Example 1

Charles Purkess, ITM Power

ITM POWER
Energy Storage | Clean Fuel

Green Hydrogen for Mobility

UKHFCA | Sheffield

16 October 2019

Charles Purkess | BDM UK

PRESENTATION CONTENTS

HYDROGEN ENERGY SYSTEMS

ITM POWER
Energy Storage | Clean Fuel

- What we do
- Markets
- Power to Gas
- Mobility
- Mobility Projects -Zefer

ITM | Linde JV announced 3 Oct 2019

WHAT WE DO?
HYDROGEN ENERGY SYSTEMS

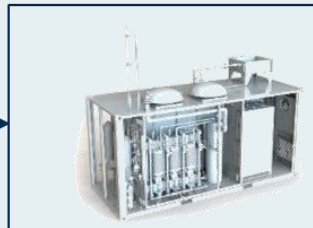
ITM POWER
Energy Storage | Clean Fuel

Unique selling points:

- **Rapid response:** less than 1 second
- **Elevated Pressure:** 20 - 50 bar
- **High efficiency:** 70 - 86% (with heat recovery)
- **Small Footprint:** smaller than alkaline
- **Low cost:** approaching large scale alkaline
- **Reference plant:** at MW scale
- **Experience in the field:** in many applications


Renewable Electricity


Water


ITM Electrolyser

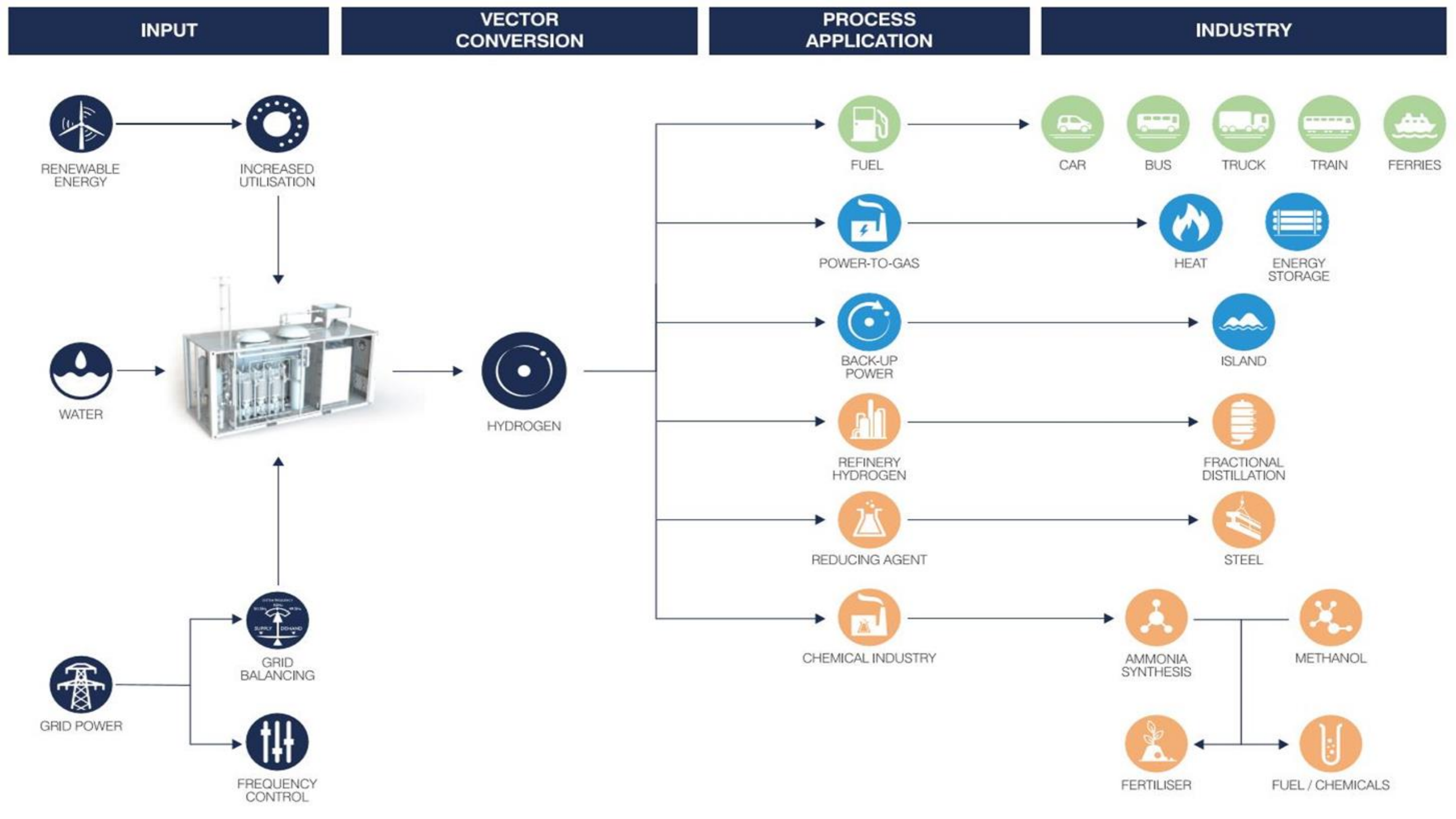
HYDROGEN


Power-To-Gas


Clean Fuel


Renewable Chemistry

ITM Power manufactures integrated hydrogen energy systems


INPUT
VECTOR CONVERSION
PROCESS APPLICATION
INDUSTRY
RENEWABLE ENERGY
INCREASED UTILISATION
WATER
HYDROGEN
GRID POWER
GRID BALANCING
FREQUENCY CONTROL
FUEL
CAR
BUS
TRUCK
TRAIN
FERRIES
POWER-TO-GAS
HEAT
ENERGY STORAGE
BACK-UP POWER
ISLAND
REFINERY HYDROGEN
FRACTIONAL DISTILLATION
REDUCING AGENT
STEEL
CHEMICAL INDUSTRY
AMMONIA SYNTHESIS
METHANOL
FERTILISER
FUEL / CHEMICALS

1 GW MANUFACTURING FACILITY

HYDROGEN ENERGY SYSTEMS

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Bessemer Park:

- Low cost, high volume UK manufacturing
- 134,000 sqft circa 5x existing space
- Product assembly plant
- Stack manufacturing facility
- Adoption of semi-automated stack processes
- Increased site power for testing of larger systems
- Marketing area | 140 offices | 160 parking spaces

Worlds largest electrolyser manufacturing plant by a factor of 3x

SHELL 10MW PROJECT | WORLD'S LARGEST
HYDROGEN ENERGY SYSTEMS

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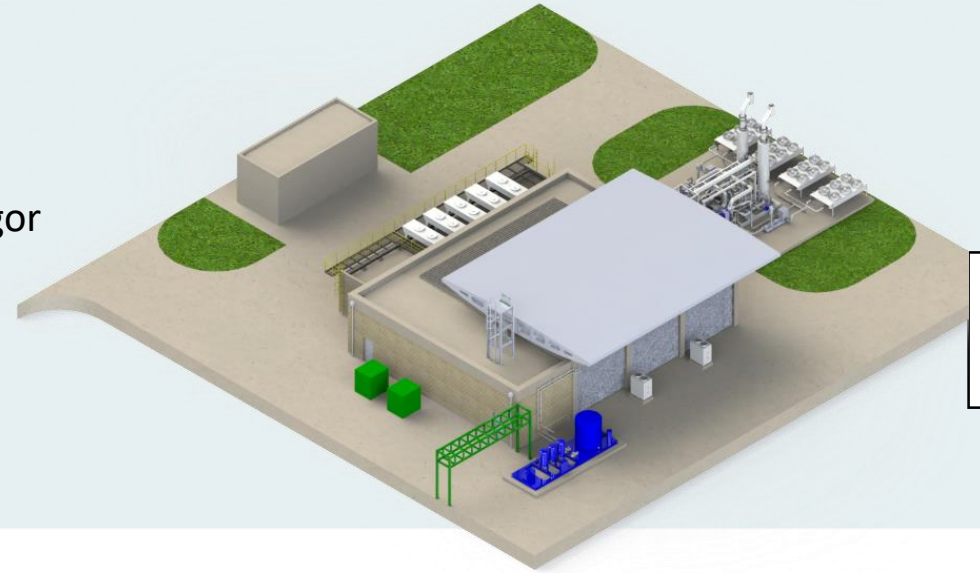
10MW PEM electrolyser system

- Flagship 10MW project with Shell
- Largest PEM electrolyser in the world
- Largest refinery in Germany
- Benefit of Shell engineering & permitting rigor
- Primary Grid Balancing (1 and 4 sec.)
- Load Balancing
- Future direct RE coupling
- Operation 2021

REFHYNE
CLEAN REFINERY HYDROGEN FOR EUROPE



10MW Electrolyser System enclosed in Shell Refinery building

FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Building the world's largest PEM electrolysis plant at Rhineland refinery, Germany

SCALING UP | 100MW PLANT DESIGNS

HYDROGEN ENERGY SYSTEMS

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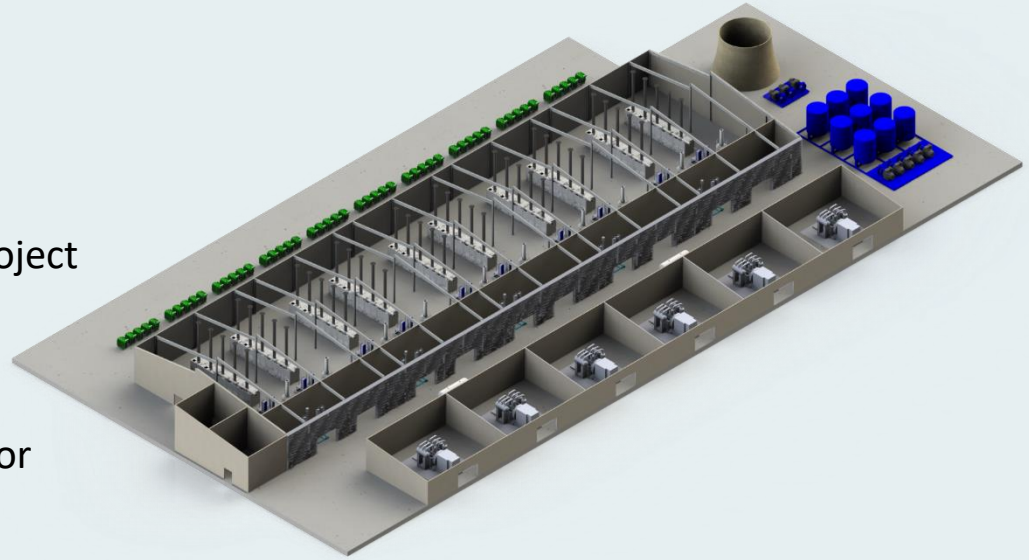
100MW PEM electrolyser system

- Based on 10MW standard skids
- Increasing industrial interest
- Centurian | Runcorn | 100MW Feasibility Project

- **Shell experience:**
- Benefit of Shell engineering & permitting rigor
- Excellent reference plant



CCC Report: Between 6GW (6,000 MW) & 17GW (17,000 MW) of electrolysis required in the UK by 2050

PIONEERING H2 AS A MAINSTREAM FUEL

HYDROGEN ENERGY SYSTEMS

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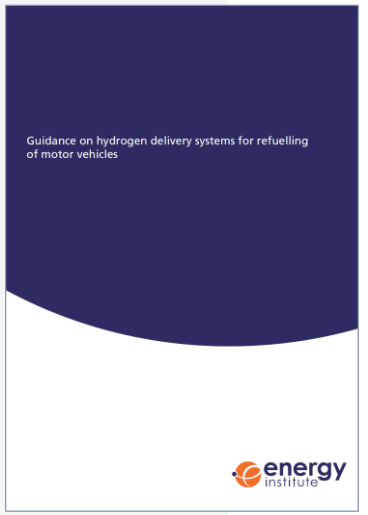
Codes of Practice | Industry Collaboration | Fleet user Engagement | Funding support

- Build | Own | Operate Model
- Knowledge | Know-how | experience
- Forecourt integration with dispenser under main canopy
- High profile sites
- Beaconsfield, M40 Shell Forecourt
- Gatwick Airport, M23 Shell Forecourt
- Bus Stations, Birmingham UK, City of Pau- France



open energi

Office for Low Emission Vehicles

Innovate UK

FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

ITM POWER HRS ASSETS

HYDROGEN ENERGY SYSTEMS

ITM POWER
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Hydrogen Refuelling Stations:

- 7 UK HRS in operation
- 1 US HRS in operation
- 6 UK HRS in construction
- Currently dispensing 20 tonnes pa
- Load aggregation for Grid Balancing
- Working with Open Energi Ltd.

ITM Power HRS Assets:

Station	Status	Opening	Electrolyser (kg/day)	Dispenser (kg/day)
Riverside USA	Open	2015	100	200
Rotherham	Open	2015	100	570
Teddington	Open	2016	200	570
Rainham	Open	2016	200	570
Cobham	Open	2017	100	570
Beaconsfield	Open	2017	100	570
Swindon	Open	2018	100	570
Kirkwall	Open	2018	400	200
Gatwick	Construction	Q3 2019	100	570
Derby	Construction	Q1 2020	100	570
Birmingham Public	Construction	Q4 2019		570
Birmingham Bus	Construction	Q1 2020	1400	1100
Barking	Planning approved	Q2 2020	200	570
London	Funded	Q2 2020	200	570
Crawley	Funded	Q4 2020	200	570
Total:			3200	7770

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FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

ITM POWER
Energy Storage | Clean Fuel

21 fuel contracts in place

- ITM fuel card & training pack
- Growing network

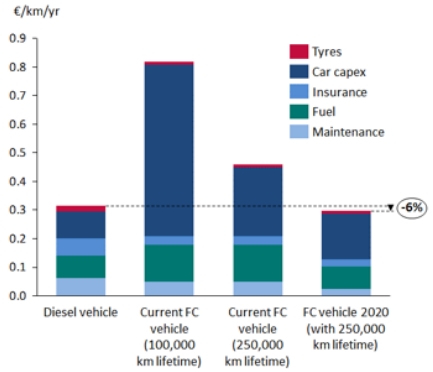
Amey
Anglo American
Arcola Energy
Arval UK Ltd
BAM
Commercial Group
Europcar
Green Tomatoes Cars
Honda Motor Europe
Hyundai Motor UK Ltd
JCB
Johnson Matthey
Northern Gas Networks
Sheffield CC
Skanska
The Science Museum
Toyota GB PLC
UK Government Car Service
UlemCo Ltd
Yorkshire Ambulance Service

Early remarks on the project and the status of the deployment of FCEVs and HRS in general 2/2

ZEFER

ZEFER intends to address some of the challenges identified in earlier initiatives:

- **Attractive ownership models are starting to emerge** which can overcome these issues for example:
  - ***long distance captive fleets with high utilisation mode***
  - ***taxis or private hire vehicles in cities with strict environmental targets***
- Improving the communications around the vehicles and ***creating an aspirational element*** as well as ***clarity over the value case*** is a key priority to promote the technology.
- Increasing the ***focus on colocation of vehicles and HRS*** (e.g. adoption of demand-led approach) will ensure ***higher customer satisfaction*** and allow ***better investment cases*** for both HRSs and FCEVs.



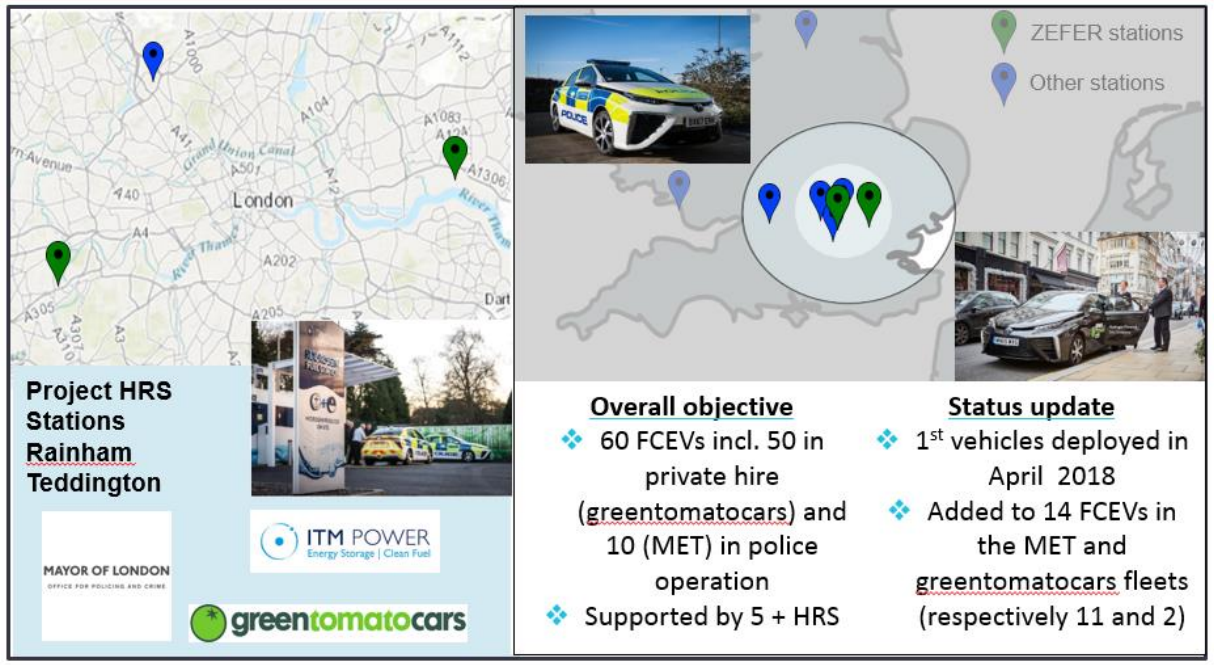
Total cost of ownership assessment for FCEVs against diesel vehicles along with 2020 targets. The two bars for current FCEVs show the impact of the lifetime of the FCEV on the business case.

Source: Element Energy

HRS: Hydrogen Refuelling Station | **FCEV**: Fuel Cell Electric Vehicle | **PHV** : Private Hire Vehicle

50 FCEVs will be deployed as PHVs and 10 as incident response vehicles for the Met Police in London

ZEFER



Overall objective

- 60 FCEVs incl. 50 in private hire (greentomatocars) and 10 (MET) in police operation
- Supported by 5 + HRS

Status update

- 1st vehicles deployed in April 2018
- Added to 14 FCEVs in the MET and greentomatocars fleets (respectively 11 and 2)

HRS: Hydrogen Refuelling Station | **FCEV**: Fuel Cell Electric Vehicle | **PHV** : Private Hire Vehicle

Building on success of HyFive | H2ME 1&2

TRANSIT HUBS | MULTIPLE MODES OF TRANSPORT

HYDROGEN ENERGY SYSTEMS

ITM POWER
Energy Storage | Clean Fuel

Land | Sea | Air

- Buses: 30kg/day
- Trucks: 75kg/day
- Trains: 180 - 400kg/day
- Ferries: 500kg/day

Large scale refuelling stations | 2MW | 10MW |30MW |50MW

ON-SITE & OFF SITE HYDROGEN PRODUCTION

HYDROGEN ENERGY SYSTEMS

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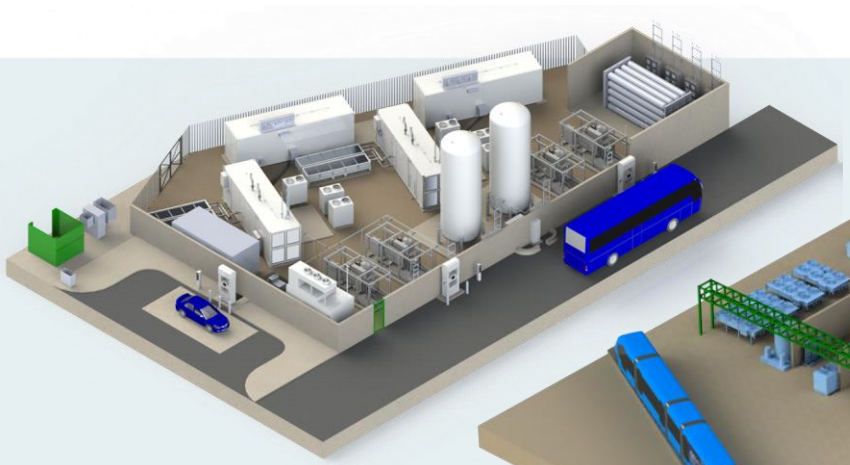
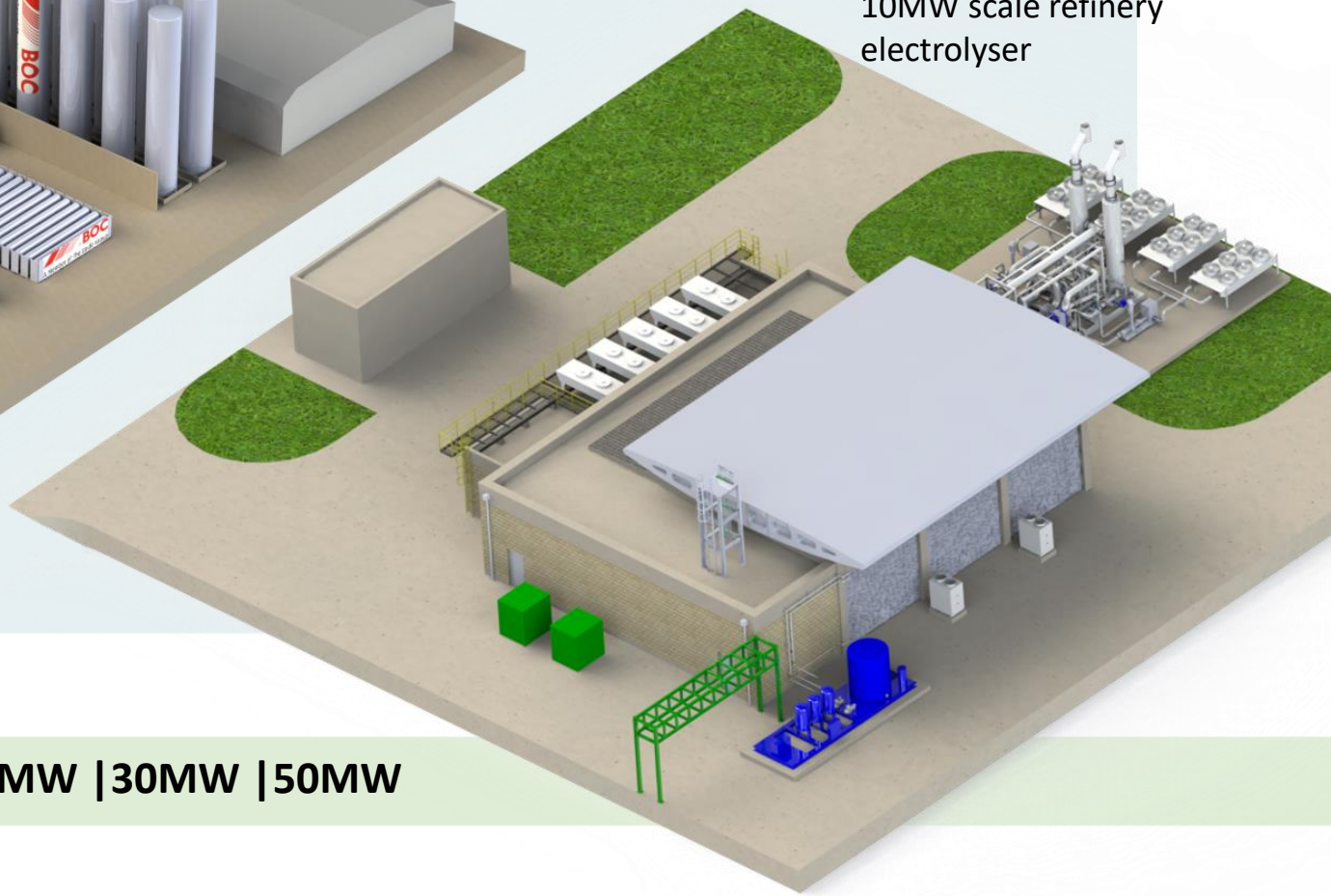


Containerised Products:
Bus refuelling station

Skid Mounted Products:
Train refuelling station

Building Housed Products:
10MW scale refinery electrolyser



Large scale refuelling stations | 2MW | 10MW |30MW |50MW

CITY OF PAU BUS| FRANCE|

HYDROGEN ENERGY SYSTEMS

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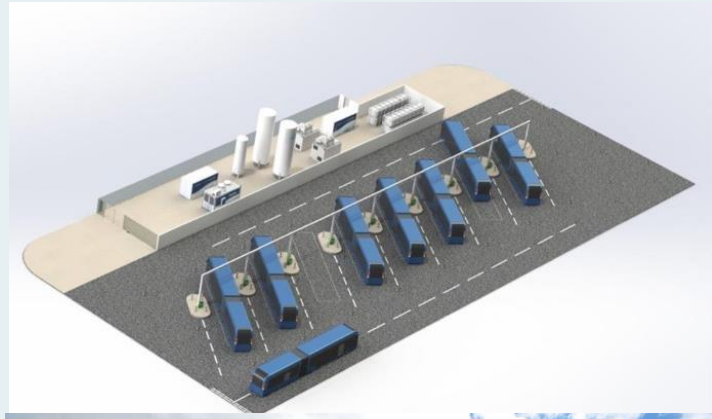
0.7MW ITM electrolyser | ~270kg/24hrs

- First French 18m bus project
- 6+2 buses @ up to 36kg/bus per day
- Led by Engie | GNVert
- SMTU Public Transport | owner operator of bus
- Supported by FCH JU
- Linde Storage Compressing & Dispensing equipment
- Operational 2019



Buses powered by renewable energy

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