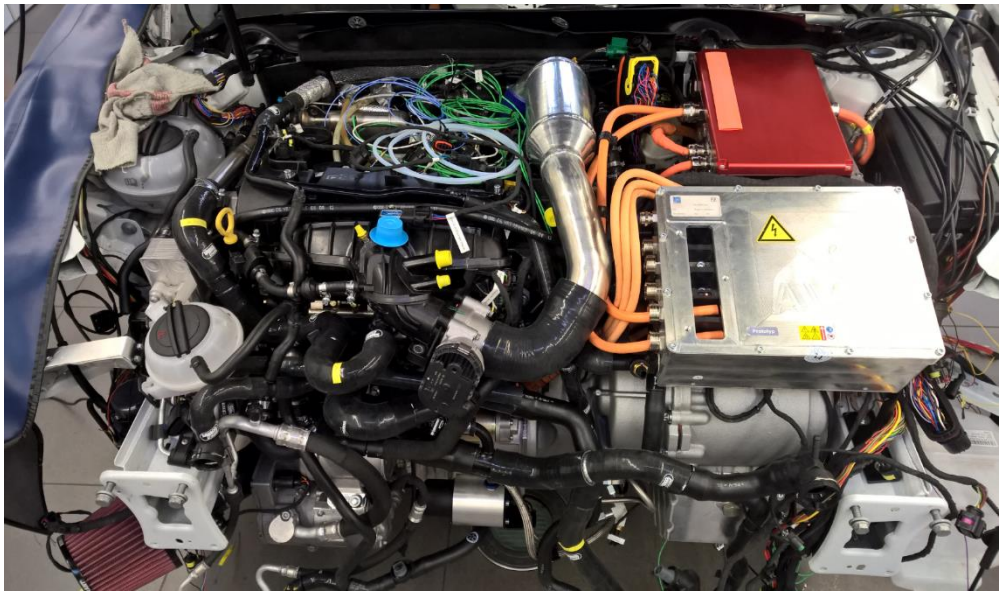
Source: AVL

Integration - Vehicle Build up

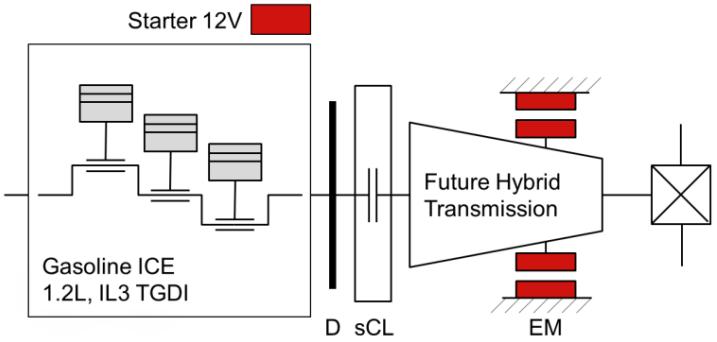
Integration - Vehicle Build-Up

Demo Vehicle Build-Up is finished

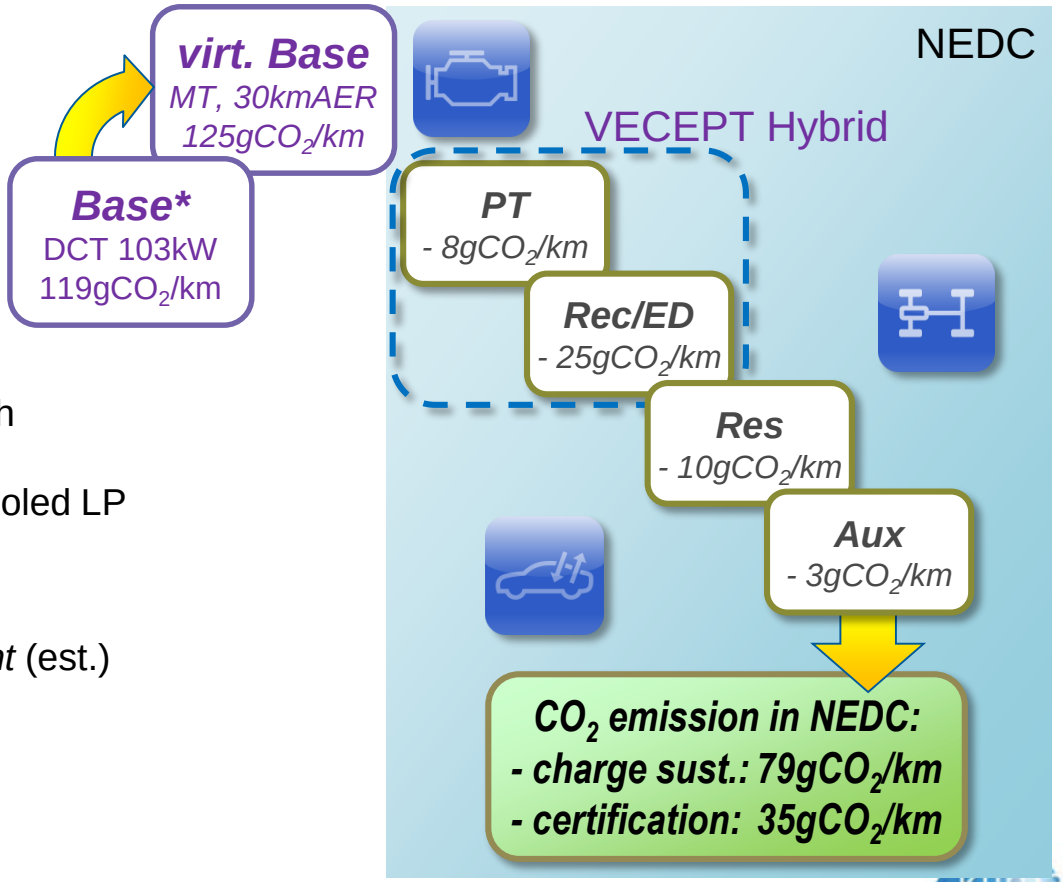
The calibrated demo vehicle will be available of December 2015
Demo at CTI 2015 in Berlin



VECEPT
All Purpose Cost Efficient Plug-In Hybridized EV



Source: AVL



PT: Powertrain:
- *AVL "VECEPT" 7-mode* transmission with integrated EM
- AVL ICE with Miller combustion cycle, cooled LP EGR, low friction design, beltless engine

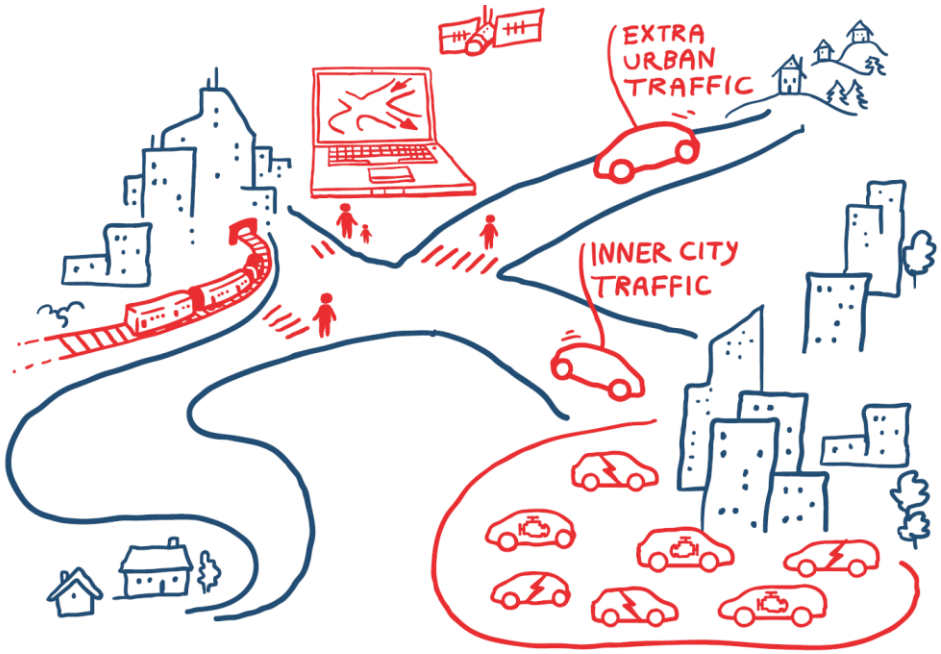
Rec/ED: Recuperation / Electric Drive

Res: *Vehicle drive resistance improvement* (est.)

Aux: Low power LV consumers

* base vehicle with DCT transmission 103kW → 119gCO2/km

WP3 User Behaviour / Fleetmanagement



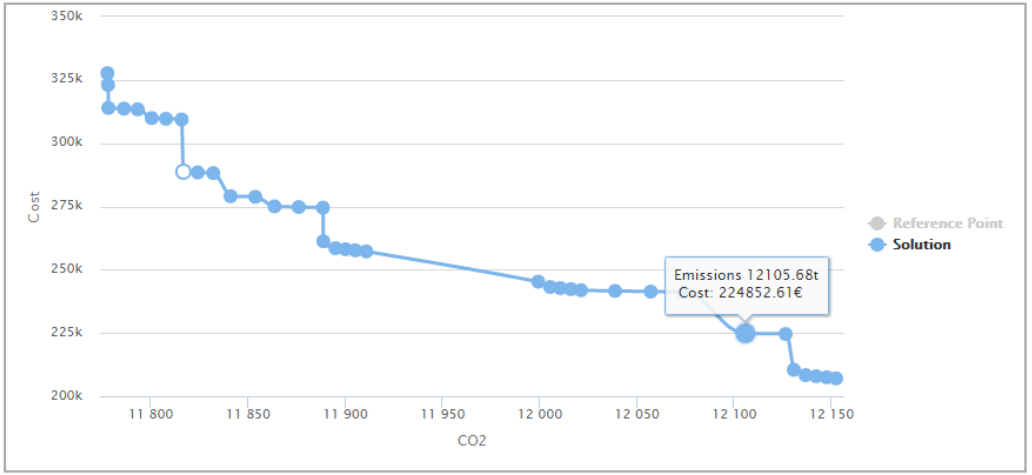
WP3 User Behaviour / Fleetmanagement

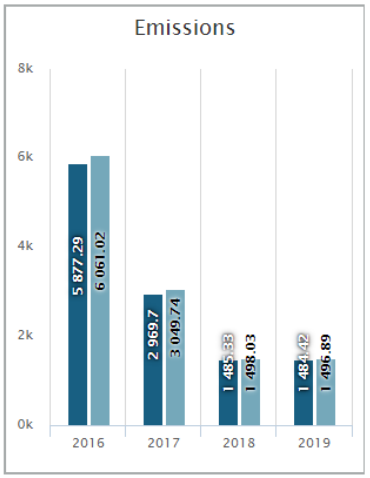
Scenario in WP3 VECEPT Vehicle in fleet operations

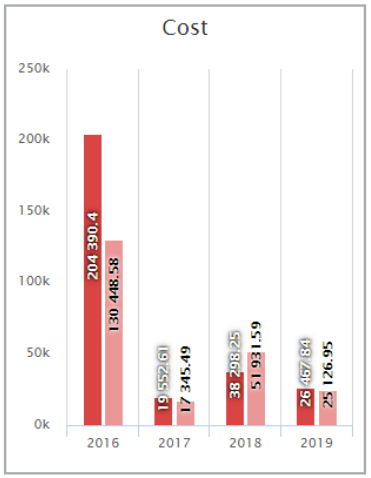
Corridor Vienna-Graz
Fleet composition (start):
7 conventional vehicles

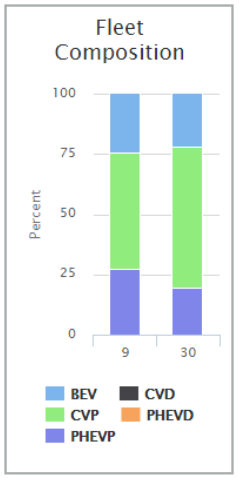
Solution 1 (final):
+4 BEV
+4 PHEV

Solution 2 (final):
+3 BEV
+2 PHEV









WP4 Infrastructure

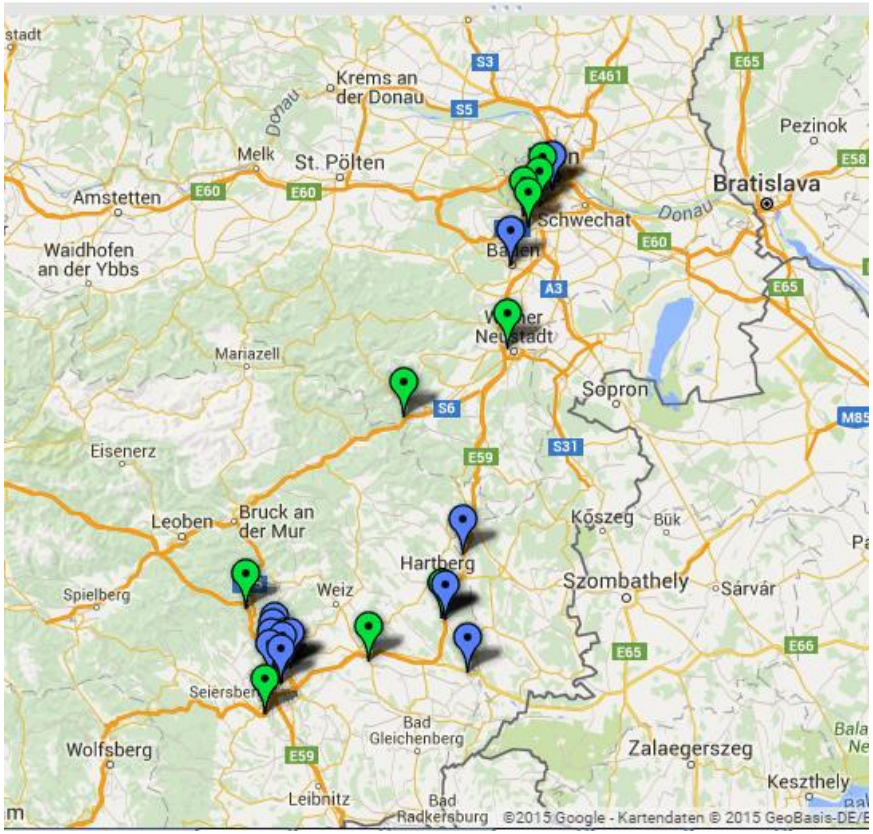
WP4 Infrastructure

- 4 of 4 Fast Charging Stations implemented
  - Raststation Dobl-Kaiserwald
  - Wiener Neustadt
  - Raststation Schottwien
  - Raststation Sebersdorf

- All tests are finished

- Charging data is collected for testing and evaluation in WP3

WP4 Infrastructure



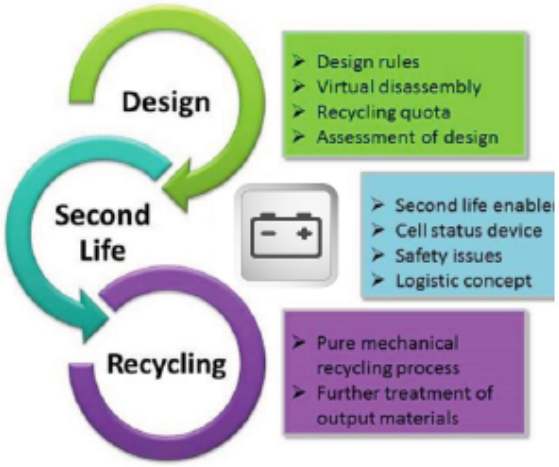
large_green
= FC in operation

large_blue
= AC in operation

Outlook on eMPROVE

eMPROVE aims at innovative solutions for the **industrialization of electrified vehicles**, increasing both energy and cost efficiency, with particular focus on possibilities for future industrial mass production.

- CO_2 Reduction
- Cost Reduction / Efficiency
- Usability, Safety and Comfort
- Highest Added Value for Austrian Economy
- High International visibility



USPs of eMPROVE

- Focus on mass production from requirements to product
- Focus on recycling of environmentally critical components of the storage and energy system
- Design of intelligent battery housing concept
- Second Life Cycle Instructions for batteries
- Demonstrators for PHEV (overall system) and modularized battery (component level)

Consortium of eMPROVE

This project is funded by the Climate and Energy Fonds and realized in the programme "Flagship projects of electro mobility".

Project Data

Duration: 1 Oct 2015 - 30 Sept 2018

Consortium: 12 European partners

Overall Budget: 6.7 Mio €

Contact

Project coordinator: IESTA

Dr. Michael Nöst

emprove@iesta.at

VECEPT
ELECTRIC VEHICLE WITH COST EFFICIENT POWERTRAIN

eMPROVE
Innovative solutions
for the industrialization
of electrified vehicles

Dr. Theodor SAMS (AVL), Dr. Michael NÖST (IESTA)

10. Nov. 2015, A3PS Conference Vienna

klima+ energie fonds