

Hydrogen for transport from constrained renewables generation in the Orkney Islands



BIGHIT

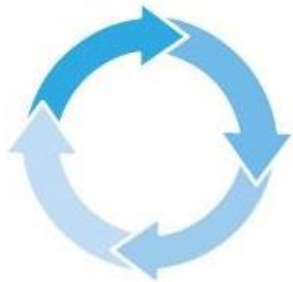


BIG HIT
Grant agreement
no.: 700092



Nigel Holmes, SHFCA

All-Energy, Glasgow, 2nd May 2018



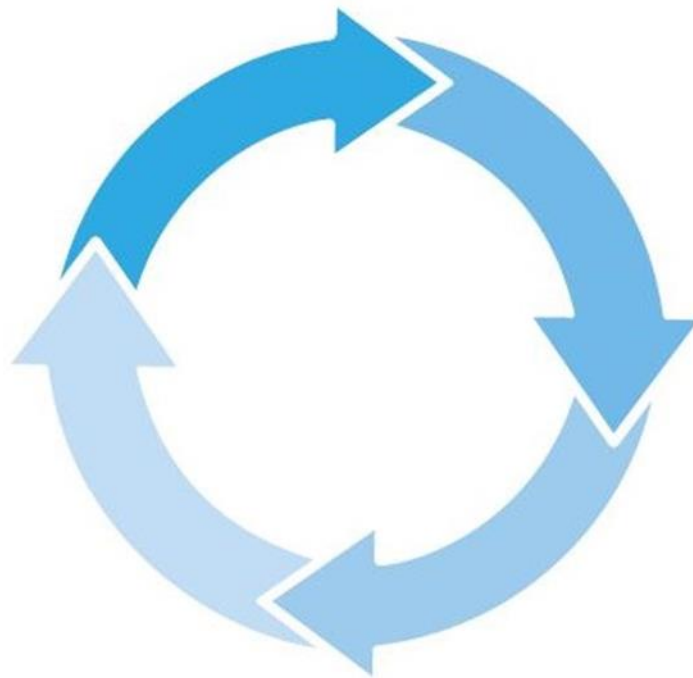
**A WHOLE-SYSTEM
VIEW**



**AN INCLUSIVE ENERGY
TRANSITION**



**A SMARTER
LOCAL ENERGY MODEL**



**A WHOLE-SYSTEM
VIEW**

Scotland's Ambitions for Reducing CO₂



Reduce CO₂ emissions by 42%
in 2020 (compared to 1990
baseline)

42%

(the answer to life, the
universe and everything)



Generate 100% of Scotland's
power* from Renewables



Install 1 GW of Locally Owned
Renewables

In 2017 Scotland generated **68.1%** of its gross
annual electrical demand from Renewables.



Where next : 'Future of Energy in Scotland'

Hydrogen projects are supporting delivery of the Climate Plan and its three main themes:

1. Managed energy transition
2. A 'whole-system' view
3. Local vision for energy

Using a whole energy systems approach with hydrogen.

Making better use of locally generated energy.

Scottish Energy Strategy:
The future of energy in Scotland



December 2017

 Scottish Government
Riaghaltas na h-Alba
gov.scot



**SCOTLAND IS A
WORLD LEADER IN
RENEWABLE ENERGY**

WE AIM FOR

100%

**OF SCOTTISH ELECTRICITY DEMAND
MET BY RENEWABLES BY 2020**



**RENEWABLES GENERATED 42.9% OF
OUR ELECTRICITY PRODUCTION IN
2016, MEETING THE MAJORITY OF
SCOTTISH DEMAND**



2002



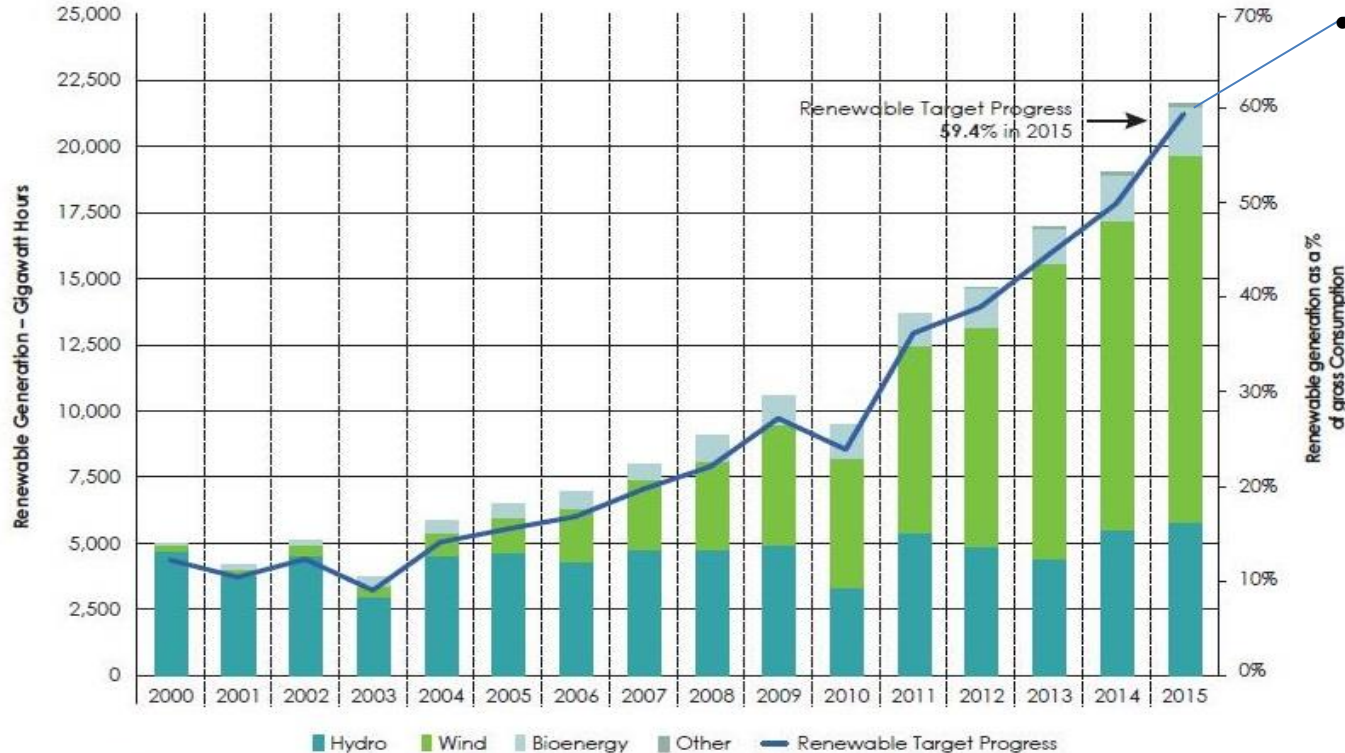
2016



**SCOTLAND ALMOST QUADRUPLLED ITS
RENEWABLE ELECTRICITY GENERATION
BETWEEN 2002 AND 2016**

Rapid Growth in Renewable Energy

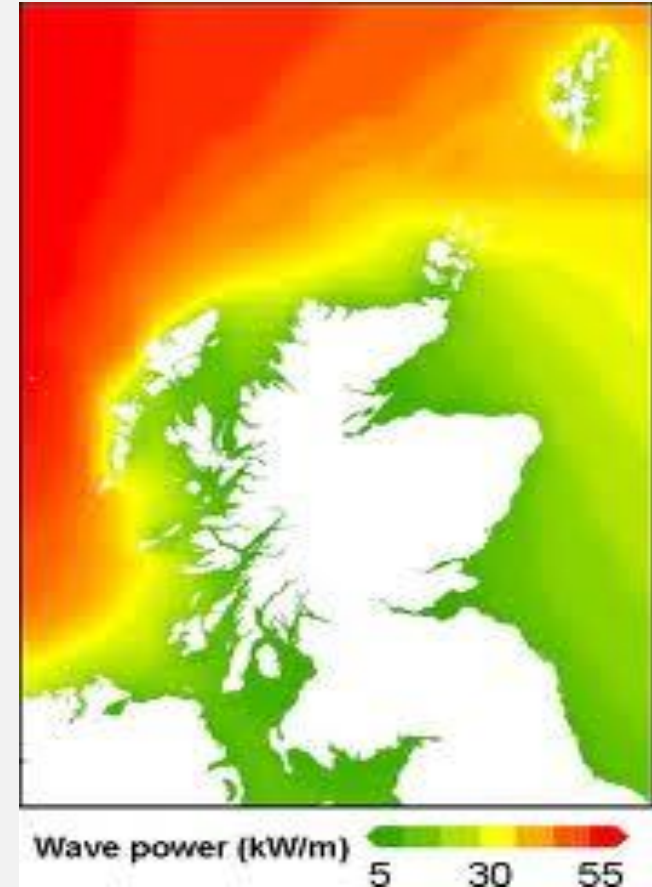
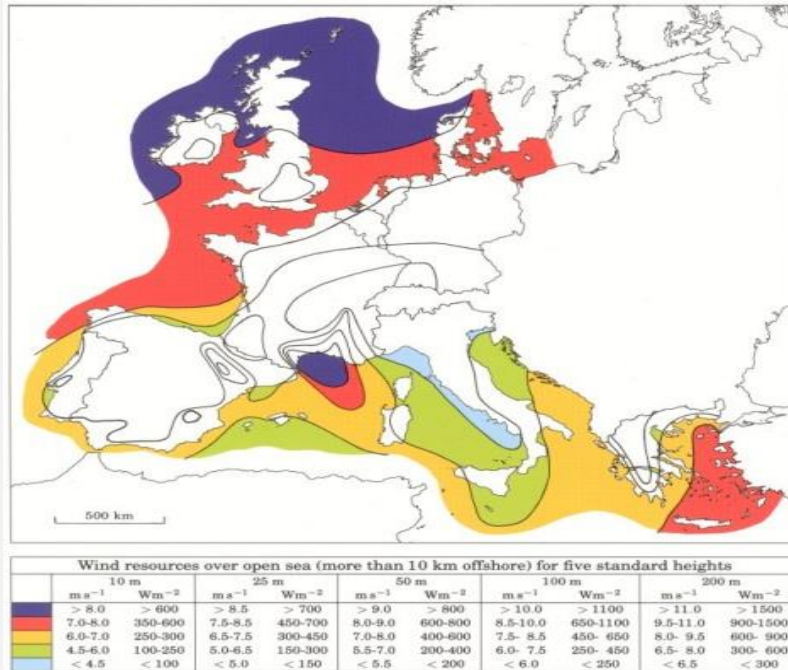
Diagram 4: Electricity generated (GWh) from renewable sources, Scotland, 2000-2015



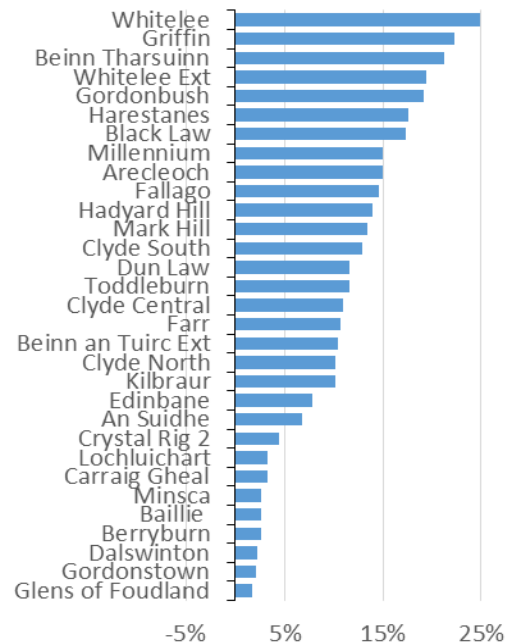
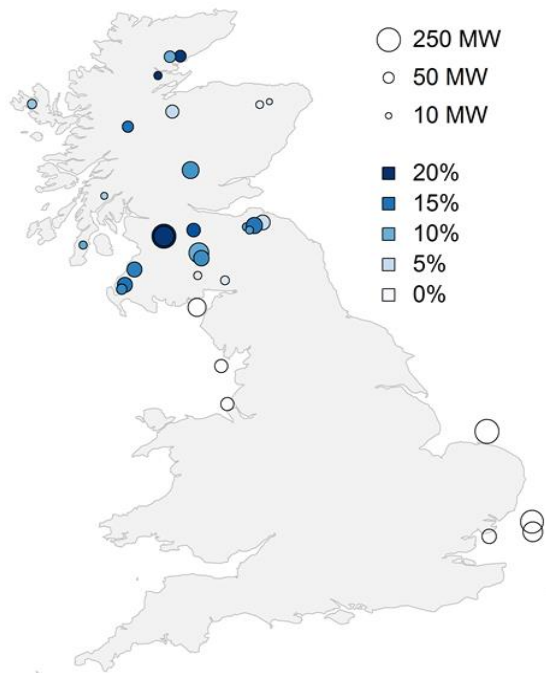
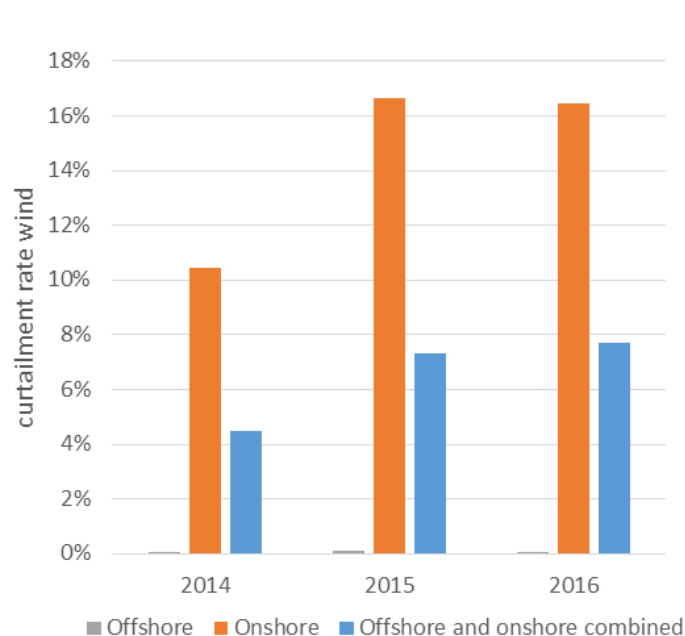
68.1% of Scotland's gross electricity demand was met from renewables in 2017

Location, Location, Location...

- Scottish wind & marine resources
- Many in remote/island locations...



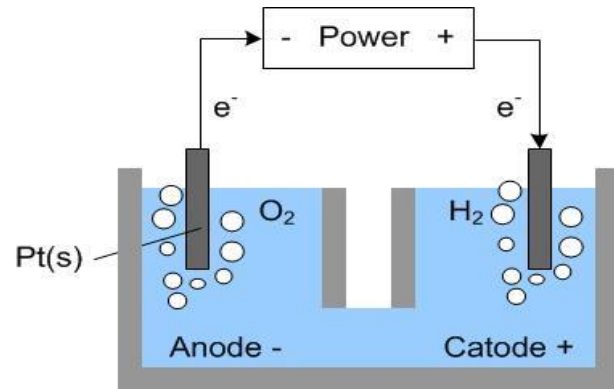
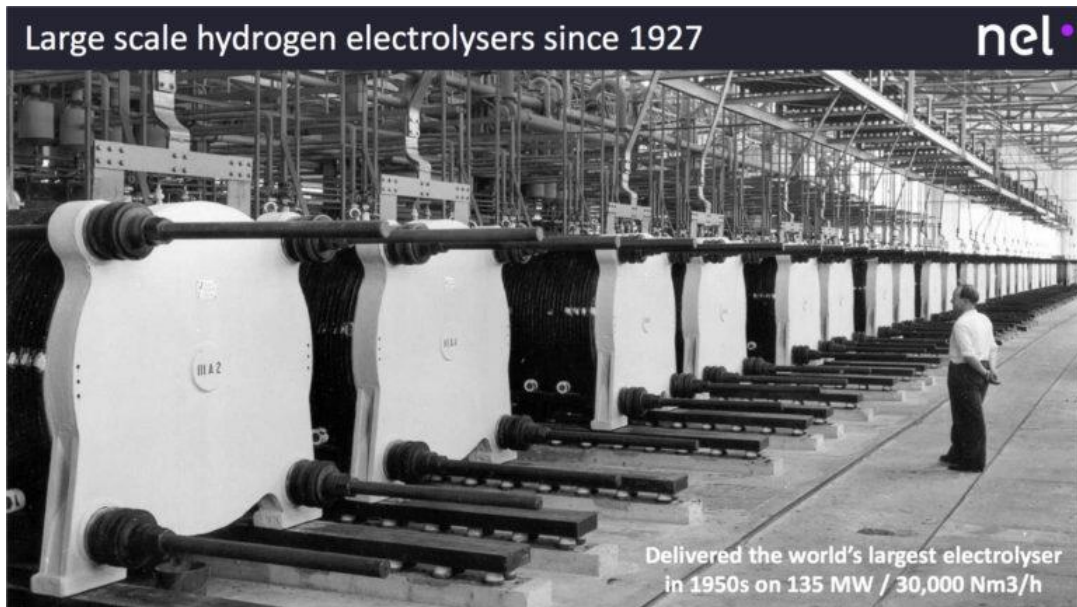
But Wind Increasingly Constrained



From Joos & Staffell “Short term integration costs of variable renewable energy: Wind curtailment and balancing in Britain and Germany”

...converting Electricity to Hydrogen

- Electrolysis of Water
- Using Renewable Electricity
- Provide Grid Balancing Services



Electrolyser Schematic ↑

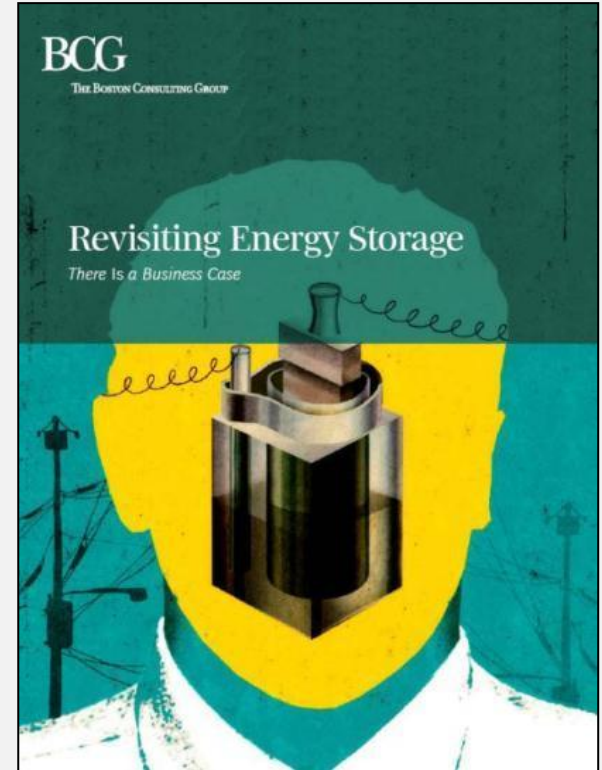
← 100MW Alkaline
Electrolyser for Ammonia
Manufacturing Plant

Islands – Early Adoption Opportunities

BCG report concluded that utilisation of renewables held back by lack of energy storage solutions. Storage is key to removing grid capacity constraints and making more wind projects investable

Identifies early adoption markets:

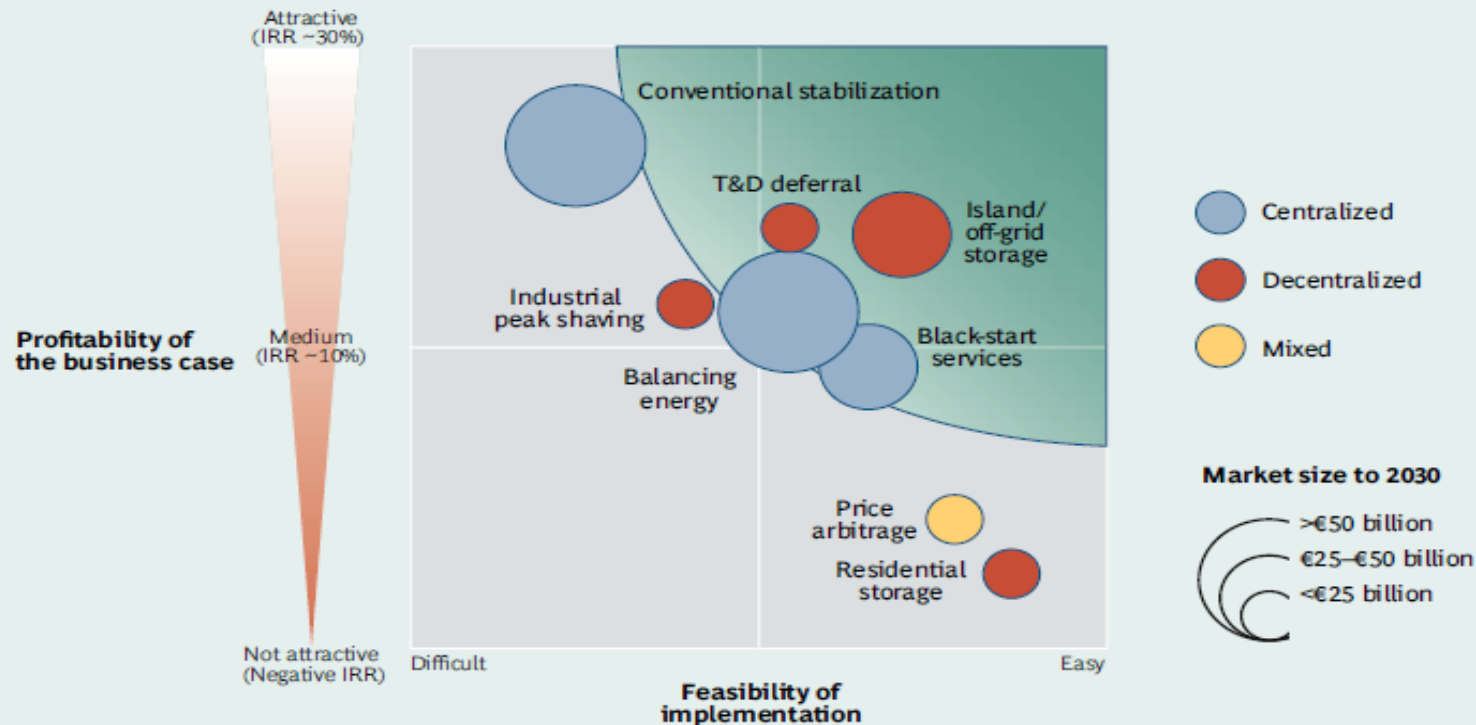
- Island energy systems
- Off grid energy storage
- Worth €25bn to 2030



Link to BCG report : <https://www.bcg.com/documents/file72092.pdf>

Islands for Off-Grid Storage & Conversions

EXHIBIT 4 | Four or Five Storage Business Cases Will Be Attractive in the Near Future



Calculations based on estimated storage prices for 2015–2020; price decreases would improve profitability in all cases



**A WHOLE-SYSTEM
VIEW**



**AN INCLUSIVE ENERGY
TRANSITION**



**A SMARTER
LOCAL ENERGY MODEL**



**A SMARTER
LOCAL ENERGY MODEL**

Scottish Hydrogen from Renewables



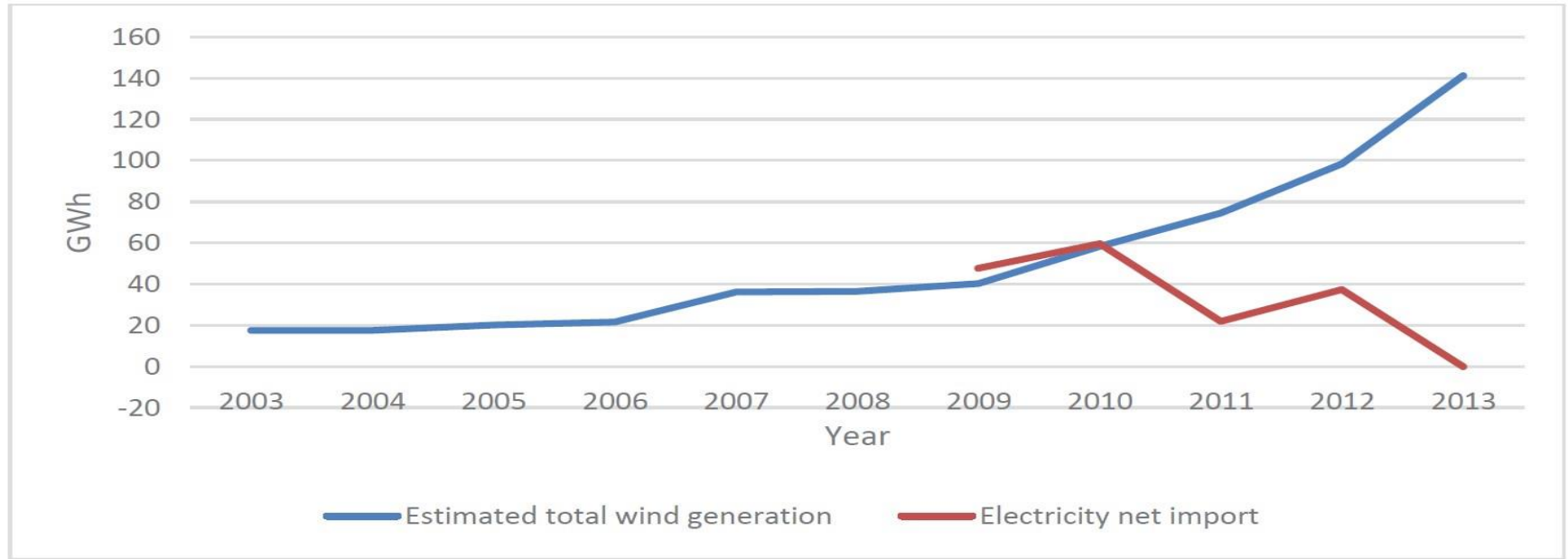
Local Energy in the Orkney Islands

- Renewables generate > 100% of Orkney's electricity since 2010
- Over 50MW of installed renewable capacity
- 1000 renewable installations for 10,000 households
- Hosts the European Marine Energy Centre (EMEC)



By 2014 the Orkney Islands were generating 120% of annual electrical demand from Renewables

Renewable Energy Growth in Orkney Islands



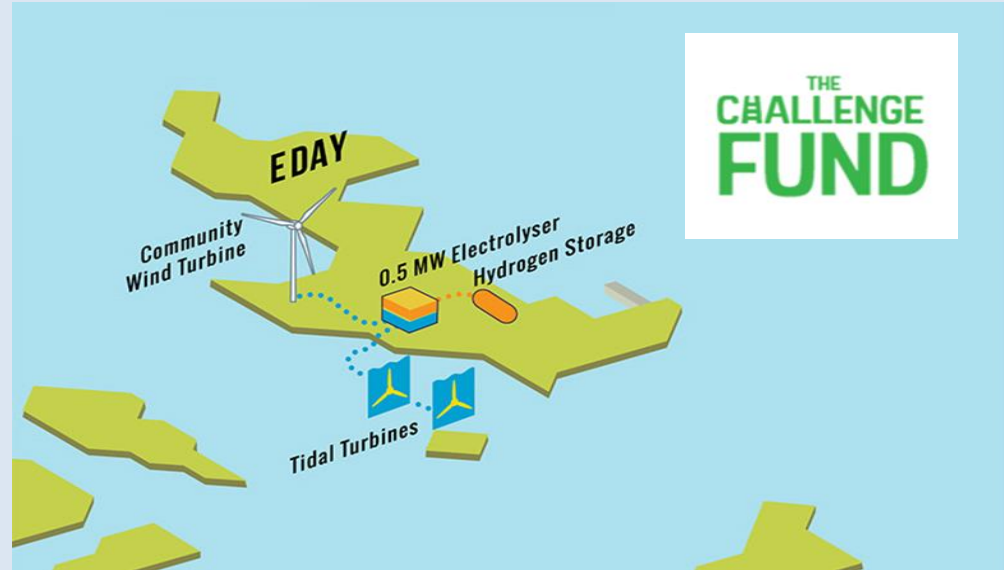
Steady increase in Orkney Islands renewable generation
...but no additional grid connection capacity to mainland



EMEC Electrolyser : Surf 'n' Turf



High pressure PEM electrolyser supported by Highlands and Islands Enterprise innovation funding



Surf 'n' Turf is generating hydrogen from wind and tidal on Eday to avoid grid limitations and develop local use.

Projects were supported by HIE & Local Energy Challenge Fund.

Surf 'n' Turf Launch 27th Sept 2017



Orkney Islands: Fully Charged

Robert Llewellyn (Red Dwarf) and Neil Kermode (EMEC) talk about how hydrogen can help overcome grid constraints at EMEC on the island of Eday.



Link: <https://www.youtube.com/watch?v=Rybpaghg5Qg>



BIG HIT Building on Surf 'n' Turf

BIG HIT
Grant agreement
no.: 700092



Shapinsay's 0.9MW turbine



H₂ Trailer



Green H2 for Van Fleet



Building Innovative Green Hydrogen Systems in Isolated Territories
€5m FCH 2 JU project. Green hydrogen using 1MW electrolyser
Supply hydrogen for HFC range extended EV vans in Kirkwall
Also hydrogen for zero-carbon heating at school on Shapinsay



BIG HIT Partnership Working

BIG HIT
Grant agreement
no.: 700092

BIG HIT Project – 12 Partners from Europe



FOUNDATION FOR THE
DEVELOPMENT OF NEW
HYDROGEN TECHNOLOGIES
IN ARAGON



ORKNEY
ISLANDS COUNCIL

EMEC
THE EUROPEAN MARINE ENERGY CENTRE LTD



CALVERA



SYMBIO
ZERO EMISSION MOBILITY
SOLUTIONS

**Community
Energy
Scotland**
Empowering Communities



ITM POWER
Energy Storage | Clean Fuel

**SCOTTISH
Hydrogen
& Fuel Cell
ASSOCIATION**

DTU Technical University of Denmark



**The Scottish
Government**

BIG HIT Project – Many Supporters

Innovate UK



Highlands and Islands Enterprise
Iomairt na Gàidhealtachd 'n nan Eilean



CRPM CPMR

HyER



BIG HIT Grant
no.: 700092





www.calmac.co.uk

Loch Shira



Caledonian MacBrayne

LOCH SHIRA
GLASGOW



BIG HIT Hydrogen Logistics

BIG HIT
Grant Agreement
no.: 700092



Hydrogen trailers are manufactured by Calvera at factory in Zaragoza, Spain



Hydrogen trailer being used in the Orkney Islands, arriving in Kirkwall

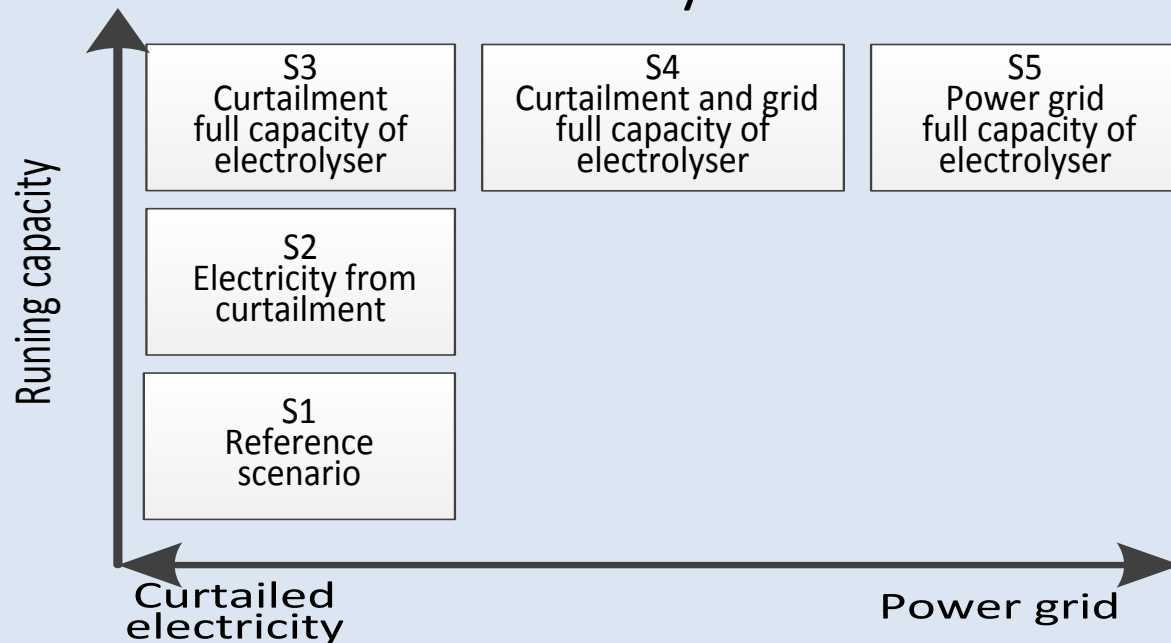


BIG HIT Economic Analysis

BIG HIT
Grant Agreement
no.: 700092

Work on BIG HIT Economic & Social Impact Analysis carried out by BIG HIT partner Danish Technical University

Production
controlled by
electrolyser full
capacity

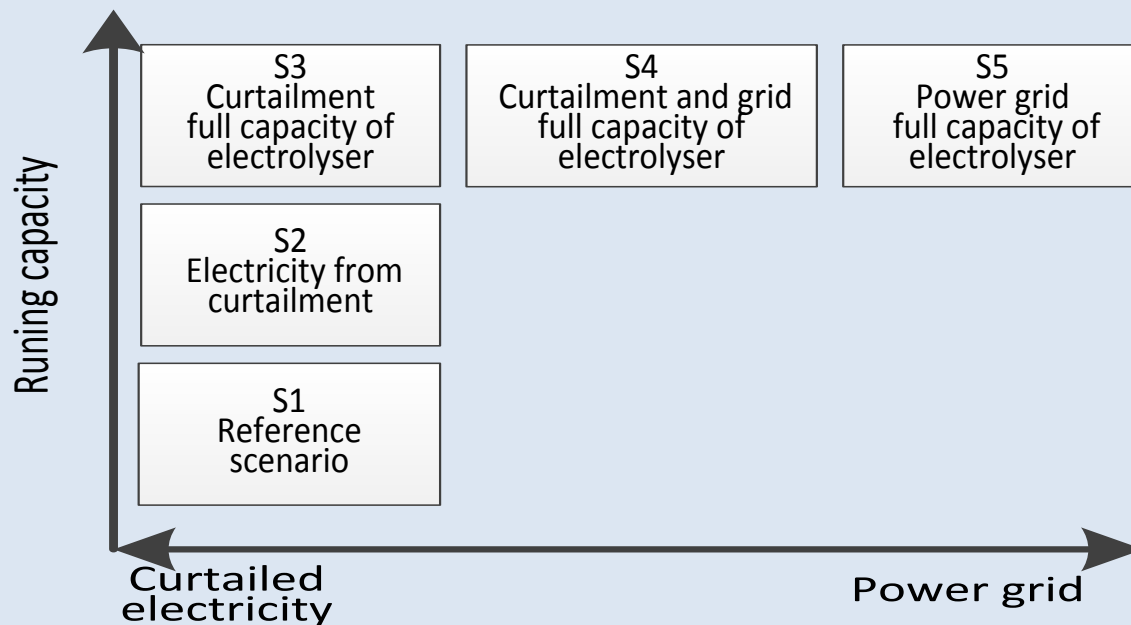




BIG HIT Production Analysis

BIG HIT
Grant Agreement
no.: 700092

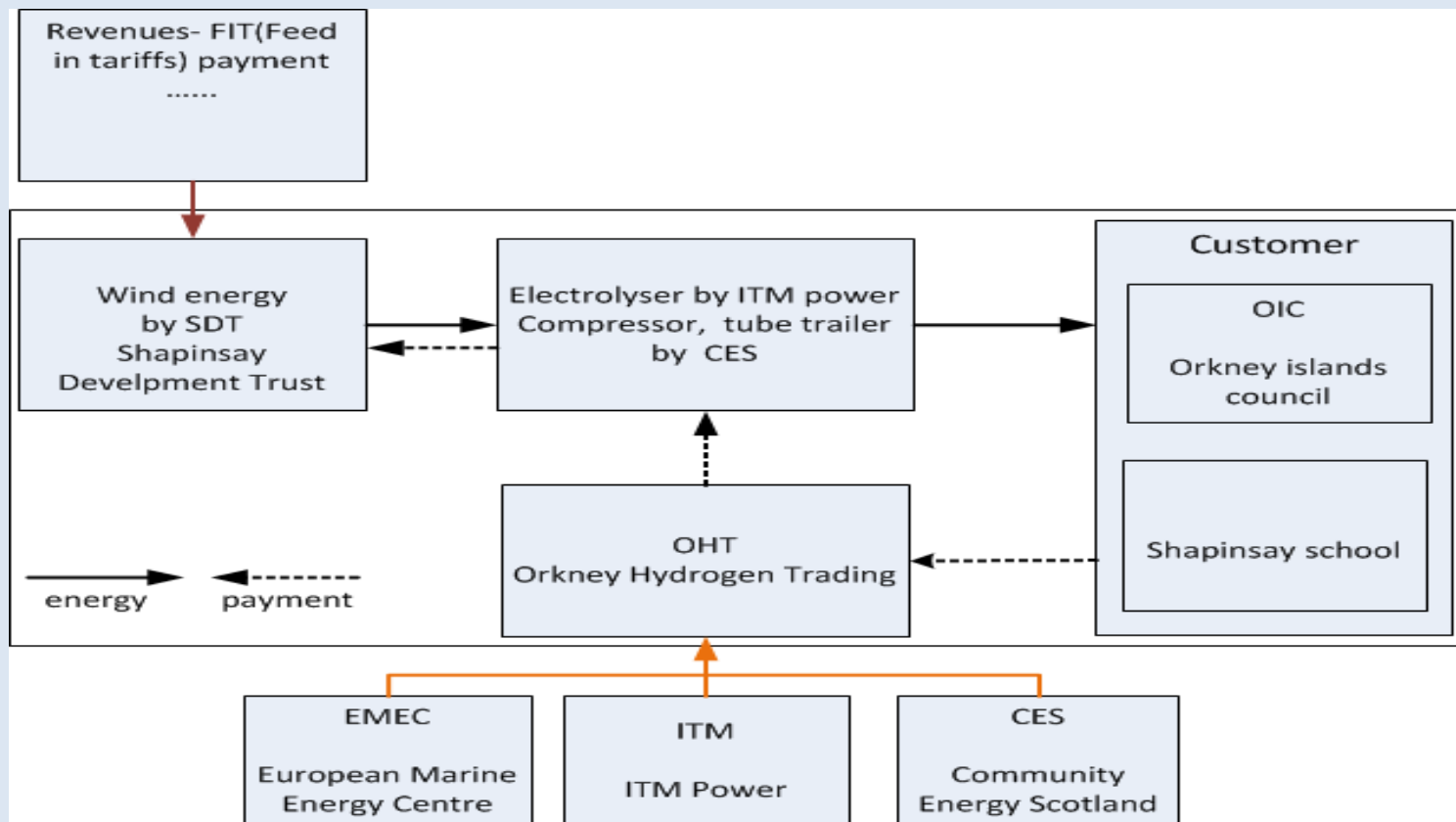
Hydrogen production (ton/year)	
Shapinsay	Eday
124	62
26	14
16	14





BIG HIT Business Modelling

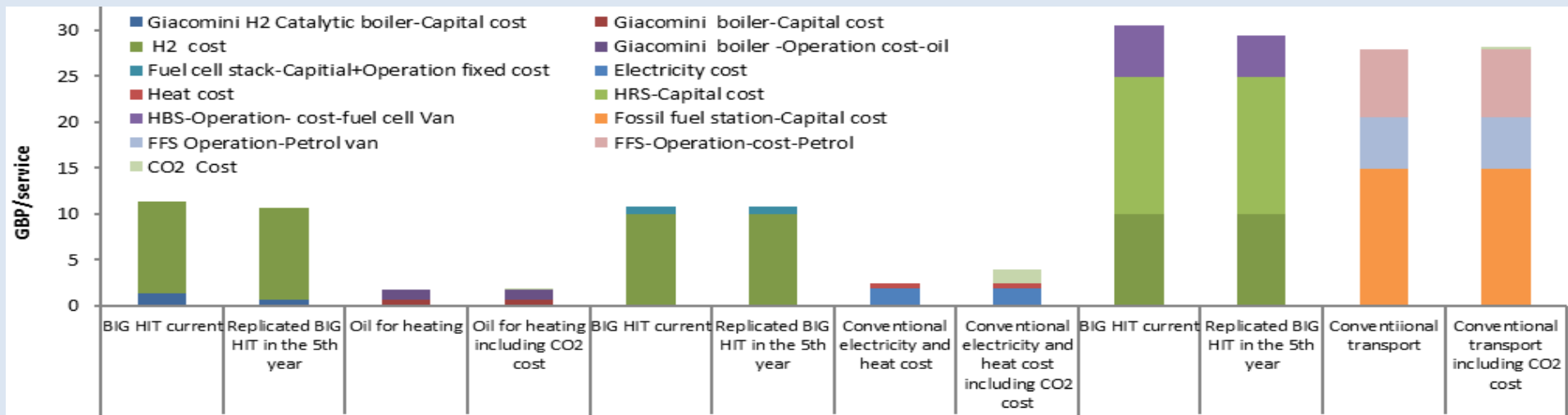
BIG HIT
Grant Agreement
no.: 700092





BIG HIT Economic Analysis

BIG HIT
Grant Agreement
no.: 700092



Heat service

Power service

Mobility

At Hydrogen cost of £10 per kg only mobility is attractive market



BIG HIT Consumer Surveys

BIG HIT
Grant Agreement
no.: 700092

Hydrogen Fuel Cell Technology in the Local Community Heat and Power

Demographic

This section is created for the sole purposes of defining different categories and areas.

Sex

- ☐ Male
☐ Female
☐ Other

What age are you?

Dit svar _____

Where is your current home?

- ☐ Mainland (Kirkwall)
☐ Mainland (Other)
☐ Eday
☐ Shapinsay

Where were you raised?

Dit svar _____

Social impact survey to partners / suppliers of BIG HIT project

(None of the questions are mandatory, any or all can be left unanswered)

19/06/2017 made by Guangling Zhao (quaz@dtu.dk), Eva Ravn Nielsen, DTU Energy.

1. Which company/organisation are you in?

- Name of the company/organisation _____ location (country and city) _____
- ☐ Public sector
☐ Private company
☐ Non- profit organisation

2. How many employees are engaged in the BIG HIT project in your company/organisation?

No. _____ (both full-time and part-time)

3. What are the nationalities of the engaged employees? Please provide nationalities and number of employees.

Nationality _____ No. _____
Nationality _____ No. _____
Nationality _____ No. _____
Nationality _____ No. _____
Nationality _____ No. _____

4. What is the age of the engaged employees?

18-30 yr. No. _____
30-40 yr. No. _____
40-50 yr. No. _____
60+ yr. No. _____

5. Which type of employment do the employees involved in BIG HIT have? How many of them?

Full-time contract: No. _____
Part-time contract: No. _____

6. Usually, what are the average working hours per week at your company?

Please provide the number _____ (hours/week)



LOCAL IMPACT and the WIDER BENEFITS

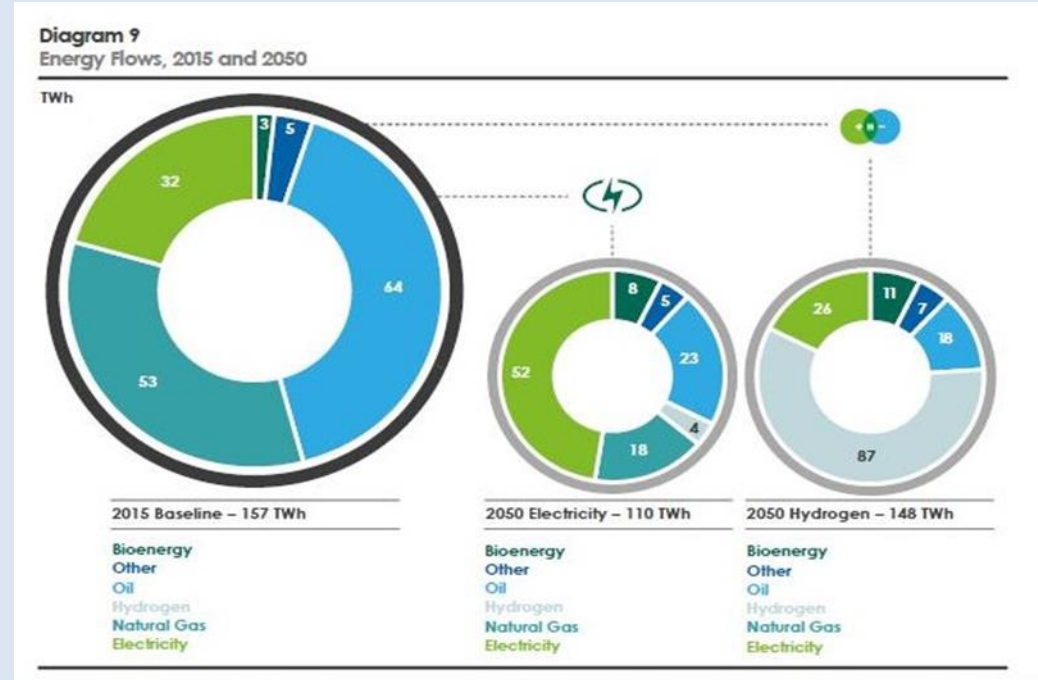
- Overcome grid constraints and harness local renewables
- Reduce grid investment costs & improve grid utilisation
- Validate business model for integration of Renewables locally via hydrogen (near-to-market solutions)
- Reduce fossil fuel consumption & carbon emissions
- Boost local economy including development of local skills & qualified jobs in emerging technologies



BIG HIT Energy Transition

BIG HIT
Grant Agreement
no.: 700092

- Target is 50% of all Scotland's energy from Renewables by 2030
- Scenarios for 2050
 - 1. electric or
 - 2 . hydrogen





BIG HIT Replication

BIG HIT
Grant Agreement
no.: 700092

BIG HIT : 'Learning by Doing' at Local Level



Supporting the Energy Transition - Building up for Hydrogen at Scale



BIG HIT Launch

BIG HIT
Grant Agreement
no.: 700092

BIG HIT Launch Event – 15th & 16th May 2018



BIG HIT launch in Kirkwall, Orkney Islands on 15th May & Hydrogen Territories Platform event 16th May 2018

To register your interest send email to info@bighit.eu



BIG HIT Grant
no.: 700092



Thanks for listening – Any Questions?



nigel.holmes@shfca.org.uk

Mobile +44(0)7818 091466