Submission to the Consultation on the Introduction of a Renewable Heat Obligation

Prepared by Codema - Dublin’s Energy Agency

October 2021

Background

Codema is Dublin's Energy Agency is a not-for-profit company limited by guarantee and was founded in 1997. We are the energy agency to the four Local Authorities in Dublin, and our mission is to accelerate Dublin's low-carbon transition through innovative, local-level energy and climate change research, planning, engagement and project delivery, in order to mitigate the effects of climate change and improve the lives of citizens. We are the Dublin Local Authority's one-stop-shop for developing pathways and projects to achieve their carbon reduction and climate targets. Examples of Codema's work include energy masterplanning, district heating system analysis, energy performance contracting, management of European projects, energy saving behavioral campaigns and detailed energy reviews. Codema is well networked in Europe and has been very successful in bringing European projects to Dublin with a local implementation for the Local Authorities.

Context

Codema welcomes the opportunity to make a submission to this consultation process. Codema's interest in the proposed Renewable Heat Obligation scheme stems from our ongoing analysis of energy use and emissions from heating systems, and the development of cost-optimal heating technology pathways for the Dublin region. Our research and practical experience of developing projects allows us to advise on local level low-carbon policies which aim to reduce energy, fossil fuel use and associated costs & emissions. We have more than 20 years' experience in the climate change and energy sector, specifically in how EU and national legislation will affect the DLAs activities and the Dublin region as a whole.

Codema's Experience Developing Heating Technology Pathways for Dublin

Codema are Ireland's leading experts in the area of Energy Masterplanning. As part of our work on the Dublin Region Energy Masterplan we have assessed the **cost-optimal, technically feasible decarbonisation pathway for the heat sector in Dublin to 2030 and 2050**. This pathway considers multiple factors to assess the suitability of heating technologies including spatial constraints, infrastructural costs, building fabric suitability, supply temperature requirements, fugitive emissions etc. One of the key findings from the masterplan is the importance of district heating networks which utilise both waste heat and renewable heat in decarbonising Dublin where **approximately 70% of heat demand in the capital is suitable for district heating**.

Codema's Experience in District Heating

Codema is Ireland's leading expert in District Heating research and project implementation. We have built the evidence-base to support the roll-out of DH in Dublin, developing the first heat demand and heat source maps in Ireland, based on European best practice methodologies. We have identified potential projects across Dublin and, working with Local Authority project champions, have **brought projects from idea to reality; from pre-feasibility, techno-economic analysis, business case through to securing funding, procurement, contracting and delivery**. We are the Dublin Local Authority's one-stop-shop for the roll-out of DH projects. Codema therefore very much welcome this opportunity to make a submission to this consultation to inform the RHO process, which has the potential to be a key initiative for decarbonising heating in Ireland. We fully understand the barriers at all stages of the project development process and hope our submission will be informative to DECC.

Based on our knowledge of best-practice in the European DHC market and our close collaboration with cities and energy agencies across Europe through involvement in multiple EU projects, we feel strongly that the ownership of DHC systems should lie with the public sector. Enabling LAs and giving them the autonomy and resources to act at a local level in the energy sector will also not only help to overcome some of the many barriers facing the development of DHC in Ireland, but importantly ensure the development of a low-cost, low-carbon heating solution that puts priority on the protection of customers. It enables a local, bottom-up energy utility to evolve who's core values are based on **making the region lower-carbon and a more attractive, healthier environment for its citizens**. It allows **fair and equal access** for the lowest carbon, lowest cost heat suppliers to supply the system. It also allows possibilities to open **investment opportunities to urban citizens to invest in local low-carbon energy projects**.

Codema is a founding member of the **Irish District Energy Association (IrDEA)**, and some of our response will also be reflected in the IrDEA submission.

Response to Consultation

This submission focuses primarily on one of the cornerstones of a smart energy system, district heating and cooling (DHC)networks. Heating is a hugely important sector in Ireland when it comes to decarbonisation as it represents approximately **40% of energy demand (twice the demand of electricity)** and is the worst performing sector in terms of renewable proportion (currently at 6.3% of total heat production) behind both electricity and transport. **District heating is new technology in Ireland, currently representing less than 1% of the heat market but with potential for this to be between 50% and 60% based on a 2019 study performed by the Heat Roadmap Europe researchers and provisional results from SEAI's National Heat Study**. District heating networks potential to enable greater uptake of renewable and waste heat sources is shown in the figure below where there is a strong correlation between DH and renewable heat proportions.

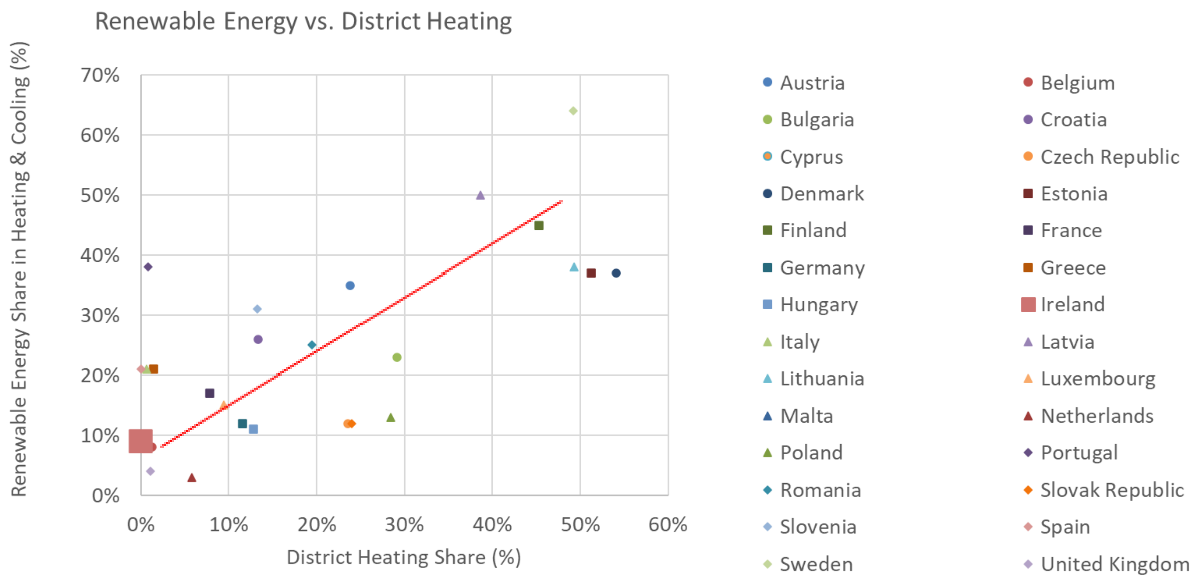

Figure 1: Correlation Between Renewable Heat Share and District Heating Share in Europe (Source: Heat Roadmaps Europe)

Apart from being a method for increasing the proportion of low-carbon and renewable heating, DHC provides many additional benefits to an overall integrated energy system, such as:

- **Easier integration of renewable and low-carbon heat sources** without disruption to customers/home owners as access to each individual dwelling is not required
- **Lower local air pollution** as buildings fossil fuel boilers would no longer be required
- Facilitates **utilisation of indigenous low-carbon resources which would not make sense at a smaller (individual building) scale such as deep geothermal and industrial waste heat resources** – leading to more efficient operation of both industrial plants and heat production and supporting a more circular economy
- **Provides storage and demand side response for the electricity grid** at a fraction of the cost of battery storage when supplied by large-scale heat pumps, electric boilers etc. This also **facilitates greater production of renewable electricity** (e.g. curtailment of wind turbines can be reduced) due to the flexibility provided by this thermal storage capacity.
- **Increased customer safety** as there is no risk of gas leaks or carbon monoxide due to on-site combustion of fuels
- **Benefits local economy** by providing low-cost heating to customers (reduced overheads) and residents (**reduced fuel poverty**), potential revenue from waste heat for local industries and providing **new local employment** in the construction, operation and maintenance of the network
- **Providing a just transition for those with complimentary skills** which currently work in the fossil fuel industry (welders, engineers, civils contractors, geotechnical experts, etc.)
- Efficient operation of heat production plants is ensured by **constant monitoring, operation and maintenance being carried out by trained professionals** – this is not possible with solutions located in individual homes where equipment is often not maintained to regularly achieve **high operating efficiencies**

General Comments

Eligibility District Heating Networks to Earn RHO Credits

We welcome the approach outlined in the consultation where "it is not proposed that district heating systems using waste heat/renewable heat would be subject to the obligation". However, as an enabling infrastructure which supplies homes and businesses with renewable and/or waste heat that can contribute to Ireland's renewable heat targets, district heating pipe networks themselves are currently not supported under any existing support schemes outlined in this consultation (certain types of heat production plants are supported through the SSRH but the network installation, heat substations, thermal energy storage, or waste heat collectors etc. of a DH system are not)**. Were DH networks able to earn credits for the renewable heat or waste heat they supply to their customers, this could provide a supplementary means of financing this critical low-carbon infrastructure through private rather than public investment**.

The Renewable Heat Obligation should allow credits to be earned by DH systems which utilise waste heat that cannot be used on site and therefore is normally lost to the environment (typically dumped into waterways or vented to atmosphere). This waste heat can be reused to heat nearby local homes and businesses via district heating network infrastructure. **Waste heat is often lower carbon than renewable heat sources such as heat pumps and should be considered eligible for credits**. This would also **bring the RHO in line with the EU Renewable Energy Directive[1] (RED) Articles 15 and 23 which acknowledges waste heat as being on a par with renewable heat and allows waste heat use via heat networks to contribute to member states renewable heating targets**. Higher temperature waste heat sources such as waste heat from power stations or flue gas heat recovery, etc. do not require heat pumps to raise their temperature to a usable level and therefore are **not currently supported by the Support Scheme for Renewable Heat (SSRH)**. Networks which utilise lower temperature waste heat that do use heat pumps can only avail of SSRH support for the heat pump itself (up to 30% of the HP cost) which due to diversity of demand and economies of scale represents a smaller portion of the overall system cost when compared with individual building heat pumps. The cost and energy efficiency benefits provided by the use of the network itself (more efficient operation of heat pumps from reduced short-cycling, additional benefits to the electricity grid provided by large-scale grid balancing etc., ability to serve protected buildings that cannot be retrofitted due to ability to generate heat at higher temperatures with higher efficiency that individual building HPs, etc.) is not supported though via the SSRH.

These DH networks are ready for investment. DH networks **are already being developed in Ireland, are a proven technology (providing more than 90% of heat in cities like Copenhagen and Stockholm) and have more of the structures in place to facilitate scaling of renewable heat roll-out sooner and are more efficiently than alternatives** such as a green hydrogen (as shown in figure 1 above).

Eligibility of Deep Geothermal Heating

Greater clarity should be provided regarding the eligibility of Deep Geothermal heat to earn RHO credits. Unlike shallow geothermal, deep geothermal does not require heat pumps to achieve

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN

usable temperatures. This means that Deep Geothermal is not currently supported under the SSRH scheme which supports only heat pumps and biomass installations. Also, Deep Geothermal systems have a much higher heating efficiency (typically ten times more efficient than heat pumps) and would not experience any material support from electricity-based supports. Therefore, **Deep Geothermal systems should be eligible to earn RHO credits in the absence of support from other existing support measures like the SSRH**. Deep Geothermal requires significant upfront capital investment, particularly for the drilling of the production boreholes (which in the case of Ireland would typically be in excess of 2.5km depth). As a result of this upfront capital cost these projects need investment to get off the ground that is not linked to the heat production equipment. Deep Geothermal is a proven technology (unlike green hydrogen for example) which can provide a long-term renewable heating supply (for many decades compared with 12-15 years from an individual domestic heat pump). The additional value of deep geothermal is that it is a local renewable source which also provides an opportunity for those with complimentary skills (geotechnical skills, drilling, etc.) currently working in the fossil fuel sector to transition into renewable heating.

Clarity About How the RHO Market Will Operate

It would be beneficial to understand how some elements of the market may operate in practice. Specifically in relation to the following:

- Are there advantages for potential bulk credit earners like DH networks in terms of covering the admin cost of engaging in such a market compared with smaller individual renewable and waste heat traders
- What verification is required to earn credits for the provision of renewable or waste heat to consumers?

Assurances

A certain level of assurances will need to be in place in relation to securing RHO credits in order to leverage investment in renewable and waste heat technologies. What level of verification is required for credits to be assured at an early stage of a renewable heating project?

Traceability & Verification

It should be noted that the process of tracing and verifying renewable and waste heat sources is much easier when these sources are located within Ireland, as is the case with a local heat system that utilises indigenous sources like a district heating network.

Responses to Consultation Questions

Q1: Do you think that a Renewable Heat Obligation is an appropriate measure to introduce?

The RHO is a welcome measure, but is not a silver bullet for the sector, and has to be only one of the ways the Government should support and incentivise the increase in renewable heating in Ireland, particularly given that Ireland is now last in the EU in terms of percentage of renewable heating and cooling. It is well-known and proven by other member states that increased carbon taxes on fossil fuels used for heating is a key driver, increasing the business case to switch to alternative renewable energy sources.

The RHO will need more ambitious targets that reflect the targets set in relevant policy such as the Programme for Government, Carbon Budgets, National Heat Studies, etc. in order to contribute significantly to the uptake of renewable heating. Appropriate targets are discussed as part of questions 9 and 10.

Q2: If not, what alternative measures would you consider appropriate to increase the use of renewable energy in the heat sector?

The eligibility of district heating networks which utilise renewable and waste heat sources to earn credits provides a significant opportunity. These networks are already being developed and are further ahead in terms of delivery and scalability when compared with solutions like green hydrogen. This can be seen through the number of heat networks already operating in Europe (more than 5,000 networks) and the systems already being delivered in Ireland. These systems can also contribute significantly to Ireland's renewable heating targets as set out in the Renewable Energy Directive.

Q3: Do you agree that the obligation should apply to all non-renewable fossil fuels used for heating as set out above?

Yes

Q4: 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?

We agree with this approach where “it is not proposed that district heating systems using waste heat/renewable heat would be subject to the obligation”. However, as an enabling infrastructure which supplies homes and businesses with renewable and/or waste heat that can contribute to Ireland's renewable heat targets, district heating pipe networks themselves are currently not supported under any existing support schemes outlined in this consultation (certain types of heat production plants are supported through the SSRH but the network installation, heat substations, thermal energy storage, or waste heat collectors etc. of a DH system are not). **DH networks should be eligible to earn credits for the renewable heat or waste they supply to their customers, this could provide a supplementary means of financing this critical low-carbon infrastructure through private rather than public investment**.

The Renewable Heat Obligation should allow credits to be earned by DH systems which utilise waste heat that cannot be used on site and therefore is normally lost to the environment (typically dumped into waterways or vented to atmosphere). This waste heat can be reused to heat nearby local homes and businesses via district heating network infrastructure. **Waste heat is often lower carbon than renewable heat sources such as heat pumps and should be considered eligible for credits**. This would also **bring the RHO in line with the EU Renewable Energy Directive[2] (Articles 15 and 23) which acknowledges waste heat as being on a par with renewable heat and allows waste heat use via heat networks to contribute to member states renewable heating targets**. Higher temperature waste heat sources such as waste heat from power stations or flue gas heat recovery, etc. do not require heat pumps to raise their

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN

temperature to a usable level and therefore are **not currently supported by the Support Scheme for Renewable Heat (SSRH)**. Networks which utilise lower temperature waste heat that do use heat pumps can only avail of SSRH support for the heat pump itself (up to 30% of the HP cost) which due to diversity of demand and economies of scale represents a smaller portion of the overall system cost when compared with individual building heat pumps. The cost and energy efficiency benefits provided by the use of the network itself (more efficient operation of heat pumps from reduced short-cycling, additional benefits to the electricity grid provided by large-scale grid balancing etc., ability to serve protected buildings that cannot be retrofitted due to ability to generate heat at higher temperatures with higher efficiency that individual building HPs, etc.) is not supported though via the SSRH.

Deep Geothermal should also be eligible to earn RHO credits. Unlike shallow geothermal, deep geothermal does not require heat pumps to achieve usable temperatures. This means that Deep Geothermal is not currently supported under the SSRH scheme which supports only heat pumps and biomass installations. Also, Deep Geothermal systems have a much higher heating efficiency (typically ten times more efficient than heat pumps) and would not experience any material support from electricity-based supports. Therefore, Deep Geothermal systems should be eligible to earn RHO credits in the absence of support from other existing support measures like the SSRH.

Q5: 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?

Yes, this cost should then be passed on to the consumer via the primary product of the power plant, the electricity.

Q7: Is the 400 GWh of energy supplied an appropriate level for a supplier to become obligated?

It is important to include requirements that all parent companies need to be included when calculating the quantity of fossil fuels supplied. This would prevent large fossil fuel companies from splitting into subsidiaries for the purpose of avoiding this threshold. Also need greater clarity around whether this energy threshold is referring to the energy in the fuel based on the Gross Calorific Value. The assumption is that this 400GWh figure is an annual figure, it may be good to confirm this in the RHO consultation text.

This threshold of 400GWh roughly translates to the heating provided to approximately 27,000 irish homes[3]. This could have the potential to exclude many heating oil suppliers. With heating oil having a larger carbon emissions factor and representing the largest proportion of the fossil fuel mix for heating in homes (at 37% compared to the next biggest, gas at 21%) it seems that a significant proportion of the fossil fuel market for heating may not be subject to this obligation. Further research may be done in this area in relation to the size of heating oil suppliers in Ireland and whether they would be subject to this obligation.

Q8: Do you agree with the 2023 start date for the obligation?

Given the **urgency of the action needed to remain within our carbon budgets and ensure the greatest impacts of climate change are mitigated, this date should be brought forward as**

[3] Assuming 14.8MWh of heating fuel consumed per dwelling

much as possible. We have technology now that can be invested in in the short term. District heating networks which utilise renewable and waste heat sources is one such technology. These DH networks are already being developed in Ireland, are a proven technology (providing more than 90% of heat in cities like Copenhagen and Stockholm) and have more of the structures in place to facilitate scaling of renewable heat roll-out sooner and are more efficient than alternatives such as a green hydrogen. Delaying obligations in the short term kicks the can down the road when there are technologies ready to invest in now.

The lower initial level of 0.5% would be easily introduced at an earlier start date than that proposed, and then the level raised significantly, as stated in the response below.

Q9: In terms of the obligation rate, do you agree with the proposed initial level of obligation of 0.5%?

No, this target severely lacks ambition as described in more detail in question 10 below.

Q10: In terms of ambition for a 2030 target, what level of ambition do you think is appropriate?

The proposed approach to targets currently shows a significant lack of ambition. Biomethane from agriculture can cover approximately 17% of the current gas market according to report published by GNI and KPMG[4]. There is enough waste heat in Dublin alone to cover 100% of total heat demand in the city. The national renewable heat target of 40% by 2030 set for the wider heat sector in the REI report[5] should be considered to bring the RHO targets in line with this objective.

Q11: Do you agree with the first obligation period being multiple years 2023-2025 to give the industry time to develop supply lines?

No, the purchasing of credits from existing renewable and waste heat technologies which are already capable of the required scaling in the near term - such as district heating infrastructure - should be prioritised as discussed in question 8. The majority of renewable heat technologies are already proven, and the market is ready to react to such an incentive which is less burdensome in terms of bureaucracy compared to other existing incentives. Consideration should be given to supporting renewable heating from any installation which has been built in the last 5 years, to improve economics and encourage expansion.

Q12: Once the first period 2023-2025 expires, do you agree with the obligation then becoming an annual obligation?

The obligation should become annual as soon as possible and should follow trajectories in line with national heat plans such as the 40 by 30 report developed by Renewable Energy Ireland.

Q13: Do you agree with suppliers being able to trade credits in order to meet their obligation?

[4] https://www.gasnetworks.ie/biomethane-sustainability-report-2021.pdf

[5] https://renewableenergyireland.ie/wp-content/uploads/2021/05/Renewable-Energy-Ireland_Renewable-Heat-Plan_-Final.pdf

Yes, but only trading of credits from within Ireland. Also these companies should be allowed to purchase credits from DH companies which use renewable or waste heat to provide heat to customers for the reasons outlined previously.

Q14: Do you agree with allowing 10% carry over of renewable credits to be used in the following year's obligation?

Allowing some carry over can be beneficial in the early life of the RHO scheme to provide a certain amount of flexibility when looking at step changes in terms of renewable heating roll out.

Q15: What are the sustainable energy sources likely to meet the Renewable Heat Obligation at an obligation rate of (i) 3%, (ii) 5%, (iii) 10% by 2030?

In the near term, DH networks which supply renewable and waste heat to customers via super insulated pipe networks will be available for fossil fuel suppliers to purchase renewable heat credits from. Biomethane also represents an opportunity in the medium term albeit at a higher cost than DH. Green hydrogen is unlikely to play a significant role within this time period due to multiple challenges it faces in terms of technical, efficiency, safety and production cost (these challenges for Hydrogen are discussed in greater detail in question 24). Allowing waste heat supply credits to be eligible to meet the scheme's obligations would greatly incentivise the use of this largely untapped indigenous sustainable energy source.

Q16: Will there be enough sustainable indigenous supply to meet this demand?

A recent report by Gas Networks Ireland and KPMG[6] suggests that up to **17% of the current gas demand could be supplied by biomethane in the future. Between 50% and 60% of Ireland's heat demand could feasibly be supplied by DH networks** based on a 2019 study performed by Heat Roadmaps Europe[7] and provisional results from SEAI's National Heat Study[8]. These DH networks will utilise renewable and waste heat which can contribute to Ireland's renewable heat targets as set out in the RED. **In Dublin alone there is enough waste and renewable heat - that is only viable for widespread use through DH networks - to heat 1.6 million homes (as shown in the map below).**

[6] https://www.gasnetworks.ie/biomethane-sustainability-report-2021.pdf
[7] https://www.districtenergy.ie/heat-atlas
[8] SEAI National Heat Study final results are not currently published

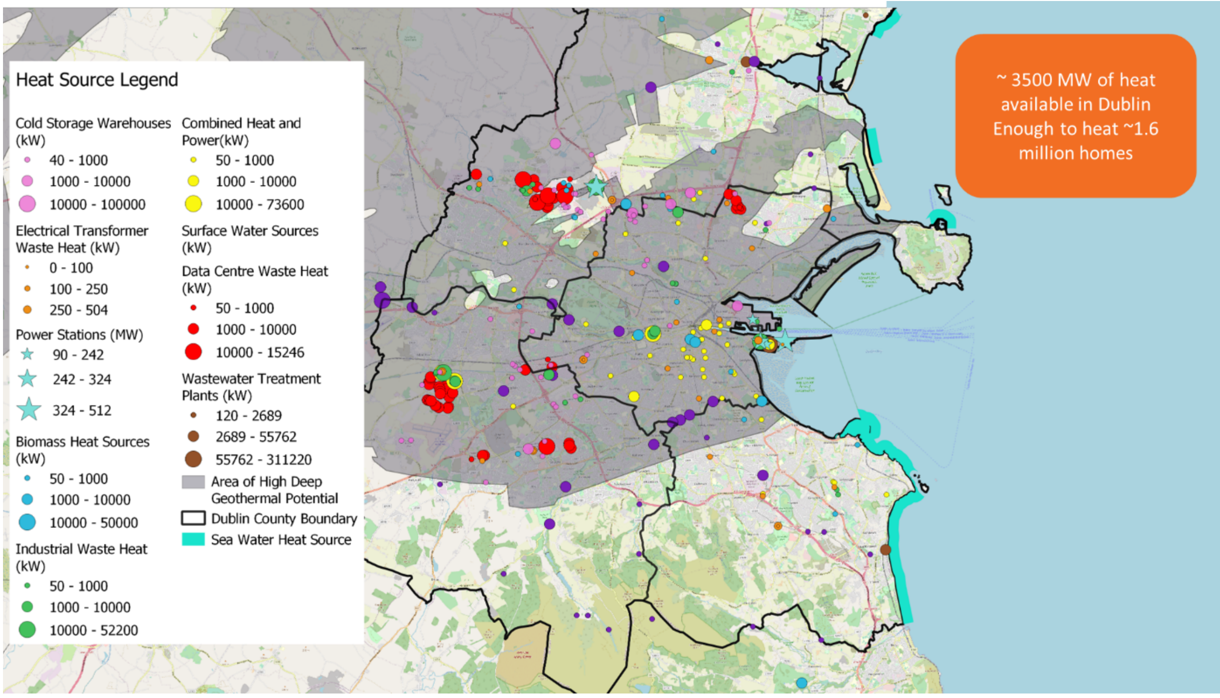

Figure 2: Heat Source Map for District Heating (Source: Codema)

Q17: Do you agree that for renewable fuel delivered directly to a consumer that this will be the point of supply?

The RHO should not just cover fuel alone but also cover renewable and waste heat delivered to customers via insulated distribution pipes in a heat network which is transferred into their buildings via heat substation (heat exchanger).

Q18: Which option do you think should be applied for renewable energy that is indirectly supplied (e.g. via the natural gas grid)?

The option chosen should be equitable for the consumer i.e. whoever is paying for the RHO should receive the benefit. It comes back to how well can the renewable content be ensured at the point of delivery. It may not be possible to ensure different renewable contents for different consumers in line with their RHO payment contribution. If this is the case then Option B seems to more accurately reflect what is happening in reality. If with some fuels it's easier to ensure the renewable content then option A may be possible and in many cases may be preferable.

Q21: Do you agree with the intended position in relation to penalties for non-compliance?

Broadly agree with the approach. However, it may be useful for the fossil fuel price to also be considered in this calculation. If for example the spot gas prices are low for a period and the penalty is linked to the renewable fuel cost alone it could still be cheaper to not be involved in the RHO scheme from a fossil fuel companies perspective.

Q23: How best could the impacts on energy poverty be minimised?

The RHO obligation can be used to reduce energy poverty through initiatives such as the development of DH networks, fabric upgrades for dwellings where residents are most at risk to fuel poverty (Codema have developed a tool for Dublin which can broadly help identify these areas). Further protections can be given to vulnerable consumers via alternative means via tax alleviation or social welfare payments.

Q24: Do you agree with the outlined approach for additional support for green hydrogen?

Codema believe that green hydrogen should only be supported for use in certain applications where the heat supply cannot already be supplied more efficiently and more cost-effectively through renewable and waste heat sources. The use cases where green hydrogen may be supported are likely to include: Industry where it is used as a feedstock, shipping, long-haul aviation, and seasonal power storage, etc. Figure 3 below shows the ranking of the potential use cases for green hydrogen with A-rated uses being the most likely to be viable and G-rated the least likely. This figure also outlines how **green hydrogen is highly unlikely to be a viable option for domestic or commercial heating**.

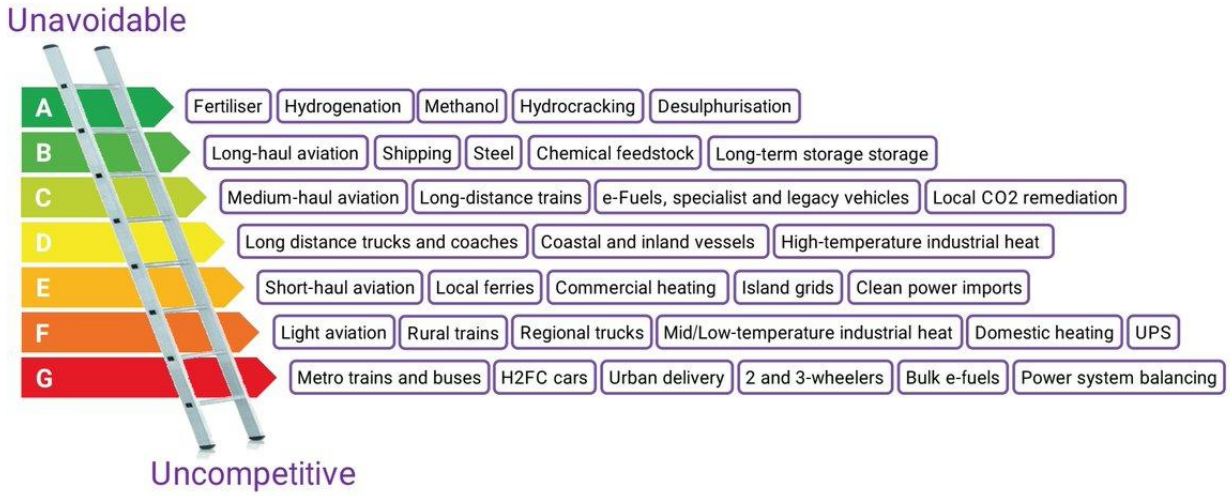

Figure 3: Hydrogen Ladder Ranking Potential Viable Uses of Green Hydrogen (Source: Liebrich Associates)

The reason for Codema's position on green hydrogen when it comes to lower temperature heating (less than 120°C) is that better alternatives already exist for providing heat at this temperature which are not subject to the same uncertainties around viability that green hydrogen is. Some of these uncertainties which make green hydrogen adoption challenging include:

- The need to avoid lock-in risk - investing in infrastructure that is based on polluting imported fossil fuels for which significant decarbonisation is extremely unlikely to occur in the short or medium term. Whilst existing infrastructure can accommodate small proportions of H2. The maximum proportion of H2 that can be accommodated without issues by volume is 20%. It is worth noting that the by volume percentage differs significantly from the delivered energy proportion due to the difference in energy density between gas and H2 at the same pressure (i.e. in the same pipe). In the case where fossil gas has 20% of H2 blended in, this actually translates to a 13% reduction in energy capacity of the pipework and H2 only providing 7% of the energy used. To increase the proportion of H2 beyond 20% replacement of pipework, compressors, valves & fittings, boilers, meters and safety sensors would likely be required.

- Suitability of existing pipework for transporting H2 - High pressure steel pipework (>7bar) which represents approximately 4.5% of the gas grid in Dublin is vulnerable to Hydrogen embrittlement (where H2 diffuses into surface flaws in the pipework, reducing ductility) which causes cracking and failure of the pipe network, valves and fittings (the location of all fittings may not always be apparent in infrastructure that is buried underground). High pressures are believed to increase the likelihood of these failures and hence high-pressure steel networks are not considered suitable for transporting H2. Older lower pressure pipework may also be constructed from steel or iron and may also be prone to hydrogen embrittlement if the gas pressure is high enough, this likelihood is reduced somewhat if mild steel is used for the pipework

- While hydrogen has more energy per weight than fossil gas it has a lower energy per mole, this would result in the pressure in the the gas network to be increased threefold to provide the same energy capacity and hence increase the likelihood of pipe failure caused by embrittlement. This required increase in compression also means that a threefold increase in compressors resulting in increased energy/electricity used to compress the gas would be required as well as ensuring pressure ratings of all pipework is not exceeded to avoid critical network failure.

- Suitability of Polyethylene pipework (used for pipes carrying fossil gas in pipelines less than 7bar pressure) for transporting H2 - Polyethylene pipes are not prone to H2 embrittlement in the same way that steel pipes are but PE pipes are more porous than steel pipes. These hydrogen-porous pipes represent 95% of the gas network in Dublin. The porosity of such pipes may also be exacerbated by the molecular size of hydrogen molecules - hydrogen is the smallest size molecule that exists, and hence is one which diffuses easily through materials. This can create problems in terms of safety particularly when it comes to elements within buildings but also creates another possible issue in that the Hydrogen itself has a global warming potential estimated with 95% certainty to be between 0 and 9.8 times greater than CO2 with a central value of 4.3 over a 100-year time horizon based on best available research. It should be noted however that the research on the GWP of H2 is limited but this early research indicates that while it will likely have an effect on global warming this will be relatively small.

- Safety is again a concern due to H2 being odourless and the difficulty in attaching an odour to a gas which cannot be detected with current sensors installed in boilers. This presents a significant safety issue as H2 is an explosive gas with a much higher flame rate than fossil gas.

- Converting electricity to H2 is about 60 - 70% efficient, converting H2 to heat is about 90% efficient giving an overall electricity to heat conversion efficiency of approximately 60% even when excluding leaks from the pipe network. Alternative heating methods have far higher efficiency. For example the current large-scale DH networks in Dublin have an average efficiency of 460% (almost 8 times more efficient than using hydrogen boilers).

- If H2 is to be used for combustion in hydrogen boilers then their NOx emissions will need to be considered. Assuming flame combustion rather than catalytic combustion, burning hydrogen can result in NOx emission up to six times higher than fossil gas boilers. NOx do not directly affect Earth's radiative balance, but they catalyse tropospheric O3 formation through a sequence of reactions GWP of 7 - 10 over a 100-year horizon (30 - 33 over a 20-year horizon). NOx is also a main cause of poor air quality which impacts people's health.

- Green H2 production requires green electricity to be supplied at a low price point. The two main factors which make H2 financially viable are in conflict with each other, these are (1) the low cost green electricity (available during low demand times) and (2) high utilisation of the electrolyser which produces the green hydrogen to pay off its large upfront cost. Further research is required to determine whether the required levels of each can be achieved simultaneously to produce cost-effective green hydrogen.

For further enquiries regarding this submission, please contact:

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