GIANTLEAP

Giantleap Improved Automation of Non-polluting Transportation with Lifetime Extension of Automotive PEM fuel cells

Federico Zenith
SINTEF Mathematics & Cybernetics

giantleap.eu
Email Coordinator: federico.zenith@sintef.no

Programme Review Days 2017
Brussels, 23-24 November

PROJECT OVERVIEW

- Call year: **2015**
- Call topic: **FCH-01.2-2015**, *Diagnostics and control for increased fuel cell system lifetime in automotive applications*
- Project dates: 01/05/**2016** – 30/04/**2019**
- % stage of implementation 01/11/2017: **50 %**
- Total project budget: **3,260,297.50 €**
- FCH JU max. contribution: **3,260,270.50 €**
- Other financial contribution: **0 €**
- Partners: **SINTEF, FESB, UFC, Bosch Engineering, ElringKlinger, VDL**

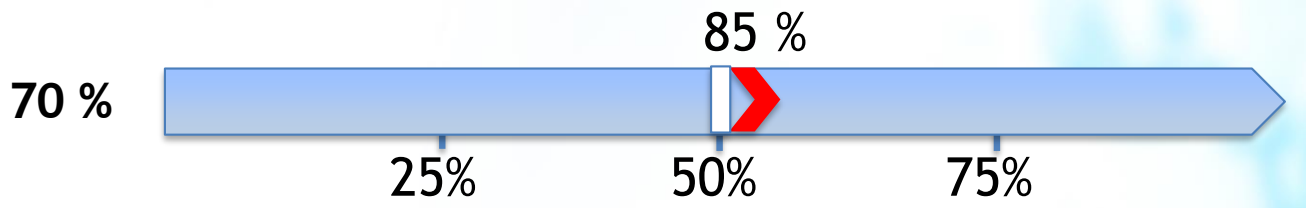
PROJECT SUMMARY

- Objectives
  - Diagnostics and prognostics (also BoP)
  - Control system for extended life
  - System Demonstration
- State of Art
  - Low availability (CHIC, but also US): ~70%
- Application
  - FC range extender for battery buses

PROJECT PROGRESS/ACTIONS - Availability

Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Availability	System availability	%	(80%)	95	90	95

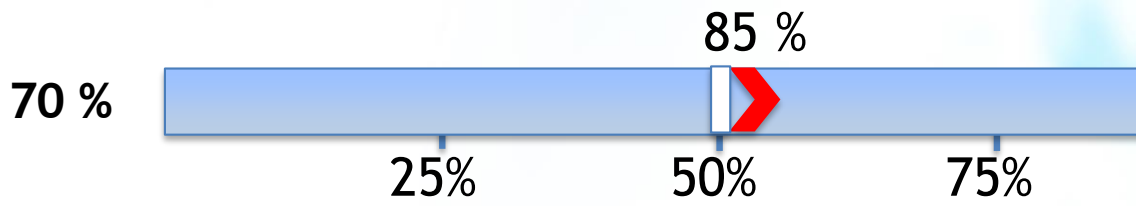
Future steps:

- Realisation of prototype range extender (early 2018)
- Demonstration (if possible on road)

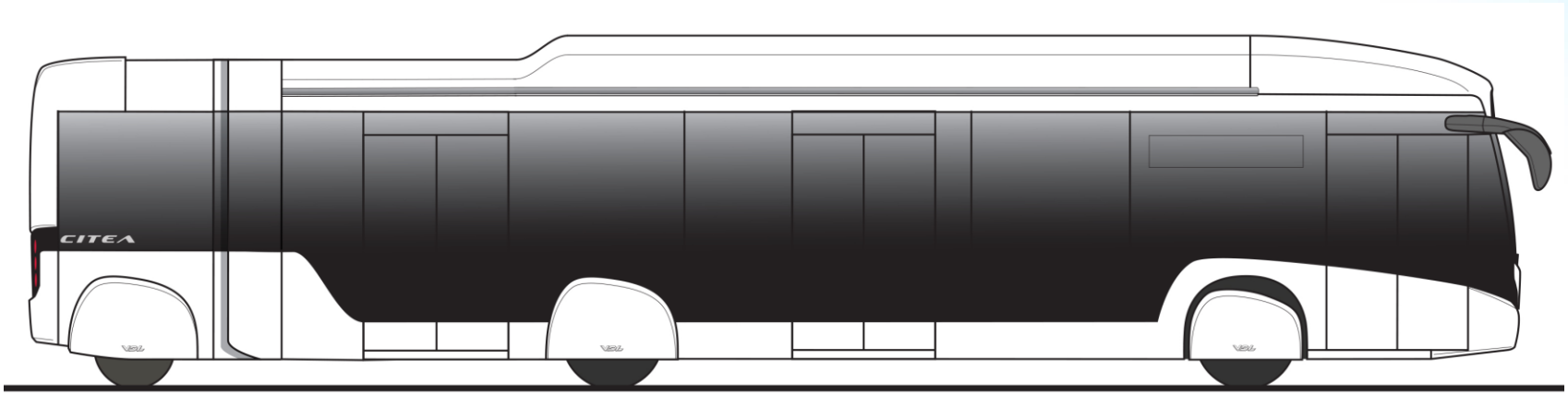
PROJECT PROGRESS/ACTIONS - Availability

Achievement to-date

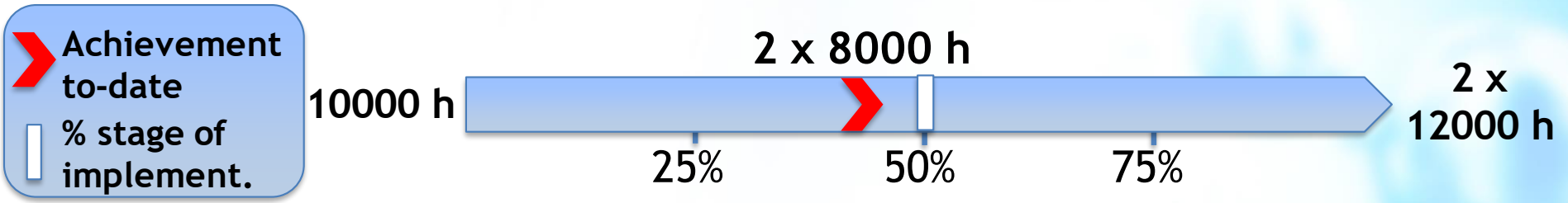
% stage of implement.



- Detachable range extender paradigm instead of pure hydrogen bus
- Flexibility in use: any battery bus can become a hydrogen bus
- Higher reliability in case of FCS failures
- Higher availability – the range extender connects to any battery bus



PROJECT PROGRESS/ACTIONS - Durability

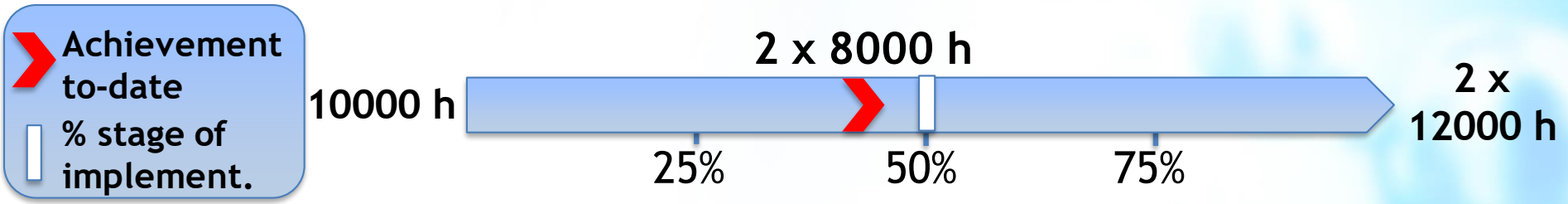


Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Durability	Lifetime	h	25000 (bus FC)	2x 10 k	2x 8 k	2x 10 k

Future steps:

- Stack testing
- System testing
- Cell testing and rejuvenation

PROJECT PROGRESS/ACTIONS - Durability



- Ballard stack passed 25,000 h this year
  - GIANTLEAP focuses on car-derived stacks
- Range-extender: **high hybridisation**
  - A whole bus battery as buffer
  - Degrees of freedom for optimisation
  - On-line testing possible
- Currently testing stack lifetime, > 8000 hours
- Operation at up to 2.5 bar
- Passive recirculation
- Stack test results expected in April 2018
  - D4.3, public deliverable

ElringKlinger stack module (NM5)

PROJECT PROGRESS/ACTIONS - Cost

Achievement to-date

% stage of implement.

565 k€ (*at scale!*)

Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Cost	Cost of a 12 m FCEB	€	565 k€	650	700	650

Future steps:

- Realisation of range-extender prototype
- Exploitation plan
- Business case study for hydrogen buses (D7.6, public, end of project)

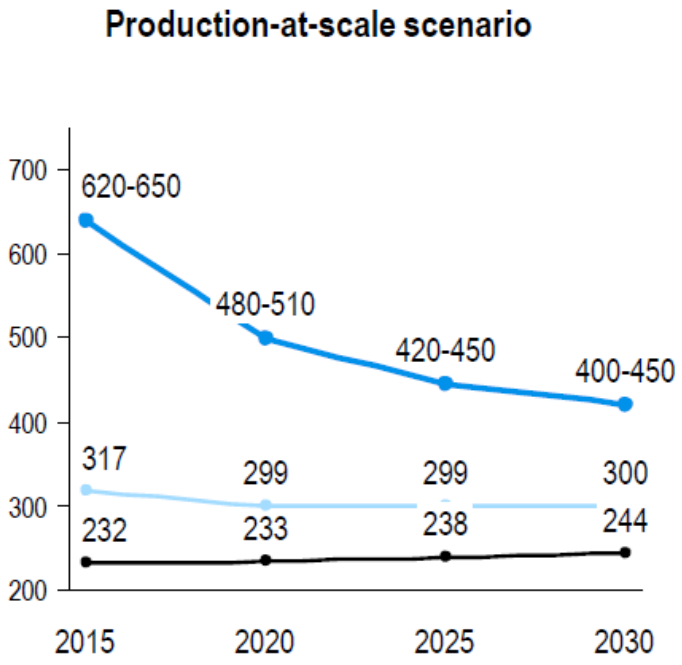
PROJECT PROGRESS/ACTIONS - Cost

Achievement to-date

% stage of implement.

1250 k€ → 650 k€ → **565 k€** *(at scale!)*

50%



- Gap with diesel rapidly closing
  - FCEB Base case
  - FCEB Optimistic case
  - Diesel buses
- Main cost drivers
  - FC stacks
  - Hydrogen fuel

SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

- **Interactions with projects funded under EU programmes**
  - HEALTH-CODE: prognostics and diagnostics activities
  - NewBusFuel: invited speaker to workshop
  - High V.LO-CITY (HyTransit, 3Emotion): invited speaker to workshop, networking at Aberdeen hydrogen transport summit 2017
- **Interactions with national and international-level projects and initiatives**
  - DoE fuel cell program: invited speaker to workshop

RISKS AND MITIGATION

Insufficient data on balance-of-plant (BoP) components

Specific tests will be run by Bosch on compressor, humidifier.

Ejector data from public-funded German federal project.

Delayed ERDF funds for FESB laboratory

Other partners took over stack-testing activities.

FESB focus on single-cell testing until ERDF funds are released.

Regulatory uncertainty on status of range extenders

Risk identified by VDL during project. H_2 in range extenders can be cargo or fuel; different sets of regulations apply.

DISSEMINATION ACTIVITIES

Public deliverables

- D1.2 Experimental protocols
- D1.4 Diagnostics in automotive FCS
- D2.1 Prognostic methods
- D3.2 Control system specification
- D6.1 Range extender standards

Conferences/Workshops

- **1** organised by the project
- **1** in which the project has participated (but not organised)

Social media

- N/A

Publications: 4

- Pivac, Šimić, Barbir: *Experimental diagnostics and modeling of inductive phenomena at low frequencies in impedance spectra of proton exchange membrane fuel cells*, J. Pow. Sour. 365 (2017) 240-248
- Petrone, Yousfi Steiner, Jemeï, Harel, Hissel, Péra: *Model-based strategy oriented to PEMFC system prognostic for Bus transportation applications based on EMR formalism*, FDFC 2017, Stuttgart, Germany

Patents: 0

UPCOMING WORKSHOP

- Hosted by Vehicle Power Propulsion Conference 2017, Belfort, France
  - December 12, 2017
- Diagnostics, Prognostics, Control, FC Systems and Range Extenders
- Invited speakers from:
  - NewBusFuel, High V.LO-City, DoE, Valeo, GEA
- *You are welcome to register!*
  - *http://giantleap.eu/?event=giantleap-workshop-vppc2017*

Thank You!

Coordinator: federico.zenith@sintef.no