

North & West Yorkshire Emissions Reduction Pathways Executive Summary

York and North Yorkshire LEP

elementenergy

Supported by:



UKCEH

February 2021

Final report

Emrah Durusut
Celine Cluzel
Antonia Mattos
Katherine Orchard
Yorukcan Erbay

- Introduction
- Key findings

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, including 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

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 scope¹

- ✓ Scope 1 (direct) and scope 2 (electricity consumption) CO₂e 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 CO₂, N₂O, CH₄.
- ✓ Negative emissions from Drax Bioenergy + Carbon Capture and Storage and new forest planting inside region.

Emissions out of scope

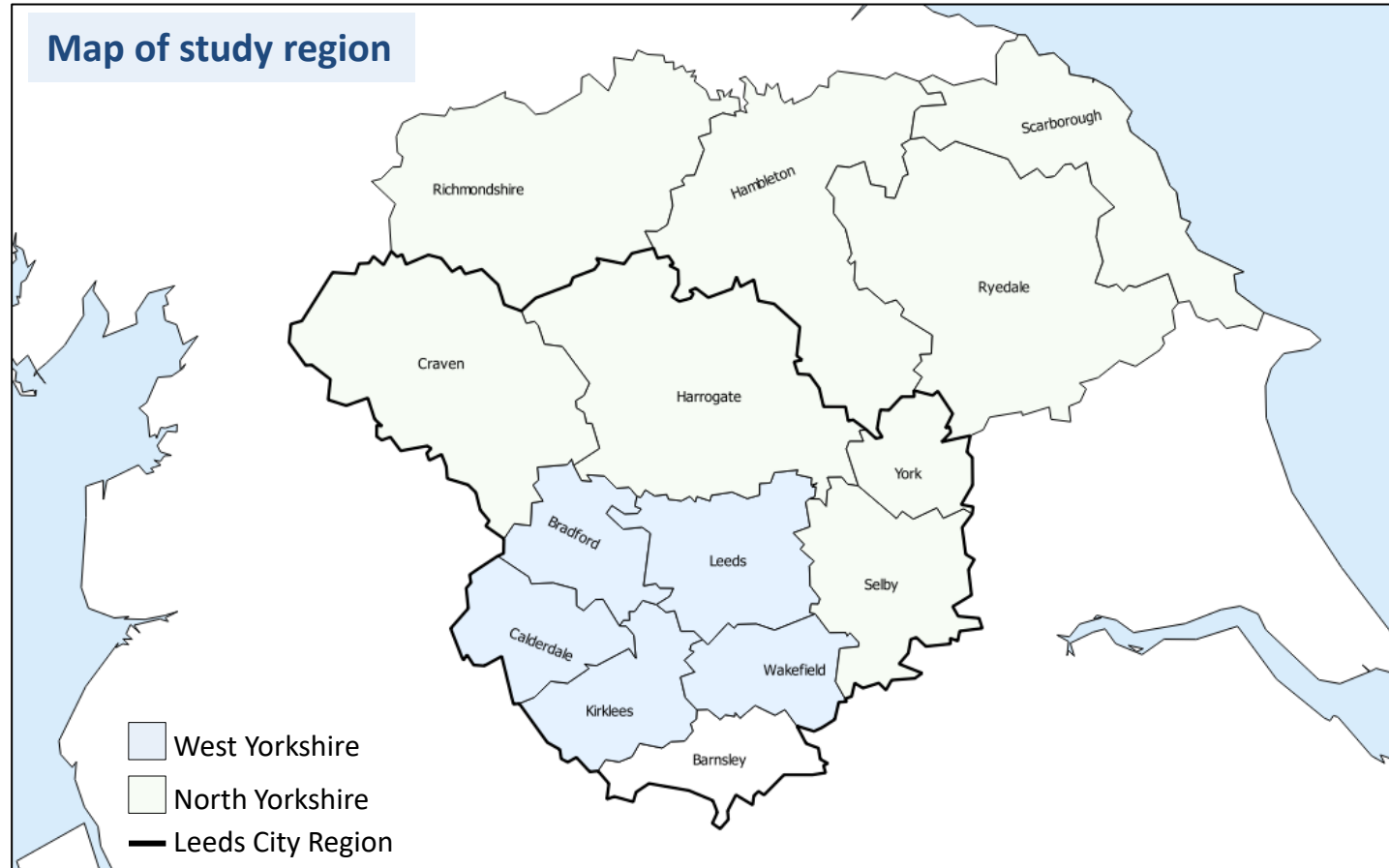
- Scope 3 emissions, including embedded emissions in product/service imports
- Emissions from power *generation* in the region are calculated, but the pathways only include emissions from regional electricity *consumption* at national carbon content¹.
- Emissions from shipping.
- Emissions offsetting 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 CO₂ 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

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 emissions². 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 (H₂)

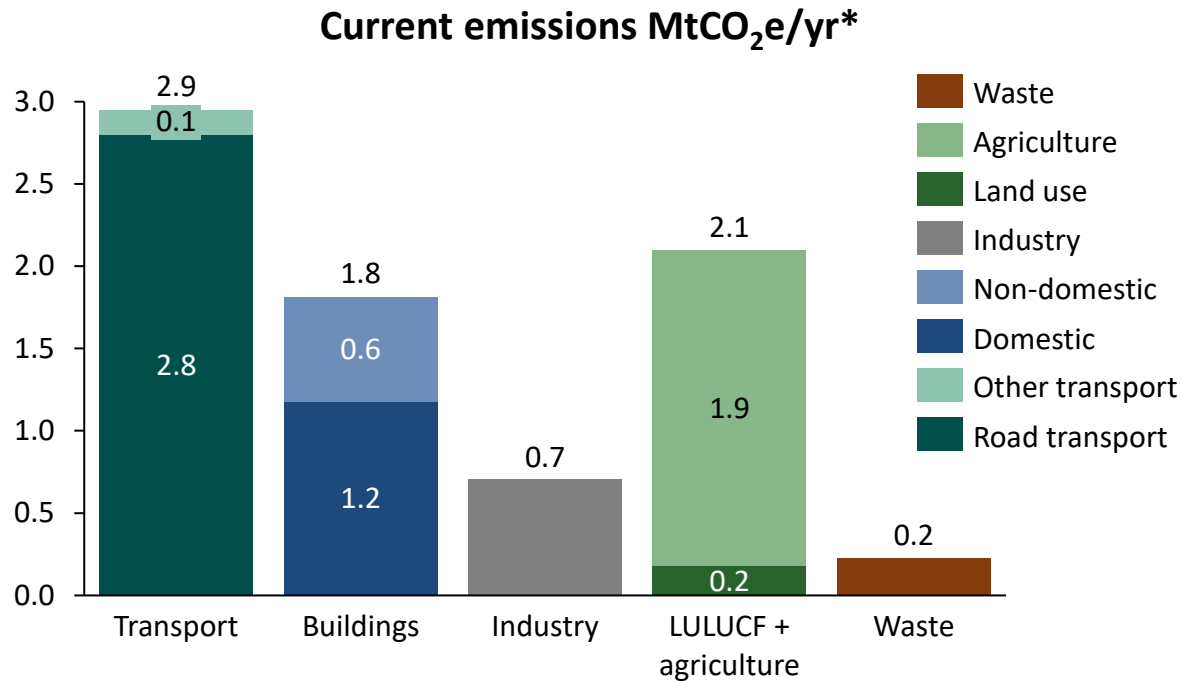
The high hydrogen scenario promotes **large-scale hydrogen and CCS roll-out**. The gas network is repurposed for H₂, enabling significant low carbon hydrogen use in buildings/heat, industry, power and transport. This is supported by land-use measures such as afforestation and bioenergy production; lower 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.

- Introduction
- Key findings
 - Y&NY emissions pathways
 - Roadmap and action plans

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



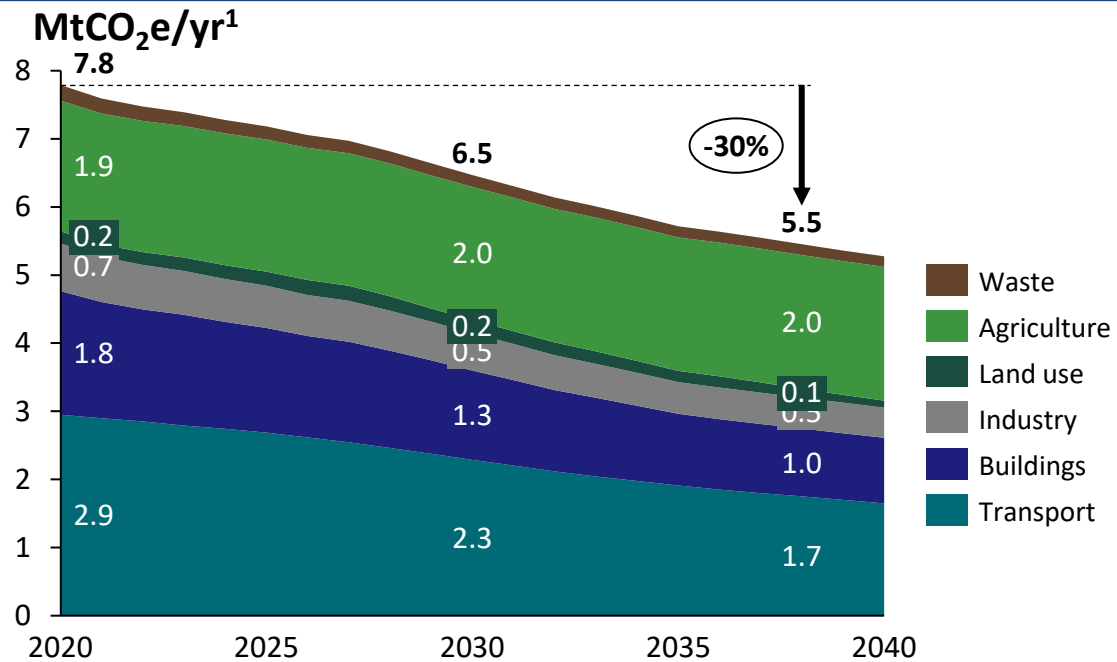
- This graph shows the region’s current emissions (2020), broken down into sectors and key subsectors. More detail within this is shown in the main report sectoral results.
- The scope of emissions included is greater than that in the local authority emissions datasets (see scope slide).
- Due to the 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-CO₂ 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. CO₂e is CO₂ equivalent, considering other GHG produced by combustion of fuels and in agriculture.

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

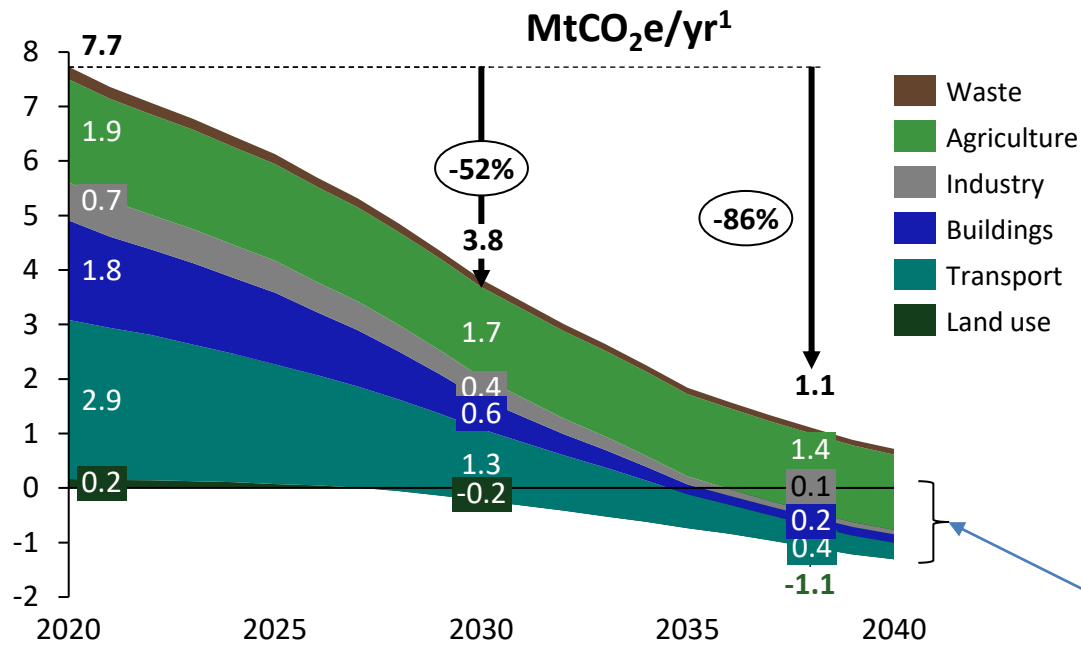


- This graph shows the region’s emissions projection under the baseline scenario, divided into the contribution from each of the sectors. The numbers on the graph show the emissions in 2020, 2030 and 2038 for each sector and the total.
- **The baseline scenario sees a 30% reduction in emissions by 2038, with 5.5 MtCO₂e/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 shown²) 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



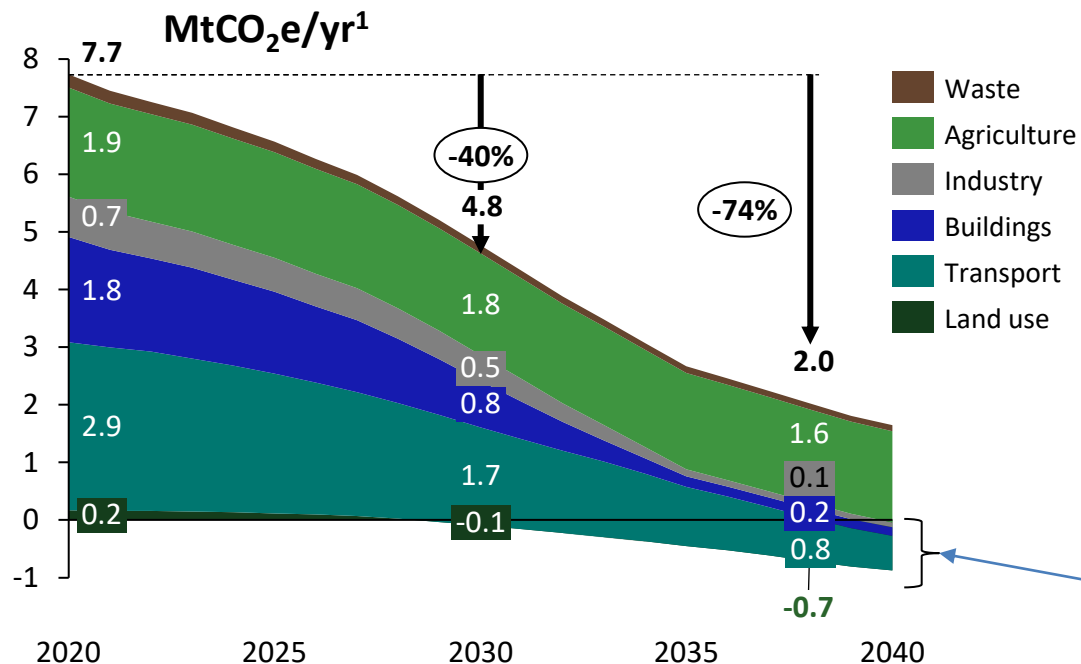
- This graph shows the region’s emissions projection under the Max ambition scenario, divided into the contribution from each of the sectors.
- The scenario sees an 86% reduction in emissions by 2038, with 1.1 MtCO₂e/yr remaining in 2038. When BECCS negative emissions from Drax are included, the region 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, H₂, 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 shown¹).
- 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 H₂ scenario, divided into the contribution from each of the sectors.
- The scenario sees a 74% reduction in emissions by 2038, with 2.0 MtCO₂e/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.

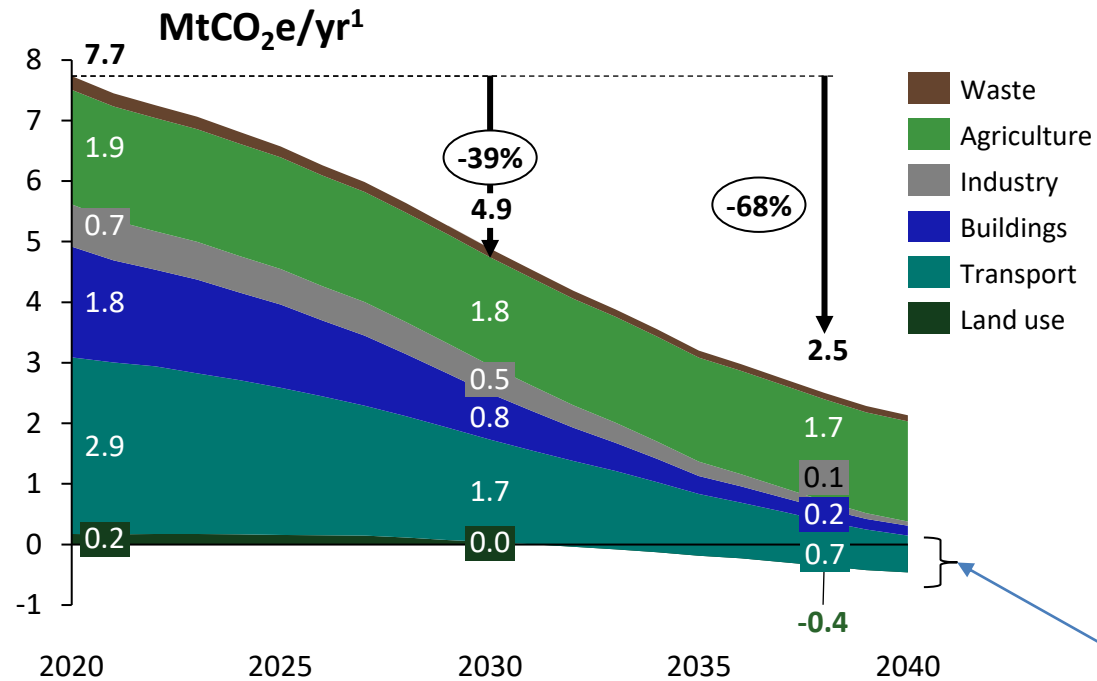
Land use emissions are negative, offsetting some residual emissions in other sectors

- 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 shown¹) 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.

Y&NY

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 MtCO₂e/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.

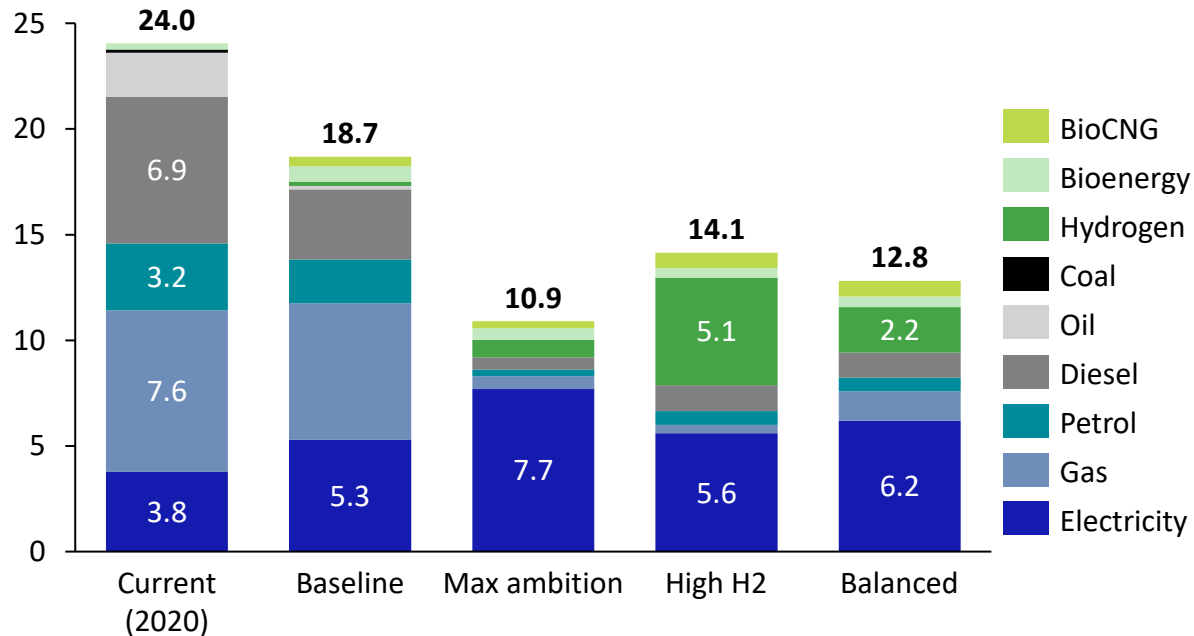
Land use emissions are negative, offsetting some residual emissions in other sectors

- 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

Fuel use in 2038 across scenarios TWh/yr¹



- This graph compares the fuel demand across the scenarios by fuel type. This includes the fuel required for all sectors¹. 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.

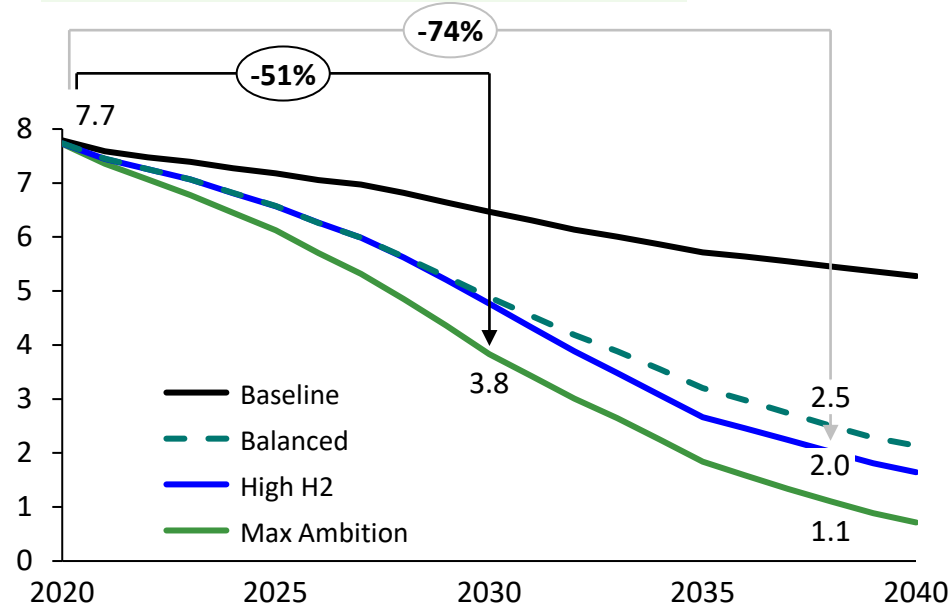
- By 2038, the scenarios rely on predominantly electricity or hydrogen, depending on the choices made.
- The Max ambition scenarios sees electrification of heat and transport, leading to a **102% increase in electricity demand between 2020 and 2038**. There is limited hydrogen and bioenergy use.
- In 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 MtCO₂e/yr¹

National electricity carbon intensity, no BECCS



- This graph compares the emissions trajectories across the scenarios¹. 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 MtCO₂e/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 H₂ and Balanced scenarios make less progress in the next few years, but progress accelerates from the mid-2020s. **The High H₂ 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.

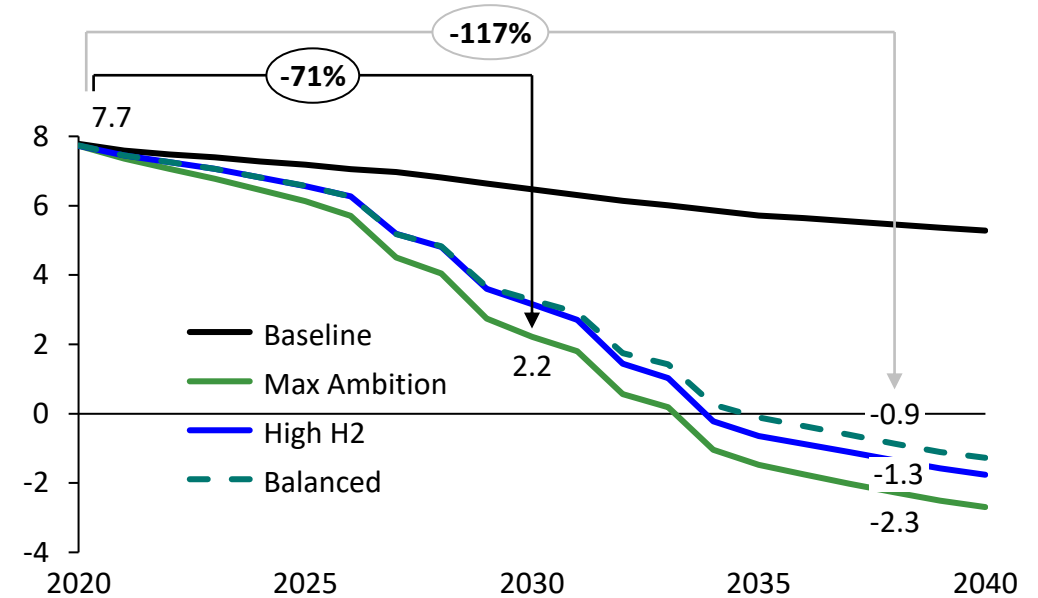
¹ excluding negative emissions from BECCS. National electricity carbon content is chosen for electricity consumed in the sectors to align with current GHG reporting, and regional power sector emissions are therefore not included. ² See [further discussion slide](#) for impact of petrol and diesel ban 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 CO₂ is removed from the atmosphere as the bioenergy grows, but on combustion of the bioenergy the CO₂ is then trapped and stored through CCS, leading to a net reduction in the CO₂ 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 MtCO₂e/yr in negative emissions.

Pathway emissions MtCO₂e/yr

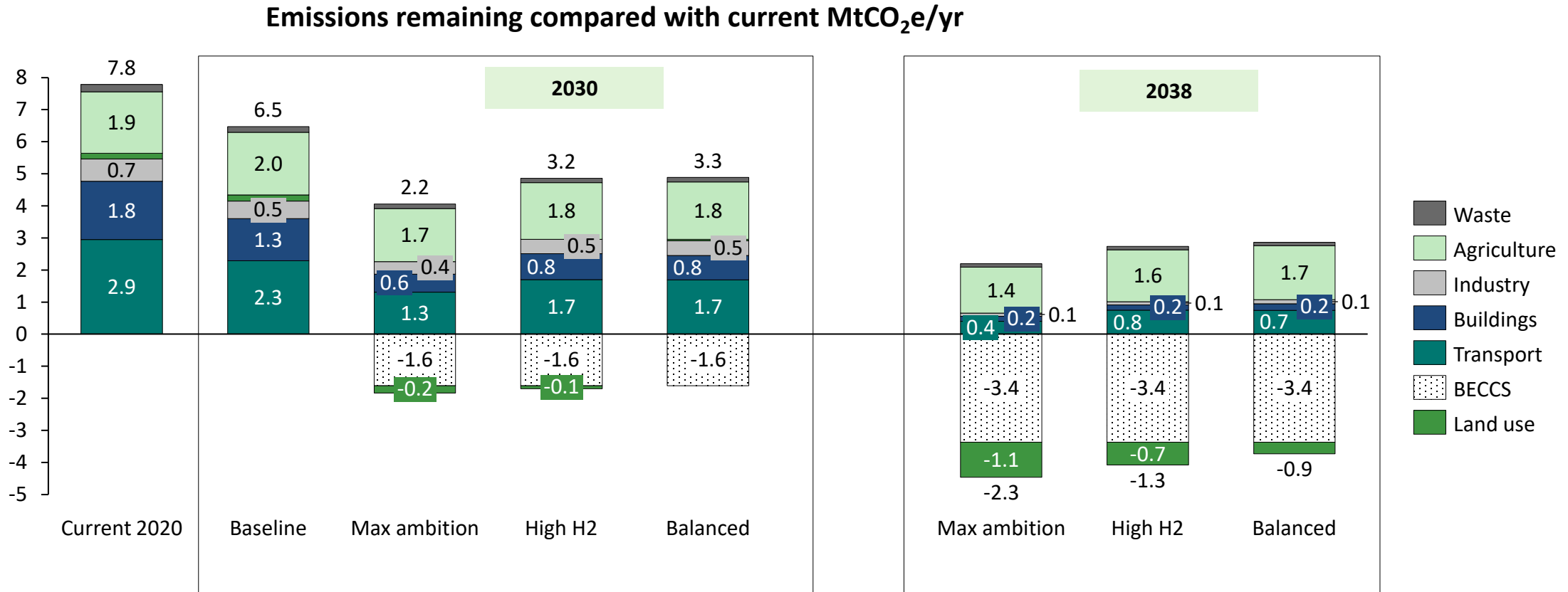
National electricity carbon intensity, with 20% Drax negative emissions



- 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 CO₂ 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.

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

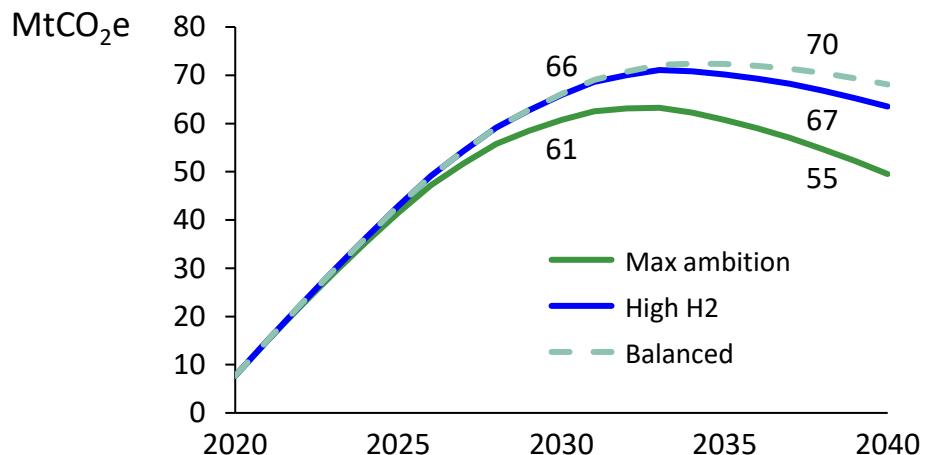


- In 2030 there are significant emissions remaining, particularly in agriculture, transport and buildings. A key challenge in buildings and transport is the stock turnover rate, and in agriculture is the time taken for both change (e.g. diet change) and for changes to take effect.
- In 2038, the majority 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.

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

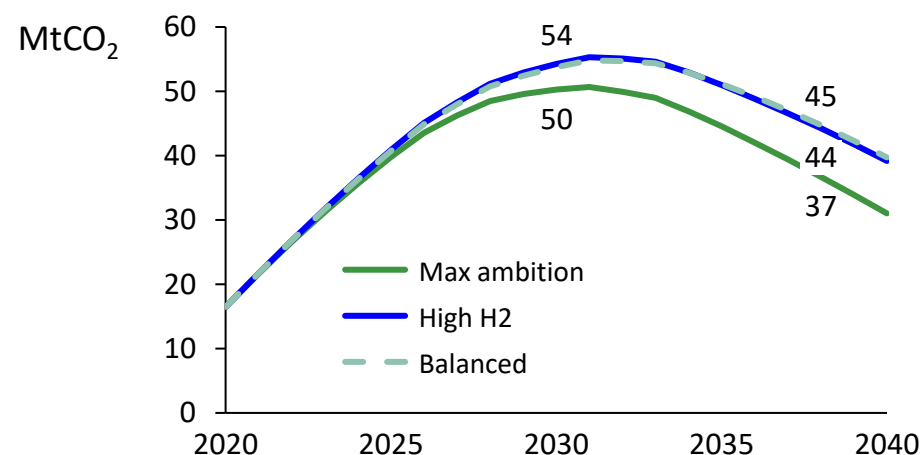
Cumulative emissions MtCO₂e

From 2020 including all emissions in the study scope



Cumulative emissions MtCO₂

From 2018, broadly following Tyndall Centre emissions scope¹



- From a climate perspective, the net cumulative CO₂ emitted is the key factor, as this is the CO₂ 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 MtCO₂e 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 CO₂ budget is related to the energy system only and excludes land use, agriculture, aviation, waste and non-CO₂ emissions¹. Under these conditions, the Y&NY net cumulative carbon emissions are 37 – 45 MtCO₂e by 2038 depending on the scenario.
 - N+W Yorkshire's carbon budget is 134 MtCO₂ 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 MtCO₂e/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 2034¹**, saving 6.9 MtCO₂e/yr over baseline, if an ambitious strategy is deployed immediately, backed by strong policy.
- Cumulative emissions² reach 61 MtCO₂e by 2034 in the Max ambition scenario then begin declining, enabling a **cumulative emissions saving of 71 MtCO₂e 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 MtCO₂e/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 H₂ 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

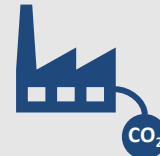


Diet change to reduce meat and dairy consumption by 32%. 24% reduction in cattle and sheep numbers.

Power



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



CCS deployed at scale from 2027 enabling BECCS (-17 MtCO₂/yr, 2038)



Electricity infrastructure investment enabling 102% higher annual demand

- Introduction
- Key findings
 - Y&NY emissions pathways
 - Roadmap and action plans

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:

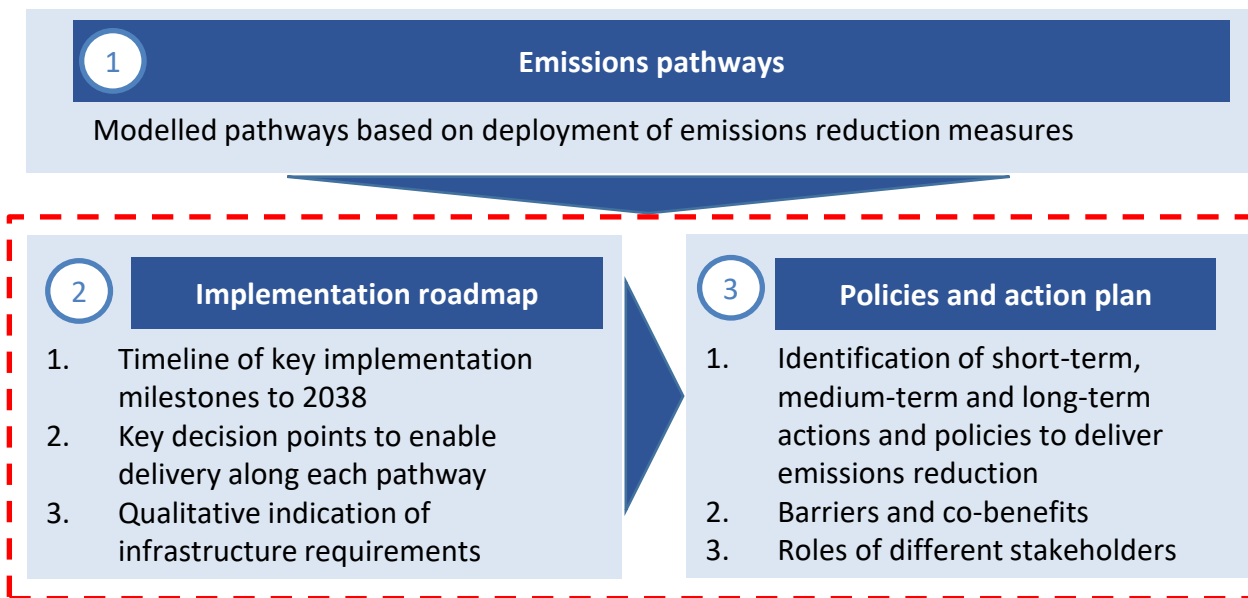
- **Implementation roadmaps** – outcomes from the emissions pathway modelling was used to identify key implementation timescales and activities to support delivery of the pathways, and milestones by which to monitor progress
- **Policies and action plans** – best practice examples and outcomes from wider 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

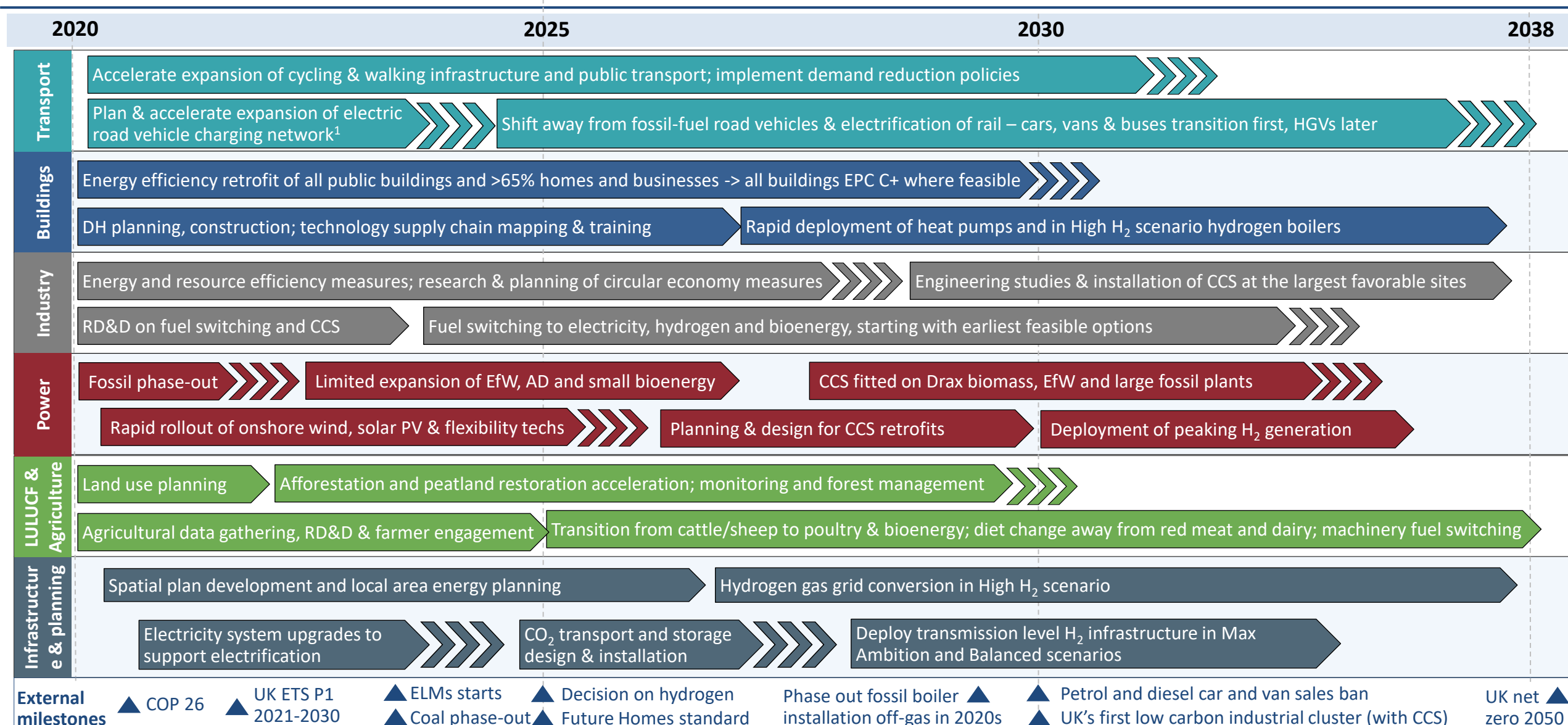


Cross-sectoral summary roadmap showing indicative timelines for implementation of the major measures

▲ Key decision points/ external milestones

Activity timings

»»» Indicates continuous action until 2038



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

Top priority 

Short term actions 

Medium term decisions 

Long term options 

Transport

Reduce car use through modal shift and demand reduction



- Improve cycling and walking infrastructure
- Explore bus Partnership
- Invest in digital infrastructure
- Expand electric vehicle charging network
- Work with partners to limit road building and decarbonise rail

- Level of financial support for vehicle uptake and modal shift
- Role and level of support for shared mobility, including on-demand services

- Stronger regulatory and financial incentives
- Support rollout of innovative technologies (inc. H₂ trains)

Buildings

Reduce energy demand through energy efficiency



- Set up a 'One-stop shop' to help consumers decarbonise
- Retrofit existing LA buildings and put in place policy for wider building stock¹
- Implement heat networks
- Influence Government to deliver planning policy and heat strategy

- Level and focus of financial support for energy efficiency and technology uptake
- Heat zoning policy need
- Role of H₂ for heat

- Stronger regulatory and financial incentives
- Public-led business models for communal and district heating

Land use and agriculture

Ensure local land use priorities are met by setting the strategy



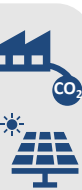
- Complete spatial land strategy
- Gather data and evidence on optimal local LULUCF solutions
- Develop food waste strategy
- Influence Government to develop ELMs in a way that supports locally-relevant measures

- Level and focus of financial support
- Strength of public messaging around diet change

- Stronger regulatory and financial incentives
- Support innovative technologies and techniques

Power and industry

Support planning for CCUS & hydrogen technologies and infrastructure



- Complete regional energy planning, including solar PV
- Setup green public procurement programme
- Financial scheme for efficiency, renewables, RD&D.
- Influence government to support CCUS/hydrogen infrastructure

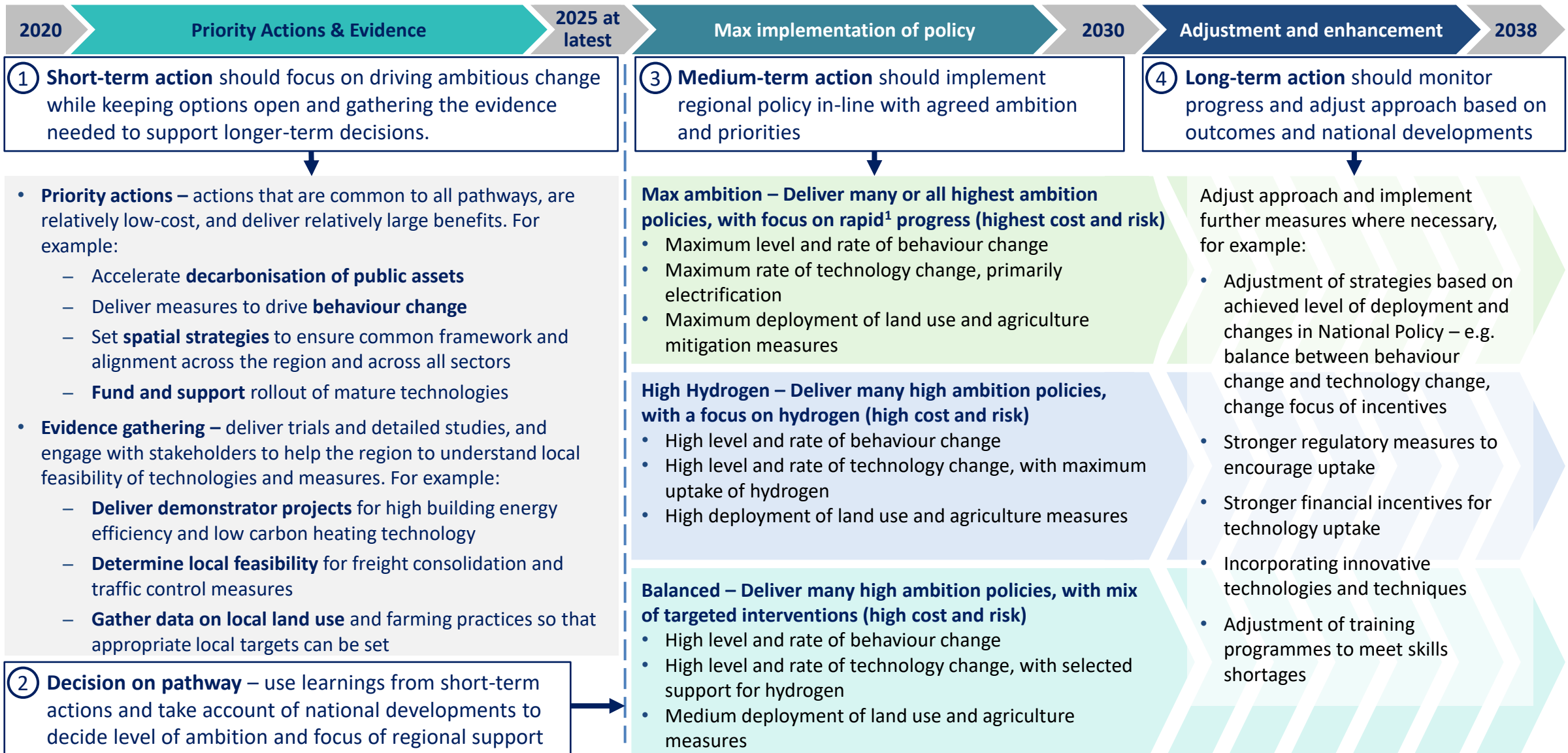
- Role of CCS vs hydrogen vs electrification or renewables
- Level and focus of financial support for fuel switching

- Stronger regulatory and financial incentives
- 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



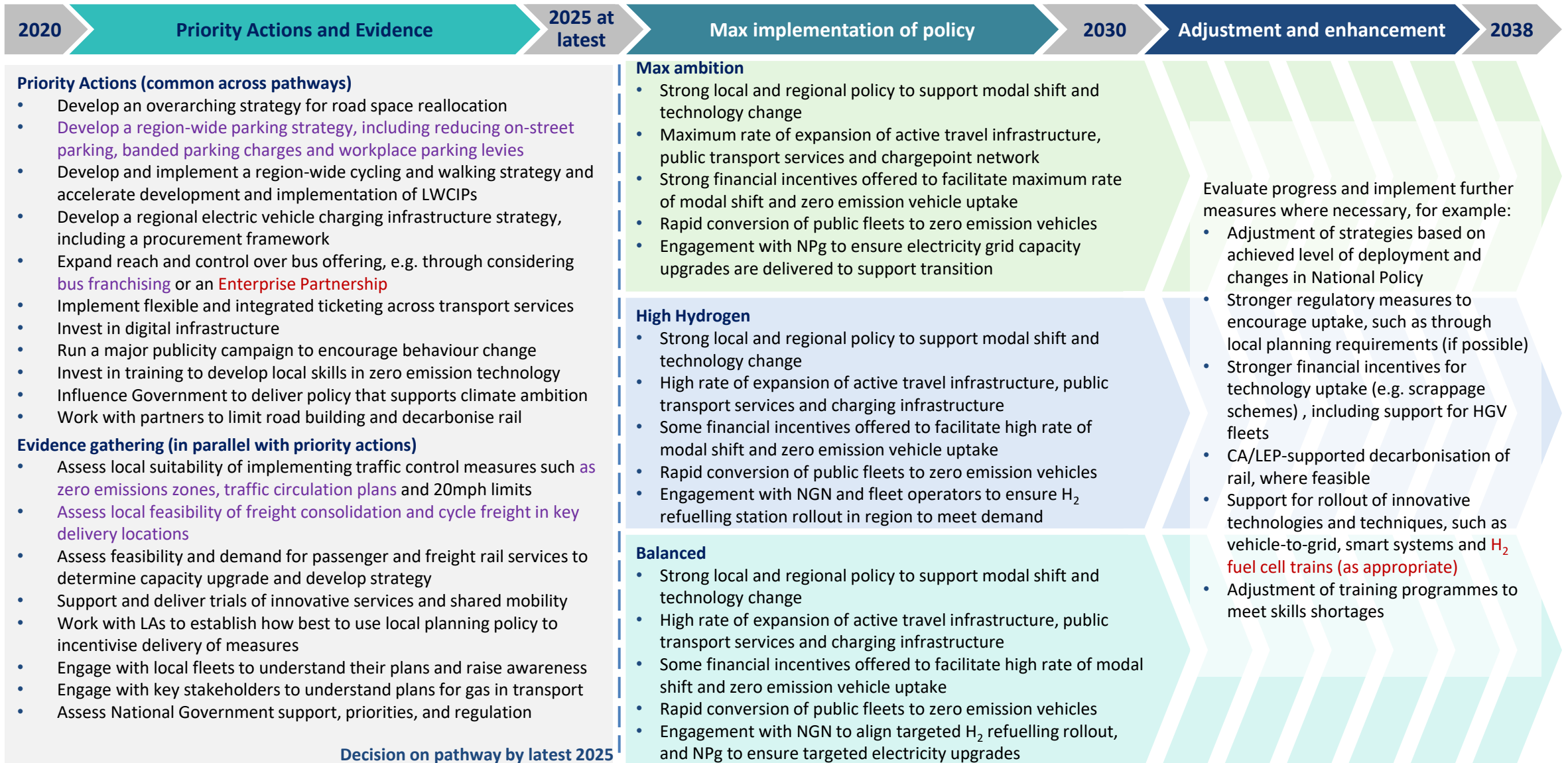
1. The Max ambition pathway targets the fastest feasible rate of decarbonisation, with a focus on delivering as many emissions savings as possible by 2030 but necessarily relies on currently mature technologies

Action plan – Transport

Key¹

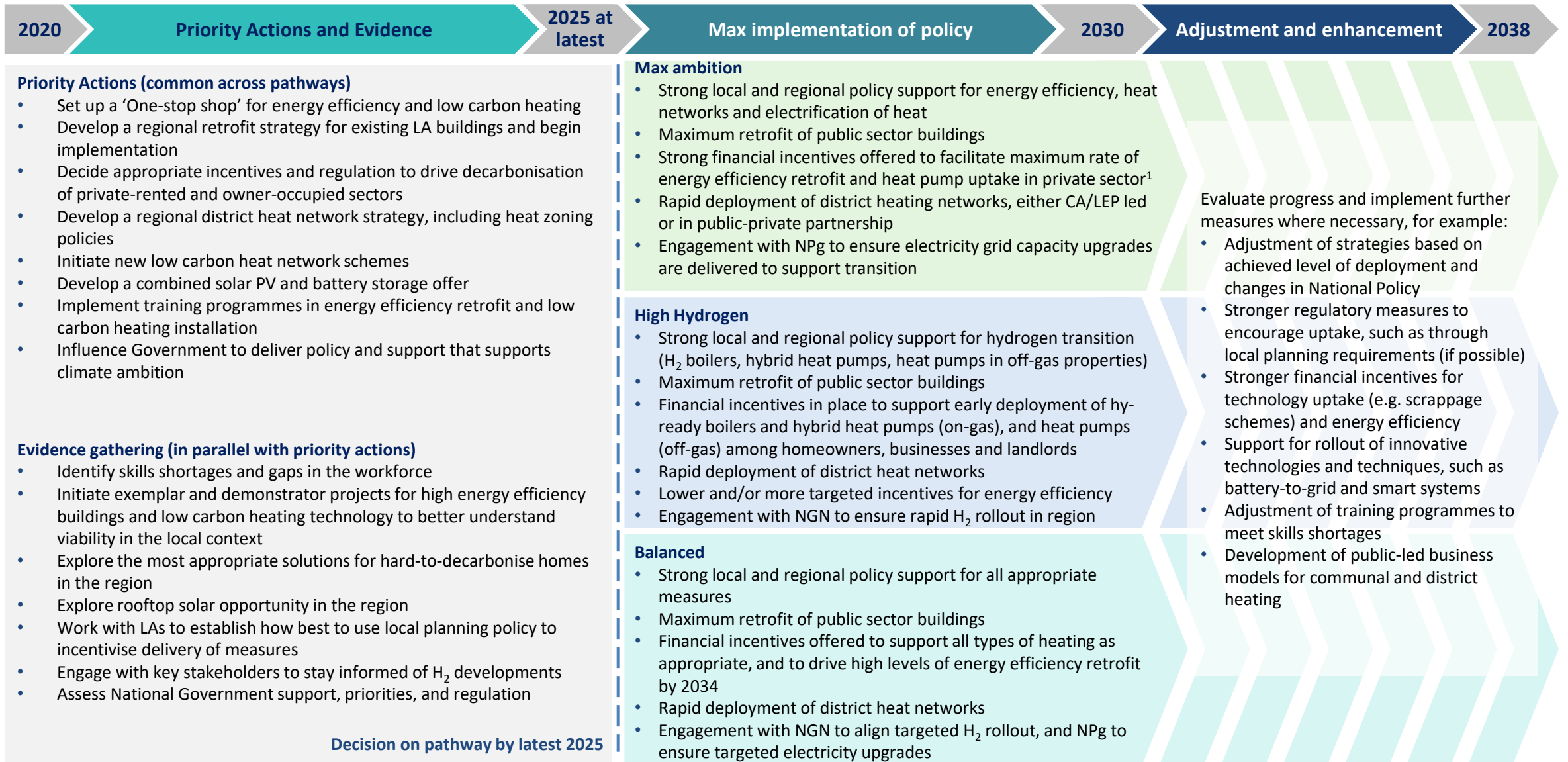
Policy with higher significance for WY

Policy with higher significance for YNY



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

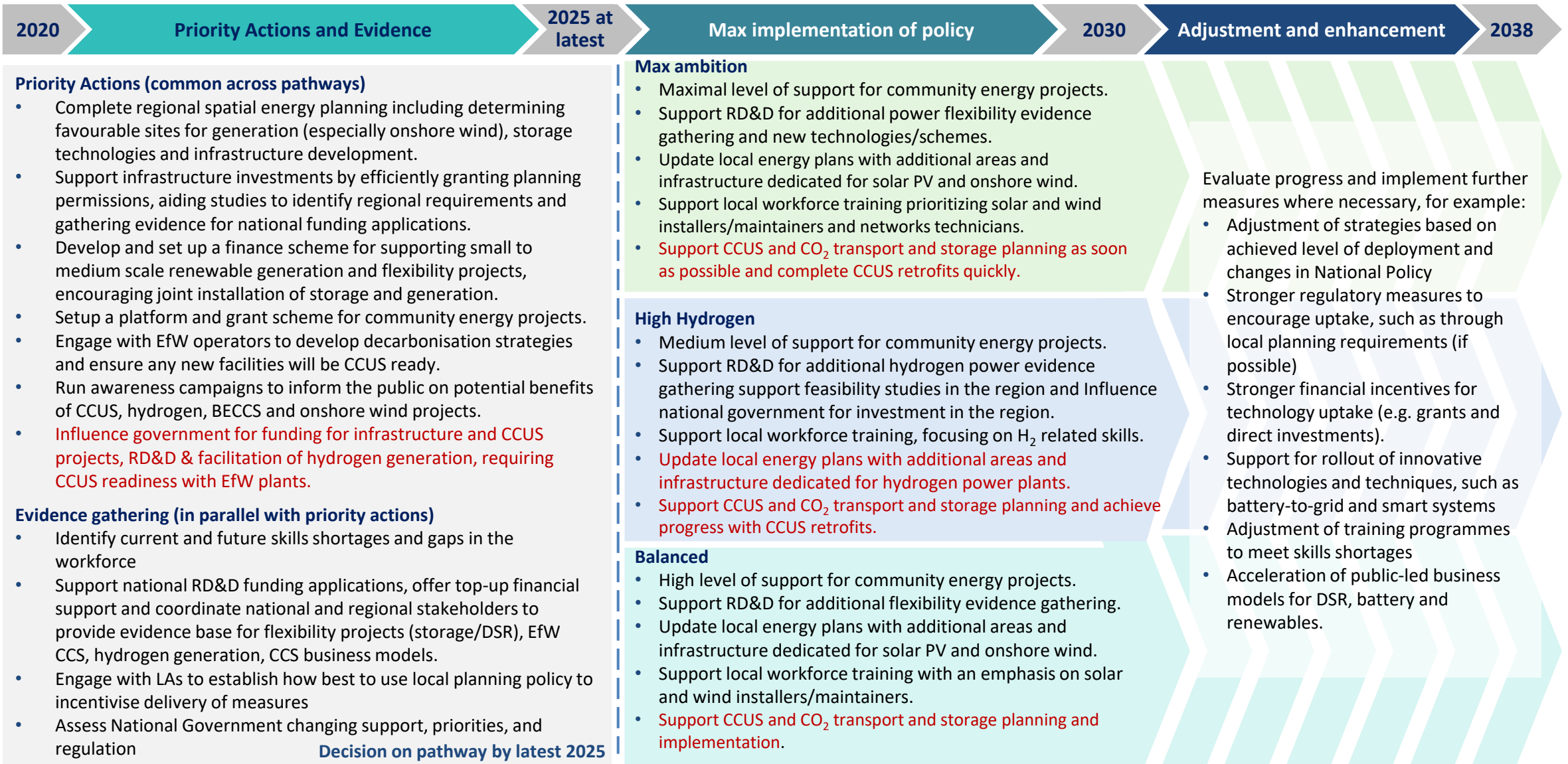


1. Homeowners, private landlords and businesses

Action plan – Power

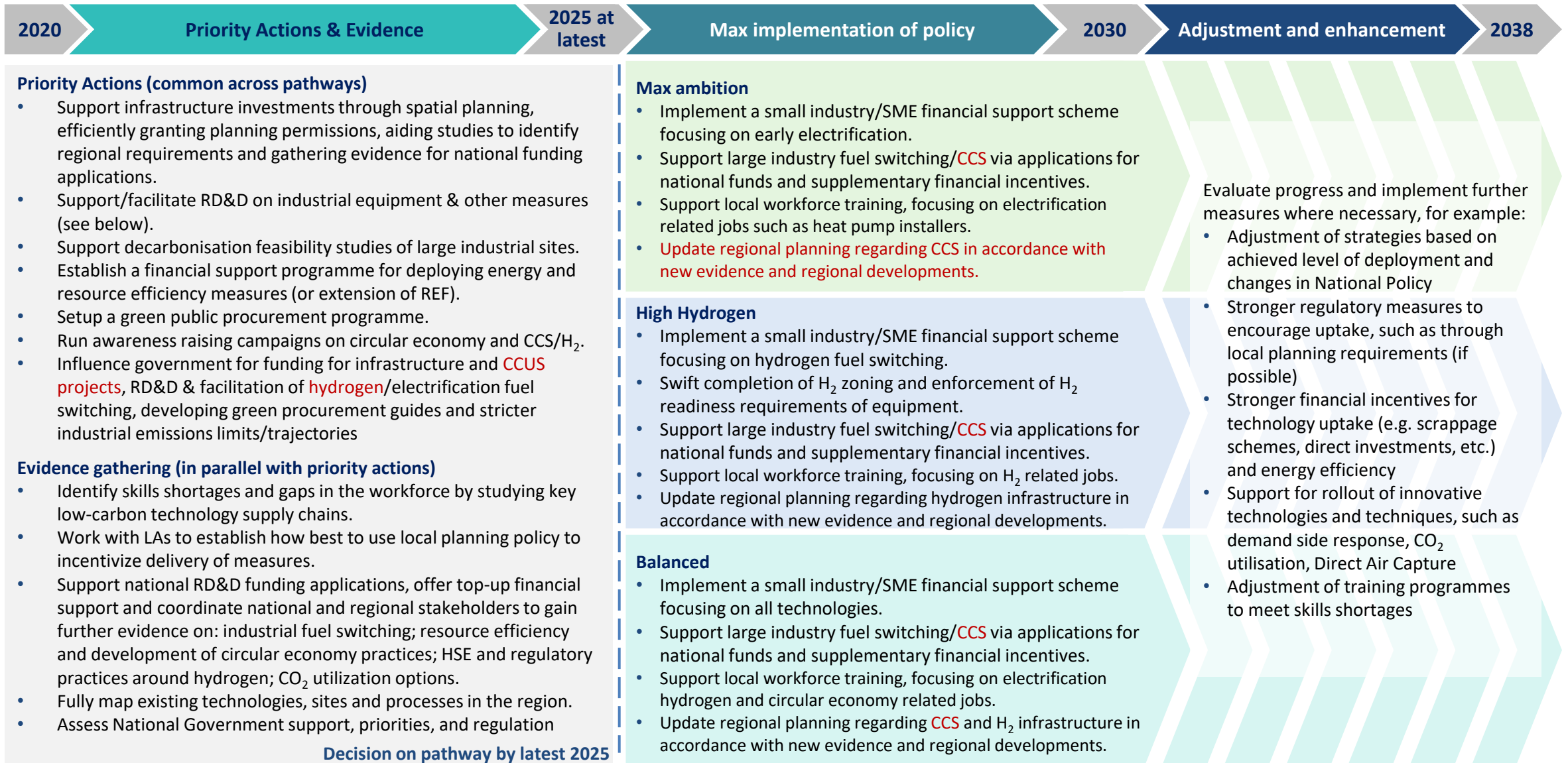
Key

Policy with higher significance for YNY



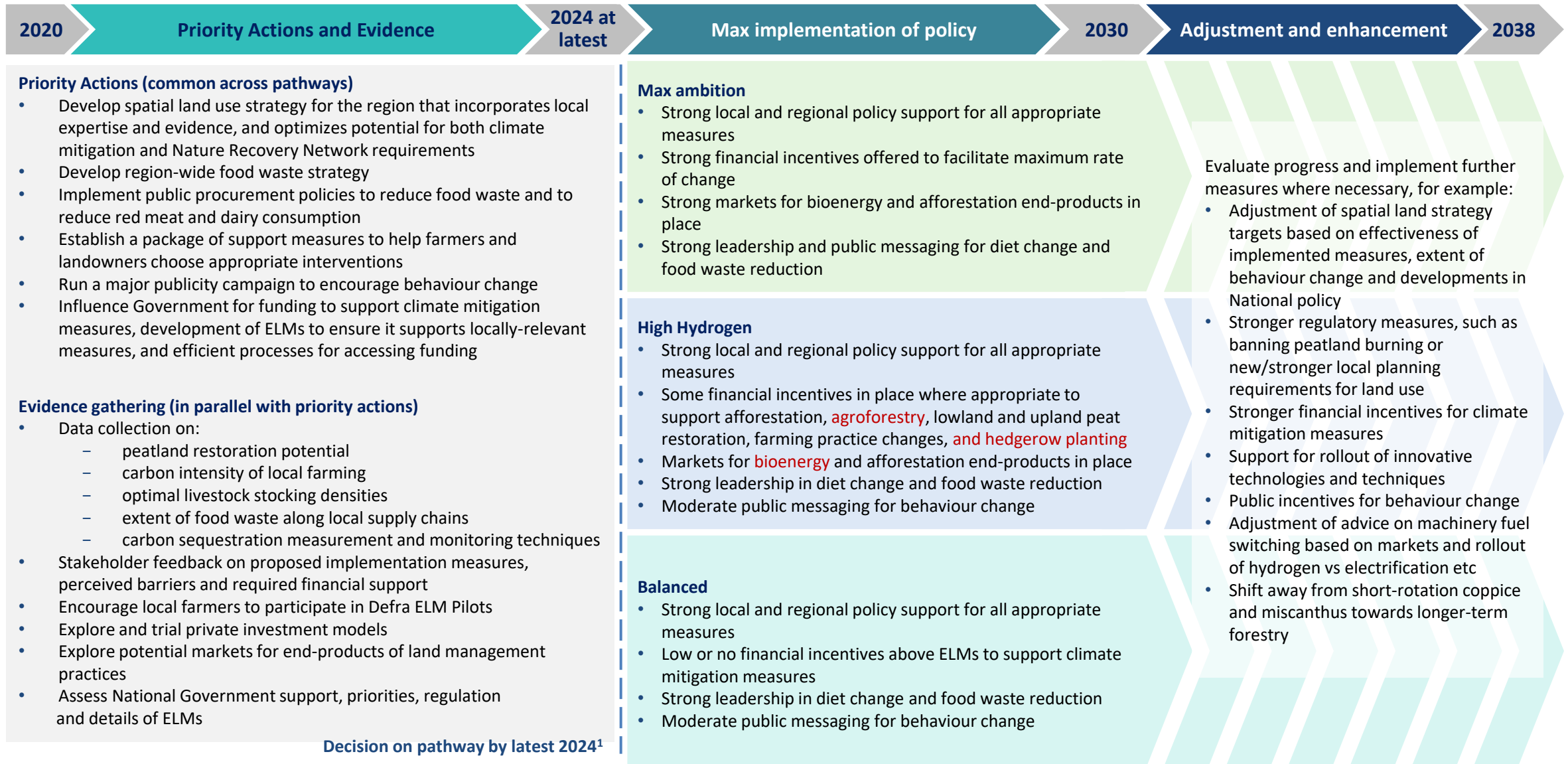
Action plan – Industry

Key
Policy with higher significance for YNY



Action plan – LULUCF and agriculture

Key
Policy with higher significance for YNY



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	<ul style="list-style-type: none"> • Reduction and delayed growth in travel demand as travel demand is linked to economic growth • Reduced overall energy use – both in domestic and commercial/industrial sectors 	<ul style="list-style-type: none"> • Reduced household spending power limiting the competitiveness of new technologies with fossil-based incumbents • Risk of delay to deployment of technologies if public spending is cut back, particularly for technologies in demonstration or scale-up phase¹
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}	<ul style="list-style-type: none"> • Reduced travel demand due to commuting • 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 • Changes in energy demand profiles, with flattening of peak demand 	<ul style="list-style-type: none"> • Contributes to emissions reduction where overall reduction in travel is maintained • 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	<ul style="list-style-type: none"> • Reliance on high emissions modes risks transport emissions surpassing pre-pandemic levels as restrictions ease • Potential for more trips to be taken using active travel through increased awareness/experience during lockdown 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Increased van and HGV demand, particularly in retail and grocery sectors 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Potential for higher emissions where fossil fuel use is favoured over lower emissions alternatives 	<ul style="list-style-type: none"> • 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:

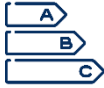



- **Long-term viability of shared and public transport** – reductions in patronage and restrictions on capacity mean that some services may be lost, particularly in low population density areas; ensuring that these services work for everyone in the future is one of the most important outcomes of a COVID-19 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

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
	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	<i>Not included</i>	T24
		Aircraft support vehicle electrification	<i>Not included</i>	<i>Not included</i>

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




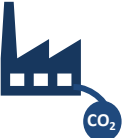


Summary table – Buildings. This table shows how the modelled outcomes map to the measures and through to the required policies and actions

Sector	Modelled outcome	Measure	Roadmap theme	Policies and actions to deliver measure ¹
Buildings    	Improved energy efficiency	Retrofit existing public buildings		B2 , B5 , B9 , B10 , B11
		Retrofit existing private buildings	Energy efficiency	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 flexibility²	Flexibility technologies (e.g. storage, DSR)	Other	P1 , P2 , P4 , P6 , P7 , P8 , P12 , P15 , P13 , P14	
	New infrastructure	<i>Not included</i>	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	<i>Not included</i>	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		<i>Not included</i>	L4 , L5 , L11
Reduced emissions from agricultural machinery	Other agricultural practices			L1 , L4 , L5 , L11 , L13	
	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

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 risks¹.
- 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.

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.