CALOR

Submission - DECC Consultation - Introduction of a Renewable Heat Obligation

October 29th, 2021

Calor Gas

A champion for change in rural Ireland

CALOR

Introduction

Calor welcomes the opportunity to respond to the Department of the Environment, Climate and Communications' consultation on the Introduction of a Renewable Heat Obligation (RHO).

The transition to a low-carbon economy brings opportunities for clean technology growth, job creation and competitive advantage in FDI, as well as wider benefits including improved standard of living, clean air and better health. Calor recognises that if Ireland is to maximise these opportunities and deliver the benefits, a whole of government approach is critical, together with strong collaboration with energy suppliers, industry and local communities.

Calor supports, in principle, the proposal for a RHO, as a market mechanism to incentivise the development of renewable heat and specifically renewable gas, which addresses the EU's core principles of sustainability, security of supply and competitiveness.

In the enclosed response, Calor highlights that in the development of a RHO, it is imperative that the need for an equitable and Just Transition process is ensured. As is already committed to in the Programme for Government (PfG, 2020), it is crucial that as part of a Just Transition, the Government addresses the cost implications for rural consumers and businesses. Analysis on the cost impact of a proposed obligation is highlighted in our response. Calor supports the call for several policy interventions, in line with the heating sector's 40by30 report (2021) – "A 40% Renewable Heat Vision by 2030".

Calor has been supplying lower carbon LPG to rural homes, businesses and communities across Ireland for over 80 years. Sustainability is at the heart of Calor's business strategy. By 2037, Calor's ambition is that all of its energy products will be from renewable sources, the company's centenary year.

In 2020, Calor joined 40 leading companies in Ireland in achieving the Business Working Responsibly Mark, the leading independently audited standard for Corporate Social Responsibility (CSR) and Sustainability certification in Ireland. The Mark is audited by the National Standards Authority of Ireland (NSAI) and is based on ISO26000.

Calor supports a multi-technology pathway to decarbonisation in the heat and transport sectors in Ireland and is devoting significant resources to product innovation and diversification as part of the company's decarbonisation strategy. With the launch of a renewable liquefied petroleum gas (BioLPG) in 2018, Calor demonstrated its commitment to playing an active role in Ireland's transition to a decarbonised economy. BioLPG offers up to 90% lower emissions than existing LPG products.

75% of rural areas in Ireland are without availability to the natural gas distribution network. Calor can ensure that low carbon fuels are available throughout the island of Ireland in communities, villages and towns which are not connected to the national natural gas network, ensuring greater access and greater adoption of low carbon fuels.

Importantly, we bring considerable experience and a proven track record in delivering low carbon energy solutions to off-grid consumers, not only in Ireland but across Europe, through our parent company SHV. Liquefied Petroleum Gas (LPG), BioLPG and Liquefied Natural Gas (LNG) are low carbon emission technologies, proven as effective alternatives to heating oil, petrol and diesel.

Calor has the experience and the expertise to play a leading role in Ireland's energy transition. Our customers and our society demand that change and we look forward to delivering it for them.

Calor can actively support the government's policy goal to further reduce carbon intensity, increase renewable fuel use and tackle air quality challenges in the heat and transport sectors to 2030 and beyond.

About Calor Ireland

Calor supplies and distributes LPG (Liquefied Petroleum Gas) and BioLPG in Ireland, allowing homes and businesses, located off the natural gas network, to avail of the benefits of lower carbon and renewable gas. Calor launched Liquefied Natural Gas (LNG) for the commercial and industrial sectors in 2020.

Calor employs 284 staff in 6 sites located throughout the island of Ireland serving c. 50,000 bulk customers across residential and industrial commercial sectors. Additionally, we serve c. 400,000-cylinder users and other customers, north and south.

Calor is a part of the SHV Energy Group, the world's largest distributor of LPG. SHV Energy operates in more than 20 countries – in Europe, under brands such as Primagaz, Calor Gas, Liquigas, Gaspol and Ipragaz. SHV is proud to serve 30 million customers across three continents. SHV firmly believes that its energy can create clean air and dramatically reduce carbon impact and is committed to working sustainably with communities, stakeholders and policymakers to advance energy, together.

About LPG and BioLPG

LPG has been a key part of Ireland's energy mix for almost a century. Going forward, we believe LPG and BioLPG can support the Irish Government's commitment to transition to a low-carbon economy and fulfil its binding obligations under the 2015 Paris Agreement on climate change.

As natural gas network penetration in Ireland is relatively low (39% of households, (Ervia, 2018)), the full potential of lower-carbon gaseous fuels like LPG needs to be further exploited. Over 40% of households in Ireland rely on oil to heat their homes. This share varies significantly by region, with roughly 26% of households located in towns using oil for central heating compared to 65% in rural areas (CSO, 2016; SEAI, 2019).

While LPG already offers significant reductions in carbon and air pollutant emissions, BioLPG is the future, providing up to 90% certified carbon emission savings compared to conventional LPG.

Already available on the market today, BioLPG allows off-grid homes and businesses to significantly reduce their carbon footprint without expensive retrofitting or changes to heating systems.

BioLPG is certified as renewable by the EU and Irish Government and is exempt from carbon tax, meaning it is a great investment for the future. As BioLPG is a 'drop-in' fuel, LPG infrastructure is already prepared for the future, so no new equipment is required.

For customers in rural off-grid homes and businesses, this is an easy and affordable switch to make, and the environmental benefits are immediate.

About LNG

Liquefied Natural Gas (LNG) is natural gas which has been cooled to a cryogenic level, allowing it to be easily transported via road or ship in specially designed transport containers. This means it does not need a pipeline infrastructure to be in place. LNG is most commonly used by very large businesses and in heavy goods transport. LNG is lower cost than LPG and other fuel sources, making it an attractive option for large energy users. It is also a low carbon fuel source.

LNG meets the objectives of Ireland's climate and energy policy by offering a low carbon alternative for large energy users unable to use the national gas grid for location or capacity reasons. Switching an oil user to LNG will have a substantial impact on emissions.

Calor LNG is shipped, through a number of routes, from continental Europe. As one of Europe's leading energy companies, SHV has an established network of LNG supply points. This additional supply can enhance Ireland's energy security.

The adoption of LNG as a low carbon fuel opens the possibility to utilise renewable BioLNG in the future. BioLNG is biomethane which is liquefied in the same process as LNG, it emits negligible NOx or particulate matters when burned and reduces CO2 by up to 90%. Once LNG is established in Ireland, the transition will be seamless.

Consultation response

As part of Calor's response to the Department of Environment, Climate and Communication's Consultation for the Introduction of a RHO, we wish to respond to the consultation questions posed under the following sections:

10.1 Background

- **Do you think that a RHO is an appropriate measure to introduce?**

Calor supports, in principle, the proposal for a RHO as a market mechanism to incentivise the development of renewable heat and specifically renewable gas, which addresses the EU's core principles of sustainability, security of supply and competitiveness.

Ireland is under increasing pressure to deliver its carbon emissions reductions targets and achieve Net Zero by 2050. Placing a focus on the decarbonisation of Ireland's heating sector by aligning the RHO with Ireland's current climate ambitions such as the Programme for Government (2020), the Climate Action Plan and Ireland's National Energy and Climate Plan, will better help Ireland achieve its targets.

Calor currently play a key role in supporting Ireland's decarbonisation journey through the supply of BioLPG for heating rural homes and businesses. As outlined in our sector's Vision 2040 (LGI, 2020), BioLPG, or biopropane, is chemically indistinct from LPG and provides the same heating and fuel properties. It is made from sustainably sourced renewable vegetable oils, wastes, and residues, and delivers up to 90% certified carbon emission savings compared to conventional LPG (LGI, 2020).

For customers in rural off-grid homes and businesses, this is an easy and affordable switch to make, and the environmental benefits are immediate. Affordability of cleaner, lower carbon energy solutions will be key for the economic recovery of rural households and businesses. LPG/BioLPG boilers are the most cost-effective lower carbon option for many households, especially older properties that are less energy efficient.

BioLPG carries the same low air and particulate pollutant emissions (NOx, SOx and PM) as conventional LPG, importantly contributing to improvements in local air quality. BioLPG should continue to be included in all Government initiatives that seek to reduce the carbon intensity of heating fuels supplied, as it already forms a key part of Ireland's transition to a cleaner, greener economy.

While Calor supports, in principle, the move to a RHO, we request that the Department considers several important policy interventions highlighted by the heating industry and set out in Renewable Energy Ireland's (REI) 40by30 report (2021) – "A 40% Renewable Heat Vision by 2030".

Calor cautions on the burden of cost of the obligation on rural consumers and we advocate strongly for the necessary policy supports to ensure a Just Transition. Recommended measures on the supply and demand side, in line with the REI 40% Renewable Heat Vision, include:

Supply Side: The brunt of incentives should focus on empowering suppliers to meet their renewable obligation targets in the longer term, without assistance. Firstly, the Government should seek to incentivise the production of BioLPG, expanding the terms of reference for the Climate Action Fund to consider BioLPG, facilitating research and development funding for the sector, providing a platform for those entities intending to support domestic production to do so.

In addition, in line with the REI 40x30 report, we advocate for:

- An update to the building regulations and BER assessment methodology to accurately reflect the decarbonisation benefits of renewable heat.
- Implementation of Article 23 of the Renewable Energy Directive (REDII) under the EU Clean Energy Package with a mandatory high ambition of at least 3% per annum.

Demand Side: Following on from this, the Government should seek to adopt measures which target consumers, households, and rural businesses directly. These should include scrappage schemes which seek to finance the upgrade from older, inefficient higher carbon heating systems to newer ones. Furthermore, supporting fabric efficiency upgrades should also be a priority. Both should contribute to lower end-user energy consumption, and consequently reduce the financial pressures on rural business and residential consumers.

- Make it simpler and easier for consumers/businesses to apply for the financial incentives for renewable heat technologies.
- Widen the support for renewable heat in the Home Energy Grants and in the Support Scheme for Renewable Heat (SSRH) and incentivise large heat users to adopt renewable heat solutions
- Set Green Procurement targets for the public sector requiring a minimum annual increase in using renewable heat of 20% of demand and mandate that all new or replacement public sector heating systems must be 100% renewable.

Calor favours a consumer-led switch to renewables, and we look forward to engaging with the Department on the proposed scheme. A switch to renewable gas solutions like BioLPG, as outlined above, will ensure that residential and business consumers in rural Ireland are given choice and affordability when making the effort to decarbonise their home heating systems.

- **If not, what alternative measures would you consider appropriate to increase the use of renewable energy in the heat sector?**

As outlined in Calor's response to the Energy Efficiency Obligation Scheme (April 2021), and as evident from our contribution to the current Biofuels Obligation Scheme led by the Department of Transport, BioLPG can make a significant contribution to the decarbonisation of rural homes and businesses under a proposed RHO Scheme.

Already available on the market, BioLPG allows off-grid homes and businesses to significantly reduce their carbon footprint without expensive retrofitting or changes to heating systems. As BioLPG is a 'drop-in' fuel, LPG infrastructure is already prepared for the future, so no new equipment is required. It is also certified as renewable by the EU and Irish Government in accordance with the EU RED II Directive and is exempt from carbon tax. Delivering up to 90% carbon emission savings compared to conventional fossil fuels, such as oil, it carries the same low air and particulate pollutant emissions (NOx, SOx, and PM) as conventional LPG, importantly contributing to local air quality.

There is no single solution to decarbonising our heating system, but we can heat our homes, schools, hospitals, and businesses using a combination of several different heating technologies and creating a pathway to more energy efficient building stock.

10.2 Market Coverage

- **Do you agree that the obligation should apply to all non-renewable fossil fuels used for heating as set out above? [Oil, LPG, natural gas, coal, and peat]**

We agree that the obligation should apply to non-renewable fossil fuels used for heating as set out [Oil, LPG, natural gas, coal, and peat]. However, it is imperative to make sure that no market distortion takes place and that any such obligation does not:

1. Place additional costs on rural consumers
2. Favour urban over rural communities

For Ireland to decarbonise, a Just Transition must be prioritised to ensure that all rural and business consumers have the ability to decarbonise in a way that is affordable *for them*. In particular, note must be taken of the urban-rural divide in income, wealth, and energy poverty, which is expanded upon in section 10.10.

- **It is intended that electricity used for heating purposes and renewable/waste district heating systems would be exempt from this obligation, do you agree with this approach?**

No comment.

- **Do you agree that the portion of fossil fuel input used in CHP plants to generate heat would be considered to be part of the obligation?**

Calor will assess the proposal / request further detail.

10.3 Obligated Parties and Obligation Threshold

- **Are energy suppliers the most appropriate bodies to become the obligated parties in the heat sector?**

Yes, in line with similar obligation schemes.

- **Is the 400 GWh of energy supplied an appropriate level for a supplier to become obligated?**

Calor agrees with the proposed 400GWh threshold level.

10.4 Obligation Rate

- **Do you agree with the 2023 start date for the obligation?**

Yes, Calor agrees that 2023 is an appropriate start date.

- **In terms of the obligation rate, do you agree with the proposed initial level of obligation of 0.5%?**

The obligation rate should be based on a feasibility analysis of what is available in the global biofuels market, which will change dramatically within the next ten years. Evidence of these forthcoming shifts can be seen in some of the significant investments being made in the area (Argus Media, 2021). An advanced biofuel obligation as a key incentive to promote research and innovation in this field is welcomed. A data and statistics led proposal is recommended, taking account of future biofuel alternatives, in addition to biomethane.

As per the SEAI (2021), 507 GWh of LPG was consumed in the residential sector. A 0.5% obligation requires around 2.5GWh of BioLPG to be supplied – equivalent to ~183 tonnes. Calor deems this to be an acceptable and realistic target.

- **In terms of ambition for a 2030 target, what level of ambition do you think is appropriate? 3% minimum 5% medium ambition 10% higher ambition - other?**

Calor believes that a 3% target is most appropriate in light of the financial challenges presented for rural customers (as described below in Section 10.6). However, given the urgent need to decarbonise as a country and an economy, we would be supportive of a higher obligation rate, such as 5% or 10%, provided that these issues are adequately tackled.

Given the disproportionate effect of the obligation on rural consumers, and the subsequent tendency for these rural households to suffer more frequently from energy poverty (SEAI, 2020, and highlighted in Figure 11) – we propose the following solutions, as set out in REI's 40by30 report, targeting specific points of the chain, from production to end-consumer:

Supply Side: The brunt of incentives should focus on empowering suppliers to meet their renewable obligation targets in the longer term, without assistance. Firstly, the Government should seek to incentivise the production of BioLPG, expanding the terms of reference for the Climate Action Fund to consider BioLPG, facilitating research and development funding for the sector, providing a platform for those entities intending to support domestic production to do so.

- Update the building regulations and BER assessment methodology to accurately reflect the decarbonisation benefits of renewable heat.
- Implement Article 23 of the Renewable Energy Directive (REDII) under the EU Clean Energy Package with a mandatory high ambition of at least 3% per annum.

Demand Side: Following on from this, the Government should seek to adopt measures which target consumers, households, and rural businesses directly. These should include scrappage schemes which seek to finance the upgrade from older, inefficient systems to newer ones. Furthermore, supporting fabric efficiency upgrades should also be a priority. Both should contribute to lower end-user energy consumption, and consequently reduce the financial pressures on rural business and residential consumers.

- Make it simpler and easier for consumers/businesses to apply for the financial incentives for renewable heat technologies.
- Widen the support for renewable heat in the Home Energy Grants and in the Support Scheme for Renewable Heat (SSRH) and incentivise large heat users to adopt renewable heat solutions.
- Set Green Procurement targets for the public sector requiring a minimum annual increase in using renewable heat of 20% of demand and mandate that all new or replacement public sector heating systems must be 100% renewable.

10.5 Meeting the Obligation

- **Do you agree with the first obligation period being multiple years 2023-2025 to give the industry time to develop supply lines?**

Yes, Calor agrees this would be the correct approach, as outlined in section 10.4.

- **Once the first period 2023-2025 expires, do you agree with the obligation then becoming an annual obligation?**

Yes. Calor agrees with this approach.

As referenced in section 10.1, Calor plays a key role in supporting Ireland's decarbonisation journey through the supply of BioLPG. BioLPG is a certified renewable fuel delivering up to 90% carbon emission savings compared to conventional fossil fuels such as oil. It carries the same low air and particulate pollutant emissions (NOx, SOx and PM) as conventional LPG, importantly contributing to improvements in local air quality. Therefore, BioLPG should be included in Government initiatives that seek to reduce the carbon intensity of fuels supplied, as it already forms a key part of Ireland's transition to a cleaner, greener economy.

- **Do you agree with suppliers being able to trade credits in order to meet their obligation?**

Yes, this initiative should be considered in consultation with energy suppliers. However, the trading of credits should not be seen as the solution to the inequalities in supplying different groups e.g., urban versus rural.

- **Do you agree with allowing 10% carry over of renewable credits to be used in the following year's obligation?**

Yes. Calor would agree with this approach, as is the case in other similar obligations schemes.

10.6 Sustainability

- **What are the sustainable energy sources likely to meet the RHO at an obligation rate of (i) 3%, (ii) 5%, (iii) 10% by 2030?**

LPG has been a key part of Ireland's energy mix for almost a century. Our sector has demonstrated significant progress in feedstock development since the product's introduction to the Irish market in 2018. In 2020, 22.5% of the BioLPG in the Biofuels Obligation Scheme (BOS) was made from Used Cooking Oil and our sector continues to invest in significant research and development to progress advanced feedstock options, including the potential for future supply of BioLPG from local feedstock pathways which include the gasification of municipal solid waste. Calor's R&D team is currently engaged with several Irish universities on future pathway development opportunities.

Going forward, we believe LPG and BioLPG can support the Irish Government's commitment to transition to a low-carbon economy and fulfil its binding obligations under the 2015 Paris Agreement on climate change.

As natural gas network penetration in Ireland is relatively low at approximately 39% of households (Ervia, 2018), the full potential of lower-carbon gaseous fuels like LPG needs to be further exploited. Over 40% of households in Ireland rely on oil to heat their homes. This share varies significantly by region, with roughly 26% of households located in towns using oil for central heating compared to 65% in rural areas (CSO, 2016; SEAI, 2019).

While LPG already offers significant reductions in carbon and air pollutant emissions, BioLPG is the future, providing up to 90% certified carbon emission savings compared to conventional LPG. Already available on the market today, BioLPG allows off-grid homes and businesses to significantly reduce their carbon footprint without expensive retrofitting or changes to heating systems.

BioLPG supplied by Calor on the market today is approved in accordance with 'EU-RED II', is a fully traceable renewable fuel and is certified under the International Sustainable Carbon Certification (ISCC) scheme. As BioLPG is a 'drop-in' fuel, LPG infrastructure is already prepared for the future, so no new equipment is required. For customers in rural off-grid homes and businesses, this is an easy and affordable switch to make, and the environmental benefits are immediate.

In addition to BioLPG, the industry is developing new fuels such as renewable DME (Argus, 2021), which have similar molecular properties to conventional LPG, and can support the decarbonisation of heat in off-grid areas. This investment in new production processes and new fuels, creates the opportunity to utilise a wider array of waste feedstocks with a higher conversion yield. More needs to be done, however, to reach Government targets, and policy has a role to play in supporting the development of new technology and production facilities.

These novel fuels and production routes are well-placed to play a key role for off-grid consumers in the future. BioLPG production utilises Used Cooking Oil[1] as a key feedstock and energy source, and rDME production utilises waste methanol, biogas from diary waste and other food/agricultural wastes to produce renewable fuels.

- **Will there be enough sustainable indigenous supply to meet this demand?**

Calor estimates that it needs 5 to 10 years to supply second generation/advanced biofuels in Ireland. This ambition involves a vertical integration strategy with producers to gain more control of the BioLPG supply-chain. However, these conversion technologies are still in pilot phase, and time is needed to develop these industrial processes at scale with affordable energy prices. As outlined in 10.4, the Government should seek to incentivise the production of BioLPG, expanding the terms of reference for the Climate Action Fund to consider BioLPG, facilitating research and development funding for the sector, providing a platform for those entities intending to support domestic production to do so.

Calor seeks alignment with the EU position in order to mature, alongside the EU biodiesel market, to advanced biofuel feedstocks in the medium term and to ensure stability and competitive prices for rural consumers in the transport and heat sectors as we strive to reach our 100% decarbonisation goal by 2037.

10.7 Traceability

Option A: Renewable energy is traced to the end consumer. For renewable gas, this would work similar to other fuels with individual customers being supplied the gas (verified by a certification system). This would allow consumers who value the 'greenness' more to pay slightly more and thus reduce the cost for other consumers. However, it could lead to some gas consumers funding the obligation but being credited with no 'greenness'

Option B: Renewable energy is equally proportioned to all of the supplier's consumers. For a supplier of natural gas, the same proportion of renewable gas would be deemed to be supplied to its consumers in the heat sector.

- **Do you agree that for renewable fuel delivered directly to a consumer that this will be the point of supply?**

This method appears to be a sensible way to determine whether a fuel is renewable or not.

- **Which option to you think should be applied for renewable energy that is indirectly supplied (e.g., via the natural gas grid)?**

No comment.

10.8 Estimated Costs for Consumers

- **Do you think the costs set out above are reflective of likely costs?**

The analysis presented in the consultation makes several heavy-handed assumptions, many of which fail to consider the nuances of the rural market.

Firstly, it is important to make clear the differences between the rural and urban housing stocks. Rural houses tend to have been built earlier, as seen in the age distributions of both urban and rural houses (Figures 1 and 2).

Figure 1: Age of Construction Distribution – Urban (CSO, 2021b)

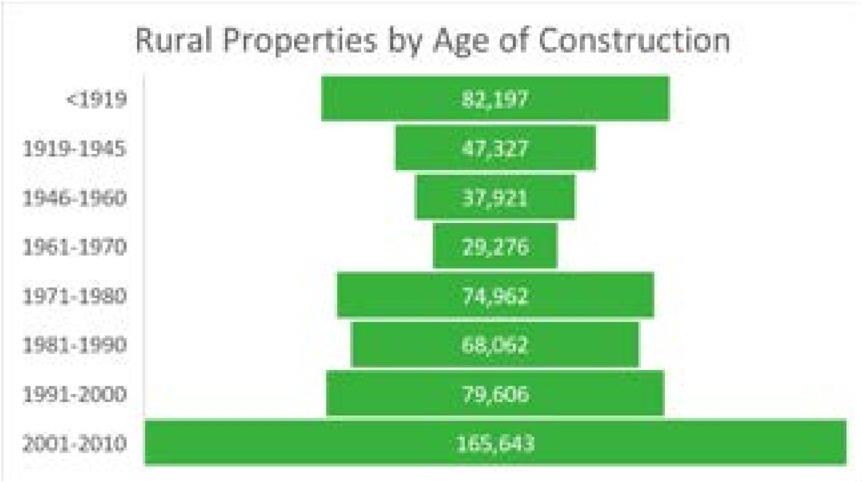

Figure 2: Age of Construction Distribution – Rural (CSO, 2021b)

As seen between Figures 2 and 3, rural houses tend to be older than urban houses. This is an important fact to consider, because older properties tend to require more energy to heat. The same fact is true of house size and type, the distribution of which is shown in Figures 3 and 4:

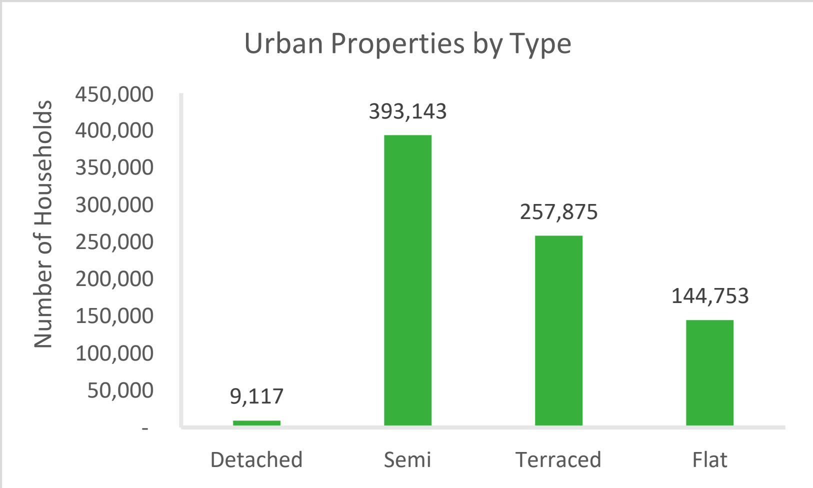

Figure 3: Property Type – Urban (CSO, 2021b)

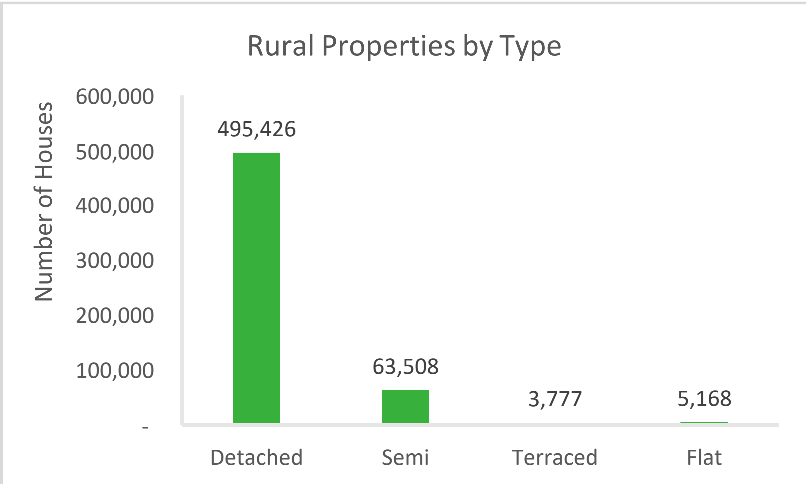

Figure 4: Property Type – Rural (CSO, 2021b)

The difference in house type is very pronounced - rural houses are overwhelmingly detached (which tend to be larger), whilst urban houses tend towards the smaller types (the median being a terraced house). Moving onto Figures 5 and 6, there is a tendency for rural properties to have worse energy efficiency ratings, albeit slightly:

Figure 5: Energy Efficiency Rating Distribution – Urban (CSO, 2021a)

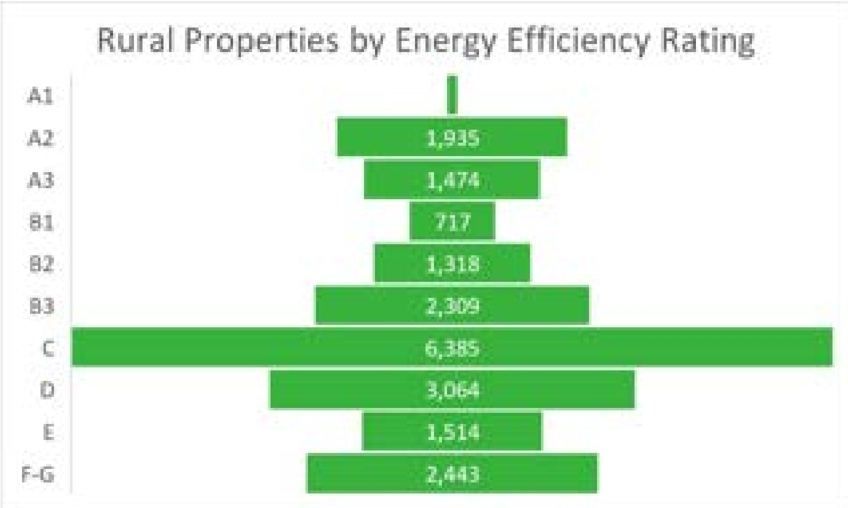

Figure 6: Energy Efficiency Rating Distribution – Rural (CSO, 2021a)

Overall, rural houses in Ireland tend to be older, larger, and less energy efficient, than the urban housing stock. The energy usage values used in the consultation document (9,000, 11,000 and 13,000 kWh), are debatable if they accurately represent the full distribution of energy usage profiles across Ireland. However, taking them to be true:

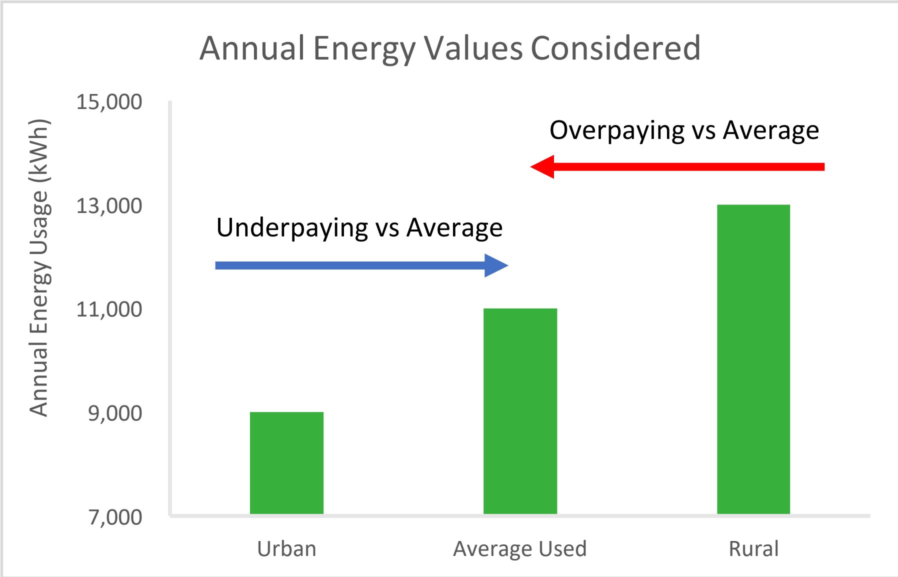

Figure 7: Annual Energy Values Considered by the Consultation

What Figure 7 demonstrates is that, using the average value to calculate costs ultimately obfuscates an imbalance in the financial burden of the obligation. Considering the evidence presented in Figures 1 to 6, this can be confidently interpreted as the imbalance in costs faced by urban and rural households. Returning to the energy values used, we believe these to be underestimates at the higher end. Using the TABULA web tool, which contains housing information – localised to Ireland, an urban and rural archetype can be designated:

Table 1: Urban and Rural Housing Archetypes (TABULA, 2021).

Variable	Unit	Urban	Rural
Representative Picture			
Year of Construction		1978 - 1982	1967 - 1977
Housing Type		Terraced	Detached
Area	m^2	83	115
Annual Energy Demand (Inc. Hot Water)	kWh	7,055	13,984
Heating Fuel		Natural Gas	LPG
Renewable Alternative		Biomethane	Bio-LPG

These archetypes encapsulate the differences highlighted prior, with the rural house being older, larger, and less energy efficient. The end result are two archetypes with annual heat demands even further apart than the existing values used. Regardless, analysis can be conducted using the above archetypes in Table 1, and the nominal price increase of 10 cents per kWh.

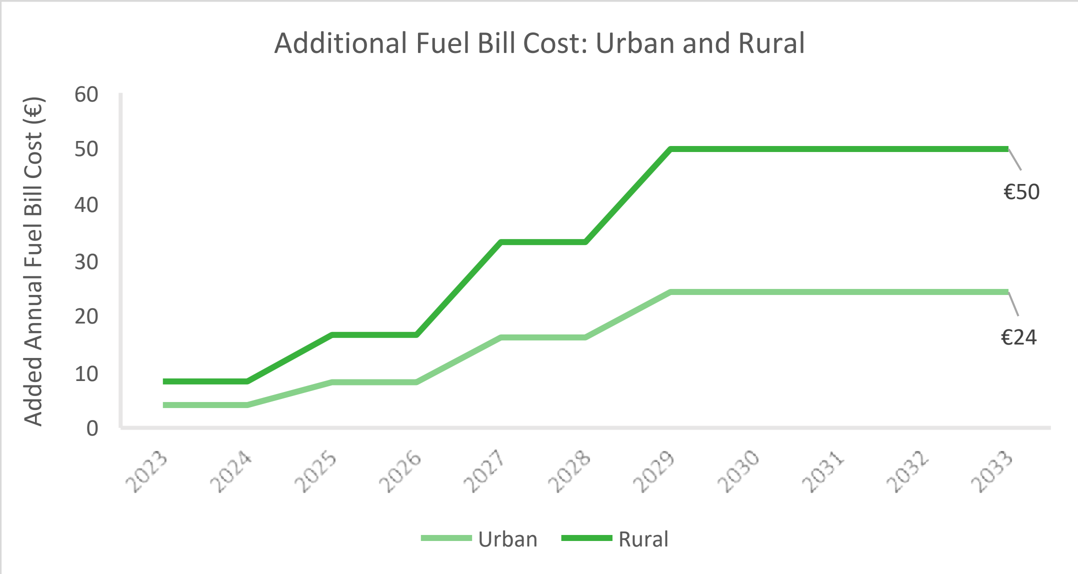

Figure 8: Urban vs Rural Estimated Cost, Running Values

As Figure 8 demonstrates, rural households can expect to pay twice as much as urban households, given central estimates at the 3% obligation rate. This effect is compounded when considering the cumulative cost of these obligations, costing rural customers an additional €400. This difference is greater than the one highlighted in the initial consultation document.

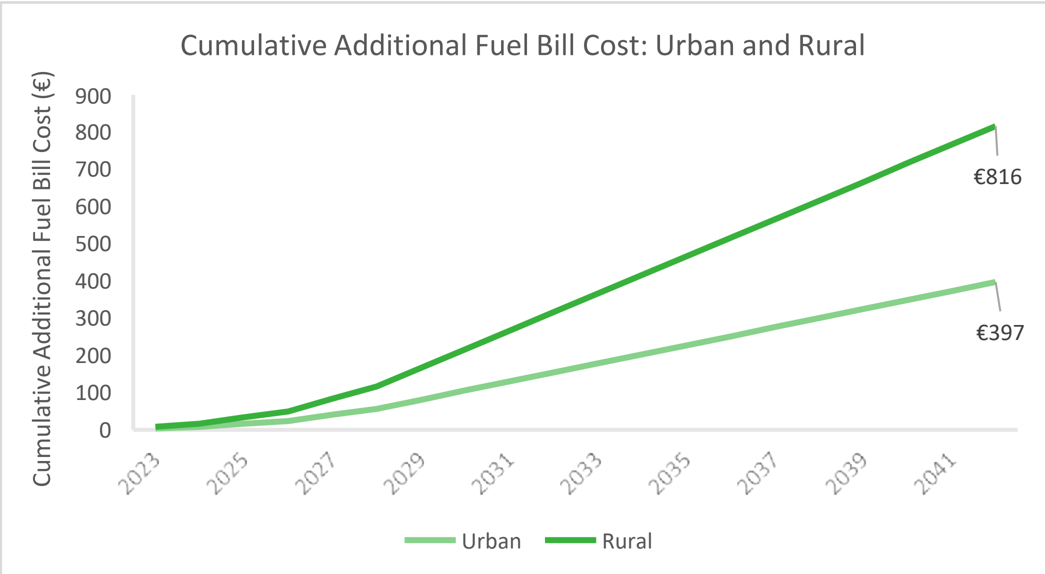

Figure 9: Cumulative Cost of Obligation

Figure 10 shows that under the obligation (over two decades), rural consumers can expect to pay an extra €816, whilst urban consumers pay €397 (half as much). Importantly, these figures are for the archetypes mentioned above – these would be even higher for some of the older rural buildings in Ireland.

Pivoting towards the methodology used in the initial calculations by the Department– we take issue with the estimating of costs for the added renewable obligation. There is a clear lack of consideration for rural consumers in the approach towards this calculation, as the added cost of supplying biomethane is used. This situation clearly does not apply to rural consumers without a connection to the gas grid (Gas Networks Ireland, 2021).

- **Are these costs reasonable to impose on consumers?**

We believe there are two fundamental issues with the burden of cost of the obligation. Firstly, is the issue of *fairness*, the idea that rural customers are expected to pay more towards reaching net-zero based on where they live is clearly *unfair*. Secondly is the ability for people to pay towards these costs. Again, given that households in urban areas tend to be wealthier than those in rural areas (SEAI, 2019), there is again an imbalance (the energy poverty urban-rural divide is expanded upon in 10.10). When the two are combined, rural consumers are burdened with higher costs – this clearly conflicts with the principle of a Just Transition.

As described above, in principle we also support, with conditions, the obligation being set at the 10% level. However, it is extremely important to highlight the additional cost burden that this places on rural customers (and urban customers, but to a significantly lesser extent). As seen in Figure 10, moving the obligation rate percentage up to the 5% rate adds an extra €33 to an annual rural fuel bill. Increasing it all the way up to the 10% level adds a further €83 – a total of €116 from the three percent level.

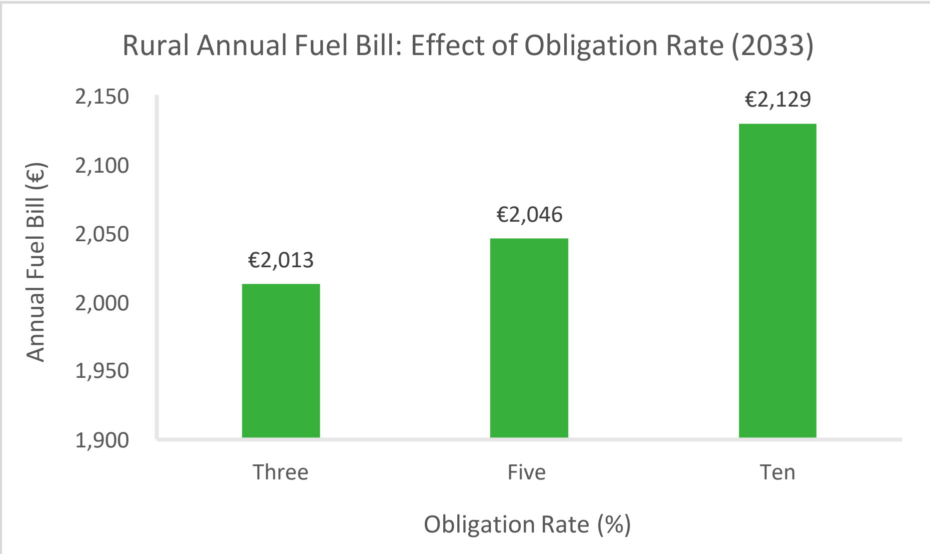

Figure 10: Effect of the Obligation Rate on Rural Fuel Bills

10.9 Penalties

- **Do you agree with the intended position in relation to penalties for non-compliance?**

The method of penalty application is suitable. However, for a new obligation, with little precedence, and subsequent evidence of outcomes elsewhere, penalties of this relative size are disproportionately high.

10.10 Energy Poverty

- **Do you think the proposed obligation poses a significant risk to increased energy poverty?**

As highlighted in our response to 10.6, the obligation will pose significant costs, but will impose an added fuel bill for rural customers twice that of urban customers. This is an issue in itself but becomes even more important when considering the differences in energy poverty between the two areas.

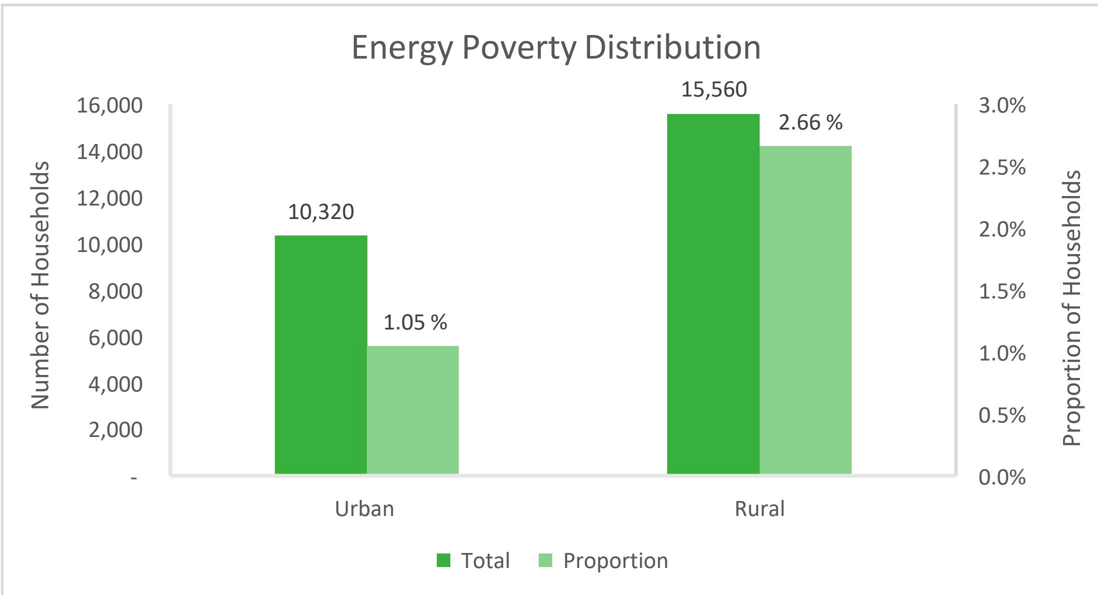

Figure 11: Energy Poverty Across Urban and Rural Areas (SEAI, 2020)

- **How best could the impacts on energy poverty be minimised?**

Given the disproportionate effect of the obligation on rural consumers, and the subsequent tendency for these rural households to suffer more frequently from energy poverty – we propose the following solutions, targeting specific points of the supply chain, from production to end-consumer:

While Calor support the move to a RHO, we request that the Department considers the following policy interventions to help alleviate the impacts on energy poverty, with specific recommendations agreed by the heating industry, and set out in Renewable Energy Ireland's 40by30 report:

Supply Side: The brunt of incentives should focus on empowering suppliers to meet their renewable obligation targets in the longer term, without assistance. Firstly, the Government should seek to incentivise the production of BioLPG, expanding the terms of reference for the Climate Action Fund to consider BioLPG, facilitating research and development funding for the sector, providing a platform for those entities intending to support domestic production to do so.

- Update the building regulations and BER assessment methodology to accurately reflect the decarbonisation benefits of renewable heat.
- Implement Article 23 of the Renewable Energy Directive (REDII) under the EU Clean Energy Package with a mandatory high ambition of at least 3% per annum.

Demand Side: Following on from this, the Government should seek to adopt measures which target consumers, households, and rural businesses directly. These should include scrappage schemes which seek to finance the upgrade from older, inefficient systems to newer ones. Furthermore, supporting fabric efficiency upgrades should also be a priority. Both should contribute to lower end-user energy consumption, and consequently reduce the financial pressures on rural business and residential consumers.

- Make it simpler and easier for consumers/businesses to apply for the financial incentives for renewable heat technologies.
- Widen the support for renewable heat in the Home Energy Grants and in the Support Scheme for Renewable Heat (SSRH) and incentivise large heat users to adopt renewable heat solutions
- Set Green Procurement targets for the public sector requiring a minimum annual increase in using renewable heat of 20% of demand and mandate that all new or replacement public sector heating systems must be 100% renewable.

10.11 Supporting New Green Fuels

- **Do you agree with the outlined approach for additional support for green hydrogen?**

Calor is generally supportive of the recognition, and subsequent incentivisation of novel renewable fuels. However, we note that green hydrogen is unlikely to play a role in the decarbonisation of rural communities, given recognised challenges compressing, storing, and transporting hydrogen economically. Furthermore, the level of detail in the proposal seems premature, given the uncertainty surrounding the viability of green hydrogen.

- **Do you think that offering multiple credits for green hydrogen in the heat sector might have unintended consequences for supply in other sectors such as transport?**

Calor reiterates its answer to the above question, in this instance.

10.12 General Input

Calor would like to draw DECC's attention to the LPG sector's Vision 2040 as well as the Renewable Energy Ireland's (REI) 40by30 report, which both outline the role that BioLPG can play as a cleaner, greener fuel in helping Ireland to meet its decarbonisation targets. We have also included a section on our sector's efforts in relation to Research and Development.

Vision 2040

In September 2020, Liquid Gas Ireland (LGI) launched its Vision 2040 document, which sets out how our industry can contribute to Ireland's 'Green New Deal', including the ambitious goal to reach net zero emissions by 2050, and to the Government's Clean Air Strategy.

Calor is committed to working with Ireland's policymakers to develop a long-term supportive policy framework to achieve 'net zero' and address barriers to decarbonisation in the off-grid heat and transport sectors.

Our society demands an energy transition that is fair, affordable, and convenient; Calor has the experience and expertise to help deliver it. We look forward to engaging with Government and energy sector stakeholders in the coming weeks and months.

40by30

Renewable Energy Ireland launched its 40by30 report launched in 2021, which sets out REI's roadmap to an Ireland where 40 per cent of heat can come from renewables by 2030 and outlines the role that renewable gas (BioLPG) can play. If 500,000 rural homes switched from using oil-fired central heating to BioLPG by 2040, it would save about 1.9 million tonnes of CO_2 emissions per year.

Research and Development

BioLPG currently used in Ireland is a by-product of a conventional hydrotreated vegetable oil (HVO) process that mainly produces renewable biodiesel. It is made at Neste's renewable product refinery in Rotterdam from a mix of sustainably sourced renewable vegetable oils, residues, and waste materials. In the next five to ten years, HVO and co-processing are likely to be the dominant sources of BioLPG, after which the focus will be on second generation pathway development by using existing technologies re-engineered to produce BioLPG.

BioLPG supplied on the market today is approved in accordance with 'EU-RED II', is a fully traceable renewable fuel and is certified under the International Sustainable Carbon Certification (ISCC) scheme.

Calor has demonstrated significant progress in feedstock development since the product's introduction to the Irish market in 2018. In 2020, 22.5% of the BioLPG in the Biofuels Obligation Scheme (BOS) was made from Used Cooking Oil and our sector continues to invest in significant research and development to progress advanced feedstock options, including the potential for future supply of BioLPG from local feedstock pathways which include the gasification of municipal solid waste. Calor's R&D team are currently engaged with a number of Irish universities on future pathway development opportunities.

Calor recognises the importance of close collaboration with both EU and national industry stakeholders and policymakers to ensure the necessary policy support for the production or use of BioLPG in Ireland, and to provide investment confidence to producers, suppliers, and investors across the bio propane supply chain.

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To find out more about Calor, please visit www.Calorgas.ie

CALOR

BioLPG

40 By 30

A 40% Renewable Heat Vision by 2030 Delivering 7% CO_2 Abatement per Year

April 2021

Report prepared by

XD Consulting
Sustainable Energy Engineers

Renewable Energy Ireland

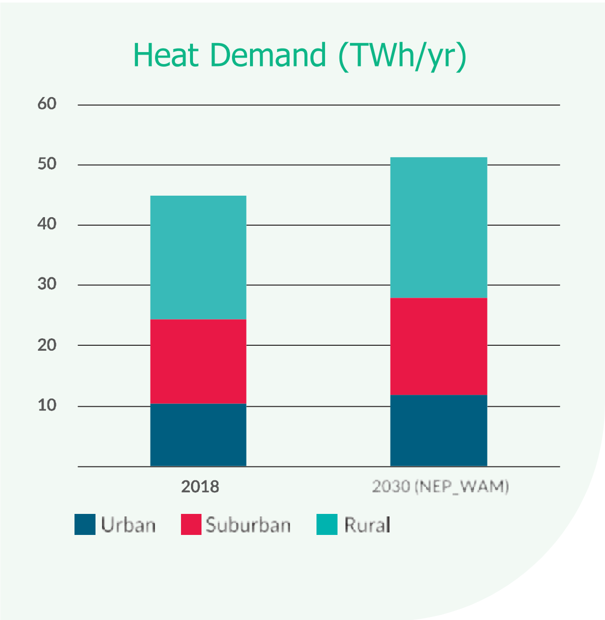


Figure 7: Projections heat demand by density 2018-2030

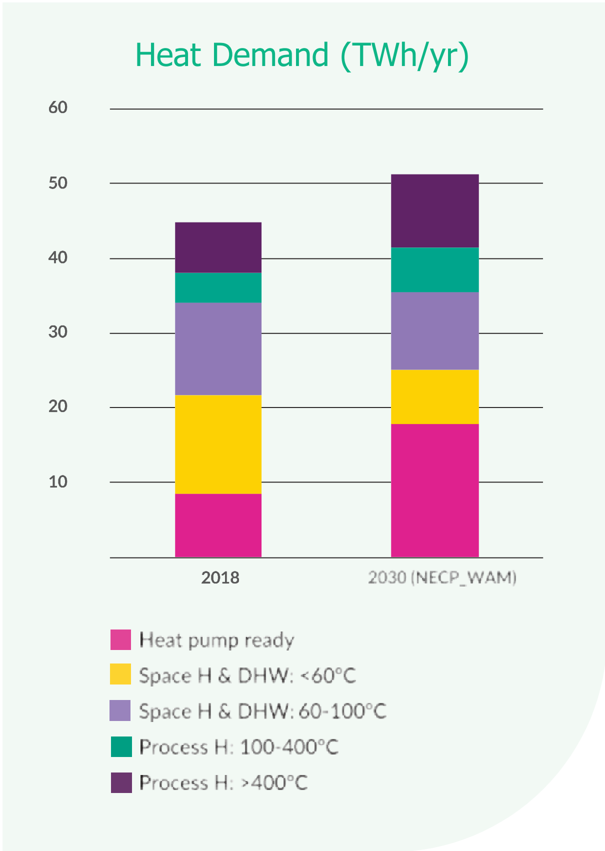
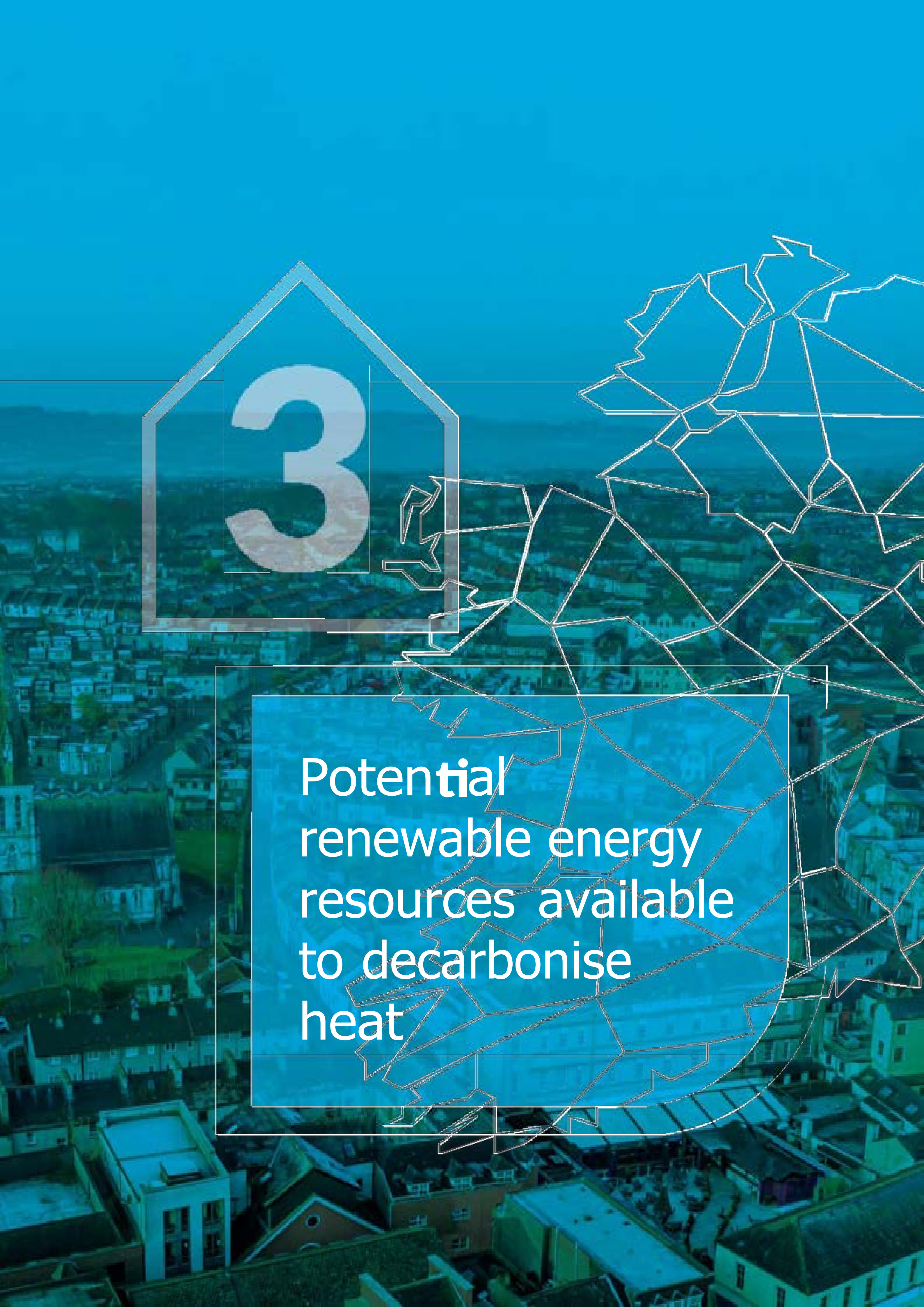


Figure 8: Projections heat demand by temperature 2018-2030

The heat demand profiling undertaken as part of the study provides a good basis to assess renewable energy options for decarbonising heat. As homes become more suitable for low-temperature heating due to improve energy efficiency standards, the opportunity for heat pumps in new and existing homes will grow, in particular for areas with low heat density. Where the required investment in building retrofit is not assured, biomass heating systems using wood fuels or renewable gas can offer a cost effective decarbonisation option. The substantial share of high heat density areas provides strong opportunities for district heating to play a much bigger role in servicing towns and cities, in particular for buildings requiring higher heating temperatures (typically up to 80ºC).

Decarbonising thermal processes in industry will be very challenging and high temperature renewable technologies using solid biomass and renewable gas could play a key role in this regard, possibly with thermo-electric systems. These options are considered further hereafter in terms of the availability of renewable resources and the feasibility of different technological pathways.



3

Potential renewable energy resources available to decarbonise heat

A comprehensive literature review was undertaken to assess the potential renewable energy resources for the production of renewable heat in Ireland.

This was complemented with data provided directly by the study partners and representatives from the sector. The key objectives of this assessment was to identify the resources that are accessible[10] and can realistically be harnessed in Ireland in a cost-effective way by the end of the decade. Imported resources that already have a market in Ireland have been considered. For each resource, the primary energy costs, the associated heat production technologies and their key characteristics have been outlined.

[10] Generally, the study considered the definition of ‘accessible’ potential as per SEAI's LARES methodology technical resource, but constrained by practical and physical incompatibilities, and constrained by institutional or regulatory deletions, which limit RE extraction (SEAI, 2013).

3.1 Bioenergy

Bioenergy refers to the use of biomass, which can be used directly or transformed into biogas and biofuels, to produce energy.

Biomass is defined in the RE Directive as the biodegradable proportion of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, including fisheries and aquaculture, and the biodegradable fraction of industrial and municipal waste.

The revised Renewable Energy Directive (REDII) published by the EC in 2018 introduces the Sustainability Criteria, requiring among others that i) biomass is not sourced from lands that will not be replanted, ii) sensitive areas are protected, iii) forest carbon stocks remain stable or increase across the sourcing region, and that iv) harvesting respects biodiversity and soil quality. The Directive also imposes further requirements to minimise the risk of using forest biomass derived from unsustainable practice. All these criteria are subject to third party verification.

Where bioenergy is sourced from sustainably managed land resources and processes, and is included within an economy-wide greenhouse gas accounting system, carbon dioxide emissions on combustion of biomass are accounted as zero[11].

Among other renewables, bioenergy rollout is particularly effective in the creation of permanent employment in the harvesting, transport and processing of biomass, as well as the production of biogas. Rural communities in particular are well placed to participate in such activities, through direct and indirect employment and wealth creation.

The study considered two main sources of biomass appropriate for thermal applications, solid biomass suitable for combustion (e.g. wood fuel) and renewable gas produced from the anaerobic digestion (AD) of organic waste (e.g. from food processing, municipal waste, farm wastes, etc.) or other chemical processes (e.g. BioLPG as a by-product of biofuel production). Please note that where potential resources estimates are provided, they refer to the energy content of the biomass fuel (solid biomass, biogas/biomethane, BioLPG, etc.), before they are converted to heat.

[11] IPCC approach to greenhouse gas emissions from combustion of biomass) at the national level, which allows for complete coverage of emissions and sinks, and involves all IPCC sectors, including in particular, Energy, Agriculture, Forestry and Other Land-Use (AFOLU), and Waste. Carbon dioxide emissions from the combustion of biomass are captured within the CO_2 emissions in the AFOLU sector through the estimated changes in carbon stocks from biomass harvest, even in cases where the emissions physically take place in other sectors (e.g. energy) (Calvo Buendia E, 2019).

3.1.1 Solid biomass

Ireland now has a sizable forest resource, with a growing wood component. In particular, thinning material harvested during the early stages of growth and harvest residues can be mobilised to meet increasing levels of biomass demand in line with sustainable forest management. In addition, Ireland has an excellent climate for tree growth and, with its low population density, a sizable resource of land suitable for the production of biomass fractions to grow through forest establishment and management, and to a lesser extent, establishment of bespoke short rotation coppice and forest crops. Solid biomass can be stored long-term when dry and can be used on demand. The primary solid biomass resources considered were:

Indigenous Forestry and wood processing residues: 11% of the national land area is afforested (c. 770,000 ha, 50% in public ownership), mostly with conifers (70%) (DAFM, 2020). The Irish Bioenergy Association (IrBEA), considering forecasts by COFORD (2018), estimates that over 4.5 million m^3 of forestry and wood processing residues will be suitable for bioenergy by 2030, resulting in an accessible biomass potential of 6.3 TWh/yr from existing forestry. Another 0.4 TWh/yr will be available from Post-Consumer Recovered Wood (PCRW).

Short rotation coppice and short rotation forestry: an ambitious programme of planting willow short rotation coppice (2 3-year harvest rotation) and short rotation forest (8-20 year harvest rotation) could result in a total dedicated wood energy crop resource of 150,000 ha within 15 years, capable of yielding 3 TWh/yr of biomass fuel by 2030 and 6.7 TWh/yr in 2035.

This solid biomass resource can be available in the form of roundwood, wood chips and wood pellets. Good quality, dry wood fuels combusted in clean and efficient appliances such as stoves and automated boilers are a suitable option for less efficient buildings requiring higher heating temperatures, in low heat density areas. They are also suitable for industrial applications or district heating, particularly to meet thermal base loads with highly efficient boilers or combined heat and power (CHP) plants.

3.1.2 Renewable gas

Renewable gas can be produced from a range of biomass resources readily available in Ireland. Anaerobic digestion is a well proven pathway to convert organic matter into biogas which can be burned in a gas boiler or combined heat and power unit. Biogas can also be upgraded to biomethane (a direct substitute for natural gas) which can be stored, transported, injected into the gas grid or used in off-grid applications. Biomethane can also play an important role as a transport fuel.

The following biomass resources were considered for the production of biogas:

Slurry and manure from cattle, pigs, poultry, etc. with published potential resource estimates varying from 0.7 TWh/yr (Ricardo, 2016) to 1.4 TWh/yr (Richard O'Shea, 2017).

Grass silage is also an excellent AD feedstock with a very significant potential, which can be derived from increasing grass production above current needs for animal grazing, and/or possibly as an alternative use of grass in the context of farm diversification. Published potential resource estimates indicate a potential varying from c. 8 TWh/yr (Ricardo, 2016). However, silage feedstock is an expensive feedstock and O'Shea (2017) estimates that the economically viable potential is circa 3.4 TWh/yr for grid injection.

Segregated food waste from brown bin collections and from industrial food production is also an interesting feedstock, with the production of biogas as part of a circular waste management approach, and the additional advantage of potentially attracting gate fees. The potential resource is estimated at 0.6 TWh/yr.

The total potential from these forecasts varies from 4.7 to 10 TWh/yr. Other projections for the potential production of biomethane were provided by the participating trade associations, including:

IrBEA and Cre advocate for a medium-term target of 1.6 TWh/yr for biomethane in line with the Climate Action Plan Ireland (IrBEA & Cre, 2019). This should be mobilised on a phased basis in the medium term.

In their analysis for the RGFI, KPMG proposes an ambitious programme comprising 225 Agri-based AD plants (feedstocks comprising 60% silage, 40% slurry) and 11 commercial waste plants operational by 2030, with a potential production of 5.6 TWh/yr of biomethane. These projections are based on the RGFI/KPMG Integrated Business case for Biomethane in Ireland 2019. (KPMG, 2019).

Other biomass resources which can be considered for the production of renewable gas include:

The organic fraction of residual municipal solid waste (1.13 TWh/yr according to Riccardo, 2016) which can be used in waste-to-energy plants, for anaerobic digestion or in thermo-chemical processes such as pyrolysis or gasification to produce renewable gas.

Tallow (animal fat) is a food industry by-product (0.80 TWh/yr) which can be used to produce biodiesel, with BioLPG as a by-product.

BioLPG is currently a co-product of biofuel production using plant oils, but it can also be produced from bio-residues in agriculture & forestry (gasification plus Fischer Tropsch process) as well as from food processing residues and plant oil. Liquid Gas Ireland (LGI) projects that BioLPG has a potential of 0.46 TWh/yr produced from indigenous resources by 2030, and a further 1.05 TWh/yr from imported sources.

3.2 Electrification of heat

With rapidly increasing shares of renewable energy in electricity production, the electrification of heat is a central pillar of the national and European strategy for decarbonisation.

In 2018, 33% of the electricity produced in Ireland was renewable, with an average carbon content of 375 gCO_2/kWh (SEAI, 2019). By 2030, the target is to grow to 70% renewable electricity (DECC, 2019), with an average carbon content of 118 gCO_2/kWh[12].

Heat pumps are a very efficient form of electrical heating. They harness 'ambient heat' sources such as air, water bodies and the ground, using a refrigeration cycle to upgrade their temperature to levels suitable for thermal applications, typically central heating in homes and tertiary buildings. Most heat pumps are driven by electricity, and it is expected that for each unit of electricity used, between 3 and 4 units of heat are produced (with a share of renewable ambient heat between 66% and 75%). Considering the projected carbon content of electricity by 2030, this would result in at least 80% reduction in CO_2 emissions compared to oil heating.

The WAM scenario of the NECP forecasts up to 6.5 TWh/year production of renewable heat from heat pumps (DECC, 2020), based on the Irish Government's Climate Action Plan (2019) target of 600,000 domestic heat pumps installed by 2030. The Geothermal Association of Ireland projects that ground-source heat pumps retrofitted in tertiary buildings could have a total thermal capacity of 200 MW by 2030, with the potential to produce 300 GWh/yr.

In addition, large surface water bodies (rivers, lakes, seawater) and grey water from the sewage systems are ideal renewable heat sources for heat pump applications in conjunction with district heating, with a technical potential estimated at 1.4 TWh/yr (Persson U, 2014/2019).

With 70% renewable electricity penetration targeted for 2030, largely from intermittent sources such as wind and solar energy, the electrification of heat can play an importantrole in balancing the electricity grid. At anticipated annual 'dispatch-down' of intermittent renewable generation of 10% is assumed for 2030, which could be conservative considering it is already 11.4% today[13], so the available surplus electricity would be in the order of 2.8 TWh. If this surplus electricity is harnessed by heat pumps with an efficiency of 300%, combined with thermal storage, 8.5 TWh of renewable heat could be produced very cost-effectively as part of a demand-response strategy. This can be achieved with a multitude of decentralised heat pumps or with large, centralised heat pump systems combined with large thermal stores and district heating.

[12] Assuming carbon intensity in the 2030 Base Case Scenario (70% renewable electricity penetration) modelled by the EAI/MaREI in the 'Our Zero eMission Future' study (Dr Paul Deane, 2020).
[13] 2020 EirGrid Annual Dispatch Down report indicates levels of 11.4% for Ireland: https://www.eirgridgroup.com/site-files/library/EirGrid/2020-Qtrly-Wind-Dispatch-Down-Report.pdf

3.3 Surplus heat

A number of sources of surplus heat have been considered as part of this assessment of renewable heat available:

Waste-to-energy plants operating in combined heat and power mode, such as the Covanta Plant in Poolbeg, with a surplus heat potential estimated at 1.9 TWh/yr by 2030 (IrDEA, 2020).

Data centres are a rapidly growing segment of the Irish economy and energy system, with forecasted electricity demand of 1400 MW by 2030. The surplus heat available from these data centres' ongoing cooling has a potential estimated at 6.1 TWh/yr by 2030 (IrDEA, 2020).

Surplus heat from industrial processes is not only a great way to get carbon neutral heat for district heating, but it can increase the attractiveness of industry to a location[14]. Industry surplus heat in Ireland has been estimated at 4.4 TWh/yr (Persson U, 2014/2019).

Currently, the vast majority of power plants are releasing heat equivalent to 40% of their fuel input into the atmosphere or in adjacent water bodies. The theoretical potential for recovering heat as a by-product from power stations has been estimated at 8.7 TWh/yr for 2030[15] (IrDEA, 2020).

This surplus heat can potentially play a very significant role in supplying low-carbon, low-cost heat to many urban centres in Ireland with district heating.

[14] For example, the Kemira sulphuric acid plant in the city of Helsingborg in Sweden (population ~108,000) supplies one-third of the cities heat demand from heat that would otherwise be discarded, which benefits the city but also created an additional revenue stream for the company making the city a more attractive location. See http://www.euroheat.org/wp-content/uploads/2019/09/Helsingborg_DHCities.pdf for further details.

[15] The adequacy and availability of waste heat from power plants in a 70% renewable electricity system, with a lower number of operating hours for gas turbines should be further investigated to ascertain its practical potential.

3.4 Other accessible resources of renewable heat

The potential of other sources of renewable heat was considered as part of this assessment, including:

Deep geothermal energy: Although Ireland does not possess high temperature geothermal reserves, there is the potential to use low enthalpy resources located in or near high heat density areas such as in the Greater Dublin Area, for applications such as district heating or on specific commercial and industrial sites with intensive thermal processes. The Heat Roadmap Europe study indicates that the geothermal resource suitable for district heating is 3.2 TWh/yr (Persson U, 2014/2019). The Geothermal Association of Ireland projects that the industry could deploy a total of 23 MW of installed thermal capacity by 2030, resulting in the production of 91 GWh/yr of renewable heat (GAI, 2020).

Solar thermal energy is already well established in Ireland for the production of domestic hot water in individual buildings. Large solar thermal systems are also making a substantial contribution to district heating in countries like Denmark, Austria and Germany. For example, the town of Marstal in Denmark produces over 50% of its heat annually using large scale solar and thermal storage on a district heating scheme[16]. The potential of solar district heating has been estimated at 3.6 TWh/yr by 2030 (Persson U, 2014/2019).

[16] http://co2mmunity.eu/wp-content/uploads/2019/03/Factsheet-Aer%C3%B6-Marstal.pdf

3.5 The overall potential of renewable heat resources accessible

Overall, the renewable energy resources accessible for heat supply in Ireland, as identified above, have a total potential forecasted at 67 TWh/yr for 2030 (see summary of breakdown in Table 1 below), of which biomass has the biggest share (solid biomass, biogas and biofuel combined at 34%), followed by surplus heat (32%[17]), and the electrification of heat (25%). If an average heat production efficiency of 90% is assumed across the different renewable heating technologies available (biomass boilers, heat pumps, district heating, etc.), this renewable heat resource could produce 60 TWh/yr of useful heat. This compares to a total national heat demand forecast of 51 TWh/yr by 2030, demonstrating that Ireland could meet its heating requirement with 100% indigenous clean energy.

Table 1: Accessible potential of renewable heat resources considered in the study.

Renewable heat resource potential	TWh/yr	%
Indigenous forestry & energy crops	9.7	15%
Tallow, residual MSW, BioLPG	2.4	4%
Biogas/Biomethane	10.0	15%
Surplus heat	21.1	32%
Electrification of heat[18]	16.7	25%
Other renewable heat resources	6.8	10%
Total	66.7	

Ireland is endowed with sufficient renewable energy resources to meet 100% of its total heating requirement, and more.

[17] If the full theoretical potential of waste heat from power plants is considered.
[18] This includes the heat which could be produced from green electricity which is expected to be lost or 'dispatched down' in Ireland in a 2030 power system with 70% renewable electricity.

3.6 The role of energy networks to support the renewable heat transition

Energy supply networks provide an essential infrastructure for the transition to renewable heat, enabling the distribution of thermal energy from sources of production to the end - users and the integration of different energy systems. The electricity and the gas networks are the well-known incumbents in this regard, but the decarbonisation of the energy system will require adaptation and innovation.

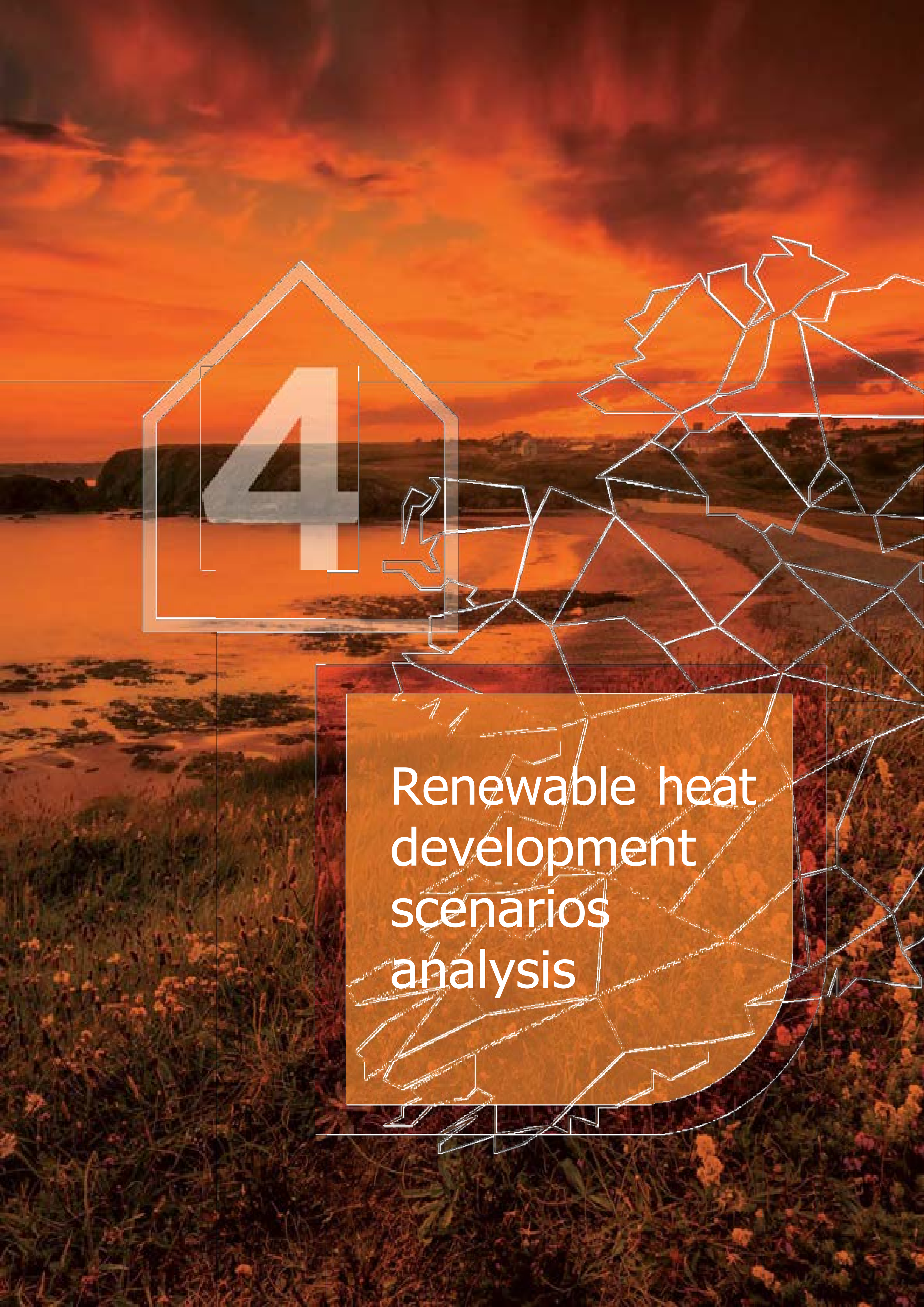
District heating (DH) networks offer a different model of heat supply, using a hot water pipe network to distribute heat from centralised heat producers to heat consumers, enabling the large-scale substitution of the incumbent individual fossil-fuel based heating systems. A key criteria for district heating systems to be economically viable, given the large capital cost associated with the heat production and supply infrastructure, is the heat density[19] of the areas to be served by district heating systems.

Table 2 below presents the results on an analysis conducted for the Irish District Energy Association (IrDEA) by experts involved in the Heat Roadmap Europe projects (https://heatroadmap.eu/) on the spatial distribution of heat density in Ireland and the associated potential for district heating applications[20]. This analysis indicates that 35% of the heat demand is at a sufficient heat density for district heating to be highly feasible and feasible with current technology. District heating would be feasible for another 21% of the heat demand with the deployment of the most advanced technology. In this study, it is assumed district heating could reach 10% of the building heat demand by 2030 and a maximum of 35% longer-term, which is relatively conservative considering the potential.

Table 2: Spatial heat density distribution & district heating feasibility.

	Heat Density (TJ/km2)	Share of heat demand	Economic feasibility of DH
Rural & peri urban	<20	35%	Not feasible
Sub urban	20-50 50-120	8% 21%	Not feasible yet Feasible w. 4th generation DH
Urban	120-300 >300	27% 8%	Feasible w. current technology Highly feasible

[19] The higher the heat density, the shorter the pipe network required to service a given amount of heat, and therefore the lower the investment.
[20] For details of the Irish Heat Atlas and the above analysis, please visit https://districtenergy.ie/heat-atlas



4 Renewable heat development scenarios analysis

To determine the level of ambition for 2030, a cost-benefit analysis of different scenarios of renewable heat development in Ireland was carried out, considering Ireland's heat profile (as presented in section 2), the renewable energy resource available (as presented in section 3), their life cycle cost and their impact on decarbonisation (as presented in this section).

The approach and findings are presented below.

4.1 Overview of the modelling approach

A techno-economic model was created to enable a discounted cash flow analysis of different renewable heat deployment scenarios, each combining selected heating technologies using the renewable resources identified in the previous section. A scenario is defined by setting the percentage of the 2030 heat demand to be met by each of the renewable heat technologies, in the three sectors (residential, tertiary and industry). The sum of these renewable heat contributions is aggregated across the sectors to determine the overall renewable heat supply of a scenario.

The nominal capacity of the renewable heating systems to be installed is calculated, considering the amount of heat to be produced, their efficiency and the expected load factor[21]. The capital and operation & maintenance (O&M) costs are estimated by multiplying the installed capacity required by specific capital investment and operating expenditure factors (€/kW and €/kW/yr respectively). The capital cost of each system is then annualised using a discount rate of 5% over its lifetime.

Annual energy costs are calculated on the basis of projected unit costs and fuel & electricity consumption. Annualised capital costs, O&M costs and energy costs are added to calculate the total annual cost of each type of renewable heating system and aggregated across the three sectors for the modelled scenarios.

The energy costs of the incumbent heating systems[22] are added to the new renewable heat systems to calculate the annual 'whole-system' cost to meet the national heat demand in each scenario.

The quantity of energy (fuels, electricity, surplus heat) consumed in each scenario is multiplied by the relevant carbon intensity ($kgCO_2/kWh$) to calculate the amount of CO_2 emissions of each scenario. Bioenergy fuels are taken as carbon neutral, electricity is assumed to have a carbon intensity of 0.118 $kgCO_2/kWh$ and an average of 0.018 $kgCO_2$ per kWh is assumed for the surplus heat supplied.

The assumptions underlying the analysis (specific capital O&M costs, energy costs, system efficiencies, etc.) are summarised in Annex 2.

[21] Equivalent 'nominal capacity' operating hours of a heating system divided by the number of hours in a year.
[22] 'Incumbent' systems include the renewable heating systems already accounted for in the baseline scenario and the fossil fuels required to meet the balance of the heat demand (total heat demand – heat supplied by existing and new renewable systems).

4.2 Outline of the scenarios modelled

The following scenarios were modelled to compare different levels of renewable heat ambitions and different technological pathways.

The 2018 heat usage analysis is taken as the baseline, and the following scenarios were built to meet the projected heat demand for 2030.

NECP_WAM: this scenario replicates the NECP's 'With Additional Measures and Low Energy Costs' scenario, with significant gains in energy efficiency in housing, and reflecting the Climate Action Plan's ambitious targets for heat pumps in buildings. Biomass supply contributes to industrial heat demand, and to a lesser extent in tertiary buildings. Biomethane plays only a modest role.

RES-H_7%: this scenario reflects what the sector believes can be realistically achieved by 2030 with a progressive policy-framework going beyond the objectives of the Climate Action Plan to meet the Programme for Government Target of 7% annual GHG emission reduction. District heating meets 10% of the national heat demand[23] mostly with high temperature surplus heat from, waste-to-energy and power plants, data centres and industry. Solid biomass plays a substantial role in industry to replace coal and oil, and in buildings requiring high temperature heating where it substitutes some oil and totally replaces peat and coal[24]. Renewable gas plays a more modest role, in line with the Irish Bioenergy Association (IrBEA) projections for farm-based biogas production, and the use of BioLPG to substitute liquid and solid fossil fuels in off-gas grid applications. Heat pumps have a similar level of penetration as in NECP_WAM (600,000), and also contribute to district heating using medium temperature heat sources (e.g. from data centres). This scenario puts Ireland on a stronger path for decarbonisation by 2050.

RES-H_Max: this scenario represents a radical ambition for the transformation of the heating sector, leveraging a much larger share of the accessible renewable resource potential to further decarbonise it. It builds on the RES-H_7% scenario and assumes that district heating is deployed in all high density areas and meets 35% of the residential and tertiary heat demand. District heating sources its heat from high-temperature sources (70%, surplus heat and deep geothermal), and from low-temperature surplus heat sources in combination with heat pumps (25%, from data centres, grey water and rivers), and some biomass (5%)[25]. RES H_Max also provides for a very ambitious renewable gas supply, in line with the RGFI projections for 2030 which includes tripling the use of BioLPG for rural heat and in industrial applications. This scenario represents a forceful response to the climate emergency and is a step further in achieving net zero carbon status at national level by 2050.

Electricity plays an important role in the above scenarios, to drive heat pumps and to a lesser extent for direct electrical heating. The renewable share of electricity projected for 2030 (70%) is also accounted for as part of the overall contribution of renewable energy to the national heat supply.

The balance of heat demand not met from renewable sources in each scenario was allocated to fossil fuels, prioritising the displacement of high-carbon intensity fuels.

[23] In the RES-H_7% scenario, district heating supplies over 50% of the heat demand in high heat density areas in Dublin, Cork, Limerick & Drogheda. This represents an annual increase of 1% of national heat demand in DH penetration, in line with its historical growth trajectory in Scandinavian countries.

[24] This scenario requires 1.2 TWh/yr of wood chips from short rotation coppice and mobilises most of the existing forestry resource.

[25] Please note that an additional 10% of the heat demand is accounted for through distribution losses along district heating networks.

4.3 Scenario analysis results

The results of the modelling for the scenarios described above were compiled to provide a comparative analysis on the basis of the following KPIs: CO_2 emissions, final energy consumption, renewable energy penetration, energy costs, capital cost, annual whole-system cost, Levelized cost of energy (LCOE)[26], CO_2 abatement cost. The following sections of the analysis present the results aggregated across the residential, tertiary and industrial sectors. The detailed breakdown per sector is available in Annex 1.

4.3.1 CO_2 emissions

Table 3 and Figure 9 present the breakdown of energy-related CO_2 emissions across all the scenarios. They indicate that 6 million tonnes of CO_2 have been avoided with scenario RES-H_7%, and 9 million with scenario RES-H_Max, compared to 2018 levels. That's a 48% and 67% reductions of emissions in the heating sector respectively, 17% and 24% reductions in energy-related emissions, or 10% and 15% reductions in overall national greenhouse gas emissions. These CO_2 emission reductions have been achieved despite a projected 14% growth in heat demand between 2018 and 2030. The displacement of coal, peat and oil in heating also means significant improvements in air quality, in particular in urban areas.

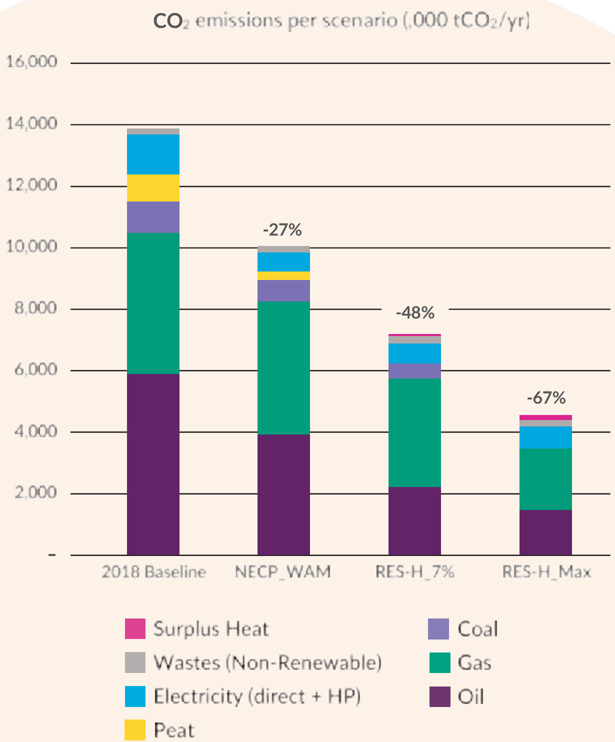


Figure 9: CO_2 emissions per scenario.

> Renewable heat can play a key role in meeting the Programme for Government target of annual 7% GHG reduction, and put Ireland on a strong footing to achieve zero-carbon status by 2050.

[26] Levelized cost of energy is calculated by dividing the total annual 'whole-system' cost (incl. annualised capital cost) by the amount of energy supplied by the system, in this case 'useful heat'.

Table 3: Breakdown of CO_2 emissions per scenario.

CO_2 emissions	2018 Baseline ($ktCO_2/yr$)	2030 Scenarios NECP_WAM ($ktCO_2/yr$)	2030 Scenarios RES-H_7% ($ktCO_2/yr$)	2030 Scenarios RES-H_Max ($ktCO_2/yr$)
Oil	5,895	3,935	2,244	1,478
Gas	4,585	4,333	3,521	2,016
Coal	1,031	673	488	–
Peat	881	306	–	–
Electricity (direct + HP)	1,291	597	661	695
Wastes (Non-Renewable)	168	204	229	229
Surplus Heat	–	–	50	137
Biomass	–	–	–	–
RES-gas mix	–	3.64	9	8
Solar	–	–	–	–
Ambient energy	–	–	–	–
Total	13,851	10,052	7,202	4,563

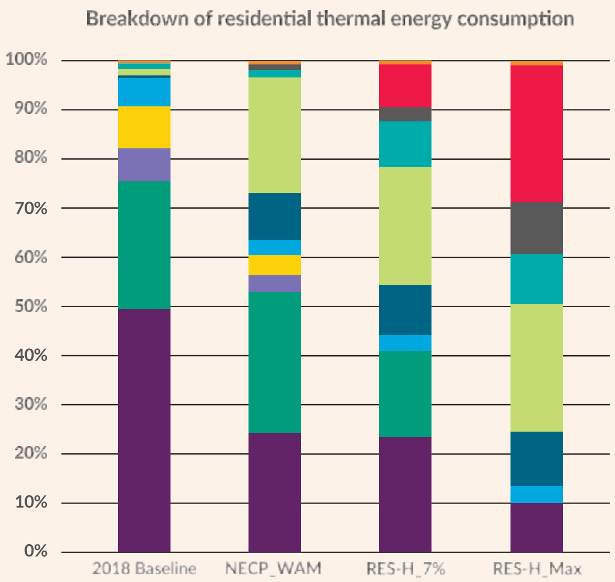
4.3.2 Final energy consumption

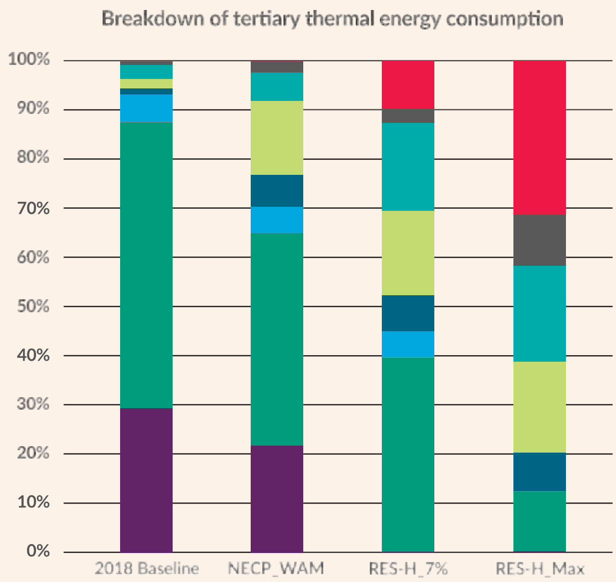
Table 4 presents the breakdown of final energy consumption across all the scenarios, with a more detailed breakdown for the residential, tertiary and industrial sectors presented in Annex 1. They highlight the potential for a significant increase in renewable heat penetration[27] from current levels of just above 6% (half the 2020 target) to 22% by 2030 under the current policy framework, to c. 40% with the ambitious RES-H_7% scenario and c. 60% with the radical RES-H_Max scenario. Figure 10 illustrates how the thermal energy mix evolves in each sector from the 2018 to 2030 scenarios, with a gradual phasing out of fossil fuels and dominance of renewable heat. Further details on the sectorial thermal energy mix of each scenario is provided in Annex 2.

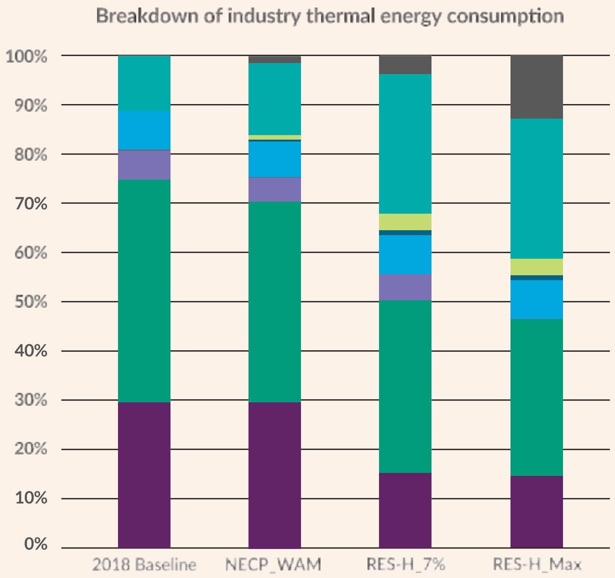
Further details on the share of each energy source's contribution to meeting the heating requirements of each sector, for the scenarios analysed, are presented in the tables in Annex 3.

These levels of renewable penetration increase by another 6-7% across all advanced scenarios if the contribution of renewable electricity to heating is accounted for, but this is not included here in the overall renewable heat share to avoid double counting. Given that the share of imported heating fuels has been reduced to an estimated 34% and 17% in the RES-H_7% and RES-H_Max scenarios respectively, from 64% in 2018. Ireland is now in a much stronger position in terms of energy security.

[27] Surplus heat is considered as renewable heat for the purpose of the analysis.







The ResH_7% scenario demonstrates that an ambitious target of 40% renewable heat by 2030 is both practical and realistic, displacing imported fossil fuels with indigenous resources.

Figure 10: Share of energy sources in the overall thermal energy consumption of the residential, tertiary and industrial sectors.

Table 4: Breakdown of □nal energy consumption across all scenarios modelled.

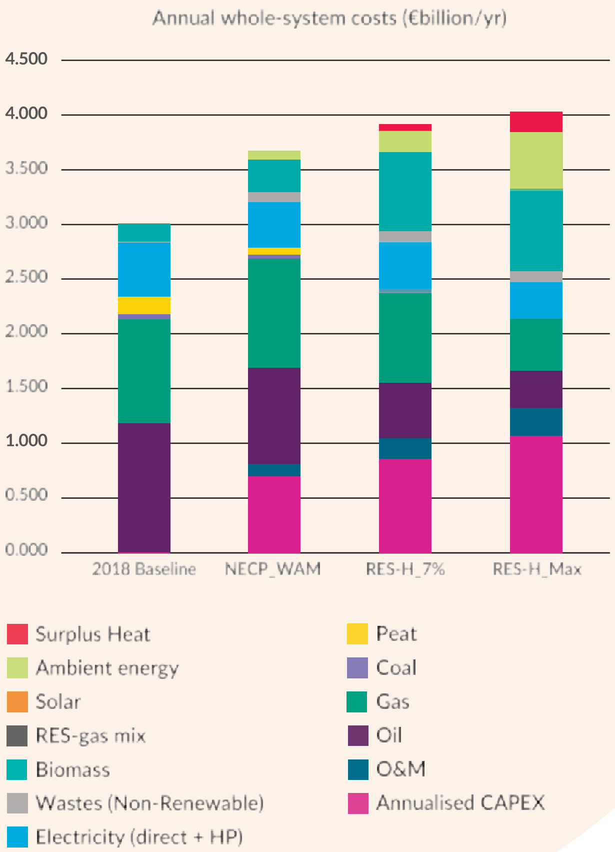
		2030 Scenarios		
Total □nal enegy consumption	2018 Baseline (TWh/yr)	NECP_WAM (TWh/yr)	RES-H_7% (TWh/yr)	RES-H_Max (TWh/yr)
Oil	22.43	14.97	8.54	5.62
Gas	22.40	21.17	17.20	9.85
Coal	3.03	1.98	1.43	□
Peat	2.30	0.80	□	□
Wastes (non-res)	0.64	0.78	0.87	0.87
Electricity (direct)	3.11	2.37	2.47	1.86
Electricity (heat pumps)	0.26	2.69	3.09	3.25
Surplus heat & deep geothermal	□	□	2.82	8.10
Biomass	2.93	4.83	11.66	12.14
RES-gas	0.11	0.79	1.86	6.37
Solar	0.16	0.16	0.16	0.16
Ambient energy	0.51	6.56	7.40	7.40
RES-heat	*3.72*	*12.34*	*23.90*	*34.17*
RES-e total	*1.01*	*3.54*	*3.89*	*3.58*
Fossil fuels & electricity	53.15	41.21	29.71	17.88
Grand total (incl all RES)	57.88	57.09	57.50	55.63
RES-Heat (%)	*6.4%*	*22%*	*42%*	*61%*
RES-Heat + RES-e (%)	*8.2%*	*28%*	*48%*	*68%*
Imported fuels	*64.2%*	*50%*	*34%*	*17%*

4.3.3 Whole-system annual costs and capital costs

Figure 11 and Table 5 provide a breakdown of the annual whole-system costs per scenario, including energy expenditure, CAPEX and OPEX. This gives an insight into the economic cost of the national heat supply systems and its decarbonisation. First, the modelling results indicate that future annual whole-system costs of the NECP-WAM, RES-H_7% and RES-H_Max scenarios are broadly in line[28], ranging from □3.7 to □4 billion per year[29].

[28] Please note that the capital and O&M costs of incumbent systems have not been factored in the annual whole-system cost analysis of the different scenarios. This somewhat underestimates the cost of scenarios with a higher share of fossil fuel systems which need to be repaired and maintained, and a significant proportion of which would have to be replaced over the next decade.

[29] For reference, these future heating systems costs are about 1.2% of what Ireland's Gross National Product is projected to be in 2030 (DECC, 2020).



High levels of renewable energy supply and decarbonisation of heat do not necessarily lead to significant increase in costs to meet our heating requirements □ the additional cost of capital investment is more than balanced by the savings in energy expenditure.

Figure 11: Annual whole system costs across scenarios.

Table 5: Breakdown of annual whole-system costs per scenario, including energy expenditure, CAPEX and OPEX.

		2030 Scenarios		
Whole Heat Supply System Cost	2018 Baseline (□bn/yr)	NECP_WAM (□bn/yr)	RES-H_7% (□bn/yr)	RES-H_Max (□bn/yr)
Oil	1.165	0.778	0.444	0.292
Gas	0.935	0.884	0.718	0.411
Coal	0.050	0.033	0.024	□
Peat	0.154	0.054	□	□
Wastes (Non-Renewable)	0.011	0.078	0.087	0.087
Surplus Heat	□	□	0.056	0.162
Biomass	0.159	0.263	0.630	0.641
RES-gas mix	□	0.073	0.172	0.457
Solar	□	□	□	□
Ambient energy	□	□	□	□
Total fossil fuels	*2.315*	*1.825*	*1.272*	*0.790*
Direct elec	*0.487*	*0.371*	*0.386*	*0.291*
Heat pump elec	*0.045*	*0.421*	*0.485*	*0.544*
Renewables total	*0.159*	*0.336*	*0.858*	*1.260*
Total energy expenditure	*3.006*	*2.954*	*3.002*	*2.886*
Annualised CAPEX		*0.616*	*0.753*	*0.926*
O&M		*0.099*	*0.162*	*0.219*
Total annual energy system cost	3.006	3.669	3.917	4.031

This is borne by the levelized cost of the heat supplied calculation[30] (Figure 12) which indicates that the unit cost of the heat delivered to the consumer varies between €71.5/MWh for NECP_WAM, €76.4/MWh (+7%) for RES-H_7%, and €78.7/MWh for RES-H_Max (+10%).

From the point of view of CO_2 emission reduction, the marginal cost of further decarbonising the national heat supply between the NECP_WAM and the RES-H_7% scenario is €86/tCO_2, and €66/tCO_2 with RES-H_Max (see Figure 13). The lower marginal cost of CO_2 reductions with the RES-H_Max scenario can be explained by a combination of economies of scale as the renewable heat sector becomes the dominant player in the national heat supply, as well as the significant reliance on low-cost surplus heat with district heating in high heat density areas.

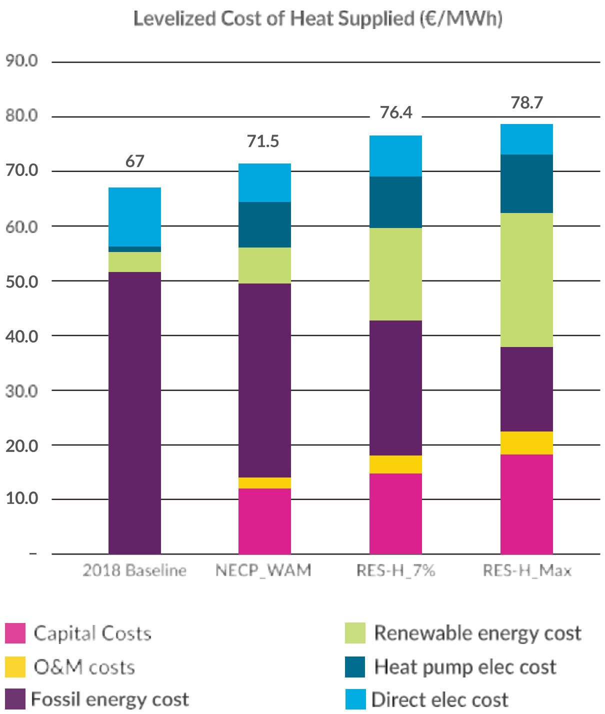


Figure 12: Levelized cost of the heat supplied.

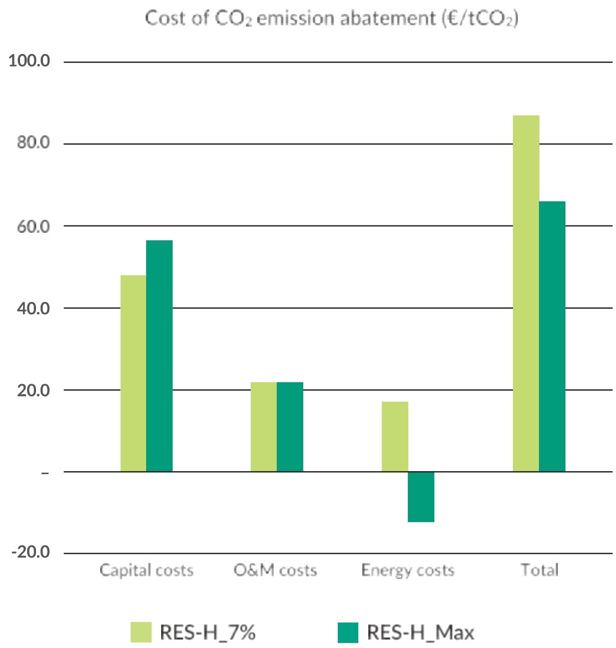


Figure 13: Cost of CO_2 emission abatement, with breakdown between capital, O&M and energy costs.

The capital investment in new RES-H systems has been estimated at €9.6 billion for the RES-H_7% scenario and €12.5 billion for the RES-H_Max scenario, including €0.7 and €3.1 billion in district heating infrastructure respectively (Table 6). That is a 25% and 60% increase on the capital investment associated with the National Energy & Climate Plan's WAM scenario (Figure 14).

[30] Annualised capital cost + other annual costs, divided by the total heating requirement.

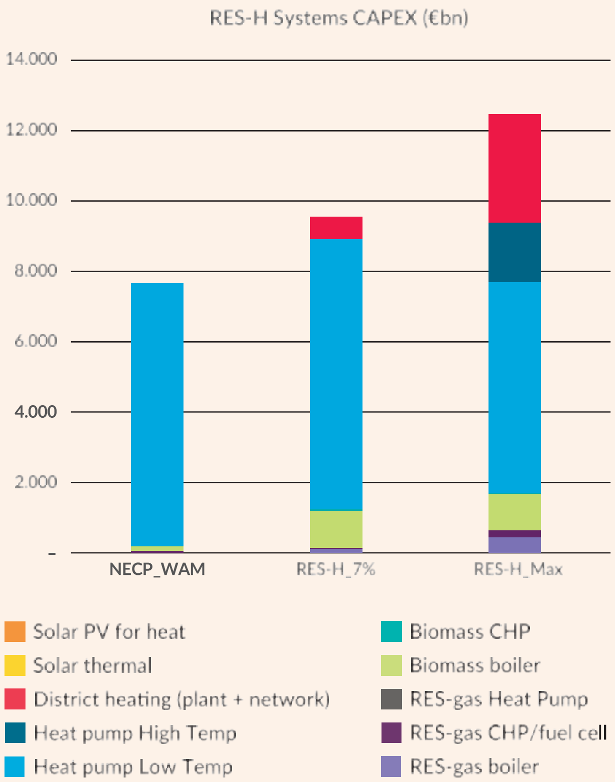


Figure 14: Breakdown of RES-H system Capex per scenario.

The capital investment required to achieve 40% of the national heat supply from renewable sources and 7% annual reduction in CO_2 emissions is about a third of the □30 billion investment earmarked for the national energy retrofit programme.

Table 6: Capital expenditure per RES-H system across scenarios.

RES-H Systems CAPEX	NECP_WAM (□bn)	RES-H_7% (□bn)	RES-H_Max (□bn)
RES-gas boiler	0.049	0.120	0.426
Biomass boiler	0.122	1.055	1.055
Biomass CHP	0.028	0.028	0.028
Heat pump Low Temp	7.476	7.688	5.985
Heat pump High Temp	□	□	1.702
Solar thermal	□	□	□
Solar PV for heat	□	□	□
RES-gas Heat Pump	□	□	□
RES-gas CHP/fuel cell	□	0.015	0.193
District heating (plant + network)	□	0.654	3.067
TOTAL	7.676	9.561	12.458

4.4 Job Creation

While it is difficult to be exact when calculating the impact of renewable heat deployment in terms of job creation, an estimate has been made here following the methodology applied in the peer-reviewed analysis behind Green Plan Ireland (Connolly & Vad Mathiesen, 2014). The methodology assumes that the average Irish employee earns €45,000/year and that the job creations associated with a given 2030 RES-H scenario is distributed equally over this decade[31] and benchmarked against the 2018 baseline. It is also assumed that the import share for investments, O&M, fossil fuels and biomass is 60%, 20%, 90%, and 10% respectively. Ideally each technology would have a specific import share but due to the nascent status of many low-carbon heating technologies in Ireland, these are currently not available and even if they were, would not be reflective of what is likely to occur as they become prominent features of the Irish heat sector.

This simplified methodology indicates that over 23,000 new jobs would be created in full-time equivalent (FTE) as an outcome of achieving the 40% renewable heat target for 2030.

Table 7: Job creation potential of renewable heat deployment.

Job creation potential			2030 Scenarios		
Cost item	Spent locally	2018 Baseline (€bn/yr)	NECP_WAM (€bn/yr)	RES H_7% (€bn/yr)	RES H_Max (€bn/yr)
Capital	40%	–	0.307	0.382	0.498
O&M	80%	–	0.079	0.129	0.175
Fossil fuels	10%	0.23	0.18	0.13	0.08
RES fuels	90%	0.14	0.30	0.77	1.13
Total local expenditure		0.374	0.872	1.412	1.887
Local jobs (FTE/yr)		8,317	19,371	31,372	41,931
New jobs created (FTE/yr)			11,053	23,055	33,614

Achieving the 40% renewable heat target of scenario RES-H by 2030 would result in the creation of over 23,000 new jobs over this decade.

[31] Capital expenditure, O&M costs and energy costs calculated have been averaged over a 10 year period.


5

Overall, this analysis provides evidence that Ireland can and should adopt an ambitious 40% renewable heat target, that will put our nation on the right path to achieve zero-carbon heating by 2050. This can be achieved cost-effectively with the country's natural renewable energy resources, benefiting Ireland's balance of payment by a €1 billion saving in imported fossil fuels compared to 2018.

Achieving this ambitious 40% target by 2030 means growing the production of renewable heat by an absolute 3.4% every year from the current 6% share. This will require a radical market transformation, underpinned by deep reform of the heating sector with technological innovation, training and education, as well as infrastructural development. This presents significant challenges for our society, but the good news is that the environmental and socio-economic dividends will be very significant. Capital investment in green technologies, together with their operation & maintenance, and the development of local supply chains in indigenous biomass fuels, will lead to tremendous job creation opportunities, in particular in our rural communities.

A detailed list of changes is included in this report, outlining how government and industry can work together to deliver a 40% renewable heat target by 2030. The list includes 21 actions for government across policy and regulation (7), financial stabilisation (11) and capacity building (3). It also includes 19 industry-led actions the renewable heat sector is prepared to drive if an ambitious target is put in place across capacity building (7), innovation (4), quality assurance (5) and awareness-raising (3).

Here are a number of highlights of cross-sectorial actions required:

1. Updating the building regulations and BER assessment methodology to accurately reflect the decarbonisation benefits of renewable heat.
2. Simplify administrative & regulatory requirement barriers, particularly in relation to financial incentives for renewable heat technologies to increase uptake and reduce compliance costs.
3. Implement Article 23 of the Renewable Energy Directive (REDII) under the EU Clean Energy Package with a mandatory high ambition of at least 3% per annum.
4. Set Green Procurement targets for the public sector at a minimum of a 20% annual increase in renewable heat and mandate that all new or replacement heating systems to be 100% renewable.
5. Widen the support for renewable heat in the Home Energy Grants and in the Support Scheme for Renewable Heat (SSRH), and seek ways to incentivise large heat users to adopt renewable heat solutions.

The table on the next page provides key details of cross-sectorial measures that are advocated by the members of Renewable Energy Ireland, with their aims, proposed lead and support roles, the next steps to be undertaken and target dates, and the likely impacts of not taking action. A complete list is put forward in Annex 4 of this report.

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of Delay on 2030 targets
Buildings	All RES-H 1 Building Regulations Part L	Update Building Regulations Part L compliance procedure and BER methodology to reflect properly the decarbonisation benefit of renewable heat options.	Remove Part L compliance & BER methodology barriers to the adoption of renewable heat technologies & district heating.	DHLGH	SEAI, REI RGFI, IrBEA, IrDEA	a) Cross-sectorial working group to prepare recommendations. b) Publication of revised methodology and software update. c) Raise awareness and educate BER assessors & advisors.	a) H1 2021 b) H2 2021 c) H2 2021	Decision-makers will continue to be disincentivised to adopt cost-effective decarbonisation solutions.
Cross sectorial	All RES-H 2 Simplify regulatory & administrative requirements	Terms & conditions and procedures for funding schemes to be streamlined and simplified. Accelerate digitalisation of processes. Foster a collaborative approach between funding authorities & industry.	Remove red tape and accelerate access to financial supports by consumers.	SEAI, DECC, DHLGH (Building Regulations), DAFM.	REI RGFI, IrBEA, IrDEA	a) Co-design approach to schemes administration. b) Publish joint Quality Assurance and Consumer Protection Charter. c) Investment in efficient administrative systems. d) Annual review of progress by joint steering commitee.	a) H1 2021 b) H2 2021 c) H2 2021 d) Annual	Failure to mobilise private and state investment in RE technologies and continuing dependence on fossil fuels in the heat sector.
Cross sectorial	All RES-H 3 Renewable Heat Obligation Scheme	Implement Article 23 of REDII with a mandatory high ambition of at least 3% per annum.	To mandate fuel suppliers to increase the share of RES H in their supply by 3% per year.	DECC, Department of Transport, NORA	REI, RGFI, IrBEA, IrDEA	a) Establish administrative system (certification, M&V, etc.) b) Introduction of Renewable Heat Obligation Scheme, in line with transposition of REDII. c) Annual review in CAP by steering commitee.	a) H1 2021 b) H1 2021 c) Annual	Consumer carrying financial burden on lack of choice. Anti-competiveness, non-compliance with SDGs, ESGs.
Non-residential	All RES H 4 Public sector green procurement	Public sector to set Green Procurement targets at a minimum of a 20% annual increase in RES-H. All new or replacement of heating systems procured to be 100% renewable.	Public sector to be driver for adoption of renewable heat through green procurement policy and practices.	DPER, all public bodies.	OGP, REI, RGFI, IrBEA, IrDEA	a) Mandate an annual increasing share of renewable heating in the Green Procurement Guidance for the Public Sector. b) Establish M&V system with annual reporting.	H2 2021	Prevent 'locked in' fossil fuels in the public sector.
Tertiary & Industry	All RES-H5 Non-residential sectors, incl. industry & ETS sectors	Widen and improve supports for RES-H in the non-residential sectors. Seek ways to incentivise large users of heat to adopt RES-H, including in hard to decarbonise sectors, in particular industry and ETS sector.	Support the decarbonisation of the industrial sector and encourage efficient use of RES resources.	DECC, SEAI	REI, RGFI, IrBEA, IrDEA	a) Improve and widen SSRH supports for biomass, renewable gas, heat pump and district heating systems. b) Remove carbon tax exemption for fossil-fuel based CHP. c) Increase carbon tax. d) Detailed study of ETS and non-ETS sectors on large heat users solutions.	H2 2021	RES-H remains uncompetitive, hard to decarbonise sectors lagging behind and their economic activity being impacted.
Residential	All RES-H6 Wider domestic grant supports	Expand range RES-H technologies eligible for Home Energy Grants and offer more options to homeowners, including for hard to retrofit homes.	Remove barriers to adoption and incentivise a wider range of RES-H options.	SEAI, DECC	REI, RGFI, IrBEA, IrDEA	a) Incentivise bioenergy solutions and district heating substations. b) Relax max HLI requirement for heat pumps retrofits.	Budget 2022	Much of the existing housing stock will remain on fossil fuels for the foreseeable future.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Annex 1. Details of final energy consumption for the scenarios modelled

				2030 Scenarios		
Sector	Fuel	Temperature grade	2018 Baseline (TWh/yr)	NECP_WAM (TWh/yr)	RES H_7% (TWh/yr)	RES H_Max (TWh/yr)
Residential	Oil	All	13	5	4	2
Residential	Gas	All	7.03	5.62	3.34	□
Residential	Coal	All	1.80	0.68	□	□
Residential	Peat	All	2.29	0.78	□	□
Residential	Direct elec	All	1.56	0.60	0.60	0.60
Residential	Wastes (Non Renewable)	All	□	□	□	□
Residential	Biomass	All	0.33	0.31	1.78	1.78
Residential	RES gas mix	All	□	0.20	0.54	1.85
Residential	DH mix	All	□	□	1.66	4.91
Residential	Solar	All	0.15	0.16	0.16	0.16
Residential	Ambient energy	All	0.32	4.60	4.59	4.59
Residential	Heat pump elec	All	0.16	1.88	1.97	1.97
Residential	Renewables total	All	0.79	5.28	7.08	8.39
Residential	Grand total (incl all RES)	SH: Heat pump ready	7.95	12.41	12.10	11.17
Residential	Grand total (incl all RES)	SH, HW: <60ºC	12.26	5.07	4.94	4.56
Residential	Grand total (incl all RES)	SH, HW: 60 100ºC	6.73	2.10	2.04	1.89
Residential	Grand total (incl all RES)	PH: 100 400ºC	□	□	□	□
Residential	Grand total (incl all RES)	PH: >400ºC	□	□	□	□
Residential	Grand total (incl all RES)	All	26.94	19.57	19.09	17.61
Tertiary	Oil	All	3.12	2.42	□	□
Tertiary	Gas	All	6.19	4.81	4.41	1.25
Tertiary	Coal	All	□	□	□	□
Tertiary	Peat	All	□	□	□	□
Tertiary	Direct elec	All	0.60	0.60	0.60	□
Tertiary	Wastes (Non Renewable)	All	□	□	□	□
Tertiary	Biomass	All	0.30	0.65	2.01	2.01
Tertiary	RES gas mix	All	0.09	0.24	0.31	1.06
Tertiary	DH mix	All	□	□	1.09	3.22
Tertiary	Solar	All	□	□	□	□
Tertiary	Ambient energy	All	0.20	1.69	1.90	1.90
Tertiary	Heat pump elec	All	0.13	0.72	0.81	0.81
Tertiary	Renewables total	All	0.59	2.58	4.22	4.97
Tertiary	Grand total (incl all RES)	SH: Heat pump ready	3.13	7.06	7.06	6.50
Tertiary	Grand total (incl all RES)	SH, HW: <60ºC	4.83	2.88	2.88	2.65
Tertiary	Grand total (incl all RES)	SH, HW: 60 100ºC	2.66	1.19	1.19	1.10
Tertiary	Grand total (incl all RES)	PH: 100 400ºC	□	□	□	□
Tertiary	Grand total (incl all RES)	PH: >400ºC	□	□	□	□
Tertiary	Grand total (incl all RES)	All	10.62	11.13	11.14	10.25
Industry	Oil	All	6.00	7.82	4.10	3.88
Industry	Gas	All	9.19	10.74	9.45	8.60
Industry	Coal	All	1.22	1.30	1.43	□
Industry	Peat	All	0.01	0.02	□	□
Industry	Direct elec	All	0.95	1.16	1.26	1.26
Industry	Wastes (Non Renewable)	All	0.64	0.78	0.87	0.87
Industry	Biomass	All	2.28	3.86	7.68	7.68
Industry	RES gas mix	All	0.03	0.34	1.01	3.47
Industry	DH mix	All	□	□	□	□

Sector	Fuel	Temperature grade	2018 Baseline (TWh/yr)	2030 Scenarios NECP_WAM (TWh/yr)	RES H_7% (TWh/yr)	RES H_Max (TWh/yr)
Industry	Solar	All	□	□	□	□
Industry	Ambient energy	All	0.00	0.27	0.90	0.09
Industry	Heat pump elec	All	□	0.09	0.30	0.30
Industry	Renewables total	All	2.28	4.48	9.59	12.05
Industry	Grand total (incl all RES)	SH: Heat pump ready	□	□	□	□
Industry	Grand total (incl all RES)	SH, HW: <60ºC	□	□	□	□
Industry	Grand total (incl all RES)	SH, HW: 60 100ºC	6.52	8.47	8.66	8.65
Industry	Grand total (incl all RES)	PH: 100 400ºC	5.18	6.73	6.88	6.87
Industry	Grand total (incl all RES)	PH: >400ºC	8.62	11.19	11.45	11.43
Industry	Grand total (incl all RES)	All	20.32	26.38	27.00	26.95
Total	Oil	All	22.43	14.97	8.54	5.62
Total	Gas	All	22.40	21.17	17.20	9.85
Total	Coal	All	3.03	1.98	1.43	□
Total	Peat	All	2.30	0.80	□	□
Total	Direct elec	All	3.11	2.37	2.47	1.86
Total	Wastes (Non Renewable)	All	0.64	0.78	0.87	0.87
Total	Biomass	All	2.93	4.83	11.47	11.47
Total	RES gas mix	All	0.11	0.79	1.86	6.37
Total	DH mix	All	□	□	2.74	8.13
Total	Solar	All	0.16	0.16	0.16	0.16
Total	Ambient energy	All	0.51	6.56	7.40	7.40
Total	Heat pump elec	All	0.26	2.69	3.08	3.08
Total	Renewables total	All	3.72	12.34	20.89	25.40
Total	Grand total (incl all RES)	SH: Heat pump ready	11.08	19.47	19.17	17.67
Total	Grand total (incl all RES)	SH, HW: <60ºC	17.09	7.95	7.82	7.21
Total	Grand total (incl all RES)	SH, HW: 60 100ºC	15.91	11.75	11.90	11.63
Total	Grand total (incl all RES)	PH: 100 400ºC	5.18	6.73	6.88	6.87
Total	Grand total (incl all RES)	PH: >400ºC	8.62	11.19	11.45	11.43
Total	Grand total (incl all RES)	All	57.76	57.09	57.22	54.81
Total	DH mix	Meet distbn and storage loss	□	□	0.27	0.81
Total	Direct elec	CHP generated electricity	□	0.37	0.37	0.37

District heating heat by fuel

DH Component Fuel	2018 Baseline (TWh/yr)	NECP_WAM (TWh/yr)	RES H_7% (TWh/yr)	RES H_Max (TWh/yr)
Solid biomass		0.00	0.19	0.68
RES gas mix		0.00	0.00	0.00
Heat pump elec		0.00	0.01	0.17
Waste heat		0.00	2.82	8.10
Solar		0.00	0.00	0.00
HP Ambient		0.00	0.00	0.00

Totals with DH assigned to individual fuels

Sector	Fuel	Temperature grade	2018 Baseline (TWh/yr)	2030 Scenarios NECP_WAM (TWh/yr)	2030 Scenarios RES H_7% (TWh/yr)	2030 Scenarios RES H_Max (TWh/yr)
Total	Oil	All	22.43	14.97	8.54	5.62
Total	Gas	All	22.40	21.17	17.20	9.85
Total	Coal	All	3.03	1.98	1.43	-
Total	Peat	All	2.30	0.80	-	-
Total	Direct elec	All	3.11	2.37	2.47	1.86
Total	Wastes (Non Renewable)	All	0.64	0.78	0.87	0.87
Total	Biomass	All	2.93	4.83	11.66	12.14
Total	RES gas mix	All	0.11	0.79	1.86	6.37
Total	Surplus/Geothermal	All	□	□	2.82	8.10
Total	Solar	All	0.16	0.16	0.16	0.16
Total	Ambient energy	All	0.51	6.56	7.40	7.40
Total	Heat pump elec	All	0.26	2.69	3.09	3.25
Total	Total (based on deliv fuels)	All	57.20	50.37	49.94	48.06
Total	Renewables total	All	3.72	12.34	21.08	26.08
Total	Grand total (incl all RES)	SH: Heat pump ready	11.08	19.47	19.17	17.67
Total	Grand total (incl all RES)	SH, HW: <60ºC	17.09	7.95	7.82	7.21
Total	Grand total (incl all RES)	SH, HW: 60 100ºC	15.91	11.75	11.90	11.63
Total	Grand total (incl all RES)	PH: 100 400ºC	5.18	6.73	6.88	6.87
Total	Grand total (incl all RES)	PH: > 400ºC	8.62	11.19	11.45	11.43
Total	Grand total (incl all RES)	All	57.88	57.09	57.50	55.63

Annex 2. Thermal energy mix per sector and per scenarios modelled

Sector	Energy Source	Temperature grade	2018 Baseline	2030 Scenarios NECP_WAM	RES H_7%	RES H_Max
Residential	Oil	All	49.4%	24.2%	23.3%	9.9%
Residential	Gas	All	26.1%	28.7%	17.5%	0.0%
Residential	Coal	All	6.7%	3.5%	0.0%	0.0%
Residential	Peat	All	8.5%	4.0%	0.0%	0.0%
Residential	Direct elec	All	5.8%	3.1%	3.2%	3.4%
Residential	Wastes (Non Renewable)	All	0.0%	0.0%	0.0%	0.0%
Residential	Biomass	All	1.2%	1.6%	9.3%	10.1%
Residential	RES gas mix	All	0.0%	1.0%	2.8%	10.5%
Residential	DH mix	All	0.0%	0.0%	8.7%	27.9%
Residential	Solar	All	0.6%	0.8%	0.9%	0.9%
Residential	Ambient energy	All	1.2%	23.5%	24.1%	26.1%
Residential	Heat pump elec	All	0.6%	9.6%	10.3%	11.2%
Residential	Renewables total	All	2.9%	27.0%	37.1%	47.6%
Residential	Grand total (incl all RES)	SH: Heat pump ready	29.5%	63.4%	63.4%	63.4%
Residential	Grand total (incl all RES)	SH, HW: <60ºC	45.5%	25.9%	25.9%	25.9%
Residential	Grand total (incl all RES)	SH, HW: 60 100ºC	25.0%	10.7%	10.7%	10.7%
Residential	Grand total (incl all RES)	PH: 100 400ºC	0.0%	0.0%	0.0%	0.0%
Residential	Grand total (incl all RES)	PH: > 400ºC	0.0%	0.0%	0.0%	0.0%
Residential	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Tertiary	Oil	All	29.3%	21.7%	0.0%	0.0%
Tertiary	Gas	All	58.2%	43.2%	39.6%	12.2%
Tertiary	Coal	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Peat	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Direct elec	All	5.7%	5.4%	5.4%	0.0%
Tertiary	Wastes (Non Renewable)	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Biomass	All	2.8%	5.8%	18.0%	19.6%
Tertiary	RES gas mix	All	0.8%	2.2%	2.8%	10.3%
Tertiary	DH mix	All	0.0%	0.0%	9.8%	31.5%
Tertiary	Solar	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Ambient energy	All	1.9%	15.1%	17.1%	18.6%
Tertiary	Heat pump elec	All	1.2%	6.5%	7.3%	7.9%
Tertiary	Grand total (incl all RES)	SH: Heat pump ready	29.5%	63.4%	63.4%	63.4%
Tertiary	Grand total (incl all RES)	SH, HW: <60ºC	45.5%	25.9%	25.9%	25.9%
Tertiary	Grand total (incl all RES)	SH, HW: 60 100ºC	25.0%	10.7%	10.7%	10.7%
Tertiary	Grand total (incl all RES)	PH: 100 400ºC	0.0%	0.0%	0.0%	0.0%
Tertiary	Grand total (incl all RES)	PH: > 400ºC	0.0%	0.0%	0.0%	0.0%
Tertiary	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Industry	Oil	All	29.5%	29.6%	15.2%	14.4%
Industry	Gas	All	45.2%	40.7%	35.0%	31.9%
Industry	Coal	All	6.0%	4.9%	5.3%	0.0%
Industry	Peat	All	0.1%	0.1%	0.0%	0.0%
Industry	Direct elec	All	4.7%	4.4%	4.7%	4.7%
Industry	Wastes (Non Renewable)	All	3.1%	2.9%	3.2%	3.2%
Industry	Biomass	All	11.2%	14.6%	28.4%	28.5%
Industry	RES gas mix	All	0.1%	1.3%	3.7%	12.9%
Industry	DH mix	All	0.0%	0.0%	0.0%	0.0%
Industry	Solar	All	0.0%	0.0%	0.0%	0.0%

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES H_7%	RES H_Max
Industry	Ambient energy	All	0.0%	1.0%	3.3%	3.3%
Industry	Heat pump elec	All	0.0%	0.3%	1.1%	1.1%
Industry	Grand total (incl all RES)	SH: Heat pump ready	0.0%	0.0%	0.0%	0.0%
Industry	Grand total (incl all RES)	SH, HW: <60ºC	0.0%	0.0%	0.0%	0.0%
Industry	Grand total (incl all RES)	SH, HW: 60 100ºC	32.1%	32.1%	32.1%	32.1%
Industry	Grand total (incl all RES)	PH: 100 400ºC	25.5%	25.5%	25.5%	25.5%
Industry	Grand total (incl all RES)	PH: > 400ºC	42.4%	42.4%	42.4%	42.4%
Industry	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Total	Oil	All	38.8%	26.2%	14.9%	10.3%
Total	Gas	All	38.8%	37.1%	30.1%	18.0%
Total	Coal	All	5.2%	3.5%	2.5%	0.0%
Total	Peat	All	4.0%	1.4%	0.0%	0.0%
Total	Direct elec	All	5.4%	4.2%	4.3%	3.4%
Total	Wastes (Non Renewable)	All	1.1%	1.4%	1.5%	1.6%
Total	Biomass	All	5.1%	8.5%	20.0%	20.9%
Total	RES gas mix	All	0.2%	1.4%	3.3%	11.6%
Total	DH mix	All	0.0%	0.0%	4.8%	14.8%
Total	Solar	All	0.3%	0.3%	0.3%	0.3%
Total	Ambient energy	All	0.9%	11.5%	12.9%	13.5%
Total	Heat pump elec	All	0.4%	4.7%	5.4%	5.6%
Total	Grand total (incl all RES)	SH: Heat pump ready	19.2%	34.1%	33.5%	32.2%
Total	Grand total (incl all RES)	SH, HW: <60ºC	29.6%	13.9%	13.7%	13.2%
Total	Grand total (incl all RES)	SH, HW: 60 100ºC	27.5%	20.6%	20.8%	21.2%
Total	Grand total (incl all RES)	PH: 100 400ºC	9.0%	11.8%	12.0%	12.5%
Total	Grand total (incl all RES)	PH: > 400ºC	14.9%	19.6%	20.0%	20.9%
Total	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%

Total with heat supplied by district heating broken down per heat source

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES H_7%	RES H_Max
Total	Oil	All	38.7%	26.2%	14.8%	10.1%
Total	Gas	All	38.7%	37.1%	29.9%	17.7%
Total	Coal	All	5.2%	3.5%	2.5%	0.0%
Total	Peat	All	4.0%	1.4%	0.0%	0.0%
Total	Direct elec	All	5.4%	4.2%	4.3%	3.3%
Total	Wastes (Non Renewable)	All	1.1%	1.4%	1.5%	1.6%
Total	Biomass	All	5.1%	8.5%	20.3%	21.8%
Total	RES gas mix	All	0.2%	1.4%	3.2%	11.5%
Total	Surplus Heat/Geothermal	All	0.0%	0.0%	4.9%	14.6%
Total	Solar	All	0.3%	0.3%	0.3%	0.3%
Total	Ambient energy	All	0.9%	11.5%	12.9%	13.3%
Total	Heat pump elec	All	0.4%	4.7%	5.4%	5.8%
Total	Renewables total	All	6.4%	21.6%	36.7%	46.9%
Total	Grand total (incl all RES)	SH: Heat pump ready	19.1%	34.1%	33.3%	31.8%
Total	Grand total (incl all RES)	SH, HW: <60ºC	29.5%	13.9%	13.6%	13.0%
Total	Grand total (incl all RES)	SH, HW: 60 100ºC	27.5%	20.6%	20.7%	20.9%
Total	Grand total (incl all RES)	PH: 100 400ºC	9.0%	11.8%	12.0%	12.4%
Total	Grand total (incl all RES)	PH: > 400ºC	14.9%	19.6%	19.9%	20.5%
Total	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%

Annex 3. Share of energy sources in meeting the heating requirement of each sector, per scenarios modelled

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES H_7%	RES H_Max
Residential	Oil	All	52.3%	23.7%	22.3%	8.8%
Residential	Gas	All	27.6%	28.2%	16.8%	0.0%
Residential	Coal	All	3.5%	2.6%	0.0%	0.0%
Residential	Peat	All	4.5%	2.8%	0.0%	0.0%
Residential	Direct elec	All	7.7%	3.4%	3.4%	3.4%
Residential	Wastes (Non Renewable)	All	0.0%	0.0%	0.0%	0.0%
Residential	Biomass	All	1.2%	1.4%	7.7%	7.7%
Residential	RES gas mix	All	0.0%	1.0%	2.7%	9.3%
Residential	DH mix	All	0.0%	0.0%	9.5%	33.2%
Residential	Solar	All	0.7%	0.9%	0.9%	0.9%
Residential	Ambient energy	All	1.6%	25.6%	25.7%	25.7%
Residential	Heat pump elec	All	0.8%	10.4%	11.0%	11.0%
Residential	Renewables total	All	3.5%	28.9%	37.0%	43.6%
Residential	Grand total (incl all RES)	SH: Heat pump ready	29.5%	63.4%	63.4%	63.4%
Residential	Grand total (incl all RES)	SH, HW: <60ºC	45.5%	25.9%	25.9%	25.9%
Residential	Grand total (incl all RES)	SH, HW: 60 100ºC	25.0%	10.7%	10.7%	10.7%
Residential	Grand total (incl all RES)	PH: 100 400ºC	0.0%	0.0%	0.0%	0.0%
Residential	Grand total (incl all RES)	PH: > 400ºC	0.0%	0.0%	0.0%	0.0%
Residential	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Tertiary	Oil	All	28.7%	21.2%	0.0%	0.0%
Tertiary	Gas	All	57.0%	42.2%	38.7%	11.0%
Tertiary	Coal	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Peat	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Direct elec	All	7.0%	5.9%	5.9%	0.0%
Tertiary	Wastes (Non Renewable)	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Biomass	All	2.7%	5.1%	15.2%	15.2%
Tertiary	RES gas mix	All	0.8%	2.1%	2.8%	9.3%
Tertiary	DH mix	All	0.0%	0.0%	10.9%	38.1%
Tertiary	Solar	All	0.0%	0.0%	0.0%	0.0%
Tertiary	Ambient energy	All	2.3%	16.4%	18.6%	18.6%
Tertiary	Heat pump elec	All	1.5%	7.1%	7.9%	7.9%
Tertiary	Renewables total	All	5.8%	23.7%	36.5%	43.1%
Tertiary	Grand total (incl all RES)	SH: Heat pump ready	29.5%	63.4%	63.4%	63.4%
Tertiary	Grand total (incl all RES)	SH, HW: <60ºC	45.5%	25.9%	25.9%	25.9%
Tertiary	Grand total (incl all RES)	SH, HW: 60 100ºC	25.0%	10.7%	10.7%	10.7%
Tertiary	Grand total (incl all RES)	PH: 100 400ºC	0.0%	0.0%	0.0%	0.0%
Tertiary	Grand total (incl all RES)	PH: > 400ºC	0.0%	0.0%	0.0%	0.0%
Tertiary	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Industry	Oil	All	30.3%	30.5%	16.0%	15.1%
Industry	Gas	All	46.3%	41.8%	36.8%	33.5%
Industry	Coal	All	3.1%	3.9%	4.3%	0.0%
Industry	Peat	All	0.0%	0.1%	0.0%	0.0%
Industry	Direct elec	All	6.0%	5.0%	5.4%	5.4%
Industry	Wastes (Non Renewable)	All	3.0%	2.5%	2.8%	2.8%
Industry	Biomass	All	11.1%	13.4%	25.9%	25.9%

				2030 Scenarios		
Sector	Energy Source	Temperature grade	2018 Baseline	NECP_WAM	RES H_7%	RES H_Max
Industry	RES gas mix	All	0.1%	1.2%	3.5%	12.0%
Industry	DH mix	All	0.0%	0.0%	0.0%	0.0%
Industry	Solar	All	0.0%	0.0%	0.0%	0.0%
Industry	Ambient energy	All	0.0%	1.2%	3.9%	3.9%
Industry	Heat pump elec	All	0.0%	0.4%	1.3%	1.3%
Industry	Renewables total	All	11.1%	15.8%	33.3%	41.8%
Industry	Grand total (incl all RES)	SH: Heat pump ready	0.0%	0.0%	0.0%	0.0%
Industry	Grand total (incl all RES)	SH, HW: <60ºC	0.0%	0.0%	0.0%	0.0%
Industry	Grand total (incl all RES)	SH, HW: 60 100ºC	32.1%	32.1%	32.1%	32.1%
Industry	Grand total (incl all RES)	PH: 100 400ºC	25.5%	25.5%	25.5%	25.5%
Industry	Grand total (incl all RES)	PH: > 400ºC	42.4%	42.4%	42.4%	42.4%
Industry	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%
Total	Oil	All	40.0%	26.2%	15.0%	9.9%
Total	Gas	All	39.9%	37.1%	30.2%	17.3%
Total	Coal	All	2.7%	2.7%	2.0%	0.0%
Total	Peat	All	2.0%	1.0%	0.0%	0.0%
Total	Direct elec	All	6.9%	4.6%	4.8%	3.6%
Total	Wastes (Non Renewable)	All	1.1%	1.1%	1.3%	1.3%
Total	Biomass	All	5.0%	7.5%	17.4%	17.4%
Total	RES gas mix	All	0.2%	1.3%	3.1%	10.5%
Total	DH mix	All	0.0%	0.0%	5.5%	19.2%
Total	Solar	All	0.3%	0.3%	0.3%	0.3%
Total	Ambient energy	All	1.1%	12.8%	14.4%	14.4%
Total	Heat pump elec	All	0.6%	5.2%	6.0%	6.0%
Total	Renewables total	All	6.7%	21.9%	35.3%	42.7%
Total	Grand total (incl all RES)	SH: Heat pump ready	19.1%	34.9%	34.8%	34.8%
Total	Grand total (incl all RES)	SH, HW: <60ºC	29.4%	14.2%	14.2%	14.2%
Total	Grand total (incl all RES)	SH, HW: 60 100ºC	27.5%	20.3%	20.3%	20.3%
Total	Grand total (incl all RES)	PH: 100 400ºC	9.0%	11.5%	11.5%	11.5%
Total	Grand total (incl all RES)	PH: > 400ºC	15.0%	19.1%	19.1%	19.1%
Total	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%

Total with heat supplied by district heating broken down per heat source

				2030 Scenarios		
Sector	**Energy Source**	**Temperature grade**	**2018 Baseline**	**NECP_WAM**	**RES H_7%**	**RES H_Max**
Total	Oil	All	40.0%	26.2%	14.9%	9.7%
Total	Gas	All	39.9%	37.1%	30.0%	17.0%
Total	Coal	All	2.7%	2.7%	1.9%	0.0%
Total	Peat	All	2.0%	1.0%	0.0%	0.0%
Total	Direct elec	All	6.9%	4.6%	4.8%	3.6%
Total	Wastes (Non Renewable)	All	1.1%	1.1%	1.3%	1.3%
Total	Biomass	All	5.0%	7.5%	17.6%	18.1%
Total	RES gas mix	All	0.2%	1.3%	3.1%	10.3%
Total	Waste Heat	All	0.0%	0.0%	5.6%	18.4%
Total	Solar	All	0.3%	0.3%	0.3%	0.3%
Total	Ambient energy	All	1.1%	12.8%	14.4%	14.2%
Total	Heat pump elec	All	0.6%	5.2%	6.1%	7.2%
Total	Renewables total	All	6.7%	21.9%	35.1%	41.9%
Total	Grand total (incl all RES)	SH: Heat pump ready	19.1%	34.9%	34.6%	34.2%
Total	Grand total (incl all RES)	SH, HW: <60ºC	29.4%	14.2%	14.1%	14.0%
Total	Grand total (incl all RES)	SH, HW: 60 100ºC	27.5%	20.3%	20.2%	20.0%
Total	Grand total (incl all RES)	PH: 100 400ºC	9.0%	11.5%	11.4%	11.3%
Total	Grand total (incl all RES)	PH: > 400ºC	15.0%	19.1%	19.0%	18.7%
Total	Grand total (incl all RES)	All	100.0%	100.0%	100.0%	100.0%

Annex 4. Modelling assumptions for the techno economic analysis of renewable heat scenarios

Table 8: Technical and financial assumptions for renewable heat system modelling.

				Lifetime (years)							
Residential	RES gas boiler	RES gas mix	All	20	8.0%	10	90%	12%	11	210	20.0
Residential	Biomass boiler	Biomass	All	20	8.0%	15	80%	12%	16	500	30.0
Residential	Heat pump	Heat pump elec	SH: Heat pump ready	20	8.0%	10	350%	12%	11	1250	15.0
Residential	Heat pump	Heat pump elec	SH, HW: <60ºC	20	8.0%	10	300%	12%	11	1250	15.0
Residential	Solar thermal	Solar	SH, HW: <60ºC	20	8.0%	3.5	100%	6%	2	1200	8.0
Residential	Solar PV for heat	Solar	SH, HW: <60ºC	25	7.1%	1.75	100%	6%	1	1700	8.0
Residential	RES gas Heat Pump	RES gas mix	SH, HW: <60ºC	20	8.0%	10	140%	12%	11	1500	17.0
Residential	RES gas CHP/ fuel cell	RES gas mix	All	20	8.0%	10	50%	12%	11	875	62.5
Residential	District heating	DH mix	All	50	5.5%	10	98%	23%	20	475	15.0
Tertiary	RES gas boiler	RES gas mix	All	20	8.0%	300	90%	20%	526	130	10.0
Tertiary	Biomass boiler	Biomass	All	20	8.0%	300	80%	35%	920	600	15.0
Tertiary	Biomass CHP	Biomass	All	20	8.0%	300	45%	35%	920	1563	33.9
Tertiary	Heat pump	Heat pump elec	SH: Heat pump ready	20	8.0%	300	350%	35%	920	479	8.0
Tertiary	Heat pump	Heat pump elec	SH, HW: <60ºC	20	8.0%	300	300%	35%	920	1100	8.0
Tertiary	Solar thermal	Solar	SH, HW: <60ºC	25	7.1%	150	100%	6%	79	1500	8.0
Tertiary	Solar PV for heat	Solar	SH, HW: <60ºC	20	8.0%	50	100%	6%	26	430	5.0
Tertiary	RES gas Heat Pump	RES gas mix	SH, HW: <60ºC	20	8.0%	300	140%	35%	920	700	50.0
Tertiary	RES gas CHP/fuel cell	RES gas mix	All	20	8.0%	300	50%	35%	920	563	31.3
Tertiary	District heating	DH mix	All	50	5.5%	300	98%	23%	600	333	10.5
Industry	RES gas boiler	RES gas mix	All	20	8.0%	10000	80%	80%	70,080	75	5.0
Industry	Biomass boiler	Biomass	All	20	8.0%	10000	80%	82%	71,832	470	10.0
Industry	Biomass CHP	Biomass	All	20	8.0%	10000	45%	82%	71,832	885	26.0
Industry	Heat pump	Heat pump elec	SH, HW: <100ºC	20	8.0%	1000	400%	82%	7,183	479	5.0
Industry	Heat pump	Heat pump elec	SH, HW: <100ºC	20	8.0%	1000	250%	82%	7,183	839	5.0
Industry	Solar thermal	Solar	SH, HW: <100ºC	25	7.1%	500	100%	6%	263	1100	3.0
Industry	Solar PV for heat	Solar	SH, HW: <100ºC	20	8.0%	50	100%	82%	359	430	5.0
Industry	RES gas Heat Pump	RES gas mix	All	20	8.0%	1000	140%	82%	7,183	500	25.0
Industry	RES gas CHP/fuel cell	RES gas mix	All	20	8.0%	1000	50%	82%	7,183	500	15.6
Industry	District heating	DH mix	All	50	5.5%	10000	n/a (per scenario)	82%	71,832	238	7.5

Please note the costs for district heating refer to the heat consumer connection to the district heating network (Heat Interface Unit and connection branch).

Table 9: Capital and O&M costs for district heating network (distribution). Source: Danish Energy Agency, 2020.

Capital cost	(€/MWh delivered)
Urban	150
Suburban	655
Rural	720
Operation and maintenance	**(€/MWh delivered)**
O&M	1.88

Table 10: District heating plant – technical and financial assumptions for the heat producing technologies modelling.

DH component type	DH component fuel	Seasonal thermal efficiency [%]	Capex/kW [€]	O&M costs/kW/yr [€] (not including fuel costs)	Fuel cost €/kWh	Primary energy factor	CO_2 kg/kWh	Load factor per system
Biomass boiler	Solid biomass	80%	470	10.00	0.024	1.1	0.000	82%
Biomass CHP	Solid biomass	45%	885	26.04	0.024	1.1	0.000	82%
RES gas boiler	RES gas mix	85%	75	5.00	See RES Gas mix	See RES-Gas mix	See RES Gas mix	23%
RES gas CHP	RES gas mix	50%	500	15.63	See RES Gas mix	See RES-Gas mix	See RES Gas mix	82%
HP ambient & shallow geo	Heat pump elec	250%	479	5.00	0.092	0.647	0.166	82%
Surplus heat low temp + HP	Heat pump elec	400%	839	3.00	0.092	0.647	0.166	82%
Surplus heat high temp	Waste Heat	100%	0	1.50	0.02	1.05	0.018	82%
Solar thermal	Solar	100%	1100	3.00	0	0	0	6%
Deep Geothermal	Geothermal	100%	2000	5	0	1.1	0	82%

Table 11: Technical and financial assumptions for the production of the different renewable gas types in the mix modelled.

RES gas type	LCOE per RES GAS type (€/kWh) RES-H_7% scenario (IrBEA & Cré assumptions*)	LCOE per RES GAS type, RGFI (€/kWh) RES-H_Max (RGFI assumptions**)	Primary energy factor per RES GAS type (kWh/kWh)	CO_2 per RES GAS type [kg/kWh]
10 GWh/yr AD plant	□ 0.120		1.1	0
BioLPG	□ 0.070	□ 0.054	1.1	0.01
20 GWh/yr AD plant	□ 0.110	□ 0.085	1.1	0
40 GWh/yr AD plant	□ 0.100	□ 0.078	1.1	0

** IrBEA & Cré assumptions are based on IrBEA & Cre. (2019). Biogas support scheme. Mobilising an Irish Biogas industry with policy and action.*
*** RGFI assumptions are based on KPMG. (2019). Integrated Business Case for Biomethane in Ireland - Executive Summary. RGFI.*

Table 12: Gas network – transmission and distribution costs per unit of gas delivered.

	(€/kWh supplied)
Residential market	□ 0.0277
Tertiary & industry	□ 0.0109

Annex 5. Policy improvements and industry-led actions to support 40% renewable heat target in Ireland by 2030

Summary of Policy Improvements (PIs)

Planning & Regulatory Framework

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Cross sectorial	DH1 Zone for DH with mandated connections over time	Publish heat planning and DH zoning at local authority level to mandate deployment of DH in areas with heat density > 120 TJ/km2 and renewable heat sources, including deep geothermal, are available. Planning regulations to mandate connection to DH networks where in place, for all new developments and major redevelopments, or upon boiler replacement.	County/City Development Plans to zone for district heating networks and renewable heating deployment as a priority.	DHLGH Regional Assemblies	DH Delivery Company (see DH5), Local Authorities, Energy Agencies, IrDEA, DHGLG, DECC	a. National Planning Framework and National Development Plan to introduce planning policy that will support heat planning and DH roll-out. b. Regional Spatial & Economic Strategy to formally recommend heat planning and designation of low-carbon heat zones in County & City Development Plans. c. Guidelines for heat planning and district heating development to be issued to Regional Assemblies & Local Authorities.	a. H1 2021 b. H2 2021 c. H1 2022	Zoning is required in order to de risk the market, and delays will significantly impact roll out targets to 2030.
Residential and non-residential	All RES-H1 Building Regulations Part L	Update Building Regulations Part L compliance procedure and BER methodology to reflect properly the decarbonisation benefit of renewable heat options such as bioenergy, surplus heat and district heating.	Remove Part L compliance & BER methodology barriers to the adoption of renewable heat technologies & district heating.	DHLGH	SEAI, REI, RGFI, IrBEA, IrDEA	a. Cross-sectorial working group to prepare recommendations for BER methodology revisions & update to associated software. b. Publication of revised methodology and software update. c. Raise awareness and educate BER assessors & technical advisors.	a. H1 2021 b. H2 2021 c. H2 2021	Decision-makers will continue to be disincentivised to adopt cost-effective decarbonisation solutions.
Cross sectorial	All RES-H2 Simplify regulatory & administrative requirements	Terms & conditions and procedures associated with application and payment of financial supports for renewable heat technologies to be streamlined and simplified with a customer-centric policy. Accelerate digitalisation of processes to increase productivity and reduce compliance burden. Foster a collaborative approach between funding authorities & industry in design and implementation of quality assurance & consumer protection policy.	Remove red tape and accelerate access to financial supports by consumers.	SEAI, DECC, DHLGH (Building Regulations), DAFM	REI, RGFI, IrBEA, IrDEA	a. All parties to engage in meaningful consultation and co-design of financial support schemes' administrative requirements & procedures. b. Publish joint Quality Assurance and Consumer Protection Charter defining principles, commitments and implementation plan. c. Investment in development and management of efficient administrative systems. d. Annual review of progress by steering committee representing stakeholders.	a. H1 2021 b. H2 2021 c. H2 2021 d. Annual	Failure to mobilise private and state investment in RE technologies and continuing dependence on fossil fuels in the heat sector.
Cross-sectorial	All RES-H3 Renewable Heat Obligation Scheme	Implement Article 23 of REDII with a mandatory high ambition of at least 3% per annum. Mandated incorporation schemes have proven to be both cost efficient and effective in achieving the objective.	To mandate fuel suppliers to increase the share of RES-H in their supply by 3% per year.	DECC, Department of Transport, NORA	REI, RGFI, IrBEA, IrDEA	a. Establish administrative system for certification, M&V and quality control. b. Introduction of Renewable Heat Obligation Scheme, in line with transposition of REDII. c. Annual review in CAP by steering committee.	a. H1 2021 b. H1 2021 c. H2 2021 d. Annual	• Consumer carrying financial burden on lack of choice. • Anti-competitiveness, non-compliance with SDG's, ESG's.

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Non-residential	All RES H4 Public sector green procurement Policy for RES H	Public sector to lead in decarbonising its heat supply by setting Green Procurement targets at a minimum of a 20% annual increase in RES-H. All new or replacement of heating systems procured to be 100% renewable.	Public sector to be driver for adoption of renewable heat through green procurement policy and practices.	DPER, all public bodies	OGP, REI, RGFI, IrBEA, IrDEA	a. Mandate an annual increasing share of renewable heating in the Green Procurement Guidance for the Public Sector. b. Establish M&V system with annual reporting.	H2 2021	Prevent 'locked in' fossil fuels in the public sector.
Cross sectorial	GeoH1 Regulatory framework & licensing	Develop a regulatory framework for GSHPs and deep geothermal systems, including licensing and regulatory conditions for deep geothermal energy projects through a centralised government body.	Ensure the sustained development of the geothermal sector in the future.	DCCAE DHLGH	SEAI, EPA, GSI, GAI, Local Authorities	a. Develop regulatory framework for GSHPs. b. Develop regulatory framework and licensing system for deep geothermal.	a. H2 2021 b. H1 2022	Lack of consumer confidence and investor confidence results in slow development of geothermal energy.
Residential	All RES-H5 Mandatory boiler carbon rating & annual maintenance	Introduce energy & carbon rating system for existing and new heating systems to foster adoption of renewable heat options at replacement. Mandate minimum carbon rating for sale of new heating appliances. Gradually raise minimal requirement towards phasing out of fossil fuel appliances. Introduce mandatory annual/bi-annual preventative maintenance scheme for heating appliances to ensure ongoing performance, emissions and safety standard.	Inform and encourage consumers to adopt renewable heating solutions at critical purchase decisions. Improve the performance of heating appliances in operation.	SEAI, DECC	REI, RGFI, IrBEA, IrDEA	a. Revise heating appliance rating system to reflect carbon performance. b. Integrate with Part L compliance requirements, subsidy schemes, RES-H Obligation Scheme, etc. c. Promote new rating system & labelling among consumers and supply chain. d. Regulate carbon rating of heating appliances being sold, raising standards to gradually phase out fossil fuel appliances.	Phase approach	Much of the older housing stock will remain on fossil fuels for the foreseeable future as the disruption and cost from deep retrofit will prove prohibitive.
Residential	BioHEAT1 Regulation for wood fuel quality	Regulate wood fuel quality to improve heating efficiency and address air quality issues.	Only clean dry wood fuel is sold on the market based on the ISO 17225 standard.	DECC / SEAI	IrBEA	Regulate the moisture content of wood fuels for sale. SI 128 2016 Air Pollution Act (Marketing, Sale, Distribution and Burning of Specified Fuels (Amendment 2016)) offers an existing legislative process to implement the proposal, by extending the fuels covered to firewood, referencing ISO 17225 Part 5, Class A1 and Class A2.	Sept 2021	Wet wood fuels negatively impact on air quality and reduce heating efficiency.
Cross sectorial	Res Gas1	Recognition and inclusion of renewable gas solutions (including biomethane, BioLPG and bio-hydrogen) in Ireland's Climate Action Plan and NECP (2021-2030), for the residential, commercial, and industrial sectors, as well as transport. Align with Renewable Energy Directive definition for renewable gases. Identify opportunities and potential that will utlise and valorise this feedstock, together with the waste management sector.	To support the production and supply of RES-Gas to consumers on and off the natural gas grid. To provide investor confidence with clear direction. Develop a circular and bio economy in collaboration with the commercial waste sector.	DECC	Industry & sectoral representation, including RGFI, IrBEA, the waste management industry	a. Include the RES-Gas sector in the achievement of the 40% RES-H target, as part of Ireland's Climate Action Plan and NECP (2021-2030). b. Include a clear definition of renewable gas (incl. biomethane, BioLPG and biohydrogen current and future pathways), with default energy content and GHG emissions savings. c. Launch consultation and establish milestones. d. Define a coordinated roadmap for RES-Gas, expanding the role of the gas suppliers to decarbonise.	H2 2021	• Missing RES-H target 2030. • Economic impact of EU fines on energy consumers. • Lack of consumer choice. • Lack of clarity on renewable gas offering and exclusion of viable renewable heat technologies.

Financial Stabilisation

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Tertiary & Industry	All RES-H6 Non-residential sectors, incl. industry & ETS sector	Widen and improve supports for RES- H in the non-residential sectors. Seek ways to incentivise large users of heat to adopt RES-H, including in hard to decarbonise sectors, in particular industry and ETS sector.	Support the decarbonisation of the industrial sector and encourage efficient use of RES resources.	DECC	REI, RGFI, IrBEA, IrDEA	a. SEAI to improve and widen SSRH supports (grants and tariffs), including for biomass & RES-Gas heating, biomass & RES-Gas CHP systems, heat pumps, incl. hybrid heat pumps, district heating, and solar thermal systems. b. DECC to remove carbon tax exemption for fossil-fuel based CHP. c. DECC to increase carbon tax in line with budgetary steps process towards €100/tCO_2 by 2030. d. SEAI to introduce measures to make the SSRH scheme more attractive to large industry. e. SEAI to carry out detailed study of ETS and non-ETS sectors to identfy all high heat demand users and suitable measures to decarbonise heat demand.	H2 2021	RES- H remains uncompetitive with incumbent fossil fuels. Hard to decarbonise sectors lagging and their economic activity being impacted by lack of ‘carbon’ competitiveness.
Cross sectorial	HP1 Electricity Tariffs	Development of new dynamic time of use tariffs reflecting cost of electricity generation and carbon intensity.	Support electrification of heat, together with demand response, and renewable heating.	CRU, ESB Networks, Energy Suppliers	SEAI, HPA	a. Prioritise consumers with heat pumps for smart meter installation/ upgrade. b. Speed up the general roll out of smart meters. c. Introduce time of use tariffs for all consumers.	H2 2021	Smart grid development, with high RES e and demand response impeded.
Cross sectorial	DH2 Heat Supply Tariff	Surplus heat and renewable heat injected into DH network qualifies for support for the SSRH.	Incentivise harnessing surplus heat and renewable heat opportunities for supply into DH networks.	DCCAE, SEAI	CRU, IrDEA	Amend SSRH T&Cs to add surplus heat eligibility.	H2 2021	Opportunities to harness surplus heat not captured and DH remains uncompetitive
Cross sectorial	DH3 Capital investment supports	Support financing of DH network deployment with investor-specific instruments: • National DH Delivery Company (See DH5) • Local Authorities • Community cooperatives • Private developers • Heat users.	Increase viability and bankability of DH capital investment to reach 10% penetration by 2030.	DCCAE, SEAI, ERDF	Regional authorities, EC, IrDEA	a. Allocate a €650 million capital investment fund to build networks for 10% DH e.g. via the Climate Action Fund and/or a DH Price Control. b. Secure low-cost guaranteed loan facility such as the Strategic Banking Corporation of Ireland's energy efficiency scheme. c. Launch grant scheme for connection to DH network and installation of heat user interface units. For example, by offering grants equivalent to those available for heat pump and bioenergy boilers.	H2 2021	Investment in DH stalled as developers cannot finance their projects. DH remains uncompetive against incumbents.
Cross sectorial	GeoH2 Deep geothermal development fund	Deep geothermal project development support fund for initial feasibility studies and project scoping for large scale DHN projects and commercial applications.	Reduce risk and increase investor confidence in geothermal projects.	DCCAE SEAI	DoF, DETI GAI	a. Launch 3 year fund for geothermal project development support.	H1 2022	Opportunities for viable geothermal project development not identified and no appetite for investment.

Sector	Policy Improvement	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Cross sectorial	RES Gas2	Support for industry-led projects. Empower communities to understand, participate and replicate.	Stimulate the production of scalable Agri and Waste based AD. Develop circular economy model.	DECC, DAFM & DPER	Community Power, DPER, DRCD. RGFI, IrBEA	a. Funding and supports to stimulate indigenous AD biomethane industry. b. Alignment with EGD and implementation of farm to fork and industrial waste strategies, i.e. Paris Agreement.	H2 2021	Missing RES-H targets. Consumer carrying financial burden on lack of choice. Anti-competitiveness, non-compliance with SDG's, ESG's.
Cross sectorial	RES Gas3	Provide incentives to produce and valorise BioLPG from indigenous biomass feedstocks.	Develop circular economy solutions.	DECC	DAFM, RGFI, IrBEA	a. Expand the terms of reference for the Climate Action Fund to consider BioLPG and facilitate future research & development funding for the sector. b. Renewable and low-carbon fuel producers should be incentivised to capture BioLPG or directly produce it.	a. H2 2021 b. H2 2022	Opportunity to switch consumers using higher carbon fuels like oil and solid fuels to cleaner and lower carbon solutions will be missed.
Residential	All RES H7 Wider domestic grant supports	Expand range RES-H technologies eligible for Home Energy Grants and offer more options to homeowners, including for hard to retrofit homes.	Remove barriers to adoption and incentivise a wider range of RES-H options.	SEAI, DECC	IrBEA, HPA, REI, RGFI, IrDEA	a. Include Eco Design labelled biomass heating solutions and district heating substations. b. Relax max HLI requirement and facilitate cost-optimal home energy retrofits with heat pumps. c. Incentivise off gas grid homeowners to switch from oil to BioLPG, including with hybrid heat pumps.	Budget 2022	Much of the existing housing stock will remain on fossil fuels for the foreseeable future, and Climate Action targets for heat pumps won't be met.
Cross sectorial	RES Gas4	A biogas/biomethane support payment/Feed in tariffs required to support biomethane injected onto the gas grid, or shipped to consumers by alternative means. This support is needed to bridge the cost of production of biogas and the current price of fossil gas. This support could be provided by either market or exchequer support.	To support the deployment of RES- Gas production and decarbonisation of heat and transport.	DECC, SEAI	IrBEA, RGFI	a. DECC to introduce a feed-in tariff for certified biomethane injected onto the gas grid, or shipped to consumers by alternative means.	Dec 2021	Hard to decarbonise sectors lagging behind and their economic activity being impacted by lack of 'carbon' competitiveness.

Capacity Building

Sector	Policy Improvement	Descrip on	Aim	Lead	Suppor ng Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Cross sectorial	DH4 DH Delivery Company	Establish a utility, or mandate an existing one, to develop DH networks at scale. The transmission & distribution infrastructure would primarily be in public ownership, with co-ownership & operation models possible where appropriate.	Prioritise large scale roll-out of 'essential public infrastructure' DH networks in areas with high heat demand density.	DECC, DHLGH, DoF, DPER	Local Authorities, CRU, SEAI	a. Propose legislation to establish a DH state company. b. Allocate ☐50 million per year of OPEX under a Price Control. c. CAPEX alloca on (see DH4). d. Reassign 40-50 people with expertise in planning, procurement, financing and others.[32]	a. H2 2021 b. Budget 2022 c. Budget 2022	The target for DH by 2030 is 10%, for every year delay it will decrease this target by ~1%.
Cross sectorial	All RES H8 Training & educa on	Resource provision of training for trades people in RES-H technologies installation and maintenance to ensure quality and consumer protection.	Huge need to train heating system designers and heat pump installers-SEAI estimates 1,600 additional FTE installers are needed.	SEAI, HPA, 3rd level institutes, SOLAS	HPA members, DECC, IrBEA	a. Investment in training facilities to equip and resource for the delivery of RES-heat installation & maintenance courses. b. Mandate QQI level 6 accredited training and manufacturer training for installations.	H2 2021	Immense ☐ targets will be missed if the delivery capacity falls.
Local communities	DH5 Community & LA DH support	Support for local authorities & community groups to develop local DH schemes, with appropriate guidance and support from trusted intermediaries.	Enable local communities in partnership with the national DH company (see DH5) and LAs to develop local DH networks with community benefit/ ownership.	SEAI	DECC, IrDEA, RGFI, IrBEA	a. SEAI to create guidance/training for community DH schemes. b. Establish trusted intermediaries to provide technical support and guidance in DH project development.	H1 2022	Energy transition is no just, with open participation, and lack of community acceptance.
Cross sectorial	GeoH3	Research support to further progress the regional scale mapping of geothermal resources.	To improve spatial knowledge of geothermal resources and project opportunities.	SEAI, SFI	DECC, GAI	a. Annual call for proposals for RD&D in geothermal resource assessment.	H1 2022	Lack of confidence and knowledge in geothermal resources slows investment.

[32] For comparison, GNI currently receives a budget of approximately ☐60 million per year for OPEX (p5) and ☐60 million per year for CAPEX (p4) under a Price Control that is regulated by the CRU: https://www.cru.ie/wp-content/uploads/2017/07/CER17128-PC4-CER-Consultation-Paper-October-2017-to-September-2022-Transmission-Revenues-for-GNI.pdf

Summary of industry -led ac tions

Capacity Building

Sector	Industry-led actions	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
District Heating	DH1 Roll Out Plan	Create a strategic roll-out plan for DH in Ireland with 2030 and 2050 targets, including required upskilling, capacity building and customer acceptance, and examining sector integrati on opportunities.	To reach full DH potential across Ireland, which is 35-55% of the heat demand in buildings.	IrDEA, SEAI, National DH Company	DECC, LAs, EirGrid/ ESBN	Publish 2030/2040/2050 roll-out plan in consultation with sector stakeholders, targeting highest impact areas as a priority.	H2 2021	Without a long-term strategy for DH, the 2030 roll-out may not be optimally designed for a zero carbon energy sector in 2050.
District Heating	DH2 DH Centre of Excellence	Create a partnership between industry and academia to bring best practice and research on DH to Ireland.	To upskill Irish energy sector and stay up to date on and apply latest DH technological developments.	IrDEA	An Irish University/ College, Industry Partners, IDA/SFI	IrDEA to identify relevant partners.	H1 2022	Lack of expertise and innovation impairs rapid development of DH in Ireland according to best practice.
District Heating	DH3 Bring international expertise to Ireland	Connect with EU companies which are well-established in DH and attract to Ireland due to opportunity available.	Encourage scaling up of Irish DH industry building on capacity of leading EU companies.	IrDEA	Industry Members	IrDEA to promote findings of the heat study and role of DH across U markets.	Ongoing	Irish DH industry too small and inexperienced to upscale DH deployment.
Solid biomass	BioHEAT1 Feasibility study & business case models	Work with industry and government to develop cost models for bioenergy projects in commercial and industrial heat installations, within and outside the ETS, and elaborate supply chain and resource pathways.	Provide confidence to potential users of biofuels and the investor community regarding financial viability, GHG savings, biomass resource quality and availability.	IrBEA, RGFI	DECC DAFM SEAI	Development of model costings models and supply chain and resource information.	H2 2021	Lack of investor and industry confidence on bioenergy costings and GHG and CR benefits constraining fuel switching.
Cross sectorial	All RES H1 Training & upskilling	Roll out industry led training programme for designers and installers, as well as BER assessors & other building professionals.	Increase the number of skilled professionals with RES H competence.	REI members	Industry Members	Associations to identify knowledge gaps in their sector and continue rolling out CPD programmes.	Ongoing	Lack of indigenous know how slows down RES H deployment and arms quality.
	RES Gas1	Align Biogas projects with EGD and implementation of farm to fork and industrial waste strategies, i.e. Paris Agreement.	Industry to comply with its regulatory and compliance requirements of Paris Agreement, and alignment with Climate Action Plan, NECP and Ag Climatise.	RGFI, IrBEA	Industry led - Project Clover, Community Power, DPER, DRCD, DAFM & DECC	a. Secure commercial funding. b. Capital grants and support scheme funding to projects to stimulate indigenous AD biomethane industry.	H2 2021	Placing Ireland Inc, manufacturing and processing industries in an anticompetitive position and commercially unsustainable.
	BioHeat2 Biomass Capacity Statement	Develop a Biomass Capacity Statement to assure large scale heat users that biomass is available and the infrastructure to supply it.	Instil confidence in large energy users of the long term security of supply of biomass fuels.	IrBEA	SEAI	Produce detailed report on: a. Raw material availability over the next 20-30 years. b. Biomass industry capacity to process and supply quality fuel. c. Industry expertise to install and maintain large biomass plant.	2021	Large industry requiring high grade heat will remain on fossil fuels, or will be forced to adopt costly alternatives.

Innovation

Sector	Industry led actions	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Solid biomass	BioHEAT3 Research & Development in bioenergy carbon capture & advanced fuels	Extend the benefits of sustainably sourced bioenergy through research and development focussed on bioenergy carbon capture, storage, and use (BECCS/U), second generation biofuels, and biorefining/bioenergy synergies.	Enable advanced bioenergy technologies to extend their contribution to reductions in near term GHG emissions and the development of the circular bioeconomy.	IrBEA, RGFI	DECC SEAI DAFM SFI	Input to research and development policy and advocate for pilot projects related to advanced biofuel technology testing and deployment.	Ongoing	Failure to invest in RD and D in these areas will disadvantage Ireland's efforts to make the fundamental changes needed to decarbonise the economy and society.
Solid biomass	HP1 Research & Development	Improve energy monitoring and usage data available for case studies, innovation in system design and controls. To explore complementarity of heat pumps with PV, battery storage, and electric vehicles – looking also to medium term future move to net zero buildings.	To increase the sector's ability to improve heat pump systems performance and develop ancillary services.	HPA, HPA members	HPA, SEAI, 3rd Level institutes	An R&D strategy paper needs to be developed. Consider partnership/ links with LIT, TEA etc.	H2 2021	Lack of innovation and poor practice lead to underperformance of HP and poor confidence among potential HP buyers.
Renewable Gas	RES Gas2	Support ongoing investment in research and development focussed on renewable gas, including BioLPG pathways to support the decarbonisation of the off-grid energy market.	Enable advanced renewable gas solutions to contribute to GHG emissions reductions, cleaner air, water quality and the development of the circular bioeconomy.	RGFI, IrBEA	DECC, DAFM, SFI. NUIG	a. Input to renewable gas research and development policy. b. Identify research and development of national & EU collaborators to work on advanced biofuel technology options.	Ongoing	Long term ability to deliver supply pathways and contribute to enduring solutions to the decarbonisation of the off-grid heat sector.
	All RES H2 Decarbonisation of low energy efficiency houses	Explore options for using biomass as a solution for homes where retrofit is not an option due to excessive capital cost of retrofit, or architectural/ heritage reasons.	To identify technology options to decarbonise homes that otherwise would have no option to move from fossil fuels. Identify support measures to encourage adoption.	IrBEA, RGFI	SEAI	Develop proposals and financial models of support measures that will incentivise home owners to replace fossil fuel systems with cost effective renewable heating systems. For consideration by SEAI / DECC for the introduction of support measures.	H4 2021	Many homes will remain on fossil fuels for the coming decade and beyond.

Quality Assurance

Sector	Industry-led actions	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
District Heating	DH4 Standardised Designs	Create a catalogue of designs for typical Irish buildings e.g. housing estates, and technical guidance for M&E designers of secondary side DH installations.	Upskill and bridge knowledge gap, increase efficiency in secondary side systems.	IrDEA	CIBSE Engineers Ireland	a. Secure funding. b. Develop the code and consult with stakeholders. c. Publish the code.	a. H1 2021 b. H2 2021 c. H1 2021	DH system engineering of sub-standard or not adapted to Irish conditions.
District Heating	DH5 Develop voluntary Consumer Protection	In the absence of market regulation, establish a voluntary customer service standard for DH operators (e.g. Heat Trust UK) as an independent, non-profit consumer champion that holds the industry to account for the benefit of everyone involved.	To protect and give confidence to the consumer and add transparency and high standards to DH operations in Ireland.	IrDEA	DECC, CRU	a. Secure funding & buy in. b. Establish voluntary body. c. Operate the service.	a. H2 2022 b. H1 2023 c. H2 2023	Poor customer protection results in lack of confidence in DH and adoption.
Heat Pumps	HP2 Quality Label	Quality assurance schemes to provide heat pump buyers with sufficient warranties and supports to allay any performance concerns.	Protect consumers and increase confidence in HP technology.	HPA	SEAI	a. Research existing quality standard models e.g. EU Heat Pump Keymark. b. Establish quality standard scheme in Ireland.	a. H2 2021 b. H1 2022	Lack of confidence in HP leads to low levels of adoption.
Solid biomass	BioHEAT4 Quality Assurance for Wood Fuels & Training for installers and designers	Further develop and grow industry competence through the Wood Fuel Quality Assurance (WFQA) scheme, Biomass Designers Register and Biomass Installers Register.	Promote high standards across all levels of the industry and reinforce consumer confidence.	IrBEA	REI	a. IrBEA to continue to grow, promote and develop the WFQA Biomass Designers Register and Biomass Installers Register. b. Roll out an information campaign on use of dry quality wood fuels at domestic level. c. Training for installers and designers.	a. Ongoing b. Dec 2021	Reputational damage to the industry and low uptake of biomass in the marketplace.
Renewable Gas	RES-Gas3 (Voluntary) Biomethane Certification Scheme	Green Gas Certification scheme (GGCS) for Ireland is in place and operational with biomethane being injected into the gas grid, certificates issuedto the biomethane producer and claims made by the shipper/end consumer.	This will certify Renewable Gas for use by industrial heat users.	GNI, RGFI	DPER, DECC, REI, DAFM, DBEI IrBEA, CRU	The GGCS for Ireland was designed by DENA & DBFZ in compliance with the REDII sustainability criteria, with verification/auditing by either ISCC and RedCert as the recognised entities by the EU Commission.	Operational since Feb 2021	Consumer confidence and certification that complies with REDII sustainability criteria. Verification required by accredited entities recognised by EU and Global authorities.

Awareness-Raising

Sector	Industry led actions	Description	Aim	Lead	Supporting Role	Next Step	Target Date	Impact of delay on achieving 2030 targets
Cross sectorial	All RES H3 Large Heat Users Awareness Campaign	Engage in an awareness campaign with high temperature heat users on the options to transition to renewable heat sources such as biomass, biogas/ biomethane, bioLPG and electrification, along with how they can provide surplus heat to district heating networks.	Highlight resources available. Improve the knowledge of the industry to the options available, sustainability of biogas and biomass, highlight the benefits for transition.	REI, RGFI, IrBEA, IrDEA	SEAI, IDA, IBEC	a. Develop a list of large heat users. b. Prepare a targeted campaign. c. Roll-out multi-annual awareness-raising campaign & CPD.	H2 2021	Slow decarbonisation of industrial sector, impacting on international competitiveness of Irish goods and economy.
Heat Pumps	HP5 Awareness raising campaign	A national communications strategy for heat pumps needs to developed, led by SEAI, DECC, partnership with industry & electricity suppliers.	To increase awareness of heat pump solutions to the Irish public and to stimulate interest and appetite to adopt.	HPA	SEAI, DECC, Energy Suppliers	a. Develop a coordinated communication plan. b. Resource a multi-stakeholder plan. c. Roll out communication campaign on a sustained basis.	H2 2021	If the mass market is not convinced of the necessity to use heat pumps, it will be impossible to achieve the 400,000 HP retrofits.
Renewable Gas	RES Gas 4	Develop consumer-led case studies and industry alliances that demonstrate and promote the tangible benefits of renewable gas solutions including biogas/biomethane and bioLPG to the off-grid domestic and non-domestic heat sector.	Enable advanced renewable gas solutions/biogas /biomethane/ bioLPG to contribute to GHG emissions reductions, cleaner air, water quality and the development of the circular bioeconomy.	RGFI, IrBEA	DECC, DAFM, DBEI, DPER, SEAI	Work with SEAI to identify how consumer case studies can contribute to general education and awareness of renewable heat solution deployment. Form key industry alliances that can support the promotion of the renewable gas solutions for the off-grid domestic and non-domestic heat sector.	Ongoing	Lack of education and awareness of the lessons learned and success stories on decarbonising off-grid heat. Lack of Informed consumer choice in selecting renewable heat technology.

www.renewableenergyireland.ie

XD Consulting
Sustainable Energy Engineers

Renewable Energy
Ireland

September / 2020

LIQUID GAS IRELAND VISION FOR 2040

Liquid Gas Ireland

LPG and BioLPG:

a Greener Deal for Rural Ireland

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Liquid Gas Ireland

Foreword

I am delighted to launch Liquid Gas Ireland's Vision 2040, which sets out how our industry can contribute to Ireland's 'Green New Deal', including the ambitious goal to reach net zero emissions by 2050, and to the Government's Clean Air Strategy.

LPG has been a key part of Ireland's energy mix for almost a century. Going forward, we believe LPG and BioLPG can support the Irish Government's commitment to transition to a low-carbon economy and fulfil its binding obligations under the 2015 Paris Agreement on climate change.

As natural gas network penetration in Ireland is relatively low (39% of households)[1], the full potential of lower-carbon gaseous fuels like LPG needs to be further exploited. Over 40% of households in Ireland rely on oil to heat their homes. This share varies significantly by region, with roughly 26% of households located in towns using oil for central heating compared to 65% in rural areas.[2]

While LPG already offers significant reductions in carbon and air pollutant emissions, BioLPG is the future, providing up to 90% certified carbon emission savings compared to conventional LPG. Already available on the market today,[3] BioLPG allows off-grid homes and businesses to significantly reduce their carbon footprint without expensive retrofitting or changes to heating systems.

Liquid Gas Ireland estimates that if 500,000 homes switched from using oil-fired central heating to BioLPG by 2040, it would save about 1.9 million tonnes of CO2 emissions per year.[4]

Liquid Gas Ireland members are committed to working with Ireland's policymakers to develop a long-term supportive policy framework to achieve 'net zero' and address barriers to decarbonisation in the off-grid heat and transport sectors.

A 'one-size-fits-all' approach will not work. It is crucial that the Government brings both urban and rural communities on the decarbonisation journey, providing them with technology choices that meet their unique needs through secure, clean, efficient, and reliable lower-carbon fuels. In this document, we outline three key actions that we believe the Government must take to achieve this, as well as the role that LPG and BioLPG can play in the decarbonisation process.

Our society demands an energy transition that is fair, affordable, and convenient; Liquid Gas Ireland's member companies have the experience and expertise to help deliver it. We look forward to engaging with Government and energy sector stakeholders in the coming weeks and months.

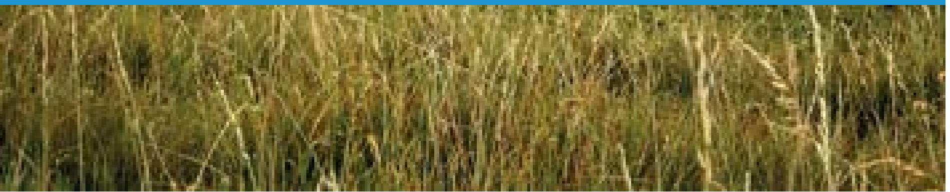
Brian Derham / Chair, Liquid Gas Ireland

1

Vision and recommendations

Liquid Gas Ireland

The LPG industry aims to transition to renewable BioLPG by 2040



Our 2040 vision for rural energy provision

The Irish LPG and BioLPG industry is a key part of Ireland's energy mix, ensuring thousands of homes and business have access to lower-carbon fuels. Liquid Gas Ireland (LGI), as the representative body for the LPG and BioLPG industry, is determined to support the Irish Government in achieving its climate change and clean air targets in a timely, affordable, and non-intrusive way, taking into account the unique needs and economic and infrastructural challenges of rural Ireland.

Our objectives are therefore to:

- Transition up to 500,000 oil boilers to LPG by 2030, equivalent to 50,000 households and businesses per annum.
- As an industry, transition to 100% BioLPG by 2040.

The case for change:

- 1.8 million people live in rural areas across Ireland.[5] These communities matter and need to be understood. To deliver a just energy transition, policy should reflect conditions in rural areas.
- 75% of rural areas in Ireland are not connected to the natural gas grid.[6] Most rural homes (65%) are heated with oil and over 10% use peat for heating. Since 2017, rural fuel emissions have risen by 8% due to an increase in oil and coal consumption.[7]
- 42% of the rural building stock is relatively old, built before 1980. Older homes are also typically less energy efficient and have higher fuel bills than modern homes.
- Where other forms of low-carbon energy are not readily available, or require expensive infrastructural intervention, LPG and BioLPG are crucial alternatives.
- LPG, commonly butane or propane, is a clean-burning, smoke-free fuel. It contributes directly to climate and energy policy by reducing emissions by up to 33% compared to other fossil fuels such as oil and solid fuels.[8]
- BioLPG, also called biopropane, is a chemically indistinct but renewable version of LPG. BioLPG delivers up to 90% in certified carbon emissions reductions versus conventional LPG.[9]
- Affordability of energy solutions will be key for the economic recovery of rural households and businesses. LPG/BioLPG boilers are the most cost-effective low-carbon option for many households, especially older properties that are less energy efficient.
- For an average household, the upfront cost of an electric heat pump unit is €15,000 versus €4,000 for a new LPG or BioLPG boiler. Implementing the necessary energy efficiency upgrades to accommodate heat pump technology in an average older rural home would add an additional €15,000-€20,000 to the upfront cost.[10]
- As BioLPG is a 'drop-in' fuel, LPG infrastructure is already prepared for the future, so no deep retrofitting or new equipment is required.

Our recommendations to Government

Decarbonisation must be a priority for Ireland. However, the Government must also recognise that the energy transition will not work with a one-size-fits-all approach. To secure buy-in from the rural population, the transition must be 'just', considering the unique needs and economic and infrastructural challenges of rural Ireland.

Rural areas account for around two-fifths of Ireland's population.[11] These rural communities are often not connected to the natural gas grid. As a substitute, heating oil and solid fuels are widely consumed for heating purposes. Around 65% of the Irish rural housing stock is fuelled by heating oil.[12] Over half of these homes are detached houses, which have higher than average heating demand. Around 48% of detached homes using oil-heating have a Building Energy Rating (BER) of 'C' and below.[13] For these homes, switching to electric heat pumps is not a silver-bullet solution.

However, LPG and BioLPG are affordable, clean-burning, readily accessible, lower-carbon alternatives. Oil boilers can be replaced with an LPG or BioLPG boiler at minimal cost in a fraction of the time of electric heat pump installation. Government policy and legislation should recognise and support the role of LPG and BioLPG in a just transition to lower carbon energy and cleaner air in rural Ireland. We therefore recommend that the Government takes the following three key actions:

Legislate for a mixed technology approach to decarbonisation

Decarbonising heat will be necessary if Ireland is to meet its climate change targets. To do this in a just and effective way, policymakers need to balance emission reduction, air quality, and energy affordability challenges, all of which impact Ireland's rural communities.

The role of LPG and BioLPG in national climate and energy policy and plans must be considered in order to support rural households and business in the energy transition.

Commit to clean alternatives to improve regional air quality

Ireland needs a strong vision for a regional approach to delivering on air quality targets. This must include a clear commitment to cleaner, greener alternatives. Communities off the natural gas grid need support to make the change. LPG/BioLPG is a clean burning smoke-free fuel that supports cleaner air quality and can play a role in improving the health of rural communities across Ireland.

Prioritise a just transition

Take fully funded, sustainable, and achievable steps to bring rural ireland along the low-carbon journey.

The leap from old technology to new will leave many behind. Government policy should support cost-efficient solutions like fuel-switching and support to upgrade to modern, high-efficiency appliances, which are future-proofed and ready for 'drop-in' solutions.

LPG and BioLPG can help rural consumers and businesses achieve this transition with affordable, reliable, and sustainable options.

2

The LPG and BioLPG industry in Ireland

Liquid Gas Ireland

LPG combustion emits 33% less carbon dioxide than coal and 11% less than heating oil

LPG and the BioLPG future

Liquefied petroleum gas (LPG) is a hydrocarbon gas that exists in a liquefied form. It is supplied in two main forms, butane (C4H10) or propane (C3H8), and comes in a tank or cylinder. This flexibility and portability allow LPG to reach places that other energies cannot.

LPG combustion emits 33% less carbon dioxide than coal and 11% less than heating oil.[14] LPG also emits almost no black carbon, which scientists now believe is the second biggest contributor to climate change, and very low levels of air and particulate pollutant emissions (e.g. nitrogen oxides, sulphur oxides).

BioLPG, or biopropane, is chemically indistinct from LPG and provides the same heating and fuel properties. It is made from sustainably sourced renewable vegetable oils, wastes, and residues, and delivers up to 90% certified carbon emission savings compared to conventional LPG.[15]

BioLPG is certified as renewable by the EU and Irish Government and is exempt from carbon tax, meaning it is a great investment for the future.

As BioLPG is a 'drop-in' fuel, LPG infrastructure is already prepared for the future, so no new equipment is required. For customers in rural off-grid homes and businesses, this is an easy and affordable switch to make, and the environmental benefits are immediate.

LPG and BioLPG can also be used seamlessly in cutting edge heating systems, such as gas-driven heat pumps and hybrid heat pumps.

BioLPG is certified as renewable by the EU and Irish Government and is exempt from carbon tax, meaning it is a great investment for the future.

Innovative production pathways post 2030 are likely to be biological focused

Increasing BioLPG supply through innovation

BioLPG is not an innovation for the distant future: it is already available on the Irish and European markets in quantities that can service the energy needs of thousands of families and businesses.

Production is being increased and the market upscaled. LGI members are actively exploring a range of production methods, including both imported and localised production options in Ireland.

BioLPG currently used in Ireland is a by-product of a conventional hydrotreated vegetable oil (HVO) process that mainly produces renewable biodiesel. It is made from a mix of sustainably sourced renewable vegetable oils, residues, and waste materials.

An LGI member has also partnered with KLM and SkyNRG to develop BioLPG as a co-product of sustainable aviation fuel (SAF). They will develop Europe's first dedicated plant for the production of SAF, which is scheduled to open in 2022.

In the next decade, HVO and co-processing are likely to be the dominant sources of BioLPG, after which the focus will be on pathway development by using existing technologies re-engineered to produce BioLPG. One such development is 'Fisher Tropsch technology', which was invented in the 1920s to produce fossil liquid fuels. Adapting the process to use renewable and sustainable feedstocks, including lignocellulosic biomass and waste, instead of fossil inputs results in the production of renewable biofuels including BioLPG.

Innovative production pathways post 2030 are likely to be biological focused. An example is the fermentation of glucose by bacteria, yeasts, or other microorganisms.

LGI members recognise the importance of close collaboration with both EU and national industry stakeholders and policymakers to ensure the necessary policy support for the production or use of BioLPG in Ireland, and to provide investment confidence to producers, suppliers, and investors across the biopropane supply chain.

How is BioLPG made?

This graphic illustrates the potential feedstocks and production pathways identified alongside an ambitious timeline to commercialisation.

Feedstocks - Sustainably Sourced

Vegetable Oil
(short rotation crops)

Used Cooking Oils

Industrial & Domestic Solid Waste

Wood Waste

Industrial Waste Gases

Hydrogen

Carbon Dioxide CO2
(future feedstock)

Seaweed
(future feedstock)

Production Pathways

2018
CONVENTIONAL

Hydrotreatment
Conversion with hydrogen (biodiesel)

Co-processing
Co-feeding biocrude into conventional refineries

2025+
ADVANCED

Via Gasification
Conversion with high temperatures

Pyrolysis
Conversion via chemicals

Power2Gas
Carbon capture and utilisation

Fischer Tropsch
Synthetic fuels

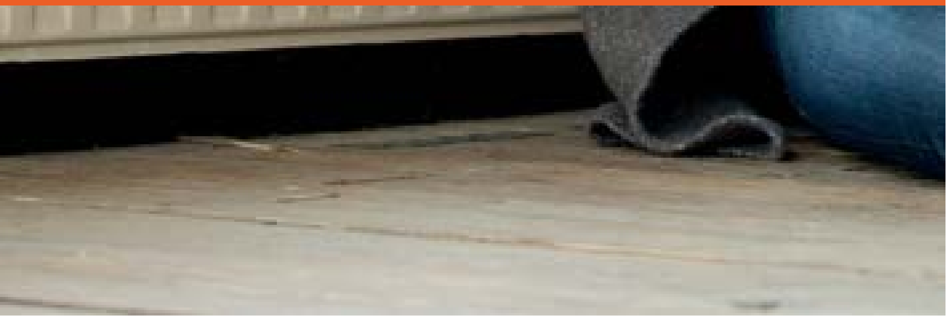
2030+
BIOLOGICAL

Fermentation
Conversion by bacteria

Anaerobic Digestion
Conversion by bacteria

Renewable Gas - BioLPG

Oil accounted for 49% of energy-related CO2 emissions from heat in 2018[16]



The role of LPG and BioLPG in the future of rural heat and transport

Contributing to the decarbonisation of off-grid heating

More than 37% of the Irish population live in rural areas (higher than the EU average of 27.3%). 75% of rural areas in Ireland are without access to the natural gas distribution network.[17]

Many rural off-grid properties are considered both 'hard to heat' and 'difficult to treat'. Their age, design, and building materials make most energy efficiency improvements impractical and expensive.

Electrification of heat is less suitable and costlier than gas alternatives in larger, less-efficient homes.

There are approximately 800,000 rural off-grid homes in Ireland that are heated by conventional fossil fuels, such as heating oil, peat, and coal.[18] Oil accounted for 49% of energy-related CO2 emissions from heat in 2018.[19]

If 500,000 homes switched from using oil-fired central heating to BioLPG by 2040, it would save about 1.9 million tonnes of CO2 emissions per year.[20]

Switching to BioLPG also forgoes the expensive cost of grid reinforcement and the physical disruption it causes. Mass deployment of heat pumps requires expensive grid reinforcement, which would be subsidised by raising energy bills for homes and businesses. This is likely to increase the depth of fuel poverty of households in the most acute areas.

Contributing to cleaner air

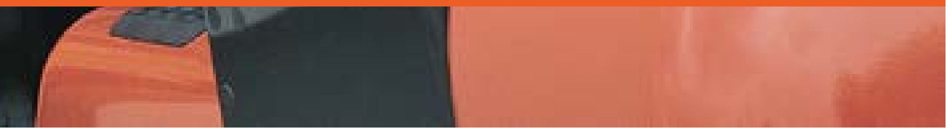
Air pollution is a leading cause of premature deaths. It is considered by the World Health Organisation to be the single largest environmental health risk in Europe.

Heart disease and stroke are the most common reasons for premature deaths attributable to air pollution, followed by lung diseases and lung cancer. Around 391,000 premature deaths were attributed to exposure from particulate matter concentrations in the EU and UK in 2015.[21]

Environmental Protection Agency figures released in February 2019 indicate that poor air quality is now responsible for 3 premature deaths per week in Ireland, or 1,100 in a year.[22]

Due to the use of heating oil and solid fuels for heating, rural energy users can suffer from poor air quality. LPG and BioLPG are cleaner burning fuels. They produce virtually no black carbon and very low levels of air and particulate pollutant emissions. A switch to LPG and BioLPG therefore has a major impact on regional air quality in Ireland's rural areas.

Clean and lower carbon fuels like LPG and BioLPG can help to decarbonise the transport sector and address Ireland's clean air objectives



The role of LPG and BioLPG in the future of rural heat and transport

Contributing to the decarbonisation of transport

Ireland's transport system is currently highly dependent on carbon intensive fuels, which results in significant carbon emissions and air pollutants that are contained in exhaust fumes. According to the Environmental Protection Agency, the transport sector accounted for 12% of all air pollutant emissions in 2015 and is one of the largest contributors to particulate matter pollution in cities.[23]

With LPG and BioLPG, there is the opportunity to switch commercial vehicles, and even smaller private vehicles, to a clean and lower carbon fuel.

Some of Ireland's largest businesses currently depend on LPG for their forklift operations. This sector currently uses diesel, electric and LPG engines, with fossil diesel being the prominent choice of fuel.

LPG and BioLPG powered forklifts offer Irish businesses unrivalled flexibility, offering the ability to work safely both indoors and outdoors and without a requirement for electric charging. LPG and BioLPG powered forklift trucks, offer reduced emissions benefits and importantly, air quality improvements.

BioLPG is recognised and eligible for the Biofuels Obligation Scheme (BOS) under the definition of 'road transport'. Supporting and actively contributing to Ireland's Biofuels Obligation Scheme with biofuels such as BioLPG, can play an important role in helping Ireland to meet its renewable energy targets.

By supporting the development and adoption of renewable fuels like BioLPG, the government can ensure a multi technology approach to addressing the transport decarbonisation challenge to 2030 and support the LPG industry's ability to supply BioLPG from advanced feedstocks in the future.

Some of Ireland's largest businesses currently depend on LPG and BioLPG for their forklift operations.

LPG and BioLPG in action

Gerard Hennessy, Homeowner

Co. Cork

Gerard was converting and upgrading his rural property, which contained a main house and a self-contained apartment. The home had an old oil heating system that was inefficient. He wanted a clean, easily controlled, and energy-efficient system. Taking into account the unique features of his rural home, an underground gas tank and high-efficiency condensing gas boiler were recommended, which were both readily suitable for the 'drop-in' recommended solution, BioLPG.

Gerard was already realising the benefits of gas cooking and the convenience of a gas fire using LPG cylinders. Due to the versatility of BioLPG, these were also connected to his new BioLPG supply. This enabled Gerard to have a single and secure fuel source for his home, as well as a 100% renewable fuel source.

KEY BENEFITS

- Carbon savings: over 6 tonnes saved since switching to BioLPG from oil, 2 tonnes per year.
- A 70% reduction in carbon emissions.

MacNean House and Restaurant

Co. Cavan

As MacNean House and Restaurant's popularity increased, so too did the demand for accommodation. In late 2010, an opportunity to purchase the building next door arose, so chef Neven Maguire and his team set about remodelling the interior in order to create an additional nine guest bedrooms. Recognising that increased energy demands and costs would ensue, they looked to LPG for their energy needs.

LPG already fuelled the catering equipment in the kitchen and the gas fire in the lounge, although an oil-fired boiler generated the heating and hot water. Modern, high-efficiency gas boilers were recommended to replace the oil boiler in the original restaurant building and also for the new building.

Flogas LPG boilers were installed, and now the whole operation benefits from one-source efficiency for all its cooking, heating, and hot water requirements.

KEY BENEFITS

- One source efficiency for all the house and restaurant, cooking, heating and hot water.
- Significantly reduced running costs despite extra bedrooms.
- Reduced carbon footprint.

LPG and BioLPG in action

BrookLodge & Macreddin Village

Co. Wicklow

Home to The Strawberry Tree, the first restaurant in Ireland to have an organic licence, sustainability has always been a high priority for BrookLodge & Macreddin Village.

LPG already provided the energy solution for their spa, heating, hot water, and eight kitchens throughout, but they had the aim of meeting their sustainability goals of increasing their renewable energy usage across the property.

BrookLodge & Macreddin Village made the simple transition from LPG to BioLPG with no interruption to the day-to-day functioning of the business or need for new appliances and equipment.

KEY BENEFITS

- Carbon savings: over 260 tonnes saved since switching to BioLPG in the last year alone.
- A 70% reduction in carbon with zero capital expenditure investment needed.

The Dunne Dairy Farm

Co. Wexford

With a growing farm, in 2018 the Dunnes began a major transformation of their old dairy parlour into one suitable for housing the state-of-the-art Lely Astronaut robotic milking system.

Gerald and Henry pride themselves in supplying a top-quality dairy product, so they began a search for a hot water solution that would suit their needs and fulfil the requirements of the Lely Astronaut.

The Dunnes opted for an LPG hot water system. A smooth changeover process was arranged as part of the overall parlour upgrades and expansion.

An LPG bulk tank was delivered while the wall-mounted water heaters were installed and connected to the tank.

KEY BENEFITS

- On-demand hot water delivering temperatures from 37˚C to 85˚C.
- Reduced running costs.
- Reduced carbon footprint.

Liquid Gas Ireland is committed to working with consumers, industry stakeholders, and policymakers to support Ireland's goal to improve air quality, drive decarbonisation, and achieve net zero emissions by 2050

About Liquid Gas Ireland

Liquid Gas Ireland is the association representing companies operating in the LPG and BioLPG industry in Ireland. Members include LPG and BioLPG producers, distributors, equipment manufacturers, and service providers.

Established in 1969 (as the Irish Liquified Petroleum Gas Association), Liquid Gas Ireland's mission is to ensure that policymakers continue to recognise LPG and BioLPG as the clean, versatile, and alternative lower-carbon energy of choice for off-grid energy users in the residential, commercial, industrial, agriculture, leisure, and transport sectors in Ireland.

Liquid Gas Ireland represents its members in all relevant policy, regulatory, and stakeholder engagement to shape and contribute to policy goals related to the decarbonisation of heat, transport, and industry.

Liquid Gas Ireland also takes a leading role in safety, setting high standards for the safe, progressive development and use of LPG and BioLPG.

Liquid Gas Ireland is committed to working with consumers, industry stakeholders, and policymakers to support Ireland's goal to improve air quality, drive decarbonisation, and achieve net zero emissions by 2050.

Liquid Gas Ireland is a member of Liquid Gas Europe.

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2. **CSO and SEAI Data**

   CSO Housing in Ireland, 2016
   SEAI Energy in Ireland, 2019

3. BioLPG reduces GHG by at least 50% and up to 90% against set values of fossil fuels, in accordance with the European Union Renewable Energy Directive ('EU-RED'). Actual figure is dependent upon input feedstocks.

4. **CSO and SEAI Data**

   BioLPG carbon value of 68.8gCO2eq/ kWh is based on a 70% saving against conventional LPG (229.3gCO2eq/kWh SEAI).

   SEAI Energy Conversion Factors
   CSO Housing in Ireland, 2016

5. **CSO and SEAI Data**

   CSO Housing in Ireland, 2016
   SEAI Energy in Ireland, 2019

6. **CSO Housing in Ireland, 2016**

7. **CSO and SEAI Data**

   CSO Housing in Ireland, 2016
   SEAI Energy in Ireland, 2019

8. **SEAI Energy Conversion Factors**

9. BioLPG reduces GHG by at least 50% and up to 90% against set values of fossil fuels, in accordance with the European Union Renewable Energy Directive ('EU-RED'). Actual figure is dependent upon input feedstocks.

10. **SEAI, Renewable Heat in Ireland to 2020**

11. **CSO Housing in Ireland, 2016**

12. **CSO Housing in Ireland, 2016**

13. **CSO Housing in Ireland, 2016**

14. **SEAI Energy Conversion Factors**

15. BioLPG reduces GHG by at least 50% and up to 90% against set values of fossil fuels, in accordance with the European Union Renewable Energy Directive ('EU-RED'). Actual figure is dependent upon input feedstocks.

16. **SEAI Energy in Ireland, 2019**

17. **CSO Housing in Ireland, 2016**

18. **SEAI, Key Learning from the SEAI Heat Pump Programme, 2019**

19. **SEAI Energy in Ireland, 2019**

20. **CSO and SEAI Data**

    BioLPG carbon value of 68.8gCO2eq/ kWh is based on a 70% saving against conventional LPG (229.3gCO2eq/kWh SEAI).

    SEAI Energy Conversion Factors
    CSO Housing in Ireland, 2016

21. **EEA Report, Air Quality in Europe, 2018**

22. **EEA Report, Air Quality in Europe, 2018**

23. **EPA, Ireland's Environment – An Assessment, 2016**

Liquid Gas Ireland