

# Scotland's Hydrogen Future Study

A report prepared for  
Scottish Hydrogen Fuel Cell Association

# Report commissioned to define future potential landscape for renewable hydrogen in Scotland

- **What are the future energy demand and supply needs in Scotland to 2050 in 10 year increments?**
- **What are the future opportunities for renewable hydrogen within this landscape?**
- **What are the resource implications in terms of infrastructure for hydrogen production, storage, distribution and consumption?**
- **What is a realistic timeline for commercialisation of viable sources of hydrogen in Scotland?**



**Assist in informing the future development of a Hydrogen Road Map for Scotland**

The 8 week study was based on the review of existing data sources and independent validation

## Methodology

Baseline  
Research

Validation  
using FESA  
Model

Develop  
Insights

Prepare  
Final Report

- **Scottish Government not in favour of new nuclear power – implications for hydrogen?**
- **Scottish Government target of 50 % renewable electricity generation by 2020 – contribution of renewable hydrogen?**
- **Scottish Government wants to achieve 80 % reduction in CO<sub>2</sub> emissions by 2050 – role of hydrogen in this?**

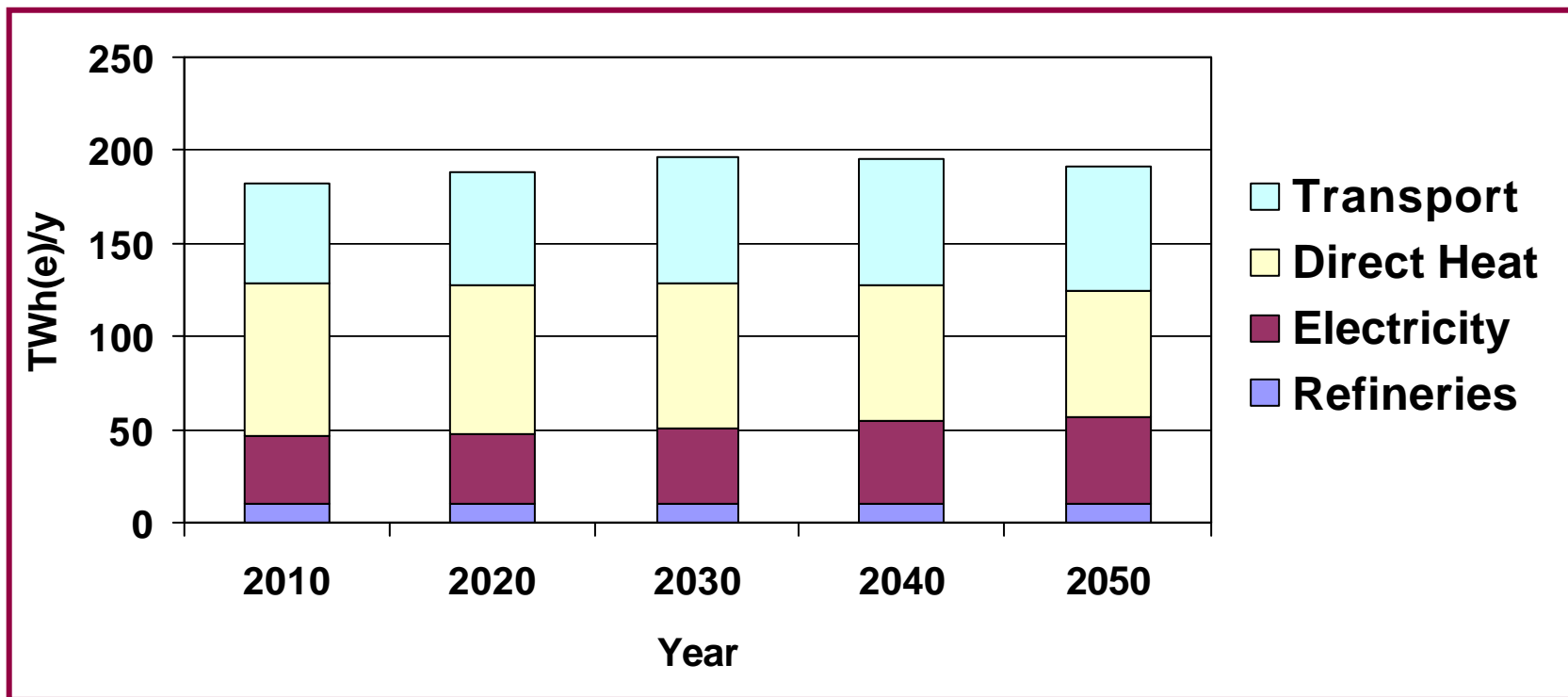
# Within the scope of this study a number of key assumptions have been made

- **Data quality up to 2020; level of confidence reduces to 2050**
- **Population in Scotland will increase slightly to peak of 5.37m in 2030, then slowly decline to 5.25m in 2050**
- **Holistic view of the energy system, i.e. all uses of energy including electricity, heating and transport**
- **Distribution of intermittent electricity surpluses via the grid without conversion**
- **Hydrogen's low position in merit order of DSM options**
- **Primary driver for generation capacity is electricity demand**
- **Renewable supply projections made to match on average demand projections**

# In consultation with key stakeholders, a preferred scenario was developed

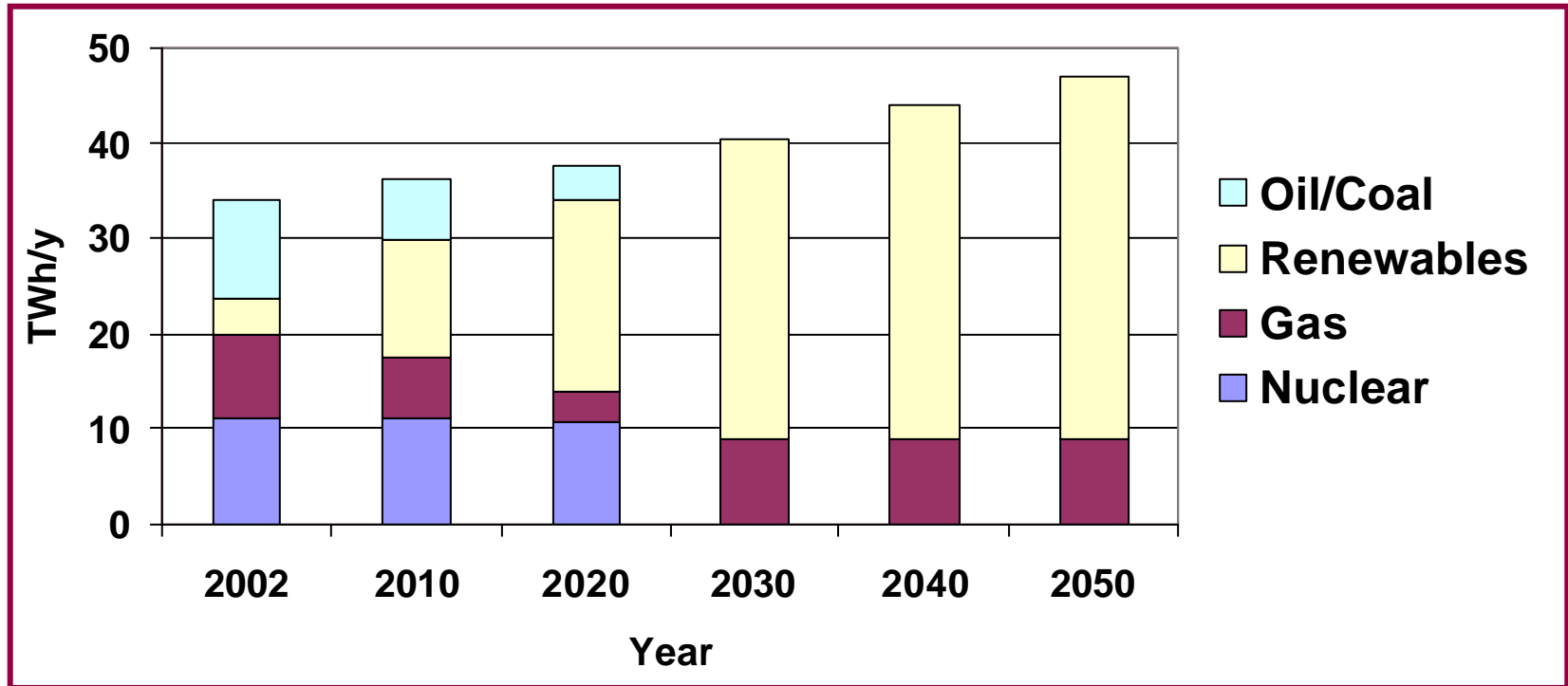
- 1. Energy demand profile based on published data up to 2020\*  
Subsequent growth in line with population.**
- 2. Use of coal and gas to 2020 split on assumption that coal is cheaper and is first choice. No coal capacity beyond 2030**
- 3. Gas power capacity remains constant to 2050**
- 4. No nuclear power after 2030**
- 5. Grid upgrade as required to 'enable' renewable capacity**
- 6. Ongoing dominance of onshore wind to 2050**
- 7. Unlimited demand for renewables**

# Total energy demand in Scotland is forecast to grow by c. 9% over the period 2002 - 2050



- **Transport demand will grow by c. 42 %**
- **Electricity demand will grow by 37 %**
- **Heat demand will fall by 20 %**

The generating profile required for this demand is strongly reliant on renewables from 2020



- **Matching of 2020 target of 50 % renewables**
- **No nuclear or coal generating capacity beyond 2030**
- **7.7 GW installed renewable capacity by 2020 (54 % of energy supply); 14.5 GW by 2050 (80 % of supply)**

# The HEG Report\* previously examined the potential for renewable hydrogen in Scotland

- **Established to examine and report on the potential and opportunities for hydrogen and fuel cells in Scotland**
- **HEG's vision for Scotland drawn heavily from EU 'Snap shot' 2020**
- **Vision includes 50 leading demonstration projects by 2010 and at least one EU 'Lighthouse' project**
- **By 2020, includes 20 % of homes with fuel cell based micro CHP; 10 % of transport powered by fuel cells using renewable fuels**
- **Estimated total potential hydrogen resource from intermittent renewables in Scotland of c. 141 TWh (based on total available renewables resource and potential 'spare' capacity)**

However, to date development of a hydrogen infrastructure has been fragmented

Examples

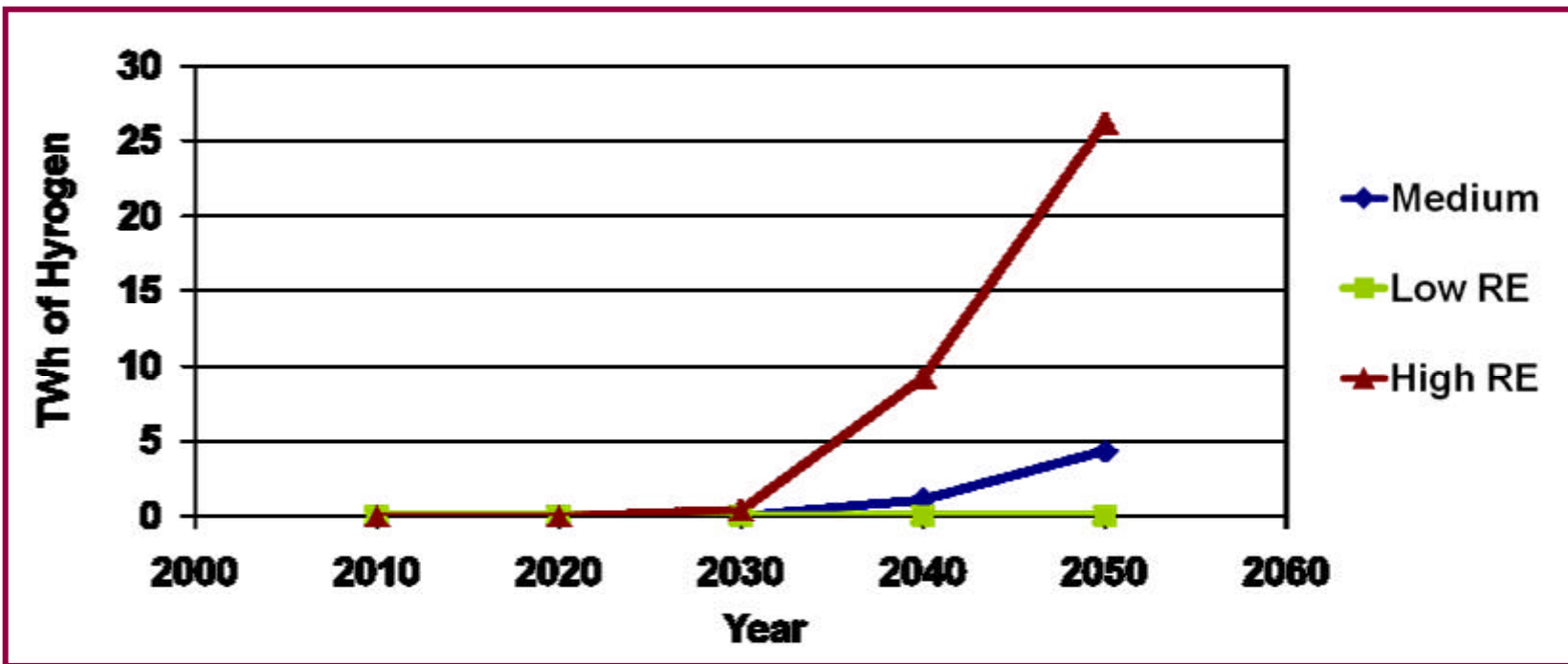
<b>Project</b>	<b>Scope of Project</b>
<b>Hebridean Hydrogen Park</b>	Vision to establish a hydrogen economy within the Outer Hebrides
<b>PURE Project</b>	Demonstration project with integrated wind power and hydrogen technology
<b>Hydrogen Office, Fife Energy Park</b>	Construction of a new 11, 000 ft <sup>2</sup> energy efficient office facility with hydrogen/fuel cell CHP system.
<b>Berwickshire Housing Association</b>	Operation of a beta prototype fuel cell CHP system

**Available skills base in Scotland generally good; weaknesses identified in H<sub>2</sub> production technology, supply chain and grid connection engineering expertise**

# FESA is a time step model that analyses energy flows through the year on a virtual system

- **Functional, techno-economic model**
- **Holistic view incorporates power, heat and transport sectors**
- **Used to analyse user-definable scenarios**
- **Technology neutral**
- **Includes demand side management (DSM) measures**
  
- **Inputs: weather data, demand profiles**
- **Assumptions: technology and fuel costs, policy related factors, scenarios based on previous studies**
- **Outputs: year-round supply and demand profiles, total supply and demand figures, sensitivities of key parameters**

FESA was used to determine the availability of hydrogen from non-despatchable renewables



Three sensitivities run on the model over and above Base Case:

- 1. High and low levels of renewables capacity (see above)
- 2. No expansion of interconnectors
- 3. On going nuclear input from Torness from 2030

# Conclusions and Implications of Findings (1)

- **Current Scottish Government policy on decommissioning places heavy dependence on renewable capacity from 2020**
- **Scotland will be reliant on interconnectors for both import and export of electricity**
- **Renewable hydrogen will start playing a significant role in renewables mix from c. 2030; meanwhile intermittent surplus power accommodated by grid reinforcement and other DSM**
- **Estimates of availability of renewable hydrogen (TWh/y):**

	<b>2030</b>	<b>2050</b>
<b>FESA Base Case</b>	<b>0.03</b>	<b>4.3</b>
<b>High Renewables</b>	<b>0.39</b>	<b>26</b>
<b>Total Energy Demand</b>	<b>200</b>	<b>192</b>

## Conclusions and Implications of Findings (2)

- 5. Beyond 2030 main role for hydrogen will be forecourt scale hydrogen production facilities – transport/grid management**
- 6. 0.03 TWh/y sufficient to support 3,500 cars, or 850 buses**
- 7. FESA Base Case indicates a 60 % reduction in CO<sub>2</sub> levels by 2020 (versus 80 % target)**
- 8. Transitional technologies will have a key pre-emptive role in the run up to full scale hydrogen deployment**
- 9. Near term opportunities for small number of localised renewable hydrogen systems with favourable economics**
- 10. Future infrastructure needs driven by downstream hydrogen production (e.g. at point of use)**
- 11. Significant technical development required in run up to 2030, hence action required now.**

Ultimately, evolution of this sector will be reliant of a variety of externalities

### *Key Influencing Factors*

**Installation of Extensive Renewables Capacity**

**Availability of Intermittent Energy Surpluses**

**Development Market for H<sub>2</sub> Powered Vehicles**

- ✓ **Fossil fuel prices**
- ✓ **Government policy and intervention e.g. energy supply mix, energy security, emissions reduction**
- ✓ **Management of grid constraints and availability of interconnectors**
- ✓ **Development of cost effective/reliable technology**
- ✓ **Successful demonstration of transitional technologies and infrastructure**
- ✓ **Development of national skills base**