


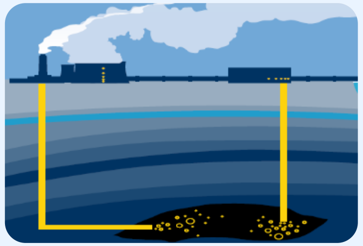

# North & West Yorkshire Emissions Reduction Pathways Executive Summary

York and North Yorkshire LEP

elementenergy

Supported by: UKCEH

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**Final report**

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# Introduction, context and aims



## Context and key objectives

In May 2019, the Climate Change Committee (CCC) published 'Net Zero: The UK's contribution to stopping global warming'. The report set out the Committee's advice that the **UK should commit to achieving net zero greenhouse gas emissions by 2050**. The Government and Devolved Administrations subsequently legislated for net zero greenhouse gas targets.

Authorities and LEPs within North and West Yorkshire have strengthened their commitments to local emissions reductions through the declaration of a Climate Emergency and the setting of targets to reach net zero carbon emissions by 2038. The region is now in the process of identifying and detailing technology options, measures, policies and interventions required to deliver its targets. This work will contribute to the region's climate strategy through the following objectives:

- **Develop technically robust emissions reductions pathways**, to enable North and West Yorkshire to meet their respective net-zero emission reduction targets.
- **Identify key milestones, decision points, policies and interventions** that can drive the transition toward these outcomes, including timeframes of actions and roles of stakeholders in delivering actions.

## Structure of the tasks and report

### 1 Emissions pathways

1. Policy review and agree scenario narrative with local stakeholders
2. Model sectoral emissions pathways for 5 sectors to 2038
   Transport, buildings, power, industry, land use
3. Combine sectoral emissions to form an economy-wide set of pathways
4. Stakeholder engagement to validate scenarios

### 2 Implementation roadmap

Develop a roadmap of the timing of decarbonisation measures and the associated milestones and decision points. Highlight the required technologies and infrastructure for each sector.

### 3 Policies and action plan

Develop a series of actions and policy recommendations for the delivery of the interventions required to meet decarbonisation goals, included the expected timing and role of stakeholders

# **Scope of the study -** the study aims to assess the interventions which could enable the region to address the climate emergency

Study region

**This study aims to assess the technologies, interventions and policies needed to drive reduction in scope 1 and 2 emissions** across the region. Due to the extremely broad, cross-sectoral nature of the study, it is necessarily high-level in some areas. Further evidence would be required to support large-scale policy implementation and investment decisions.

Whilst the study allows comparison of the scenarios in terms of emissions, energy consumption and risks, **this study is not intended to enable a decision to be made on which scenario to pursue**. Crucial evidence is still being gathered and important national decisions are being made in the next few years. This does not mean that the region should wait to act, but that it should **take low regrets actions which can support any pathway.**

**The study aims to show potential futures for the energy system through the use of scenarios.** These are needed to represent uncertainties in timing and costs of technologies and infrastructure, as well as uncertainties in consumer perception and behaviour change. The study does not attempt to 'optimise' the future energy system. The analysis is not spatial, so cannot directly guide location of infrastructure or projects and does not incorporate detailed infrastructure considerations or costs.

## Emissions in scope[1]

- ✓ Scope 1 (direct) and scope 2 (electricity consumption) $CO_2e$ emissions from transport, buildings, industry, LULUCF and agriculture.
- ✓ High-level inclusion of emissions from domestic and international aviation and waste (for completeness but not modelled in detail).
- ✓ Emissions associated with land use and agriculture in the region, including $CO_2$, $N_2O$, $CH_4$.
- ✓ Negative emissions from Drax Bioenergy + Carbon Capture and Storage and new forest planting inside region.

## Emissions out of scope

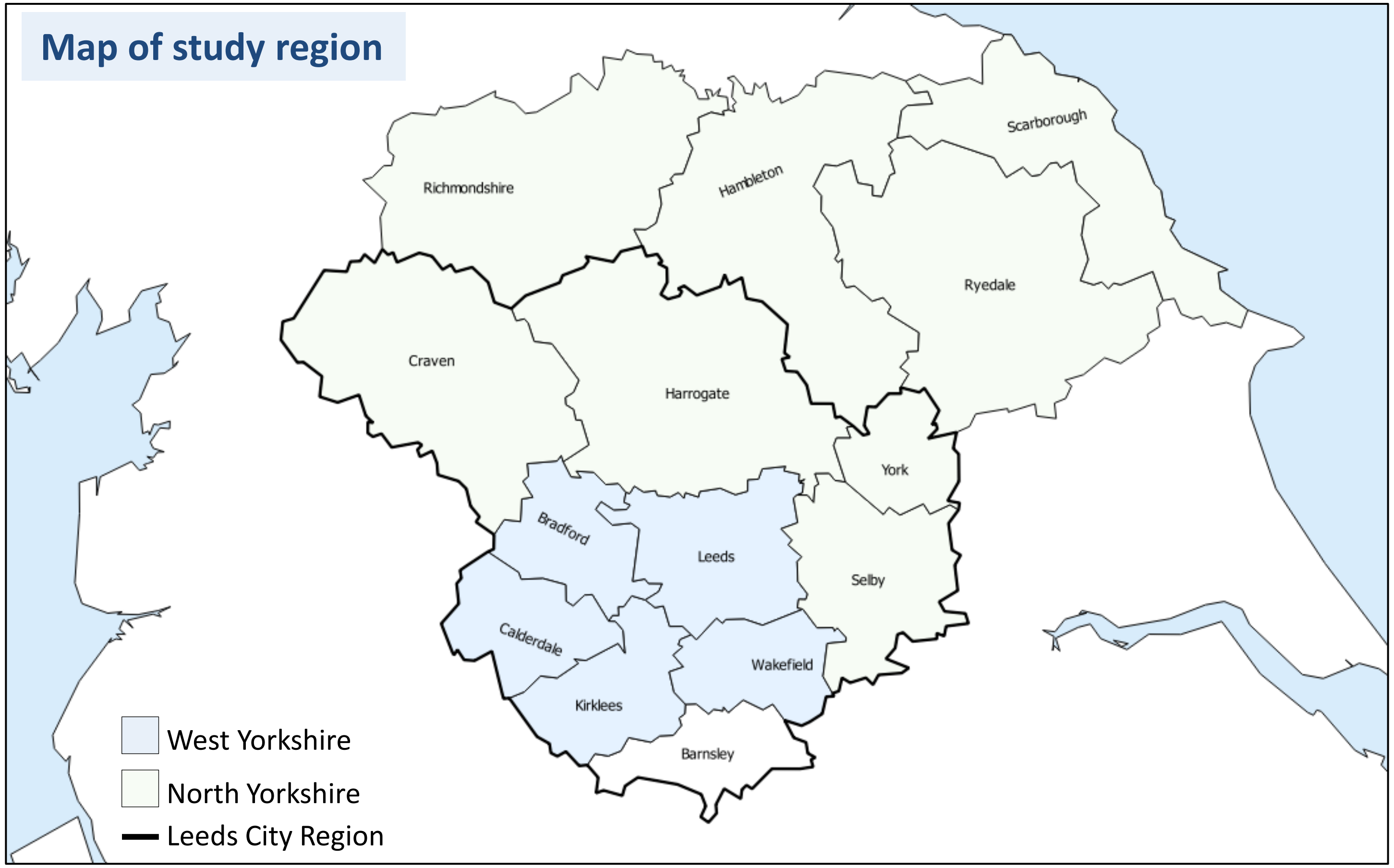
- Scope 3 emissions, including embedded emissions in product/service imports
- Emissions from power *generation* in the region are calculated, but the pathways only include emissions from regional electricity *consumption* at national carbon content[1].
- Emissions from shipping.
- Emissions offsetting outside region
- Circular economy and radical system changes are out of scope

*The modelling is based primarily on adjustments to the 'status quo' e.g. projected population growth, minimal change in industrial landscape, rather than radical changes in lifestyle or system function. There are some speculative/disruptive changes that may have implications further in the future.*

1 Scope suggested is similar to that of BEIS *'Emissions of $CO_2$ for LA areas dataset'*, however some additional emissions are included (aviation), the sectoral breakdown is different, LULUCF uses an updated methodology and agricultural non-CO2 emissions are included

# Geography: The full study region includes 14 Local Authorities, with varying decarbonisation ambition

Study region
West Yorkshire
Y&NY




The emissions reduction pathways were modelled for the study region as a whole (green and blue area) and disaggregated into the subregions - West Yorkshire, York and North Yorkshire (Y&NY) and Leeds City Region. This pack will present the key quantitative results for West Yorkshire and Y&NY separately, using the coloured tags on the left of slides to signpost which subregion is being presented.

# **Scenario Characteristics:** The emissions reduction pathways present a range of visions as to how the region can reach Net-Zero

Study region

## 1- Baseline

The baseline scenario represents the **likely outcome with current policies**.[1] There will be relatively low uptake of most technologies beyond 2025 in the absence of new policies, incentives and regulations.

## 2- Max Ambition

The Max Ambition scenario assesses how quickly the region could technically reduce emissions[2]. This will necessarily involve **significant electrification** of heat, transport and industry, supported by enabling technologies such as energy storage. Significant increases in low carbon power generation, with accelerated negative emissions technologies (e.g. BECCS) and ambitious forest planting rates.

## 3- High Hydrogen ($H_2$)

The high hydrogen scenario promotes **large-scale hydrogen and CCS roll-out.** The gas network is repurposed for $H_2$, enabling significant low carbon hydrogen use in buildings/heat, industry, power and transport. This is supported by land-use measures such as afforestation and bioenergy production; lower electricity system changes (production, distribution and storage) are required.

## 4- Balanced

The Balanced scenario encompasses a **balanced technology mix across sectors**, with contributions from hydrogen, electrification, bioenergy, CCS and decentralised energy production. This represents how technologies are deployed in parallel, with differing factors impacting their adoption, from location to price or consumer comfort.

BECCS – Bioenergy Carbon Capture and Storage; CCS – Carbon Capture and Storage; $H_2$ – hydrogen. 1. Current as of January 2020; note that the Baseline does not include targets, such as the petrol & diesel car ban, that are currently not fully funded/defined policy; 2 pathway reflects what is perceived to be the fastest realistic decarbonisation

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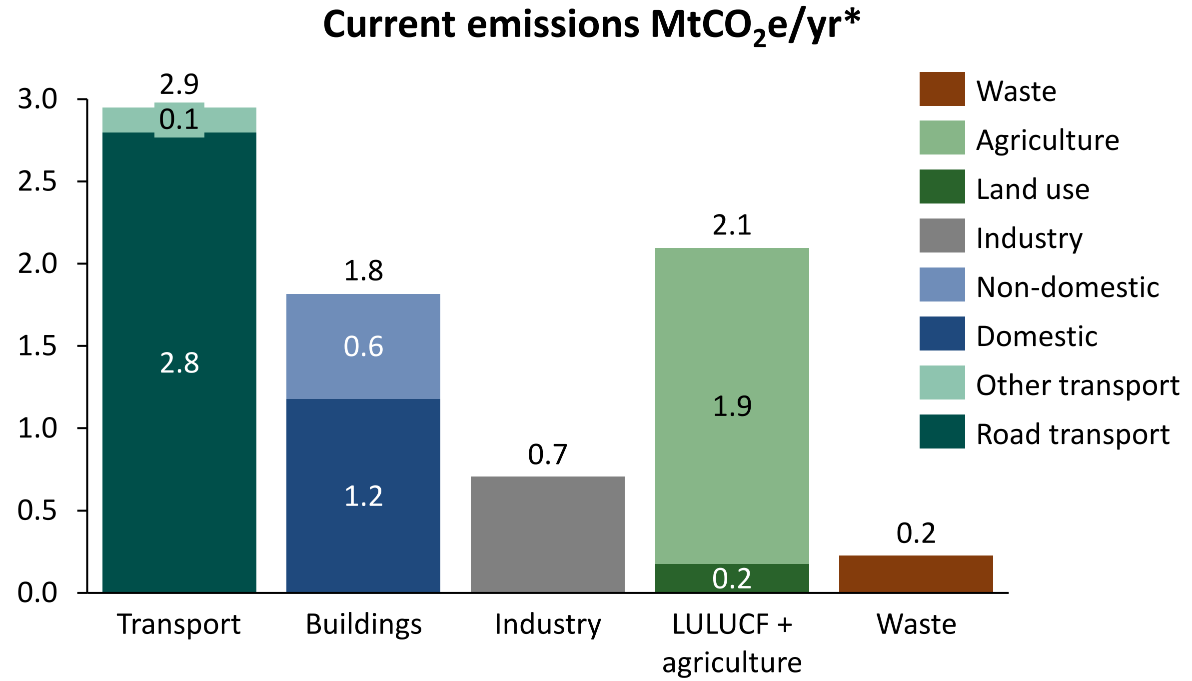
# **Current emissions by sector –** the largest contributions are from road transport, building heat and agriculture




- This graph shows the region's current emissions (2020), broken down into sectors and key subsectors. More detail within this is shown in the main report sectoral results.
- The scope of emissions included is greater than that in the local authority emissions datasets (see scope slide).
- Due to the rural nature of much of Y&NY, there are large contributions from agriculture and transport, and limited emissions from heavy industry.

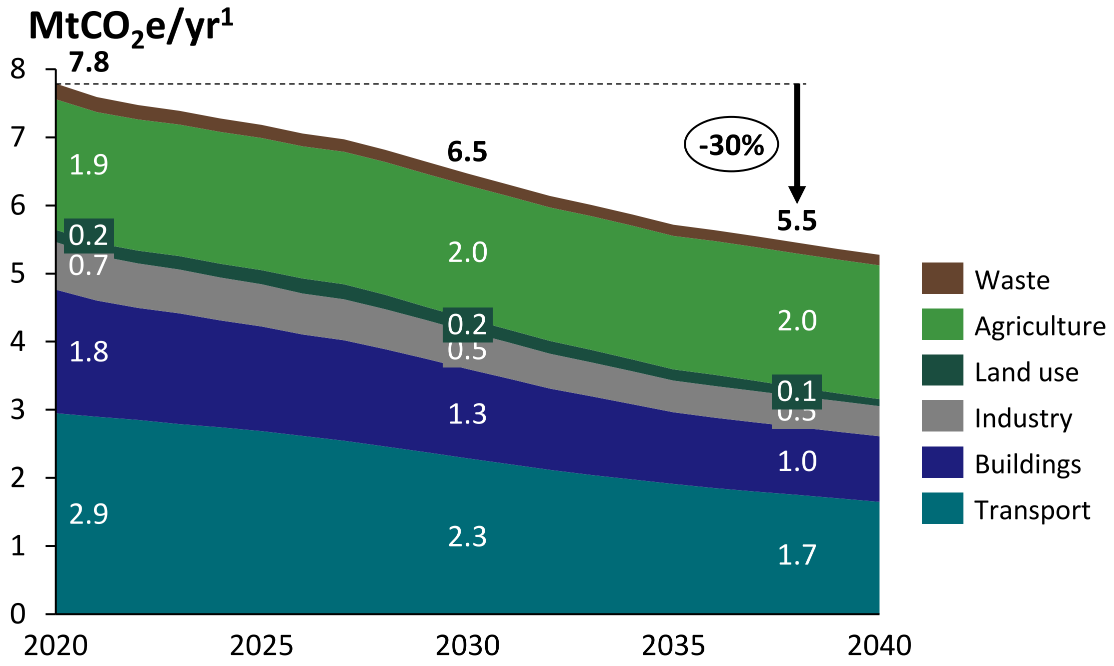
- Transport  is the largest emitting sector, with emissions currently dominated by road transport, primarily private vehicle use.
- Much of the emissions from buildings and industry are due to heat generation, primarily using natural gas and some oil. Electricity related emissions will be addressed through decarbonisation of the power sector.
- There is limited heavy industry in the region, mostly in Selby; the largest heavy industry sectors are food and drink and minerals.
- Land use, land use change and forestry (LULUCF) + agriculture emissions are high in the region, dominated by agricultural non-$CO_2$ emissions
- Most of current waste emissions are from landfill, followed by wastewater treatment processes.

**Note that the power sector is not explicitly shown in this graph or the following graphs, as this is included within the sectors consuming electricity. This aligns with the current UK government Local Authority accounting of emissions*.**



*National electricity carbon content used. Electricity carbon intensity nationally has dropped significantly (43%) between 2017 (latest LA emissions dataset) and 2020, reducing the emissions contribution of electricity use, mostly in buildings and industry. Other transport includes rail, aviation (domestic and international) as well as aircraft support vehicles and emissions from lubricants. $CO_2e$ is $CO_2$ equivalent, considering other GHG produced by combustion of fuels and in agriculture.

# **Baseline scenario** – slow progress results in around 30% emissions reduction by 2038



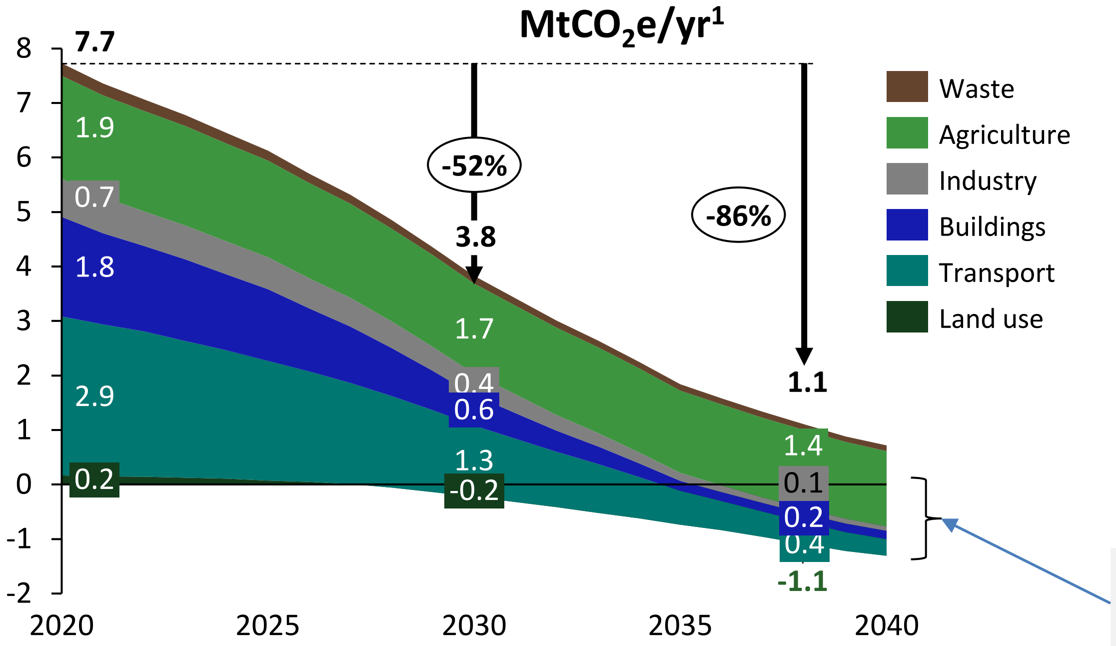

- This graph shows the region's emissions projection under the baseline scenario, divided into the contribution from each of the sectors. The numbers on the graph show the emissions in 2020, 2030 and 2038 for each sector and the total.
- **The baseline scenario sees a 30% reduction in emissions by 2038, with 5.5 $MtCO_2e/yr$ remaining in 2038.**
- All sectors see slow change due to lack of strong incentives for consumers and businesses to switch to low carbon heat, transport and other practices.

- The transport sector sees the most progress due to the faster development of technically ready and cost-effective solutions, leading to uptake of electric vehicles.[1]
- The majority of the emissions reduction in the buildings and industry sectors is due to **national renewable electricity** and some energy efficiency implementation. **There is slow uptake of low carbon heat** due to high cost, low awareness and consumer behaviour challenges.
- **Agricultural emissions grow due to population growth** and, in the land use sector, new forest planting continues at the current rate and makes a small contribution to reducing emissions.
- **Power sector (not shown[2]) almost doubles its emissions** due to deployment of a new unabated large-scale gas power plant, which runs to balance the grid.
- The remaining emissions in 2038 are still primarily in the transport and agriculture sector due to the rural nature of much of the region.
- Note that the power sector is not explicitly shown in this graph or the following graphs, as this is included within the sectors consuming electricity. This aligns with the current UK government Local Authority accounting of emissions.



1. Note that the Baseline does not include targets, such as the petrol & diesel car ban, that are currently not fully funded/defined policy .2 National electricity carbon intensity; no BECCS negative emissions included in the charts for clarity. The final emissions with BECCS inclusion are low as demonstrated in the scenario comparison.

# **Max ambition scenario** – highly ambitious roll out of electric vehicles, active travel, heat pumps and new forest planting makes rapid progress




- This graph shows the region's emissions projection under the Max ambition scenario, divided into the contribution from each of the sectors.
- The scenario sees an 86% reduction in emissions by 2038, with 1.1 $MtCO_2e/yr$ remaining in 2038. When BECCS negative emissions from Drax are included, the region reaches net zero in 2034 and by 2038 is considerably net negative (see later).
- All sectors see rapid change, requiring strong incentives for consumers and businesses to switch to low carbon heat, transport and other practices.

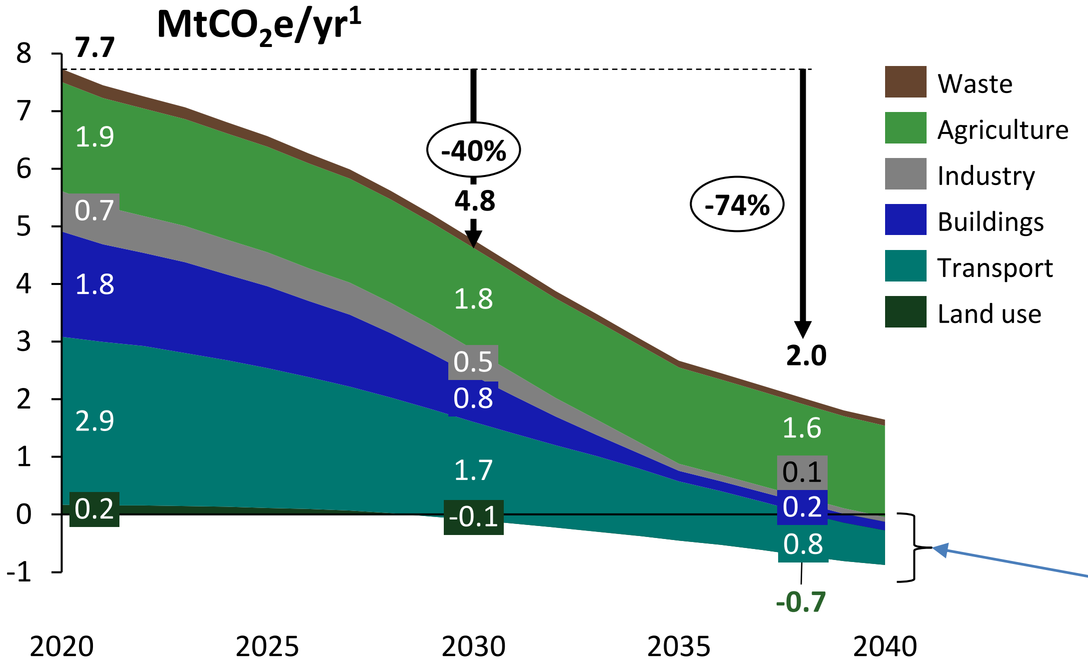
Land use emissions are negative, offsetting some residual emissions in other sectors

- The transport sector sees **rapid uptake of electric vehicles (EVs) alongside significant consumer and industry behaviour change** to reduce travel demand and to shift journeys from private cars to active and public transport.
- The buildings sector sees **highly ambitious roll out of heat pumps (270k domestic by 2038)** and heat networks, particularly between 2025-2035, and large-scale building efficiency retrofit in the 2020s.
- **Industry focusses on developing new technology** and switching to low carbon fuels (electricity, $H_2$, bioenergy)
- The power sector sees the **rapid roll-out of solar PV and onshore wind, as well as Carbon Capture and Storage (CCS)** on bioenergy and natural gas before 2030 to reach negative emissions (not shown[1]).
- Land use emissions rapidly drop to net-negative before 2030 due to **swift action in new forest planting** and peatland restoration. Agricultural emissions struggle to decarbonise in the timeframes, with significant emissions in 2038, however, the agriculture sector does play a crucial role in enabling land use emissions savings



1 National electricity carbon intensity; no BECCS negative emissions included in the charts for clarity. The final emissions with BECCS inclusion are lower.

# **High Hydrogen scenario** – widespread availability of hydrogen by 2030 enables deployment of hydrogen boilers and fuel cell vehicles



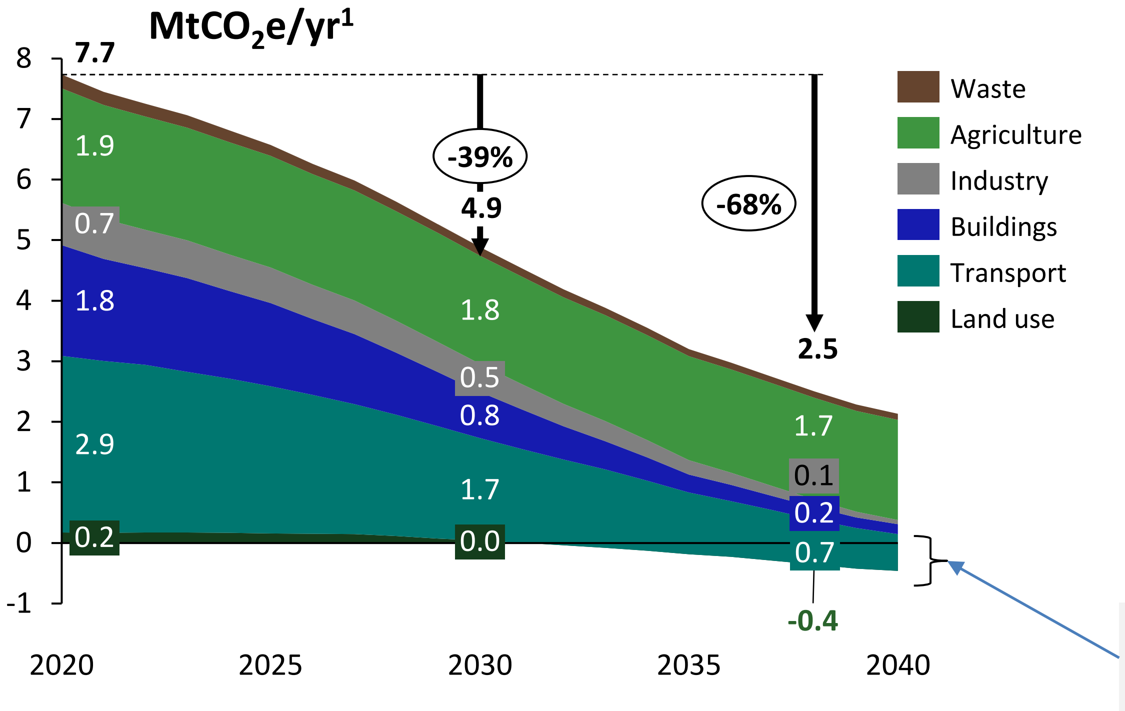

- This graph shows the region's emissions projection under the High $H_2$ scenario, divided into the contribution from each of the sectors.
- The scenario sees a 74% reduction in emissions by 2038, with 2.0 $MtCO_2e$/yr remaining in 2038.
- All sectors see rapid change, partially enabled by the **transition from natural gas to hydrogen**, used in hydrogen boilers, vehicles and power generation. Hydrogen conversion is a significant infrastructure challenge.

Land use emissions are negative, offsetting some residual emissions in other sectors

- The transport sector sees significant uptake of **hydrogen fuel cell vehicles**, particularly in the heavy goods vehicle and bus sectors during the 2030s, although battery electric vehicles still form a significant share of the vehicle fleet. Shift of journeys to active and public travel occurs more gradually between 2020-2038.
- The **buildings and industry sectors rely heavily on the conversion of the natural gas grid to hydrogen** from 2028 to supply low carbon heat. In the 2020s hybrid heat pumps and energy efficiency are implemented, and by 2038 there are over **180k homes heated by hydrogen**.
- The power sector sees **implementation of CCS** on bioenergy (BECCS is not shown[1]) and natural gas, as well as the **implementation of hydrogen fired gas turbines**.
- Land use emissions become net-negative around 2030 due to **swift action in new forest planting and peatland restoration**, but at a slower rate than the Max ambition scenario.
- The scenario relies on the deployment of CCUS and hydrogen at large scale, aligned with the government's 10 Point Plan, but there is still considerable uncertainty over the timeframes and the exact nature of their role in the energy system.

1 National electricity carbon intensity; no BECCS negative emissions included in the charts for clarity. The final emissions with BECCS inclusion are lower.

# **Balanced scenario** – the mix of technologies and fuels allows greater choice, with areas differing in their characteristics



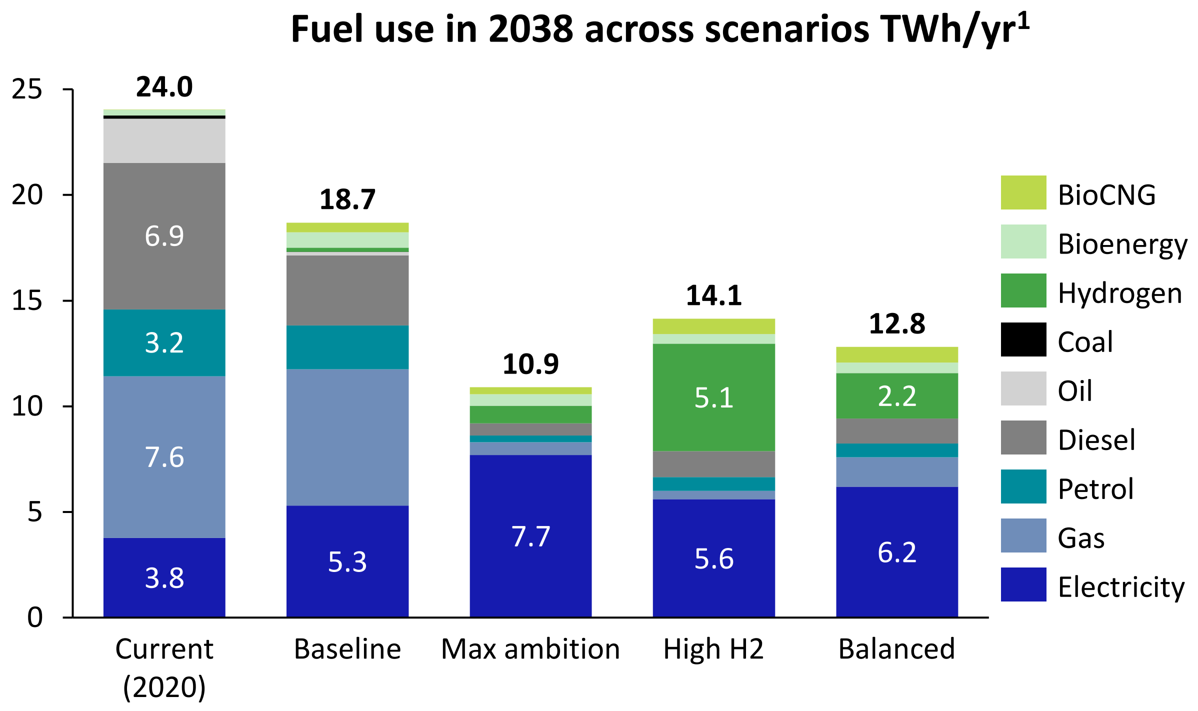

- This graph shows the region's emissions projection under the Balanced scenario, divided into the contribution from each of the sectors.
- The scenario sees a 68% reduction in emissions by 2038, with 2.5 $MtCO_2e/yr$ remaining in 2038.
- The pathway sees significant electrification of heat and transport, but also introduction of hydrogen in areas of the gas grid enabling hydrogen boilers.
- Progress is slower than the other scenarios, particularly in the land use sector, representing the uncertainty in feasible rates of deployment.

- The transport sector sees a mixed rollout of hydrogen and electric vehicles across vehicle types, alongside ambitious behaviour change.
- The **buildings and industry sectors rely on a mixture of hydrogen heating technologies and heat pumps**, due to the **partial nature of gas grid conversion to hydrogen**; the remaining areas of the gas grid remain a blend of natural gas and biomethane.
- The power sector sees implementation of **significant solar PV and onshore wind, as well as BECCS and CCS** on natural gas turbines.
- The **land use sector sees less progress due to slower rates of forest planting, peatland restoration and agroforestry** being achieved. This means the sector contributes less negative emissions and doesn't come close to offsetting the remaining agricultural emissions.



1 National electricity carbon intensity; no BECCS negative emissions included in the charts for clarity. The final emissions with BECCS inclusion are lower.

# **Scenario energy** – the pathways rely on differing fuel mixes to reach their goals




- This graph compares the fuel demand across the scenarios by fuel type. This includes the fuel required for all sectors[1]. The numbers at the top represent the total fuel demand.
- In 2020, the fuel mix is primarily fossil fuel, with a small amount of electricity.
- All emissions reduction scenarios see significant reduction in the total amount of fuel required, due to increased technology efficiency as well as energy demand reduction measures.
- The transport and buildings sectors are the key components of the energy usage.

- By 2038, the scenarios rely on predominantly electricity or hydrogen, depending on the choices made.
- The Max ambition scenarios sees electrification of heat and transport, leading to a **102% increase in electricity demand between 2020 and 2038**. There is limited hydrogen and bioenergy use.
- In the High hydrogen scenario, with hydrogen widely available in the gas grid, 36% of fuel demand is hydrogen. The increase in electricity demand is only 46%.
- The balanced scenario sees a mix of fuels, with large amounts of electricity, but also hydrogen, bioenergy and some gas grid usage (including biomethane blending).

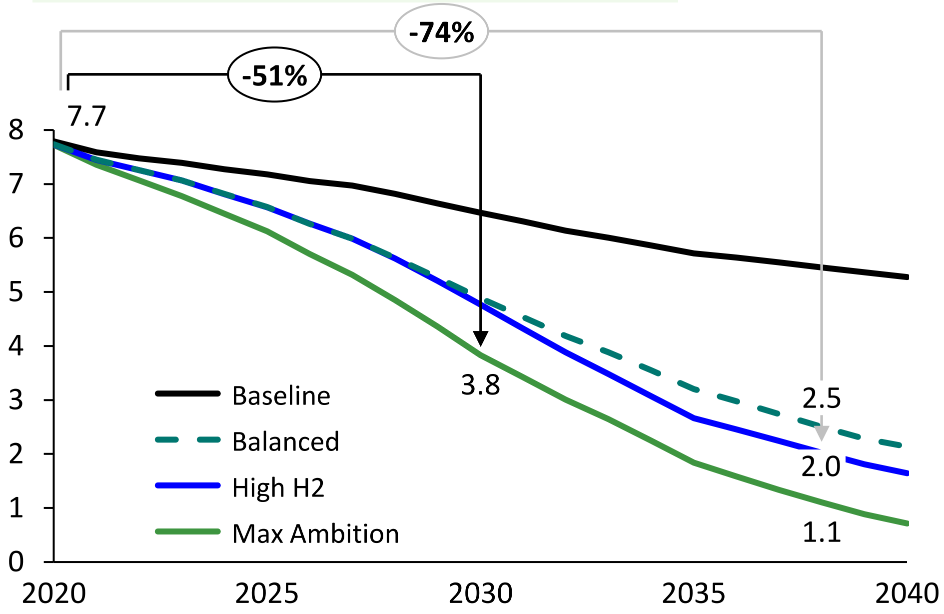


1 Aviation fuel is not included as this is not attributed to specific subregions; bioenergy is bio-LPG and biomass in buildings and industry, but excluding power as per other graphs; gas is from the gas grid, a blend of natural gas and biomethane

# **Scenario emissions trajectory** – emissions reductions occur at different rates across the scenarios due to differing choices

### Pathway emissions $MtCO_2e/yr$[1]

National electricity carbon intensity, no BECCS




- This graph compares the emissions trajectories across the scenarios[1]. All pathways make ambitious emissions reductions over the next 2 decades, using different technologies, measures and fuels.
- Without BECCS negative emissions (see next slide) no pathway reaches net-zero and the emissions remaining in 2038 are 1.1 – 2.5 $MtCO_2e/yr$ depending on the scenario.
- The key differences between the scenarios are the technology choice, level of electrification vs hydrogen in heat and transport and rate of technology deployment and behaviour change. More details can be found in the main report and Technical Appendix on the underlying assumptions.

- **The Max ambition scenario makes considerably more progress by 2030**, due to ambitious rates of electric vehicle roll-out and uptake of active travel,[2] unprecedented heat pump installation and faster rates of forest planting. Despite this, the emissions are still 49% of the current emissions by 2030, with challenges including misalignment with national policy timing, technology readiness, behaviour change and stock turnover rates.
- The High $H_2$ and Balanced scenarios make less progress in the next few years, but progress accelerates from the mid-2020s. **The High $H_2$ scenario sees rapid emissions reductions 2028-2035 as the gas grid is repurposed** for hydrogen, facilitating the switch of buildings, industry and some transport to hydrogen. The Balanced scenario sees steady progress through a mix of technologies deploying at different rates.



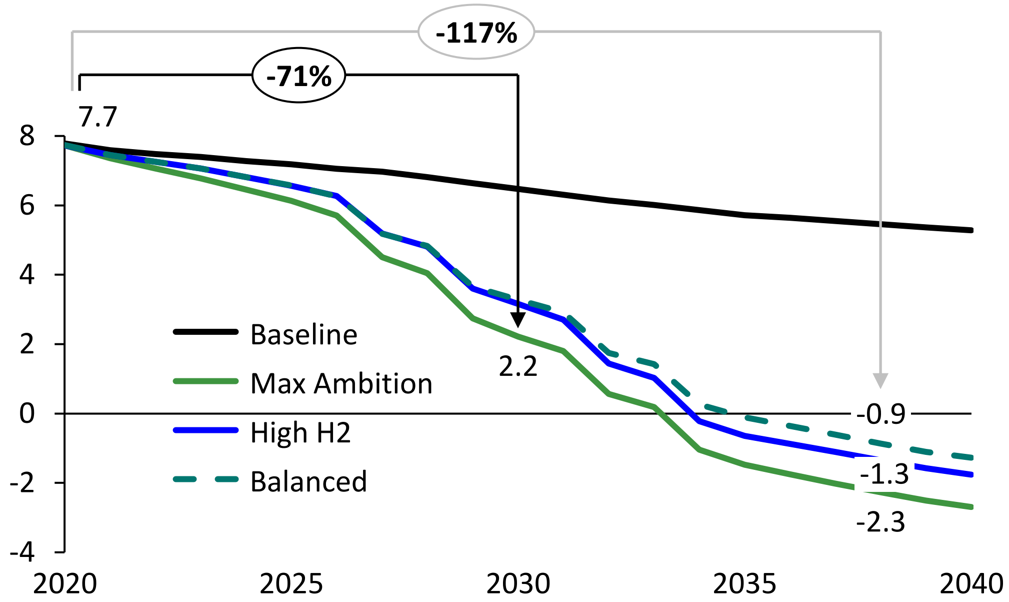
1 excluding negative emissions from BECCS. National electricity carbon content is chosen for electricity consumed in the sectors to align with current GHG reporting, and regional power sector emissions are therefore not included. 2. See further discussion slide for impact of petrol and diesel ban date on the findings of this study.

# **Net-zero point** – negative emissions is required to meet net-zero targets in the region by offsetting remaining emissions

- This graph compares the emissions trajectories across the scenarios, WITH the inclusion of 20% of the negative emissions from Drax BECCS plant[1,2].
- BECCS allows negative emissions as the $CO_2$ is removed from the atmosphere as the bioenergy grows, but on combustion of the bioenergy the $CO_2$ is then trapped and stored through CCS, leading to a net reduction in the $CO_2$ in the atmosphere.
- With BECCS accounted for, the Max ambition pathway reaches net-zero by 2034 and the other scenarios follow within the next few years.
- By 2038 the pathways have reached -0.9 to -2.3 $MtCO_2e/yr$ in negative emissions.

**Pathway emissions $MtCO_2e/yr$**

National electricity carbon intensity, with 20% Drax negative emissions

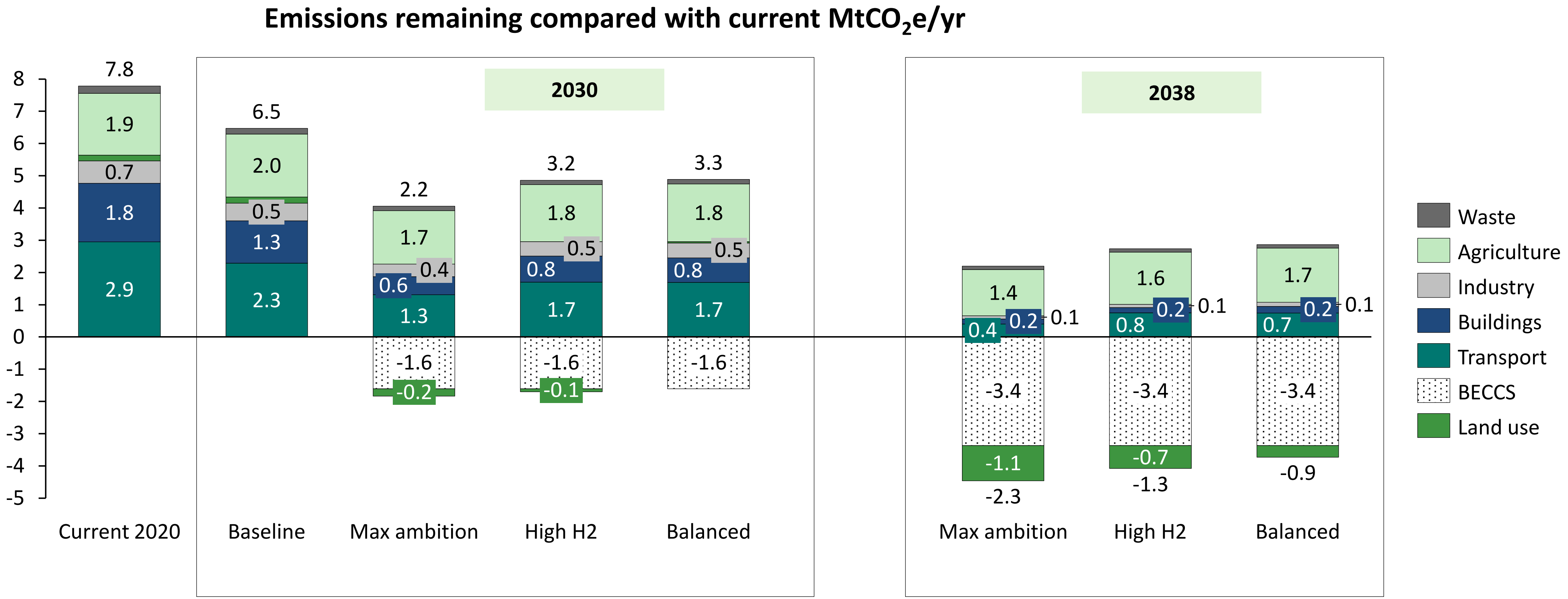



- Drax is currently planning to implement CCS before 2030, retrofitting two of its four bioenergy turbines by this point. However, there is significant uncertainty over the timeframes as there is currently no firm policy and funding support for the CCS infrastructure. Therefore, delays to these plans would jeopardize the region's net-zero plans and timeframes.
- The land-use sector also provides negative emissions through new forest planting activities, which remove $CO_2$ from the atmosphere to store it in the woodland. This is already accounted for in all graphs and new forest planting roughly offsets the remaining emissions from the agriculture sector at its most ambitious rates.

Y&NY

1 BECCS: Bioenergy Carbon Capture and Storage, NET Negative emissions technology 2 The net-zero date is highly sensitive to the % BECCS selected; 20% is used as it is the proportion of generated electricity in N Yorkshire that is consumed in NY in the Max ambition pathway by 2040

# **Remaining emissions** are significant in 2030 across sectors, but by 2038 these have reduced and are offset by negative emissions




- In 2030 there are significant emissions remaining, particularly in agriculture, transport and buildings. A key challenge in buildings and transport is the stock turnover rate, and in agriculture is the time taken for both change (e.g. diet change) and for changes to take effect.
- In 2038, the majority of remaining emissions in Y&NY come from agriculture. Remaining emissions are more than offset by negative emissions to provide a net-negative region for all scenarios.
- More detail on the subsector contribution to remaining emissions can be found in the main report.

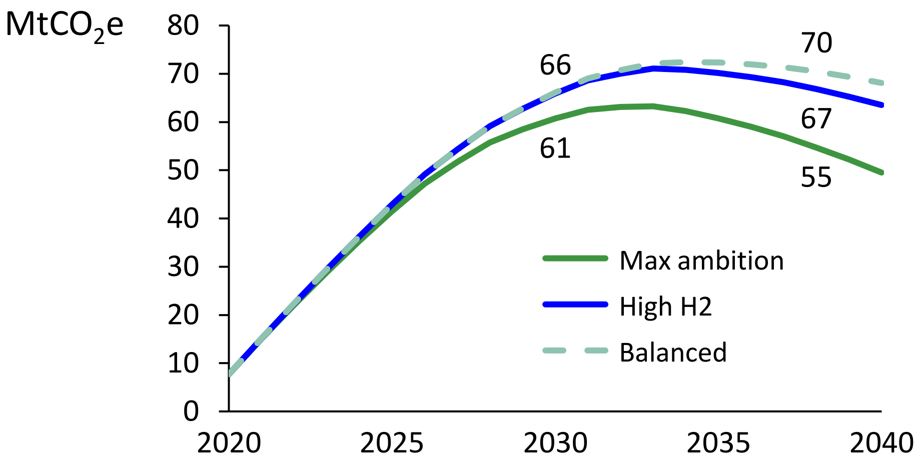


BECCS – bioenergy carbon capture and storage

# Cumulative emissions reach a peak in the early 2030s before reducing due to rapid progress and BECCS implementation

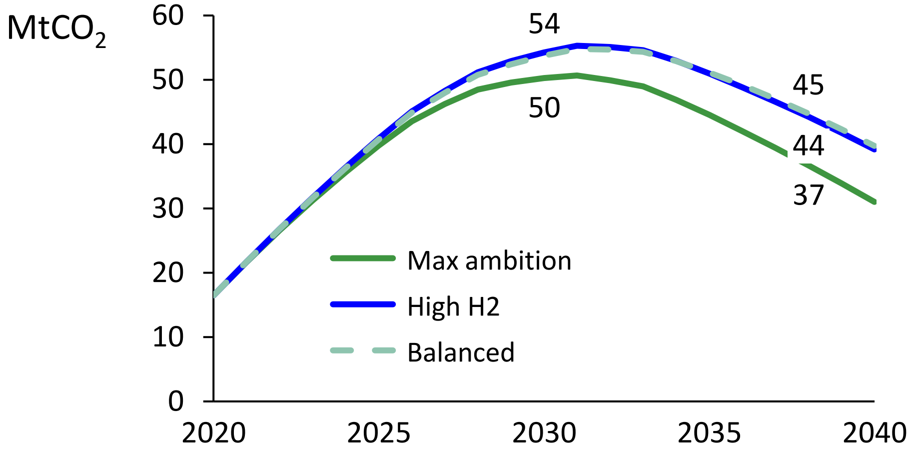
## Cumulative emissions $MtCO_2e$

From 2020 including all emissions in the study scope




## Cumulative emissions $MtCO_2$

From 2018, broadly following Tyndall Centre emissions scope[1]




- From a climate perspective, the net cumulative $CO_2$ emitted is the key factor, as this is the $CO_2$ contributing to global warming. The cumulative emissions of all scenarios rise rapidly during the 2020s, but then flatten around 2030 as interventions slow emissions and as BECCS is implemented.
- For all emissions (left), the **region reaches 55 – 70 $MtCO_2e$ cumulatively by 2038** depending on the scenario.
- The Tyndall Centre developed a science-based carbon budget for the region based on compliance with the Paris Agreement. The cumulative $CO_2$ budget is related to the energy system only and excludes land use, agriculture, aviation, waste and non-$CO_2$ emissions[1]. Under these conditions, the Y&NY net cumulative carbon emissions are 37 – 45 $MtCO_2e$ by 2038 depending on the scenario.
  - N+W Yorkshire's carbon budget is 134 $MtCO_2$ 2018-2100, and **the combined region breaches this in 2027, but cumulative net emissions fall in the 2030s** (due to negative emissions measures).



1 Cumulative carbon budget work is approximate, as Element modelling is not set up for the specific conditions of the Tyndall Centre carbon budgets.

# Y&NY could be net negative by 2034, saving 7 $MtCO_2e$/yr over baseline, if highly ambitious interventions are achieved

Y&NY is more rural than many areas of the UK, with lower emissions from buildings and industry, but larger % of emissions from agriculture and transport. The region faces specific challenges around private car use, off-gas homes and agricultural emissions. However, it has a key opportunity in negative emissions from forest planting and Bioenergy use with CCS (BECCS).

- **York and North Yorkshire could be a net negative region by 2034[1],** saving 6.9 $MtCO_2e$/yr over baseline, if an ambitious strategy is deployed immediately, backed by strong policy.
- Cumulative emissions[2] reach 61 $MtCO_2e$ by 2034 in the Max ambition scenario then begin declining, enabling a **cumulative emissions saving of 71 $MtCO_2e$ by 2038 over the baseline scenario**.
- None of the scenarios reach net-zero in the 2030s without contributions from negative emissions and CCS. **Without CCS, the annual emissions in 2038 are 3.4 $MtCO_2e$/yr higher** and the cost to heat buildings is over £0.5 billion higher cumulatively in the High hydrogen scenario.
- **The Max ambition scenario has the lowest cumulative and annual emissions, but requires highly ambitious leadership** and policy to drive extensive change across the economy. Support will be required from national government, both in terms of policy and funding, as well as upgrades to the regional electricity infrastructure.
- **The scenarios take different trajectories as the timing of actions differ**. For example, Max ambition begins electrification early, whereas the High $H_2$ accelerates progress in the late 2020s as hydrogen is deployed.
- **Key challenges include:** misalignment with national policy timing; rapid building of technology supply chains, skills and infrastructure; enabling consumer awareness, behaviour change and acceptance.
- Decision makers must consider a wide range of factors when comparing the pathways, such as climate, air quality, economic factors, employment, risks and deliverability, consumer impact and acceptance.
- **Key evidence must be gathered** in the next few years around remaining uncertainties. For example: viability, feasibility and consumer perception of hydrogen for heat; real world performance of new technologies; national policy changes; land availability for new infrastructure, land use measures and solar PV.



1 Assuming 20% Drax BECCS negative emissions; 2 emissions in study scope, from 2020.

# **The scale of the challenge –** what must happen by 2038 to achieve the level of emissions reduction in the Max ambition scenario?

## Transport

Sales of zero emissions cars reach ca. 20,000/yr by 2038

Walking increases by 50% and cycling increases 9x compared to today

Public transport capacity doubles compared to today

## Buildings and industry

Retrofit of 250k homes to reach EPC C or better (reduced thermal energy demand)

270k heat pumps installed (62% homes), or 58/day from 2025-2035

Hydrogen equipment developed and deployed for industry

## Land use and agriculture

100% peatland restored to minimise emissions

Forest area almost doubles, reaching 91 kha

Diet change to reduce meat and dairy consumption by 32%. 24% reduction in cattle and sheep numbers.

## Power

Solar PV and onshore wind reach 2960 MW (175 MW/yr from 2020-2030)

CCS deployed at scale from 2027 enabling BECCS (-17 $MtCO_2$/yr, 2038)

Electricity infrastructure investment enabling 102% higher annual demand

# Contents

# The outcomes of the emissions pathways modelling have been used to define roadmaps for implementation and key policies and actions that the regions can take have been identified

The emissions pathway modelling defined the scale of action required to reduce emissions in each region across three possible scenarios. To empower the regions to take appropriate, targeted action to deliver their climate ambitions, these findings were used to develop the following tools:

- **Implementation roadmaps** – outcomes from the emissions pathway modelling was used to identify key implementation timescales and activities to support delivery of the pathways, and milestones by which to monitor progress
- **Policies and action plans** – best practice examples and outcomes from wider consultation run by WYCA and YandNY LEP were used to identify policies for each sector that the regions can take towards delivering the modelled pathways and sectoral action plans for delivering these measures

Across each sector, key recommendations have been developed which identify:

- **Top priority** – outcomes that deliver benefits early and/or support all scenarios, that WYCA, YandNY LEP and the local authorities have highest influence to deliver
- **Short-term actions** – low regrets actions that support the top priority outcome and delivery of future actions, including strategy-setting and evidence gathering
- **Medium-term decisions** – decisions that will support the choice and rate of progress along the future emissions reduction pathways
- **Long-term options** – future actions that can be taken to refine the regions' approach in response to progress and future national developments

This report focusses on the role of West Yorkshire Combined Authority (CA), the Local Enterprise Partnership (LEP) and the North Yorkshire County Council in supporting the net-zero transition. This role ranges from strategic planning and coordination, to funding programmes and consumer campaigns. It is important to note that:

- The regions will still be **reliant on strong national policies** to achieve their goals and deploy many of the recommended policies
- The CA/LEP will **need additional resource (designated staff) and funding** to deploy these policies and take crucial actions

**1 Emissions pathways**

Modelled pathways based on deployment of emissions reduction measures

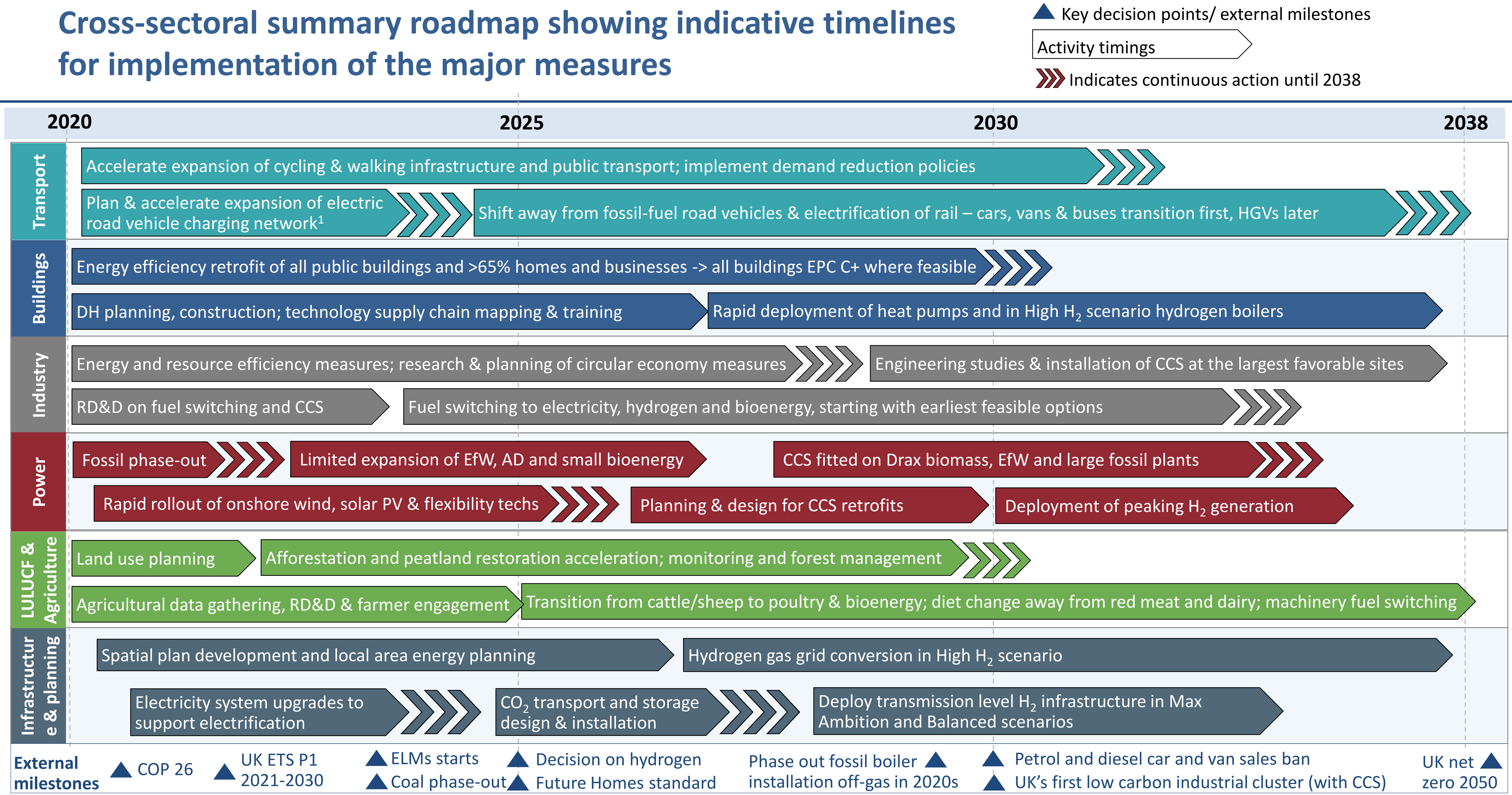
**2 Implementation roadmap**

1. Timeline of key implementation milestones to 2038
2. Key decision points to enable delivery along each pathway
3. Qualitative indication of infrastructure requirements

**3 Policies and action plan**

1. Identification of short-term, medium-term and long-term actions and policies to deliver emissions reduction
2. Barriers and co-benefits
3. Roles of different stakeholders

# Cross-sectoral summary roadmap showing indicative timelines for implementation of the major measures




Acronyms: CCS: carbon capture and storage; H2: hydrogen; DH: district heating; EfW: energy from waste; AD: anaerobic digestion; ICE: internal combustion engine; HGV: heavy goods vehicle; EPC: energy performance certificate; RD&D: research development and demonstration; ETS: emissions trading system; ELMs: environmental land management scheme

Note: timings are indicative due to simplification – please see sectoral roadmaps for more detail; 1. Expansion of charging network will continue beyond 2025

# Key recommendations – York and North Yorkshire

*Note that while these are selected as key actions due to their importance in delivering key measures for emissions reductions, there are other essential actions outside these that must be taken to deliver the pathways*

| | Transport | Buildings | Land use and agriculture | Power and industry |
|---|---|---|---|---|
| **Top priority** | Reduce car use through modal shift and demand reduction | Reduce energy demand through energy efficiency | Ensure local land use priorities are met by setting the strategy | Support planning for CCUS & hydrogen technologies and infrastructure |
| **Short term actions** | • Improve cycling and walking infrastructure<br>• Explore bus Partnership<br>• Invest in digital infrastructure<br>• Expand electric vehicle charging network<br>• Work with partners to limit road building and decarbonise rail | • Set up a 'One-stop shop' to help consumers decarbonise<br>• Retrofit existing LA buildings and put in place policy for wider building stock[1]<br>• Implement heat networks<br>• Influence Government to deliver planning policy and heat strategy | • Complete spatial land strategy<br>• Gather data and evidence on optimal local LULUCF solutions<br>• Develop food waste strategy<br>• Influence Government to develop ELMs in a way that supports locally-relevant measures | • Complete regional energy planning, including solar PV<br>• Setup green public procurement programme<br>• Financial scheme for efficiency, renewables, RD&D.<br>• Influence government to support CCUS/hydrogen infrastructure |
| **Medium term decisions** | • Level of financial support for vehicle uptake and modal shift<br>• Role and level of support for shared mobility, including on-demand services | • Level and focus of financial support for energy efficiency and technology uptake<br>• Heat zoning policy need<br>• Role of $H_2$ for heat | • Level and focus of financial support<br>• Strength of public messaging around diet change | • Role of CCS vs hydrogen vs electrification or renewables<br>• Level and focus of financial support for fuel switching |
| **Long term options** | • Stronger regulatory and financial incentives<br>• Support rollout of innovative technologies (inc. $H_2$ trains) | • Stronger regulatory and financial incentives<br>• Public-led business models for communal and district heating | • Stronger regulatory and financial incentives<br>• Support innovative technologies and techniques | • Stronger regulatory and financial incentives<br>• Support novel technologies e.g. Direct Air Capture, DSR |

CCUS: Carbon Capture Utilisation and Storage, DSR: demand side response, ELMs: Environmental Land Management Scheme, LULUCF: Land use, land use change and forestry.

Link to contents

1. The County Council and the local authorities have greater influence and control over Retrofit of LA buildings and social housing, whereas facilitating private rented and owner-occupier homes will require a mix of regulation and incentives

# Action to achieve decarbonisation must start now, but the choice of longer-term pathway relies on further local evidence and developments at national level

**2020** → **Priority Actions & Evidence** → **2025 at latest** → **Max implementation of policy** → **2030** → **Adjustment and enhancement** → **2038**

## Priority Actions & Evidence (2020 – 2025 at latest)

① **Short-term action** should focus on driving ambitious change while keeping options open and gathering the evidence needed to support longer-term decisions.

- **Priority actions –** actions that are common to all pathways, are relatively low-cost, and deliver relatively large benefits. For example:
  - Accelerate **decarbonisation of public assets**
  - Deliver measures to drive **behaviour change**
  - Set **spatial strategies** to ensure common framework and alignment across the region and across all sectors
  - **Fund and support** rollout of mature technologies
- **Evidence gathering –** deliver trials and detailed studies, and engage with stakeholders to help the region to understand local feasibility of technologies and measures. For example:
  - **Deliver demonstrator projects** for high building energy efficiency and low carbon heating technology
  - **Determine local feasibility** for freight consolidation and traffic control measures
  - **Gather data on local land use** and farming practices so that appropriate local targets can be set

② **Decision on pathway** – use learnings from short-term actions and take account of national developments to decide level of ambition and focus of regional support

## Max implementation of policy (2025 – 2030)

③ **Medium-term action** should implement regional policy in-line with agreed ambition and priorities

**Max ambition – Deliver many or all highest ambition policies, with focus on rapid[1] progress (highest cost and risk)**

- Maximum level and rate of behaviour change
- Maximum rate of technology change, primarily electrification
- Maximum deployment of land use and agriculture mitigation measures

**High Hydrogen – Deliver many high ambition policies, with a focus on hydrogen (high cost and risk)**

- High level and rate of behaviour change
- High level and rate of technology change, with maximum uptake of hydrogen
- High deployment of land use and agriculture measures

**Balanced – Deliver many high ambition policies, with mix of targeted interventions (high cost and risk)**

- High level and rate of behaviour change
- High level and rate of technology change, with selected support for hydrogen
- Medium deployment of land use and agriculture measures

## Adjustment and enhancement (2030 – 2038)

④ **Long-term action** should monitor progress and adjust approach based on outcomes and national developments

Adjust approach and implement further measures where necessary, for example:

- Adjustment of strategies based on achieved level of deployment and changes in National Policy – e.g. balance between behaviour change and technology change, change focus of incentives
- Stronger regulatory measures to encourage uptake
- Stronger financial incentives for technology uptake
- Incorporating innovative technologies and techniques
- Adjustment of training programmes to meet skills shortages

1. The Max ambition pathway targets the fastest feasible rate of decarbonisation, with a focus on delivering as many emissions savings as possible by 2030 but necessarily relies on currently mature technologies

# Action plan – Transport

**Key[1]**
Policy with higher significance for WY
Policy with higher significance for YNY

2020 | Priority Actions and Evidence | 2025 at latest | Max implementation of policy | 2030 | Adjustment and enhancement | 2038

**Priority Actions (common across pathways)**
- Develop an overarching strategy for road space reallocation
- Develop a region-wide parking strategy, including reducing on-street parking, banded parking charges and workplace parking levies
- Develop and implement a region-wide cycling and walking strategy and accelerate development and implementation of LWCIPs
- Develop a regional electric vehicle charging infrastructure strategy, including a procurement framework
- Expand reach and control over bus offering, e.g. through considering bus franchising or an Enterprise Partnership
- Implement flexible and integrated ticketing across transport services
- Invest in digital infrastructure
- Run a major publicity campaign to encourage behaviour change
- Invest in training to develop local skills in zero emission technology
- Influence Government to deliver policy that supports climate ambition
- Work with partners to limit road building and decarbonise rail

**Evidence gathering (in parallel with priority actions)**
- Assess local suitability of implementing traffic control measures such as zero emissions zones, traffic circulation plans and 20mph limits
- Assess local feasibility of freight consolidation and cycle freight in key delivery locations
- Assess feasibility and demand for passenger and freight rail services to determine capacity upgrade and develop strategy
- Support and deliver trials of innovative services and shared mobility
- Work with LAs to establish how best to use local planning policy to incentivise delivery of measures
- Engage with local fleets to understand their plans and raise awareness
- Engage with key stakeholders to understand plans for gas in transport
- Assess National Government support, priorities, and regulation

**Decision on pathway by latest 2025**

**Max ambition**
- Strong local and regional policy to support modal shift and technology change
- Maximum rate of expansion of active travel infrastructure, public transport services and chargepoint network
- Strong financial incentives offered to facilitate maximum rate of modal shift and zero emission vehicle uptake
- Rapid conversion of public fleets to zero emission vehicles
- Engagement with NPg to ensure electricity grid capacity upgrades are delivered to support transition

**High Hydrogen**
- Strong local and regional policy to support modal shift and technology change
- High rate of expansion of active travel infrastructure, public transport services and charging infrastructure
- Some financial incentives offered to facilitate high rate of modal shift and zero emission vehicle uptake
- Rapid conversion of public fleets to zero emission vehicles
- Engagement with NGN and fleet operators to ensure $H_2$ refuelling station rollout in region to meet demand

**Balanced**
- Strong local and regional policy to support modal shift and technology change
- High rate of expansion of active travel infrastructure, public transport services and charging infrastructure
- Some financial incentives offered to facilitate high rate of modal shift and zero emission vehicle uptake
- Rapid conversion of public fleets to zero emission vehicles
- Engagement with NGN to align targeted $H_2$ refuelling rollout, and NPg to ensure targeted electricity upgrades

Evaluate progress and implement further measures where necessary, for example:
- Adjustment of strategies based on achieved level of deployment and changes in National Policy
- Stronger regulatory measures to encourage uptake, such as through local planning requirements (if possible)
- Stronger financial incentives for technology uptake (e.g. scrappage schemes) , including support for HGV fleets
- CA/LEP-supported decarbonisation of rail, where feasible
- Support for rollout of innovative technologies and techniques, such as vehicle-to-grid, smart systems and $H_2$ fuel cell trains (as appropriate)
- Adjustment of training programmes to meet skills shortages

1. Policies with higher relevance for urban areas, such as traffic flow measures, parking restrictions, and freight consolidation, are considered more relevant for WY

# Action plan – Buildings

2020 → Priority Actions and Evidence → 2025 at latest → Max implementation of policy → 2030 → Adjustment and enhancement → 2038

**Priority Actions (common across pathways)**

- Set up a 'One-stop shop' for energy efficiency and low carbon heating
- Develop a regional retrofit strategy for existing LA buildings and begin implementation
- Decide appropriate incentives and regulation to drive decarbonisation of private-rented and owner-occupied sectors
- Develop a regional district heat network strategy, including heat zoning policies
- Initiate new low carbon heat network schemes
- Develop a combined solar PV and battery storage offer
- Implement training programmes in energy efficiency retrofit and low carbon heating installation
- Influence Government to deliver policy and support that supports climate ambition

**Evidence gathering (in parallel with priority actions)**

- Identify skills shortages and gaps in the workforce
- Initiate exemplar and demonstrator projects for high energy efficiency buildings and low carbon heating technology to better understand viability in the local context
- Explore the most appropriate solutions for hard-to-decarbonise homes in the region
- Explore rooftop solar opportunity in the region
- Work with LAs to establish how best to use local planning policy to incentivise delivery of measures
- Engage with key stakeholders to stay informed of $H_2$ developments
- Assess National Government support, priorities, and regulation

**Decision on pathway by latest 2025**

**Max ambition**

- Strong local and regional policy support for energy efficiency, heat networks and electrification of heat
- Maximum retrofit of public sector buildings
- Strong financial incentives offered to facilitate maximum rate of energy efficiency retrofit and heat pump uptake in private sector[1]
- Rapid deployment of district heating networks, either CA/LEP led or in public-private partnership
- Engagement with NPg to ensure electricity grid capacity upgrades are delivered to support transition

**High Hydrogen**

- Strong local and regional policy support for hydrogen transition ($H_2$ boilers, hybrid heat pumps, heat pumps in off-gas properties)
- Maximum retrofit of public sector buildings
- Financial incentives in place to support early deployment of hy-ready boilers and hybrid heat pumps (on-gas), and heat pumps (off-gas) among homeowners, businesses and landlords
- Rapid deployment of district heat networks
- Lower and/or more targeted incentives for energy efficiency
- Engagement with NGN to ensure rapid $H_2$ rollout in region

**Balanced**

- Strong local and regional policy support for all appropriate measures
- Maximum retrofit of public sector buildings
- Financial incentives offered to support all types of heating as appropriate, and to drive high levels of energy efficiency retrofit by 2034
- Rapid deployment of district heat networks
- Engagement with NGN to align targeted $H_2$ rollout, and NPg to ensure targeted electricity upgrades

Evaluate progress and implement further measures where necessary, for example:

- Adjustment of strategies based on achieved level of deployment and changes in National Policy
- Stronger regulatory measures to encourage uptake, such as through local planning requirements (if possible)
- Stronger financial incentives for technology uptake (e.g. scrappage schemes) and energy efficiency
- Support for rollout of innovative technologies and techniques, such as battery-to-grid and smart systems
- Adjustment of training programmes to meet skills shortages
- Development of public-led business models for communal and district heating

1. Homeowners, private landlords and businesses

# Action plan – Power

**Key**
Policy with higher significance for YNY

2020 | Priority Actions and Evidence | 2025 at latest | Max implementation of policy | 2030 | Adjustment and enhancement | 2038

**Priority Actions (common across pathways)**
- Complete regional spatial energy planning including determining favourable sites for generation (especially onshore wind), storage technologies and infrastructure development.
- Support infrastructure investments by efficiently granting planning permissions, aiding studies to identify regional requirements and gathering evidence for national funding applications.
- Develop and set up a finance scheme for supporting small to medium scale renewable generation and flexibility projects, encouraging joint installation of storage and generation.
- Setup a platform and grant scheme for community energy projects.
- Engage with EfW operators to develop decarbonisation strategies and ensure any new facilities will be CCUS ready.
- Run awareness campaigns to inform the public on potential benefits of CCUS, hydrogen, BECCS and onshore wind projects.
- Influence government for funding for infrastructure and CCUS projects, RD&D & facilitation of hydrogen generation, requiring CCUS readiness with EfW plants.

**Evidence gathering (in parallel with priority actions)**
- Identify current and future skills shortages and gaps in the workforce
- Support national RD&D funding applications, offer top-up financial support and coordinate national and regional stakeholders to provide evidence base for flexibility projects (storage/DSR), EfW CCS, hydrogen generation, CCS business models.
- Engage with LAs to establish how best to use local planning policy to incentivise delivery of measures
- Assess National Government changing support, priorities, and regulation

**Decision on pathway by latest 2025**

**Max ambition**
- Maximal level of support for community energy projects.
- Support RD&D for additional power flexibility evidence gathering and new technologies/schemes.
- Update local energy plans with additional areas and infrastructure dedicated for solar PV and onshore wind.
- Support local workforce training prioritizing solar and wind installers/maintainers and networks technicians.
- Support CCUS and $CO_2$ transport and storage planning as soon as possible and complete CCUS retrofits quickly.

**High Hydrogen**
- Medium level of support for community energy projects.
- Support RD&D for additional hydrogen power evidence gathering support feasibility studies in the region and Influence national government for investment in the region.
- Support local workforce training, focusing on $H_2$ related skills.
- Update local energy plans with additional areas and infrastructure dedicated for hydrogen power plants.
- Support CCUS and $CO_2$ transport and storage planning and achieve progress with CCUS retrofits.

**Balanced**
- High level of support for community energy projects.
- Support RD&D for additional flexibility evidence gathering.
- Update local energy plans with additional areas and infrastructure dedicated for solar PV and onshore wind.
- Support local workforce training with an emphasis on solar and wind installers/maintainers.
- Support CCUS and $CO_2$ transport and storage planning and implementation.

Evaluate progress and implement further measures where necessary, for example:
- Adjustment of strategies based on achieved level of deployment and changes in National Policy
- Stronger regulatory measures to encourage uptake, such as through local planning requirements (if possible)
- Stronger financial incentives for technology uptake (e.g. grants and direct investments).
- Support for rollout of innovative technologies and techniques, such as battery-to-grid and smart systems
- Adjustment of training programmes to meet skills shortages
- Acceleration of public-led business models for DSR, battery and renewables.

EfW: Energy from Waste; CCUS: Carbon Capture, Utilisation and Storage; BECCS: Bioenergy CCS; RD&D Research, development and demonstration; DSR: demand side response; CC: County Council; CA: Combined Authority; LA: Local Authority; LEP: Local Enterprise Partnership; WY: West Yorkshire; YNY York & North Yorkshire

# Action plan – Industry

**Key**
Policy with higher significance for YNY

2020 | Priority Actions & Evidence | 2025 at latest | Max implementation of policy | 2030 | Adjustment and enhancement | 2038

## Priority Actions (common across pathways)

- Support infrastructure investments through spatial planning, efficiently granting planning permissions, aiding studies to identify regional requirements and gathering evidence for national funding applications.
- Support/facilitate RD&D on industrial equipment & other measures (see below).
- Support decarbonisation feasibility studies of large industrial sites.
- Establish a financial support programme for deploying energy and resource efficiency measures (or extension of REF).
- Setup a green public procurement programme.
- Run awareness raising campaigns on circular economy and CCS/$H_2$.
- Influence government for funding for infrastructure and CCUS projects, RD&D & facilitation of hydrogen/electrification fuel switching, developing green procurement guides and stricter industrial emissions limits/trajectories

## Evidence gathering (in parallel with priority actions)

- Identify skills shortages and gaps in the workforce by studying key low-carbon technology supply chains.
- Work with LAs to establish how best to use local planning policy to incentivize delivery of measures.
- Support national RD&D funding applications, offer top-up financial support and coordinate national and regional stakeholders to gain further evidence on: industrial fuel switching; resource efficiency and development of circular economy practices; HSE and regulatory practices around hydrogen; $CO_2$ utilization options.
- Fully map existing technologies, sites and processes in the region.
- Assess National Government support, priorities, and regulation

**Decision on pathway by latest 2025**

## Max ambition

- Implement a small industry/SME financial support scheme focusing on early electrification.
- Support large industry fuel switching/CCS via applications for national funds and supplementary financial incentives.
- Support local workforce training, focusing on electrification related jobs such as heat pump installers.
- Update regional planning regarding CCS in accordance with new evidence and regional developments.

## High Hydrogen

- Implement a small industry/SME financial support scheme focusing on hydrogen fuel switching.
- Swift completion of $H_2$ zoning and enforcement of $H_2$ readiness requirements of equipment.
- Support large industry fuel switching/CCS via applications for national funds and supplementary financial incentives.
- Support local workforce training, focusing on $H_2$ related jobs.
- Update regional planning regarding hydrogen infrastructure in accordance with new evidence and regional developments.

## Balanced

- Implement a small industry/SME financial support scheme focusing on all technologies.
- Support large industry fuel switching/CCS via applications for national funds and supplementary financial incentives.
- Support local workforce training, focusing on electrification hydrogen and circular economy related jobs.
- Update regional planning regarding CCS and $H_2$ infrastructure in accordance with new evidence and regional developments.

## Adjustment and enhancement

Evaluate progress and implement further measures where necessary, for example:

- Adjustment of strategies based on achieved level of deployment and changes in National Policy
- Stronger regulatory measures to encourage uptake, such as through local planning requirements (if possible)
- Stronger financial incentives for technology uptake (e.g. scrappage schemes, direct investments, etc.) and energy efficiency
- Support for rollout of innovative technologies and techniques, such as demand side response, $CO_2$ utilisation, Direct Air Capture
- Adjustment of training programmes to meet skills shortages

REF: Resource Efficiency Fund; CCUS Carbon Capture Utilisation and Storage; RD&D Research, Development and Demonstration

# Action plan – LULUCF and agriculture

**Key**
Policy with higher significance for YNY

2020 → Priority Actions and Evidence → 2024 at latest → Max implementation of policy → 2030 → Adjustment and enhancement → 2038

**Priority Actions (common across pathways)**
- Develop spatial land use strategy for the region that incorporates local expertise and evidence, and optimizes potential for both climate mitigation and Nature Recovery Network requirements
- Develop region-wide food waste strategy
- Implement public procurement policies to reduce food waste and to reduce red meat and dairy consumption
- Establish a package of support measures to help farmers and landowners choose appropriate interventions
- Run a major publicity campaign to encourage behaviour change
- Influence Government for funding to support climate mitigation measures, development of ELMs to ensure it supports locally-relevant measures, and efficient processes for accessing funding

**Evidence gathering (in parallel with priority actions)**
- Data collection on:
  - peatland restoration potential
  - carbon intensity of local farming
  - optimal livestock stocking densities
  - extent of food waste along local supply chains
  - carbon sequestration measurement and monitoring techniques
- Stakeholder feedback on proposed implementation measures, perceived barriers and required financial support
- Encourage local farmers to participate in Defra ELM Pilots
- Explore and trial private investment models
- Explore potential markets for end-products of land management practices
- Assess National Government support, priorities, regulation and details of ELMs

**Decision on pathway by latest 2024[1]**

**Max ambition**
- Strong local and regional policy support for all appropriate measures
- Strong financial incentives offered to facilitate maximum rate of change
- Strong markets for bioenergy and afforestation end-products in place
- Strong leadership and public messaging for diet change and food waste reduction

**High Hydrogen**
- Strong local and regional policy support for all appropriate measures
- Some financial incentives in place where appropriate to support afforestation, agroforestry, lowland and upland peat restoration, farming practice changes, and hedgerow planting
- Markets for bioenergy and afforestation end-products in place
- Strong leadership in diet change and food waste reduction
- Moderate public messaging for behaviour change

**Balanced**
- Strong local and regional policy support for all appropriate measures
- Low or no financial incentives above ELMs to support climate mitigation measures
- Strong leadership in diet change and food waste reduction
- Moderate public messaging for behaviour change

Evaluate progress and implement further measures where necessary, for example:
- Adjustment of spatial land strategy targets based on effectiveness of implemented measures, extent of behaviour change and developments in National policy
- Stronger regulatory measures, such as banning peatland burning or new/stronger local planning requirements for land use
- Stronger financial incentives for climate mitigation measures
- Support for rollout of innovative technologies and techniques
- Public incentives for behaviour change
- Adjustment of advice on machinery fuel switching based on markets and rollout of hydrogen vs electrification etc
- Shift away from short-rotation coppice and miscanthus towards longer-term forestry

ELMs = Environmental Land Management Scheme; 1. In-line with rollout of ELMs

# The COVID-19 pandemic has implications for energy use and emissions going forward



- **The scenarios considered in this study were developed prior to the COVID-19 pandemic** and represent changes in energy demand relative to pre-pandemic behaviours and sector trends.
- Travel restrictions and social distancing measures put in place as a result of the pandemic have had a huge impact on the economy and on personal work and travel choices, with a number of associated implications for energy use and a net zero transition, including:

| COVID-19 impact | Impact on energy/emissions | Implications for net zero transition |
|---|---|---|
| **Economic recession** – large sections of the economy slowed or ceased operations during lockdowns, with resulting increases in unemployment and delays to supply chains | • **Reduction and delayed growth in travel demand** as travel demand is linked to economic growth<br>• **Reduced overall energy use** – both in domestic and commercial/industrial sectors | • **Reduced household spending power** limiting the competitiveness of new technologies with fossil-based incumbents<br>• **Risk of delay to deployment of technologies** if public spending is cut back, particularly for technologies in demonstration or scale-up phase[1] |
| **Increased working from home** – a large proportion of the workforce have worked from home during lockdown and, surveys indicate that those who have worked from home intend to continue doing so more in future[2,3,4] | • **Reduced travel demand** due to commuting<br>• **Change in distribution of energy demand –** Reduced non-domestic energy demand, for example where office space is no longer used, with increase in domestic energy use<br>• **Changes in energy demand profiles**, with flattening of peak demand | • **Contributes to emissions reduction** where overall reduction in travel is maintained<br>• **Complements renewables** where demand patterns match supply more closely |
| **Changes in travel behaviour** – increases in cycling and walking for leisure trips, but significant decreases in public transport patronage and capacity, and increases in personal car use as a result of social distancing | • **Reliance on high emissions modes** risks transport emissions surpassing pre-pandemic levels as restrictions ease<br>• **Potential for more trips to be taken using active travel** through increased awareness/experience during lockdown | • **Risk that bus and rail services become unviable** limiting the potential for modal switch, with associated impacts on disadvantaged groups that rely on these services |
| **Changes in purchasing behaviour** – with increases in online shopping | • **Increased van and HGV demand**, particularly in retail and grocery sectors | • **Greater challenge in reducing van and HGV use** with greater need to manage growth alongside operational efficiency |
| **Reduction in fossil fuel prices** – due to reduced demand, with associated risk to the UK oil and gas sector[5] | • **Potential for higher emissions** where fossil fuel use is favoured over lower emissions alternatives | • Potential **reduced cost-competitiveness of low emissions technologies** however the long-term impacts are uncertain |

1. *Energy Technology Perspectives Special Report on Clean Energy Innovation* (2020) IEA; 2. For example, 47% of respondents in Wave 1 of West Yorkshire COVID-19 Survey, June 2020; 3. Ipsos Mori online survey, May 2020; 4. SYSTRA survey, April 2020; 5. Just Transition Commission, Advice for a Green Recovery (2020)

# The long-term impact of COVID-19 on the pathways is uncertain but the recovery can benefit both emissions and the economy



- The global response to the pandemic is still evolving, and both the longevity and overall positive or negative effect of its impacts are uncertain; however, many of these impacts are likely to be short-to-medium term.
- The emissions reduction pathways developed in this study all require ambitious action across three key areas with potential to be impacted by COVID-19:
  - **Energy demand reduction** through deployment of building energy efficiency measures, and reductions in travel through a combination of working from home, teleconferencing, co-location of homes and services, and reductions in waste
  - **Shift of travel away from private cars to lower emissions modes** such as shared, public and active travel
  - **Deployment of low carbon technology** including low carbon heating, zero emissions vehicles, industrial fuel-switching, and large-scale deployment of hydrogen and CCS
- The overarching actions that local authorities can take to deliver these pathways are likely to be the same as those available pre-COVID, but the primary impact of the pandemic is on the relative barriers to delivering these actions – either through providing opportunities that make action easier or, conversely, challenges that make action more difficult.

**Opportunities**: Some trends observed during the pandemic support emissions reduction measures, such as:

- **changes in working patterns** –businesses and employees have rapidly adapted to greater use of teleconferencing and more widespread home working, and a proportion of this is likely to be maintained going forward
- **increases in active travel** – increased interest in walking and cycling presents an opportunity to lock-in positive travel behaviours
- **changing perception of value of air quality** – more people report being willing to consider clean technology, such as an electric vehicle, to retain emissions and air quality benefits[1,2]
- **national funding streams for green recovery** – DfT has continued to develop its decarbonisation strategy,[3] and funding streams to support emergency active travel measures,[4] more efficient homes,[5] and a greener recovery have been announced during the pandemic;[6] although it is noted that this comes alongside conflicting funding announcements such as highways expansion
- **Alignment of funding priorities** – significant funding has been made available to support recovery from COVID-19. If this funding is spent wisely then it is possible that this money can achieve both goals of reducing emissions and supporting recovery

**Challenges:** The main emerging risks to delivery of the pathways are likely to be:

- **Long-term viability of shared and public transport** – reductions in patronage and restrictions on capacity mean that some services may be lost, particularly in low population density areas; ensuring that these services work for everyone in the future is one of the most important outcomes of a COVID-19 recovery, as it will support emissions reduction and will determine the impact of the transition on disadvantaged groups
- **Ensuring accelerated technology deployment** – delays to low emissions technology deployment due to reduced R&D support and/or supply chain risks have been suggested to result not only in a slower transition – with reduced potential for emissions savings – but also in slower rates of technology cost reduction.[7] The emissions reduction pathways already require strong policy both nationally and locally to deliver technology change at the required rate, and it is not yet clear whether COVID-19 will significantly change the level of support needed or increase the risk of it not being delivered
- **Diversion of local authority resources** away from climate action and towards COVID recovery

1. UK Motor article, April 2020; 2. Baringa, April 2020; 3. Decarbonising transport ; 4.Emergency active travel fund; 5. Green homes grant; 6. Green Recovery Challenge Fund 7. *Energy Technology Perspectives Special Report on Clean Energy Innovation* (2020) IEA

# **Summary table – Transport.** This table shows how the modelled outcomes map to the measures and through to the required policies and actions

| Sector | Modelled outcome | Measure | Roadmap theme | Policies and actions to deliver measure[1] |
|---|---|---|---|---|
| **Transport** | **Decreased private car use** | Decreased travel demand | Cars | **T1**, **T2**, T13, **T16**, **T19** |
| | | Increased walking and cycling | Active travel | **T1**, T2, **T3**, T4, T6, T13 |
| | | Increased public transport use | Bus and rail | **T1**, T2, T6, **T7**, T8, T9, T11, T13, **T18**, T24 |
| | | Increased shared car use | Cars | **T1**, T2, T6, T13, **T15**, **T18** |
| | **Decreased van and truck use** | Consolidation and shift to cycle freight | Vans and HGVs | T10 |
| | | Shift from road to rail[2] | Vans and HGVs | T11 |
| | **Low emissions technology** | Low emissions cars | Cars | **T5**, T6, T12, T16, **T18**, T19 |
| | | Low emissions vans and HGVs | Vans and HGVs | **T5**, T12, T17, **T18**, T19, T20, T21 |
| | | Low emission buses | Bus and Rail | **T7**, T22 |
| | | Electrification of trains and/or lines | Bus and Rail | T23, T24 |
| | **Decreased aviation emissions** | Decreased flight demand | *Not included* | T24 |
| | | Aircraft support vehicle electrification | *Not included* | *Not included* |

*YNY transport results*
*Transport roadmap*
*Technical Appendix*

1. Policies in bold represent direct delivery of funding or measures by the CA/LEP, other policies are considered supporting actions; 2. Note that modal shift to water transport (e.g. canals or rivers) was outside the scope of this study

# **Summary table – Buildings.** This table shows how the modelled outcomes map to the measures and through to the required policies and actions

| Sector | Modelled outcome | Measure | Roadmap theme | Policies and actions to deliver measure[1] |
|---|---|---|---|---|
| **Buildings** | **Improved energy efficiency** | Retrofit existing public buildings | Energy efficiency | **B2**, B5, B9, B10, **B11** |
| | | Retrofit existing private buildings | | B1, B5, B9, B10, **B11**, B13 |
| | | High standards for new buildings | | B8, **B11**, B13 |
| | **Switch to district heating** | Deploy district heating | District heating | B3, **B4**, B5, B13 |
| | **Switch to low carbon heating** | Large-scale deployment of heat pumps | Heat pumps | B5, B10, **B11**, B13 |
| | | Deploy hybrid heat pumps | | B5, B10, **B11**, B13 |
| | | Deploy $H_2$ boilers | $H_2$ boilers | B5, B10, B12, B13 |
| | **Rooftop solar PV** | Deploy rooftop solar PV | Other | B6, **B7**, B8 |

*YNY buildings results*
*Buildings roadmap*
*Technical Appendix*

1. Policies in bold represent direct delivery of funding or measures by the CA/LEP, other policies are considered supporting actions

# **Summary table – Industry and Power.** This table shows how the modelled outcomes map to the measures and through to the required policies and actions

| Sector | Modelled outcome | Measure | Roadmap theme | Policies and actions to deliver measure[1] |
|---|---|---|---|---|
| **Industry** | **Increased efficiency** | Increased energy efficiency | Efficiency | I3, I4, I5, **I7**, **I10**, I11, I12, I14, |
| | | Increased material efficiency/circularity | Efficiency | I3, I4, I5, **I7**, **I10**, I11, I12, I13, I15 |
| | **Decreased industrial carbon intensity** | Increased electrification | Fuel Switching | I1, I2, I3, I4, I5, I6, **I8**, **I9**, **I10**, I11, I12, I14, |
| | | Fuel switch to hydrogen | Fuel Switching | I1, I2, I3, I4, I5, I6, **I8**, **I9**, **I10**, I11, I12, I13, I14 |
| | | Fuel switch to bioenergy | Fuel Switching | I1, I3, I4, I5, **I8**, **I9**, **I10**, I11, |
| | | Install $CO_2$ capture | $CO_2$ Capture | I1, I2, I3, I6, **I8**, **I10**, I11, I12, I13, I16 |
| **Power** | **Larger-scale low carbon generation** | CCS retrofits to large biomass and fossil plants | Bioenergy and Large Fossil | P1, P4, P5, **P7**, P12 |
| | | Deployment of hydrogen generation | Other | P1, P4, P5, **P7**, P12, P13, P14 |
| | | Decarbonisation of EfW | Large EfW | P1, **P2**, P4, P5, **P7**, P9, P10, P11, P12 |
| | **Smaller scale low-carbon generation** | Solar PV and onshore wind deployment | Solar and Wind | P1, **P2**, P5, **P6**, **P7**, **P8**, P12, P13, P14 |
| | | Limited expansion of AD & small bioenergy | Bioenergy | P1, **P2**, P11 |
| | **Infrastructure and flexibility[2]** | Flexibility technologies (e.g. storage, DSR) | Other | P1, **P2**, P4, **P6**, **P7**, **P8**, P12, P15, P13, P14 |
| | | New infrastructure | *Not included* | P1, P3, P12, P15, P13, P14 |

*YNY industry results*
*Industry roadmap*
*Industry Technical Appendix*
*YNY power results*
*Power roadmap*
*Power Technical Appendix*

EfW: energy from waste; AD: anaerobic digestion; DSR: demand side response

1. Policies in bold represent direct delivery of funding or measures by the CA/LEP, other policies are considered supporting actions 2. not explicitly modelled

# **Summary table – LULUCF and agriculture.** This table shows how the modelled outcomes map to the measures and through to the required policies and actions

| Sector | Modelled outcome | Measure | Roadmap theme | Policies and actions to deliver measure[1] |
|---|---|---|---|---|
| **LULUCF + agriculture** | **Negative emissions through carbon sequestration** | New forest planting | Afforestation | L1, L2, L4, L5, L8, L10, **L11**, L12, L14, L15, L16 |
| | | Peatland restoration[1] | Peatland restor. | L1, L2, L4, L5, L8, **L9**, L10, **L11**, L12, L15, L16 |
| | | Agroforestry | *Not included* | L1, L2, L4, L5, L10, **L11**, L16 |
| | | Hedgerow increase | Agri measures and other | L1, L4, L5, L10, **L11** |
| | | Increase in biomass crops | | L1, L4, L5, L10, **L11**, L14 |
| | **Increased land availability and reduced agricultural emissions** | Reduced red meat and dairy consumption | Diet and waste | L6 |
| | | Food waste reduction | | L2, L3, L5, **L6**, **L7**, L8, **L11**, L15 |
| | | Increased stocking density | Agri measures and other | L1, L2, L4, L5 |
| | | Indoor horticulture | | L4, L5, L13 |
| | | Improved crop yields | *Not included* | L4, L5, **L11** |
| | | Other agricultural practices | | L1, L4, L5, **L11**, L13 |
| | **Reduced emissions from agricultural machinery** | Machinery fuel switching | Agri measures and other | L4, **L11** |

*YNY LULUCF results*
*LULUCF roadmap*
*Technical Appendix*

LULUCF = Land use, land use change and forestry; 1. Policies in bold represent direct delivery of funding or measures by the CA/LEP, other policies are considered supporting actions; 2. Peatlands are currently an emissions source and do not become a sink within the timeframe of the emissions pathways

Link to contents

# The main report includes some additional discussion sections to highlight particular features and co-benefits associated with the pathways, as well as external influences.

## Discussion

The main report also includes wider discussion on the below topics:

1. **Scenario features** – overview of the key features of each scenario, including a summary of opportunities, risks and challenges, investment, infrastructure, skills and consumer considerations.
2. **Covid-19** – overview of the implications of Covid-19 for the energy transition, including the key opportunities and risks[1].
3. **Impact of National policy** and decisions on regional progress and targets. For example national regulations, research programmes, financial support and decisions (e.g. the future of heat decarbonisation)
4. **Co-benefits** – a summary of the co-benefits associated with climate action, for example health benefits, job creation, inclusive growth, circular economy measures, knowledge creation and skills development.
5. **Offshore wind** – outside the scope of the study, but discussed at high-level to ensure opportunity is considered in terms of the potential skills and investment in related manufacturing or infrastructure.

## Technical Appendix

The Technical Appendix provides further detailed information to support the results. This includes:

- The assumptions underpinning the emissions scenarios for each sector.
- Information on the granularity of the subregion modelling, the emissions pathways for the Leeds City Region and the impact of not having CCS.
- Quantitative information on all the deployed measures to underpin the implementation roadmap.
- Information to support the policies and action plans, such as references of best practise and policy costing.
- Mention of additional factors outside the scope of this study, such as carbon offsetting, air quality, scope 3 emissions and SF6 emissions.

1 also show in this executive summary

# Glossary and Terminology



| Term | Meaning |
|---|---|
| AD | Anaerobic digestion |
| BECCS | Bioenergy with carbon capture and storage |
| BEV | Battery electric vehicle |
| BioCNG | Compressed natural gas, 100% biomethane |
| CA | Combined Authority (WYCA) |
| Capex | Capital expenditure |
| CCGT | Combined cycle gas turbine (power plant) |
| CCS | Carbon capture and storage |
| CHP | Combined heat and power |
| $CO_{2(e)}$ | Carbon dioxide (equivalent) |
| DSR | Demand side response |
| EfW | Energy from waste[1] |
| EV | Electric vehicle |
| FCEV/H2FC | (Hydrogen) Fuel Cell Electric vehicle |
| $H_2$ | Hydrogen (as a fuel) |
| H2GT | Hydrogen gas turbine (power plant) |
| Ha (kha) | Hectares (land area) |
| HGV | Heavy good vehicle |
| HHP | Hybrid heat pump |
| kW (MW, GW) | Kilowatt – unit of power |

| Term | Meaning |
|---|---|
| kWh (MWh etc) | Kilowatt hour – unit of energy |
| LA | Local Authority |
| LEP | Local Enterprise Partnership |
| LPG | Liquefied petroleum gas |
| LULUCF | Land Use, Land Use Change and Forestry |
| MBT | Mechanical biological treatment (of waste) |
| $MtCO_2e/yr$ | Mega tonnes of $CO_2$ equivalent per year |
| Opex | Operational expenditure |
| Passenger km | Passenger travel activity (number of passengers x average distance travelled) |
| PHEV | Plug in hybrid electric vehicle |
| (Solar) PV | Solar Photovoltaic (electricity generation) |
| R&D | Research and development |
| T&S | Transport and storage |
| Tonne km | Freight travel activity (tonnes lifted x average distance transported) |
| Vehicle km, vkm | Vehicle transport activity (number of vehicles x average distance travelled) |
| WYCA | West Yorkshire Combined Authority |
| Y&NY | York and North Yorkshire |
| £m | £ million |

1 Energy from waste (EfW) includes electricity only EfW, EfW CHP, waste based AD and power from cooking oil, sewage sludge digestion and landfill gas.