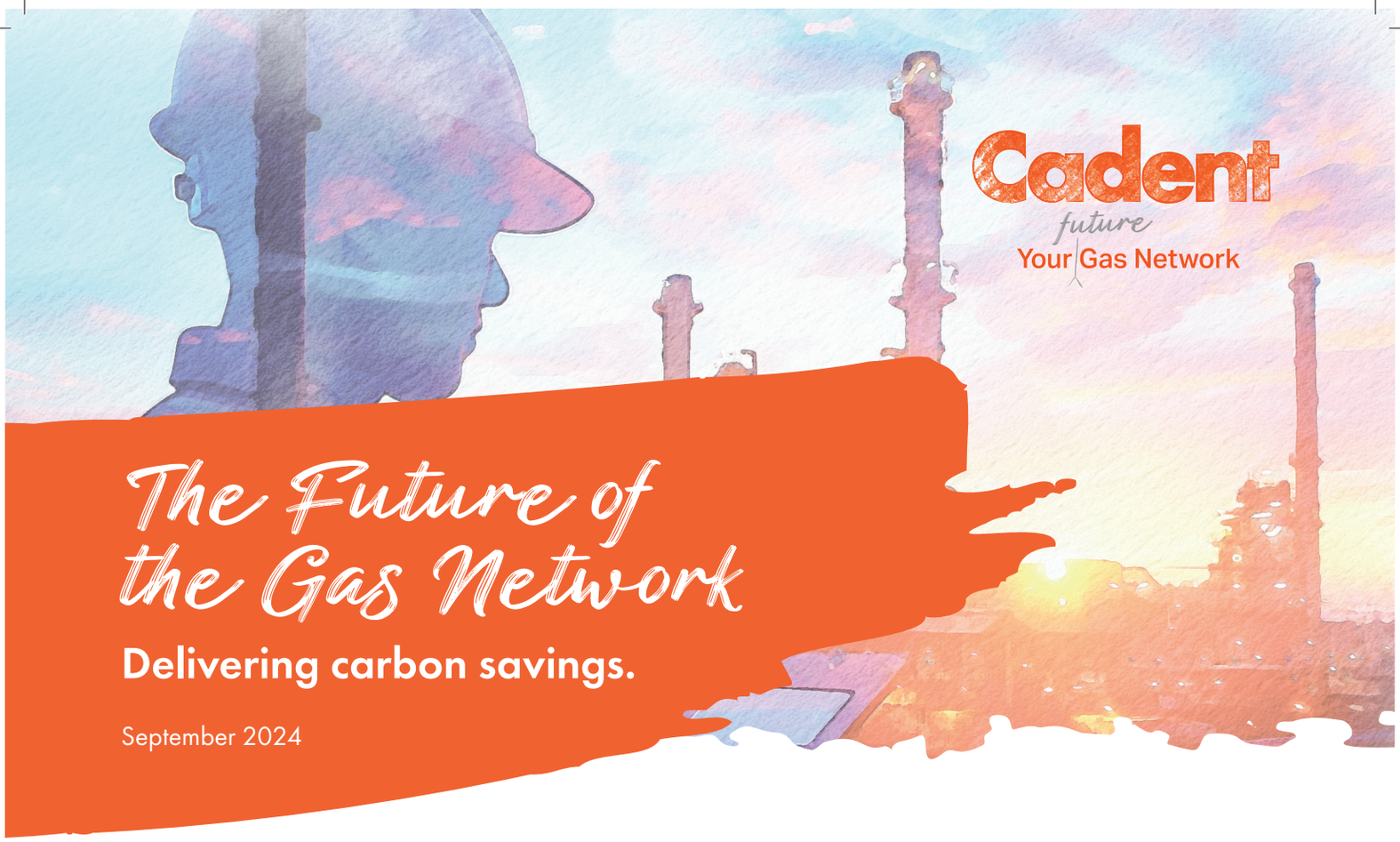


The Future of the Gas Network

Delivering carbon savings.

September 2024

Executive summary

There are several published pathways and scenarios that would enable the UK to achieve its net zero greenhouse gas emissions targets. What is increasingly clear is that across these pathways the gas network will be required for some time to come and will play a pivotal role in enabling the UK to hit net zero. Delivering and managing a lower carbon gas network is therefore a key priority for Government and the gas network companies alike.

There is a growing gap in the carbon budgets that sets the total amount of greenhouse gas the UK can emit during a five-year period, caused by the slow delivery of home heat decarbonisation. Over the fifth and sixth carbon budgets (CB5 and CB6) that cover a critical decade between 2028 and 2037, there is very likely to be a shortfall in the uptake of heat pumps, which we conservatively estimate could be in the region of five to six million, against a government target of around eight million.

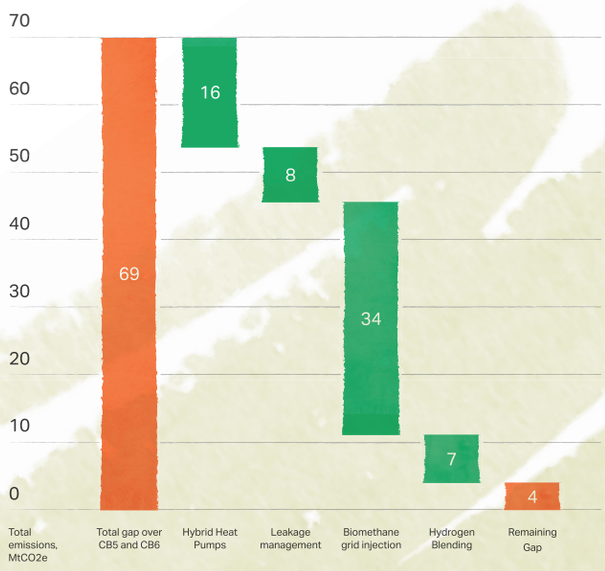
If we pick the middle of that range, that amounts to a shortfall of around 5.5 million heat pumps, resulting in an estimated **total emission gap of 69 mtCO2e.** A combination of three key interventions, which can be enabled by the gas network could help close the bulk of the gap in carbon emissions:

1. The adoption of hybrid heat pumps;
2. An acceleration of methane leakage management; and
3. Maximising the potential of biomethane together with hydrogen blending into the gas network.

We estimate that together these interventions could amount to a reduction in emissions of around 65 mtCO2e over CB5 and CB6, (i.e. around 94% of the total emission shortfall).

This is illustrated in Figure 1.

Figure 1 - Total emission reduction from interventions over CB5 and CB6



Introduction

In May 2024, Cadent published a report on The Future of the Gas Network [1] , which set out the crucial role that the gas network will play in delivering net zero. Our gas distribution infrastructure transports gas to more than 11 million homes and 40,000 industrial customers safely across 135,000km of network, making us the largest energy provider to homes, businesses and industry in the UK today. Our network alone carries almost as much energy as the entirety of the UK's electricity network does today and includes the three largest cities in the UK – London, Birmingham and Manchester – as well as big businesses like Rolls Royce, British Sugar, and Liberty Steel.

In that report we outlined three key roles that our gas network can play as we transition to net zero. Firstly, we'll enable energy solutions that provide flexibility, resilience, and reduce consumption, such as access to gas for flexible power generation and hybrid heating systems. Secondly, we'll drive reductions in emissions while our customers still need gas, and this means a focus on reducing gas leaks and displacing fossil fuel methane with biomethane. Finally, we'll get the network ready to distribute hydrogen for when and where it is needed, because repurposing gas pipes is less expensive than decommissioning them or building a new network.

In this report, which is designed to accompany The Future of the Gas Network report, we have calculated the carbon budget impact of delivering three key interventions that were set out in the report

1. The adoption of hybrid heat pumps;
2. An acceleration in methane leakage management; and
3. Maximising the potential of biomethane together with hydrogen blending into the gas network.

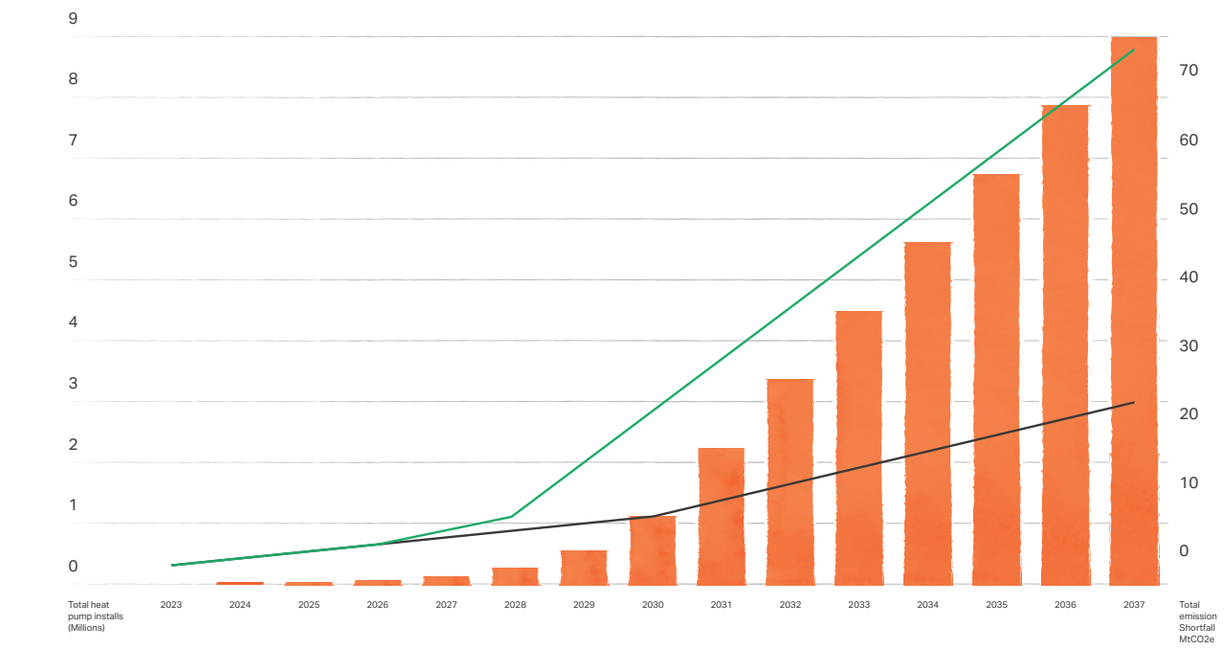
The methodology of the analysis and sensitivities are all outlined in the Annex to this paper for transparency. We have compared the potential savings to the current shortfall in carbon emission savings from heat pumps, to demonstrate the scale of the opportunity. There is a growing gap in the carbon budgets caused by the slow delivery of decarbonisation efforts in domestic dwellings, that are a result of the slow uptake of heat pumps. Continued under delivery creates a carbon budget gap of 69 million tonnes of CO2e (mtCO2e) by the end of CB6. This report also sets out ten policy recommendations throughout, which we summarise at the end.

About the carbon budgets

The Climate Change Committee's (CCC's) five-year fifth and sixth carbon budgets cover a critical decade between 2028 and 2037 which require the UK to halve its total emissions from 478 mtCO2e per year in 2024 to 254 mtCO2e per year on average across the decade. Achieving this requires decarbonisation across all sectors of the economy. The CCC's 2024 Progress Report published in July 2024 indicates that 'credible plans' cover only about 20-25% (42-55 mtCO2e) of the emissions over these budgets. A major challenge contributing to this gap is the slow progress in heat decarbonisation, particularly the slow uptake of heat pumps.

The CCC's Balanced Pathway [2] scenario requires annual heat pump installations to reach 739,000 a year by 2030, rising to around 800,000 a year by the end of CB6. In comparison, the Government has set a target of 600,000 installations annually by 2028. However, with only 60,000 [3] installed in 2023 and an estimated 70,000 this year, the 2028 target is unlikely to be met. On this trajectory, there would be a total shortfall of **between five and six million heat pumps over CB5 and CB6, yielding a total emission gap a little over 69 mtCO2e. Over CB5, the emission gap is 19 mtCO2e and 49 mtCO2e over CB6.** This is illustrated in Figure 2.

Figure 2 - Heat pump deployment and the emission shortfall



Emission gap

HP deployment based on current trajectory

HP deployment needed to meet CB5 & CB6

Mitigating the risk to delivering the carbon budget is a critical priority for energy policy and meeting net zero. A material contribution could be made in closing this or any emissions gap, through support from gas networks through:

1. the adoption of hybrid heat pumps;
2. accelerating methane leakage management; and
3. maximising the potential of biomethane together with hydrogen blending into the gas network.

Given the Cadent network constitutes approximately 50% of the UK gas network one would expect the impact of Cadent's initiatives to be able to be doubled for the purposes of the calculations in this paper. The emissions reductions outlined here could of course in large part be additional to those delivered through heat pump deployment should that technology deliver to the expected plan. In any case, the opportunity is significant.

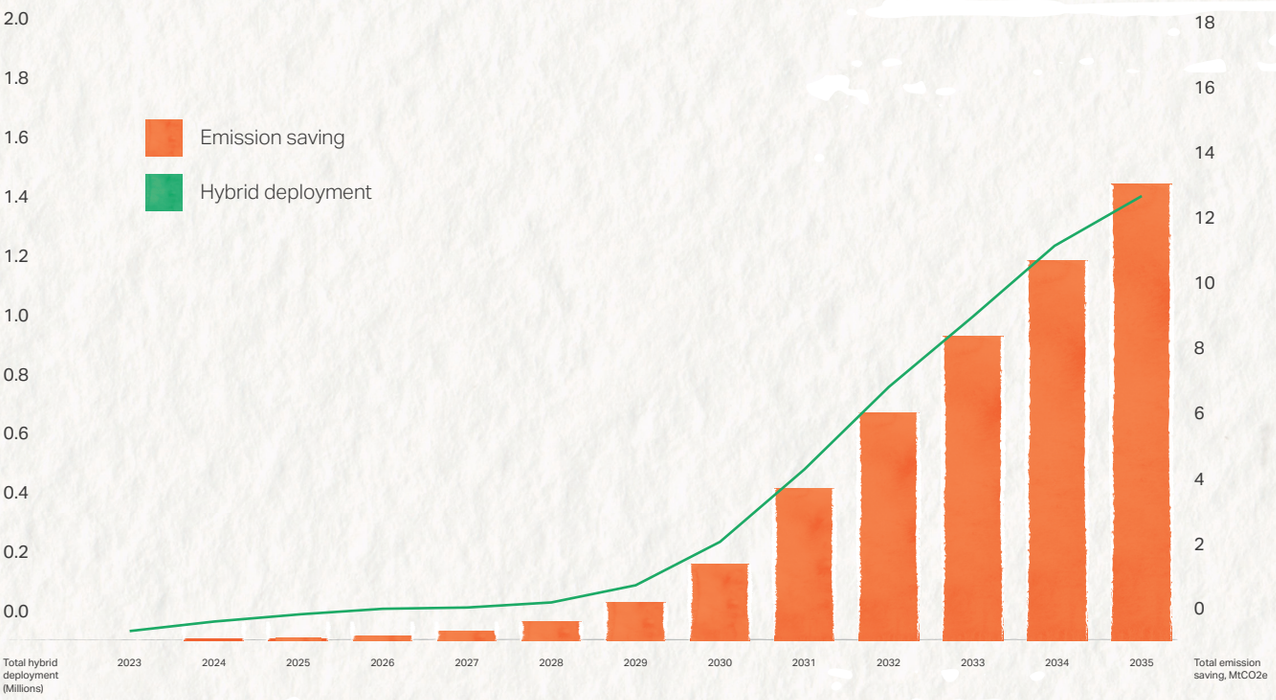
Adopting hybrid heating systems

Many homes today cannot easily adopt heat pumps due to space, cost, or disruption constraints. Various reports [4] have estimated the proportion of homes that are not viable for a heat pump – ranging broadly between 20 and 40% (Delta-EE, Element Energy for the CCC, Energy Utilities Alliance and Aurora for the National Infrastructure Commission). This suggests that up to 40% of homes, equivalent to 9.2 million homes across the UK, are difficult for full heat pump systems. Hybrid heating systems could provide a viable alternative.

Hybrids are a known technology in Europe and have been supported to reduce electricity reinforcement needs and save carbon emissions by up to 80%. Support for hybrids could enable immediate emission reductions without waiting for an affordable full electric solution. While there are similar challenges related to the supply chain and skills, hybrids are more likely to be supported by consumers due to lower costs and space-saving benefits.

The CCC's Balanced Pathway estimates there could be 1.8 million hybrids by the end of CB6. Assuming these hybrids displace gas heating, a total of 16 mtCO2e could be saved, over CB5 and CB6. Around 76% of this saving occurs over CB6 (12.2 mtCO2e) due to higher deployment and a nearly decarbonised power grid. The remaining 24% of emission savings (3.8 mtCO2e) occur over CB5.

Figure 3 - Total hybrid deployment and emission saving by the end of CB6



Despite this ambition from the CCC, hybrid heat pumps have not yet taken off due to a lack of financial and policy support. This represents a missed opportunity for consumers who could reduce emissions now. In Europe, hybrid heat pumps are gaining traction, particularly in Italy and the Netherlands, where gas networks are extensive. In Italy, hybrid heat pumps have captured 40% of the heat pump market while in the Netherlands, around 125,000 hybrids could be installed in 2024. This progress is driven by supportive policies, including financial grants, tax rebates, subsidies and zero-interest loans.

If support was forthcoming, there would be causes for optimism that hybrids would grow. Therefore, we propose three actions:

1. To add hybrid heat pumps to the Boiler Upgrade Scheme, and other affordability schemes that provide grants to support consumers investing in hybrid heating.
2. To support a series of hybrid demonstrators and trials that help to establish minimum control standards so that hybrid systems maximise carbon savings and demonstrate how hybrids can support electricity flexibility and demand-side response.
3. For Ofgem to require, at a suitable point, the electricity network operators to calculate the benefit of hybrids to reducing the costs needed in electrical capacity upgrades. This requirement could be for example when the electricity network operators prepare their plans for their RIIO-3 submissions in 2026, or sooner.

2

Accelerating methane leakage management

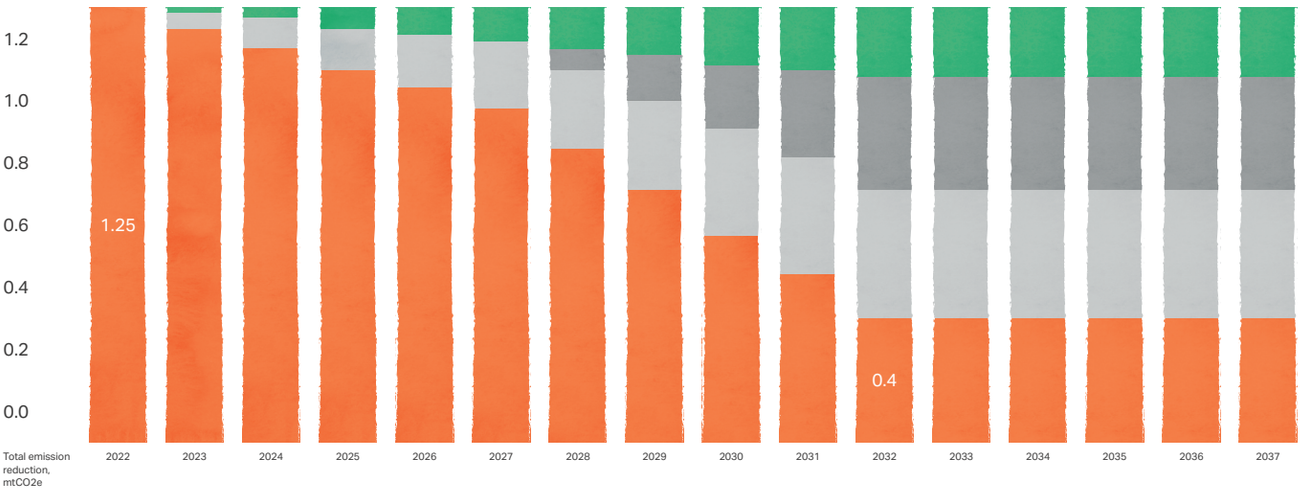
Cadent's Scope 1 and 2 greenhouse gas emissions (i.e. direct emissions and those from the generation of purchased energy) totalled 1.25 mtCO2e in 20221. Around 95% of these emissions are driven by methane leakage from metallic pipes remaining on the network. Hence, one of the largest mitigations to reduce emissions is to tackle the leakage from metal pipes. Through the Iron Mains Risk Reduction Programme (IMRRP), gas distribution networks have been replacing old iron pipes with plastic ones which are less prone to leakage. This is a 30-year programme to meet a requirement set by the Health and Safety Executive. The emission benefit of this policy is already accounted for in the Carbon Budgets, delivering annual savings of 1 mtCO2e over CB5 and CB6.

Cadent has been working in partnership with other organisations to better target leakage interventions and to create more rapid and greater leakage reduction through deploying innovative new leak detection technology and creating a Digital Platform for Leakage Analytics (DPLA). DPLA will show data, analytics and use sensors to identify, locate and proactively predict leaks in the gas distribution network and enable more optimised and rapid intervention. Other operational areas to lower emissions including venting measures - replacing controllers, recompression, and deploying zero-emission odorising stations.

While the IMRRP is accounted for in CB5 and CB6, other areas of potential emission reduction are not, such as additional or more optimised interventions from leak detection technology and the DPLA (effective from 2028). We have assessed the potential benefits from creating a targeted programme of interventions building on the new leakage technology. These programmes could reduce emissions from the network by an additional c.40% by 2032 [5] or around 0.5 mtCO2e a year – roughly the equivalent of the emissions from 60,000 homes.

The cumulative emission reduction potential from this is 4.2 mtCO2e over both CB5 and CB6. Extrapolating this emission reduction potential for the UK would see a doubling of the potential to 8.4 mtCO2e over CB5 and CB6. This is illustrated in Figure 4.

Figure 4 - Cadent network emission profile through to the end of CB6



We are developing targeted interventions to continue reducing our carbon footprint and will be proposing these in our upcoming regulatory business plan submission to our economic regulator Ofgem for the 2026-2031 period (known as RIIO3). Ofgem has set out its intent to support a greater ambition to reduce leakage in its decision on the proposed regulatory framework for RIIO3 and has been supporting leakage innovations during this current regulatory period. We recommend two actions for Ofgem:

1. Support the rapid rollout of leakage detection technology and the creation of the DPLA.
2. Support cost beneficial additional interventions that would materially benefit the carbon budget.

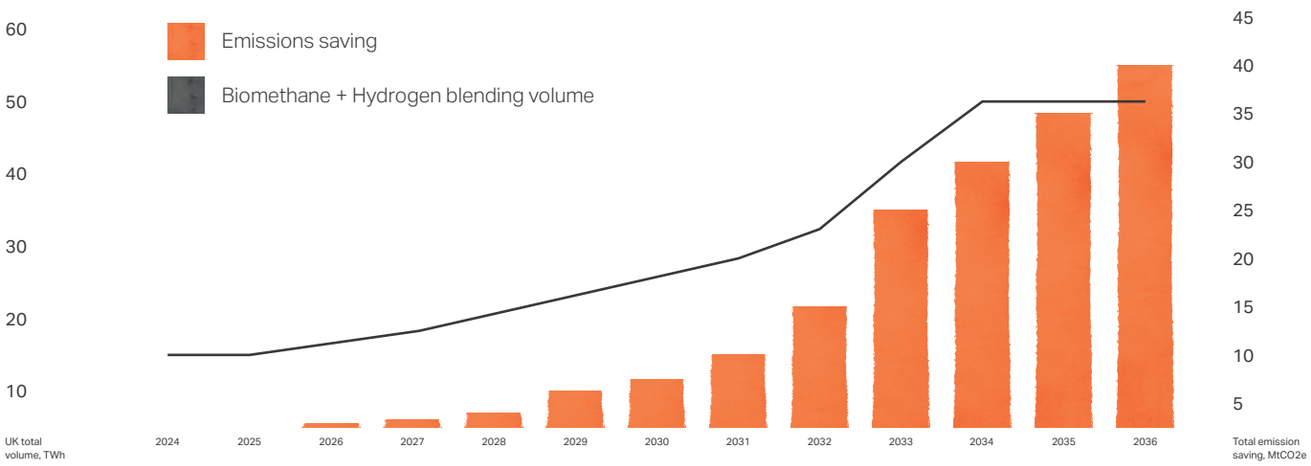
3

Maximising biomethane and blended hydrogen

We plan to reduce the carbon intensity of the gas we supply by maximising biomethane and hydrogen into the gas network, thus displacing methane. Biomethane is currently supported under the Green Gas Support Scheme and the Government have approved the potential to blend hydrogen at 20% by volume (subject to HSE confirmation). We estimate that biomethane potential can grow significantly by the end of CB6 reducing the overall emissions of gas supply.

Today, connections across our footprint total 45 sites enabling 3.5 TWh of biomethane injection into the grid. Our ambition is that by 2035, we will have up to 20 TWh of low carbon biomethane by the end of CB6. This could be supplemented by up to 5 TWh of blended hydrogen across the Cadent region. This is illustrated in Figure 5.

Figure 5 - Biomethane and blended hydrogen total volume and emission savings



The UK benefit seen in terms of the UK's emissions can be extrapolated by assuming Cadent constitutes 50% of the gas distribution system. Over CB5, 10.1 mtCO2e could be abated due to biomethane, while the benefit from hydrogen blending is 0.5 mtCO2e. Over CB6, 23.6 mtCO2e could be abated through biomethane, while the benefit from hydrogen blending increases to 6.1 mtCO2e as more hydrogen is blended into the gas network. The total emission savings from biomethane and hydrogen blends over CB5 and CB6 is 40 mtCO2e.

To enable continued growth in biomethane and hydrogen, we would encourage Government and regulators to:

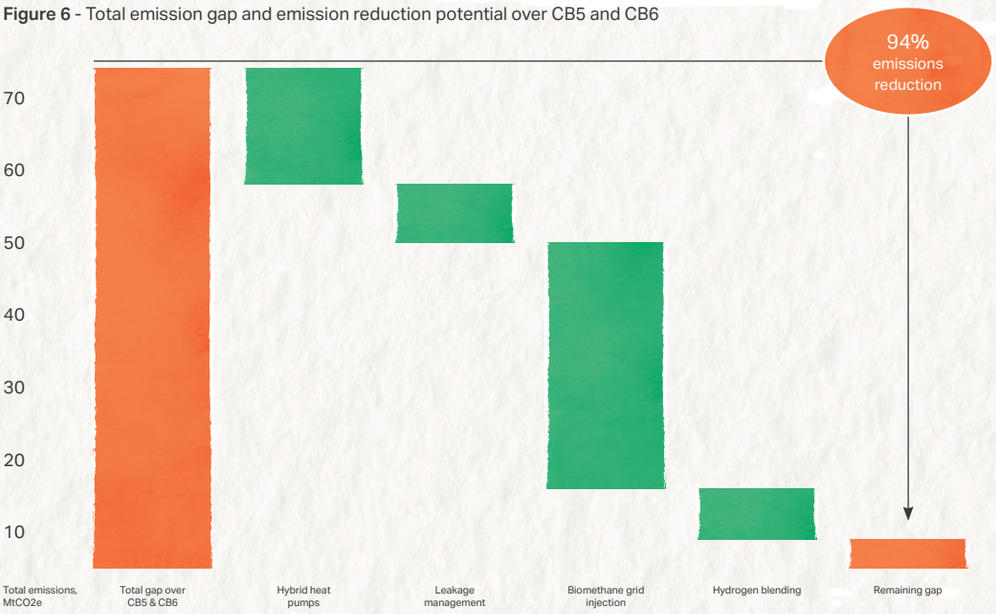
1. Continue the Green Gas support mechanism beyond 2028.
2. Enable gas networks to invest in actions that create capacity for biomethane through the RIIO3 business planning process.
3. Take a positive decision on the role of hydrogen blending as soon as possible.
4. Add hydrogen to the green gas certification scheme so that blended hydrogen can be traded - and has a decarbonisation value.
5. Enable hydrogen producers to benefit, and scale up their activities, by allowing blended hydrogen to achieve support under the Contracts for Difference mechanism.

Conclusions

Impact on the gap in fifth and sixth carbon budgets

Between CB5 and CB6, there is an estimated shortfall of around 5.5 million heat pumps. This creates an emission gap of 69 mtCO2e, covering a critical decade between 2028 and 2037. **The emission reduction strategies outlined above, when combined, help reduce emissions by 65 mtCO2e over CB5 and CB6, helping to meet around 94% of the total emission shortfall.** This is illustrated in Figure 6.

Figure 6 - Total emission gap and emission reduction potential over CB5 and CB6



We believe the emissions reductions set out are challenging yet achievable, and we have added the methodology and some sensitivity analysis to the Annex.

A summary of our policy asks in this paper

In this paper we have set out ten key policy asks of Government and Ofgem:

1. To add hybrid heat pumps to the Boiler Upgrade Scheme, and other affordability schemes that provide grants to support consumers investing in hybrid heating.
2. To support a series of hybrid demonstrators and trials that help to establish minimum control standards so that hybrid systems maximise carbon savings and demonstrate how hybrids can support electricity flexibility and demand-side response.
3. For Ofgem to require, at a suitable point, the electricity network operators to calculate the benefit of hybrids to reducing the costs needed in electrical capacity upgrades. This requirement could be for example when the electricity network operators prepare their plans for their RIIO-3 submissions in 2026, or sooner.
4. For Ofgem to support the rapid rollout of leakage detection technology and the creation of the DPLA.
5. For Ofgem to support cost beneficial additional interventions that would materially benefit the carbon budget.
6. Continue the Green Gas support mechanism beyond 2028.
7. For Ofgem to enable gas networks to invest in actions that create capacity for biomethane through the RIIO3 business planning process.
8. Take a positive decision on the role of hydrogen blending as soon as possible.
9. Add hydrogen to the green gas certification scheme so that blended hydrogen can be traded - and has a decarbonisation value.
10. Enable hydrogen producers to benefit, and scale up their activities, by allowing blended hydrogen to achieve support under the Contracts for Difference mechanism.

Annex

The key assumptions used in this paper are set out below:

Key domestic heat targets over CB5 and CB6

5th Carbon Budget (2028 to 2032) Targets for domestic heat

- Heat pumps and district heating for 13% of homes.
- Increased insulation (1.5 million solid walls, 2 million cavity walls)
- Heating controls and efficient lights and appliances

6th Carbon Budget 2033 to 2037 Targets for domestic heat

- Over 8 million heat pumps installed in existing homes
- More than 3 million homes on low-carbon heat networks
- Rapid scale-up of supply chains for critical insulation measures (14 million by 2037)
- 12% reduction in demand through energy efficiency and behavioural changes

Heat pump emissions

We assume the efficiency of heat pumps is 300% through to CB6. Annual heat demand is calculated by taking Ofgem's typical domestic consumption value, 11,500 kWh, and adjusting by the average gas boiler efficiency (87%). We assume heat demand decreases 0.6% per year, a conservative estimate. Heat demand is then adjusted by the efficiency of a heat pump to give an annual consumption value. This consumption value multiplied by the emission intensity of the electricity grid which decreases from 131gCO2e/kWh in 2023 to 17gCO2e/kWh by 2037. The annual emissions from a heat pump in 2023 is 44gCO2e/kWh and falls to 5gCO2e/kWh by 2037.

Hybrid heat pump operation and emissions

We assume that the heat pump element meets 80% of annual heat demand, with the boiler meeting the remaining 20%. A typical gas household emits 2.1 tonnes of CO2e. Using the heat pump emissions data (above) and applying the relevant heat shares to each technology, the annual emissions from a hybrid in 2023 are estimated to be 0.77gCO2e/kWh, falling to 20gCO2e/kWh by 2037.

Estimating the heat pump deployment shortfall over CB5 and CB6

The CCC provides projections on heat pump uptake from 2020 to 2050. Under their Balanced Pathway scenario, annual heat pump installs increase from 56,000 in 2023, to 740,000 a year by 2030 and 785,000 a year from 2034 onwards. This enables us to create an annual time series from 2024 to 2037 which shows the number of annual heat pump installs needed to meet CB5 and CB6.

We then estimate the projected growth in heat pump installs based on historic deployment levels. Heat pump sales in 2019 were c.35,000 and have risen to 60,000 in 2023. Future growth in heat pump deployment could be linear (with the same increase in installs each year) or exponential (small increases before increasing sharply as the market booms). We model both deployment trajectories (linear and exponential) and take the average of the two. This gives us a realistic estimate of future heat pump deployment based on historic deployment.

We then calculate the shortfall which is the difference between target heat pump installs (under the CCC's Balanced Pathway scenario) and projected heat pump installs based on historic deployment.

Biomethane emissions, technical potential and additional site requirement

- Emission intensity

We have taken the emission factor as recommended in the Green Gas Support Scheme Impact Assessment [6]. The overall biomethane emissions factor under the governments central scenario is 30gCO2e/kWh. This is based on a weighted average of the emissions from different feedstocks such as food waste, maize, agricultural waste and sewage sludge.

- Technical potential

Cadent has ambitions to enable up to 20 TWh of biomethane by 2035.

Blended hydrogen technical potential

The Future Energy Scenarios see blending largely taking place from the late 2020s to early 2030s. The maximum amount of blending reaches 15 TWh in 2030 under the Holistic Transition pathway and 10 TWh in 2030 under the Hydrogen Evolution pathway. Blending is minimal by the late 2030s in these pathways.

From this and given the likely timescales for blending on a commercial scale, we assume blending takes place from 2030, reaching a maximum of 10 TWh by 2035. The amount of blending across Cadent's network could reach 5 TWh by 2035.

- Emission intensity

We assume 60% of total hydrogen supply comes from electrolytic hydrogen and has a carbon intensity of zero. The remaining 40% is met by autothermal reforming of methane with carbon capture which has a maximum emission intensity based on the Low Carbon Hydrogen Standard – 20 gCO2e/MJLHV or 7.2 gCO2e/kWhLHV. The average intensity is therefore 2.8 gCO2e/kWh.

Total Emission reduction potential

The table below tabulates a full breakdown of the total emission shortfall and emission reduction potential from the various strategies over CB5 and CB6.

Proposed strategy							
	Year	Emission shortfall from heat pump gap	Leakage management	Enabling hybrids	Maximising biomethane	Hydrogen blending	**Total**
Cumulative, MtCO2e							
CB5	2028	1.4	0.4	0.5	0.8	0.0	**1.6**
	2029	4.0	0.9	1.0	2.2	0.0	**4.0**
	2030	7.9	1.6	1.7	4.2	0.1	**7.5**
	2031	13.1	2.4	2.5	6.8	0.2	**12.0**
	2032	19.4	3.4	3.8	10.1	0.5	**17.7**
CB6	2033	27.0	4.4	5.3	13.9	0.9	**24.5**
	2034	35.7	5.4	7.1	18.4	1.9	**32.8**
	2035	45.6	6.4	9.6	23.5	3.4	**42.9**
	2036	56.6	7.4	12.5	28.6	5.0	**53.5**
	2037	68.7	8.4	15.9	33.7	6.6	**64.6**

Sensitivity analysis – exploring alternative trajectories

The level of emission reduction can be higher or lower depending on the level of deployment of each activity. These can be higher or lower, relative to the current assumption, depending on a range of economic, political and technical factors.

The current assumptions presented in this paper are that total biomethane deployment reaches 20 TWh by 2035 across the Cadent network (40 TWh for the UK), nearly 2 million hybrid heat pumps displace gas heating, and targeted interventions reduce gas network methane leakage emissions. The table below presents alternative trajectories that could also materialise, thereby impacting the level of emission reduction.

	Current assumptions	Trajectory 1	Trajectory 2
Leakage	- DPLA - Other operational improvements	- Other operational improvements only deliver 50% of the target emissions savings - DPLA delivers 100% emission reduction against target	- DPLA only achieves 50% emission reduction against target - Other operational improvements deliver 100% emission reduction against target
Biomethane	- 20 TWh by 2035 (40 TWh across UK)	- 16 TWh deployed by 2035 - (32 TWh across UK) – similar to the level assumed by the REA	- 10 TWh deployed by 2035 (20 TWh across the UK)
Hybrids	- 1.8 million hybrids displace gas heating	- 1 million hybrids displace gas heating	- 0.5 million hybrids displace gas heating
Hydrogen blending	- 5 TWh by 2035 (10 TWh across UK)	- Same as current assumption	- 3 TWh by 2035 (6 TWh across UK)
Total emission reduction, MtCO2e	64.6	38.1	15.5
% emission reduction, relative to emission shortfall by heat pumps	94%	56%	23%

End notes

1. 2024_Future-of-the-Gas-Network_vFinal_1.pdf (cadentgas.com)
2. Sixth Carbon Budget – Climate Change Committee
3. Heat Pump Association - HPA
4. Delta EE, Element Energy (for the CCC), Energy Utilities Alliance and Aurora (for the NIC)
5. For this paper, the impact of IMRRP is excluded as it's already accounted for in the Carbon Budgets. It is, however, shown in figure 2 for completeness.
6. Final stage IA: Green Gas Support Scheme/Green Gas Levy - BEIS

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