Portland clean industry study

TOWARDS CLEAN, DECARBONIZED, CIRCULAR AND INCLUSIVE PRACTICES

Colophon

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Executive summary

In 2021, the concept of a "Clean Industry Hub" was suggested as a way to address industrial and institutional emissions while improving profitability, inclusive prosperity, and environmental co-benefits. Under the leadership of Commissioner Carmen Rubio, the Bureau of Planning and Sustainability secured funds to explore the hub concept – whether that be a physical space, virtual space, or combination. The project included two components: an Assessment process to consider current conditions, global hub models, and policy and finance tools, and a Roadmap process to identify priority strategies moving forward. The Assessment and Roadmap were guided by an Advisory Group of 28 leaders representing private, public, nonprofit, and academic sectors. This document shares the Assessment and Roadmap findings.

The vision guiding Portland's clean industry work is as follows:

• Industry thrives while contributing to climate goals, environmental quality, and inclusive prosperity.
• Our results solidify Portland's reputation as an inclusive clean economy leader and bring additional innovation and investment that benefits our community.
• Our inclusive clean economy success is the result of productive collaboration among diverse sectors - which becomes the new normal in Portland.

This project utilized quantitative and qualitative research to address five key topics:

• Current conditions regarding industrial businesses in Portland, including the composition of this sector and impacts to air pollution, carbon, and waste.
• Businesses' current attitudes and practices regarding clean, decarbonized, circular, and inclusive practices.
• Clean industry[1] hub lessons from around the globe that may be applicable to Portland.
• Policy and finance tools that support the clean industry transition.
• Strategies to support the clean industry transition in Portland and collaboration structures to move forward.

Our assessment of current industry conditions and impacts focused on the following six industries:

	Food & Beverages manufacturing
	Metals & Machinery manufacturing
	Electronic manufacturing
	Miscellaneous manufacturing
	Hospitals & universities
	Waste management

[1] Throughout this report the term "Clean Industry" is used to refer to clean, circular, decarbonized, and inclusive practices.

For each of these sectors, we conducted an impact analysis to consider inputs (energy, water, materials) and outputs (carbon emissions, air pollution, waste). High-level insights derived from this impact analysis are as follows:

Food and beverage manufacturing: This sector is high in waste, carbon emissions and air pollutants, and is ideal for an integrated approach.

Metals and machinery manufacturing: This sector generates high CO_2 and waste heat that could be productive in other sectors.

Electronic manufacturing: Water use is a significant impact in this sector.

Miscellaneous manufacturing: Focus on textile outputs, which represent one of the highest-impact waste streams.

Hospitals and universities: The high volumes of waste in this sector could be recycled/reused in same or other place-based facilities.

Waste management: There are opportunities to reduce or repurpose waste for all industries in the study set.

Key themes that emerged from the survey, listening sessions, and literature review inform our understanding of clean industry challenges and opportunities:

Industry is important to Portland's economy, making valuable contributions to tax revenue and well-paying jobs. At the same time, Portland industry faces a number of challenges, such as access to land and high costs of doing business. Many manufacturing businesses are struggling to recruit and retain workers, however, a number of initiatives are underway to address this talent gap. Portland is home to a number of clean industry leaders, yet, these practices are not the norm, nor necessarily easy to adopt. Barriers include information, cost, and technology. The region is home to a robust ecosystem of service providers that help businesses improve efficiency or grow clean industry business opportunities. Nevertheless, often businesses are not aware of these or do not take advantage of them. This ecosystem is difficult to navigate and some gaps remain (e.g., circularity). Significant policy commitments at the federal, state, and local levels support the clean industry transition though additional work is needed, particularly with respect to setting targets and creating a regulatory framework that encourages the adoption of clean industry practices. There is support for the clean industry vision and some engaged leaders, however, the concept and value proposition are not well understood and effective structures for collaboration are needed. Together, these insights tell us that Portland has supportive conditions for the clean industry transition, though with some gaps to address.

Looking at clean industry models around the globe, we found many different approaches applicable to Portland. For example, some address a specific sector (e.g., food, heavy industry) while some focus on a single issue (e.g., decarbonization, circularity). In this report, a total of twelve global examples are considered to derive lessons learned for developing a clean industrial hub in Portland.

Through the policy and finance analysis, a number of tools were identified that can support the clean industry transition. Some of these are internal to the City such as procurement and infrastructure investments. Policy goals specific to clean industry are captured in the Advance Portland economic development strategy, and were adopted in City Council's 90-Day Declaration. Funding the clean industry transition will require a mix of capital sources ranging from federal grants to rebates and green financing mechanisms. Some of these will assist businesses with the implementation of solutions, some will support research and development of new solutions, and some can support the activities of the hub. A particularly timely source of funding is the unprecedented federal investment to accelerate investment in its clean industry transition.

We defined a strategy framework based on the Assessment findings. The framework includes seven distinct but interrelated strategies that support the clean industry transition. The seven strategies are as follows:

Business Support: Businesses have a user-friendly pathway to identify and implement clean industry actions.

Industry and Higher Education Connections: Effective linkages between and among industry and higher education enhance clean industry talent development and research.

Transformative Investments: Opportunities for large scale clean industry investments, such as industrial symbiosis or green hydrogen, have been assessed and adopted.

Supportive Policy and Regulation: Policies and programs facilitate adoption of clean industry practices.

Strong Brand and Engagement: Effective communication and outreach leads to workers, businesses, and others engaging in the clean industry opportunity.

Funding and Finance: Diverse sources of capital enable the clean industry transition - both industry adoption of solutions and the collective impact infrastructure.

Effective Collaboration Structures: Progress toward the shared vision is enabled through strong coordination, communication, and continuous learning.

After completing the assessment, we held a full-day "Roadmap" event to review the findings and discuss potential strategies. This event engaged more than 80 participants representing business, government, higher education, utilities, workforce development, and community and environmental organizations. Participants expressed enthusiasm for the clean industry vision and the seven potential strategies.

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This Clean Industry Assessment and Roadmap process has provided valuable insight regarding Portland's opportunity to transition to clean, decarbonized, circular, and inclusive industry practices. We have improved our understanding of existing industry conditions, considered lessons learned from global clean industry models, identified relevant policy and finance tools, and defined seven strategies to bring the clean industry vision to life.

Many of the ideas identified in our research do not require a Clean Industry Hub to get started. However, without a hub it will likely be a case of the whole being less than the sum of its parts. If designed and executed well, a hub can provide the coordination and scale needed to realize the ambition and full potential of the clean industry vision.

Moving forward, three interrelated items must be attended to in order to create a clean industry hub: focus, resources, and leadership. Regarding focus, while a clean industry vision for Portland has been defined, a critical next step is to define the mission of the clean industry hub (what it does to bring the vision to life). A clear mission, with goals and key performance indicators, is needed to attract funding and partners, strategically invest time and dollars, and track progress. Second, resources are required to implement the strategies. This is related to focus, as one must define what needs to be funded in order to identify the resource streams suitable to those activities. Finally, committed leadership is needed to perform the essential functions needed to create a clean industry hub. These include the functions of network coordination, guidance and oversight, resource gathering, and project development and implementation.

The Assessment and Roadmap Phase has concluded, providing the information and ideas necessary to move forward with creating a clean industry hub in Portland that can help businesses thrive while delivering environmental quality and inclusive prosperity. During the final meeting of the Clean Industry Assessment and Roadmap Advisory Group, participants decided to assemble a nimble core team that will address the issues of focus, resources, and leadership with the urgency needed to seize this timely opportunity.

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01 Introduction
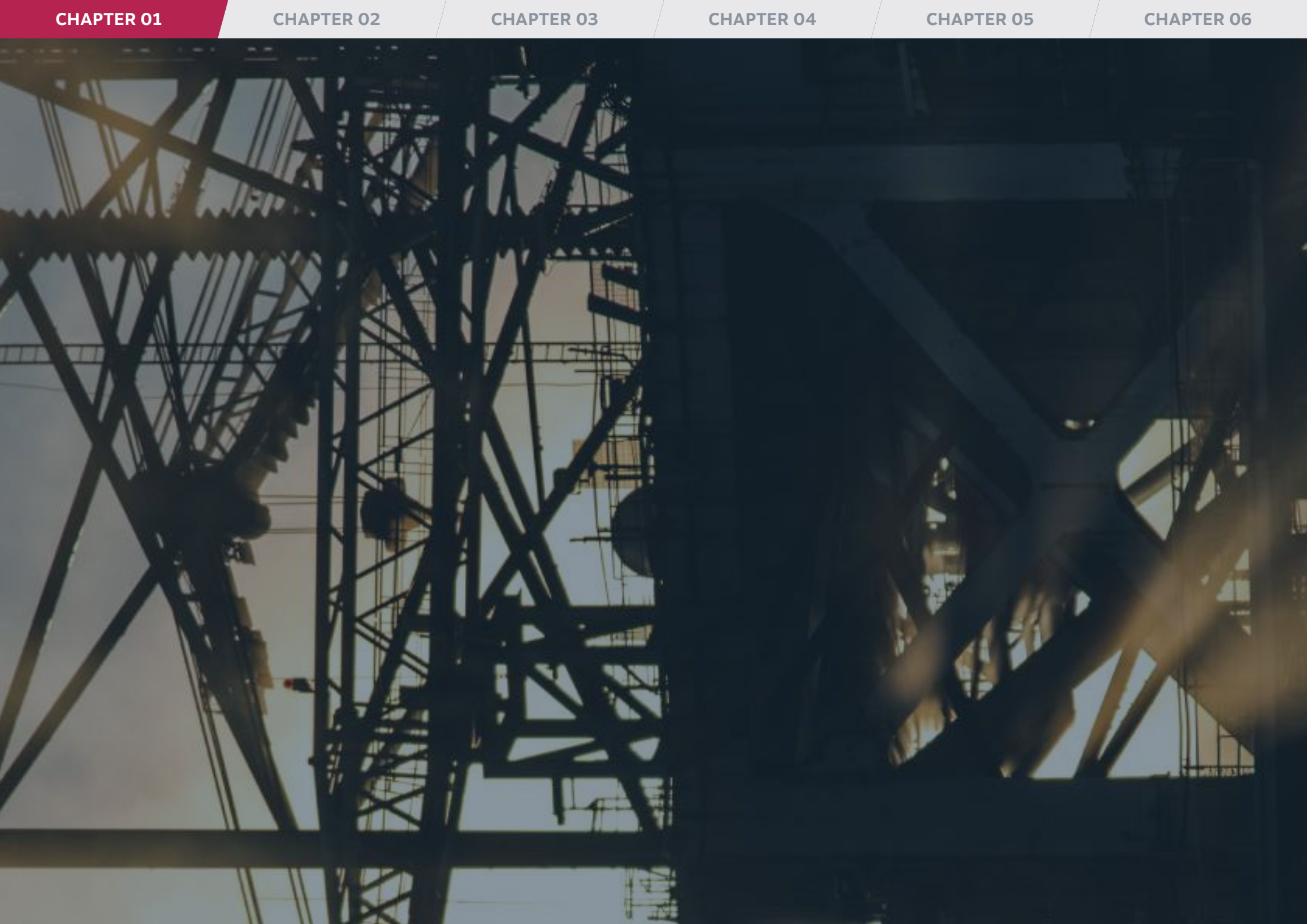
Imagine that Portland's manufacturers and institutions are thriving while at the same time contributing to climate goals, environmental quality, and inclusive prosperity; that Portland's reputation as an inclusive clean economy leader is bringing additional innovation and investment to our community; and that the productive collaboration that shaped our success is establishing a new normal in Portland. This clean industry vision is shared by a group of private, public, nonprofit, and academic leaders in Portland. Over the past six months we have been engaged in a process to understand existing conditions and opportunities related to this vision. With this report we share our findings and recommendations and invite you to join us in bringing the inclusive clean industry vision to life.

ABOUT THE CLEAN INDUSTRY PROJECT

In 2021, a group of local leaders met to discuss how best to reduce greenhouse gas emissions and toxic air pollution from Portland's industrial sector, hospitals, and universities. The concept of a "Clean Industry Hub" presented an innovative opportunity to address climate and other environmental problems while affirming the industrial sector's importance to the local economy. The clean industry project represents a collaborative effort for industrial businesses, local government, and community leaders to co-create solutions together.

THE SUSTAINABILITY IMPERATIVE

Manufacturers, hospitals, and universities are important to Portland. They provide important services, jobs and a tax base. At the same time, their operations contribute to critical environmental problems. These problems can no longer be ignored as business as usual is pushing the planetary boundaries. In order to sustain human life and economies it is necessary to stay (or return) within these boundaries. Additionally, not only do we need an economy that provides a healthy and thriving place to live, we need an economy that provides pathways to opportunity and prosperity for all its residents. The sustainability imperative is recognized

![Metabolic Consulting logo] ![MSH Strategy logo]

in Advance Portland, the City's recently adopted economic development strategy. The clean industry transition is being driven by many factors including changes in market demand, federal and state policy, and investor priorities. Not attending to the sustainability imperative means that Portland's businesses and economy will slip in competitiveness and performance.

- Beyond zone of uncertainty (high risk)
- In zone of uncertainty (increasing risk)
- Below boundary (safe)
- Boundary not yet quantified
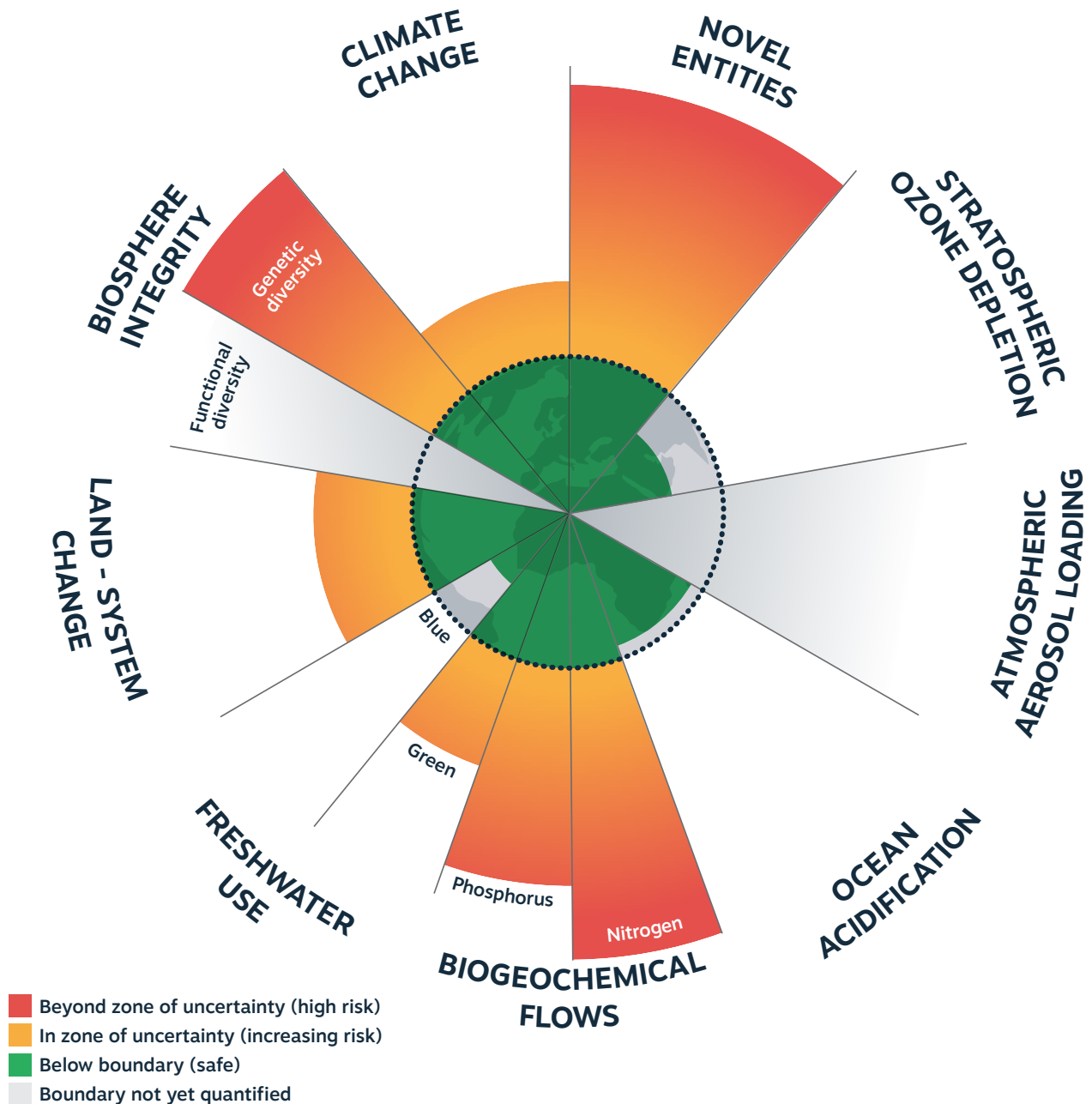
Source: Updated Planetary Boundaries, Stockholm Resilience Centre, based on analysis in Wang-Erlandsson et al., 2022, Persson et al 2022 and Steffen et al 2015.

Fig. 1

The planetary boundaries by the Stockholm Resilience Centre, depicting 9 critical aspects of the Earth's ecosystem and the boundary of the safe operating space for each aspect. Red areas outside the boundaries signify potential risks and exceedances, whereas green areas within the boundaries represent a safe and sustainable state for our planet's ecosystems.

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AN INTEGRAL APPROACH TO SUSTAINABILITY

A new economic model is needed – one that is clean, decarbonized, circular, and inclusive. That means that economic production does not degrade the environment, greenhouse gasses are not emitted, materials remain in productive use, and workers and communities participate in and benefit from the economic system. Let's take a closer look at these terms.

Clean practices

Ensure that business operations do not degrade the natural environment. This includes eliminating toxic pollution and using bio-based products, clean energy, and other strategies that limit negative impacts to water, air, and biodiversity.

Decarbonized practices

Eliminate greenhouse gas emissions that contribute to climate change. This includes Scope 1 emissions (direct emissions from business operations such as natural gas combustion), Scope 2 emissions (indirect emissions resulting from business operations such as using electricity), and Scope 3 emissions (indirect emissions that occur upstream and downstream in the value chain such as mining, manufacturing of materials and employee travel or product waste).

Circular practices

Shift from the linear "take-make-waste" model to design, produce, and manage products in ways that relieve pressure on the Earth's ecological systems and keep resources at their highest quality for the longest time.

Inclusive practices

Ensure equitable outcomes for neighboring communities and workers. Neighboring communities must benefit from the clean industry transition, and workers
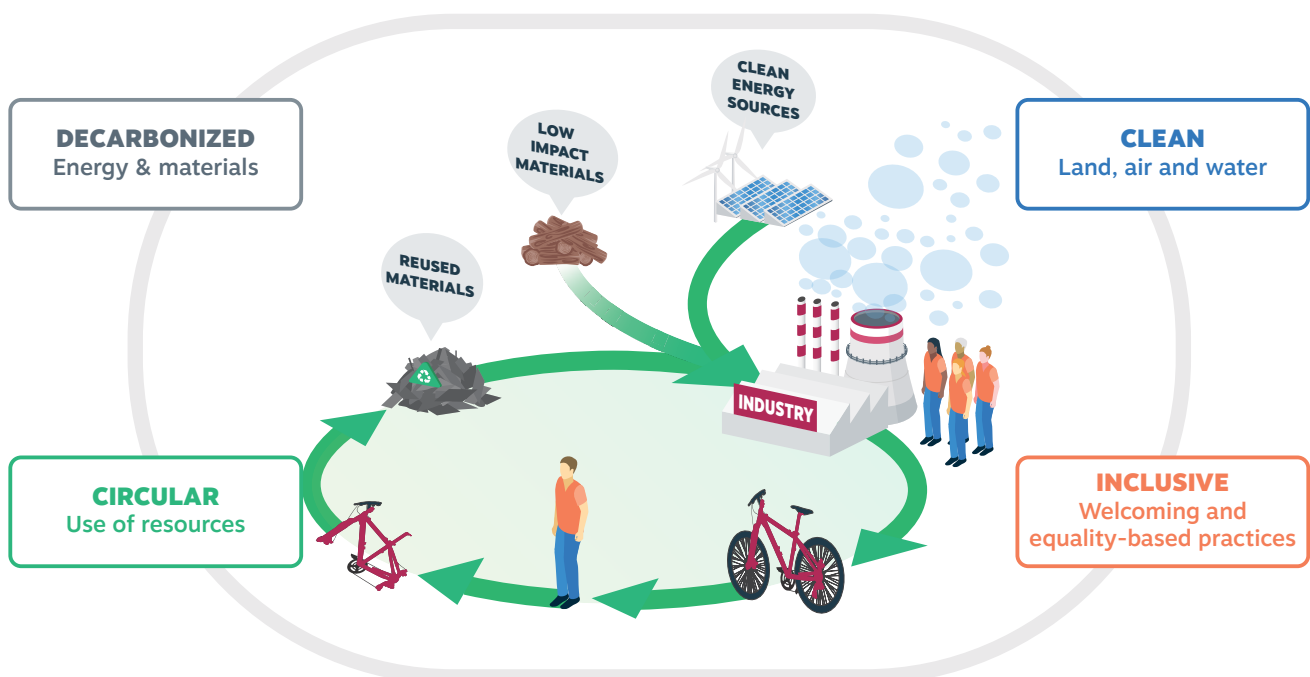

Fig. 2   *The visual representation of a circular economic model, including the four key aspects: decarbonized, clean, circular and inclusive.*

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and contractors must earn living wages, experience fair and safe working conditions, and have access to opportunity, training, and advancement – particularly populations that have historically been marginalized or under-represented.

Though listed discretely, these practices are interrelated. For example, reducing diesel emissions is a clean practice that reduces emissions and improves local air quality,

as well as a practice that reduces carbon and contributes to reducing pressure on communities burdened by the effects of climate change.

*Please note that throughout this report we will use the term **"Clean Industry" to refer to clean, decarbonized, circular, and inclusive practices.***

EXTEND LIFESPAN OF PRODUCTS AND ITS PARTS

Reuse
Reuse by another consumer of discarded product which is still in good condition and fulfils its original function.

Repair
Repair and maintenance of defective product so it can be used with its original function.

Refurbish
Restore an old product and bring it up to date.

Remanufacture
Use parts of discarded product in a new product with the same function.

Repurpose
Use discarded product or its parts in a new product with a different function.

SMARTER PRODUCT USE AND MANUFACTURING

Reduce
Increase efficiency in product manufacture or use by consuming fewer natural resources and materials.

Refuse
Make product redundant by abandoning its function or by offering the same function with a radically different product.

Rethink
Make product use more intensive (e.g. by sharing products or by putting multi-functional products on market).

Redesign
To revise the product in appearance or function.

EFFECTIVE USE OF MATERIAL

Recycle
Process materials to obtain the same (high grade) or lower (low grade) quality.

Fig. 3 *This illustration demonstrates the integration of the Value Hill model and the 9R framework. The graphic visually demonstrates the integration of these concepts, highlighting the holistic approach to value creation and resource utilization in the circular economy.*

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INDUSTRIAL SECTOR AS A CATALYST FOR CHANGE

Industry plays a significant role in a city's metabolism of materials, economic development, and impact on community members. With its great influence, these sectors can therefore be a catalyst for positive change in a city and beyond. The Assessment and Roadmap process aims to identify how Portland's industry can be a catalyst for change by transitioning to clean, decarbonized, circular, and inclusive practices.

OUR APPROACH

The Clean Industry Assessment and Roadmap process was led by the City of Portland and a team of consultants and guided by a diverse stakeholder Advisory Group (see Appendix VIII for a list of organizations involved). Our goal was to answer the following questions:

- What are the current conditions regarding industrial businesses in Portland including the composition of this sector and impacts on air pollution, carbon, and waste?
- What are businesses' current attitudes and experience regarding clean, decarbonized, circular, and inclusive practices?
- What global clean industry model lessons might be applicable to help Portland improve industrial decarbonization, emissions, circularity, and inclusion?
- What policy and finance tools are available to support the clean industry transition?
- What strategies for moving forward are best suited to Portland and how might we collaborate to move them forward?

The Assessment research included qualitative and quantitative methods. As described below, this included an impact analysis, a survey of businesses, listening sessions, and a review of existing reports and publicly available information.

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IMPACT ANALYSIS

A quantitative analysis, including a material flow analysis, was conducted in order to estimate inputs and outputs by sector. This is described in Section 2.

SURVEY OF BUSINESS

A survey was sent to manufacturers and large institutions in Portland to learn about existing practices, challenges, and opportunities. This is described in Appendix V.

LISTENING SESSIONS

Individual and small group interviews were held with key informants to gain insight into existing conditions, challenges, and opportunities. This included interviews with representatives of local businesses, nonprofit organizations, utilities, and government entities as well as national and international experts.

Reports and Publicly Available Information Information was drawn from relevant reports such as Portland's Economic Opportunity Analysis and Advance Portland's Economic Development Strategy, and a review of literature and webpages related to hub models and policy and finance tools.

Our Assessment findings informed the development of the Clean Industry Roadmap. A description of the Roadmap process, suggested strategies and recommended next steps can be found in Section 6.

HOW TO READ THIS REPORT

This report includes five sections. We begin by examining Portland's current industry conditions. This includes an introduction to the industries that are the focus of this report (study set) followed by a review of the impacts of these industries with regards to greenhouse gas emissions, waste, air pollution, and water (impact analysis) and a discussion of key themes regarding the Portland context, including challenges and opportunities. Next, we share the key challenges and opportunities for a clean industry in Portland, and our findings from our review of clean industry hub models around the world. This is followed by the findings from our review of policy and finance tools. The report concludes with an introduction to the Roadmap process and recommendations for moving forward.

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02 Portland's industry conditions
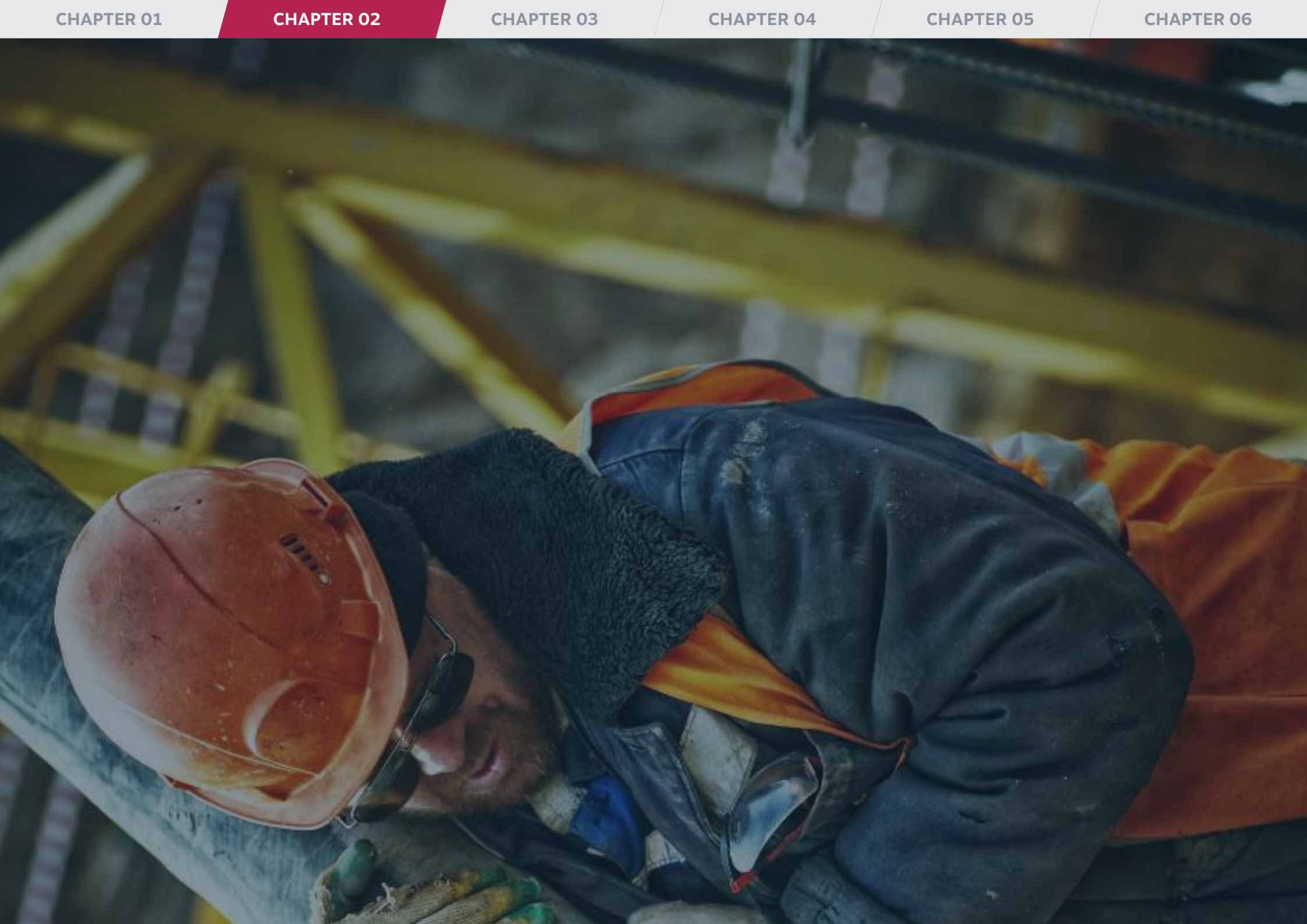
This section aims to provide a comprehensive overview of current characteristics and circumstances pertaining to Portland's industry, including the composition of this sector and impacts on air pollution, carbon, and waste. First, we define the study set, after which the impact of the defined sectors is determined focusing on three input categories (energy use, water consumption, and material use) and three output areas (greenhouse gas emissions, emission of pollutants, and waste production).

DEFINITION OF THE STUDY SET

This study is specifically focused on the impacts, opportunities and barriers of Portland's manufacturing industries and large institutions – which for simplicity will be referred to as industries throughout the report – to become clean, decarbonized, circular and inclusive.

In addition to the manufacturing industries, also large hospitals and universities, as well as waste management are included in the study set. The institutions are deemed relevant to the analysis because they employ many people, consume many resources, and have similar facilities to other groups in the study set. The waste management sub-sector is included because it interacts with all other industries in a way that is relevant to the assessment, specifically from the perspective of the circular economy and high-quality processing of waste materials. Our step-by-step approach to defining the study set is further explained in Appendix I.

To come up with a meaningful understanding of the industrial sector, the Quarterly Census of Employment and Wages (QCEW) data was used to identify the largest industries in Portland by the number of employees. The categories are grouped thematically, building upon previous work through the Economic Opportunity Analysis.

Sectors and sub-sectors

This report uses the terms 'sectors' and 'sub-sectors'. Sectors are the categories determined by the first two digits of the NAICS codes (e.g. the first two digits 33 at the beginning of the NAICS code stand for the sector 'Metals and Machinery'). The sub-sectors are a sub-category of the sectors and are indicated with the 3rd and 4th digits in the code (e.g. the code '331' stands for the sub-sectors 'Primary Metal Manufacturing' within the 'Metals and Machinery' sector). The first three digits of the NAICS codes are used by default to define a sub-sector. The first four digits of the NAICS codes are only used for selecting the relevant educational institutions as the first 3 digits of the NAICS codes are not granular enough.

Only the most relevant sub-sectors are included in the selected sectors. As a result, not all sub-sectors that are part of a sector are included in the study set. For example, the Waste Management sector entails multiple sub-sectors, but within this study we only include the 'Waste Management and Remediation Services' sub-sector. Furthermore, distinguishing between sub-sectors within a sector allows for a better understanding of the most relevant impacts.

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The industry sectors within the study set are determined based on the employee distribution, and economic and environmental impact in Portland. The industries are distributed across the following six main sectors and sub-sectors:

Food & beverages manufacturing

Includes manufacturing of food and beverages products.

Metals & machinery manufacturing

Includes primary metal, fabricated metal products, machinery, and transformation manufacturing.

Electronic manufacturing

Includes manufacturing of computer and electronic products, electrical equipment, appliances, and components.

Miscellaneous manufacturing

Includes textile mills, textile product mills, apparel manufacturing, leather and allied product manufacturing, wood product manufacturing, paper manufacturin, printing and related support activities, petroleum and coal products manufacturing, chemical manufacturing, plastics and rubber products manufacturing, nonmetallic mineral product manufacturing, furniture and related product manufacturing and miscellaneous manufacturing.

Hospitals & universities

Hospitals and universities, large institutions that share the challenges and opportunities of the industrial sector to become cleaner.

Waste management

Includes waste collection, waste treatment and disposal, and remediation and other waste management services.

Food & beverage manufacturing	Metals and machinery manufacturing	Electronic manufacturing	Miscellaneous manufacturing	Hospitals & Universities
Includes manufacturing of **food and beverages** products.	Includes **primary metal, fabricated metal** products, **machinery**, transformation manufacturing.	Includes manufacturing of **computer and electronic** products, **electrical** equipment, **appliances**, and **components**.	Includes the manufacturing of **chemical, plastic, wood products, paper, petroleum, textile, mineral**, and **others**.	Hospitals and universities, large institutions that share the **challenges and opportunities** of the industrial sector to become cleaner.
Total number of **businesses**: 378 Total **employees**: 7,053 Total **wages** ($ Millions): 371	Total number of **businesses**: 284 Total **employees**: 11,063 Total **wages** ($ Millions): 883	Total number of **businesses**: 79 Total **employees**: 1,717 Total **wages** ($ Millions): 133	Total number of **businesses**: 633 Total **employees**: 9,243 Total **wages** ($ Millions): 546	Total number of **businesses**: 13 Total **employees**: 49,506 Total **wages** ($ Millions): 4,472

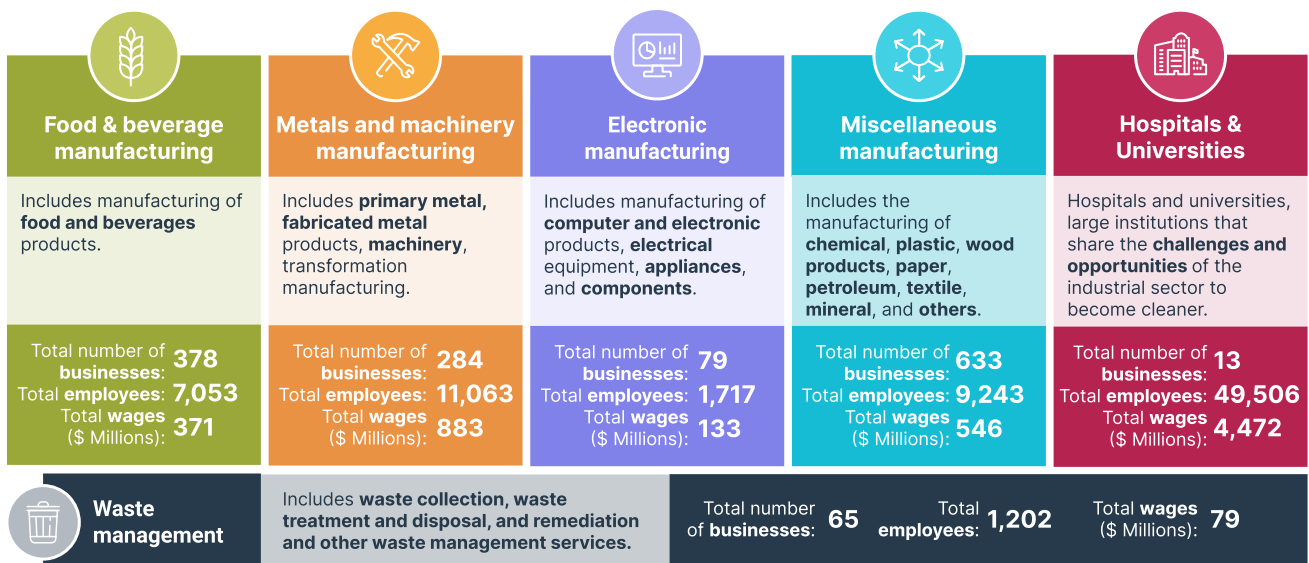| Waste management	Includes **waste collection, waste treatment and disposal, and remediation and other waste management services.**	Total number of **businesses**: 65	Total **employees**: 1,202	Total **wages** ($ Millions): 79

Fig. 4 *The six industrial sectors that are included in this study, along with the respective number of businesses, total employees, and total wages within each sector in Portland.*

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More detailed information on the definition of the study set, NAICS codes per sector and specific methodologies, can be found in Appendix I, II and III, respectively.

Market size of study set compared to Portland and national economy

It is important to understand the representability of the study set with respect to the whole economic sector in Portland. The 1,452 businesses included in this study set are a small fraction of the total number of businesses in Portland (3.7%). However, these businesses account for 15% of the employment in Portland.

Although accounting for only 15% of the employment in the city, these industries are expected to contribute to a large share of the city's environmental impact and offer several opportunities for reducing the city's impact.

Although there is no perfect relationship between the number of employees and the actual economic 'size' of a business, the number of employees is the best proxy available for estimating and comparing overall business size. Within the study set the hospitals and universities sector is the largest employer. In terms of employment, this sector is relatively larger in Portland than on the national level. The presence of one large educational organization is the reason for this difference. For comparison, we have excluded the Hospital & Universities sector on both Portland and national level. In that scenario, the remaining five sectors are comparable in size on the national level and in Portland.

Fig. 5 *The study set compared to Portland as a whole. Left: number of businesses. Right: number of employees.*
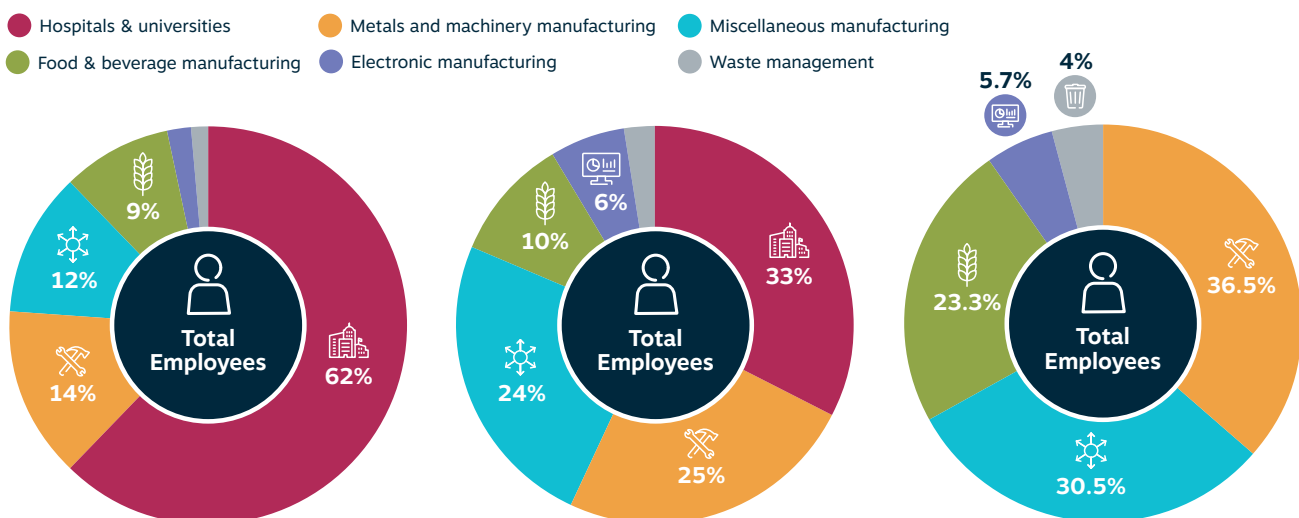
Fig. 6 *Percentage of employees per sector. Left: Portland. Middle: USA. Right: Portland, Hospitals and Universities excluded.*

Sub-sector distribution

This chart shows the number of employees per sub-sector within our study set in Portland. For readability of the chart we have excluded the hospitals and universities sub-sectors. Notably, food manufacturing, rather than beverage and tobacco manufacturing, make up the vast majority of its sub-sector. The miscellaneous manufacturing sector consists of many different sub-sectors, of which the 'printing and related support activities' sub-sector is the largest. Within the metal and machinery manufacturing sector, the largest three sub-sectors are 'transportation equipment manufacturing', 'fabricated metal product manufacturing', and 'primary metal manufacturing'.
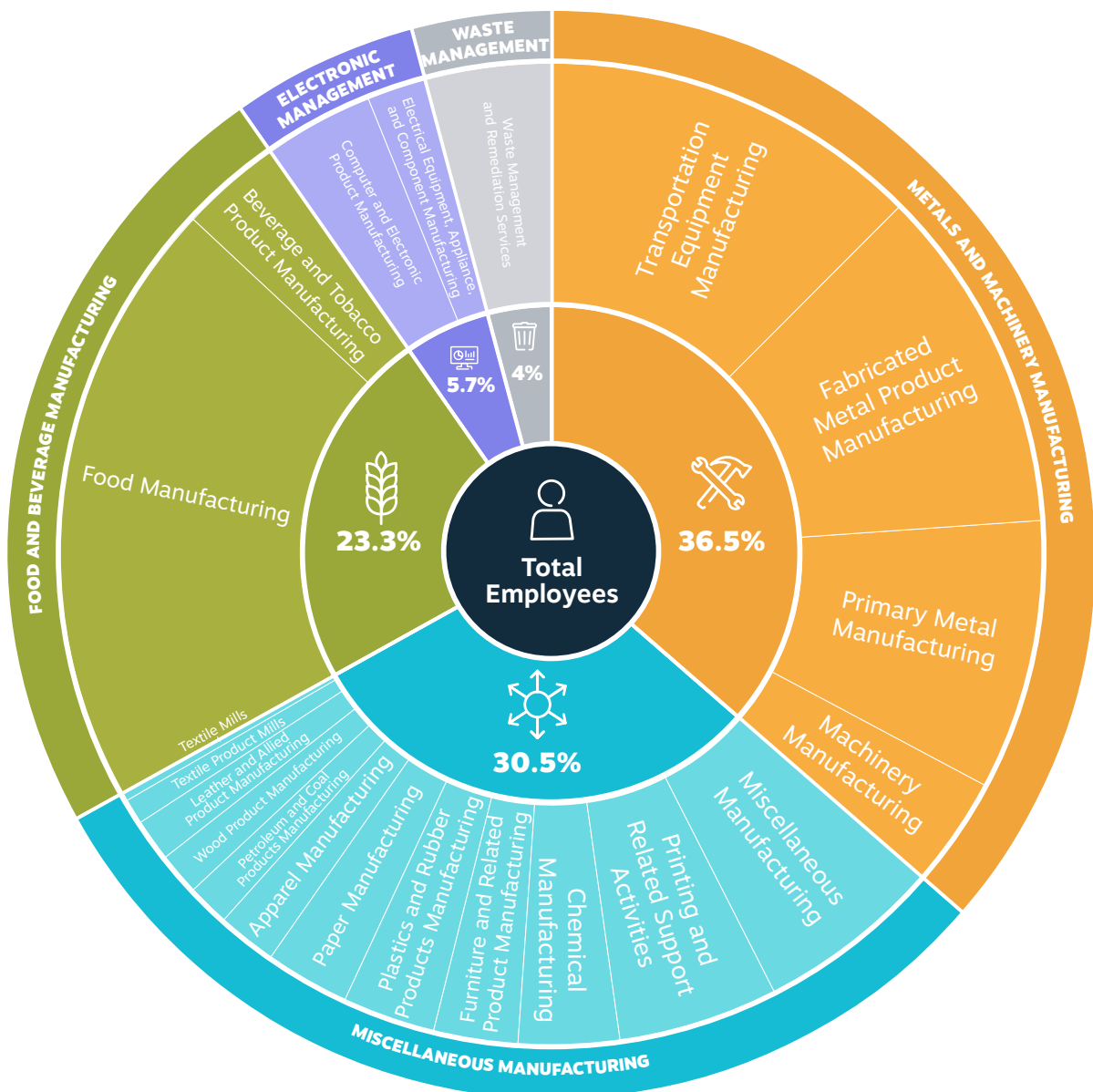
Fig. 7 *The size of the sub-sectors (using employee count as a proxy for business size).*

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Projected growth per sector 2021-2031

The hospitals and universities and metals and machinery sectors are expected to experience the largest employment growth between 2021 and 2031.

● 2031
○ 2021
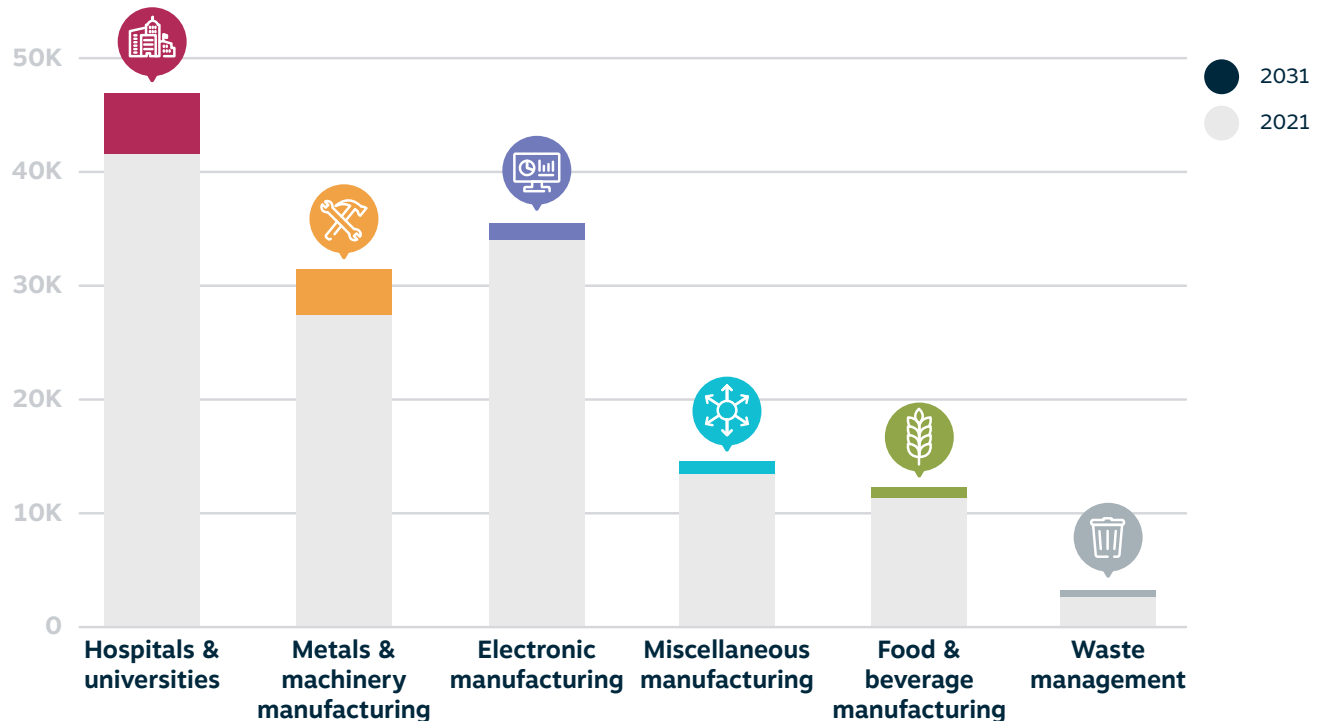
Fig. 8 — The current market size and the expected employment growth per sector.

Comparing the average size of businesses

This graph allows us to compare the total number of businesses, the total number of employees and the total wages per industrial sector. The hospitals and universities sector is excluded from this comparison because its size distorts the image. Although the miscellaneous manufacturing sector accounts for the largest number of businesses, it has fewer employees than the other sectors. The opposite holds true for the metals and machinery manufacturing sector, which has a higher proportion of employees compared to the number of businesses.

● Waste management
● Electronic manufacturing
● Metals & machinery manufacturing
● Food & beverage manufacturing
● Miscellaneous manufacturing
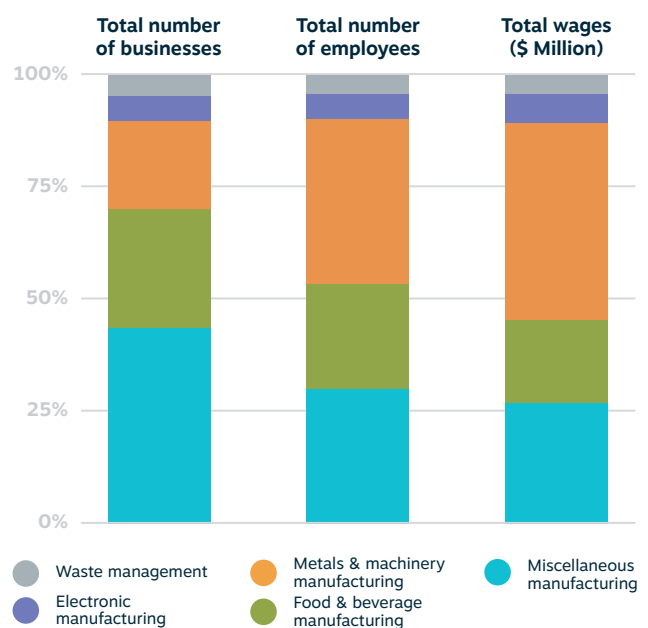
Fig. 9 — Comparison of the number of businesses, number of employees, and the total wages.

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The average number of employees per business per sector further exemplifies the comparison. On average, miscellaneous manufacturing businesses are the smallest in terms of employees and the hospitals and universities are by far the largest employers with on average 3,800 employees. This is further influenced by the choice of which organizations in the hospital and universities sector to include, which is explained in Appendix I.
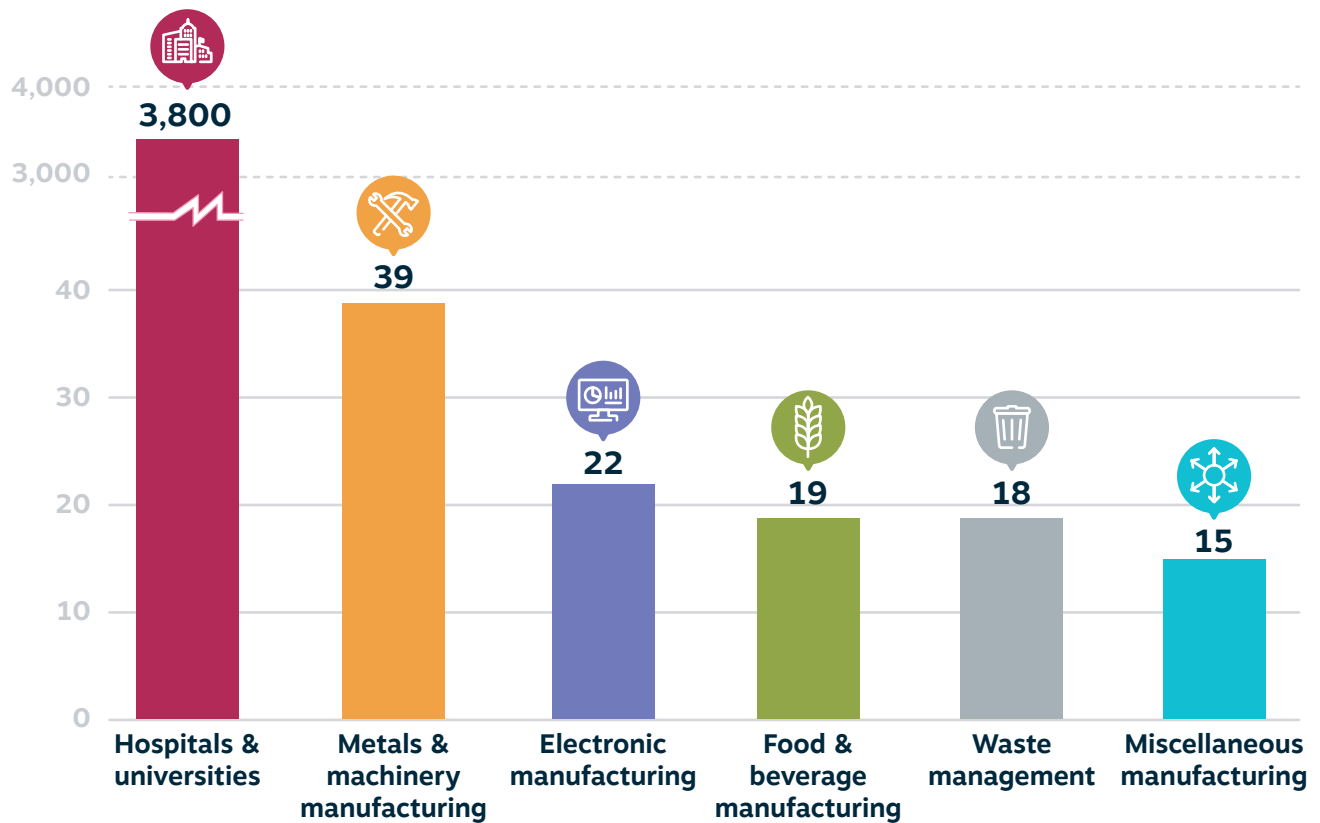

Fig. 10 *The average number of employees per business per industrial sector.*

IMPACT ANALYSIS

This section shows the impacts of Portland's industrial sectors. The impact analysis pertains to three output areas: greenhouse gas (GHG) emissions, emission of pollutants, and waste production. To complete the picture, three input categories (which bring their own impacts) are included: energy use, water consumption, and material use.

Fig. 11 *Overview of inputs and outputs discussed in the impact analysis.*

This chapter will run through these inputs and outputs regarding Portland's industry sectors as defined within the study set, to show their impacts regarding these themes. Thereafter, the six industry sectors will be discussed separately so that conclusions and insights can be given per sector. This synthesis will form the quantitative basis for the listening sessions and the roadmap development to address the largest impacts per sector.

METHODOLOGY

For the impact analysis, multiple data sources and methodologies were used to obtain outcomes for the individual industrial sectors regarding the different impacts. As (local) data availability can be a limitation in this process, some assumptions had to be made where these data gaps occurred. The specific sources, methodologies per topic and corresponding (dis)advantages and limitations are described in detail in Appendix III.

An important note regarding the input-output analysis is that it was done based on an environmentally extended input-output model for the United States of America. We then downscaled these impacts based on the number of employees working in the different industries as the basis for our analysis to calculate estimated impacts for the industries in our study set. Wherever possible, we substituted or juxtaposed the results from the input-output analysis with impact analysis results based on local datasets.

An important consequence of this assumption is that the input-output analysis shows a result where the outputs of the petroleum and coal manufacturing industry are relatively large compared to other sectors. This is because the total revenue of this industry in Portland is estimated using national data, which gives an overestimation as it also includes high values of revenue from, for instance, petroleum refineries, whereas in Portland this industry is mostly represented by asphalt product manufacturers, such as roofing shingles. In order to give a more accurate calculation of the outputs of this industry, more specific regional data including revenue per NAICS-4 code would be needed.
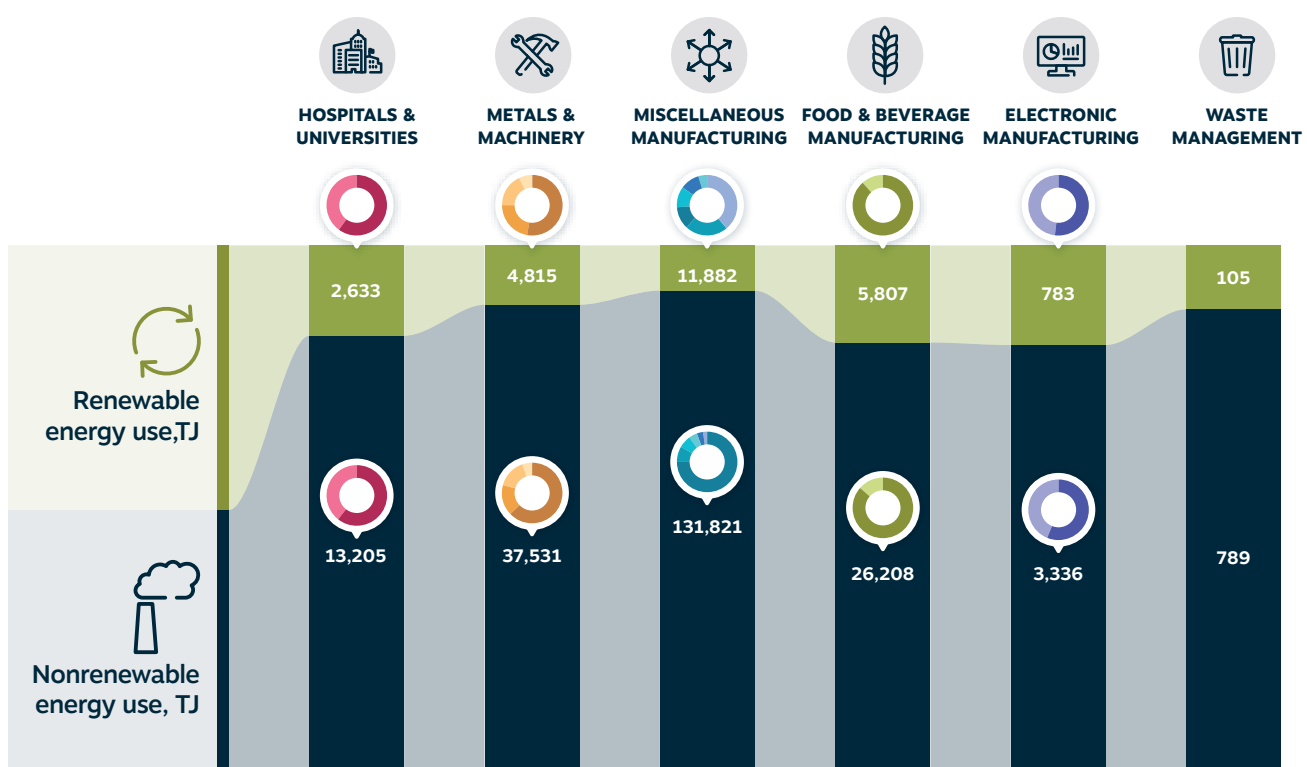

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Inputs

On the input side, the consumption of energy, materials and water will be discussed. For each of these three flows, it is assessed to what extent the six main sectors contribute to the total consumption and where needed, more detailed elaboration on this usage is given.

Energy consumption

Of the total energy used by industries in Portland, 10.9% comes from renewable sources. Renewable sources of energy include hydroelectric power, geothermal, solar, wind and biomass. In Figure 12, this relation can be seen for the six different sectors. The total energy use includes electricity, natural gas, fuel oil, and district heat. While already

| HOSPITALS & UNIVERSITIES | METALS & MACHINERY | MISCELLANEOUS MANUFACTURING | FOOD & BEVERAGE MANUFACTURING | ELECTRONIC MANUFACTURING | WASTE MANAGEMENT |

Renewable energy use,TJ

| 2,633 | 4,815 | 11,882 | 5,807 | 783 | 105 |

Nonrenewable energy use, TJ

| 13,205 | 37,531 | 131,821 | 26,208 | 3,336 | 789 |

- ● Electrical Equipment *(NEU 56.3%, REU 52%)*
- ● Computer & Electronic *(NEU 43.7%, REU 48%)*
- ● Food *(NEU 86.4%, REU 88.5%)*
- ● Beverage & Tobacco *(NEU 13.6%, REU 11.5%)*
- ● Petroleum & Coal *(NEU 75.2%, REU 11.9%)*
- ● Other (Textile Mills, Textile Product Mills, Leather & Allied, Wood , Apparel, Plastics & Rubber, Furniture, Printing) *(NEU 8.3%, REU 23%)*
- ● Chemical Manufacturing *(NEU 6.6%, REU 11.2%)*
- ● Nonmetallic Mineral *(NEU 4.6%, REU 4.7%)*

- ● Nonmetallic Mineral *(NEU 4.6%, REU 4.7%)*
- ● Miscellaneous *(NEU 3.3%, REU 10.2%)*
- ● Paper *(NEU 2.1%, REU 39.1%)*
- ● Primary Metal Man. *(NEU 62.9%, REU 53.4%)*
- ● Transportation Equipment *(NEU 16.5%, REU 21.7%)*
- ● Fabricated Metal *(NEU 15.4%, REU 17.6%)*
- ● Machinery Man. *(NEU 5.3%, REU 7.2%)*
- ● Educational Services *(NEU 60.7%, REU 59.8%)*
- ● Hospitals *(NEU 39.3%, REU 40.2%)*

Fig. 12 *Energy use per sector, divided in renewable (REU) and nonrenewable energy use (NEU). Integrated pie charts elaborate on subsectors.*

having the largest total energy use, the miscellaneous manufacturing sector also has the lowest share of renewable sources. Sub-industries with a large energy use are food manufacturing and primary metal manufacturing.

Electricity use

The pie chart shows the estimated electricity consumption per industry sector. The total electricity consumption of the industry in Portland is 634,775,000 kWh per year. According to the data, the "Metals and machinery" industry sector is using more than half of the electricity. Almost a quarter is used by miscellaneous manufacturers and the rest by the food & beverage and electronic manufacturing sectors.

This data was provided by PGE and Pacific Power via the City of Portland. It includes most but not all of the NAICS-3 codes in our study set. Hospitals and waste facilities are not included in this data and are thus left out of this pie chart.
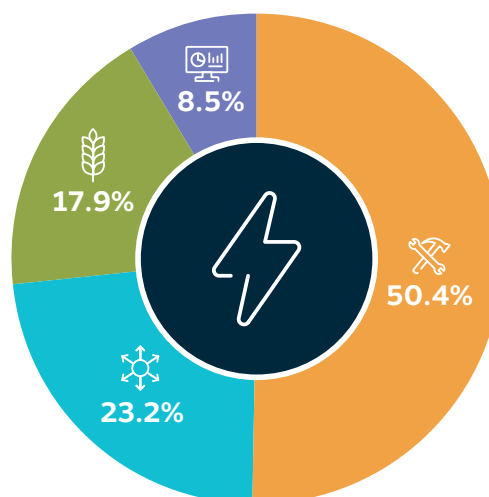
Industry cluster:

- 🟠 Metals and machinery manufacturing, **319,707 mwh**
- 🔵 Miscellaneous manufacturing **147,077 mwh**
- 🟢 Food & beverage manufacturing, **113,658 mwh**
- 🟣 Electronic manufacturing, **54,333 mwh**

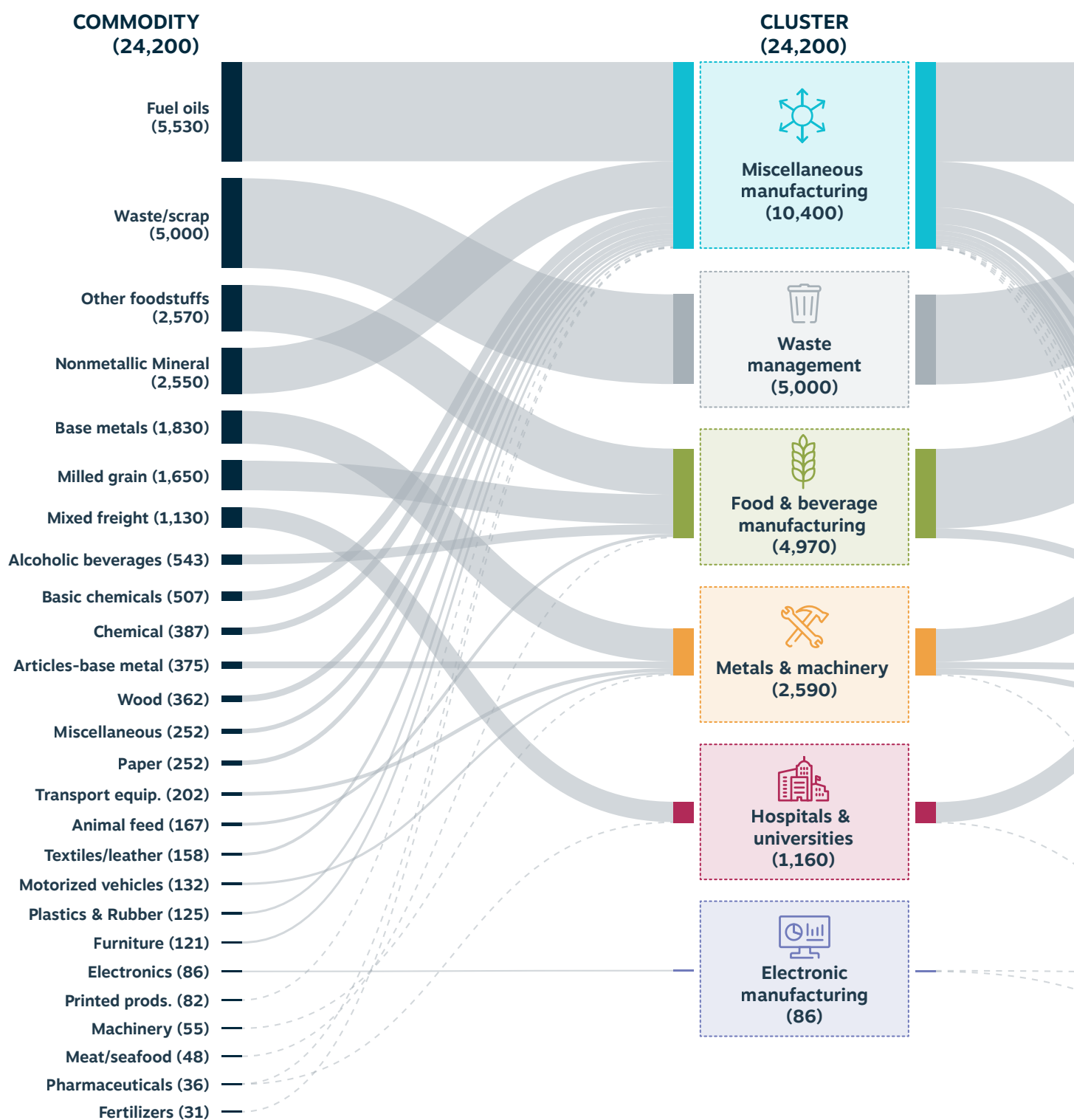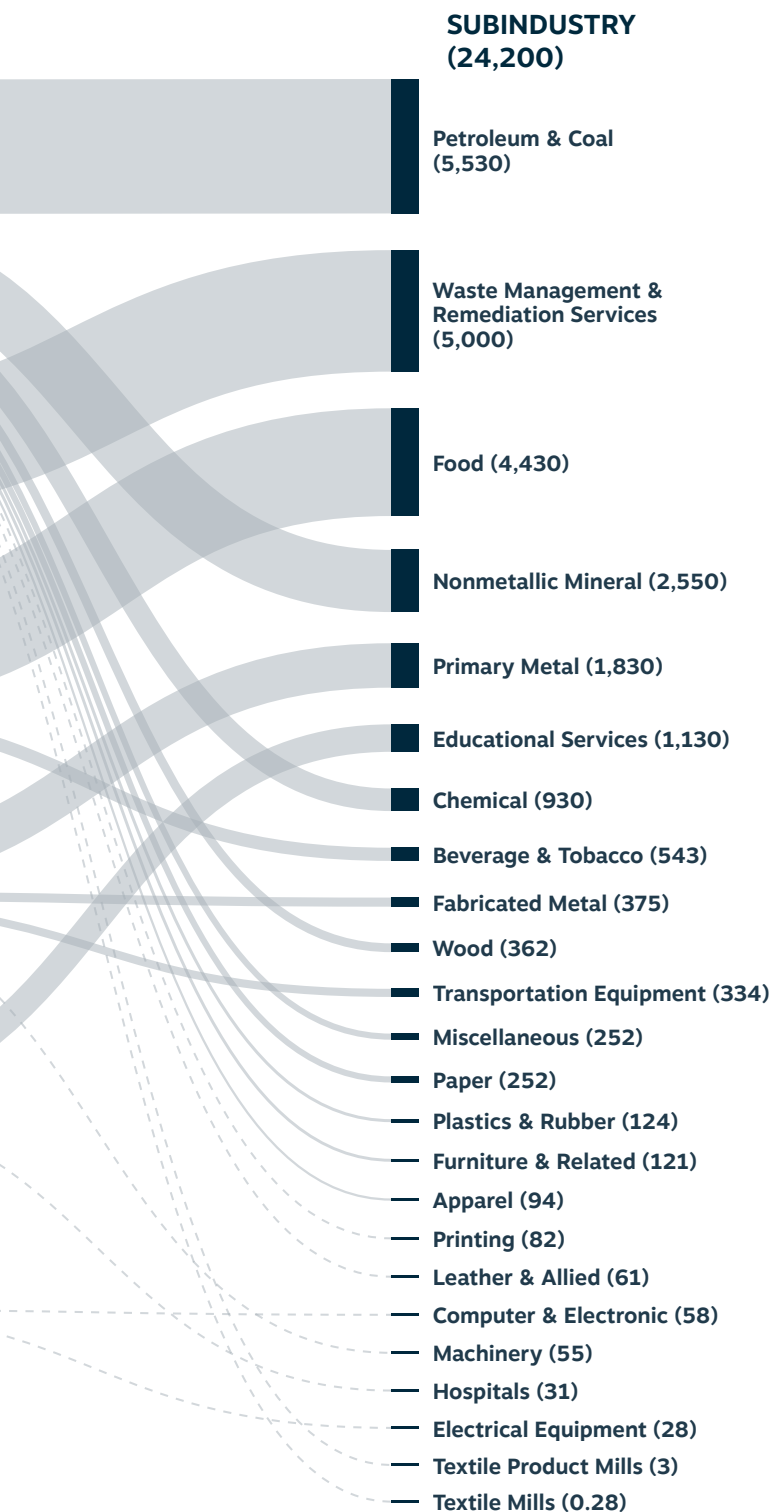**Fig. 13** *Total electricity use per sector in mWh. Source: PGE and Pacific Power*

COMMODITY (24,200)

CLUSTER (24,200)

Fuel oils (5,530)

Waste/scrap (5,000)

Other foodstuffs (2,570)

Nonmetallic Mineral (2,550)

Base metals (1,830)

Milled grain (1,650)

Mixed freight (1,130)

Alcoholic beverages (543)

Basic chemicals (507)

Chemical (387)

Articles-base metal (375)

Wood (362)

Miscellaneous (252)

Paper (252)

Transport equip. (202)

Animal feed (167)

Textiles/leather (158)

Motorized vehicles (132)

Plastics & Rubber (125)

Furniture (121)

Electronics (86)

Printed prods. (82)

Machinery (55)

Meat/seafood (48)

Pharmaceuticals (36)

Fertilizers (31)

Miscellaneous manufacturing (10,400)

Waste management (5,000)

Food & beverage manufacturing (4,970)

Metals & machinery (2,590)

Hospitals & universities (1,160)

Electronic manufacturing (86)

Fig. 14 *Material input split per commodity (left), industrial sector (middle), and industrial sub-sector (right) in thousand metric tons.*

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**SUBINDUSTRY
(24,200)**

Petroleum & Coal
(5,530)

Waste Management &
Remediation Services
(5,000)

Food (4,430)

Nonmetallic Mineral (2,550)

Primary Metal (1,830)

Educational Services (1,130)

Chemical (930)

Beverage & Tobacco (543)

Fabricated Metal (375)

Wood (362)

Transportation Equipment (334)

Miscellaneous (252)

Paper (252)

Plastics & Rubber (124)

Furniture & Related (121)

Apparel (94)

Printing (82)

Leather & Allied (61)

Computer & Electronic (58)

Machinery (55)

Hospitals (31)

Electrical Equipment (28)

Textile Product Mills (3)

Textile Mills (0.28)

Material consumption

The next input flow that will be discussed are the materials that are used by Portland's industry, which are illustrated in the Sankey diagram in Figure 14. On the left are the input of commodities for the referenced industrial sectors of Portland, in total 24.2 million metric tons. The largest flows of input materials are fuel oils, waste, food and non-metal mineral products. In the middle of the diagram, it can be seen that the largest part of all the materials is used within the miscellaneous sector, followed by waste management and the food & beverage sector. On the right side of the diagram the sub-industries are shown, indicating that the highest input of materials is the manufacturing of petroleum & coal products, waste management services and food production.

Water consumption

In the Portland area ten industrial facilities have a significantly higher water consumption than the other facilities. These top ten water consumers are shown in Figure 15 and each facility is labeled with their own shade of color and every facility is grouped with the facilities from the same sector which is illustrated by the different bars. For hospitals and universities most of the water consumption can be assigned to the high amount of employees and visitors. The industrial processes used in electronic manufacturing and primary metal manufacturing are extremely water intensive, mostly due to cooling and HVAC systems.
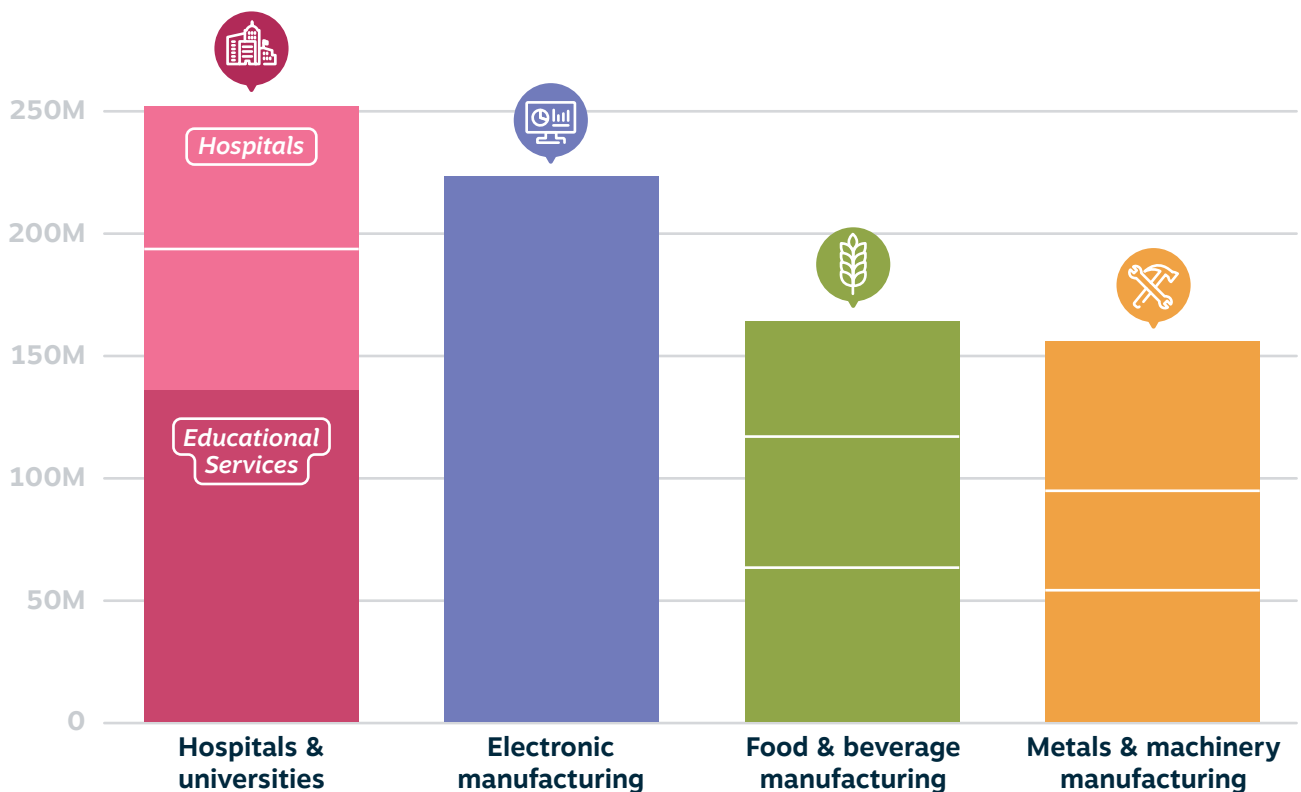
The water consumption in M gallons of the top 10 facilities with the highest water consumption in Portland.

Fig. 15

Output

On the output side of this impact analysis, the categories carbon emissions, pollution and waste production will be discussed. For each of these three output flows, it is assessed to what extent the six main sectors contribute.

Carbon emissions

The total GHG emissions by the industries in Portland are equal to 17.9 million metric tons CO_2-equivalent. The sub-industries accounting for the largest share of GHG emissions are food manufacturing (26.0%), petroleum and coal products manufacturing (19.9%) and primary metal manufacturing (9.0%).
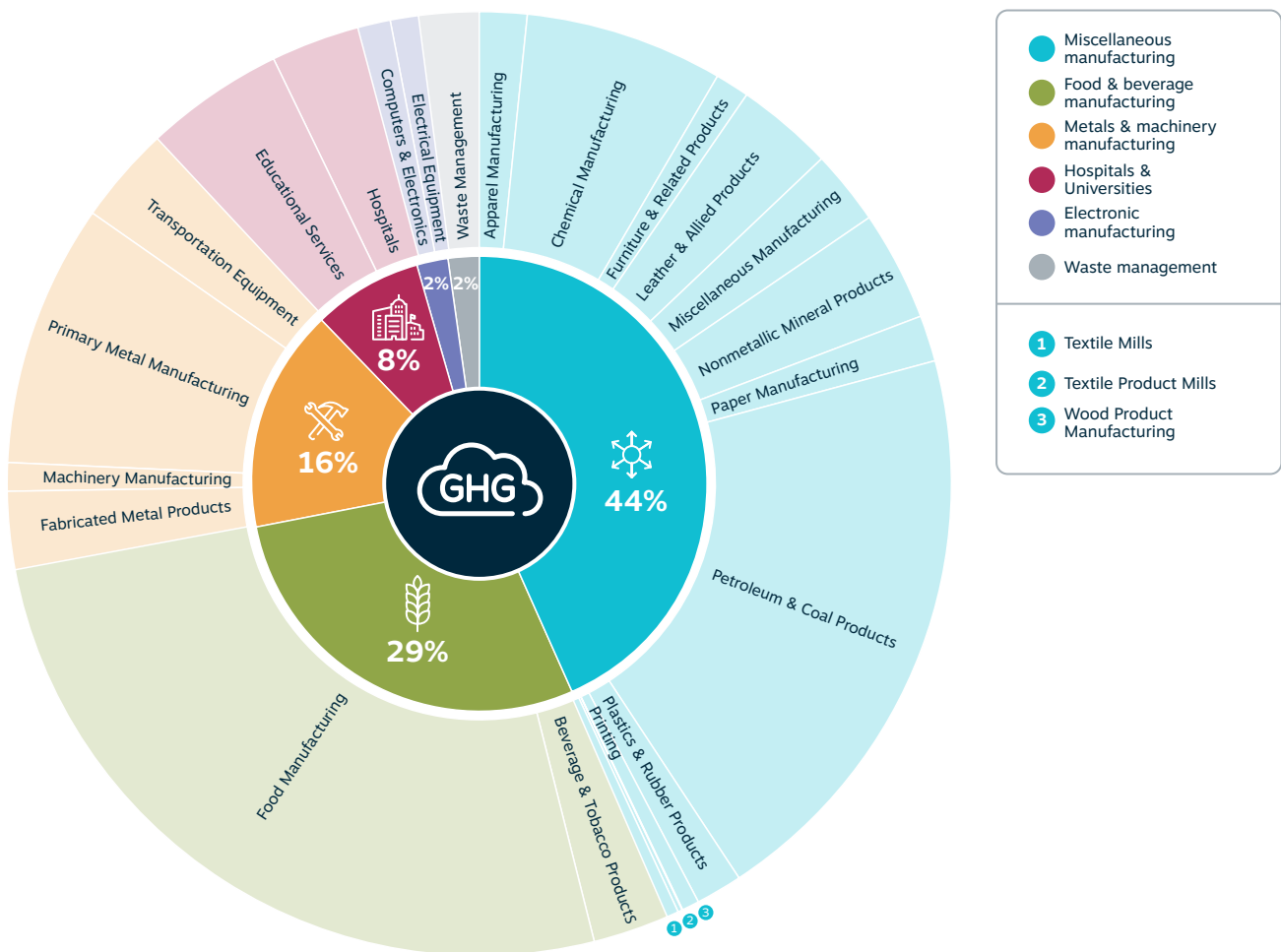
Fig. 16   *Total carbon emissions divided over the (sub)sectors part of the study set.*

Pollution

The industries of Portland account for a total of 2.4 million kg of hazardous air pollutants. The most polluting sub-sectors are food manufacturing (19.9%), petroleum & coal products manufacturing (19.2%) and transportation equipment manufacturing (9.9%).

Particulate matter (PM) is one of the main groups of 'hazardous air pollutants'. In Figure 17 this pollutant type is singled out. It can be seen that the miscellaneous manufacturing followed by the metals and machinery sector emit by far the most particulate matter (PM).

⚠️ **Note:** *The pollution and greenhouse gas emissions impacts for the petroleum & coal sub-sector are based on national data which might not be representative for the industries in Portland. See Appendix III.*

Waste management **2.28%** — Electronic manufacturing **0.64%** — Hospitals & universities **0.28%** — Food & beverage manufacturing **0.09%**

Metals and machinery manufacturing **46.7%** — Miscellaneous manufacturing **50.0%**
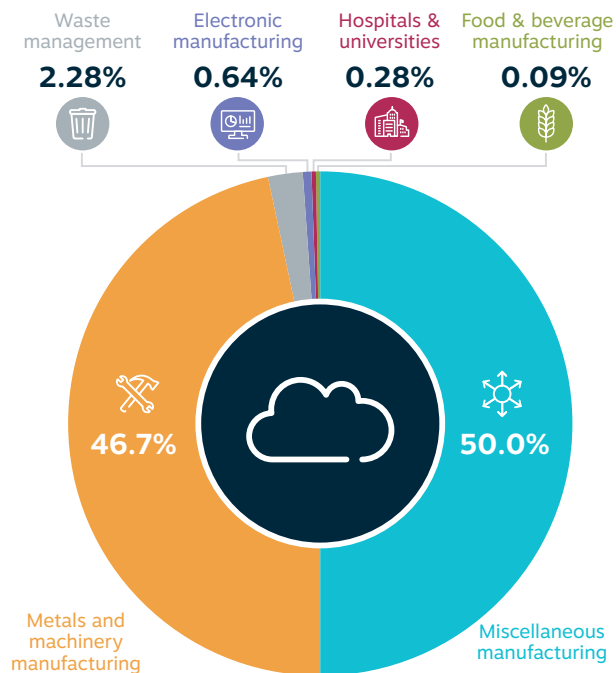
Fig. 17 *Particulate Matter (PM) emissions per sector (accurate split per sub-sector is not available).*

Legend:
- Miscellaneous manufacturing
- Food & beverage manufacturing
- Metals & machinery manufacturing
- Waste management
- Hospitals & Universities
- Electronic manufacturing

1. Textile Mills
2. Textile Product Mills
3. Electrical Equipment Manufacturing
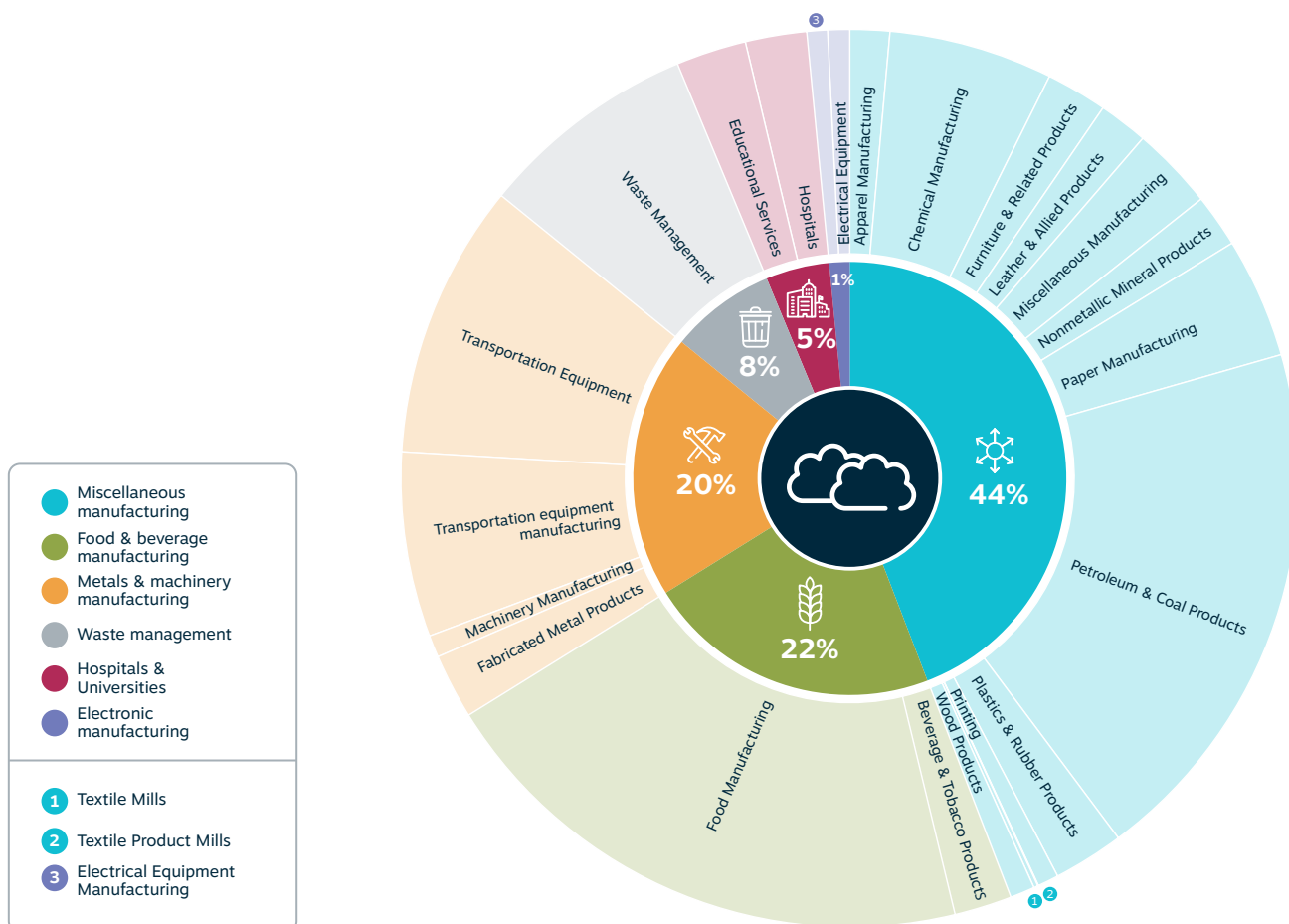
Fig. 18 *Air pollution impacts divided over the different (sub)sectors included in the study set.*

Waste generation

The total waste produced by the industries of Portland is equal to 348 million kg. The main contributors of waste are manufacturers of food (20.8%), educational services (16.2%) and apparel manufacturing (9.8%). The high contribution of waste by educational services can be explained by the relatively large size of the sub-sector in terms of employees.

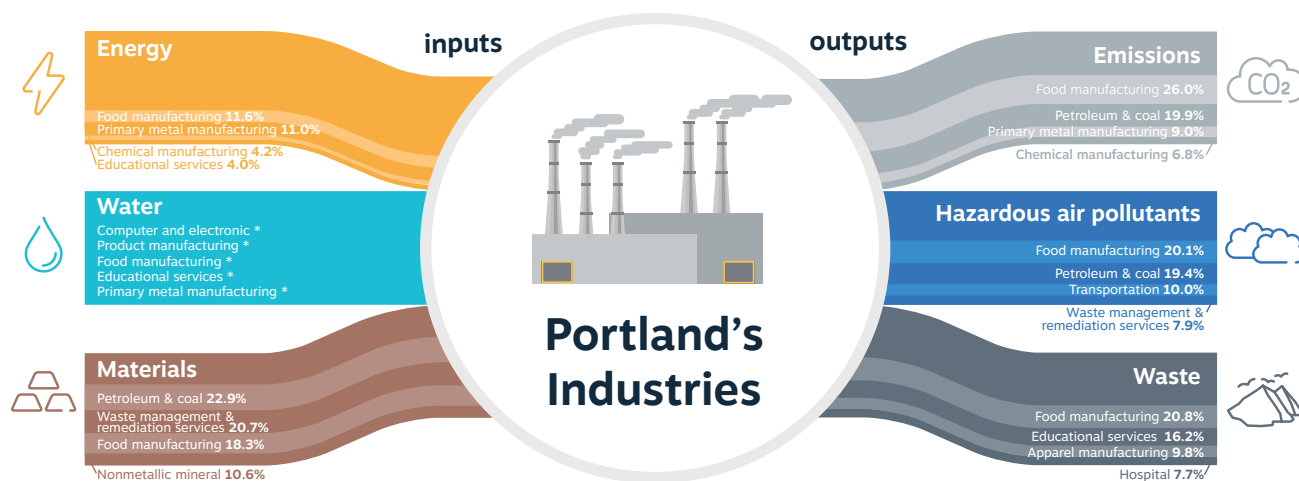A detailed split of the waste composition in Portland can be found in Appendix IV.
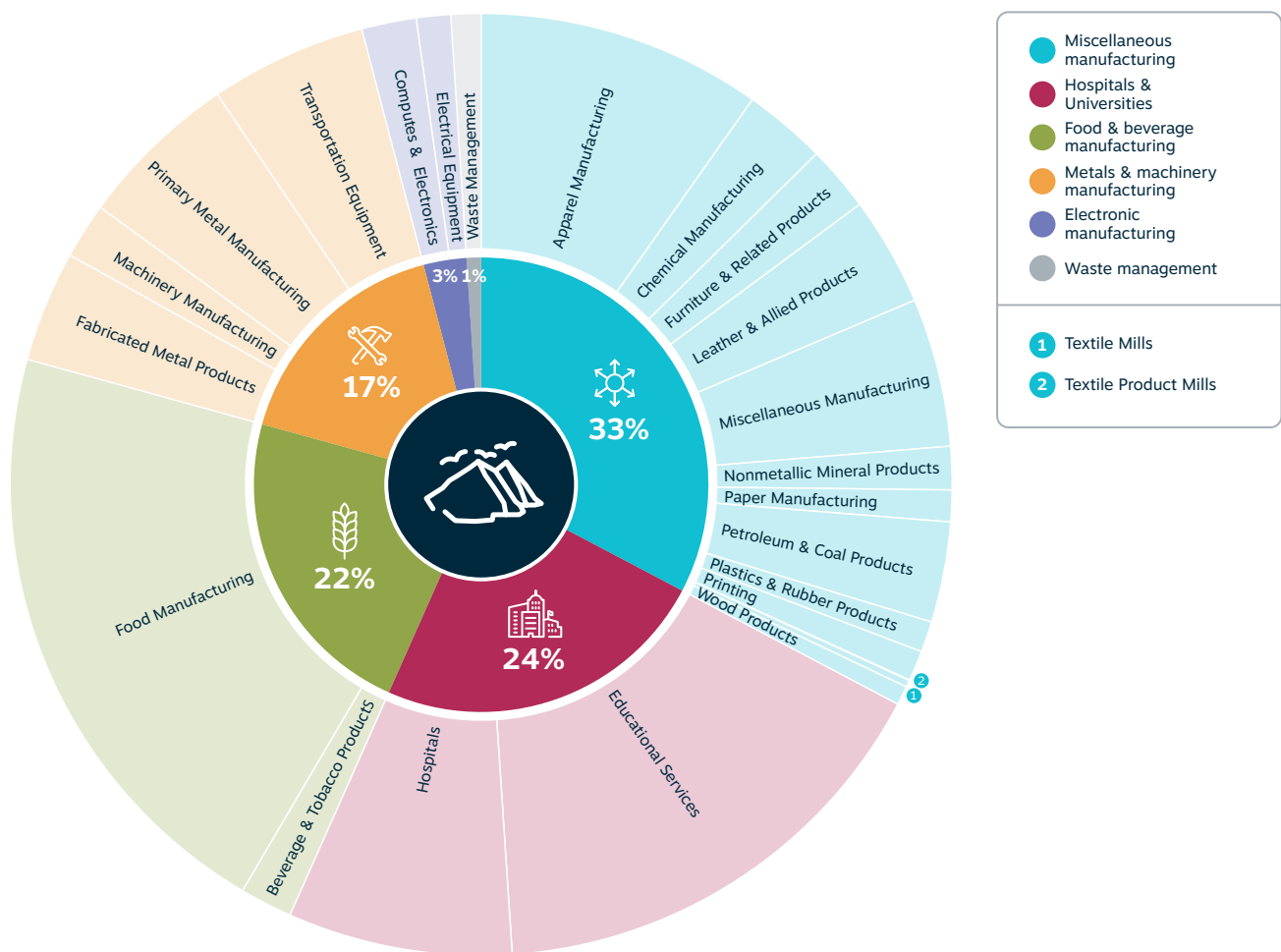
Fig. 19 *Waste generation divided over the different (sub)sectors included in the study set.*

inputs

outputs

Energy
Food manufacturing **11.6%**
Primary metal manufacturing **11.0%**
Chemical manufacturing **4.2%**
Educational services **4.0%**

Water
Computer and electronic *
Product manufacturing *
Food manufacturing *
Educational services *
Primary metal manufacturing *

Materials
Petroleum & coal **22.9%**
Waste management &
remediation services **20.7%**
Food manufacturing **18.3%**
Nonmetallic mineral **10.6%**

Portland's Industries

Emissions
Food manufacturing **26.0%**
Petroleum & coal **19.9%**
Primary metal manufacturing **9.0%**
Chemical manufacturing **6.8%**

Hazardous air pollutants
Food manufacturing **20.1%**
Petroleum & coal **19.4%**
Transportation **10.0%**
Waste management &
remediation services **7.9%**

Waste
Food manufacturing **20.8%**
Educational services **16.2%**
Apparel manufacturing **9.8%**
Hospital **7.7%**

* = The water inputs do not have percentages on purpose. The order of the sub-industries is the order of what industries consume the most water. Percentages were left out because we only looked at the addresses with the most water consumption and not at the water consumption of Portland in general.

Fig. 20   *Overview of the six inputs and outputs that have been discussed in the sections above including the largest sub-sectors contributing to these six flows.*

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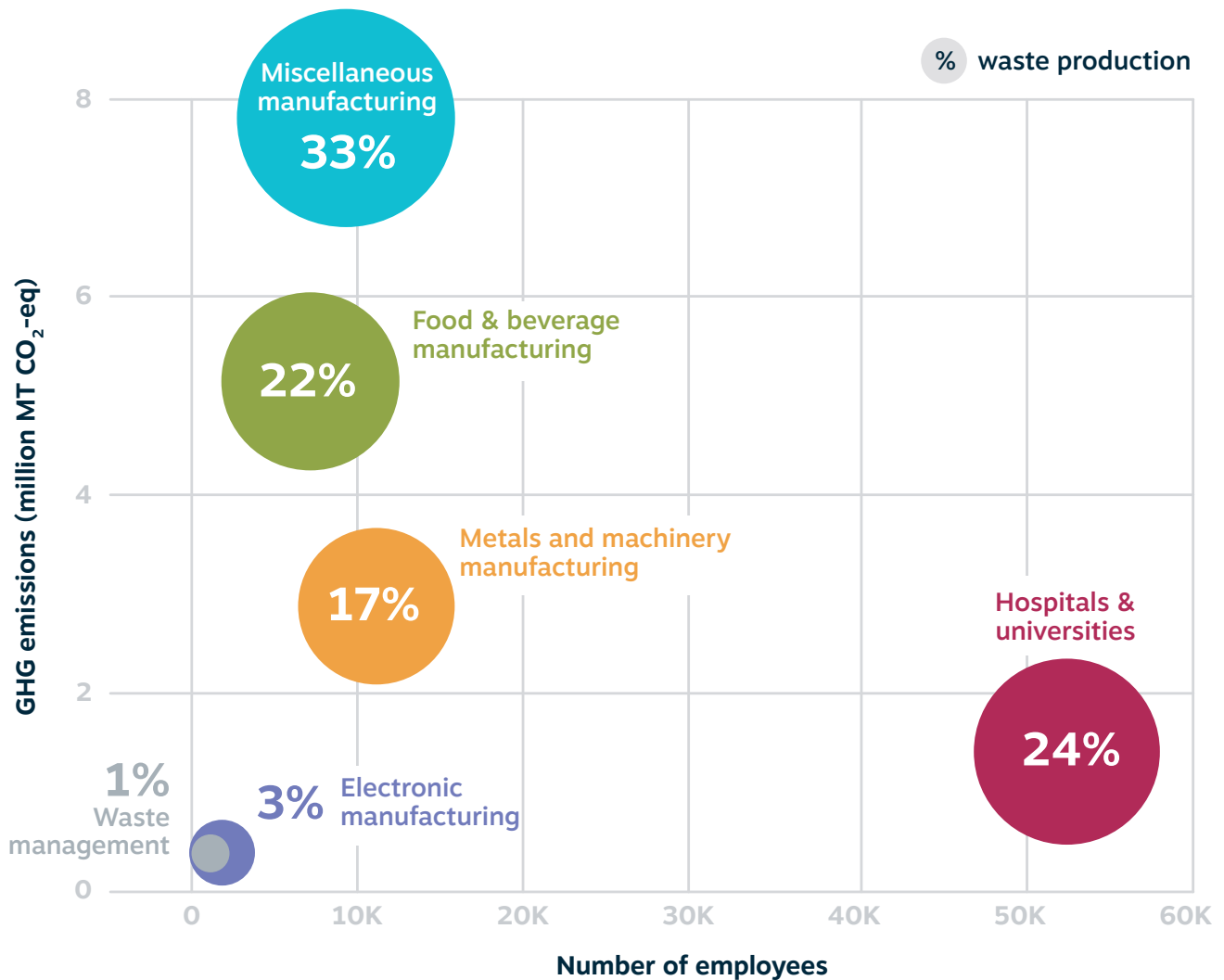
Fig. 21 *Relationship between number of employees and the GHG emissions of each of the six sectors part of the study set. The size of the bubbles represents the amount of waste production.*

When looking at the relationship between number of employees, GHG emissions and waste generation, it can be seen that while representing a small amount of employees, the miscellaneous manufacturing sector produces the highest amount of emissions and waste. Hospitals and universities on the other hand, produce a relatively high amount of waste, while having low carbon emissions compared to the other sectors.

Conclusions

The impact analysis informs us of each sector and sub-sector's largest impact areas in comparison to others. These impact areas were also factored into discussion guides for the listening sessions, as well as the global hub models research.

Food & beverage manufacturing, miscellaneous manufacturing and metals and machinery sectors have a relatively large impact compared to the size of these sectors and the impact of the other sectors.

When focusing on the sub-industries, we see that food manufacturing has the largest impact on greenhouse gasses and hazardous air pollutants. Primary metal manufacturing and chemical manufacturing have a relatively large impact in these categories too.

Additionally, we see that food manufacturing, educational services and apparel manufacturing produce a relatively large amount of waste.
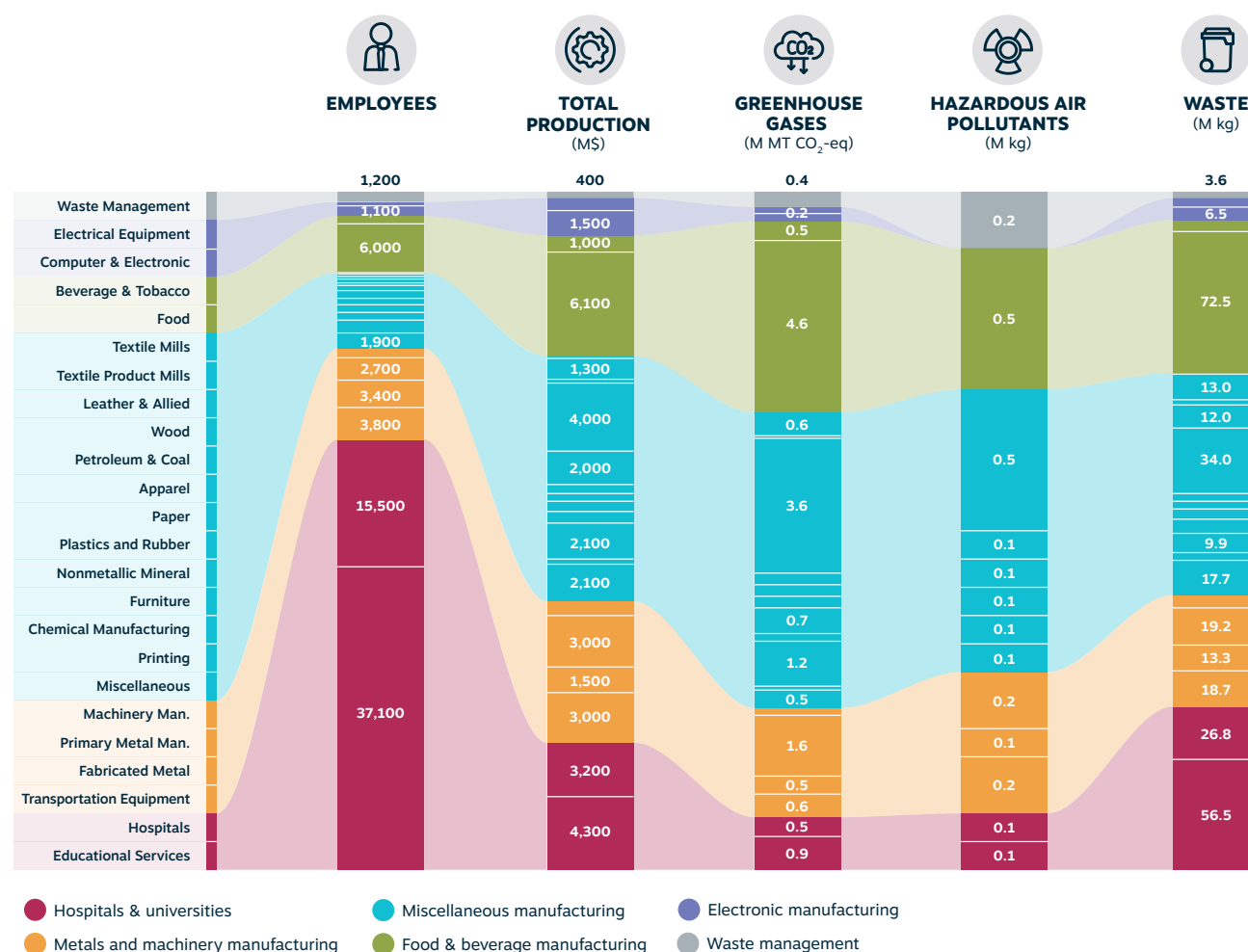
Fig. 22 *The impact of the outputs (GHG emissions, hazardous air pollution, and waste) per (sub)sector compared to employee count and total financial production.*

Food and beverage manufacturing

The impact of the food and beverage sector is high for each of the output categories. Most notable are the production of waste and greenhouse gas emissions. A small fraction is caused by the 'beverage & tobacco' sub-sector, but the most significant share is related to the manufacturers in the 'food' sub-sector.

Regarding inputs, the food manufacturing sub-sector is also third highest in energy consumption (32,015 TJ), third highest in material input (4,970 thousand metric tons) and is represented in the facilities with the highest water consumption (+- 150 million gallons per year for one facility).

Metals and machinery

The metals and machinery industrial sector is the largest manufacturing sector in our study set in terms of employees, and is only surpassed by the (non-manufacturing) hospitals and universities sector. The sector is responsible for a relatively large share of the hazardous air pollutants and greenhouse gas emissions: both the third largest impact of this study set. Regarding energy consumption it is the second largest consumer overall and the largest consumer of electricity specifically. The facility that ranks fifth largest consumer of water is a business in the primary metal manufacturing sub-sector.

Within the metals and machinery sector, it is most interesting to focus on the businesses in the transportation equipment manufacturing and the primary metal manufacturing sub-sectors.

Electronic manufacturing

The electronic manufacturing sector in Portland is relatively small and the consequential impacts are too. The sector has a relatively small impact on the output categories. On the other hand, the facility with the largest water consumption is part of the electronics manufacturing sector. For this sector, it is therefore relevant to look closely into water consumption.

Miscellaneous manufacturing

In Figure 23 the outputs of the miscellaneous manufacturing subsectors relative to the amount of employees and total production value are shown in more detail. Within the sector the manufacturing of petroleum and coal products generates a relatively large amount of greenhouse gases and hazardous air pollutants. However, the impact of the petroleum and coal sub-sector is based on national data and that is not representative of the situation in Portland. On a national level, most impact in this sub-sector is caused by refineries and the companies in Portland in this sector are not refineries and produce different petroleum and coal products. To determine the actual input and output impacts, further analysis with regional data would be required.

Looking further, chemical manufacturing is the second largest contributor to greenhouse gases and air pollution. The largest impact in waste production is caused by apparel manufacturers.

Overall, the miscellaneous manufacturing sector is the largest consumer of materials (10,400 thousand metric tons) and consumes the most energy (143,703 TJ) in this study set. On the other hand the sector is not represented in the ten most water-using facilities of Portland.
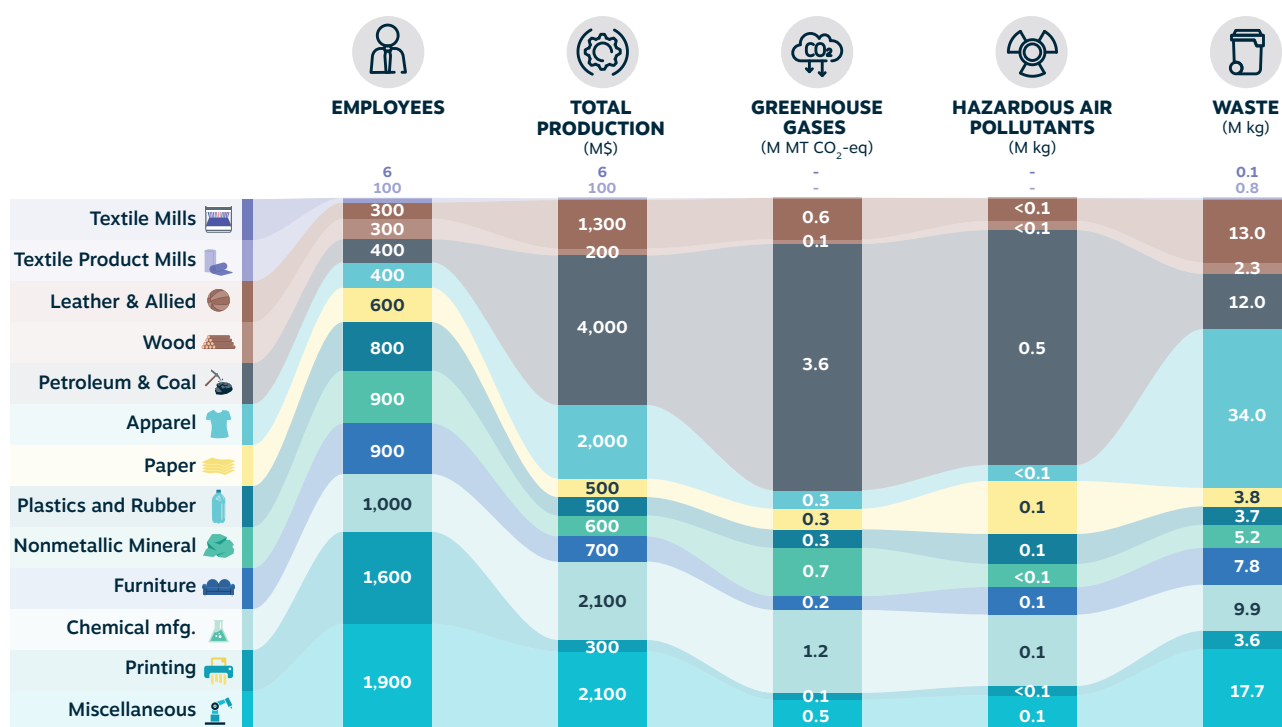
	EMPLOYEES	TOTAL PRODUCTION (M$)	GREENHOUSE GASES (M MT CO$_2$-eq)	HAZARDOUS AIR POLLUTANTS (M kg)	WASTE (M kg)
	6 / 100	6 / 100	- / -	- / -	0.1 / 0.8
Textile Mills	300 / 300	1,300	0.6 / 0.1	<0.1 / <0.1	13.0
Textile Product Mills	400	200			2.3
Leather & Allied	400				12.0
Wood	600	4,000			
Petroleum & Coal	800		3.6	0.5	
Apparel	900				34.0
Paper	900	2,000			
Plastics and Rubber	1,000	500	0.3	<0.1	3.8
Nonmetallic Mineral		500	0.3	0.1	3.7
Furniture	1,600	600	0.3		5.2
Chemical mfg.		700	0.7	0.1	7.8
Printing		2,100	0.2	<0.1	9.9
Miscellaneous	1,900	300	1.2	0.1	3.6
		2,100	0.1 / 0.5	<0.1 / 0.1	17.7

Fig. 23 *The impact of the outputs of each sub-sector in the miscellaneous manufacturing sector relative to the amount of employees and total production value per sub-sector.*

Hospitals and universities

The hospital and universities sector is the largest sector in this study set. The sector ranks second in waste production and relatively low in greenhouse gas emissions and hazardous air pollution. Regarding water consumption there are two facilities, one educational facility and a hospital facility, that rank in the top ten of large water consumers. The material input in this sector is mostly 'mixed freight' and is used in the educational sub-sector. For this sector it is most important to look into waste management and water consumption.

Waste management

The waste management sector has a relatively large impact of hazardous air pollutants in regard to the size of the sector in Portland. The material input in the waste management sector is 5,000 thousand metric tons which is the second largest input in the study set. Material handling is the core business of the waste management sector and in that sense it is not the aim to minimize the amount of material they handle but rather how they handle it. Waste management is a connecting factor between the industrial sectors for how much material is regarded as waste and how the output materials of industry are handled.

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Key opportunities from an impact perspective

The outcomes of the impact analysis can be used to identify where and how to focus on the biggest impacts that can be achieved moving towards a clean industry in Portland. Solely from this impact analysis, some key opportunities can already be identified, which are shown in Figure 24. To dive deeper into these and other challenges and opportunities, supplementary research was conducted, including engagement with relevant stakeholders. The outcomes of this additional research are described in the next section.

Food & Beverage

High in waste, emissions and pollutants is ideal for an integral approach

Metals & Machinery

High in CO_2 and heat production that could yield production in other sectors

Electronic

The impact is limited but they are very linked to the mindset transition that is needed to push forward all the other sub-sectors.

Miscellaneous

Focus on its textile outputs which represent one of the most impact waste streams

Hospitals & Universities

The high volumes of waste could be recycled/reused in same or other place-based facilities

Waste management

The waste processing represents a great opportunity for all industries.

Fig. 24 *The key opportunities for each sector from an impact perspective.*

03 Assessment of Challenges and Opportunities for Clean Industry
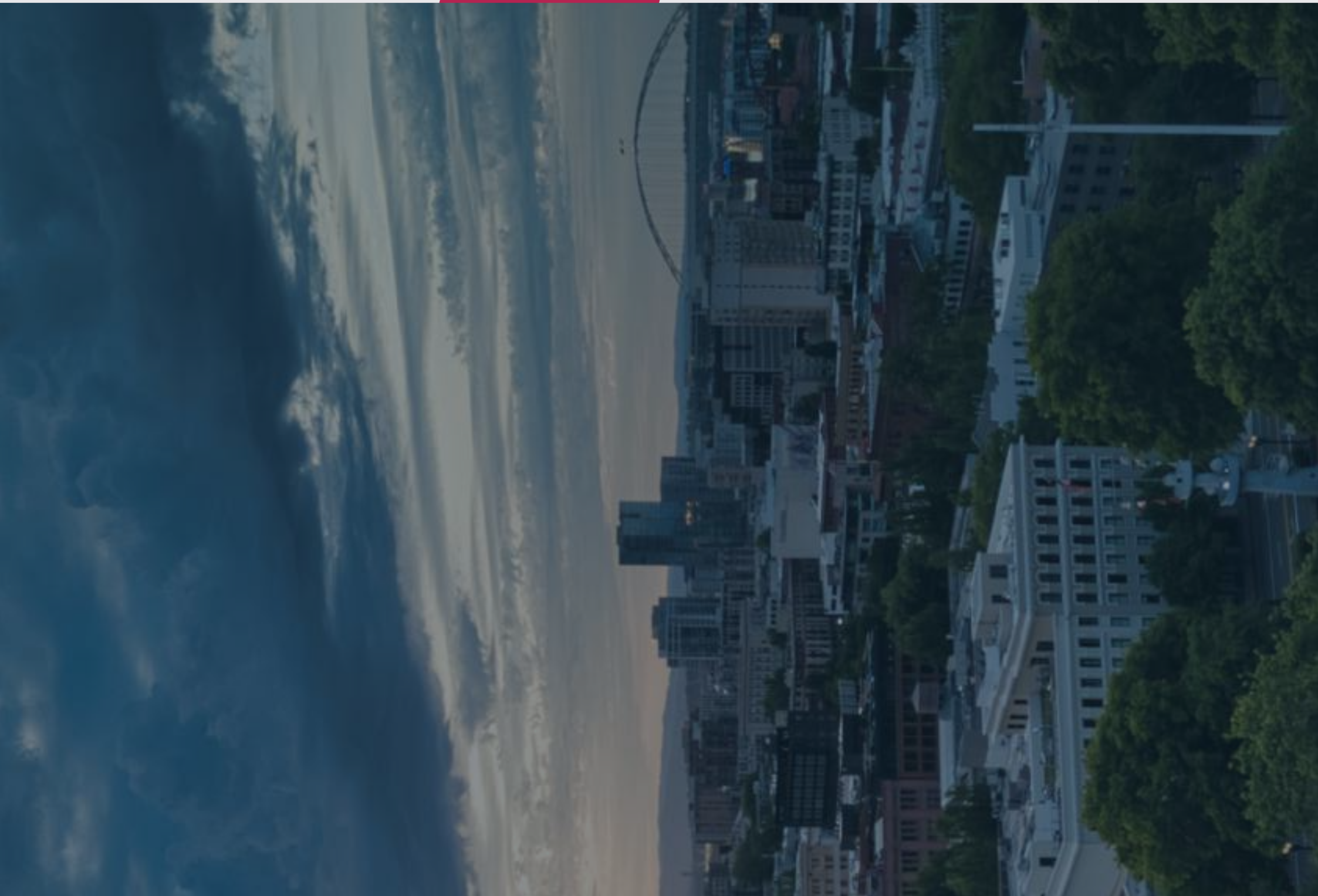
ENGAGEMENT APPROACH

The assessment of key challenges and opportunities for fostering clean industry in Portland comprises three components aimed at engaging local industrial actors and gaining insights into the context of clean industrial development in the area. Furthermore, these results contribute to our understanding of how these actors perceive and address various issues related to clean industries.

The three components include a survey, listening sessions, and a review of reports and publicly available information. These elements are interconnected as the findings from the survey and the report review are utilized to refine the approach for the listening sessions.

First, we will discuss the overall methodology, and then we will present the consolidated results as key insights. These insights serve as the foundation for the development of a roadmap, guiding future actions in promoting a clean industry in Portland.

METHODOLOGY

SURVEY

The purpose of the survey was to gauge the current state of sustainability in industrial actors and their familiarity with existing clean industry programs. The main three themes of the survey were:

• Background information on the business,

• Current sustainability practices, perceived barriers and motivation to address the topics

• Knowledge of available resources and network.

The survey was sent out by the Portland Bureau of Planning and Sustainability to local businesses and industries with data collected and managed by Metabolic. Confidentiality was guaranteed for participants, for additional information about the survey see Appendix V.
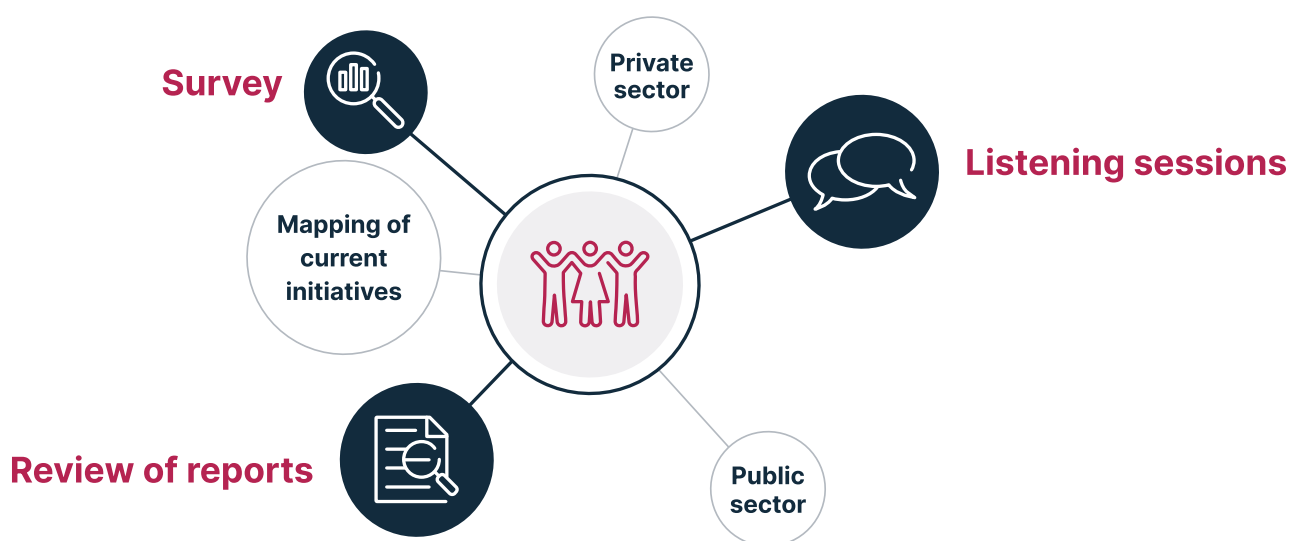
Fig. 25 *Overview of the different engagement components.*

LISTENING SESSIONS

The listening sessions are used to deepen the understanding of challenges and opportunities of industrial stakeholders. These sessions included one-on-one interviews and group interviews with businesses within a sector.

Utilities, non-profit organizations, and government entities

The primary objective of the initial interviews was to gather background information from organizations and utilities on the existing conditions, challenges and opportunities for clean industry initiatives. Additionally, the interviews provided an opportunity to gather more data and information for the impact analysis. Eight interviews were conducted: Energy Trust of Oregon (ETO), Oregon Department of Environmental Quality (DEQ), Portland Bureau of Environmental Services (BES), Energy utility companies (Pacific Power, Portland General Electric, and NW Natural), Oregon Manufacturing Extension Partnership (OMEP) and Neighbors for Clean Air. See Appendix VI for the description of these entities.

Local business representatives

Several listening sessions were conducted, complementing prior findings from the impact analysis, survey, and one-on-one interviews. The aim of these sessions was to connect local businesses with each other, initiate group discussions to explore the stakeholder's ambitions in relation to sustainability, as well as the key challenges and opportunities for achieving these.

The listening sessions were organized for the following stakeholder groups:

- Waste management and remediation services
- Glass and glass product manufacturers
- Heavy industry (a combined group of metals and machinery manufacturers and miscellaneous manufacturers such as non-metallic mineral product manufacturers)
- Higher education institutions
- Hospitals and Health services
- Apparel manufacturers
- Food and beverage manufacturers

REVIEW OF REPORTS AND PUBLICLY AVAILABLE INFORMATION

In addition to the two types of engagement, we conducted a review of relevant reports and publicly available information to complement our findings. This review encompassed various sources, including the Advance Portland strategy and Economic Opportunity Analysis.

LIMITATIONS

The results from our engagement cannot be assumed to apply to all industries in Portland. This is primarily due to the small sample sizes in both the survey and listening sessions. However, by drawing on multiple data sources, our findings do provide valuable insights into barriers and opportunities.

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KEY INSIGHTS

The section below discusses key insights that emerged after integrating findings from the impact analysis, survey, and listening sessions.

SUPPORTIVE CONDITIONS FOR CLEAN INDUSTRY

Portland has a growing and highly educated working-age population that is followed by a significant portion of young people living in the city. Demographically, Portland is primed to implement the new technological, economic and structural developments that form the basis of sustainable industrial development. Portland's population is highly educated coming mostly out of public schools that can deploy and expand innovation in the industrial sector.

INDUSTRY CONTRIBUTIONS AND VIABILITY

Industry is essential to the well-being of Portland. These businesses provide a significant number of jobs and contribute tax revenue that funds essential city services. In addition, jobs in the industrial sector provide middle-wage jobs, including for people without bachelor's degrees, and raise the income of BIPOC[2] workers relative to other sectors.[3] At the same time, increasing costs of doing business in Portland, regulatory hurdles and workforce shortages challenge business competitiveness and viability.[4,5]

CLEAN INDUSTRY BUSINESS SUPPORT

Portland is home to a broad and rich ecosystem of services designed to help businesses improve efficiency or grow clean industry business opportunities. Within the scope of this study we have assessed the experiences and perspectives of OMEP, OMIC, ETO, and DEQ. This list is not exhaustive and a brief description of these organizations and additional entities can be found in Appendix VI.

However, the majority of businesses are not aware of these resources or do not avail themselves of these opportunities. Further, the abundance of services is difficult to navigate. Entrepreneurs need a more streamlined way to identify and navigate resources and make informed decisions. In addition, many of these services are under-resourced or under-connected[4] and gaps remain (e.g., assistance identifying IRA opportunities). Better integration of these supports is recommended, as is greater technical and financial assistance for green process consulting and innovation related to clean industry, clean tech and advanced manufacturing.[4]

Besides better accessibility and visibility it has also been suggested to consider to scale certain programs to also address other issues. For example, Energy Trust of Oregon's programming could be broadened to not only increase energy efficiency but also to increase material efficiency within industry.

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[2] *Black, Indigenous, and People of Color (BIPOC).*

[3] *Economic Opportunity Analysis. Note that this does not include hospitals and universities and industry is defined more broadly than in this study. However, the overall theme of opportunity jobs applies. Information about jobs by sector, including wages and BIPOC representation can be found in Advance Portland (full report).*

[4] *Advance Portland*

[5] *https://olis.oregonlegislature.gov/liz/2021I1/Downloads/CommitteeMeetingDocument/257897; https://portlandmetrochamber.com/resources/2023-tax-comparison/*

WORKFORCE SKILLS AND EXPERIENCE

Access to skilled labor is one of the main challenges for businesses. Several businesses mentioned that they do not care who walks through the door as long as they can do the work, yet employers currently often have low investment and engagement in workforce training,

The value of building a local ecosystem of industrial training and effective workforce pathways into green manufacturing was identified as an opportunity, as investing in training and employment opportunities for marginalized individuals attracts and retains a skilled workforce.

Also communicating the opportunity for workers in the manufacturing for a clean economy is important. Overall, expertise and knowledge gaps hinder the independent implementation of energy efficiency and sustainability solutions.

A number of initiatives are underway to address these gaps. Examples include Worksystems' Next Generation Manufacturing Partnership, Portland State University's Future Ready workforce development project, and Portland Community College's (PCC) Machine Manufacturing Technology Program with Oregon Manufacturing Innovation Center (OMIC). These are important initiatives, many of which are just getting underway. At the same time, there is a need to better integrate talent development efforts.[4]

CLEAN INDUSTRY COMPETITIVENESS

Portland's aspiration to become a clean industry leader faces both opportunities and challenges. Portland is strategically located to natural resources, has a well-educated population, is a major export hub, and has made a commitment to inclusive and climate-centered economic development.[4] In addition, Portland's priority clusters align well with our industry impact findings. Efforts to refine and deliver on cluster action plans can and should ensure that clean industry opportunities are addressed – both actions that help existing businesses with clean industry challenges and those that assist clean economy businesses to start or scale.

Yet higher costs associated with manufacturing in Portland can sometimes make it challenging for businesses to allocate the necessary time and resources to work on sustainability initiatives. These financial constraints may divert attention and resources away from implementing sustainable practices. Although the region is home to clean economy innovators, many of them are located outside the city. The reality that economies function at a regional scale suggests that a metropolitan approach may be appropriate to the clean industry work. The regional approach favored by many of the federal decarbonization investments affirms this finding.

ACCESS TO LAND

Portland manufacturers seeking to expand, or new businesses seeking to locate, face a constrained supply of available land.[3] Existing infrastructure will have to be modernized and new infrastructure to be supplied to enable and keep up with changes in the industrial sector. Waste facilities expressed that they have difficulty in obtaining permits and land use, particularly for composting sites, and hospitals and universities expressed that space constraints limit capacity for efficiency improvements in occupied areas. As land supply is limited, it will be important to consider where and how land-based opportunities can support the clean industry vision.

The Port of Portland has already played a significant role in developing large-lot industrial parcels, and is currently developing a new clean industry campus at its Terminal 6 facility for mass timber. Clean industry uses may be appropriate for land held by the Port. It is also worth noting that the IRA includes reinstatement of the Superfund Excise Tax, which may open up funding possibilities for the long-awaited Portland Harbor cleanup, potentially making available new working sites for clean industry. With site control, it can be much easier to determine the types of businesses and industrial processes that are contiguous to each other. This can create conditions for circular and symbiotic solutions.

Prosper Portland and BPS can also align clean industry strategy around geography. For example, the City is currently evaluating the creation of new tax increment finance (TIF) districts on the Eastside, as well as a new district for the Central City. These include potential clean industry industrial areas that could benefit the community without the environmental impacts of legacy industries. Critical infrastructure investments could be made with TIF, if they meet conditions for a clean and inclusive economy. Prosper could also align the Enterprise Zone (E-Zone) tax abatement program with clean industry objectives.[6]

DATA AND MONITORING

Developing cleaner practices starts with understanding the current baseline and setting a pathway forward. Creating an accurate picture of emissions, energy use, and waste stream remains a challenge for Portland manufacturers. And once improvements have been identified and implemented, tracking progress through monitoring is essential to ensure the desired outcomes are achieved and if necessary the course of action can be adjusted. Although the use of data and the availability of tracking tools has increased over the past years, there is still a need for better-integrated use across all sectors.

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[6] *Tax increment financing (TIF) is used by Prosper Portland when the city defines an urban renewal boundary. The county assessor "freezes" the assessed value of real property within the urban renewal district. Urban renewal districts raise money by borrowing against future growth in property taxes. The city uses the borrowed money to pay for capital improvements, which spur more development. As the city and others invest in the urban renewal area, property values go up. The property taxes above those that were collected when the values were "frozen" – the tax increment – are used to repay the loans used for the improvements in the urban renewal area. When the urban renewal district expires in 20-25 years, the intent is to return a much higher property tax base to the tax rolls. https://prosperportland.us/faq-items/what-is-tax-increment-financing/*

The Oregon Enterprise Zone (E-Zone) Program is a state economic development program that allows property tax exemptions for up to five years in exchange for certain public benefits. Participating firms are required to meet the program requirements set by state statute and the local sponsor. https://prosperportland.us/portfolio-items/portland-enterprise-zone/

INCLUSIVE PROSPERITY AND COMMUNITY BENEFIT

Clean industry poses an opportunity to eliminate environmental harms caused by industrial GHG emissions and air pollution, while also creating meaningful benefits for surrounding communities and industrial workers. Low-income and people of color in Portland are disproportionately harmed by air pollution and climate impacts, and many industrial facilities are located in or near low-income communities and communities of color. Reducing industrial GHG emissions and air pollution will help mitigate the longstanding harms of systemic racism and environmental injustice in these communities.

Employment opportunity is strongly correlated with better health outcomes and life expectancy. However, employment opportunities are not distributed equally among a community, going to workers who have the skills, experience, and mobility to take advantage. While the industrial sector provides access to good wage jobs for BIPOC populations, these populations are underrepresented and underserved in high-growth career pathways and in clean economy business ownership and development.4 Programs and organizations such as the industry-driven Next Generation Sector Partnership for manufacturing, Portland Community College's green workforce development curriculum, and Worksystems' clean sector and manufacturing focus areas are local assets that will support equitable outcomes in the clean industry transition. Additionally, collaboration with Oregon State University provides businesses with access to valuable resources and programs that address both workforce and sustainability challenges. This partnership enables businesses to tap into the expertise and research capabilities of the university to drive sustainable innovation and growth.

Clean industry benefits from shared projects and community-driven goals. The air quality advocacy organization Neighbors for Clean Air identifies the need to go beyond decarbonization efforts and focus on addressing air quality concerns comprehensively with a holistic approach. It is crucial to develop strategies that take into account localized community benefits, as this approach can have a greater impact in reducing pollution. For example, in 2016 Neighbors for Clean Air and Vigor Industrial signed a Good Neighbor Agreement requiring ships docked at Vigor's Swan Island shipyard to connect to shore power as a way to reduce diesel emissions, leading to improved air quality in the surrounding neighborhoods, fewer GHG emissions, and reduced operating costs for Vigor.

Awareness of clean industry benefits Addressing climate issues provides an opportunity to let the economy thrive while also contributing to inclusive prosperity. This occurs as new products and services are developed, energy and related costs are reduced for firms, government costs are reduced, and resilience and quality of life are improved. However, although the benefits are many, the concept and value proposition are currently not broadly understood. Creative solutions to build understanding and enthusiasm have been identified by stakeholders. Examples include hosting block parties with industry peers, developing clean industry career maps, and sharing success stories. Another example is a 'whole chain approach' suggested by waste management facilities to identify key areas along the supply chain where environmental impacts can be reduced, to drive a more systemic change.

POLICY AND REGULATION

The need for supportive policy and regulation was another key theme, and is addressed more fully later on in this report. It's important to understand the realities of businesses competing in a global and regional market. This means ensuring a strong tax value proposition and ensuring that the balance of positive and negative incentives supports businesses with the transition to clean and inclusive practices without pushing them to close or relocate.

One example of regulatory challenges was observed with the food and beverage sector. Specifically, current permitting hinders the use of alternative waste management methods. Additionally, the requirement of a steady waste volume in waste management facility contracts does not incentivize alternative waste management methods. For the businesses in the 'heavy industry' sector, the permitting process for a new sustainable facility is time-consuming and complex and the challenges are not understood well enough by the city. The Recycling Modernization Act provides an opportunity for innovation of the waste management methods and technologies and should be leveraged intentionally.

Effective collaboration and leadership
The importance of effective collaboration cannot be overstated. Achieving the clean industry vision requires support and participation by the full range of stakeholders – private, public, nonprofit, academic, and philanthropic. Currently, this system is not well-defined or organized. Despite interest and assets, Portland has been unable to apply for and compete for many of the federal clean industry investments that have begun to flow.

Advance Portland strongly encourages members of the public, private, and civic sectors to heighten their capacity to engage in collaborative, cross-sector efforts. Models for doing so exist locally and globally, however, specific challenges to doing so must be acknowledged and addressed. Challenges include a context that is politicized and fragmented, with hesitancy and distrust among some stakeholders, and a history of prior collaboration strategies often not receiving sufficient funding, political will, or commitment to realize implementation.[4]

Private sector leadership is a critical ingredient. As noted in Advance Portland, green growth opportunities must be private sector led and include collaboration across sectors and clusters. Existing assets are in place to support this success, including potential entry points for outreach and organization for sectors, issues, and geographies. Examples include Prosper Portland Cluster leads; business associations such as Columbia Corridor Association and Central Eastside Industrial Council; and business assistance providers such as Energy Trust of Oregon, OSU Industrial Assessment Center, OMIC, and OMEP; and industry collaborations such as Community Co-Pack (existing) and Textile Recycling and Logistics (proposed). Not all of these assets are well known amongst businesses and not every asset has delivered satisfactory results according to businesses.

In addition, clean economy business leaders can play an important role in sharing with peers how a clean industry can help improve competitiveness, build the brand, and grow the workforce. Enhanced opportunities for peer learning

may be a productive step to address user-identified challenges. Suggestions include collaborative research between private sector firms and universities or research labs, and better integration of both research and workforce efforts among higher education institutions.[4]

04 Global clean industry examples

Numerous initiatives worldwide have aimed to foster cleaner industrial sectors, and most industrial innovation is happening outside of the United States. To support the transition towards clean industry in Portland, we are therefore leveraging insights from global clean industry examples. With this, Portland has an opportunity to be at the cutting edge of American clean industry and climate action.

This section focuses on identifying national and international clean industry hub models, summarizing key lessons learned in terms of geographic scale, industry sectors, structure and governance, funding mechanisms, durability, and impact. The lessons learned from the clean industry solutions are summarized per strategy at the end of this section.

The insights below draw on extensive research, including a review of existing literature and reports. Each global model is analyzed based on three primary aspects: the clean industry transition strategy it advances, the enabling factors present, and the measurable impacts of the initiative.

Each of these aspects is explained in further detail below.

Business Support

Effective Collaboration Structures

Industry and Higher Education Connections

CLEAN INDUSTRY

Funding and Finance

Transformative Investments

Strong Brand and Engagement

Supportive Policy and Regulation

Fig. 26   *The seven core strategies that can be used to drive the clean industry transition.*

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STRATEGIES

We identified seven core strategies that can be used to drive the clean industry transition. This strategy framework outlines different potential areas of focus for various actors to become involved in a clean industry initiative. The strategies were informed by our research and are presented here so that we can reference them in the global examples described below. The seven strategies in our framework are as follows:

Business Support: Businesses have a user-friendly pathway to identify and implement clean industry actions.

Industry and Higher Education Connections: Effective linkages between and among industry and higher education enhance clean industry talent development and research.

Transformative Investments: Opportunities for large scale clean industry investments, such as industrial symbiosis or green hydrogen, have been assessed and adopted.

Supportive Policy and Regulation: Policies and programs facilitate adoption of clean industry practices.

Strong Brand and Engagement: Effective communication and outreach leads to workers, businesses, and others engaging in the clean industry opportunity.

Funding and Finance: Diverse sources of capital enable the clean industry transition - both industry adoption of solutions and the collective impact infrastructure.

Effective Collaboration Structures: Progress toward the shared vision is enabled through strong coordination, communication, and continuous learning.

Within the clean industry strategy framework, technology plays a crucial role, primarily through transformative investments and assisting businesses in identifying and implementing solutions. The report highlights specific technology examples as potential solutions to address challenges identified within the different industry sectors in Portland.

ENABLING FACTORS

Enabling factors refer to the circumstances that have contributed to the success of clean industry examples. As detailed below, we identified nine enabling factors that may influence the success of an initiative. The presence or absence of a specific factor does not determine an initiative's success; however, without any of the enabling factors present, a clean industry hub is likely to fail. In our evaluation of each example, we have assessed the alignment of these enabling factors with the specific context of Portland.

The enabling factors in the context of clean industry examples are as follows:

Technology: Advanced and efficient technologies play a crucial role in driving the success of clean industry examples. These technologies enhance productivity, reduce environmental impact, and improve overall efficiency, making them suitable for adoption in various contexts.

Policy & Funding: Supportive policies and adequate funding incentivize the adoption of clean technologies and practices, while sufficient funding provides the necessary resources for implementation.

Land Use & Availability: Accessible and suitable land in desired locations, accompanied by necessary infrastructure and zoning regulations, facilitates the establishment and expansion of the industry.

Partnerships: Collaborative partnerships with relevant stakeholders, including government entities, research institutions, and industry associations, provide vital support and expertise for the success of clean industry examples. Building partnerships with local organizations enhances the implementation and scalability of such initiatives.

Expertise & Skills: Trained professionals, specialized knowledge, and technical skills are necessary for effective implementation and operation of clean industry practices.

Resource Availability (Physical): Sufficient availability of physical resources, such as raw materials, waste streams, energy sources, water, and land, supports the success of clean industry examples. Evaluating the availability and sustainability of these resources is important to ensure the viability of such initiatives.

Finance: Adequate financial resources and investment are critical for clean industry development. Access to capital, loans, grants, and other financial mechanisms enables necessary infrastructure development, research, and operational activities.

Data & Metrics: Data-driven decision-making, monitoring, and evaluation allow for continuous improvement and informed policy development. Access to relevant, reliable data and performance metrics enables effective implementation and assessment of clean industry initiatives.

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MEASURABLE IMPACTS

Clean industry initiatives can have a range of positive impacts across different categories. The five impacts we considered when reviewing examples are as follows:

Socio-economic Impact: Clean industry initiatives offer significant socio-economic benefits, including increased revenue and job creation, promoting economic growth and a sustainable local economy.

Material Impact: Implementing clean industry initiatives leads to material savings and waste diversion, reducing the demand for raw materials, and contributing to a circular economy, minimizing resource depletion and waste generation.

Emissions Impact: Clean industry initiatives can result in substantial reductions in greenhouse gas emissions, helping mitigate climate change and aligning with regional emission reduction goals.

Energy Impact: Clean industry initiatives can save significant amounts of energy through the adoption of energy-efficient technologies and practices. Some examples also contribute to renewable energy production, enhancing energy sustainability and resilience.

Water Impact: Clean industry initiatives promote water conservation through sustainable water management practices, reducing water usage, and promoting responsible water stewardship.

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CLEAN INDUSTRY EXAMPLES

We have curated a selection of clean industry examples that encompass various strategies discussed earlier, ensuring their relevance and applicability to both Portland and similar contexts with regards to the enabling environment. Additional clean industry examples can be found in the Appendix of this report.

How to read this section

Each clean industry example includes basic information about the project, the main purpose and problem it addresses, funding, and organizational structure.

Each example is also evaluated on the three important aspects outlined above: the presence of various enabling factors, which strategy(s) it advances, and the measurable impacts of the project.

The last three examples have been highlighted purple, as they focus on a technological solution to a barrier specific to Portland..

The following "Lessons Learned" section gives suggestions on how to apply these findings to Portland's local context.

CASE STUDY 1:

National Industrial Symbiosis Programme (NISP)

GEOGRAPHICS AND SCALE

Location: Originated in the United Kingdom and replicated in 34 other countries, amongst which Canada and South Africa.
Scale: National

Description:

Timeline: 2005 - 2013 (UK), 2017 - 2019 (Canada)

The National Industrial Symbiosis Programme (NISP) identifies and facilitates profitable transactions between companies, including micro, small and medium businesses (SMEs) and multinationals. The programme addresses the challenge of establishing industrial symbiosis partnerships. NISP® is a registered trademark product that was developed in the United Kingdom and was operated there between 2005 and 2013. It has since been implemented in other countries, for example NISP Canada is implemented as a pilot programme between Oct 2017 and May 2019.

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National Industrial Symbiosis Programme (NISP)

Investments

The projects in the UK, Canada and South Africa are each financed with government funding. In Canada the project was funded $1M for a 1.5 year programme on a cost-recovery basis. There is no cost for businesses to participate in the programme.

Organizational structure and partnerships

The NISP is a national programme that is executed by a not-for-profit or commercial organization. One of its key strengths is the use of local or regional facilitators to help in workshops for coaching businesses.

Enabling factors

Partnerships:
The NISP program focuses on fostering connections between businesses, with the coordinating company taking responsibility for research and communication in establishing industrial symbiosis.

Resource availability:
The program's success relies on businesses seeking solutions for their residual waste and actively engaging in the circular economy. The NISP facilitates the process by identifying suitable recipients for these waste streams.

Measurable impacts

	United Kingdom	Canada	South Africa
CO_2 reduction	42 million tonnes	23,900 tonnes	435,000 tonnes
Waste diversion from landfill	47 million tonnes	253,800 tonnes	135,000 tonnes
Industrial water savings	-	1,153,000 m^3	-
Financial benefit	£1 billion new sales + £1 billion cost reduction	$ 6,347,900 (total sales and savings)	R150 million
Jobs created	10,000	-	398

Strategies

- Business Support
- Funding and Finance
- Effective Collaboration Structures

CASE STUDY 2:

CIRCULÉIRE

GEOGRAPHICS AND SCALE
Location: Ireland
Scale: National

Description:

Timeline: 2020 - 2022 (three years), with extension to 2023

CIRCULÉIRE is an industry-led innovation network that supports industry members to deliver reductions in CO_2 emissions and waste. Its objective is to source, test, finance, and scale circular manufacturing systems, supply chains and circular business models to deliver significant reductions in both CO_2 emissions and waste. The activities include baselining, auditing, business case development and deep demonstration innovation projects. The program is cross-sectoral, with a main focus on construction, furniture, and medical devices, plastics and textiles sectors.

Investments

The initial funding was €4.5 million, with additional funding of €1.5 million from the Irish Government. The initial funding is governmental funding only.

Organizational structure and partnerships

CIRCULÉIRE is a public-private partnership created by Irish Manufacturing Research and the department of the Environment, Climate and Communications, the Environmental Protection Agency (EPA) and EIT Climate-KIC, and 25 Founding Industry Members. The Network Members (both Founding Industry Members and other industry partners) can apply for funds and lead Innovation Demonstration Projects. They are encouraged to partner within and outside of the network.

Enabling factors

Funding: The project receives funding from both the government and potentially the private sector through network memberships. The Irish government has provided additional funding, extending the project from three to four years.

Partnerships: The network provides members with access to knowledge and funding from partner organizations. Furthermore, members are encouraged to collaborate with external organizations, expanding the network of relevant and interested partners.

Expertise & Skills: The projects benefit from the support of partners specializing in manufacturing research (IRM), who contribute their expertise and skills.

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CIRCULÉIRE

Measurable impacts

No recorded/measured impacts of the programme overall (the project is ongoing).

Strategies

- Funding and Finance
- Effective Collaboration Structures
- Supportive Policy and Regulation

CASE STUDY 3:

Zero Waste Scotland

GEOGRAPHICS AND SCALE
Location: Scotland (UK)
Scale: National

Description:

Timeline: 2010 - current

Zero Waste Scotland (ZWS) is a not-for-profit organization to drive policy and change the mindset and practices of individuals and businesses to embrace a circular economic model. They produce specific plans and a "Route Map" for advancing circularity. In addition, they have issued direct innovation grants in the textiles and recycling industries. It also operates as an information clearing house for EU funding opportunities. ZWS serves as a partner to Scottish institutions in grant applications to the UK Research and Innovation fund.

ZWS focuses on the Construction, Food & Drink, Organics & Bioeconomy, Manufacturing, and Textiles sectors.

Investments	Enabling factors
The initiative is funded entirely as an arm of the Scottish Government. The Scottish Government launched a £70 million five-year Recycling Improvement Fund (RIF) in 2021 to provide opportunities for capital funding grants for local authorities to improve recycling infrastructure and services across Scotland. Zero Waste Scotland will manage and administer the Fund across its five-year life.	**Funding:** ZWS was incubated as a fully-owned subsidiary of the UK Charity, The Waste and Resources Action Programme (WRAP). This allowed ZWS to directly fund projects and issue innovation grants. The program also helped with information gathering for EU funding opportunities, ensuring access to additional funding schemes.

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Zero Waste Scotland

Organizational structure and partnerships	Enabling factors
ZWS is a not-for-profit organization funded by the Scottish Government. It is led by a non-governmental CEO, who answers to a board of directors consisting of academic, technical, and community leaders (no prominent businesses). The board operates under the auspices of Scottish Government ministers.	**Policy:** ZWS leveraged the existing OECD policy framework for the circular economy, and its policies are informed by research and higher education through the Circular Economy Resource Center at the University of Edinburgh. Scottish policies fall under the UK Carbon Reduction mandate and the UK Emissions Trading Scheme.

Measurable impacts

The major impacts of ZWS have come through new government regulations. ZWS is currently advancing a more ambitious Circular Economy Bill, which would develop plans and targets for each sector with expanded enforcement authority and funding to support business transitions.

Strategies

- Supportive Policy and Regulation
- Strong Brand and Engagement
- Funding and Finance

CASE STUDY 4:

ReHubs (by the EURopean Apparel and TExtile Confederation, EURATEX)

GEOGRAPHICS AND SCALE

Location: Europe
Scale: International

Description:

Timeline: 2020 - current

ReHubs is a joint initiative coordinated by EURATEX for industrial recycling (fiber-to-fiber) of textile waste streams and circular materials. The goal is to create a network of companies to help develop the market for industrial textile waste recycling in Europe. Through ReHubs, EURATEX is looking to serve as a matchmaker between companies to advance circular economy solutions. The first of these projects is called "Transforming Waste into Feedstock," an initiative led by Swiss company Texaid. It aims at further developing and scaling sorting technologies with the objective to create by 2024 a facility capable of recycling 50,000 tons of textiles per year using materials sourced in Central Europe and the US.

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ReHubs (by the EURopean Apparel and TExtile Confederation, EURATEX)

Investments

EURATEX is a membership-based model of industry groups.

Organizational structure and partnerships

EURATEX is an international textile trade association with membership consisting entirely of EU-member state national trade associations. Additionally it **features partnerships with some signature brands.** It is an entirely industry-led and funded organization, registered as an international non-profit organization. EURATEX serves as the industry response to EU regulations on textiles, working with other industry groups and supporting R&D. EURATEX' overall goal is to create a favorable environment within the European Union for manufacturing of textile and clothing products.

The ReHubs initiative is governed by EURATEX on three levels: the ReHubs Task Force (national textile and apparel associations focusing on the general strategy), the Business Council (companies committed to invest in ReHubs and finance the Technical Economic Master Study), and the Stakeholder Forum (interested stakeholders who wish to use or contribute to the ReHubs initiative).

Enabling factors

Funding: The organization operates solely through industry funding and is driven by industry leaders.

Regulatory: ReHubs is designed to support compliance with the EU directive that requires member states to separately collect their textiles by 2025.

Partnerships: EURATEX aims to facilitate circular economy solutions by acting as a mediator between companies, connecting them through the ReHubs initiative.

Expertise & skills: The organization's industry-led nature ensures that experts with comprehensive knowledge of technological barriers and opportunities are actively engaged in the initiatives.

Measurable impacts

No data available

Strategies

- Supportive Policy and Regulation
- Strong Brand and Engagement
- Funding and Finance

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CASE STUDY 5:

Circular Flanders

GEOGRAPHICS AND SCALE
Location: Flanders, Belgium
Scale: Regional scale

Description:

Timeline: 2020 - current

Circular Flanders is a 'hub' and source of inspiration for Flanders' circular economy. It is a partnership between different stakeholders that want to set up initiatives related to the circular economy. They come up with targets together and define strategies around six themed strategic agenda's:

• Circular construction
• Chemistry & plastics
• Water loops
• Bioeconomy
• Food chain
• Manufacturing

Investments	Enabling factors
The Flemish government will invest around 120 million euros in circular innovation in the period 2019 and 2022. Flanders is also investing further in research and monitoring of its own performance with the CE Monitor and a new Circular Economy Support Center for the period 2022-2026.	**Policy & Funding:** The project was initially established by the public waste agency of Flanders, OVAM, in accordance with European guidelines, ensuring a strong policy foundation and funding support. **Partnerships:** Extensive involvement of diverse stakeholders, including representation in the steering committee, fosters broad acceptance and unity among participants.

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Circular Flanders

Organizational structure and partnerships

Circular Flanders brings together different actors at all levels of the organization. The organization is a public-private partnership with representatives of 20 organizations from different sectors that together decide on the strategy and actions of the partnership. Every strategic agenda is a partnership itself and is assigned a public and private lead. These representatives are expected to think and act according to the shared ambition of a circular Flanders. They come up with targets together and define a strategy.

The steering committee reflects the 'social pentagon', including government, industry & business, local & social profit, knowledge institutions, and the financial world. The Circular Flanders operations team remains part of OVAM, the public waste agency.

Enabling factors

Expertise & Skills: The public waste agency possesses expertise in circular economy, and entrepreneurs are actively pursuing circular topics, contributing valuable skills and knowledge to the initiative.

Measurable impacts

No measurable impact yet, the partnership has structured its efforts into working on six thematic work agendas, which will yield results in the longer term. To involve society, a workshop has been launched where participants have to imagine that they live in a circular economy and have to come up with possible barriers and solutions. Circular Flanders also focuses on education, for example by hosting boot camps on the circular economy targeted to young people.

Strategies

- Industry and Higher Education Connections
- Supportive Policy and Regulation
- Strong Brand and Engagement
- Funding and Finance
- Effective Collaboration Structures

CASE STUDY 6:

Bioindustrial Manufacturing Initiative

GEOGRAPHICS AND SCALE

Location: North San Joaquin Valley, Stanislaus County, CA
Scale: Regional

Description:

Timeline: 2021 - current

To promote the circularity and innovation in the bioeconomy, as well as workforce development, the initiative aims to convert the region's abundant food and agricultural waste ("biology's natural systems") into valuable bio-based products, energy, and materials, such as bioplastics, adhesives, resins, construction materials, or fuel.

Investments	Organizational structure and partnerships
The Stanislaus County Board of Supervisors authorized the use of $10 million federal ARPA funding to jump-start the effort. $650,000 was invested in the BEAM Circular hub over a period of two years to move through coalition building and program design, research and data analysis, engagement and reporting, and strategy development towards implementation/team development and activation/investment plans. The BEAM concept was rooted in Stanislaus 2030, a public-private partnership for economic prosperity. The partners co-created an Investment Blueprint to serve as an expedited economic development strategy for a struggling region, supported by philanthropy, businesses, and the public sector. Bioproducts and Circular Economy was identified as the priority industry cluster. This is to say that the circular economy approach stems from institutional support for inclusive economic growth.	The specific initiative is housed within BEAM, which is in its early stages of development. In reality, it is being driven by Stanislaus County and the public-private partnership of Stanislaus 2030. The project is the result of significant partnerships previously established and strengthened in the region. At its core is Beam Circular, a newly established hub for the bioindustrial manufacturing industry in Stanislaus County. BEAM itself operates under the umbrella of Modesto non-profit Opportunity Stanislaus. The initiative is described as a public-private partnership (although initial funding is public) with the goal of catalyzing private investment. Civic, business, and government stakeholders were convened to create a shared Blueprint. There is a separate but connected Circular Bioeconomy Innovation Collaborative (CBIO Collaborative), a coalition co-led by UC Merced, Lawrence Berkeley National Lab, and BEAM Circular with over 25 local and state partners, focused on building regional innovation and workforce capacity in the sector.

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Bioindustrial Manufacturing Initiative

Investments

The region has a pilot and proof of concept with Aemetis Biogas, which has been awarded $7.8 million in matching grants from the California Department of Food and Agriculture to expand its dairy digester development.

It is critical to note that the partners recognized that there was a role in connecting the dots between research and capital investment, and that coordination would be required to align resources and pursue new ones. The initiative submitted, and is currently a finalist, for a $1 million from the U.S. National Science Foundation's (NSF) Regional Innovation Engines program.

Enabling factors

Technology: The pace of R&D in the field was outpacing development of bioindustrial manufacturing facilities in the area. Many unused opportunities are available to transform agricultural waste into products, materials or energy.

Policy & Funding: Because the initiative emerged out of an economic development strategy where partial focus was on these themes, the development was justified, and also funded.

Partnerships: The North San Joaquin Valley came together as part of economic development strategy and together identified opportunities for a circular economy in bioproducts based on proximity to innovations, feedstock, and manufacturing know-how.

Resource Availability (Physical): Large amounts of agricultural waste are available in the area and gives the initiative viability

Measurable impacts

Establish Supportive Policy and Regulation
Make Transformative Investments
Establish Effective Collaboration Structures

Strategies

- Business Support
- Funding and Finance
- Effective Collaboration Structures

CASE STUDY 7:

Greenhub Denmark

GEOGRAPHICS AND SCALE
Location: Aalborg, Denmark
Scale: Regional

Description:

Timeline: start unknown - current

Green Hub Denmark is connecting businesses, consumers, researchers, the utility sector and authorities in order for them to co-create a platform for green growth and a green societal transition. This is mainly done through the development, testing, and application of sustainable technologies while simultaneously attracting further green investment and creating green jobs. The developed technologies aim to decarbonize the energy sector. GreenHub is targeted at the Northern region of Denmark, in which Industrial Symbiosis North is also located.

Investments	Enabling factors
Green Hub Denmark itself was partly funded by the Interreg Europe programme, on a three-year grant of 480,000 EUR. The grant covers expenses for personnel, salaries for the chairman of the professional board, collaboration meetings, communication and back-office staff. Green Hub Denmark is established as a foundation to enable wider engagement. The partners behind Green Hub Denmark have an extensive national and international network and have collectively poured 7,5 billion DKK (approx. 1 billion USD) into the initiative.	**Technology, expertise & skills:** Denmark has a strong commitment to renewable energy and sustainable development and is a frontrunner in green technology. GreenHub supports the organizations with their expertise in navigating the European and national legislative framework and (inter)national funding options. **Partnerships:** This partnership includes many stakeholders from a wide variety of backgrounds (educational institutes, public and private organizations, businesses) to include all perspectives, expertise and skills. Ensuring that the project is anchored in local institutions and businesses is an essential part. This requires being informed about the stakes and perspectives of the local organizations on the topics.

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Greenhub Denmark

Organizational structure and partnerships	Enabling factors
Aalborg Municipality initiated the creation of Green Hub Denmark by gathering all the major energy stakeholders in the region -public and private- into a single point of contact collaboration platform - consisting of 75 stakeholders representing a quadruple helix approach. Within the first nine months of existence, Green Hub Denmark has attracted, through its network, the interest of more than 500 stakeholders.	

Measurable impacts

Jobs created
In the carbon capture project GreenHub is aiming at creating 5,000 jobs in the entire region of Northern Denmark (interview GreenHub).

Strategies

- Industry and Higher Education Connections
- Funding and Finance
- Effective Collaboration Structures

CASE STUDY 8:

Aalborg Industrial Symbiosis North

GEOGRAPHICS AND SCALE
Location: Aalborg, Denmark
Scale: Regional

Description:

Timeline: 2010 - current (Sustainable synergies project: 2017 - 2020)

The Industrial Symbiosis North is the collective name for the different types of Industrial Symbiosis partnerships and projects that are going on in the region of North Jutland, Denmark. Recently the project 'Sustainable Synergies' was developed to support small and medium enterprises to participate in and benefit from Industrial Symbiosis in the region. This project is a collaboration of companies, the municipality and research institutions and aims to enable the reuse of waste and by-products as valuable inputs for other businesses. Many large companies in North Denmark have been benefiting from Industrial Symbiosis for decades, but smaller companies have had much more difficulty participating due to a range of barriers.

Investments	Enabling factors
The project was supported by the European Fund for Regional Development and based at the Danish Centre for Environmental Assessment at Aalborg University.	**Partnerships:** The collaboration between research, utilities, companies, municipalities, regional port authorities and private actors started in 2010. The partners of the 'sustainable synergies' project have been working together for a while before this specific project started.
Organizational structure and partnerships	**Resource Availability (Physical):** The initial Industrial Symbiosis collaborations amongst the larger companies were established because there were residual resources available. The resource flows attracted new companies (such as a wastewater treatment plant) to establish a business valorizing the residual material flows.
It is housed and staffed by the Port of Aalborg, along with donated staff from Aalborg Municipality and the utility. The main partners in the partnership are: Port of Aalborg, Aalborg University, Aalborg Municipality, Aalborg Utilities and RenoNord.	

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Aalborg Industrial Symbiosis North

Measurable impacts	Enabling factors
Analysis by Aalborg University found that between 2017-2020, symbioses facilitated by the project resulted in 3,000 MWh of energy saved and 10,000 tons of CO_2 emissions reductions annually. The project addresses community benefit in the sense that it is targeted at including small and mid-sized businesses which had historically been excluded from the economic and environmental benefits of industrial symbiosis and green transition in the region.	**Expertise & Skills:** University of Aalborg has expertise in symbiosis and has done research into symbiosis collaborations, results and benefits specific to the Aalborg/North Denmark region. Port of Aalborg is providing the leadership and venue for collaboration with University of Aalborg, the municipality, utilities, and private partners to effectively engage and support participation by small and mid-sized companies that have historically been left behind on symbiosis development. **Finance:** Symbiosis has a 30+ year track record of saving money and generating new revenues for larger companies in the area so there is broad awareness that this is a process that benefits individual companies and the larger industrial sector of the region.

Strategies

• Industry and Higher Education Connections
• Effective Collaboration Structures

CASE STUDY 9:

Skive GreenLab

GEOGRAPHICS AND SCALE

Location: Skive, Denmark
Scale: city

Description:

Timeline: 2016 - current

The GreenLab model is a groundbreaking green and circular industrial park, which started in 2016. It is supplying its industry partners – six major industrial facilities currently, with four more in progress – with power, heat, steam, water, instrumental air, and nitrogen, and is developing infrastructure to supply or deliver to market hydrogen, methanol, and recovered CO_2. Besides, it creates a living lab environment supporting research, collaboration and knowledge sharing, support and services to businesses and stimulates sustainable community engagement. The industrial park is 60 hectares currently, built on a greenfield site within the Skive Municipality, with planned expansion on an adjacent 70 hectares.

Investments	Enabling factors
Initial funding: $10 million (USD) from the Skive Municipality, the Norlys utility, and a foundation. **Additional funding:** $10 million for Innovation Center (50/50 from the foundation and Norlys utility), $50 million from Norlys utility and two foundations **Total public/private investment in the Park, as of January 2023:** $430 million	**Technology:** Due to the availability of advanced and efficient technologies the initiative was able to make validated business cases and showcase and further develop these sustainable technologies. **Policy & Funding:** Because the project benefited from favorable policies and access to adequate funding, also for organizational support, they were able to set-up a comprehensive establishment. **Land use & availability:** The availability of sufficient suitable land and already available infrastructure played a crucial role in making the project feasible.

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Skive GreenLab

Organizational structure and partnerships

GreenLab is "a collaborative public-private partnership" and includes sustainable industries, green hydrogen producers, renewable energy developers, researchers, regulators, government, and facilitates high engagement with local community development.

It serves as a "Value Mediary" for the partner companies, public entities, researchers, and utilities. GreenLab's staff of 27 are housed in offices located in the industrial park and the main partners are Skive Municipality, Klimafonden Skive (foundation), Sparvestfonden, and Norlys (utility).

Enabling factors

Partnerships: The collaboration between businesses, researchers, educational institutions, local authorities, and the community provided the support, expertise and resources necessary for the success of the initiative.

Expertise & Skills: Due to the available skilled workforce and access to expertise the lab is able to provide support and services to companies and entrepreneurs.

Measurable impacts

Each of these operational facilities rely on local resources and have significant positive sustainability impacts:

• Wind & Solar Power generation
• Waste heat recycled into Green Heatsource
• Local biomass wastes recycled to produce proteins, energy and biochar
• Plastic wastes recycled via pyrolysis back into oil fractions and naphtha
• Invasive starfish into high value proteins for animal feed

Job Creation Benefits: The non-polluting industrial development creates local working class jobs, and converts local waste streams from costs into valuable feedstocks. 90 full time jobs in the circular industrial park currently among the companies operating (GreenLab, Quantafuel, Vestjyllands Andel, Skive Biogas, Nomi4, Stiesda), with three more job-creating facilities in development.

Strategies

• Business Support
• Industry and Higher Education Connections
• Transformative Investments
• Funding and Finance
• Effective Collaboration Structures

CASE STUDY 10:

Technology: Bio-LNG plant

Sector: Food and beverage manufacturing

Local barrier addressed: Large volumes of organic waste from food processing, retail and restaurants is currently not optimally processed and used in Portland.

GEOGRAPHICS AND SCALE

Location: Netherlands
Scale: Regional

Description:

Timeline: 2021 - current

Renewi (a waste management facilitator), Nordsol and Shell partnered to develop the first commercial bio-LNG plant in Europe. This development addresses the challenge of valorizing organic waste in the food sector and the supply of green energy sources. Organic waste from retail, restaurants and the food processing industry is collected, processed and via anaerobic digestion converted into biogas. The digestate is used in agriculture as a fertilizer. The methane in the biogas is cleaned and liquefied into bio-LNG and sold to power heavy-duty trucks and short-haul shipping. The CO_2 from the biogas is converted into liquid bio-CO_2, which is used in horticulture and could be potentially used in sustainable chemistry.

Technology: Bio-LNG plant

Investments

The bio-LNG plant development is a commercial business case between the three companies. The partners have received a grant by the EU, as part of its strategy to decarbonize road transport, Nordsol said. The EU funded 20 percent of the total costs. The total investment reached about 9 million euros ($10.5 million).

Organizational structure

The project is a strategic partnership between the three organizations and is built at the Renewi site.

Renewi: Collection of organic waste throughout the Netherlands and conversion into biogas via anaerobic digestion.

Nordsol: Cleans and liquifies the biogas into bio-LNG and liquid bio-CO_2.

Shell: Sells the bio-LNG in its fuel stations to power heavy-duty trucks and short-haul shipping.

Enabling factors

Technology: Significant advancements in bio-LNG technology facilitated the realization of large-scale production, enabling the initiative's success.

Land use & availability: The strategic location of the LNG plant on Renewi's site, along with the availability of suitable land, played a crucial role in making the project feasible.

Partnerships: Collaborating with specialized private entities, including a waste management company, green energy supplier, and energy multinational, allowed for the establishment of a comprehensive value chain solution.

Expertise & skills: The combined expertise of the partnering organizations across different phases of the technological process contributed to the initiative's effectiveness.

Resource availability: The abundance of food waste generated by restaurants, retail establishments, and food processing industries provided the necessary volume to support a viable business case.

Measurable impacts

Production of 3.4 kilotons of bio-LNG per year (equivalent to 13 million CO_2-neutral kilometers for an average truck). Thereby 14.3 kilotons of fossil CO_2 are prevented. Additionally, the plant produces 6.3 kilotons of bio-CO_2 per year, which displaced fossil CO_2 in the industry.

Strategies

- Transformative Investments
- Funding and Finance
- Effective Collaboration Structures

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CASE STUDY 11:

Technology: Climate-Smart Health Care Project

GEOGRAPHICS AND SCALE

Location: Several countries (Argentina, China and the Philippines)
Scale: National

Description:

Timeline: 2019 - 2020

Health Care without Harm developed the "Climate-Smart Health Care - Cooling Energy Monitoring, Audits and Demonstration Project" to improve the energy efficiency and cooling of healthcare facilities in Argentina, China, and the Philippines. The selected facilities were part of the Global Green and Healthy Hospitals (GGHH) network. The first step (after establishing consultant teams for the projects in each country) is an audit for the baseline of energy use, the possible improvements to equipment and cost estimates. Health Care Without Harm and partners then advocated for the implementation of improvements and the development of policies at municipal and national levels that encourage the implementation of improvements. Additionally, Health Care Without Harm worked with Clean Cooling Collaborative (formerly K-CEP, a philanthropic initiative of the ClimateWorks Foundation) to identify potential funding sources. The potential cost-savings were calculated and used to inform hospital finance managers. Finally, one facility per country was selected for a pilot project of the implementation of the improvements.

Examples of measures implemented: installing more efficient cooling systems, alternative sources of water or other thermal energy carriers, and energy management systems to monitor and control air conditioning.

Technology: Climate-Smart Health Care Project

Investments

This project was funded by Clean Cooling Collaborative (formerly K-CEP, a philanthropic initiative of the ClimateWorks Foundation). The Collaborative was funded by leading climate foundations in 2016 with more than $50 million to create the largest-ever fund of its kind for action on efficient, climate-friendly cooling.

Organizational structure and partnerships

Health Care Without Harm is a global organization with local teams and partners. The project is globally coordinated with consulting teams for the audits that were established nationally.

Enabling factors

Partnerships: Through effective partnerships with a philanthropic foundation, the project secured the essential investment needed to conduct initial energy audits and implement pilot projects for improvements.

Expertise & Skills: Health Care Without Harm contributed its expertise and skills by providing professionals for the audit.

Finance: By collaborating with partners to address the financial aspects, including potential funding, the process was streamlined for healthcare providers. One facility was specifically selected as a pilot project, potentially receiving additional support.

Measurable impacts

The impacts are not available yet.

Strategies

- Business Support
- Funding and Finance
- Effective Collaboration Structures

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CASE STUDY 12:

Technology: San Zeno Smart Beam Manufacturing Mill

Sector: Metals and machinery

Local barrier addressed: Decarbonizing the metal fabrication sector poses a challenge due to its reliance on gas-fired heat application and the significant amount of waste heat generated, which remains largely unutilized.

GEOGRAPHICS AND SCALE

Location: San Zeno Naviglio, Brescia, Italy.

Geographical scale: Regional

Description:

The San Zeno 'Green' rolling mill represents a fully integrated production facility that enhances overall process efficiency in multiple aspects. Notably, it prioritizes environmental sustainability by strategically locating the reheating furnace near the existing continuous castings. This allows for the rolling of semi-finished products while they are still partially hot, resulting in a significant reduction in gas consumption for reheating to the processing temperature. Additionally, the integration of the steel mill and peripheral rolling mills minimizes intercompany transport, leading to a notable decrease in CO_2 emissions from road and rail transportation.

Moreover, the new rolling mill introduces several innovative features. The reheating furnace is equipped with hydromethane and methane injection burners, designed to operate on alternative fuels such as hydrogen or bioethanol, marking a significant step towards decarbonization.

In terms of water management, the San Zeno 'Green' rolling mill prioritizes sustainability through water recovery initiatives. The water treatment plant associated with the reheating furnace operates on a completely closed cycle, eliminating the need for water reintroduction, thanks to an innovative cooling technology called Air Cooler. Furthermore, the water treatment plant in the new rolling mill is designed to achieve maximum water savings and optimize consumption, incorporating advanced water recovery technology. This development was the result of collaboration between the company's teams and universities and research institutes, similar to previous projects implemented within the plant.

Technology: San Zeno Smart Beam Manufacturing Mill

Investments

The total investment is around 220 million euros by the Duferco Group for the new facility.

Organizational structure and partnerships

The mill is commissioned by the Duferco Group, a private organization with core activities in the energy and steel businesses, in strong collaboration with SMS Group, technology partner and supplier for the project.

Enabling factors

Technology: Simultaneous development of various technological innovations has facilitated efficiency gains in the fabrication process, such as strategically placing process steps closer to minimize waste heat and preparing for future fuel switching to hydrogen or bioethanol, exemplified by the reheating furnace.

Partnerships: Collaborative efforts with research institutes and universities played a crucial role in designing and optimizing the entire fabrication process, leading to enhanced efficiency.

Expertise & Skills: The integration of expertise and skills from researchers, technology partners, and skilled workers at the rolling mill enabled the design of an integrated and efficient mill.

Measurable impacts

Reduction of gas consumption by 20% compared to comparable systems. 10% reduction in electricity consumption compared to existing systems. Reduction of a further 10% of gas consumption thanks to the hot loading application. Reduction of water consumption below 1 cubic meter per tonne. The new mill will create 150 new job positions and many opportunities for the local satellite activities.

Strategies

• Industry and Higher Education Connections
• Funding and Finance
• Effective Collaboration Structures

LESSONS LEARNED FROM GLOBAL CLEAN INDUSTRY EXAMPLES

In conclusion, the lessons learned from clean industry examples around the world highlight how elements of the clean industry strategy framework drive the transition. Strategies such as helping businesses identify and implement solutions, enhancing industry-academia connections, making transformative investments, establishing supportive policies, building engagement, securing funding, and establishing effective collaboration structures have proven to be instrumental in achieving successful clean industry outcomes. By employing these strategies, Portland can create a conducive environment for clean industry adoption and sustainable economic development. Below is a summary of the lessons learned from the clean industry examples considered, organized by the seven strategies set out at the beginning of this chapter. More information on specific organizations in Portland discussed in this section can be found in appendix VII.

Business Support: Businesses have a user-friendly pathway to identify and implement clean industry actions.

The strategy of helping businesses identify and implement solutions has been successfully demonstrated by various initiatives - a few of which are highlighted here. The NISP® method stands out as a proven tool that supports businesses in repurposing their residual resources, emphasizing the importance of resource optimization.

Health Care Without Harm developed an audit template for facilities. The project highlights the significance of understanding the energy and cooling systems' impact and advocating for implementation improvements. The value of taking action beyond audits is emphasized and supported by the initiative.

The Bioindustrial Manufacturing Initiative in Stanislaus County also demonstrates the effectiveness of helping businesses in identifying solutions, via the BEAM Circular hub, by fostering partnerships to convert agricultural waste into bio-based products. Potential solutions are identified and showcased, by highlighting the benefits of circular economy practices, making it easier and more attractive for businesses to implement solutions.

The Skive GreenLab initiative serves as an example of providing a user-friendly pathway that facilitates the adoption of sustainable practices by providing support and several services to businesses, and creating a collaborative living lab environment. Within the Skive project, the creative strategies to manage risk were necessary for businesses to participate in symbiosis. Overall, the key lessons emphasize the importance of accessible pathways and active engagement in promoting and implementing clean industry actions.

Applicability in Portland

Portland is home to a rich ecosystem of business support services. However, businesses often are not aware of these resources or do not have the bandwidth to engage. Further, there are some gaps in the ecosystem of services- such as resources to address circularity or IRA funding. An important next step would be to inventory existing resources and determine how to link, leverage, and augment them to ensure that businesses have an easy pathway to identify and implement clean industry solutions.

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Industry and Higher Education Connections: Effective linkages between and among industry and higher education enhance clean industry talent development and research.

Collaboration between industry and academia emerged as a crucial factor in fostering connections and enhancing talent development and research. The case of Circular Flanders, as well as Green Hub Denmark exemplify this approach by supporting collaboration in the organization itself, representing many different stakeholders from public, private and educational institutions. This leads to a shared understanding of the most pressing challenges, stimulates active involvement of academia and consideration of latest technological developments. Similarly, the San Zeno Smart Beam Manufacturing Mill demonstrates this value, specifically to optimize research on fabrication processes.

Aalborg Industrial Symbiosis North (AISN) and Skive Greenlab also enhance the connection between industry and academia. AISN does this by highlighting the significance of providing smaller enterprises access to research and development opportunities, and Skive Greenlab by actively supporting talent development, research advancements, and knowledge exchange within the initiative. These initiatives collectively underscore the value of partnerships and collaborations between academia and industry in driving progress in the clean industry.

Applicability in Portland

Effective linkages between and among industry and higher education can require high or low engagement of stakeholders. An example of a low engagement linkage is participating in collaboration meetings (like at Green Hub Denmark), which would ultimately lead to collaboration initiatives. A linkage that requires more engagement is providing test sites by industrial stakeholders for research by higher education institutions (like in Stanislaus County). Another option is creating a partnership where government, research institutions, industries, civil society and financial partners are equally represented, such as Circular Flanders.

There are a number of existing and emerging initiatives in the region that connect industrial and institutional businesses with each other and with higher education, as well as initiatives that connect higher education institutions. This provides valuable momentum for collaboration within and between industry and higher education to work towards a clean industry in Portland.

Transformative Investments: Opportunities for large scale clean industry investments, such as industrial symbiosis or green hydrogen, have been assessed and adopted.

A number of the clean industry examples employed transformative investment. Initiatives such as ReHubs focus on collective efforts from European industrial stakeholders to build large-scale recycling facilities. Skive GreenLab financed the shared infrastructure for industrial symbiosis and green hydrogen based on a master plan. Some of the transformative investments in the global examples were entirely privately funded and some utilized a combination of municipal and private funding.

Applicability in Portland

Industrial symbiosis and green hydrogen are clean industry technologies that are receiving consideration in Portland. Further, a 'Textile recycling and logistics' initiative has been suggested. Such a project could take inspiration from ReHubs or EURATEX and collectively invest in a large-scale recycling facility. Existing interest in investments at scale suggests this as a strategy ripe for further exploration.

Supportive Policy and Regulation: Policies and programs facilitate adoption of clean industry practices.

Our review of global clean industry examples highlights the importance of establishing supportive policies and regulations to drive sustainable practices, as clearer regulatory frameworks can provide greater certainty. The EPR Schemes for WEEE are a successful example for replication in other sectors.

The ReHubs aligns with EU regulations and is part of the EURATEX development of an industry agenda for a circular economy in textiles, where Zero Waste Scotland showcases the effectiveness of recycling and waste regulations, including restrictions on single-use plastics.

Circular Flanders demonstrates the benefits of providing subsidies for circular projects which optimizes local policies and uncovering practical bottlenecks. This is also supported by the Circuléire project, where the need for flexibility for research and development within existing regulatory frameworks is emphasized to enable innovative practices. The network members indicated that ongoing dialogue between public bodies, the third sector, industry, and citizens is a welcome commitment. Additionally, it is shown that circular economy criteria need to be included into existing public funding calls and there is a need for developing capital expenditure funds for strategic infrastructure.

Health Care Without Harm works with local facilitators and experts to implement energy efficiency measures and inform national and municipal policies to enhance energy efficiency measures. These include regular audits and cost analyses and training and communication programs. All these initiatives collectively underline the importance of policy alignment, regulatory clarity, incentives, and stakeholder engagement in promoting the transition towards a clean industry.

Applicability in Portland

Portland and Metro are known for innovative policy development and could expand that work in support of the clean industry transition. Areas to consider include establishing targets and incentives, enhancing procurement policy, and expanding beyond the existing realm of recycling to a broader producer/consumer strategy. The Plastic Pollution and Recycling Modernization Act is an example of a legislation that is intended to stimulate innovation in the recycling industry. For the organic waste of the food and beverage industry a similar legislation could be implemented to stimulate the minimization and valorization of organic residual sources.

Strong Brand and Engagement: Effective communication and outreach leads to workers, businesses, and others engaging in the clean industry opportunity.

Effective communication and outreach are crucial for driving participation and involvement in clean industrial development. Several of the global examples show the positive effects of this strategy. Linking small initiatives to a larger network that provides context, data, and objectives helps establish a sense of purpose and direction. The example of Zero Waste Scotland clearly illustrates this and highlights the importance of this approach. Also, the Circular Flanders initiative emphasizes the significance of involving diverse stakeholders in setting targets and defining strategies, creating a widely accepted brand that garners broad societal support. This not only aids in identifying relevant topics and projects but also enhances the chances of successful implementation of project results.

Applicability in Portland

The global examples reviewed revolve around a specific topic (the circular economy and waste management) which allows for a more focused discussion and targeted strategies. It was underlined by Green Hub that it is easier to organize engagement if the focus is clear. Choosing a topic of focus (waste management, decarbonizing energy sources, etc.) might be important for a viable hub initiative.

Funding and Finance: Diverse sources of capital enable the clean industry transition - both industry adoption of solutions and the collective impact infrastructure

Our review of global examples identified a range of financial resources and financing mechanisms for clean industry initiatives, from public or private funding only to combining funds for larger projects. An example of a private initiative is the development of a Bio-LNG plant by Renewi, Nordsol and Shell. The partnership between these three companies demonstrates the significance of strong collaborations and long-term offtake contracts to create viable business cases and mitigate risks. This is a private initiative only, but such contracts can also be provided for public utilities or public projects.

Circuléire is an exclusive network that is publicly funded and provides funding opportunities for both established businesses and start-ups through its Network Membership and Circular Venture Programme. In a similar way, the NISP® Canada project highlights that alternative financing mechanisms such as green bonds or trust funds are crucial and could

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possibly support initiatives like NISP®. In the case of GreenHub, the initiative acts as a platform to help businesses and initiatives find available European and Danish funding opportunities.

Having diverse sources of capital supports the success of upcoming and existing initiatives. In the case of the Bioindustrial Manufacturing Initiative in Stanislaus County, this included federal funding and grants. Also Skive GreenLab is supported by a combination of public and private investments, as well as donations from foundations and utilities. Additionally, the facilitator organization at Skive GreenLab is adequately funded to recruit and retain expertise.

Applicability in Portland

There are a number of pathways for capital to flow through a clean industry hub. For example, the hub could help businesses access funding (e.g., as a navigator to resources) or could be a distributor of resources (e.g., a revolving loan fund). The hub can also be a recipient of funds, for example, to fund network activities or a catalytic project. Sources of capital could come from membership fees, fees for service, grants, public dollars, community investment or other sources. Successful acquisition of funds will require clarity regarding the intended use and a solid plan for implementation.

Effective Collaboration Structures: Progress toward the shared vision is enabled through strong coordination, communication, and continuous learning.

The implementation of a clean industry strategy requires the establishment of effective collaboration structures, as demonstrated by various initiatives. Circuléire emphasizes the importance of a committed network of private organizations through which they access funding opportunities. The network members connect with external parties through Innovation Demonstration Projects, allowing for further extension of the impact in the sector. ReHubs (by EURATEX) focuses on industry-led collaboration across European countries, advocating for waste reduction and circularity in textiles. It focuses on creating a market for recycled textiles and shows how businesses within a sector can collaborate to stimulate innovation.

Several initiatives highlight the significance of public-private partnerships. In the case of Circular Flanders this is very well demonstrated, as every agenda of the initiative has a public and a private lead and representatives of 20 organizations. The operations team is part of OVAM, the public waste management utility and they have indicated they would like to advance innovation and have relevant recommendations on what is needed. Circular Flanders brings together public, private and educational institutions in events and projects and encourages the sharing of results, which is meant to lead to further adoption by other partners in the region.

For large-scale circular industrial parks such as Skive GreenLab, or initiatives such as Greenhub Denmark, it proved to be essential to have a facilitator organization with deep expertise. With Skive GreenLab, the public-private collaboration allows them to establish comprehensive partnerships, governance models, and staffing arrangements for their industrial park and GreenHub similarly engages a variety of stakeholders (public, private, businesses and educational institutes) to ensure a wide range of skills and expertise is included.

Our review of global models also identified examples where involving local communities and local and smaller businesses is vital and requires special attention. Skive Greenlab engaged the local community in the development of their industrial park, whereas GreenHub and the 'Sustainable Synergies' project in Aalborg Industrial Symbiosis North consciously include local and smaller businesses. GreenHub actively involves local businesses to ensure they are well informed and their perspective is included in the projects.

Applicability in Portland

Collaboration is a theme across the global examples - sometimes within a sector such as an alliance of businesses and sometimes across sectors such as private-public partnerships or private-public-academic partnerships. Portland has experience delivering on the promise of collaboration and has resources such as Regional Solutions and Oregon Consensus that can support the structuring of effective collaboration.

05 Policy and finance tools
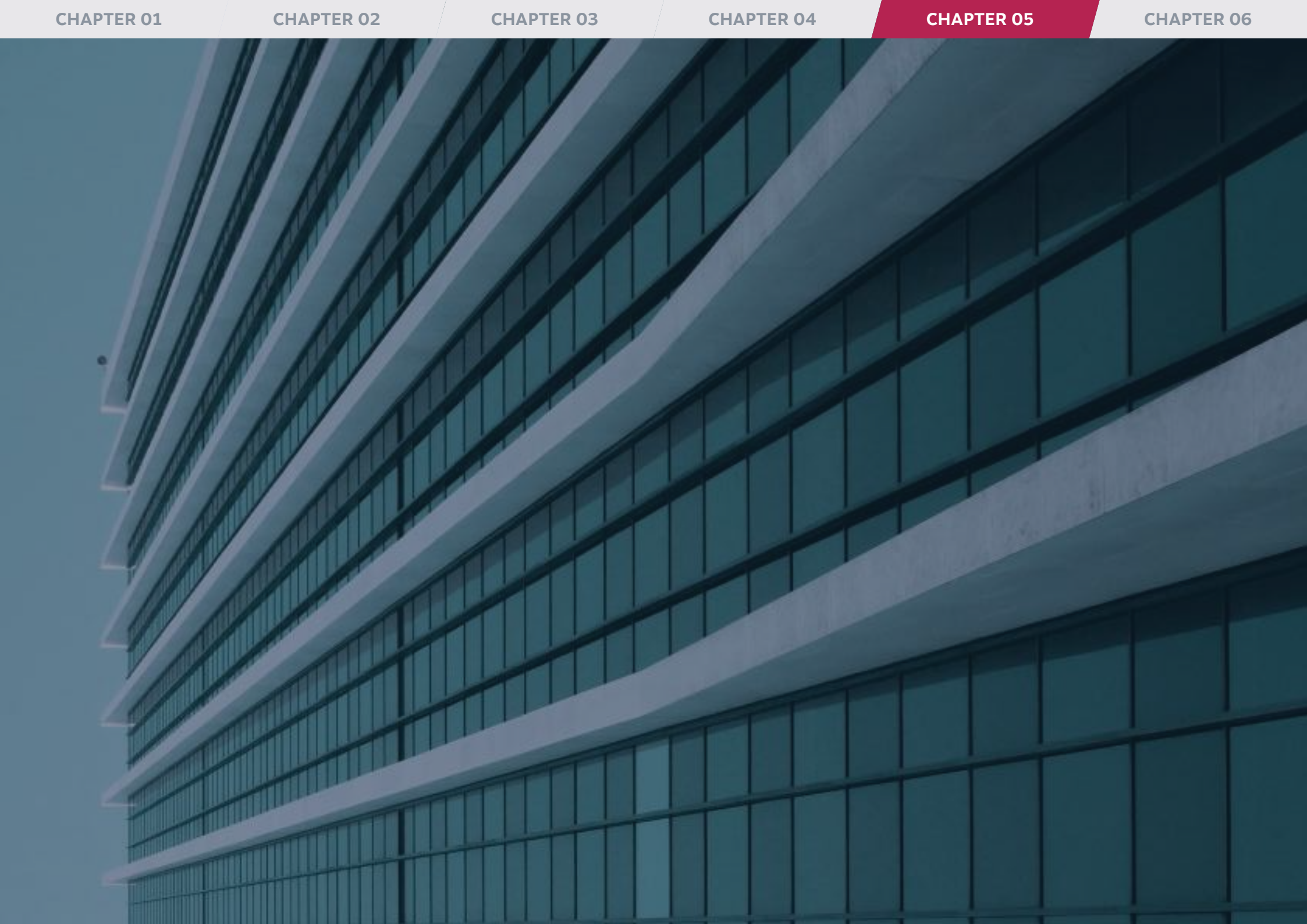
Clean industry takes root and grows within a conducive policy context that allows the public and private sectors to work towards common objectives. This includes clear public policy objectives for industry, and understanding from government about the role that private investment can play in shaping a clean economy. This section considers the specific policy conditions in Portland at this time, resources and incentives available to support a clean industry hub, and opportunities to define the value proposition of such a hub. The examples covered demonstrate that clean industry hubs are not only the product of their policy conditions but also help shape future policies for a clean industry transition.

THE ROLE OF POLICY AND REGULATION IN CLEAN INDUSTRY

A successful clean industry transition is most likely to succeed in an environment where regulatory objectives are clearly defined and predictable, while not being so onerous or prescriptive as to stifle innovation and growth. The dynamic tension between carrots and sticks is common to all of the examples cited in this report and, in the best cases, manifests as a productive dialogue that leads to shared goals and desired outcomes.

A stable regulatory environment, especially at the national level, provides the highest level of predictability and prevents competitive disadvantages for businesses within the country. It also provides a framework for local government and industry to advance partnerships with the national government and to access larger financial resources. This integrated approach currently exists in many countries, including the US, for the reduction of numerous contaminants and carcinogens, but is less common when it comes to GHG emissions or circularity. Although the US policy and regulatory context leave much to be desired, the proposed clean industry hub aims to access all available tools to achieve an economy that is clean, decarbonized, circular, and inclusive.

PORTLAND'S POLICY AND REGULATORY CONTEXT

In this section, we focus initially on Portland's policy context for decarbonizing at the local level, while also integrating examples that may have co-benefits in a clean, circular, and inclusive economy. It is helpful to review Portland's current regulatory and policy environment, as well as potential resources, in relation to the clean industry examples offered previously in this report.

Within the City of Portland, the _Climate Emergency Workplan_ 2022-2025 lays out the necessary steps to address the Climate Emergency Declaration issued by City Council in 2020. The plan specifically calls for a reduction in remaining industry emissions by 2030, achieving net zero emissions by 2050. Clean industry is also a core feature of Advance Portland, the city's inclusive economic development strategy, which highlights the sector's higher wages, opportunities for new manufacturing jobs that have a low barrier of entry, and increased entrepreneurship. The strategy calls out specific opportunities for green innovation in public procurement, and the opportunity to leverage the Portland Clean Energy Fund to create green jobs. Portland City Council included next steps for clean industry in its 90-Day Declaration as part of its commitment to implementing Advance Portland.

It is important to situate Portland's clean industry transition in the broader national and statewide context. Under the Paris Climate Agreement, the US committed to reduce national GHG emissions 50–52% by 2030. This commitment will be part of the United States' "nationally determined contribution." However, the US has no mandated caps on GHGs, and mostly regulates point-source pollution through the Environmental Protection Agency (EPA).

Attempts to expand the EPA's purview to GHGs have been blocked or severely restricted by the Supreme Court. Cap-and-trade schemes have therefore been pursued only at the state level, with limited impact.

Putting a price on carbon has been suggested as a market-based tool to account for the costs of GHG emissions and stimulate reductions. However, this has not been feasible in the US. In lieu of putting a price on CO_2 and other GHG emissions, Congress and the President passed a historic climate investment package in the Inflation Reduction Act (IRA) that sends market signals favoring decarbonization. This is being administered through a number of federal agencies, which establish climate strategies by administrative authority. With regards to clean industry, the most significant is the US Department of Energy *Industrial Decarbonization Roadmap*, which aligns with programs funded by the IRA, Bipartisan Infrastructure Law, and the CHIPS and Science Act.[7]

Oregon has yet to legislate a price or full cap on GHGs. However, in 2020 Governor Kate Brown issued Executive Order (EO) 20-04 to update and achieve statewide goals for reducing GHG emissions by at least 80 percent below 1990 levels by 2050. As it relates to industry, the EO directed the Oregon Department of Environmental Quality (DEQ) to reduce industry CO_2 emissions, focusing on fossil fuel providers and large stationary sources of emissions.[8] In response to the EO, DEQ

created the Climate Protection Program (CPP) which establishes an annual CO_2 emissions cap on fossil fuel providers and a price for excess metric tons of emissions.[9]

These actions are a huge step towards achieving Oregon's climate goals, but do not guarantee a clean industry on their own. They are ambitious targets that will challenge utilities and energy providers. The larger that industrial demand grows, the harder these targets will be to meet. Energy efficiency and fuel switching at the source will help Oregon achieve its goals from both the energy supply and demand sides. In addition, decarbonization is not synonymous with waste reduction or utilization of clean materials. This puts a strain on environmental quality and misses potential benefits to business by reducing waste heat and monetizing output in a circular economy. Further, at this time, only two Portland companies are large enough to be affected by CPP regulations.

This push towards a more circular economy is also embedded in Oregon's Plastics Pollution and Recycling Modernization Act, which went into effect Jan. 1, 2022 (recycling program changes will start in July 2025). Key goals of the legislation include increasing responsible recycling and better meeting the needs of unserved and underserved communities. Oregon DEQ anticipates new clean industry jobs will be created and advance a more circular economy when the new law is implemented in several recycling subsectors, including:

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[7] *The DOE Industrial Decarbonization Roadmap focuses on five of the highest CO_2-emitting industries: petroleum refining, chemicals, iron and steel, cement, and food and beverage. The Roadmap identifies four fundamental pillars: low-carbon fuels, energy efficiency, industrial electrification, and carbon capture, utilization, and storage.*

[8] *Existing permitted facilities with annual covered emissions that meet or exceed a threshold of 25,000 metric tons of carbon dioxide equivalent (MT CO_2e) and proposed new facilities anticipated to exceed the threshold. 10 percent of compliance obligation can be paid into the statewide Community Climate Investment fund in the early years, but increases to 20 percent in later years. Every 5 years, Stationary Entities must develop a Best Available Emissions Reduction (BAER) plan to reduce their emissions. This plan must be approved by DEQ at which time DEQ will issue a BAER order that will mandate execution of the plan to achieve its stated goals.*

[9] *There are several pending lawsuits against the CPP. It may take as long as 18 months for those cases to resolve and until that time, it is likely that no funds will be flowing through the program. Finally, the outcome of those lawsuits and/or potential future legislative changes could significantly alter key elements of the CPP.*

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- Regional end-markets that use recycled wastes as feedstocks
- Companies that reprocess recyclables as feedstocks to these industries
- Commingled processing facilities
- Equipment providers that supply recycling industries
- Reuse businesses and services.

The Metro Council is currently developing a long-term Garbage and Recycling System Facilities Plan, and is looking at pioneering models internationally for building or running innovative facilities that manage waste to reduce human health and environmental impacts through increased reuse, repair, recycling and composting. Important values guiding the work include racial equity, community restoration, community partnerships and community investment. Following these principles, staff will assess who is being served by the current system, who is not being served, and how Metro's investments can give back to underserved communities.

With new regulations in place, businesses have an opportunity to explore waste reduction and management strategies to comply with the requirements and improve their operations.

COMING TO THE TABLE (WITH OR WITHOUT REGULATIONS)

A strong and predictable regulatory environment is helpful for advancing clean industry, but is not a necessary precondition.

Denmark is often cited as the most compelling example of an effective carrot and stick approach. The government began imposing a CO_2 tax on industry in the 1990s, with reduced taxes for voluntary agreement commitments, and shifted to an electricity tax from 2015-2020. After significant gains in emissions reductions, the government eliminated the CO_2 tax and shifted to a waste-heat penalty to increase energy efficiency and a circular economy.[10] Regulatory requirements were accompanied by subsidies and access to financing for industrial electrification and decarbonization.

While industry experts acknowledge that regulatory and tax structures played an important role in Denmark, they point as much to the change in business culture as to the financial incentives themselves. This is now referred to as "Smart Climate Capitalism," which serves as the foundation for the *Danish Climate Partnerships 2030*. This is an example of public and private sector collaboration to reach shared goals (reducing GHG emission 70 percent by 2030). The Danish government helped convene industry-led groups in fourteen sectors to develop specific strategies and develop a regulatory framework and sector emissions targets that support competitiveness, exports, jobs, welfare and prosperity.

The need to audit energy consumption and waste has enabled businesses to recognize opportunities for savings and to make longer-term investments for increased competitiveness. This in turn created a whole industry for energy efficiency expertise and energy screening processes. Companies in Sweden, the Netherlands, Mexico, South Korea, and Belgium are now pursuing a similar approach even without the same regulatory framework.

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[10] *Both the CO_2 and electricity taxes have expired, the government passed a new corporate carbon tax in 2022 in compliance with the EU's carbon quota system.*

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In South Korea, a business enterprise can enter a 3-5 year agreement with the government–on a strictly voluntary basis– and receive free energy audits to reduce energy intensity, overall usage or GHG emissions. This makes the company eligible for low-interest loans and tax credits to support the recommended transition.

There is similar interest among industries in the Pacific Northwest. Tillamook Creamery is currently working with the Danish Energy Agency (DEA) on an assessment of energy efficiency and technologies. In Washington, experts from the Danish Energy Agency, the Danish Consulate in Silicon Valley, and Danish industry are providing consultation on industrial symbiosis projects – one in Pasco, where the City is bringing circular innovation to wastewater treatment from major food processors, and one in Longview, where early discussions are underway to bring circular practices to multiple existing heavy industries as well as a new facility to produce renewable natural gas from pre-consumer food waste. The Washington State Department of Commerce now administers the country's first program dedicated to supporting industrial symbiosis projects, and (like Portland) has been a partner in the DEA-funded project "Systemic Approach to Clean Industry," which seeks to assist jurisdictions to learn about and adapt symbiosis models.

Companies that participate in these clean industry initiatives often share the desire to reduce GHG emissions and other pollutants, but they are also motivated by an interest in shorter supply chains and insulating their business from instability in energy and resource prices. In addition, when larger companies shift to clean industry practices, it has a broader effect on the entire supply chain as smaller companies adapt to meet their demand.

Portland can draw inspiration from such examples, but it is important to recognize that it is a sub-national jurisdiction operating in an environment of constrained resources. There is no perfect model for the city to follow in charting its own transition to clean industry. Portland will have to be creative in identifying its own win-win solutions for business and the environment, layering available policy tools and resources at all levels. In order to access and deploy these resources successfully, it is important to determine the policy and finance parameters of the hub itself.

FEDERAL FUNDING AND FINANCE OPPORTUNITIES

The IRA represents a generational investment in transforming and decarbonizing the US economy with a significant focus on manufacturing. At the same time, it does not provide a clear pathway for local governments to partner in the creation of that economy. Only nine percent of IRA ($37B, primarily climate and resilience) funding is directly allocated to a combination of local governments, counties, states, and tribes. 55 percent of federal investment will go directly to businesses in the form of tax credits.

While this section does look at direct grant opportunities for Portland, it is also worth considering the role of local government and institutions to support the conditions that will attract private investment through tax credits. Additional benefits accrue to companies, for example, for using apprenticeship program workers, or paying workers prevailing wages, locating projects in a low-income or legacy energy community or brownfield location, Buying American, and/or serving an affordable housing development.[11]

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[11] *https://www.thenewlocalism.com/newsletter/how-communities-can-maximize-the-inflation-reduction-act/*

In general, it has become standard practice for federal agencies to prioritize funding to regional and cross-sector partnerships that are able to demonstrate effective governance and the ability to raise matching funds. This emphasizes the need for a coordinated hub model to scale up clean industry.

The U.S. Economic Development Administration awarded Oregon Mass Timber Coalition a $41.4 million Build Back Better grant to drive jobs, sustainable forestry, and mass timber housing.

ENVIRONMENTAL PROTECTION AGENCY

Climate Pollution Reduction Grants

Total funding availability: $5 billion

The CPRGs are available to local governments to develop and implement plans for reducing greenhouse gas emissions and other harmful air pollution. The Metro Regional Government is in the early planning stages for a $1 million block grant that will make the region eligible to compete for future funding allocations. **Funding for a clean industry hub could be an eligible project as part of the 7-county climate strategy.**

Additional note: The bulk of IRA funding through the EPA is dedicated to community grants and residential use. There are a number of options for greening commercial fleets, if this is determined to be within the scope of the hub.

DEPARTMENT OF ENERGY

Energy Efficiency Conservation Block Grant (live)

Total funding availability: $550 million (not part of the IRA)

This is a direct grant program available to local governments for the establishment of financial incentive programs for energy efficiency improvements. Although largely focused on energy efficiency in residential and commercial buildings, it also includes "the application and implementation of energy distribution technologies that significantly increase energy efficiency, including—
(A) distributed resources; and
(B) district heating and cooling systems."

The Cit y could partner with specific companies to support capital costs for early development of a circular or symbiosis project. In addition to direct capital investments, DOE also makes streamlined funding available for blueprints and planning processes. Eligibility also includes "the purchase and implementation of technologies to reduce, capture, and, to the maximum extent practicable, use methane and other greenhouse gasses generated by landfills or similar sources." This may be of value to the waste management sector (public and private).

The Advanced Industrial Facilities Deployment Program

Total available funding: $5.8 billion, to be allocated by 2026

This program, operated under the Office of Clean Energy Demonstrations, will provide competitive financial support directly to owners and operators of energy-intensive industrial facilities for high-impact, transformational projects to significantly reduce GHG emissions. With the right technology solutions, this could be a worthwhile pursuit for some of Portland's larger industries, particularly those that fall under DEQ's CPP requirements.

Given that the process is currently in the NOI phase, any proposals would need to be prepared with urgency. The program requires a 50 percent cost share and can be used for:

- The purchase and installation or implementation of advanced industrial technologies at eligible facilities;
- Retrofits, upgrades or operational improvements at eligible facilities to install or implement advanced industrial technologies;
- Engineering studies and other work needed to prepare eligible facilities.

Industrial Assessment Center (IAC) and Combined Heat and Power Technical Assistance Partnership (CHP TAP) programs

(live-deadline is July 14, 2023 but more rounds coming)

Total available funding: $80 million in first round (Bipartisan Infrastructure Law)

Designed for small- and medium-sized manufacturing firms (SMMs) to accelerate the adoption of recommendations made by DOE to improve energy efficiency to lower costs and reduce industrial emissions. The programs are being run through a new DOE Clean Energy Manufacturing Innovation Institute: The Electrified Processes for Industry without Carbon (EPIXC) at Arizona State.

The grant program expands the long-standing IAC program and will provide up to $300,000 in funding, per entity, to help eligible SMMs implement recommendations from assessments conducted between 2018 and 2023. SMMs will provide at least 50% cost share for each project. Portland companies that begin the assessment process now will be eligible for future rounds of funding. Oregon's designated Industrial Assistance Center runs through Oregon State University.

CHP TAPs, a regional network of technical assistance providers, promote and assist in transforming the market for combined heat and power throughout the United States. The CHP TAP for the Pacific Northwest is run from Washington State University.

DOE is also soliciting applications from non-IAC or CHP TAP assessment providers to qualify assessments from other entities as "IAC-equivalent." The hub could either partner with the existing entities at OSU and WSU or support a new qualified entity that aligns with the clean industry mission.

The Manufacture of Advanced Key Energy Infrastructure Technologies (MAKE IT) Prize

Total available funding: $30 million in first round

The MAKE IT Prize was developed by the Office of Technology Transitions in partnership with the Office of Clean Energy Demonstrations and the Office of Energy Efficiency and Renewable Energy, and administered by the National Renewable Energy Laboratory. It has a prize pool of approximately $30 million spread across two tracks—the Facilities Track and the Strategies Track.

It is specifically aimed at supporting regional hubs for clean energy technology components, moving manufacturing facilities from planning to shovel-ready and enabling strategies for vibrant manufacturing activities in communities.

The Strategies Track competitors will develop a roadmap to promote clean energy manufacturing activity in their region and provide a statement of interest from an entity interested in establishing a facility in their region. This would be applicable if Portland were to focus the hub on a specific type of clean energy manufacturing (e.g. clean hydrogen).

DEPARTMENT OF TREASURY

Clean Energy Investment and Production Tax Credits (through 2023)

Replaced by Clean Electricity Investment and Production Tax Credits (2024 through 2032)

Management and Budget estimate value: $62 million.

The IRA substantially restructured renewable energy tax credits to make them transferable for developers who wouldn't otherwise have a sufficient tax liability to benefit. It also makes eligible tax-exempt entities, such as governments and not-for-profits. This makes smaller projects more viable and reduces the need to bundle investments through more complex financial mechanisms. It also makes it more likely that sites will remain under the ownership of local developers.[12]

This would require some creative cross-sector thinking in a Portland hub scenario, but could benefit public and private co-located facilities. A hub could also facilitate credit swapping arrangements between local entities committed to renewable energy generation and use.

Additional eligibility bonuses are also awarded to projects meeting prevailing wage and apprenticeship requirements, and/or developed in low income census tracts or brownfield cleanup sites. A hub could help identify and prepare targeted sites, layering other resources such as E-Zone tax abatements and brownfield cleanup grants. Maximizing these tax credits would also have positive impacts on local workers.

[12] https://www.americanprogress.org/article/understanding-direct-pay-and-transferability-for-tax-credits-in-the-inflation-reduction-act/

Advanced Energy Project Investment Tax Credit (Section 48C)

Total funding availability: $10 billion expansion under IRA

The IRA expanded a tax credit that provides incentives for renewable energy production and considerably broadened eligibility. It now includes projects that "expand clean energy manufacturing and recycling and critical materials refining, processing and recycling, and for projects that reduce greenhouse gas emissions at industrial facilities." In addition, the Department of Energy is aiming to leverage credit allocations in the first round to support small- and medium-sized manufacturers. Section 48C offers a tax credit up to 30% on investments.

NATIONAL SCIENCE FOUNDATION

NSF Regional Innovation Engine Program (CHIPS and Science Act)

There are alternating rounds of funding for two types of awards: Type-1 awards that provide up to $1 million for up to two years; and Type-2 awards that provide up to $160 million for up to 10 years. The first round of Type-2 awards are anticipated in the fall of 2023 and will fund NSF Engines across three distinct phases — the nascent, emergent and growth phases.

The goal of the program is to "support the development of diverse regional coalitions of researchers, institutions, companies and civil society to conduct research and development that engages people in the process of creating solutions with economic and societal impacts. Through the process, NSF Engines will train and develop the local workforce and grow regional innovation ecosystems throughout the U.S."

DEPARTMENT OF COMMERCE

US Economic Development Administration (EDA)

The EDA is not one of the primary implementing agencies for the IRA, but has integrated climate goals into other funding streams. It directed $1 billion from the American Rescue Plan to the Build Back Better Regional Challenge (the Oregon Mass Timber Coalition was a successful applicant). It will be worth tracking current and future programs, working with regional partners, to identify opportunities for a clean energy hub.

Regional Tech Hubs (CHIPS and Science Act)

Total available funding: Authorized for $10 billion over 5 years, $500 million appropriated (applications due August 15)

"The Tech Hubs Program is an economic development initiative designed to drive regional technology- and innovation-centric growth by strengthening a region's capacity to manufacture, commercialize, and deploy critical technologies." Portland regional partners are currently looking at several options for competitive applications, some of which may be aligned with the vision and goals of a clean industry hub.

Build to Scale (B2S)

The B2S program within EDA's Office of Innovation and Entrepreneurship, strengthens regional economies by enabling startups to start and grow through the Venture Challenge and Capital Challenge. The opportunity is currently live and designed to "strengthen ecosystems that equitably and inclusively support diverse technology innovators, entrepreneurs, and startups." While not specifically targeted at clean industry, it could be applied for that purpose.

Small Business Administration (SBA)

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (SBTT)

The SBIR and STTR are competitive programs that encourage domestic small businesses to engage in R&D with the potential for commercialization. Central to the STTR program is the partnership between small businesses and nonprofit research institutions. The STTR program requires the small business to formally collaborate with a research institution. There is no specific clean industry focus to the programs, but a coordinated hub approach to support emerging solutions in the Portland area.

FUNDING & FINANCING MECHANISMS

Capital will be required both to establish and sustain a hub and to attract the kinds of investments that can advance clean industry in Portland. This can be achieved through incentives, grants, and financing (debt). Before pursuing specific sources of outside funding, a hub will need to identify the appropriate investment tools, desired policy outcomes, and possible applications in a Portland context.

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INCENTIVES

Incentives can help organizations reduce the costs or risks associated with making clean industry investments and come in various forms:

INCENTIVE TYPE / DESCRIPTION	POTENTIAL APPLICATIONS *Examples are suggestions for Portland clean industry hub offerings–not formal proposalS.*
Rebates *3rd Party cash back to encourage targeted investments.*	**Energy Trust of Oregon (ETO**) – ETO would be a natural hub partner to implement a clean industry rebate program for various capital investments. ETO's mandate does not currently allow fuel switching, but this could either be expanded or the existing energy-efficiency mandate could be expanded to address clean industry objectives. The hub could help support a greater ETO role with an infusion of federal funds or with an update to the existing utility charge. more specific regional data including revenue per NAICS-4 code.
Tax Credits *Like rebates but the incentive is in the form of a tax credit. Unless credits can be traded, they are only beneficial to organizations that have a tax liability and thus their impact can be limited.*	The Inflation Reduction Act (IRA) offers multiple tax credits directly to businesses for clean vehicles, energy efficient buildings, etc. A Portland hub could help gather information and help businesses make eligible investments, or operate as a matchmaker for transferable credits. A close relative of the tax credit is property tax abatement, which is available in Portland within designated E-Zones and for brownfield cleanup. The hub could help coordinate with public agencies to help locate new clean industry in eligible locations.
Performance Incentives *Government sets key waste / emissions goals and applies tax / fee / awards based on attainment of goals.*	Through the **Climate Protection Program**, the state offers a regulatory framework for large CO_2 emitters to reduce their emissions. A comparable framework could be established for smaller emitters in Portland and/or incorporate other metrics such as waste generation, with specific targets for specific businesses or sectors. This would be most effective if paired with a subsidy program to assist companies implement their transition plans. Prosper Portland's **Thriving Small Business Loan Program**, where interest rates can be reduced based upon completion of technical assistance milestones, could be adopted to align with emissions or waste related metrics.

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GRANTS

Grants are typically offered by government agencies and foundations. The amount of capital available through grants is generally relatively small with applicability limited to specific purposes:

GRANT TYPE / DESCRIPTION	POTENTIAL APPLICATIONS
Study / Planning Grants *Fund initial research, concept development, assess feasibility, develop plans for a given initiative.*	**Energy Trust of Oregon** offers Project Development Assistance to cover 50 percent of the cost of hiring a consultant to help with planning a renewable energy project. This could be considered for a district energy approach to clean industry. The hub could also pursue federal planning grants for targeted sectors, such as the Solid Waste Infrastructure for Recycling Grant Program created by the Bipartisan Infrastructure Law or Climate Pollution Reduction Grants through the EPA.
Pilot / Proof of Concept Grants *Fund initiatives to test unproven solutions and concepts. Successful outcomes mitigate project risk thus increasing the availability of more implementation capital.*	The hub could operate as a partner and clearing house for **SBIR** and **STTR** grants for new emissions or waste reduction technologies. These often require a company match, which a hub could help underwrite to ensure eligibility.
Technical Assistance Grants *Funding to provide assistance, guidance and information to project implementers to reduce project risk and increase the chances for successful outcomes*	A clean industry hub could help small- and medium-sized businesses conduct technical assessments and strategies with grants **Industrial Assessment Center (IAC) and Combined Heat and Power Technical Assistance Partnership (CHP TAP)** programs. Oregon State University and the Oregon Manufacturing Extension Partnership would be natural partners.

GRANT TYPE / DESCRIPTION	POTENTIAL APPLICATIONS
Gap / Catalytic Grants *Funding to fill in a small part of the overall capital stack. Can be leveraged to secure additional debt capital through de-risking.*	The cash flow generated from an initiative might be marginally sufficient to service the debt. The hub could raise its own funds or find partners to help reduce the financing needed such that the cashflow can properly service that debt. *BEAM Circular in the North San Joaquin Valley, CA has made SBIR investments central to its core services to area bio-industrial businesses. The hub provides subsidies to companies with conditions for workforce development and GHG reduction. It is also launching an Innovation Grant Program to support the adoption of new technologies.*
Implementation Grants *Smaller projects (typically less than $1 million) can be funded by implementation grants (larger projects must often require multiple grants and/or financing (loans) to fund the entire capital stack).*	This would be an appropriate focus for funding from the Oregon Legislature, perhaps within a larger legislative vehicle for either economic development or energy transition. *In 2021, the Washington Legislature passed SB 5345, with unanimous bipartisan support, creating an Industrial Symbiosis program at the State Department of Commerce. It now allocates $2 million per biennium for grants to symbiosis projects statewide. They allocated an additional $500,000 in 2022 to explore opportunities for symbiosis to strengthen the economic competitiveness and sustainability of Washington agriculture.*

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FINANCING

Financing, capital in the form of debt, can leverage the largest amount of private capital. However, as debt, it must ultimately be repaid and is only feasible for projects that generate revenues, reduce costs, or levy a performance-based activity tax or fee to service that debt.

While bank and public (bonds) financing can be a viable, affordable, and ample source of debt for established, proven initiatives, new, unproven projects are often too risky or too expensive for these sources of capital. Catalytic finance can be used to de-risk initiatives or lower the cost of financing thus allowing more capital to be accessed.[13] Examples of catalytic financing options include:

CATALYTIC FINANCING TYPE / DESCRIPTION	POTENTIAL APPLICATIONS
Lender Enhancements - Various means are available to reduce the risk to lenders thereby catalyzing additional capital to help fund the programs.	
Loan Guarantees *A 3rd party with a strong balance sheet guarantees a portion of any outstanding debt thereby eliminating any risk associated with that capital. The Guarantor does not invest in the project, but sets aside a reserve that can be used in the event of a default.* *Government agencies wishing to see a desired outcome are often willing to offer a guarantee. Foundations have often been known to serve as a guarantor.*	Business Oregon offers the **Capital Access Program** and the **Credit Enhancement Fund,** which could be used as models for a specific clean industry program. A variation of a loan guarantee is to fund a **lender's loan loss reserve** to help them cover anticipated loan losses. House Bill 2266 enacted the Community Lender Loan Loss Reserve Program offered by Business Oregon; something similar could be legislated for clean industry purposes.

[13] *An example is the Council of Development Finance Agencies, which recently announced a Greenhouse Gas Reduction Fund of $27 billion to leverage EPA grant programs with additional private investment. This is largely targeted at residential and commercial projects, but offers a model for clean industry financing.*

CATALYTIC FINANCING TYPE / DESCRIPTION	POTENTIAL APPLICATIONS
Subordinated / First-Loss Loan *To de-risk a project for a broader set of lenders, it may be feasible for a subset of lenders to accept a subordinated position and be a lender willing to accept the first loss in the capital stack. In essence, these lenders are willing to let the borrower repay the other lenders first (thereby reducing their risk) before they are repaid.*	Potential subordinated lenders for the Clean Industry Hub are those with aligned missions and have access to purpose-driven or patient capital. This could include: o Government agencies with legislative-mandated capital for this purpose o Foundations and institutions who desire to make purpose-driven investments via their endowment or investment funds o Some Financial Institutions (banks) are mandated to allocate a portion of their assets under the Community Reinvestment Act (CRA). These loans are often referred to as Equity Equivalent (EQ2) loans. o Community Development Financial Institutions (CDFIs) have access to more patient and flexible capital. o Green Banks – Through the Inflation Reduction Act, $27 Billion has been allocated throughout the country for climate financing purposes.[14]

[14] *It is expected that IRA funds would be leveraged to raise additional private capital thereby making the available funds significantly higher. However, because the IRA is so new, rules are still being developed and Green Banks vary significantly from state to state, and it remains to be seen whether a Green Bank can be a viable subordinated lender in this instance. While there is currently no Green Bank in Oregon and no active legislation to establish one, there are discussions to pursue other means to access those funds from the IRA.*

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CATALYTIC FINANCING TYPE / DESCRIPTION	POTENTIAL APPLICATIONS
Borrower Enhancements - The capital offered by lenders could be deemed too expensive or cumbersome for borrowers thereby making that capital non-accessible to prospective borrowers. Several means are available to make capital more accessible.	
Interest Rate Reduction *Providing a subsidy to the borrower by paying a portion of the interest cost.*	A public agency or foundation could offer a grant to effectively "buy down" the interest rate offered by a lender to facilitate, for example, lending to establish a wastestream conversion facility. **Concessionary capital** that doesn't require a market rate return could be offered by a public agency, foundation, institution or CDFI for the specific purpose of financing Clean Industry Hub initiatives. **Revenue based loans** offer a payment schedule based upon the cashflow generated from a project. While these loans may not necessarily reduce the interest costs, they are structured to accommodate the anticipated project cashflow.
Financed Capital Reduction *A 3rd party can inject equity (investment, grant, in kind) into a project that reduces the amount of capital that needs to be financed thereby making the project more affordable.*	A **land trust** could offer land via a long term lease to a clean industry initiative thereby eliminating the need to finance the land acquisition. **Grants and other in-kind donations** can be offered to cover certain cost components. **Preferred Equity or Recoverable Grant**s allow an investor to recover some of their (concessionary) investment under certain conditions when affordable by the borrower. **Combined Debt & Equity Financing** - A funder can offer both types of capital thereby, in essence, leveraging their own capital.

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06 Moving forward
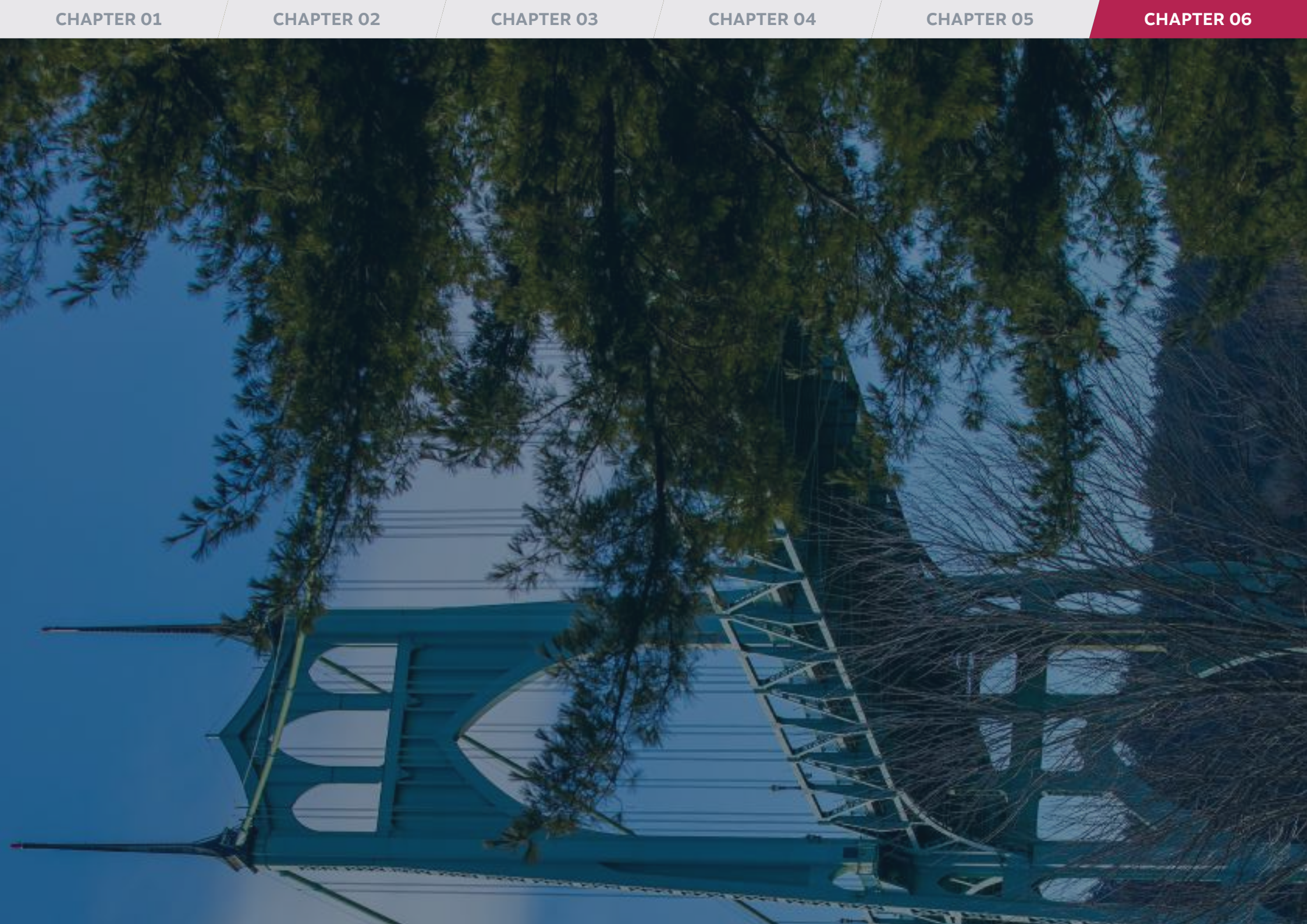
This section lays out a path from analysis to implementation. Building on the findings from the Assessment phase, this report concludes with recommendations and a path forward to advance a clean industry transition in Portland.

CLEAN INDUSTRY ROADMAP EVENT

After completing the assessment of current conditions, global hub models, and policy and finance tools, the project team hosted a full-day "Roadmap" event to share the Assessment findings to identify a path forward.

The Roadmap event had approximately 80 attendees representing business, government, higher education, utilities, workforce development, and community and environmental organizations, as well as expert consultants, BPS staff, and facilitators in supporting roles. During the event, participants met in breakout sessions based on the strategies identified earlier in the "Clean Industry Solutions" section of this report. In each facilitated group, participants imagined the future vision for the strategy, discussed existing assets and gaps, and identified priority actions to get underway.

A number of themes emerged across the breakouts and throughout the day. Four key takeaways are as follows:

• There is enthusiasm for the clean industry vision (though "clean industry" might not be the right language to use).

• Communication and coordination is lacking within and between sectors. This inhibits the flow of information, ideas, and resources and presents bottlenecks to implementation.

• Industry, people, and the environment are important and interdependent; we need to work together to ensure all three are thriving.

Establish effective **collaboration** structures

Help business identify and implement **clean industry** solutions

Build the brand and increase industry and worker **engagement**

Make transformative **investments**

CLEAN INDUSTRY

Enhance linkages between industry and higher **education**

Establish supportive **policy & regulation**

Adequately **fund & finance** the transition

Fig. 26 *The Clean Industry Framework used during the roadmap event.*

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- Key performance indicators and quality data are needed to make decisions and assess progress

The following section provides detailed information regarding identified strategies to support achievement of Portland's clean industry vision, which is currently formulated as:

Industry thrives while contributing to climate goals, environmental quality, and inclusive prosperity.
Our results solidify Portland's reputation as an inclusive clean economy leader and contribute to additional innovation and investment that benefits our community.
Our inclusive clean economy success is the result of productive collaboration among diverse sectors - which becomes the new normal in Portland.

POTENTIAL SOLUTIONS AND RECOMMENDATIONS

The Clean Industry Assessment identified significant assets and enthusiasm for Portland's Clean Industry vision. This section describes the seven strategies to advance a clean industry transition and provides recommendations for each.

HELP BUSINESS IDENTIFY AND IMPLEMENT CLEAN INDUSTRY SOLUTIONS

Many resources are available to support Portland businesses with the clean industry transition. These include Energy Trust of Oregon, Oregon Manufacturing Extension Partnership, Oregon Manufacturing Innovation Center, and OSU's Industrial Assessment Center to name a few. However,

businesses often don't have the bandwidth or means to identify and implement clean industry solutions. In addition, there are some gaps in the ecosystem of services, such as identifying Inflation Reduction Act funds or addressing circularity. This strategy considers how we might build on existing assets to create an easy pathway for businesses to identify and implement practices that are clean, decarbonized, circular, and inclusive. This strategy would center the user experience and define low-friction pathways to get businesses what they need (e.g., assessment, financing, technical assistance).

Stakeholders expressed strong support for the concept of a navigator, concierge, or account manager to support businesses with clean industry. The navigator concept can also connect to other strategies. For example, a business support navigator could help businesses identify financing, address permitting challenges, engage with inclusive workforce and contracting programs, or collaborate with researchers to co-develop solutions.

Recommendation

Convene existing service providers to identify areas of coverage, gaps, and potential synergy, and engage with businesses to understand the user journey and develop programming that responds to their needs and preferences. Initial resources required for this strategy include staff and/ or consultant time to coordinate convening and engagement. Additional resources will likely be needed for implementation (e.g., hiring navigators).

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ENHANCE CONNECTIONS BETWEEN INDUSTRY AND ACADEMIA

Effective networks between businesses and higher education could help address clean industry challenges. This strategy aims to facilitate more effective collaboration among businesses and higher education to better solve clean industry workforce and technology challenges. There are two main components to this potential strategy: connecting industry and higher education to address talent and technology issues, and connecting higher education institutions to each other to serve industry's talent development and technology research needs.

Some resources exist that could be enhanced and/or better communicated, though gaps exist. For example, there is not a central way to identify industry challenges and develop use-inspired and collaborative research. With respect to talent development, PSU, PCC, and Worksystems are currently engaged in workforce development efforts related to manufacturing and climate careers and there may be opportunities to connect to and leverage that work. In addition, Prosper Portland cluster leads may be able to facilitate better system coordination.

Recommendation

For the two components defined above, 1) identify existing pathways to connect as well as gaps and potential synergies and 2) create programming that responds to industry-identified needs and preferences. Initial resources required may include staff and/or consultant time to coordinate convening and engagement. Additional resources may be needed for implementation.

MAKE TRANSFORMATIVE INVESTMENTS

Many cutting-edge, impactful clean industry solutions are poorly understood or not yet widely available, such as industrial symbiosis and green hydrogen. These and other transformative solutions will require significant capital investment, research, and coordination to implement at scale. This strategy aims to assess and address clean industry challenges that are best-suited to coordinated action at scale.

A number of challenges stand out regarding transformative investments. First, some of these concepts are not well understood. For example, some people think industrial symbiosis refers solely to infrastructure-heavy investments where one company's waste is transported to become another company"s input while others have a broader understanding of the concept as one where businesses identify opportunities to reduce waste, turn wastes into new product lines, and then find markets for residual waste once internal opportunities have been identified and implemented. Second, some potential investments languish because infrastructure is not being developed until businesses are on board and businesses are not on board until the infrastructure is developed. Third, transformative investments can be challenging to execute if they require access to land or rights-of-way, significant permitting, complex financing, or involvement of multiple parties.

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Recommendation

1) Identify and assess opportunities for transformative investment (e.g., green hydrogen, industrial symbiosis, food waste, heat recovery, waste exchanges) with the assessment including consideration of financial viability, environmental impact, and community benefit. 2) Develop partnerships and financing to implement the most promising investment options. Initial resources required include staff and/or consultant time to conduct the assessment, including engagement with key stakeholders. Additional resources would be needed for implementation.

Note: *The Port of Portland has noted that they are interested in being a leading entity for this strategy.*

- The hub needs to define goals and key performance indicators (KPIs), and track progress. Further, co-benefits and community impact should be included in these indicators and incorporated into decision-making.

- Regulation should be reframed as accountability to a shared social value and a culture of partnership between regulators and regulated should be rebuilt, including community participation.

- There is a need for better coordination between and among local and state government agencies so that it is easier for businesses to adopt clean industry practices.

- The process needs flexibility on how to get to an outcome, as well as in refining and iterating policy in response to lessons learned.

- Access to land needs to be addressed; for example, by incentivizing build up, adaptive reuse, or leasing underutilized parcels.

ESTABLISH SUPPORTIVE POLICY AND REGULATION

Policies and regulations can support or inhibit the adoption of clean industry practices. This strategy aims to ensure that policies and regulations facilitate the transition to clean, decarbonized, circular, and inclusive industry practices. Policy and regulation are addressed extensively in an earlier section of this report. Here we focus on six key themes that emerged during the Roadmap event.

- Policy and regulation should incentivize preferred behaviors, creating an advantage to do business in Portland.

Recommendation

1) Define goals, KPIs and processes for implementation and tracking. 2) Identify existing policies and regulations that inhibit uptake of clean, decarbonized, circular, and inclusive practices and coordinate a response to address. 3) Define and prioritize policies and regulations that can support uptake of clean, decarbonized, circular, and inclusive practices and coordinate implementation. Initial resources required include staff and/or consultant time to define goals and KPIs and identify policy priorities, including engagement with key stakeholders. Resources for ongoing performance monitoring would need to be defined.

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BUILD THE BRAND AND INCREASE ENGAGEMENT

Portland's clean industry vision is not well known. This strategy aims to ensure that businesses and workers, as well as the larger community, are aware of and engaged in clean industry opportunities. Effective communication and outreach requires clarity regarding the target audience, core message, and communication channels (who to reach, what message to share, how to reach the audience).

Potential target audiences and key messages include (but are not limited to) the following:

- **Industry -** How clean industry actions can benefit your business

- **Community -** The value of industry to Portland and the ways Portland's clean industry vision can benefit community

- **Policymakers and government staff -** The value of industry to Portland and Portland's clean industry vision

- **Workers -** Opportunities in the clean industry economy

Effective connection needs a relevant call to action and delivery in the ways that resonate with the specific audience. For example, hosting block parties with industry peers might build visibility and enthusiasm among industrial businesses; sharing a clean industry career map might be useful for workers and folks in workforce development and career counseling; and tours and story maps might be useful for sharing success stories and increasing understanding of issues and opportunities.

One theme that emerged is the need to revisit "Clean Industry" as the term for this effort. Clean Industry has been used as an umbrella phrase for clean, decarbonized, circular, and inclusive industry practices,

however, the term may not effectively communicate the vision or resonate with various audiences.

Recommendation

1) Define target audiences, messages, and channel and 2) develop and implement an outreach and communication plan. Resources may be needed for implementation.

ADEQUATELY FUND AND FINANCE THE TRANSITION

Achievement of Portland's clean industry vision will require financial resources. This strategy aims to ensure that diverse sources of capital are available to support the adoption of clean industry solutions as well as the network infrastructure that is needed for collaboration.

Finance and funding are addressed extensively in an earlier section of this report. Here we focus on four key themes that emerged during the Roadmap process.

- Businesses face a number of challenges accessing finance for clean industry solutions. For example, it takes time and expertise to identify funding sources (lenders, grants, rebates, etc.), funds may not be available for the solution (e.g. no funder for that technology, business doesn't qualify), and the cost of funds may be too high.

- Inflation Reduction Act funds are already flowing and some deadlines have passed. Portland needs to organize quickly if it wants to engage in these opportunities.

- Creative funding solutions merit consideration. Examples include revolving loan programs and community investment models.

• A fee incentive could be productive if structured appropriately and the tax or fee is clearly tied to the clean industry work. Suggestions included both carrots (reward for doing well) and sticks (fee for not performing but tied to assistance addressing the issue). Any fees tied to earnings should be based on net rather than gross income.

> ### Recommendation
>
> *1) Determine funding goals and budgets (e.g., help businesses pay for solutions, fund a clean industry hub project such as industrial symbiosis planning study, clean industry business navigator, hub coordinator). 2) Develop and implement a funding strategy for the defined goals and budgets. Resources required for this strategy include staff and/or consultant time for research, engagement, and implementation (e.g., grant applications, development of new funding stream).*

ESTABLISH EFFECTIVE COLLABORATION STRUCTURES

Effective collaboration among diverse stakeholders is necessary to achieve Portland's clean industry vision. This strategy aims to ensure that essential roles and habits for effective collaboration are in place.

While there are many types of clean industry hubs and many ways to do this work, there are a few key functions that are essential for success. These include the following:

• **Network Coordination.** This function attends to the coordination, communication, and convening that needs to happen among diverse stakeholders. Ideally this function is delivered by an entity or entities that are perceived as neutral and capable.

• **Guidance and Oversight.** This function attends to overall stewardship of the vision. Activities include things like identifying relevant issues and opportunities, tracking progress toward the vision, and making decisions on behalf of the collaborative. Ideally, this function is delivered by a core team that includes representatives of each of the key stakeholder groups.

• **Resource Gathering.** This function attends to the securing of resources for the collaboration. Ideally this function is performed by an entity or entities that have experience and capacity to identify, secure, and manage funds and a reasonable overhead rate.

• **Project Development and Implementation.** This function brings to life specific projects that have been identified in support of the vision. To be considered part of the collaborative, projects should be endorsed or approved by those providing the guidance and oversight function.

Delivery of these functions can take a variety of forms. The functions may be filled by one or many organizations, and those organizations may rotate over time. Further, overlap between the functions is to be expected - for example, as a project team addresses resource gathering.

Undergirding these functions are the relationships and habits that foster durable and effective collaboration. A key ingredient for successful collaboration is attention to the norms and processes that cultivate trust and partnership.

> **Recommendation**
>
> *Identify where there is interest, enthusiasm, and capacity for various collaboration functions. Convene those entities to refine and determine next steps. Resources required for this strategy include staff and/or consultant time to manage this deliverable.*

CREATING THE CLEAN INDUSTRY HUB

This Clean Industry Assessment and Roadmap process has provided valuable insight regarding Portland's opportunity to transition to clean, decarbonized, circular, and inclusive industry practices. We have improved our understanding of existing industry conditions, considered lessons learned from global clean industry models, identified relevant policy and finance tools, and defined seven strategies to bring the clean industry vision to life.

Moving forward, a number of questions must be addressed to develop the clean industry hub. Described below, these include mission and purpose, financing role, government support, industry leadership, staffing and expertise, and land.

MISSION AND PURPOSE

The clean industry vision describes the ideal future for the industrial sector; the mission tells us what the hub does to make the vision a reality. Having a clearly defined mission and purpose for the hub is essential for success. A clear focus helps funders and partners understand the value proposition and how it might help them achieve their goals. For example, is the focus on the reduction of emissions and other pollutants or building a different economy from the ground up; is the focus on a specific sector or geography? Without a clear mission it is impossible to define and measure success, difficult to prioritize resources, and challenging to attract resources and partners.

Outstanding question:
What is the mission of the hub?
-

FINANCING ROLE

Related to the question of mission and purpose, it is important to determine what, if any, financial role the hub will play in relation to Portland's industry transition. At a basic level, the hub can inform, educate, and advocate for key businesses and industries to access opportunities. With more capacity, a hub could help businesses facilitate and unlock capital, brokering clean industry financing by connecting businesses with (multiple) funders and helping to overcome barriers to capital formation.

If there is sufficient volume and potential borrowers, it may be feasible to establish a local loan fund – either as a standalone or one that is part of a public agency or Community Development Financial Institution (CDFI) specifically designed to support clean industry. Such a fund would access and structure capital in a manner specific to the hub's objectives and have staff expertise in this arena. A hub could also help launch financing entities or programs focused specifically on clean industry transition, such as CDFIs or green banks. Each of these solutions would require outside funding support from the state or federal government, but begins with an intentional decision to move into this space.

Outstanding question:
What financing role will the hub play?
-

GOVERNMENT SUPPORT

Public investment is often necessary to overcome the initial risk to industry that comes with disrupting existing business practices or to provide common goods such as infrastructure. In the US, many clean economy initiatives were launched using ARPA dollars. In Europe and Asia, combinations of municipal, national, and EU funding are often used to establish, staff, and operate hubs, with private dollars coming in response.

Public investment can come in a variety of forms. In some cases, public utilities serve as the backbone of a district energy or heating system for clean industry, helping to establish governance around operations. In other cases, hubs are fully funded and overseen by public agencies. Seed funding for clean industry financing would likely need to be obtained from the public sector, either locally or as part of a proposal for state and/or federal investment. In general, the use of taxpayer dollars should be focused on catalyzing private investment. While the exact role for government is unique to each location and situation, it is irreplaceable in all of them.

Government can also play a catalytic role within its own operations, introducing circular processes within public infrastructure, as the Bureau of Environmental Services has done with the Poop to Power program. The public sector can also have a clean industry impact through procurement practices, such as the City's use of recycled paving materials, with supportive policies such as co-created targets, and with funding or staffing to support the hub. These effects can be multiplied further through intergovernmental cooperation and agency alignment.

Outstanding question:
How will government support the hub?
–

INDUSTRY LEADERSHIP

The clean industry transition cannot occur without industry leadership. This means playing an active role in defining and implementing policies and programs that support the shared vision and goals. Peer leaders play an important role in demonstrating what is possible and communicating the value proposition. Business groups also play a role, connecting with their members and cultivating enthusiasm and support. The best approach is to start with a core group of willing companies and expand the circle from there.

Outstanding question:
How will industry support the hub?
–

STAFFING AND EXPERTISE

Creating a clean industry hub requires the ability to connect many different organizations and fields of expertise. In all of the global examples studied, the value of a connector cannot be overstated. Having adequate staffing and expertise is central to the hub's success. The number of staff and type of expertise required will depend upon the mission and structure of the hub. For example, is the staff playing a coordinating role or delivering business technical assistance?

Outstanding question:
What staffing and expertise does the hub need?
–

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LAND

While some hub activities may be virtual or take place in the field, a minimum amount of space is required to host the hub. Further, many clean industry hubs require significant land resources as they serve a specific sector or solution (e.g., bio-manufacturing and waste, off-shore wind, green hydrogen, innovation center).

Outstanding question:
What land resources does the hub need?
-

COLLABORATIVE STRUCTURE

As noted earlier, there are some key functions that must be attended to for collaboration to succeed. These include coordination of the network, guidance and oversight, resource gathering, and project development and implementation. Delivery of these functions can take a variety of forms. The functions may be filled by one or many organizations, and those organizations may rotate over time. Overlap between the functions is to be expected. In addition, undergirding these functions are the relationships and habits that foster durable and effective collaboration. A key ingredient for successful collaboration is attention to the norms and processes that cultivate trust and partnership for the long haul.

Outstanding question:
How will the collaborative structure be established and maintained?
-

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NEXT STEPS

As noted earlier, the Assessment and Roadmap were guided by a robust Advisory Group representing diverse clean industry stakeholders. At its final meeting, the group reviewed the Assessment and Roadmap findings and discussed next steps. Three specific items were identified as needing immediate attention: focus, resources, and leadership. First, as noted above, while a clean industry vision for Portland has been defined (preferred future), a critical next step is to define the mission of the clean industry hub (what it does to bring the vision to life). A clear mission, with goals and key performance indicators, is needed to attract funding and partners, strategically invest time and dollars, and track progress. Second, resources are required to implement the strategies. This is related to focus, as one must define what needs to be funded in order to identify the resource streams suitable to those activities. Finally, committed leadership is needed to perform the essential functions needed to create a clean industry hub. These include the functions of network coordination, guidance and oversight, resource gathering, and project development and implementation. The group decided to assemble a nimble core team that will address the issues of focus, resources, and leadership with the urgency needed to seize this timely opportunity.

We hope that this report on the Clean Industry Assessment and Roadmap provides the information and ideas necessary to move forward with creating a clean industry hub in Portland. This research brings us closer to a future where businesses thrive while delivering environmental quality and inclusive prosperity. With this report we share our findings and recommendations and invite you to join us in bringing the inclusive clean industry vision to life.

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APPENDIX

APPENDIX I. DEFINITION OF THE STUDY SET

The scope of the industrial businesses included in this study is determined through a series of iterations (Figure 27). The initial selection of companies within the manufacturing sector is further narrowed down to include only the essential subsectors. The waste management sector has been recognized as crucial in addressing the matter of waste. Additionally, hospitals and universities are incorporated due to their significant role and shared facilities with other groups.

The following breakdown of the industries to be included in the analysis shows the total number of businesses studied, the total number of employees, and the total wages associated with the given industrial sector (Figure 28).
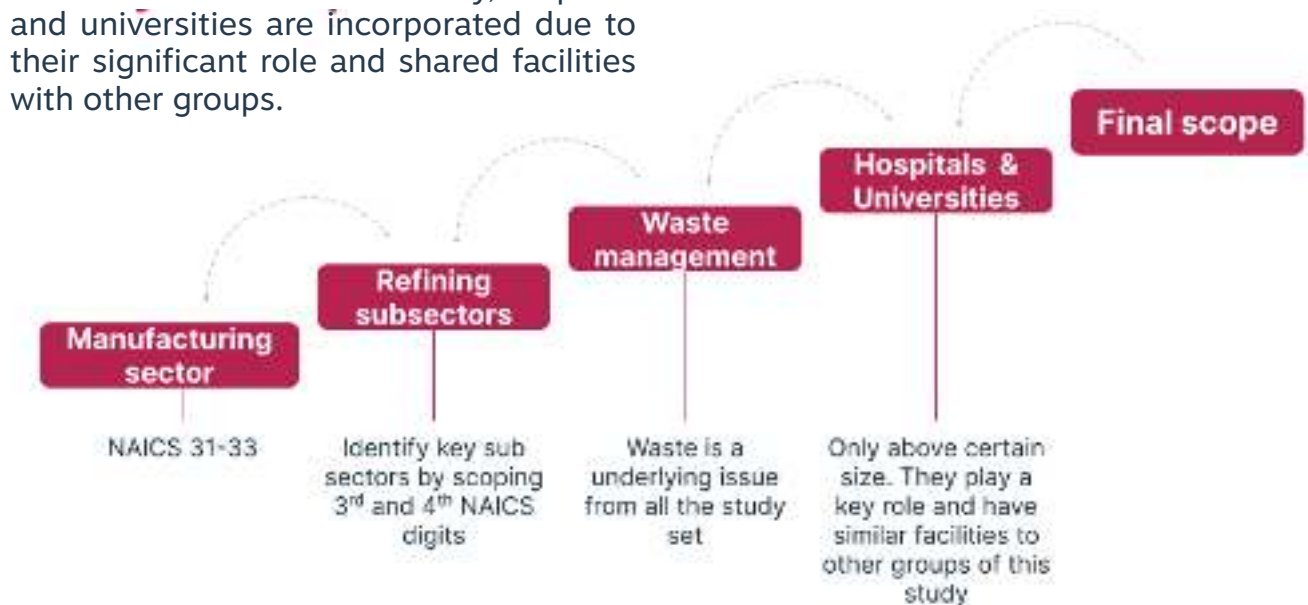
| Fig. 27 | The process of deciding on the sectors to include in the study set. |

Food & beverage manufacturing	Metals and machinery manufacturing	Electronic manufacturing	Miscellaneous manufacturing	Hospitals & Universities
Includes manufacturing of **food and beverages** products.	Includes **primary metal**, **fabricated metal** products, **machinery**, transformation manufacturing.	Includes manufacturing of **computer and electronic** products, **electrical** equipment, **appliances**, and **components**.	Includes the manufacturing of **chemical**, **plastic**, **wood products**, **paper**, **petroleum**, **textile**, **mineral**, and **others**.	Hospitals and universities, large institutions that share the **challenges and opportunities** of the industrial sector to become cleaner.
Total number of **businesses**: **378** Total **employees**: **7,053** Total **wages** ($ Millions): **371**	Total number of **businesses**: **284** Total **employees**: **11,063** Total **wages** ($ Millions): **883**	Total number of **businesses**: **79** Total **employees**: **1,717** Total **wages** ($ Millions): **133**	Total number of **businesses**: **633** Total **employees**: **9,243** Total **wages** ($ Millions): **546**	Total number of **businesses**: **13** Total **employees**: **49,506** Total **wages** ($ Millions): **4,472**

| **Waste management** | Includes **waste collection, waste treatment and disposal, and remediation and other waste management services.** | Total number of **businesses**: **65** | Total **employees**: **1,202** | Total **wages** ($ Millions): **79** |

| Fig. 28 | The six industrial sectors that are included in this study, along with the respective number of businesses, total employees, and total wages within each sector in Portland. |

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Hospital & Universities sector

We only consider educational institutions and hospitals with more than 500 registered employees as industry. We included 7 hospitals and excluded 9 smaller hospitals. We have included 6 educational institutions and excluded 88. Many educational institutions registered in Portland have no more than 10 employees and 14 institutions have more than 10 employees but less than 500 employees. Both and are excluded because of their relatively small size. For one of the universities, the number of employees mentioned in the QCEW data is about 8,000 more than what is stated on their own website. For this analysis, we have decided to go with the QCEW data to be consistent with the method used for all the other industries.

Why NAICS
The NAICS (North American Industry Classification System) is a necessary classification but does not suffice for all purposes.

Our decision on what NAICS level we would use was a tradeoff between granularity and interpretability.

We based most of our study set classification on NAICS 3 codes.

Only for educational services we used NAICS 4 codes to only include educational institutions that provide tertiary education. For other sectors like food manufacturing and chemical manufacturing NAICS 3 codes provide enough granularity while keeping the results understandable.

⊕ Pros

- *It allows for a data-driven analysis and the justification of an industrial sector*
- *It allows for tracking changes in sector growth over time*
- *It provides ability to crosswalk to skills and occupations*
- *It allows us to match other datasets to our specified industry sectors*

⊖ Cons

- *The NAICS codes are self-assigned by companies*
- *Emerging industries require an update of the system to be included*
- *Some public datasets use other business classification methods like the Bureau of Economic Analysis who have their own business classification system.*

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APPENDIX II. NAICS CODES PER SECTOR

SECTOR	SUB-SECTOR	NAICS 2	NAICS 3	NAICS 4
Food & beverage manufacturing				
Manufacturing	Food Manufacturing	31	311	
	Beverage and Tobacco Product Manufacturing	31	312	
Metals and machinery				
Manufacturing	Primary Metal Manufacturing	33	331	
	Fabricated Metal Product Manufacturing	33	332	
	Machinery Manufacturing	33	333	
	Transportation Equipment Manufacturing	33	336	6113
Electronic manufacturing				
Manufacturing	Computer and Electronic Product Manufacturing	33	334	
	Electrical Equipment, Appliance, and Component Manufacturing	33	335	

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SECTOR	SUB-SECTOR	NAICS 2	NAICS 3	NAICS 4
Miscellaneous manufacturing				
Manufacturing	Textile Mills	31	313	6112
	Textile Product Mills	31	314	
	Apparel Manufacturing	31	315	
	Leather and Allied Product Manufacturing	31	316	
	Wood Product Manufacturing	32	321	
	Paper Manufacturing	32	322	
	Printing and Related Support Activities	32	323	
	Petroleum and Coal Products Manufacturing	32	324	
	Chemical Manufacturing	32	325	
	Plastics and Rubber Products Manufacturing	32	326	
	Nonmetallic Mineral Product Manufacturing	32	327	
	Furniture and Related Product Manufacturing	33	337	
	Miscellaneous Manufacturing	33	339	
Hospitals & universities				
Health Care and Social Assistance	Hospitals	62	622	
Educational services	Educational Services	61	611	
	Educational Services	61	611	
Waste management				
Administrative and Support and Waste Management and Remediation Services	Waste Management and Remediation Services	56	562	

APPENDIX III. METHODOLOGIES

DATA SOURCES	METHODOLOGY	OUTPUTS	ADDITIONAL COMMENTS/ LIMITATIONS
Summary and general assumptions			
Main datasets used: • Quarterly Census of Employment and Wages (QCEW) data for the state of Oregon • Water consumption for the 304 most water consuming addresses • National environmentally extended input-output model for industries • Use and production table for the industries in the USA • Satellite data openly made available by the European Commission via their Joint Research Centre • Demographic data provided by the United States Census Bureau • Criteria pollutants and air toxics per industrial facility provided by the Department of Environmental Quality (DEQ)	**General assumptions:** • The impact of industry in Portland is roughly similar to the impact of industry on the national level per NAICS-3 code. • For some of the businesses in the QCEW dataset the number of employees and total salary are not filled out. We assume that the salary and number of employees not registered in the dataset is equally distributed across the industries. • Note that the input-output analysis shows a result where the outputs of the petroleum and coal manufacturing industry are relatively large compared to other sectors. This is because the total revenue of this industry in Portland is estimated using national data, which gives an overestimation as it also includes high values of revenue from, for instance, petroleum refineries in the USA. In order to give a more accurate calculation of the outputs of this industry, we need more specific regional data including revenue per NAICS-4 code.		

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DATA SOURCES	METHODOLOGY	OUTPUTS	ADDITIONAL COMMENTS/ LIMITATIONS
Study set overview			
• The Quarterly Census of Employment and Wages dataset (QCEW) for Oregon for the year 2020. The dataset provides the NAICS codes for the businesses in Portland, their location, the average number of employees throughout the year, and the total pay that these employees received. The information was provided by the city of Portland. • The number of employees per industry provided by the United States Census Bureau. • The projected employment growth is based on data by the Oregon Employment Department, which is different from the employment numbers calculated from the QCEW data.	• Add sectors to the businesses in Portland based on our own study set definition and the business' NAICS code. • Calculate the size of the businesses based on our defined sectors and their NAICS code. • Compare the size of the industries with the size of the same industries in the United States.	• An overview of the size of the industries in Portland by number of employees, total salary and number of businesses. • The relative size of the industries in Portland compared to the same industries in the United States.	
Electricity Analysis			
• The energy use data for the industry based on SIC codes provided by Pacific Power via the City of Portland. • The energy use data for the industry is based on the NAICS codes provided by Portland General Electric.	• Crosswalk the SIC codes in the data from Pacific Power to NAICS-3 codes. • Add the industry sectors from our study set to the the NAICS codes in both datasets • Calculate the sums per industry sector.	• An overview of the electricity consumption per industry sector.	• This analysis does not incorporate the energy use of hospitals and universities because the analysis data only focused on industries.

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DATA SOURCES	METHODOLOGY	OUTPUTS	ADDITIONAL COMMENTS/ LIMITATIONS

Water consumption heatmap

DATA SOURCES	METHODOLOGY	OUTPUTS	ADDITIONAL COMMENTS/ LIMITATIONS
• The water consumption of the 304 addresses with the most water consumption. • The Quarterly Census of Employment and Wages dataset (QCEW) for Oregon for the year 2020. The provides the NAICS codes for the businesses in Portland, their location, the average number of employees throughout the year, and the total pay that these employees received. The information provided by the city of Portland.	• Look at the distribution of the water consumption of the 304 addresses with the highest water consumption. Based on this distribution we decided to focus on the 10 addresses with the highest water consumption because their water consumption was significantly higher than the rest. • Match the addresses in the water consumption dataset with the businesses in the QCEW dataset and the sectors that the businesses belong to. • If there are multiple businesses registered at an address, estimate the water consumption per business based on the number of employees per business. • Based on the most water consuming addresses, create a bar chart containing industries which consume the most water.	• An overview of the industries that have some of the most water consuming facilities.	• Since the only data available was from the 300 addresses with the most water consumption, we had to make a decision on what addresses to include in the analysis. Since the water consumption of the bottom half of the businesses was much closer together it was likely that the addresses who had between the 300th and 400th most water consumption would have a similar water consumption as well. We decided to focus on the top 10 water consumers since their water consumption was much higher than the water consumption of the other addresses. • Since we were not able to match all the addresses of water consumption to businesses, we had to make some educated guesses based on the surrounding businesses.

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DATA SOURCES	METHODOLOGY	OUTPUTS	ADDITIONAL COMMENTS/ LIMITATIONS
Input-Output analysis			
• The Quarterly Census of Employment and Wages dataset (QCEW) for Oregon for the year 2020. The dataset provides the NAICS codes for the businesses in Portland, their location, the average number of employees throughout the year, and the total pay that these employees received. The information was provided by the city of Portland. • The number of employees per industry provided by the United States Census Bureau. • An Environmentally-Extended Input-Output (USEEIO model) provided by the U.S. Environmental Protection Agency (EPA). • The Input-Output Accounts Data (2021) by the Bureau of Economic Analysis (BEA).	• The USEEIO model contains impact factors per sector (categorized by the US Bureau of Economic Analysis) which specify the direct and indirect impacts per 1 USD production per sector. • Since the QCEW dataset only contains number of employees and not total production per industry, we use national input-output data per sector and national employee data to estimate the total outputs in USD per industry in Portland. • These total production numbers are then multiplied by the impact factors to give the total impacts per industry in Portland.	• Estimated impacts of all the industries in our study set based on national averages. These impacts are energy usage, GHG emissions, hazardous air pollutants, and waste per industry.	• As mentioned under 'general assumptions', we assume the impacts of industries on the national level scale well to the city-level. This approach does not take into account the local context. Legislation or the ambitions of local businesses could have a significant influence on the impact which is not accounted for in this input-output analysis. • Businesses within a sub sector can have vastly different impacts. Aggregating the impacts per sub sector reduces the difference between businesses. On the level of the individual businesses this leads to a less accurate image. However, on the city level the deviations of individual businesses from the average level out and are probably a better representation of the actual situation. This is called the 'Central limit theorem'.

DATA SOURCES	METHODOLOGY	OUTPUTS	ADDITIONAL COMMENTS/ LIMITATIONS
Material Flow Analysis			
• The Quarterly Census of Employment and Wages dataset (QCEW) for Oregon for the year 2020. The dataset provides the NAICS codes for the businesses in Portland, their location, the average number of employees throughout the year, and the total pay that these employees received. The information was provided by the city of Portland. • The number of employees per industry provided by the United States Census Bureau. • Freight Analysis Framework (FAF) v5 from the Oak Ridge National Laboratory. • The Input-Output Accounts Data (2021) by the Bureau of Economic Analysis (BEA).	• Since the QCEW dataset only contains the number of employees and not total production per industry, we use national input-output data per sector and national employee data to estimate the total input in USD per industry in Portland. • The Freight Analysis Framework contains data for a broad set of commodities which we use to calculate the average number of dollars per ton for a specific commodity in a state. We assign a commodity from the FAF to every industry in our study set. For instance, we assign the commodity 'Textiles/leather' to the apparel manufacturing industry. • Using the total input per industry in Portland, we calculate the total number of tons of a commodity used for every industry.	• The total material consumption in commodities per sub-industry and sector.	• Similar to the input-output analysis the material flow analysis does not take into account the local context. It approximates the values but local legislation or ambition from businesses could structurally skew the impacts from the national averages.
PM emission per industry			
• Air pollutants per industrial facility provided by the Department of Environmental Quality (DEQ). Facilities often have multiple associated NAICS codes.	• Check for all the facilities if they have a corresponding industry sector. » If there is only one corresponding sector, assign the facility to that sector. » If there is more than one associated sector manually select the sector based on the primary function of the facility. This was done for four facilities. • Create a pie chart for the total PM emissions per sector.	• The PM emissions per industry cluster.	• This analysis only looks at permitted pollution. Unpermitted pollution is not taken into account. • The pollution per facility are estimates

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APPENDIX IV. IMPACT ANALYSIS
ADDITIONAL INFORMATION ON ELECTRICITY RESOURCES AND WASTE COMPOSITION IN PORTLAND

Total waste composition in Portland

The Waste Composition Study by the Oregon Department of Environmental Quality shows us a total waste of 455 million kg in Portland. Organic waste is the largest category consisting mainly of wood (17.8%) and food (14.8%). Also paper (12.4%) and plastic (9.5%) make up a relatively large part of the waste.
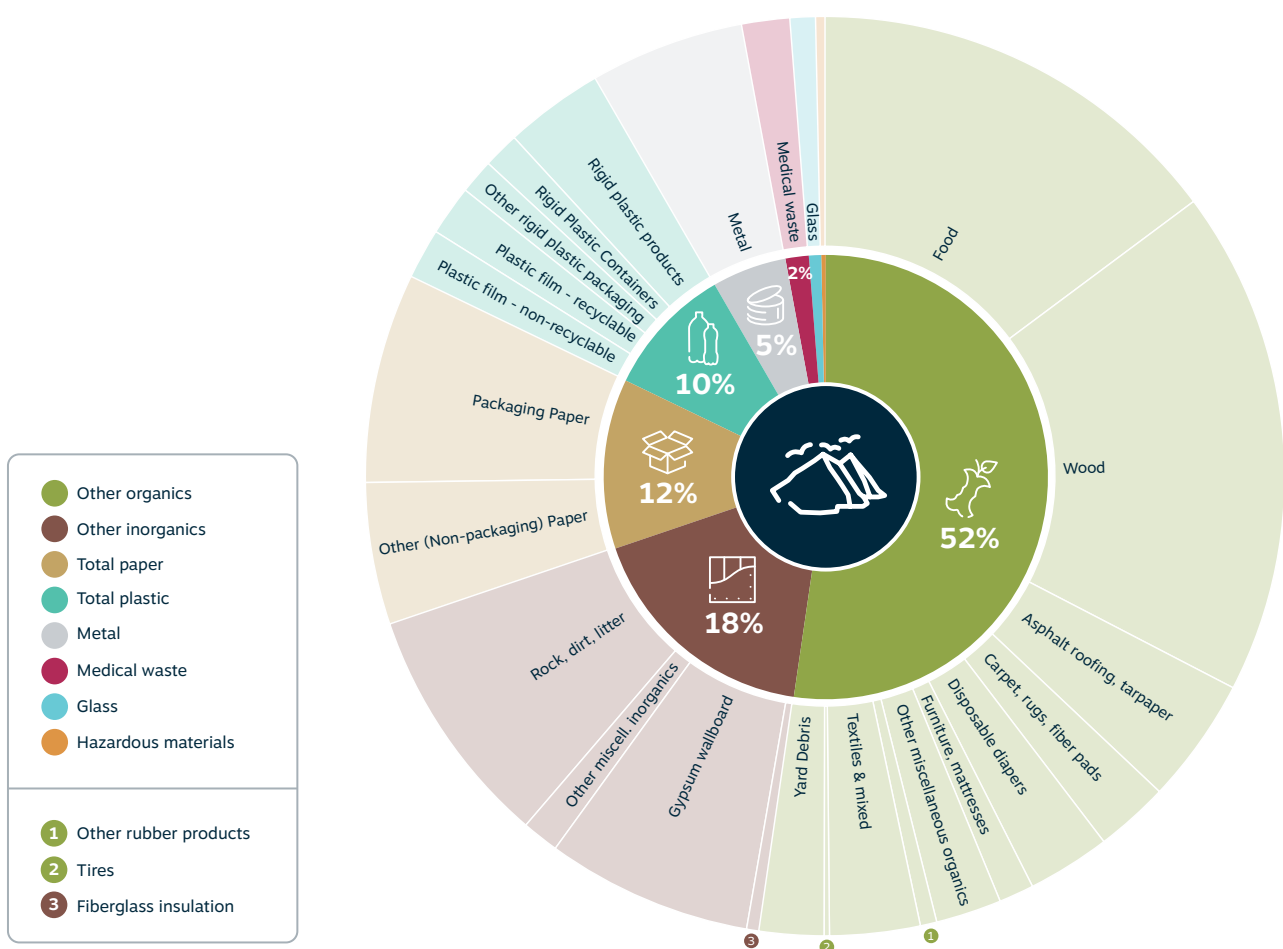

Legend:
- Other organics
- Other inorganics
- Total paper
- Total plastic
- Metal
- Medical waste
- Glass
- Hazardous materials

1. Other rubber products
2. Tires
3. Fiberglass insulation

Fig. 29 *The total waste composition in Portland.*

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APPENDIX V. SURVEY

A brief survey was administered to Portland businesses. The survey questions and format are shared below. The survey was mailed to businesses in the study set identified from QCEW data. Approximately 1,500 surveys were mailed and 290 were returned as undeliverable. Additional outreach was conducted through social media and Advisory Group networks. Data was collected and managed by Metabolic; participants were assured confidentiality. Entry into a gift card drawing was offered as an incentive for participation.

The survey was open to respondents for the span of a month. During this time the survey was filled out by 250 respondents. However, there are reasons to assume that part of the responses are not from reliable respondents, most likely due to the gift card reward. The responses peaked abnormally on some days (15th, 27th, and 28th of March) and several criteria were checked to select relevant responses. The criteria applied to arrive at the final selection of 80 respondents are listed below.

Criteria to include

- Anonymous respondents: the preference to remain anonymous was expressed by several participants. The anonymous responses are therefore included.
- Company email address.
- Names and email addresses match.

Criteria to exclude

- Double names/email addresses (all on the 28th of March).
- Empty answers: when only an email address and some company information is given, but none of the actual questions is answered. This in combination with the selection to participate in the raffle for the gift card is considered an unreliable response.
- Names and email addresses do not match.

The actual content of the survey is added below.

Welcome!

This survey is part of a Clean Industry Initiative led by Prosper Portland, the Bureau of Planning and Sustainability, the Portland Business Alliance, Columbia Corridor Association and other stakeholders from the private, public, and nonprofit sectors.

The information you provide will help us better understand what Portland's industrial businesses and large institutions need to protect and enhance their bottom line while adopting practices that benefit the environment and community. Information about the Clean Industry Initiative and this study can be found here.

We value your time and input! **The survey will take about 12-15 minutes and participants are eligible to win one of five $100 gift cards.**

Who should complete this survey

This survey is intended to be completed by owners or employees responsible for operations of a manufacturing business, hospital, or university located in Portland. **Please ensure the survey is only completed once for your company.**

How to complete this survey

We recommend completing this on a **computer**, not a phone. You may save your entries and come back later to complete the survey. **When you click "save"** you wil be prompted to sign in with your google or facebook account or create a free jotform account.

Confidentiality

The answers provided in this survey are confidential. The consultant team will not share any identifying information and will only be reporting key themes.

Contacts

If you have any questions about the project or the survey, please do not hesitate to contact the Bureau of Planning and Sustainability or the consultant team. The consultant on this project, Metabolic, is an internationally recognized firm that works across sectors to help economies transition to a sustainable state where people and the planet thrive.

Bureau of Planning and Sustainability (BPS), City of Portland
Janet Hammer, Clean Industry Assessment and Roadmap Lead
(cleanindustry@portlandoregon.gov)

Metabolic (Consultant team)
Guillermo Corella Dekker, Project Manager
(guillermo@metabolic.nl)

Introduction

The first two questions help us ensure we are reaching a broad mix of industrial businesses and large institutions.

1. Which of the following industry types best defines your business/organization?

⊓ Food and beverage manufacturing

⊓ Metals and machinery manufacturing

⊓ Electronic manufacturing

⊓ Miscellaneous manufacturing

⊓ Hospitals and universities

⊓ Waste management

⊓ None of the above

2. Which of the following industry categories best defines your business/organization (the numbers represent the category's' NAICS code)?

⊓ Food Manufacturing (311)

⊓ Beverage and Tobacco Product Manufacturing (312)

2. Which of the following industry categories best defines your business/organization (the numbers represent the category's' NAICS code)?

⊓ Fabricated Metal Product Manufacturing (332)

⊓ Machinery Manufacturing (333)

⊓ Transportation Equipment Manufacturing (336)

2. Which of the following industry categories best defines your business/organization (the numbers represent the category's' NAICS code)?

⊓ Computer and Electronic Product Manufacturing (334)

⊓ Electrical Equipment, Appliance, and Component Manufacturing (335)

2. Which of the following industry categories best defines your business/organization (the numbers represent the category's' NAICS code)?

⊓ Textile Mills (313)

⊓ Textile Product Mills (314)

⊓ Apparel Manufacturing (315)

⊓ Leather and Allied Product Manufacturing (316)

⊓ Wood Product Manufacturing (321)

⊓ Paper Manufacturing (322)

⊓ Printing and Related Support Activities (323)

⊓ Petroleum and Coal Products Manufacturing (324)

⊓ Chemical

3

⚡ Jotform

⊓ Plastics and Rubber Products Manufacturing (326)

⊓ Nonmetallic Mineral Product Manufacturing (327)

⊓ Furniture and Related Product Manufacturing (337)

⊓ Miscellaneous Manufacturing (339)

2. Which of the following industry categories best defines your business/organization (the numbers represent the category's' NAICS code)?

⊓ Hospitals (622)

⊓ Colleges, Universities and Professional schools (611310)

2. Which of the following industry categories best defines your business/organization (the numbers represent the category's' NAICS code)?

⊓ Waste Collection (5621)

⊓ Waste treatment and disposal (5622)

⊓ Remediation and other waste management services (5629)

Thank you for your willingness to participate in this survey. It appears that your business is not one of the industries that is a focus of this research. If you have any questions please contact:

Bureau of Planning and Sustainability (BPS), City of Portland

Janet Hammer, Clean Industry Assessment and Roadmap Lead (cleanindustry@portlandoregon.gov)

CURRENT PRACTICES

The questions in this section help us understand how businesses are engaging with the topics of energy, waste, pollution, and workforce and business opportunity. Each topic includes a definition followed by a few questions about priorities and current practices.

Energy efficiency and conservation

4

The questions in this section address energy efficiency and conservation. We define energy efficiency and conversation as:

"the reduction of energy consumption by 1) **using less of an energy resource** (e.g., set thermostat to a lower temperature), 2) **using fewer energy resources for the same result** (e.g., replace an inefficient furnace with a more efficient furnace), or 3) **recycling energy for other uses** (e.g., one industry's lost heat can become a heat source for another)."

Given this definition, please answer the following questions.

3. In what ways, if any, has your business addressed energy efficiency and conservation in the past 5 years? Check all that apply.

Created an energy plan or a strategy and/or set energy saving goals

Conducted an energy audit

Regularly monitor energy data

Changed process equipment (e.g., boilers)

Made building improvements (e.g., added insulation, changed lighting)

Changed practices (e.g., set thermostat to a different temperature, automatic shut-off)

Internal learning (e.g., staff training about new processes or equipment)

None of the above

4. Which of the following is a barrier to your business addressing energy efficiency and conservation? Check all that apply.

Limited space for new equipment

Technological solutions are not available

Too expensive or competing budget priorities

Limited staff capacity

Don't have staff with this expertise/ not sure what change to make

Lack of support or buy-in from key staff/ decision-makers

Regulatory or legal barriers

None of the above

5. What are the main reasons your business is interested in energy efficiency and conservation? Select up to four answers.

Cost savings

Desire to positively impact environmental or climate issues

Attract or retain customers

Brand reputation

Attract or retain investors

Employee recruitment or

5

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Regulatory compliance

Our business is not interested in energy efficiency and conservation

6. What are the main sources of energy for your business? Select up to two answers.

Electricity from an account with the electricity utility

Electricity from a power purchase agreement (PPA) with the electricity utility

Natural gas

Onsite renewables

Coal

Sustainable waste management

The questions in this section address sustainable waste management. We define sustainable waste management as:

"the process of designing, producing, and managing products in ways that **minimize waste and pollution** and **keep resources at their highest value** for the longest time".

Given this definition, please answer the following questions.

7. In what ways, if any, has your business addressed sustainable waste management in the past 5 years. Check all that apply.

Created a waste reduction plan or a strategy, and/or set sustainability goals

Conducted a waste audit

Design to reduce production waste

Design to extend product life (e.g., reuse, remanufacturing)

Design for less toxic materials or processes

Regularly monitor data

Added or changed equipment

Changed procurement practices

Changed operational processes

Internal learning (e.g.

6

None of the above

Don't know

8. Which of the following is a barrier to your business when addressing sustainable waste management? Check all that apply.

Limited space for new equipment or storage

Technological solutions are not available

Too expensive or competing budget priorities

Limited staff capacity

Don't have staff with this expertise/not sure what changes to make

Lack of support or buy-in from key staff/decision-makers

Regulatory or legal barriers

Lack of standardization (e.g., in packaging or transportation)

Absence of market for new products (e.g., by-products)

None of the above

9. What are the main reasons your business is interested in sustainable waste management? Select up to four answers.

Cost saving

Desire to positively impact environment or climate issues

Attract or retain customers

Brand reputation

Attract or retain investors

Employee recruitment or retention

Regulatory compliance

Our business is not interested in sustainable waste management

None of the above

10. What are the major types of waste generated at your organization? Select up to four answers.

Municipal solid waste

Wood

Metals

Hazardous materials

Inert materials (e.g., brick, concrete, stone)

Plastics

Glass

Chemicals

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Water

None of the above

11. What are the main ways your waste flows are currently managed ? Select up to four answers.

Reuse or recycle materials on site

Reuse or recycle off site

Send waste to landfill (hauler)

Landfill on site

Incinerate on site

Incinerate off site

Don't know

Air pollution reductions

The questions in this section address air pollution reduction. We define air pollution reduction as:

"**eliminating or minimizing the emission of toxic or hazardous substances** into the air (e.g. particulate matter, CO2, NOx)".

Given this definition, please answer the following questions.

12. In what ways, if any, has your business addressed air pollution reduction in the past 5 years? Check all that apply.

Created an emissions reduction plan or a strategy and/or set emissions reduction goals

Conducted an emissions audit

Regularly monitor emissions data

Added or changed equipment

Changed operational processes

Internal learning (e.g., staff training)

None of the

8

Don't know

13. Which of the following is/are a barrier to your business reducing air pollution? Check all that apply.

Limited space or physical requirements

Technological solution not available

Too expensive or competing budget priorities

Limited staff capacity

Don't have staff with this expertise/Not sure what changes to make

Lack of support or buy-in from key staff/ decision-makers

Regulatory or legal barriers

None of the above

14. What are the main reasons your business is interested in reducing air pollution? Select up to four answers.

Cost savings

Desire to positively impact environmental or climate issues

Attract or retain customers

Brand reputation

Attract or retain investors

Employee recruitment or retention

Regulatory compliance

Neighbor relations

Our business is not interested

15. What are the top air emissions at your business (in mass, tons, or volume)? Select up to four answers.

Ozone (O3)

Particulate matter (PM)

Carbon monoxide (CO)

Carbon dioxide (CO2)

Lead (Pb)

Sulfur dioxide (SO2)

Nitrogen dioxide (NO2)

None of the above

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Inclusive workforce, contracting, and community engagement

The questions in this section address inclusive workforce, contracting, and community engagement. Here we define inclusion to mean:

"neighboring communities experience **positive engagement and impact**, and workers and contracters experience **fair wages**, **working conditions, opportunity, and advancement-** particularly **historically marginalized and underrepresented populations** (e.g., people of color, women, LGBTQ+)".

Given this definition, please answer the following questions.

16. In what ways, if any, has your business addressed the topic of inclusion in the past 5 years? Check all that apply.

Set inclusion goals and monitor progress

Modified recruitment, hiring, retention, and advancement

Modified purchasing and/or contracting to increase supplier diversity

Offered internal learning (e.g., staff training or workshop)

Set up an internal equity team

Hired a Diversity Equity Inclusion manager or staff person to oversee activities

Offered work experience programs (e.g., mentorship ,internship, or partnership with a youth workforce programs)

External community engagement (e.g., community benefit plan, good neighbor agreement, volunteering)

None of the above

Don't know

17. Which of the following is a barrier to your business when addressing the topic of inclusion? Check all that apply.

Don't have staff with this expertise/not sure what changes to make

Limited staff capacity

Lack of support or buy-in from key staff/ decision-makers

Legal

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Limited budget

Lack of internal structures or processes for addressing inclusion issues

None of the above

18. What are the main reasons your business is interested in advancing inclusion? Select up to four answers.

Desire to positively impact the working culture and environment

Attract or retain customers

Brand reputation

Attract or retain investors

Employee recruitment or retention

Regulatory compliance

Alignment with core values

Improve quality/productivity of work

Our business is not interested

None of the above

Other

BUSINESS RESOURCES

The questions in this section help us understand what sources of information and technical assistance are most useful to businesses and large institutions.

19. How familiar are you with the following business assistance organizations or networks that are designed to help industries and institutions address energy, emissions, waste, or inclusion? Select the level of familiarity that is most appropriate.

	Never heard of it	Heard of it but have not used	Have used it but was not satisfied	Have used it and was satisfied
Energy Trust of Oregon (ETO)	⊓	⊓	⊓	⊓
Manufacturing USA (e.g., REMADE Institute, BiofabUSA, BioMADE)	⊓	⊓	⊓	⊓
Oregon Manufacturing Innovation Center (OMIC)	⊓	⊓	⊓	⊓
Oregon Manufacturing Extension Partnership (OMEP)	⊓	⊓	⊓	⊓
Oregon State University Industrial Assessment Center (OR-IAC)	⊓	⊓	⊓	⊓

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	Never heard of it	Heard of it but have not used	Have used it but was not satisfied	Have used it and was satisfied
VertueLab	⊓	⊓	⊓	⊓

20. Are there other business assistance organizations or networks that you turn to for assistance addressing energy, emissions, waste, or inclusion? If so, please describe.

21. How familiar are you with the following governmental organizations or programs that are designed to help industries and institutions address energy, emissions, waste, or inclusion? Select the level of familiarity that is most appropriate.

	Never heard of it	Heard of it but have not used	Have used it but was not satisfied	Have used it and was satisfied
Green Cities Liaison at Prosper Portland & We Build Green Cities Initiative	⊓	⊓	⊓	⊓
Metals & Manufacturing Liaison at Prosper Portland	⊓	⊓	⊓	⊓
Oregon Department of Energy (ODOE)	⊓	⊓	⊓	⊓
Oregon Department of Environmental Quality (DEQ)	⊓	⊓	⊓	⊓
Portland Means Progress with Prosper Portland	⊓	⊓	⊓	⊓
US Department of Energy - (e.g., Advanced Materials and Manufacturing Technologies Office, Industrial Efficiency and Decarbonization Office, Office of Energy Efficiency Office)	⊓	⊓	⊓	⊓
US Environmental Protection Agency (EPA)	⊓	⊓	⊓	⊓

22. Are there other governmental organizations or programs that you turn to for assistance addressing energy, emissions, waste, or inclusion? If so, please describe .

23. How familiar are you with the following business associations? Select the level of familiarity that is most appropriate.

	Never heard of it	Heard of it but have not used	Have used it but was not satisfied	Have used it and was satisfied
Central Eastside Industrial Council	⊓	⊓	⊓	⊓
Columbia Corridor Association	⊓	⊓	⊓	⊓

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	Never heard of it	Heard of it but have not used	Have used it but was not satisfied	Have used it and was satisfied
Greater Portland Inc	⊓	⊓	⊓	⊓
NW Industrial Business Association	⊓	⊓	⊓	⊓
Portland Business Alliance	⊓	⊓	⊓	⊓
Swan Island Business Association	⊓	⊓	⊓	⊓
Oregon Business Council	⊓	⊓	⊓	⊓
Oregon Business and Industries	⊓	⊓	⊓	⊓

24. Are there any other business associations that you regularly turn to for information? If so, please describe.

25. How familiar are you with the following workforce organizations or programs? Select the level of familiarity that is most appropriate.

	Never heard of it	Heard of it but have not used	Have used it but was not satisfied	Have used it and was satisfied
Inspiring Diversity Grant with Prosper Portland	⊓	⊓	⊓	⊓
Partners in Diversity	⊓	⊓	⊓	⊓
Manufacturing Workforce Navigator at Urban League	⊓	⊓	⊓	⊓
Worksource Oregon	⊓	⊓	⊓	⊓
Worksystems - Advanced Manufacturing Industry Lead	⊓	⊓	⊓	⊓
PCC's Oregon Manufacturing Institute Center (OMIC) Training Center	⊓	⊓	⊓	⊓
Oregon Manufacturing Extension Program (OMEP)	⊓	⊓	⊓	⊓

26. Are there other workforce organizations or programs that you regularly turn to? If so, please

13

describe which ones?

BACKGROUND INFORMATION

All information in this survey is confidential. The following information is voluntary, but helps us ensure we have reached a broad range of Portland businesses.. Also, providing this information enters you in a drawing for one of five $100 gift cards.

27. Name of the business or organization you represent?

28. How many people are currently employed at your business/organization in Portland?

⊓ Less than 10 employees
⊓ Between 10 and 49 employees
⊓ Between 50 and 249 employees
⊓ Between 250 and 499 employees
⊓ Between 500 and 999 employees
⊓ Between 1,000 and 9,999 employees
⊓ Above 10,000 employees

29. Is there a specific position or unit (e.g., team, department, division, office) within your business/organization whose job is devoted to the business' environmental performance? Check all that apply.

⊓ Yes, we have a person or unit that focuses on environmental regulation and compliance.
⊓ Yes, we have a person or unit that focuses on improving the organization's environmental performance (e.g., seeking ways to save energy or reduce waste).
⊓ Yes, we have a person or unit both for environmental regulation and compliance, as well as for the organization's environmental performance.
⊓ We do not have a person or unit devoted to environmental regulation, compliance, or performance.
⊓ I am unsure if we have a specific position or unit devoted to environmental regulation, compliance, or performance.

30. Which of the following best describes your unit, division, or area of focus?

⊓ Accounting and finance
⊓ Administration and operations
⊓ Business development and sales
⊓ Customer service
⊓ Engineering
⊓ Executive and/or owner

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⊓ Human resources

⊓ Marketing and communications

⊓ Research and development

⊓ Safety

⊓ Environment/Sustainability

⊓

31. Can we contact you for any of the following? (please select which apply)

Participation in the raffle to win one of five $100 gift cards (note: you must select this option to participate in the raffle)

To send you an occasional email with updates on the project

If we host a conversation to explore key findings of this survey, may we invite you or someone from your organization to join us?

32. Your name

33. Your email address

34. Which of the following best describes your seniority in the organization?

⊓ Senior Leadership

⊓ Mid-level

⊓ Junior level

⊓

35. We love to hear from you! If you have any final remarks, questions or comments, you're welcome to leave them here (optional):

APPENDIX VI. REFERENCED ORGANIZATIONS

A number of organizations have existing policy or programmatic links to the clean industry vision and are referenced throughout the document. While this is not an exhaustive list it introduces some of key organizations that were frequently mentioned in the course of our research.

ENERGY TRUST OF OREGON (ETO)

Energy Trust of Oregon is a non-profit that provides rebates and technical support to individual consumers and businesses to reduce energy consumption and shift to renewable power. Their funding comes primarily from a small fee incorporated into utility bills. ETO currently provides rebates for various industrial equipment incentives offered to manufacturing businesses for overall energy efficiency. There is a strong correlation between energy savings and emissions reduction, but the latter is not explicitly part of ETO's current authorization and neither is fuel switching. Large customers who buy fossil fuel products on the open market are not currently eligible for ETO incentives. A number of participants in this study suggested that this role could be expanded to support clean industry more broadly, and that ETO might serve as an effective vehicle for obtaining and investing federal funds.

GREATER PORTLAND INC (GPI)

GPI is the only regional public-private partnership dedicated to creating and expanding jobs and driving tangible regional prosperity. The partnership is supported by public partners, private investors and philanthropic groups.

METRO

Metro is a comprehensive regional government agency that plays a pivotal role in the development and management of the Portland metropolitan area. Besides Portland, the agency's boundary encompasses 23 other cities – from the Columbia River in the north to the bend of the Willamette River near Wilsonville, and from the foothills of the Coast Range near Forest Grove to the banks of the Sandy River at Troutdale.

It encompasses diverse responsibilities including long term land-use planning, guiding decisions on growth boundaries, housing, and infrastructure investments. It also takes charge in regional transportation coordination, waste management and manages an extensive network of parks, trails and natural areas.

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

DEQ implements state and federal environmental laws to protect Oregon's air, water and land. DEQ executes many programs, of which we highlight two relevant programs, the 'Cleaner Air Oregon' program and the 'Climate Protection Program' (CPP). The 'Cleaner Air Oregon' program requires industrial and commercial facilities to regulate the emissions of toxic air contaminants. The DEQ Climate Protection Program has two approaches to regulate the greenhouse gas emissions of facilities: capping the emissions from fossil fuel suppliers and the BAER (Best Available Emissions Reduction) program which applies to other sources of emissions

not covered by the emissions cap. DEQ offers grants and funding options such as the Diesel Emissions Mitigation Grants to replace polluting diesel engines with cleaner technologies and exhaust control retrofits.

OREGON MANUFACTURING EXTENSION PARTNERSHIP (OMEP)

OMEP is part of a national network of manufacturing extension partnerships, with funding support from state and federal governments. They work mostly with small- and medium-sized businesses in Oregon, providing services that help companies become more competitive. They focus primarily on efficiency improvements, workforce, and increasing profitability, though without a specific focus on environmental impact. When it comes to energy efficiency and waste management, however, there is potential for stronger alignment with clean industry goals. OMEP's existing relationships with a broad range of companies are a significant asset, and its focus on workforce development and equitable hiring could help make the clean economy more inclusive. It is worth exploring the extent to which circular and decarbonization strategies could be integrated with existing offerings.

OREGON MANUFACTURING INNOVATION CENTER (OMIC)

OMIC's mission is to develop and apply advanced metals manufacturing technologies and processes for industrial competitive advantage and academic growth, while inspiring and educating the next generation's manufacturing workforce. It is located at the Portland Community College Columbia County campus. Metals manufacturing is one of the primary candidates within this report for a clean industry transition.

OREGON STATE UNIVERSITY (OSU)

As a leading research university, OSU offers a wide range of technology and innovation solutions for a clean economy. It is also home to the Industrial Assessment Center (OR-IAC), which provides free energy, productivity, and waste assessments to small and medium-sized industrial facilities through funding provided by the US Department of Energy.

PORTLAND COMMUNITY COLLEGE (PCC)

PCC aims to prepare their students for valuable jobs in a greener industry and shrinking the carbon footprint. One of their programs is their Machine Manufacturing Technology Program in which they partner with OMIC (see below).

PORTLAND STATE UNIVERSITY (PSU)

PSU is a well-established leader in sustainability with a strong commitment to diverse climate-focused workforce development. PSU has a number of programs and initiatives that align with the clean industry vision. For example, it recently received a grant from Business Oregon, the state's economic development agency, for a regional innovation planning grant and also was recently awarded a $1 million Regional Innovation Engine Grant by the National Science Foundation (NSF) to lead a regional and interdisciplinary effort to develop the next generation electrical grid.

Other initiatives by PSU that contribute to advancing a clean industry:

• PSU Business Accelerator (PSBA)
• PSU Centre for Entrepreneurship
• Future Ready workforce development project

PROSPER PORTLAND

Portland City Council recently adopted the inclusive economic development strategy 'Advance Portland: A Call to Action for Inclusive Economic Growth for the city'. Development of the strategy was led by Prosper Portland in collaboration with the Bureau of Planning and Sustainability (BPS), with a consultant team and deep stakeholder engagement. Development of a clean industry hub is prioritized in the strategy. It calls out specific opportunities for green innovation in public procurement and the opportunity to leverage the Portland Clean Energy Fund to create green jobs. In the 2015-2020 Strategic Plan Prosper Portland presented the Cluster Action Plans, the first-ever traded sector strategy aiming at centering equity at the core. The following four clusters are included: the Metals & Machinery cluster, Green Cities cluster (companies producing innovative products, services, and technologies that benefit the environment or conserve natural resources), Technology & Media cluster, and Athletic & Outdoor cluster.

WORKSYSTEMS, INC (WSI)

WSI is the city's primary workforce development entity. Its mission is to coordinate a regional workforce system that supports individual prosperity and business competitiveness. WSI has a clean energy staff lead and a manufacturing staff lead. WSI is rolling out a NextGen Partnership model for manufacturing that can help provide a pipeline to good quality green jobs.

OTHER ORGANIZATIONS, INSTITUTIONS AND UTILITIES

The following entities are not assessed in this study but are part of the wider ecosystem of services to help businesses improve efficiency or grow clean industry business opportunities:

- VertueLab (received a 'Center for Innovation Excellence' planning grant from Business Oregon)
- North West Xcelerator (NWXcelerator)
- Cascadia CleanTech Accelerator
- Oregon Nanoscience and Microtechnologies Institute (ONAMI)
- Oregon Translational Research and Development Institute (OTRADI)
- Pacific Northwest National Laboratory (PNNL)
- National Energy Technology Laboratory (NETL)

APPENDIX VII. CLEAN INDUSTRY DATABASE

We discovered several other global examples that were intriguing in terms of clean industrial hub development. Although these are not included in the final selection, these examples hold potential for further research:

NAME	LOCATION
Helsinki Metropolitan Smart & Clean Foundation	Helsinki, Finland
HyNet North West	Manchester & Liverpool, UK
Sweden Green Hydrogen	Sweden
Climate Partnerships	Denmark
Chicago Circular Economy Leaders Network for Small Businesses (CELN)	Chicago, United States
Circular Economy Resource Centre	Edinburgh, Scotland
Center for Intersectoral Studies and Research on the Circular Economy	Quebec, Canada
Decarbonisation Innovation Hub	New South Wales, Australia
REMADE Circular Economy Institute	United States
The Smart Factory (SMAF)	Sonderborg, Denmark
Green Tech Valley	Austria
Center for Smart and Circular Transition	Slovenia
GreenLab Denmark	Skive, Denmark

APPENDIX VIII. CLEAN INDUSTRY ASSESSMENT AND ADVISORY GROUP

A Clean Industry Assessment and Roadmap Advisory Group was convened to provide guidance to this effort. The Advisory Group included private, public, and nonprofit leaders representing diverse organizations and expertise. The group includes people from manufacturing, utilities, government, community and environmental justice, labor, business assistance, and higher education.

We appreciate the time and thoughts shared by each member and thank them for their service. Their insights and collaboration were key to the project's success. Acknowledgement below does not imply endorsement by Advisory Group members or their organizations.

- BlueGreen Alliance
- Clean Energy Transition Institute (CETI)
- Climate Solutions
- Columbia Corridor Association
- COR – City of Roses Disposal and Recycling
- Energy Trust of Oregon (ETO)
- Evraz Oregon Steel Mills
- Greater Portland Inc (GPI)
- Multnomah County Office of Sustainability
- National Energy Technology Laboratory - Albany
- Native American Youth and Family Center (NAYA)
- Neighbors for Clean Air
- Northwest Natural
- Oregon Department of Energy (ODOE)
- Oregon Manufacturing Innovation Center (OMIC)
- Oregon State University Industrial Assessment Center (OSU IAC)
- Pacific Power
- Portland Business Alliance (PBA)
- Portland Community College
- Portland General Electric (PGE)
- Port of Portland
- Prosper Portland
- Portland State University (PSU)
- Schnitzer Steel
- Verde
- VertueLab
- Vigor
- Willamette Technical Fabricators

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