Net-Zero Emissions Primer

For Textile Manufacturing Firms

Environment and Climate Change Canada
Environnement et Changement climatique Canada

Canada

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Introduction

1.1 Background and Context

Environment and Climate Change Canada's (ECCC) Net-Zero Challenge, in collaboration with the Transition Accelerator, has created a series of industry specific Net-Zero Primers. The purpose of this collaboration is to provide support to businesses and organizations and help them create a strategy to reduce emissions while improving their competitiveness and resilience in a net-zero economy. These primers were all developed in consultation with Net-Zero Challenge participating companies in the relevant sector at the time of writing.

1.2 Purpose of this Primer

The purpose of this Net-Zero Emissions Primer is to help companies in the textile manufacturing subsector in Canada:

a) Improve their understanding of the importance of net-zero and what the transition to net-zero could look like, both for their subsector and globally; and
b) Develop a net-zero strategy and plan for their company or organization.

1.3 Who is This Primer For?

This primer is designed to help **textiles manufacturing** companies and organizations achieve net-zero emissions by 2050. It can be used by businesses at the beginning stages of their net-zero journey, as well as those at a more advanced stage who are seeking detailed, actionable advice to further advance their decarbonization strategies, specifically focusing on production-oriented processes such as dyeing, drying, bonding, and finishing textiles.

While this primer focuses primarily on textile mills and textile product mills (NAICS 313–314), some of the content may also be relevant to firms in related industries, where textile production is a key input for manufacturing of "end use" goods, including:

- Apparel manufacturing (NAICS 315)
- Leather and allied product manufacturing (NAICS 316)
- Upholstered household furniture manufacturing (NAICS 337121)

1.3.1 Overview of the subsector

Companies in the textiles manufacturing subsector produce various textile products, ranging from apparel and household furnishings to specialized goods such as medical textiles, protective gear, and construction materials [1].

The full list of the relevant North American Industry Classification System (NAICS) codes for this subsector is provided in ANNEX 1.

In Canada, there are approximately 850 businesses in this subsector, predominantly composed of medium and large-sized firms employing anywhere from a few to several hundred employees. Together the subsector employed over 13,800 people in 2024 [2] [3] [4]. The sector contributed a total of $1.02 billion to Canada's gross domestic product (GDP) in 2024 (~0.05% of Canada's total GDP) [5]. Total greenhouse gas (GHG) emissions from this subsector are estimated to be about 200,000 tonnes of carbon dioxide equivalent (CO_2e) per year (~0.24% of Canada's total emissions) [6].

In most cases, textiles manufacturing firms are not major emitters individually and will not have to make significant changes to their business model as the economy shifts to net-zero emissions. However, the sector's total emissions are still significant and must be addressed if Canada is to meet its net-zero target.

1.3 How to Use This Primer

This primer is separated into two main sections:

SECTION 2: The Shift to Net-Zero Emissions; and,

SECTION 3: Net-Zero Strategy and Planning for Textile Manufacturing Firms

The purpose of SECTION 2 is to provide information on what net-zero is, why it is important, and what the shift to net-zero will look like both for the textile manufacturing subsector and globally. This section provides important background and context that companies should be aware of before developing their net-zero strategy and plan.

The purpose of SECTION 3 is to provide companies with guidance on how they can develop a net-zero strategy and a concrete plan for implementation. Note that this primer is based on the typical activities of a firm in the textile manufacturing sector. While it provides a guide to simplify the process of net-zero planning, it must apply to the specific circumstances of each company to develop a path forward.

The following steps in net-zero planning will be covered in SECTION 3:

SECTION 2 The Shift to Net-Zero Emissions

The purpose of this section is to provide relevant background and context on the shift to net-zero emissions, to help textile firms understand their role in the transition and prepare to develop their net-zero strategy and plan.

This section describes what net-zero is, why it is important, and what the shift to net-zero will look like for companies and organizations in the textile manufacturing subsector in Canada and globally. It also gives an introduction on how to measure emissions using internationally recognized GHG emissions accounting practices.

2.1 What is Net-Zero?

Net-zero emissions are achieved when anthropogenic[1] GHG emissions to the atmosphere are balanced by anthropogenic removals over a specified period [7].

Net Zero means emissions are balanced by removal

GHGs are gases emitted from both human and natural sources, that once in the atmosphere, absorb and release heat. Rising concentrations of GHGs in the atmosphere contribute to climate change. GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. A commonly used unit of measurement for GHGs is CO_2e, which stands for carbon dioxide equivalent, and takes into account the global warming potential of all of the GHGs.

2.2 Why is Planning for Net-Zero Emissions by 2050 Important?

The world is moving toward net-zero emissions because the science is clear: to avoid the worst impacts of climate change, we must ultimately eliminate all net addition of GHGs to the atmosphere. Achieving the Paris Agreement goal of limiting warming to 1.5°C requires immediate action across all sectors of the economy. Not taking action will increase risks to health, ecosystems, and economic stability and make future transitions more difficult and costly. As the costs and impact of climate change continue to grow, the case for climate action is clearer than

[1] GHG emissions originated from human activity.

ever – that's why governments, businesses, and communities are committing to actively cut emissions and build a climate-resilient future.

For the textiles manufacturing subsector, reaching net-zero emissions is important, since the aggregate emissions from the sub-sector are significant, even if those from individual firms may be small[2]. The sector as a whole has a role to play in the global transition to net zero.

For individual companies in this subsector, planning for net-zero emissions is important, as it allows firms to prepare for the future, increase their resilience to climate risk, identify business opportunities, secure a competitive advantage in a decarbonizing market, and build their reputation with clients and investors. Net-zero planning can also be useful for ensuring compliance with evolving regulatory standards and meeting conditions for participation in voluntary emissions reduction programs (such as the Government of Canada's Net-Zero Challenge).

2.3 The Global Shift to Net-Zero

Globally, the main sources of GHG emissions come from the burning of fossil fuels (oil, natural gas, propane, and coal) for energy production, industry, transportation, and buildings. Other significant sources of GHGs come from agriculture, forestry, and land use changes [8].

Broadly speaking, the main actions required to reach net-zero emissions in Canada include:

- **Decarbonize and expand the electricity grid** using technologies such as wind, solar, and nuclear, to electrify end-uses (such as light duty vehicles, building heating, and industry) that currently rely on fossil fuels.
- **Increase the production and use of low-carbon fuels** – such as hydrogen and advanced biofuels to address end-uses that are not easily electrified such as high temperature industrial processes, and certain types of transportation.
- **Promote energy efficiency** to reduce costs and minimize the scale of the new clean energy infrastructure that must be built over coming years.
- **Address non-energy related emissions** from industrial processes (like the production of cement or steel), waste management practices, and agriculture.
- **Deploy carbon removal approaches –** including nature-based solutions (such as tree planting) and direct air capture (DAC)– to trap greenhouse gas emissions that cannot be eliminated and permanently remove them from the atmosphere.

Getting to net-zero will require efforts from every economic sector. Economic sectors are intertwined: products from one firm are used by others; goods and services flow across borders and production chains link many disparate activities. Change on this scale will be spread over decades, with some countries and sectors able to move more quickly than others. Canada has

[2] The total GHG emissions from this subsector are estimated to be 200,000 tonnes CO_2e/year [15]

committed to achieving net-zero emissions by 2050 through the *Canadian Net-Zero Emissions Accountability Act,* which became law in June 2021.

2.4 The Shift to Net-Zero for the Textile Manufacturing Subsector in Canada

This section describes what the shift to net-zero will look like for textile manufacturing as a whole in Canada (what this could look like for your company specifically is addressed in SECTION 3).

2.4.1 Where do Emissions in the Textile Manufacturing Subsector Come From?

The activities of firms in this subsector involve the transformation of raw materials into finished products through energy-intensive processes such as spinning, dyeing, finishing, drying, and bonding. Emissions associated with these operations stem from both direct on-site fuel combustion and indirect emissions across the value chain, including electricity use, raw material sourcing, transportation, and waste. Details on where these emissions typically come from are provided in Table 1.

Table 1. Main sources of emissions from textile manufacturing

Category	Description	Explanation	Relative magnitude of emissions	Degree of company control
Thermal Manufacturing Processes	Use of heat in production (e.g. dyeing, drying, heat-setting, bonding).	Direct emissions from use of energy, including natural gas, oil, or electricity for heating textile machinery and generating steam.	High	Medium to high
Facility Heating & Cooling	Space and water heating for buildings and offices.	Direct emissions if fossil fuels are used (natural gas, oil); indirect if electricity is used, involving HVAC and water heating systems.	Medium	Medium
Electric Machinery and Equipment (Non-HVAC)	Powering motors, looms, lighting, and control systems	Indirect emissions from electricity consumption, including machinery operation, lighting, and control systems within the facility.	Low to medium	Low to medium
Transport & Shipping	Movement of raw materials and finished goods (inbound and outbound).	Emissions from freight transport (trucks, ships, rail) for inbound raw materials and outbound finished textile products distribution.	Medium to high	Low to medium

Category	Description	Explanation	Relative magnitude of emissions	Degree of company control
Employee Travel & Commuting	Employee commutes, deliveries, business travel.	Emissions from employee vehicles commuting to manufacturing facilities and company-related travel for meetings or logistics purposes.	Low to medium	Medium
Fiber Lifecycle	Emissions embedded in the production of yarns and fibers and their end-of-life management.	Indirect emissions from producing virgin synthetic fibers (polyester, nylon). Lower emissions from recycled or bio-based materials.	Medium to High	Low to medium

2.4.2 How to Reduce Emissions from Textile Manufacturing

There are several actions that can be taken to reduce emissions from textile manufacturing. Some actions are under the control of a given company, whereas others are actions that need to occur across the broader economy. Table 2 summarizes the main mitigation actions required for the textile manufacturing subsector to reach net-zero emissions.

Table 2. Main emissions mitigation actions in the Textile Manufacturing Subsector

Category	Actions Companies Could Take	Actions Across the Broader Economy
Thermal Manufacturing Processes	• Electrify process heat through electric technologies like boilers and heat pumps. • Optimize processes and heat recovery.	• Development and commercialization of high-temperature industrial electric heating (e.g. industrial heat pumps, thermal energy storage). • Decarbonization of provincial electricity grids. • Policies or incentives for retooling industrial plants and supporting pilot demonstrations.
Facility Heating & Cooling	• Replace fossil fuel space and water heating equipment with low-emission alternatives, such as electric heat pumps. • Reduce building energy demand through energy efficiency measures (e.g. insulation and building controls)	• Widespread deployment of electric heat pumps, including industrial-grade and cold-climate models. • Phasing out of fossil-fuel based HVAC equipment. • Modernization of building codes and retrofit incentives to support electrification and envelope upgrades.

Category	Actions Companies Could Take	Actions Across the Broader Economy
Electric Machinery and Equipment (Non-HVAC)	• Upgrade motors, compressors, lighting. • Use smart controls or energy management systems (EMS). • Monitor usage to identify savings.	• Grid decarbonization and expansion of clean power generation. • Investment in local grid capacity to support load increases from electrification. • Continued innovation in energy-efficient industrial equipment.
Transport & Shipping	• Electrification of appropriate vehicles. • Route / load optimization. • Prefer low-carbon freight modes. • Switch to low-emissions packaging.	• Availability and affordability of zero-emission freight vehicles (medium/heavy-duty zero-emission vehicles). • Expansion of zero-emission vehicle (ZEV) charging and refueling infrastructure (e.g. hydrogen) for commercial fleets. • Improvements in rail and intermodal freight services.
Employee Travel & Commuting	• Switch from internal combustion engines (ICE) to zero emission vehicles (ZEV) for road transport. • Install electric vehicle (EV) chargers on-site • Adopt active transport (biking, walking, etc.) for commuting. • Choose rail travel instead of air travel for short journeys. • Avoid travel where possible and encourage remote work when possible	• Build-out urban mass transit systems and either electrify or shift to low-carbon fuels. • Expand charging infrastructure for electric vehicles and increase availability of ZEVs. • Expand and upgrade passenger rail travel networks, and switch to electric or hydrogen fuel-cell powered locomotives. • Replace jet fuel with sustainable aviation fuel (SAF), hydrogen, synthetic fuels or electric propulsion.
Fiber Lifecycle	• Use recycled or bio-based fibers • Work with suppliers on material transparency and circularity • Implement eco-design at the conception stage to reduce product impact early • Improve quality control systems to reduce defect-induced overproduction	• Expansion of recycled fiber supply chains (e.g. rPET, mechanically or chemically recycled textiles). • Development of bio-based and low-carbon textiles. • Greater access to supplier GHG reporting and emissions data.

The emissions mitigation actions outlined in Table 2 address quantifiable emissions sources in the textile manufacturing subsector, adhering to globally recognized accounting standards such as the GHG Protocol and ISO 14064. Textile manufacturing firms can also contribute through:

- **Knowledge Sharing –** ensuring staff receive ongoing training about climate change mitigation specific to textile manufacturing processes, enabling them to serve as industry thought leaders and publicly share insights and successes in sustainable textile production.
- **Branding –** A textile manufacturer can market itself as a leader in sustainable production, emphasizing their adoption of low-carbon processes and eco-friendly materials as part of their brand identity. This can help normalize sustainable practices across the textile industry and motivate peers and consumers to support climate-conscious manufacturing.

2.5 Measuring GHG Emissions

Accurately determining a company or organization's emissions profile is critical to identify where to direct mitigation actions. There are several widely accepted international resources that can be used to calculate a company's GHG emissions. Two widely used resources are explained below, the international GHG Protocol and the International Organization for Standardization (ISO) 14064 standards.

2.5.1 International GHG Accounting Protocol

The GHG Protocol is the most widely used framework for GHG accounting and identifies, explains, and provides options for GHG emissions inventory best practices. It is used widely across many voluntary GHG initiatives including the Government of Canada's Net-Zero Challenge and the Science Based Targets initiative.

The GHG Protocol adopts standard accounting categories companies can use to effectively communicate their emissions data with stakeholders, investors, and regulatory bodies. The GHG Protocol's categorization provides a holistic view of a company or organization's entire value chain, offering deeper insights into emission sources and potential areas for cost and carbon reductions. These emissions categories will also be referred to throughout this primer, and are as follows:

- **Scope 1 emissions**: Direct emissions from owned or controlled sources, such as company-owned facilities and vehicles.
- **Scope 2 emissions:** Indirect emissions from purchased electricity, steam, heating, and cooling.
- **Scope 3 emissions:** All other indirect emissions that occur throughout the supply chain, from raw material extraction to transportation, product use, distribution and disposal.

Scope 3 emissions

In the GHG Protocol there are fifteen categories for Scope 3 emissions:

Category 1: Purchased goods and services

Category 2: Capital goods

Category 3: Fuel- and energy-related activities

Category 4: Upstream transportation and distribution

Category 5: Waste generated in operations

Category 6: Business travel

Category 7: Employee commuting

Category 8: Upstream leased assets

Category 9: Downstream transportation and distribution

Category 10: Processing of sold products

Category 11: Use of sold products

Category 12: End-of-life treatment of sold products

Category 13: Downstream leased assets

Category 14: Franchises

Category 15: Investments

2.5.2 International Organization for Standardization

The International Organization for Standardization 14064 standards can be used to quantify, monitor, report, and verify GHG emissions. Relevant standards include:

- ISO 14064-1 (GHG emissions and removals for organizations – corporate level), and
- ISO 14064-3 (validation and verification of GHG statements).

The ISO 14064 series is complementary to the GHG Protocol and companies could benefit from using both sets of guidance. Specifically, if a company wishes to have their GHG emissions inventory verified by an accredited third-party, it is recommended that they use the ISO 14064-1 standard to ensure that their GHG emissions inventory is developed in a way that can be easily verified and compared to the inventories of other organizations.

SECTION 3 Net-Zero Strategy and Planning for Textile Manufacturing Firms

The purpose of this section is to help textile manufacturing firms make a strategy and a plan to reach net-zero emissions by 2050 or earlier and position their company competitively in a net-zero world. This section is for companies who understand the background and context provided in SECTION 2 and are ready to take action.

Note that this primer is based on the typical activities of a firm in the textile manufacturing sector. While it provides a guide to simplify the process of net-zero planning, your company or organization must apply it to your own specific circumstances to develop a path forward.

3.1 Corporate Strategy in a Net-Zero World

Before creating a detailed net-zero plan, your company should create a corporate strategy that determines broadly how your company wants to position itself in a net-zero emissions world. Your company should research and evaluate both the external competitive landscape and the company's internal strengths and weaknesses, to determine the best path forward for the company.

Some of the questions you could ask are:

- What could the textiles manufacturing subsector look like in Canada in 2050, and how will our company fit into this future?
- What aspects of our business may be the most exposed to change and risk —and where could we find strategic advantages in the transition to net zero?
- What key risks should we mitigate to ensure our company's success as we eliminate our emissions over the coming years?
- Are there any new business opportunities that our company could pursue in the transition to net-zero?
- Does our company have any weaknesses that expose it to risk due to the effects of climate change and a changing economy?

3.1.1 Net-Zero Business Model

Next, you should reflect on if your company should make any changes to its business model.

For many firms in the textile manufacturing subsector, achieving net-zero emissions may not radically alter day-to-day operations since core manufacturing activities will remain central. However, the materials used, the energy sources powering equipment, and the expectations of customers and supply chain partners are all evolving. This shift offers a chance not just to decarbonize, but to strategically reposition the company for long-term success. Firms that embrace recycled or bio-based fibers, invest in clean process technologies, and improve supply chain transparency will be better placed to thrive in a low-carbon economy.

3.1.2 The Competitive Advantage of Net-Zero

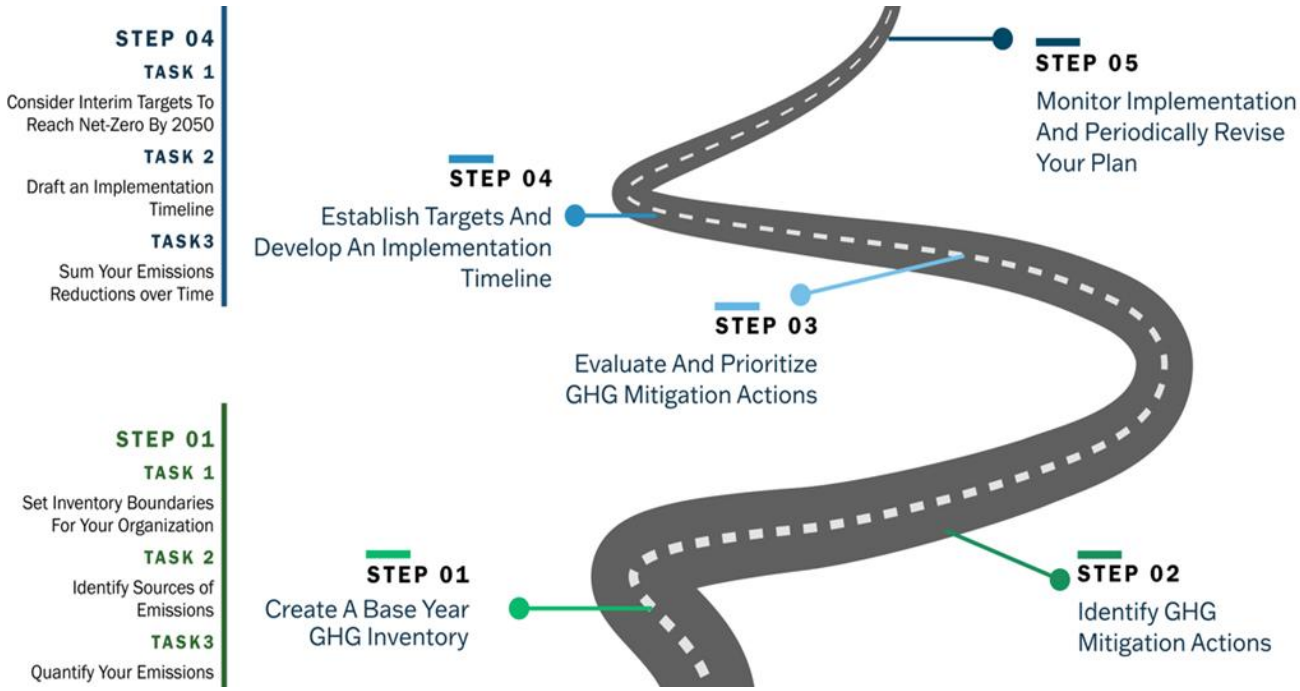
Indeed, moving to net-zero isn't just about managing compliance or reputational risk; it also presents real opportunities for growth and differentiation. In Canada, growing industries like green construction, clean transportation, and bio-based product development are likely to increase demand for sustainable, high-performance textiles. Firms can explore supplying specialized low-carbon textiles for use in building materials, insulation, uniforms, or electric vehicle interiors. At the same time, domestic and international buyers are looking for suppliers who can help them meet their own climate targets.

Canadian manufacturers who demonstrate leadership through emissions reduction and material innovation will have a competitive edge in securing long-term contracts and brand partnerships. This is also an opportunity to rethink how your company positions itself in the market: branding your business as an eco-friendly textile provider—with third-party certifications, clear climate targets, and transparent sourcing—can attract environmentally conscious buyers and serve as a powerful signal of credibility, innovation, and forward-thinking leadership.

3.2 Net-Zero Planning for Textile Manufacturing Firms

Once you have an understanding of what the net-zero transition could look like globally and for your sector, and you have considered your company's strategy in a net-zero world, you are ready to create a net-zero plan that will outline the tangible actions you can take.

This section goes over the steps your company will need to complete to create a credible and achievable net-zero plan. The steps you will need to take are:



Details on how to complete each of these steps are in the sections below.

For some textile manufacturing companies, doing a simple net-zero plan in-house is possible. However, some companies may have more complex situations or lack the internal resources to create a credible net-zero plan. In these cases, companies may wish to seek out external expertise in clean technology, the energy transition, energy and climate policy, and finance.

3.2.1 Step 1 - Create a Base Year GHG Inventory

The first step in creating a net-zero plan is creating an inventory of your GHG emissions for a one-year period, which will be your base year. To create the base year inventory, you will need to set inventory boundaries for your organization, identify your sources of emissions, and quantify your emissions over 12 consecutive months.

Set inventory boundaries for your organization

Setting the inventory boundary allows you to determine what sources of emissions are the result of your activities and accordingly, what emissions will need to be addressed in order to reach net-zero emissions.

Generally, inventory boundaries can be set through three criteria: equity share, financial and operational boundaries. Please refer to ECCC's Net-Zero Challenge Technical Guide 2.0 and the GHG Protocol Corporate Standard for details on how to set inventory boundaries for your organization.

Identify sources of emissions

Table 3 shows common sources of emissions for textile manufacturing firms. Identify which of these sources apply to your organization.

Table 3. Common sources of emissions for textile manufacturing firms

Category	Common Sources of Emissions
Thermal Manufacturing Processes	• Steam boilers for thermal processes like heat-setting, dyeing, scouring, bonding, and finishing. • Gas-fired dryers and stenter frames. • Heated process water and chemical baths.
Facility Heating & Cooling	• Space heating (furnaces, boilers, baseboard heating etc.). • Air conditioning and mechanical ventilation. • Refrigerants released from AC units and heat pumps.
Electric Machinery and Equipment (Non-HVAC)	• Electrical operation of looms, knitting, sewing, and spinning machines.

Category	Common Sources of Emissions
	• Auxiliary systems like compressors, vacuum pumps, and motors. • Lighting, control panels, IT systems, and electronic devices.
Transport & Shipping	• Diesel or natural gas trucks used for transporting raw materials and finished products. • Rail or marine freight for long-distance supply chain movements. • Air freight for urgent or overseas shipments. • Emissions associated with packaging
Employee Travel & Commuting	• Daily commuting by employees in gasoline or diesel vehicles. • Business travel by car or plane for supplier meetings, trade shows, etc.
Fiber Lifecycle	• Emissions from fiber farming (diesel machinery, fertilizer use, irrigation). • Methane emissions from animals used in wool production. • Fossil fuel consumption and emissions from synthetic fiber (e.g., polyester) manufacturing. • Methane emissions from landfilling.

Once you have identified the sources of emissions, you will need to identify which category each emissions source falls into (Scope 1, 2 or 3), as described in the International GHG Accounting Protocol.

While the table above identifies the most common sources of emissions for textile manufacturing firms, the full list of Scope 3 emissions should be reviewed, to determine if there are any other sources that could be relevant to your business.

Quantify your emissions

Once emissions sources have been identified, you must quantify your emissions. This is done by gathering activity data and emission factors that quantify the GHG emissions associated with each type of activity.

Activity data are quantitative measures of activities that result in GHG emissions. Examples of activity data could include:

- Cubic meters of natural gas used to heat a building
- Liters of gasoline used by vehicles
- Kilowatt hours of electricity consumed
- Kilometers travelled by airplane

- Dollar amount of supplies purchased

Emissions factors are calculated ratios, that specify the amount of GHGs that are emitted per unit of activity. Multiplying the activity data by the correct emissions factor will produce an estimate of total emissions associated with this activity.

There are several reputable organizations that provide publicly available emissions factors. Environment and Climate Change Canada provides the following resources to find emissions factors:

- For electricity: National Inventory Report, Part 3, Annex 13
- For other activities: National Inventory Report, Part 2, Annexes 3 and 6

Other helpful resources to create your GHG Inventory include:

- ECCC's Net-Zero Challenge Technical Guide 2.0
- ECCC's Net-Zero Challenge Emissions Calculator[3]
- GHG Protocol Corporate Standard

3.2.2 Step 2 - Identify GHG Mitigation Actions

Once the base year GHG inventory is complete, the second step is to identify possible actions your company could take to mitigate those emissions. Possible mitigation actions for each category of emissions are given in the sections below.

Once you have implemented all feasible mitigation actions and can no longer reduce your emissions, you can consider purchasing Carbon Offset Credits.

Thermal Manufacturing Process

Table 4 presents the top mitigation actions for GHG emissions from thermal manufacturing processes based on available sector information and existing studies [9] [10]. Reaching net-zero in thermal manufacturing processes will depend primarily on electrifying systems that currently rely on fossil fuels. Electrification offers the greatest emissions reduction potential and, over the lifetime of the equipment, may also deliver operational savings [11] [12]. Energy efficiency measures, particularly in already electrified processes, are also essential, helping to maximize emissions cuts and reduce energy costs even further. However, energy efficiency and heat recovery alone cannot achieve net-zero emissions.

[3] Please contact the Net-Zero challenge team at defizeronet-netzerochallenge@ec.gc.ca to receive a copy of the emissions calculator

Table 4. Practical actions to reduce GHG emissions for Thermal Manufacturing Process

Source of Emissions	Possible mitigation actions
Steam boilers for dyeing, scouring, and finishing	• Electrify steam generation using electric steam boilers. • Reduce heat loss through insulation of pipes and tanks, condensate recovery, and heat exchangers for wastewater [13].
Gas-fired dryers and stenter frames	• Transition to electric thermal oil boilers or industrial heat pumps for process heat, particularly beneficial during equipment renewal cycles. • Implement electric infrared (IR), radiofrequency (RF), microwave, or induction heating depending on specific drying or curing needs and process precision requirements. • Reduce drying times and optimize cycles through improved process controls and automation. • Implement heat recovery or preheating of air in dryers by recirculating air in a heat exchanger.
Heated process water and chemical baths	• Use industrial heat pumps to efficiently heat process water by recovering waste heat or utilizing ambient heat. • Integrate thermal energy storage systems such as insulated water tanks or molten salt beds, utilizing off-peak electricity rates and balancing grid loads. • Optimize water use and minimize heating requirements through low-liquor-ratio dyeing equipment and cycle optimization.

Facility Heating & Cooling

Table 5 presents the top mitigation actions for GHG emissions from facility heating and cooling. These possible mitigation actions are presented roughly in order of what will likely be the most impactful and practical, to the least.

Table 5. Practical actions to reduce GHG emissions for Facility Heating & Cooling

Source of Emissions	Possible mitigation actions
Natural gas space heating (furnaces, boilers)	• Replace natural gas heating systems with electric alternatives such as air-source or ground-source heat pumps or connect to low-carbon district energy systems [13]. • For the company's office spaces, engage landlords proactively if renting, discussing plans for electrification and potential for equipment replacement [12].

Source of Emissions	Possible mitigation actions
Water heating for sanitation and processes (boilers, tank systems)	• Switch from gas-fired water heating to electric water heaters or heat pump-based water heating solutions.
Air conditioning and mechanical ventilation	• Transition to heat pumps which efficiently provide both heating and cooling, reducing the need for separate infrastructure. • Upgrade older air conditioning units to higher-efficiency models at the end of equipment life.
Electricity use for HVAC systems and lighting	• Improve insulation, air sealing, and building controls to reduce heating and cooling loads, indirectly reducing HVAC electricity use. • Implement energy-efficient lighting and HVAC systems.
Refrigerants released from AC units and heat pumps	• Ensure proper disposal of old equipment to prevent refrigerant leakage. • Prioritize replacement HVAC equipment using low-GWP refrigerants (such as R-32, CO_2, ammonia) to minimize emissions from leaks. • If renting, engage landlords about refrigerant type and inquire about low-impact refrigerants during HVAC equipment replacement cycles.

Electric Machinery and Equipment (Non-HVAC)

Table 6 presents the top mitigation actions for GHG emissions from non-HVAC electric machinery and equipment.

Table 6. Practical actions to reduce GHG emissions for Electric Machinery and Equipment (Non-HVAC)

Source of Emissions	Possible mitigation actions
Electrical operation of looms, knitting, sewing, and spinning machines	• Upgrade aging machinery motors to high-efficiency models. • Integrate variable speed drives and sensors to run machinery at optimized capacity only when needed. • Retrofit spinning frames or looms with automated controls to cycle down equipment during low production periods.
Auxiliary systems like compressors, vacuum pumps, and motors	• Replace inefficient compressed-air systems with high-efficiency compressors. • Install smart controls such as timers, automated logic, and sensors to run auxiliary systems only as required.

Source of Emissions	Possible mitigation actions
	• Consider an energy management system (EMS) to optimize operation and timing of auxiliary equipment.
Lighting, control panels, IT systems, and electronic devices	• Deploy smart power management systems for IT and electronic equipment to reduce idle energy consumption. • Install automated lighting controls responding to occupancy and daylight sensors.

Transport & Shipping

Table 7 presents the top mitigation actions for GHG emissions from transport and shipping.

Table 7. Practical actions to reduce GHG emissions for Transport and Shipping

Source of Emissions	Possible mitigation actions
Diesel trucks used for transporting raw materials and finished products	• Transition company-owned delivery vans and light-duty trucks to electric models, particularly suited to short- and medium-haul urban routes. • Use hybrid or high fuel-efficiency vehicles when electrification isn't feasible yet. • Optimize routes and shipment loads to reduce unnecessary fuel consumption, minimize empty trips, and consolidate deliveries.
Rail or marine freight for long-distance supply chain movements	• Increase utilization of rail freight for long-distance transport. • Encourage intermodal freight combining trucking and rail to optimize emissions reductions and operational flexibility • Engage third-party logistics (3PL) providers who offer verified low-emission transport options.
Air freight for urgent or overseas shipments	• Minimize reliance on air freight by improving inventory management, forecasting accuracy, and supply chain planning. • Prioritize marine or rail freight, supplemented by trucking, whenever feasible. • When air freight is unavoidable, consolidate shipments to reduce frequency and maximize payload efficiency.
Emissions from Packaging	• Minimize the amount of packaging per product. • Choose packaging with low raw and high recycled material content.

Source of Emissions	Possible mitigation actions
	• Optimize shipment planning so that packages, pallets, trucks, and shipping containers are fully loaded.

Employee Travel and Commuting

Table 8 presents the top mitigation actions for GHG emissions from employee travel and commuting.

Table 8. Practical actions to reduce GHG emissions for Employee Travel and Commuting

Source of Emissions	Possible mitigation actions
Daily commuting by employees in gasoline or diesel vehicles	• Promote commuting via public transit where available, including subsidizing transit passes or offering incentives. • Encourage active transport methods such as biking and walking, supported by on-site facilities. • Facilitate and incentivize the adoption of electric vehicles (EVs), including installation of charging stations and/or providing financial assistance for EV purchases. • Enable remote or hybrid work arrangements where feasible, significantly reducing commuting emissions.
Business travel by car or plane for supplier meetings, trade shows, etc.	• Eliminate unnecessary travel by optimizing virtual meeting use and consolidating trips when travel is essential. • Prioritize rail or other low-emission transport modes over air travel for short to medium-distance trips. • Prioritize direct flights when air travel is unavoidable. • Establish clear corporate travel policies specifying electric vehicles for car rentals unless a conventional vehicle is explicitly necessary.

Fiber Lifecycle

Table 9 presents the top mitigation actions for fiber lifecycle GHG emissions.

Table 9. Practical actions to reduce GHG emissions for Fiber Lifecycle

Source of Emissions	Possible mitigation actions
Emissions from cotton farming (diesel machinery, fertilizer use, irrigation)	• Shift toward mechanically recycled cotton fibers, significantly reducing impacts from cotton cultivation (e.g., water use, diesel machinery, fertilizer use). • Choose from suppliers providing certified sustainable or organic cotton, lowering the emissions and chemical inputs from conventional cotton farming.
Methane emissions from animals used in wool production	• Substitute wool with recycled or alternative renewable fibers (e.g., plant-based cellulose fibers), reducing methane emissions from livestock.
Fossil fuel consumption and emissions from synthetic fiber (e.g., polyester) manufacturing	• Replace virgin polyester with recycled polyester (rPET) fibers [14]. • Transition to bio-based fibers such as polylactic acid (PLA) or bio-polyesters [15]. • Promote and require supplier transparency and third-party certifications (Global Recycled Standard, OEKO-TEX) to verify low-carbon synthetic fiber sourcing.

Carbon Offset Credits

Purchasing carbon offset credits is a mitigation action that can be taken when no other option is feasible.

Carbon offset credits represent GHG emissions reductions or removals generated from activities that are additional to what would have occurred in the absence of the offset project (i.e., generated from activities that go beyond legal requirements and a business-as-usual standard). Each offset credit generated by an offset project represents one tonne of CO_2e reduced or removed from the atmosphere.

Today, most offsets are emissions reductions. But as the economy approaches net-zero, emission reduction offset opportunities will decline, as emissions fall across all sectors of the economy. Companies that do rely on offsets should therefore over time increase the proportion of offsets that come from carbon removals.

3.2.3 Step 3 – Evaluate and Prioritize GHG Mitigation Actions

Now that several possible mitigation actions have been identified, companies will need to evaluate and prioritize them. Each company will have a different evaluation framework depending on various factors including their level of ambition, financial position, resourcing and management support.

Table 10 shows common factors that companies should consider when evaluating and prioritizing emissions mitigation actions. Companies should also consider supporting Canadian businesses when selecting mitigation strategies.

Table 10. Factors you should consider when selecting which mitigation actions to prioritize

	Possible Pros	Possible Cons
Emissions Impact	• The mitigation action will have a significant impact on reducing the firm's emissions	• The mitigation action will have a small impact on the firm's emissions
Technology Maturity	• The mitigation action has been successfully used in real life conditions • The mitigation action is a non-technical solution (e.g. walking to work)	• The mitigation action has not yet been commercially deployed.
Capital Cost	• The capital cost is similar to or lower than the high-emitting option • There are funding, grants or incentives available to help reduce the capital cost	• The capital cost is much higher than the existing option • There are limited funding options available
Operation and Maintenance (O&M) Costs	• The O&M costs are lower than the existing option (e.g. high efficiency equipment will have lower energy costs) • Government policy can lower the ongoing O&M cost (e.g. a price on carbon can make electrification more cost effective)	• The O&M costs are higher than the existing option (e.g. switching to electricity may be more expensive than natural gas)
Availability	• The mitigation action is readily available • Enabling infrastructure is available (e.g. charging stations for EVs)	• There are supply chain constraints, making the solution less readily available • The enabling infrastructure is not yet in place
Timing	• The timing of implementing the mitigation action is logical (e.g. equipment is reaching the end of its lifetime and will need to be replaced anyways)	• The timing of implementing the mitigation action is not ideal (e.g. equipment was recently replaced, and it would not make sense to replace it again in the short term)
Lifestyle Considerations	• Mitigation action increases quality of life, is more convenient (e.g. no more pumping gas when you own an EV)	• Mitigation action decreases quality of life, is more

Possible Pros		Possible Cons
		inconvenient (e.g. a longer commute).

Completing this analysis of the mitigation actions, along with understanding your company's available resources and strategic priorities, can help identify the top mitigation actions that your company would like to pursue. You will complete this exercise based on the situation today but note that all of these factors are constantly changing, and this exercise will need to be repeated regularly as the landscape changes.

3.2.4 Step 4 - Establish Targets and Develop an Implementation Timeline

Now that you have identified your main emissions sources and potential actions to decarbonize your activities it is time to bring it all together, to assess what is possible within specific time horizons, and to formulate or adjust targets.

Task 1: Consider Interim Targets to Reach Net-Zero by 2050

Targets provide crucial grounding for decarbonization efforts. They communicate a company's ambition, allow the organization to coordinate its response, and provide a benchmark against which progress can be measured. Many voluntary initiatives, including the Government of Canada's Net-Zero Challenge, require member companies to plan their path towards net-zero emissions by 2050 or earlier. This aligns with Canada's legislative commitments to net-zero and the recommendation of the Science Based Targets initiative.

Interim targets are important to focus attention on what can practically be done in the short term and to ensure progress. Some companies have adopted shorter term targets based on an aspiration to be a leader in their sector and/or to harmonize with Canada's national goal of a 40-45% emissions reduction by 2030. Nevertheless, interim targets are more likely to be achieved when they align with your strategic objectives and are grounded in a solid analysis of the costs, timing, and effectiveness of proposed mitigation measures.

Task 2: Draft an Implementation Timeline

The mitigation actions should be placed on a timeline to establish and/or confirm interim targets and to form the basis for a phased decarbonization plan.

In Step 3 – Evaluate and Prioritize GHG Mitigation Actionsyou evaluated several possible emissions mitigation actions, and this evaluation can help you determine a realistic implementation timeline.

Factors that influence the implementation timeline will include:

- Availability of equipment and enabling infrastructure (e.g. low carbon grid, EV charging infrastructure)

- Technology life cycle (e.g. end of life of HVAC equipment, average vehicle lifetime).
- Upfront cost and financing options

Task 3: Sum Your Emissions Reductions Over Time

Each of the actions you have decided to take can be included in your plan together with the anticipated reductions over time. Summing up the proposed reductions at key interim dates (2030, 2035, etc.) can then allow you to validate (or establish) appropriate interim targets.

It is important to remember that net-zero emissions can only be achieved if other organizations up and down your value chain are also decarbonizing their activities at the same time. Therefore, in consideration of this, the pathway to full decarbonization may be unclear. However, over time, as manufacturing, transport, and energy production are increasingly decarbonized, the carbon intensity of the goods and services needed by your business will in turn decrease and net-zero will become more achievable.

3.2.5 Step 5 - Monitor Implementation and Periodically Revise Your Plan

Full decarbonization of the economy will take time. It is hard to anticipate developments five years from now, let alone in thirty years. Net-zero planning will necessarily be an iterative process, with plans adjusted periodically to reflect changing circumstances.

Net-zero plans will also need to be periodically revised and updated as your company and the whole economy move towards net-zero emissions. Technological, economic, social and geo-political circumstances will evolve, shifting the environment within which your company operates, and presenting new challenges and opportunities.

You should establish a regular process for monitoring the implementation of your plan, such as:

- **At least once a year:** Formally review progress, assessing whether the assumptions on which the plan was based have shifted, whether the proposed actions have been taken, and the extent to which they are attaining the desired objectives.
- **Every five years:** A new plan can be developed that draws on the lessons learned and charts the rest of the journey towards net-zero.

SECTION 4 Conclusion

Reaching net-zero emissions is a long-term journey, but every business has a role to play—and every step matters. Whether your company or organization is just starting to think about climate action or already exploring or implementing emission reductions measures, the most important thing is to begin with what you can control and to put a plan in place.

This primer has laid out how to:

- Reflect on how your firm fits into a net-zero economy,
- Understand where your emissions come from,
- Identify practical actions across your operations and value chain,
- Set targets and goals,
- And adapt your plan as the world changes.

Remember: this isn't about perfection. Your first plan doesn't need to solve everything all at once. Focus on taking meaningful action in the next 1–3 years. Talk to your employees, clients, and suppliers. Learn as you go. Use this plan to guide decision-making, communicate your direction, and build momentum.

As markets, technologies, and other factors evolve, so will your opportunities to reduce emissions. Revisit your plan regularly and update it as new solutions become available. As you reduce your own footprint, look for ways to amplify your impact.

Net-zero is a collective effort. Textile manufacturing firms like yours are critical to shaping the path forward—for your clients, your sector, and your community. Start where you are, aim high, and keep going.

If you are ready to take the next step, learn more about how to join the Government of Canada's Net-Zero Challenge.

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Glossary

Base Year: A year in history against which a company's emissions are tracked over time to compare it with future emissions. It must be a consecutive twelve months, either as a full calendar year or consecutive over two calendar years.

Carbon dioxide equivalent (CO_2 eq): A unit of measure for comparison between greenhouse gases (GHGs) that have different global warming potentials (GWPs). This unit of measure allows other GHGs to be expressed in terms of the GWP of one unit of CO_2. To express GHG emissions in units of CO_2 eq, the quantity of a given GHG is multiplied by its GWP.

Decarbonization: The process of reducing carbon dioxide emissions from a product, process, facility, or sector.

Direct emissions: Emissions from sources that are owned or controlled by a company or organization (GHG Protocol 2004: 97).

Downstream emissions: Emissions from downstream activities associated with the operations of a company, including processing of sold products, use of sold products, investments, franchises, downstream transportation and distribution, end-of-life treatment of sold products, and downstream leased assets.

Emission factor: A value that quantifies an average amount of emissions associated with an activity. For more details on Canada-specific emission factors, see the latest National Inventory Report for Canada.

Emissions: The release of greenhouse gases (or other substances) into the atmosphere.

Emissions inventory: A quantified list of emissions and emission sources for a company, organization, municipality, region, province/territory, or country.

Energy Efficiency: A measure of how effectively energy is used for a given purpose. It is a ratio or other quantitative relationship between an output of performance, service, goods, commodities, or energy, and an input of energy.

Global Warming Potential (GWP): Allows the comparison of the global warming impacts of different gases or particles (such as black carbon). It is a measure of how much energy the emissions of 1 tonne of a gas or particle will absorb over a given period of time, compared to the emissions of 1 tonne of carbon dioxide. For the purposes of net-zero planning, use of 100-year GWP is recommended.

Greenhouse gas (GHG): A gas that absorbs and re-emits radiation, resulting in the greenhouse effect, which contributes to a warming climate. For the purposes of this guidance and for the Net-Zero Challenge, GHGs include all of those that are subject to reporting for the Greenhouse Gas Reporting Program. This includes carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O),

sulphur hexafluoride (SF6), 13 different hydrofluorocarbons (HFCs), and 7 different perfluorocarbons (PFCs).

Indirect emissions: Emissions that are a consequence of the activities of a company but occur at sources owned or controlled by another company (GHG Protocol 2004: 99).

Inventory boundary: Allows a participant to determine what sources of emissions are the result of their activities and accordingly, what emissions will need to be addressed in order to reach net-zero emissions by 2050. Generally, the inventory boundary includes geographical boundaries and organizational boundaries.

Mitigation strategy: A practice, process, or technology that contributes to mitigation, e.g., enhancing energy efficiency and adopting renewable energy sources.

Net-Zero Challenge: A voluntary Government of Canada program that encourages businesses to develop and implement credible and effective plans to transition their facilities and operations to net-zero emissions by 2050.

Net-zero emissions: Achieving net-zero emissions means that anthropogenic emissions of greenhouse gases into the atmosphere are balanced by anthropogenic removals of greenhouse gases from the atmosphere over a specified period; for organizations, net zero GHG emissions is commonly considered as the condition in which emissions have been reduced such that only residual emissions remain, and offsetting is restricted to removal credits only (ISO 14068).

Net-zero plan: A net-zero plan includes an emissions inventory and base year, interim targets, descriptions of the considered scenarios, pathways and mitigation strategies, and an outline of how net-zero planning will be incorporated into a company's governance and disclosures.

Offset credits: Represent GHG emissions reductions or removals generated from activities that are additional to what would have occurred in the absence of the offset project (i.e., generated from activities that go beyond legal requirements and a business-as-usual standard). Each offset credit generated by an offset project represents one tonne of carbon dioxide equivalent (CO2 eq) reduced or removed from the atmosphere.

Organizational boundaries: The boundaries that determine the operations owned or controlled by a company, depending on the consolidation approach taken (equity share, operational control, or financial control).

Scope: Defines the operational boundaries in relation to direct and indirect emissions (GHG Protocol 2004: 101).

Scope 1 emissions: A company's direct emissions, principally the generation of electricity, heat, or steam, physical or chemical processing, transportation, and fugitive emissions (GHG Protocol 2004: 101).

Scope 2 emissions: A company's indirect emissions associated with the purchase of electricity, heating/cooling, and steam for own consumption (GHG Protocol 2004: 101).

Scope 3 emissions: A company's indirect emissions excluding those covered in scope 2. Also known as value chain emissions (GHG Protocol 2004: 101).

Upstream emissions: Emissions from upstream activities associated with the operations of a company, including purchased goods and services, capital goods, fuel- and energy-related activities, upstream transportation and distribution, waste generated in operations, business travel, and employee commuting.

Value chain: All business processes or activities involved in the production of a good or service for market, from conception to end use and beyond. A simplified value chain would include corporate services (e.g., marketing, logistics), research and development, inputs, assembly, distribution, sales, and after-sales service.

Value chain emissions: These are indirect emissions that may exist upstream or downstream of a company's operations. Value chain emissions are also known as scope 3 emissions.

ANNEX 1 North American Industry Classification System

Based on the North American Industry Classification System (NAICS), such businesses in the textile manufacturing sector include:

Subsector	Industry Group	Industry
313 – Textile Mills	3131 – Fibre, yarn, and thread mills	31311 – Fibre, yarn and thread mills
	3132 – Fabric mills	31321 – Broad-woven fabric mills
		31322 – Narrow fabric mills and schiffli machine embroidery
		31323 – Nonwoven fabric mills
		31324 – Knit fabric mills
	3133 – Textile and fabric finishing and fabric coating	31331 – Textile and fabric finishing
		31332 – Fabric coating
314 – Textile Product Mills	3141 – Textile furnishing mills	31411 – Carpet and rug mills
		31412 – Curtain and linen mills
	3149 – Other textile product mills	31491 – Textile bag and canvas mills
		31499 – All other textile product mills
315 - Apparel manufacturing	3151 - Apparel knitting mills	31512 - Apparel knitting mills
	3152 - Cut and sew clothing manufacturing	31521 - Cut and sew clothing contracting

Subsector	Industry Group	Industry
		31525 - Cut and sew apparel manufacturing (except contractors)
316 - Leather and allied product manufacturing	3161 - Leather and hide tanning and finishing	31611 - Leather and hide tanning and finishing
	3162 - Footwear manufacturing	31621 - Footwear manufacturing
	3169 - Other leather and allied product manufacturing	31699 - Other leather and allied product manufacturing

ANNEX 2 Thermal Manufacturing Process Electric Alternatives

The following table provides a high-level overview of electrified alternatives for thermal manufacturing processes in the textiles manufacturing sector. It is intended to offer directional guidance only.

The suitability and performance of each technology will vary depending on specific operational contexts, equipment configurations, and facility needs. Companies are encouraged to assess the relevance and feasibility of each option based on their own technical, financial, and process requirements before making investment decisions.

Table 6. Summary of Electrified Thermal Heating Technologies for Textile Manufacturing Processes

Technology	Description	Best Suited For	Considerations
Electric Steam Boilers	Use electricity (resistance or electrode) to produce steam for process heating.	Any process currently using steam boilers, including: • Dyeing • Scouring • Finishing	High efficiency; clean and reliable; simple retrofit in steam-based systems.
Electric Thermal Oil Boilers	Electrified systems that heat thermal oils used in high-temperature applications (e.g. heat-setting).	Processes requiring stable high temperatures, including • Heat-setting • Bonding • Coating	Avoids pressure issues with steam; enables high-temperature heating (up to 400°C).
Industrial Heat Pumps	Use refrigerant cycles to extract heat from waste streams or ambient sources and raise its temperature.	Low- to mid-temperature processes, such as: • Pre-heating • Washing • Dyeing • Drying	Highly efficient and can reduce significantly energy costs.
Induction Heating	Uses electromagnetic fields to heat conductive materials directly and precisely.	Bonding layers, activating adhesives, mold heating.	Excellent for localized heating; high precision; best for small-area or high-speed tasks.

Technology	Description	Best Suited For	Considerations
Radio-Frequency (RF) Heating	Uses alternating electric fields to generate uniform internal heating in dielectric materials.	Drying nonwovens, thick fabrics, adhesives.	Effective for low-conductivity materials; equipment is specialized; mid-range capital cost.
Electric Infrared (IR) heating	Converts electricity into radiant heat for surface-level heating.	Fabric drying, surface finishing, curing coatings.	Low maintenance; fast response; can be retrofit or modular; relatively low cost.
Ultraviolet Heating (UV Curing)	Uses UV light to instantly cure adhesives, inks, and coatings.	Coating and adhesive curing on technical textiles.	Requires UV-reactive materials; no thermal energy needed.
Microwave Heating	Uses dielectric heating to volumetrically heat materials from within.	Drying bulky or thick, moisture-retaining fabrics.	Very uniform drying; good for thermal-sensitive products; higher capital cost, but faster throughput.
Thermal Energy Storage	Stores excess/off-peak electric heat (e.g., in water tanks or salt beds) for later use.	Complementary to any electric thermal system; managing peak loads.	Useful for grid load management; complements boilers/heat pumps; moderate cost; depends on grid pricing.