COMPASS

Competitive Auxiliary Power Units for vehicles based on metal supported stack technology

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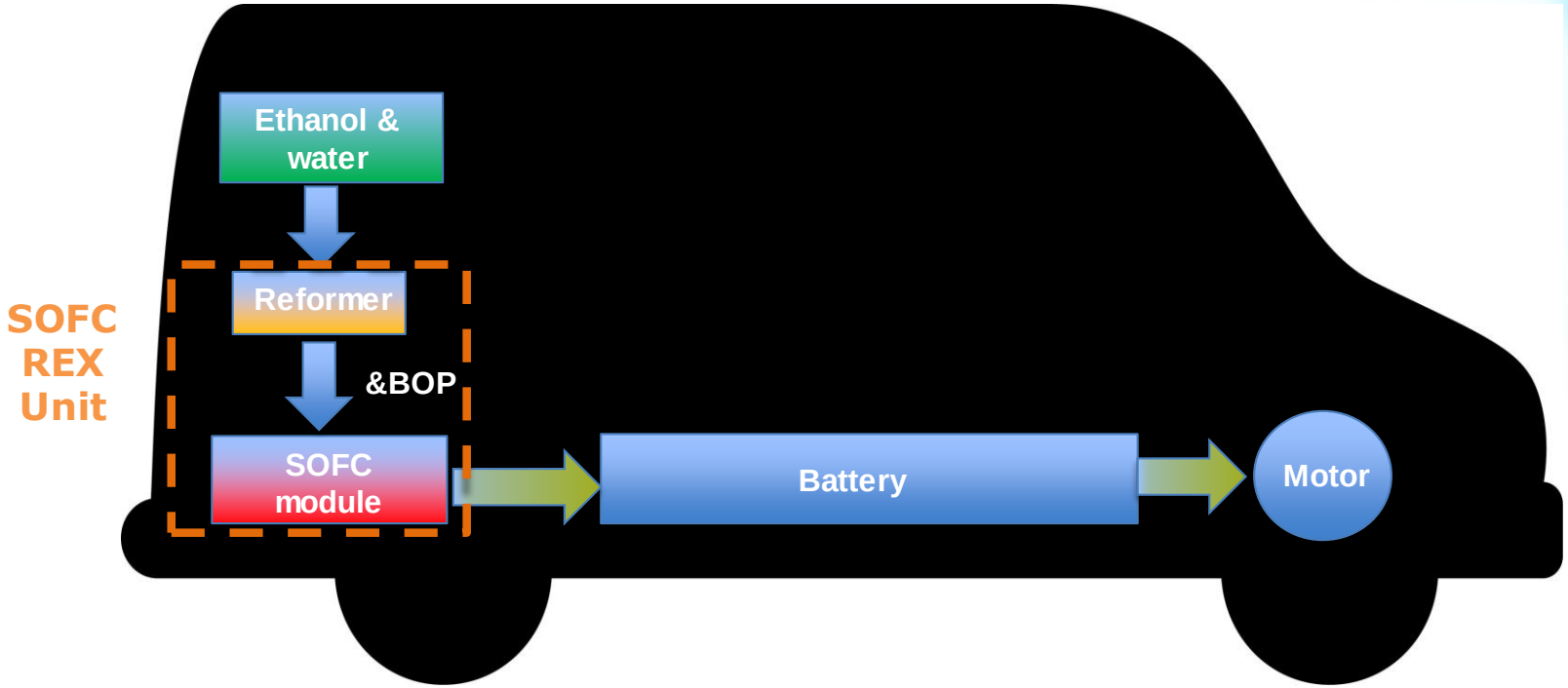
Programme Review Days 2017
Brussels, 23-24 November

PROJECT OVERVIEW

- Call year: 2015
- Call topic: FCH-01.5-2015
- Project dates: Oct.2016 – Sept. 2019
- % stage of implementation 01/11/2017: [33 %]
- Total project budget: 3.920.302,50 €
- FCH JU max. contribution: 3.920.302,50 €
- Other financial contribution: -
- Partners: AVL List GmbH, Nissan Motors UK, Plansee SE, Forschungszentrum Jülich

Project Summary

- BEV range extender based on SOFC technology
- Novel & competitive solution for EV battery REX
- Light BEV van with up scaling potential



- 55 % fuel to battery efficiency target
- Stacks, Balance of Plant & system Operation developed
- Demonstrated in a vehicle

Background & Targets

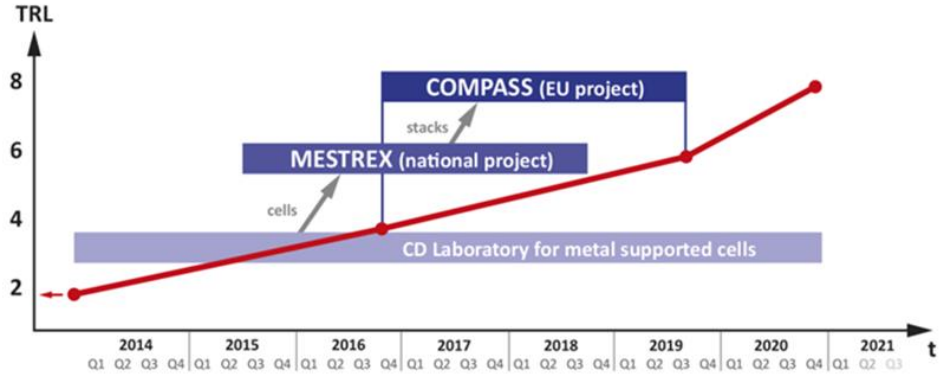


Figure 1.3a: Technology Roadmap

The project COMPASS will start on TRL 3-4 (developed mainly in MestRex) and will validate the technology under real world conditions to reach TRL 6 at the end of the project.

MeStREx

REX 1
- Concepts tested on bench
- Insight into E45 APU system
- Anode supported stacks

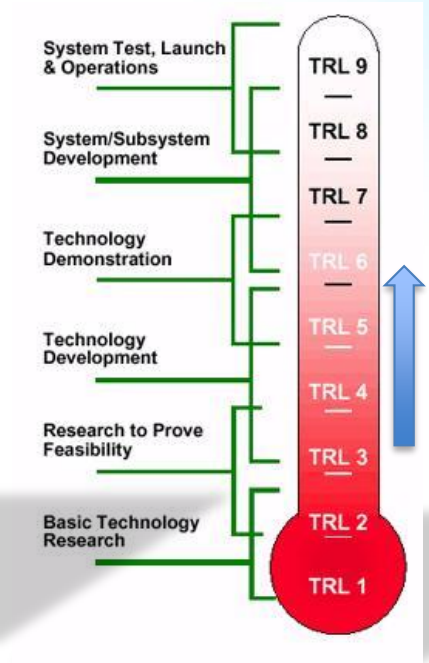
REX 2
- ✓ Fits into Vehicle/bench tested
- ✓ 5kW 50% efficency
- ✓ 30 Min start time

COMPASS

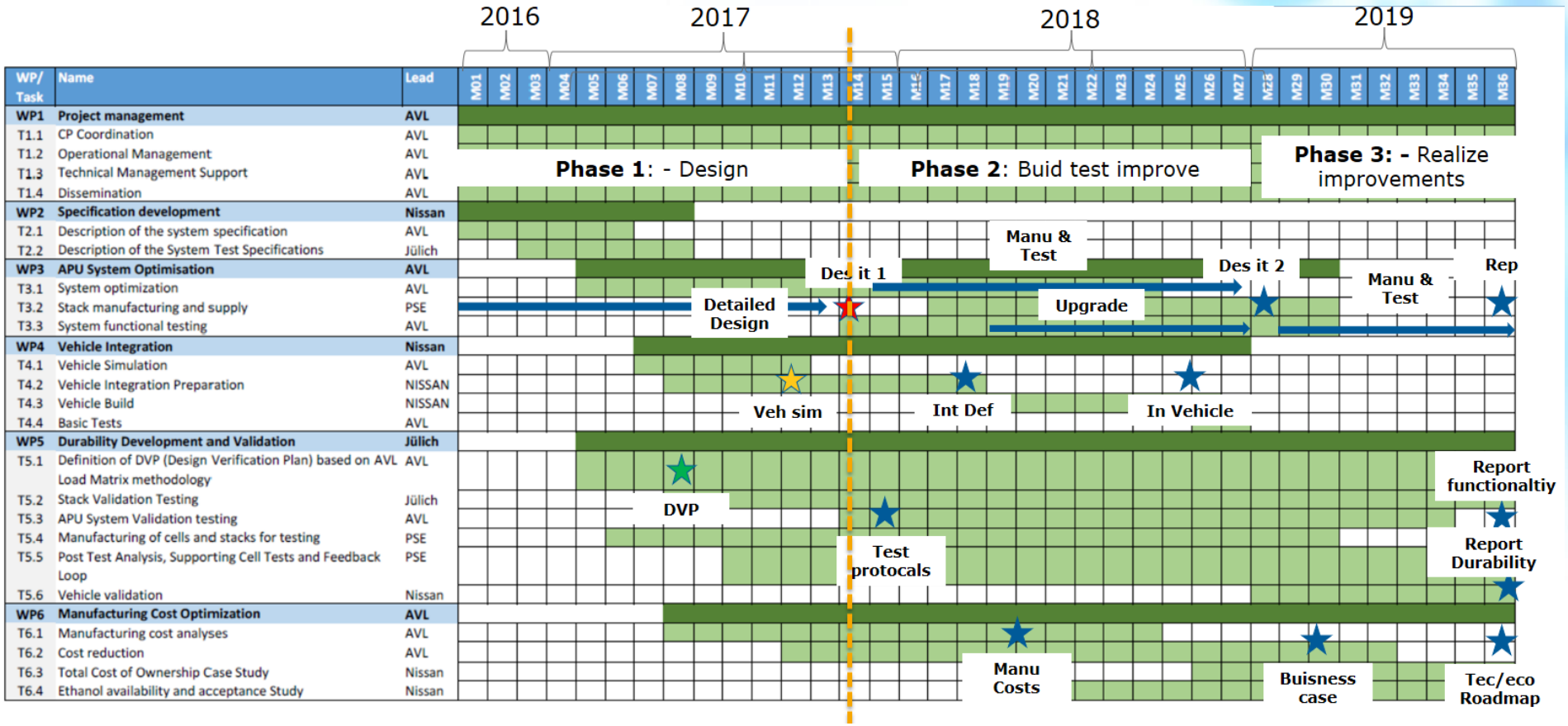
IT1
- ✓ Can be tested in vehicle
- ✓ Advanced starting technique(s)
- ✓ 15 Min start time

IT2
- ✓ Functional optimisations
- ✓ Reliability & durability optimisations
- ✓ Durability tested

Feasability → Demonstration



Project Overview & Content

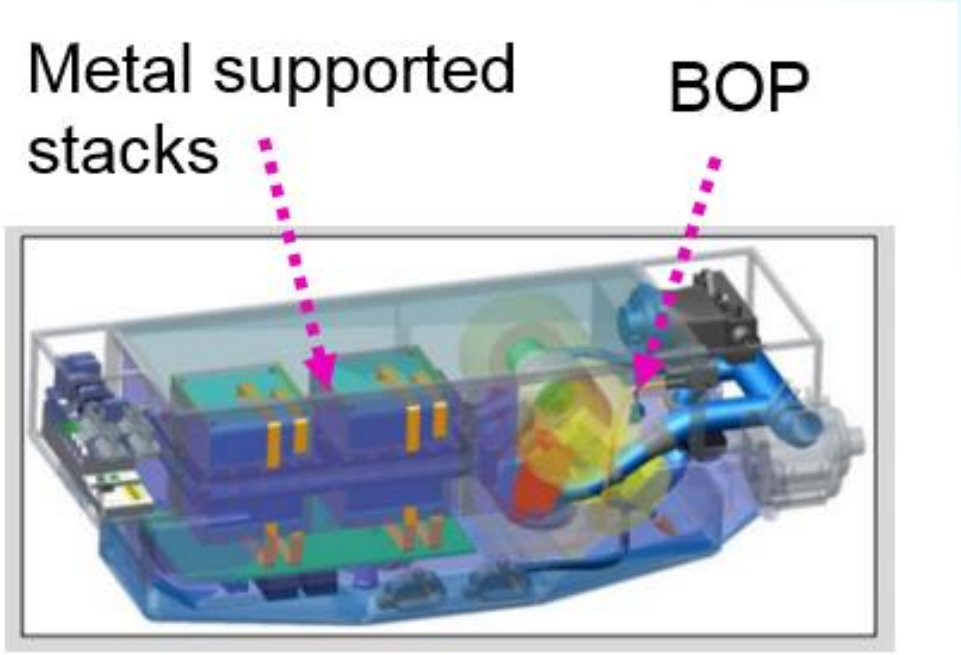


WP/ Task	Name	Lead
WP1	**Project management**	**AVL**
T1.1	CP Coordination	AVL
T1.2	Operational Management	AVL
T1.3	Technical Management Support	AVL
T1.4	Dissemination	AVL
WP2	**Specification development**	**Nissan**
T2.1	Description of the system specification	AVL
T2.2	Description of the System Test Specifications	Jülich
WP3	**APU System Optimisation**	**AVL**
T3.1	System optimization	AVL
T3.2	Stack manufacturing and supply	PSE
T3.3	System functional testing	AVL
WP4	**Vehicle Integration**	**Nissan**
T4.1	Vehicle Simulation	AVL
T4.2	Vehicle Integration Preparation	NISSAN
T4.3	Vehicle Build	NISSAN
T4.4	Basic Tests	AVL
WP5	**Durability Development and Validation**	**Jülich**
T5.1	Definition of DVP (Design Verification Plan) based on AVL Load Matrix methodology	AVL
T5.2	Stack Validation Testing	Jülich
T5.3	APU System Validation testing	AVL
T5.4	Manufacturing of cells and stacks for testing	PSE
T5.5	Post Test Analysis, Supporting Cell Tests and Feedback Loop	PSE
T5.6	Vehicle validation	Nissan
WP6	**Manufacturing Cost Optimization**	**AVL**
T6.1	Manufacturing cost analyses	AVL
T6.2	Cost reduction	AVL
T6.3	Total Cost of Ownership Case Study	Nissan
T6.4	Ethanol availability and acceptance Study	Nissan

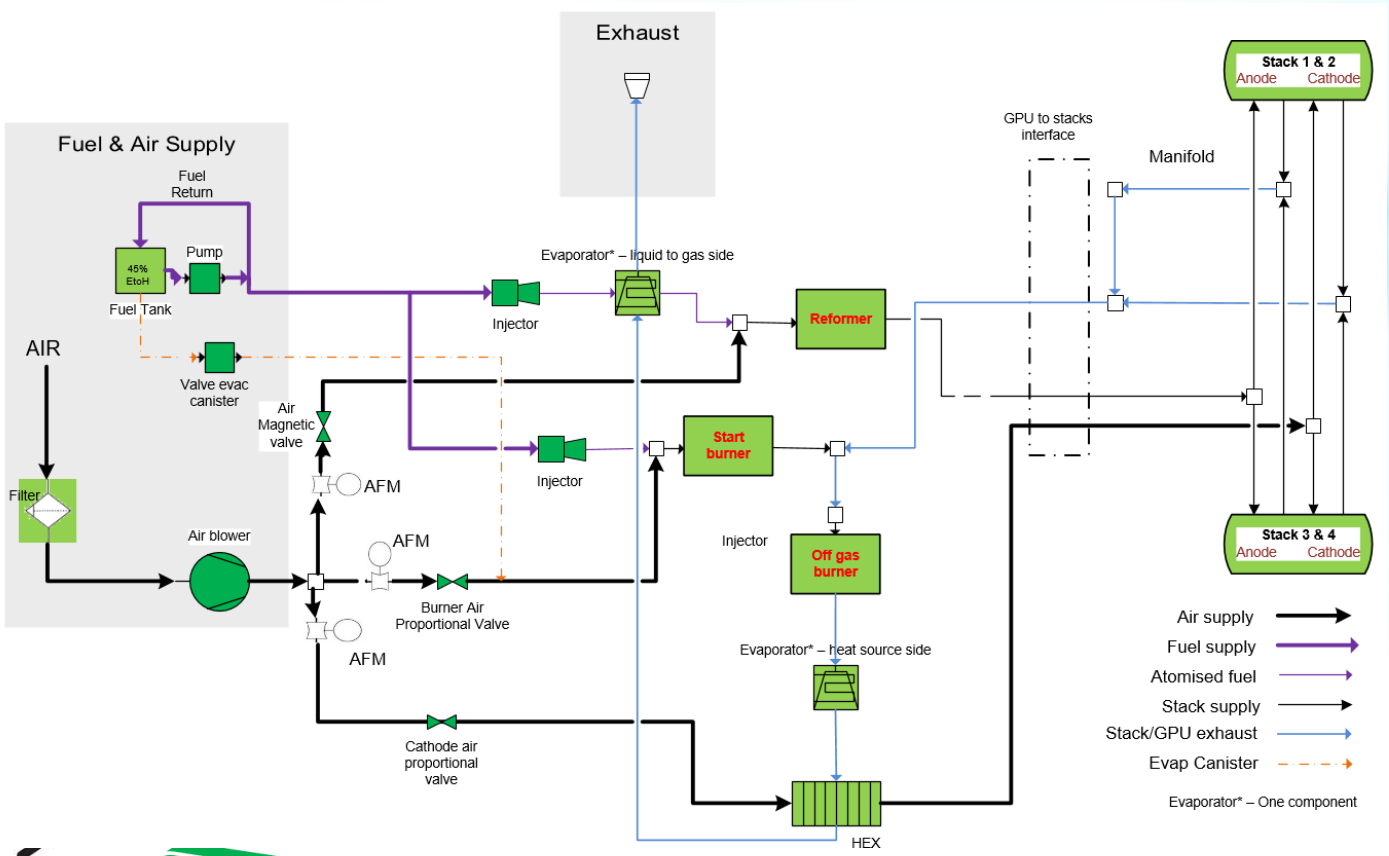
WP2/4 - Specification Development & Vehicle Integration

- ✓ System specifications
- ✓ Part specifications
- ✓ Vehicle Packaging study
- ✓ System test specifications

Test Category	Test ID	Name of Test Method (including Test Procedure Number)	Test Description	Acceptance Criteria	Requirements Documents IDs	Test Environment
10 Functional System Development and Integration						
Performance Testing	10.1	Performance Simulation (Burner System)	Virtual check of required thermal performance and temperature level attainability Virtual proof of design and concept	Confirmation of Burner System Performance according to intended design	Not yet specified: Temperature Level and Thermal Power Performance of Burner System	Simulation
Performance Testing	10.2	Performance Test (Burner System)	Proof of design and concept. Functional testing of temperatur level and thermal power performance. Includes Emission evaluation described in Test ID 10.3	Temperature distribution on catalyist surface within given limits. (EHC - Electric Heated Catalyst) Thermal Power Output and Temperature Level according to specifications. Confirmation of complete burn of fuel	Not yet specified: Tepmerature of EHC surface, Temperature Level and Thermal Power Performance of Burner System	Test Rig



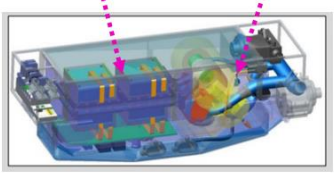
WP3 – APU system optimisation



6. Added Value – Novelty
5. Manufacturing of intended design / cost
4. Durability / Reliability
3. Compact & Light Weight
2. Increased Efficiency or and more than 5kW
1. Rapid Start

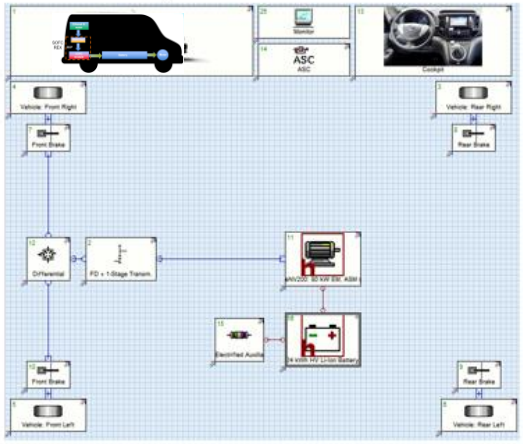
Metal supported stacks

BOP



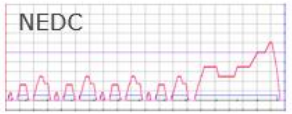
WP3 – APU system operation

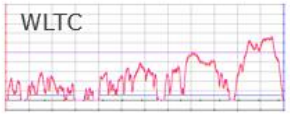
- Preliminary EV Cruise Model:

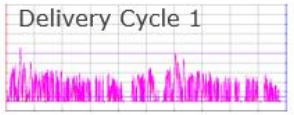


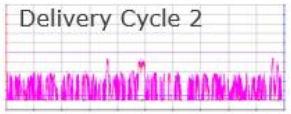
- Initial calculations and results validation in progress

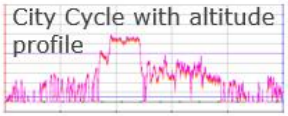
- Cycle runs selected:







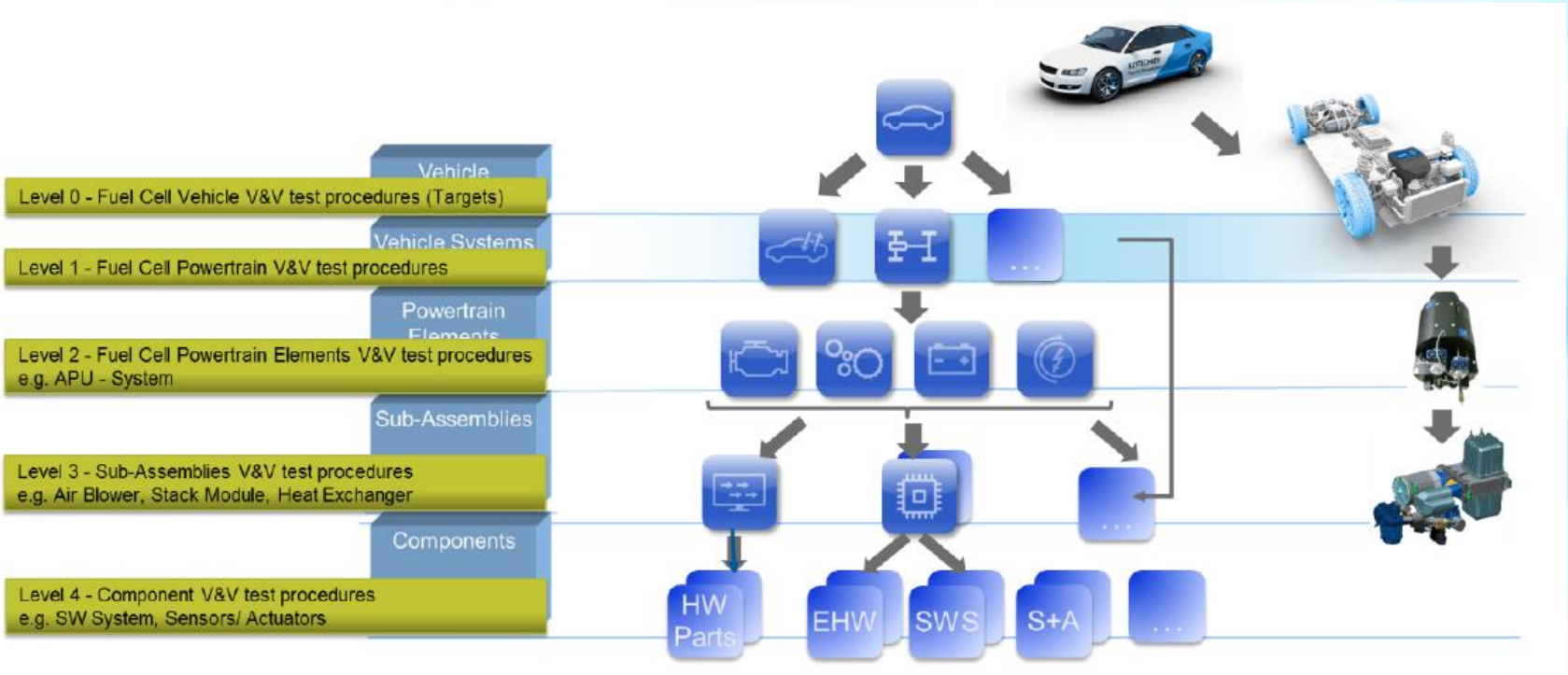




		NEDC	WLTC	Delivery 1	Delivery 2	City with alti.
Duration	[s]	1.180	1.800	28.980	28.922	4.445
Duration	[h]	0,33	0,5	8,05	8,03	1,23
Stop duration	[s]	287	234	3.949	2.223	1.002
Distance	[km]	11,0	23,3	147,7	172,0	52,6
% of Stops	[%]	24,3	13,0	13,6	7,7	22,5
Max Speed	[km/h]	120,0	131,3	109,1	87,5	123,1
Avg Speed	[km/h]	44,4	53,5	18,3	21,4	42,0

- EV Cruise model (Vehicle & REX), parameterization & model validation
- Power requirement's per application/drive cycle
- Operating strategies for range extension & APU system size
- Benchmark for system performance evaluation

WP5 – Durability & Validation



DVP&R: Planning						
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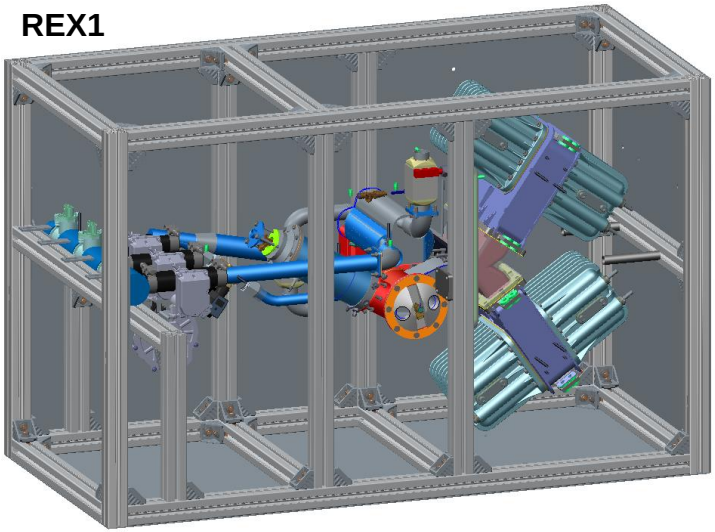
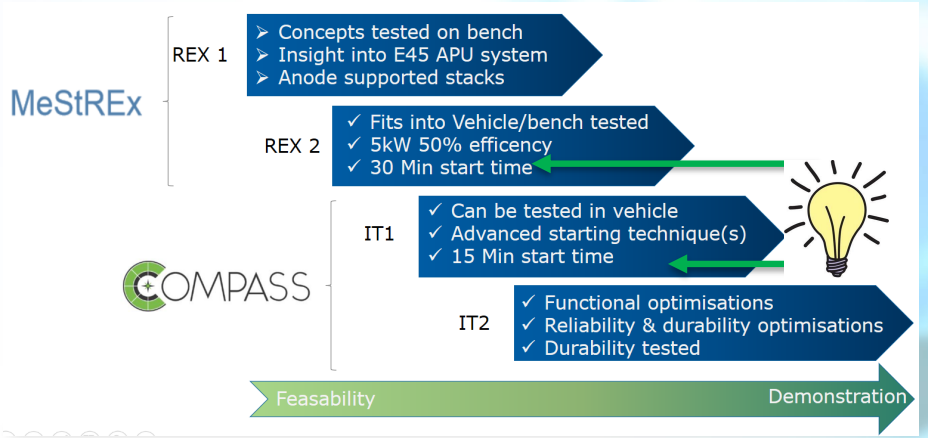
Next steps

REX1





- ✓ Methods & Procedure for fast start and anode protection explored.
- ✓ Itterated BOP upgrades.
- ✓ Validate communication to vehicle.
- ✓ Test component performance
- ✓ Validate BOP side of fast start concept.
- ✓ Generate know how & experience to benifit Rex 2 & COMPSS IT 1

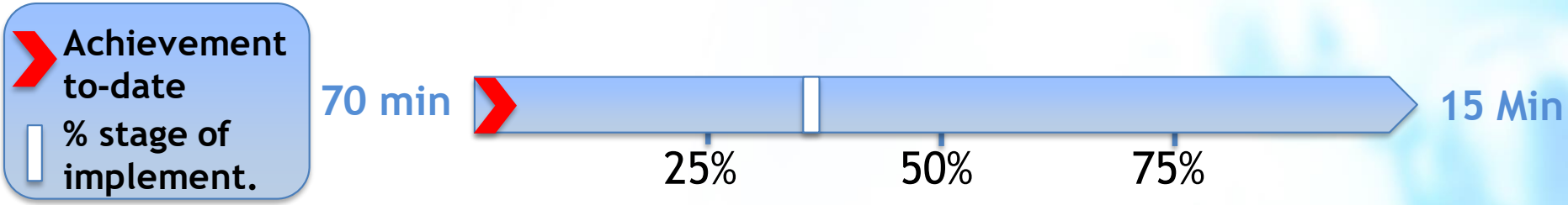
- ➢ Validations for Rapid start simulation
- ➢ Validations for efficiency increase simulation
- ➢ Input for weight, volume & cost reduction
- ➢ Opportunities for IP closure
- ➢ Opportunities to advance technology from Mestrex limits/experience/refinments

PROJECT PROGRESS/ACTIONS

- Delay in Mestrex has caused a Delay in Compass
- Mestrex now providing key data for COMPASS!
- To-date Compass activity limited to Simulation & limited component testing
- Lessons learned mean a rapid Compass system development towards project targets (e.g. 15min start time)
- IT1 system detailed design will start in early 2018

PROJECT PROGRESS/ACTIONS - Startup Time

Example and explanation in the next slide



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Start up	25°C to 5kW supply	min	70 min	**Pillar 1**	-	-

Future steps:

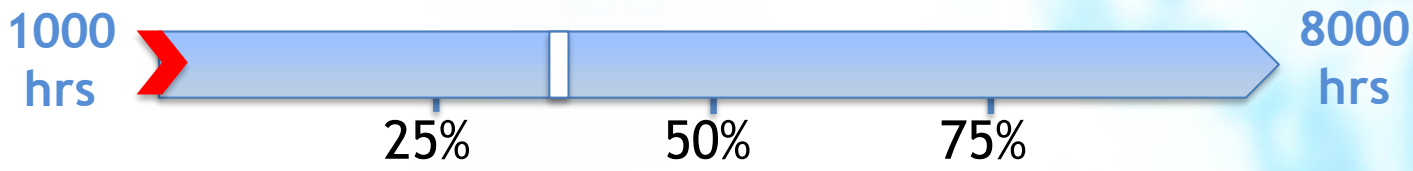
- *Results from stack & BOP testing in mestrex before end 2017 provide*
  - *Validation for simulation activity*
  - *Insights into limitations & opportunities for advances in COMPASS*
  - *In 2018 targeted system operation and design for 15 minute start*

PROJECT PROGRESS/ACTIONS - Durability

Example and explanation in the next slide

Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Durability	Parameter addressed	hrs	1000	**Pillar 1:**	-	-

Future steps:

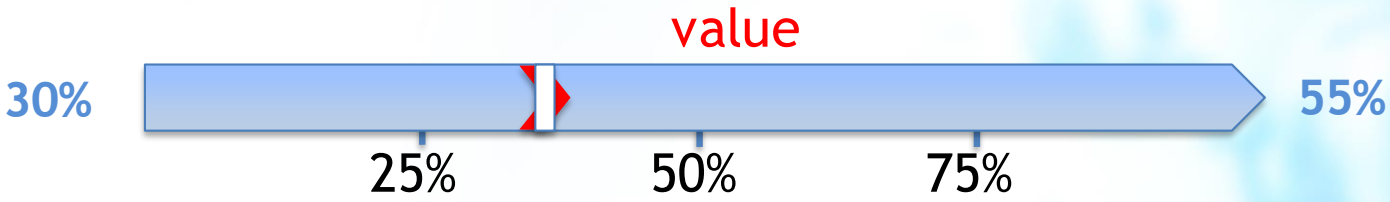
- *Durability will be a key testing parameter for the COMPASS IT 2 system which is planned towards the end of the project.*

PROJECT PROGRESS/ACTIONS - Efficiency

Example and explanation in the next slide

Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Aspect 1	Efficiency	%	30%	**Pillar 1:**	-	-

Future steps:

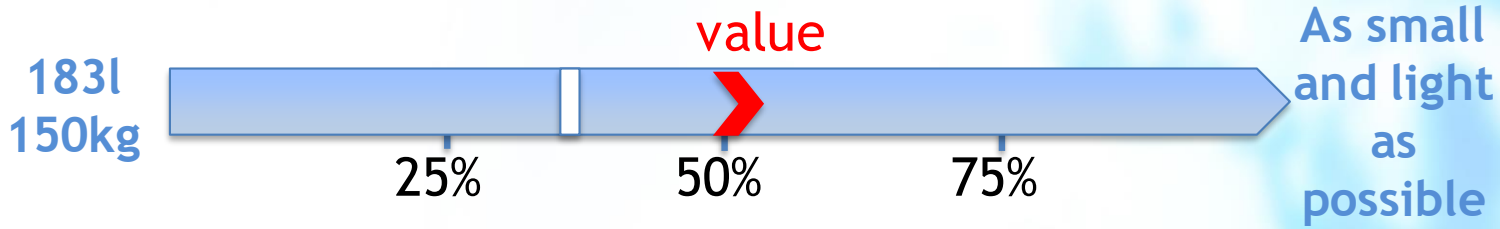
- *Specify next steps and actions to be carried out within the project for this aspect*

PROJECT PROGRESS/ACTIONS -Volume/Weight

Example and explanation in the next slide

Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Volume	Volume/Weight	L	183	**Pillar 1:**	-	-
Weight	Volume/Weight	Kg	150	**Pillar 1:**	-	-

Future steps:

Volume: AVL designs the system to the volume assigned by partner

Weight: Current prediction is 50% higher than the target. Design efforts will reduce the weight significantly

SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

- Interactions with projects funded under EU programmes
  - DESTA: Provided initial insights into APU design and operation on Diesel fuel for truck application.
    - Allowed a benchmark for: lessons learned, concept/design platform, system control, opportunities for improvements relating to KPIs

- Interactions with national and international-level projects and initiatives
  - MestRex: Key information from MESTREX is carried over into COMPASS.
    - BOP functionality, opportunities to increase efficiency/performance/durability
    - Validate COMPASS Simulation and allow detailed design for COMPASS IT 1
    - Mestrex targets less stringent than COMPASS, advances required!

DISSEMINATION ACTIVITIES

Public deliverables

- D1.2 – Project Website
- D2.2 - Summary of System Specification
- D1.2 – Dissemination Activities Report

Conferences/Workshops

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

Social media

Publications:

- EFCF 2018 contributions planned

Patents: 0

Thank You!

Coordinator: Vincent.Lawlor@avl.com
Speaker: Richard.Schauperl@avl.com