# ISLE OF MAN FUTURE ENERGY SCENARIOS

19th July 2021

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# Climate Targets

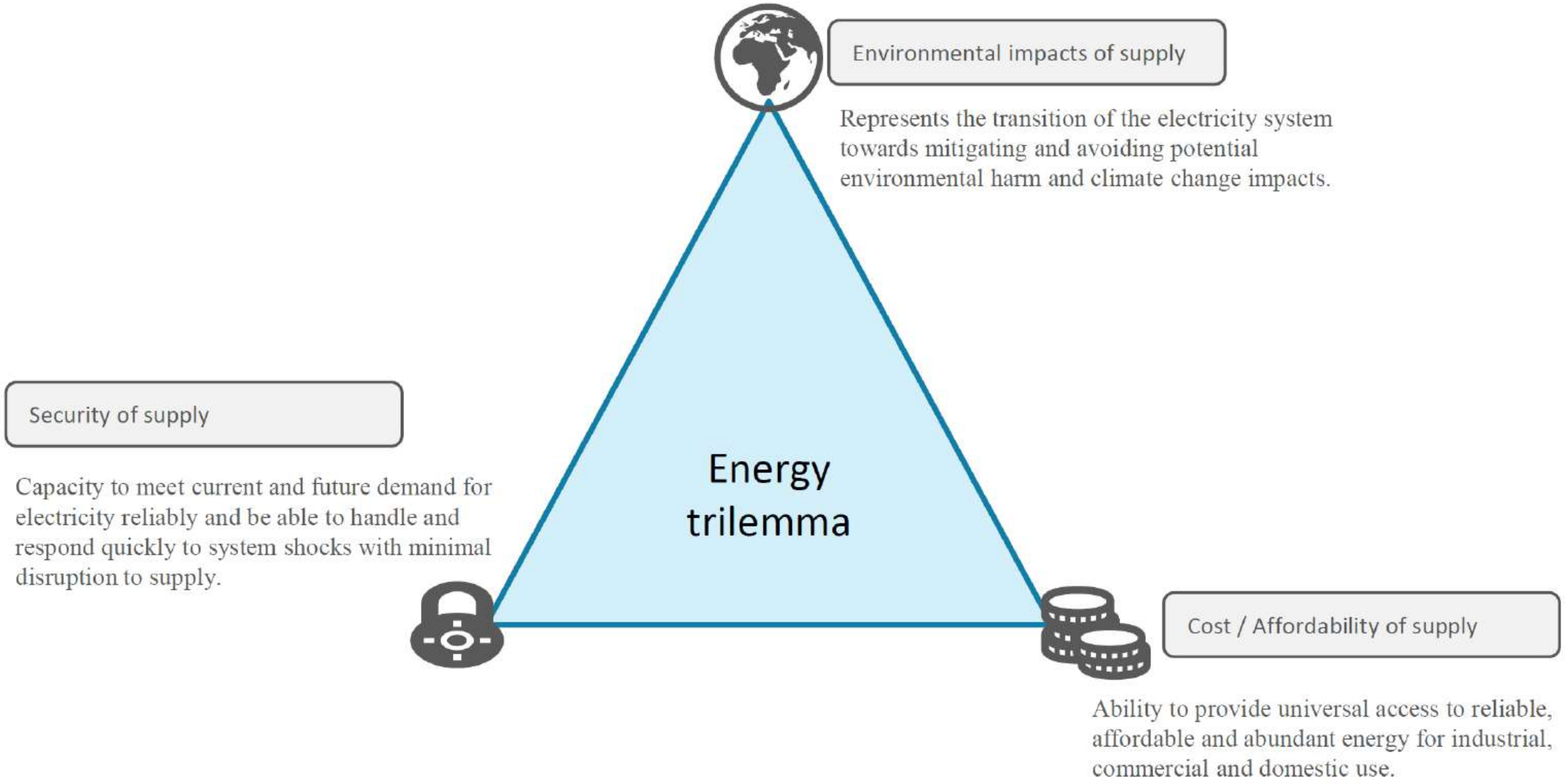
- In December 2020, the Isle of Man Government launched its Future Energy Scenarios (FES) Strategy to determine the pathway to meet the following:

  - **To ensure 75% of the island's electricity is generated from renewable sources by 2035**
  - **To deliver Net Zero emissions by 2050**

- Electricity generation is now responsible for around 33% of all Greenhouse Gas Emissions on the Isle of Man.

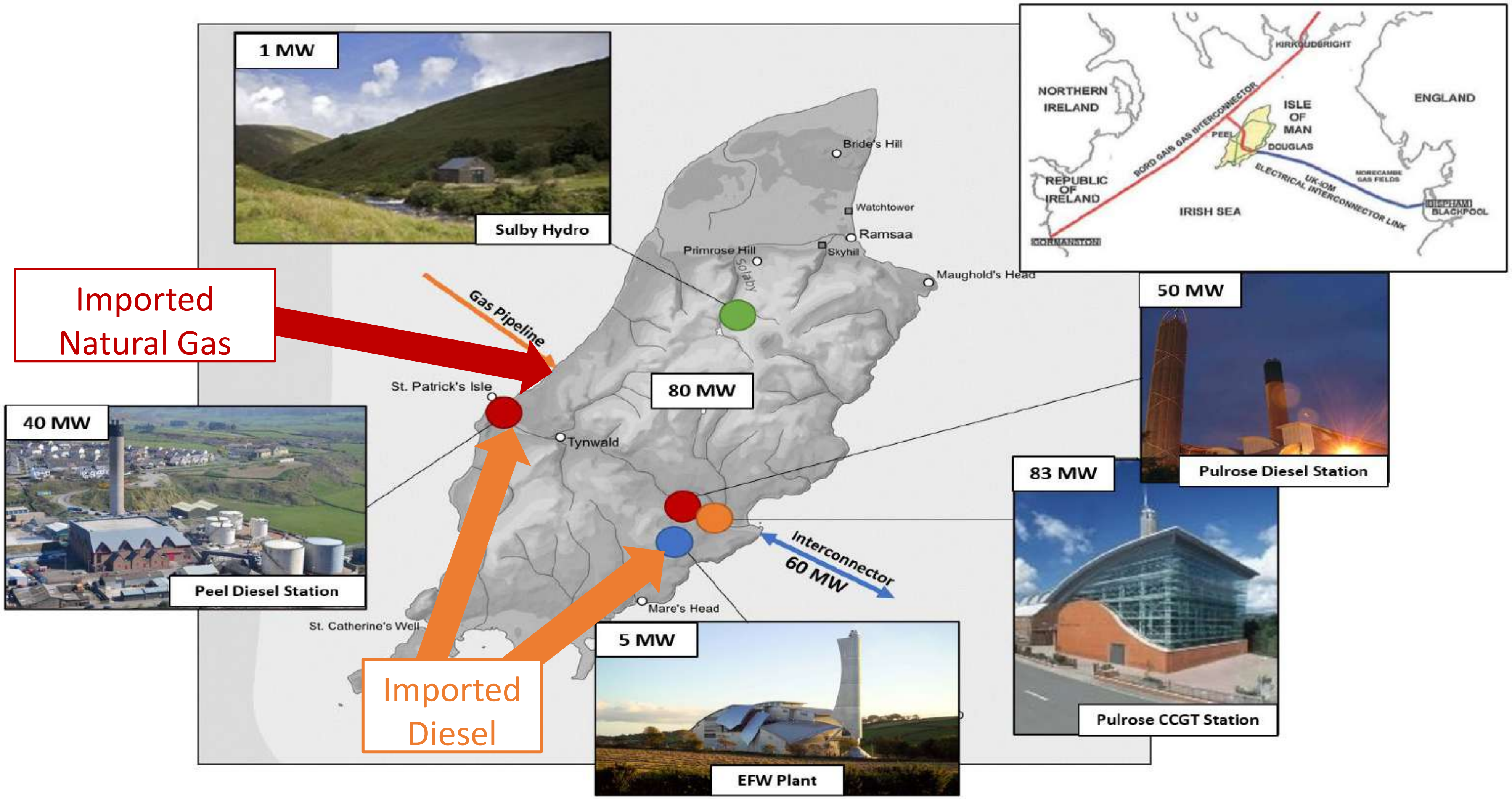
- Without the decarbonisation of electricity, it is not possible to reduce emissions in other areas e.g. Heating, Transport etc.

# The Energy Trilemma




SOURCE: WORLD ENERGY COUNCIL

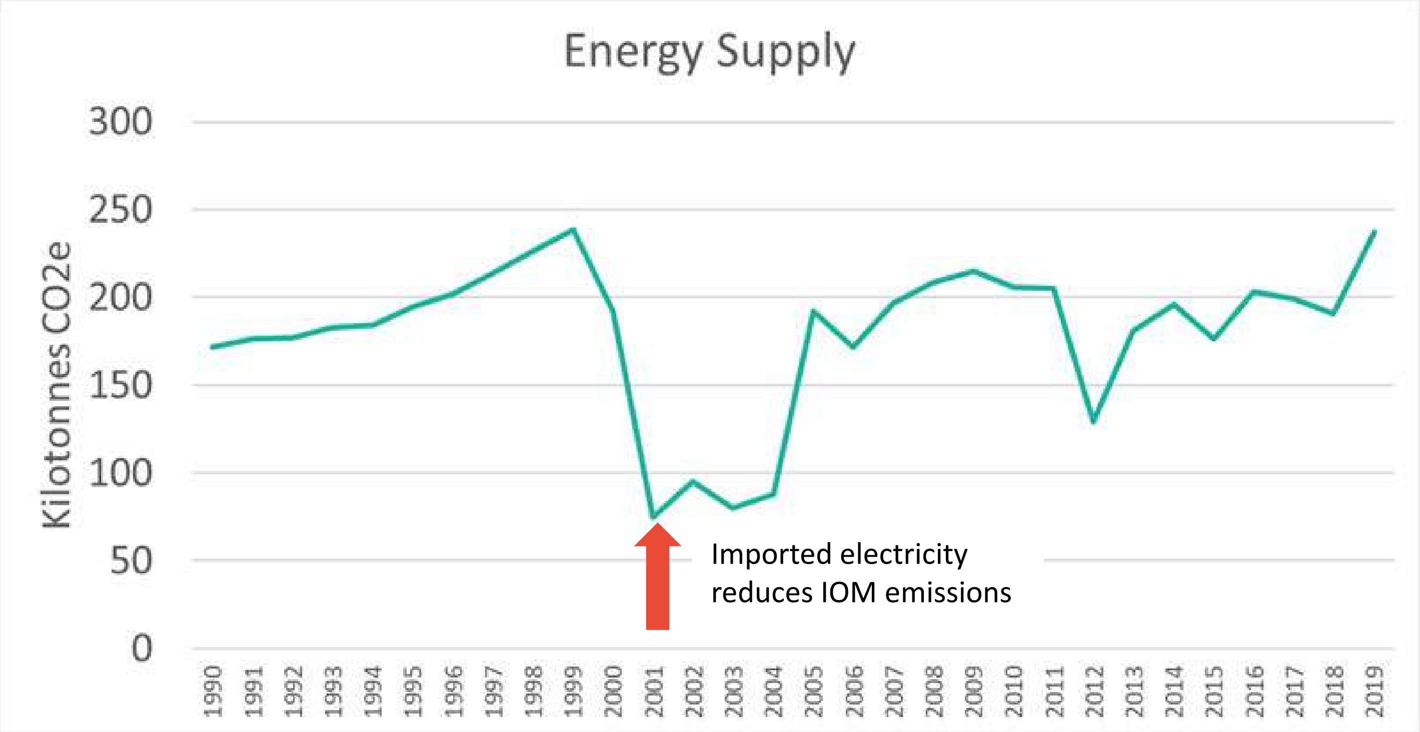
# Current Generation Mix – *(92% generated from imported energy)*

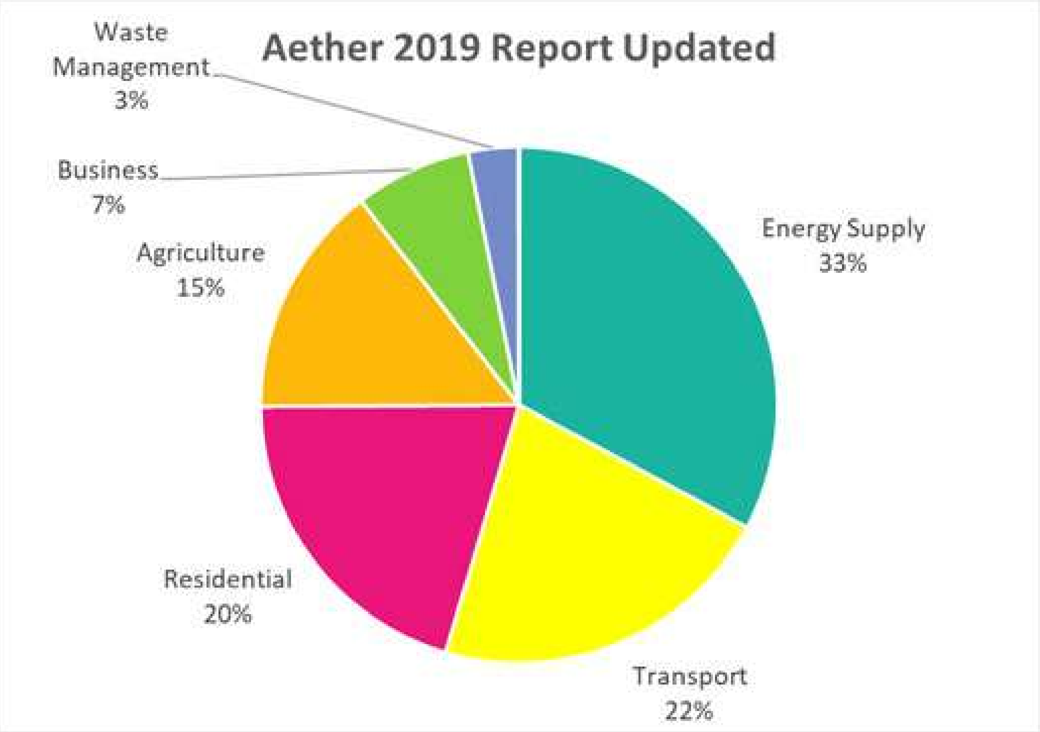



Majority of current power generated from imported gas

N-2 resilience meets peak demand if two largest assets are unavailable

# Emissions from Electricity Supply



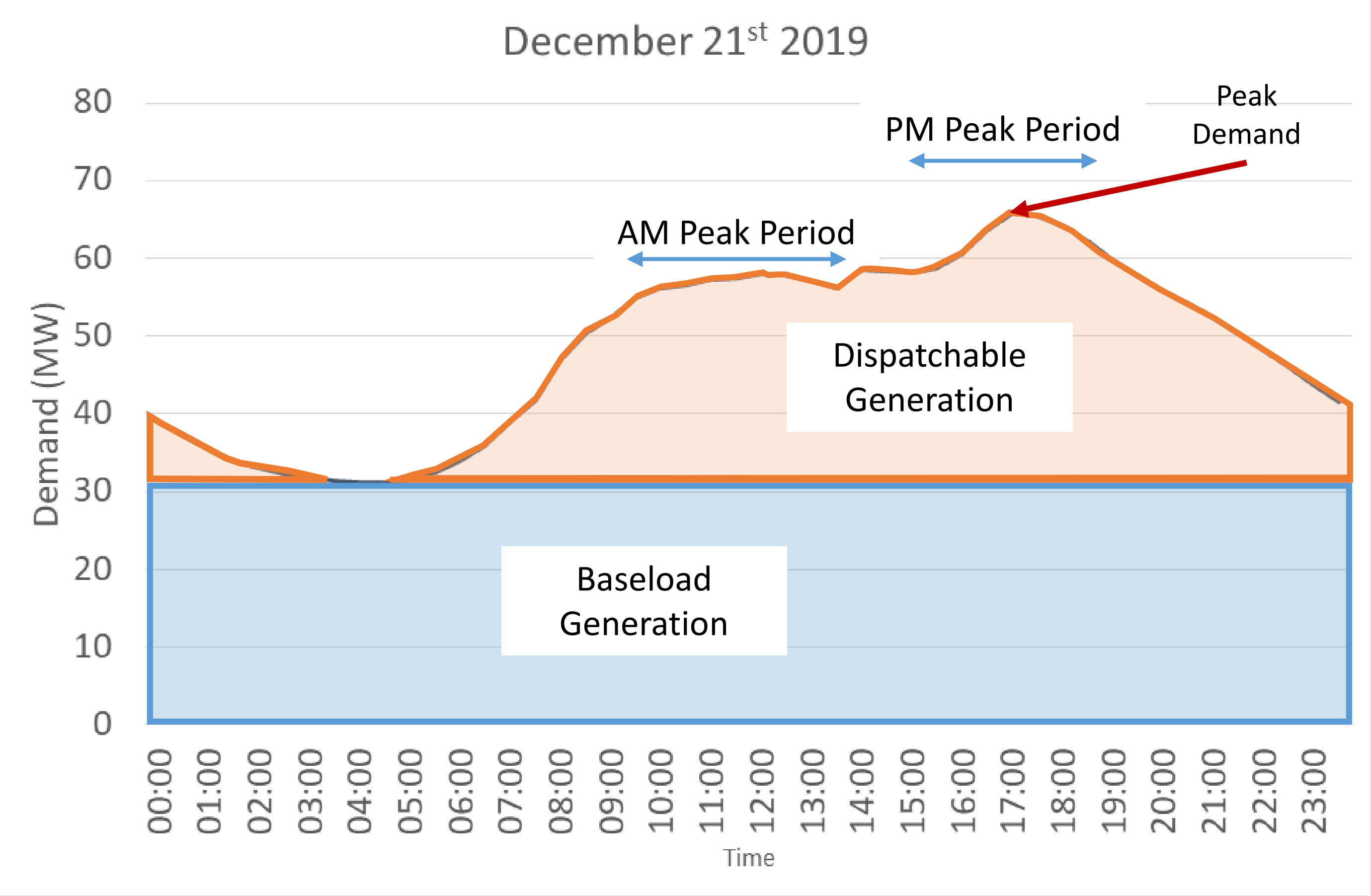




*Source: Aether*

Electricity generation is currently the largest source of carbon emissions on the Isle of Man.

Importation of electricity from the UK would immediately reduce the Isle of Man emissions

# Generation Capacity to Meet Demand




**Dispatchable generation**

Highly flexible and power output can be varied to meet peak demand

- Fossil fuel Generation (Gas, oil)
- Biofuels (Biomass, Biogas, Biodiesel)

AND

- Interconnectors

**Baseload plant**

Required to maintain stability on all Transmission Networks. Meets the minimum electricity demand, less flexible

- Fossil fuel Generation (Coal, gas)
- Large Scale Biomass
- Nuclear Generation
- Large Scale Geothermal/Hydro

AND

- Interconnectors

# Baseload Options for Isle of Man

## Interconnector

**<£60 per MWh**

Advantages:

- Cheapest baseload option for island in terms of CAPEX and O&M costs.
- Provides a route for exported electricity from the island when generation exceeds demand.
- Provides both dispatchable and baseload capacity
- Network ancillary services can be provided by the cable itself which avoids significant network upgrade costs.
- Renewable generation can be purchased from other jurisdictions at low cost on top of standard import charges.

Disadvantages:

- Reliant on other jurisdictions for imports.

## Large Scale Biomass

**£98 per MWh**

Advantages:

- GB currently short of baseload capacity
- Renewable source of electricity providing source material is sustainably forested

Disadvantages:

- Island does not have sufficient resources to grow enough biomass to meet a large generating unit
- Reliant on other jurisdictions for imports
- Biomass must be sustainably sourced to qualify as carbon neutral
- Strict environmental controls required to ensure air quality limits are achieved

## Small Modular Reactors

**£95 per MWh**

Advantages:

- Large capacity from small generating unit. Huge export potential.
- GB currently short of baseload capacity
- Commitment to build 17 new SMRs by 2050
- Creation of ~500 jobs at the plant with other jobs required in regulation
- Up to 1500 visitors to island every year for outages plus WANO reviews.
- One of safest technologies

Disadvantages:

- Public perceives safety issues with nuclear
- Nuclear waste must be strictly controlled and managed
- Stringent Regulation and security measures must be adopted by island

# Dispatchable Options for Isle of Man

## Interconnector

**<£60 per MWh**

Advantages:

- Cheapest baseload option for island in terms of CAPEX and O&M costs.
- Provides a route for exported electricity from the island when generation exceeds demand.
- Provides both dispatchable and baseload capacity
- Network ancillary services can be provided by the cable itself which avoids significant network upgrade costs.

Disadvantages:

- Reliant on other jurisdictions for imports.

## Smaller Scale Biofuels


**~£111 per MWh**

Advantages:

- Potential to produce 30KT of sustainably sourced solid biomass on island per year
- Potential to generate island sourced biogas (or bioethanol) from sewage and waste-crops to supply directly to the gas grid and convert the existing CCGT to biogas for renewable electricity, which could save CAPEX costs.
- Source of local forestry and lumbermill employment or potential for additional income for agriculture sector
- No reliance on other jurisdictions for small scale biomass/biogas/bioethanol.
- UK Short of dispatchable generation. Potential export market.

Disadvantages

- Strict environmental controls required to ensure air quality limits are achieved
- Reliant on other jurisdictions for imported biodiesel. Challenges in transport.
- Further study required to assess viability and cost of Anaerobic digestion, biodiesel and bioethanol.

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# Intermittent Renewables

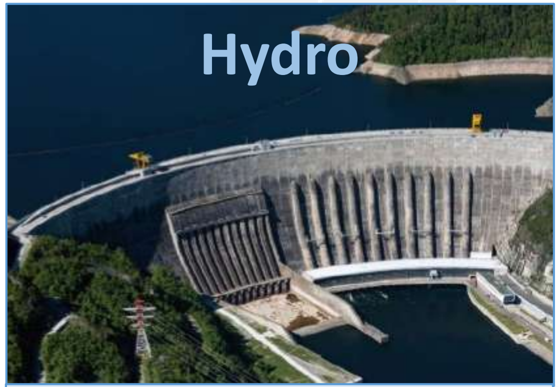
Intermittent renewables are sources of generation powered by natural resources i.e. wind, tide and solar.

The power output (or availability) of these generation units is highly dependent on prevailing weather conditions.

The lack of ability to vary power output from intermittent renewables means voltage and frequency (along with many other stabilising factors) cannot be controlled on their own. These technologies can off-set some or all of the dispatchable generation assets when they are available but must still be stabilised. This is why baseload generation units are still required.


£50 per MWh
LF – 10%


£52 – 59 per MWh
LF – Average 37%



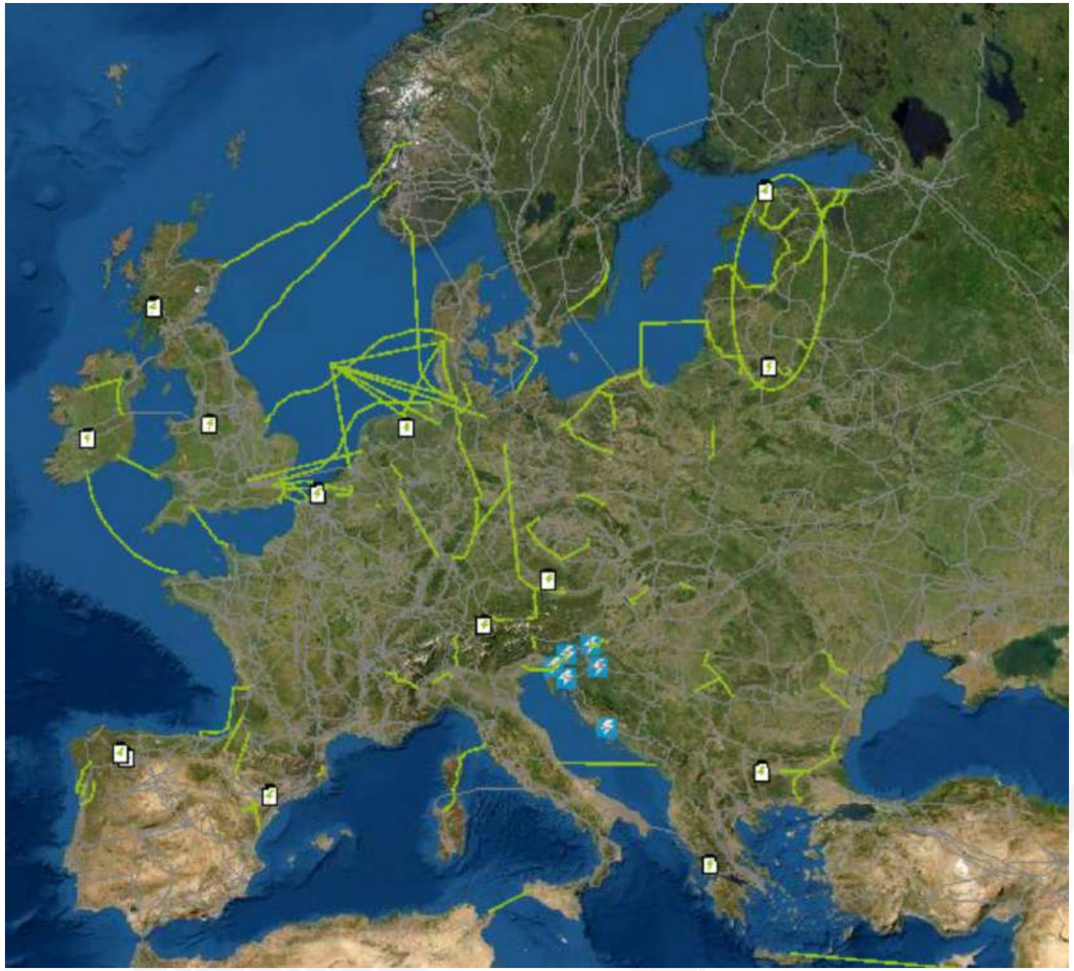

£99 per MWh (storage)
*Dependent on other renewables


£286 per MWh
LF – 28%

# UK Interconnectors

**Currently 4GW of interconnector capacity:**
- 2,000MW to France
- 1,000MW to the Netherlands
- 500MW to Northern Ireland
- 500MW to the Republic of Ireland

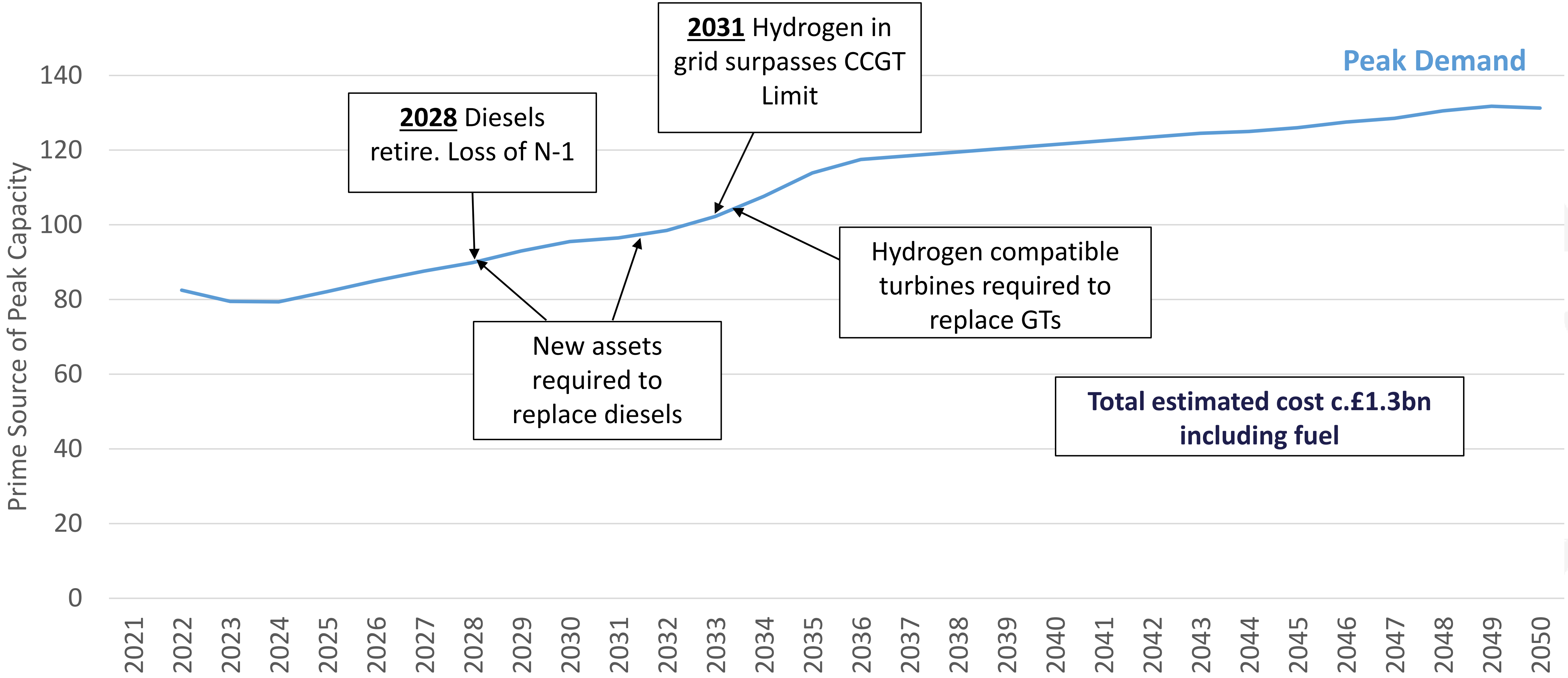
**Future 7.7GW of planned interconnector capacity:**
- 3,400MW to France
- 1,000MW to Belgium
- 1,400MW to Norway
- 1,400MW to Denmark
- 500MW to Ireland



Isle of Man has an existing 60MW cable connection to the UK

Interconnectors provide export opportunities, security and stabilisation

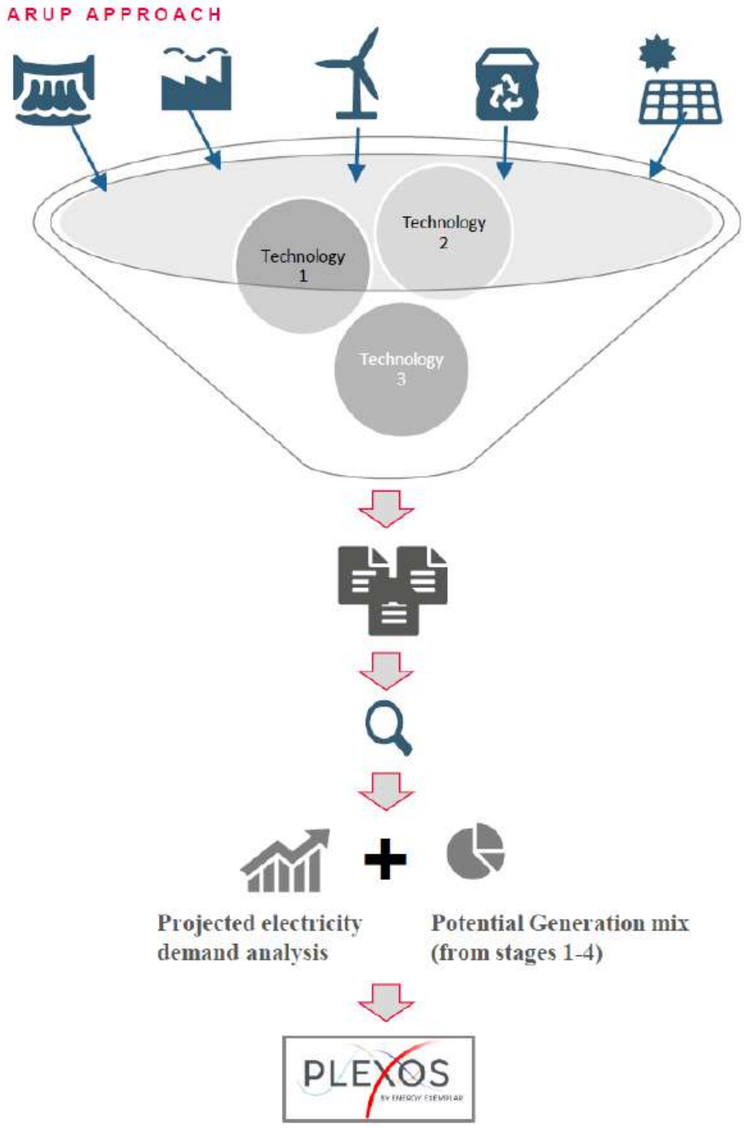
# Investment Still Required without Net Zero



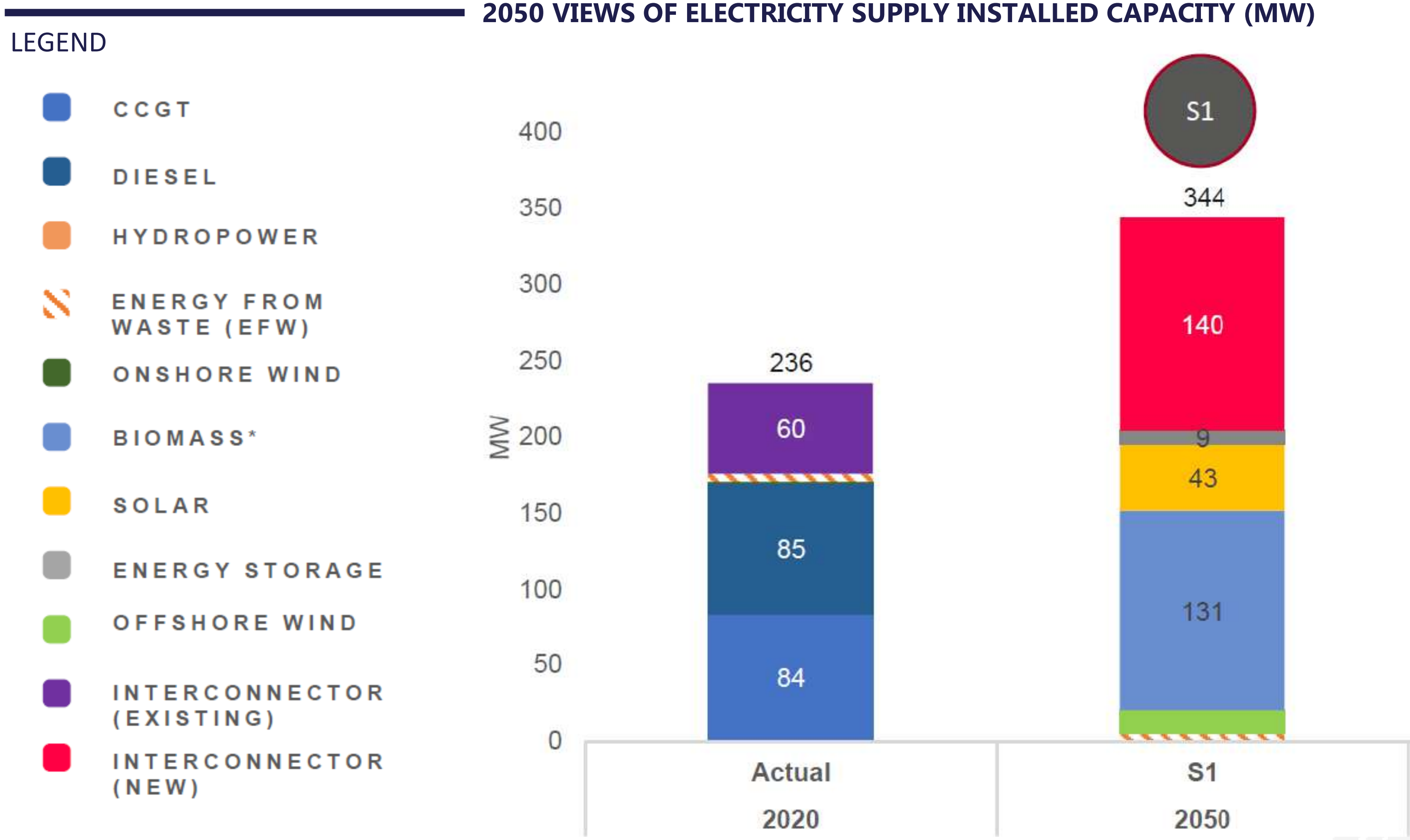

This was not fully modelled as it is not considered an appropriate route given the climate emergency. In all scenarios demand is projected to increase due to increased electricity for heating and transport. New assets are required to maintain N-2 resilience

# Future Energy Scenarios Methodology

- Ove Arup appointed to prepare future energy scenarios to provide the most cost effective pathway to achieve Government emission targets.
- Work considered the balance of security of supply, low cost to consumers, and the environment.
- Arup assisted by a technical team consisting of representatives from the Climate Change Transformation Team, DEFA, DfE, Manx Utilities, Treasury and DOI.
- Independent, technical and economic modelling carried our to create three scenarios based on technologies which were appropriate for the Isle of Man.
- Two further models with greater local intermittent renewable generation were requested, removing the requirement of lowest cost.



# Scenario 1




*Source: Arup Analysis*

**43MW** solar farm with **9MW** storage

**16 MW** Offshore wind turbines

Biomass provides up to **131 MW** dispatchable generation

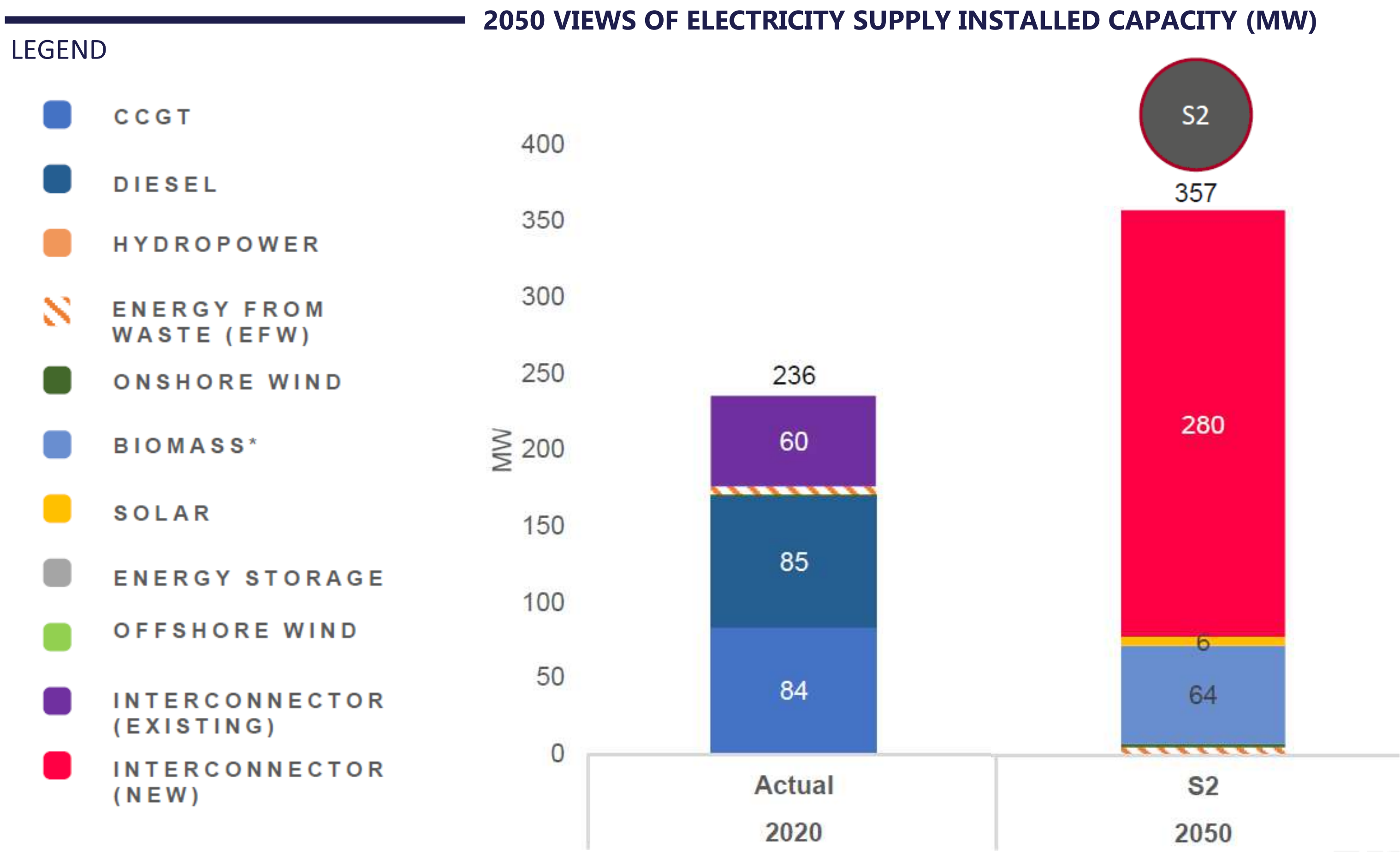
Estimated cost **£1.49bn**

(N-2 cost £1.66bn)

**£1142** per household per annum

**57%** on island generation capacity; **20%** demand met by island sources

# Scenario 2




*Source: Arup Analysis*

**6MW** Small scale roof-top solar e.g. installed on public buildings

**2 x 140MW** interconnectors supply renewable electricity from GB and provide baseload

Biomass provides up to **64 MW** dispatchable generation

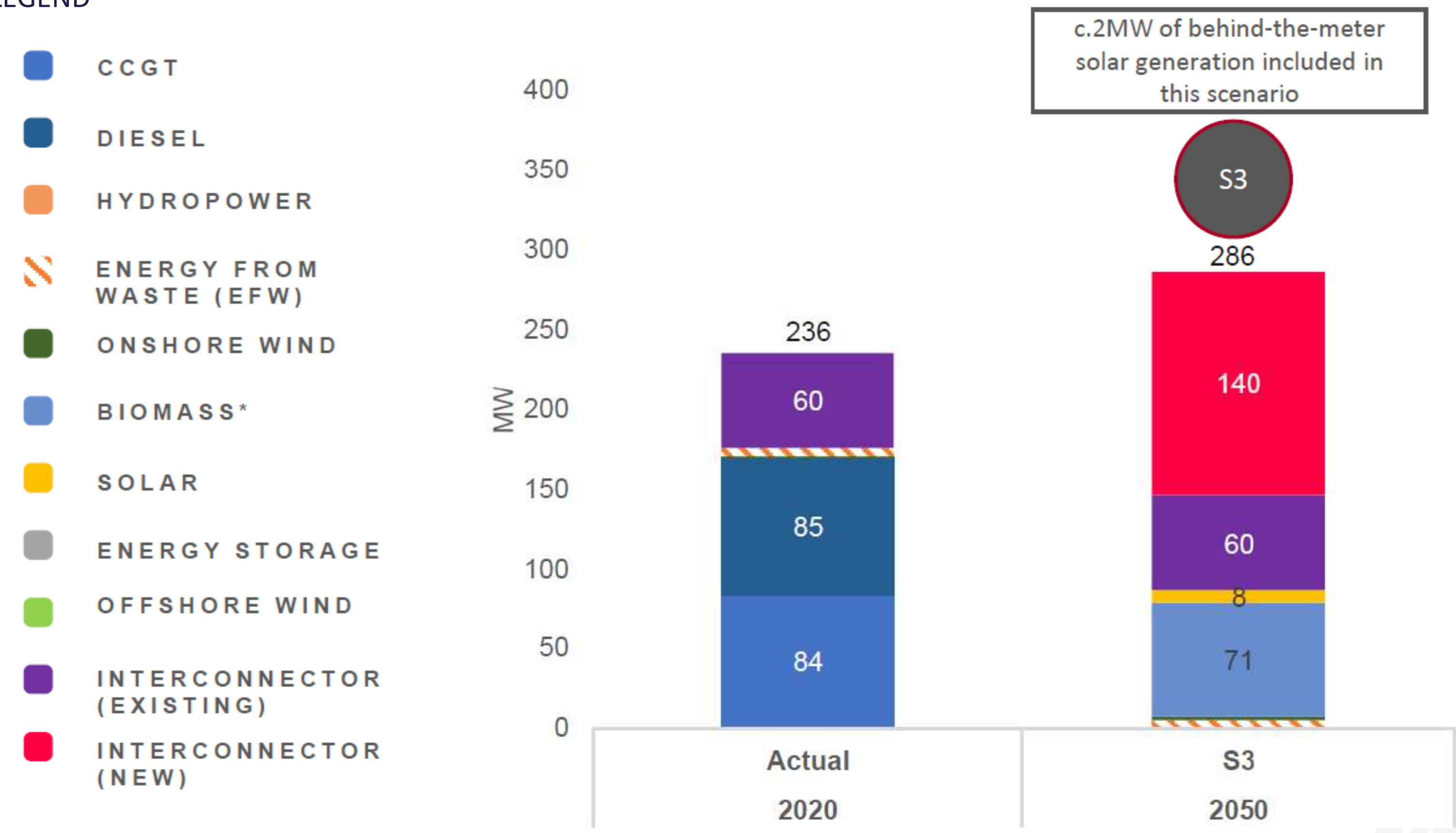
Estimated cost **£1.4bn** (N-2 cost £1.57bn)

**£1073** per household per annum

**20%** on island generation capacity; **8%** demand met from island sources

# Scenario 3

**2050 VIEWS OF ELECTRICITY SUPPLY INSTALLED CAPACITY (MW)**




*Source: Arup Analysis*

**6MW** Small scale community solar

**2.3 MW** roof-top solar on new builds

**2 MW** Community wind projects

Biomass provides up to **71 MW** dispatchable generation and interconnector provides baseload

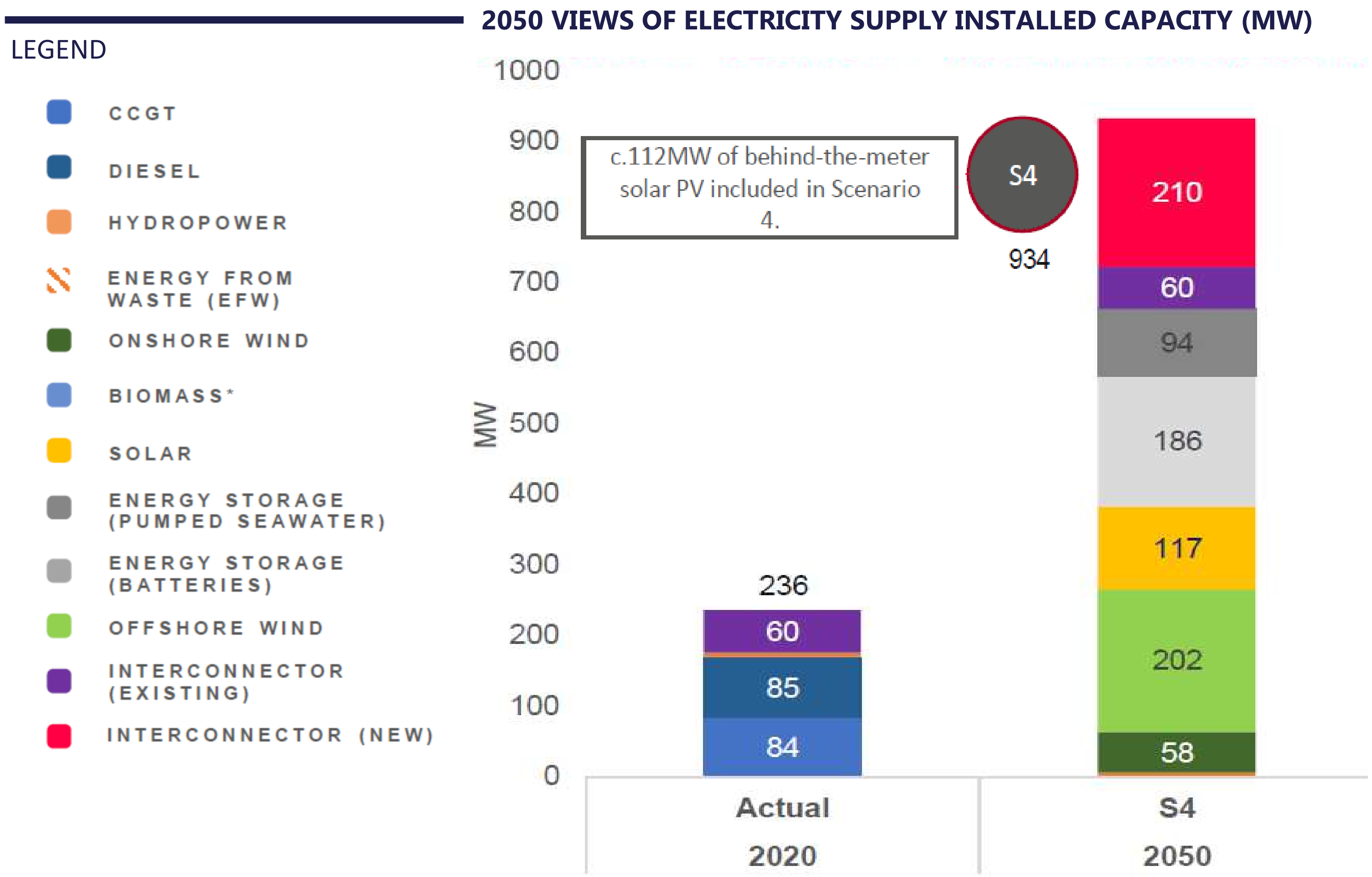
Estimated cost **£1.07bn**

(N-2 cost £1.24bn)

**£820** per household per annum

**30%** on island generation capacity; **9%** demand met by island sources

# Scenario 4




*Source: Arup Analysis*

**377MW** intermittent renewable capacity

**280MW** storage (including onshore marine pumped hydro) required for balancing.

GB provides all baseload stabilisation through **270MW** interconnectors

Estimated cost **£1.8bn*** (N-2)

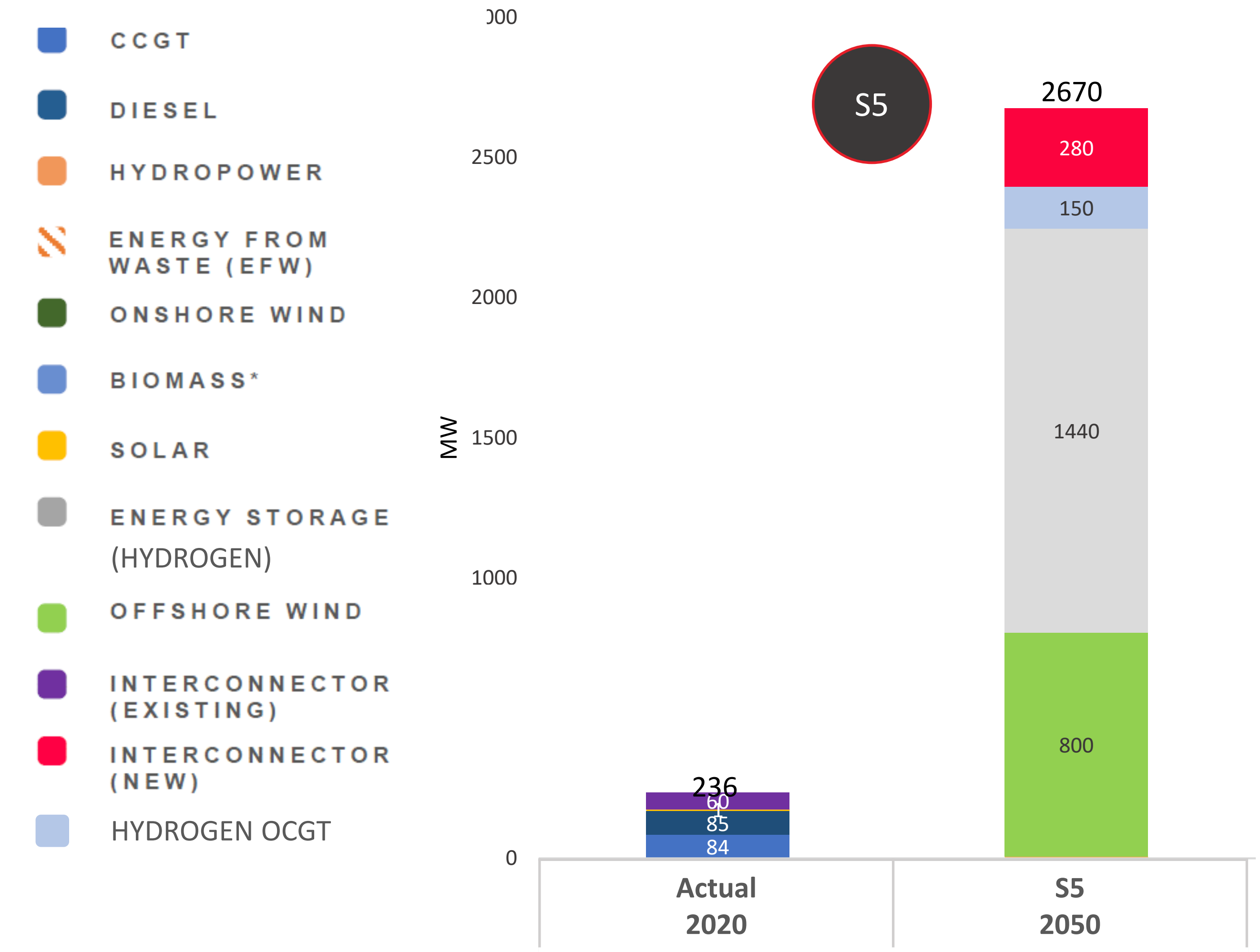
**£1379** per household per annum

**345%** on-island generation capacity; **58%** demand met by on island sources

*Excluding constrainment costs

# Scenario 5

**2050 VIEWS OF ELECTRICITY SUPPLY INSTALLED CAPACITY**




*Source: Arup Analysis*

**800 MW** Offshore wind farm

**1440 MW** Hydrogen storage to provide up to 4h electricity generation

**150 MW** Open-cycle Hydrogen gas turbines to convert the stored Hydrogen back into electricity

GB provides all baseload stabilisation through

**270MW** interconnectors

Estimated cost **£4.5 – 6.1bn** *(N-1+)

**£3450 – £4700** per household per annum

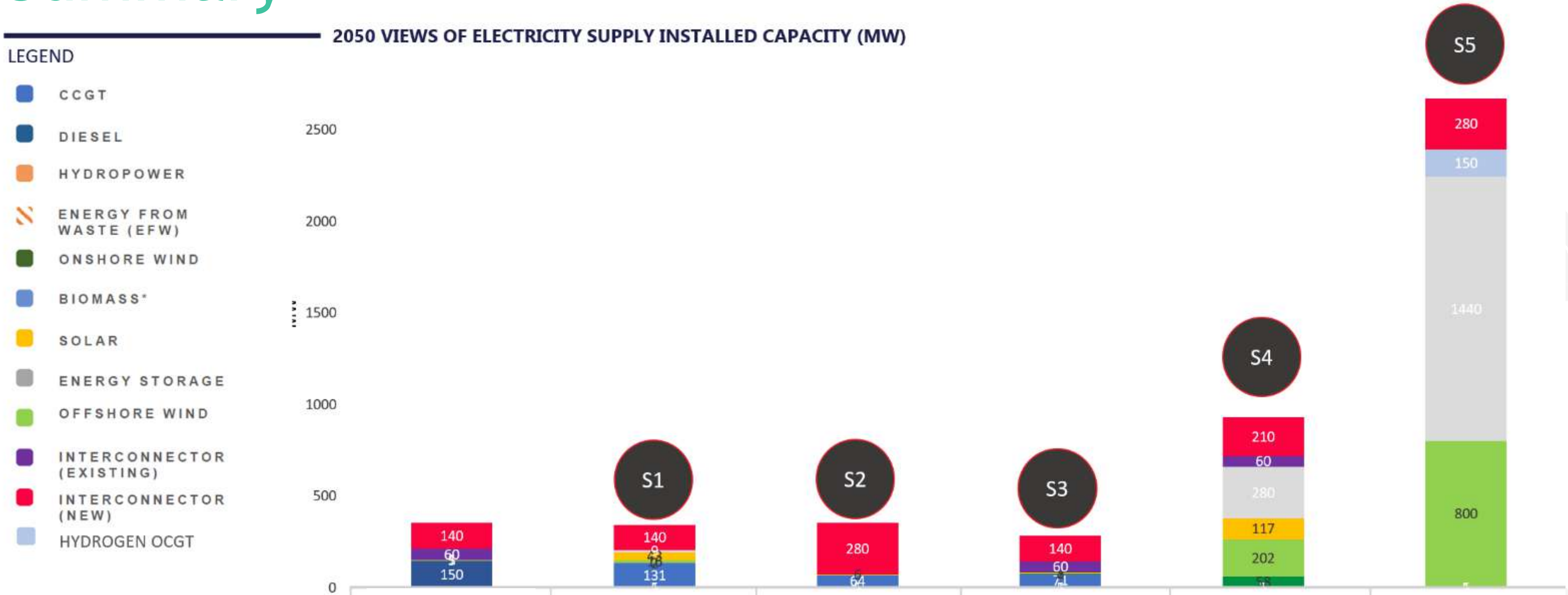
**954%** Island-based generation capacity.

**60 – 90%** demand met by on island sources

*Dependent on cost of electrolysis. Excluding constraint costs

# Summary

2050 VIEWS OF ELECTRICITY SUPPLY INSTALLED CAPACITY (MW)




| | Continued Use of Gas Infrastructure | S1 2050 | S2 2050 | S3 2050 | S4 2050 | S5 2050 |
|---|---|---|---|---|---|---|
| Estimated Total Cost | £1.3bn | £1.49bn | £1.4bn | £1.07bn | £1.8bn | £4.5 – 6.1bn |
| Estimated Cost to Households p.a. | £996 | £1142 | £1073 | £820 | £1379 | £3450 - £4700 |
| On Island Generation Capacity<br>As % of minimum capacity required | 53% | 73% | 25% | 32% | 345% | 954% |
| Total Supplied from Island sources | 91% | 20% | 8% | 9% | 58% | 60% – 90% |

# Short-Term Emissions Reductions

1. A green tariff is already available for business customers, which would allow existing consumers to purchase imported renewable energy as well as energy generated on island from Sulby Hydro. The more customers that uptake this tariff, the greater the amount of electricity that would need to be imported. Greater uptake could allow this tariff to be opened up to domestic customers as well.

2. New businesses, which would require more electricity to operate than could be accommodated by the current network could be encouraged to go 'off-grid'; existing consumers, especially where retail units are grouped together and can 'share assets' looking to decarbonise could also adopt this approach.

# Economic Opportunities for IoM – Generation

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### Intermittent Renewables

- Exports to both GB and Republic of Ireland from wind and solar on island likely to be limited.
- UK and ROI are already constructing a large amount of intermittent renewables at much larger scale.
- If the Isle of Man gains access to GB's CFD market then there may be opportunity to export offshore wind directly from an offshore wind farm to GB

### Dispatchable Generators

- Shortage of dispatchable generation in the UK allows the Island to export dispatchable power from the CCGT to the UK.
- Arup's scenarios show generating electricity from biomass is viable on island and off-sets high peak charges from the UK during times when the UK is short.
- Importation of sustainably-sourced biomass would allow the Island to generate electricity from biomass which could then be exported to GB.

### Baseload Generators

- Both UK and RoI are predicted to become short of baseload power over the next decade.
- Opportunities for the Isle of Man to provide stabilising power to GB or ROI from a large-scale baseload power station, e.g. biomass or a small modular reactor?
- Neither option is without challenge, but likely provide the greatest potential for export. These options have not been explored in the analysis.

# Economic Opportunities for IoM – Demand Shift

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- Traditionally, electricity supply has been based around the demand curve
- Much greater capacity is required than average consumer demand to ensure peak demand can be met.
- For countries that have moved quickly with the transition, this high capacity can start to cause problems during low demand periods, especially in the case of intermittent renewables
- Instead, shifting the demand peak by changing energy consumption can avoid excess capacity
- Storage can work by increasing the demand during times of low customer demand to avoid constrainment charges. This flattens the demand profile but acts to raise the average demand. Inefficiencies in storage technologies means that excess capacity is still required.
- Some countries in Europe are making economic cases for greater storage potential e.g. Norway, Switzerland. Due to geography, these countries have fantastic potential for pumped hydro storage, which is the cheapest storage medium due to its relatively high efficiency.
- Smart networks and smart appliances instead act to reduce Peak demand and raise minimum demand to flatten the curve. These work by switching on energy intensive devices (e.g. washing machines and tumble driers) when there is low demand on the network. Alternatively electric heating (combined with storage systems) can be switched on by smart systems at low demand

# Next steps

Consult on the scenarios over the Summer, as part of 5 year climate change plan.

Decision on preferred pathway to follow publication of 5 year plan in February 2022.

**Action:**

- Carry out feasibility study for new interconnector (no regret decision)

**Further work:**

- Gather additional information from other strategies and smart metering roll-outs
- Identify if a source of sustainable biofuel can be secured and carry out feasibility study
- Carry out Risk Assessment on resilience
- Identify private sector investment opportunities

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# Summary

- Pathways to achieve net zero emissions by 2050 are feasible, maintain security of supply and affordable
- Cost of generating on island renewables is more expensive than importing power
- Large infrastructure projects take 5-10 years, immediate reductions within 5 years are only possible from importing power