

## BRA99G32 Brasilien Fuel Cell Hybrid Bus

Monica Saraiva Panik (Guido Bunzel)



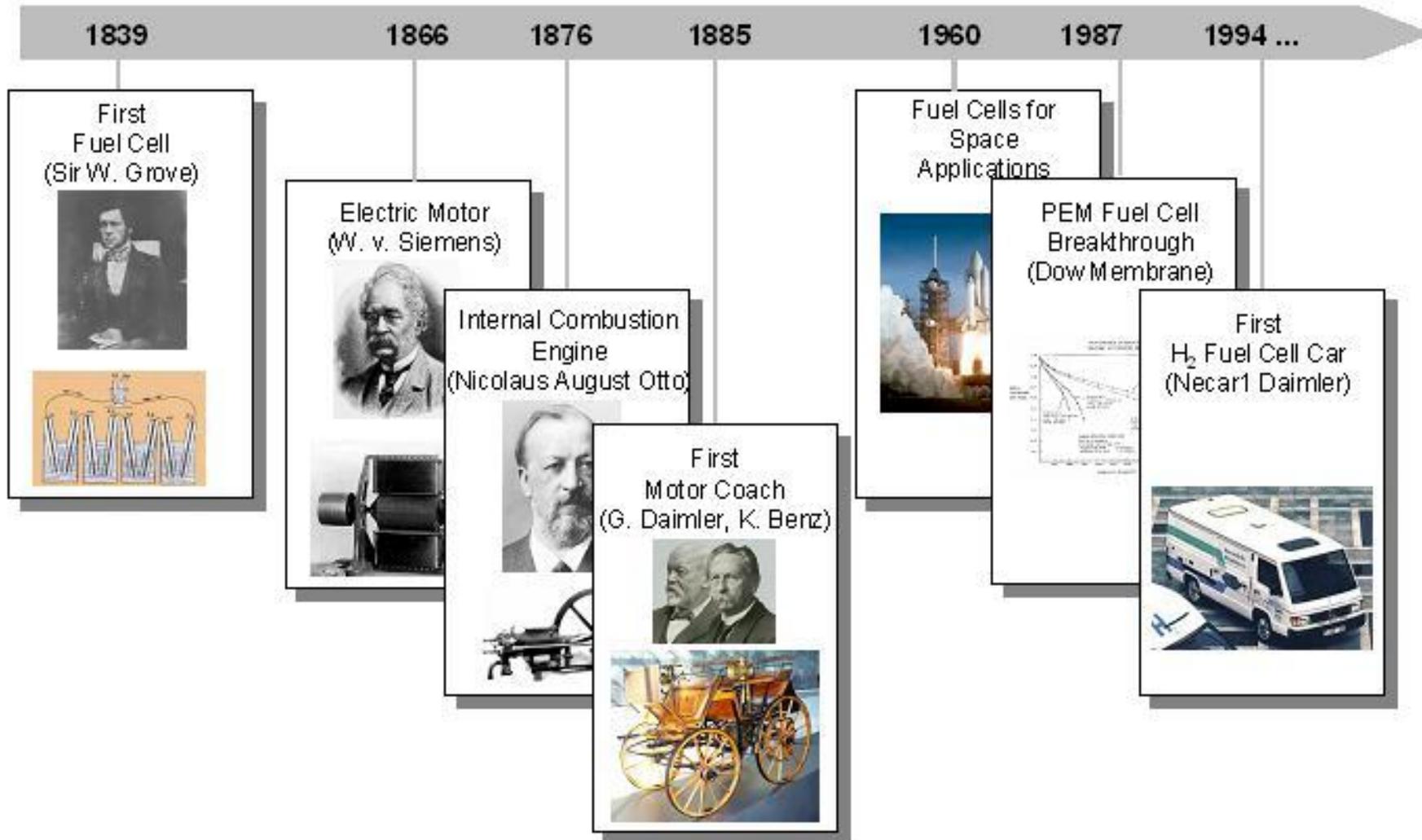
**Nabern – the technology center for Fuel Cell Systems. Since 1997, all activities for the development of Fuel Cell Systems have been concentrated at the Nabern location near Kirchheim-Teck.**



## **Company position on the market, products and activities**

NuCellSys GmbH - The Fuel Cell System Company - is a 100% Daimler AG company is the worldwide leader in the development and manufacturing of fuel cell systems for automotive applications. Within the Fuel Cell Alliance between Daimler, Ford, and AFCC (Automotive Fuel Cell Cooperation), NuCellSys is responsible for system engineering and design, component and software development, system testing, manufacturing, integration and validation.

# History

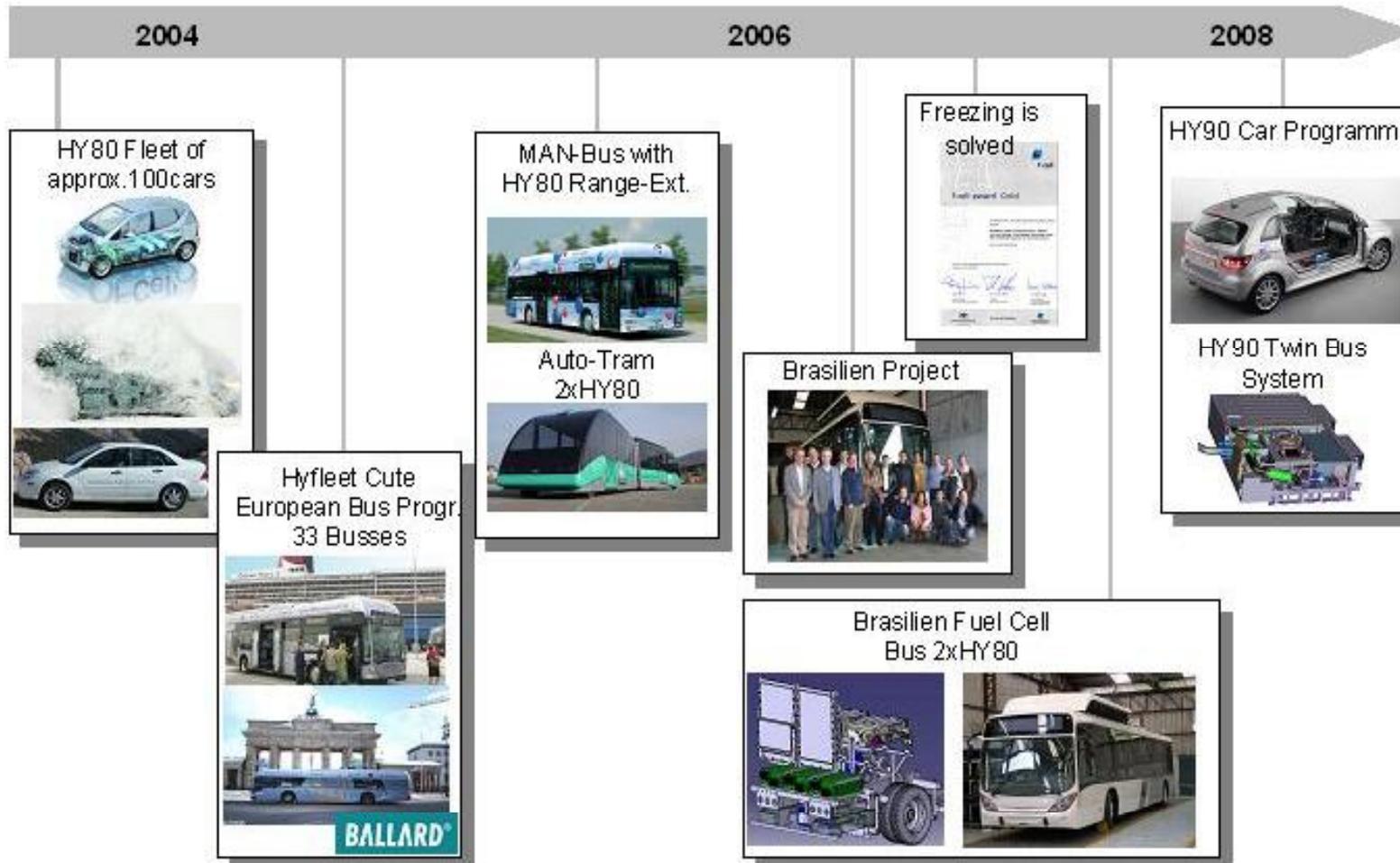


**Major milestones of the Company's history**

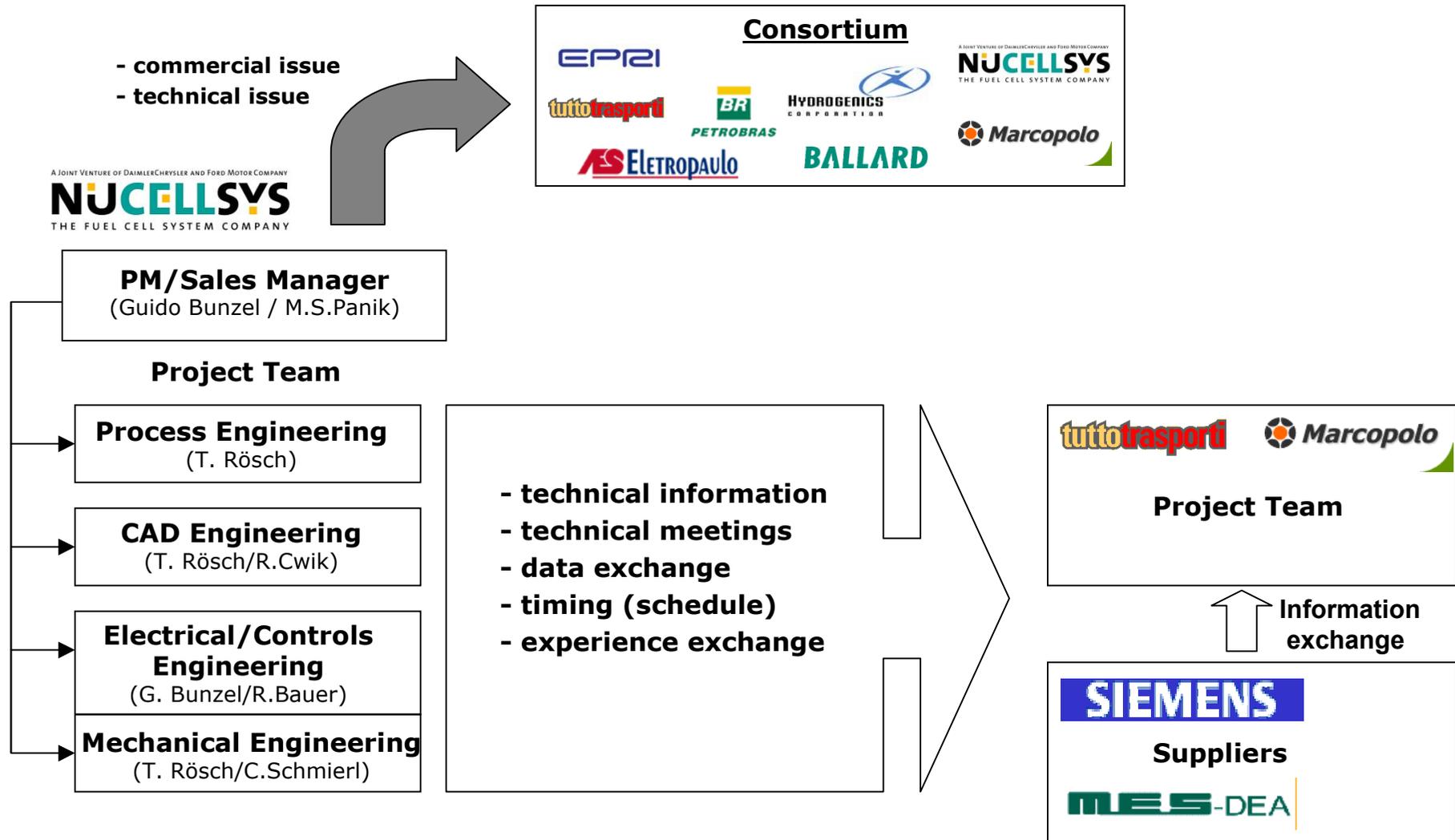
**Daimler-Benz and Ballard started initial co-operations in the early 90's and in:**

- |   |                    |   |
|---|--------------------|---|
| <p>Início da Aliança em prol do Desenvolvimento da Célula a Combustível.</p>  | <p><b>1996</b></p> | <p>Start of the Fuel Cell Alliance.</p>   |
| <p>Os parceiros fundaram a empresa 'dbb fuel cell engines' para o desenvolvimento de sistemas completos de célula a combustível.</p>  | <p><b>1997</b></p> | <p>The partners found the company 'dbb fuel cell engines' for the development of complete Fuel Cell Systems.</p>  |
| <p>Ford Motor Company se junta a Aliança.</p>   | <p><b>1998</b></p> | <p>Ford Motor Company joins the Alliance.</p>   |
| <p>dbb muda de nome para 'XCELLSIS - A Empresa de Sistemas de Célula a Combustível'</p>   | <p><b>1999</b></p> | <p>dbb changes its name to 'XCELLSIS - The Fuel Cell Engine Company'.</p>   |
| <p>Integração dentro da empresa Ballard Power Systems devido à uma re-estruturação da Aliança.</p>  | <p><b>2001</b></p> | <p>Integration into Ballard Power Systems in the course of an Alliance restructuring.</p>   |
| <p>Daimler e Ford fazem uma joint-venture e assumem o negócio de desenvolvimento de sistemas de célula a combustível fundando a 'NuCellSys GmbH - A Empresa de Sistemas de Célula a Combustível'.</p> | <p><b>2005</b></p> | <p>Daimler and Ford take over the system business and found 'NuCellSys GmbH - The Fuel Cell System Company' as a joint venture.</p>                                       |
| <p>Daimler e Ford fazem uma nova joint-venture e assumem a Divisão de Stack da Ballard Power Systems fundando a AFCC - Cooperação de Célula a Combustível Automotiva.</p>                             | <p><b>2007</b></p> | <p>Daimler and Ford take over the Automotive stack Division business from Ballard Power Systems and found AFCC - Automotive Fuel Cell Cooperation as a joint venture.</p> |
| <p>Daimler assume 100% da NuCellsys</p>   | <p><b>2009</b></p> | <p>Daimler take over the 100% share in NuCellsys.</p>   |

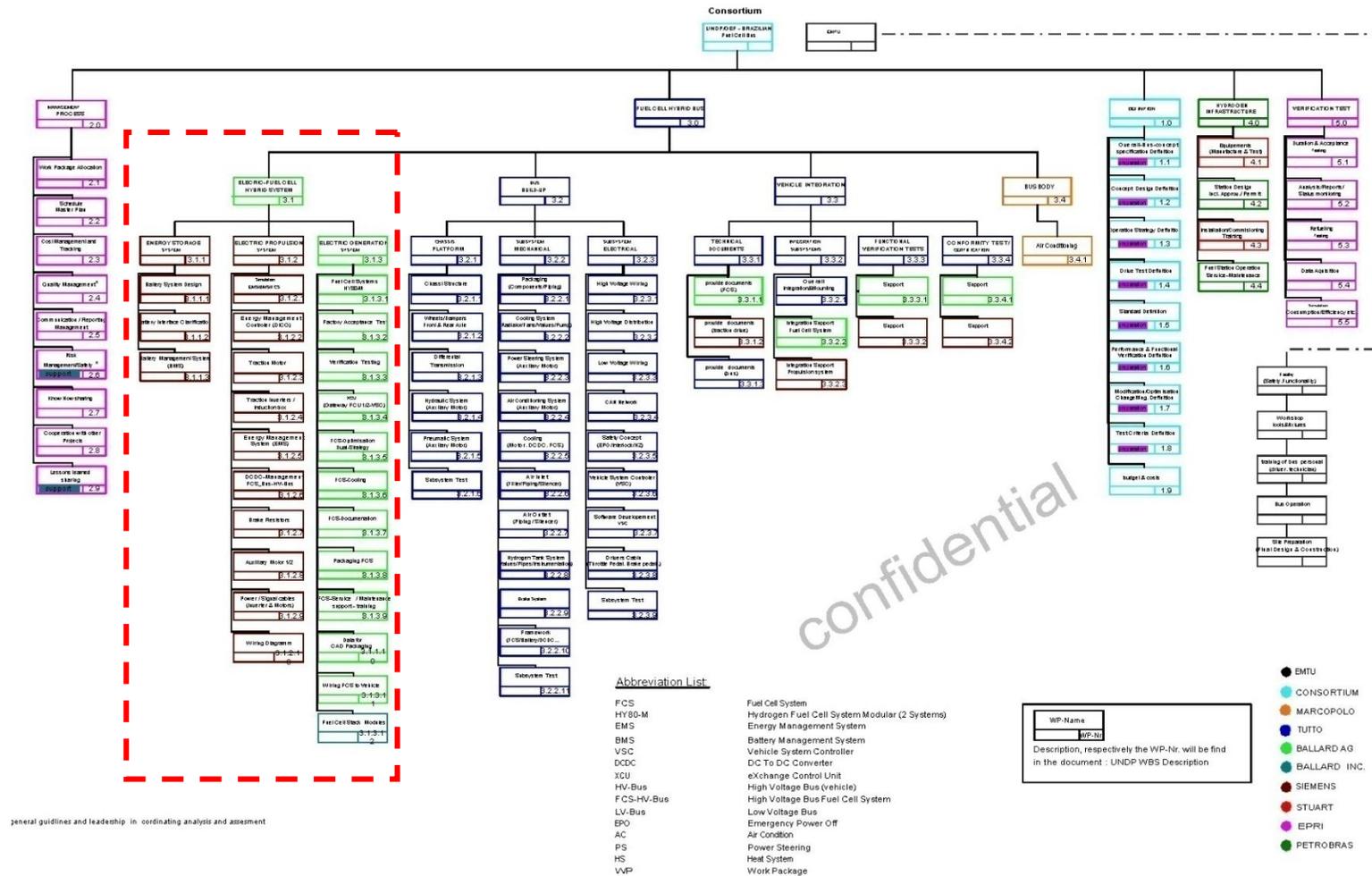
## NuCellSys Achievements in mobile applications



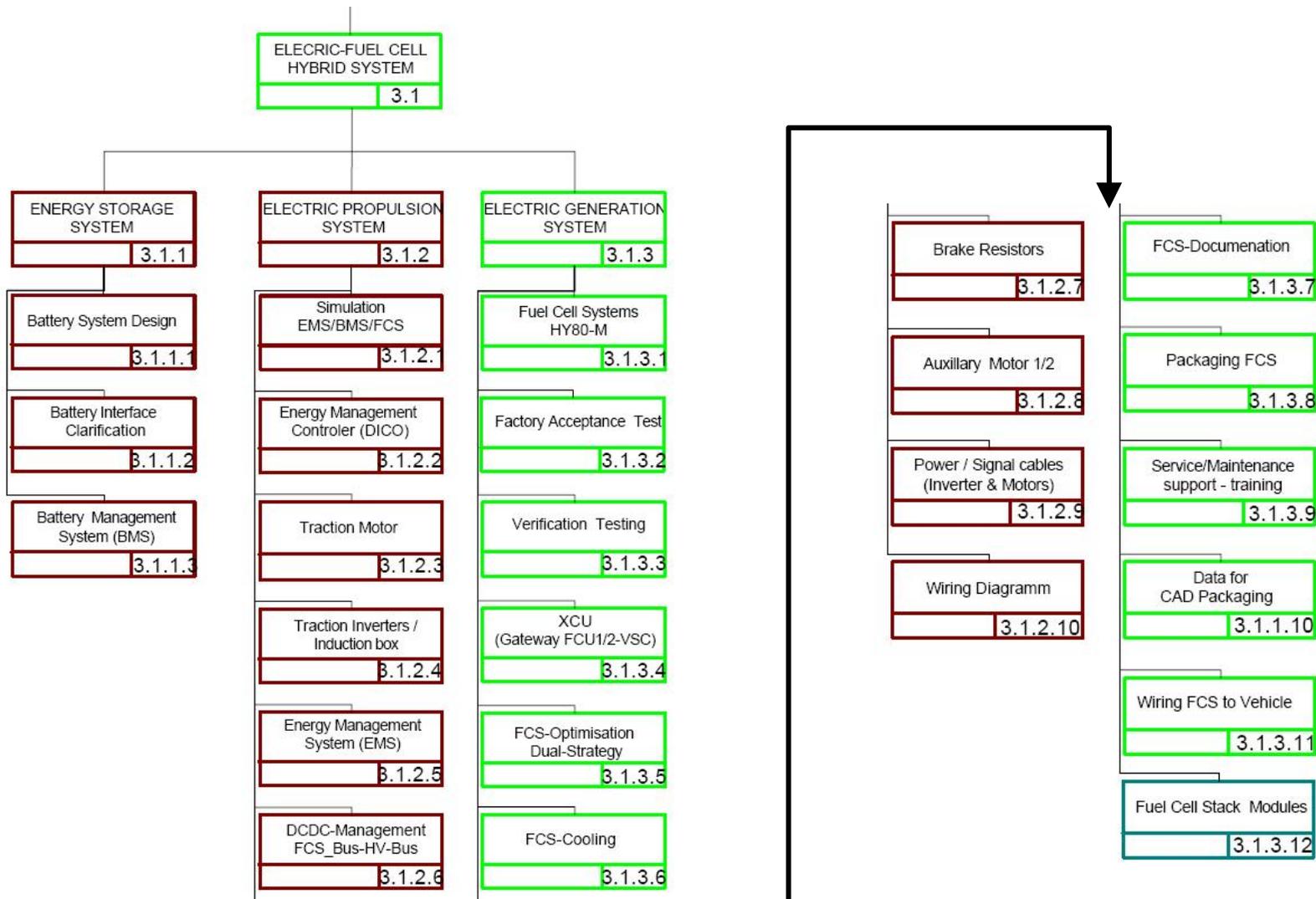
Project Organisation & Communication (Workpackage 3.1)



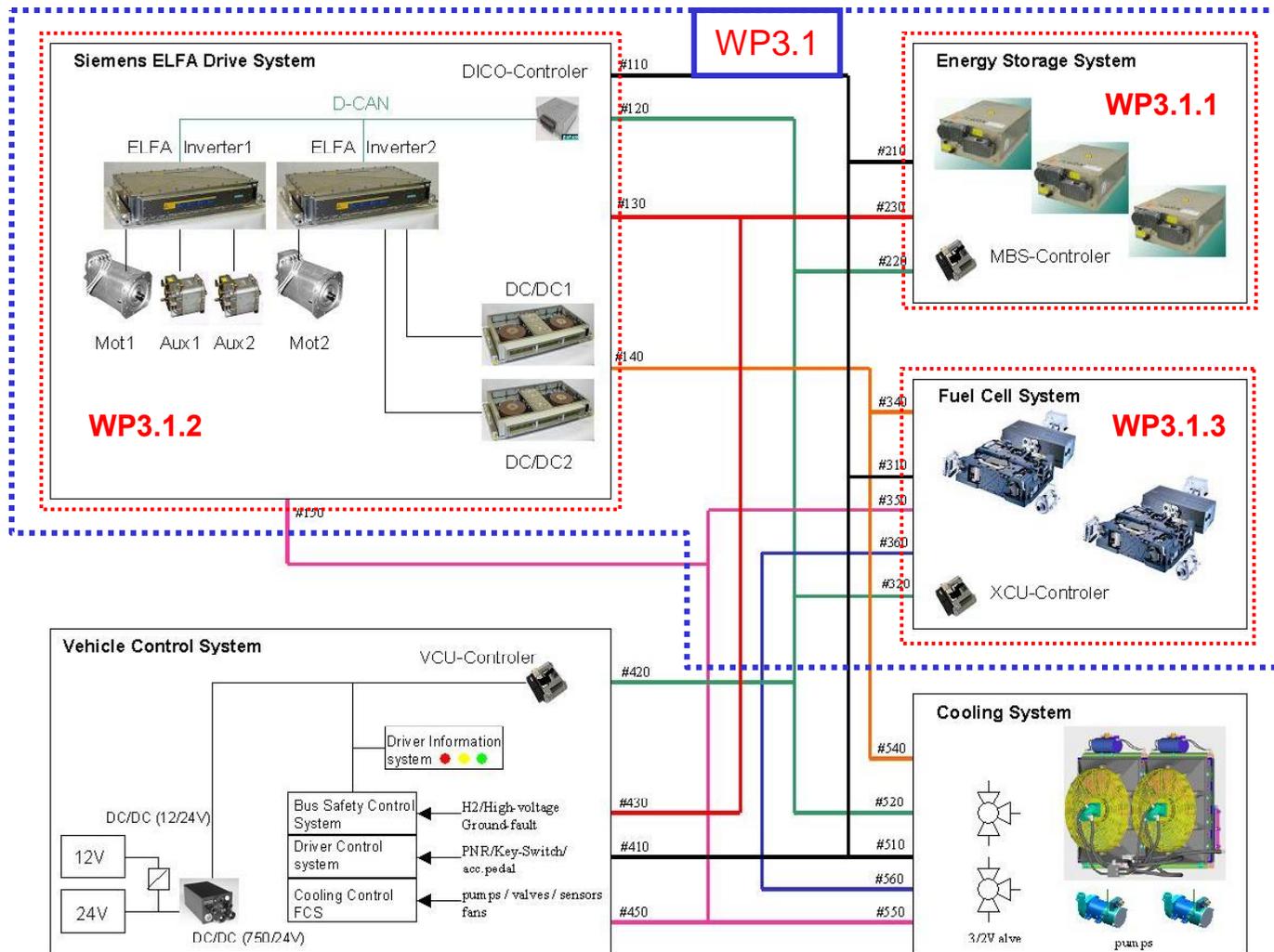
# Work Break Down Structure

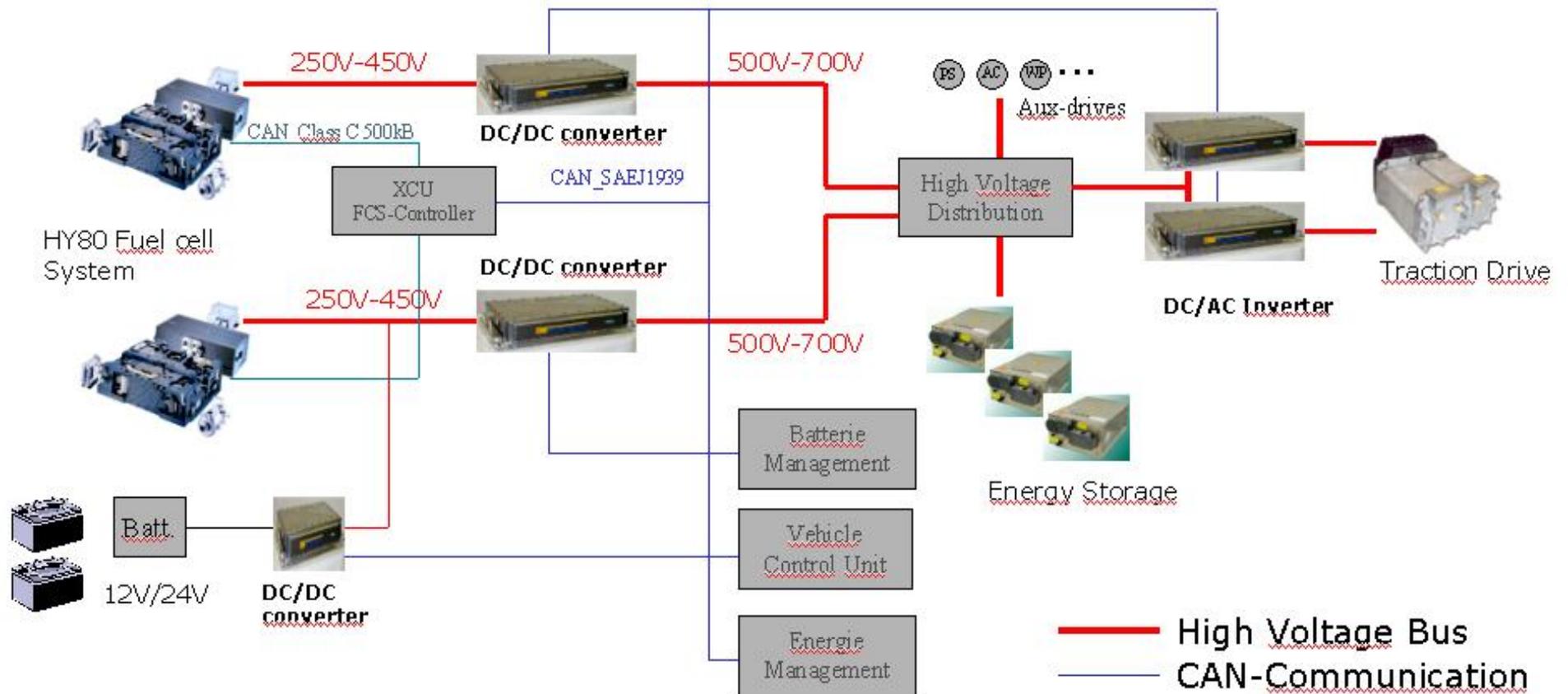


## Work Package Responsibility (NuCellSys)

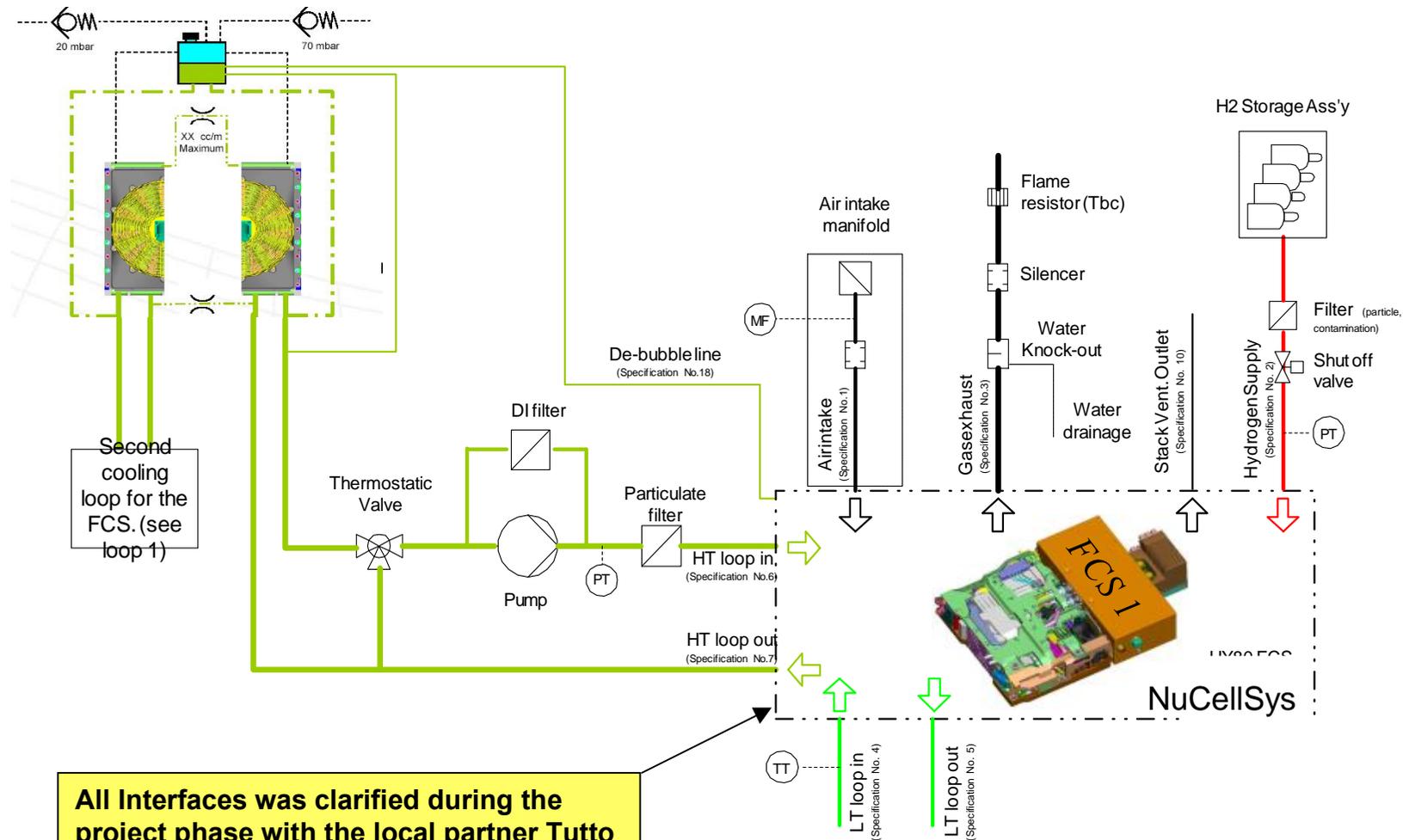


# System architecture and scope of work for WP3.1





# Fuel Cell System Interface clarification

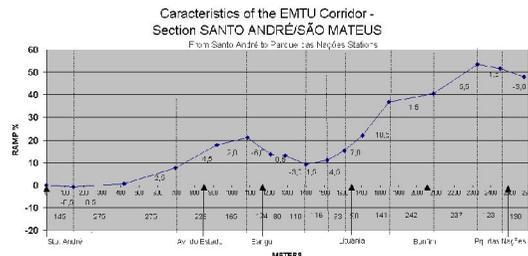
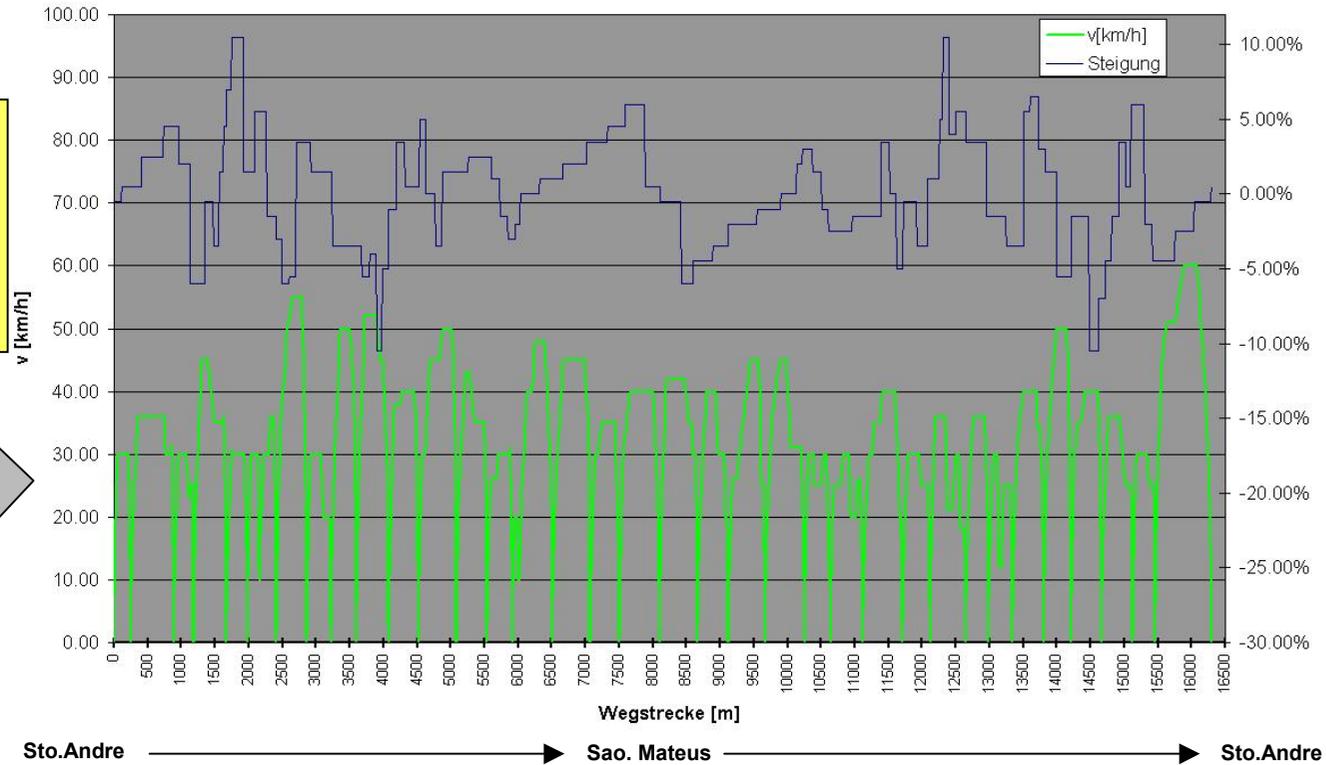
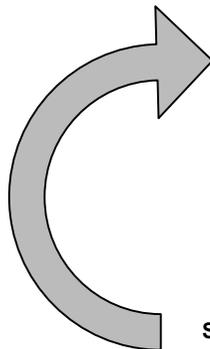


**All Interfaces was clarified during the project phase with the local partner Tutto to get the systems in operation regarding the requirements**

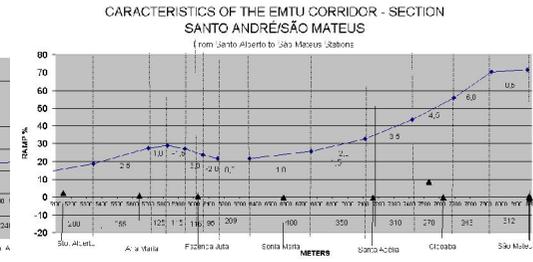
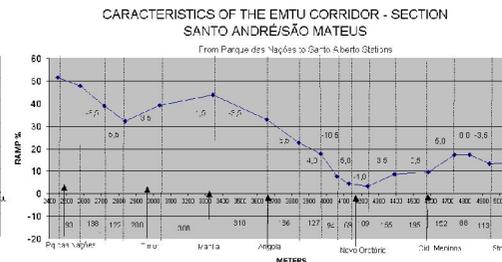
# Drive Cycle Generation

## Sao Paulo Corridor

The EMTU Corridor profile was taken to generate a drive cycle with the bus stops. With a simulation tool, the requirements of the designed hybrid system was verified

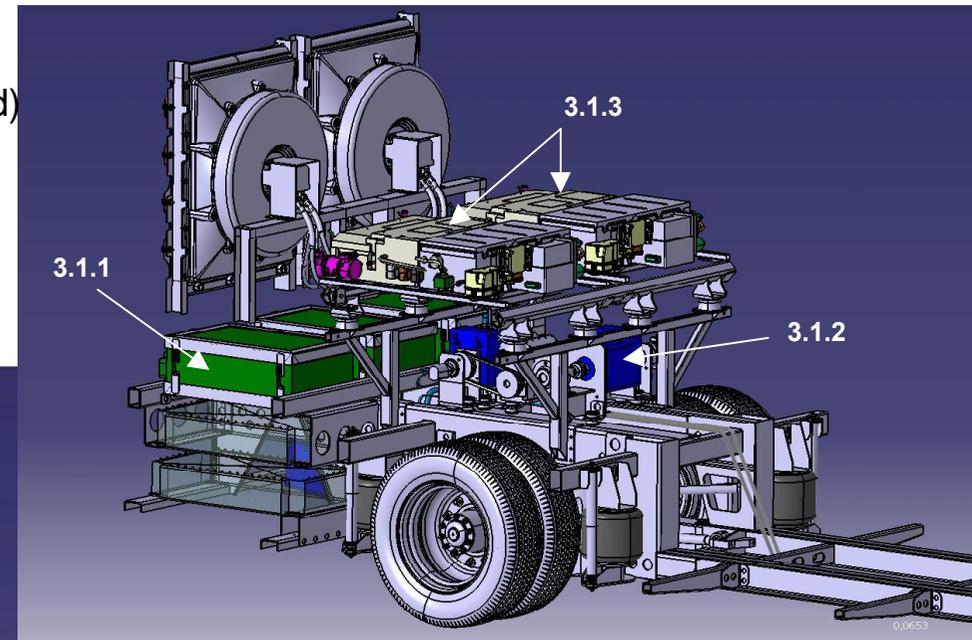
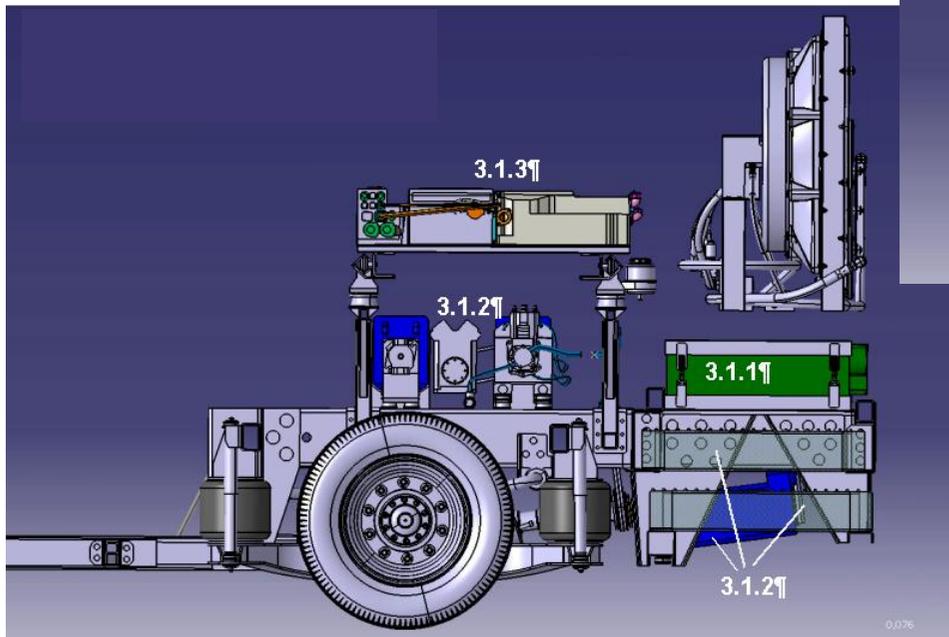


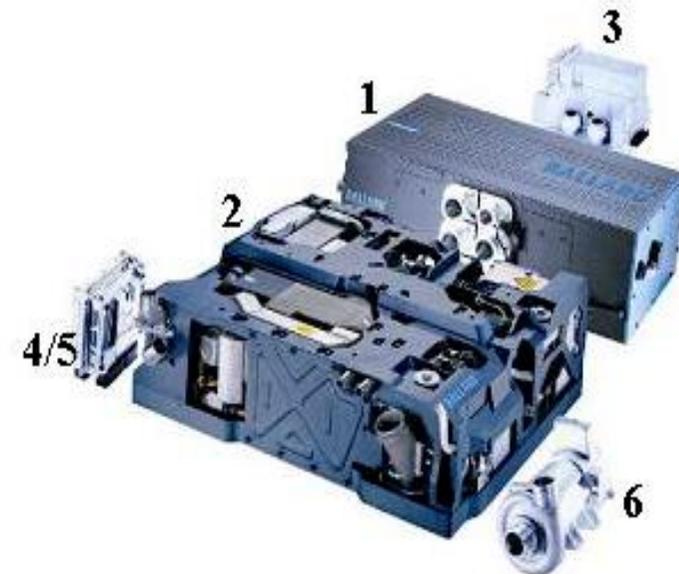
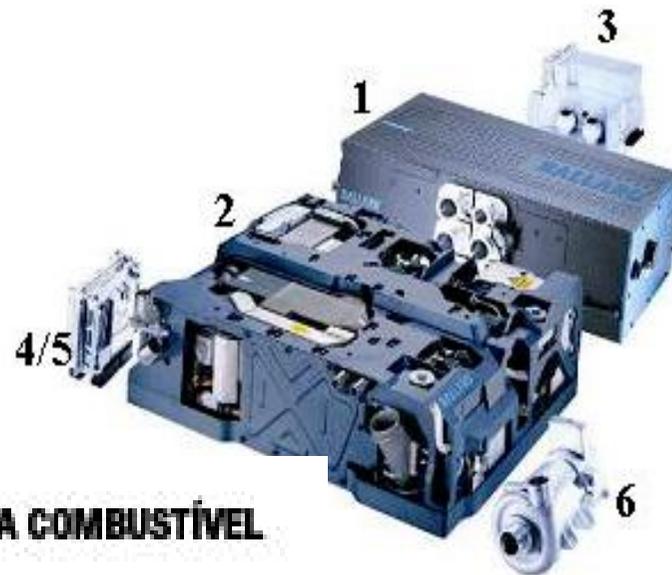
EMTU Corridor profile



## Bus Rear Packaging of the Fuel Cell Hybrid components

- 3.1.1 Electric Energy Storage System (MES-DEA)
- 3.1.2 Electric Propulsion System (Siemens)
- 3.1.3 Electric Generating System (NuCellSys/Ballard)





## SISTEMAS À CÉLULA A COMBUSTÍVEL

Os dois sistemas de célula a combustível HY80 mostrados na figura abaixo consistem dos seguintes sub-módulos:

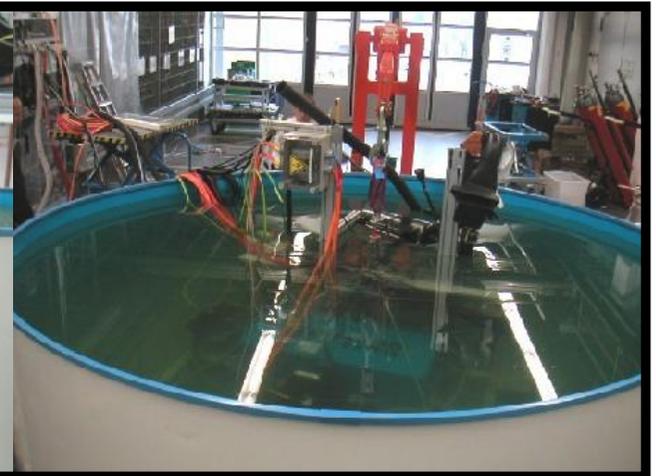
1. Stack de Célula a Combustível
2. Sistema de Célula a Combustível
3. Unidade de Distribuição de Potência
4. Unidade de Controle
5. Unidade de Monitoramento e Interface com o Stack
6. Bomba de Arrefecimento de Alta Voltagem



**Crash**



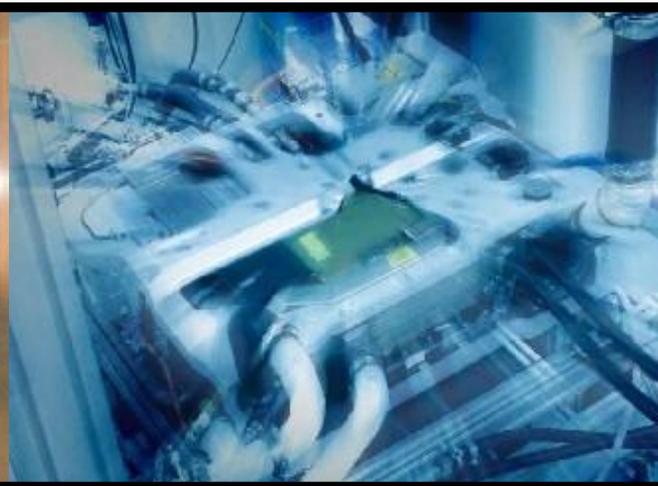
**Water spray operation**



**Water immersion during operation**



**Inclination in enviromental chamber**



**Vibration test in operation**



**Electromagnetic compatibility test**

*Teste do sistema de célula a combustível  
na câmara climática com inclinação.*

*Fuel Cell System Test In Climate Chamber  
with Incline.*

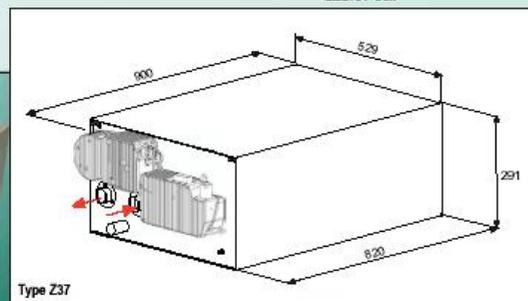


Technical data Type	ZEBRA® Battery Z37				
	Z37-310-ML3C-64	Z37-620-ML3C-32	Z37-310-ML3P-76	Z37-620-ML3P-38	
	<i>unit</i>				
Capacity	Ah	64	32	76	38
Rated Energy	kWh	19.8	19.8	23.5	23.5
Open circuit voltage					
0 - 15% DOD	V	310	620	310	620
Max. regen. voltage	V	372	744	372	744
Min. op. voltage	V	206	412	206	412
Max. discharge current	A	224	112	224	112
Cell Type / N° of cells		ML3C / 240		ML3P/240	
Weight with BMI	kg	207		207	
Specific energy without BMI	Wh/kg	96		113	
Energy density without BMI	Wh/l	156		186	
Energy 2 h discharge	kWh	17.8		21	
Peak power	kW	36 DOD 80%		36 DOD 70%	
2/3 OCV, 30s, 335°C					
Specific power	W/kg	174			
Power density	W/l	284			
Ambient temperature	°C	-40 to +50			
Thermal loss	W	< 120			
at 270°C internal temperature					
Cooling		air			
Heating time	h	24 h at 230 VAC			
Periphery		BMI, Fan			

ZEBRA® charger recommended



ZEBRA® Cell



Type Z37



## System Specification of Energy Storage System

The energy storage system for the bus consists of 3 NaNiCl batteries, also called ZEBRA battery, which are integrated into the Electric Fuel Cell Hybrid Bus System. The batteries are supplied from MES-Dea a Swiss company. The batteries in the Fuel Cell Hybrid System have to fulfil the following functions:

**Assist Fuel Cell Systems to meet instantaneous power requirements.**

**Store regenerative braking energy**

**Reduce Fuel Cell System transient operation**

**Improve overall power train efficiency**

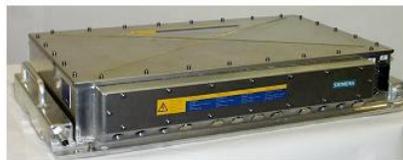
### Battery System Design (Specification)

The ZEBRA battery is a high energy battery, with 3 ZEBRA Z37 modules providing 108 kW of peak power.



Large Drives  
Traction

## Component overview (WP 3.1.2)



**7 & 8 Phase Inverter 9003.02/03 or 9004**  
Current: 170 A cont. / 300 A peak  
Power: 2 x 120 kVA cont. / 175 kVA peak.  
1 / 2 x 60 kW Chopper Phases



**Reactor circuit**  
Current: 2x120 A cont. / 300 A peak  
Power: 2 x 120 kVA cont. / 175 kVA peak.



**DICO**  
(Gateway / Hybrid & Drive Control)



**Drive Motor 1PV5135/5138**  
Power: 67/85 kW cont.



Cable-set



**Auxiliary Motor 1PV5131**  
Power: 25kW cont. / 65 Nm cont.

**SIEMENS**

Preliminary

Weight without cable 760kg  
A&D LD T 07 / hck / 28.10.04

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# Fuel Cell System Manufacturing and Integration

Manufacturing  
Airmodule



24hTest  
Airmodule



Manufacturing  
Systemmodule



Systemmodule  
Acceptance Test



Stackmodule Integ-  
ration from Ballard



Fuel Cell System Integration into Bus @ Tutto  
Facilities



Build and test of  
FCS wiring/electronics



Fuel Cell System  
Testing (FAT)



Shipping to Brasil



## Resume of Phase I

- Nucellsys was impressed to see how professional the Team worked together.
- The progress of Integration and Testing was very good and successful
- The local partner Tutto has now a very good experience in fuel cell hybrid technology.

**Thank**



**You**

**Bild von Technical  
Busteam**