

Role of Hydrogen in  
**Energy Transition**  
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**#SCOTLANDISNOW**



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- Scottish Development International – Who we are and what we do?
- Net Zero
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- Scotland - Hydrogen



## **ABOUT US AND HOW WE CAN HELP**

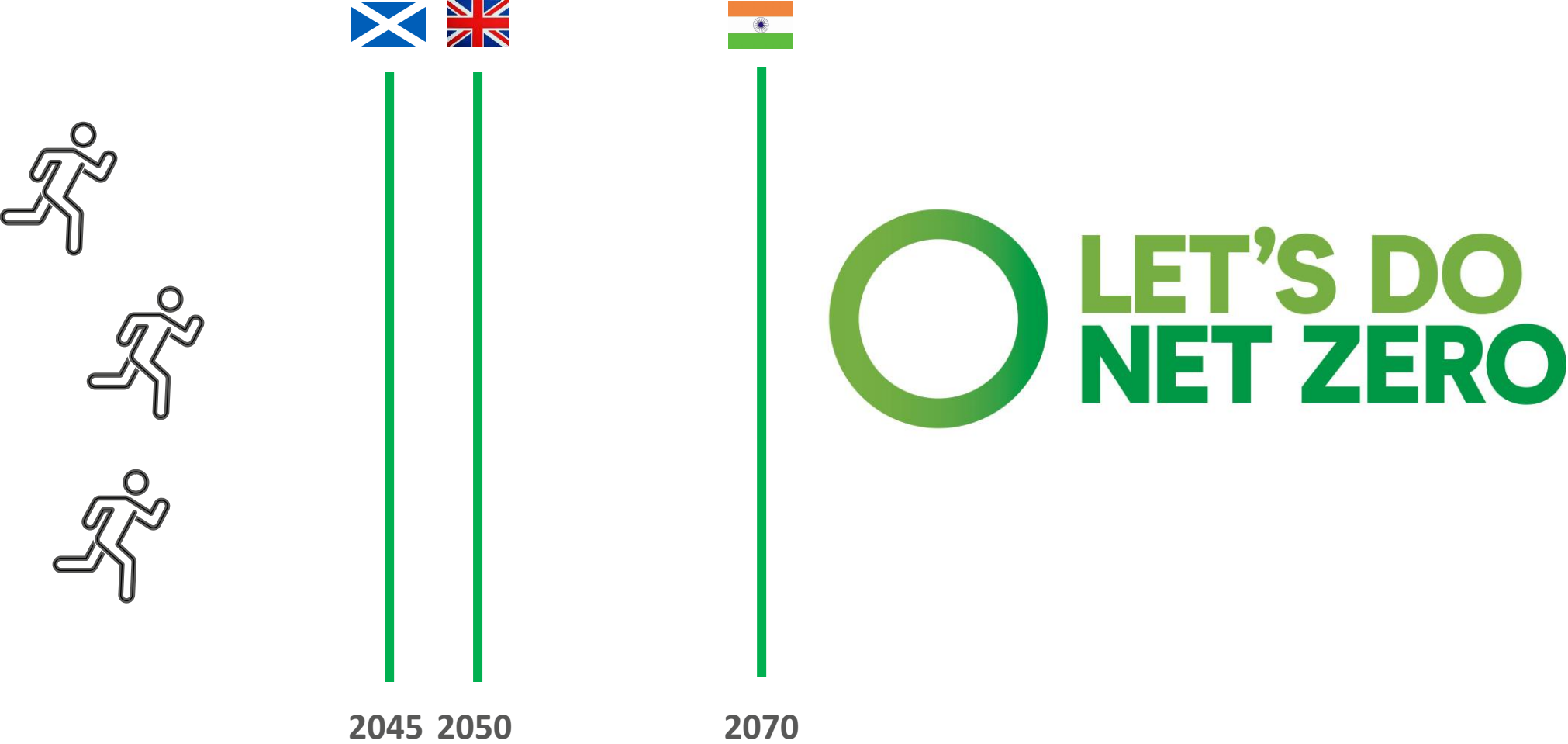
As Scotland's trade and inward investment agency, we aim to help more businesses from around the world do business in or with Scotland. If you're an overseas business looking to set up in Scotland or source Scottish products or services, we can help.

# **#SCOTLANDISNOW**

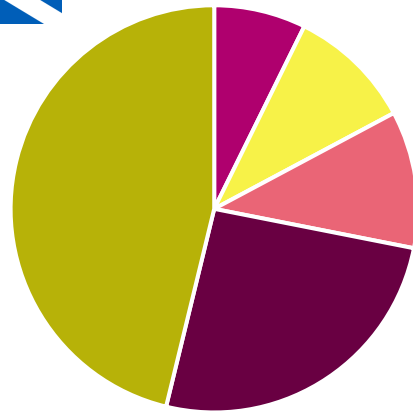
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# Goal - Net Zero



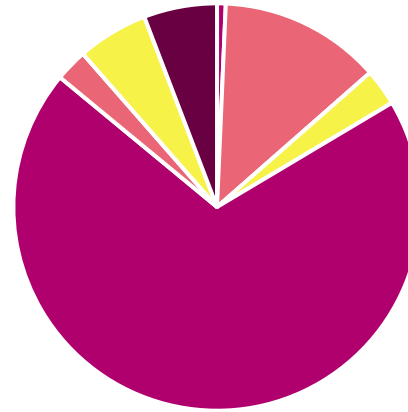
# Net Zero Electricity - Scotland and India



- Biomass
- Hydroelectric
- Gas
- Nuclear
- Wind

50g CO<sub>2</sub>/kWh

- Consumption 33 TWh
- 98.6% from RE and Low Carbon Resources
- RE would be surplus soon and will be available for exports or Green Hydrogen Production

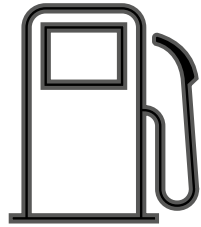


- Biomass
- Hydroelectric
- Gas
- Coal
- Nuclear
- Solar
- Wind

628g CO<sub>2</sub>/kWh

- Consumption 1229 TWh
- 28% from RE and Low Carbon Resources
- Can save 770 MTPA CO<sub>2</sub> emissions by shifting to RE and Low Carbon Resources
- Huge Renewable Energy capacity addition is required

# Net Zero Transport (Liquid Fuels) - India



## Gasoline

~31 MTPA  
~372 TWh  
~95 MTPA CO<sub>2</sub>  
~42 GW RE installation

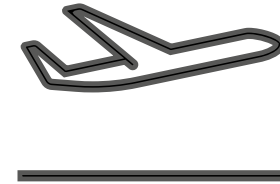
Battery Most Suitable



## Diesel

~77 MTPA  
~907 TWh  
~241 MTPA CO<sub>2</sub>  
~247 GW RE Installation

Hydrogen Suitable for  
long haul buses/ trucks  
and remote rail tracks



## ATF

~5 MTPA  
~60 TWh  
~15 MTPA CO<sub>2</sub>

Biofuels most suitable  
Hydrogen being tried

# Net Zero LPG and Natural Gas - India



## LPG

~28 MTPA  
359 TWh  
~86 MTPA CO<sub>2</sub>  
~42 GW RE installation

Electric stoves is suitable

Hydrogen is suitable

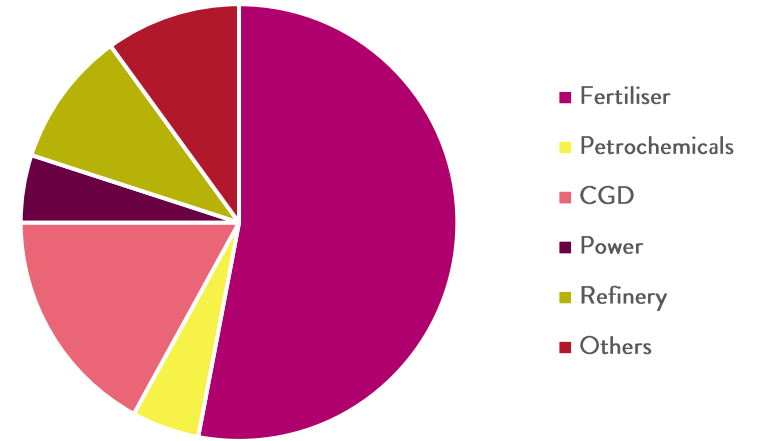


## Natural Gas

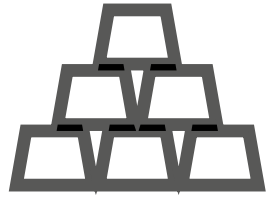
~50 MTPA  
~743 TWh  
~137 MTPA CO<sub>2</sub>  
~6 MTPA Gray Hydrogen

CGD application - Electric stoves suitable

Other applications – Hydrogen is suitable



# Net Zero Cement, Steel and Refineries - India



## Steel

~94 MTPA Coal  
~255 MTPA CO<sub>2</sub> (from coal)  
~17 MTPA CO<sub>2</sub> (from NG)  
~273 MTPA CO<sub>2</sub> Total  
~25 GW Electrolyser Capacity  
~ 83 GW RE installation

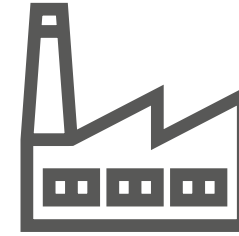
Hydrogen is suitable



## Cement

~94 MTPA Coal  
~255 MTPA CO<sub>2</sub> (from coal)  
~17 MTPA CO<sub>2</sub> (from NG)  
~273 MTPA CO<sub>2</sub> Total  
~25 GW Electrolyser Capacity  
~ 83 GW RE installation

Carbon Capture and Storage is suitable



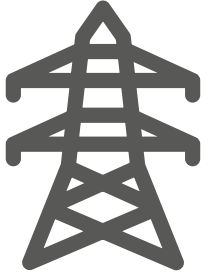
## Refinery and Fertiliser

~31.4 MTPA NG  
~6.6 MTPA Gray Hydrogen  
~59 MTPA CO<sub>2</sub> for Gray Hydrogen  
~30 MTPA CO<sub>2</sub> for other uses of NG  
~34 GW Electrolyser Capacity  
~ 114 GW RE installation for Gray Hydrogen

Green Hydrogen is suitable  
Carbon Capture and Storage is suitable

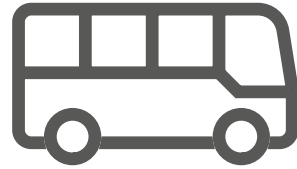


# Hydrogen for Net Zero



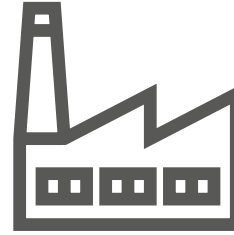
## Electricity

- Intermittent nature of RE Power Needs Energy Storage Solutions
- Hydrogen can be used as energy storage and power generation to stabilize the grid



## Transport

- Hydrogen can be used for long haul trucks and public transport buses
- Hydrogen can be used for remote railway tracks that are expensive to electrify



## Industries

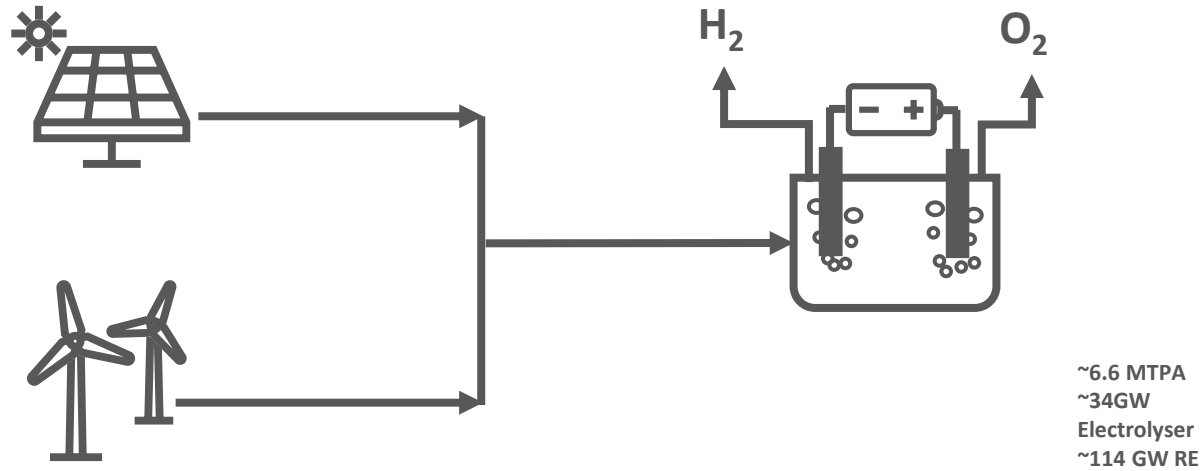
- Hydrogen can be used for steel, cement, miscellaneous industries and Whisky!
- Current Refinery grey hydrogen can be converted to green or low carbon hydrogen



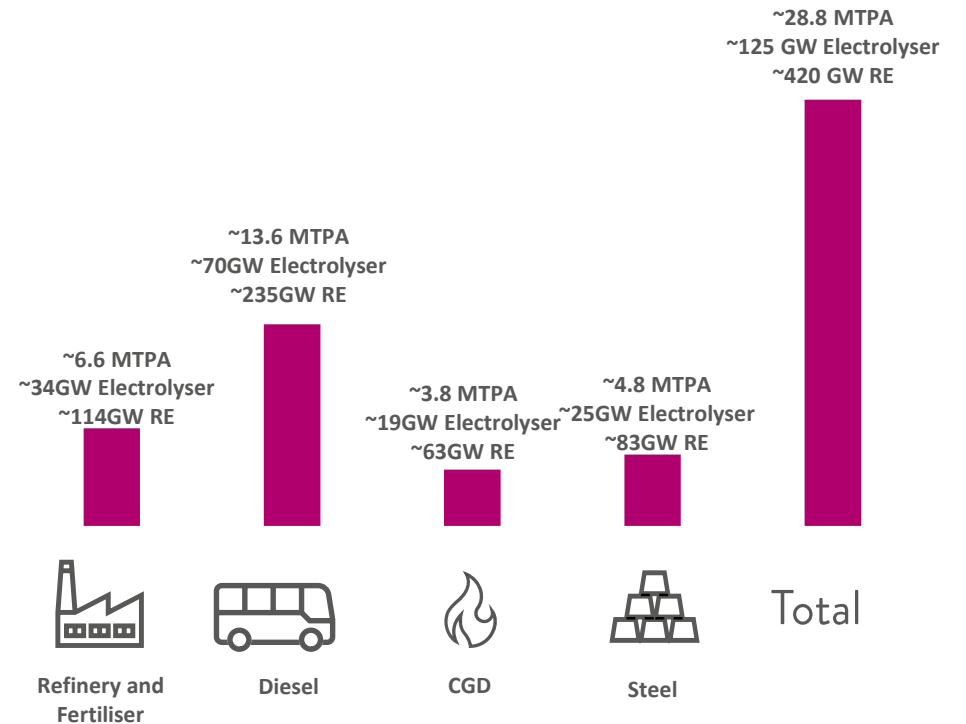
## Heating/Cooking

- Hydrogen can be used for steel, cement, miscellaneous industries and Whisky!
- Current Refinery grey hydrogen can be converted to green or low carbon hydrogen

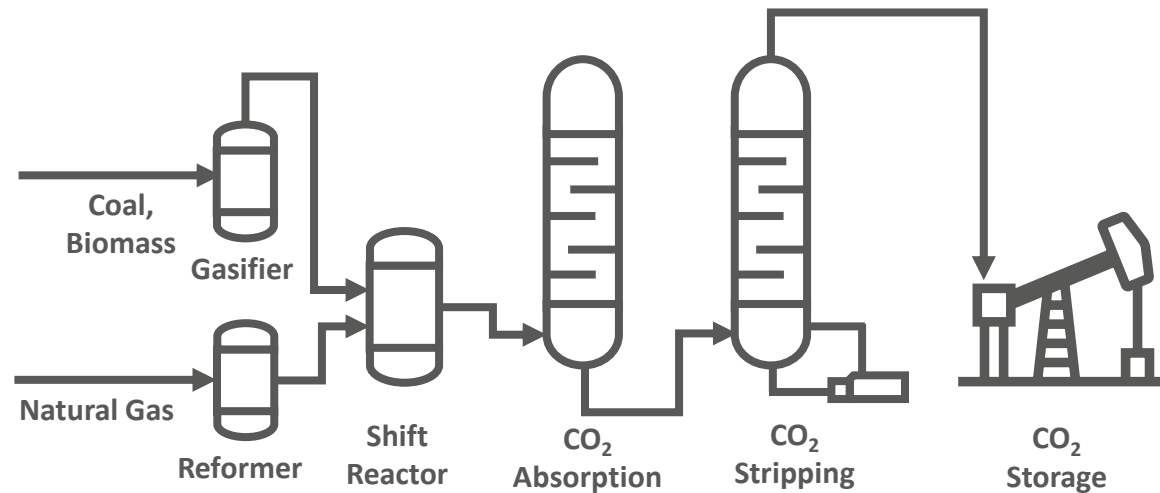
# Green Hydrogen - India



- To decarbonise current Grey Hydrogen, we need ~34GW electrolyser capacity and ~114GW RE or Low Carbon resources
- To reach net zero, we need ~ 125 GW electrolyser capacity and ~ 420 GW RE or Low Carbon resources

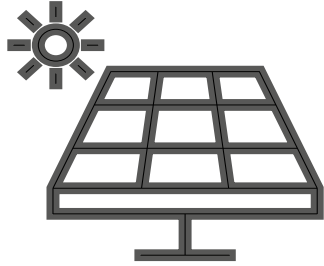


# Low Carbon Hydrogen - India

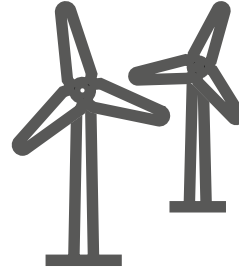


- Constructing huge capacity of RE to achieve Net Zero can be very challenging
- Energy security requirements cannot be overlooked
- Low carbon hydrogen can be used to quickly scale up the infrastructure
- CCS and Low Carbon Hydrogen provide alternate way to reach Net Zero
- It is important to map the geological Carbon Storage capacities in India

# Energy Security - India



Solar Potential in India **749 GW**  
Actual Average Power Generation **187 GW**  
(PLF 25%)



Wind Potential in India **302 GW**  
Actual Average Power Generation **115 GW** (PLF 38%)



Coal reserves **107.7 billion tons**  
Energy content – **903603 TWh**  
~**273 years of Wind + Solar combined**



Wind + Solar Potential in India **1051 GW**  
Actual Average Power Generation **302 GW**  
Total energy per annum actual – **3307 TWh**



# Net Zero Scotland

Scottish  
Government

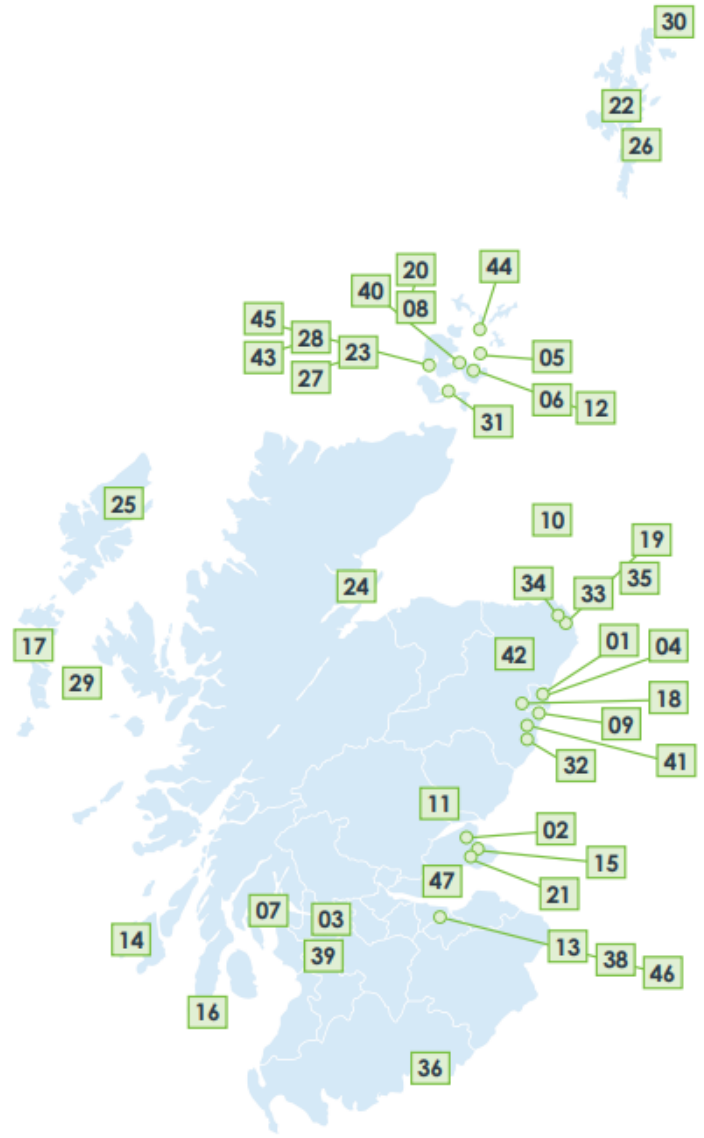
## Scotland - Hydrogen

- Scotland has a legally binding target of reaching net zero by 2045
- 98% of its electricity is from renewable/ low carbon sources
- Hydrogen is important for hard to abate sectors
- Surplus RE and limited constraints on water supply, big opportunity for Green Hydrogen exports

### Map 1 - Some of Scotland's Current Hydrogen Projects

- End User**
- 01 Cloverhill's Aberdeen Hydrogen First
  - 02 Eden Mill distillery
  - 03 Glasgow Hydrogen Gritters
  - 04 HECTOR project
  - 05 HyDIME
  - 06 HyFlyer
  - 07 HySeas III
  - 08 HySpirits
  - 09 Hytransit Project - Aberdeen Hydrogen Busses
  - 10 Hytec
  - 11 JIVE 2 - Dundee Hydrogen Transport
  - 12 Kirkwall Airport Decarbonisation
  - 13 Liquid Organic Hydrogen Carriers (LOHC) for the transportation of hydrogen
  - 14 Project HyLaddie
  - 15 Scottish Hydrogen Train project
  - 16 TimberLINK
  - 17 Uist Distilling Company
- Multi-vector**
- 18 Aberdeen Hydrogen Hub
  - 19 Aberdeen Vision
  - 20 BIG HIT
  - 21 East Neuk Power to Hydrogen
  - 22 GENCOMM - AD
  - 23 ITEG - Integrating Tidal Energy into the European Grid
  - 24 North of Scotland Hydrogen Programme
  - 25 OHLEH - Outer Hebrides Local Energy Hub

- 26 Orion Project
  - 27 PITCHES
  - 28 ReFLEX (Responsive Flexibility) Project
  - 29 SWIFTH2
  - 30 PURE Energy Centre
  - 31 Flotta Hydrogen Hub
- Production**
- 32 Aberdeen Hydrogen Centre (ACHES)
  - 33 Acorn CCS
  - 34 Acorn Hydrogen
  - 35 Caledonia Clean Energy Project
  - 36 Chapelcross Initiative
  - 37 Dolphyn Project
  - 38 Edinburgh International Festival decarbonisation project
  - 39 Green Hydrogen for Glasgow
  - 40 Hammars Hill Green Ammonia project
  - 41 Kittybrewster Refuelling Station
  - 42 Skelmonae Green Hydrogen
  - 43 'Surf 'n' Turf'
- Storage**
- 44 Eday Flow Cell Battery Project
  - 45 HyAl
  - 46 HyStorPor Project
- Transmission/distribution**
- 47 H100 Fife project



# Scotland - Hydrogen

- World's long range zero emission Hydrogen Flight
- World's first floating green hydrogen facility
- World's first hydrogen power heating network
- World's first hydrogen powered Gin
- World's first tidal powered hydrogen electrolyser
- World's first hydrogen powered double daker bus
- Hydrogen innovation accelerator facility
- Hydrogen Powered train and many more!



## Scotland - Just Transition

- Working with people, businesses and communities across Scotland to ensure they have a clear role in decision making
- Access to support and advice
- Costs to users are kept as low as possible
- The benefits of the transition are spread fairly



Let's Collaborate!  
Let's Learn from Each Other!



**LET'S DO  
NET ZERO**

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# Thank You!

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16<sup>th</sup> November 2022

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