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Addressing Workforce Development Challenges Inhibiting the United States' Industrial Thermal Energy Transition

PREPARED BY

Matt Beiger
Master of Public Policy Candidate,
University of Virginia

PREPARED FOR

Renewable Thermal Collaborative

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Disclaimer & Honor Pledge

The author conducted this study as part of the program of professional education at the University of Virginia Frank Batten School of Leadership & Public Policy. This report is submitted in partial fulfillment of the course requirements for the Master of Public Policy degree. The judgments and conclusions are solely those of the author and are not necessarily endorsed by the Frank Batten School of Leadership & Public Policy, the University of Virginia, Renewable Thermal Collaborative, or any other agency.

"On my honor as a student of the University of Virginia, I have neither given nor received unauthorized aid on this Applied Policy Project"

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Executive Summary

This report was prepared for the purpose of analyzing policy alternatives on behalf of the Renewable Thermal Collaborative (RTC) to address the lack of a domestic workforce capacity to support the deployment of industrial electrification technologies across the United States. Transitioning industrial thermal processes from non-renewable to renewable energy sources through electrification is critical for reducing emissions from the U.S. industrial sector. However, the pace of the transition to industrial electrification technologies is slowed by several contributing factors, including a need for domestic workforce capacity.

This report provides background on critical industrial electrification technologies like heat pumps and others, as outlined by the Renewable Thermal Collaborative. Additionally, this report analyzes the slow global and U.S. transitions to industrial electrification by identifying and describing key contributing factors like energy costs and alternatives, a lack of incentives and regulation, high upfront capital costs, and buyer confidence limitations. The root cause identified is the absence of existing industrial electrification workforce development programs across the United States.

The importance of addressing this workforce capacity challenge is made clear - without people equipped to integrate and maintain emerging electrification technologies, the necessary emissions reductions from the industrial sector will not be achieved. Lessons are drawn from historical workforce development efforts in the solar and electric vehicle sectors.

This report offers the Renewable Thermal Collaborative three policy alternatives to address the workforce development and capacity challenge: an RTC-internal needs assessment and communication action plan, the establishment of a new RTC workstream with educational partners, and for the RTC to formally advocate for skills-based hiring. These alternatives were evaluated based on RTC capacity, costs, and alignment with the RTC's mission values of collaboration/partnerships and equity. Ultimately, the recommended alternative is to conduct an internal needs assessment across RTC Members, examining Members' workforce gaps and long-term industrial electrification plans. Findings from this assessment will then inform RTC advocacy strategies with relevant federal and state government entities.

In conclusion, implementing this policy alternative will improve the Renewable Thermal Collaborative's understanding of its Members' workforce-related needs to enable more effective lobbying that drives policies and programs working to build the future industrial electrification workforce. By acting on this policy alternative now, the RTC can serve as a policy leader by laying the groundwork for an equipped workforce when conditions align for an accelerated deployment of industrial electrification technology in the coming years.

Introduction

Problem Definition

The lack of a qualified and developed workforce to support the deployment of industrial electrification technology is a major obstacle to the industrial-level transition to renewable energy sources. The Renewable Thermal Collaborative (RTC) coalition must address the workforce development challenges in the industrial energy sector or the U.S. will fail to achieve a decrease in emissions from industrial thermal energy use, which account for 13% of total U.S. emissions.

Client Overview

"The Renewable Thermal Collaborative (RTC) is the leading global coalition tackling the long-neglected challenge of reducing greenhouse gas emissions from energy used for heating and cooling to help reach critical climate goals. The coalition is comprised of companies, institutions, and governments committed to decarbonizing thermal energy by scaling up renewable heating and cooling technologies across their operations and facilities. The RTC collaborates with end users ("Members") and Solutions Providers ("Sponsors") to accelerate industrial decarbonization by identifying and addressing ways to overcome the technology, policy, and market challenges facing large thermal energy users. The RTC was founded in 2017 and is facilitated by the Center for Climate and Energy Solutions (C2ES), David Gardiner and Associates (DGA), and the World Wildlife Fund (WWF)" (Renewable Thermal Collaborative, 2024).

Background

Industrial Electrification Overview

The industrial sector is among the most energy-intensive sectors in the U.S. and global marketplaces. According to the U.S. Energy Information Administration, "in 2022 the industrial sector accounted for 35% of total U.S. end-use energy consumption and 33% of total U.S. energy consumption" (U.S. EIA, 2023). Several standard and critical production processes in the industrial sector rely on electricity and heat from the combustion of fossil fuels such as natural gas or coal. Currently, these combustion-based processes produce significant CO2 and direct greenhouse gas emissions (GHG), negatively impacting the global climate (Systems Change Lab, 2023). To combat these emissions, energy experts, policy professionals, industry leaders, and other relevant stakeholders are looking to electrify industry.

"Electrifying industry and buildings with renewable electricity is one of the key pathways to wide-scale decarbonization, with the potential to immediately deliver significant emissions reductions. Thermal energy used in industrial processes and to heat and cool buildings accounts for half of global energy demand and produces nearly 40% of energy-related carbon dioxide emissions. In the United States, industrial thermal energy use accounts for 13% of total emissions, as industrial process heat is typically generated from fossil fuels" (Renewable Thermal Collaborative, 2024).

Electrification is the process of replacing technologies or processes that involve the combustion of fossil fuels with electrically sourced equivalents. A well-known electrification example is the ongoing process of transitioning vehicles from combustion engine vehicles to electric-powered vehicles (EVs). In terms of the industrial sector, "as renewables are rapidly deployed to decarbonize the electric grid, electrification technologies including industrial heat pumps (IHPs), electric boilers, and thermal batteries offer an opportunity to improve efficiency and dramatically cut emissions from industrial thermal processes and building heating and cooling" (Renewable Thermal Collaborative, 2024). The RTC describes electrification as "a primary decarbonization pathway in the short, medium, and long term."

However, with a broad range of technologies and processes in manufacturing and production, the industrial electrification transition is more challenging (IEA, 2023). One industrial technological transition involving electrification is the transition from using industrial gas boilers to electric boilers and industrial heat pumps (IHPs). Industrial gas boilers are widely used in the U.S. industrial sector to produce steam or heat water for space and process heating and are primarily powered by either coal or gas. Industrial electric boilers and IHPs are now replacing these.

IHPs have been among the prioritized technologies in the global industrial electrification transition due to their accessibility, efficiency, and widespread deployment history, particularly in Asia and Europe. In addition, IHPs deal with lower temperature ranges, meaning they are operationally easier to deploy and maintain. However, IHPs and electric boilers can only cover roughly 50% of electrification potential in the industrial sector, meaning deployment of other electrification technologies will be necessary for sector-wide success (Roelofson, et. al, 2020). Other key electrification technologies and industrial process heating applications include electric resistance, thermal energy storage, electric arc furnaces, electromagnetic induction, plasma melting, infrared heating, dielectric heating, and electron beam heating.

For expanded information on electrification technologies, see *Appendix A*, which is sourced from the Renewable Thermal Collaborative's "Electrification Action Plan", published in January of 2024.

A Slow Global Transition

The Systems Change Lab and Climate Action Tracker estimates that the global industrial electrification rate is "off track" and will not hit the 2030 electrification target of 35% electrification of the industry sector's final energy demand, to be compliant with the Paris Climate Agreement (Climate Action Tracker, 2020). *Figure A* shows the target points and the "well off track" trend below. (Systems Change Lab, 2023)

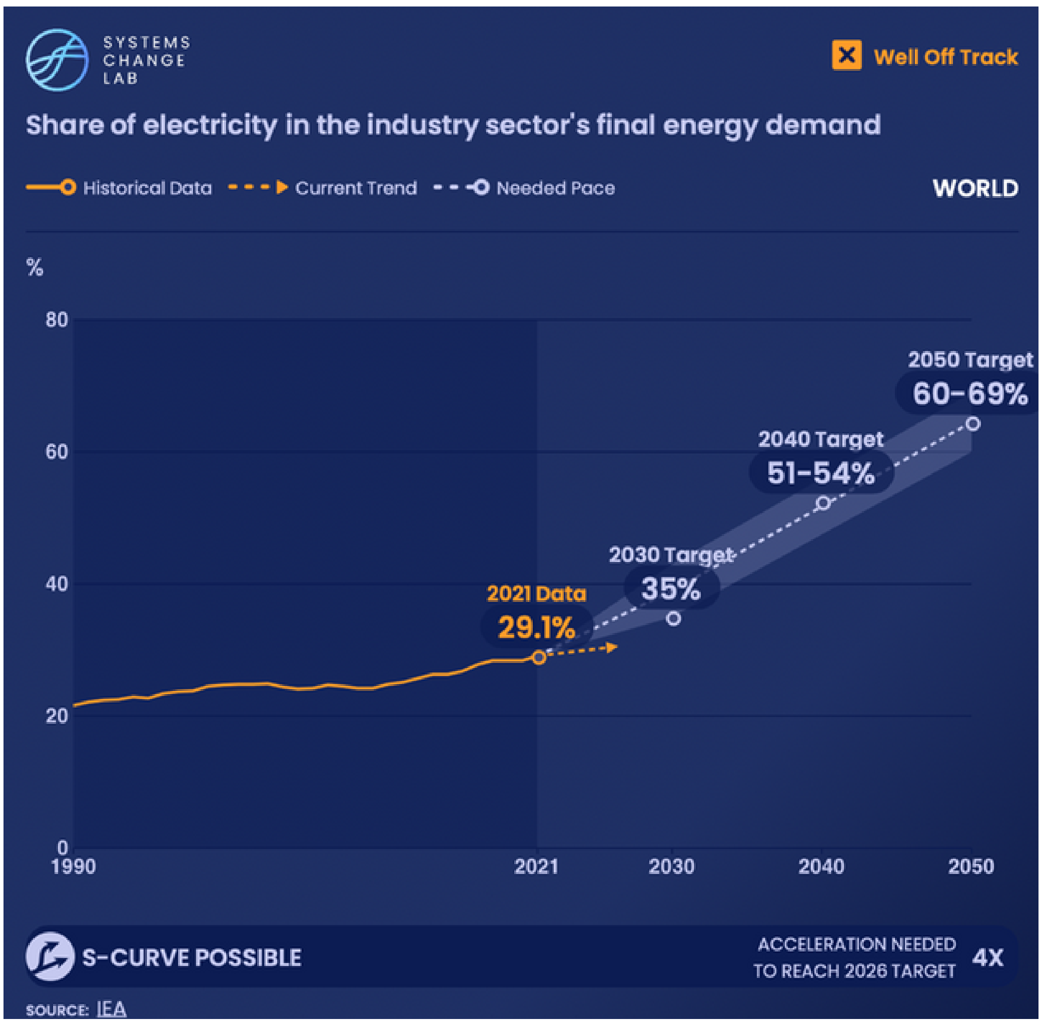

Figure A: Share of electricity in the industry sector's final energy demand by year, targets included (Systems Change Lab, 2023)

According to data collected by the International Energy Agency (IEA), as of 2021, the share of electricity in the industrial sector's final energy demand was 29.1%. This was up from 26.8% in 2015, hinting at a slow global technology deployment even with the existence of commercialized electrification technologies. This pace is not fast enough to hit global targets. *Figure B* shows a similar global trend to the projections displayed in *Figure A* in the context of the Net Zero by 2050 Scenario (IEA, 2023).

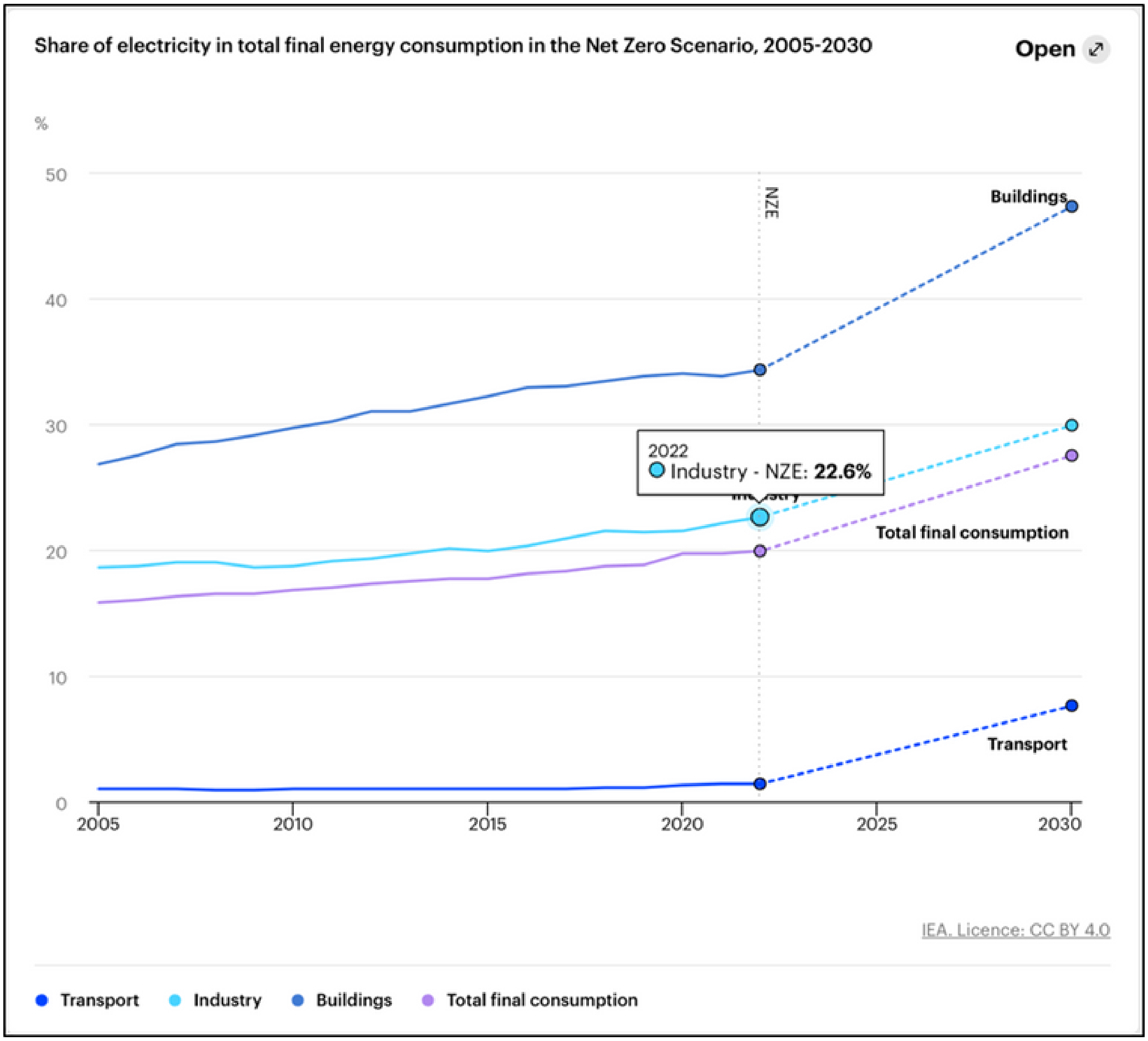

Figure B: Share of electricity in total final energy consumption in the Net Zero Scenario, 2005-2030, targets included (IEA, 2023).

Contributing Factors to the United States' Slow Transition

The United States has made significant progress in electrifying several key energy sectors, including the residential and commercial energy sectors in which heat pumps outsold fossil fuel-based heating systems in 2022. However, the deployment of electrification technologies in America's industrial sector has been comparatively limited and occurred at a slower pace (IEA, 2023). Lower-temperature electrification technologies designed for industrial processes in food and beverage, paper, light manufacturing, and chemicals segments have slowly emerged in the domestic market, but high-temperature electrification technology has yet to emerge at scale nationwide due to several issues.

Overall, the slow uptake of industrial electrification technology in the United States results from several contributing factors. Listed below are five key factors creating barriers or hesitation for industrial companies to engage in electrification:

- <u>High Upfront Capital Costs</u>: Significant investments in new electric equipment and machinery are necessary for industrial companies to electrify. Large-scale transitions require investments in obtaining new technology and machinery, deconstruction of dated equipment and industrial structures, installation/retrofitting of new technology and machinery, and associated labor costs. Process integration and electricity infrastructure upgrades prove costly. (Renewable Thermal Collaborative, 2024)

- <u>Lack of Workforce Capacity</u>: Companies in the industrial sector lack people equipped with expertise in electrification and heat pump selection, integration, and maintenance. Without internal/domestic human capital prepared to support the deployment of electrification technology and machinery, companies may have to rely on the hiring of foreign labor to support their electrification transition, a costly and unsustainable practice. Additionally, the absence of workforce capacity will fail to "deliver significant [and necessary] emissions reductions" (Renewable Thermal Collaborative, 2024).

- Lack of Incentives and Regulation: The United States currently does not offer substantial incentives to drive industrial transition to electrification technology and heat pumps. Companies are discouraged from engaging in a financially burdensome transition without incentives to offset high upfront capital costs. Only recently has the Department of Energy begun to offer incentives and awards for industrial decarbonization projects (Department of Energy, 2024), with the latest incentives program called the "Industrial Demonstrations Program" selecting 33 projects for award negotiations anticipated to amount to $6 billion. While this recent program is a step in the right direction, the effects will be limited to a handful of projects and will not incentivize stakeholder groups sector-wide.

- Energy Costs and Alternatives: Given the shale gas boom in the United States over the last 10-15 years, natural gas has been an inexpensive energy source for the American industrial sector. Due to low natural gas costs, industrial companies and stakeholders are not incentivized to transition to electrically powered systems with associated higher energy input costs. The industrial sector accounts for about one-third of U.S. natural gas consumption (Natural Gas Supply Association, 2023).

- Supply and Buyer Confidence Limitations: Industrial electrification technology is perceived to be an emerging technology category in the United States. Currently, certain technologies have limitations related to performance, temperature limits, and constrained integration ability due to electric grid capacity issues. In addition, limited domestic adoption and a lack of performance data make industrial companies hesitant to engage in the early phase of the domestic rollout of industrial electrification technology. Simply, buyer confidence is low. (Renewable Thermal Collaborative, 2024).

While there are other contributing factors to the lack of industrial electrification in America, these five encapsulate many of the core problems associated with the overall issue area. Among the five contributing factors, one of the most glaring is the lack of domestic workforce capacity. Currently, the United States needs a domestic workforce capable of supporting the deployment of industrial electrification technology at the necessary scale and pace to reach domestic emissions reduction targets. Even if the United States could assemble the necessary quantity of financial and technological capital to support industrial electrification, there is not a foundational workforce available and capable of achieving successful nationwide deployment.

Root Cause Analysis of the U.S.' Industrial Electrification Workforce Capacity Problem

The primary root cause of lacking workforce capacity to support industrial electrification is the absence of domestic workforce development programs for industrial electrification technology from buyers, solutions providers, and education institutions. Current industrial workforce training programs in the United States do not have standardized curricula or instructors focused on industrial electrification technology, meaning that new graduates and certified workers lack expertise in emerging industrial technology. Additionally, industrial private companies do not have plans prepared to train their existing workforce, ranging from engineers to project managers, for emerging industrial electrification technologies (Claussell Velez, 2024).

The primary root cause is further perpetuated by secondary causes/contributing factors. First, the lack of focus on industrial electrification by industrial leaders and public policymakers results in insufficient funding for the establishment of training programs. Because industrial electrification technology has yet to gain the attention of these key stakeholders, problem recognition is not apparent. Both the federal government and private sector leaders, holistically, need to develop comprehensive, long-term success plans for industrial electrification in the United States.

Second, reliance on alternative industrial systems and practices prevents the need for exploration of industrial electrification. Risk-averse industry leaders are hesitant to change, denoted by low buyer confidence in the industry. They face pressure from corporate sustainability leaders within their companies to update practices to meet climate targets, but are concerned with the everyday operations of their manufacturing plants (Checknoff, 2023).

Third, industrial processes vary significantly between segments because each segment's industrial processes operate at varying ranges of temperatures. This means that necessary workforce expertise will vary by process and associated technology, increasing the diversity of necessary workforce skills and operations across industry (Yuan, 2023).

Despite the challenges posed by secondary contributing factors, workforce development for industrial electrification is still a critical foundational component of America's renewable energy transition. The groundwork for industrial electrification workforce development must occur now to enable a smooth and successful national transition when conditions are ready (Heinrich, 2023).

Evidence Review

This evidence review will examine workforce development processes in the comparable modern-era clean energy transitions of solar and electric vehicles. First, it will summarize the conditions and key program features of each energy transition. Second, it will identify the support from federal programs for each transition and the critical successes resulting from federal support. Lastly, key takeaways will be synthesized from literature consensus, RTC insights, and issue realities to identify lessons and gaps in each workforce development process.

Recent Renewable Energy Transitions in the United States

With the clean energy transition taking off nationwide over the last twenty years, several documented successes of clean energy technology deployment have occurred in the United States. Two of the most prominent renewable technology deployments have been Solar/Photovoltaic (PV) in the 2010s and Electric Vehicles (EV) in the last 5-10 years. Each transition occurred at different paces with varying support from the government, interest groups, and private interests. However, early-stage workforce development was a commonality of each innovation's deployment. Considerations from within each workforce development process provide lessons for workforce development of upcoming renewable energy technology transitions, including industrial electrification.

Solar Energy Transition

In the United States, the emergence of macro-level solar energy usage began in the mid-2000s, following the implementation of the Energy Policy Act of 2005 (Mai et. al, 2016). The Energy Policy Act of 2005 included the creation of a 30% Solar Investment Tax Credit (ITC) for residential (under Section 25D) and commercial (under Section 48) solar energy systems that applied to projects placed in service between January 1, 2006, and December 31, 2007. The solar ITC has since been lengthened and modified to support the solar industry's evolution. Since the solar ITC enactment in 2006, "the U.S. solar energy has grown by more than 200x" (Solar Energy Industries Association, 2023) and served as the primary accelerant for nationwide technological deployment. Deployment of solar technology as a renewable energy alternative has arguably been highly successful, as many states notably achieved grid parity by at least 2015 (Chriayath, 2015). Grid parity occurs when an alternative energy source can generate power at a localized cost of electricity that is less than or equal to the price of power from the electric grid.

While tax credits and other economic incentive mechanisms served as effective stimulants for the accelerated deployment of solar technology, the development of human capital to support the accelerated deployment was arguably just as critical (U.S. National Science Board, 2009). This is particularly true as workforce development was a prerequisite for expansive economic incentive policy that accelerated investment in, and subsequently the deployment of, solar technology (Pasqualetti & Haag, 2011). To develop a capable workforce, successful initiatives have relied on vocational training programs supported by federal programming and trade association partnerships (Howes & Gilland, 2019). It should be noted that apprenticeship and on-the-job training are also extremely valuable. A significant benefit of vocational training programs at community colleges and trade schools is that "there are opportunities to include new curricula" to meet skill gaps (Gadzanku, Kramer, & Smith, 2023) within the existing educational infrastructure. Preexisting educational infrastructure also enables nationwide reach and rapid scalability.

Vocational programs served as a primary method for workforce development in the solar transition, given heavy initial investment by the Obama Administration. In 2009, the U.S. Department of Energy launched the Solar Instructor Training Network (SITN) to provide high quality solar training programs and build a strong solar workforce (U.S. Department of Energy, 2010; U.S. Department of Energy, 2023). The goals of the program were to develop well-trained solar instructors, engage in curriculum building, and provide broader access to solar training through community colleges and trade schools. Over the five years of the program, the U.S. Department of Energy invested over $17.5 million in SITN grants to fund supporting initiatives. It was able to establish a national network of over 400 community colleges and other organizations offering courses on solar energy topics, including installation, design, sales, and manufacturing (U.S. Department of Energy, 2023). As a result of this program, more than 30,000 students across the United States have received education in solar training from an SITN-supported educational partner (U.S. Department of Energy, 2023). The final number of students who entered this workforce segment is unclear from the provided data.

SITN was followed up with a secondary program in 2016 called the Solar Training Network (STN). The program was launched to support and improve solar industry workforce development, particularly regarding the unmet demand for qualified installers. STN sought to increase the industry's capacity for workforce development and foster robust regional workforce pipelines. These goals were part of progress toward a long-term objective of reduced "soft" costs (non-hardware costs associated with an installation). "Through avenues related to stakeholder engagement and information sharing, STN laid the groundwork for a better qualified, more diverse, better connected, and job-ready solar workforce" (Howes & Gilland, 2019, p. 2). "STN provided hands on learning to over 700 trainees, and piloted a work-based learning program, which saw significant job placement outcomes. 14 career fairs around the country facilitated in-person connections among solar employers and over 1500 job seekers" (Howes & Gilland, 2019, p. 4).

Electric Vehicle Transition

Given the recent emergence of Electric Vehicle (EV) technology, several initiatives have been implemented in both the public and private sector to aid the preparation of the workforce for EV infrastructure. Federal legislation and rules have established standards for the EV workforce, accelerating the need for specialized training programs. For example, a provision in the Bipartisan Infrastructure Law (BIL) "requires that the electricians installing and maintaining the National Electric Vehicle Infrastructure (NEVI) funded system be certified through the Electric Vehicle Infrastructure Training Program (EVITP) or a state-based equivalent continuing education (CE) credit" (Federal Register, 2022). This has intensified the reliance on the EVITP as the standard educational program for all EV workers.

The Electrical Vehicle Infrastructure Training Program (EVITP) "was created by collaborating with industry stakeholders from the private sector and educational institutions. The EVITP program certifies electricians to perform all maintenance, installation, and upgrade implementation for EV charging stations. It also provides information on utility interconnection policies, Original Equipment Manufacturer (OEM) charging performance standards, and integration of EVSEs into distributed generation infrastructure. This includes all charging levels, from in- home Level 2 charging to Medium-and Heavy-Duty (MHD) depot charging installations. This training program is regularly updated with advancing EV technology and industry standards. The curriculum is currently on its fourth revision since its creation in 2008, so it is up to date with current technology" (Electrification Coalition, 2023). The course costs students $275 and constitutes 20 hours of online classes. The program has received significant support from the federal government, particularly the Biden Administration (The White House, 2022).

In addition to deploying EVITP nationwide as the standard training program, the Biden Administration has supported EV workforce development by establishing the Talent Challenge Pipeline (The White House, 2022). The culmination of this initiative was commitments made by over 350 organizations across all 50 states to support workforce development through various educational, philanthropic, and talent recruitment methods. One example of a commitment, made by International Brotherhood of Electrical Workers (IBEW), was a pledge to train their more than 12,500 members in EVITP to prepare them to install EV charging infrastructure nationwide (The White House, 2022). While program effectiveness and success cannot be adequately identified, given the newness of the implemented programs, success is beginning to be seen due to the recent increase in investment from private sector interests. For example, "the Siemens Foundation announced a $30-million, 10-year initiative to drive an inclusive workforce for the electric vehicle (EV) charging sector. The program, Everyone Charging Forward, was created in response to the rapid growth of the EV charging sector due to both public and private investment, resulting in significant demand for skilled workers across the industry. With this workforce development initiative, Siemens Foundation seeks to ensure and scale equitable access to jobs for individuals from all backgrounds and meaningfully contribute to the decarbonization and strengthening of the US economy" (Green Car Congress, 2023).

Investments like these only come following recognition of public-led progress that exhibits promising long-term program sustainability.

Key Evidence Review Takeaways

From reviewing the literature and analyzing actions from key stakeholders and interest groups, it is apparent that workforce development processes from solar and electric vehicle deployment provide key lessons that could be applied to workforce development for industrial electrification.

First, in the development of a solar workforce, initiatives like SITN prioritized investment in instructors before curriculum and students. This step was critical in preparing for increased workforce demand once economic incentives were established for corporate investment in solar technology (Pasqualetti & Haag, 2011). In terms of application to the industrial sector, as the transition to renewable thermal energy technology begins, it would be in the interest of private industrial companies and educational institutions to follow this approach by ensuring that project managers and faculty are equipped to lead and train incoming or existing workers or students.

Second, existing vocational programs serve as an excellent foundation for teaching necessary skills and training but should also be supplemented by hands-on training, as seen in the analysis of the federal STN solar program (Howes & Gilland, 2019). Partnerships between private industrial companies and educational institutions could facilitate this educational approach in the context of the industrial thermal energy transition.

Third, public sector investment serves as a necessary solidifier for long-term success of nationalized training programs. While regional or private investments may produce alternative impactful results, national recognition through programming and funding can bring greater opportunities to the table. This was exemplified in both solar and EV deployments. To ensure parallel success in the industrial sector, private companies and coalitions must effectively communicate their investment and workforce needs to the federal government through targeted lobbying and advocacy.

Lastly, as seen in the electric vehicle transition, consolidation of support by educational institutions, private interests, and the federal government for select training programs and skills standards aids various stakeholders in the recruitment and training processes. Uniformity is key, and standards should reflect the industry's workforce needs as unnecessary standards could negatively impact workforce recruitment.

However, to qualify these takeaways, it is important to note that parallels between these transitions are limited. Solar and EV are both consumer-facing, with implications for residential and commercial sectors. The industrial sector has not gone through this kind of transition in decades. Additionally, with 2030 rapidly approaching, there is greater urgency in the industrial sector to take parallel approaches to accelerate progress in pursuit of targets.

Synthesis of Background

Given the complexities of the ecosystem surrounding the industrial thermal energy transition in the United States, it is evident that successful deployment at scale is in the early development stages and is years away from comprehensive implementation. The existence of several industry-wide contributing factors to the slow pace of the transition underscores this analysis. Cooperation and engagement from stakeholders in both the public and private sectors will be necessary to improve the trajectory associated with transition-related targets.

While many of the issues (contributing factors) discussed in the background are interdependent within the issue ecosystem, the workforce development component of the problem is comparatively manageable and can be acted upon in the early development stage of the industrial thermal energy transition. As noted in the key takeaways from the evidence review, workforce development is foundational to the successful rollout of emerging renewable technology. Implementation cannot be achieved without an equipped workforce. Workforce capacity must be established prior to or coinciding with incentivization of deployment from federal or state governments to ensure maximum deployment efficiency, scalability, and pace.

This analysis is supported by the workforce development methodology associated with the deployment of solar technology.

As a leading coalition involved with the industrial thermal energy transition, the Renewable Thermal Coalition must address existing workforce development challenges in the United States informed by ecosystem realities and current and former renewable energy workforce development strategies.

Policy Alternatives Overview

Scoped for the Renewable Thermal Collaborative

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- **Policy Alternative #1**: Internal Needs Assessment & Communication Plan
  - Step A: Internal Needs Assessment & Information-Sharing
  - Step B: Communication Action Plan – Federal & State Entities

- **Policy Alternative #2**: Establish a Workstream that Brings Educational Partners into the RTC
  - Potential Follow-up Step: Educational Partner Plan

- **Policy Alternative #3**: Formally Advocate for Skills-Based Hiring Instead of Credential-Based Hiring

Criteria

RTC Capacity (30%)

RTC Capacity aims to analyze the staffing capabilities of the RTC to implement each alternative's associated tasks and activities. Limited capacity is a major constraint for the RTC, so this criterion will optimally give the RTC a realistic estimate for how much time may need to be devoted to the successful implementation of a given policy alternative.

This criterion will be measured by how many hours per week a staff member would theoretically devote to the implementation of each policy alternative over the next fiscal year. A full-time employee (FTE) would be equivalent to 1760 hours per year, so measurements can be defined in either the context of total hours per year or FTE (Ex: 880 total hours = 0.5 FTE). Estimations for each policy alternative will be provided by RTC staff, sourced from internal data. The calculation method for FTE/Total Hours is formulated under *Appendix B*.

Costs (30%)

Costs aims to analyze the additional variable costs that each policy alternative will impose on the RTC. This will help give the RTC an estimate for how its budget may be impacted by the undertaking of each alternative. Budget constraints are a significant factor at the RTC.

This criterion will be measured in terms of dollars the policy alternative will cost the RTC to implement within the next complete fiscal year. Costing will exclude the RTC's current fixed or existing costs, solely accounting for additional costs for tasks and activities associated with the implementation of each policy option, including the hiring of new personnel, executing events, communication materials, lobbying efforts, etc. Estimations for each policy alternative will be provided by RTC staff, sourced from internal data.

Mission Alignment (40%)

Mission values are a major component of the RTC and its decision-making processes. This criterion considers each policy alternative's alignment with two of the RTC's core mission values: productive usage of partnerships/collaboration and impact equity. A survey was administered to RTC staff to gather qualitative data on alignment between each policy alternative and each mission value. Each value will be given 50% weight and scored on a scale of 1 (low alignment) to 5 (high alignment). Respondents submitted six total scores (1 score per each of the 2 mission values, for all 3 policy alternatives), as well as associated commentary justifying their scoring choices. An average will be taken for each of the six scores and the average scores of each mission value will be added together per policy alternative to establish a final score out of 10. This criterion will be measured on a total score range from 2 (low alignment) to 10 (high alignment).

Scoring Classification Ranges

- A total score ranging from 2 - 4.66 will be classified as Low Alignment.
- A total score ranging from 4.67 – 7.33 will be classified as Moderate Alignment.
- A total score ranging from 7.34 - 10 will be classified as High Alignment

Policy Alternative #1: Internal Needs Assessment & Communication Action Plan

Description

The Renewable Thermal Collaborative (RTC) is currently one of the largest interest groups supporting renewable heating and cooling industrial energy transitions. Its main purpose is to facilitate pragmatic relationships within a global coalition consisting of energy solution providers and public-aligned and private business partners. Under this policy alternative, the RTC will seek further understanding regarding the long-term workforce development plans and needs of those within its partnership seeking to decarbonize via industrial electrification.

At present, the majority of RTC Members tackle industrial electrification through short-term, project-focused methods and lack sustainable comprehensive plans. In the first step of this policy alternative, the RTC will collect information by surveying its Members through formal surveys, interviews, and/or focus groups on several questions pertaining to short-term and long-term workforce development efforts. Following information collection and permission from surveyed members, the RTC may choose to circulate key findings internally within the RTC coalition.

In the second step of this policy alternative, the RTC will use key findings related to short-term strengths and weaknesses of its Members, as well as key findings pertaining to long-term strategies (or lack thereof) to inform advocacy of Federal and State government entities on industrial electrification workforce development issues, gaps, and needs.

Step A: Internal Needs Assessment & Information-Sharing

In the first step of this policy alternative, information gathering, will specifically target short-term and long-term workforce development strategies/action plans of RTC Members. Three key overarching questions will be asked of Members:

- Does your organization have a long-term outlook related to industrial electrification workforce development? If so, please share what strategies your organization seeks to deploy to ensure long-term sustainability and if there is an associated time horizon that has been identified. If not, please share why your organization does not have an outlined plan? Are there specific barriers or challenges preventing long-term planning?

- Does your organization have any recent or ongoing implementation projects related to industrial electrification? If so, how has your organization fulfilled workforce needs for these short-term industrial electrification projects?

- For those with recent, ongoing, or near future/short-term industrial electrification projects, where have you noticed critical gaps or further needs for support as relating to workforce development and associated challenges?

Once responses from Members are gathered, the RTC should engage in two ways. First, if able, the RTC should provide direct support to Members following disclosure of new information/needs, particularly if pertinent issues are raised/identified. Second, the RTC should aggregate findings from across its membership to identify a set of key trends and takeaways for both short-term projects and long-term action plans. The aggregation of key findings could potentially provide great benefit to Members within the RTC, who could utilize findings to shape workforce policy or project management within their organization. In addition, facilitation of working groups, roundtables, or talks sponsored by the RTC could provide a productive environment for the RTC to facilitate information-sharing of key findings and relevant data.

Step B: Communication Action Plan - Federal & States Entities

In the second step of this policy alternative, the RTC should use findings from its members to strengthen the scope of its advocacy with Federal and State government entities. A major restraining force in the successful deployment of industrial electrification technology is the lack of government support of the overall effort. However, to be supportive, policymakers and agencies must properly understand the specific existing challenges related to the issue. Here, direct key findings from stakeholders committed to change can inform RTC efforts to lobby legislators and executive agencies. Below is an in-depth description of a three-pronged communications-focused implementation approach:

- Analyze current renewable workforce development programs at the Federal and State level to identify policy successes and failures. Compare and contrast these findings with the needs of RTC internal stakeholders to pinpoint areas of opportunity/partnership between government and the RTC coalition. One state-level program to note and monitor is the Illinois Climate and Equitable Jobs Act, as program objectives under this act align with interests of the RTC, particularly related to equity.

- Engage in discussions with Federal and State government contacts regarding analysis conclusions and alignment of the current and projected needs of RTC Members in relation to current policy plans and proposals.

- Progress on the adoption of RTC priorities within government-sponsored policy through continual monitoring and engagement within RTC lobbying streams. Utilize RTC public-aligned and private corporate partners in these discussions to maximize impact.

Criteria Analysis

RTC Capacity

520 Total Hours or 0.30 FTE (80 Optional Hours Included)

- Step A - Needs Assessment Tasks:
  - Develop survey (16 hours)
  - Circulate survey to gather responses (2 hours)
  - Send survey reminders and answer questions about data utilization (2 hours)
  - Follow up individually with respondents to discuss any issues raised and gather more information (16 hours)
  - Aggregate survey responses and develop key takeaways two-pager/factsheet (14 hours)
  - Organize working group meeting, roundtable, or webinar to share findings with RTC community (10 hours)

- Step B - Policy Communications Tasks:
  - Analyze federal and state level workforce development strategies (160 hours – likely external consultant)
  - Compare analysis with findings from RTC survey (60 hours)
  - Meet with members of Congress and state legislators to discuss findings and opportunities (120 hours)
  - Monitor policy progress (40 hours)
  - Event planning (80 hours) – optional

Above assessments were made by RTC staff based on internal data and experience. Given these assessments, it is evident that Step B of Policy Alternative #1 includes the most burdensome activities and tasks due to their dependency on/involvement of external actors and stakeholder group. In total, Policy Alternative #1 would require 520 total hours or 0.3 FTE needing to be committed within the RTC to successfully implement the policy alternative. It is important to note that 80 of the hours within the 520 total hours are optional, as the planning and execution of a formal event may increase the likelihood of Policy Alternative #1's success but is not necessary.

Costs

$81,000 ($20,000 Optional Costs Included)

- Designer: Approx. 2 hours of time = $400
- Printing one-pagers for Hill meetings: $200
- Travel for lobbying: $400
- In person event: $20,000 - optional
- External consultant for federal and state workforce policy analysis: $60,000

Above assessments were made by RTC staff based on internal data and experience. Overall, Policy Alternative #1 would require a total additional cost being estimated at $81,000, with $20,000 being considered optional. $20,000 is considered optional as they are associated with the costs of an in-person event in Step B, which may increase the likelihood of Policy Alternative #1's success but is not necessary.

<u>Mission Alignment</u>

Overall Score: 8.00/10.00 – High Alignment

Collaboration/Partnerships (4.67) + Equity (3.33) = Overall Score (8.00/10.00)

Policy Alternative #1	Respondent #1 Score	Respondent #2 Score	Respondent #3 Score	Respondent #4 Score	Respondent #5 Score	Respondent #6 Score	Average Score
Collaboration /Partnerships Mission Value	4	5	5	5	5	4	4.67
Equity Mission Value	4	3	4	2	3	4	3.33

Overall, Policy Alternative #1 scored a 4.67/5 on Collaboration/Partnerships and a 3.33/5 on Equity, for a total score 8.00/10, therefore classified as High Alignment. It is important to note that the survey sample size was limited, but respondents were specifically selected by RTC staff because of their proximity to the problem being addressed in this APP report. Respondents justified high scores for collaboration/partnership by noting that this policy alternative best aligns with existing workstreams and practices within the RTC. Additionally, some respondents noted that an increase in communication best aligns with the collaboration mission value. Regarding equity, which received a moderate average score, respondents noted that this policy alternative does not necessarily directly generate equitable practices but lays the groundwork for future advocacy that could be equity focused.

Policy Alternative #2: Establish a Workstream that Brings Educational Partners into the RTC

Description

Given recent membership growth and membership classification changes, the RTC should consider conducting a reevaluation of the status and current segmentation of its membership as outlined in the client overview. In addition, with an evolving landscape in the renewable thermal energy sector, it may be of interest to the RTC to consider expanding its membership network to meet evolving industry issues and demands, including the challenge of workforce development.

This policy alternative considers the introduction of a new workstream within the RTC coalition that invites educational partners to the coalition under their own segment, separate from Members and Solutions Providers. The RTC can identify potential educational partners to invite one of two ways:

- Source hiring data from existing RTC coalition members to identify which education institutions supply industrial energy workers to RTC Members.
- Identify educational institutions or programs currently active in workforce development for industrial renewable energy, particularly those with vocational or degree-programs aligned skills training for renewable energy technology.

After identifying potential educational partners, the RTC will formally invite identified institutions to join a newly organized faction of the RTC coalition titled "Educational & Development Partners", emphasizing the benefits of joining the RTC including an established network of mission-focused industry players, access to RTC advocacy and information tools and events, expanded access to hiring streams and opportunities for students, and engagement in key relevant policy discussions.

As previously mentioned, expansion of membership should be coupled with a segmentation reevaluation, which will require internal discussion and analysis. The following example questions could serve as foundation for internal discussions: "How does the RTC segment its Members and Solutions Providers?", "Are these segmentations too broad or too narrow?", and/or "How could the RTC shift segmentation scope?".

Potential Follow-up Step: Educational Partner Plan

The following step of this policy alternative is contingent on the successful recruitment and integration of Educational & Development Partners as outlined above.

Following the development of an expanded RTC coalition to include educational partners, the RTC should maximize its new partnerships to develop standardized curriculum focused on renewable industrial energy workforce training. This may involve the hiring of education experts or consultants, or the construction of an education focused RTC advisory board. Newly developed curriculum should draw on the resources and capacity of RTC's Education and Development Partners and identified skill needs associated with renewable thermal technologies to craft first-of-kind skill standards within the industry. Standardization of skills will allow for the potential development of credentials for both students and hirers.

Criteria Analysis

RTC Capacity

880 Total Hours or 0.5 FTE

- Segmentation Reevaluation Tasks:
  - Discuss internally (40 hours)
- Education Partner Identification Tasks:
  - Create strategic plan for identification (20 hours)
  - Research and prioritize education partners (60 hours)
- Recruiting Tasks:
  - Meet with priority education partners (200 hours)
  - Update website with education partners (40 hours)
- Curriculum Development Tasks (contingent on success of above):
  - Convene a series of working groups to develop curriculum (120 hours)
  - Develop curriculum (400 hours – likely external consultant)

Above assessments were made by RTC staff based on internal data and experience. In total, Policy Alternative #2 requires commitment of 880 total hours or 0.5 FTE within the RTC to be successfully implemented. It is important to note that Policy Alternative #2 has a contingent component. This means that if further simplified, without the inclusion of the "Educational Partner Plan", then Policy Alternative #2 would only have an RTC Capacity of 360 total hours or 0.2 FTE, a significant decrease. Given this assessment, Policy Alternative #2 may need to be considered without the "Educational Partner Plan" component. While the subtraction of this component may decrease the effectiveness of the overall policy alternative in addressing workforce development challenges in the industry, it would increase feasibility of implementation within the RTC due to decreased capacity burden.

<u>Costs</u>

$122,000

- Consultant or new hire for curriculum development: $120,000
    - *This may be a modest estimate. The kind of specialized knowledge required for this could make it more expensive.*
- Website updates consultant: $2,000

Above assessments were made by RTC staff based on internal data and experience. Overall, Policy Alternative #2 has a total additional cost being estimated at $122,000. It is important to note that Policy Alternative #2 has a contingent component. This means that if further simplified, without the inclusion of the “Educational Partner Plan”, then Policy Alternative #2 would likely see a massive reduction in total additional costs, closer to approximately $2,000. The recruitment and integration (non-contingent) portion of Policy Alternative #2 primarily incurs costs for the RTC related to capacity, not costs related to financing. While the subtraction of the “Educational Partner Plan” component may decrease the effectiveness of the overall policy alternative in addressing workforce development challenges in the industry, it would increase feasibility of implementation within the RTC due to significant decreases in additional monetary costs. In addition, minor additional costs may be associated with recruitment, however these vary greatly depending on a case-by-case basis and were not included in the costs assessment for Policy Alternative #2.

Mission Alignment

Overall Score: 6.50/10.00 - Moderate Alignment

Collaboration/Partnerships (3.17) + Equity (3.33) = Overall Score (6.50/10.00)

Policy Alternative #2	Respondent #1 Score	Respondent #2 Score	Respondent #3 Score	Respondent #4 Score	Respondent #5 Score	Respondent #6 Score	Average Score
Collaboration /Partnerships Mission Value	2	4	3	4	4	2	3.17
Equity Mission Value	3	4	5	3	3	2	3.33

Overall, Policy Alternative #2 scored a 3.17/5 on Collaboration/Partnerships and a 3.33/5 on Equity, for a total score 6.50/10, therefore classified as Moderate Alignment. It is important to note that the survey sample size was limited, but respondents were specifically selected by RTC staff because of their proximity to the problem being addressed in this APP report. With a mix of scores for collaboration, some respondents argued that bringing more stakeholders to the table would facilitate an increase in collaboration, but others argued that existing RTC membership may not be interested in the addition, leading to less collaboration than desired. Respondents largely agreed that the addition of a new stakeholder group would moderately align with the equity mission value.

Policy Alternative #3: Formally Advocate for Skills-Based Hiring Instead of Credential-Based Hiring

Description

Under this policy alternative, the Renewable Thermal Collaborative (RTC) would formally adopt and advocate for skills-based hiring as a policy stance. Advocacy would target RTC membership and external stakeholder groups. Given the RTC's significant influence in the policy space for renewable industrial energy, adopting and advocating on behalf of skills-based hiring instead of credential-based hiring will serve as an influential signal to its Members and other interest groups in the industrial energy policy space. General Motors, an RTC Member, is an example of an organization that has ditched credential-based hiring for skills-based hiring. While credentials, such as academic degrees, can often facilitate skills building, they do not necessarily always elevate the talent pool. By eliminating credential requirements in the hiring process, the talent pool may increase and be elevated, as skills mastering, and experience will become the prominent hiring criteria. In addition, skills-based hiring practices may reduce barriers for underrepresented groups in the hiring process, mitigate biases in hiring that can occur in resumé screenings, further support inclusive or non-traditional career pathways, and aligns with standard competency-based employee progression.

To formalize advocacy the RTC would incorporate new language surrounding recommendations for workforce-related issues that prioritizes skills rather than credentials into RTC materials. New language would be incorporated into RTC-published one-pagers, issue briefs, advocacy sheets, etc. In the RTC's facilitation of meetings, talks, interviews, etc., the RTC will invite proponents of skills-based hiring practices, like RTC-Member General Motors, to explain how workforce development capacities could be expanded and strengthened by revitalizing hiring methods. An excellent forum to introduce this formal stance adoption would be a monthly RTC community call with all Members and Solution Providers.

Criteria Analysis

RTC Capacity

280 Total Hours or 0.16 FTE

- Research Tasks:
    - Deeper research on skills-based hiring (40 hours)
    - Write brief or policy principles memo on skills-based hiring (80 hours)
- Advocacy Tasks:
    - Facilitate working group meetings and encourage Members to share information (80 hours)
    - Incorporate skills-based hiring into federal policy advocacy (80 hours)

Above assessments were made by RTC staff based on internal data and experience. Given these assessments, Policy Alternative #3 includes limited burdensome activities and tasks for the RTC. In total, Policy Alternative #3 requires commitment of 280 total hours or 0.16 FTE within the RTC to be successfully implemented. While Policy Alternative #3 requires less on capacity, a benefit to the RTC, it is unclear if it would be the most worthwhile for the RTC to take up.

Costs

$1,000

- Designer: Approx. 2 hours of time = $400
- Printing one-pagers for Hill meetings: $200
- Travel for lobbying: $400

Above assessments were made by RTC staff based on internal data and experience. Overall, Policy Alternative #3 has a total additional cost being estimated at $1,000. Costs associated with Policy Alternative #3 primarily deal with the creation and production of advocacy materials and associated advocacy practices (lobbying). Formulation of language for the policy position outlined in Policy Alternative #3 would occur within the RTC and result in no additional monetary costs.

Mission Alignment

Overall Score: 5.84/10.00 – Moderate Alignment

Collaboration/Partnerships (2.17) + Equity (3.67) = Overall Score (5.84/10.00)

Policy Alternative #3	Respondent #1 Score	Respondent #2 Score	Respondent #3 Score	Respondent #4 Score	Respondent #5 Score	Respondent #6 Score	Average Score
Collaboration /Partnerships Mission Value	2	2	4	1	2	2	2.17
Equity Mission Value	4	4	5	3	4	2	3.67

Overall, Policy Alternative #3 scored a 2.17/5 on Collaboration/Partnerships and a 3.67/5 on Equity, for a total score 5.84/10, therefore classified as Moderate Alignment. It is important to note that the survey sample size was limited, but respondents were specifically selected by RTC staff because of their proximity to the problem being addressed in this APP report. Respondents ranked this policy alternative low for the mission value of collaboration/partnerships since this policy alternative is designed as a top-down dictation from the RTC to its membership. In addition, respondents acknowledged that at face-value, this policy alternative has the most equity considerations, but a few qualified their score saying that the position taken under this policy alternative could be contested and resisted.

Outcomes Matrix

	RTC Capacity	Costs	Mission Alignment
Policy Alternative #1: Internal Needs Assessment & Communication Plan	520 Total Hours or 0.30 FTE (80 Optional Hours Included)	$81,000 ($20,000 Optional Costs Included)	8.00/10.00 – High Alignment
Policy Alternative #2: Establish a Workstream that Brings Educational Partners into the RTC	880 Total Hours or 0.5 FTE	$122,000	6.50/10.00 – Moderate Alignment
Policy Alternative #3: Formally Advocate for Skills-Based Hiring Instead of Credential-Based Hiring	280 Total Hours or 0.16 FTE	$1,000	5.84/10.00 - Moderate Alignment

Outcomes Matrix Key

RTC Capacity: On the outcomes matrix, policy alternatives with 580 total hours (0.33 FTE) or less will be rated best (green), policy alternatives with between 580 total hours (0.33 FTE) and 1160 total hours (0.67 FTE) will be rated moderate (yellow), and policy alternatives with 1160 total hours or more will be rated worst (red).

Costs: On the outcomes matrix, policy alternatives with costs less than $50,000 or less will be rated best (green), policy alternatives with costs between $50,000 and $100,000 will be rated moderate (yellow), and policy alternatives with costs totaling $100,00 or more will be rated worst (red).

Mission Alignment On the outcomes matrix, policy alternatives with High Alignment will be denoted in green, policy alternatives with Moderate Alignment will be denoted in yellow, and policy alternatives with Low Alignment will be denoted in red.

Recommendation

Given the extensive analysis of each policy alternative in the areas of RTC Capacity (30%), Costs (30%), and Mission Alignment (40%), with assessment estimates and survey scores and responses, **it is recommended that the Renewable Thermal Collaborative execute an "Internal Needs Assessment & Communication Plan" (Policy Alternative #1)** to advance its work in addressing workforce development challenges in the industrial renewable thermal energy sector.

While Policy Alternative #1 does not score the best/rank the highest on all criteria, it offers the most comprehensive, mission-aligning course of action of the three policy alternatives. Compared to the other two policy alternatives, Policy Alternative #1 ranks in the middle in terms of RTC Capacity, with 520 total hours (0.30 FTE). While this is almost double the capacity burden of Policy Alternative #3, Policy Alternative #1 requires more action collaborating with partners, as evident in its high scoring of alignment with the RTC mission value of collaboration/partnerships. In terms of associated costs, Policy Alternative #1 costs significantly more than Policy Alternative #3, primarily due to the necessity of outsourcing federal and state policy analysis work to an external consultant. However, the work conducted under this policy alternative will best prepare the entire RTC coalition for the future, as alternatively, Policy Alternative #3 simply takes an advocacy position without consideration of its coalition in its entirety.

In comparison to Policy Alternative #2, Policy Alternative #1 ranks better/higher on all criteria. While there are notable benefits and opportunities for the RTC in selecting Policy Alternative #2, the RTC should prioritize work with its existing membership before expanding into new terrain. One respondent to the mission alignment survey noted "While [Policy Alternative #2] sources data from new members, engagement with [overall membership] needs is less." In addition, there are many uncertainties surrounding how well educational-related partners would fit into the RTC as their own subclass. There are likely alternative methods to involving educational stakeholders with the RTC without attempting to recruit them to become official members of a new subclass. A potential example of this would be holding talks or roundtables with existing RTC Members and Solutions Providers on the campuses of relevant educational institutions to increase engagement with academic stakeholders and students who will be instrumental to the workforce tackling the industrial thermal energy transition.

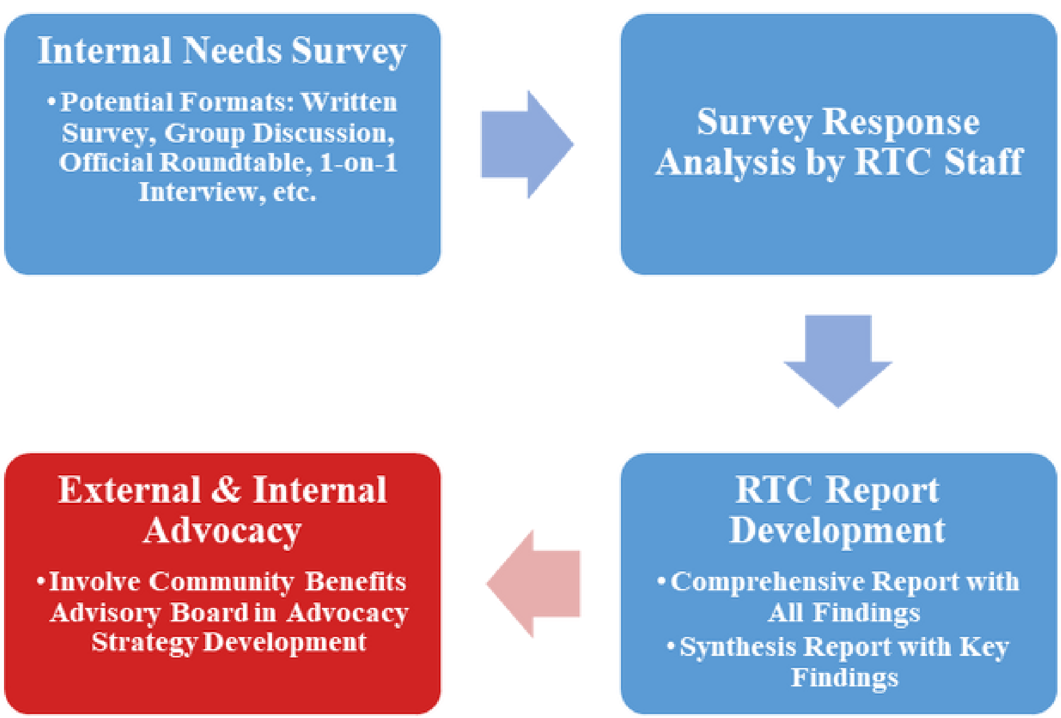
The primary reason for recommending Policy Alternative #1 over others is due to its high alignment with the RTC's mission and structure. In discussion of Policy Alternative #1, one respondent said, "This information-gathering approach and drawing patterns across responses to align for action recommendations/advocacy items feels in line with our model and will honor the realities of our membership and help to guide them in an actionable manner." Another stated, "[Policy Alternative #1] seems like the best option of the three because it directly gets at Members' needs. We can increase the likelihood of equity alignment by recommending equity-based options for workforce policy development, such as skills-based hiring." It is particularly notable that advocacy for skills-based hiring (Policy Alternative #3) could be potentially integrated into later stages of implementation of Policy Alternative #1. Overall, with the analysis suggesting that Policy Alternative #1 bests aligns with the current mission and structure of the RTC and offers the greatest potential for advancing the entire RTC coalition forward on the issue of workforce development, Policy Alternative #1 is the recommended policy.

Implementation

Overview

With the recommendation being that the Renewable Thermal Collaborative should execute an "Internal Needs Assessment & Communication Plan" (Policy Alternative 1), with multiple steps included, several questions and concerns must be addressed to ensure successful implementation. The goal of the recommended policy is to improve the understanding of the workforce development needs of the RTC community so that RTC advocates and lobbyists can affect policy progress within federal and state governments, as well as within the RTC coalition.

An overview of the range of steps is highlighted in the graphic below, beginning with the Internal Needs Survey and ending with External & Internal Advocacy. Be advised that this overview represents a simplification of the four key steps in the implementation process of Policy Alternative #1. Finer implementation steps are classified under each key step. Additionally, in the graphic below, implementation steps in blue correspond with Step A of Policy Alternative #1, while the implementation step in red corresponds with Step B of Policy Alternative #1.



The execution of Policy Alternative #1 will be a multi-year process, particularly because lobbying and advocacy at the federal and state level will be an ongoing effort. In Step A, collection of sufficient and thorough survey data will likely take 1 to 2 years to complete, as Members and Solutions Providers will give responses at varying paces. Additionally, it is recommended that survey responses are garnered in differing formats to ensure there are not major response gaps in adhering to only one survey method. The subsequent two key steps will likely take a total of about 1 year to complete, however survey response analysis by RTC staff may coincide with survey response collection, potentially shortening the total timeline. RTC Capacity will be a major determinant of the time required for the successful implementation of Step A. Limited capacity will result in an increase in implementation time.

As previously noted, Step B will be an ongoing effort with no exact time frame. Advocacy and lobbying strategy will be informed by the RTC's Community Benefits Advisory Board, an effort that may take 3-6 months to complete with ongoing advising depending on results. Potential unaccounted for variables (election outcomes, technological advances, increase in funding, etc.) that may impact timing are possible in the future.

Details & Considerations

As outlined in the policy alternative description, it is first necessary to start by understanding what the RTC community specifically needs. This may include both policy needs and business needs, which potentially could overlap in several areas. To do this, the first step is surveying the internal workforce needs of RTC Members who are considered "buyers". Examples of buyers would be corporations looking to transition their industrial/manufacturing practices to systems dependent on renewable thermal energy. This first step in the implementation process is best because it would maximize information relevancy within the RTC coalition, and it serves as an easier entry point for the RTC in working to address the greater workforce development and capacity challenge in the United States. As denoted by RTC survey respondents and from research, this choice parallels what was done by the RTC in their targeted analysis of decarbonizing process heat in the food and beverage sector (Renewable Thermal Collaborative, 2023). From engaging in dialogue and surveying Members from the food and beverage sector the RTC was able to first understand that the largest workforce development challenge for food and beverage buyers/Members is that in-house (company-internal) engineering teams and/or facility managers are not familiar with electrification technologies. The survey process provided valuable feedback from Members and was feasible given the constraints that the RTC faces, thus proving a more comprehensive, coalition-wide survey approach could yield success.

A potential concern for Step A is regarding ensuring high response rates and quality answers for the purpose of compiling a comprehensive set of key findings and data points. Stakeholders for Policy Alternative #1 are RTC Members, so the success of implementation and ultimate benefits rests within the RTC coalition. To ensure that the survey is accessible to all Members, it could be deployed in several forums including written and oral (in group settings, roundtables, interviews, etc.). These information-gathering techniques have been used in past research/surveying projects by the RTC and would be easy for the RTC to deploy on a larger scale in accordance with Policy Alternative #1.

Additionally, to improve the RTC mission value of equity in Step A of implementation the RTC could also center equity in the needs assessment survey One survey respondent suggested that this could be done by "asking RTC Members and Solutions Providers how they are approaching diversity and inclusion in their workforce development efforts" along with the other questions outlined/suggested in the policy description of Step A. Information gathered in response to this question could potentially inform communication and advocacy strategies in Step B.

Overall, Step A largely builds upon existing practices and strategies that the RTC currently utilizes, thus explaining why there would not be much additional costs associated with Step A of Policy Alternative #1. However, the difference in the implementation of this policy alternative compared to previous RTC research projects is that this policy alternative would be generating responses and subsequent analyses from all RTC Members. In the past, as stated above, the RTC has focused analyses to being specific to sectors, like the food and beverage sector. To ensure that all Members feel represented and have their needs properly evaluated, it would be helpful to produce two separate reports for information-sharing purposes. The first should be a comprehensive report that divides Members up by sector, however, includes all written responses per each Member. Then, for more digestible reporting of findings, the RTC should develop a synthesis report that can be used for advocacy and other external purposes. This system is congruent with current reporting/publishing practices of the RTC.

In Step B of Policy Alternative #1, implementation largely deals with advocacy of policy needs, as reported by Members, to government entities at the federal and state level. In this process, a concern raised by RTC staff is that equity is not squarely in focus in the same vein as membership needs. RTC staff and survey respondents praised the focus of membership needs (collaboration/partnerships) in Policy Alternative #1 but were slightly unsure of how to neutralize equity concerns. To do so, it is recommended that government advocacy done in Step B of Policy Alternative #1 focuses on equity strategies in addition to other expressed needs. For example, at the state level, the RTC could amplify the benefits and considerations of the Illinois Climate and Equitable Jobs Act (CEJA) during communication operations and advocacy to center successful equity workforce development strategies in the overall policy debate (Illinois Department of Commerce & Economic Opportunity, 2023). The Illinois CEJA, passed into law in 2021, seeks to effectively and equitably create jobs across several segments of industry and ensure that these workforces are trained to deploy renewable technologies to transition the state of Illinois to 100% carbon-free power by 2045. Replication by other states could greatly accelerate the industrial thermal energy transition to renewable sources.

Lastly, the RTC should lean on its Community Benefits Advisory Board when developing strategies for advocating for greater equity in workforce development policy and rules-making. The expertise of the Community Benefits Advisory Board will help refine advocacy efforts to be more effective, particularly in dealing with the Biden Administration.

It can be anticipated that Members will be supportive of the RTC's deployment/implementation of Policy Alternative #1, as most rely on the work of the RTC to inform their renewable energy strategies. There are few risks associated with this policy alternative, thus making its implementation process much easier and feasible. However, prioritization of mission values must remain in focus throughout the implementation process, in Step A and Step B. Given the status of the industrial renewable thermal workforce, it is likely that the findings from the needs assessment (Step A) will yield findings that will remain applicable to advocacy and communication efforts for years to come as renewable thermal technologies continue to emerge in the U.S. market at scale.

Appendices

Appendix A: IE Technology - RTC Electrification Action Plan

The following information is directly sourced from pages 6-10 of the Renewable Thermal Collaborative "Electrification Action Plan", published January 2024. For the RTC's sourcing and corresponding graphics, please see the official report which is cited in the Bibliography of this Applied Policy Project. The purpose of *Appendix A* is to provide further supplemental information regarding Industrial Electrification Technology. (Renewable Thermal Collaborative, 2024, p. 6-10)

HEAT PUMPS

Electric heat pumps are a mature technology, commonly used in buildings for space and water heating. Heat pumps have also been deployed to meet demand for low temperature heat across a range of industrial processes, particularly in Europe and Asia, with fewer examples in the U.S. Some commercially available industrial heat pumps (IHPs) can deliver heat up to 160°C, although efficiency degrades at temperatures above 100°C.(12) With this temperature range, IHPs are well-suited to applications in the chemicals, food and beverage, and pulp and paper sectors, wherein a large share of emissions come from low temperature process heat.

The RTC's Renewable Thermal Vision Report (hereinafter "Vision Report") finds that IHPs can cost-effectively decarbonize applications with temperature requirements under 130°C, representing 29% of industrial thermal demand in the U.S., and recommends that IHPs be deployed immediately to electrify low temperature applications such as washing, drying, and preheating. With further research and development, IHPs capable of delivering heat at temperatures above 200°C are expected to become commercially available by 2030, which would expand the range of IHP applications and the potential for emissions reductions.(13)
IHPs use electricity to transfer heat from their surroundings or waste heat (the "heat source") to a process at a higher temperature (the "heat sink"). While there are several types of IHPs, they can be separated into two main categories: closed cycle and open cycle. Closed-cycle mechanical vapor compression heat pumps

mechanically compress water vapor, usually from low pressure waste steam, to increase its temperature.15

IHPs are typically highly efficient because the amount of heat delivered exceeds the amount of energy used to increase the temperature of the heat. This ratio is known as the Coefficient of Performance (COP). The high efficiency of heat pumps bolsters the case for their immediate deployment—because IHPs can achieve efficiencies of 300% or more, they can reduce emissions relative to natural gas even in areas where the electric grid is "dirty." Specifically, the Vision Report finds that IHPs could reduce emissions using grid electricity in 35 states in 2022, and in all 50 U.S. states by 2035 or sooner (see Figure 2).

Despite the significant potential for IHPs to deliver immediate energy savings and emissions reductions, the U.S. market for IHPs is nascent. The high upfront cost of IHP equipment, as well as other barriers including the lack of domestic supply, workforce capacity, cost-competitive renewable electricity, and buyer knowledge, must be addressed to deploy IHPs at an accelerated pace.

ELECTRIC RESISTANCE

Electric resistance technologies use an electric current to produce heat from a material's electrical resistivity. Electric resistance heating can achieve temperatures up to 1,800°C,17 which applies to all industrial process heat applications except for those with the highest temperature requirements (e.g., cement kiln, steelmaking, metal fabrication).18 However, the applicability of electric resistance technologies to industrial processes depends on the type and commercial availability of the technology. Common electric resistance technologies include electric air heaters, boilers, furnaces, and ovens.19 Broadly speaking, these technologies are highly mature and commercially available. For example, electric boilers that can generate heat or steam at temperatures up to 350°C are widely available,20 and electric furnaces that can achieve temperatures above 1,000°C are commercially available for certain applications.21 Accordingly, the Vision Report finds that electric resistance technologies are highly applicable to low and medium temperature

temperature industrial applications, and moderately applicable to high temperature processes.22

A key benefit of electric resistance technologies is that they can directly replace most natural gas-fired equipment without major system modifications.23 Some energy buyers within the RTC report that the potential to use electric resistance technologies like electric boilers as a drop-in replacement for fossil fuel-powered equipment is a key benefit of these technologies, as they can avoid long periods of system downtime and expensive retrofits (e.g., de-steaming) that might otherwise threaten company profit margins. Moreover, the capital cost of an electric boiler is approximately 40% less than that of a natural gas-fired boiler on average.24

While electric resistance technologies are close to 100% efficient, their immediate decarbonization potential is constrained by the emissions intensity of U.S. electric grids. The Vision Report finds that electric resistance heating could reduce emissions relative to natural gas combustion in about half of U.S. states using grid electricity by 2026, which represents a considerable short-term decarbonization opportunity. However, because electric resistance technologies have high electrical demand and electricity is currently more expensive than natural gas in most of the U.S., electric resistance heating is typically not cost-competitive with natural gas combustion.25 Industrial end users also report that the increased electricity load required for electric resistance heating usually exceeds their local distribution grid's capacity and may require costly infrastructure upgrades.26 Unless electric resistance heating is significantly incentivized or natural gas prices substantially increase (e.g., through a carbon price), electric resistance technology deployment may be limited to specific applications in the food, paper, pharmaceuticals, and chemicals sectors, or to regions where electricity prices are low relative to natural gas prices (e.g., the Pacific Northwest and portions of the southern Midwest).27

Hybrid electric boilers, which produce hot water or steam from electricity and another fuel source (e.g., natural gas), allow industrial end users to use electricity during *periods when it is low-cost and opt for other fuels when electricity demand charges are high.28 Because these hybrid systems reduce emissions and take advantage of cost competitive electricity, some technology providers view hybrid applications as a significant near-term growth area.*

THERMAL ENERGY STORAGE

Thermal energy storage (TES) systems store heat that can be used immediately or saved for future use. TES has historically been used in buildings for space heating and in combination with solar thermal systems. Now, an emerging class of commercially available TES systems, commonly referred to as thermal batteries, is gaining attention as an electrification technology with a variety of industrial process heat applications and grid balancing benefits.29

Electrified thermal batteries convert electricity into heat with electric resistance heaters, store the heat for hours or days, and release heat or steam for use in industrial processes. The heat is stored in a storage medium, such as carbon blocks, crushed rocks, refractory bricks, or silicon dioxide sand, and insulated to prevent heat losses.30 Commercially available thermal batteries can produce heat up to 750°C, and companies are actively developing thermal battery systems that can deliver heat at 1,500 to 1,800°C—these higher temperature thermal battery systems are expected to become commercially available by 2030.31

As with other electrification technologies, thermal batteries must source electricity from renewable resources to deliver carbon-free heat. However, unlike other electrification technologies, thermal batteries can be scheduled to charge at specific times, meaning they can access renewable electricity during the lowest-price hours of the day (e.g., whenever renewable power would otherwise be curtailed). The business case for thermal batteries is further underpinned by the technology's ability to smooth over mismatches in supply and demand for heating and supply a stable stream of heat at a given temperature, which is critical for 24/7 industrial operations. In areas with large quantities of low-cost renewable electricity, thermal batteries are already *cost competitive with natural gas. However, industrial end users are generally unfamiliar with the technology, and barriers related to traditional retail electricity rate structures and wholesale market access may slow down wide-scale thermal battery deployment.32*

OTHER ELECTRIFICATION TECHNOLOGIES

There is a variety of other electrification technologies that have been commercially deployed for specific industrial process heating applications, including electric arc furnaces, electromagnetic induction, plasma melting, infrared heating, dielectric heating, and electron beam heating. Many of these technologies can achieve temperatures higher than fossil fuel or hydrogen combustion.33 For example, plasma melting, which has applications for metals, plastics, and ceramics, can generate heat at temperatures as high as 5,000°C.34

(Renewable Thermal Collaborative, 2024, p. 6-10)

Appendix B: FTE/Total Hours Formula

Total hours = (40 hours*52 weeks) - (8 hours*(16 paid holidays + 20 vacation days + 4 sick days)) = 1760 hours per year = 1 Full Time Employee (FTE)

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