BW KONSTRUKTION

Design and requirements specification for developing fuel cell propelled BE-trucks

Presentation by:

Boh Westerlund

BW Konstruktion AB

1905

By Al Gore
2006

by far the most terrifying film
you will ever see.

an inconvenient truth

A GLOBAL WARNING

https://www.youtube.com/watch?v=I-SV13UQXdk

now playing in select theaters

BW KONSTRUKTION

ELC

A part of the solution to climate change is Zero Emission transportation

That is:

Electric Vehicles (EV)

That is:

Battery Electric Vehicles (BEV)

That is:

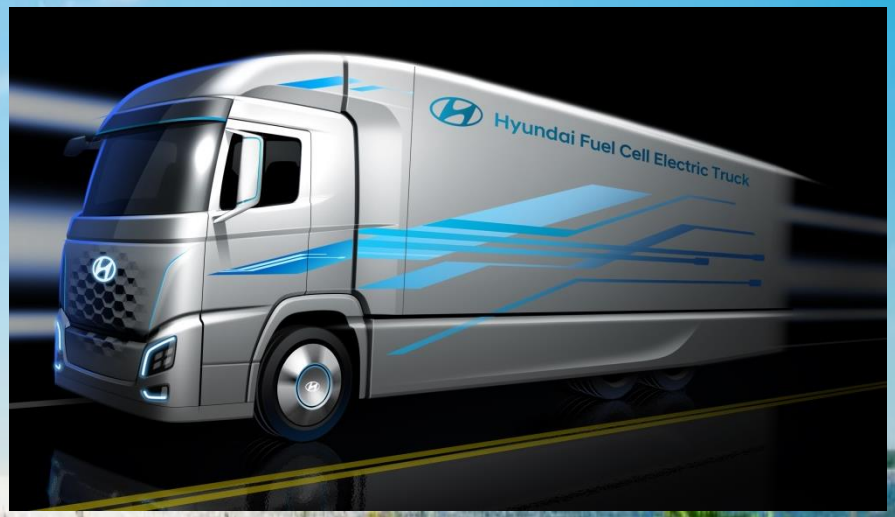
Battery Electric Vehicles (BEV)

Fuel Cell Electric Vehicles (FC-EV)

BW KONSTRUKTION

Heavy E-Trucks

Heavy FC-Trucks



City logistics / Urban logistics

Several serious logistic companies have been involved, as:

- DHL
- DB Schenker
- Ragnsell
- Postnord
- Bring
- martin&servera
- Polarbröd
- Svevia

City logistics / Urban logistics

Several serious logistic companies have been involved, as:

- DHL
- DB Schenker
- Ragnsell
- Postnord
- Bring
- **martin&servera**
- **Polarbröd**
- **Svevia**

City logistics / Urban logistics

Several serious logistic companies have been involved, as:

- DHL
- DB Schenker
- Ragnsell
- Postnord
- Bring

- **martin&servera**
- **Polarbröd**
- **Svevia**

BW KONSTRUKTION

ELC

The challange of urban logistics is complex:

The challange of urban logistics is complex:

- Many different types of vehicles
- Has to compete in limited spaces
- Problems with loading/unloading

The basic solution is N1 (light) trucks

The basic solution is N1 (light) trucks

- N1 = 3 500 kg maximum weight
- Gives with diesel driveline a payload = 1.5 ton

The basic solution is N1 (light) trucks

- N1 = 3 500 kg maximum weight
- Gives with diesel driveline a payload = 1.5 ton
- = 6 x 250 kg roll cages

But this basic solution is not good enaugh

- N1 = 3 500 kg maximum weight
- Gives with diesel driveline a payload = 1.5 ton
- = 6 x 250 kg roll cages
- 4.2 m cargo length allows 15 and

But this basic solution is not good enaugh

- N1 = 3 500 kg maximum weight
- Gives with diesel driveline a payload = 1.5 ton
- = 6 x 250 kg roll cages
- But 4.2 m cargo length allows 15 and
- 5 m = 18 cages . . .

= OVERLOAD

But this basic solution is not good enough

- **OVERLOAD** calls for a N2 truck (max. 7.5 ton)
- N2 trucks needs C driver license & YKB
- = Higher costs
- = Shortage of drivers

The challange of urban logistics is more complex:

- Many different types of vehicles
- Has to compete in limited spaces
- Problems with loading/unloading

- **Several types of environmental challenges**
- **Low efficiency and high energy consumption**
- **All in all = there is a need for a better solution**

BW KONSTRUKTION

ELC

The needed solution is <u>electric</u> N1 (light) trucks

- Many different types of small trucks
- Are better in limited spaces
- Less problems with loading/unloading

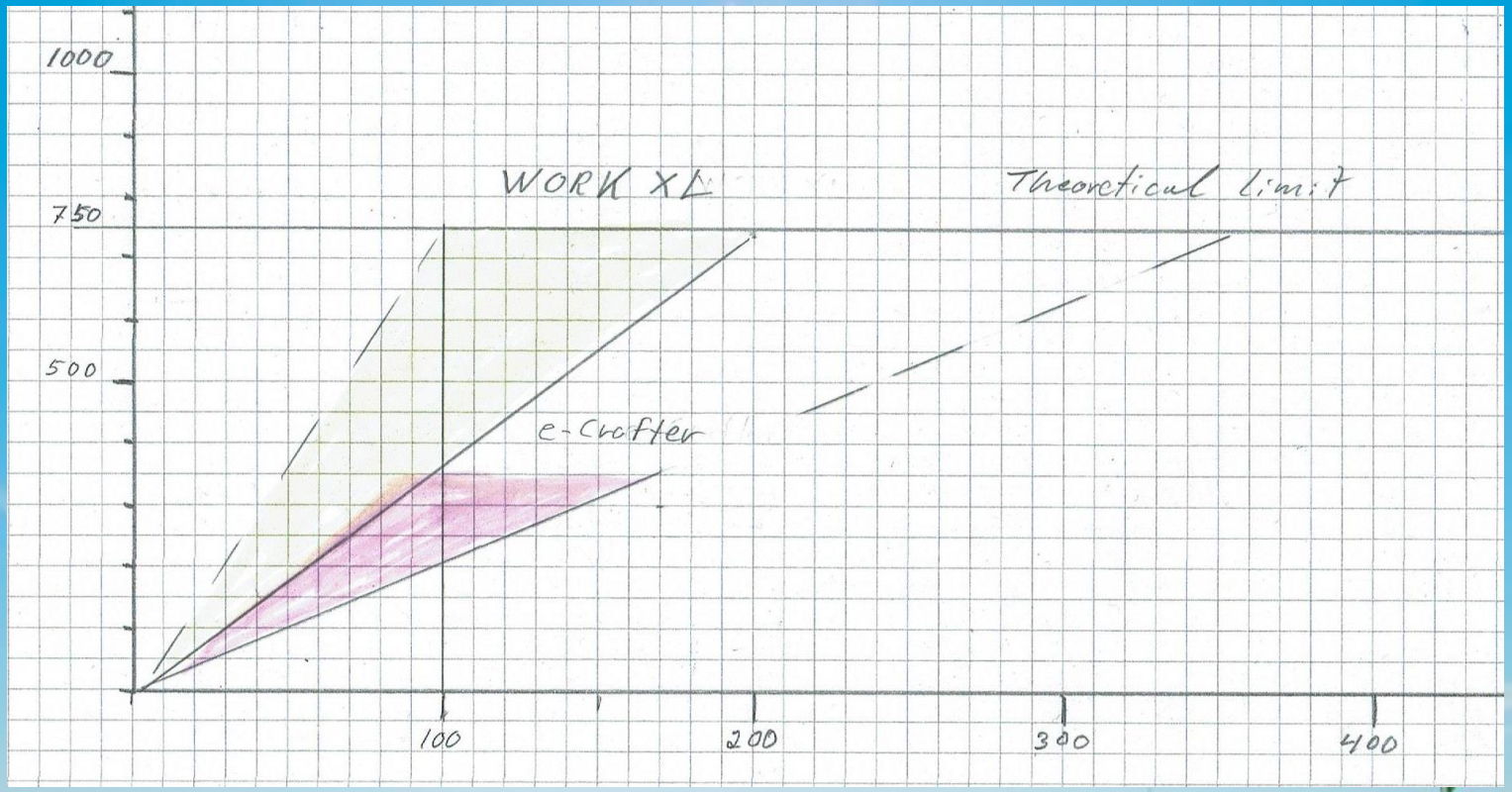
- **Zero emission and no noise**
- **High efficiency and low energy consumption**
- **All in all = basically a good solution**

The challange of electric N1 (light) trucks is the pay load / range

- N1 = 3 500 kg maximum weight
- Gives with diesel driveline a payload = 1.5 ton
- Needs at least 750 kg batteries
- With electric driveline a payload < 1 ton

N1 E-Trucks for urban logistics

Battery needs for N1 E-Trucks

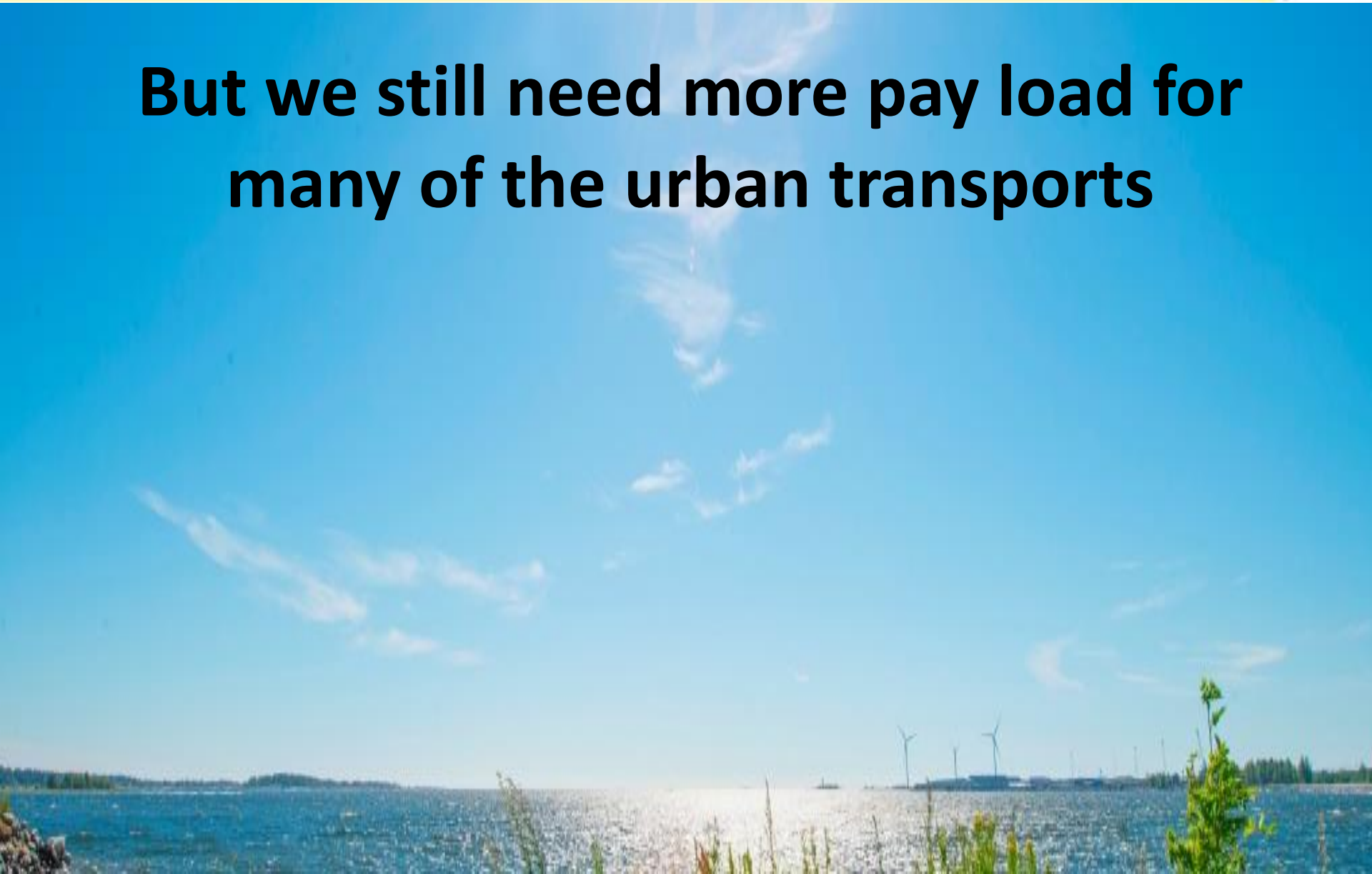


The solution for Electric N1 (light) trucks for the same pay load / range as diesel:

- N1 = 3 500 kg maximum weight
- Gives with diesel driveline a payload = 1.5 ton
- Needs at least 750 kg batteries
- With electric driveline a payload < 1 ton

- **New N1 definition for electric truck = 4 250 kg**
- **Restores payload to 1.5 ton**

But we still need more pay load for many of the urban transports

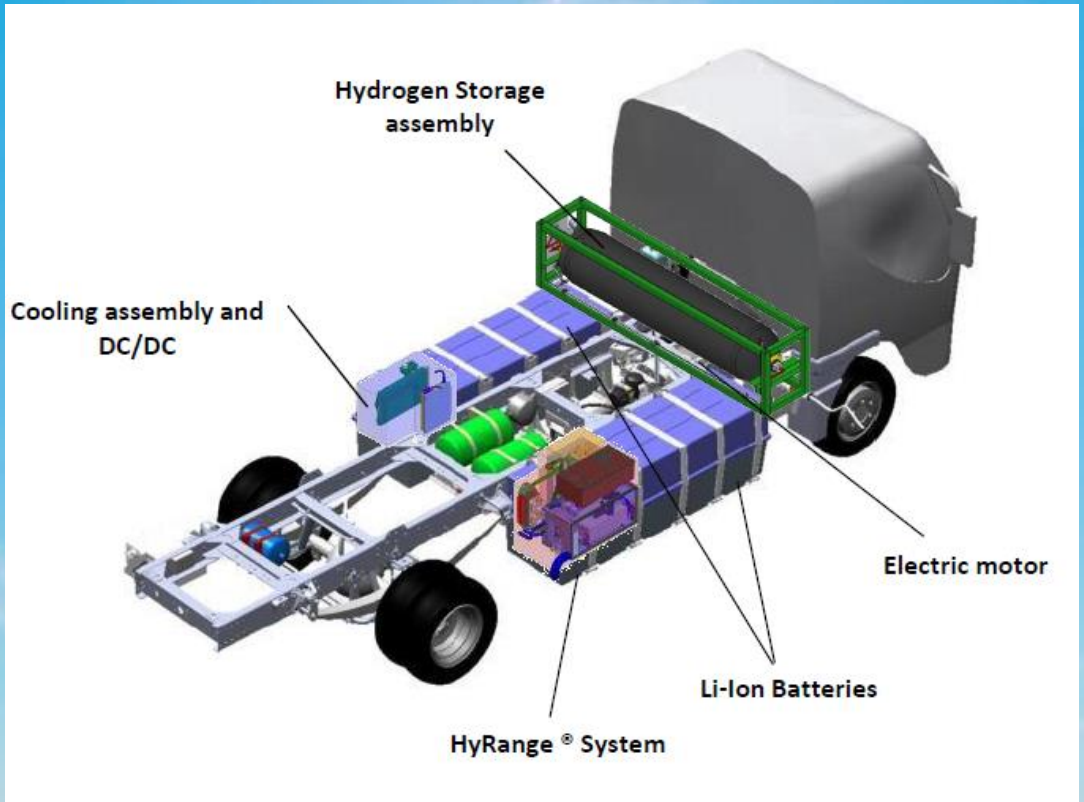


But we still need more pay load for many of the urban transports

and:

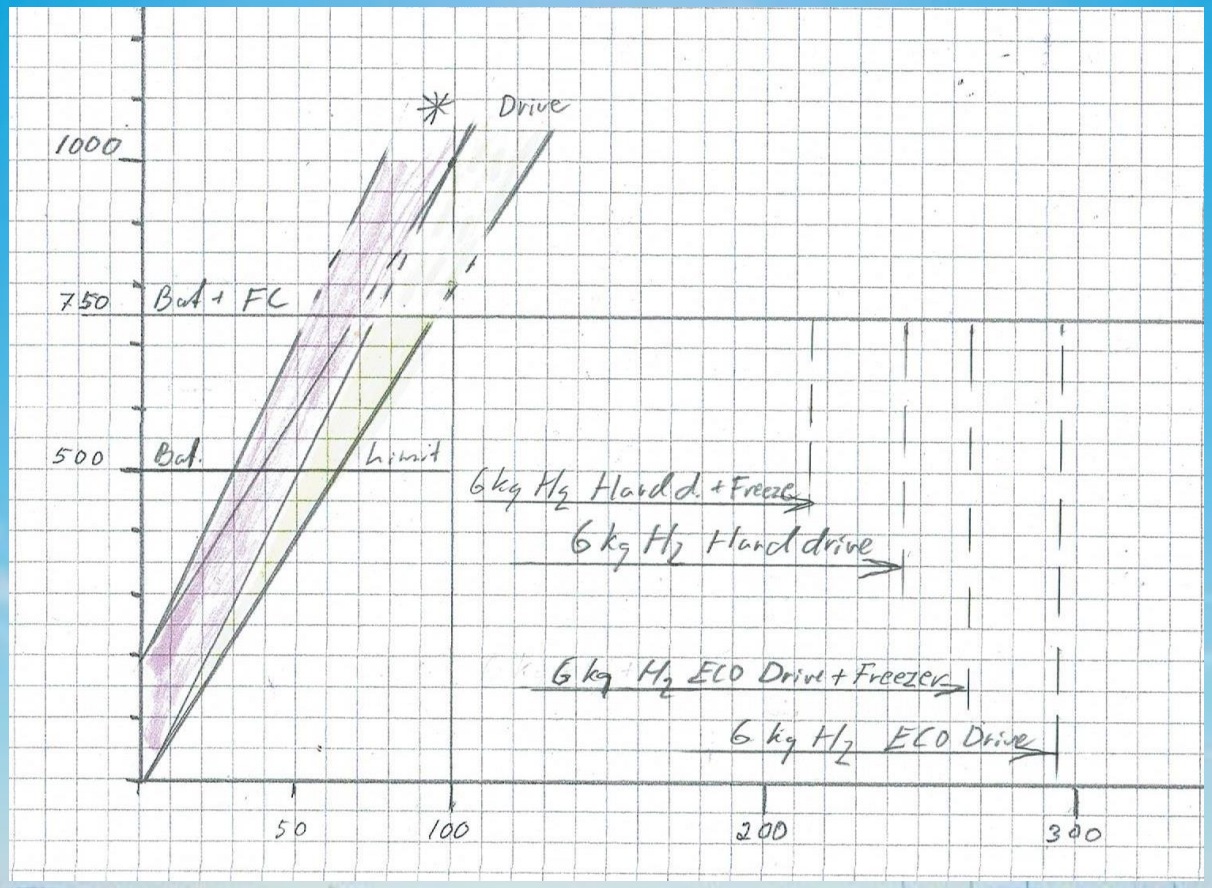
We often need loger range

FC-E-Trucks is then the solution

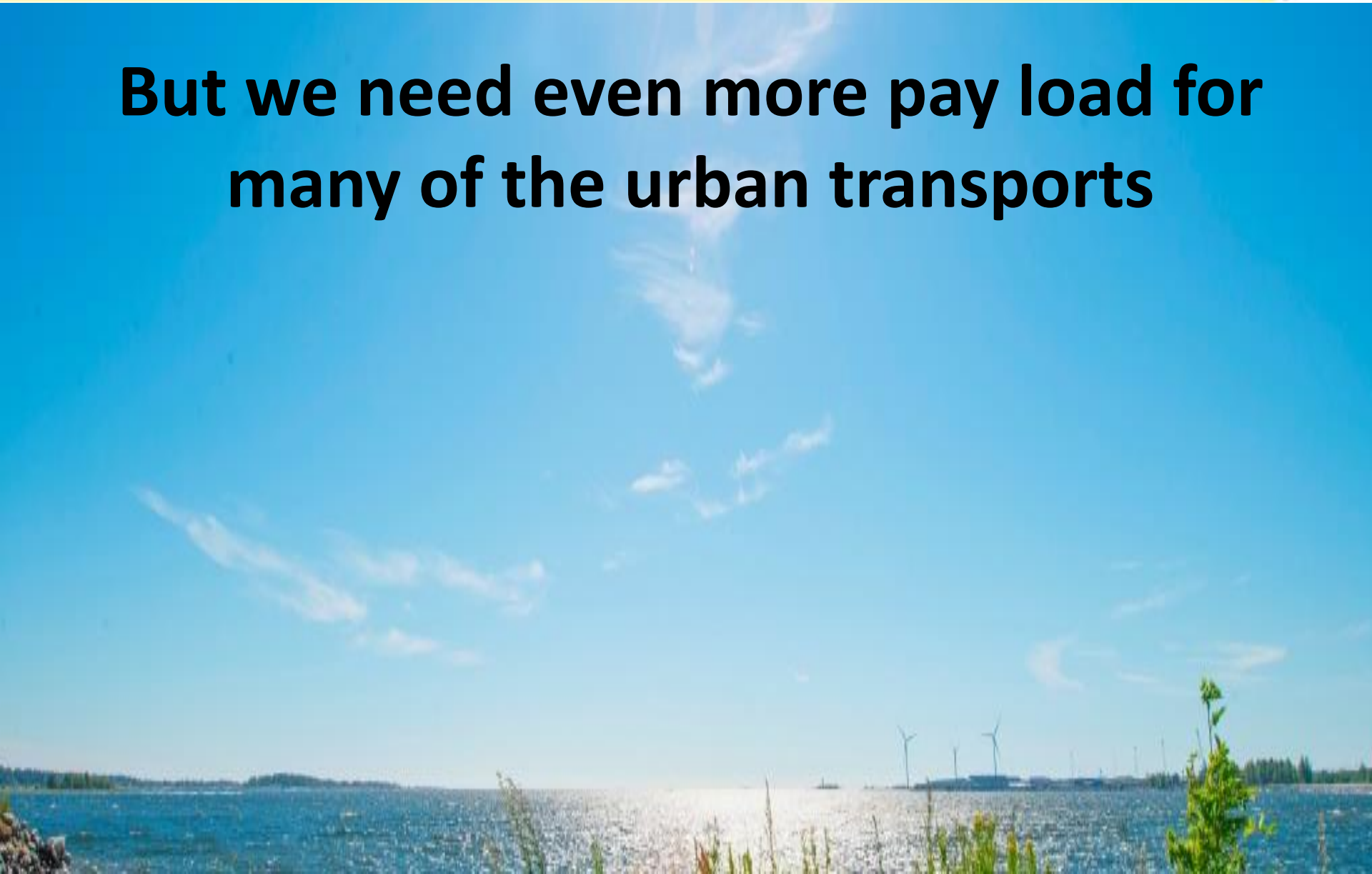


N1 FC-E Trucks are coming

N1 FC-E-Trucks gives the range



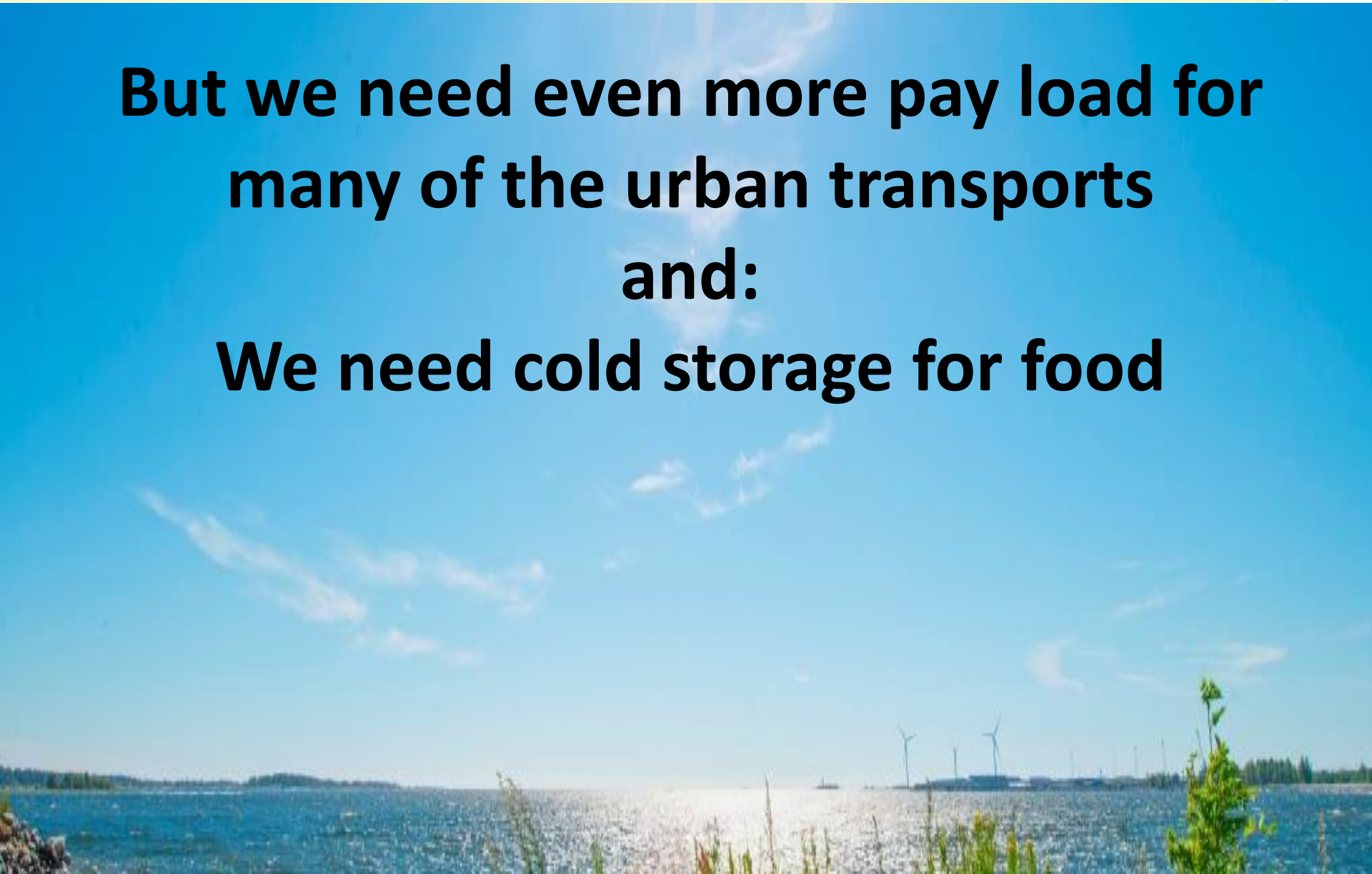
But we need even more pay load for many of the urban transports



But we need even more pay load for many of the urban transports

and:

We need cold storage for food



But we need even more pay load for many of the urban transports

and:

We need cold storage for food

and:

We also need sub-urban transports

= longer range demands

But we need even more pay load for many of the urban transports

and:

We need cold storage for food

and:

We also need sub-urban transports

= longer range demands

= impossible challange for N1 E-Trucks

Our focus has therefore been to create a solution to both urban and sub-urban zero emission logistics, that is basically simple but modular, scalable and very flexible

Our base for this is the BE-Truck

The BE driver licence

BW KONSTRUKTION

The BE-Trailer

BW KONSTRUKTION

The BE-Truck trick

Creates a N2- Trucks (7.5 ton) classified as N1 + O2 (/ O3)

The Electrical solution: The E-BE-Truck gives many benefits as:

- Many options from one truck chassis
- Zero emission and no noice
- Bigger pay load than N1 trucks

- But needs stronger motor = more energy
- = needs more batteries

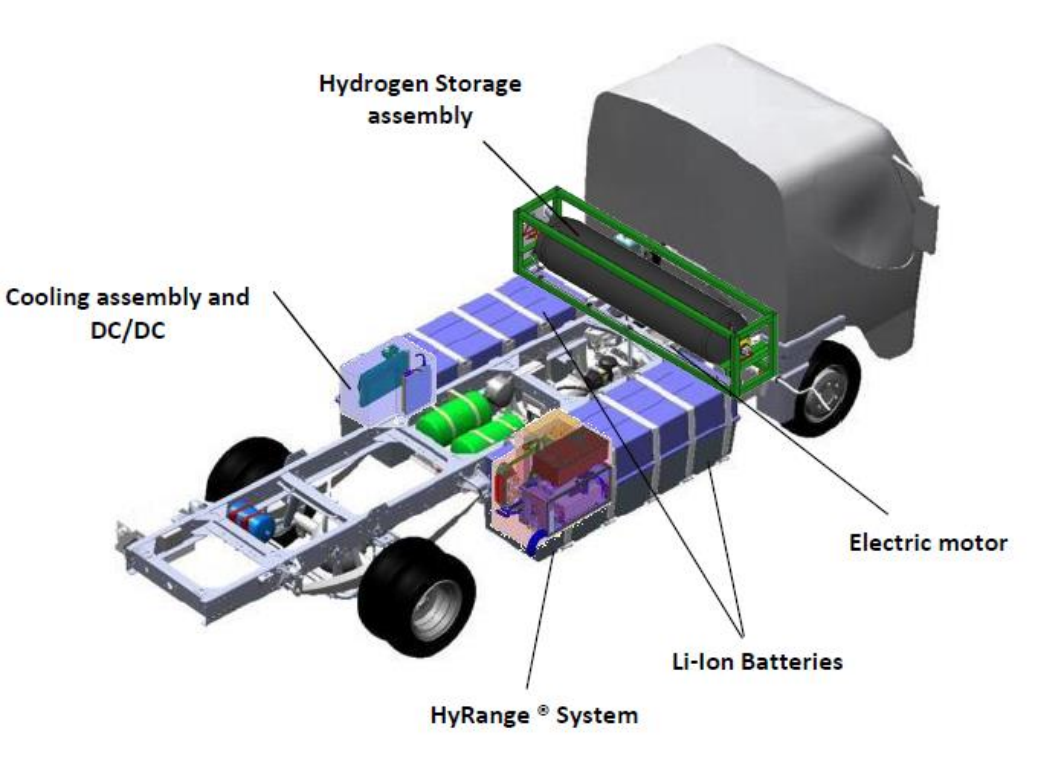
The <u>Fuel Cell Electrical</u> solution: The FC-E-BE-Truck gives even more benefits as:

- Many options from one truck chassis
- Zero emission and no noice
- Needs less batteries
- **Much bigger pay load than N1 trucks**
- **Much longer range**
- All in all = basically a **very** good solution

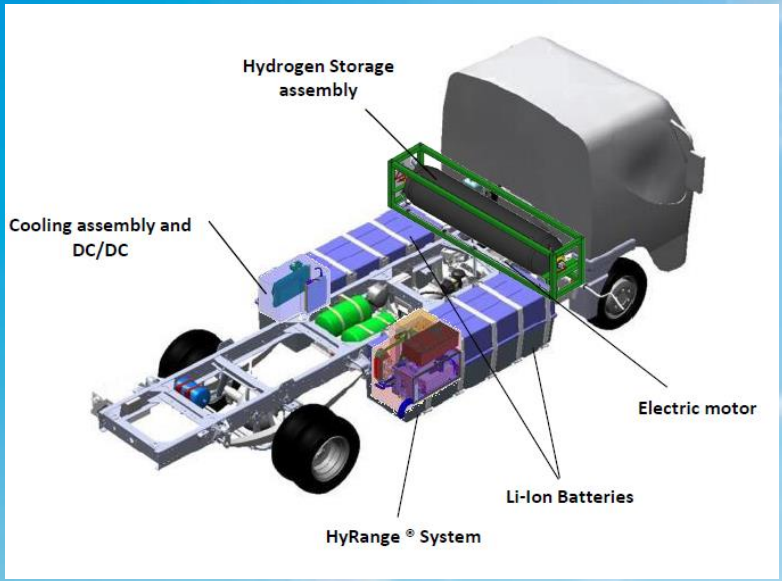
BW KONSTRUKTION

From diesel BE- to FC-E-BE

The main challange for all electrification:

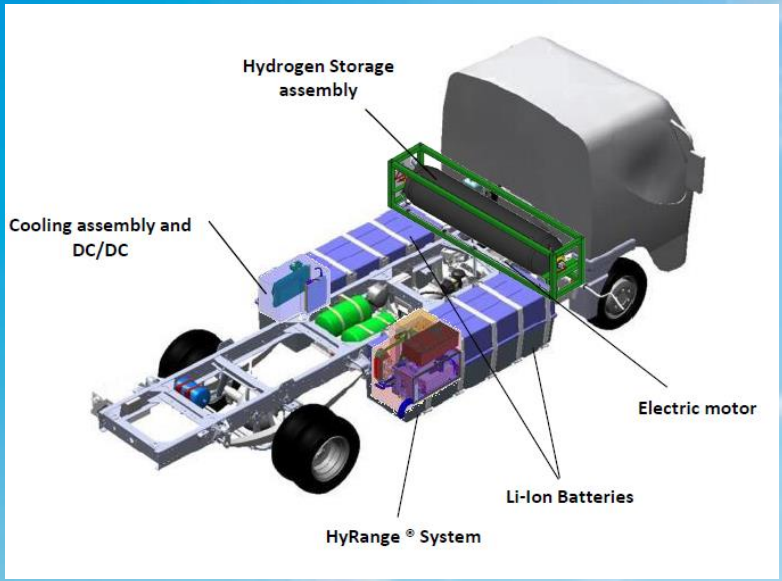


The main challange for all electrification:



Weight and
Weight distribution

The main challange for all electrification:



Weight and
Weight distribution

Also with FC-E-BE-Truck

BW KONSTRUKTION

ELC

Our challange for the FC-E-BE-Truck

Cold climate adaptation

Our challange for the FC-E-BE-Truck

Cold climate adaptation

But also

BW KONSTRUKTION

Our challange for the FC-E-BE-Truck

Cold climate adaptation

Hot climate adaptation

BW KONSTRUKTION

<u>Our</u> challange for the FC-E-BE-Truck

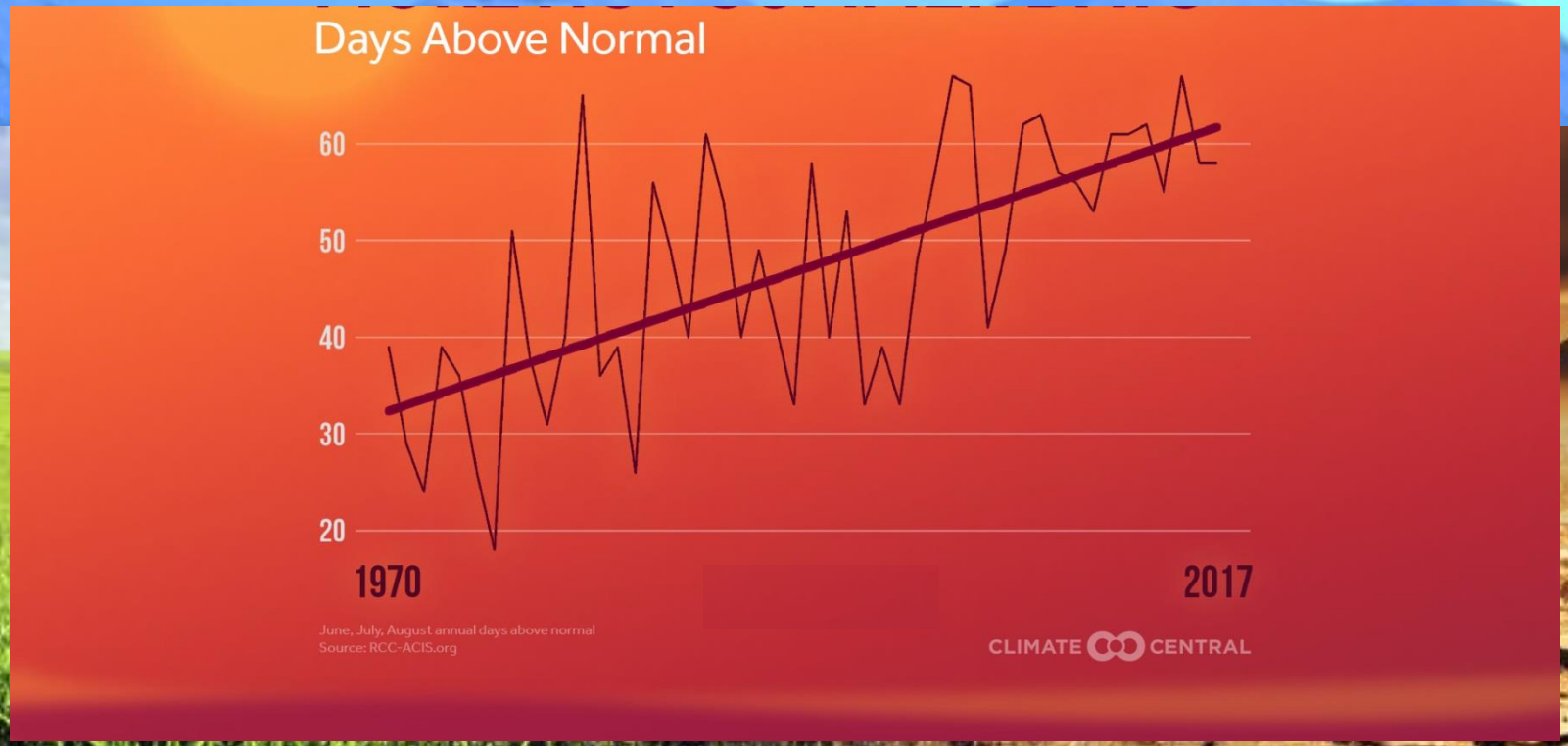
Cold days as -40 C° and

Hot days as +40 C°

BW KONSTRUKTION

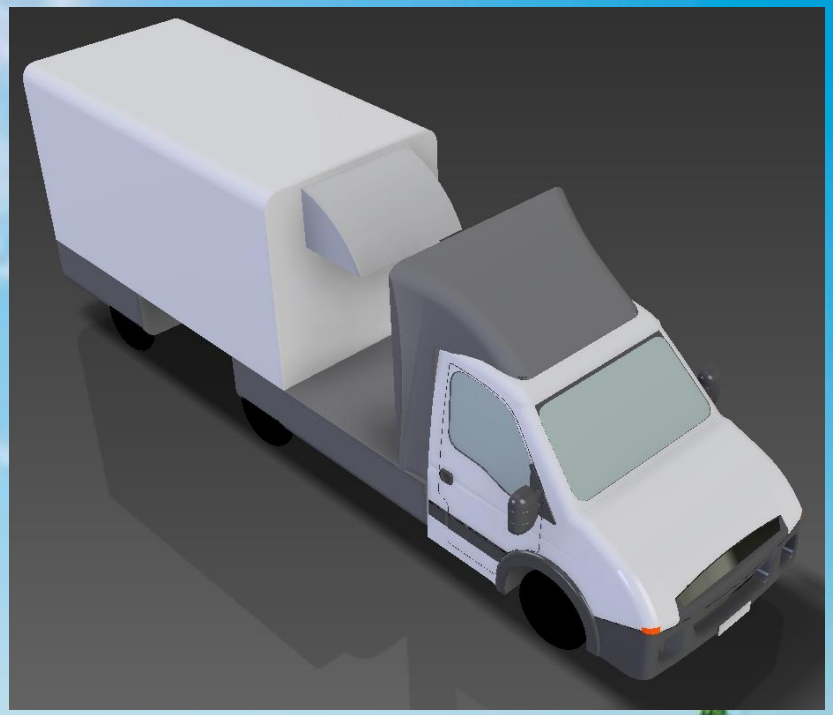
Our challange for the FC-E-BE-Truck

From -40 C° to +40 C° and it's getting worse



BW KONSTRUKTION

Our solution for a FC-E-BE-Truck



Our solution for a FC-E-BE-Truck is based on our experience from other EV and FC-EV-projects including:

BW KONSTRUKTION

ELC

Our solution for a FC-E-BE-Truck is based on our experience from other EV and FC-EV-projects including:

Climate adaptions

BW KONSTRUKTION

ELC

Our solution for a FC-E-BE-Truck is based on our experience from other EV and FC-EV-projects including:

Climate adaptions

Battery systems

BW KONSTRUKTION

ELC

Our solution for a FC-E-BE-Truck is based on our experience from other EV and FC-EV-projects including:

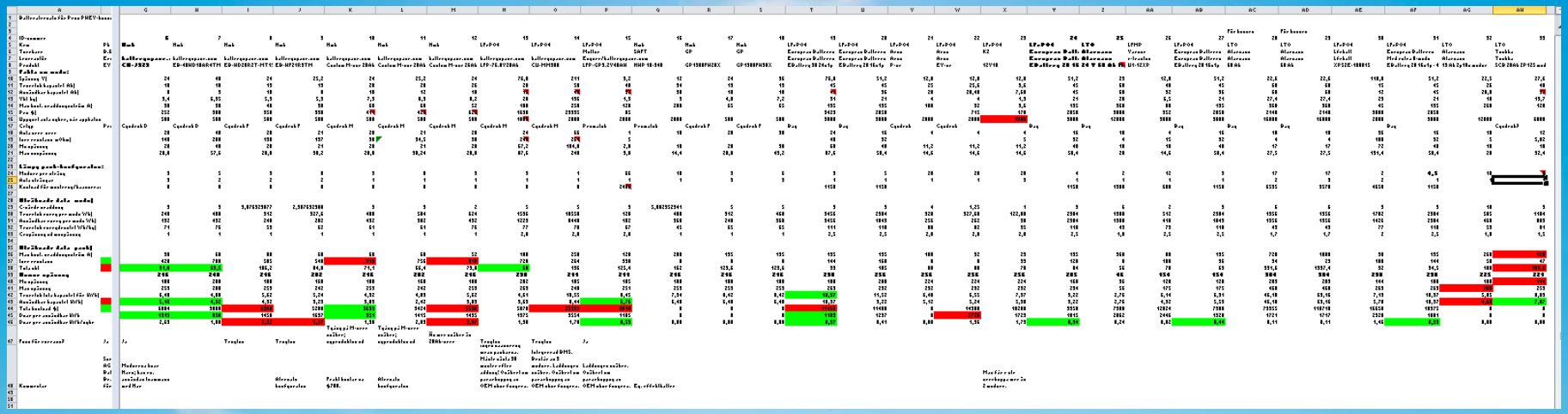
Climate adaptions

Battery systems

Fuel Cell systems

BW KONSTRUKTION

A glimpse at battery systems



BW KONSTRUKTION

A glimpse at battery systems

Kopia av phev-batterier.xls [Kompatibilitetsläge]

	A		Z	AA	AB	AC	AD	AE	AF	
2										
3						För bussen	För bussen			
4	ID-nummer		**25**	26	27	28	29	30	31	
5	Kemi	Pb	**LTO**	LFMP	LiFePO4	LTO	LTO	LiFePO4	LiFePO4	LTO
6	Tillverkare	B.B.	**Altairnano**	Valence	European Batteries	Altairnano	Altairnano	Lifebatt	European Batteries	Altair
7	Leverantör	Electric Ric	**Altairnano**	e-traction	European Batteries	Altairnano	Altairnano	Lifebatt	Med extra 8-modul	Altair
8	Produkt	EVP20-12B	**24 V 60 Ah Module**	U1-12XP	EBattery 20 16s1p	60 Ah	60 Ah	XPS2E-108015	EBattery 20 16s1p - 45Ah	13 Ah
9	**Fakta om modul:**									
10	Spänning (V)		23	12,8	51,2	22,6	22,6	118,8	51,2	
11	Teoretisk kapacitet (Ah)		60	40	45	60	60	15	45	
12	Användbar kapacitet (Ah)		60	32	36	60	60	12	45	
13	Vikt (kg)		28	6,5	21	27,4	27,4	23	21	
14	Max kont. urladdningsström (A)		360	80	135	360	360	45	135	
15	Pris ($)		3000	952	2050	2140	2140	3000	2050	
16	Uppgivet antal cykler, vår applikation		12000	3000	3000	16000	16000	2000	3000	
17	Celltyp	Prismatisk	Bag		Bag	Bag	Bag		Bag	
18	Antal celler i serie		10	4	16	10	10	36	16	
19	Inre resistans (mOhm)		4	15	32	4	4	100	32	
20	Min spänning		18	10	40	17	17	72	40	
21	Max vilospänning		28	14,6	58,4	27,5	27,5	131,4	58,4	
22										
23	**Lämplig pack-konfiguration:**									
24	Moduler per sträng		2	12	3	17	17	2	**4,5**	
25	Antal strängar		1	1	1	2	3	2	1	
26	Kostnad för montering/balanserare/etc		1900	600	1150	6595	9570	4650	1150	
27										
28	**Uträknade data (modul)**									
29	C-värde urladdning		6	2	3	6	6	3	3	
30	Teoretisk energi per modul (Wh)		1380	512	2304	1356	1356	1782	2304	
31	Användbar energi per modul (Wh)		1380	410	1843	1356	1356	1426	2304	
32	Teoretisk energidensitet (Wh/kg)		49	79	110	49	49	77	110	
33	Cellspänning vid minspänning		1,8	2,5	2,5	1,7	1,7	2	2,5	
34										
35	**Uträknade data (pack)**									
36	Max kont. urladdningsström (A)		360	80	135	720	1080	90	135	

BW KONSTRUKTION

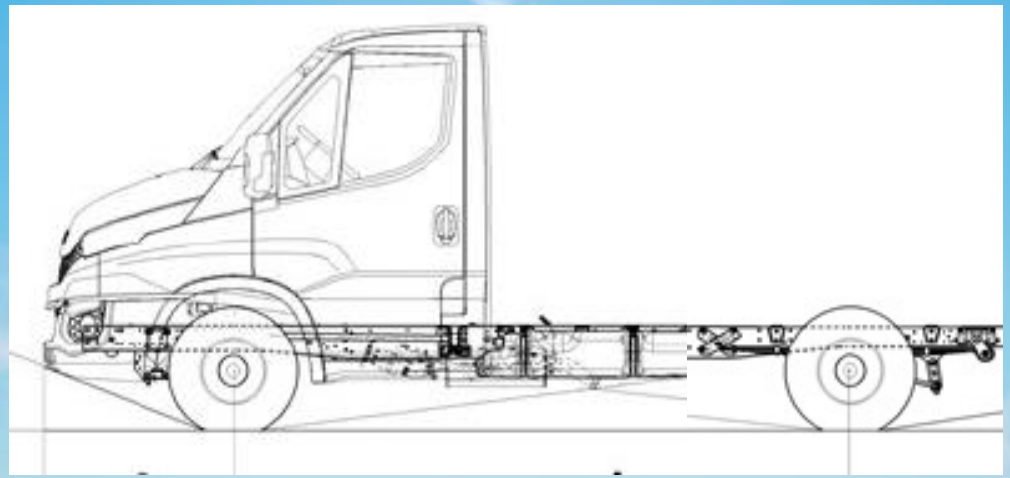
A glimpse at Fuel Cell systems

Fuel cell System comparison

	Hydrogenics				Powercell				HyMove				ProtonMotor			
	1	5	10	25	1	5	10	25	1	5	10	25	1	5	10	25
System Name	HyPM HD30				MS-30 with S2 stack				3 stacks system				HyRange 38			
Budget fuel cell Range Extender																
System cost from supplier			52 000		160 000			100 000	100 000							
Additional hardware costs	15 000															
Development costs	35 000															
Maintenance																
Service costs																
Performance																
System Power (now 30 kW max)	31 kW				32 kW				33 kW				37,4 kW			
System and stack predicted lifetime	>10.000				10 000				15 000				>20.000			
Voltage range	60-120				135-264				140-270				75-137			
Amps range	0-500				0-240				0-240				0-500			
Weight	75 kg				145 kg				290 kg							
Size (lxbxh)	720*406*261				451*641*656				1024*620*643							
Ambiant temp range (running)	- 10grC - +46grC				-20grC - +50grC				- 20grC - +40grC				- 45grC - +60grC			
Minimum startup temperature	2grC				not clear				2grC							
Minimum storage temperature	-40grC				not clear				- 20 grC (-40 grC ??)							
subzero startup?	keep warm/pre-heat				partly				keep warm/pre-heat							
Blow out system (for below zero use)?	yes for subzero storage!				not clear				at shutdown							
Sound level					< 80 dBA				<70 dBA (estimation)							
Cell plate material	Carbon polymer				Metall				Carbon polymer				Carbon polymer			
Operational parameters																
Fuel consumption at different power c																
Temperature of cooling water	50-70 grC coolant out				max 70grC coolant in				65-70 grC internal							
Interfacing																
Hydrogen supply pressure	5,5 - 8,3 barg				10 barg				6 - 8 barg				1,2 - 8 barg			
Hydrogen quality	4.0 CO< 0,2ppm				>3.5				5.0				ISO 14687-2 SAEJ2719			
CAN-bus interface for monitoring anc	CAN 2.0A				CAN				CAN 2.0 or J1939							
System supply voltage	12 or 24V				24V				24V							
System supply watts	30W (system) + 60W (airpump)				500W				ca 800W							
Airpump supply	From system				max 5 kW 300V-440VDC				max 4 kW HV							
IP class					IP54				depending on housing IP67				IP66			
Powerelectronics																
Recommended DC/DC	0-500Amps.				8000 Visedo				8000 (Visedo, max 405 amps)							
Size, weight and cost of DC/DC	35000 (Hydrogenics 2014)				10000 Tame Power											
	8000 (Visedo, max 405 amps)															
Conformity													ECE 79/2009, R10, R100			

BW KONSTRUKTION

Our solution for a FC-E-BE-Truck: One basic chassis



BW KONSTRUKTION

ELC

Our solution for a FC-E-BE-Truck: One basic chassis with customer adapted energy storage:

BW KONSTRUKTION

Our solution for a FC-E-BE-Truck: One basic chassis with customer adapted energy storage:

Different battery systems

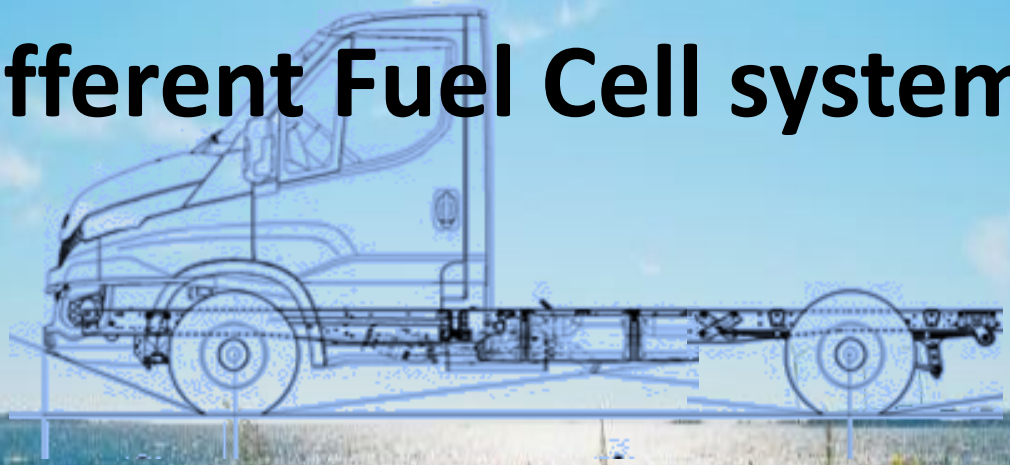
BW KONSTRUKTION

ELC

Our solution for a FC-E-BE-Truck: One basic chassis with customer adapted energy storage:

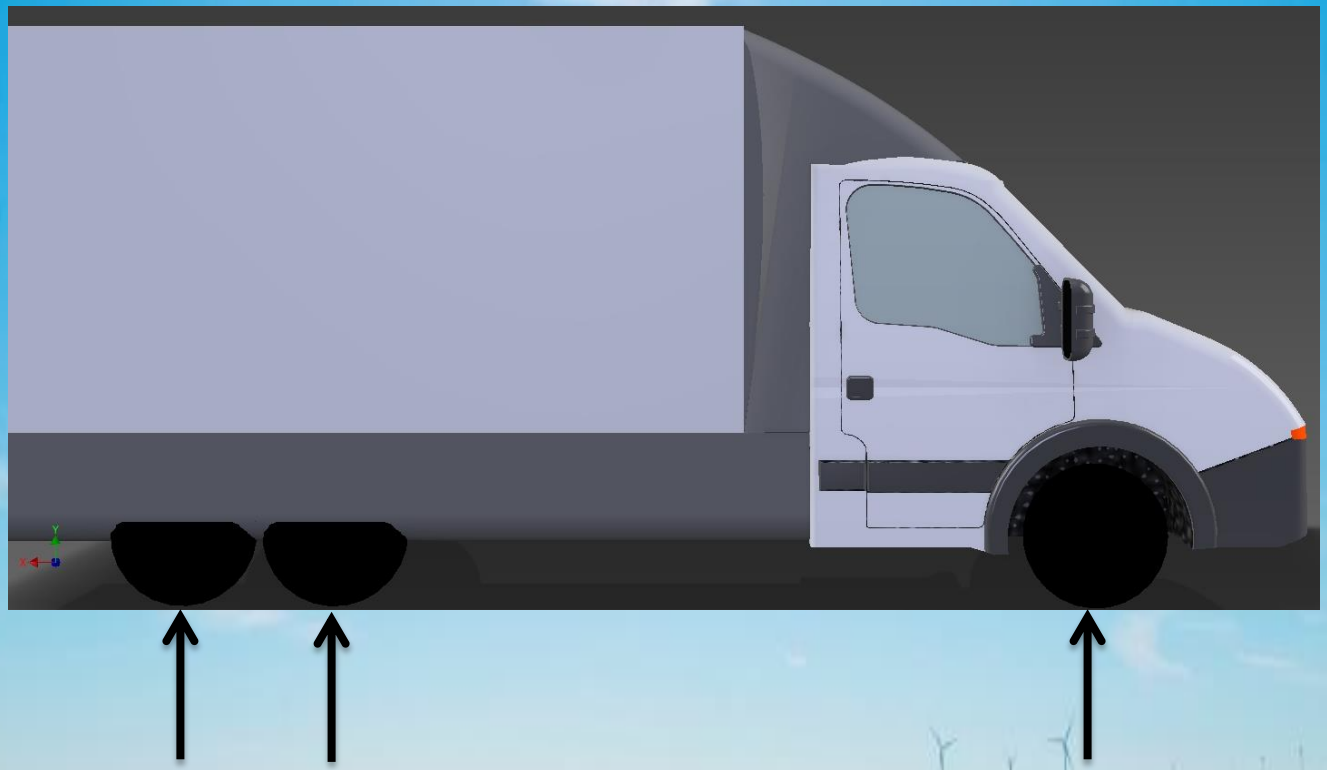
Different battery systems

Different Fuel Cell systems



The FC-E-BE-Truck trick

Is all about weight distribution

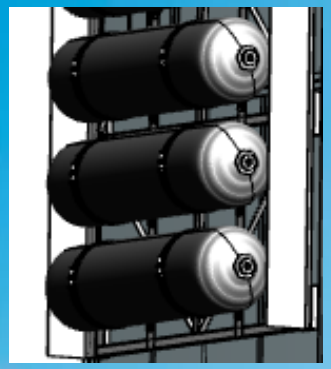


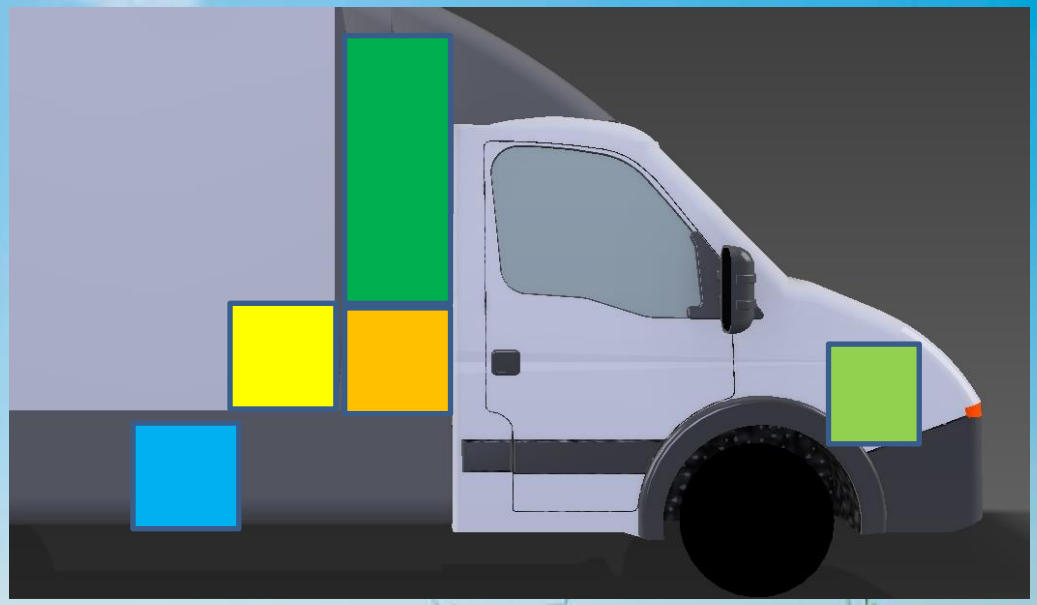
BW KONSTRUKTION

ELC

The solution for our FC-E-BE-Truck

Is 3D RL TETRIS



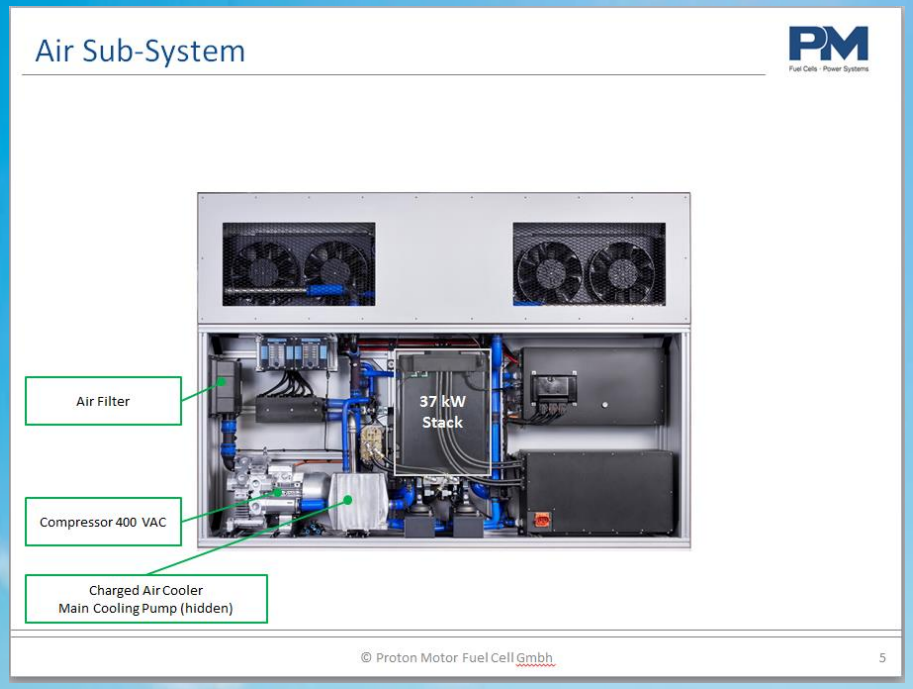


BW KONSTRUKTION

The FC-module for the FC-E-BE-Truck

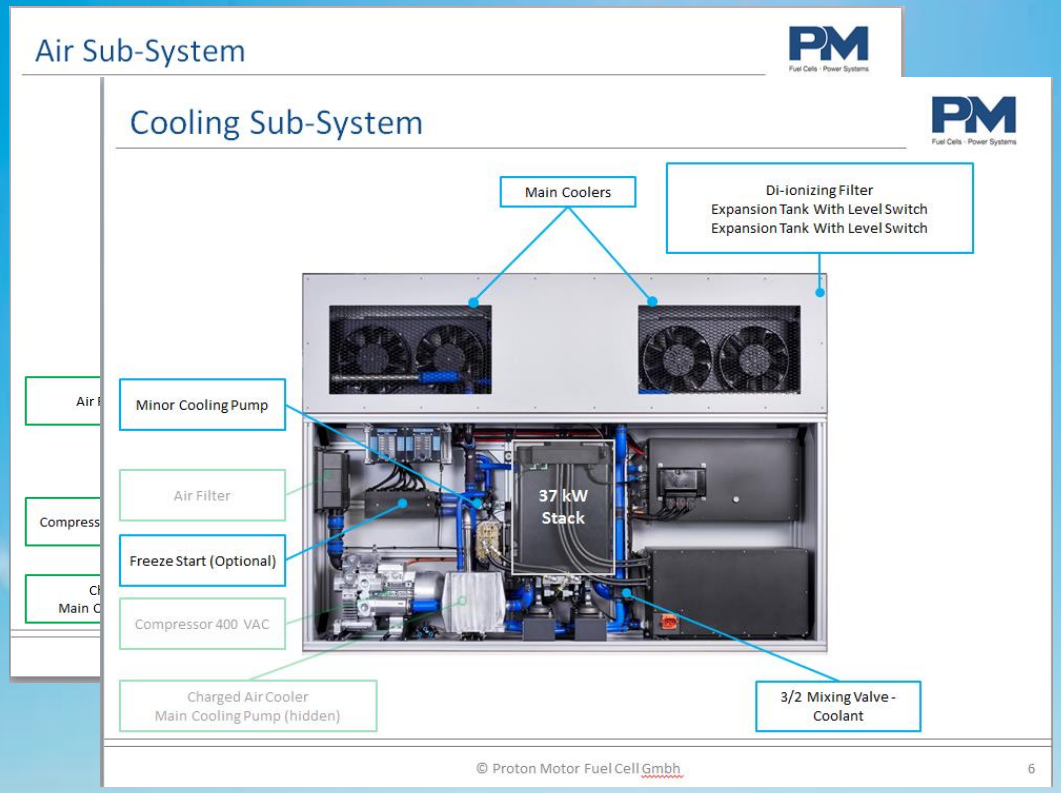
BW KONSTRUKTION

The FC-module for the FC-E-BE-Truck



BW KONSTRUKTION

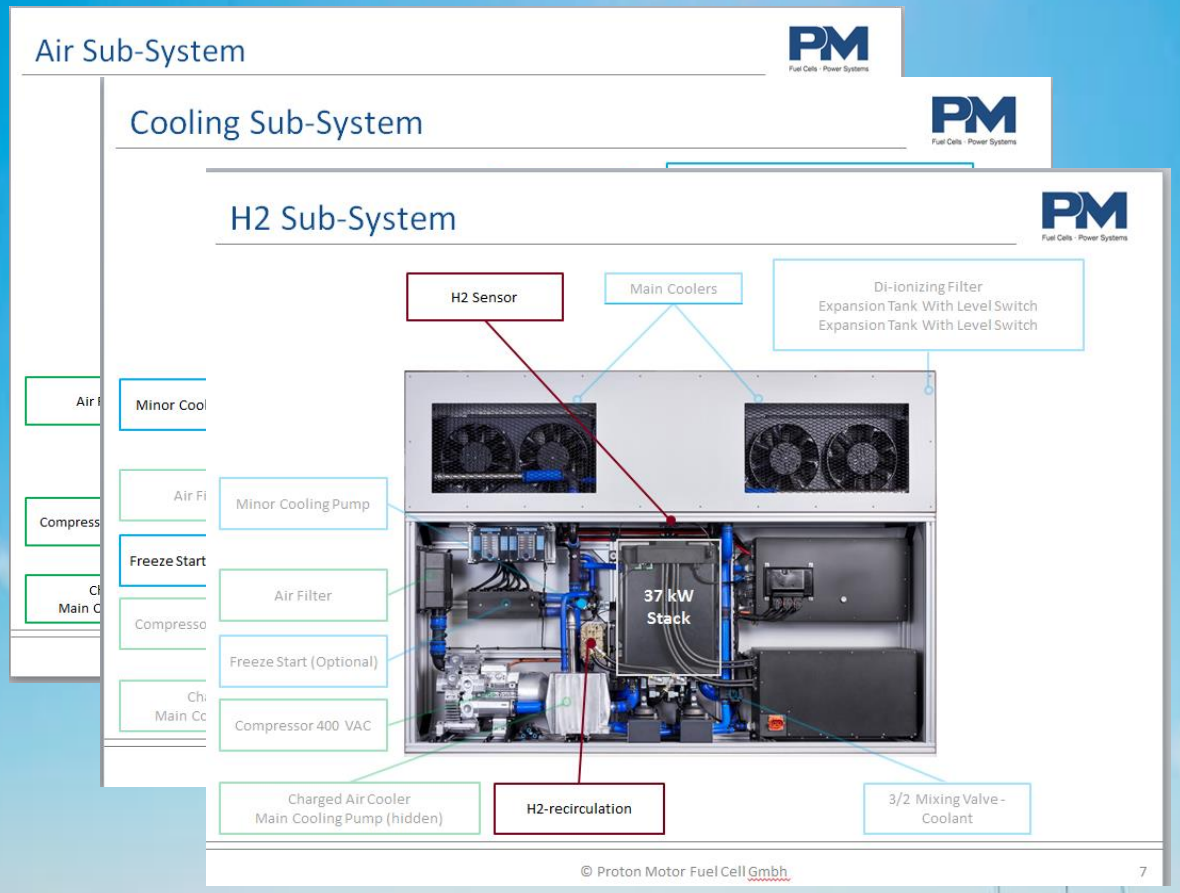
The FC-module for the FC-E-BE-Truck



BW KONSTRUKTION

ELC

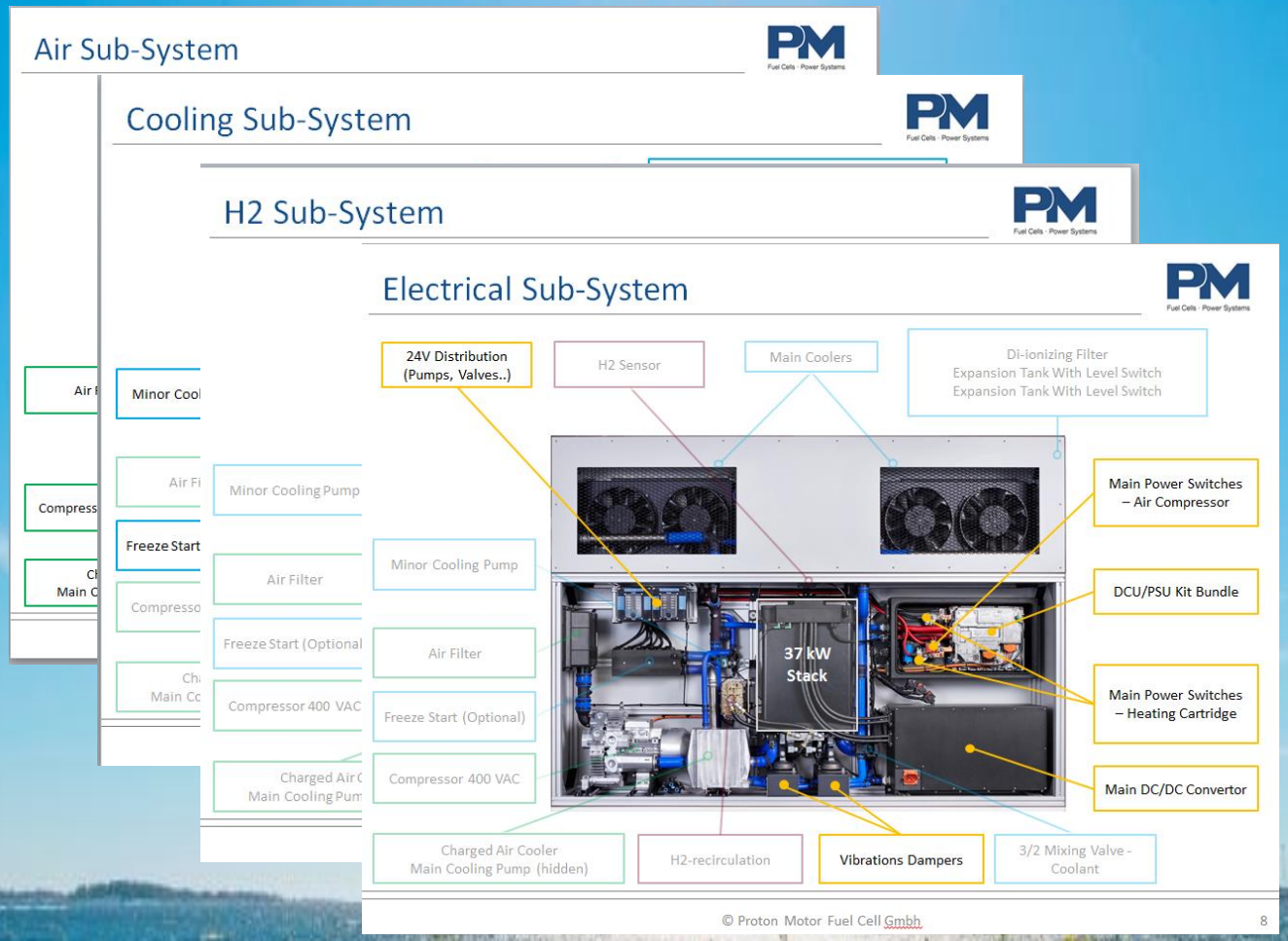
The FC-module for the FC-E-BE-Truck



BW KONSTRUKTION

ELC

The FC-module for the FC-E-BE-Truck



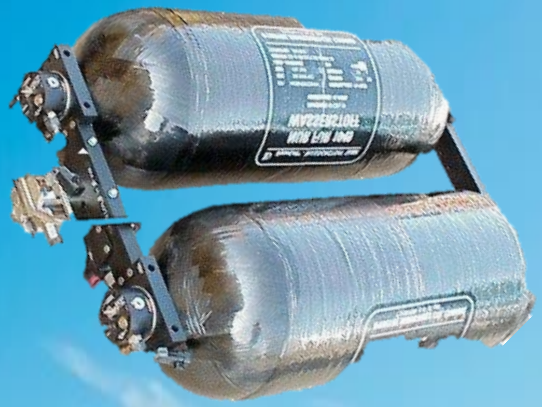
Besides the FC-module

we need

BW KONSTRUKTION

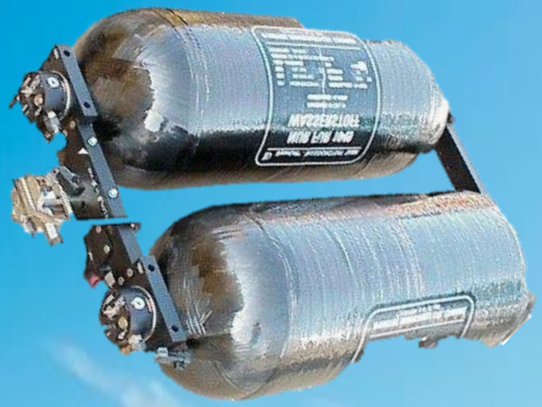
ELC

The H_2 tanks for the FC-E-BE-Truck



And:

The H_2 tanks for the FC-E-BE-Truck



And:

Different battery modules

Summary:

We now know how to build these trucks

BW KONSTRUKTION

ELC

Summary:

We now know how to build these trucks

We have the potential customers

martin& servera

SVEVIA

POLARBRÖD

BW KONSTRUKTION

ELC

Summary:

We now know how to build these trucks

We have the potential customers

We even have the hydrogen!

OAZER

BW KONSTRUKTION

ELC

Summary:

We now know how to build these trucks

We have the potential customers

We even have the hydrogen!

But:

OAZER

Summary:

We now lack financing. . .

BW KONSTRUKTION

Do you want to partner up?

Thank you for your attention

Boh Westerlund

BW Konstruktion AB

bwk@telia.com

1905