



PYXERA Global

# CIRCULAR CLEVELAND

## Stage 1: Landscape Analysis



Cleveland  
Neighborhood  
Progress



CITY OF CLEVELAND  
Mayor Justin M. Bibb



NEIGHBORHOOD  
CONNECTIONS

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# 01. TOWARDS CIRCULAR CLEVELAND

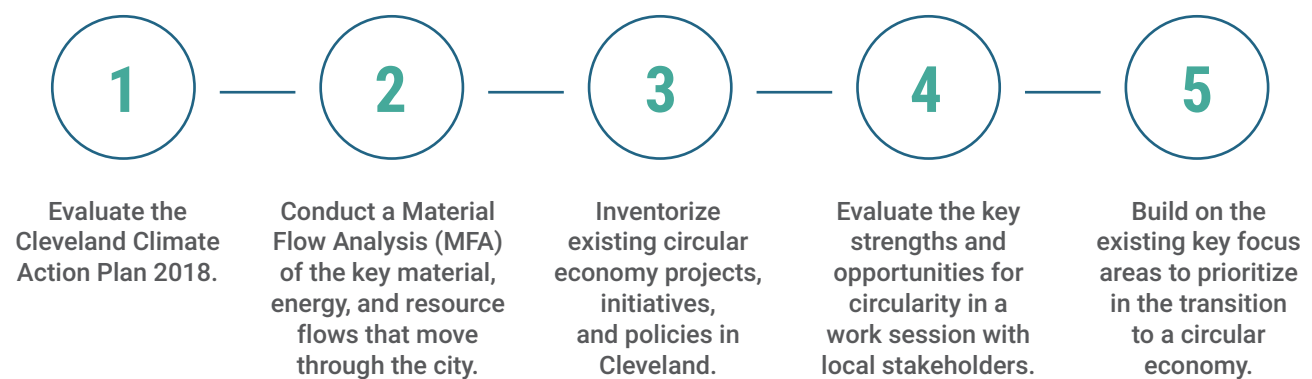
The City of Cleveland has embarked on an ambitious journey towards becoming a North American leader in designing and implementing an inclusive circular economy. As part of the wider 30-month Circular Cleveland initiative

funded by the Robert Wood Johnson Foundation, the City and Cleveland Neighborhood Progress (CNP) are working with local champions to develop a roadmap to enable an inclusive circular economy in the Great Lakes region.

## LANDSCAPE ANALYSIS

To understand how the City of Cleveland can achieve the implementation of a circular economy, our team must first assess the city's current situation by taking a snapshot of the city. Our research on existing initiatives and policies is coupled with an extensive analysis of the city's flows

(material flow analysis), as well as with some community engagement sessions, giving us a realistic picture of the situation. The following steps lie at the heart of this landscape analysis:



**DATA GAPS** The MFA was performed with data provided by the City of Cleveland combined with publicly available data. Several data gaps were observed locally which required to scale down national and state level information. These estimations were done based on the number of residents, businesses or employees in Cleveland, which does not give the most accurate picture of the local context.

## THE CLEVELAND CLIMATE ACTION PLAN

The Cleveland Climate Action Plan is an extensive document co-created in 2013 by the City of Cleveland, and several other organizations (e.g. Bendle Group, CNP, ioby). Updated every five years, the last update dates from 2018. The plan builds on local knowledge to address local challenges and opportunities in relation to climate change. Key elements of the plan include reducing greenhouse gas emissions, inequitable distribution of climate impacts, equitable distribution of healthy and energy efficient housing, access to green spaces, and extreme weather events.

Since the beginning of its implementation, the city of Cleveland has seen many positive changes, including a reduction of carbon, water and air pollution, an increase in the development of renewable energies, an extensive development of bicycle infrastructure, the implementation of the Cleveland Tree Plan, and the support of more than 50 resident-led neighborhood-based projects.





## A CIRCULAR CLEVELAND

The development and implementation of a circular economy in Cleveland should be building on the positive momentum created by the Climate Action Plan and on the knowledge previously acquired. On top of addressing climate issues, the circular economy framework aims primarily at creating an economy that does not exceed planetary boundaries by keeping materials in circulation at their highest value for the longest time. The reduced dependency on raw materials and waste generation for economic growth shifts away from the “take-make-waste” linear economic model while limiting

consumption, toxicity, and waste to the benefit of the society. Reframing the way we think about resources and “waste” can create various opportunities leading to the creation of new jobs and environmental benefits.



## READING GUIDE

This document is the synthesis of this research process, and demonstrates the gap between the current systems in place in Cleveland, the extensive climate initiatives, and a circular economy. It starts with a brief context of Cleveland and its industrial history, which provides the city with challenges but also a strong potential for circular development. The following sections highlight key projects and initiatives that are already in place towards achieving circularity in Cleveland. Following the presentation of the results of the Material Flow Analysis (MFA), a description of policies in place or missing to enable a systemic change is following. The final section presents four proposed circular focus areas to reach an inclusive and resilient circular state in the city.

## A HOLISTIC FRAMEWORK FOR BUILDING AN INCLUSIVE, RESILIENT ECONOMY

A sustainable urban future should be built on resilient communities, strong ties to their local environment, and provide a backbone of social goods and services to all citizens. Too often, the attempt to solve one problem in isolation from social, economic, ecological, or political considerations leads to unintended and undesirable consequences in other domains

of society. The principles of the circular economy (Figure 1) provide a clear framework to achieve this. Those clear performance outcomes allow our team to holistically evaluate the city's initiatives and identify potential improvement pathways through the lenses of equity, transparency, and resilience.

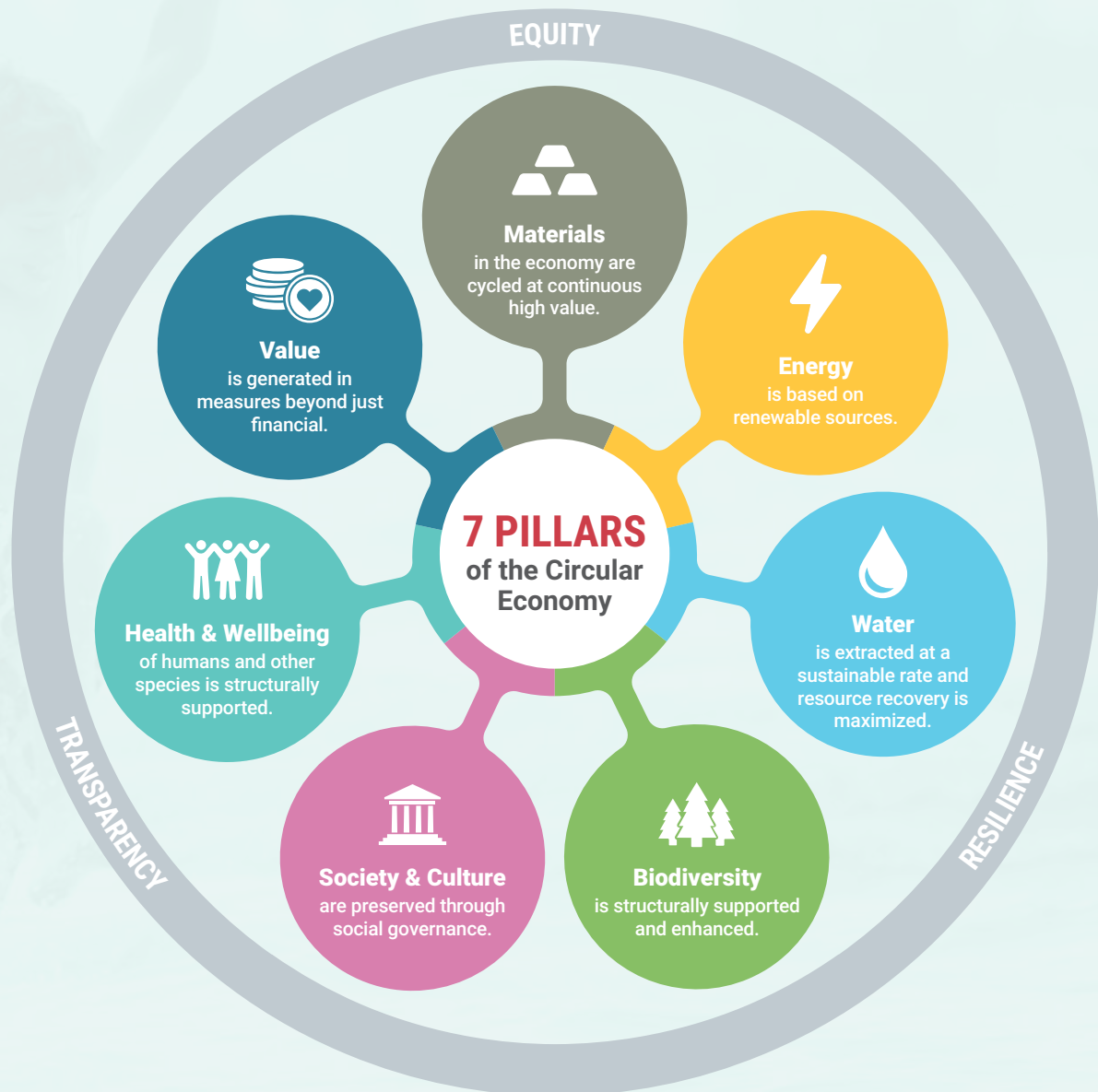


Figure 1  
1 The Seven Pillars of the Circular Economy

## 02. FROM INDUSTRIAL HERITAGE TO AN INCLUSIVE SUSTAINABLE ECONOMY

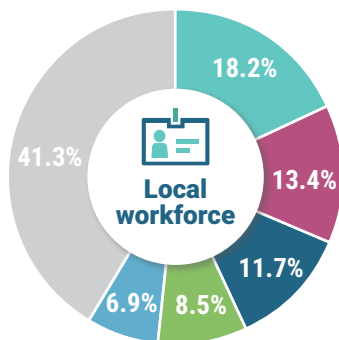
Cleveland has historically functioned as a strong industrial hub, which has led to the development of a strong, multi-modal infrastructural network including trains, planes, trucks, and ships. Although significant parts of the industrial activity have moved abroad, the City is still characterized by its strong metal industry and accompanying industrial infrastructure. The region still

produces around 10% of the entire steel output of the U.S., and around 12% of employment in Cleveland is directly or indirectly linked to this steel industry. Apart from the presence of an extensive manufacturing industry, a large fraction of Cleveland's workforce is active in the food industry, in retail, and in the healthcare sector.



### EMPLOYMENT AND EDUCATION

In 2019, Cleveland's workforce was estimated at **163k workers**.



- Health Care & Social Assistance
- Retail Trade
- Manufacturing
- Accommodation and Food Services
- Educational Services
- Others



**13,023**  
Degrees in 2019

Student population:

55% Females ♀ 45% Males ♂

Most popular majors:

- 14% Liberal Arts & Sciences
- 5% Business
- 4% Nursing

Source: [Data USA](#)

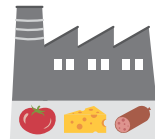
### Key sectors in Cleveland



**20%** Metal product suppliers and end-users

Cleveland alone counts **44** of the 200 largest Northeast Ohio metal product suppliers and end-users.

Source: [Teamneo](#)



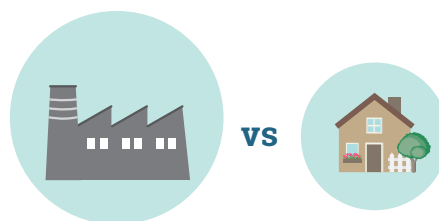
**370**  
Food processing & manufacturing establishments



**29%**  
Employment growth

There are more than **370** food processing and manufacturing establishments in Northeast Ohio which makes the food and agriculture industry among Ohio's top industries. Between 2007 and 2018, the sector has seen a **29%** employment growth.

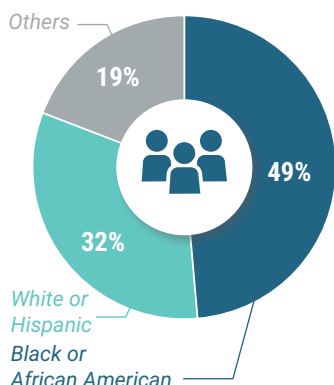
Source: [Make it Cleveland](#)



**x1.5** Industries produce more food waste than households

In 2018 in the U.S., industries have produced more than **1.5** times the amount of food waste produced by households.

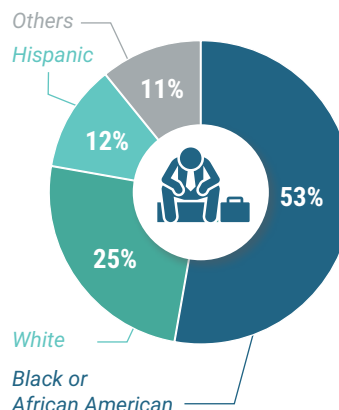
Source: [Epa](#)



### Cleveland's residents

The Diversity of Cleveland's residents is: Black or African American (**48.7%**), White or Hispanic (**32.2%**), and Others (**19.1%**)

Source: [Data USA](#)



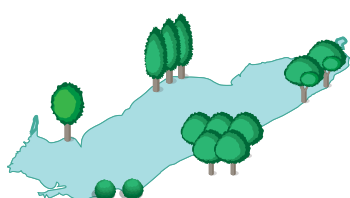
**33%**

Poverty rate

### Living in poverty:

The poverty rate in Cleveland is **32.7%**. Black or African American (**53%**), White (**24.8%**), Hispanic (**11.5%**), Others (**10.7%**)

Source: [Data USA](#)



Cleveland is the largest city on Lake Erie, one of the five lakes of the Great Lakes. The **Great Lakes** are the **largest freshwater system in the world**.

Source: [Michigan.org](#)



Cleveland was ranked in 2021 the **6th** worst city for asthma sufferers

Source: [Asthmas Capital](#)

Any urban development strategy for the city of Cleveland must directly contribute to an inclusive, equitable society that fosters the well-being of all its residents, while building a new, sustainable form of industrial and manufacturing sector. All in, Cleveland's industrial heritage still shapes the urban fabric, and provides the city with unique assets that can be leveraged to build an inclusive, sustainable new economy. The city's extensive vacant lots can be a source of community wealth while contributing to a city that is sustainable, green and healthy. Other lots can be repurposed for local place-making and local sustainable entrepreneurship while the industrial infrastructure can be leveraged for new systems of resource exchange.

As experts of their own environment, Cleveland's residents and organizations are well on their way to leverage these assets. The city prides itself on its many community projects and programs, from food waste and repair initiatives to innovative forms of urban agriculture. Any strategic program for Cleveland must, at its core, be focused on strengthening these existing initiatives for the benefit of local communities.



## WHAT DOES THE CIRCULAR ECONOMY MEAN TO LOCAL STAKEHOLDERS?

During the worksessions, stakeholders from the local construction sector, housing authority, material exchange program, and community organizations came together to evaluate the key challenges and opportunities for stimulating more circular industry and construction in Cleveland. Circular economy is primarily understood as an inclusive model to build stronger and more resilient communities. Key elements discussed involved:

- the need for physical infrastructure to process resources;
- increased incentive through financial regulations and educational processes;
- insight into available materials;
- collaboration to develop concrete tools for including circular strategies in construction efforts.



## 03. EXISTING PROJECTS AND INITIATIVES IN CLEVELAND

Cleveland has numerous local organizations, communities, and local, regional, and governmental initiatives that are already embedded in the circular economy. The following section provides the key insights derived from our team's evaluation of the Climate Action Plan and the current projects and initiatives in place for the transition towards a more inclusive and circular economy. Additionally, our team evaluated where there might be additional margin for improvement.



### WHAT IS WORKING?

- **Climate Action Plan** Many relevant recommendations to implement a circular economy in the city (e.g. food waste reduction, energy efficiency, clean energies).
- **Bottom-up initiatives** Cleveland is working hard to facilitate bottom-up community initiatives and raising awareness of circular practices within its community (e.g. *Circular Cleveland Ambassadors*, *Cleveland Climate Action Fund*, *PCs for People*, *Community Development Block Grant program*)
- **Food** Cleveland has many community programs focusing around reducing food waste (e.g. *Stone Soup*, *Hunger Network of Greater Cleveland*, *Rust Belt Riders*) and equal access to local and healthy food (e.g. *Farm Fare*, *Bistro at Bridgeport Place*).
- **Green spaces** Cleveland counts a number of plans to implement new parks and green spaces (e.g. *Cleveland Metroparks Masterplan*) as well as extensive small-scale and place based programs to support green space development (e.g. *free tree installation*, *community garden resources*, *Cleveland Tree Plan*) with a focus on vacant land.
- **Understanding of environmental justice** Environmental justice and environmental protection has been in the political agenda since the burning of Cuyahoga River in 1969. Approaching the 2021 citywide elections, *an extensive document* has been put in place by more than a dozen organizations to inform the candidate about the needs of Clevelanders.
- **Built environment challenges** There are currently several challenges offered in the city that aim to reduce energy loss in the built environment (e.g. *Architecture 2030 Challenge for Planning*, *Annual Green Building Challenge*).
- **Safe and sustainable transportation** Cleveland has several initiatives in place to make the city safer and more accessible by sustainable means of transportation (e.g. *Year of Sustainable Transportation*, corporate and student discounts on public transportation, *Bicycle Friendly businesses*, *bicycle parking*, etc.). *The city's public transport was also considered as the most sustainable in America.*
- **Refugee integration** Cleveland has several programs that aim to integrate refugees and immigrants in the local community (e.g. *Refugee Response*, *Refugee Services Collaborative Of Greater Cleveland*).

When taking a deeper look at the extensive list of local projects and initiatives, several areas can be identified that could benefit from further attention or resources. Some of the key highlights include:



### WHAT CAN BE IMPROVED?

- **Recycling:** After implementing curbside recycling in Cleveland, the contamination rate of waste fractions was too high and the project stopped. The City has now restarted the curbside recycling program on a voluntary basis.
- **Vacant polluted lands and brownfields:** Cleveland has a large number of vacant but polluted lands and brownfields. A strong focus should be placed on regenerating those polluted areas and building a thriving environment for the local biodiversity.
- **Investments for industrial energy efficiency:** The City of Cleveland has done some pilots around increasing the energy efficiency of their municipal infrastructure (e.g. *public lighting*, buildings) and plans on *investing more towards bike infrastructures*, however, to lower the overall impacts of the city, more investment could be targeted at reducing the energy usage of local industries.
- **Nutrient loading in Lake Erie:** Despite efforts taken by the U.S. and Canada to reduce phosphorus pollution in Lake Erie, it remains the subject of significant agricultural runoff from nonpoint sources (more marked in Western Lake Erie). This nutrient excess results in eutrophication of the water body and requires additional treatment.

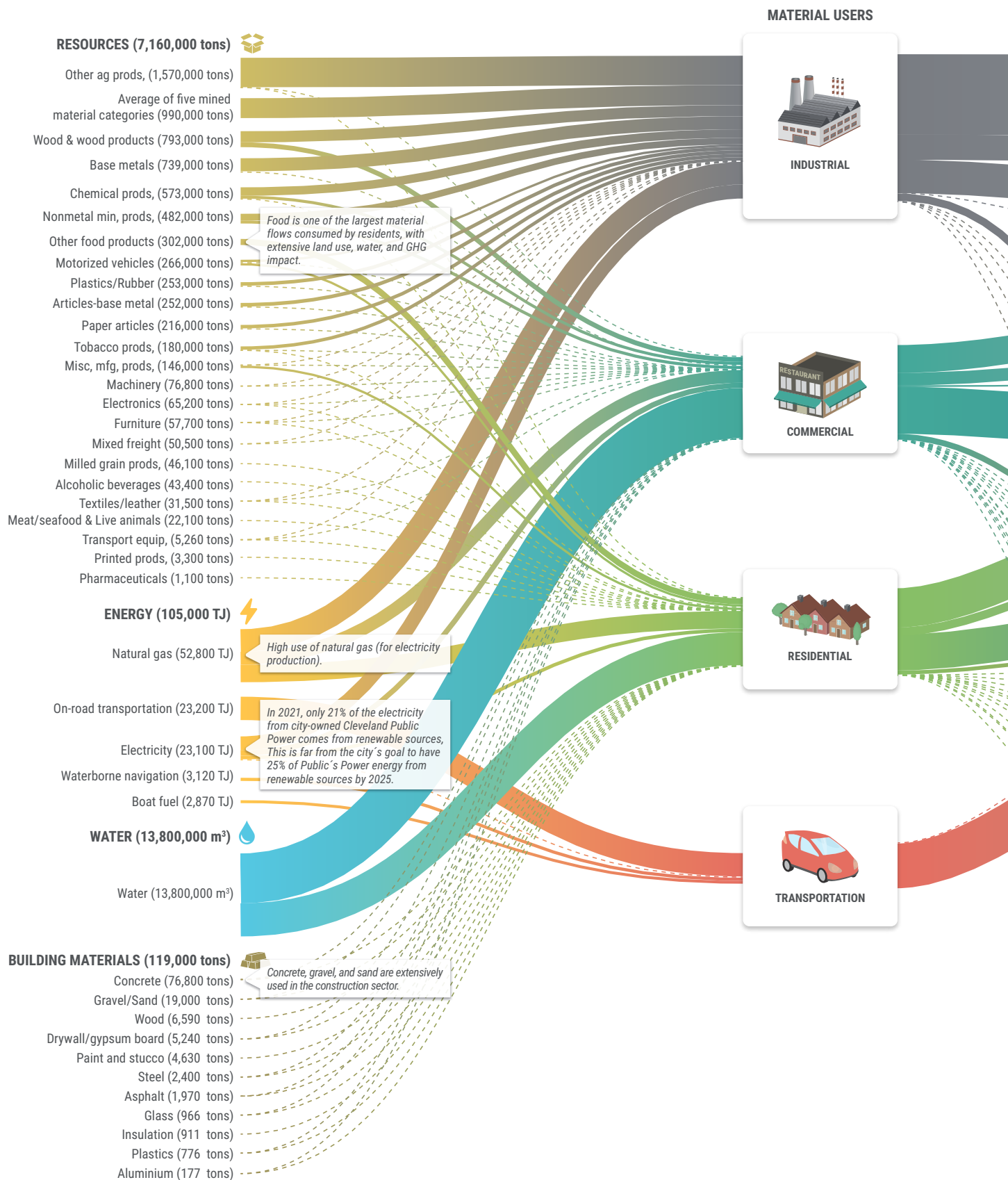


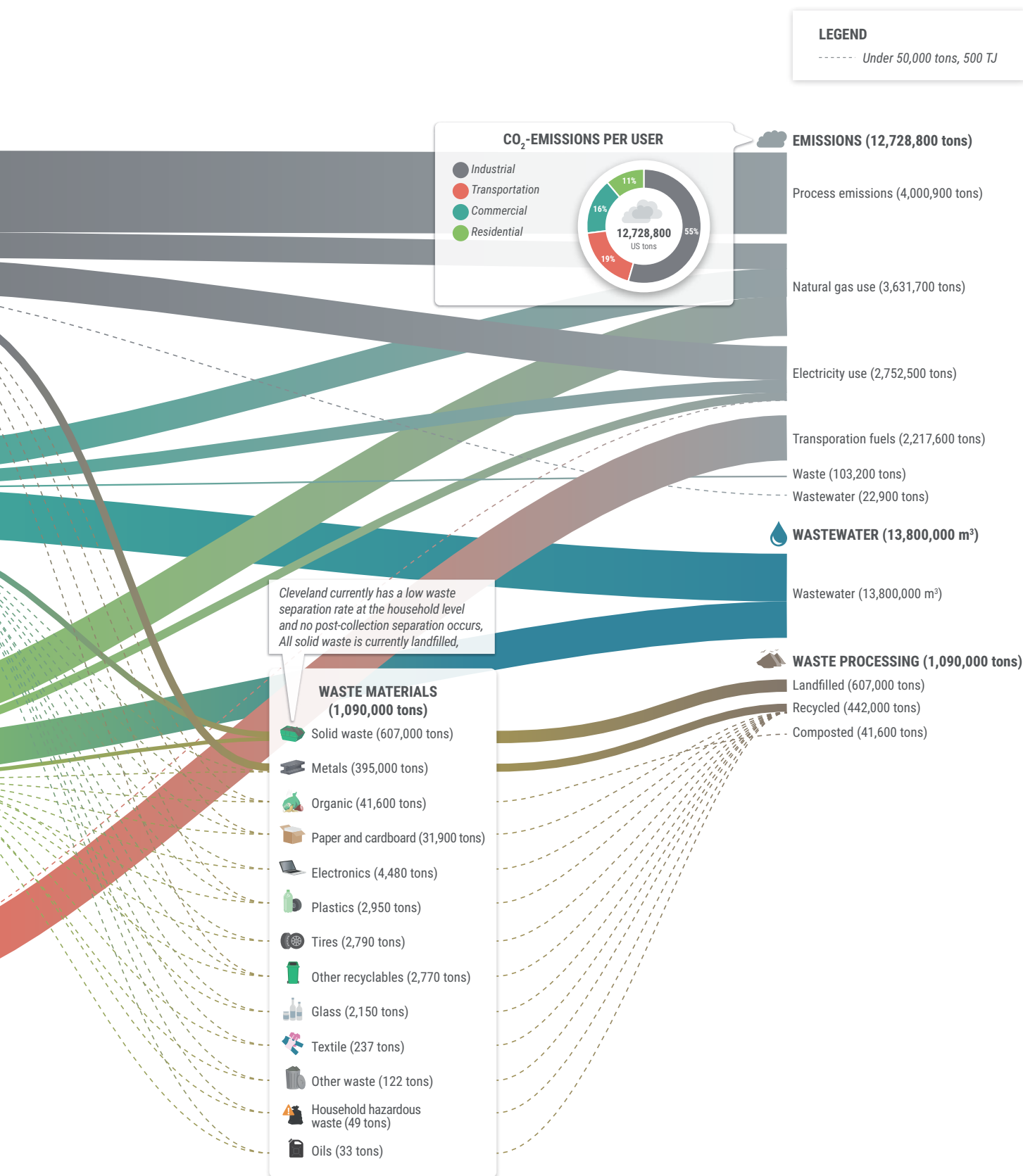
## 04. REGIONAL MATERIAL FLOW ANALYSIS & IMPACT ASSESSMENT

To gain a clearer understanding of how many resources are used and produced in the city, and by whom, our team performed a Material Flow Analysis (MFA). The analysis relies on various public national, regional, and local sources on the quantities and fractions of waste collections; energy consumption; and projected construction, among other sources (Appendix I). A Sankey diagram (Figure 2) visualizes the results of the analysis, graphically depicting where resources come from, their consumption by industrial, commercial, or households, and where they end up.

The thickness of the lines are scaled to match the total material mass in that category, with material inputs entering on the left and waste streams exiting on the right. Our team uses this diagram to identify which resource flows are most impactful and serve as a starting point for the selection of circular strategies in the roadmap.







**Figure 2**

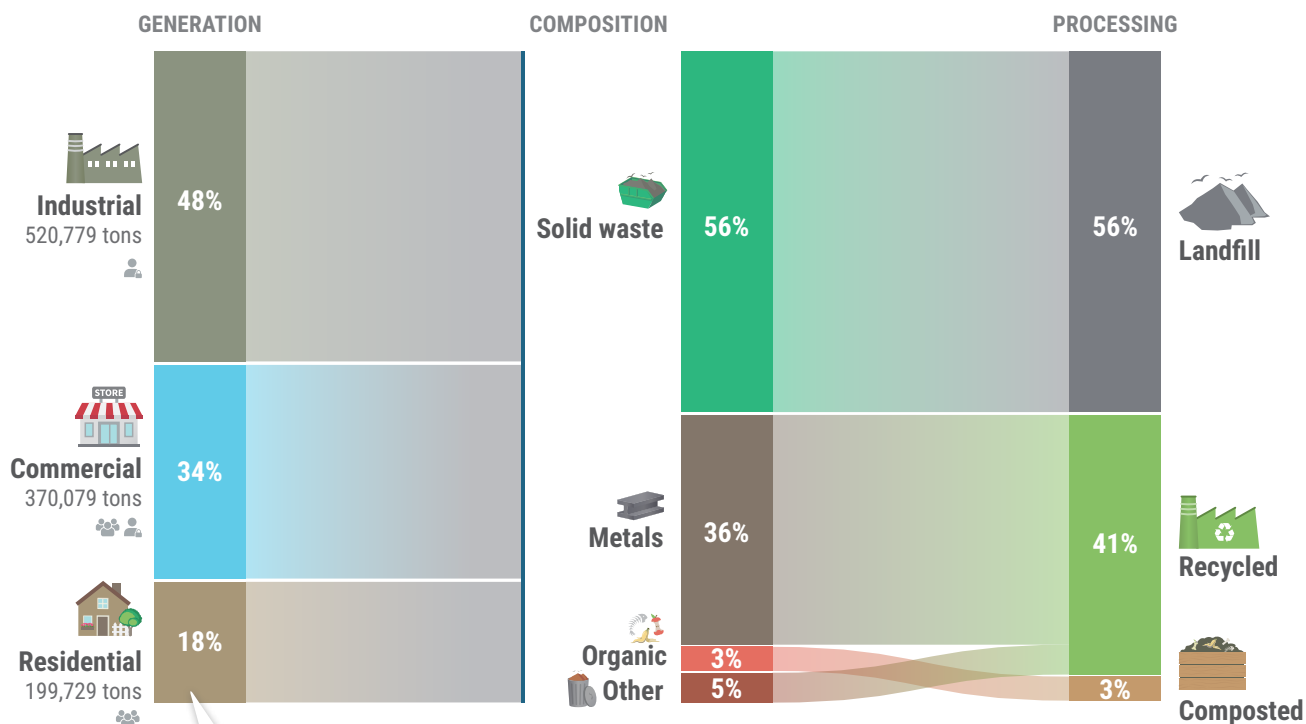
A Material Flow Analysis for the city of Cleveland. This diagram shows the material, energy and water flows through the city of Cleveland. It demonstrates how different users (industrial, commercial, residential) and sectors (transportation) consume resources and generate waste and CO<sub>2</sub>-emissions.





## KEY INSIGHTS FROM THE REGIONAL MATERIAL FLOW ANALYSIS

WASTE GENERATION\* IN CLEVELAND: 1,090,000 ton waste/year



Public collection Private collection

\*For the detailed waste generation in Cleveland per sector, see Appendix II.

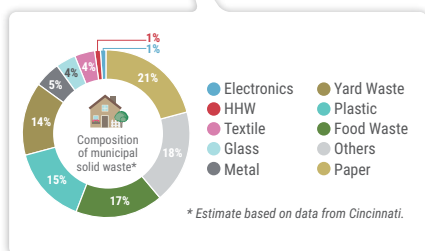


Figure 3

Waste generation in Cleveland.



### DATA GAPS

Again, having access to more data from private industry would have increased the accuracy of the industrial flows in our analysis. Currently, all industrial data are collected through voluntary assessments.



## Industries

Scaling down national data on resource consumption by industries indicates that Cleveland's industrial sector is likely the largest consumer of materials (e.g. fuel oils, agricultural products), and the largest waste generator in the city: 48% of all waste in Cleveland is produced by local industry. The majority of materials produced (steel and metals) are highly impactful materials for the environment (i.e. CO<sub>2</sub> emissions) and their production in the region accounts for 10% of overall U.S. output of steel.



METABOLIC



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The Great Lakes Region  
Champion Connect & Influence

## End-of-life management

The majority (56%) of waste produced in the region is minimally separated and is processed as mixed waste which is all landfilled. The exact composition of Cleveland's Mixed Solid Waste (MSW) is unknown. Regional reports indicate MSW consists mostly of organic waste (31.1%),

paper (21%), and plastic (15%). The recycling processes of the various materials are also unknown and would need further characterisation to avoid downcycling and minimise refusal.



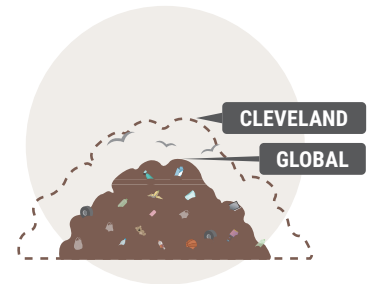
**1,788 lbs/year**

The **USA** produces close to the most Municipal Waste per resident in the world.



**1,142 lbs/year**

Residents of **Cleveland** sit far below this number.



**578 lbs/year**

Yet Cleveland's residents produce far more Municipal Waste per capita than the **global** average.

## Food

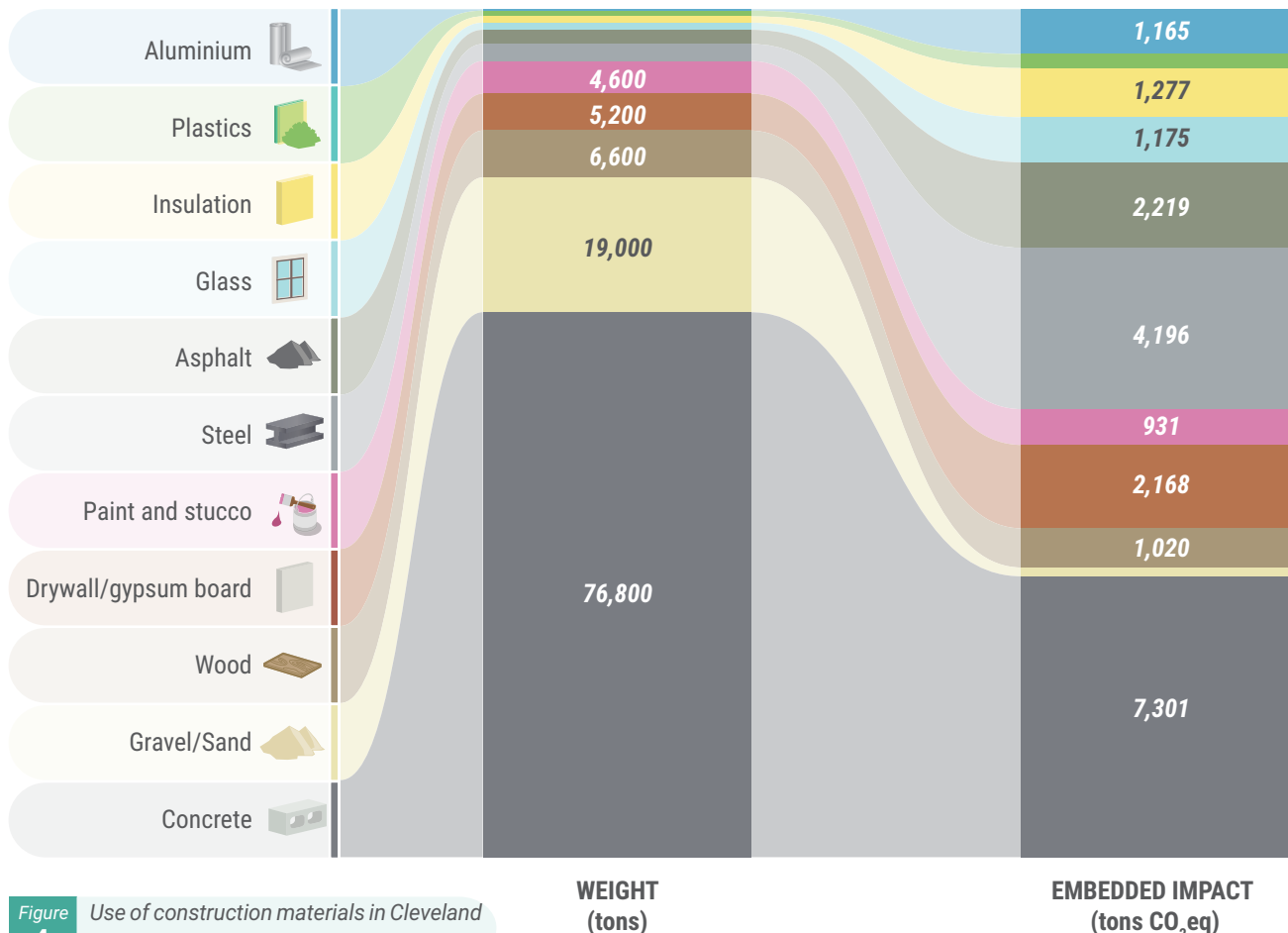
Food is one of the largest material flows consumed by households across the City, with a yearly quantity of 463,000 tons of food and other agricultural products consumed by households in Cleveland, from which 105,900 tons are collected in the mixed waste and only 3,900 tons (4%) are composted. As for the total organic waste produced by all actors in Cleveland, out of the estimated 230,000 tons, only 41,000 tons (18%) is composted.



## Construction

The construction sector is mostly described by an extensive concrete (76,900 tons), gravel, and sand (19,000 tons) use by weight. When looking at the embedded CO<sub>2</sub>-emissions of construction materials, which take into account the emissions associated with production

and transport up until retail (calculated based on *Dutch estimates*), concrete is responsible for 33% of total emissions from construction materials, followed by steel (19%) (Figure 4).



## Electronic waste

Electronics are a relatively small portion of the total waste produced. However, this waste has a high potential for value recovery due to the complexity of products and presence of rare metals. Cleveland has electronic recycling programs (e.g. *PCs for People*), however, it is currently difficult to know the exact scale at which those materials are recycled.





## 05. EVALUATED CE POLICIES IN CLEVELAND

Policies touching on legislation and procurement are one of the biggest enablers to further incentivize the circular economy transformation. When implemented properly, they can contribute to increasing employment, minimizing resource use, and providing safer and cleaner cities for better health outcomes. Many policies are in place providing a fruitful starting point for implementing circular projects and initiatives. At the same time, some topics and sectors could benefit from stronger policies, including at a state and national level, as mentioned in the Climate Action Plan, to guide the transition. The following section provides key insights derived from an evaluation of the current policies in Cleveland.



### WHAT IS WORKING?

- **Municipally controlled vacant land** Many vacant lots in Cleveland are under public control and can serve as a resource for inclusive socio-economic development. The Climate Action Plan has proposed to develop a plan for vacant land reuse and, since 2013, a pilot tree planting was completed and the lands hold some of the largest urban farms and greenhouses in the country.
- **Capture potential for renewable energy** The City of Cleveland adopted *zoning regulations* allowing for wind turbine placement in the city. Research shows the potential for renewable energy
- **Municipal green procurement** The City of Cleveland has several policies in place to minimize its environmental impact through green procurement and construction and management of her buildings (e.g. through the *local and sustainable purchasing ordinance*; the *sustainable municipal building policy*, and the *Advanced Energy Portfolio Standard* which required a minimum of 20% renewable energy by 2020).
- **Strong focus on active mobility** The City is quickly developing infrastructure (e.g. *Bicycle Parking Zoning*) and *adopting urban development norms* and programs (e.g. *Bicycle Friendly Businesses Certification*, *HOPR Bike Share*) that contribute to a walking, biking and public transportation-friendly city.
- **Strong focus on active mobility** the City is quickly developing infrastructure (e.g. *Bicycle Parking Zoning*) and *adopting urban development norms* that contribute to a walking, biking and public transportation-friendly city.
- **Strong citizen participation processes** The City of Cleveland strongly incorporates citizen participation methods in its planning process and decision-making process.
- **Cleveland's Green building Standard** The standard was updated, which must be met to receive tax abatement for green building constructions.



### WHAT CAN BE IMPROVED?

- **Policies focus on end-of-life management** Policies focus mostly on end-of-life management rather than reduction based approaches (output rather than input).
- **Limited focus on industrial activities** Current policies narrowly focus on making existing industry more sustainable or attracting new sustainable (circular) businesses.
- **Low availability of data** Little data on resource flows and associated impacts. Data collection is largely performed on a voluntary basis which does not allow good insights on the overall material flows in the city.
- **Non-binding construction standards** The City has little or not very ambitious binding policy on the environmental impact of the built environment. Through the *District 2030* program, private actors are stimulated to contribute to sustainable construction and area development. Additionally, the City uses a financial mechanism to support Green Building (through the *Green Building Tax Abatement*).
- **Renewable energies** According to the Climate Action Plan and the Clean and Equitable Energy Future report findings, incentives and policies for renewable energy are limited (and unfavorable) at the state level. The State of Ohio currently runs on only 3% renewables, and is still largely dependent on natural gas and fossil fuels for its energy needs. The City of Cleveland's Public Power's energy comes mostly from fossil fuels.
- **Pollution** Some residents still face challenges to *accessing clean, safe, and affordable water* (e.g. strong correlation between the racial composition of K-8 schools and the share of students with elevated blood lead levels), and air quality was shown to be one of the worst compared to other metropolitan areas (*American Lung Association*).
- **Policies enforcement:** The existing policies could be better implemented and enforced as well as new ones (e.g. curbside recycling).
- **Systemic racism:** The current system in Cleveland perpetuates systemic racism and inequities, which is a strong barrier for equitable circular development.

## 06. OPPORTUNITIES FOR A CIRCULAR CLEVELAND

As the above-mentioned sections demonstrate, an extensive focus exists around the topic of sustainability in Cleveland. When looking at all the insights from the project inventorization, material flow analysis, and policy analysis, we can extract several opportunities to build upon the existing Climate Action Plan to accelerate the transition towards a circular economy. Our team uses the following four concepts to structure our thinking about the circular economy and our prioritization of efforts, in addition to already existing plans.



### REDUCTION

The easiest way to prevent the impact of raw material extraction and production is reducing our production. It is important to design a system where low energy and material demand is central. The goal is to improve the quality of life while not increasing the quantity of raw materials used.



### SYNERGY

As soon as the demand for raw materials and the related effects have been reduced as much as possible, then it is time to look at the prospect of exchanging residual flows. Synergies should be done along every step of the value chain. If, for example, residual heat is produced in a building, it would be ideal to absorb this heat and reuse it in the same location. In particular, locally available resources (such as rainwater or heat from local water resources) and raw materials known to be released during the demolition of buildings are important to consider in the design step.



### PRODUCTION AND PURCHASING

As soon as the opportunities for synergies become exhausted, it is time to see how the remaining demand can be met from clean, renewable or otherwise environmentally favorable sources. Resources that are in local production are preferable because the impact is usually lower and the efficiency higher, because no transport or major infrastructure investments are needed. In the long run however, the choice for local resources must be guided by impact and efficiency.



### MANAGEMENT

It is important to get feedback on how the system works to keep it optimal. This includes, among other things, the provision of transparent data and a single information network to enable an efficient and well-functioning system. This form of feedback makes behavioral change and technological adjustments possible.

This following section highlights several opportunities for amplifying existing initiatives, and for building on Cleveland's strengths and challenges in their pursuit of an inclusive, circular economy.



## OPPORTUNITIES TO REDUCE

- **Set clear waste reduction goals** Formulate ambitious waste (and impact) goals for commercial and industrial actors in Cleveland, and evaluate the progress towards set goals over time through mandatory data collection.
- **Pay-As-You-Throw** On the longer term, the City can adopt more differentiated waste fees to give a financial incentive for reducing waste and stimulating waste separation.
- **Designing out waste** The municipal policies extensively focus on end-of-life solutions and initiatives, whereas this energy should first be targeted at reducing the consumption and disposal which will lead to less waste to deal with. The Value Hill approach (Figure 5), where the value in materials is kept at its highest, should be ideally applied on all material flows in the city (e.g. textiles, plastic, glass, paper, etc.).
- **Food waste prevention** Work with supermarkets, industries, and households to develop regulations aimed at preventing food waste.
- **Energy efficiency awareness** In the past, there were programs specifically built to educate homeowners about cost-savings gained from energy efficient homes and to help *small businesses* reduce their energy consumption. As for manufacturing companies, the University of Dayton Industrial Assessment Center has agreed to offer *free energy-efficiency audits* to qualifying companies in the region. Those initiatives could become mandatory for all homeowners and all industries.



## OPPORTUNITIES TO SYNERGIZE

- **Industrial symbiosis:** Connect local industries to create industrial symbiosis where materials and resources are exchanged. Large quantities of waste heat or wastewater could potentially be recovered and reused.
- **Update construction and demolition standards:** Include more ambitious environmental impact and material reuse targets, energy performance, and the mitigation of polluted areas.
- **Resource recovery from wastewater:** Wastewater from households and industries includes valuable nutrients (P, N, C) and can be treated in a way to recuperate resources and valorize them, hence closing the biological loop.







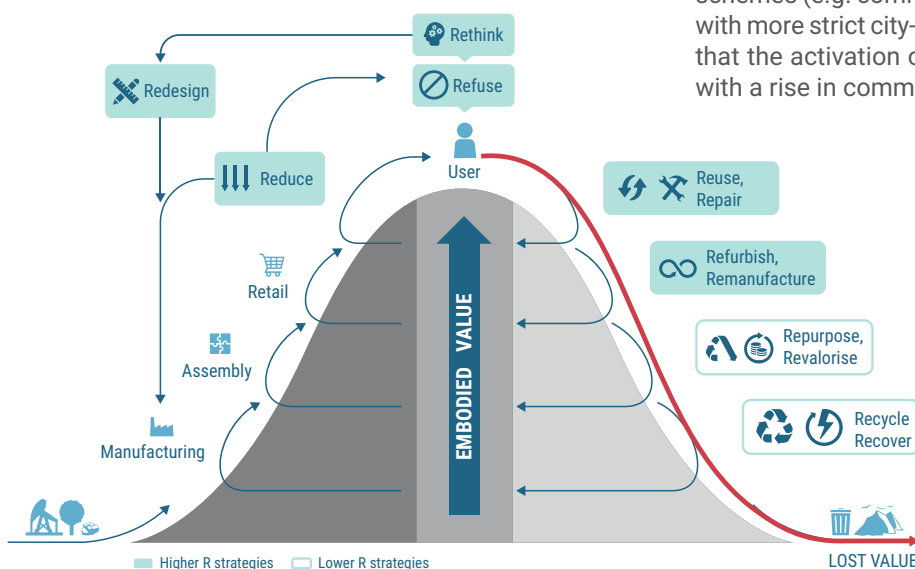
## OPPORTUNITIES TO SUPPLY

- **Decentralized energy systems** Vacant land can be leveraged for decentralized, community-owned renewable energy systems (e.g. *Hough Solar Energy Program*).
- **Clean energies** Cleveland has a large *green energy potential* on which they are working on (e.g. *LEEDCo - Icebreaker Wind Project in Lake Erie*, United Solar Initiative, *Cleveland Solar Cooperative*) and some small initiatives such as *Grind2Energy*. The implementation of more renewable energy sources could come hand-in-hand with the implementation of energy COOPs which would drive the economy and the revenues would come back to residents.
- **Innovative materials in the built environment** Cleveland can make the green procurement clause for public projects more strict to promote the use of innovative and sustainable materials (e.g. permeable pavements, biomaterials) and incentives must be offered to residents for responsible material choices.



## OPPORTUNITIES TO MANAGE

- **Participatory budgeting** To further strengthen the highly participatory form of governance that lies at the heart of the values of the City of Cleveland, extended forms of participatory budgeting can be explored.
- **Waste sorting education** Waste reduction and sorting education programs should be widely offered to residents and businesses. For residents, existing youth programs can be leveraged, whereas for businesses, education in the workplace can be implemented. Those practices could be incorporated into the *green infrastructure maintenance training plan* that has the goal to create a workforce development program leveraging existing local organizations.
- **Polluted areas** Leverage polluted land to offer more inclusive areas that include urban farming and parks and educate about bioremediation techniques.
- **Circular culture** Let circular practices be at the forefront of Cleveland's arts and culture scene (e.g. temporary structures, reusing materials, building for disassembly, etc.).
- **Affordable housing** The current lack of affordable housing and the large number of vacant lots in Cleveland provides an opportunity for alternative housing schemes (e.g. CLT), which would prevent homelessness.
- **Leveraging land to build community wealth** Currently there is a lack of affordable housing and extensive vacant lots. However, the repurposing and activation of vacant lots often results in gentrification trends. By stimulating alternative housing and land ownership schemes (e.g. community land trusts (CLT)), combined with more strict city-wide policies, Cleveland can assure that the activation of vacant lands goes hand in hand with a rise in community wealth.



An adaptation of the Value Hill Model to include the 9R Framework. Buren, N., Demmers, M., Heijden, R., & Witlox, F. (2016). Towards a Circular Economy: The Role of Dutch Logistics Industries and Governments. | Circle Economy, Het Groene Brein, Nuovalente, Sustainable Finance Lab, TU Delft (2016). Master Circular Business With The Value Hill. | Kirchherr, J., Reike, D. & Hekkert, M. (2017). Conceptualizing the Circular Economy: An Analysis of 114 Definitions. | Potting, J., Hekkert, M., Worrell, E., & Hanemaaijer, A. (2017). Circular Economy: Measuring Innovation in the Product Chain.

Figure 5

Value Hill infographic.

## 07. PATHWAYS FORWARD

The Cleveland Climate Action Plan includes an overview of five focus areas in relation to the local climate goals (Energy Efficiency & Green Building, Clean Energy, Sustainable Transportation, Clean Water & Vibrant Green Spaces, More Local Food, Less Waste). In our current effort to create a circular economy strategy, we can build upon these focus areas laid out in the CAP, while applying a lens with a focus on the elements most relevant to a circular economy. From the perspective of a circular economy, key criteria of evaluation include the quantity of materials consumed; the associated impact of the consumed materials; and the relevance of the sector to contribute to systems of circular material production and use, and/or improve quality of life.

Focussing on the areas most directly related to the circular economy, we land on the following four circular focus areas:

1. Circular Manufacturing
2. Circular Built Environment
3. Remediating Pollution
4. Getting more value from resources

### Adopting a holistic lens

*Across these four focus areas, our team captured the key values for developing a resilient and sustainable urban ecosystem by looking through three lenses:*

1

#### MATERIALS & ENVIRONMENT

How can we reduce the consumption of primary materials and their embedded

2

#### COMMUNITY & SOCIO-ECONOMIC DEVELOPMENT

How can we build a just, inclusive and sustainable urban economy that benefits Cleveland's residents?

3

#### DATA ACCESSIBILITY

What information do we need, now and in the future, to assure that we allocate our resources effectively and meet our goal?





## CIRCULAR MANUFACTURING

Given the large impact of local industry in Cleveland on resource consumption, waste production, and CO<sub>2</sub>-emissions, this sector must be an important focus in the Cleveland circular economy roadmap. Despite having made progress in terms of reducing their energy consumption and emissions, Cleveland's industries have lowered their waste diversion rates from 2010 to 2016. Hence, manufacturers must double-down their efforts to maximize their diversion rates while

adopting high air quality standards. We must work with the local industry sector to decrease the impact of existing industries, as well as attract new industrial actors that function in line with the earth's ecological boundaries. The roadmap will stipulate strategies for decreasing the impact of material use, expanding local, clean energy production, and stimulating material symbiosis among local industries.



## REMIEDIATING POLLUTION

Cleveland's industrial history and its current manufacturing activities have resulted in extensive polluted areas. While prioritizing the health of citizens and the biodiversity of the region, tackling and remediating pollution must be one of the focus areas. Environmental justice is at the core of the discussion

to ensure a fair and excellent living environment for all Cleveland's residents. The circular roadmap will build upon the strategies suggested in the Climate Action Plan from a circular perspective, and propose additional policies and programs that can regenerate Cleveland's polluted areas for a healthy, thriving environment.







## CIRCULAR BUILT ENVIRONMENT

Given the extensive amount of impactful resource consumption by the built environment and the strong link to energy consumption by household heating, the built environment is another key focus area to stimulate a circular economy. Not considering local industries, stimulating green building and energy efficiency is the single largest leverage point for decreasing Cleveland's

CO<sub>2</sub>-emissions, as mentioned in the Climate Action Plan. In addition, there is extensive knowledge available on circular strategies in the built environment. These strategies focus on minimizing environmental impact of construction, ensuring reusability and end-of-life, as well as supporting socio-economic development through inclusive building and management structures.



## GETTING MORE VALUE FROM RESOURCES

The Climate Action Plan lays out goals and objectives to stimulate local food production and reduce waste. This circular economy roadmap builds upon the formulated focus area, and adds additional goals and objectives focused on the topic of a circular economy.

Cleveland currently sends a large fraction of its household waste straight to landfill from which a

large fraction could be further valorized. Therefore, maximizing the value from Cleveland's waste, with an emphasis on organic resources, is the last key focus area. Building on Cleveland's strong industrial background, extensive space, and strong local agricultural initiatives, the roadmap will leverage those assets to generate more local value out of organic flows and close nutrient cycles.



As a next step in the project, our team will work with local stakeholders to identify the key barriers and opportunities to implementation for each of the four focus areas. By combining the information from these work sessions

with Metabolic's experience and an analysis of best circular practices worldwide, we will create a roadmap and implementation plan that presents key actions for stimulating a circular economy in Cleveland in the coming years.



# APPENDIX I: MATERIAL FLOW ANALYSIS METHODOLOGY

## Material Flow Analysis- explanation of methodology

To create the Material Flow Analysis we use a combination of local data from the City of Cleveland, bottom-up calculations and top-down calculations. This section briefly explains the data sources and method used for evaluating the resource flows through the city of Cleveland.



### INPUTS

#### Use of Commodity by industry

To indicate what resources are consumed by local industry in Cleveland, we build upon data from the Bureau of Economic Analysis (BEA) for the state of Ohio. This data indicates the use of commodities by different industries in the state. This data was downscaled to the city of Cleveland based on the number of employees and establishments present in the city of Cleveland in different industries.

#### Energy consumption

Data on the energy consumption in the city of Cleveland was directly available from the municipal office.

#### Water consumption

Water consumption by commercial actors and residents in Cleveland was directly provided by the city's municipal office. Data on industrial water consumption was not available and is therefore not included in this analysis.

#### Construction

To evaluate the material flows of the construction sector in Cleveland, data was used on the amount of square footage of newly constructed and demolished buildings. The building projects were classified into two building typologies (residential or commercial buildings). For each of these two typologies, a material profile was created to evaluate the expected material flows.



### OUTPUTS

#### CO<sub>2</sub>-emissions

The City of Cleveland collects data on the city's direct carbon emissions (scope 1 and scope 2), captured in the Cleveland Emissions Profile. This data could be applied to represent the emissions from the city's industry, commercial actors and residents.

#### Wastewater

Data on the flows of water in the city was provided by the City of Cleveland. Due to a lack of data, the analysis does not include industrial wastewater flows.

#### Waste materials

To evaluate the waste materials that the city produces, several datasets had to be combined. There is currently no singular overview of all waste materials in the city of Cleveland. This is mostly due to the fact that industries can report their waste flows on a voluntary basis, resulting in incomplete data collection. Data on the municipal waste flows, coming from residents and small businesses, was taken from the Cuyahoga County Solid Waste Department Residential Recycling (2019). This data was downscaled to the city of Cleveland based on the population numbers. In addition, state-wide data from Ohio EPA (2019) was scaled-down to the city of Cleveland to get an indication of the industrial waste flows.

## Use of commodities by industry - top 10 material categories by weight explained

The Material Flow Analysis draws upon data from the BEA for its data and classification of commodities. The following list clarifies what materials are included in the used classification, for the top 10 most consumed (material) commodities in Cleveland:



### Other agricultural products

This category includes an extensive list of agricultural products, including vegetables, fruits, tree nuts, food and feed grains, tobacco, sugar crops, other crops, and cotton.



### Average of five mineral material categories

Key minerals in this category include unprocessed iron and steel minerals (such as those in the form of ores), copper, and other metal mineral products.



### Wood & wood products

Wood and wood products are used in all sorts of manufacturing processes, such as the timber industry, plywood industries, but also pulp and paper industries.



### Base metals

This material category includes many of the produced metals that serve as input to the extensive local metal production and processing industries in the region. Key base metals include: iron, steel, copper, lead, tin and zinc.



### Chemical products

There are thousands of industrial chemicals that fulfill a range of functions in industrial processes. The data doesn't specify which ones are used by local industry in Cleveland. Worldwide, the most commonly produced industrial chemical is Sulfuric Acid, which is, among others, used as a critical component for metal manufacturing.



### Nonmetal mineral product

This commodity category includes mineral products such as clay, glass, lime, cement, concrete, and mineral wool.



### Other food products

This category contains the majority of processed food, excluding only meat products, seafood, and a small amount of grains. Several examples of the wide product range in this category are: flour, cereals, canned food, bread, cookies, processed sugar, chocolate, candy, roasted nuts, coffee, pasta.



### Motorized vehicles

This category includes motors, cars, trucks and other engine-driven vehicles.



### Plastics/rubber

Materials in this category include: plastic materials and resins, synthetic rubber, and several manmade fibers.

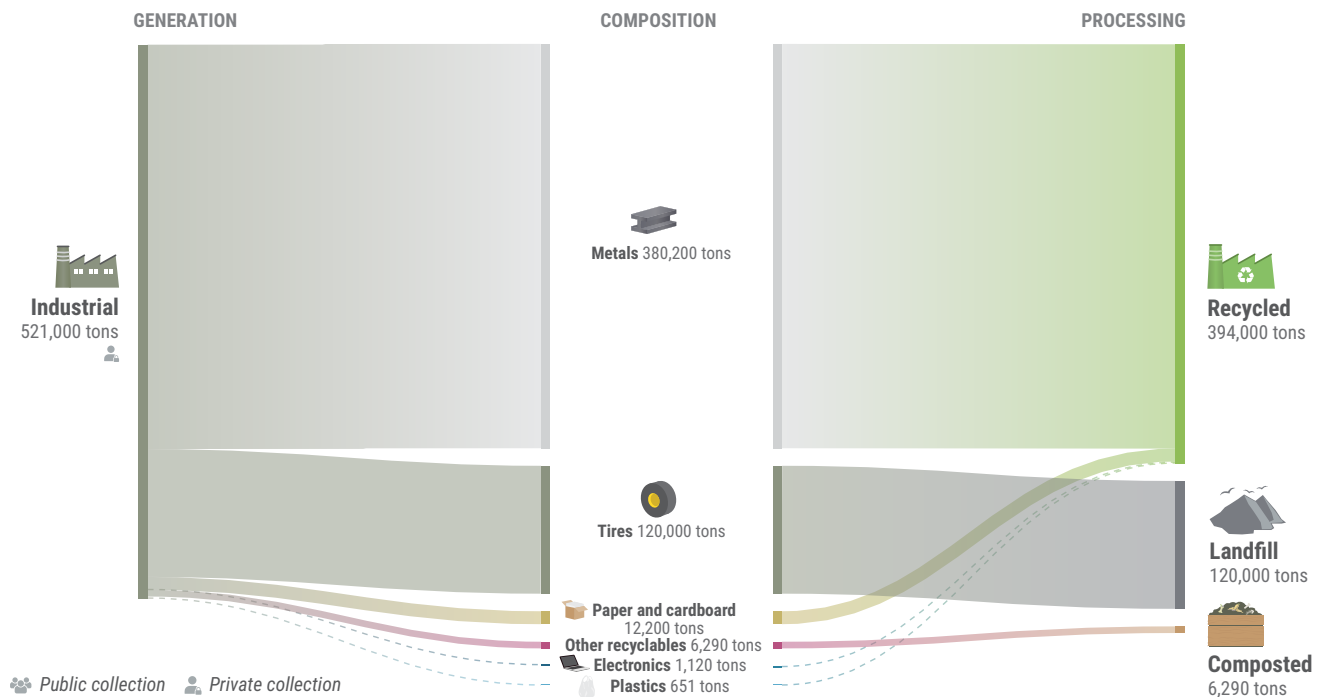


### Articles-base metal

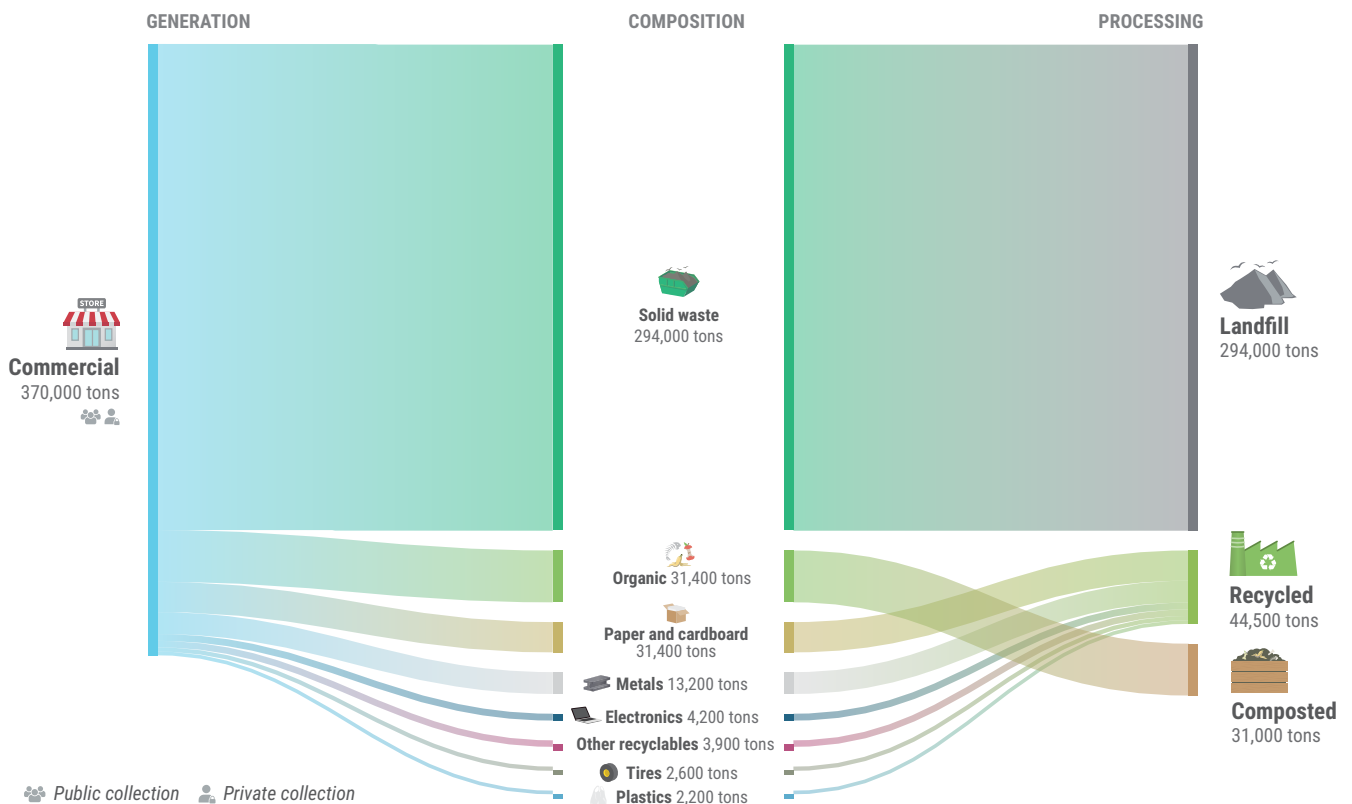
Manufacturing industries process previously prepared metal components into new components or products (e.g. vehicles).

# APPENDIX II: WASTE GENERATION IN CLEVELAND PER SECTOR

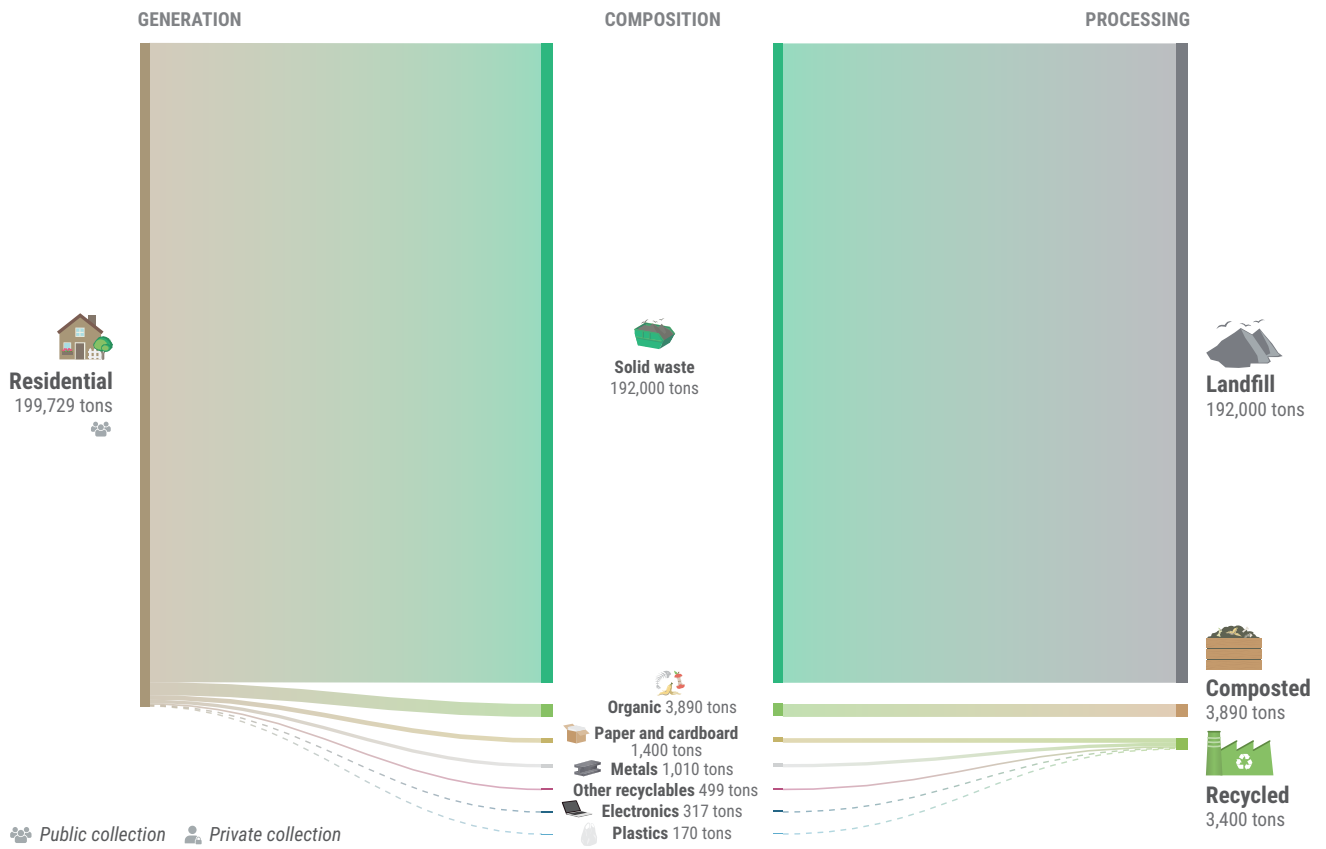
## INDUSTRIAL WASTE GENERATION: 521,000 ton waste/year



## COMMERCIAL WASTE GENERATION: 370,000 ton waste/year



# RESIDENTIAL WASTE GENERATION: 200,000 ton waste/year





# APPENDIX III: DESCRIPTION OF THE MATERIAL FLOW ANALYSIS

## Inputs

On the left side of the Sankey diagram we see the different resources that were consumed in the city of Cleveland for the year 2020, broken down into four categories. The following sections briefly describe the key insights and flows per category.



## Resources

This material flow analysis provides insights into the material, energy and water flows that are consumed in the city of Cleveland. At the top left of the diagram we see an overview of general **material resources (7,160,000 tons)** that are consumed on an annual basis in the city. The largest resource flows for Cleveland are *Agricultural products (1,570,000 tons)*, *Mined materials (990,000 tons)*, *wood and wood products (793,000 tons)*, and *base metals (739,000 tons)*. The agricultural products are processed by the food processing industry into new food products for local, regional and global consumption. The metals and mined elements are an indication of Cleveland's extensive metal production and processing industry, which consume large amounts of primary (virgin) materials. In the pursuit of a circular economy, we are faced with the challenge to decrease the environmental impacts of the materials we consume by consuming more secondary materials or biobased materials.

### Data source:

Based on the national sector use (\$) converted to mass (with a \$/tons factor calculated from imports in Ohio) and scaled down to the city with employee numbers per sector.

Built environment based on annual square footage per building type – calculated from the number of buildings and material intensity factors from a [MIT study](#).

Residential consumption based on consumer expenditures in Ohio and scaled down to Cleveland's population – calculated from the \$/tons factor calculated before.



## Energy

Cleveland's energy consumption (105,000 TJ) was mostly from natural gas (52,800 TJ), which was predominantly used by industrial actors. Industrial actors therefore play a large role in the city's transition towards less and cleaner energy consumption. Secondly, residences consume large amounts of natural gas. Insulation of houses can also strongly contribute to Cleveland's energy goals. On-road transport also consumes large amounts of energy (both trucks and cars). A clean transportation system is crucial to decrease Cleveland's CO<sub>2</sub>-emissions as well as address local air quality issues.

### Data source:

Based on the City of Cleveland's GHG Inventory Report (City wide energy consumption and emissions) and on the Cleveland Transportation GHG Emissions (municipal transport emissions).



## Water

Commercial actors consume large amounts of water for utilities, washing, irrigation and consumption, as do households. Decreasing drinking water consumption can occur by collecting local rainwater and using it for non-consumption uses (e.g. irrigation).

### Data source:

Based on the Department of Public Utilities - Water Sales and Service Report (net water consumption for the city of Cleveland).



## Building materials

New buildings require extensive material use, which currently mostly consist of newly produced, primary materials, predominantly concrete (76.800 tons). More circular building materials include secondary (reused) materials, or renewable materials such as wood and other plant-derived materials.

#### Data source:

Based on Cleveland's construction and demolition permits and building profiles from: Ochsendorf et al. (2011), retrieved from: [https://cf.specifyconcrete.org/doc/MIT\\_Buildings\\_LCA\\_Report.pdf](https://cf.specifyconcrete.org/doc/MIT_Buildings_LCA_Report.pdf)

Building profiles that contain material usage per square footage of residential and commercial buildings were used in combination with the amount of square footage of newly constructed and demolished buildings to calculate material flows. All buildings fall into two rough categories; residential or commercial buildings.

### Outputs

On the right side of the Sankey diagram we see the different flows that were produced in the city of Cleveland in the form CO<sub>2</sub>-emissions and waste. The following sections briefly describe the key insights and flows per category.



#### Emissions

In the year 2020 Cleveland's residents and businesses emitted around 12,728,800 tons CO<sub>2</sub>. Most of these emissions (4,000,900 tons) were process emissions, which are emissions that occur when raw materials (e.g. iron ore) are processed into industrial products (e.g. steel). In total, local industry accounted for around 55% of all Cleveland's emissions. Transitioning towards clean industries can strongly contribute to the city's climate ambitions. In addition, natural gas use accounts for a large amount of local emissions (3,631,700 tons). Less energy consumption and more renewable energy sources (e.g. wind and solar) can decrease local emissions.

#### Data source:

Based on the City of Cleveland's GHG Inventory Report (City wide energy consumption and emissions).



#### Wastewater

Wastewater from commercial actors and residents amounted to around 13,800,000 m<sup>3</sup>. Wastewater from residents often contains many valuable nutrients, such as nitrogen (N), phosphorus (P) and carbon (C). These and other nutrients can potentially be recovered and used for fertilization or the creation of circular products.

#### Data source:

Based on the Department of Public Utilities - Water Sales and Service Report (net water consumption for the city of Cleveland).

Assuming that the wastewater is equal to the water consumption.



#### Waste processing

Currently, local industry, commercial actors and residents produce at least 1.090.000 of waste per year. The largest waste stream in the city is solid mixed waste, largely coming from households. This waste flow is currently landfilled, but contains many materials that could potentially be recycled. Increased separation at the household level could allow more materials to be reused. Additionally, waste separation technology can potentially separate out materials from a solid mixed waste flow, such as plastics, tins, drinking cartons. Metal waste from the metal industry is already recycled at a high rate, because it can be used as an input relatively easily when producing new steel products. Small fractions of organic waste are currently already composted. However, there are still large amounts of organic waste in the solid mixed waste flows that are now sent to landfill, which represents a large value loss.

#### Data source:

Based on the 2019 Cuyahoga County Solid Waste District recycling rates and scaled down for Cleveland.

Assuming the solid waste breakdown is the same as the Cincinnati solid waste breakdown for the same year.



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