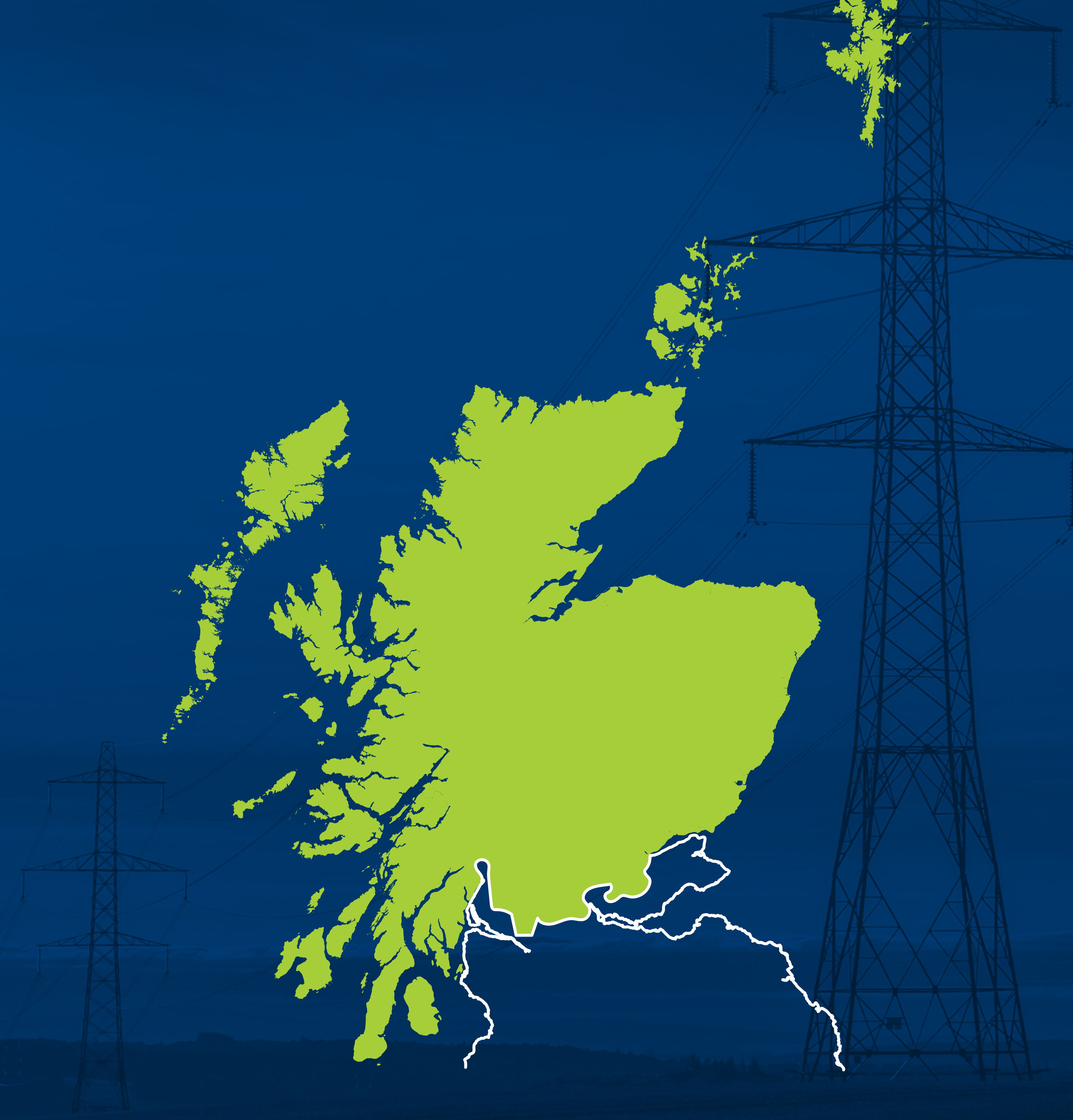
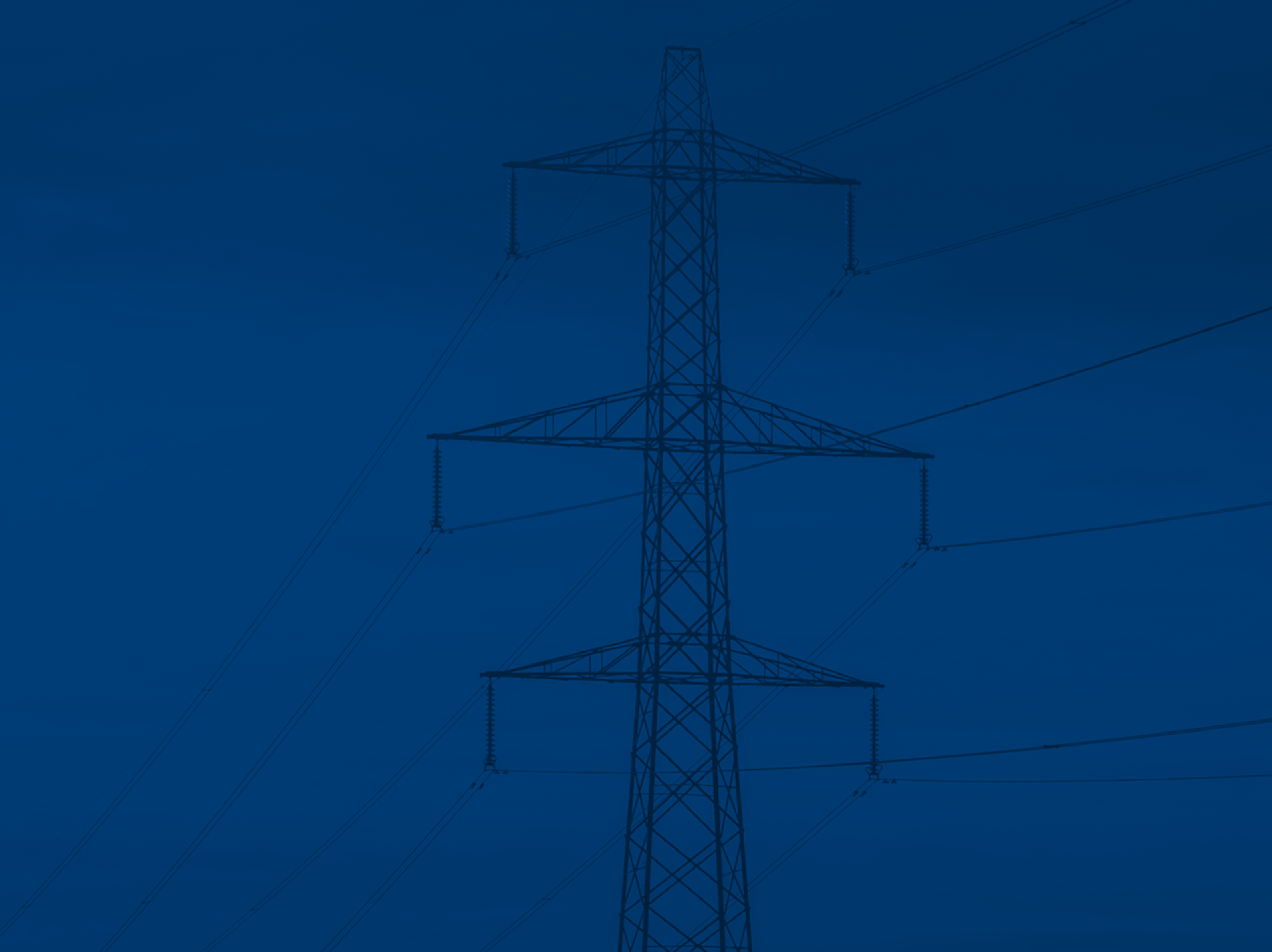
Scottish & Southern Electricity Networks



North of Scotland Future Energy Scenarios

August 2018

ssen-transmission.co.uk



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Contents

This publication

The Great Britain (GB) energy landscape has undergone significant change in the past decade as decarbonisation and renewable energy targets have driven a rapid growth in renewable energy generation and overall reductions in electricity and gas demand.

To be able to meet customers' future needs over the next decade and beyond, we must understand which technologies are likely to impact generation and demand profiles.

This publication sets out SHE Transmission's view of a range of potential generation and demand scenarios in the north of Scotland for the period 2021-2030.

The analysis will help shape the business plan submitted to Ofgem ahead of the next price control, RIIO-T2, as well as SHE Transmission's long-term investment strategy.

About us

We are Scottish Hydro Electric Transmission (SHE Transmission), part of the SSE Group, responsible for the electricity transmission network in the north of Scotland. We operate under the name of Scottish and Southern Electricity Networks, together with our sister companies, Scottish Hydro Electric Power Distribution (SHEPD) and Southern Electric Power Distribution (SEPD), who operate the lower voltage distribution networks in the north of Scotland and central southern England.

As the Transmission Owner (TO) we maintain and invest in the high voltage 132kV, 275kV and 400kV electricity transmission network in the north of Scotland. Our network consists of underground cables, overhead lines on wooden poles and steel towers, and electricity substations, extending over a quarter of the UK's land mass crossing some of its most challenging terrain.

We power our communities by providing a safe and reliable supply of electricity. We do this by taking the electricity from generators and transporting it at high voltages over long distances through our transmission network for distribution to homes and businesses in villages, towns and cities.

Introduction

As the electricity network owner in the north of Scotland, our main focus in the last decade has been on delivering the additional capacity and connections required for increased renewable energy generation in an economic and efficient way, while ensuring reliability of supplies for our network users and consumers.

As planning begins for the next price control period, RIIO-T2, SHE Transmission needs to be mindful of the uncertainty related to the future of energy which will influence what network developments are required.

RIIO and the role of the regulator

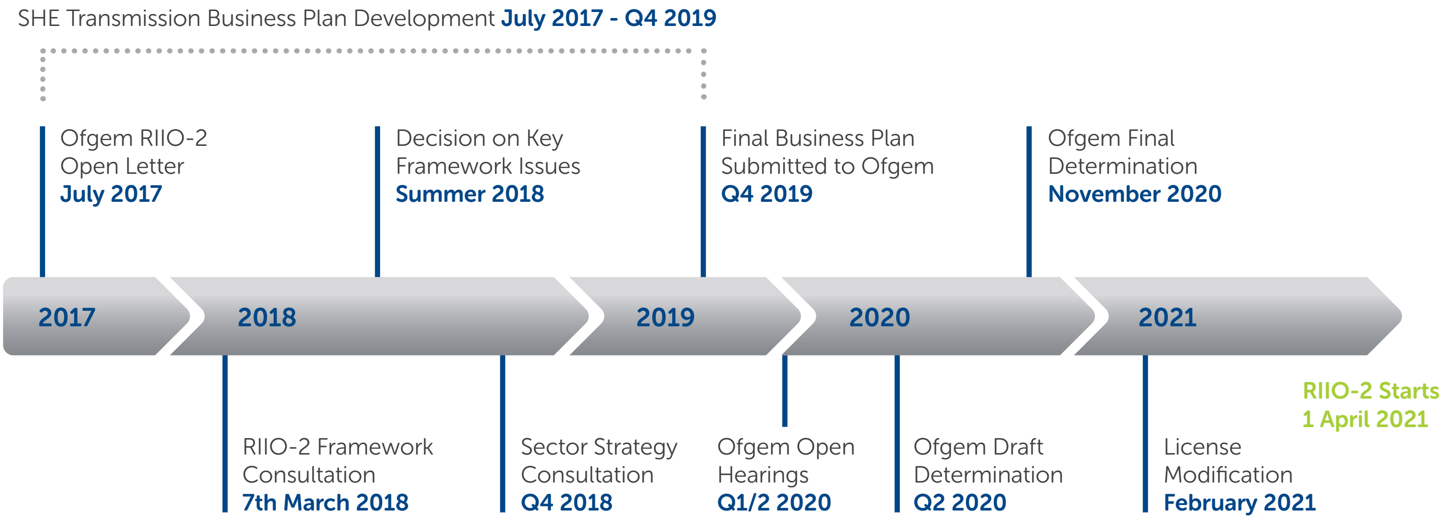
Price controls are required as GB energy networks are considered natural monopolies, so to protect the interests of consumers Ofgem regulates network companies through the RIIO price control framework (Revenue = Incentives + Innovation + Outputs). The current price control for electricity transmission, RIIO-T1, runs from 2013-2021, and will be followed from April 2021 by RIIO-T2.

The RIIO price control framework underpins SHE Transmissions's business activities as it specifies the services and level of performance that is to be provided to network users, and imposes restrictions on the money that can be recovered through network charges.

A core input to the RIIO framework is network companies' well-justified business plans. The plans, which are submitted to Ofgem ahead of the price control period for approval, demonstrate how companies will deliver in the interest of both existing and future consumers.

Ofgem sets an allowed revenue and specifies defined outputs for each company for that price control period based upon the approved plans.

To be able to build a business plan that will allow us to meet customers' existing and future needs, We must understand the range of potential generation scenarios, and their associated investment impact.



Why scenarios

The scenarios currently used by the GB Network System Operator, National Grid, and all Transmission Owners are the National Grid Future Energy Scenarios (FES).

At a macro level, the FES are a powerful tool as they capture a range of potential national political, economic, social and technological possibilities.

However, the application of the FES assumptions on a regional level is limited.

In the north of Scotland, SHE Transmission has seen developments that have not always matched the prevailing GB trends and therefore believe that additional granularity, provided through localised future energy scenarios for the north of Scotland, would best meet energy users' needs. This view was shared by stakeholders who agreed there is significant uncertainty in energy system developments.

Scenario analysis was therefore deemed an effective method of building an understanding of potential outcomes and allowing associated network requirements to be modelled for SHE Transmission's north of Scotland network area to inform our business planning for the next price control.

Previously, SHE Transmission would have limited its network modelling to changes on the electricity transmission network however as we move towards whole-system planning, consideration must also be given to developments in other areas of the energy system such as electricity distribution, heat and transport.

How we developed our scenarios

The process to develop Future Energy Scenarios for the north of Scotland began over 18 months ago. An initial internal workshop was held to identify areas of uncertainty.

We published our North of Scotland Energy Trends paper in August 2017, which highlighted that developments in the north of Scotland did not always follow the GB trend, confirming the need for localised analysis.

A series of external engagement was proposed as the best method for gathering further insight to develop our scenarios.

An overview of the process is shown opposite.

Creation of our scenarios

Internal workshops
▼
Initial list of scenario driving forces
▼
External engagement
▼
Research and analysis
▼
Finalised list of scenario driving forces
▼
Preliminary scenario descriptions
▼
External scenario workshops
▼
Scenarios

Assumptions and variables

There are a number of underlying assumptions that are common across our scenarios.

We have also identified the main uncertainties that are adjusted for each scenario.

Common assumptions

- Each of our scenarios tackles issues across electricity supply (generation, interconnection, battery storage and onshore wind repowering) and electricity demand (electric vehicles, heat, energy efficiency, microgeneration and new homes).
- In all of our scenarios, renewable generation plays a consistent role.
- In all of our scenarios, the existing combined cycle gas turbine (CCGT) plant at Peterhead is in operation.

Key variables in each scenario

Policy support

Across our scenarios, we varied the levels of policy support available to established and less established technologies.

Decentralisation

Across our scenarios, we changed the levels decentralisation.

Affordability

The focus on affordability was altered across our scenarios.

Economic performance

The performance of the economy was varied across the scenarios.

Consumer behaviour/attitudes

Consumer behaviour/attitudes towards the energy industry was varied across our scenarios.

Technology development/cost reduction

Across our scenarios, technology development/cost reduction was varied.

Local environment

The role of local government and planning policy was varied across our scenarios.

Stakeholder engagement

There were four stages in our Scenarios engagement approach in 2017/18

1

Targeted interviews to confirm the need for localised scenarios, identify issues affecting customers and stakeholders and agree best methods for future engagement.

3

Reviewing consultation findings (including a range of potential outcomes) and proposed scenario development methodology with targeted customers and stakeholders.

2

Broad, public consultations on identified areas of uncertainty with a regional element.

SHE Transmission consulted on five papers:

- North of Scotland Energy Trends
- North of Scotland Onshore Wind Repowering
- North of Scotland Electric Vehicles
- North of Scotland Energy Efficiency and Heat
- North of Scotland Generation and Storage.

4

Publication of this ‘North of Scotland Future Energy Scenarios Report’ summary paper.

This paper will outline a summary of the feedback received through the consultations and stakeholder engagement, and how this feedback has been incorporated into our scenarios and the results of this – the scenarios themselves.

PRINCIPAL CUSTOMERS AND STAKEHOLDERS

GOVERNMENT AND LOCAL AUTHORITIES

COMMUNITY ENERGY GROUPS

DEVELOPERS

NETWORK OPERATORS

FUTURE CUSTOMERS

Throughout the consultation period customers and stakeholders were encouraged to respond via an online feedback form or directly via telephone or email. These findings were used to develop the scenario ranges in the North of Scotland Future Energy Scenarios that we will use as the basis for our Load Related Expenditure plans and uncertainty mechanisms for the RIIO-T2 price control.

This will also inform our view on what outputs and incentives will be required in RIIO-T2 to promote the needs of customers and stakeholders. Throughout the process customers and stakeholders were invited to agree or challenge the treatment of the feedback and the resulting scenario proposals. These confirmations and challenges were used in the refinement of the methodology and scenarios assumptions.

We engaged with **Circa 150** customers and stakeholders

How did we engage with them?

- Working papers and blog articles published on website
- Via local press articles and energy industry insight reports
- Direct mail
- Face-to-face and telephone interviews
- Workshops in Glasgow and Inverness

> I have very much appreciated the opportunity to take part in the Future Energy Scenarios workshop.

Argyll and Bute Council

> Good to see SSEN consulting on this vital segment of the future energy system (The future of Energy Efficiency and Heat and Preparing our network for Electric Vehicles).

Energy UK

Our scenarios

Scope

In our scenarios, we have not sought to balance supply and demand within the north of Scotland area. Scotland is a net exporter of electricity and this is not expected to change during the period. As we are only building our scenarios for the north of Scotland we are unable to model the balance of supply and demand at a GB level.

This type of balanced modelling is undertaken by the System Operator in the development of their Future Energy Scenarios and we will assess the network impacts of these National Grid scenarios, in addition to our north of Scotland scenarios, to ensure that our planning is robust.

Similarly, our modelling has not included assessment of the market for interconnection, an activity also undertaken by the System Operator.

Our area and time frame

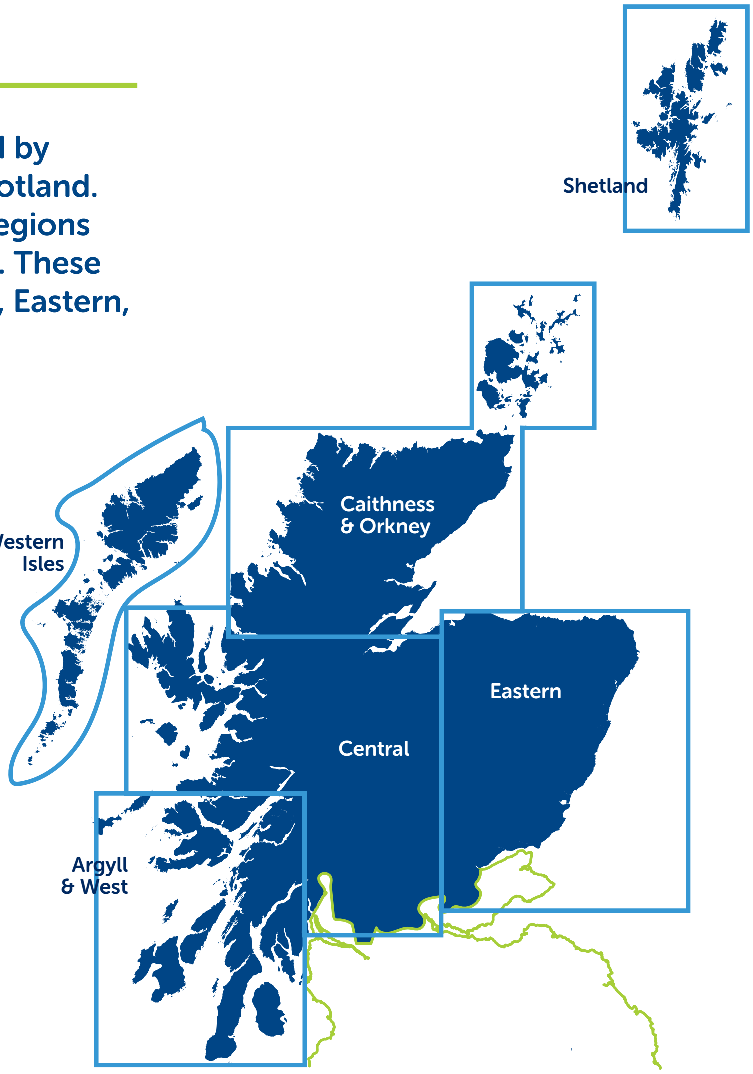
The spatial scale of the scenarios is determined by our network area which covers the north of Scotland. Within our network area there are six distinct regions with different network and user characteristics. These are: Argyll & West, Caithness & Orkney, Central, Eastern, Shetland and the Western Isles.

Scenario outcomes will be modelled for each of these areas to support the network analysis and to make communication of the outcomes more relevant to network users and stakeholders in these areas.

The time frame for the scenarios is determined by both the price control period, and investment and construction timescales. The RIIO-T2 price control will begin in April 2021.

Large scale strategic transmission infrastructure projects can spend 3-5 years in development and construction. This means that some projects which will be required after the end of the price control will begin development within the price control.

To deal with this cross-over element, and to align with government targets, it was decided that time frame for the north of Scotland Future Energy Scenarios should run to 2030.



Our scenarios

PROACTIVE DECARBONISATION

Scottish consumers are supportive of decarbonisation, increasing their use of renewables and engage in the benefits of decarbonisation and decentralisation at local levels.

The focus is on capital investment in large scale projects and policy is in place to stimulate the development of less established, low carbon energy technologies.

LOCAL OPTIMISATION

Scottish consumers and businesses are driven by cost reduction as well as decarbonisation, investing in decentralised, domestic microgeneration to reduce their spend on energy.

The focus is on delivering decentralisation and decarbonisation through democratisation of energy supply to deliver improved affordability for consumers and businesses.

COST LIMITATION

Scottish consumers are less inclined to invest in microgeneration and renewable heating technologies, but energy efficiency continues to be a focus of national and local government.

The focus is on delivering cost reduction in energy bills. Decarbonisation is a secondary consideration, as a result there is low uptake in domestic microgeneration and little focus on decentralisation.

Themes

CLIMATE CHANGE

LARGE SCALE GENERATION

AFFORDABILITY

Proactive decarbonisation

Scottish consumers are supportive of decarbonisation, increasing their use of renewables and engage in the benefits of decarbonisation and decentralisation at local levels. Targets set by both the Scottish and UK governments are surpassed and are in line with a decarbonisation pathway in which the UK is actively pursuing efforts to limit the temperature increase to 1.5 degrees Celsius, as set out in the Paris Agreement.

Intent on delivering the challenging decarbonisation and renewable energy targets, government looks to support localised and centralised energy supply to maximise use of renewable energy resources and balance local and national demand. Affordability is addressed through changes in the socialisation of energy costs.

The economy is performing well, and investment in the sector remains high. Targeted support schemes lead to high capital investment in large scale projects across the north of Scotland.

Policy is in place to stimulate development of low carbon energy technologies. Less established technologies such as offshore wind, wave and tidal, which are well suited to Scottish topography, continue to be supported by government and cost reductions increase their competitiveness.

Established technologies such as onshore wind and solar benefit from favourable Scottish planning policy, technology development and economies of scale, allowing projects to be developed without government subsidy.

Interconnection plays a role in the generation mix, which will allow for the export of large scale renewable generation from the North and balancing through imports.

Scottish consumers invest in microgeneration & low carbon heating technologies to bring down the cost of their energy bills.

Consumers use a mix of technologies with regards to heat - in rural areas where there is excess renewable generation, consumers utilise electric storage heaters and heat pumps; in more urban areas, natural gas boilers continue to be used with an increase in the uptake of hybrid systems.

Consumers invest in a range of insulation products, from loft and cavity insulation through to solid wall insulation, as well as shifting from halogen bulbs to LED bulbs to reduce the cost of their energy bills.

Many consumers and businesses switch from fossil fuel cars to electric cars as they look to mitigate their impact on the environment and make best use of their additional behind the meter generation.

Local authority led infrastructure development makes charging away from home easier with fast chargers in towns and cities and on key tourist routes in the north of Scotland.

Local optimisation

Scottish consumers and businesses are driven by cost reduction as well as decarbonisation, investing in decentralised, domestic microgeneration to reduce their spend on energy.

The focus is on delivering decentralisation and decarbonisation through democratisation of energy supply to deliver improved affordability for consumers and businesses.

The economy is growing, with high investment in small scale, renewable technologies. Government policy favours small scale, community based distributed energy resources, instead of large scale renewable projects.

Successful implementation of the Distribution System Operator (DSO) model in the north of Scotland leads to effective and efficient decentralisation of energy generation. Some renewable technologies have reduced in cost to such an extent that some large onshore and offshore wind projects are developed without the need for subsidy support.

Small scale distributed energy resources such as local and community wind, wave, solar and storage projects are supported through favourable Scottish planning policy, beneficial connection and charging arrangements, and priority in the provision of grid services.

Interconnectors provide flexibility for bulk flows, but with more decentralised generation on the distribution network, additional flexibility is provided at a local level by distributed energy resources.

Scottish consumers and businesses are driven more by cost reduction than decarbonisation and invest in microgeneration and low carbon heating technologies to reduce their spend on energy. In communities where there are large amounts of excess local generation such as the Scottish Islands and more remote rural areas, consumers utilise electric heating in the form of storage heaters and heat pumps.

Where access to excess generation is limited, a range of biomass combined heat and power (CHP) and district heat networks are used. In more urban areas, the use natural gas boilers continue alongside an increase in the uptake of hybrid systems.

Consumers focus on some simple things to help improve energy efficiency in their households such as replacing halogen bulbs with LED bulbs and fitting cavity and loft insulation to decrease the cost of their energy bills.

Scottish consumers invest in electric cars, not for the environmental benefit, but as a means of benefiting from local generation. Consumers prefer to charge their electric vehicles at home, benefitting from vehicle to grid services, with some fast chargers in cities and on the motorways in the north of Scotland.

Themes

MICRO GENERATION

CLIMATE CHANGE

AFFORDABILITY

Cost limitation

Themes

AFFORDABILITY

ENERGY EFFICIENCY

CLIMATE CHANGE

Scottish consumers are less inclined to invest in microgeneration and renewable heating technologies, but energy efficiency continues to be a focus of national and local Government.

The focus is on delivering cost reduction in energy bills. Decarbonisation is a secondary consideration, as a result there is low uptake in domestic microgeneration and little focus on decentralisation.

Economic growth flattens, and the lack of government support leads to reduced investment levels.

Government policy is for subsidy free development of energy generation (excluding the development of less established technologies such as wave and tidal energy and floating offshore wind).

Large scale onshore wind and solar projects are developed in the limited locations where subsidy free development is viable in the north of Scotland.

A lack of surplus generation for export reduces the case and need for interconnection in the north of Scotland, resulting in no new interconnector projects being connected in the period up to 2030.

The removal of subsidy costs from energy bills keeps costs down, so fewer consumers and businesses invest in microgeneration and renewable heating technologies.

There is no government intervention to encourage consumers to move towards greener sources of energy, but energy efficiency continues to be a focus of national and local Government.

New Scottish planning policy, leasing and selling requirements encourages the improvement of efficiency in building energy use through efficient natural gas boilers, appliances and lighting, and insulation.

Driven primarily by concerns on air quality and establishment of zero-emission zones, uptake of electric vehicles is limited and restricted to urban areas and some progressive rural communities.

Charging electric vehicles away from the home is made easier through investment in transport hubs primarily located in towns and cities.

Electricity supply

GB electricity supply has experienced significant change in recent years as a result of technical progress and cost reductions in technologies such as solar photovoltaic and battery storage.

This, along with supportive energy policy, has encouraged the development of renewable generation and significantly increased the market share of electricity generated from renewable sources.

Energy policy is also supporting the transition to a more decentralised electricity system, whereby electricity is produced close to where it will be used rather than transported across large distances through the national grid. This will be enabled by technological developments and effective market facilitation of the new commercial opportunities.

The drivers behind this transformation are well known - energy insecurity carries a significant social and economic cost. Greater reliance on renewable generation, and making our network more sustainable and efficient in the long term through decentralisation will help secure our future energy needs.

The components of electricity supply that we have explored in our scenarios are below.

- Generation
- Interconnection
- Battery storage
- Onshore wind repowering

Generation

The Climate Change Act (2008) committed the UK to reducing greenhouse gas emissions by at least 80% by 2050 when compared to 1990 levels, and it is this target that underpins energy policy in the UK.

The UK Government's publication of its Clean Growth Strategy, outlined key policy areas that it believes will enable the UK to meet its 2050 climate change target.

The UK government detailed that it will phase out the use of unabated coal by 2025, deliver new nuclear and improve the route to market for renewable technologies such as offshore wind and other less established technologies.

These policies remain unchanged from 2015 when Amber Rudd oversaw the Department of Energy & Climate Change. Key differences exist between the UK and Scottish Government's policy support for energy technologies such as the Scottish Government's no new nuclear stance.

The focus from the UK Government has shifted from established renewable technologies to less established renewable technologies such as offshore wind.

However, the Scottish Government continues to show support for established renewable technologies such as onshore wind and solar, evidenced through its onshore wind policy statement and potential changes to permitted development (PD) rights for certain renewable installations.

In our scenarios, we have modelled in detail the generation capacity by technology to 2025/26 and then just capacity to 2029/30 without a breakdown by type due to better visibility of data and planned projects up to 2025/26.

For distribution connected generation projects, we have only modelled contracted generation projects which will likely cause an understating of the total generation capacity on our network. Due to the high number of large generation projects connecting, we do expect to see a change in the balance of distribution and transmission connected capacity on our network.

Key insights

1. Across all of our scenarios, onshore wind represents the generation technology with the highest installed capacity by 2025/26.

2. Local optimisation has the highest levels of solar PV on the system by 2025/26 at 261MW, increasing by 220MW after 2021.

3. The combined cycle gas turbine (CCGT) plant at Peterhead features across all three of our scenarios with a capacity of 1,180MW.

4. By 2025/26, offshore wind generation capacity will reach 4,073MW in Proactive decarbonisation, 2,875MW of which is new projects connecting after 2021.

Current generation and trends

The transmission network in the north of Scotland has gone through a period of substantial growth due to increasing renewable energy generation driven by UK and Scottish Government policy support.

By 2017/18, 5,760MW of generation capacity was present on our network, more than double the generation capacity on the network in 2005. Since the beginning of RIIO-T1 until 2017/18, we have connected 1,842MW of new generation capacity onto our network, with onshore wind representing 1,547MW of generation capacity added during that time.

This is a combination of large scale generation and smaller distribution connected schemes including community, farm and estate owned generation.

In the coming years, it is expected that we will connect some large offshore wind generation projects, totalling 1,092MW. By the end of RIIO-T1, the total installed generation capacity on our network will be 8,204MW.

Stakeholder input

Through our consultation process, our stakeholders provided us with information and feedback that could be utilised to shape our scenarios.

The table below sets out some of the feedback provided by stakeholders on generation and how we have incorporated this into our scenarios.

Feedback provided	Incorporation in scenarios
Economics of investment and subsidy support will be key drivers of investment.	Varying assumptions on investment economics and subsidy levels used across our scenarios.
Further potential for onshore wind to come online during the 2020s, specifically on the islands and the west of Scotland.	Island connections included in Proactive decarbonisation and Local optimisation with higher capacity in Proactive decarbonisation.
Clustering of solar development expected in the north and north-east of Scotland.	Solar projects included in Proactive decarbonisation and Local optimisation, and located in the north and north-east of Scotland.
Potential for 680MW of offshore wind projects in Argyll & Bute and 100MW in the Outer Hebrides.	680MW of offshore wind in Argyll & Bute not included in modelling as project appears to be cancelled. 100MW of offshore wind included in Proactive decarbonisation.
Potential for 43MW of tidal projects in Argyll & Bute during the 2020s.	30MW of tidal projects included in Proactive decarbonisation as additional potential projects already included in our analysis.
Residential and business customers seeking to self-generate and reduce demand from the grid.	Increase in self-generation included within Proactive decarbonisation and Local optimisation scenarios through higher microgeneration (solar PV) uptake.

Key Assumptions

Proactive decarbonisation	Local optimisation	Cost limitation
The CCGT plant at Peterhead features across all three of our scenarios with a transmission entry capacity (TEC) of 1,180MW.		
Includes Transmission and Distribution generation projects (D>10MW) that have had consents approved, are awaiting consent and are in scoping.	Includes Transmission generation projects that have had consents approved and are awaiting consent but excludes Transmission generation projects that are in scoping.	Includes Transmission and Distribution generation projects that have had their consents approved.
Includes new applications (not included in FES).	Includes Distribution generation projects >10MW in scoping.	Excludes generation projects that have had consents refused.
Excludes generation projects that have had consents refused.	Excludes generation projects that have had consents refused.	No islands connections so no island wave, tidal or onshore wind.
Includes all 3 island connections.	Includes all 3 island connections (Shetland at lower connected capacity of 300MW).	No interconnection.
Includes the NorthConnect interconnector to Norway and the Maali interconnector to Norway.	Includes the NorthConnect interconnector to Norway.	
Includes stakeholder engagement projects.		

Generation - Scenarios

PROACTIVE DECARBONISATION

As a result of the greater policy support for large scale renewable energy generation in this scenario, 15,593MW of generation capacity will be installed on the network by 2025/26. 4,073MW of this will be offshore wind, 2,875MW of which is new projects connecting after 2021. Onshore wind has the largest share, building on the already high capacity from this technology in our area to reach 6,216MW in 2025/26. Hydro will reach 3,223MW of generation capacity on the network, 1,500MW of which is new projects.

Non-renewables such as gas CCGT, OCGT, and biomass, represents 1,407MW of generation capacity on the network in 2025/26. 564MW of wave and tidal will be on the network followed by 211MW of solar.

LOCAL OPTIMISATION

Due to the focus on smaller scale renewable energy generation in this scenario, by 2025/26, 12,146MW of generation capacity will be installed on the network. 5,336MW of this generation capacity will be onshore wind. Hydro follows with 2,335MW of generation capacity on the network in 2025/26. By 2025/26, offshore wind will reach 2,273MW of generation capacity on the network.

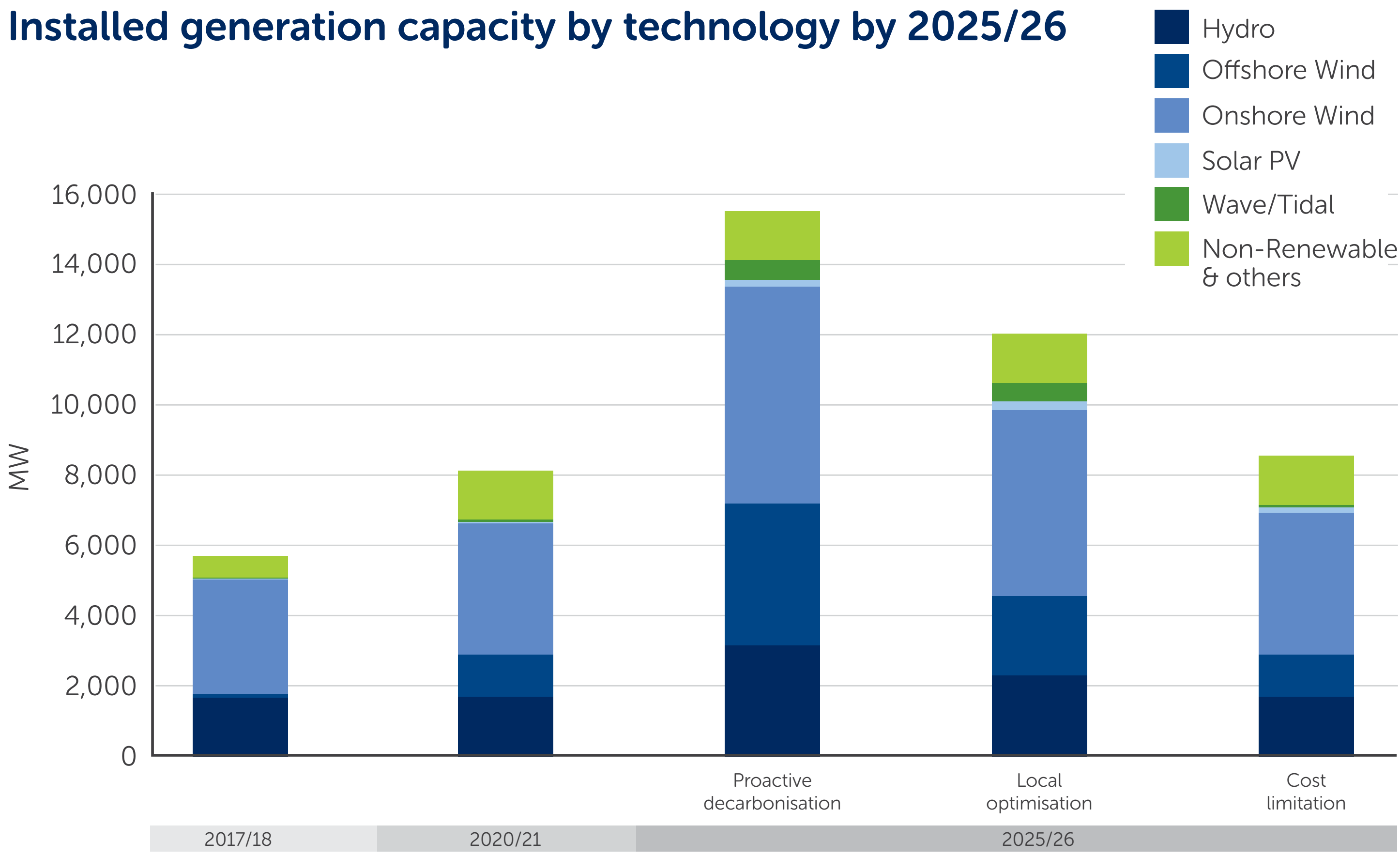
Non-renewables such as gas CCGT, OCGT, and biomass, represents 1,407MW of generation capacity on the network in 2025/26. By 2025/26, 534MW of wave and tidal will be on the network. Solar will reach 261MW by 2025/26, 220MW of which is new projects connecting after 2021.

COST LIMITATION

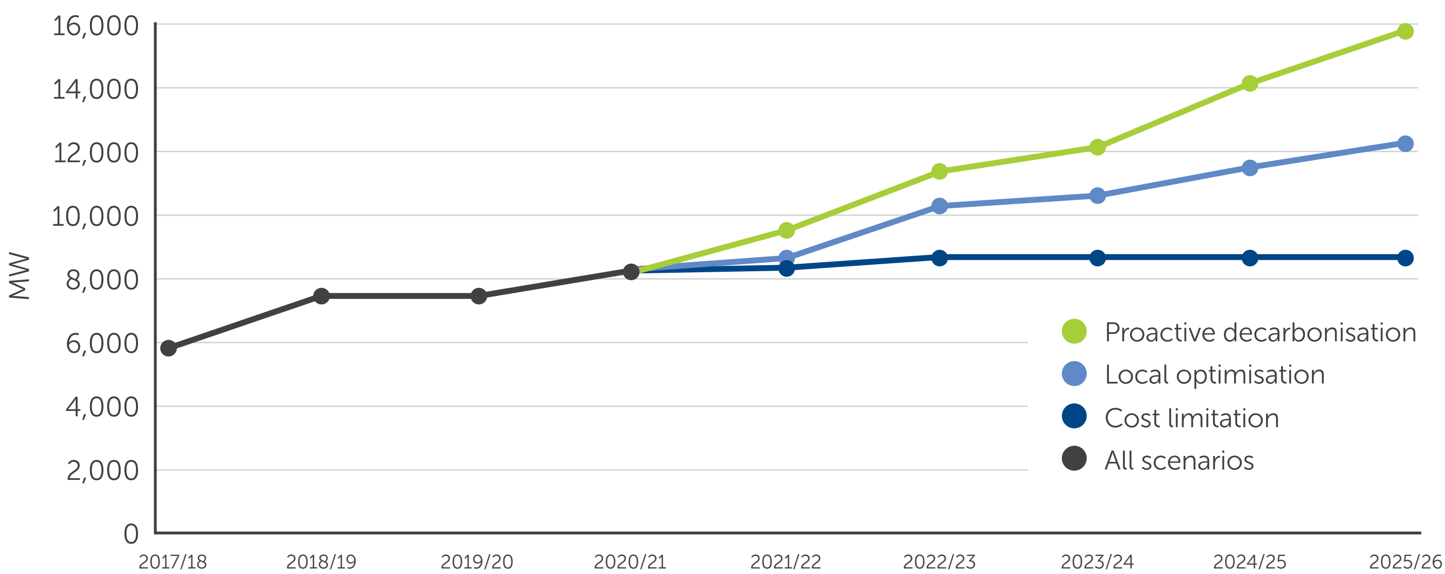
Within this scenario, fewer renewable energy generation projects come online as result of this, the generation capacity installed on the network will reach 8,635MW by 2025/26. Onshore wind has the largest share at 4,080MW, 302MW of which is new projects connecting after 2021. Hydro follows with 1,723MW of generation capacity on the network in 2025/26. By 2025/26, offshore wind will reach 1,198MW of generation capacity on the network. However, no new hydro or offshore projects come online after 2021.

Non-renewables such as gas CCGT, OCGT, and biomass, represents 1,407MW of generation capacity on the network in 2025/26. By 2025/26, 67MW of wave and tidal will be on the network. Solar will reach 161MW by 2025/26, 120MW of which is new projects connecting after 2021.

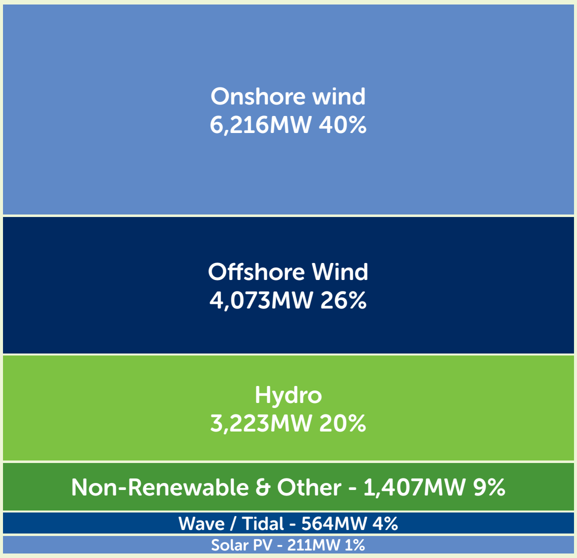
Installed generation capacity by technology by 2025/26

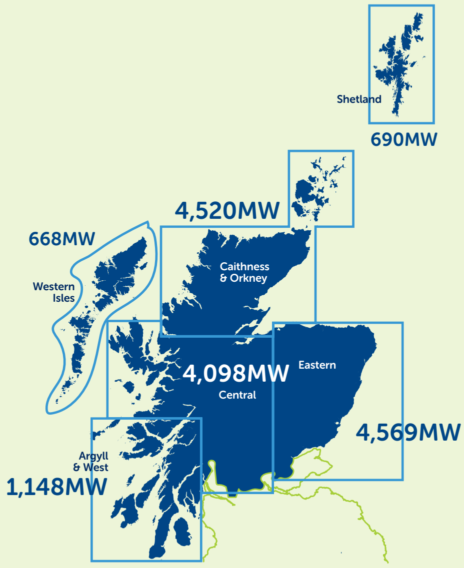


Annual installed generation capacity by scenario

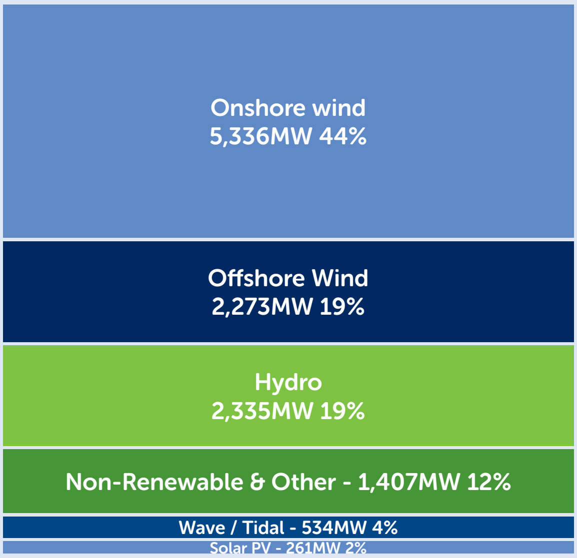


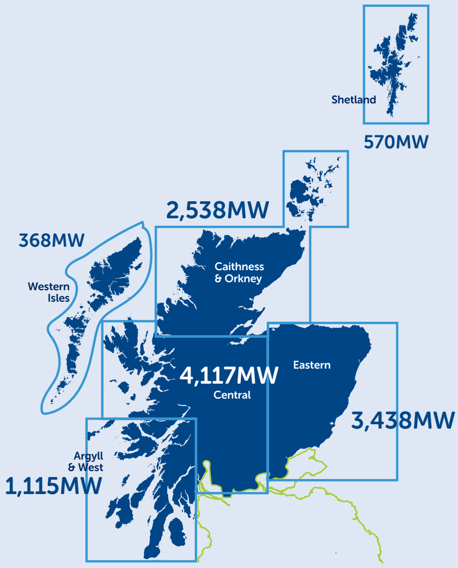
Proactive decarbonisation



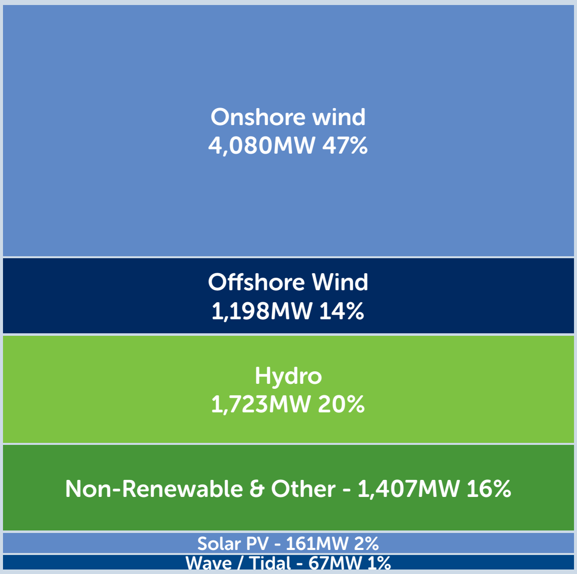


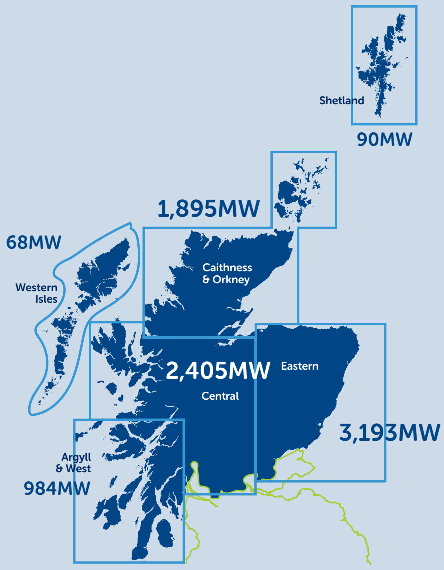
Local optimisation





Cost limitation





Interconnection

The Department of Business, Energy and Industrial Strategy (BEIS) projected in January 2018 that imports could become the UK's second largest source of electricity (around a fifth of supply) by 2025. Such increased imports would help offset closures of UK nuclear plants due for retirement, and the Government's planned phase-out of coal power by 2025.

National Grid's 2018 Network Options Assessment (NOA2018) also highlighted that the UK needs to continue to trade energy with the EU to meet demand.

Their analysis shows that a total interconnection capacity of 17.4GW between the UK and EU by 2030 would provide the lowest risk for consumers.

This means an additional 10GW of new interconnection would be needed above the currently operating 4GW and 3.4GW in construction.

Further, the National Infrastructure Commission noted in its 2018 Annual Monitoring Report that interconnectors will continue to form an essential part of the future energy system, and welcomes recent efforts to pursue additional interconnectors with other EU countries.

Within our scenarios, we have modelled interconnectors in our network area based on current proposed projects.

Key insights

1. Across all of our scenarios, Proactive decarbonisation has the highest capacity of interconnection by 2029/30 at 2,000MW.
2. The Eastern region has the highest level of interconnection across Proactive decarbonisation and Local optimisation at 1,400MW.
3. 600MW interconnector connecting to Shetland in Proactive decarbonisation.

Current interconnection and trends

There is currently 4GW of interconnection capacity. In January 2018, Ofgem granted initial regulatory approval for three new interconnectors under the cap and floor regime upon completion of their Initial Project Assessments:

- 1.4GW to Norway (NorthConnect);
- 1.4GW to France (GridLink); and
- 1.4GW to Germany (NeuConnect).

There are currently two proposed projects that will connect within the north of Scotland; NorthConnect (1,400MW) which will connect into our Eastern region, and Maali (600MW) which will connect into Shetland. Expected connection dates for the projects range from 2022/23 to 2025/26.

Stakeholder input

Through our consultation process, our stakeholders provided us with information and feedback that could be utilised to shape our scenarios.

The table below sets out some of the feedback provided by stakeholders on generation and how we have incorporated this into our scenarios.

Feedback provided	Incorporation in scenarios
No additional interconnectors, other than those currently known, expected to connect by 2029/30.	No action taken.
Include a scenario where no interconnection is required.	Cost limitation designated as the scenario where interconnection is not required.

Key Assumptions

Proactive decarbonisation	Local optimisation	Cost limitation
Includes the NorthConnect interconnector to Norway and the Maali interconnector to Norway.	Includes the NorthConnect interconnector to Norway.	No interconnection.

The HVDC Centre is where we are modelling the network impact of HVDC transmission and interconnection.

Interconnection - Scenarios

PROACTIVE DECARBONISATION

Proactive decarbonisation assumes connections from NorthConnect (Scotland to Norway), and Maali (Shetland to Norway), amounting to 2,000MW by 2029/30, which will allow for the export of large scale renewable generation from the North and balancing through imports.

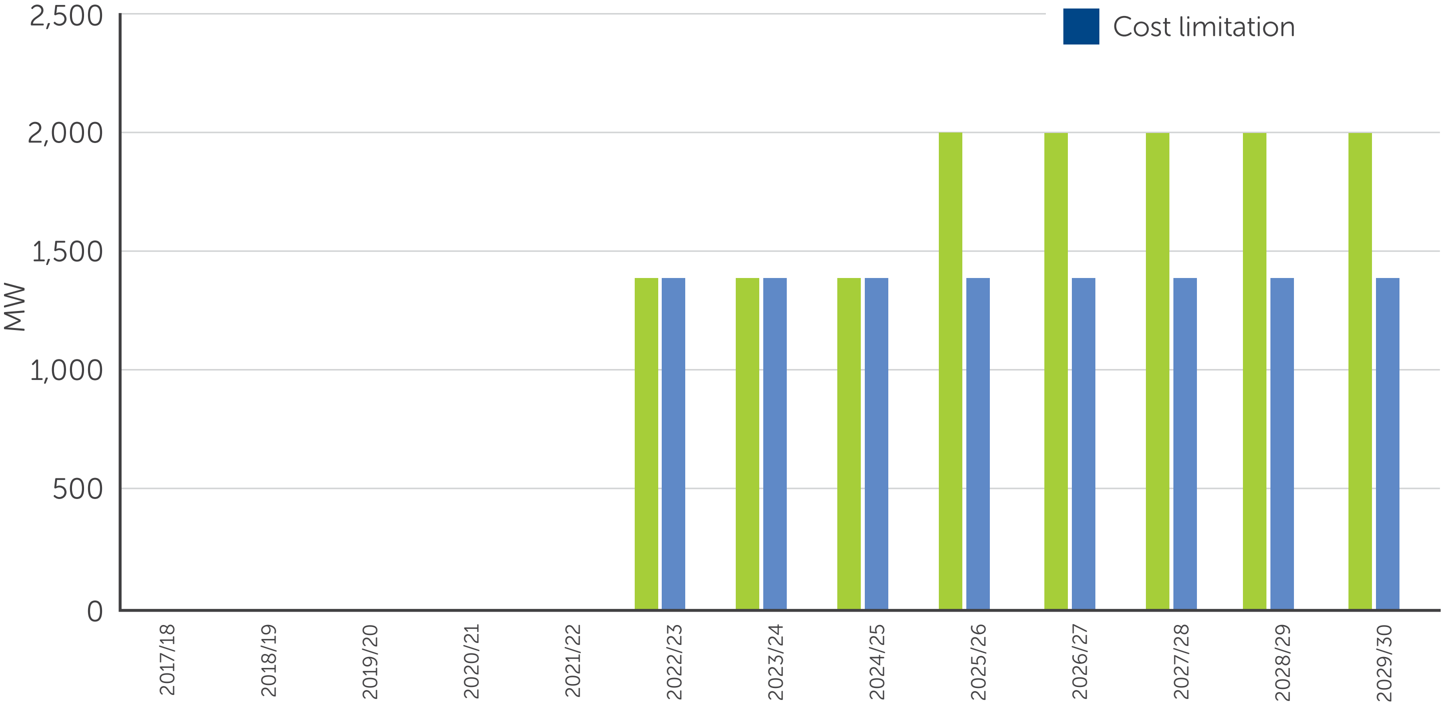
LOCAL OPTIMISATION

Local optimisation assumes only NorthConnect connects at 1,400MW by 2029/30, due to its more advanced project status and the reduced requirement for interconnection as a result of flexibility being delivered at a local level.

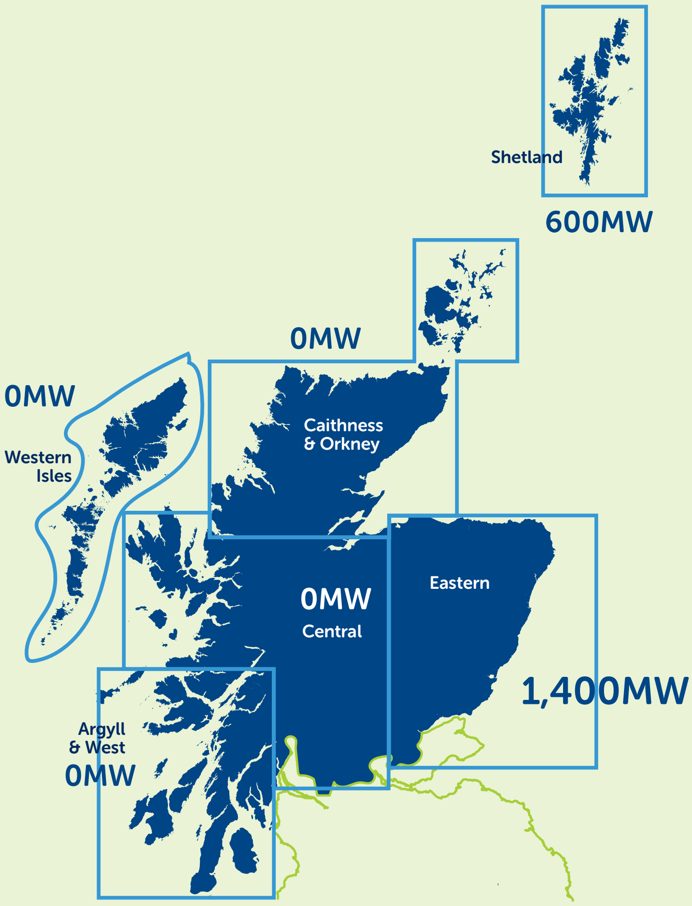
COST LIMITATION

In cost limitation, no new interconnection is assumed due to reduced requirements and a lack of surplus generation.

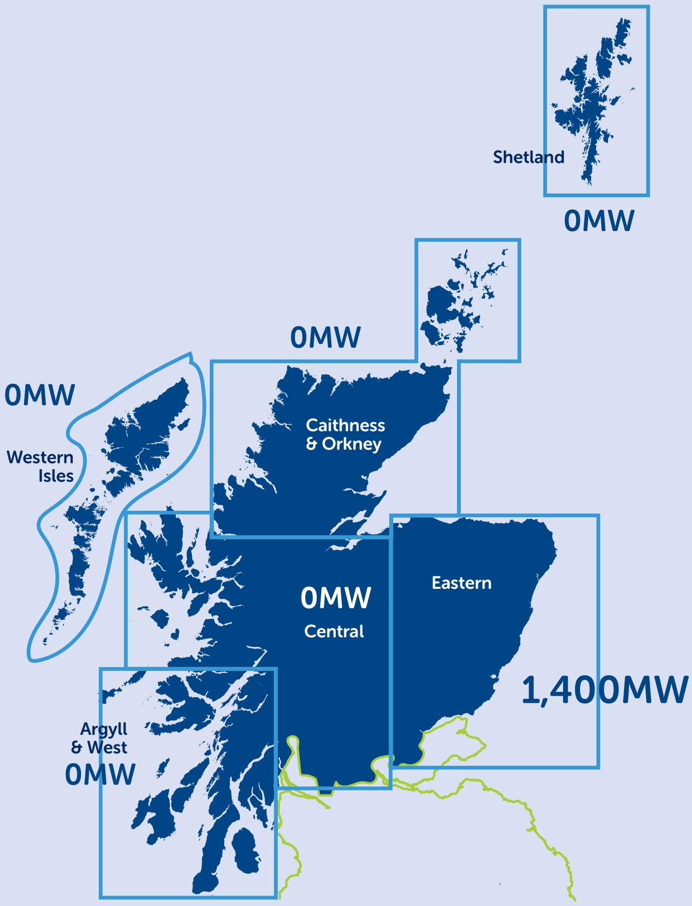
Interconnection by scenario



Proactive decarbonisation



Local optimisation



Battery Storage

With such high proportions of generation coming from variable renewable energy generation, there is an increasing need for flexibility services as the energy system is decarbonised.

As set out in the UK Government's Smart Systems and Flexibility Plan, distributed energy providers must be enabled to compete in this flexibility market to increase competition and ensure the best outcome for consumers.

Battery energy storage is a technology that is recognised as a means to better manage intermittent generation. The successes of battery storage in the Enhanced Frequency Response (EFR) tender and Capacity Market in 2016 has helped increase interest in the technology.

Key insights

1. Across all of our scenarios, Local optimisation has the highest capacity of battery storage at 150MW.
2. The Eastern region has the highest level of battery storage in Proactive decarbonisation at 60MW.
3. In Proactive decarbonisation, 25% of the installed battery storage capacity is connected at distribution.

Current battery storage and trends

Currently there are no battery storage projects connected to the transmission network in the north of Scotland. However, we are beginning to see the number of developers considering battery storage increase in recent months.

Stakeholder input

Through our consultation process, our stakeholders provided us with information and feedback that could be utilised to shape our scenarios.

The table below sets out some of the feedback provided by stakeholders on generation and how we have incorporated this into our scenarios.

Feedback provided	Incorporation in scenarios
Battery storage connected to the transmission network would be advantageous in areas where there is significant and regular excess generation.	Transmission connected battery storage included in all scenarios however a higher proportion is included in Local optimisation.
In locations where there are small scale/multiple generation sites, distribution connected battery storage could play a role.	Distribution connected battery storage included in Proactive decarbonisation as project is currently only in the scoping phase.

Key Assumptions

Proactive decarbonisation	Local optimisation	Cost limitation
Transmission connected battery storage included in all scenarios.		
Distribution connected battery storage included in Proactive decarbonisation as project is currently only in the scoping phase.		

Battery Storage - Scenarios

PROACTIVE DECARBONISATION

Proactive decarbonisation assumes that 120MW of battery storage will be on our network by 2025/26. 25% of the installed battery storage capacity will be connected at distribution.

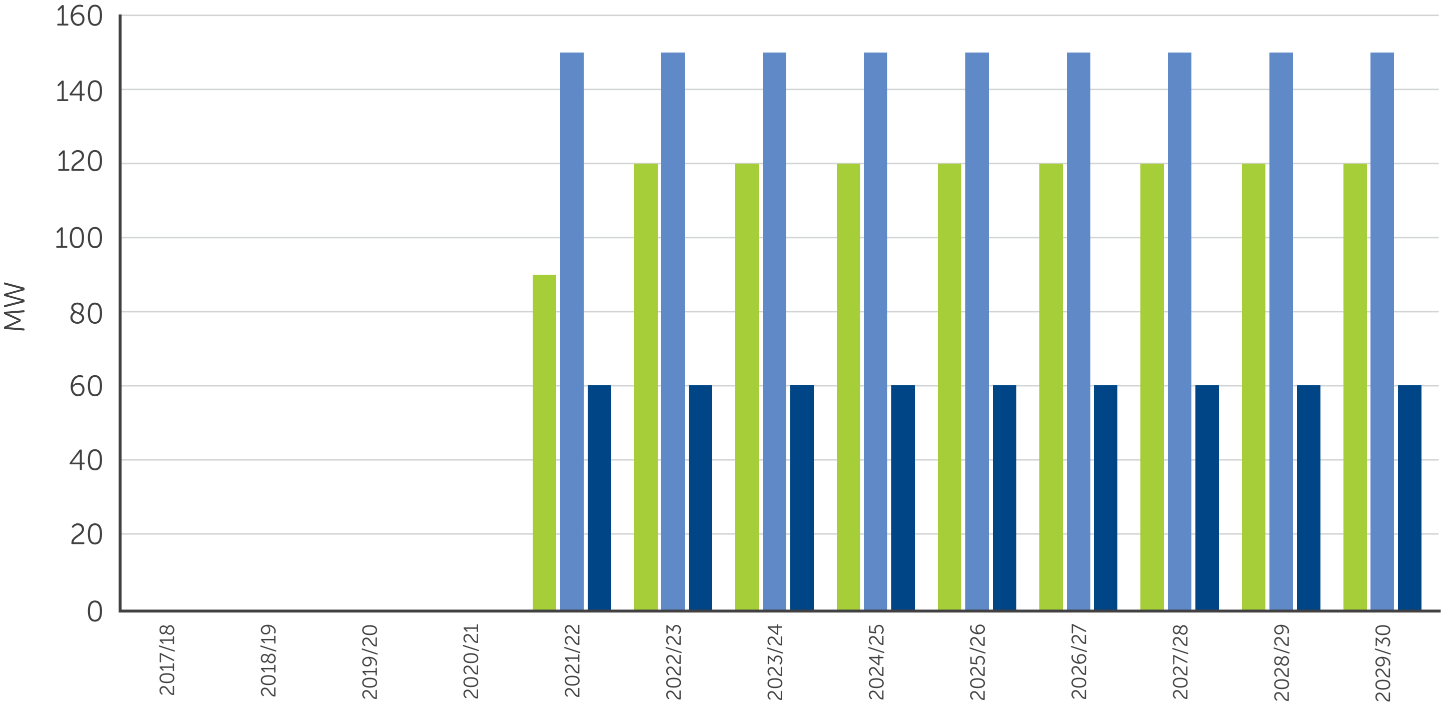
LOCAL OPTIMISATION

Due to the focus on greater flexibility being delivered at a local level in this scenario, Local optimisation has the highest level of battery storage capacity on the network by 2025/26 at 150MW, with three projects totalling 50MW each.

COST LIMITATION

In cost limitation, by 2025/26, 60MW of battery storage capacity will be on our network.

Battery Storage by scenario



Future Focus: Onshore wind repowering

Onshore wind repowering was identified as a topic with a large degree of uncertainty by our stakeholders. We assessed the potential for onshore wind sites to repower in the north of Scotland. In our consultation from Q3 2017, we initially identified that around 700MW of capacity could be nearing the end of its life assuming a 20 year asset lifetime by the end of the next decade.

This value dropped to around 120MW if a 25 year asset life was used. Since our consultation, we have continued to refine our onshore wind analysis based on the feedback gained from stakeholders.

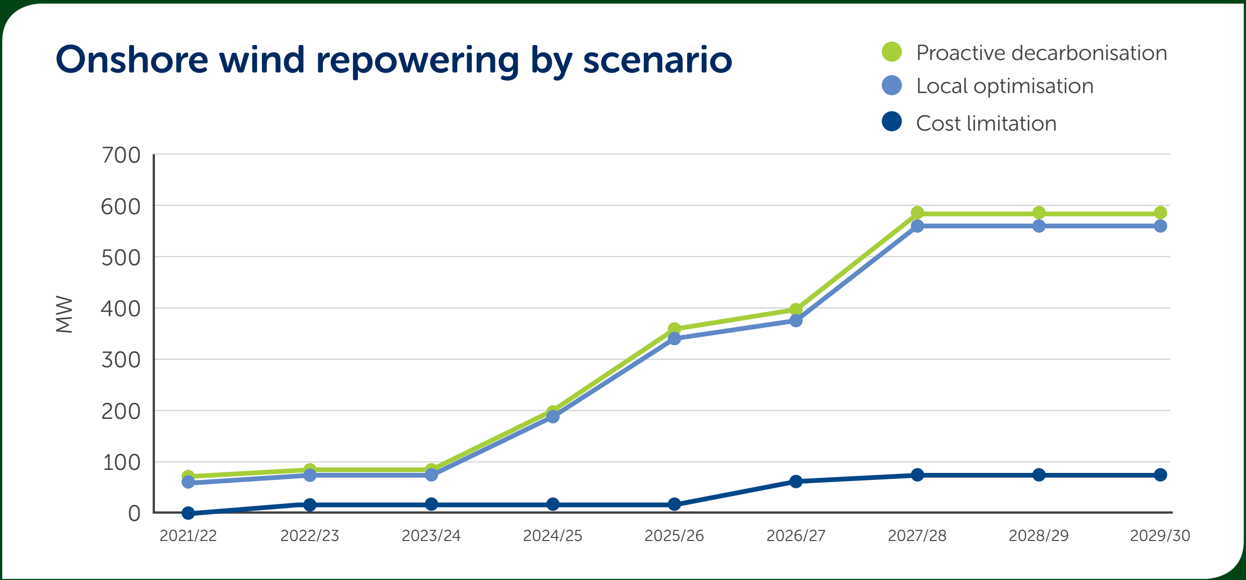
There was consensus amongst the responses that repowering is something that would be considered after the ending of ROCs (around 2027 for the earlier projects) for sites that have demonstrated good yields.

It was further observed that repowering would be attractive for locations where the consenting of new infrastructure would be supported by communities that have benefited from funds established by projects or other local positive economic impacts.

Based on the outcome of the consultation and a review of scheme load factors for older sites, calculated using a time series analysis, it is thought that repowering is likely to occur towards the end of the next decade.

We explored repowering at increases of 5, 10 and 15% across all of our scenarios for grid supply points (GSPs) with specific wind farms. Given the age and ratings of older schemes, they are connected to the distribution network in our area. No transmission connected windfarms were included in our analysis of repowering potential due to their age. The graph below shows how onshore wind repowering could develop in the north of Scotland.

In Proactive decarbonisation, 509MW of onshore windfarms have the potential to repower by 2029/30. If all of the 509MW repower, by 2029/30, the combined generation capacity of those sites will rise to 585MW. In Local optimisation, by 2029/30 the combined generation capacity of those windfarms that repower will be 560MW, an increase of 51MW. In cost limitation, the capacity expected to repower is significantly less than the other scenarios at 75MW. If all those sites repower, the combined generation capacity will increase to 79MW by 2029/30.



Total generation capacity in our scenarios by 2029/30

	PROACTIVE DECARBONISATION	LOCAL OPTIMISATION	COST LIMITATION
Current connected capacity 2017/18	5,760MW	5,760MW	5,760MW
Estimated connecting capacity 2018/19-2020/21	2,444MW	2,444MW	2,444MW
Connected capacity by 2020/21	8,204MW	8,204MW	8,204MW
Connected capacity by 2025/26	15,693MW	12,146MW	8,635MW
Of which is renewable	*14,287MW*	*10,739MW*	*7,229MW*
Estimated connecting capacity 2026/27-2029/30	6,804MW	1,620MW	94MW
Estimated total capacity on the network by 2029/30	22,498MW	13,766MW	8,729MW

In Proactive decarbonisation, 15,693MW will be on the system by 2025/26. This increases by 6,804MW post RIIO-T2, totalling 22,498MW by 2029/30.

Local optimisation will have 12,146MW on the network by 2025/26. Post 2025/26, Local optimisation sees a modest increase in generation capacity with 1,620MW connecting between 2026/27-2029/30. By 2029/30, there will be 13,766MW of generation capacity on the network.

By 2025/26 in Cost limitation, there will be 8,635MW of generation capacity on the network. 94MW will be connected between 2026/27-2029/30. By 2029/30, there will be 8,729MW of generation capacity on the network.

Electricity demand

As the electricity system becomes increasingly decarbonised, the focus of the decarbonisation agenda is shifting to other sources of energy consumption, including heat and transport.

The Scottish Government has set a target to phase out the need for petrol and diesel vehicles by 2032, underpinned by a range of actions to expand the charging network. It also expects a big rise in heat pumps, as a result of actions to deliver its target for the equivalent of 50% of Scotland's heat, transport and electricity consumption to be supplied from renewable sources.

With electrification providing an attractive lower carbon alternative to traditional transport and heating fuels, it may therefore have an impact on electricity demand across our scenarios.

The components of demand that we have explored in our scenarios are below.

- Electric Vehicles
- Heat
- Energy Efficiency
- New Homes
- Microgeneration (solar PV)

Electric Vehicles

In recent years, electric vehicles have become a topic of debate across the energy industry. The north of Scotland has seen an increase in the number of electric vehicles, supported by generous loans from the Energy Saving Trust and the continued deployment of charging infrastructure across the country.

Government policy is very supportive of electric vehicles with the Scottish Government pledging to phase out new petrol and diesel cars and vans across Scotland by 2032, eight years ahead of the UK Government target.

Further to this, the Scottish Government also has plans to make the A9 Scotland's first fully electric-enabled road for certain renewable installations.

Key insights

1. Proactive decarbonisation has the highest number of electric vehicles on the road in 2030 at 210,527, compared to the 1,878 electric vehicles on the road at the end of 2017.
2. Aberdeenshire has the highest number of electric vehicles across all three of the scenarios.
3. In Local optimisation, electric vehicles in 2030 represent 25% of all vehicles in the north of Scotland based on 2017 values.
4. Even in our scenario with the lowest EV uptake, in urban areas, the impact of charging on peak demand could be an increase of over 50%.

Current electric vehicles and trends

At the end of 2017, there were 1,878 electric vehicles in the north of Scotland, representing 27% of the total number of electric vehicles in Scotland.

However, when compared to the GB total, the number of electric vehicles in the north of Scotland represents 1.5% of licenced electric vehicles in Great Britain.

Electric vehicles represent a small proportion of the total vehicle fleet in the north of Scotland. By the end of 2017, electric vehicles represented 0.2% of the total number of vehicles in the north of Scotland.

Stakeholder input

Through our consultation process, our stakeholders provided us with information and feedback that could be utilised to shape our scenarios.

The table below sets out some of the feedback provided by stakeholders on generation and how we have incorporated this into our scenarios.

Feedback provided	Incorporation in scenarios
Clustering of EVs expected in and around our major demand centres in our area; Aberdeen, Dundee, Inverness and Perth.	Our modelling has been initially focused on the major demand areas as these are where the highest number of electric vehicles are currently located.
There will be more uptake of EVs in rural areas compared to urban areas due to the type of housing located in urban areas (flats and tenements).	Our modelling has not included higher uptake in rural areas but this will be looked at in subsequent editions of our scenarios.
7kW chargers are the most common within households.	Update modelling assumptions on charger size used in homes from current mix of 3.5kW and 7kW chargers to solely 7kW chargers.
The utilisation of smart charging and V2G would flatten load profiles at peak times.	Include peak reduction due to smart charging and V2G in some of the scenarios.

Key Assumptions

Proactive decarbonisation	Local optimisation	Cost limitation
Smart charging applies to all three scenarios.		
Propulsion ratio 0.24kWh/mile.		
The average number of miles driven per year, 8,700 miles in Scotland.		
Utilised growth rates from National Grid's highest EV uptake scenario, Community Renewables.	Utilised growth rates from National Grid's second highest EV uptake scenario, Two Degrees.	Utilised growth rates from National Grid's lowest EV uptake scenario, Steady Progression.
Charging profile – slow charger 30%, fast charger 68% and rapid charger 2%.	Charging profile – slow charger 70%, fast charger 28% and rapid charger 2%.	Charging profile – slow charger 50%, fast charger 48% and rapid charger 2%.

Electric Vehicles - Scenarios

PROACTIVE DECARBONISATION

As this is our highest electric vehicle growth scenario, Proactive decarbonisation shows a significant increase in electric vehicles across the north of Scotland with the number of electric vehicles rising from 1,878 in 2017 to 210,527 in 2030.

Electric vehicles in 2030 represents 26% of all vehicles in the north of Scotland based on 2017 values.

LOCAL OPTIMISATION

In Local optimisation, consumers wishing to generate money from selling services to the grid invest in electric vehicles, resulting in the number of electric vehicles increasing from 1,878 in 2017 to 200,065 in 2030.

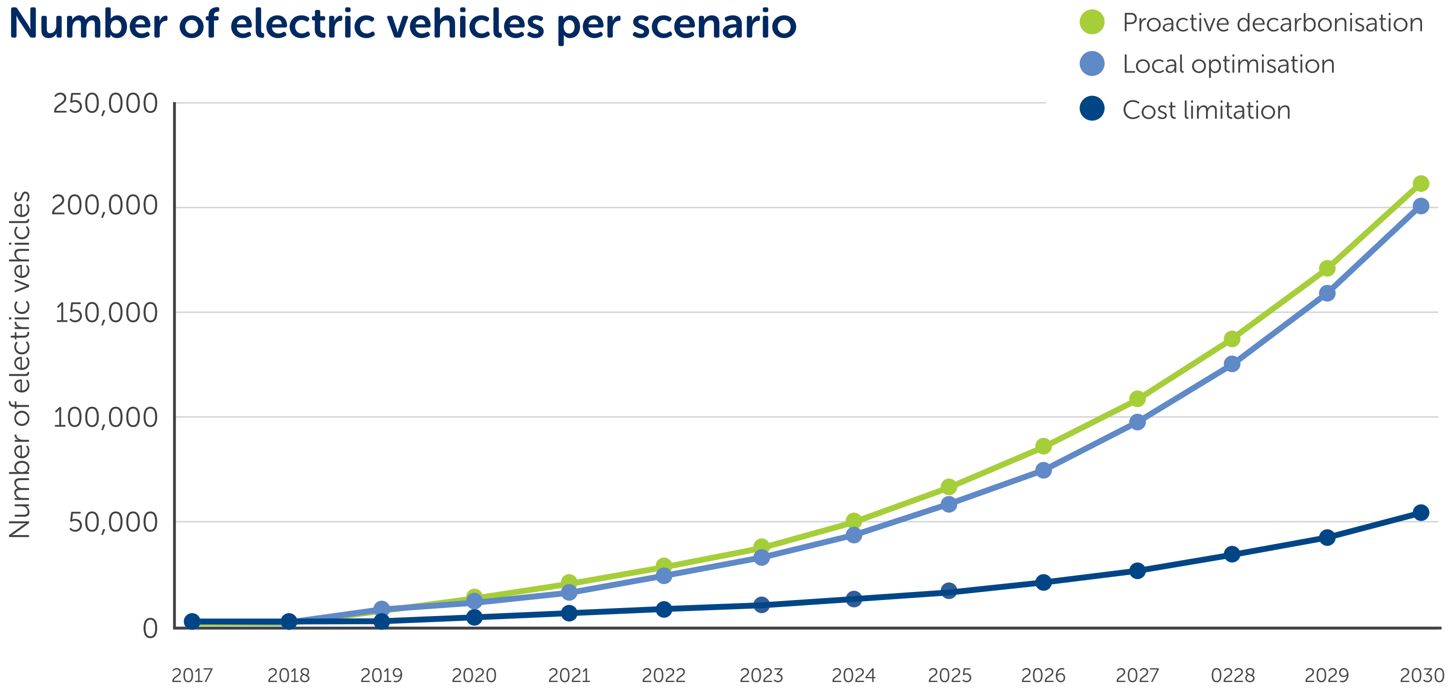
Electric vehicles in 2030 represents 25% of all vehicles in the north of Scotland based on 2017 values.

COST LIMITATION

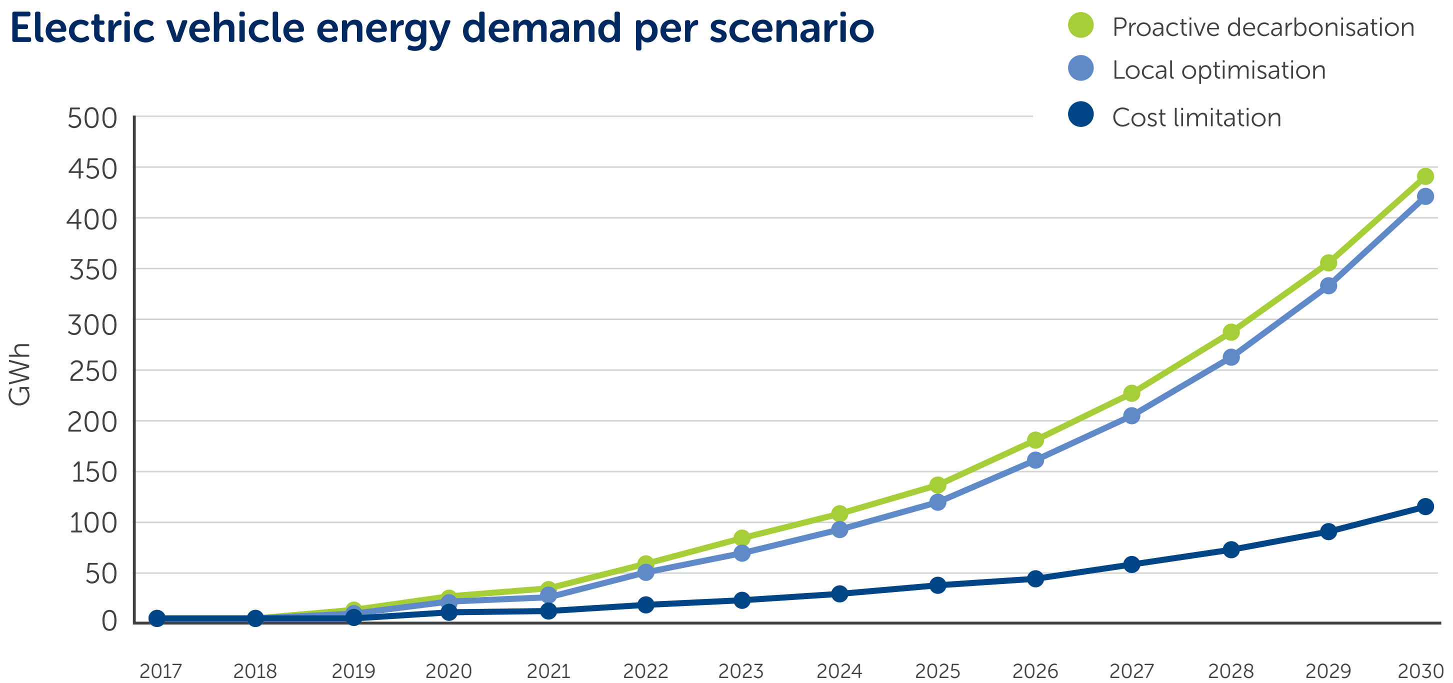
Cost limitation illustrates the lowest growth scenario for electric vehicles, increasing from 1,878 in 2017 to 54,317 in 2030 as the uptake of electric vehicles is limited and restricted to urban areas and some progressive rural communities.

Electric vehicles in 2030 represents 7% of all vehicles in the north of Scotland based on 2017 values.

Number of electric vehicles per scenario



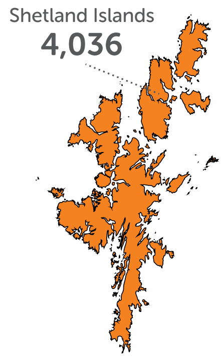
Electric vehicle energy demand per scenario

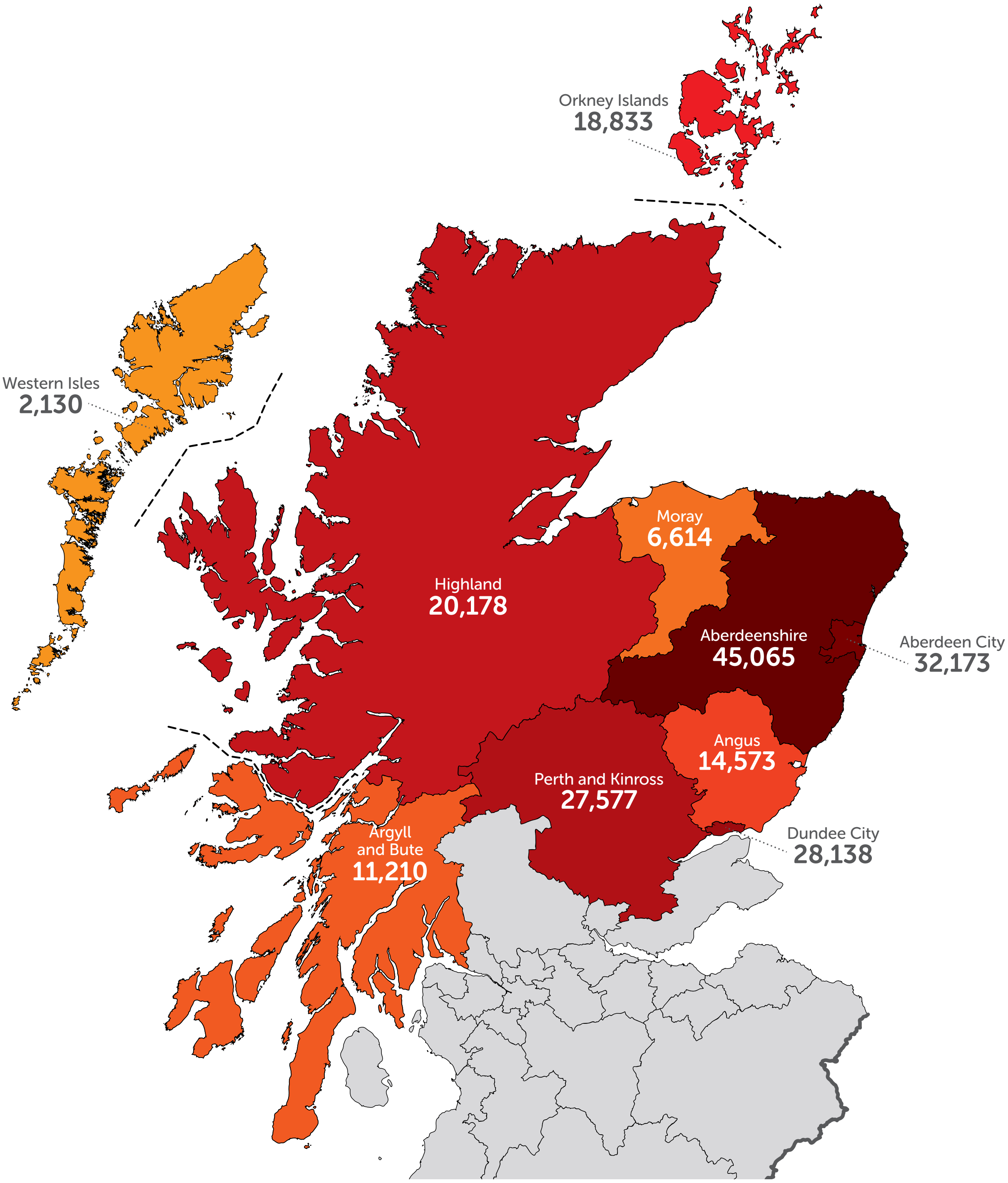


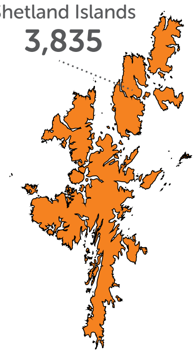
PROACTIVE DECARBONISATION

Number of electric vehicles by local authority in 2030

Number of electric vehicles - Lowest to Highest



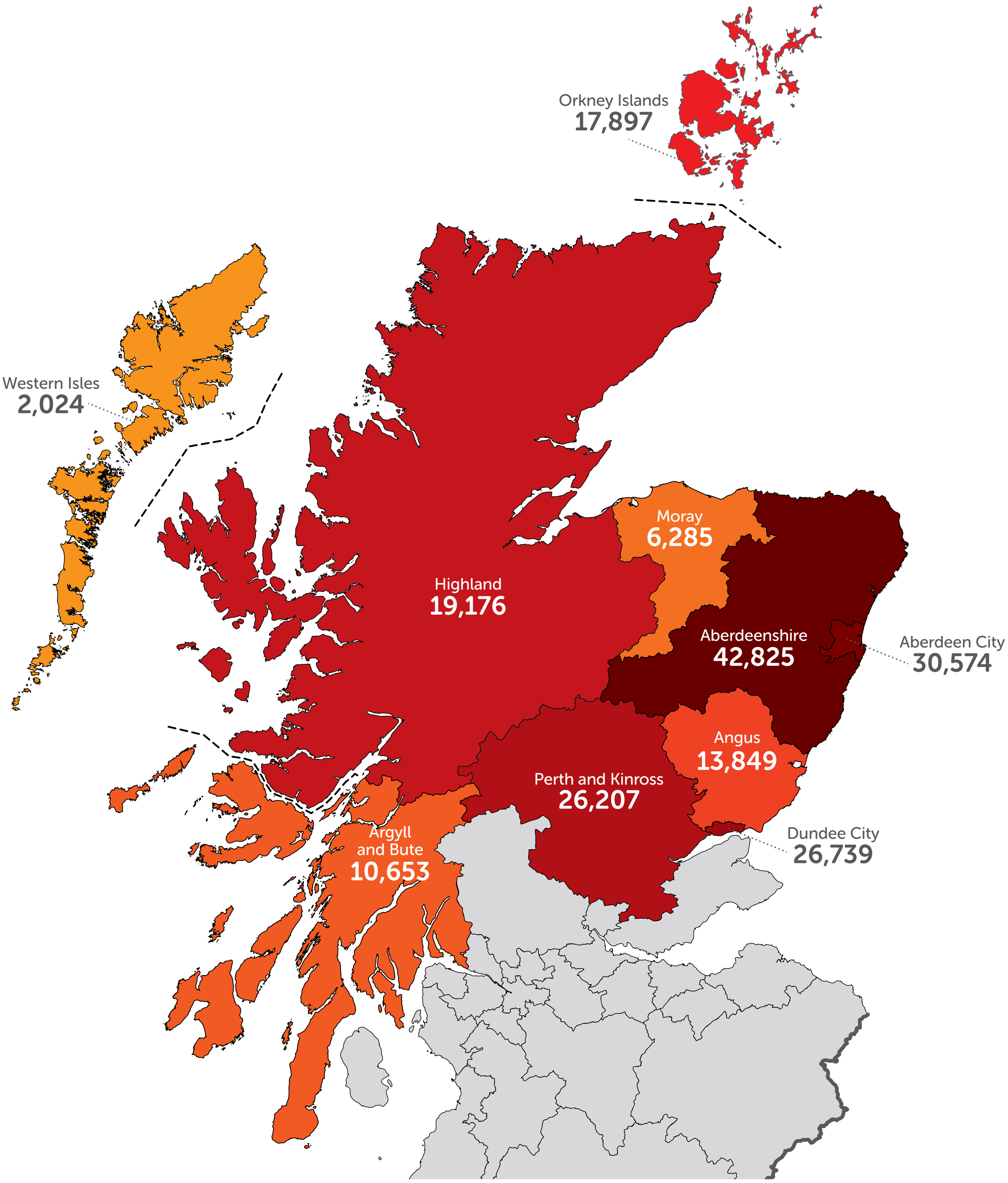




LOCAL OPTIMISATION

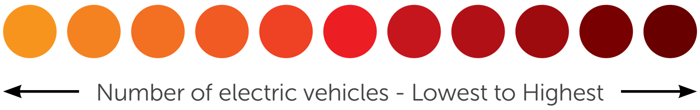
Number of electric vehicles by local authority in 2030

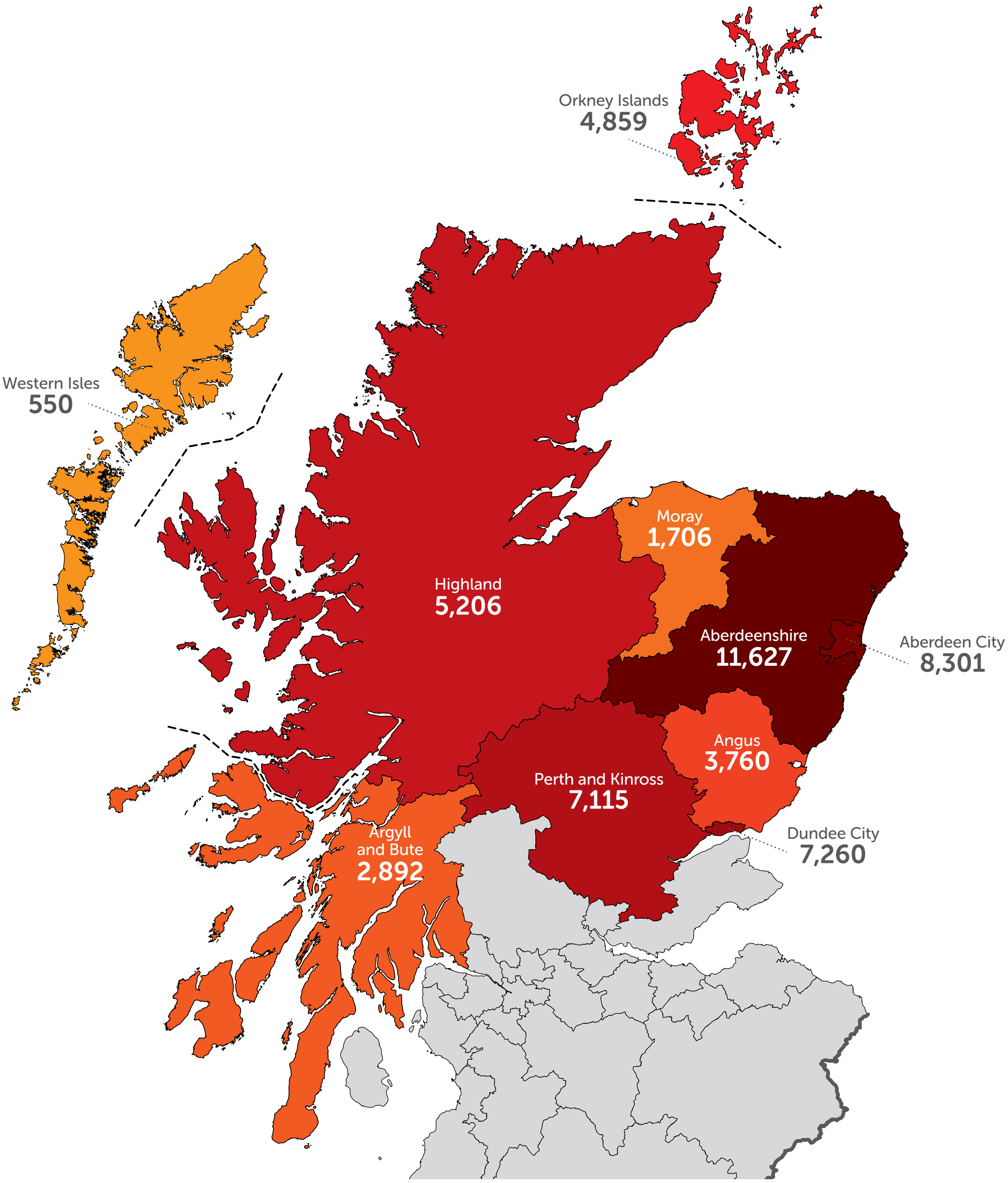
Number of electric vehicles - Lowest to Highest



COST LIMITATION

Number of electric vehicles by local authority in 2030





Future Focus: Impact of electric vehicles on peak demand

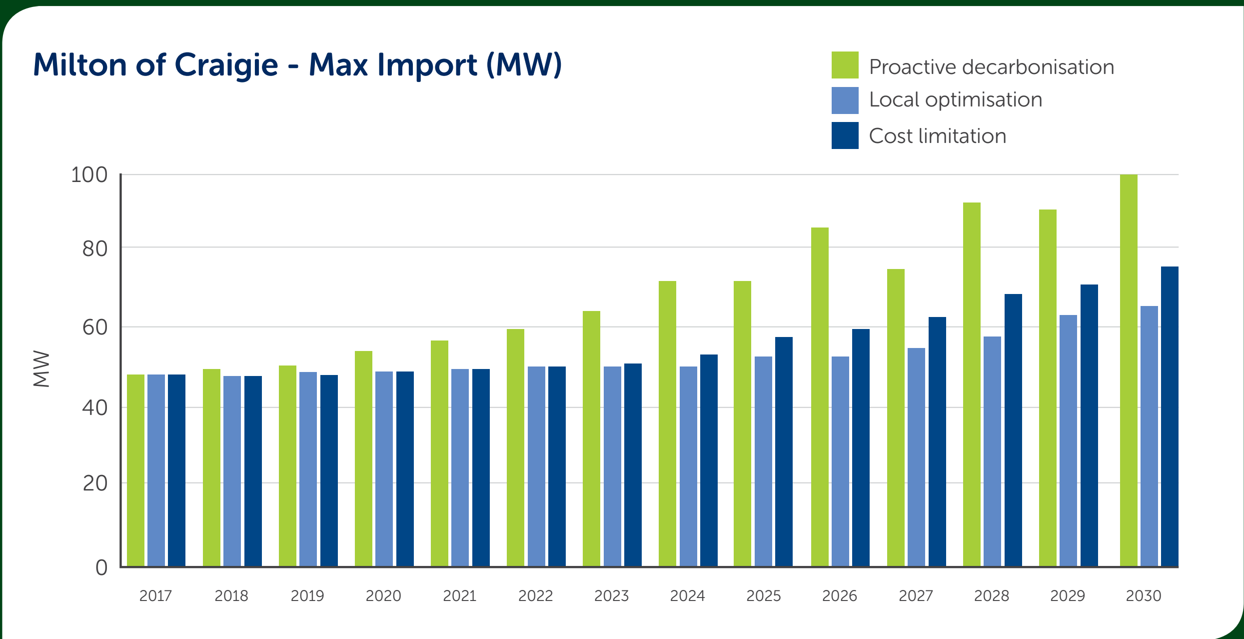
Electric vehicles were identified as a topic with a large degree of uncertainty by our stakeholders. We assessed the potential impact that the growth of electric vehicles could have on our grid supply point (GSP) transformer capacity.

A significant number of studies have been carried out at the distribution level to identify the impact on the low voltage network, however, no study has particularly focused on the impact on the transmission network.

In our 2017 consultation, stakeholders outlined that we should make a material change to the modelling assumptions on charger size used in homes. When we began our modelling of electric vehicles, we assumed that consumers would use a mix of 3.5kW and 7kW chargers to charge their electric vehicles. However, feedback received from stakeholders detailed that our modelling should be based upon consumers utilising 7kW chargers to charge their electric vehicles. Our model also included the use of fast and rapid chargers which allowed us to develop different charging profiles for each of our scenarios.

See Appendix for more detail on the charging profiles applied to each scenario.

The graph below shows an example of how the number of MW being imported into a GSP may change from 2017 to 2030.



The graph shows that in all three of our scenarios, the MW being imported at the Milton of Craigie GSP (Dundee City) increases from 2017 to 2030, exceeding the 60MW transformer capacity at the GSP. In Proactive decarbonisation, there is an increase of 50MW from 2017 to 2030, representing an increase of 102% across the period. In Local optimisation, the number of MW being imported increased by 18MW (37%). Finally, in Cost limitation, the number of MW being imported increased by 27MW, a rise of 57% from 2017 to 2030.

Heat

Over the past decade, we have seen the introduction of legislation and policies aimed at improving the efficiency of household boilers and building stock across GB. To meet challenging decarbonisation targets, the utilisation of other technologies such as heat pumps, combined heat and power plants, biomass and district heating may be required.

The Scottish Government has set a 2032 target that 35% of heat for domestic buildings will be supplied using low carbon technologies, where technically feasible.

This target provides a challenging goal as significant changes may be required to encourage homeowners to switch from their current heating fuel to low carbon heating technologies.

As heat is decarbonised, an increased electric heating and electrically powered systems such as air source heat pumps could increase demand on the networks. In our modelling, we have sought to determine what level of increased electricity demand for heat would result under each of our scenarios.

We have not sought to model changes in heat demand in other fuel types.

Key insights

1. Proactive decarbonisation is our high electrification scenario for heat.

2. Proactive decarbonisation has the highest number of homes retrofitting low carbon heating technologies by 2030 at 87,245, compared to the 151,492 homes that currently use low carbon heating technologies.

3. Local optimisation has 59,770 homes retrofitting low carbon heating technologies by 2030, compared to the 151,492 homes that currently use low carbon heating technologies.

Current heating and trends

In the north of Scotland, the types of heating used by consumers is diverse. 51% of homes in the north of Scotland use gas to heat their homes. 23% of homes use electricity to provide heating whilst the remaining 26% of homes use alternative fuels, such as oil and biomass, to heat their homes.

We have assumed that by 2029/30, electric heating will be classified as a low carbon heating technology due to further decarbonisation of electricity generation.

Under this classification, there are around 151,492 homes which use low carbon technologies to heat their homes (includes homes already using electric heating and those receiving the renewable heat incentive).

This does not include new homes which use low carbon heating as this has been modelled separately.

Stakeholder input

Through our consultation process, our stakeholders provided us with information and feedback that could be utilised to shape our scenarios.

The table below sets out some of the feedback provided by stakeholders on generation and how we have incorporated this into our scenarios.

Feedback provided	Incorporation in scenarios
Heat pumps hold great potential to decarbonise the heat sector but cost and lack of promotion impacting uptake.	Uptake of heat pumps reduced to a lower level in Local optimisation when compared to Proactive decarbonisation to reflect potential lower uptake due to cost and awareness.
Heat networks, biomass, LPG and oil will play a role in heating households in the north of Scotland.	The scenario narrative for Local optimisation was updated to reflect the role that heat networks, biomass, LPG and oil will play a role in heating households in the north of Scotland, however there was no impact on electricity used for heating demand from these heating types in the scenario.

Key Assumptions

Proactive decarbonisation	Local optimisation	Cost limitation
Average consumption from electric storage heaters - 6,416 kWh.		
Average consumption from air source heat pumps - 4,000 kWh.		
Average consumption from hybrid heat pumps - 4,000 kWh.		
Surpasses government targets by 2032.	Meets government targets by 2032.	Does not meet government targets by 2032.
40% of heat for domestic buildings will be supplied using low carbon technologies. Of which:	35% of heat for domestic buildings will be supplied using low carbon technologies. Of which:	15% of heat for domestic buildings will be supplied using low carbon technologies.
40% of homes will install electric storage.	20% of homes will install electric storage.	No households are required to retrofit low carbon heating technologies as the number of households already using low carbon technologies exceeds the target set within this scenario.
40% of homes will install air source heat pumps.	37% of homes will install air source heat pumps.	
20% of homes on the gas grid will install hybrid heat pumps.	3% of homes on the gas grid will install hybrid heat pumps.	
Consistent annual increase throughout the 2020s.	40% of homes will install biomass.	
	Consistent annual increase throughout the 2020s.	

Heat - Scenarios

PROACTIVE DECARBONISATION

Proactive decarbonisation sees consumers in rural areas utilise electric storage heaters and heat pumps. However, in more urban areas, natural gas boilers continue to be used with an increase in the uptake of hybrid systems.

This scenario is on track to surpass the Government target with 40% of heat for domestic buildings coming from low carbon technologies. By 2030, 34,898 additional homes will have fitted electric storage, 34,898 additional homes will have fitted heat pumps and 17,449 additional homes will have fitted hybrid heat pumps.

LOCAL OPTIMISATION

Within Local optimisation, consumers use electric heating in the form of storage heaters and heat pumps where possible. Where access to excess generation is limited, a range of biomass CHP, district heat networks are used whereas in more urban areas the use natural gas boilers continues alongside an increase in the uptake of hybrid systems.

This scenario is on track to meet the Scottish Government's 2032 target. By 2030, 11,954 additional homes will have fitted electric storage, 22,115 additional homes will have fitted heat pumps and 1,793 additional homes will have fitted hybrid heat pumps. Further to this, 23,908 additional homes will have fitted biomass boilers by 2030.

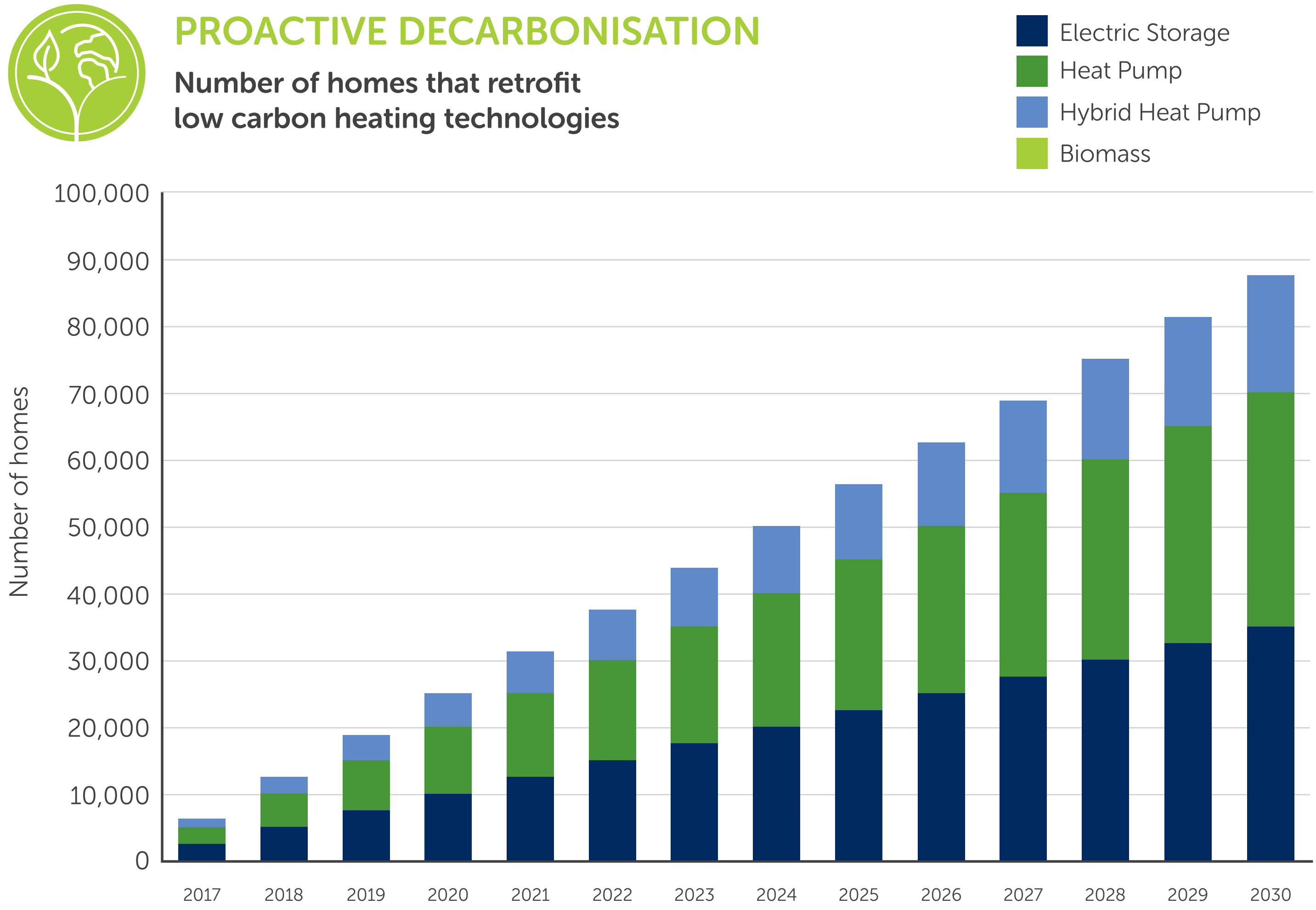
COST LIMITATION

Cost limitation sees a continuation in the use of natural gas boilers as the primary heating source and does not meet the 2032 target with 15% of heat for domestic buildings coming from low carbon technologies.

No homes retrofit low carbon heating technologies in this scenario as the number of homes currently using low carbon technologies is already more than that value, assuming the reclassification of electric heating as low carbon.

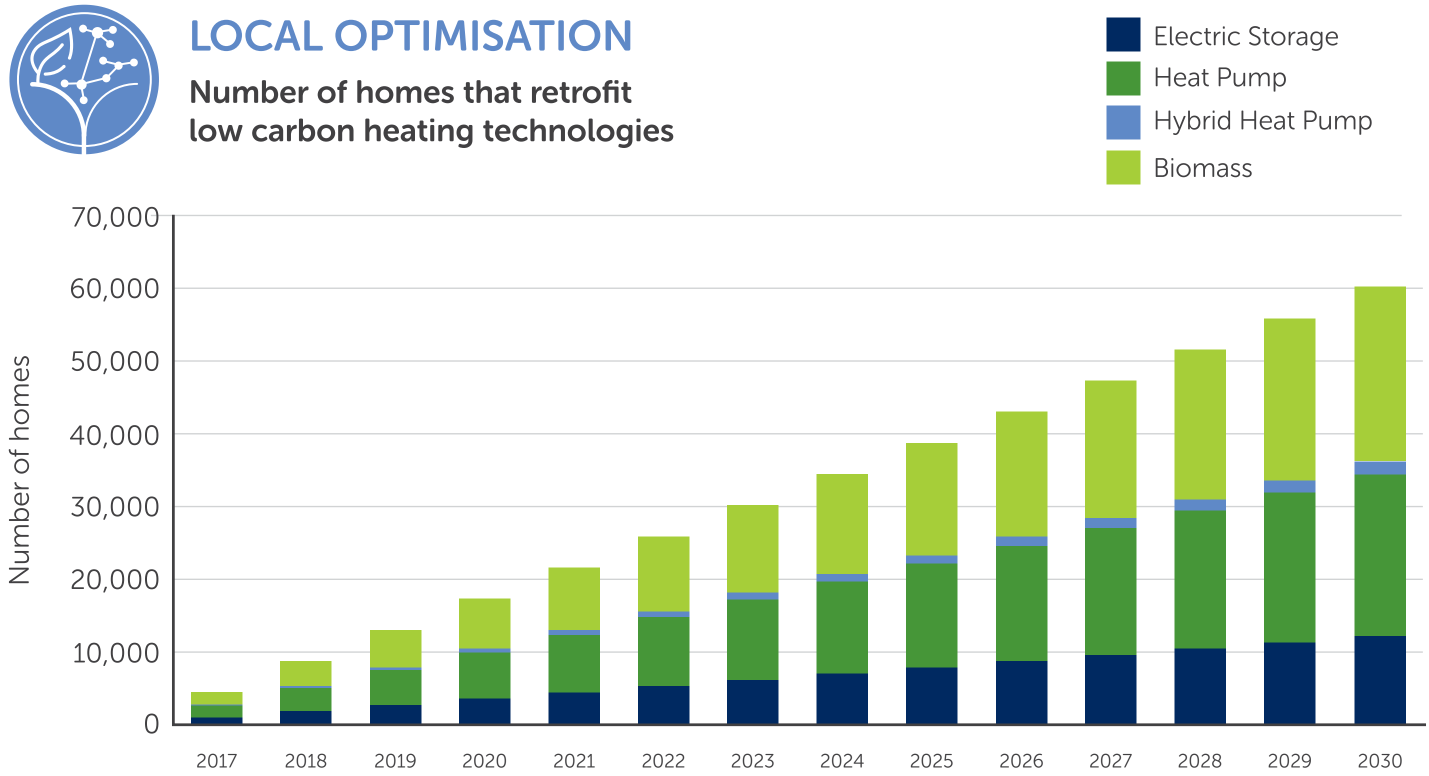
PROACTIVE DECARBONISATION

Number of homes that retrofit low carbon heating technologies

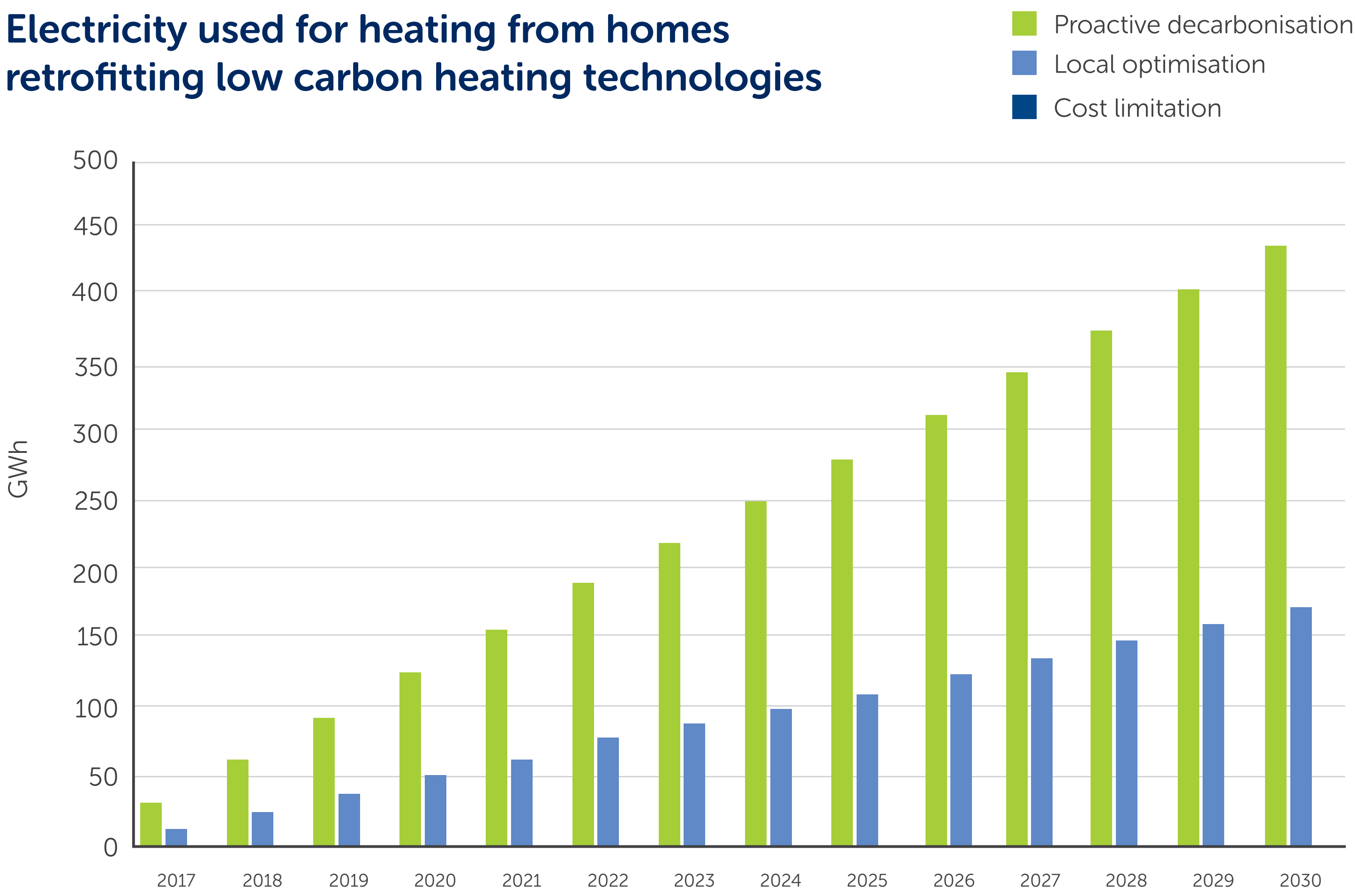


LOCAL OPTIMISATION

Number of homes that retrofit low carbon heating technologies



Electricity used for heating from homes retrofitting low carbon heating technologies



Energy Efficiency

Energy Efficiency remains an integral part of both the Scottish and UK Governments energy policy. The recent Energy Efficient Scotland consultation outlines the continued focus placed on energy efficiency by the Scottish Government.

The Scottish Government set a target that states that by 2032, all buildings – both in the residential and services sectors – will be insulated to the maximum appropriate level.

This target specifically relates to insulation however as a Transmission Operator, we are interested in the impact that changes in electrical energy efficiency could have on electricity consumption.

We have focussed on efficiency of lighting and linked improvements in this to the targets for insulation.

We have not currently sought to model changes in efficiency and ownership of appliances.

This is an area of interest for our future work.

Key insights

1. Proactive decarbonisation has the highest number of homes fitting lighting energy efficiency improvements by 2030 at 306,278 homes, representing 49% of total number of homes in the north of Scotland based on 2017 values.

2. Local optimisation has 166,278 homes fitting lighting energy efficiency improvements by 2030, representing 26% of total number of homes in the north of Scotland based on 2017 values.

3. Cost limitation has 59,770 homes fitting lighting energy efficiency improvements by 2030, representing 10% of total number of homes in the north of Scotland based on 2017 values.

Current energy efficiency trends

There are currently 628,000 homes in the north of Scotland, of which 141,000 homes are not fitted with cavity wall insulation, 160,000 homes are not fitted with solid wall insulation and 49,032 homes do not have loft insulation.

Due to the type of building stock in the north of Scotland, meeting the Scottish Government's 2032 target will be challenging. Significant investment will be required from local authorities, landlords and private homeowners to ensure that the target is met.

We have assumed that those homes who may retrofit insulation would also undertake other energy efficiency improvements such as investing in more energy efficient lighting.

This could reduce lighting demand from homes by around 230kWh per year per home on average as homes replace halogen bulbs and old energy saving bulbs with new energy saving and LED bulbs

Stakeholder input

Through our consultation process, our stakeholders provided us with information and feedback that could be utilised to shape our scenarios.

The table below sets out some of the feedback provided by stakeholders on generation and how we have incorporated this into our scenarios.

Feedback provided	Incorporation in scenarios
Scotland is ahead of GB on insulation improvements with the remaining building stock being classified hard to treat.	Our scenarios include the hard to treat buildings such as those requiring solid wall insulation.
10-30% improvement in energy efficiency is possible.	Our scenarios are designed to meet the Scottish Government's 2032 energy efficiency target.

Key Assumptions

Proactive decarbonisation	Local optimisation	Cost limitation
Fitting LED bulbs provides a reduction of around 230 kWh per year per home.		
Assumed that 100% of homes that do not currently have the respective insulation type will install the below conservation measures:	Assumed that 100% of homes that do not currently have the respective insulation type will install the below conservation measures:	Assumed that 30% of homes that do not currently have the respective insulation type will install the below conservation measures:
Cavity insulation.	Cavity insulation.	Cavity insulation.
Loft insulation.	Loft insulation.	Loft insulation.
Solid wall insulation.		

Energy Efficiency - Scenarios

PROACTIVE DECARBONISATION

As consumers are engaged in decarbonisation and energy efficiency to reduce the cost of their energy bills in this scenario, 306,278 homes will have carried out energy efficiency improvement by 2030, alongside the associated lighting energy efficiency improvements.

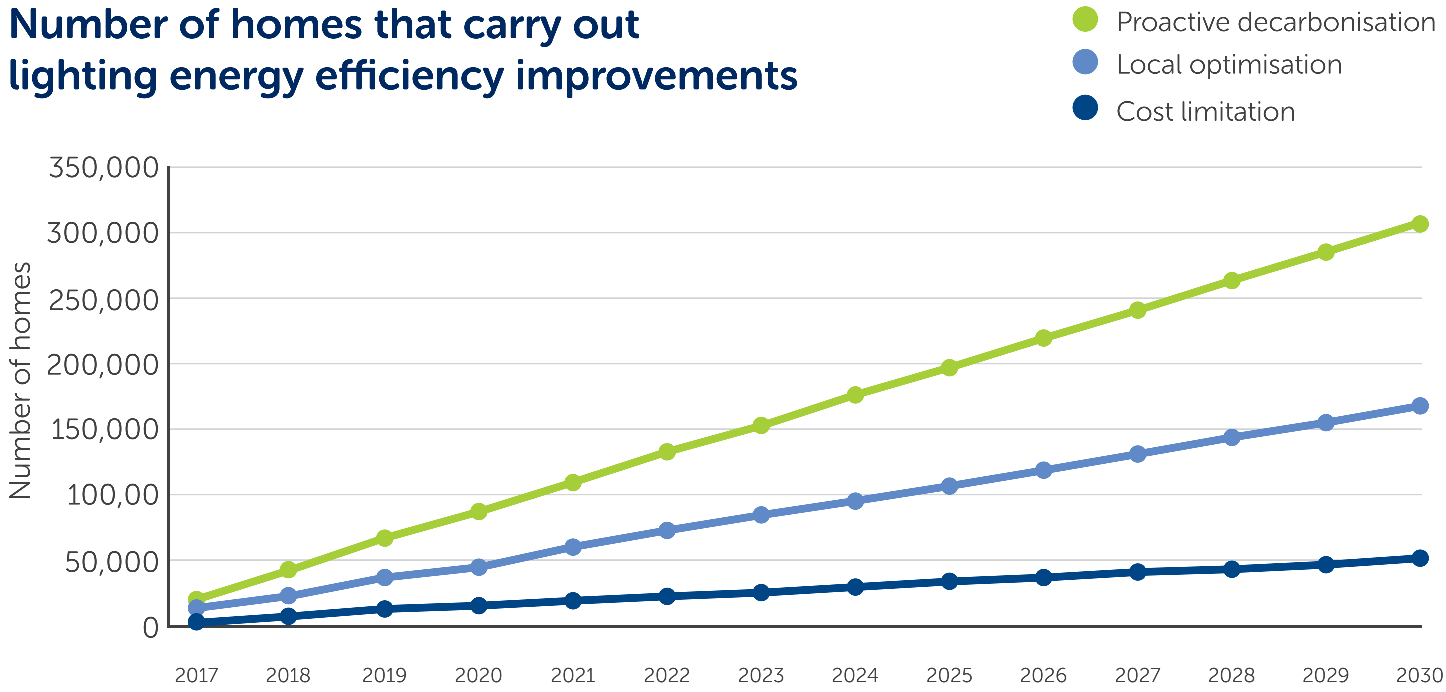
LOCAL OPTIMISATION

In this scenario, consumers focus on some simple things to help improve energy efficiency in their homes such as replacing halogen bulbs with LED bulbs and fitting cavity and loft insulation to decrease the cost of their energy bills. By 2030, 166,278 homes will have carried out lighting energy efficiency improvements.

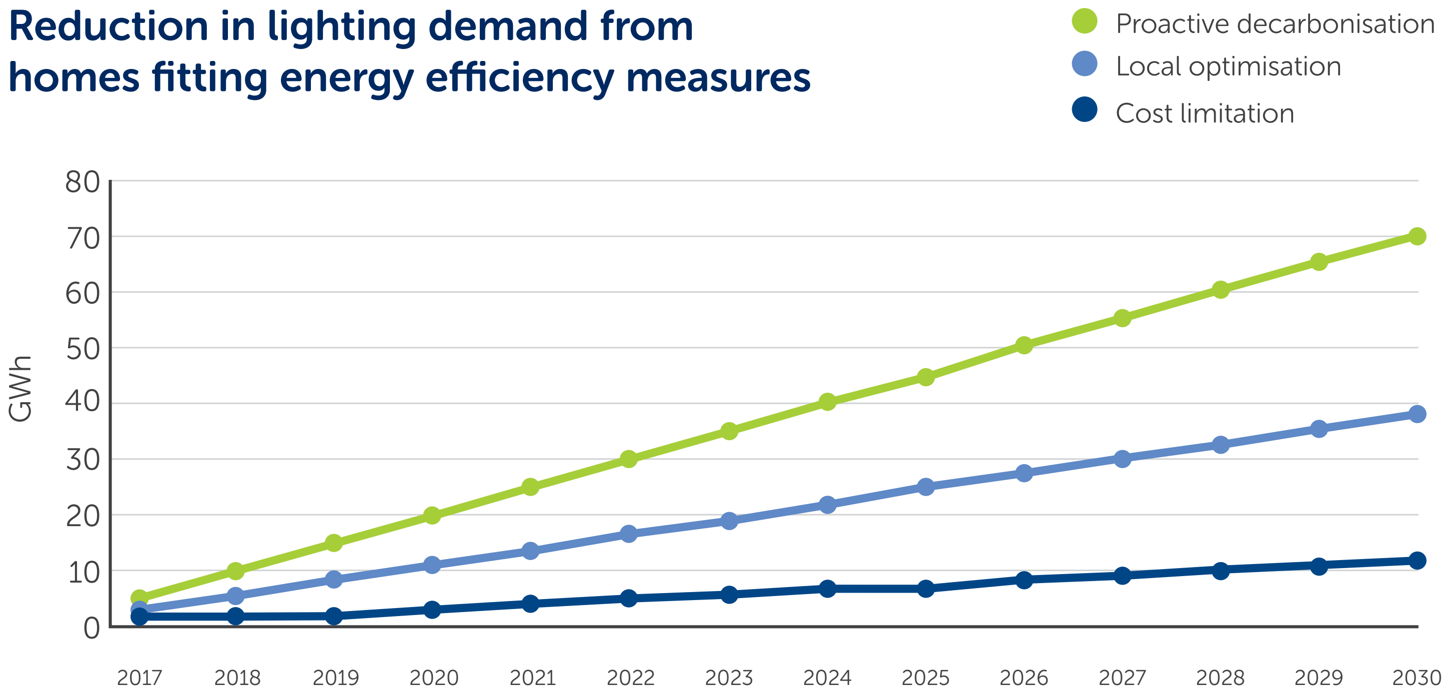
COST LIMITATION

Cost limitation illustrates the lowest scenario for homes carrying out energy efficiency improvements across the three scenarios. Consumers carry out energy efficiency improvements but as economic growth flattens, some consumers are switched off investing due to the higher cost of these technologies. 49,883 homes will have carried out lighting energy efficiency improvements by 2030.

Number of homes that carry out lighting energy efficiency improvements



Reduction in lighting demand from homes fitting energy efficiency measures



Microgeneration (solar PV)

Introduction of the feed in tariff led to significant growth in microgeneration technologies across Great Britain. However, the future of microgeneration is unclear, following government cuts to the payments given to householders which led to a considerable decline in the number of homes fitting microgeneration across Great Britain.

We have focussed on solar PV as the microgeneration technology that we considered for our scenarios.

Through our engagement, we were advised that more and more stakeholders were looking to fit solar PV as a means to reduce the amount of electricity they required from the network.

We sought to model the impact that this would have on the transmission network, a net reduction in demand.

Key insights

1. Local optimisation has the highest number of homes fitted with solar PV by 2030 at 162,299 homes, increasing by 143,780 homes from 2017.
2. Proactive decarbonisation shows that an additional 52,871 homes will fit solar PV by 2030.
3. Aberdeenshire is the local authority which has the highest number of homes fitted with solar PV across the north of Scotland.

Current microgeneration (solar PV) and trends

At the end of 2017, there were 18,519 homes across the north of Scotland that were fitted with solar PV, a substantial increase from the 212 homes in 2010 that had been fitted with the technology.

Aberdeenshire is the local authority which has the highest number of homes fitted with solar PV followed closely by the Highland local authority.

Stakeholder input

Through our consultation process, our stakeholders provided us with information and feedback that could be utilised to shape our scenarios.

The table below sets out some of the feedback provided by stakeholders on generation and how we have incorporated this into our scenarios.

Feedback provided	Incorporation in scenarios
Domestic and business customers seeking to self-generate and reduce demand from the grid.	Reduction in energy demand due to solar PV generation included in Proactive decarbonisation and Local optimisation.

Key Assumptions

Proactive decarbonisation	Local optimisation	Cost limitation
Assumed 4kW system used per household.		No retrofit of solar PV in this scenario due to no government intervention encouraging consumers to move towards greener sources of energy.
Average solar PV output in Scotland per year - 3,400 kWh.		
Utilises Solar Trade Association's 2017 low case scenario.	Utilises Solar Trade Association's 2017 high case scenario.	

Microgeneration - Scenarios

PROACTIVE DECARBONISATION

As a result of consumers investing in microgeneration technologies to bring down the cost of their energy bills in this scenario, 71,390 homes will be fitted with solar PV by 2030, an increase of 52,871 homes from 2017 levels.

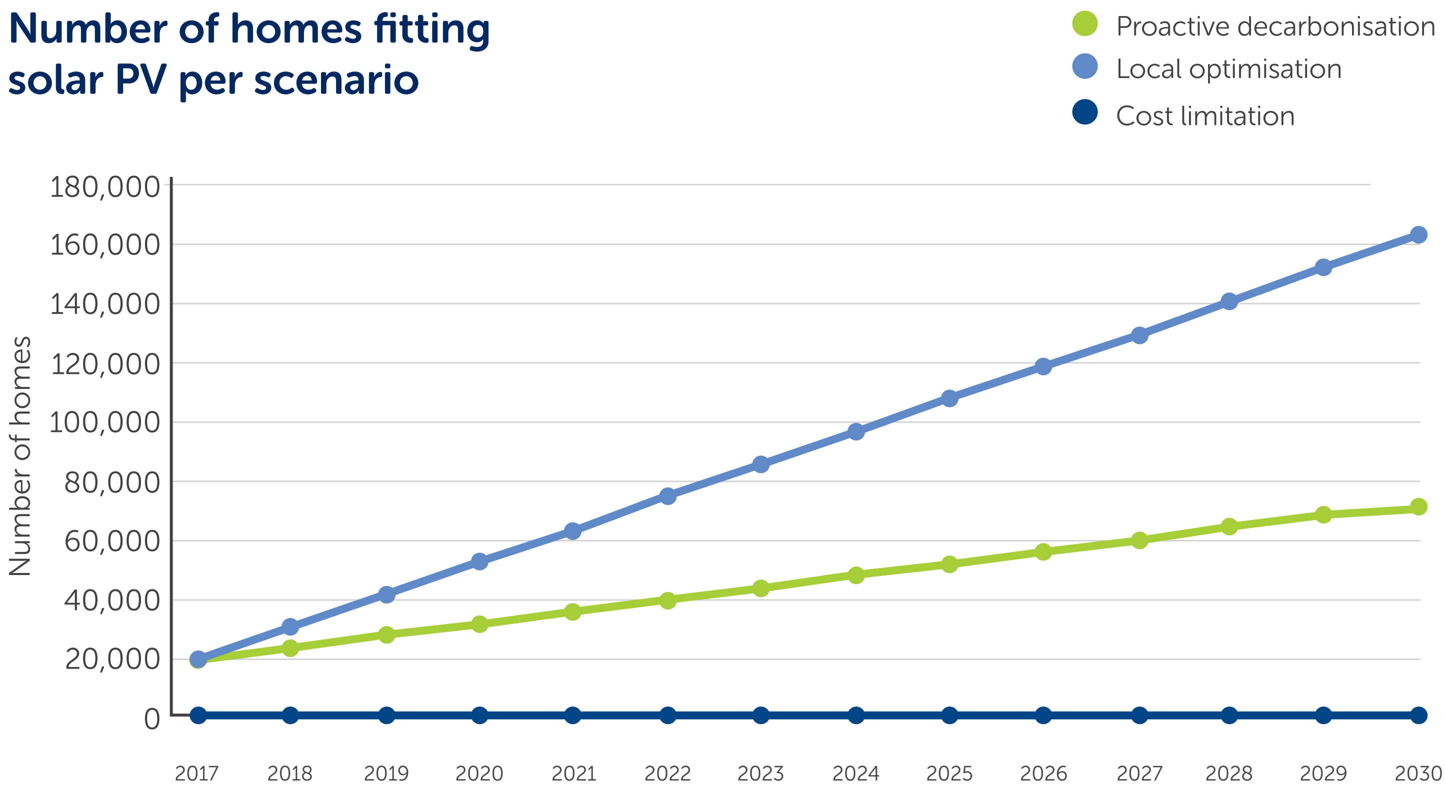
LOCAL OPTIMISATION

In this scenario, consumers are driven more by cost reduction than decarbonisation and invest in microgeneration technologies to reduce their spend on energy. An additional 143,780 homes will fit solar PV, taking the number of homes fitted with solar PV to 162,299 homes by 2030.

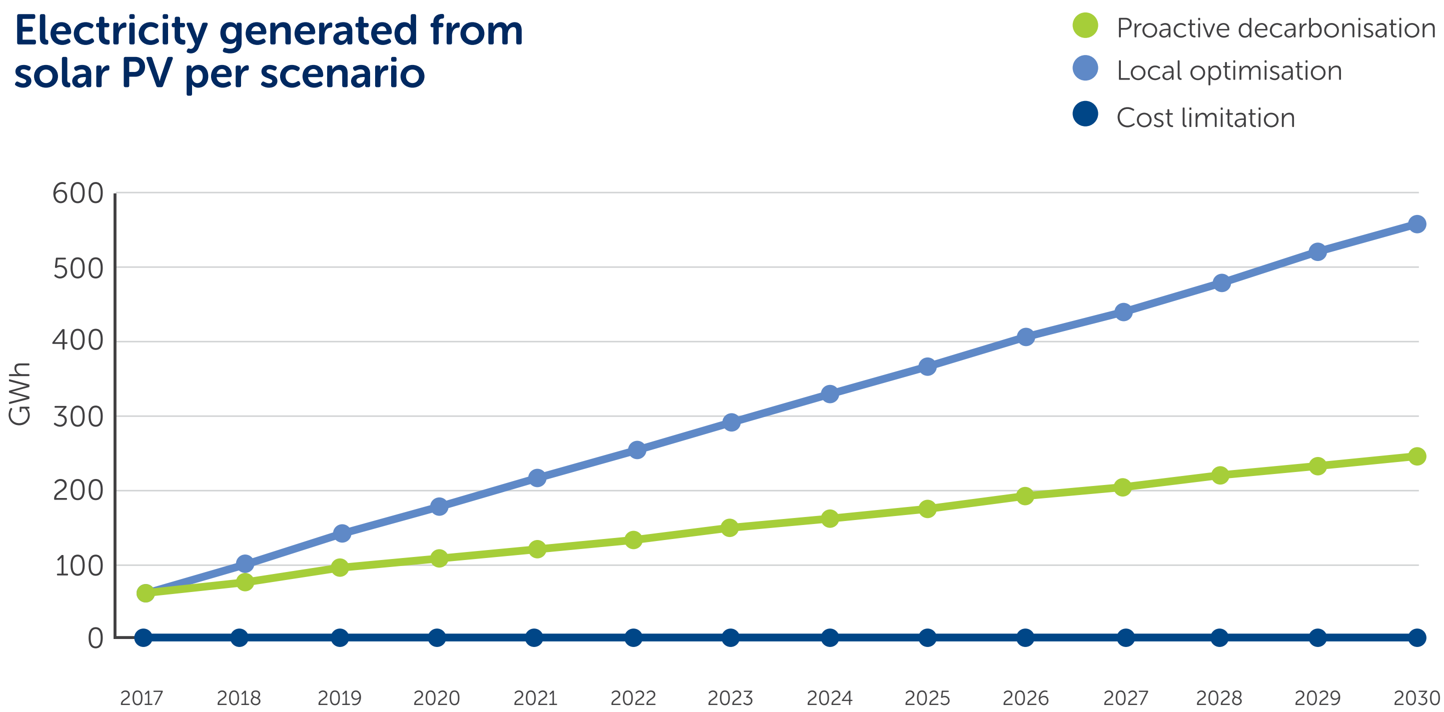
COST LIMITATION

No retrofit of solar PV takes place in this scenario due to no government intervention encouraging consumers to move towards greener sources of energy.

Number of homes fitting solar PV per scenario



Electricity generated from solar PV per scenario



New homes

Identifying where new demand is likely to connect to our network is an important area for us to consider within our scenarios as this will allow us to model the potential effect that new households could have on the electricity system.

Across the north of Scotland, all of the local authorities have clear local development plans that outline how many homes are expected to be built within their area across their various plans.

We have used these plans to inform our scenario development, supplemented with additional insight provided by stakeholders with regards to the heating technologies being installed in new homes.

Key insights

1. Proactive decarbonisation and Local optimisation has the highest number of homes being built by 2030 at 61,620 homes.
2. Local optimisation has the highest proportion of new homes fitting microgeneration (solar PV) and low carbon heating (air source heat pumps) at 75%.
3. Cost limitation has the lowest number of homes being built by 2030 at 15,405 homes.

Current new homes trends

Currently there are 628,000 homes across the north of Scotland. All of the local authorities in the north of Scotland propose to build new homes up to 2030.

The Highland local authority plan to build the highest number of homes by 2030 when compared to the other local authorities in the north of Scotland.

The local development plans set out how many homes will be built and at what rate.

Stakeholder input

Through our consultation process, our stakeholders provided us with information and feedback that could be utilised to shape our scenarios.

The table below sets out some of the feedback provided by stakeholders on generation and how we have incorporated this into our scenarios.

Feedback provided	Incorporation in scenarios
Electrification of heat on the islands is continuing as heat pumps are now being used in new builds as the primary heating source.	All new homes built on the Islands in Proactive decarbonisation and Local optimisation have been modelled with air source heat pumps to provide heating.

Key Assumptions

Proactive decarbonisation	Local optimisation	Cost limitation
Average solar PV output in Scotland per year - 3,400 kWh.		
Average consumption from air source heat pumps - 4,000 kWh.		
Fitting LED bulbs provides a reduction of around 230 kWh per year per home.		
Assumed that all new households on the Islands will be fitted with air source heat pumps to meet their heating needs.		
100% of the households identified from the local development plans will be built within this scenario. Of which:	100% of the households identified from the local development plans will be built within this scenario. Of which:	25% of the households identified from the local development plans will be built within this scenario. Of which:
50% of homes to be built will install solar PV.	75% of homes to be built will install solar PV.	10% of homes to be built will install solar PV.
50% of homes to be built will install air source heat pumps.	75% of homes to be built will install air source heat pumps.	5% of homes to be built will install air source heat pumps.
100% of homes to be built will install LED lighting.	100% of homes to be built will install LED lighting.	100% of homes to be built will install LED lighting.

New homes - Scenarios

PROACTIVE DECARBONISATION

In Proactive decarbonisation, 61,620 new homes will be built by 2030. From the 61,620 new homes, 50% of homes will be fitted with microgeneration (solar PV) and low carbon heating technologies (air source heat pumps) by 2030.

However, we have assumed that all new homes on the Islands will be fitted with air source heat pumps to meet their heating needs based upon feedback from stakeholders.

In this scenario, 30,810 homes will be fitted with microgeneration (solar PV) and 32,839 fitted with low carbon heating.

We have assumed that all of the 61,620 new homes will be fitted with LED bulbs.

LOCAL OPTIMISATION

For Local optimisation, 61,620 new homes will be built by 2030. As this scenario is our more decentralised scenario, 75% of homes will be fitted with microgeneration (solar PV) and low carbon heating technologies (air source heat pumps) by 2030.

However, we have assumed that all new households on the Islands will be fitted with air source heat pumps to meet their heating needs based upon feedback from stakeholders.

Within this scenario, 46,215 homes will be fitted with microgeneration (solar PV) and 47,229 fitted with low carbon heating.

We have assumed that all of the 61,620 new homes will be fitted with LED bulbs.

COST LIMITATION

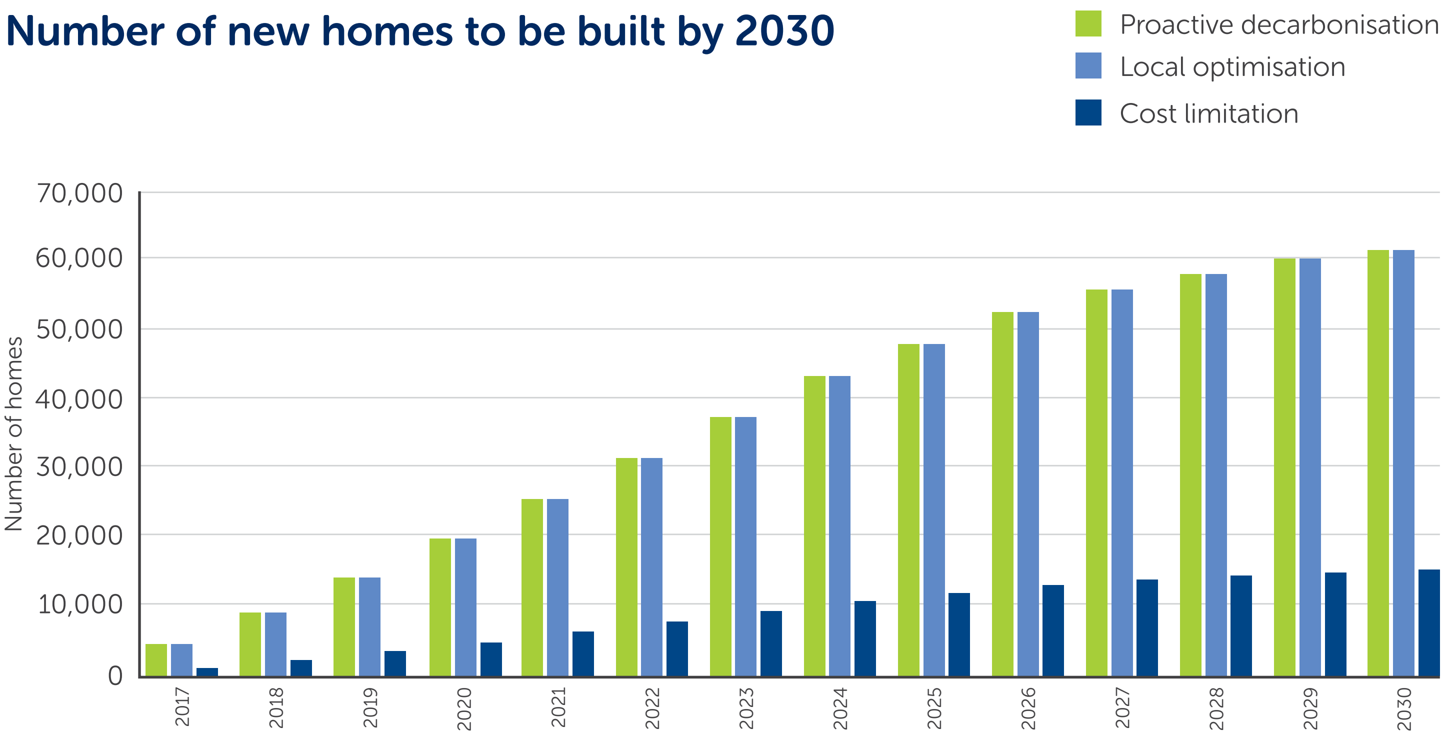
Cost limitation shows the lowest levels of new homes that will be built by 2030 across the three scenarios at 15,405 homes.

A lower proportion of households will be fitted with micro-generation (10%) and low carbon heating technologies (5%) as there is no government intervention to encourage lots of consumers to move towards greener sources of energy.

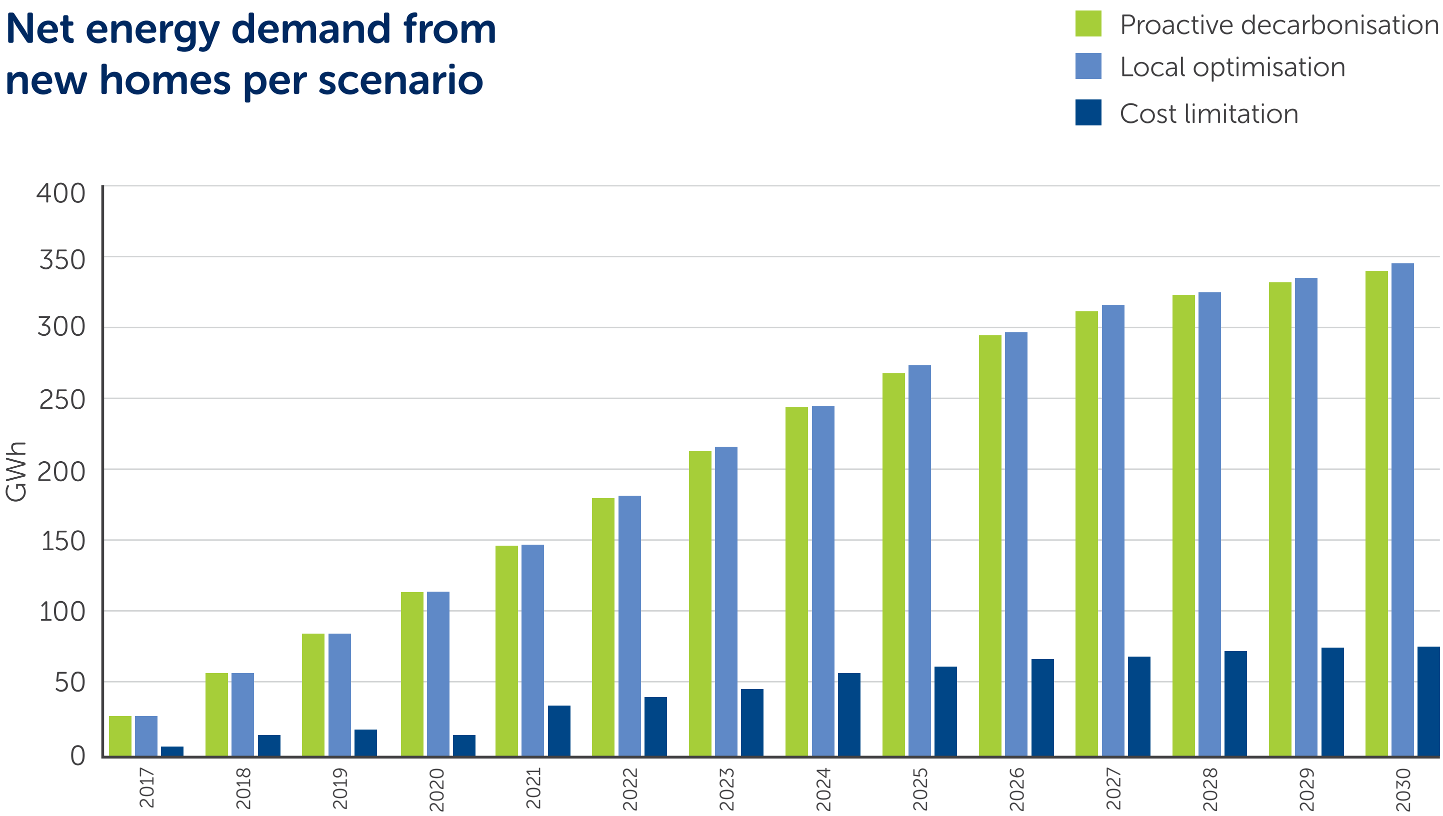
In this scenario, 1,541 homes will be fitted with micro-generation and 770 households will be fitted with low carbon heating.

We have assumed that all of the 15,405 new homes will be fitted with LED bulbs as within this scenario energy efficiency improvements continue to be a focus of national and local Government.

Number of new homes to be built by 2030



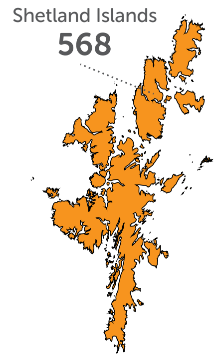
Net energy demand from new homes per scenario

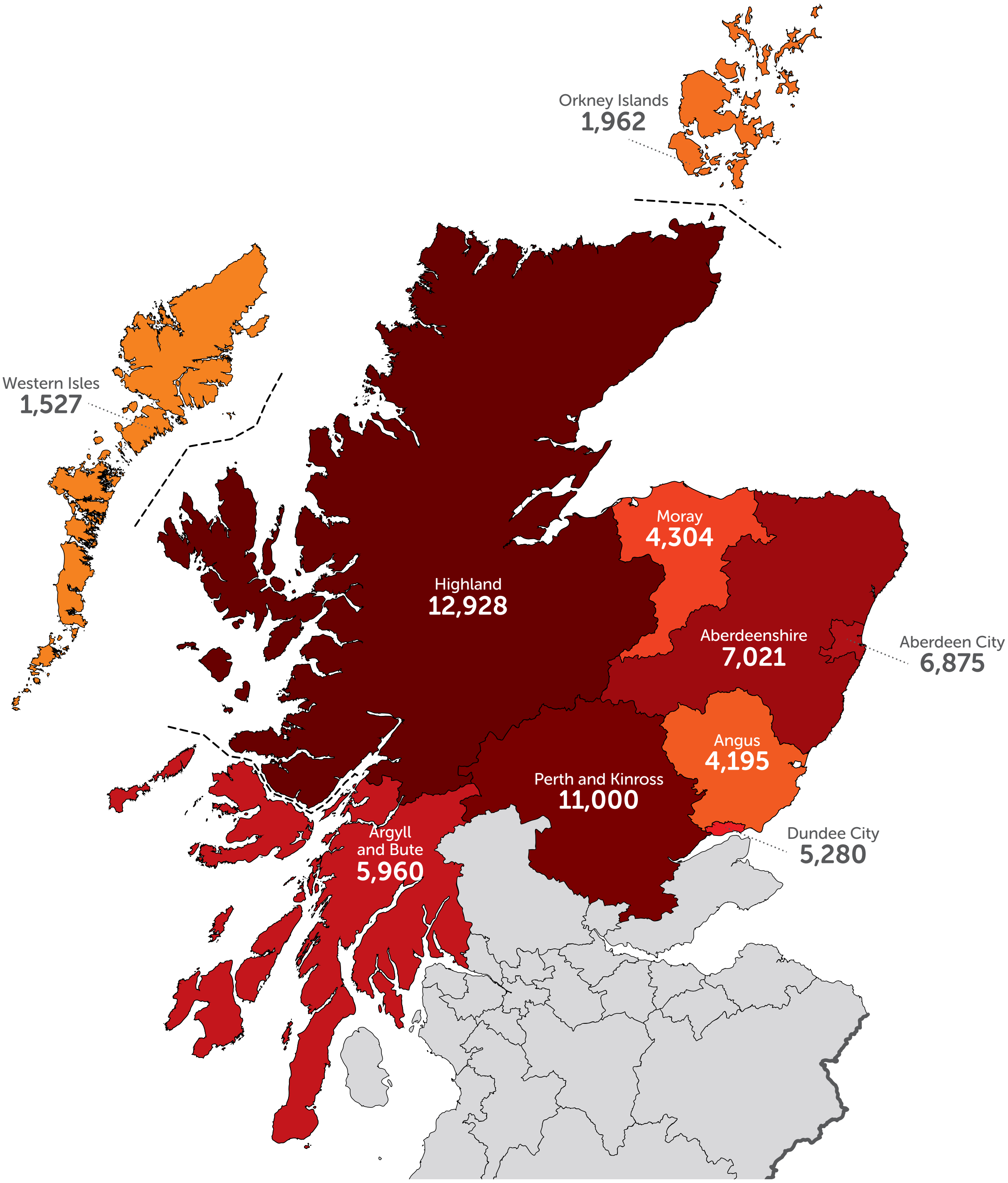


PROACTIVE DECARBONISATION
LOCAL OPTIMISATION

Number of new homes per local authority by 2030

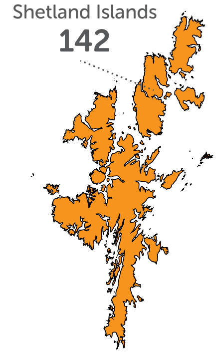
← Number of new homes - Lowest to Highest →



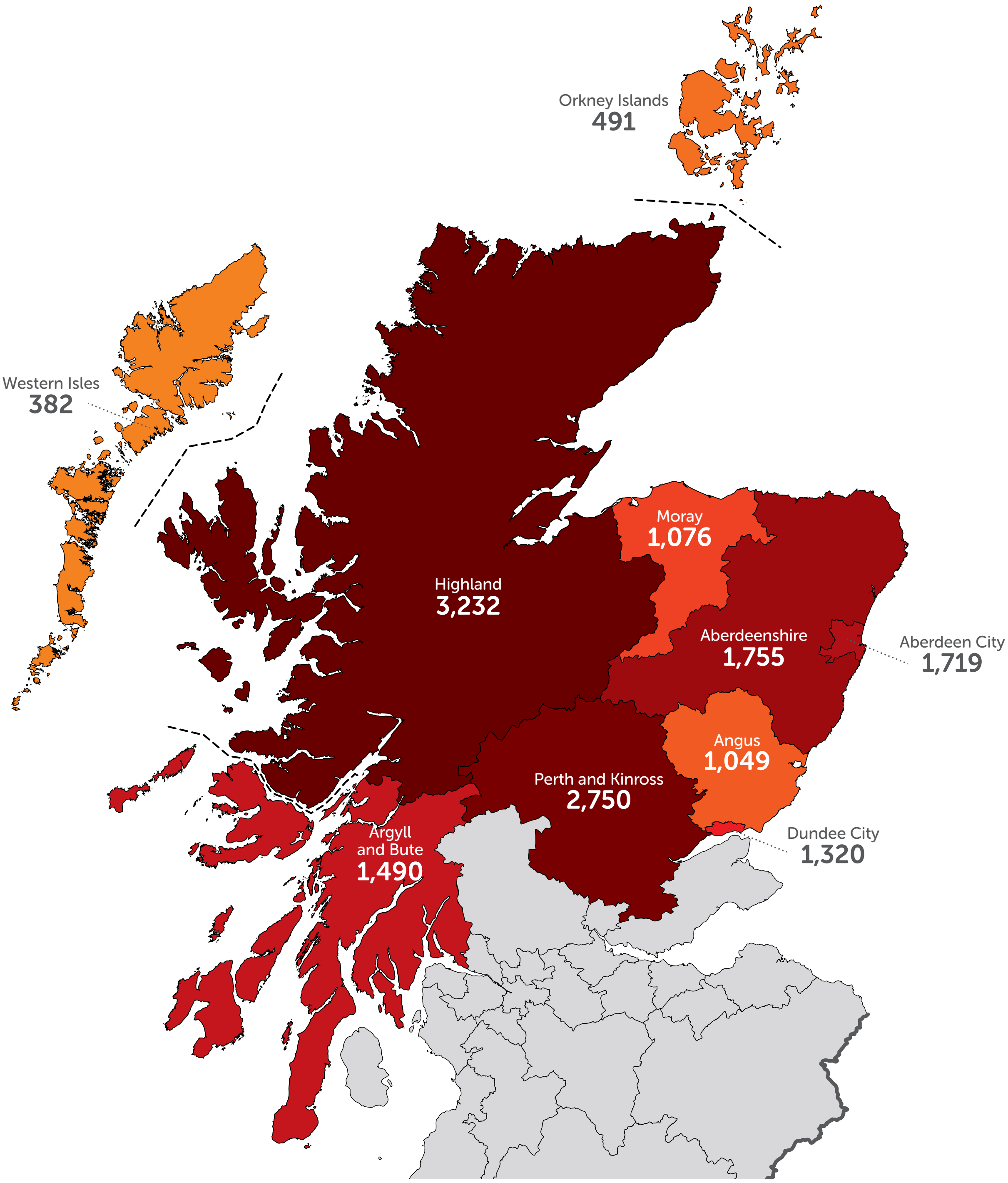


COST LIMITATION

Number of new homes per local authority by 2030

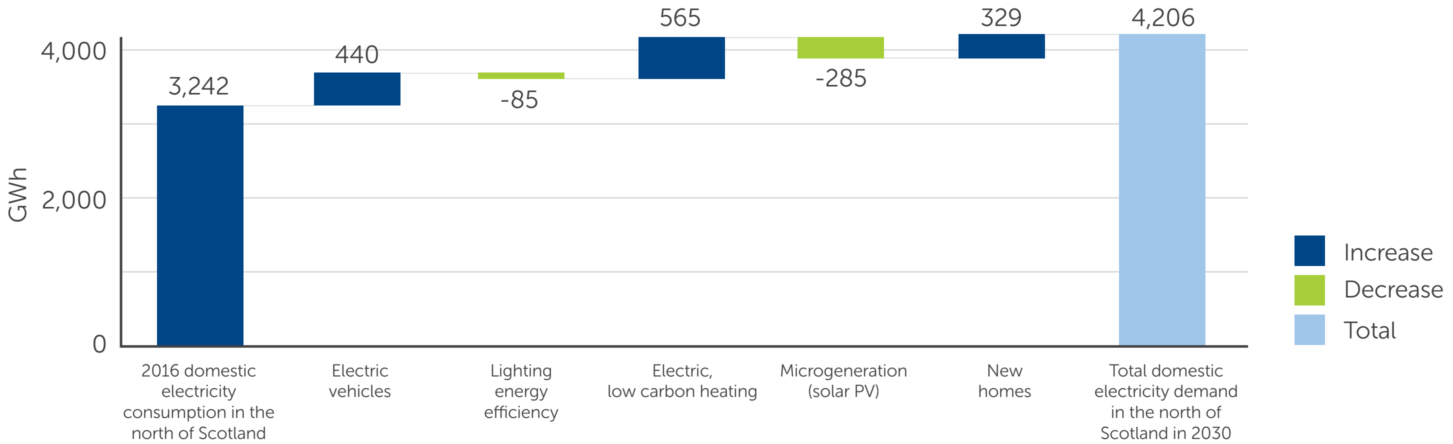


Number of new homes - Lowest to Highest

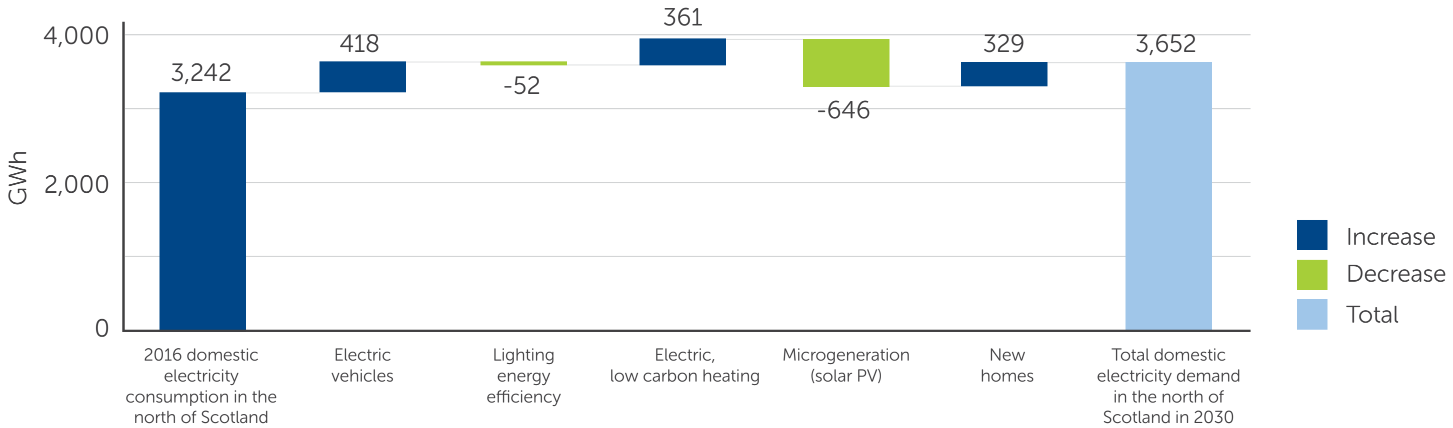


Total domestic electricity demand in 2030

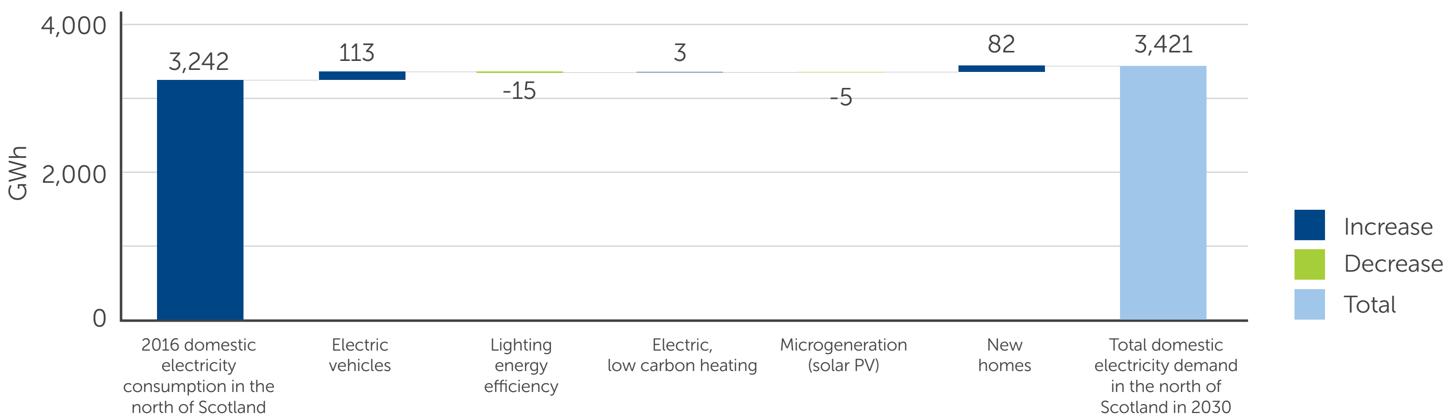
Proactive decarbonisation



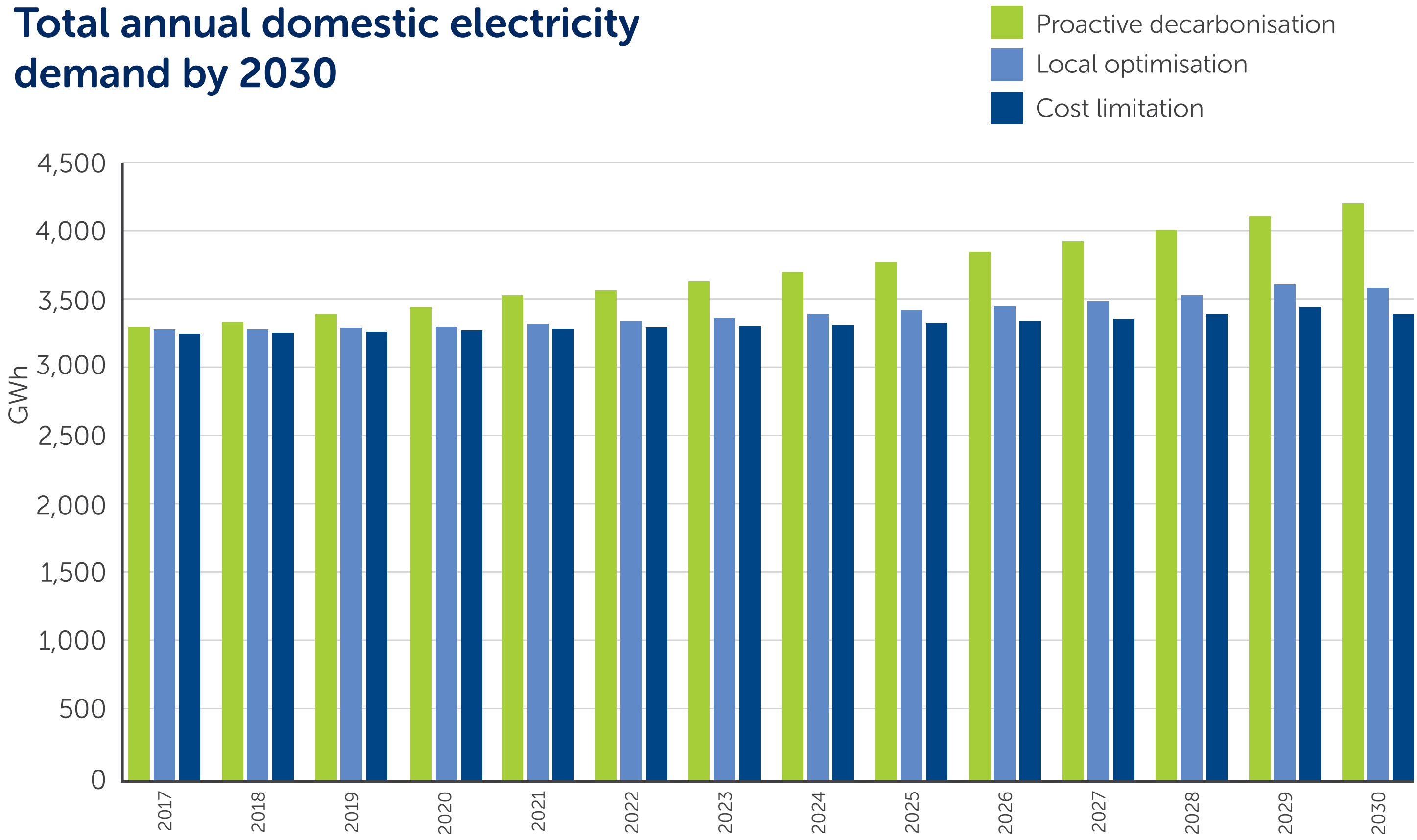
Local optimisation



Cost limitation



Total annual domestic electricity demand by 2030



PROACTIVE DECARBONISATION

Proactive decarbonisation has the highest level of domestic electricity demand by 2030 across all three of the scenarios.

This is due to the large number of homes fitting electric, low carbon heating technologies, the increase in electric vehicles and additional demand from new homes.

LOCAL OPTIMISATION

Local optimisation has the second highest level of domestic electricity demand by 2030.

This is due to the large number of homes fitting electric, low carbon heating technologies, the increase in electric vehicles and additional demand from new homes, which outweighs the reduction in domestic demand due to the number of homes fitting microgeneration (solar PV).

COST LIMITATION

Cost limitation has the lowest level of domestic electricity demand by 2030 as result of the increase in electric vehicles and additional demand from new homes.

Investment in lighting energy efficiency improvements and microgeneration (solar PV) have minimal impact on reducing domestic electricity demand.

Further analysis

As we have never carried out an exercise of this nature before, there are areas of improvement that can be made to our scenarios.

We are currently undertaking further analysis to identify the impact that our scenarios will have on peak demand. This is crucial in allowing us to determine where investment is required on our network.

The second aspect where further analysis is to be undertaken is demand from the industrial and commercial sector. Our energy trends paper highlighted that industrial and commercial electricity and gas consumption increased from 2005 to 2015, in contrast to the GB trend. Modelling this sector is more complex due to its split between different industries with highly varied energy needs. We will be undertaking further engagement in the coming months to better understand trends and customer needs in this area and will ensure that future publications of our scenarios include analysis of industrial and commercial demand and generation.

Finally, we will carry out further refinement of our scenarios to ensure that we are utilising the best available sources, and developing models and approaches that are consistent with best practice in the energy industry.

Future of our scenarios

This publication presents our first ever Future Energy Scenarios for the north of Scotland.

We are aiming to turn this into a yearly activity within our Transmission business, enabling this to become part of our continuous business planning cycle.

This will allow us to plan developments to meet the needs of our existing and future customers and society. It will also allow us to consider developments within the energy industry in our business planning.

How we will use our scenarios

Our next step is to determine the effects that the developments described by these scenarios would have on the electricity network. This will include reviewing the current network capacity and power flows within each region and whether additional capacity will be required to accommodate the changes in demand and generation.

This will be a whole electricity system analysis, taking account of changes at the distribution level in terms of how they will impact the transmission system, for example requirements to upgrade grid supply points.

Once the network needs have been identified, we will carry out optioneering to determine the potential solutions that will provide what is required.

In this optioneering we will consider:

- traditional infrastructure solutions;
- non-traditional infrastructure solutions; and,
- alternative, non-infrastructure solutions.

The results of this modelling will be used to inform our business plan submission for RIIO-T2.

Glossary

Term	Acronym	Description
Air source heat pump	ASHP	Air source heat pumps absorb heat from the outside air. This heat can then be used to produce hot water or space heating.
Combined cycle gas turbine	CCGT	A combustion turbine that uses natural gas or liquid fuel to drive a generator to generate electricity. The residual heat from this process is used to produce steam in a heat recovery boiler which, in turn, drives a steam turbine generator to generate more electricity.
Combined heat and power	CHP	Combined cycle gas turbine. A system where both heat and electricity are generated simultaneously as part of one process. Covers a range of technologies that achieve this.
Electric vehicle	EV	A vehicle powered by an electric motor. It can either be driven solely off a battery, as part of a hybrid system or have a generator that can recharge the battery but does not drive the wheels. We only consider EVs that can be plugged in to charge in this report.
Feed-in tariffs	FiT	A government programme designed to promote the uptake of a range of small-scale renewable and low carbon electricity generation technologies.
Gigawatt hour	GWh	1,000,000,000 watt hours, a unit of energy.
Great Britain	GB	A geographical, social and economic grouping of countries that contains England, Scotland and Wales.
Heat pump		A device that transfers heat energy from a lower temperature source to a higher temperature destination.
Interconnector		Transmission assets that connect the GB market to Europe and allow suppliers to trade electricity or gas between markets.
Kilowatt hour	kWh	1,000 watt hours, a unit of energy.
Load Factor		The average power output divided by the peak power output over a period of time.
Megawatt	MW	1,000,000 watts, a unit of power.
Open cycle gas turbine	OCGT	A combustion turbine plant fired by gas or liquid fuel to turn a generator rotor that produces electricity.
Renewable Heat Incentive of heat produced.	RHI	A payment incentive administered by Ofgem which pays owners of certain renewable heating technologies per unit. There is a domestic and a non-domestic version.
Repowering		Re-fitting a generation site with new equipment such as new wind turbine blades so that it can continue to generate electricity, usually more efficiently than previously.
RIIO		Revenue=Incentives+Innovation+Outputs is Ofgem's performance-based framework to set the price controls.
Smart charging		Charging units which have two way communication ability and that can react to external signals.

Appendix

Information gathered from our external engagement, consultations, connection contracts and our research has played an important role in defining the outcomes included within each of our three scenarios.

This section explains the methodologies used to create the outcomes for each of the topic areas covered in our Future Energy Scenarios report.

Generation, interconnection and storage

The information gathered through the consultations and external engagements played a crucial role in development of the generation estimates underpinning the final three scenarios.

The following processes were undertaken to develop the generation values for each of our scenarios:

Proactive decarbonisation

- Includes Transmission and Distribution generation projects (D>10MW) that have had consents approved, are awaiting consent and are in scoping*
- Includes new applications (not included in the National Grid Future Energy Scenarios)
- Excludes generation projects that have had consents refused
- Includes all 3 island connections
- Includes the NorthConnect interconnector to Norway and the Maali interconnector to Norway
- Includes stakeholder engagement projects.

Local optimisation

- Includes Transmission generation projects that have had consents approved and are awaiting consent but excludes Transmission generation projects that are in scoping.
- Includes Distribution generation projects >10MW in scoping*
- Excludes generation projects that have had consents refused
- Includes all 3 island connections (Shetland at lower connected capacity of 300MW)
- Includes the NorthConnect interconnector to Norway.

Cost limitation

- Includes Transmission and Distribution generation projects that have had their consents approved*
- Excludes generation projects that have had consents refused
- No islands connections so no island wave, tidal or onshore wind
- No interconnection.

* Project categorisation – consents approved, awaiting consents (application made, offer not signed), scoping (no consents, pre-application enquiry stage), consents refused (planning issue, project termination).

Onshore wind repowering

In parts of the SHE Transmission licence area onshore wind schemes have now been connected for longer than a decade and, looking forward into the RIIO-T2 price control period, the issue of site repowering or asset lifetime extension is attracting some attention within the developer community.

An initial review of connection dates has indicated that around 700MW of capacity could be nearing the end of its life assuming a 20 year asset lifetime by the end of the next decade. This value dropped to around 120MW if a 25 year asset life was used.

Given the age and ratings of these older schemes, they were connected to the distribution network in our area. No transmission connected windfarms were included in our analysis of repowering potential due to their age.

An external consultation was undertaken to explore industry intentions in this area with responses being obtained from several developers and Scottish Renewables. There was consensus amongst the responses that repowering is something that would be considered after the ending of ROCs (around 2027 for the earlier projects) for sites that have demonstrated good yields. It was further observed that repowering would be attractive for locations where the consenting of new infrastructure would be supported by communities that have benefited from funds established by projects or other local positive economic impacts.

Based on the outcome of the consultation and a review of scheme load factors for older sites, calculated using a time series analysis, it is thought that repowering is likely to occur towards the end of the next decade. We explored repowering at transmission entry capacity (TEC) increases of 5, 10 and 15% across all of our scenarios for grid supply points (GSPs) with candidate wind farms. It was felt that increases beyond 15% could fall within the scope of phased project developments which would be captured separately within the generation background.

A total of 13 GSPs were identified as having large wind farms with the potential for repowering and were included in the analysis.

A summary of the parameters used to generate the outcomes for each of our scenarios is shown below:

Proactive decarbonisation

- 20 year asset life.
- 15% TEC increase.

Local optimisation

- 20 year asset life.
- 10% TEC increase.

Cost limitation

- 25 year asset life.
- 5% TEC increase.

Electric vehicles

Our electric vehicles model utilises statistics from the Department of Transport to generate the current number of electric vehicles for each local authority in the north of Scotland.

To show how electric vehicles could grow by 2030, we reviewed National Grid's 2018 Future Energy Scenarios to determine if there were any similarities between the rationale used to develop their electric vehicle projections.

By cross referencing our scenarios with National Grid's scenarios, we were able to identify a similar approach of higher and lower EV uptake across the scenarios. While the driving factors in National Grids scenarios varied from our own, we were able to find correlation between the scenarios that justified using similar growth rates. We calculated the year-on-year growth rates used by National Grid and used these to produce the potential number of electric vehicles in the north of Scotland for each of our scenarios.

- **Proactive decarbonisation** – is our highest EV uptake scenario and so utilised growth rates from National Grid's highest EV uptake scenario, Community Renewables.
- **Local optimisation** – is our second highest EV uptake scenario and so utilised growth rates from National Grid's second highest EV uptake scenario, Two Degrees.
- **Cost limitation** – is our lowest VE uptake scenario and so utilised growth rates from National Grid's lowest EV uptake scenario, Steady Progression.

The average number of miles driven per year (8,700 miles in Scotland according to the Energy Saving Trust), multiplied by an assumed propulsion ratio (0.24kWh/mile based on a Nissan Leaf), and the number of electric vehicles, produces the kWh/year of the electric vehicle fleet across our scenarios.

Feedback received from stakeholders made a material change to the slow charger size that we used in our modelling. Initially, our modelling was based upon a 3.5kW slow charger however this was changed to 7kW due to feedback.

In addition, our modelling included sensitivities to explore different charging behaviours that could occur.

A summary of the parameters used for each of our scenarios is shown below:

Proactive decarbonisation

- Charging profile – slow charger 30%, fast charger 68% and rapid charger 2%
- Smart charging of electric vehicles takes place.

Local optimisation

- Charging profile – slow charger 70%, fast charger 28% and rapid charger 2%
- Smart charging of electric vehicles takes place.

Cost limitation

- Charging profile – slow charger 50%, fast charger 48% and rapid charger 2%
- Smart charging of electric vehicles takes place.

Energy Efficiency

Energy Efficiency remains an integral part of both the Scottish and UK Governments energy policy. To assess the potential impact of energy efficiency conservation measures on households, we undertook research to identify the potential reductions to be incorporated into each of our scenarios.

The Scottish Government set a target that states by 2032, all buildings – both in the residential and services sectors – will be insulated to the maximum appropriate level. This target specifically relates to insulation however as a Transmission Operator, we are interested in the impact that changes in electrical energy efficiency could have on electricity consumption.

Using data from the Scottish Household Condition Survey 14-16, we identified the number of households that could potentially retrofit different insulation types by 2030 across each of our scenarios.

We outlined the appropriate energy efficiency conservation measures for each of our scenarios as shown below:

Proactive decarbonisation

Conservation methods to be used within this scenario include;

- LED lighting,
- Cavity insulation,
- Loft insulation, and
- Solid wall insulation.

Within this scenario, we assumed that 100% of homes that do not currently have the respective insulation types shown above will install them.

Local optimisation

Conservation methods to be used within this scenario include;

- LED lighting,
- Cavity insulation, and
- Loft insulation.

Within this scenario, we assumed that 100% of homes that do not currently have the respective insulation types shown above will install them.

Cost limitation

- Does not meet government targets by 2032.

Conservation methods to be used within this scenario include;

- LED lighting,
- Cavity insulation, and
- Loft insulation.

Within this scenario, we assumed that 30% of homes that do not currently have the respective insulation types shown above will install them.

Using a reduction of around 230 kWh per year per home when applied to the number of homes carrying out energy efficiency improvements produces the kWh/year reduction in lighting demand by 2030.

Heat

The Scottish Government set a target that states that by 2032, 35% of heat for domestic buildings will be supplied using low carbon technologies, where technically feasible.

Using data from the Scottish Household Condition Survey 14-16, we identified the number of households that could potentially retrofit low carbon heating technologies by 2030 across each of our scenarios.

We defined different retrofit values for low carbon heating technologies for each of our scenarios as shown below:

Proactive decarbonisation

- Surpasses government targets by 2032.

Within this scenario, 40% of heat for domestic buildings will be supplied using low carbon technologies.

The split across the different heating technologies is shown below:

- Electric storage – 40% of homes will install
- Air source heat pumps – 40% of homes will install
- Hybrid heat pumps – 20% of homes on the gas grid will install.

Local optimisation

- Meets government targets by 2032.

Within this scenario, 35% of heat for domestic buildings will be supplied using low carbon technologies.

The split across the different heating technologies is shown below:

- Electric storage – 50% of homes will install
- Air source heat pumps – 40% of homes will install
- Hybrid heat pumps – 10% of homes on the gas grid will install.

Cost limitation

- Does not meet government targets by 2032.

Within this scenario,15% of heat for domestic buildings will be supplied using low carbon technologies.

No homes are required to retrofit low carbon heating technologies as the number of homes already using low carbon technologies exceeds the target set within this scenario due to the recategorization of electric heating as renewable heat.

Using the appropriate average consumption from each technology per year (electric heating - 6,416 kWh, air source heat pump - 4,000 kWh and hybrid heat pump - 4,000 kWh) when applied to the number of homes retrofitting the respective technology produces the kWh/year increase in electricity consumption for heating by 2030.

Microgeneration (solar PV)

The final element of underlying demand that we researched was with regards to microgeneration fitted to existing homes in the north of Scotland. We focused on solar PV as being the main microgeneration technology and this has been used across all our scenarios.

To define the potential scale of solar PV uptake we adopted the Solar Trade Association's scenarios as outlined below.

We defined different retrofit values for solar PV for each of our scenarios as shown below:

Proactive decarbonisation

- Utilises Solar Trade Association's 2017 low case scenario
- 211MW to be deployed across the north of Scotland which equates to 52,871 homes based on a 4kW system per home.

Local optimisation

- As this is our more decentralised scenario, it utilises the Solar Trade Association's 2017 high case scenario
- 575MW to be deployed across the north of Scotland which equates to 143,780 homes based on a 4kW system per home.

Cost limitation

- No retrofit of solar PV in this scenario due to no government intervention encouraging consumers to move towards greener sources of energy.

Utilising the number of homes listed for each scenario, along with the average solar PV output in Scotland per year (3,400 kWh), produces the kWh/year reduction in electricity consumption from microgeneration (solar PV) by 2029/30.

Demand from new homes

In our scenarios, we considered how demand from new homes in the north of Scotland could impact the electricity system by 2029/30.

Using the local development plans from the local authorities across the north of Scotland, we identified the potential number of homes that could be built by 2029/30.

We assigned different values for the number of homes that could be built, the uptake of microgeneration (solar PV), low carbon heating technologies (air source heat pumps) and LED lighting for each of our scenarios which are shown below:

Proactive decarbonisation

Within this scenario, 100% of the homes identified from the local development plans will be built within this scenario. The split across solar PV, air source heat pumps and LED lighting is shown below:

- Solar PV – 50% of homes to be built will install.
- Air source heat pumps – 50% of homes to be built will install.
- LED lighting – 100% of homes to be built will install.

In this scenario, we have assumed that all new homes on the Islands will be fitted with air source heat pumps to meet their heating needs based upon feedback from stakeholders.

Local optimisation

Within this scenario, 100% of the homes identified from the local development plans will be built within this scenario. The split across solar PV, air source heat pumps and LED lighting is shown below:

- Solar PV – 75% of homes to be built will install.
- Air source heat pumps – 75% of homes to be built will install.
- LED lighting – 100% of homes to be built will install.

In this scenario, we have assumed that all new homes on the Islands will be fitted with air source heat pumps to meet their heating needs based upon feedback from stakeholders.

Cost limitation

Within this scenario, 25% of the homes identified from the local development plans will be built within this scenario. The split across solar PV, air source heat pumps and LED lighting is shown below:

- Solar PV – 10% of homes to be built will install.
- Air source heat pumps – 5% of homes to be built will install.
- LED lighting – 25% of homes to be built will install.

Using the identified number of homes that could be built in each scenario by 2029/30 along with the appropriate average consumption from each technology per year (solar PV - 3,400 kWh, air source heat pump - 4,000 kWh) and reduction of around 230 kWh per year per home, produces the kWh/year electricity consumption of new homes by 2029/30.

Scottish & Southern
Electricity Networks

We want to hear from you

We welcome any comments and feedback on this document.

This document and future North of Scotland Energy Scenario documents will be hosted on **www.ssen-transmission.co.uk/information-centre/industry-and-regulation/future-energy-scenarios.**

If you would like to get in touch with the team to ask questions, and provide feedback and comments then please use the following contact methods:

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