

R&D activities and future challenges  
for the integration of efficiency, safety, and comfort functionalities  
into the system of the EV

## Optimal Energy Consumption and Recovery

Berlin, June 30, 2011

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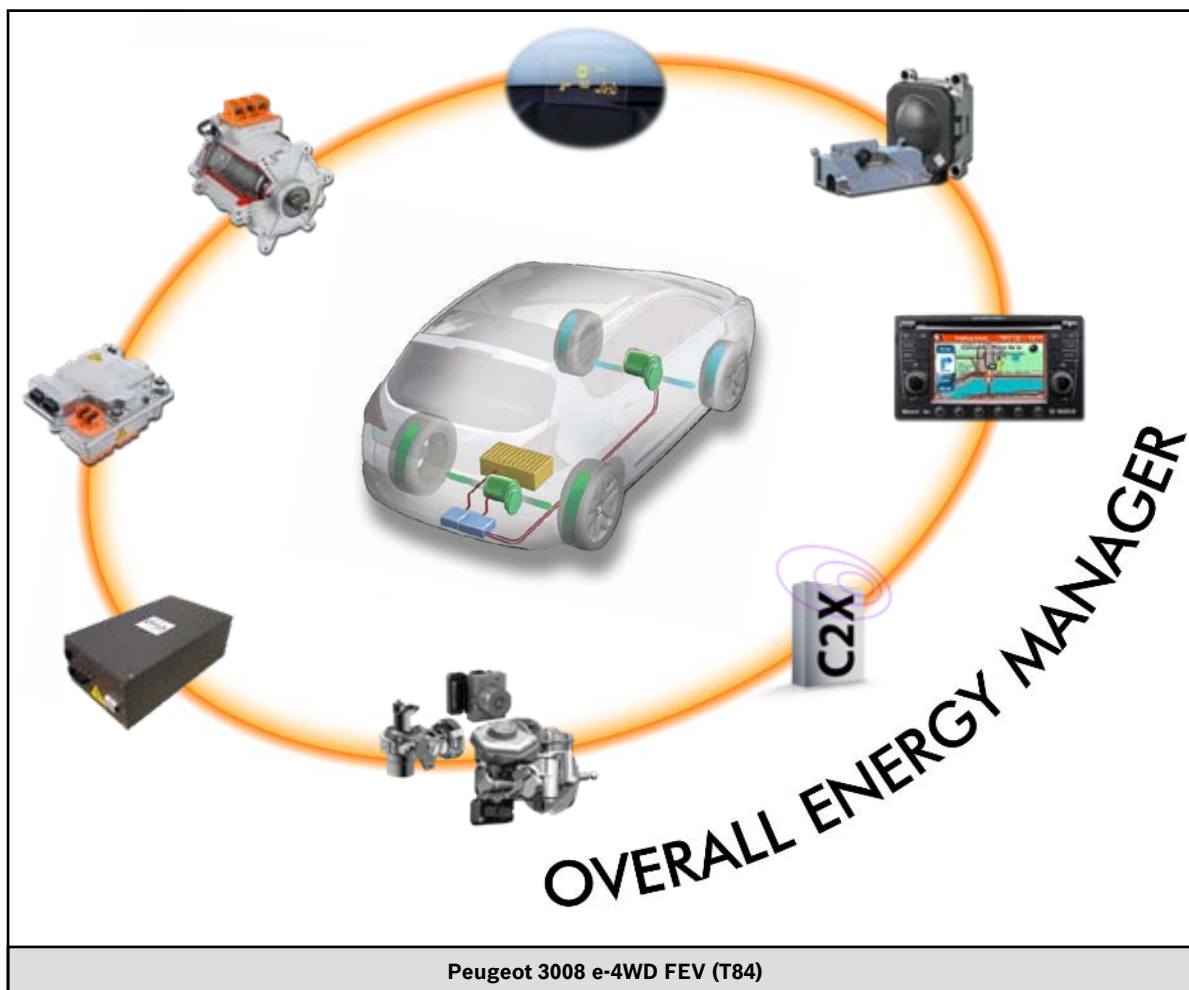
## Project Factsheet

- **Duration:** 36 months, from May 2011 to April 2014
- **Total Budget:** 7.74 mill. €, **Project funding:** 4.40 mill. €
- **Contract type:** STREP
- **OpEner Website:** [www.fp7-opener.eu](http://www.fp7-opener.eu)

- **RB** – Robert Bosch GmbH (Germany, coordinator)
- **PCA** – Peugeot Citroën Automobiles SA (France)
- **RBCM** – Robert Bosch Car Multimedia GmbH (Germany)
- **AVL** – AVL List GmbH (Austria)
- **CTAG** – Centro Tecnológico de Automoción de Galicia (Spain)
- **FZI** – Forschungszentrum Informatik Karlsruhe (Germany)

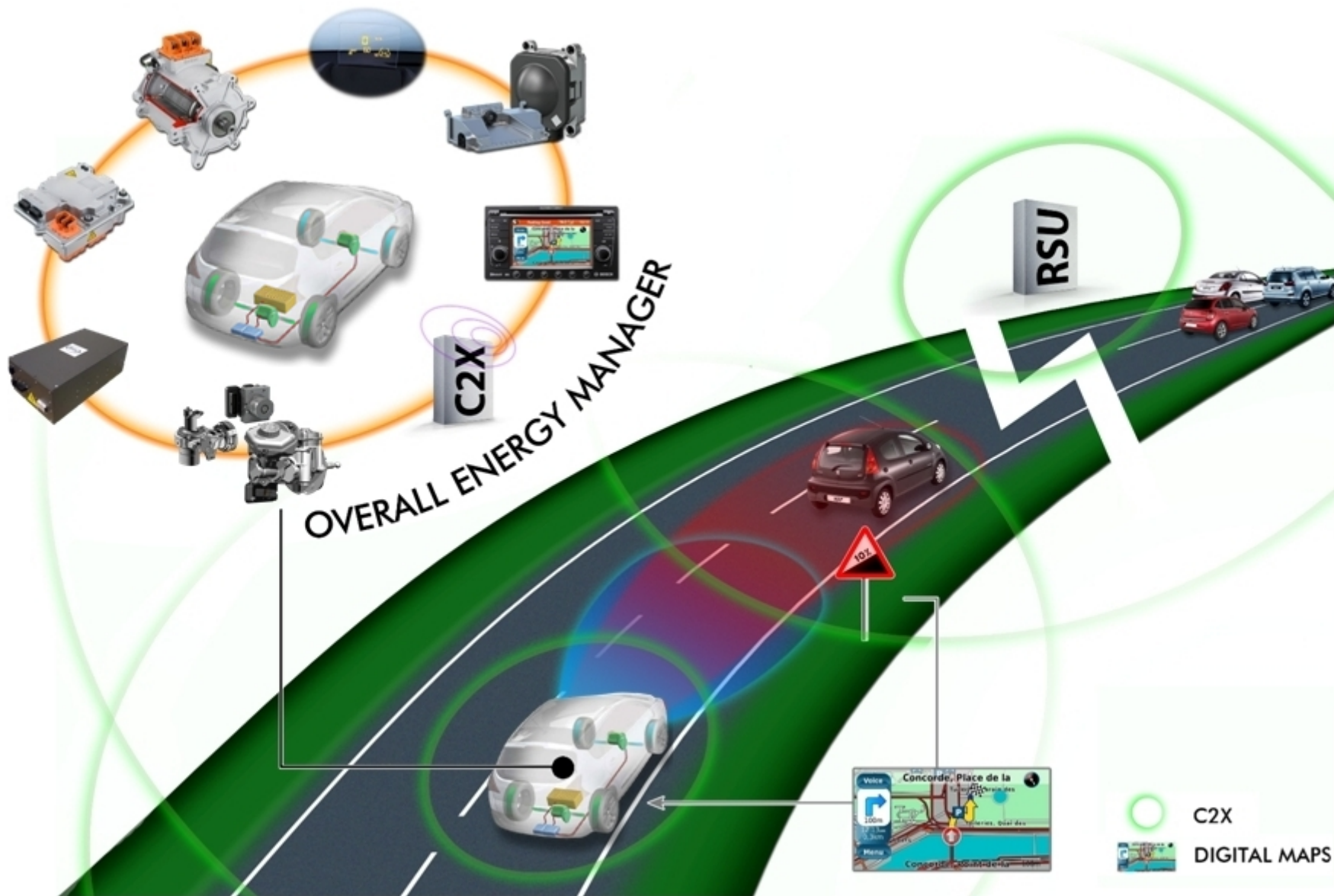


## Project Idea



**Overall energy manager** fuses data together from

- in-car subsystems
- radar and video based vehicle's surround sensing systems
- satellite navigation system and radio traffic information
- car-to-infrastructure communication systems
- car-to-car communication systems



## OpEneR's Objectives and Innovative Aspects

### Energy Efficiency

- **optimised energy efficiency on vehicle level**
  - **electric drivetrain** (analysis of multi motor concepts, multi gear concepts, inverters, e-machines, etc.)
  - use **battery Management System** information in other subsystems (SOC, SOH, temperature, cooling & heating demand, charging power, etc.)
  - **regenerative braking system** cooperates with electric drivetrain (supported by on-board and off-board systems)
  - energy optimised **system topology, E/E-architecture**
- **optimised energy management system for power consuming subsystems**
  - **operation strategies**
  - optimised **energy consumption** and **efficiencies**
  - optimal **operation timing**
  - **pre-conditioning** of subsystems

OVERALL ENERGY MANAGER

## OpEneR's Objectives and Innovative Aspects

### Energy Efficiency

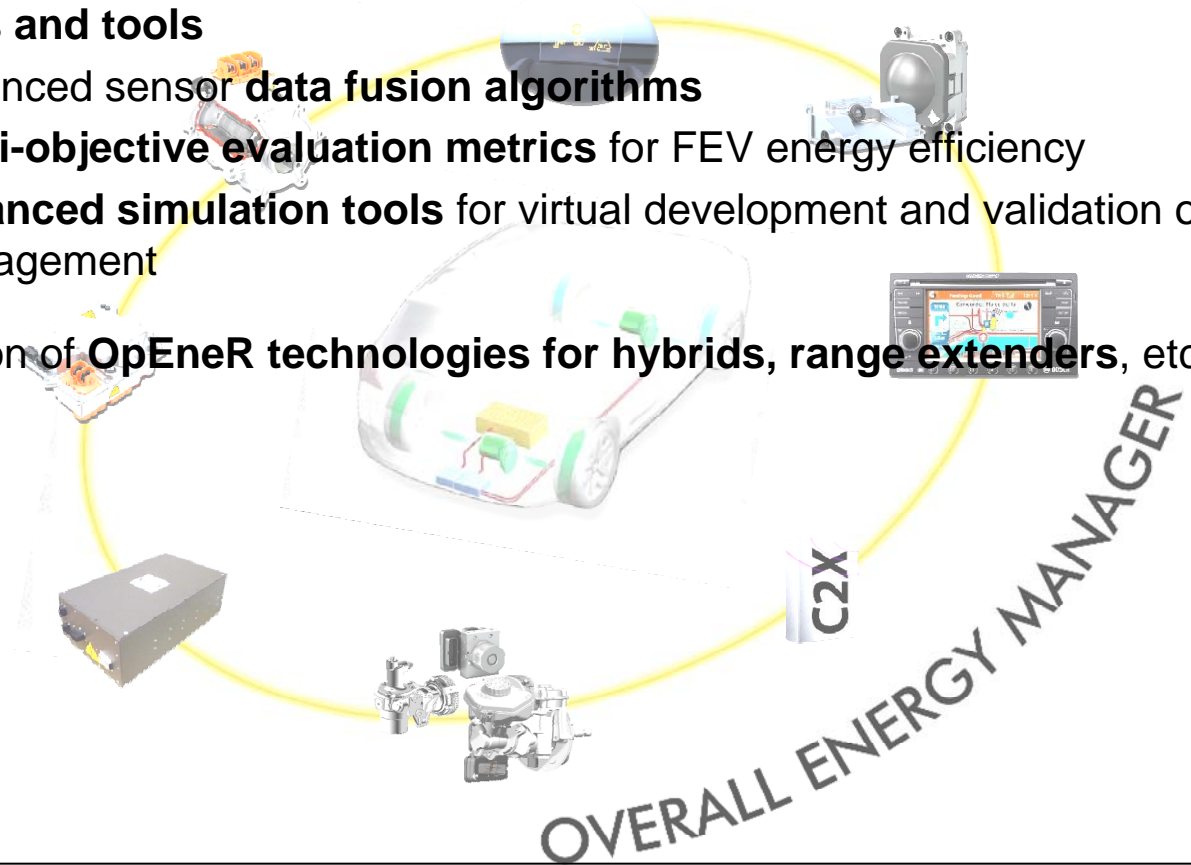
- **optimised recuperation**
  - **recuperation strategy**, e.g. regenerative brake distribution between front & rear
  - **recuperation efficiency** is influenced by vehicle stability, e-machine performance, power handling, pedal feel
- **traffic density & situation aware driving strategies & assistance**
  - radar sensor and video camera technology for **monitoring vehicle surrounding**
  - definition of **smooth driving strategies** based on radar, video, SatNav, 3D digital maps and c2x technology
  - **navigation based coasting assistant**
  - **adaptive cruise control** with energy saving following mode
  - **adaption of deceleration profile** for maximal recuperation
  - **autonomous actions for range optimisation**
  - digital map & sat. positioning for **range prediction**
  - **driver support systems** for consistent adaption of route and driving style



## OpEneR's Objectives and Innovative Aspects

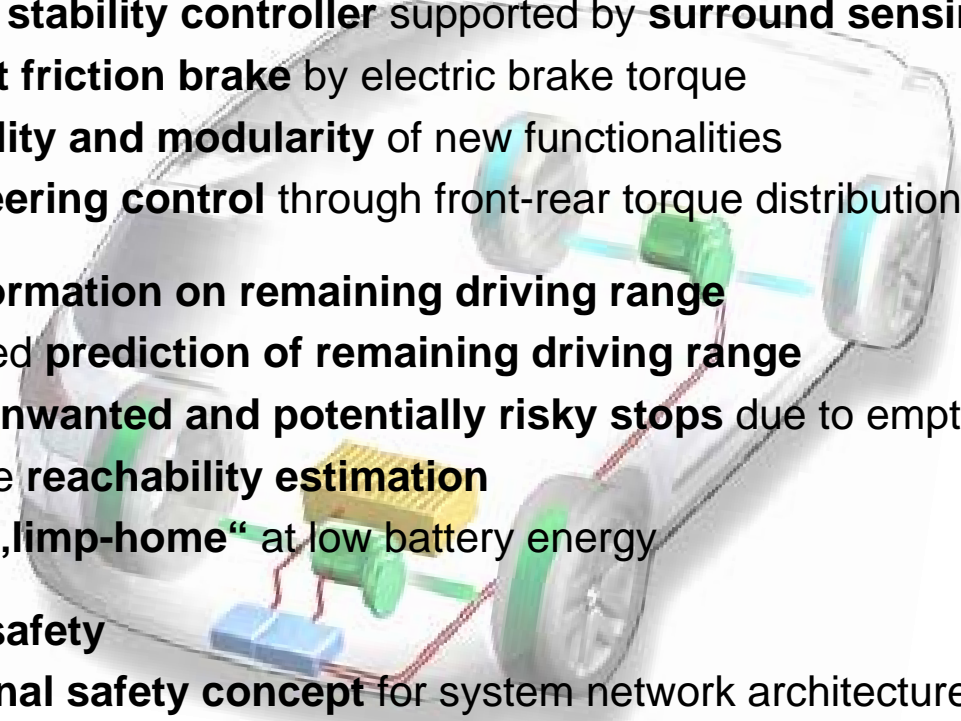
### Energy Efficiency

- **methods and tools**
  - advanced sensor **data fusion algorithms**
  - **multi-objective evaluation metrics** for FEV energy efficiency
  - **advanced simulation tools** for virtual development and validation of energy management
- application of **OpEneR technologies for hybrids, range extenders, etc.**



## OpEneR's Objectives and Innovative Aspects

### Safety

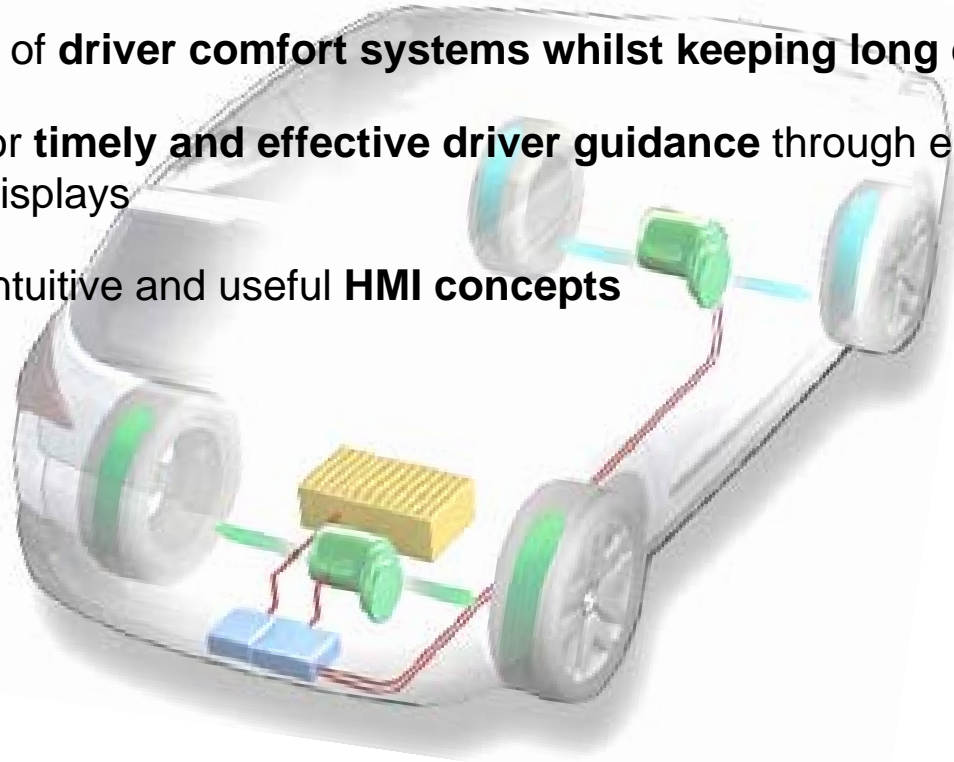
- **driving strategies & assistance** for improved safety
    - **vehicle stability controller** supported by **surround sensing**
    - **support friction brake** by electric brake torque
    - **scalability and modularity** of new functionalities
    - **Self-steering control** through front-rear torque distribution
  - **reliable information on remaining driving range**
    - optimised **prediction of remaining driving range**
    - **avoid unwanted and potentially risky stops** due to empty battery
    - accurate **reachability estimation**
    - enable „limp-home“ at low battery energy
  - **functional safety**
    - **functional safety concept** for system network architecture
    - **advanced simulation tools** for virtual development and validation of safety
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## OpEneR's Objectives and Innovative Aspects

### Comfort

- enable **best regenerative braking** without negative impact on driver
- **allow** usage of **driver comfort systems whilst keeping long driving range**
- algorithms for **timely and effective driver guidance** through enhanced vehicle dashboard displays
- innovative, intuitive and useful **HMI concepts**



## Approach: OpEneR Technology Levels

