FUEL CELLS AND HYDROGEN
JOINT TECHNOLOGY INITIATIVE

autostack moves

**AutoStack Workshop on Intermediate Results**

*8 February 2011, Grenoble*

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# WP 2.3 : Identification and classification of research needs

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# Research Needs – Objectives & contributors

- Objectives:

- To identify and classify further research needs for automotive fuel cell stacks and associated system aspects
- To define their priorities to close existing R&D gaps between ultimate development goals and identified state-of-the-art materials and components, and today's stack technologies
- To support preparation of FCJ JU AIP call for proposals (2011, 2012 and beyond) and contribute to MAIP revision

- Contributors:

- JRC (task leader), CEA, ZSW, SC, SY, UC, PSI, DANA, FFCCT

# Prerequisites for Market Introduction of automotive Fuel Cell Systems

- Performance and range similar to present vehicles powered by ICE
  - Available power and fuel efficiency are crucial
  - Lifetime (operation and overall)
- No purpose design vehicle
  - Front packaging of the fuel cell power system
- Cost
  - Only moderate extra cost might be acceptable

# Enablers for the Key Challenges in Automotive Fuel Cell Systems

- System net power 80 kW in a front packaging
  - High power density (1 W/cm$^2$)
  - Low cell pitch (< 1.5 mm)
- High fuel efficiency
  - High average single cell voltage (> 670 mV)
- Cost
  - High power density (1 W/cm$^2$)
  - Low noble metal loading (<1.5 mg/cm$^2$)
    - Potential conflict of interest
- Robustness: Operation under highly dynamic load including soak times at high single cell voltage
  - Corrosion resistant catalysts and structural materials
  - Resistant to frequent fuel cell power system startup and shutdown
  - Temperature excursions to 95°C acceptable while
  - Operating at low or no external humidification (<50% RH)

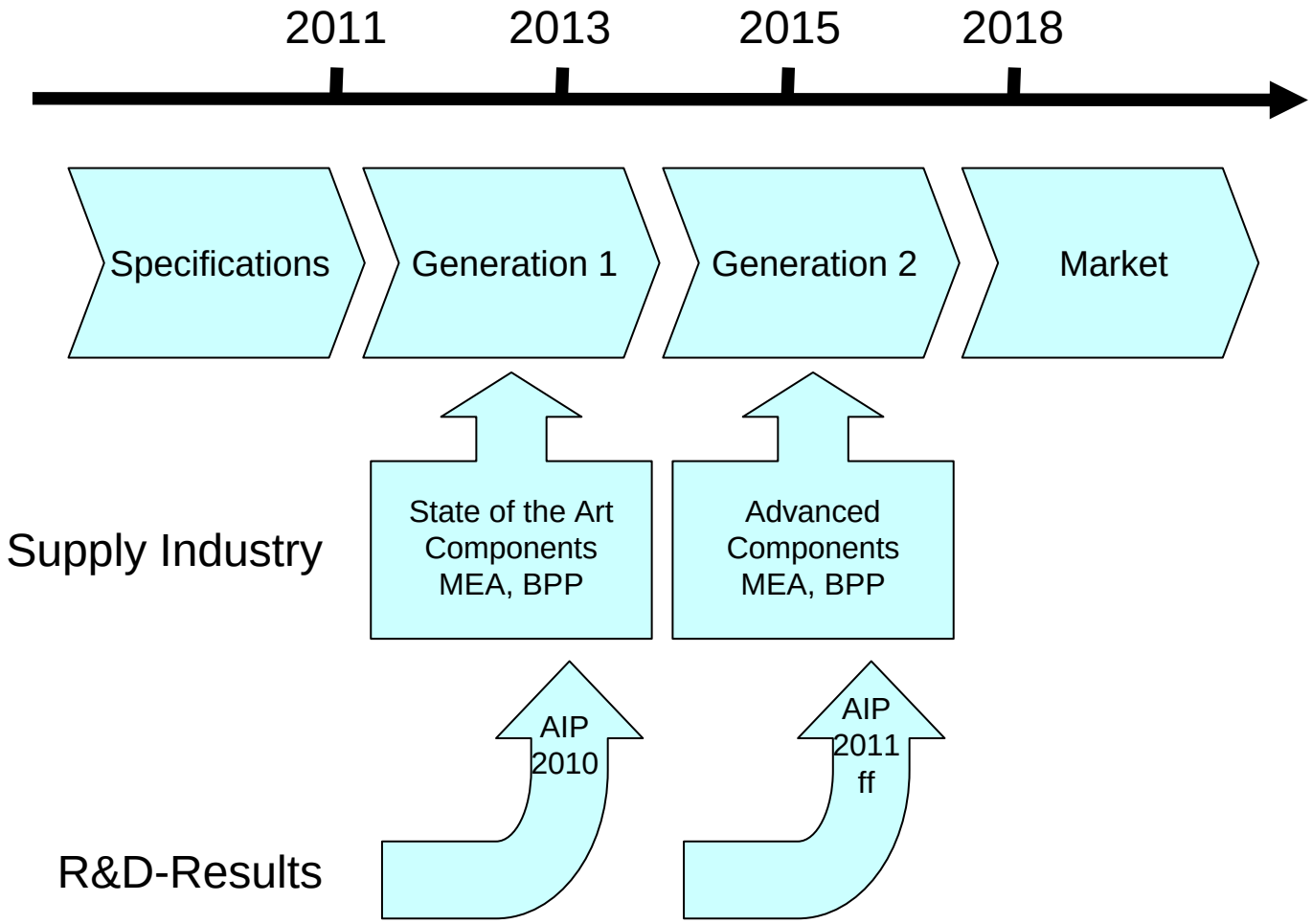
# A Successful Research Agenda Needs to Address the Challenges

- Demonstrate technical feasibility
  - Simultaneous fulfillment of all requirements
    - Power density
    - Cell pitch
    - Average single cell voltage
    - Operating temperature
    - Humidification requirements
    - Noble metal loading
- Development of tools for in depths understanding
  - Water management
  - Modeling to assist component, stack, and system design
    - Engineering models including analysis of power flow on a system basis
    - Fundamental (molecular scale based) models
    - Cost models
- Improved components and system architecture

# Research Needs – Assumptions

1. Automotive fuel cell stack specification based on identified OEM system requirements and on assessed materials and components available from European supply industry
2. Development of 1st generation stack hardware based on state-of-the-art (as of 2011) components validated against technical automotive performance requirements (volume, weight, dimension, power)
3. Development of 2nd generation stack hardware based on advanced components (AIP call 2012 and beyond) meeting additional automotive performance requirements (wide operation window: low RH, temperature; low PGM content) and cost targets for market introduction
4. Ready for market

# Research Needs – Anticipated development evolution schematic for a European full size automotive stack



# Research Needs - Scope, R&D priorities and time frame

## Short-term research needs (2011 - 2014):

- Integration of full size automotive stack– High
  - Development, design and validation of a competitive European automotive stack based on the specification and technology roadmap developed in the AutoStack project
- Development of optimum power streams in fuel cell systems– High
  - Modelling, assessment and validation of optimum power streams between fuel cell and energy storage devices to identify best hybridization concepts and operating strategies, determine viable start-stop concepts and appropriate stack and system design parameters based on OEM requirements
- Development of industry wide uniform performance test schemes – High
  - Development and validation of commonly accepted test protocols for the reliable and consistent assessment of performance, durability and cold start of stack and system, including accelerated test cycles based on OEM requirements

# Research Needs - Scope, R&D priorities and time frame

## Medium-term research needs (from 2012 - …):

- Development of advanced MEA (membrane electrode assemblies) with increased power density, lower humidification requirements and elevated operating temperatures – High
  - Concerted development of advanced membranes, GDL (gas diffusion layers), catalysts and MEA with improved durability, very high power density, low or no humidification requirements in an extended operating temperature range from -25°C up to 130°C, including validation testing according to OEM requirements
- Development of advanced low-cost bipolar plates – High
  - Concerted development of low cost advanced corrosion resistant, highly conductive and gas tight bi-polar plates including appropriate sealing structures allowing cell pitch < 1 mm suitable for operation at elevated temperatures up to 130°C according to OEM requirements

# Research Needs - Scope, R&D priorities and time frame

## Medium-term research needs (from 2012 - …):

- Development of cell modelling for accelerated stack design – Medium
  - Development of realistic cell modelling for the assessment and experimental verification of stack materials, components and design with particular focus on critical operating parameters for accelerated development cycles
- Development of characterization techniques for water management and state of health – High
  - Development of a common European tool and techniques for in-situ (non-destructive), ex-situ (non-intrusive) and real-time characterization of water management capabilities at cell and stack level, including state-of-health monitoring

# Research Needs - Scope, R&D priorities and time frame

## Long-term research needs (post 2012):

- Material research on non noble catalyst materials – Medium
  - Identification and validation of suitable non noble metal catalysts to replacement of platinum as major cost driver of fuel cells in the long term while maintaining activity comparable to Pt-based catalysts
- Development of modelling tool for MEA performance – Medium
  - Development and experimental verification of multi-scale modelling tools for best understanding of the different reaction, transport and ageing phenomena of MEA
- Development of simplified system architectures and improvement of scale effects
  - Assessment and experimental validation of different system concepts, including key components based on optimized energy flows for further simplification of system architectures and improved communalities