David Gardiner and Associates

November 22, 2019

The Honorable Kathy Castor
Chair
Select Committee on the Climate Crisis
H2-359 Ford Building
Washington, DC 20515

Dear Chair Castor,

My firm, David Gardiner and Associates, appreciates the opportunity to respond to the House Select Committee on the Climate Crisis's request for information as the Select Committee develops recommendations on policies, strategies, and innovations to achieve substantial and permanent reductions in pollution and other activities that contribute to the climate crisis. We are a strategic advisory firm focused on climate change, renewable energy, energy efficiency, electric vehicles, and an expanded and modernized electric grid. We work with businesses, associations, institutions, and others to accelerate climate and clean energy solutions and policy.

One of our projects, in collaboration with the Center for Climate and Energy Solutions (C2ES) and the World Wildlife Fund, is the Renewable Thermal Collaborative (RTC) which serves as the leading coalition for organizations that are committed to scaling up renewable heating and cooling at their facilities and dramatically cutting carbon emissions. While these comments are not submitted on behalf of the RTC, I wanted to share my firm's expertise in this emerging area of technology and encourage you to include renewable thermal energy in any comprehensive climate policy that you develop.

Sincerely,

David Gardiner
President
David Gardiner and Associates

David Gardiner and Associates | 3100 Clarendon Blvd., Suite 800 | Arlington, VA 22201 | 703.717.5590 | dgardiner.com

Response of David Gardiner and Associates to the House Select Committee on the Climate Crisis's Request for Information

Reducing emissions from thermal energy is essential in order for the United States to adequately address climate change. Renewable thermal technologies have the potential to reduce thermal emissions, especially in sectors that are difficult to decarbonize such as industry and commercial buildings. While some renewable thermal technologies are mature and market-ready, others are still in early stages of development. There are various barriers to additional development and deployment of these technologies, and all could benefit from supportive federal policies. The Select Committee should look to policies that have enabled the rapid drop in renewable electricity prices and use that approach as a model for an approach on renewable thermal technologies. As such, the Committee should recommend renewable thermal policies that include:

- Conducting or supporting **research and development** of emerging technologies.
- **Financial incentives** including loans, grants, and tax policies.
- Setting **long-term goals** for renewable heat deployment across sectors as well as medium- and short-term **benchmarks**.
- Establishing **technical assistance programs** to address informational barriers.
- Appropriate **recognition of environmental benefits**.

Adoption of such policies will support substantial and permanent reductions in carbon and other greenhouse gas (GHG) emissions. In the following, we explain the importance of addressing the emissions of thermal energy, the benefits of renewable thermal energy, types of renewable thermal technologies, barriers to additional deployment, polices that are being implemented in various locations, and more detailed descriptions of our recommended policies and how these policies will help to overcome the identified barriers. This comprehensive view provides answers to a number of the Select Committee's specific questions, which are identified in parentheticals.

Decarbonizing Thermal Energy: The Importance of Addressing Thermal Energy

In order to be truly comprehensive, any climate legislation must address the country's thermal energy needs. While renewable electricity generation has been the focus of existing climate-focused legislation at the state and federal level, addressing emissions from thermal energy presents a substantial opportunity for the U.S. to address climate change and become a world leader on climate policy. Energy used for heating and cooling account for approximately half of total final energy demand globally.[1] The majority of this energy use is powered with fossil fuels: 40% natural gas, 20% coal, and 20% oil, while only 10% of the heat production is powered with

[1] IEA-RETD, "Waking the Sleeping Giant: Next Generation Policy Instruments for Renewable Heating & Cooling in Commercial Buildings (RES-H-NEXT)," Feb. 2015, p. 1. http://iea-retd.org/wp-content/uploads/2015/02/RES-H-NEXT.pdf

renewable energy.[2] Close to half of the heat produced is used for space and water heating in buildings and for cooking, while the other half is consumed in industry.[3] In 2015, heat accounted for 39% of annual global energy-related CO2 emissions.[4] In the United States, heating and cooling account for more than 25% of total energy use across sectors.[5] In industrial manufacturing, thermal energy delivers process and non-process heating and cooling, as well as building space heating and cooling. In commercial buildings, thermal energy is used for hot water, cooking, and building heating and cooling.

The dominance of fossil fuels in the production of thermal energy presents a significant opportunity for the industrial and building sectors to reduce carbon and other GHG emissions. Energy use for heat accounts for one-third of global energy-related CO2 emissions.[6] In the U.S., GHG emissions associated with industrial heat account for 32% of all industrial-sector emissions and 7% of total U.S. emissions.[7] In residential and commercial buildings, on-site combustion of fossil fuels comprises 28% of total GHG emissions associated with building operations.[8]

Decarbonization of thermal energy across sectors is essential in order for governments, businesses, and institutions to meet their long-term carbon reduction goals. The potential to reduce carbon and other GHG emissions by increasing the use of renewable heat is significant. Heat can be produced using various fuels and devices and can be produced at different temperatures for different applications. Renewable heat technologies include biomass, biogas, geothermal, landfill gas, renewable electrification, renewable hydrogen, and solar thermal. Renewable natural gas (RNG) and hydrogen technologies, though in relatively early stages of development, also provide renewable sources of thermal energy. Clean energy solutions for the heat sector are complex and at times application-specific due to the different temperature and pressure requirements of end users.[9]

---

[2] OECD/IEA, "Heating Without Global Warming: Market Developments and Policy Considerations for Renewable Heat," 2014, p. 8. https://www.iea.org/publications/freepublications/publication/FeaturedInsight_HeatingWithoutGlobalWarming_FINAL.pdf.
[3] International Energy Agency, "Renewable heat policies: Delivering clean heat solutions for the energy transition," 2018, p. 8. https://www.iea.org/publications/insights/insightpublications/Renewable_Heat_Policies.pdf.
[4] *Id.* at 9.
[5] United States Environmental Protection Agency, "Renewable Heating and Cooling." https://www.epa.gov/rhc/basic-information-about-rhc.
[6] OECD/IEA, "Heating Without Global Warming: Market Developments and Policy Considerations for Renewable Heat," at 15.
[7] Joint Institute for Strategic Energy Analysis, "Generation and Use of Thermal Energy in the U.S. Industrial Sector and Opportunities to Reduce its Carbon Emissions," Dec. 2016, p. 4-5. https://www.nrel.gov/docs/fy17osti/66763.pdf.
[8] National Resources Defense Council (NRDC), Sept. 2016, "Slashing Emissions from Fossil Fuels Burned in Buildings" (https://on.nrdc.org/2KFPABN).
[9] International Energy Agency, "Renewable heat policies: Delivering clean heat solutions for the energy transition," at 10.

Though a range of renewable heat technologies exist, renewable heating is growing at a much slower pace than renewable electricity and has received much less attention from policy makers than the renewable electricity sector. In 2007, global direct renewable heat consumption was higher than renewable electricity consumption, but by 2015, renewable electricity had overtaken renewable heat, and is expected to continue deployment at a more rapid rate.[10] Renewable electricity has been a major focus of energy policy in many countries and has benefitted from extensive financial and other policy support programs.[11] While more than 120 countries have introduced policies designed to promote renewable electricity, only about 40 have specific policies for renewable heat, mostly within the European Union.[12]

<u>Benefits of Increased Renewable Thermal Deployment</u>

The environmental and economic benefits of renewable thermal energy are significant. Using renewable fuel sources instead can reduce carbon and other GHG emissions, and, where domestic renewable energy sources are used, create opportunities for job creation and economic development.[13]

Environmental

There is a clear and urgent need to reduce carbon and other GHG emissions, and this requires a reduction in the amount of thermal energy generated from fossil fuels. Replacing these fossil fuels with renewable thermal energy will help to mitigate emissions across sectors, including the industrial and commercial sectors which have historically been difficult to decarbonize. In addition, using renewable sources for heating instead of coal or traditional biomass can also improve local air quality, improving the environment and public health at the local level.[14]

Economic

The use of domestic renewable energy sources for heat can provide domestic economic benefits by increasing the use of domestic renewable fuels and providing opportunities for local job creation from the manufacturing and installation of renewable energy heating systems.[15] (question 2) Employment in renewable heating and cooling has increased in recent years from over 116,000 jobs in 2016 to almost 129,000 jobs in 2018.[16] The largest portion of these jobs

---

10 *Id.* at 7.
11 *Id.*
12 OECD/IEA, "Heating Without Global Warming: Market Developments and Policy Considerations for Renewable Heat," at 59.
13 *Id.*
14 *Id.* at 60.
15 *Id.*
16 National Association of State Energy Officials and Energy Futures Initiative, "The 2019 U.S. Energy & Employment Report," p. 137. https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5c7f3708fa0d6036d7120d8f/1551849054549/USEER+2019+US+Energy+Employment+Report.pdf.

were in construction (64%), followed by professional services (23%), manufacturing (6%), and wholesale trade (6%).[17] Rural economies can also benefit from increased use of renewable thermal technologies, in particular from biomass technologies, as these areas could become fuel suppliers.[18] In addition, increased use of biomass could potentially increase rural industry as it is typically more economical to use thermal energy close to where it is created.[19]

A Positive Impact in Difficult to Decarbonize Sectors

Regardless of the sector it is used in, thermal energy has proven difficult to decarbonize. While increased electrification of thermal processes and use of renewable electricity provides an opportunity to decarbonize in some applications, it may be difficult to electrify all thermal energy uses. Renewable heat provides an opportunity to reduce carbon and other GHG emissions from thermal processes without electrification. Increasing the use of renewable thermal technologies will help to decarbonize thermal energy, wherever it is used. The industrial and commercial buildings sectors have proven to be especially difficult to decarbonize. Given the large thermal loads of these two sectors and their corresponding carbon and other GHG emissions, using renewable thermal technologies creates another pathway to decarbonize these sectors in addition to electrification. The pace and scale of emission reductions needed for climate change argues for creating as many pathways for carbon reductions as we can. (questions 1.c and 1.d)

Industry

Across the globe, industrial heat makes up two-thirds of industrial energy demand and almost one-fifth of total energy consumption.[20] In the U.S., industrial manufacturing accounts for one-third of the nation's total energy use, including both electricity and thermal energy.[21] Process heat is vital to nearly all manufacturing industries and comprises 36% of total energy used in industrial manufacturing.[22] As a significant user of energy, the industrial sector is also a large source of carbon dioxide and other GHG emissions, and much of those emissions result from the energy used to produce heat for the manufacturing production process. Industrial emissions are concentrated in six energy-intensive basic material manufacturing sectors – steel, chemicals, cement, pulp and paper, aluminum, and oil refining – which produce more than 77% of global industrial emissions.[23] Climate solutions must include approaches to reduce emissions associated with heat production, while also making those industries more competitive.

---

[17] *Id.* at 139.
[18] OECD/IEA, "Heating Without Global Warming: Market Developments and Policy Considerations for Renewable Heat," at 61.
[19] *Id.*
[20] International Energy Agency, "Commentary: Clean and efficient heat for industry," Jan. 23, 2018. https://www.iea.org/newsroom/news/2018/january/commentary-clean-and-efficient-heat-for-industry.html.
[21] United States Department of Energy, "Best Practices: Process Heating," Jan. 2006. https://www1.eere.energy.gov/manufacturing/tech_assistance/pdfs/39155.pdf.
[22] *Id.*
[23] Imperial College London Grantham Institute for Climate Change, "Reducing CO2 emissions from heavy industry: a review of technologies and considerations for policy makers," Feb. 2012, p. 4.

One of the challenges of meeting the heating needs in the industrial sector with renewable thermal technologies is the wide range of specific temperatures required for various industrial processes. Different technology types are capable of delivering different temperature heat for different applications. Certain renewable technologies are well suited for particular applications. For example, both biomass and concentrated solar and evacuated tube solar are able to meet a wide range of temperature needs.[24] Other technologies are most effective with more specific applications: flat-plate solar collectors and ground source heat pumps can support industrial processes that require warm to hot water, while concentrating solar thermal technologies and deep geothermal wells can support the highest-temperature applications.[25]

According to the U.S. Environmental Protection Agency, nearly 60% of industrial heating needs can be met with currently available low- or medium-temperature renewable heating technologies.[26] While these technologies would appear to be market-ready, they are not seeing robust deployment. As discussed further below, there is a need for certain policies to incentivize what should be market-ready technologies, and another set of policies to further develop the technologies that are not yet market-ready.

Commercial Buildings

Energy used for heating, ventilating, and cooling in commercial buildings is also significant, comprising 39% of the total energy used in commercial buildings in the U.S..[27] Boilers and furnaces powered by fossil fuel combustion often supply building thermal needs, though air- and ground-based electric heat pumps can provide heating and cooling within smaller commercial buildings.[28] The opportunity exists to reduce the emissions of the commercial sector through deployment of renewable thermal technologies, though certain factors make this more challenging.

Thermal load profiles in the commercial sector vary across building types and commercial buildings have a wide range of heating and hot water loads compared to the residential sector: potential end uses for renewable heat in the commercial sector include space heating and

---

https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/Reducing-CO2-emissions-from-heavy-industry---Grantham-BP-7.pdf.

[24] United States Environmental Protection Agency, "Renewable Industrial Process Heat," https://www.epa.gov/rhc/renewable-industrial-process-heat.

[25] *Id.*

[26] United States Environmental Protection Agency, "RCH for Industrial Processes." https://www.epa.gov/rhc/rhc-industrial-processes.

[27] Whole Building Design Guide, "High-Performance HVAC," Nov. 7, 2016. https://www.wbdg.org/resources/high-performance-hvac.

[28] Renewable Thermal Collaborative, "A Landscape Review of the Global Renewable Heating and Cooling Market," July 11, 2018, p. 16. https://www.renewablethermal.org/a-landscape-review-of-the-global-renewable-heating-and-cooling-market/.

cooling, domestic hot water, cooking, and process heat.[29] Physical attributes of buildings such as available space, ground conditions, roof conditions, and thermal performance will also inform what renewable technology is best suited to a specific site.[30] Similar to the industrial sector, renewable heat technologies will need to be matched to the types of buildings to which they are best suited: a "one-size-fits-all" policy will not be effective in the commercial sector.

Renewable heat is a solution to help decarbonize the commercial building sector, though policies need to be crafted carefully to address the distinct energy profiles of commercial buildings.

Renewable Thermal Technologies

Due to the lack of existing renewable heat policies in the U.S., incorporating the use of renewable thermal technologies is an innovative concept for climate policy design. Many of these technologies are still in nascent stages of development, so advancing a broad range of renewable thermal technologies and allowing markets to determine future development is the best approach in the short-term. Over the long term, the Energy Transmission Commission, for example, recommends using three renewable technologies to address industrial emissions, especially for heat production – biomass, electrification, and hydrogen.[31] Improving industrial and building efficiency, for example by using combined heat and power (CHP) or waste heat to power (WHP) systems, and fueling such systems with renewable fuels can help to further reduce emissions. CHP and WHP systems can run on renewable fuels, such as biomass – forest and crop residues, wood waste, or food-processing residue – or biogas – manure biogas, wastewater treatment biogas, or landfill gas – as well as renewable natural gas (RNG), or biomethane, a pipeline-quality gas that is fully interchangeable with natural gas and compatible with U.S. pipeline infrastructure. Over time, CHP systems can evolve and use different types of fuel. Even CHP or WHP systems that use natural gas today may run on RNG in the future.

Renewable Natural Gas

Though additional challenges are presented when injecting RNG into the natural gas pipeline network – including variability in composition and supply of gas, the potential impact on end use applications, and odorization and leak detection – this should not prohibit advancing these technologies. RNG quality standards can help to ensure that RNG will not harm the distribution company's infrastructure or customer end-use equipment and will also prevent harm to human

[29] IEA-RETD, "Waking the Sleeping Giant: Next Generation Policy Instruments for Renewable Heating & Cooling in Commercial Buildings (RES-H-NEXT)," at 13.
[30] *Id.* at 14.
[31] Energy Transitions Commission, "Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-To-Abate Sectors by Mid-Century*,"* Nov. 2018. http://www.energy-transitions.org/sites/default/files/ETC_MissionPossible_FullReport.pdf

health and safety.[32] Several utilities in the United States have already developed gas quality standards that specifically address RNG, demonstrating that such challenges should not be a barrier to RNG deployment.[33] Interconnection guidelines can also provide clarity when connecting RNG projects to gas pipeline systems and uniform standards can offer consistency for projects across jurisdictions. The Northeast Gas Association released an Interconnect Guide for RNG in New York earlier this year, and while the report is specific to one state, the framework it presents could be adopted by other states.[34] Though adding RNG to the gas distribution system requires careful planning, this need not be an impediment to additional deployment.

Hydrogen and P2G

Power-to-gas (P2G) is a technology that takes excess renewable electricity and converts it to hydrogen which can be used, stored, or combined with carbon dioxide and fed to a bioreactor to produce RNG.[35] As such, P2G could significantly increase RNG production. Though hydrogen combustion does not generate GHG emissions, the steam methane reforming process used to produce most hydrogen today has significant GHG emissions.[36] As such, hydrogen can have greater lifecycle emissions than conventional natural gas.[37] P2G technology uses electricity in a process known as electrolysis to split water into hydrogen and oxygen.[38] The electricity used in this process could be from renewable resources, for example from wind turbines during periods where electric production exceeds demand. The hydrogen resulting from the electrolysis process can then be used as a fuel itself or it could be combined with CO2 through methanation to create methane.[39] The CO2 needed for this process could be obtained through carbon capture, utilization, and storage technologies (CCUS). Hydrogen-enriched natural gas is already being utilized in Europe and there is growing interest in the United States. Using hydrogen could reduce industry pollutant emissions without making significant changes to existing fired heaters and steam boilers.[40]

Hydrogen produced with renewable electricity and methane produced with the methanation process using waste stream CO2 described above could also be used to reduce the emissions

---

[32] M.J. Bradley & Associates, "Natural Gas Utility Business Models for Facilitating Renewable Natural Gas Development and Use," July 2019, p. 2. https://www.mjbradley.com/sites/default/files/RNGLDCOptions07152019.pdf
[33] *Id.*
[34] Northeast Gas Association, "Interconnect Guide for Renewable Natural Gas (RNG) in New York State," Aug. 2019. https://www.northeastgas.org/pdf/nga_gti_interconnect_0919.pdf
[35] National Renewable Energy Laboratory, United States Department of Energy, "NREL and Southern California Gas Launch First U.S. Power-to-Gas Project." https://www.nrel.gov/esif/partnerships-southern-california-gas.html.
[36] M.J. Bradley & Associates, "Renewable Natural Gas: Potential Supply and Benefits," July 2019, p. 4. https://www.mjbradley.com/sites/default/files/RNGSupplyandBenefits07152019.pdf.
[37] *Id.*
[38] *Id.* at 4-5.
[39] *Id.* at 5.
[40] Joint Institute for Strategic Energy Analysis, "Generation and Use of Thermal Energy in the U.S. Industrial Sector and Opportunities to Reduce its Carbon Emissions," at 74.

of industrial processes, including in the production of petroleum, iron, and steel.[41] Hydrogen can directly replace a large fraction of natural gas and combustion of other carbon-bearing fuels, and thus has the potential to reduce emissions.[42] While the potential exists, additional resources dedicated to research and development will be crucial to the further development of these technologies.

Barriers to Renewable Thermal Development

In general, inherent attributes of the generation and application of thermal energy presents challenges to developing comprehensive policies to require and encourage additional deployment of renewable heat sources. Unlike electricity which is frequently generated at a central location and brought to end users through the transmission and distribution system, heat is not readily moveable and therefore must be generated close to the point of use. Renewable heat also faces challenges due to market barriers and informational barriers.

Market Barriers

Matching Supply and Demand

Supply of renewable thermal is limited by geography as some regions have limited access to biomass, sun, or geothermal resources. Even where access is available, the supply of renewable thermal feedstocks is disaggregated and frequently far from demand. Since thermal energy cannot travel long distances, it often makes the most sense to create renewable heat on site or close to the user or convert a feedstock to biogas which can be transported through pipelines.[43] Moreover, potential buyers of renewable thermal energy have limited tools available to them to map out feedstock and technology opportunities that will meet their demand in specific locations.

In addition, end uses of thermal energy require a variety of temperatures and applications and these end uses can be served by a variety of feedstocks that are able to meet those end use requirements. As such, there is generally no simple, single solution for decarbonizing the country's heat supply: a combination of options will have to be deployed, and will vary based on local conditions such as temperatures required by types of industrial heat demand and applications such as steam or direct fire, available feedstocks and geothermal resources, proximity of feedstock supply to thermal demand, and existing infrastructure such as district heating systems and gas pipelines where RNG could be injected.

---

[41] *Id.* at 74. *See also* Imperial College London Grantham Institute for Climate Change, "Reducing CO2 emissions from heavy industry: a review of technologies and considerations for policy makers," at 13.
[42] *Id.* at 76.
[43] Renewable Thermal Collaborative, "A Landscape Review of the Global Renewable Heating and Cooling Market," at 41-42.

Matching the feedstock and thermal technology's temperature capabilities with the appropriate end user adds complexity to decision-making, and in some cases renewable heating projects may only be able to address a portion of a facility's total heating energy needs.[44]

Market Failure to Recognize Environmental and Other Benefits

Historically, renewable heat has not been recognized as a policy priority and has only been supported by limited, specific incentives.[45] This lack of market creation is pervasive throughout the United States. There is no comprehensive federal policy that supports renewable heat. At the state level, only fourteen states offer a credit for renewable thermal energy as part of their state renewable electricity standards.[46] While these states have taken the lead in increasing renewable thermal, not all states choose to participate, creating a patchwork of policies and a dearth of incentives to promote renewable heat in some areas.

In addition, the failure of the market to recognize the environmental and other benefits from renewable heat projects minimizes deployment.[47] Unlike renewable electricity projects, specific attribution for individual renewable thermal projects relative to broader natural gas use is challenging. Though some states have begun to incorporate renewable heat into their RPS, state RPS programs are typically designed to measure electricity, not thermal energy, posing a barrier to accounting for the value of renewable thermal projects. A related physical challenge is that many renewable heat sources are not equivalent to their fossil fuel analog: while the electrons produced by a wind turbine are identical to those produced by a coal-fired plant, the biogas produced by an anaerobic digester is not identical to pipeline quality natural gas.

Informational Barriers

The lack of reliable information on and familiarity with renewable thermal technologies also poses a barrier to increased deployment: potential users of these technologies may not be aware of the benefits that could be realized and institutions that could provide financing may be unfamiliar with these technologies and deny needed capital or increase the cost of capital to mitigate their risk.[48] Policymakers may also be unaware of renewable thermal technologies or their ability to reduce emissions, resulting in a lack of policies and incentives to encourage further development.

---

[44] *Id.* at 42.
[45] *Id.*
[46] Clean Energy States Alliance, "Renewable Thermal in State Renewable Portfolio Standards," July 2018. https://www.cesa.org/assets/Uploads/Renewable-Thermal-in-State-RPS-April-2015.pdf.
[47] Renewable Thermal Collaborative, "A Landscape Review of the Global Renewable Heating and Cooling Market," at 43.
[48] OECD/IEA, "Heating Without Global Warming: Market Developments and Policy Considerations for Renewable Heat," at 66.

In the commercial sector, tracking thermal energy use across sectors and end uses is difficult and good data is generally not available on heating and cooling uses.[49] This lack of information on how and where thermal energy users are operating creates barriers for developers looking to market available products to customers that need them and for investors trying to anticipate what technologies will be the most valuable and should be moved forward in development.

Renewable Thermal Technology Policy Models

In general, the United States should follow a path similar to that of the renewable electricity market, where steady technology innovation and improvement has made wind and solar cost-effective and the preferred choice in many markets. This technology innovation and improvement was made possible by a range of policies including research and development, tax and other financial incentives, federal procurement, and renewable portfolio standards (RPSs) and other deployment policies. Renewable thermal energy will benefit from a similar suite of policies to drive the development of innovative new technologies and deploy market-ready ones. Other countries are already pursuing policies to support renewable thermal deployment, and the United States needs to become a leader as well.

European Models

Unlike the United States where policies have focused almost exclusively on renewable electricity and transport, the European Union Renewable Energy Directive (RED) takes a more comprehensive approach by requiring 20% of European Union final energy consumption to be met by renewables in 2020, with contributions from electricity, transport, *and* heating and cooling. Individual countries have also seen success in increasing renewable heat by setting ambitious targets, utilizing existing infrastructure to achieve economies of scale, and providing financial incentives.

District heating can facilitate the deployment of renewable heat because of economies of scale and siting of facilities, though government policies facilitating use of additional renewables are still necessary. Denmark, Finland, and Sweden are three countries with extensive district heating systems that also have ambitious long-term targets to switch to renewables. This combination of infrastructure and policy has made these countries leaders in the deployment of renewable heat: in 2015, the share of renewables in heat consumption was 39.6% in Denmark, 52.8% in Finland, and 68.6% in Sweden, with biomass comprising the main source of renewable heat in each country.[50]

[49] IEA-RETD, "Waking the Sleeping Giant: Next Generation Policy Instruments for Renewable Heating & Cooling in Commercial Buildings (RES-H-NEXT)," at 15.
[50] International Energy Agency, "Renewable heat policies: Delivering clean heat solutions for the energy transition," at 21.

France and Germany also have ambitious targets for heat's role in their transitions to the greater use of renewable energy. France has distinct measures for different sectors: its commercial and industrial program includes subsidies for both project support and project execution and supported 3,600 projects from 2009-2015.[51] In the residential sector, tax credits of 30% of capital costs are the main incentive for renewable heat development along with a reduced value added tax (VAT) rate.[52] In Germany, the focus has been on buildings rather than industrial process heat: building code obligations for renewable heat in new construction and a subsidy program with extra incentives when linked to energy efficiency improvements have driven additional deployment of renewable heat.[53]

U.S. State Models

The United States does not have specific targets, nor a clear policy, for renewable heat at the federal level. However, some states have adopted renewable heating and cooling plans or have provided incentives, demonstrating that programs in the U.S. are possible. For example, Vermont established a goal to increase the share of renewable heat from 20% to 30% by 2025, New York offers a range of incentives for biomass heating systems, air and ground source heat pumps, and biodiesel blended with conventional heating oil, New Hampshire requires that a specific portion of its renewable portfolio standard (RPS) come from heat,[54] and 14 other states offer a credit for renewable thermal energy as part of their state renewable electricity standards.[55] Other state-level incentives include sales tax exemptions and rebates.[56] While some states have taken the lead in increasing renewable thermal, not all states choose to participate. A further challenge is that many of the existing state programs are only focused on buildings and there is less support for accelerating the use of renewable thermal technologies in the manufacturing sector.

Setting ambitious targets for renewable heat deployment and providing financial support for projects has been successful in European countries and has begun at the state level in the U.S.. As discussed further below, additional support at the federal level in the United States could help to further increase the use of renewable heat in the country.

Policy Recommendations

In order to achieve reductions in GHG emissions from thermal energy, the following policies will support increased renewable thermal technology deployment which will result in reduced emissions, in particular in the industrial (question 1.c) and commercial buildings (question 1.d)

---

[51] *Id.* at 29.
[52] *Id.*
[53] *Id.* at 31.
[54] *Id.* at 40
[55] Clean Energy States Alliance, "Renewable Thermal in State Renewable Portfolio Standards."
[56] International Energy Agency, "Renewable heat policies: Delivering clean heat solutions for the energy transition," at 40.

sectors, increase federal investment resulting in increased research, development, and deployment of renewable thermal technologies (question 5.a), and encourage more investment by private companies in these technologies both in the development and deployment phases (question 5.b).

Research and Development

As mentioned above, while some renewable thermal technologies are mature and ready for deployment, others require more time and resources to develop and become market-ready. Support for research and development of renewable heat technologies could make more of these technologies market-ready in a shorter time frame, accelerating the country's carbon and overall GHG emissions reductions. Advancing a robust array of technologies could ameliorate the challenge of temperature-specific demand for thermal energy: the evolution of multiple technologies that can produce different temperatures of thermal energy will allow various industries and end-users to benefit from renewable heat. Public investment could stimulate private investment from companies developing new technologies, companies that want to install these technologies, and financial institutions that can provide additional capital.

Financial Incentives

In general, renewable heating technologies often require a higher upfront capital investment than traditional technologies, though they typically have lower operating costs.[57] Project economics therefore depend heavily on the cost of capital and the perceived risk to investors.[58] As discussed above, even mature technologies that appear to be market-ready are not being deployed at a high rate. Reducing the financial barriers to these already-developed technologies could lead to more robust deployment and deeper decarbonization of thermal energy.

The wide variety of renewable heat technologies and applications results in a wide variety of stakeholders who will have distinct investment priorities and perceptions of risk: while industrial investors may require a high rate of return on an investment in the near-term, public sector investors may be able to take a longer-term view.[59] Policymakers creating financial incentives in the form of low-cost loans, grant programs, favorable tax treatment, or other policies must take into consideration this array of needs and should craft policies that allow flexibility to accommodate the various needs of potential investors or develop an assortment of policies that can be selected that are targeted to different types of projects that will appeal to different types of investors.

[57] OECD/IEA, "Heating Without Global Warming: Market Developments and Policy Considerations for Renewable Heat," at 64.
[58] *Id.*
[59] *Id.*

For those technologies that are already available for installation, financial incentives could further speed installation and carbon reductions in the near-term. Implementing incentives similar to those that have helped to accelerate renewable electric technologies such as wind and solar would also be beneficial to renewable heat.

Access to incentives should also be considered by policymakers. In the case of commercial rental properties, many lease structures require the tenant to be responsible for energy costs, but the landlord will make investment decisions related to building heating system upgrades. In such cases, the landlord is typically not incentivized to invest in technologies that potentially reduce energy costs unless the system costs can be passed on to tenants. Any incentives for renewable heat should be structured to encourage landlords and tenants to work together to increase the use of renewable heat and should ensure that tenants are not prohibited from participating in these programs solely due to the structure of their building lease.

Goal Setting

Establishing credible and realistic targets for deployment and performance-based incentives could help to further market development. Setting long-term goals for renewable heat deployment across sectors, as well as medium- and short-term benchmarks would move the country towards decarbonization of heat in the long-term. As described above, several European countries that have achieved increased renewable thermal market penetration have ambitious goals for increased deployment. A delivery plan on how those goals will be achieved will help to set the stage for research and development of technologies and deployment in the short-term of those that are market-ready and deployment in the long-term of those still in their early stages.

Technical Assistance

To address the informational barriers that the industrial and commercial building sectors face, any renewable thermal policy should include a robust technical assistance program concerning renewable thermal technologies, their benefits, and any federal programs or financial incentives aimed to increase deployment. Establishing technical assistance programs throughout the country would provide support to developers and consumers, lowering informational barriers and creating regional networks of experts. On-going data collection and publishing of data will allow researchers to track trends in deployment and may help to identify optimal technologies, building confidence in the market and encouraging additional public and private investment.

Recognizing Environmental Attributes

Though some states have incorporated renewable heat into their RPS as noted above, lack of universal recognition of the benefits of renewable heat diminishes its potential development. Any comprehensive climate legislation must overcome these barriers and fully account for the carbon and other GHG reductions of renewable thermal projects. Appropriate recognition of these environmental attributes may create additional financial incentives, thereby increasing and accelerating deployment, allowing the United States to further reduce its emissions in the near-term.

Conclusions

It is imperative that the U.S. address emissions from thermal energy: failing to do so will impede the country's ability to adequately reduce carbon and other GHG emissions to combat climate change. Renewable thermal technologies provide a solution, especially in sectors that are difficult to decarbonize such as industry and commercial buildings. The policy recommendations outlined here will help to reduce barriers to further implementation of renewable thermal technologies and allow the U.S. to realize the environmental and economic benefits of renewable heat.