BLUEPOWER – EV & HFCEV

Simon Hyde – CEO

FAUN ZOELLER

BLUEPOWER

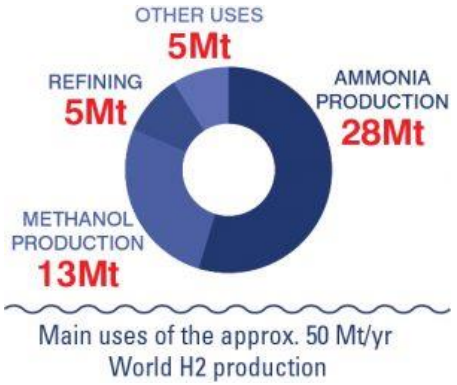
- Government Targets
- Duty Cycles / Ranges
- Operational Requirements
- Charging Infrastructure
- Resources Available
- Total Cost of Investment
- Future Proofing

CONSIDERATIONS

FAUN ZOELLER

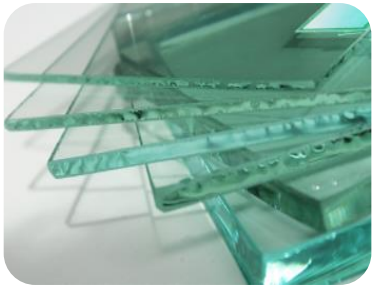
SIGNIFICANCE OF HYDROGEN TODAY

- **Chemical industry**
  - Used as a source element for synthesis of ammonia (fertilisers), methanol, and many others.
- **Metalworking**
  - Mainly used to create metal alloys.
- **Refineries**
  - Used to process crude oil into refined fuels. (Removal of sulphur and other contaminates).
  - Separation of oxygen from Iron ore. (cleaner than traditional blast furnace).
- **Industry**
  - Glass production (used as inserting protective gas, cleaning, etching).
- **Electrical generation**
  - Generator cooling, corrosion preventative in power plant pipelines.



Main uses of the approx. 50 Mt/yr World H2 production

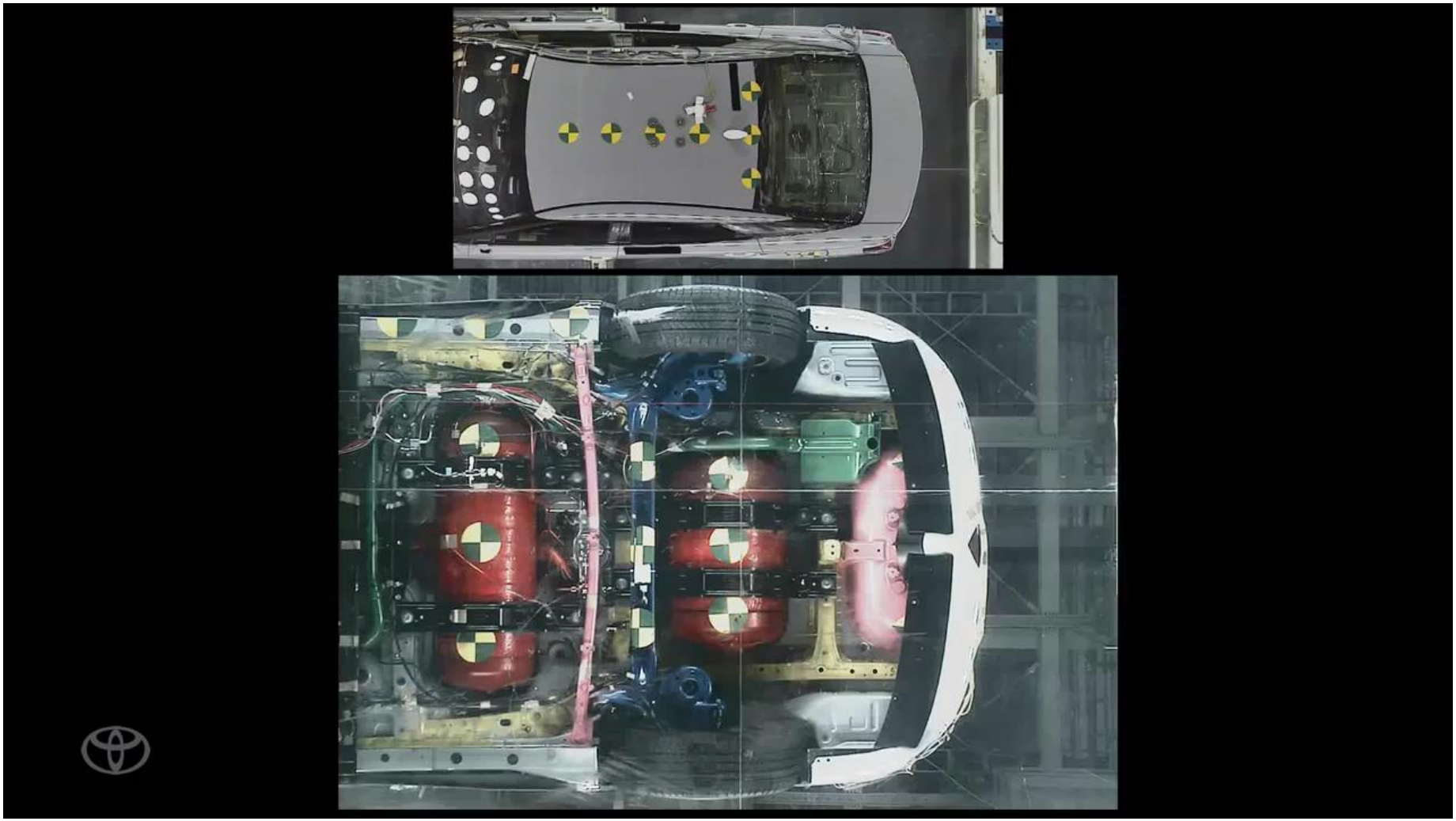



BURN OFF TEST

TOYOTA BULLET TEST HYDROGEN TANK

TOYOTA CRASH TEST HYDROGEN TANK



THE COLOURS OF HYDROGEN

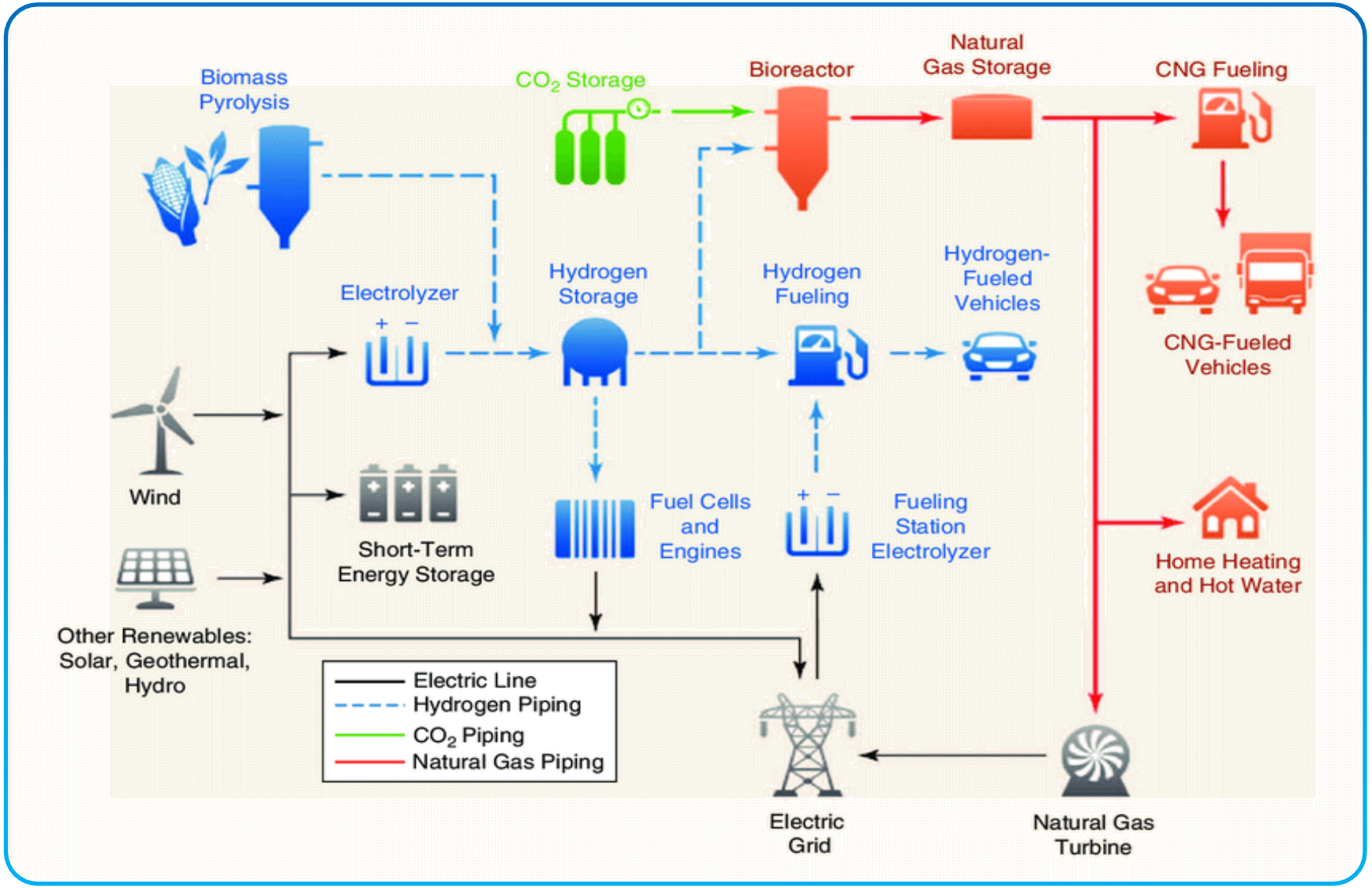
GREEN HYDROGEN
- Generated by water electrolysis.
- The electricity for the electrolyser used is only from renewable sources.
- The hydrogen generation is CO_2 free as the applied energy during electrolysis is derived from 100% renewable sources.

GREY HYDROGEN
- Made using fossil fuels like oil, coal, natural gas.
- For steam reforming it is usually natural gas.
- CO_2 is exhausted into the atmosphere causing global warming effect.
- With every ton of hydrogen produced roughly 10 tons of CO_2 is emitted.

BLUE HYDROGEN
- Is produced in the same way as Grey Hydrogen.
- However the CO_2 emission is separated and stored using CCS (Carbon Capture and Storage)
- The generated CO_2 is not accumulated in the atmosphere and the hydrogen generation is CO_2 neutral in balance.

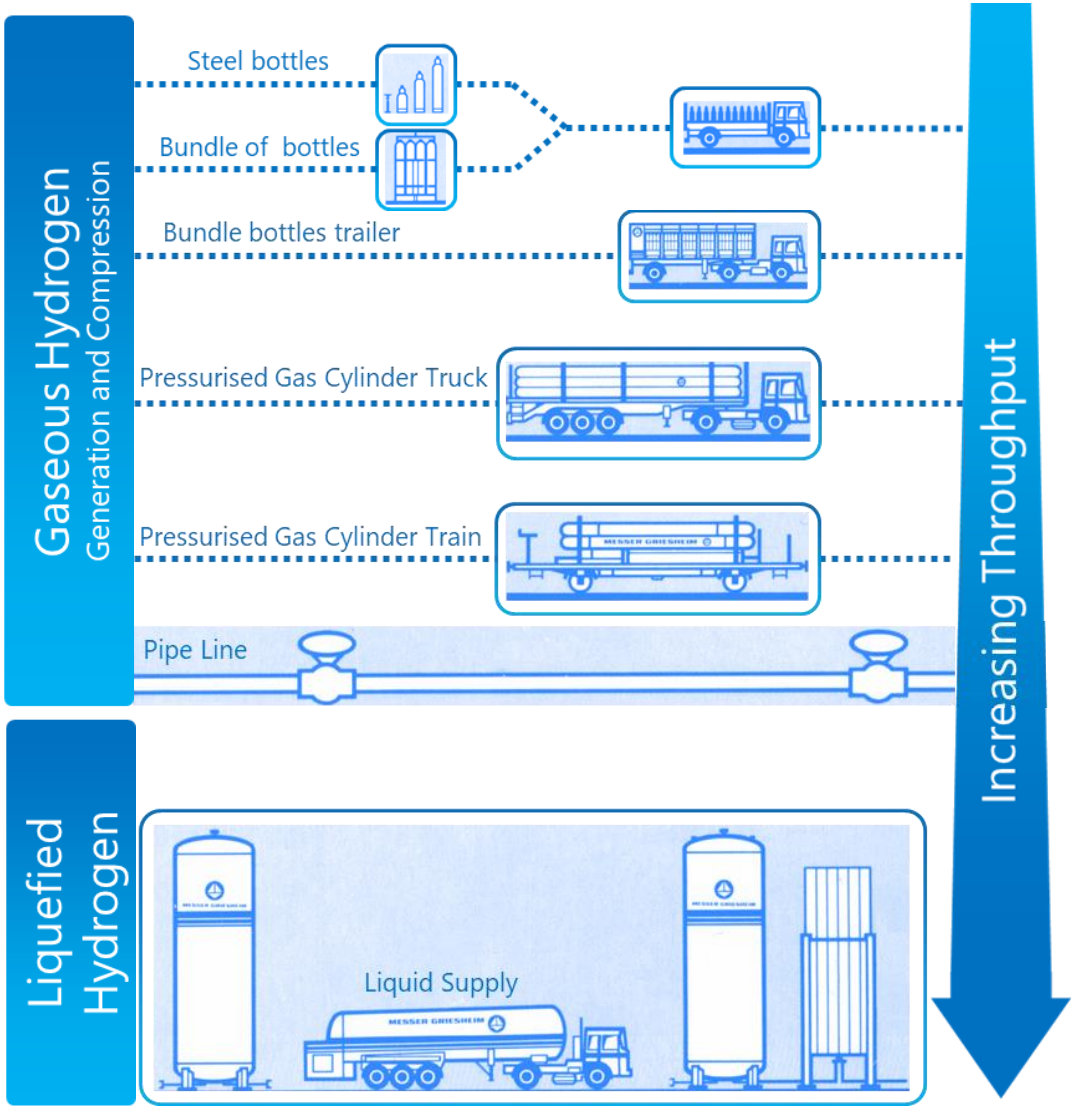
TURQUOISE HYDROGEN
- Hydrogen is generated by thermal decomposition of methane (methane-pyrolysis)
- Instead of CO_2 the byproduct is solid Carbon.
- The CO_2 neutrality of the process requires renewable sources for the supply of the high temperature reactor.
- Permanent storage is required for the generated carbon.

RENEWABLE ENERGY PATHWAYS OF HYDROGEN



HYDROGEN TRANSPORT

Depending on the amount of hydrogen required (Throughput) different storage and transportation methods exist.



One LH2 truck can transport around 3.500 kg hydrogen.

Battery Electric Vehicles vs Fuel Cell Electric Vehicles

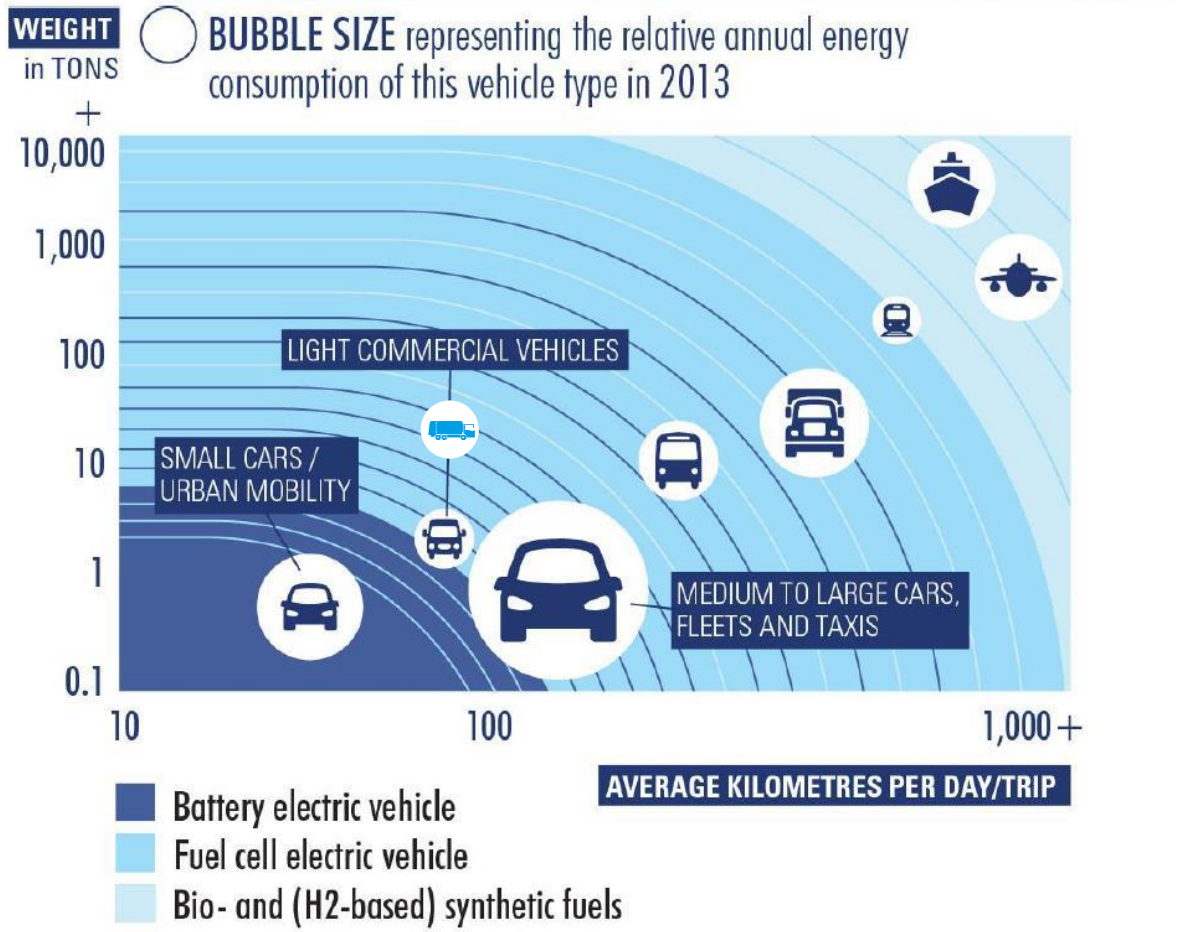
Although fuel cell systems and batteries are seen by some as competing technologies, they are actually complimentary technologies, that both offer different advantages depending on use-cases, cost and regulations.

Different Vehicles will be better suited to differing propulsion systems.

Small cars / Urban mobility might be better suited to BEV propulsion as they are light weight,. Have lower energy usage needs and cover less distance.

Heavier larger vehicles covering larger distances with higher energy demands will be better suited to FCEV propulsion.

Large Ships & Aircraft might suit Bio and H2 based synthetic fuels



WORKING PRINCIPAL FUEL CELL

FAUN ELECTRIC DRIVE EXPERIENCE

DUALPOWER / FUELCELL / BLUEPOWER	
Jan 2006	Alternate Drive Idea = DUALPOWER
Jan 2009	First Trial runs of DUALPOWER
July 2009	DUALPOWER (20 Vehicles for field testing)
Oct 2009	FUELCELL Hydrogen fuel cell refuse collection vehicle
Nov 2010	Handover of DUALPOWER to the operator
June 2011	FUELCELL vehicle in Berlin
May 2018	Concept presentation BLUEPOWER at IFAT 2018
Oct 2019	Delivery of the first fully electric vehicle to BEG Bremerhaven
Jan 2020	Hydrogen Summit: Presentation of prototype refuse collection vehicle and sweeper
June 2020	Working Prototype with hydrogen
July 2020	Establishment of a hydrogen competence centre in Osterholz-Scharmbeck

BLUEPOWER - WASTE COLLECTION VEHICLE

All necessary BLUEPOWER components are installed in a chassis without conventional drive technology (so called Glider):

BATTERY-PACKAGE:

Battery capacity: 85 kWh

Collection performance:

2 x 10 t waste with an intermediate charging (40 min, 150 kW fast charging station)

Range: 20 km transport

Chemistry:

LiFePo or NMC (subject to availability)

HYDROGEN FUEL CELLS:

Fuelcells: 30 up to 90 kW

HYDROGEN TANKS:

Storage: 150 kWh – 600 kWh

Pressure: 700 bar

Filling time: approx. 7-15 minutes

Range: up to 400 km


BLUEPOWER

Tanks and Fuel Cells in the Chassis

Auxiliary Equipment installed as Normal

Cement Mixer / Fridge Box etc

Built in Full Commercial & Technical cooperation with Daimler AG

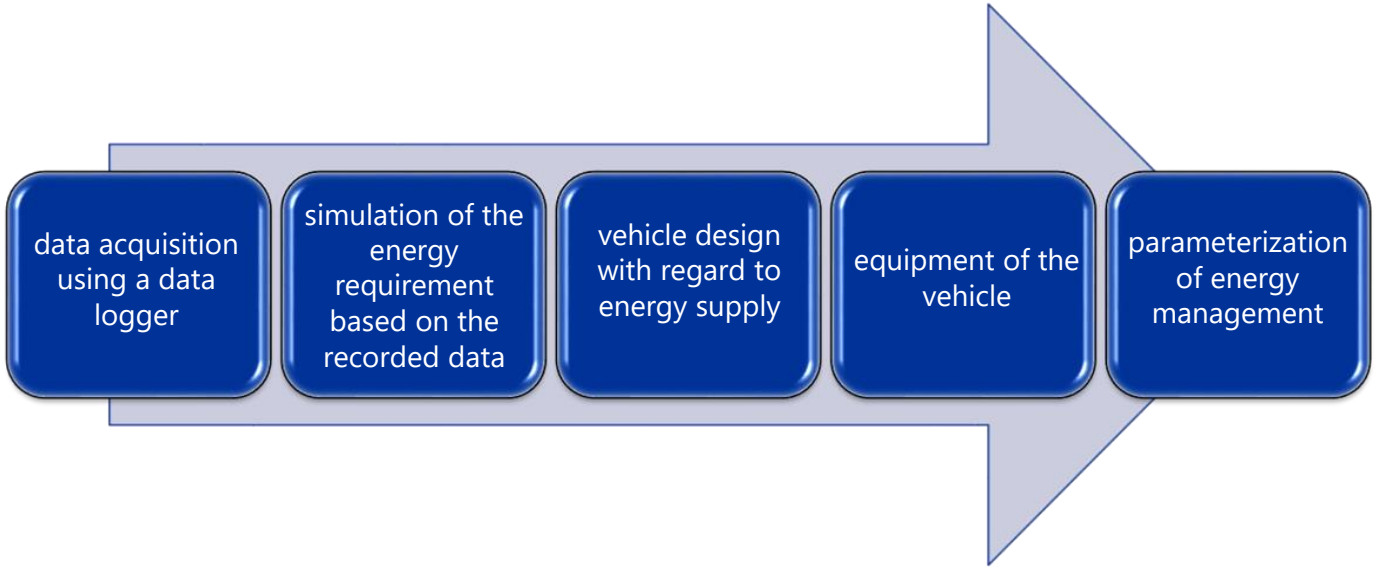
Full Manufacturing responsibility with FAUN – Warranty etc

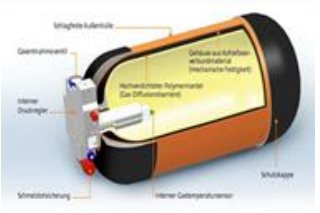
VARIOPRESS ANIMATION

ROTOPRESS ANIMATION

BLUEPOWER Competence

Adapt energy concept to local requirement based on real data





	Wed 16/12	Tue 24/11	Wed 25/11	Mon 16/11	Mon 23/11
Duration (h:m)	9:33	9:36	10.29	8:26	9:16
Distance (miles)	205	120.5	109.3	105.6	80.2
Fuel used	124.2	93.5	85.9	80.5	74.3
Energy used (KW/h)	406.19	306	281	263.12	243.22
Total single bins	406	289	253	267	349
Total compactions	279	637	595	655	695

	Tue 17/11	Tue 08/12	Mon 14/12	Thurs 03/12	Wed 02/12
Duration (h:m)	8:09	8:54	6:45	7:50	7:00
Distance (miles)	97.6	83.9	84.5	55.9	65.8
Fuel used	74.2	74.1	66.6	59.8	58.6
Energy used (KW/h)	242.72	242.31	218.05	195.59	191.89
Total single bins	216	615	508	820	251
Total compactions	596	490	295	560	433

	Thurs 19/11	Wed 09/12	Wed 18/11	Tue 01/12	Thurs 26/11
Duration (h:m)	8:06	7:15	6:57	6:21	7:13
Distance (miles)	55.9	63.4	65.2	54.7	55.3
Fuel used	58.3	57.5	57.1	54.7	54.5
Energy used (KW/h)	190.75	188.35	186.84	179.11	178
Total single bins	253	592	204	211	251
Total compactions	759	428	587	395	410

	Mon 07/12	Mon 30/11	Fri 27/11	Thurs 10/12	Tue 15/12
Duration (h:m)	6:49	6:22	7:15	6:02	6:11
Distance (miles)	50.9	59.1	42.1	54.6	54.1
Fuel used	53.7	53.4	42.1	47.6	45.0
Energy used (KW/h)	175.7	174.56	156.2	155.77	147.25
Total single bins	695	251	259	475	468
Total compactions	457	427	519	374	315

	Fri 20/11	Fri 04/12	Fri 11/12	Fri 18/12	Thurs 17/12
Duration (h:m)	6:58	6:14	5:48	0:22	n/a
Distance (miles)	34.2	23.7	30.5	7.5	n/a
Fuel used	43.8	37.8	36.0	3.8	n/a
Energy used (KW/h)	143.34	123.64	117.81	12.54	n/a
Total single bins	274	709	535	n/a	n/a
Total compactions	653	380	384	n/a	n/a

Key:
Green: Energy Consumption below 190KW/h
Amber: Energy Consumption between 190KW/h & 240KW/h
Red: Energy Consumption above 240KW/h

Total Days Tested: 23

Number of Days below 190KW/h: 12

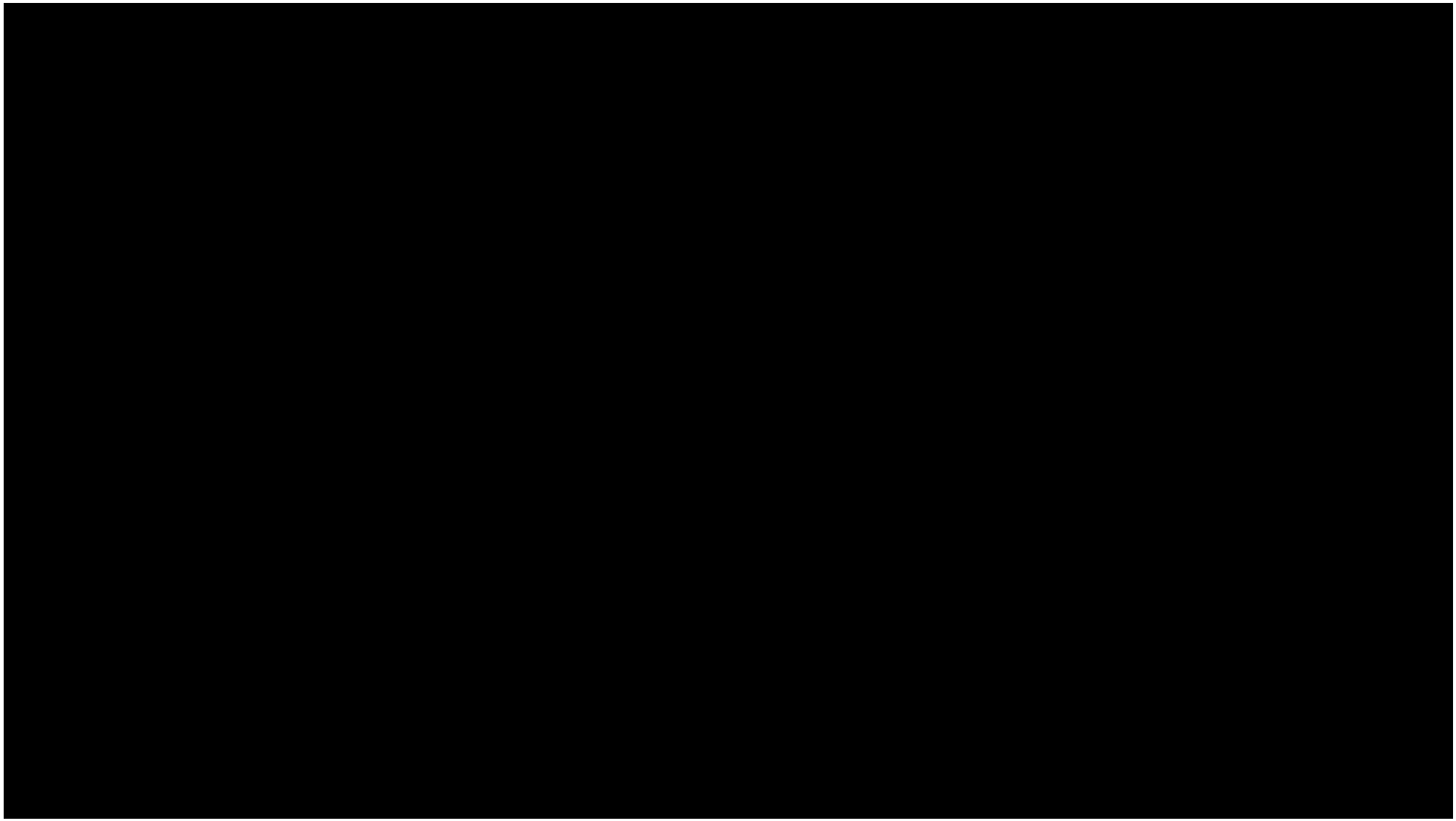
Number of Days between 190KW/h & 240KW/h: 4

Number of Days above 240KW/h: 7

	Basic configuration	One fuel cell	Two fuel cells	Three fuel cells
Battery and intermediate charging	R: 10 km C: 2 x 11,5 to S: City			
Battery + 1 tank		R: 100 km C: 2 x 11,0 to S: City	R: 100 km C: 2 x 10,9 to S: Rural	
Battery + 2 tank		R: 200 km C: 2 x 10,8 to S: City	R: 200 km C: 2 x 10,7 to S: Rural	R: 200 km C: 2 x 10,6 to S: Highway
Battery + 3 tank		R: 300 km C: 2 x 10,6 to S: City	R: 300 km C: 2 x 10,5 to S: Rural	R: 300 km C: 2 x 10,4 to S: Highway
Battery + 4 tank		R: 400 km C: 2 x 10,4 S: City	R: 400 km C: 2 x 10,3 to S: Rural	R: 400 km C: 2 x 10,2 kg S: Highway
Pure battery (400 kWh)	R: 400 km C: 2 x 6,0 to S: Highway			

R: range | C: collection capacity | S: speed profile

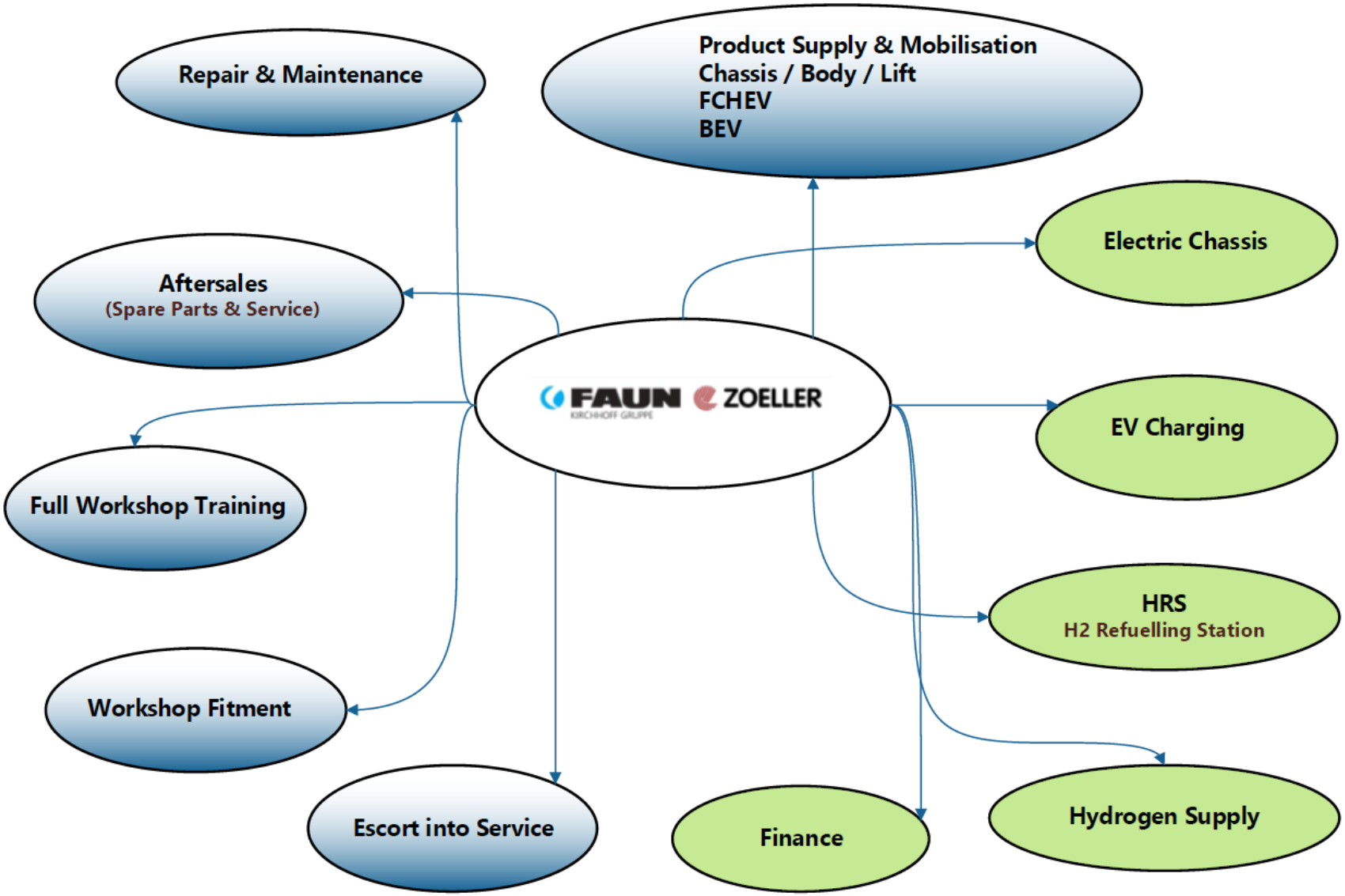
FAUN VIDEO – Handover and test use



FAUN VIDEO - REFUELLING – Jul 2020

PROGRESS SO FAR.

- 85Kw BEV Rotopress: 19.6.19 – Operating in Bremen – 2 x 11t collections
- 40min Intermediate charge @ 150kW
- 1xFC/2Tanks – 20t . 6.5kg/day of H2 - 90-100km Range
- 3 xFC/ 4Tanks – 21t – range 242km
- Max Speed 120km (limited @86km)
- 38% Regeneration (braking)
- At Pump fuel filling – 700bar / 10 mins
- 24 in operation (Germany & France)
- RHD UK – Q3 2022
- Current Order Book – 87 units – Order Book at end of 2021 – 156 units
- Dedicated production facility at OHZ/Bremen – (output 800 / year 2025)
- Build time – 10/12 weeks
- 75 dedicated staff in facility
- Full Technical/ Commercial Supply Agreement with Daimler AG
- Elektra / E-ROTOPRESS demo – Q4
- Renault ZE – VARIOPRESS demo – Q2 2022
- Scania – ROTOPRESS demo Q2 - 2022
- E Econic Demo Plan – Variopress / Rotopress – Q1 2022
- E RCV & Lifters


Repair & Maintenance
Product Supply & Mobilisation
Chassis / Body / Lift
FCHEV
BEV
Electric Chassis
Aftersales
(Spare Parts & Service)
FAUN ZOELLER
KIRCHHOFF GRUPPE
EV Charging
Full Workshop Training
HRS
H2 Refuelling Station
Workshop Fitment
Escort into Service
Finance
Hydrogen Supply

Thank you for your kind attention

QUESTIONS
&
OPEN DISCUSSION