MEASURING THE VALUE OF VANCOUVER'S CIRCULAR ECONOMY OF FOOD (CEF)

Prepared by: Dionissios Batistatos, Greenest City Scholar, 2019

(Candidate, Master of Food and Resource Economics, UBC)

Prepared for: Meg O'Shea,

Program Manager, Thriving Vancouver

Manager, Small to Medium Enterprises

Vancouver Economic Commission

August 29, 2019

This report was produced as part of the Greenest City Scholars (GCS) Program, a partnership between the City of Vancouver and The University of British Columbia, in support of the Greenest City Action Plan.

This GCS project was conducted under the mentorship of City staff. The opinions and recommendations in this report, and any errors, are those of the author, and do not necessarily reflect the views of the City of Vancouver or The University of British Columbia.

The following are the official partners and sponsors of the Greenest City Scholars Program:

ACKNOWLEDGEMENTS

The author would like to thank Meg O'Shea for their insights, feedback, and support throughout this project.

TABLE OF CONTENTS

INTRODUCTION

> "The Circular Economy aims to prevent the depletion of resources, close energy and materials loops, and facilitate sustainable development through its implementation at the micro (enterprises and consumers), meso (economic agents integrated in symbiosis) and macro (city, regions, and governments) levels." (Vanessa Prieto-Sandoval, 2018)

The City of Vancouver's ambitions to achieve increasingly high levels of waste diversion and zero waste has sparked interest around the Circular Economy (CE) and, most relevant to this research project, the Circular Economy of Food (CEF). This project advances our conversation around the CEF by investigating two questions:

Q1) Which indicators best track the valorization of waste?

Q2) What is the economic value of the local CEF?

Investigating these questions will contribute to the development of municipal and regional circular economy strategies that are anticipated to begin in 2020. The Vancouver Economic Commission (VEC) will be participating in developing these strategies, convening private sector stakeholders to facilitate action, and communicating the state of the local CE to other jurisdictions and stakeholders.

In this research project, the first question, Q1, was answered by designing an Analytic Hierarchy Process (AHP) survey that was distributed to a panel of experts. The responses were aggregated, and consensus was established around the two most suitable KPIs from a set of indicators.[1] The validated KPIs can help researchers investigate the association of circularity with other essential variables such as competitive market advantage, job creation, and environmental performance. The KPIs are also useful for businesses interested in tracking their resource efficiency, circularity, and business performance. Further research agendas around the KPIs are included when discussing the results of Q1.

The methods used for solving the second question, Q2, offer an initial framework to investigate the economic value of the CEF. Businesses that create new products from the residual streams of agri-food operations and businesses that reduce waste for these businesses are viewed as competing forces; i.e., they will compete for market share of the CEF. The results of Q2 indicate a rough estimate of the substantial economic value of the CEF.

The report begins by explaining the general mechanisms and the core principles of the CEF. Subsequently, each research question is clarified with a description of the results, implications, and challenges. The methodology is outlined in this report; however, for the sake of brevity, methods are not exhaustively detailed. This **link** brings interested readers to the technical appendix for this report which describes in more detail the methodology involved for each question[2]. The report concludes by detailing opportunities, challenges, and further research needs of the CEF.

[1] The methods used to answer Q1 can be adopted by individuals and organizations interested in reaching a consensus around ranking the best option(s) from a set of alternatives. For more detailed information on AHP, visit the technical appendix found in this link.

[2] The technical appendix will be available online as of August 30th, 2019.

BACKGROUND

While some principles of a CE are generic across all industries, the agri-food value chain has unique challenges and opportunities that require a CEF framework specific to the sector. Residual streams from agri-food production are full of valuable components with many surprising and innovative applications. Along the CEF value chain, entrepreneurs seek business opportunities from agri-food waste streams. Some examples include, upcycling food waste into nutritious animal feed,[3] creating delicious soups, stews and sauces from surplus produce[4], tech platforms that divert surplus food to the highest value end use,[5] and transforming the spent grain from breweries into tasty and healthy snacks.[6] All of these examples are CEF businesses that operate in Metro Vancouver.

In a CEF, food and non-food supply chains are often connected. With the latest advancements in biorefinery technology food waste can also be converted into new high value non-food products in a cost-effective manner. Some examples of food wastes that are transformed into high value non-food products during the bioconversion process are bio-pesticides, bioplastics, biosurfactants, pharmaceuticals and natural pigments for textiles (Sofia Maina 2017). Even unavoidable food waste can be input material for new food products. [7] For example, citrus peels have been used for pectin, natural antioxidants, carotenoid and dietary fiber extraction (Sofia Maina 2017). Making a profit on waste streams, which is referred to here as valorizing waste, can provide environmental and social benefits in addition to increasing revenues for all partners along the CEF value chain.

The Ellen Macarthur Foundation's CEF diagram distinguishes three broad pillars in the CEF (Ellen Macarthur Foundation 2019):

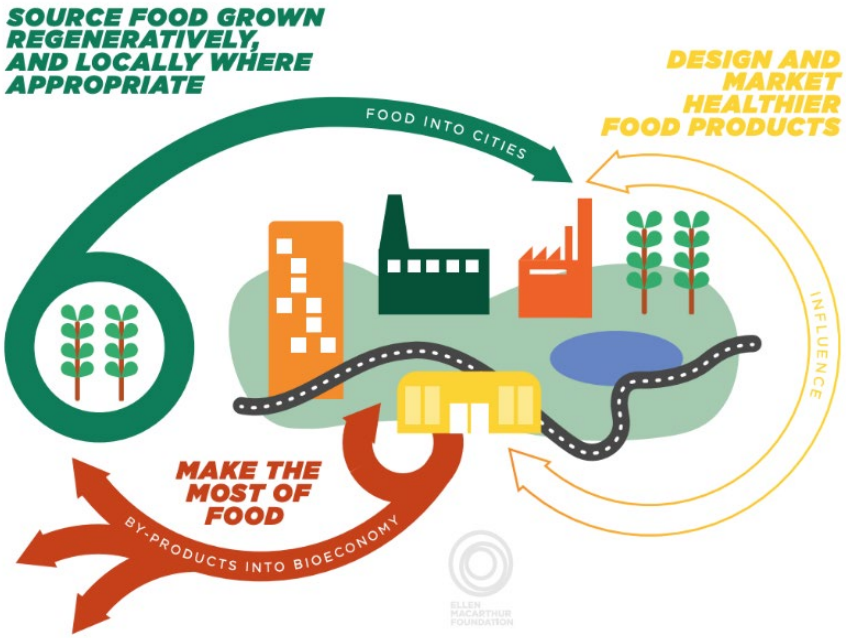


Figure 1 The Three Pillars of a Circular Economy of Food

[3] www.enterrafeed.com

[4] www.hellogoodly.ca/

[5] https://foodmesh.ca/

[6] https://www.susgrainable.com/ & https://www.craftgrain.com/

[7] Food Loss and waste (FLW) are usually categorized in two ways: Avoidable and Unavoidable. Appendix A provides examples of this classification.

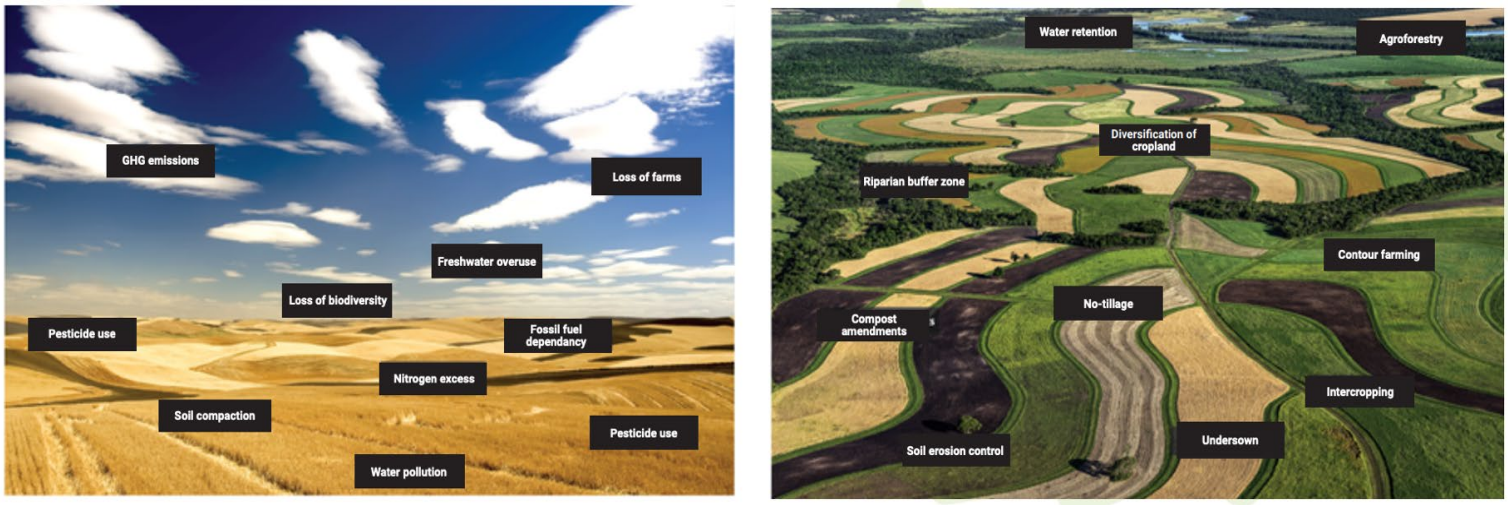
Stakeholders that partner along the CEF value chain benefit in multiple ways (Ellen Macarthur Foundation 2019). This report focuses on two financial benefits of a CEF: First, new assets are formed when the residual waste streams of agri-food businesses are connected to market opportunities. Examples of businesses operating in this space were provided above and the economic activity will be referred to as "valorizing waste". Second, liabilities can be reduced when businesses apply innovations that reduce the formation of waste. Inventory management, precision agriculture, data driven supply chain logistics, food loss and waste prevention technologies, and innovations that prolong the shelf life of food are some examples of waste reducing products and services.

The global and local environment benefits from a CEF in four ways:

1. By retaining and restoring natural capital in our soil.

   Regenerative agricultural practices present a win-win situation for agri-food producers and the rest of society. Through regenerative practices, we can store enormous amounts of atmospheric carbon in the soil, while at the same time increase crop yields by regenerating soil fertility, plant health and whole ecosystems (IPCC 2019). Reduced or no-tillage systems, intercropping, applying compost to crops, crop livestock integration, agroforestry, silvopasture systems, and the application of biochar to soil are a few examples of regenerative agricultural practices that have positive environmental effects overall (UN Environmnet 2019).

   Currently, our "industrial" agricultural practices decrease soil fertility, exacerbate eutrophication and require either increasing amounts, or more toxic concentrations, of pesticides. Self-poisoning via pesticide is now considered one of the most pervasive methods of suicide in the world (Centre for Pesticide Suicide Prevention 2018). Scaling up practices outlined by organizations such as the Savory institute, Land Institute or the local B.C. Association for Regenerative Agriculture can increase the carbon sequestration potential of soil, reduce nitrogen runoff into the water supply, reduce the release of nitrous oxide and lessen our dependency on toxic pesticides (Rosse 2018).



Problems related to industrial agriculture (left) and the benefits of regenerative agriculture (right). Design: UNEP/GRID-Geneva, Photo (right): Luis Franke (UN Environmnet 2019)

2. By supplying recovered resources as inputs for other production systems that maximise product utilisation.

   Funneling agri-food industry residuals into value-added food and non-food bioproducts enhances our ability to keep organics out of our landfills and have resources remain in use for as long as possible (Rosse 2018). Based on the results of Tetra Tech's Waste Composition Monitoring Program, Metro Vancouver produced 830, 461 Metric tonnes of waste in 2015 (Tetra Tech EBA Inc. 2016). The largest component of waste in our landfills

comes from food waste (21 percent of the waste). The social costs of the associated GHG emissions in 2015 were $20,927, 172.[8]

3. By promoting peri-urban and urban food production.

   Establishing shorter supply chains between farms and retailers or consumers reduces the emissions and energy associated with transport. Shorter supply chains can also help localize job growth and strengthen rural/urban links (Rosse 2018).

4. Using data and creating digital supply chains that reduce food waste.

   Second Harvest & VCMI estimate that the total annual food loss waste occurring along the Canadian food value chain equates to fifty-eight percent of commodities entering the Canadian food system - this translates to 35.5 million metric tonnes of annual food waste (Nikkel 2019). Big data and artificial intelligence can help to improve inventory and supply chain coordination which reduce the amount of avoidable food waste (Rosse 2018).

Many of the City of Vancouver's strategies and goals overlap with the benefits of CEF principles, such as Zero Waste 2040, Healthy City Strategy, Vancouver Food Strategy, Resilient Vancouver Strategy, and the Greenest City Action Plan 2020 (General Manager of Engineering Services 2018), (Vancouver Food Policy Council 2013) (Chief Resiliance Officer 2019) (Greenest City Action Team 2011). In order to measure progress toward the CEF-related goals in these strategies and in support of eliminating waste in the food system, appropriate data must be collected and analyzed.

Establishing a set of indicators is useful to evaluate the claims of the CEF and track progress. However, the CEF is still an evolving idea, with a range of definitions, thus entailing challenges for the establishment of indicators. In 2015 the first indicator for CE was created by the Ellen Macarthur Foundation in collaboration with Granta Design to measure progress for organisations adopting a CE approach (Tuppen 2018).

Developing appropriate and widely-accepted CE indicators is one of the most significant challenges for the adoption of a CE framework (Pedro Nuñez-Cacho 2018). Since 2015, many CE related indicators have been proposed, however, without a standardized set of KPIs and established measurement protocols there is a lack of consensus around what type of CE indicators should be used (Molina-Moreno, et al. 2017) (Griffiths and Cayzer 2016) (Saidani 2018).

There are circularity indicators designed to measure the circularity of a product, material, component, value chain, or even the circularity of whole regions and countries (Saidani 2018). Once the scale of measurement is established further considerations and tradeoffs are required by decision makers to select an appropriate indicator. For instance, some circularity indicators are retrospective but not prospective, which limits their utility for future planning. There are indicators that exclusively measure a specific subset of circularity. For example, the, "Indicators for Consumption for CE in Europe" measure how well businesses maintain or prolong the life of their products but these indicators do not inform users of how many recycled, upcycled or reused materials were used as inputs for their products (European Environmental Agency 2016).

Furthermore, a circularity indicator may precisely quantify how many times an agri-food residual material is recycled, upcycled or reused before ending up as compost, or another end of life product, but this data may tell us nothing about the overall environmental impact "looping" the material had.

Understandably, a response may be to implement many indicators and measure a multitude of variables pertinent to the CE. However, there is a balance between collecting information and using information. Collecting too

[8] The social cost of one tonne of GHG emissions is calculated to be $120 CAD/tCO2e) based on FAO guidelines using 2013 values.

little or inaccurate information leads to poor conclusion but collecting too much and even highly accurate information leads to large collection, processing and decision-making costs.[9]

It is of the utmost importance for the City of Vancouver to measure what matters in a CEF and establish KPIs within the three main pillars of the CEF to determine best practices, appropriate regulation and incentives, and consistent communications. A researcher from Paris-Scalay University developed a very useful taxonomy and database of circularity indicators, which helps those interested identify the type of measurement tools required for a given CE objective (Saidani 2018).[10] This database was used to narrow the number of possible indicators quickly from 80 to 6 of the most relevant indicators for Vancouver's CEF.

Q1) WHAT METRICS BEST TRACK THE VALORIZATION OF WASTE?

Peter Drucker once said, "What gets measured gets managed," and there is ample empirical evidence to show that this is indeed the case (Drucker 1954). However, another expression, "measure what matters," better addresses the needs of a municipality, business owner, or other decision-maker who is responsible for creating change. An organization involved in gathering useful data must make trade-offs between what does and does not get measured in the interests of time, expense, and effort. Establishing a set of criteria for evaluating data can help distinguish the most useful information to collect (Mary Kay Gugerty 2018).

The aim for this part of the project was to develop a technique that establishes a set of validated KPIs for Vancouver's CEF. From the initial database of circularity indicators (Saidani 2018), a replicable filtration method was applied to identify a final pool of six indicators.[11] Then a panel of professionals linked to the CEF were asked to prioritize criteria that would subsequently be applied to the six possible indicators. The panel prioritized the following criteria:

Transparency: Refers to the degree in which an indicator can be manipulated or presented falsely. An indicator would score highly on the criteria of transparency if it cannot be biased by self-reporting, does not rely much on subjective judgment, and can be double-checked by a third party.

Costliness: Refers to how costly an indicator is to use. A low-cost indicator would be based on information already available and linked to existing data collection activities. Questions to consider when gauging costliness are how many resources and how much time it would take to collect data to inform the indicator in question.

Attributable: This criterion refers to the degree to which the performance of an indicator can be changed over time. Relevant managers or stakeholders should be able to influence the performance measured by the indicator.

Generality: Refers to the degree in which an indicator is independent of industry and technology. Because technology and products often change over time, generality is also a precondition for useful comparisons of circularity over time in the same firm or industry. An indicator would score highly on the criteria of generality if it can be used in many contexts and across time.

---

[9] The problem with measuring many variables of interest are:

1) The data collection required to inform the set of indicators would become increasingly costly for the user.

2) If input from stakeholders is required, then more variables means lower response rates and possibly lower quality information for each variable.

3) Even if perfect data was easily available the more indicators used to interpret and transform this data the more difficult it becomes to aggregate all of the information, make sense of it, and draw conclusions.

[10] To access the dashboard of circularity indicators follow this link

[11] See Technical appendix for filtration sequence used.

Construct Validity: Refers to the extent an indicator in practice measures the concept/topic the researcher is interested in. A circularity indicator should focus on the practice of circularity and not be a proxy for other concepts or goals such as profitability or workforce equality.

Reliability: Refers to the degree in which a metric gives similar values under consistent conditions. For instance, imagine that two separate measurements are made using the same indicator of circularity for the same product. If different results are generated, then the metric is considered to have low reliability.

After establishing the criteria, an Analytic Hierarchy Process (AHP) was designed and distributed via survey to a panel of experts.[12] The group consisted of nineteen local experts and one non-local expert specializing in areas pertinent to the CEF. The participants had professional backgrounds across four institutional settings: Academia, NGO, Business, and Government.[13] The panel was first asked to compare each of the six criteria that make for a useful indicator as shown in Figure 2.

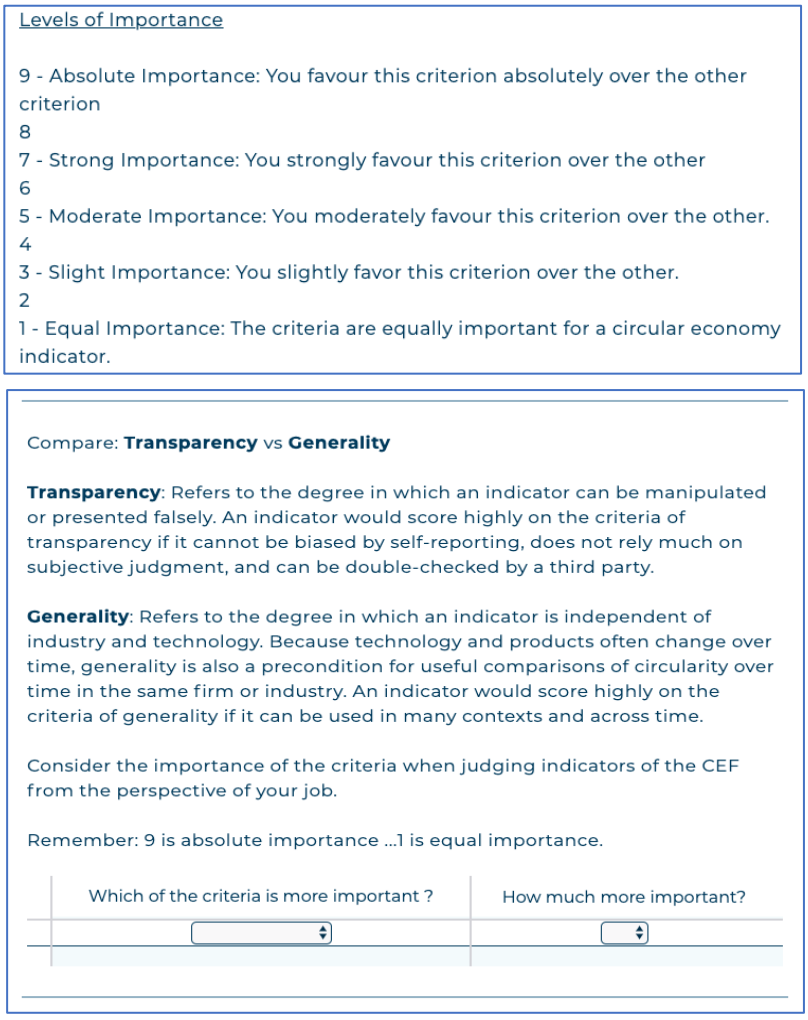


Figure 2: Defining the Levels of Importance for Criteria

The next part of the survey described each indicator, how they worked, their possible uses, and the data required to inform them. A link to the original research paper for each indicator was provided for further reading. After

[12] An example of one of the surveys can be found using this link

[13] Academia N=4, NGO's N=4 Business N=4, Government N=6

reading the material, the participants were asked to state their level of understanding about the indicator. The final request made of the participants was to rank the indicators against each of the criteria as shown in Figure 3.

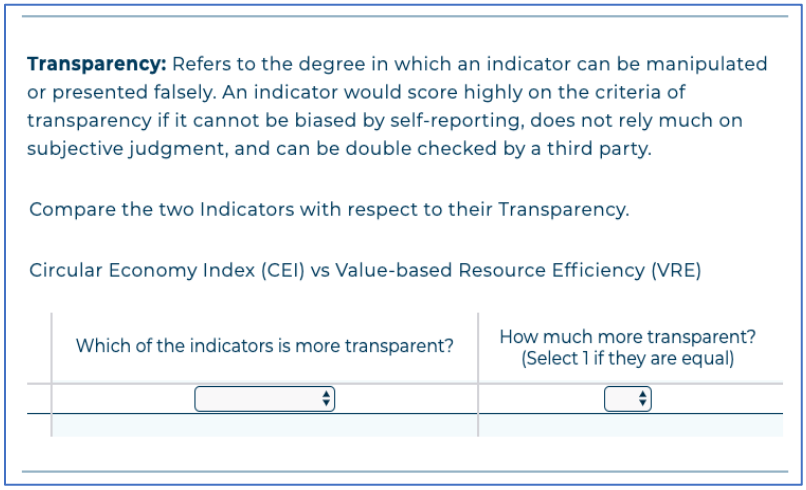


Figure 3: Comparing Indicators Against Criteria

The AHP provides a ranking algorithm that can be learned about in the technical appendix. A specific method was used to aggregate the responses of the participants, which interested readers can also learn about in the technical appendix.

The results of the survey highlighted the two most useful indicators to measure the economic value of retaining materials and creating new products from existing food "waste" in our local region. They are:

1) The Value Based Resource Efficiency Indicator (Francesco Di Maioa 2017)
2) Product Level Circularity Metric (Marcus Linder 2017)

The KPIs pertinent to the, "Make the Most of Food" pillar of the CEF determined by the panel can be used and further researched by the Vancouver Economic Commission and other interested parties in a variety of ways:

- To track the growth of the CEF and help manage the performance of partners in the supply/value chain.
- To track whether a the CEF sector uses resources in an efficient way (Francesco Di Maioa 2017).
- Help match the resource needs of one CEF business with the residual streams of another business.
- Establish the cross-price elasticity of demand and supply between waste valorization and waste reduction.
- To develop a product label to distinguish CEF commodities for customers interested in buying circular goods (Marcus Linder 2017).
- Used by impact investors interested in comparing companies' level of circular practices (Ibid).
- To study the relationship between valorized waste materials and environmental performance.
- To investigate the relationship between circularity and financial business performance.
- To help identify to what extent a given business is circular.

Q2) WHAT IS THE ECONOMIC VALUE OF THE CEF?

One way to determine the economic value of the CEF would be to calculate the sector's GDP14. Ideally, a computable generalized equilibrium model would help us accurately understand the size and impact of the GDP of CEF.15 However, there is no standard classification system for identifying businesses as participants in the CEF.16 Furthermore, elasticities related to the prices of agri-food residuals or the provision of waste reduction services were not available. Consequently, other methods of calculation are needed. To estimate the economic value of the CEF with minimal data, it is currently necessary to apply restrictions, assumptions, approximations, and simplifications. Thus, the values presented here should be interpreted with caution and readers interested in the methods behind the estimates should consult the technical appendix. Collecting pricing information from food waste markets with the validated KPIs would be especially useful for determining the economic value of the CEF. Without collecting and analyzing a robust amount of pricing information related to the local CEF, specific valuation of the CEF is virtually impossible, which raises the risk of well-intentioned policy causing more harm than good.

Keeping in mind the caveats above, the initial estimates reflect an enormous growth opportunity for businesses already in the CEF space or entrepreneurs interested in entering the CEF. In 2016, twenty one percent of total waste to landfill Metro Vancouver was compostable food waste (174,396.81 metric tonnes). Twelve percent of the food waste was considered avoidable and nine percent was unavoidable (see Appendix A). The following estimation reflects the private and social benefits[17] that could be gained if businesses fully exploit three specific economic activities within the CEF:

If

1) 50 percent of the 38,380 hectares of farmed land in Metro Vancouver switched to regenerative agricultural.
2) The 9 percent of unavoidable food waste was composted.
3) The 12 percent of avoidable food loss was sold as inputs for bio-based products or prevented at the source.

Then

$194,676,274.00[18] worth of annual sales and/or cost savings would occur for actors in the agri-food value chain in Metro Vancouver. This total includes both cost savings that would accrue at the initial site of waste production by avoiding waste, revenue generated by consultants that optimize food production to minimize waste, and $11,958,638.4 worth of revenues accrued from the sale of compost created from the (now) minimal food waste. The environmental and health benefits were calculated without including the benefits from valorizing food waste, preventing food waste and composting. This was done to isolate the benefits that arise from regenerative agriculture practices. Thus, assuming a 50

[14] The GDP of the CEF would be equal to the sum of the gross value added for all CEF businesses in operation, plus any taxes on products or services and minus any subsidies on products or services. Gross value added is the difference between a business' output and the goods and services used as inputs during production.

[15] A CGE forecasting model is made up of equations describing a number of relevant variables. An extensive database must be created to inform the model's equations. The formulation usually reflects neo-classical principles such as cost-minimizing behaviour by businesses and optimizing behaviour from consumers. Typically, the database is constructed as an input-output table or a social accounting matrix with elasticities, which describe behavioural responses to price changes.

[16] This was a major reason why the AHP and indicator validation process was created.

[17] Private benefits or costs is a term Economists use to describe the benefits and costs incurred when someone engages in a transaction for a product or service. Social benefits and costs include the externalities of these activities. An externality is a transaction's positive or negative impact on people or systems that are not involved in that transaction. For example, a negative externality often occurs when we buy our groceries; some products purchased were made in a way that harms the environment through the pollution that occurred during production. The consumer does not directly pay for this when buying groceries, but our collective environment and health incurs a negative externality as an indirect result of the purchase. A positive externality describes a benefit that society incurs from a similar transaction. For example, when a parent takes their child to the doctor to be vaccinated, not only is the child more likely to remain healthy, so are the other children who come in contact with the vaccinated child. Social costs and benefits include the external costs or benefits of a given economic transaction.

[18] All values in Canadian dollars.

percent adoption rate of regenerative agricultural practices on Metro Vancouver farmland, $11,728,928 worth of annual health benefits and $6,217,560 worth of yearly environmental benefits would be gained for the region.[19] For a full definition and calculation of the health and environmental benefits, please see the technical appendix[20].

CEF IN OTHER CANADIAN MUNICIPALITIES

Multiple cities around the world leverage the CEF strategy to develop a sustainable food system. In Canada, the City of Guelph received a 2019 federal "Smart Cities Challenge" grant to transform the local food system into a CEF (City of Guelph, County of Wellington 2019). The City of Toronto is a member of the National Zero Waste Council Circular Economy Working Group, the Circular Cities 100 network and recently became a partner city in the CEF food initiative created by the Ellen MacArthur Foundation (City of Toronto 2019).

City of Vancouver can enter into discussions with the City of Guelph and City of Toronto planners, policymakers, associated researchers, and CEF businesses to benefit local stakeholders. First, knowledge and data sharing would help each municipality learn from each other's failures and successes. Second, increased inter-municipal collaboration could develop new CEF market opportunities for businesses. Third, the competitive advantages for CEF businesses are better articulated as more reliable and robust data is collected in multiple municipalities that can be used to compare and contrast local markets. Fourth, competition and network effects help CEF actors optimize their economies of scope and scale[21]. All of these points benefit consumers with more efficient and affordable products and produce more widely felt social and environmental good.

RECOMMENDATIONS

> "We have a monumental task in front of us, but it is not impossible…This is our chance to decide what the world is going to look like." – Natalie Mahowald (Borenstein 2018).

Through the course of this research project, many significant lessons have surfaced that should inform City of Vancouver's future actions in support of a zero waste CEF. The following list provides a summary of municipal goals and associated actions that have not been detailed in the study. While extensive, the list is not exhaustive. Further analysis should be conducted to see which actions provide enough benefits to justify the investment costs. The activities listed are not currently practiced by Metro Vancouver municipalities. However, some of the recommendations may have been investigated previously and deemed unfeasible or they are currently underway but not yet publicly communicated. Paired with the economic justification of moving toward greater circularity in our food system, the following recommendations constitute an initial outline for a Circular Economy of Food Action Plan for the City of Vancouver. Recommendations are organized in accordance with the three pillars of the CEF[22]:

---

[19] Data sources: Avoidable food waste amounts in Metro Vancouver for 2015 (Tetra Tech EBA Inc. 2016); Estimated shares of avoidable food waste for each role along the supply chain (Nikkel 2019). Health and environmental externality coefficients (Ellen Macarthur Foundation 2015). Marketing Bill USDA derived marketing bill that was averaged over 24 years. See the technical appendix link to learn more about the data and the detailed methodology that produced the final estimates.

[20] Access the technical report by following this link.

[21] Economies of scope describe situations when producing two or more goods or services together results in a lower cost than producing them separately. Vertically integrated companies that have internalized a portion or all of their supply chain for multiple products are an example of an economy of scope. Economies of scale are cost advantages reaped by companies when production becomes more efficient. Companies can achieve economies of scale by increasing production and lowering costs. This happens because costs are spread over a larger number of goods.

[22] See Figure 1

SOURCE FOOD GROWN REGENERATIVELY, AND LOCALLY WHERE APPROPRIATE

Goal: Establish increasing annual targets for how many hectares of farmland in Metro Vancouver's ALR can adopt regenerative agricultural practices in an economically viable manner.

Actions:

- Conduct a cost benefit analysis and market feasibility study to understand which regenerative agricultural practices are most cost effective and maximize social and environmental welfare.

- Identify the stakeholders who already incorporate, or a willing to adopt, regenerative agricultural practices into their farming operations.
- Identify barriers and bottlenecks for the adoption of regenerative agricultural practices and create low risk strategies to overcome these obstacles. Have regenerative agriculture targets also reflect these hurdles.

Goal: Catalyze the adoption of regenerative agricultural practices.

Actions:

- Research and establish tax incentives, targeted investments, university practicums, targeted government procurement, and subsidies on compost derived from agri-food waste streams for regenerative agricultural farmers.
- Develop a computable generalized equilibrium model (CGEM) of Metro Vancouver's agri-food sector. A CGEM would help inform low risk and welfare maximizing policy interventions that would possibly achieve pareto efficiency[23] for the stakeholders involved.
- Identify what low risk government procurement targets for regenerative agricultural products can be enacted in the short, medium and long term.
- Establish research and internship programs where students and faculty studying regenerative agriculture can work with farmers on ALR land.
- Define and establish a specific number of vendor agreements between partners along the supply chain and regenerative agricultural farmers.
- Make a number of farmers markets that occur in the Metro Vancouver exclusively for regenerative agricultural farmers to market and sell their products.

Goal: Create a strong coalition amongst regenerative agricultural farmers and partners along the agri-food value chain.[24]

Actions:

- Create a stakeholder map of interested businesses and organizations and identify similar coalitions that may already be underway.
- Research ways that municipal departments can support the coalition in the short, medium and long term. i.e. provide meetup spaces and events, research support, or marketing avenues.

[23] Pareto Efficiency is a situation where no more changes can be made to the allocation of benefits (tax incentives, subsidies, targeted investments etc.) without making someone worse off.

[24] A voluntary coalition would help identify barriers, growth opportunities and catalyze network effects for regenerative agriculture.

MAKE THE MOST OF FOOD

Goal: Build a multi-purpose Bio-refinery to process agri-food residuals

Actions:

- Create an asset map of agri-food residuals found in our local supply chain.
- Identify agri-food residual materials that can be converted into high value products via the biorefinery process in an economically viable manner.
- Conduct an economic project appraisal for a multipurpose biorefinery in Metro Vancouver.
- Conduct a market feasibility analysis of the possible products that would come out of the biorefinery process.
- Identify the number of local jobs that would be created by building a Bio-refinery in Metro Vancouver.
- Attend the upcoming, "Biomass North Forum 2019 – Connecting Canada's Bioeconomy" to grow partnerships and investment opportunities. [25]

Goal: Create knowledge products and data sharing partnerships pertinent to the valorization and reduction of agri-food residuals.

Actions:

- Establish an insight sharing partnership amongst data rich organizations like Food Mesh, NISP,[26] ReFED,[27] universities and economic research labs.
- Acquire time-series pricing data from a representative sample of marketplaces where agri-food related waste reduction services or waste valorization transactions occur.
- Establish supply, demand and cross price elasticities for the agri-food residual streams along the supply chain that are valorized.
- Establish supply, demand and cross price elasticities for the types of agri-food residuals partners along the supply chain seek to prevent at the source.
- Conduct a dynamic equilibrium comparison between agri-food residual reduction and valorization.[28]
- Quantify the differences between the social costs and benefits accrued from extending the use of a given waste material, closing the loop of this waste material and preventing the formation of this waste material at the source. Ideally, this should be done for the most common types of agri-food residuals found along our supply chain.

Goal: Create a Circular Economy of Soil Action Plan

---

[25] http://bndc2019.biomassnorth.org/

[26] https://nispcanada.ca/

[27] www.refed.com

[28] From the perspective of a business, waste reduction and waste valorization are two different and competing economic activities. In a fully functioning CEF, a given agri-food residual can either be reduced at the source or sold in the market. If a business hires a service or implements a technology that reduces waste from ever occurring then, assuming there is marketplace for that waste, the price for the waste (in the short term and possibly long term) will rise. Higher prices for the waste will mean fewer businesses are economically able to create new bio-based products from that waste. Two things remain unclear in our transition to a local CEF: 1) What portion of the market will be captured by technologies and service providers who reduce waste and what portion of the market will be captured by those who valorize waste. 2) What division (at dynamic equilibrium) between the two activities produces the optimal environmental, health and economic benefits. This is not simply a theoretical question but a practical one whose answer would best inform municipal strategy and policy around the CEF.

Actions:

- Identify the most cost effective and environmentally beneficial composting and distribution options for Metro Vancouver's organic waste.
- Establish synthetic fertilizer reduction targets and composting uptake targets for the ALR and parks within Metro Vancouver.
- Establish a set of KPIs that indicate progress towards increasing the health and carbon sequestration of the land in our parks and ALR.
- Identify the barriers, cost effective and low risk opportunities for establishing a circular economy of soil.
- Identify the number of local jobs that would be created from the fulfillment of the above targets.

DESIGN AND MARKET HEALTHIER FOOD PRODUCTS

Goal: Identify the challenges and opportunities of this CEF pillar for our local context.

Actions:

- Conduct a literature review to understand the failures, past initiatives, successes and high return on investment opportunities for designing and marketing healthier food products.
- Cross-reference this research with local economic stakeholders.
- Identify gaps, opportunities, and efficiency improvements in the local CEF ecosystem.

Goal: Create incentives for influential tech platforms like Uber Eats,[29] Instacart[30] and Skip the Dishes[31] to promote CEF food products and activities.

Actions:

- Research and establish easy to understand but meaningful health and environmental impact scores for food items listed on these platforms.
- Provide progressive tax incentives for food app providers whose user base select healthier and environmentally friendly food products.

Goal: Have restaurants and food service providers promote CEF food products.

Actions:

- Provide tax credits for restaurants who source ingredients from local farms that practice regenerative agriculture.

[29] https://www.ubereats.com/en-CA/vancouver/
[30] https://www.instacart.com/
[31] https://www.skipthedishes.com/

CONCLUSION

In this project, an Analytic Hierarchy Process (AHP) survey was distributed to a panel of experts to identify KPIs from a pool of CE indicators developed by previous researchers. The results of the survey identified two indicators that can be used in a variety of ways to advance implementation and further research in our local CEF. The two KPIs were: The Value Based Resource Efficiency Indicator (Francesco Di Maioa 2017) and the Product Level Circularity Metric (Marcus Linder 2017).

The KPI validation methods can also be recreated and used by interested parties as an accessible framework to make complex decisions amongst multiple criteria and options. The research project built upon the Ellen Macarthur Foundation's and Value Chain Management Institute's methods to establish the potential economic value of a CEF in Metro Vancouver (Ellen Macarthur Foundation 2015) (Nikkel 2019). Results show the substantial market potential of the local CEF and suggest that building more sophisticated economic models to better understand and support developing the CEF are worth the investment. During the project, a database of resources was developed for those interested in learning more about the CEF and applying similar strategies to establish the economic value of the CEF.[32] The research conducted for this project provides an initial outline for a Circular Economy of Food Action Plan. Developing the recommendations further will strengthen current municipal sustainability initiatives and accelerate progress to a zero-waste future in our region.

APPENDIX A

Three by Three Matrix for Categorizing Food Loss and Waste

	Prime condition	Useable	Inedible
Avoidable	• Unharvested fruit and vegetables • Food not donated due to vendor agreement	• Vegetable stalks (e.g. broccoli) • Products thrown away early due to conservative best before date • Product falling onto floor from conveyors or bags splitting that could be made edible through processing into new product	• Fruit left to spoil • Crops incorrectly stored
Theoretically avoidable	• Undersized crop left in field • Edible fish species caught in by-catch, though not kept, as currently not marketed	• Lobster shells disposed of at sea or buried instead of processed into food ingredient • Foods served though not eaten due to portion serving size • Regulatory impact on amount of carcass condemned due to, for example, abscess or other isolated issue	• Inventory that spoils due to poor FIFO. FIFO is "first in first out" and simply means food needs to be labeled with the dates they are stored, and older foods need to be put in front so that they are selected first.
Unavoidable	• Husks, bran and germ lost during milling process	• Orange peel	• Animal bones disposed of during HRI and at-home preparation of food

Figure 4 Summarizing the Difference Between Avoidable and Unavoidable Waste (Nikkel 2019).

[32] Library can be accessed with this link. Links to Academic Articles are not provided due to copyright concerns.

WORKS CITED

Borenstein, Seth. 2018. "'Unprecedented changes' must be made to stop catastrophic climate change, UN report says." *PBS News Hour*. October 8. Accessed August 2019. https://www.pbs.org/newshour/nation/unprecedented-changes-must-be-made-to-stop-catastrophic-climate-change-un-report-says.

Centre for Pesticide Suicide Prevention. 2018. *Pesticide Suicides.* Accessed August 2019. https://www.centrepsp.org/pesticide-suicide.

Chief Resiliance Officer. 2019. *Resilient Vancouver Strategy.* Administrative Report, Vancouver: City of Vancouver.

City of Guelph, County of Wellington. 2019. *Creating Canada's first circular food economy.* Guelph: City of Guelph.

City of Toronto. 2019. *Working Towards a Circular Economy.* Accessed August 2019. https://www.toronto.ca/services-payments/recycling-organics-garbage/long-term-waste-strategy/working-toward-a-circular-economy/.

Drucker, Peter F. 1954. *The Practice of Management.* HarperBusiness.

Ellen Macarthur Foundation . 2015. *CITIES AND CIRCULAR ECONOMY FOR FOOD TECHNICAL APPENDIX: GLOBAL MODELLING.* Cowes: Ellen Macarthur Foundation .

Ellen Macarthur Foundation. 2019. *Cities and the Circular Economy for Food.* Cowes: Ellen Macarthur Foundation .

Francesco Di Maioa, Peter Carlo Rema, Kees Baldé , Michael Polder. 2017. "Measuring resource efficiency and circular economy: A market value approach." *Elsevier.*

General Manager of Engineering Services . 2018. *Zero Waste 2040.* Policy Report, Vancouver: City of Vancouver.

Greenest City Action Team . 2011. *Greenest City Action Plan* . Vancouver: City of Vancouver.

Griffiths, P., and S. Cayzer. 2016. "Design of indicators for measuring product performance in the circular econom." *Springer Science and Business Media.*

IPCC. 2019. *Climate Change and Land.* Summary for Policymakers, WMO and UNEP.

Marcus Linder, Steven Sarasini, and Patricia van Loon. 2017. "A Metric for Quantifying Product-Level Circularity." *Journal of Industrial Ecology,.*

Mary Kay Gugerty, Dean Karlan. 2018. *The Goldilocks Challenge; Right-Fit Evidence for the Social Sector.* Oxford: Oxford University Press .

Molina-Moreno, V., J.C. Leyva-Díaz, F.J. Llorens-Montes, and F.J. Cortés-García. 2017. "Design of indicators of circular economy as instruments for the evaluation of sustainability and efficiency in wastewater from pig farming industry." *Water.*

Nikkel, L., Maguire, M., Gooch, M., Bucknell, D., LaPlain, D., Dent, B., Whitehead, P., Felfel, A. 2019. *The Avoidable Crisis of Food Waste: Roadmap.* Ontario: Second Harvest and Value Chain Management International.

Pedro Nuñez-Cacho, Jaroslaw Górecki, Valentín Molina-Moreno, Francisco A. Corpas-Iglesias. 2018. "What Gets Measured, Gets Done: Development of a Circular Economy Measurement Scale for Building Industry." *Sustainability.*