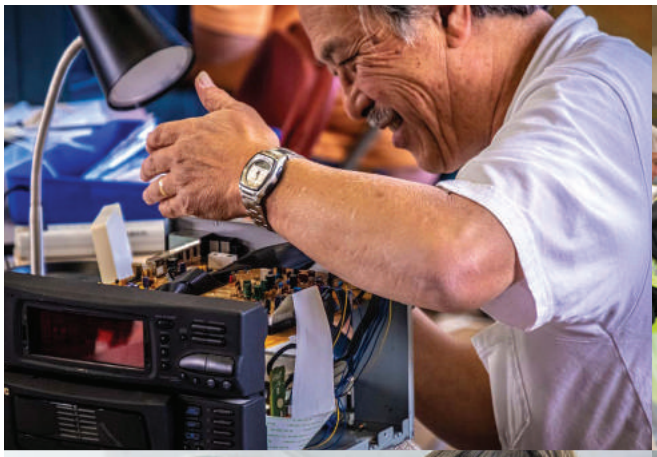


FIVE BIG GOALS FOR 2040

Goal 3

From Waste Management to Clean Materials

A 2040 Blueprint for Pacific Northwest Leadership

CSI

Center for Sustainable Infrastructure

FIVE BIG GOALS FOR 2040

From Waste Management to Clean Materials

A 2040 Blueprint for Pacific Northwest Leadership

Author: **Rhys Roth**
Executive Director, Center for Sustainable Infrastructure

Contributing Author: **Patrick Mazza**

May 2020

CSI
Center for Sustainable Infrastructure

Cover credits:

Upper left: Courtesy of King County
Upper right: Courtesy of Oregon Food Bank
Lower left: Nature Energy Biogas

Table of Contents

Executive Summary

This report offers a vision and roadmap – our 'blueprint' – for the Pacific Northwest to transform its increasingly outdated solid waste management system by 2040, at a time when waste leaders are grappling with the most profound set of challenges they have faced in forty years.

The blueprint centers on a new 'Clean Materials' system to improve on and supersede today's solid waste management system. Clean Materials is analogous to 'Clean Energy,' in that it combines both big improvements in health and environmental performance with great opportunities to grow jobs, businesses and industry.

The 2040 Clean Materials blueprint is animated by an inspiring vision: To build a world-class Clean Materials infrastructure and economy that by 2040 shrinks the Northwest's environmental footprint dramatically while creating tens of thousands of good jobs, hundreds of new and expanding businesses, and new opportunities for clean production and industry throughout the region.

The starting point for the blueprint is the intensifying crisis facing solid waste management. At least four big challenges are driving transformation of the waste sector – the failure of waste prevention strategies to actually prevent much waste; the collapse of markets for recycled materials; radical changes in packaging and other waste stream components; and a new recognition that most damage to the planet and our health happens before, rather than after, our stuff becomes waste.

Recycling is a key touchpoint for the public. The public loves recycling. For many people it is a tangible and important way for them to act in their daily lives to do right by their planet and their community. And for the past thirty years, the recycling system has worked pretty well. But our recycling system grew increasingly reliant on exporting our recycled wastes, which made us vulnerable to changes in the export markets.

That vulnerability suddenly came to the fore in 2017 when China, for years the world's leading destination for plastic and paper scraps, changed course. China instituted policies to ensure that recyclables they import are clean and uncontaminated by other materials, as when plastic bags are mixed in with recycled paper streams. Other Asian nations soon followed China's lead to require clean recyclables. As a consequence, suppliers of recycled materials today are selling into a global market where demand has quickly and dramatically shrunk. Prices that Northwest jurisdictions receive for recycled materials have plummeted sharply, wreaking havoc on the economics of recycling programs. Many jurisdictions are making the wrenching decision to eliminate recycling categories, such as glass and plastic bags, that the public is accustomed to recycling, in order to prevent contamination of other recyclables and control costs.

Recycling may be the most visible challenge, but not necessarily the most profound. One very important challenge is the failure of waste prevention – the top priority in current waste management law. Prioritizing waste prevention makes sense – after all, the most sensible way to reduce the health and environmental harms caused by waste, and the economic costs, is to prevent waste in the first place. But the persistent fact is that waste volumes in the past two decades are not declining, but instead persist. And radical changes in packaging and other wastes are creating new intractable challenges for waste prevention and recycling programs.

Perhaps the most profound challenge for solid waste management may be the growing recognition that most of the health and environmental damage caused by our stuff happens before we recycle or toss it out as trash. Increasingly, our best science is telling us that much greater damage happens earlier in the life cycle of products and packaging – when materials are extracted, processed, transported, and forged into products – than after they are discarded by users to enter the waste management infrastructure.

Today's solid waste management framework is not well-suited to solve today's challenges – or tomorrow's. We need a broader framework that moves up the value and supply chains, where most waste is generated and most damage to human health and the environment originates. It is here that we can design out waste, design for reuse or recycling, and avoid unnecessary costs and harm in the first place.

Arguably, the two most urgent challenges are global climate change and the loading of toxic chemicals in human bodies. Tackling these two urgent crises will require strategies that span the life cycle of our products and materials.

New paradigms are emerging to address these challenges more broadly:

Zero Waste — aims at eliminating waste streams entirely through responsible production, consumption, reuse, and recovery of products, packaging, and materials.

Circular Economy — designs out waste and pollution and keeps products and materials in circulation.

Sustainable Materials Management — seeks optimal environmental outcomes across the entire life cycle of materials.

Commonalities and contrasts between the three are illuminated in Chapter 3

This report proposes a unifying concept – Clean Materials infrastructure – which aims to conserve resources and recirculate materials to minimize environmental and cost impacts and maximize social and economic benefits. As with Clean Energy – a concept that inspired Clean Materials – keys to success are efficiency, conservation, clean resources, and clean processes that minimize harmful impacts.

The Clean Materials blueprint also proposes a core metric to measure progress, the Clean Score, built on the emerging science of life cycle assessment. As with nutritional labels on food, we need environmental truth-in-labeling for products. Transparency of life cycle impacts, specific to each product, will create the essential information needed to easily see which options are best for people and the environment. We recommend that the initial version of Clean Score center on scoring the climate footprint of products, along with a toxicity 5-point color scale – best-to-worst gradations of green-yellow-red. Products that attain a good clean score for climate and a low-toxics footprint will tend to do well in reducing other environmental impacts as well.

To build a world-class Northwest Clean Materials infrastructure, our blueprint proposes a new policy framework that is detailed in Chapter 4. The blueprint presents this policy framework under these key elements:

- Five Big Goals to achieve a world-class system by 2040 and measure our success along the way.
- A new metaphor to replace the traditional waste management hierarchy, a four-facet Diamond of interactive Clean Materials solutions.
- A set of five cross-cutting policies to accelerate effective Diamond solutions.

Five Big Goals

To put the Northwest on the right trajectory to build a truly world-class Clean Materials economy, policymakers will need to take the lead and act boldly by putting Clean Materials on policy par with Clean Energy. Both Oregon and Washington have adopted big goals and clear targets for clean energy and climate pollution, and those goals and targets have driven real action and created real jobs.

The 2040 blueprint for Clean Materials leadership calls for major new statewide framework legislation to comprehensively refresh and supersede the solid waste and recycling legislation of the past.

It offers 5 Big Goals that constitute the ultimate success metrics for the legislation. The first two Goals are the highest-level outcomes that define environmental and economic excellence in the Clean Materials system in 2040. The next three are key strategic Goals to drive progress toward the high-level outcomes:

Goal 1: Shrink the Health and Environmental Impacts of our Stuff by 80%

Goal 2: Build a World-class Industry-Jobs Cluster in Clean Materials Solutions

Goal 3: Cut Discards by Half, Recycle Most of the Rest

Goal 4: Invest in Local Clean Materials Infrastructure, R&D and Jobs

Goal 5: Export Clean Materials Solutions Globally

Better Solutions Through a Diamond Approach

The solid waste management "hierarchy" was enshrined in 1970s-era framework legislation in Washington, Oregon and many other states. This hierarchy prioritizes, in order: waste reduction, reuse and repair, recycling and composting, recovery typically through energy generation,

and finally, disposal. But this approach has three chronic problems that make it ripe for a rethink:

First, the solid waste hierarchy has failed to deliver the greatest share of the waste sector's effort into its highest priorities, such as waste prevention.

Second, this hierarchy steers us to think in silos and devise programs in separate categories. But these solutions often overlap and complement each other. Strategies developed in silos may not get the best economic and environmental benefit for the buck.

Third, the hierarchy can limit solutions by framing the problem to be one of solid waste alone, downplaying the importance of higher-order goals such as conserving resources, preventing toxics and reducing pollution.

To refresh the waste hierarchy, our blueprint proposes a different metaphor to guide the greatest share of resources to flow into the most effective solutions strategies, the **Clean Materials Diamond**. Diamond solutions, like the multiple points of a diamond, contain interconnected, essential facets of an integrated whole – not ranked one above the other.

The four facets of the solutions Diamond, and their elements, are:

→ Prevent Waste at All Stages
- Incentivize product redesign
- Prevent food waste
- Support sustainable consumption and ban wasteful products

→ Get Longer Life and More Use from Products
- Share products
- Re-use products
- Repair and refurbish products

→ Optimize Recycling
- Measure success based on actual recycling
- Clean up recycled material streams
- Redesign collection and processing systems

→ Develop Clean Production and Processing Hubs
- Feed clean materials into clean production hubs
- Adapt 'industrial symbiosis' to make wastes into feedstocks
- Build biorefineries and the bio-economy

Chapter 5 shows what a world-class Clean Materials system can look like in 2040, including many examples of Diamond solutions working in the Northwest and beyond.

Cross-Cutting Policies To Accelerate Diamond Solutions

The blueprint also proposes a set of 5 key cross-cutting policy elements to get the region on the right trajectory to achieve the Five Big Goals for 2040:

Extended Producer Responsibility 2.0 – Extended Producer Responsibility (EPR) is a breakthrough policy system that ensures producers of goods are responsible to fund and manage systems to recycle and dispose of their products when people are done with them. This takes the financial burden off municipalities, and places it on producers, who typically join together in product categories to collect and manage the discards. Our neighbors to the north in British Columbia are global leaders in successfully implementing a comprehensive EPR system that is achieving impressive recycling results. This Clean Materials blueprint proposes that Oregon and Washington policymakers build on the best of EPR recycling programs to adopt more comprehensive, next-generation EPR 2.0. EPR 2.0 will require producers not simply to improve recycling, but to optimize across all four Clean Materials Diamond solutions to deliver continuous improvement in Clean Scores.

Standardize and Scale Clean Score Transparency – A lynchpin of the Clean Materials framework is Life Cycle Assessments (LCAs) that are comprehensive, standardized, comparable, ubiquitous and therefore cheap. LCAs track environmental impacts of materials in products from resource extraction through processing, production and delivery. In a fully realized Clean Materials system, LCAs are standardized and required for all products and packaging sold in the Northwest, expressed in Clean Score labeling. Focused upfront investment by Washington and Oregon, perhaps in partnership with California and BC, will be needed to stand up LCA protocols and practices within five years. The blueprint proposes options to make that happen.

West Coast Clean Materials Alliance – To maximize positive and lasting impact from spending and investment in Diamond solutions, the blueprint recommends establishing a West Coast Clean Materials Alliance (WC-CMA), modeled on the Northwest Energy Efficiency Alliance (NEEA). NEEA accelerates the impact of energy efficiency investments in the Northwest's electricity sector by serving as a vehicle for multiple utilities to pool dollars. WC-CMA will pool dollars from multiple agencies to pursue Clean Materials 'market transformation' opportunities in Diamond solutions. The goal is to achieve greater lasting impact and benefits for funder dollars than individual agencies could achieve on their own. WC-CMA could launch as a partnership of Oregon and Washington, but it can achieve greater market impact by inviting an alliance that includes California and British Columbia.

Buy Clean – California's first-of-its-kind 'Buy Clean' legislation sets minimum standards for key categories of building materials – carbon steel rebar, structural steel, flat glass, and mineral wool insulation board – used in state construction projects. Bidders are required to submit Environmental Product Declarations that disclose and meet benchmarks for life cycle carbon impacts. Buy Clean legislation is under consideration in Oregon and Washington as well. So far, California's Buy Clean focuses on life cycle carbon emissions, but it could be extended to other areas such as toxics. The next wave of Buy Clean strategies will build on this first groundbreaking legislation to expand Buy Clean to many more state purchasing product categories; establish Clean Score performance targets that improve steadily over time; and form Buy Clean buyers' clubs that aggregate purchasing power and incentivize local governments, companies, institutions, and residents to Buy Clean.

Clean Materials Industry-Jobs Action Strategy – A critical component of the Northwest Clean Materials 2040 vision is that it supports tens of thousands of good jobs throughout the region. The Northwest can become a global leader in the Clean Materials economy, and thrive economically by fostering dense clusters of innovative manufacturing and service businesses that grow investment, revenues, and tens of thousands of new jobs delivering Diamond solutions. A Clean Materials cluster that builds excellence regionally can become a traded sector selling to other regions and the world. To direct activity and investment toward Clean Materials industry and jobs, the blueprint recommends robust, 18-month statewide efforts to create a comprehensive state Clean Materials industry-jobs strategies in Oregon and Washington. Chapter 6 frames and proposes key elements for a Northwest Clean Materials industry-jobs strategy.

PART A: Toward a Blueprint for Clean Materials Leadership

Chapter 1 Introduction, Purpose and Vision

This report offers a vision and blueprint for the Pacific Northwest to transform its solid waste management system into something much better by 2040. The blueprint aims to guide the region to build a world-class Clean Materials infrastructure and economy by 2040, that shrinks the Northwest's environmental footprint dramatically, and creates tens of thousands of good Clean Materials jobs throughout the region.

Doing Right by the Planet, the People and the Community

The public loves recycling, and for a couple big and very good reasons. People want to do right by the planet. And they don't like waste: they agree with Alando Simpson, CEO of City of Roses Disposal and Recycling in Portland, that, "No resource – human, environmental or monetary – should be wasted."

Alando Simpson
City of Roses Disposal & Recycling

> "Our goal is to make the Pacific Northwest the global prototype of a 21st century sustainable economy where social equity spearheads all outcomes."

A vibrant community of leaders and professionals in the Pacific Northwest invest a lot of attention and resources in solving the challenges of waste management. Many are propelled by a sense of mission – to help the public succeed in preventing waste and do right by their community and the planet.

But these leaders are increasingly finding that the solid waste management framework they've inherited is inadequate for solving the challenges they face. They need a new framework, a new vision, and a blueprint to get there.

For one, they are discovering that much of the damage to human health and the environment caused by the stuff we buy – the materials that make up products and packaging – actually happen before we use it up and toss the stuff. Extracting raw resources from the Earth, processing them, forging materials into products, transporting them, and finally using the products – at each of these material life cycle stages, damages to health and environment can accrue.

All these impacts often outweigh the impacts at the end-of-life stage, when we hand our discarded stuff over to the waste management system. Arguably, the two most urgent damages that accrue over the life cycle stages are: 1) global climate change; and 2) the loading of toxic chemicals in human bodies. Tackling these two urgent crises will require strategies that span the life cycle of our products and materials.

Clearly, great opportunities to reduce waste – environmental, human and monetary – can be found earlier in products' life cycle. But our inherited waste and recycling systems have been designed almost exclusively to address the post-consumer, 'end of life' phase. And for a while now, solid waste leaders and professionals have been perplexed about how to tackle this challenge holistically, to reduce impacts all the way across material life cycles.

Tackling that goal – to reduce human, environmental and monetary impact through the entirety of the materials' life cycle – requires that we expand the playing field dramatically and shift attention and resources to a much bigger challenge, one that includes but is not limited to waste management.

New Vision and 5 Big New Goals

Northwest leaders and professionals in this space are hungry for a new animating vision, a North Star to guide them as they navigate the transformation of today's broken waste and recycling system. And they need a blueprint for replacing it with a much larger Clean Materials system that reshapes our infrastructure and benefits the wider economy of the Northwest.

This paper offers a blueprint for the Pacific Northwest to achieve an inspiring vision for environmental excellence and broadly-shared economic prosperity:

> *To build a world-class Clean Materials infrastructure and economy in the Northwest by 2040, that shrinks the impacts on human health and the environment dramatically, and creates tens of thousands of good jobs throughout the region.*

Chapter 1: Introduction, Purpose and Vision

A Clean Materials strategy will deploy a wide range of policy, business, design, and community initiatives to reduce the life cycle impacts of products and materials, and to develop throughout the region the local enterprises and capacity to effectively and efficiently deliver Clean Materials solutions.

Without an aspirational vision and a blueprint to achieve it, the strategies we offer can too often result in suboptimal investment, wasted money, damage to health and environment, and a public confused about how they can do the right thing.

An ambitious transformation like this must be driven by bold leadership from policymakers – backed by strong public support – at least as aggressive and sustained as Northwest policymakers' push for Clean Energy.

For Clean Energy, policymakers set strong targets that have stimulated growth of a significant industry-jobs cluster in the Northwest, featuring hundreds of new businesses, billions in capital investment, and tens of thousands of jobs. By 2018, Washington boasted 82,000 clean energy jobs and Oregon 55,000 in wind, solar, efficiency and related industries, according to E2, a national nonpartisan group of business, investment, and other professionals.[1] The Northwest should replicate this effort with a new focus on Clean Materials innovation. Chapter 6 discusses prospects for jobs in an advanced Clean Materials economy in more detail.

Blueprint for Northwest Clean Materials Leadership

This report and its blueprint are for the policymakers and professionals, current and aspiring, working within public, private and nonprofit organizations, who want to play a part in the Northwest achieving a world-class Clean Materials system. It includes the people working today in waste and recycling, but also – because Clean Materials touches so much more in the economy than just waste and recycling – a much bigger and wider array of groups from economic development, business, corporate and government purchasing, clean tech investing, R&D, academia and more.

The blueprint starts with a vision for the Pacific Northwest: To build a world-class Clean Materials infrastructure and economy by 2040, that shrinks our environmental footprint[2] dramatically, and creates tens of thousands of good jobs throughout the region.

The blueprint is constructed to help leaders set the region on the right trajectory to achieve this vision, by steering policies, programs, products, packaging, processing, and production toward **5 Big Goals for 2040**. These are the big targets that, if we achieve all five of them, will virtually ensure the Northwest a place among global leaders in Clean Materials excellence in 2040.

The first two of these Five Big Goals are the highest-level targets that define environmental and economic excellence, and the next three together serve and advance the two higher goals:

Big Goal 1: Shrink the Health and Environmental Impacts of our Stuff by 80%

Big Goal 2: Build a World-class Industry-Jobs Cluster in Clean Materials Solutions

Big Goal 3: Cut Discards by Half, Recycle Most of the Rest

Big Goal 4: Invest in Local Clean Materials Infrastructure, R&D and Jobs

Big Goal 5: Export Clean Materials Solutions Globally

Alando Simpson inspires a group of future Clean Materials innovators.

The 5 Big Goals for 2040 Series

This report is the fourth of six reports to comprehensively detail an overall 25-year vision and pathway for Northwest infrastructure investment, produced by the non-profit Center for Sustainable Infrastructure (CSI), to engage top Northwest thought leaders and innovators in mapping the path to achieve a shared and transformative 2040 infrastructure vision.

Broadly, CSI champions a new infrastructure investment paradigm by centering on long-range strategic foresight, new decision tools, smart spending, and integration across systems for broadly shared, long-term community value.

The fundamental premise of 5 Big Goals is that, in a world of rapid change and growing challenges, we can no longer afford to simply replicate old infrastructure investment models. Innovation is required. Decisions made today have ramifications that will shape outcomes for decades to come. And the operating environment in that future will be different than today – just as the operating environment now is different than the 1970s and 80s when a lot of today's legacy infrastructure was designed and our senior professionals trained.

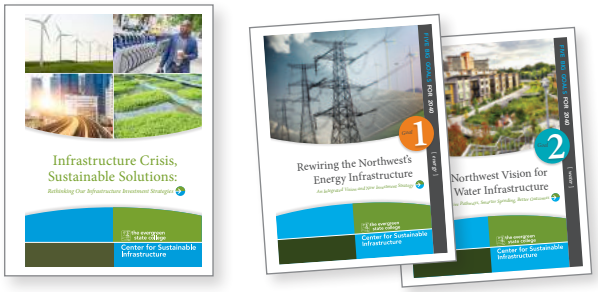
1 E2. Clean Jobs Washington. Dec. 2018, E2. *Clean Jobs Oregon*. Dec. 2018.

2 In this report, 'environmental footprint' serves as a shorthand for the full range of damages to the environment and human health caused at all the life cycle stages of products and materials.

Toward a Blueprint for Clean Materials Leadership

5 Big Goals taps the region's leading infrastructure thinkers and innovators to broadly reimagine infrastructure systems, synthesizing their insights to provide guidance and inspiration for decision-makers. Products are refined through review by high-level teams of experienced leaders.

Our 2015 framing report, *Infrastructure Crisis, Sustainable Solutions: Rethinking Our Infrastructure Investments*, set "Five Big Goals for 2040" in energy, water, waste, transportation and integrated performance. To dive much deeper into energy, *Rewiring the Northwest's Energy Infrastructure: An Integrated Vision and New Investment Strategy* was issued early in 2016. CSI followed up in 2017 with *A Northwest Vision for 2040 Water Infrastructure: Innovative Pathways, Smarter Spending, Better Outcomes*.



Clean Materials Blueprint in Six Chapters

Each of the Five Big Goals reports is tied to a strategic policy pathway, and this one is no exception.

We interviewed and consulted with over 50 thought leaders in the field for this report, including local waste management officials, state and federal environmental agency leads, technical experts, business leaders, design innovators, and public interest advocates. CSI, in collaboration with our steering committee and other strategic partners, will conduct extensive outreach to share key findings and recommendations with policymakers, managers, planners, and others with an interest in smarter investment and transforming the current waste system.

This report tells the story in three parts (A, B, and C) and six chapters, each building upon the last to sequentially flesh out the full story arc.

The parts are:

Part A: Toward a Blueprint for Clean Materials Leadership, which overviews this report and places it in context of the 5 Big Goals for 2040 series;

Part B: From Waste Management to Clean Materials, which highlights the change drivers and new thinking that are transforming the waste sector; and

Part C: The Northwest Leadership Blueprint, which lays out a bold policy vision, describes what a world-class Clean Materials system looks like, and outlines a strategy to spur Clean Materials jobs and industry in the Northwest.

Here are the chapters under each of these parts:

Part A: Toward a Blueprint for Clean Materials

Chapter 1 overviews the purpose of this report and explains 5 Big Goals for 2040, of which this is the newest installment. It previews the story arc for the report, the vision and 5 Big Goals at the center, and the strategic blueprint to put the region on the right trajectory to achieve the ambitious vision and goals.

Part B: From Waste Management to Clean Materials

Chapter 2 explains four key disruptive challenges faced by waste leaders and professionals that represent some of the most difficult forces and intractable problems in their operating environment today. Each of these challenges are pushing today's waste management systems and institutions toward transformation.

Chapter 3 outlines a new paradigm that is emerging to meet the challenge. It starts with the search by waste leaders and professionals for a framework to make sense of a field undergoing profound and disruptive change. They seek a new framework that can guide policy, action and investment going forward, to build a system that is best for our communities, health, pocketbooks and the planet. It is being forged from the interplay of three complementary but distinct frameworks that are actively reshaping our understanding. While these frameworks differ in some meaningful ways, this chapter looks at the long-range big picture to map areas of commonality and agreement. These points of agreement inform the vision and the 5 Big Goals, and provide guideposts for building the blueprint offered in this report.

Part C: The Northwest Leadership Blueprint

Chapter 4 provides the blueprint for policymakers to put the Northwest on the right trajectory to build a truly world-class Clean Materials economy. To realize this vision, Northwest policymakers will need to take the lead. That's why the 2040 Clean Materials Leadership Blueprint calls for major new statewide Clean Materials framework legislation to comprehensively refresh and supersede the solid waste and recycling legislation of the past. Clean Materials policy needs to be on par with Clean Energy policy. Both Oregon and Washington have adopted big targets for clean energy and climate pollution. Chapter 4 proposes 5 Big Goals for 2040, a new set of priority 'Diamond' solutions, and five essential cross-cutting policies to get the region on the right trajectory from the get-go.

Chapter 5 vaults into the future to show what a world-class Clean Materials system can look like in 2040. Clean Materials reduces and cleans up waste at all stages from resource extraction and processing, to manufacture and transport, and then use and disposal. A 2040 world-class system will shrink life cycle health and environmental

Chapter 1: Introduction, Purpose and Vision

impacts of products and packaging. New and reimagined enterprises, both public and private, will deliver new types of services and infrastructure to cut various waste streams; enable reuse, share and repair services; collect and process clean recycling streams; and develop state-of-the-art clean production facilities.

Chapter 6 proposes key action steps for the Northwest to become a global leader in the Clean Materials economy, and thrive economically by fostering clusters of innovative enterprises that grow investment, revenues, and good jobs.

It proposes that Oregon and Washington focus first on building an industry-jobs strategy for Clean Materials, quickly through a concentrated 18-month effort, and suggests several important elements that a smart strategy will consider and incorporate. And it explores the question of whether and how Clean Materials can create tens of thousands of jobs in the Pacific Northwest.

A Quick Glossary to the Terms of Art

…to get you conversant in the language and concepts of the 2040 Clean Materials blueprint:

- **Clean Materials:** A broad term for wide-ranging policy, business, design, and community initiatives to reduce life cycle environmental and health impacts of products and packaging, and to develop local enterprises and trained professionals who excel at 'Diamond' solutions.
- **Clean Production Hubs:** Industrial areas where facilities co-locate to sort and process recycled and organic materials, and repair and make clean products. Clean production hubs will utilize clean infrastructure like renewable energy, biorefining of organics and wastewater, and heat districts, and develop R&D partnerships with Northwest universities and research institutions. These hubs will also pursue non-toxic design, industrial symbiosis, and local markets.
- **Clean Score:** A new environmental 'truth-in-labeling' concept inspired by Walk Score which will score the life cycle environmental footprint of all products or packages sold in the Pacific Northwest. Clean Score will require significant advances in the practice of Life Cycle Assessment and concentrated investment in development.
- **Consumption-Based Emissions Inventory (CBEI):** Measures impacts (typically greenhouse gas emissions) produced around the world due to consumption of goods and services in a jurisdiction, like cars, food, fuels, appliances and clothing –many of which are produced in other regions or nations. CBEI measures both local and 'outsourced' pollution, on a life cycle basis.
- **Diamond Solutions:** A set of priority solutions to unlock Clean Materials excellence. This is a metaphor for the most effective solutions strategies, which this report proposes to replace the established 'solid waste hierarchy.' Diamond solutions are best deployed as a coordinated portfolio designed to optimize efficiency and life cycle environmental benefits.
- **Environmental Footprint:** A measure that totals up the impacts that a person, company, population, activity, etc. has on the environment, for example, the amount of natural resources that they use and the amount of pollution that they produce. For this report, environmental footprint measures impacts across the life cycle of materials, including impacts on human health, such as toxic loading in human bodies.
- **Life Cycle Assessment (LCA):** A method for quantifying environmental impacts across the life cycle of a product or material. LCA covers extraction and processing of materials, followed by manufacture, assembly, distribution, use and disposal of a product or product system, and the transportation connecting every stage.
- **Waste Prevention:** Reducing the amount of material used and the associated waste generation, across the life cycle of materials used in products. Waste prevention is the "reduce" part of "reduce, reuse, recycle" and distinct from recycling in that it involves changes in how materials are designed, produced, purchased and used.

PART B: From Waste Management to Clean Materials

Chapter 2 Big Challenges Transforming the Waste Sector

Chapter 2 overviews four disruptive challenges faced by policymakers and professionals in the waste sector that represent some of the most difficult forces and intractable problems in their operating environment. Each of these challenges are pushing today's waste management systems and institutions toward transformation.

The big challenges driving change in the waste sector outlined in Chapter 2 are framed this way:

- Our strategies to prevent waste aren't getting results
- Our recycling system needs a revamp
- The waste stream is changing
- Most damage happens before our stuff becomes waste

Our Strategies to Prevent Waste Aren't Getting Results

Waste prevention is the top priority enshrined in current waste management law, but the trendline has generally moved in the wrong direction. In a system where waste prevention is the top priority, we should see continuous decline in waste volumes. In reality, we see the opposite.

Reuse and repair is the second priority in the solid waste hierarchy, but has barely gotten off the ground – in spite of some fine Pacific Northwest innovative working examples. The measures for progress are unclear, but they might include the percentage market share for reuse systems in key product categories, and percentage of products entering local repair infrastructure. But it's a measure of the immaturity of the region's reuse and repair infrastructure that we are not tracking performance data – indeed, there aren't even agreed-upon progress measures for reuse and repair.

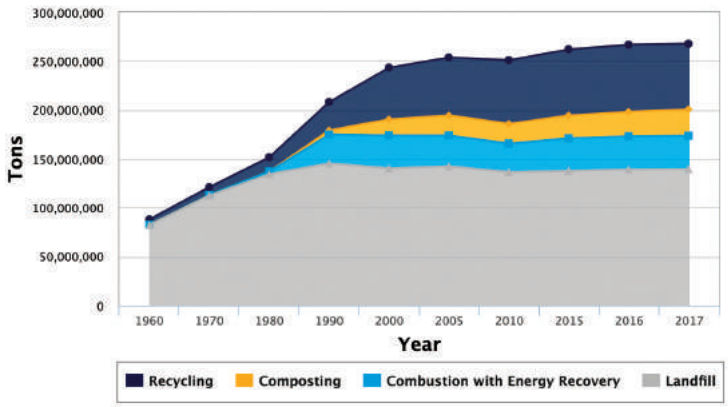
Recycling is the next priority in the hierarchy, and it has received the greatest focus from waste managers. As a result, the percentage of **municipal solid waste** (**MSW**) that has been recycled or composted in the U.S. has dramatically increased over the years, from under 7% in 1970 to 35% in 2015. The recycling rate has largely leveled off since 1995,[3] a reflection of "the low hanging fruit of the recycling world," suggests Karl Englund, recycling expert with Washington State University. "Once the easy stuff is recycled, then things get more difficult and expensive."

The recycling rate has plateaued, but the total quantities of material recycled has gone up, right along with society's growing generation of material wastes. In fact, while the *share* of waste diverted for recycling and composting grew quite slowly from 1995 to 2015, the actual *quantity* of material grew 60%, from 56 to 91 million tons, much faster than population growth. Those figures underscore a basic dilemma: governments and industry are diverting more material to recycling, but they are not staying ahead of growing solid waste streams.

Our Recycling System Needs a Revamp

Recycling as we know it only dates back around a half-century. Inspired by the first Earth Day in 1970, Oregon passed the first bottle return deposit in 1971. Through the 1970s recycling drop-off centers spread around the country. By mid-decade, curbside collection of recyclables began in Missouri and Massachusetts. In 1980, Woodbury, N.J was the first city to mandate recycling. In 1983 the Oregon Legislature required community recycling systems, and in 1987 Portland mandated that waste haulers offer recycling services, including single-family residential collection. Seattle followed with curbside collection in 1988 and began curbside collection of yard waste in 1989. In the early 2000s, San Francisco began collecting food wastes with yard waste at the curb, a practice that has spread widely across the nation and Northwest since.[4]

US Municipal Solid Waste Trends



The US expanded recycling and composting programs in recent decades, but the amount of waste burned or landfilled has barely declined.

Data from U.S. Environmental Protection Agency

In the Northwest, early leadership propelled recycling rates far above the national average. But growth has stalled, and even receded. Since 1992 when Oregon began tracking recycling rates, they have grown most years, from 27% in 1992 to nearly 50% in 2013. But from 2014 on, each

3 Advancing Sustainable Materials Management: "2015 Fact Sheet - Assessing Trends in Material Generation, Recycling, Composting, Combustion with Energy Recovery and Landfilling in the United States", U.S. Environmental Protection Administration, July 2018.

4 Goodyear, Sarah. "A Brief History of Household Recycling." *City Lab*. History of Recycling.

Chapter 2: Big Challenges Transforming the Waste Sector

Most US recyclables are sorted and baled for export to other parts of the world, but export markets shrank dramatically from 2017 to 2019.

year has seen a decline. In 2018, the amount of material dropped again, to 40.8%.[5] The state is not expected to reach its 2020 goal of 52%.

Washington has experienced a similar pinnacle. Washington's waste recovery rate grew rapidly from 15% when tracking began in 1986 to 39% in 1995, when it saw a few choppy years. Nonetheless, the state made steady progress increasing recycling rates from 2000 until 2011, growing from 37% to 57%. But that was a peak, and rates declined to 49% by 2017, the latest year for which statistics are available.

Janine Bogar
Washington Department of Ecology

> "The push for higher recycling rates has perhaps come at the expense of effective recycling."

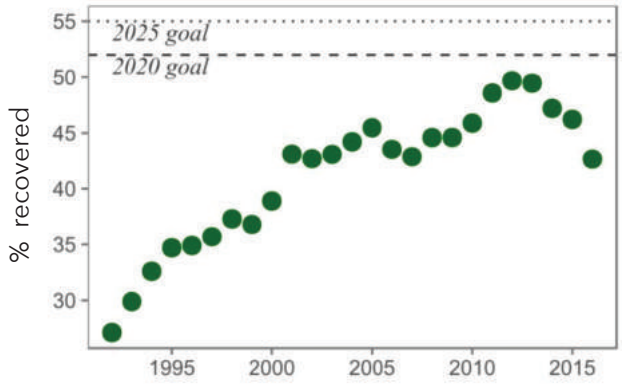
Recycling has been in the headlines recently in a way not seen since the early days of modern recycling, with a crisis that has called into question fundamental assumptions of the practice.

Issues surrounding recycling came to a head in 2017 when China slammed the door on imports of low-grade and contaminated recyclables. The policy, known as China's National Sword, was a tightening of its Operation Green Fence initiative begun in 2013 to keep out contaminated materials. China's National Sword put sharp teeth into enforcement, deeply slashing the flow of recyclable materials into China. It banned 24 categories of materials outright, and limited contamination of baled recyclables to half a percent; a level impossible for the current system to meet. Enforcement of the contamination limit, begun in March 2018, resulted in import declines of 50% for scrap paper and 99% for scrap plastic in the first two months of 2018, as compared to that timeframe in 2017.[6]

National Sword predates the current trade war and reflects genuine concerns on the part of China. National Sword's impacts were felt around a world that had come to rely on China to cheaply manage its scrap materials, with a blind eye to significant environmental or social impacts in China. Since 1992, when global plastic waste trade took off, China and Hong Kong, a gateway to the country, took 72.4% of the total. Increasing exports from, China, facilitated by international trade agreements, opened up capacity to backhaul into China, lowering costs. China alone was the destination for half the world's exported plastic scraps in 2016.[7]

National Sword policies have "acutely impacted markets for recyclables from the Pacific Northwest," according to supplemental research work from graduate student intern Meara Heubach in a background paper done for CSI. "Washington and Oregon are particularly dependent on China, as shipping containers bringing goods from China could be returned full of recyclables at very low cost. Shipping to China was actually cheaper than shipping

Oregon Waste Recycling Rates
1992-2017



Oregon's recycling rate, represented here as % recovered materials, was declining even prior to China's National Sword policy. Other states show a similar pattern.

Oregon Department of Environmental Quality

5 Oregon Department of Environmental Quality - Land Quality Division, Materials Management Program. 2018 Oregon Material Recovery and Waste Generation Rates Report. April 2020, p. 9

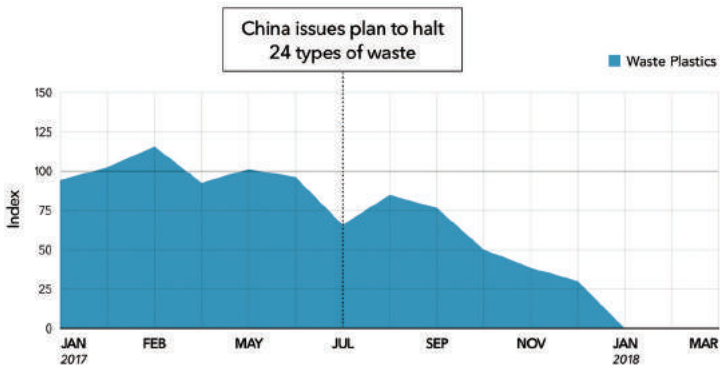
6 Colin Staub, C. China. "Scrap imports down 12 percent due to National Sword." *Resource Recycling*, April, 2018, p 14–15.

7 Brooks, A. L. et al. "The Chinese import ban and its impact on global plastic waste trade." *Science Advances*, 20 June, 2018, 4 (6).

From Waste Management to Clean Materials

locally: sending a container from Tacoma to Shanghai costs $400, compared to $800 to send one by truck from Tacoma to Portland." As a consequence, there are few local facilities that can re-process recyclables."[8]

China's Imports of Waste Plastics Down Sharply



Data sourced from Global Trade Atlas

As a result, not all of what we place in our recycling bins is actually getting recycled. Instead, contaminated recyclables can wind up in landfills, incinerators or industrial boilers. One problem is that people are confused about what should go in the bin, and so toss in items, even disposable diapers, that should actually be placed in the trash. Another special challenge is glass, as shards of broken bottles are difficult to eliminate from mixed recyclables streams, and contaminate bales of paper and plastics.

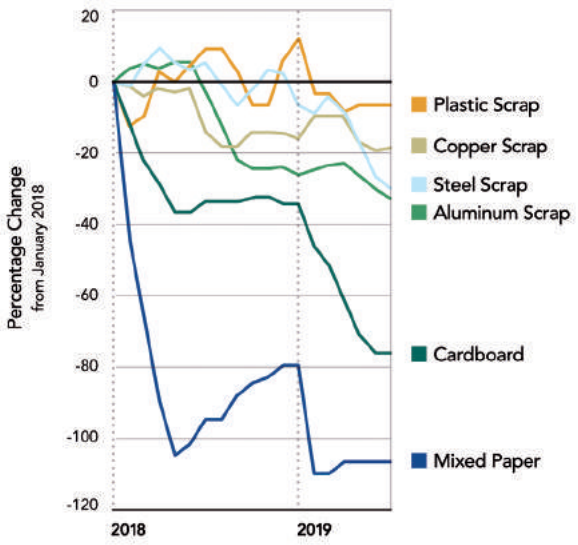
As of May 2019, the Oregon **Department of Environmental Quality** (**DEQ**) allowed about 16,000 tons, about 2% of the state's recycling stream, to be landfilled since China's National Sword took hold late in 2017. Impacts across the state range from limits on curbside recycling in Douglas County and in Roseburg, Oregon to rate hikes in Salem and Josephine County. Changing categories of recyclables are causing public confusion, and many of the region's Material Recycling Facilities (MRFs) are struggling to stay afloat. One positive note was a drop in Coos County contamination rates from 30% to 10% due to a public education effort.[10]

China's actions have highlighted this lack of regional capacity to re-process recyclables, such as mixed papers and plastics. ORPET, a company in St. Helens, Oregon, is set up to process high-grade PET plastics from drink bottles, materials that find ready markets. For a range of more challenging plastics, many haulers are transporting materials to Merlin Plastics in British Columbia, a plastics recovery facility that is unique in the region.

Paper is also challenging. Oregon lost its in-state markets for recovered paper with the 2015 closure of paper mills in Oregon City and Newberg. In Washington, the closure of Grays Harbor Paper in Hoquiam was another market loss. Spokane's Inland Empire Paper could no longer act as a market because yellow dyes from overseas manufacturers posed PCB water pollution issues. However, Longview, Washington-based NORPAC is gearing up capacity that could absorb the state's waste papers to create feedstock for cardboard, in high demand due to e-commerce.

Waste Dive, a leading industry web journal, keeps an updated report on China Sword impacts on the 50 states. By mid 2019, it rated impacts on Oregon and Washington heavy compared to other regions.[9]

Prices for Recycled Materials Drop as Export Markets Shrink



Sharply lower prices are wreaking havoc on the budgets of local recycling programs.

Used with permission from The Wall Street Journal, WSJ.com. Copyright 2020 Dow Jones & Company, Inc. All rights reserved.

8 Heubach, Meara. *China's National Sword: Origins and Impacts*. The Evergreen College, Dec. 2018, p.6

9 Rosengren, Cole, et al. "How Recycling Is Changing In All 50 States." *Waste Dive*, 5 June, 2019.

10 Rosengren, Cole, et al. "How Recycling Is Changing In All 50 States." *Waste Dive*, 5 June, 2019.

Chapter 2: Big Challenges Transforming the Waste Sector

Michael Courier Photography

In Washington, costs for recycling services are going up throughout the state in jurisdictions including Puyallup, Sumner, Bonney Lake, Walla Walla, Arlington and Edmonds. Many jurisdictions are cutting out recycling categories of plastics, metals and paper due to difficulties finding markets. Tacoma considered ending curbside pickup, but community support for continuation spurred a plan under which plastic bags, shredded paper and glass will no longer be accepted, while costs will increase $3.40/month.[11]

National Sword brought contamination issues to the fore. **A large part of the contamination problem derives from the practice of comingling recyclables in single bins**, among other factors. Early curbside collection sorted paper, metal and glass in separate bins. In the 1990s single bins mixing all recyclables emerged in California. The change was spurred by concerns with the impact of lifting bins on an aging workforce. Waste haulers sold comingling to local governments as a way to make recycling easier for customers and reduce physical wear-and-tear on their workforce, while touting the capabilities of sorting facilities to handle the commingled materials. MRFs, using sensors and mechanical systems, as well as workers, can sort certain recyclables into their proper streams. But contamination problems persist, and the addition of new multi-material products complicate the picture. By contrast, Bellingham, Washington reports a 1% contamination rate because it never went to commingled pickup.[12]

Recycling has direct economic benefits because it saves energy and replaces virgin material feedstocks. But when costs for energy and non-recycled feedstocks are low, in part because those costs do not reflect the full environmental and social impacts, then the recycling advantage is less valuable. This makes it more difficult for recycling to compete. A key example is cheap natural gas (or fossil methane) made possible by the 'fracking' revolution. The price for feedstocks to produce certain plastics like HDPE is directly proportional to natural gas prices. Prevailing low gas prices make it cheap to produce non-recycled HDPE and challenging to make HDPE recycling pencil out.

Finally, there are significant environmental justice concerns over shipping materials to countries with lower labor and environmental standards that predate National Sword. That is reflected in a May 2019 decision to include contaminated and mixed plastics under the Basel Convention on the Control of Transboundary Movements of Hazardous Waste. It mandates that a country must gain informed consent from another country before exporting such materials to it.[13]

Recyclers were drawn to the Chinese and Southeast Asian markets by low-cost operations lacking environmental and labor regulations that are standard in the U.S.

"Most recycling facilities in China are small-scale, low-tech operations that function with few environmental controls," Heubach writes. "Most plastic recycling facilities, for example, are family-owned and do not treat their own wastewater, which flows untreated into local waterways. Some scrap importers and exporters also engage in shady practices: Chinese customs agents have opened shipping containers supposedly full of recyclables only to find loose garbage or loads of syringes."[14]

11 Q13 FOX. "Price increase among proposed changes for Tacoma recycling." 14 June, 2019.

12 Rosengren, Cole, et al. "How Recycling Is Changing In All 50 States." *Waste Dive*, 5 June, 2019.

13 DeAnn Toto. "New rules place restrictions on global plastic scrap trade." *Recycling Today*, 13 May, 2019.

14 Heubach, Meara. *China's National Sword: Origins and Impacts*. The Evergreen College, Dec. 2018, p. 2.

From Waste Management to Clean Materials

After China closed its borders to contaminated materials, the panic to find markets and the lure of lower costs impelled many recyclers to shift exports from China to other SE Asian countries, increasing recyclables export to Taiwan, Vietnam, Malaysia, South Korea, Thailand and Indonesia. This shifted environmental and health costs from China to those countries. But these countries quickly caught up with China by banning or regulating contamination of recycled material imports.

The Waste Stream is Changing

A key hurdle for waste prevention and recycling is a changing waste stream that reflects a changing economy.

Recycling began with items that had obvious markets, such as used paper that could be re-processed into new products. Cans and other metals found ready markets in an industry where reprocessed materials were competitive with their raw, non-recycled variants.

But even as recycling has grown in scope to cover an increasing range of glass, plastic, organic and electronic products, the market is changing. The move to web-based news, information and shopping has sharply reduced print newspapers and phone books, while cardboard boxes and plastic packing streams have accelerated. Recycling has actually become lighter by cubic yard as the character of the waste stream has changed. New forms of plastic packaging that are more difficult to recycle increasingly supplant paper boxes and bags, cans and jars.

A particular challenge is flexible plastic pouches in which food items increasingly are packaged, and to which e-commerce shipments are moving. Flexible packaging is made of as many as 22 laminated layers. Over coming years, many of the products we currently buy in cans and glass jars are expected to come in flexible packaging.

"In 20 years, packaging is going to be completely different. I suspect there will be a lot of flexible, single-use packaging," says Susan Robinson, Senior Director of Sustainability and Policy for Waste Management. "We are going to have to be a different kind of business."

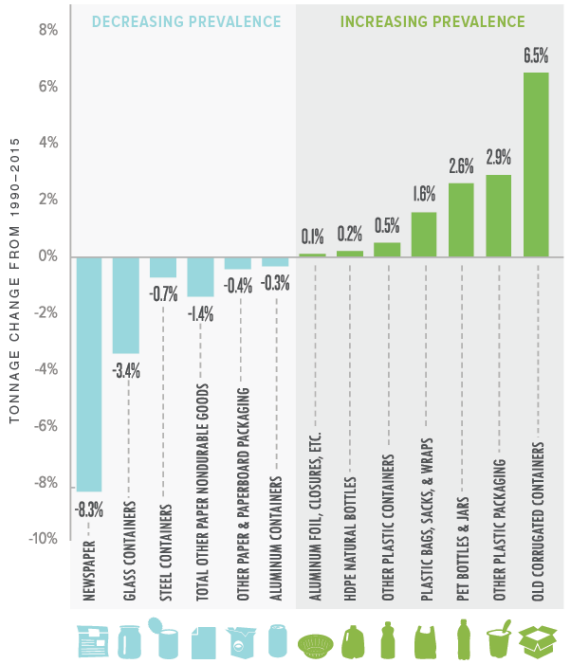
Flexible packaging has both pluses and minuses. On the plus side, it is lighter than the cans and bottles it often replaces, so it requires less materials by weight to produce, uses less fuel to ship, and takes up less space in disposal bins. So, transportation costs and energy demands are reduced, along with the air and climate pollution they entail. Flexible packaging can extend shelf life, which can reduce food waste.

Among downsides of flexible plastic packaging are the major challenges it is posing for recycling operations. Manufacturers customize packages for specific markets, so pouches contain varying plastic polymers. Some polymers

Data and text sourced from Waste Management

Chapter 2: Big Challenges Transforming the Waste Sector

Changes in the Waste Stream



Changes in the waste stream reflect a growth in online information and shopping, with newspaper continuing to decline and an increase in old corrugated containers.

Resource Recycling Systems, Inc. (RRS)

have potential recycling markets, but many do not. And flexible packaging does not work well in current MRFs. Waste managers and the recycling industry are only beginning to grapple with the many challenges of flexible packaging.

"The shift is truly away from anything recyclable. Haulers are seeing the writing on the wall. They want to limit recycling for materials that they make less money on or that costs them to recycle," says Lisa Sepanski, a lead policy analyst in King County's recycling program. "Flexible packaging is already a nightmare. It has good attributes, but it's single use. If we don't have a connection with producers, we will see products that don't fit into any recycling category."

Most Damage Happens Before Our Stuff Becomes Waste

Our best science is telling us that much of the damage to the planet and our health comes earlier in the life cycle of products and packaging, before they are discarded by users to enter the waste management infrastructure.

Every product and package is forged from materials, usually several, each of which has a life cycle that progresses through a sequence of stages. It's a 'life' that begins with resource extraction and processing, then component manufacturing and assembly operations, then to packaging and distributors. Transport segments connect each life cycle stage. In the next life stage, we the purchasers finally get involved. We buy and use the product and packaging. Only when we are done is the handoff made to the local solid waste and recycling infrastructure.

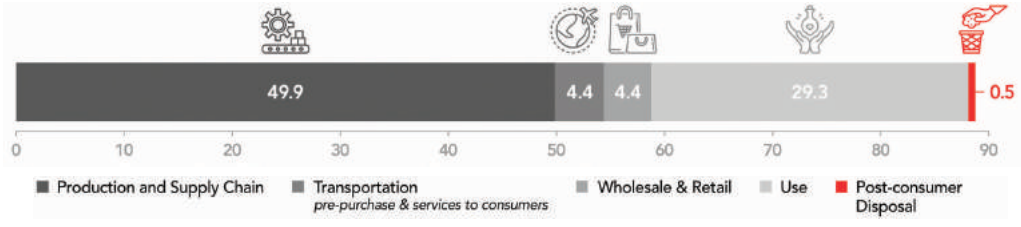
Most of the environmental damage happens earlier in product life cycles, yet our waste management system is built primarily around managing post-consumer discards. To illustrate, David Allaway of Oregon DEQ notes, "For just about any environmental issue you care about, materials are a major if not primary driver – toxic loading in people's bodies, climate, nutrient runoff, marine plastics, species loss, water depletion. At the local government level and for average people, the place we see materials and think about the environmental impact is when we toss it out. But we see that the disposal of the materials typically contributes less than 5% of most types of environmental impacts," he points out. "Upstream of that, earlier in the materials' life cycle, is 95% or more of the impact."

Waste managers are on the frontlines of society's efforts to deal with the consequences of products and packaging at end of life. But they are buffeted by winds of serious change converging on multiple fronts. The traditional tools they have used, as needed and valuable as they are, are not sufficient to fully address the challenges they face. Waste streams are still growing – and changing, in some cases dramatically. And the major systems waste managers have relied on to reduce health and environmental impacts of waste, such as recycling and composting, only address a small portion of the overall impacts of materials life cycles.

For all these reasons, the time is right to consider a new framework, also known as a new paradigm.

Most Climate Pollution Happens Pre-Disposal

Life cycle emissions (MMT CO2e) for consumption by Oregon during 2015



Data sourced from Oregon Department of Environmental Quality

From Waste Management to Clean Materials

Toxic exposure disproportionately impacts children at their earliest stages of development.

How Toxic is Our Economy?

A wide variety of toxic chemicals now reside in the bodies of Americans of all ages – measured in our blood and urine – according to data compiled by the **Centers for Disease Control** and Prevention (**CDC**). Our bodies absorb these chemicals from the food we eat, water we drink, and air we breathe, as well as from products and containers we contact which contain toxic chemicals.[1]

Toxic chemicals are also present in the umbilical cord blood of newborn infants, and the breast milk of nursing mothers. Babies can be especially sensitive to disease caused by chemicals. "Exposures in early development – during pregnancy and in the first years after birth are especially dangerous," according to **Environmental Health News** (**EHN**). EHN cites several examples:

- Early-life exposures to air pollution cause asthma.
- Prenatal exposures to phthalates cause birth defects in the reproductive organs of baby boys.
- Prenatal exposures to organophosphate insecticides, brominated flame retardants, polychlorinated biphenyls (PCBs), phthalates and bisphenol-A damage children's brains, causing neurobehavioral disorders such as dyslexia, mental retardation, attention deficit/ hyperactivity disorder and autism.
- Prenatal exposures to benzene and pesticides can cause childhood cancer, especially leukemia and brain cancer."[2]

Although the CDC monitors over 350 chemicals in American's bodies, we still are seeing only a slice of the toxic burden our bodies are coping with. Each year the U.S. Environmental Protection Agency (EPA) reviews an average of 1,700 new compounds that industry is seeking to introduce, approving about 90 percent without restrictions. But most of the chemicals absorbed in our bodies were approved by the EPA without analyzing toxic dangers. "Only a quarter of the 82,000 chemicals in use in the U.S. have ever been tested for toxicity," according to journalist David Ewing Duncan. And while we know far too little about how these chemicals impact our bodies, we know next to nothing about "synergistic effects" – how these chemicals interact in our bodies and affect us.[3]

To move toward a world-class Clean Materials system in the Northwest, we need much greater transparency and better data to know which toxic chemicals are entering people's bodies. Ultimately, industry needs to be responsible to redesign products, supply chains and systems to eliminate their chemicals' pathways into human bodies.

1 Centers for Disease Control and Prevention. "Frequently Asked Questions." https://www.cdc.gov/exposurereport/faq.html. Accessed October 2019.

2 Landrigan, Philip J. & Landrigan, Mary M. "Commentary: It's up to us to keep children safe from toxics." *Environmental Health News*, 2 Feb. 2019.

3 Ewing Duncan, David. "Chemicals Within Us." *National Geographic*, October, 2006.


KOMATSU

Chapter 3: Paradigm Shift!

Chapter 3 Paradigm Shift!

The public believes broadly in the simple idea of recycling, because it's good for the community and for the planet. But for the solid waste professionals charged with managing our waste collection and recycling infrastructure, and helping people make their best environmental contribution, the challenges are incredibly complex.

These leaders are searching for a framework to make sense of a field undergoing profound and disruptive change, a framework that can guide policy, action and investment going forward to build a system that truly benefits our communities and the planet.

This paper offers a vision and blueprint for the Pacific Northwest to transform its solid waste management system into something much better by 2040. The blueprint aims to guide the Northwest to build a world-class Clean Materials infrastructure and economy by 2040, that shrinks our impacts on human health and the environment dramatically and creates tens of thousands of good Clean Materials jobs throughout the region.

Juan Carlos González
Oregon Metro Council

"I hope there's a point in time where we have the policy and systems in place to know how we will manage and utilize the materials within every product that is created in the economy."

But this is a very different vision and ambition than the one that has driven waste and recycling infrastructure decisions over the past 40 years. Chapter 3 examines some of the profound realizations compelling leaders to rethink the solid waste paradigm and consider new frameworks to guide their strategies and investments into the future.

Waning Days for the Waste Management Paradigm?

A paradigm is a system of beliefs, ideas, values and habits that grounds a way of thinking and acting in the world. It is often shared among a community of people and is so thoroughly accepted as 'the way things are' that most members of the community may hardly be aware of the conceptual system that shapes what they think and do. Most sectors operate within a governing paradigm that organizes the activities of a variety of actors under frameworks that work reasonably well for most everyone, often for decades – as has been the case for the solid waste sector, up until now.

The solid waste community's system of beliefs, ideas, values and habits are bumping against limits. More and more people in the field are starting to question whether the paradigm that has ruled for the past four decades is still the right framework to guide thinking, action and the investment of resources. Increasingly, they are saying it's time for a new and better approach.

Waste Management Hierarchy

Source: U.S. Environmental Protection Agency

Today's solid waste professionals inherited an extensive system of waste management infrastructure, practices and processes focused largely on "end-of-life." That is the destination of products when buyers are done with them, whether these millions of tons of material will be packed into landfills, incinerated, or more ideally, cleanly recycled into new products or soils.

But today's solid waste management paradigm cannot effectively address all the compelling environmental and economic challenges involving materials. Perhaps the most difficult challenge is the realization that, while poor waste management practices are harmful – for example, the crisis of plastics in our oceans – many of the worst impacts on the planet resulting from the stuff we buy come, not at its end of life when we toss it as trash, but earlier, before we buy it.

To Tackle the Environmental Crisis, Measure the Life Cycle of Materials

Every product and package experiences the life cycle stages of manufacture, transport, retailing, use, and disposal. Our products and packages are manufactured from materials, usually several, each of which progressed through its own, earlier material extraction and processing stages. Each life cycle stage has a unique signature of environmental impacts which can be measured, then added up to build a full **Life Cycle Assessment** (**LCA**) of the product and package.

The growing use of LCA is clearly showing solid waste managers that the greatest environmental impacts caused

From Waste Management to Clean Materials

by the constellation of materials that make up our waste streams do not come after the stuff enters the waste management infrastructure. The most serious impacts mostly come earlier in a product's life cycle.

This life cycle understanding of health and environmental impacts of materials poses a profound challenge to today's solid waste management paradigm, which offers virtually no real policy tools or practical experience to reduce damages earlier in product life.

Material Use is Accelerating Worldwide

The consumption of materials extracted from the Earth to supply the global economy is dramatically accelerating worldwide.

A 2019 report from Circle Economy, supported by UN Environment and the Global Environment Facility, tracks an enormous increase in materials use in the past half century, from 27 billion metric tons in 1970 to 92 billion in 2017. Growth is accelerating, and material consumption is expected to nearly double again by 2050. Circle Economy calculates that less than 10% of all that material is cycled back into productive use.[15]

Today's material economy might be drawn as an arrow shot in one direction, from extraction of raw materials, to processing and manufacture, to transport and use of products, after which materials enter the waste and recycling infrastructure or escape into the environment as litter or marine debris. Most damage to the planet and human health happens well before the arrow sinks into its end-of-life destination.

Outsourcing our Climate Footprint

Of the many kinds of environmental damage connected to materials in the global economy, arguably the biggest and most important is disruption of the Earth's climate system. The prevailing way we measure – and manage – our states' contribution to this paramount problem misses a major segment of our climate footprint that is revealed by applying life cycle thinking.

The life cycle of materials in our products and packaging needs to join center stage in the debate over how to solve the climate challenge. Materials matter a lot for climate. But until recently we haven't measured life cycle climate pollution, so our climate policy frameworks have had no hook to manage that pollution. Instead, state climate policies have focused largely on pollution within state borders.

But when analysts with Oregon DEQ calculated life cycle pollution from the products and packaging that Oregonians purchase from outside the state, Oregon's climate footprint expanded dramatically.

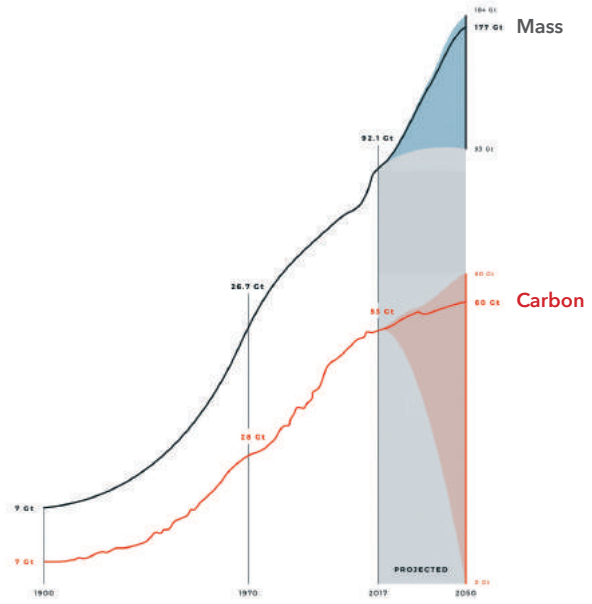
The standard, production-based inventory of climate pollutants largely measures emissions within state boundaries. An alternative way, called a "**consumption-based emissions inventory**" or **CBEI**, in contrast, calculates the climate pollution embodied in the products and packaging we import from outside the state resulting from earlier life cycle stages, in addition to in-state emissions from the use and disposal stages.

Oregon DEQ, which has been a leader in developing and applying CBEI, explains that it "measures greenhouse gas emissions produced around the world due to the state's consumption of goods and services like cars, food, fuels, appliances and clothing – many of which are produced in other states or overseas."

In essence, CBEI measures the climate pollution we are outsourcing.

In the standard inventory, the climate pollution released within Oregon borders in 2015 added up to 63 million metric tons (CO2-equivalent). When imported emissions calculated by consumption-based accounting are added in, total Oregon climate pollution jumps substantially – by 81% – to 112 million tons. King County, Washington's most populous county, found generally similar results.[16]

Global Increase in Material Use and Climate Impact



Mass: *Material extraction in billions of tons*
Carbon: *Carbon dioxide equivalent emissions in billions of tons*

Created by Circle Economy, and Sourced from The Circularity Gap Report 2019

15 The Circularity Gap: Report 2019 "Closing the Circularity Gap in a 9% World", *Circle Economy*, p. 11

16 King Country Greenhouse Gas Emissions Inventory, A 2015 Update: Executive Summary. Prepared for King County by Cascadia Consulting and Hammerschlag & Co. LLC, Dec. 2017.

Chapter 3: Paradigm Shift!

Life Cycle Assessment: An Essential but Evolving Tool

Life Cycle Assessment is an essential tool for measuring environmental impacts because it illuminates life cycle impacts of materials and products. LCA is a complex process and an evolving discipline that offers valuable insights now, but is continuously improving. There are plenty of questions still to answer for it to become the central high-value tool we need it to be.

Kyle Diesner, the City of Portland's Climate Action Program Coordinator, notes, "One of the big challenges today is that there is a wide variety of methodologies for calculating life cycle impact that aren't necessarily consistent, but we need that visibility for virtually everything in our economy. Really, the complexity is in the fact that there are so many different ways you can produce a particular product or component which each have a different life cycle impact profile."

Proponents of LCA readily concede the tool has limitations, while emphasizing that today's LCAs do utilize fairly robust and comprehensive data sets and are producing useful results. They invite colleagues in the field to join in the work of identifying gaps – for example, toxic impacts on human bodies and plastic garbage in our oceans – and improving inputs so that LCA science gets continuously better and more reliable.

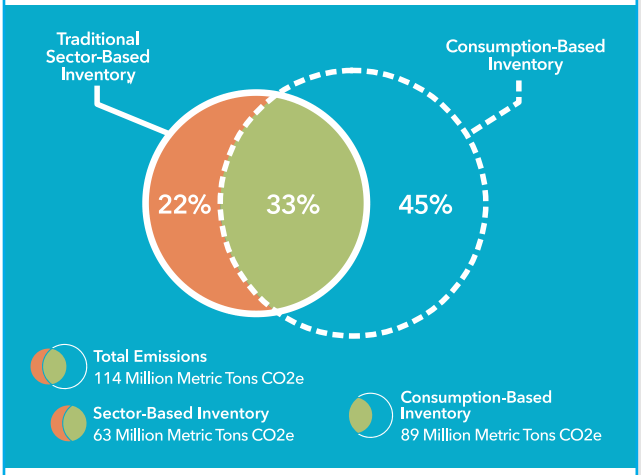
Of course, some impacts are difficult to measure and quantify. The role of plastic packaging provides a timely example. Because of its light weight, a flexible plastic pouch often shows lower climate impacts than glass or steel equivalents, even if the pouch goes to a landfill while the jar or can is recycled. But that presumes the pouch will find its way into a modern waste management system, instead of becoming litter or ocean pollution. In the latter cases, the pouch will remain in the environment for hundreds of years before breaking down, and when it does break down 'micro-plastic' particles will find their way through ecosystems and food chains. Meanwhile, toxic chemicals associated with plastics are making their way into human bodies, but in general the human health impacts of toxics are poorly understood and difficult to quantify given currently available data. LCAs of the future will require good data transparency to begin to credibly quantify these important impacts.

LCA science has come a long way, it's providing valuable insights, it's continuously improving, and has plenty of room to still improve. While LCA science is not yet where we need it to be, LCA scientists emphasize that, structurally, its bones are good. "Almost all primary LCA methodological questions had been thoroughly treated in the literature by the time the second editions of the ISO standards were adopted in 2006," says Washington-based LCA expert Roel Hammerschlag. "The problem is cost and data, not the state of the art."

In fact, LCA's greatest challenge may be more about scaling than standardizing. Can we get to a system where each product and material will be tagged with its Clean Score based on LCA data specific to that product? That will require suppliers and producers to transparently track and report the life cycle impacts specific to their processes.

Our current scale of LCA practice is tiny compared to the scale needed to get to that system. "There are a lot of product categories to inventory, and within each one, there is an overwhelming and continuously changing array of different products," says Hammerschlag. An LCA system

Oregon's Climate Footprint Including Imports



The 'consumption-based' footprint includes all products and services consumed within Oregon, whereas the 'sector-based' footprint only accounts for pollution generated within state borders.

Oregon Department of Environmental Quality

From Waste Management to Clean Materials

Georgine Grace Yorgey
WSU Center for Sustaining Ag. and Natural Resources

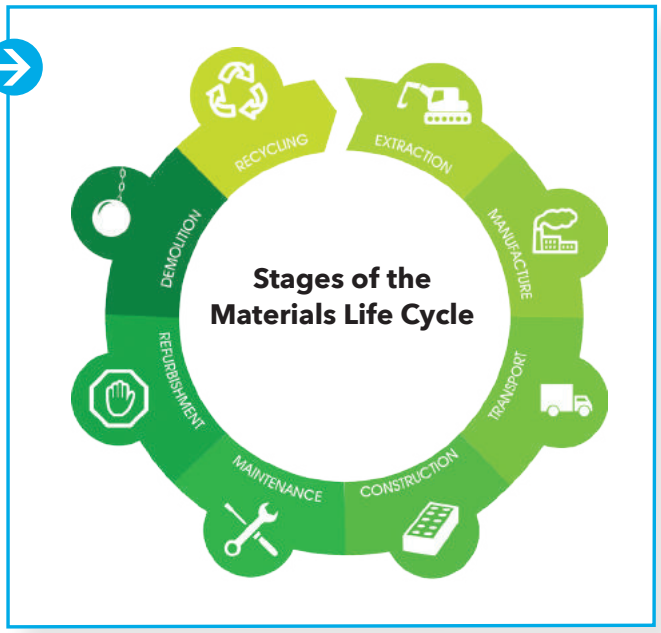
> "We'll get there by working along the whole supply chain. We need to generate less waste, and ensure that what we are producing can be meaningfully recovered."

scaled up to meet that challenge will require a new normal. Producers at all levels need to track life cycle impacts, incorporating that into their cost of doing business. LCA scientists need to evolve affordable, efficient systems that enable good science to be ubiquitous, reliable, and transparent. This new normal will require bold new thinking.

One major US corporation recently took a step, in essence, to improve the Clean Score of its products. Apple announced that it purchased the first-ever commercial batch of carbon-free aluminum from a joint venture of two of the world's biggest aluminum suppliers. Apple uses aluminum housing in its iPhones, watches, and computers. "For more than 130 years, aluminum – a material common to so many products consumers use daily – has been produced the same way. That's about to change," says Lisa Jackson, Apple's vice president of environment, policy and social initiatives.

There will undoubtedly be a steady supply of challenging design questions that will need to be wrestled with as LCA science scales up. One example is whether products and packages that are designed for easy reuse, remanufacture, and recycle get credit for avoided impacts in some way. On the one hand, the answer might be a straightforward, 'Yes!' – a Clean Score credit for better design can incentivize innovation that reduces health and environmental impacts the most. On the other, there's a danger of double-counting – shouldn't the credit for avoided impacts go to the new products that reuse, remanufacture, and recycle materials rather than the old product that was the source of the material? Or can credit be shared? By leading the way, the Northwest can uncover elegant ways to share credit that incentivize all parties to pursue great design solutions.

Typical aluminum production processes are extremely energy-intensive, resulting in a major carbon footprint.



Source: Irish Green Building Council

Toward a New Clean Materials Paradigm

This paper offers a blueprint that Northwest leaders can use to build a world-class Clean Materials infrastructure and economy by 2040, that shrinks our environmental footprint dramatically, and creates tens of thousands of good Clean Materials jobs throughout the region.

Waste managers are on the frontlines of society's efforts to reduce impacts on the planet and convert waste into local economic and community value. But the traditional solid waste tools they've inherited do not equip them to address some of the most important challenges they face. Waste streams are growing and changing, and tools such as recycling and composting only address a portion of the overall environmental impacts of materials' life cycles. The waste field is ripe for a paradigm shift.

Three Frameworks Emergent in the Clean Materials Space

Reducing our environmental footprint across the life cycle of materials sounds pretty straightforward and common sense, which it is. The public wants to do their part for the planet, and leaders in this space want to help them to do that effectively.

But that doesn't mean that designing and implementing strategies to advance that goal will be simple or easy – far from it. When the goal is to reduce environmental and health impacts through the entirety of materials' life cycle, wherever that impact happens, the challenge enters new terrain, where our waste sector's professionals and policymakers have little experience and few tools, or even models of success to draw on.

That is why waste managers are turning to new frameworks – including Zero Waste, Circular Economy, and Sustainable Materials Management – that are gaining traction in the com-

Chapter 3: Paradigm Shift!

When 'Good' Attributes Aren't What They Seem: The Oregon DEQ Life Cycle Studies

In the waste industry sector, most professionals and leaders are committed to investing in smart and effective programs that make it easy for the people they serve to reduce waste, to recycle, and to generally do right by the planet.

Over the last couple decades, some common wisdom has taken hold as to the planet-friendly attributes to look for when you purchase a product: Is it recyclable? Does it have much recycled content? Is it bio-based (made from plant materials)? Is it compostable?

The goal, of course, is to give people some good guideposts, some attributes to look for when they make purchases, to make the right choices easier. Clearly, many people, companies and institutions want to go beyond talk and take real planet-friendly action in their day-to-day purchases.

We expect that these four attributes –recycled content, recyclability, bio-based content, and compostability– will consistently deliver better environmental results. But a recent set of studies by the Oregon DEQ steps back to evaluate how well those four 'common wisdom' attributes actually predict optimal environmental outcomes, under prevailing production processes and supply chains. The DEQ studies have helped stir an important discussion on goals of our waste and materials management system.

DEQ looked at all English-language Life Cycle Assessments published between 2000-2017 for packaging and food service ware. The studies variously assessed impacts ranging from water and land use to energy use, carbon emissions, acidification, toxicity to humans and ecosystems, mineral depletion, air pollution, and eutrophication. DEQ conducted meta-analysis of the LCAs, concluding that those four attributes –recycled content, recyclable, biobased content, and compostable– are producing better environmental outcomes in some cases, but not reliably, and in some cases producing worse overall impacts.[1]

A couple examples to illustrate the point:
When comparing packaging made of the same materials, the one with recycled content almost always is better than one made with virgin materials alone. But when comparing options to package the same product in different materials, recycled content is not a good predictor of optimal outcomes, with over half of 530 such LCA comparisons showing the recycled content option delivering inferior environment outcomes.[2] One specific example: Glass bottles that contain a higher recycled content than a lightweight pouch or plastic bottle can use more virgin material overall because of their higher overall weight, and depending on how they are made, "may result in higher impacts such as emissions and resource depletion."

Recyclability, too, may not reliably indicate better environmental results. For example, when steel cans which are recycled at a high rate are compared to aseptic cartons which are recycled at lower rates, LCAs to date show "steel cans always result in higher environmental impacts in the scenario due to the extraction and production burdens of making steel sheet and then cans." The LCA meta-analysis found mixed results, too, for bio-based content in products and packaging, as well as compostability.

Of course, there are some limitations with a meta-analysis that aggregates all the LCAs from 2000-2017. For example:

- The DEQ meta-analysis did not identify which studies were funded by industry or other vested interests and test whether the source of funding may have introduced any bias into the methodology and results.
- The wide range of LCAs compiled were not performed under standardized methodology, so different approaches could yield inconsistent results.
- The science of LCAs has evolved, and LCAs from the 2000s may be qualitatively different than more recent LCAs, which are presumably better, though data on toxicity remains inadequate still today.
- The LCAs analyzed look backward, not forward, so they do not necessarily tell us how packaging choices will perform when produced with clean infrastructure, like renewable energy, non-toxic design, industrial symbiosis, and local production and markets.

In fact, an important conclusion of DEQ's research is that materials with the four attributes are not inherently flawed, even as they aren't the consistent predictors of low-impact choices that they are often assumed to be. In some cases, roughly half of the comparisons showed that materials with these attributes did correlate with lower life cycle impacts. "The key learning from DEQ is that as an evaluation framework, these popular attributes simply don't tell us enough to make consistently good decisions," says David Allaway, of Oregon DEQ. "Additional information is needed in order to choose low-impact materials."

1 Vendries, J, et al, The Significance of Environmental Attributes as Indicators of Life Cycle Environmental Impacts of Packaging and Food Service Ware, State of Oregon Department of Environmental Quality, 2018.

2 Mistry M. et al, Material attribute: *Recycled Content*, "How well does it predict the life cycle environmental impacts of packaging and food service ware?" State of Oregon, Department of Environmental Quality, 2018.

From Waste Management to Clean Materials

munity of advocates and professionals interested in a deep and long-term rethink of the inherited solid waste paradigm.

These three frameworks are by no means inherently competitive. There are some differences in both theory and implementation, and some of these distinctions are important. But stepping back to look at the big, long-range picture, these differences are outweighed by much greater areas of commonality and agreement. Key values of these three frameworks are:

- **Zero Waste:** Zero Waste aims at eliminating waste streams entirely. The Zero Waste International Alliance in December 2018 adopted its latest definition of the concept: "The conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health."[17]

Source: *The Zero Waste International Alliance*

- **Sustainable Materials Management:** Sustainable Materials Management (**SMM**) seeks optimal environmental outcomes across the entire life cycle of materials, from raw materials production to manufacturing to end of life. The U.S. Environmental Protection Agency defines SMM as "a systemic approach to using and reusing materials more productively over their entire life cycles. It represents a change in how our society thinks about the use of natural resources and environmental protection. By looking at a product's entire life cycle, we can find new opportunities to reduce environmental impacts, conserve resources and reduce costs."[18]

Source: *US Environmental Protection Agency*

- **Circular Economy:** The Ellen MacArthur Foundation (EMF), a prime advocate of the Circular Economy, describes it as a "framework for an economy that is restorative and regenerative by design." The framework centers on three principles, according to EMF: Design out waste and pollution; Keep products and materials in use; and Regenerate natural systems.[19] (*See graph on the next page.*)

Among these three frameworks that have so much in common are some important distinctions and differences that mainly play out in their emphasis and implementation. Debating these differences can fuel productive dialogue that helps the community build shared understandings, policy, and implementation strategies. Some of the key distinctions that are fueling dialogue include:

- Circular Economy tends to give preference to renewable feedstocks as original sources for materials in the economy, while SMM overviews all impacts of the life cycle, and in some cases may point to nonrenewable resources as having lower overall impact.[20]
- SMM and Zero Waste emphasize reducing overall material use through demand-side solutions that reduce consumption, while the Circular Economy movement appears to focus relatively little on consumption reduction.
- Circular Economy and Zero Waste tend to prioritize reusing and recycling all materials once they enter the economy, while SMM looks at the overall environmental impact of the process. For SMM,

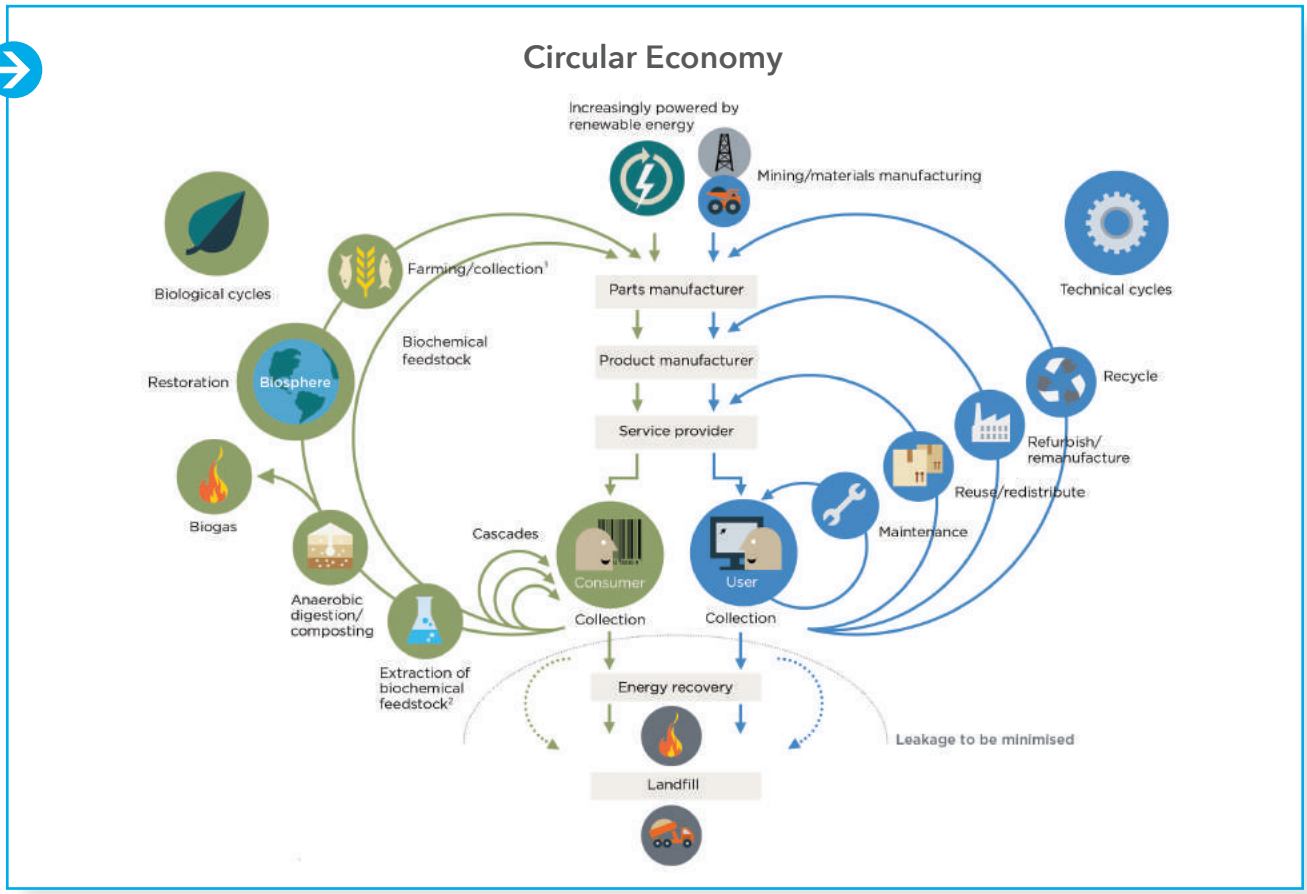
17 Zero Waste International Alliance. Definition of Zero Waste, http://zwia.org/zero-waste-definition/. Accessed Aug. 2019.

18 U.S. Environmental Protection Administration. Sustainable Materials Management page, https://www.epa.gov/smm. Accessed Aug. 2019.

19 Ellen MacArthur Foundation. "Concept: What is a circular economy?" https://www.ellenmacarthurfoundation.org/circular-economy/concept. Accessed Aug. 2019.

20 Mistry M, Allaway D, Canepa P, and Rivin J. *Material Attribute: Biobased content –How well does it predict the life cycle environmental impacts of packaging and food service ware?* State of Oregon Department of Environmental Quality. Portland, Oregon. 2018.

Chapter 3: Paradigm Shift!



Source: Ellen Macarthur Foundation.org, SUN and McKinsey Center for Business and Environment

some materials could be landfilled (if that's the least polluting option), while both Circular Economy and Zero Waste aim to eliminate landfilling entirely.

- Processing wastes that cannot otherwise be reused or recycled to produce energy is an element of SMM and Circular Economy. Zero Waste rules out waste incineration.
- SMM centers powerfully on insights from the science of life cycle assessment, but is sometimes perceived as underplaying the limitations of this evolving science in drawing conclusions about product and packaging choices.
- Zero Waste can be an effective rallying cry to mobilize the public, but has sometimes in the past been perceived as elevating solid waste avoidance over other important environmental impacts.

Big Picture: Where the Frameworks Align

The differences between these frameworks are important to debate. But there is no need to delay strategic action while that debate continues. For purposes of designing a blueprint to a world-class 2040 Clean Materials system, there is much that advocates for these frameworks can agree on. These points of agreement can inform our vision and provide good guideposts for building that blueprint:

- **Conserve resources and eliminate waste and pollution** to the greatest extent possible, not only at end-of-life but through entire product life cycles, from supply chain to manufacture, to use and reuse, repair and recycle, as well as final disposal.
- **Make it much easier to do the right thing** with convenient on-ramps for people and businesses to reduce consumption, reuse and repair products, and recycle into clean production loops that minimize impacts.
- **Remove toxic releases and exposure from the system,** including not recycling toxics back into products.
- **Reward manufacturers** who design products made from the least-impactful materials to be non-toxic, durable, repairable, reusable, recyclable, and have a low carbon footprint.
- **Build vibrant clusters of services, companies and jobs** helping communities across the region reduce, reuse, repair, and recirculate resources into clean, low-impact production processes.

Another important piece that should be part of the 2040 blueprint is a system designed to deliver "Triple Bottom Line" value, which means environmental, economic, and social benefits together. For example, new jobs in the Clean

From Waste Management to Clean Materials

Materials economy could lift many people out of poverty through green jobs opportunities in economically-distressed rural, urban and suburban areas.

State and Local Leaders Advancing the New Frameworks

Both Oregon and Washington have adopted key elements of the new frameworks into guiding visions for state policy, either within or as replacement of inherited state solid waste management plans.[21]

The Oregon Environmental Quality Commission in 2012 adopted, *Materials Management in Oregon: 2050 Vision and Framework for Action*. "We take into account the full impacts of materials throughout their life cycle. We minimize harmful disturbance of land and natural ecosystems, using resources in a responsible way only as necessary to meet human needs and maintain healthy, vibrant and prosperous communities."

Scott Cassel
Product Stewardship Institute

"We need to have a dynamic view, and not a static view. Today an LCA might yield a net cost. After targeted investments, it could yield a net benefit."

Washington has adopted a *Vision for Moving Washington Beyond Waste and Toxics*. "We can transition to a society where waste is viewed as inefficient, and where most wastes and toxic substances have been eliminated. This will contribute to economic, social and environmental vitality." The vision strongly incorporates SMM: "The sustainable materials management approach focuses on waste prevention as a way to reduce harmful effects on environmental health and climate effects while strengthening the economy. This approach emphasizes the importance of looking at the full life cycle of materials: design and manufacturing, use, and end of life."

Local jurisdictions are also bringing the new framework into local solid waste management plans, among them the region's two largest:

Washington State Department of Ecology

Oregon Metro's 2030 Solid Waste Plan, adopted in March 2019, serving 1.5 million people in a region spanning three counties and 24 cities including Portland, is groundbreaking because it takes steps to address the entire life cycle of products. "The goals and actions are designed to not only improve the way we manage materials at the end of their life, but also to reduce harmful impacts by intervening earlier. There's opportunity to improve how we design and produce products, extract raw materials from the Earth, make purchasing decisions and use what we buy. The traditional garbage and recycling system, which handles products and packaging after we are done with them, is just one part of this larger system."[22]

The King County Solid Waste Plan, adopted in November 2019, serves 1.5 million residents of the Washington State's largest county. Like Metro's, King County's new plan incorporates a set of policies to reduce impacts across the life cycle of materials. One target: "Prevent waste generation by focusing on upstream activities, including encouraging sustainable consumption behaviors, such as buying only what one needs, buying durable, buying secondhand, sharing, reusing, repairing and repurposing."[23]

21 WA Dept. of Ecology. *The State Solid and Hazardous Waste Plan: Moving Washington Beyond Waste and Toxics*, June, 2015 and Oregon Environmental Quality Commission. *Materials Management in Oregon: 2050 Vision and Framework for Action*, December, 2012.

22 Oregon Metro. *2030 Regional Waste Plan: Equity, Health and the Environment*. 7 March, 2019, p. 10.

23 King County Department of Natural Resources and Parks, Solid Waste Division. *2019 Solid Waste Comprehensive Management Plan*. Attachment A, Chapter 4, Updated November, 2019.

Chapter 3: Paradigm Shift!

Clean Score! A Nutritional Label for Materials

For this Clean Materials blueprint, we propose a riff on the idea of nutritional labels – Clean Score.

Whether we're a busy family, local business, waste professional, or policymaker in this space, all of us need clear, simple, reliable ways to see which product choices are better or worse for the planet.

Like nutritional labels on food – standard and ubiquitous on packaged food today – we need environmental truth-in-labeling for products. **Transparency of life cycle impacts, specific to each product, will create the essential information pipeline needed** to easily, reliably see which options are best for the environment.

Clean Score is inspired by Walk Score, a walkability index that assigns a numerical walkability score to any address in the U.S. It is publicly searchable – which makes it pretty transparent. Walk Score uses an algorithm that awards points based on walking distance to the closest amenities. According to Walk Score's creators, "The number of nearby amenities is the leading predictor of whether people walk."[1]

Clean Score will score the life cycle environmental footprint of any product sold in the Pacific Northwest, just as Walk Score can score proximity to amenities for any address. Best-available LCA science will inform Clean Score calculations.

Transparency of impacts is also essential for policymakers to better design policy for lasting environmental and community benefits. *But can LCA really scale up, standardize, and become ubiquitous?*

> "I've always envisioned that we'd get to Carbon Disclosure laws where the life cycle carbon impacts would be reported on the label of the product, like nutritional facts," Kyle Diesner at City of Portland says. "We can get there. Everyone just has to agree on the protocols and standards for calculating, and then set laws about what disclosure looks like. We've done this in a variety of other contexts. No country or state is leading the way on developing the protocol and standard system yet. But we do need to have this in place to get to the 2040 vision."

Forging agreement on Clean Score protocols and standards could be a lot more complex than for Walk Score. For example, there are many different kinds of environmental impacts in the life cycle of materials – how can these very different impacts be weighted and melded to create a score?

In recognition of these wide-ranging impacts, we recommend that the initial version of Clean Score center on scoring the climate footprint of products, along with a toxicity 5-point color scale – best-to-worst gradations of green-yellow-red. This is both technically doable and strategic, as products that attain a good clean score for climate and a low-toxics footprint will tend to do well in reducing other environmental impacts as well.

Clean Score should rely on LCA science that utilizes and integrates the best tools developed globally for scoring and comparing environmental and health performance. These include Northwest Green Chemistry's PriSM tool, the EU's Product Environmental Footprint, the Pharos Project, Cradle-to-Cradle certification, the Living Product Challenge, and more.

Walk Score is publicly searchable, but at the same time it's the flagship product of a private company (headquartered in Seattle). Could Clean Score be the public access product of a private company that figures out the right algorithm to become the industry standard? Or is Clean Score by nature a public asset, relied on to be objective, not bias-able by any private or special interest?

We don't yet know the answer. But we do know that the Northwest will need good tools to make the right Clean Materials choices and forge the path to a world-class 2040 system.

1 Wikipedia contributors. "Walk Score." *Wikipedia, The Free Encyclopedia*. https://en.wikipedia.org/wiki/Walk_Score. Accessed Dec. 2019.

PART C: The Northwest Leadership Blueprint

Chapter 4 New State Clean Materials Framework Legislation

Chapter 4 provides the blueprint for policymakers to put the Northwest on the right trajectory to build a truly world-class Clean Materials economy.

To realize this vision, Northwest policymakers will need to take the lead and be bold. Clean Materials needs to be on policy par with Clean Energy. Both Oregon and Washington have adopted big goals and clear targets for clean energy and climate pollution, and those goals and targets have driven real action and created real jobs.

To adopt the big goals and clear targets that are needed, the 2040 Northwest Leadership Blueprint calls for major new statewide Clean Materials framework legislation to comprehensively refresh and supersede the solid waste and recycling legislation of the past.

This strategic blueprint is intended to serve as the playbook to achieve an ambitious vision for 2040 and transform our solid waste management system into something much better.

The vision at the center, the 2040 destination of the blueprint, is ambitious and inspiring:

> ***Northwest Clean Materials 2040 Vision:*** *Build a world-class Clean Materials infrastructure and economy by 2040, that shrinks our environmental footprint dramatically, and supports tens of thousands of good Clean Materials jobs throughout the region.*

Chapter 4 proposes that Clean Materials framework legislation establish 5 Big Goals for 2040; replace the traditional 'waste management hierarchy' with a set of mutually reinforcing 'Diamond' solutions; and set in motion five cross-cutting policies to get the region on the right trajectory from the get-go.

Over two dozen Washington legislators have toured Denmark together with CSI since 2017; returning home to collaborate on groundbreaking bipartisan 'Industrial Symbiosis' legislation.

A New Policy Framework for Clean Materials Leadership

To realize this positive vision, Northwest policymakers will need to take the lead. An ambitious transformation like this must be driven by bold leadership from state, as well as local, policymakers at least as aggressive and sustained as Northwest policymakers' push for Clean Energy.

That's why this 2040 blueprint for Clean Materials leadership calls for major new statewide Clean Materials framework legislation.

It all begins with adopting big long-range goals with clear targets. Both Oregon and Washington have done this for clean energy and climate pollution. For Clean Energy, big goals and clear targets have not just delivered significant environmental improvements for the Pacific Northwest. They have also stimulated growth of a major industry-jobs cluster in the region, with hundreds of new businesses, billions in capital investment, and well over 100,000 jobs in wind, solar, efficiency, smart grid, clean vehicles and biofuels, according to E2, a national nonpartisan economy-environment group.[24]

Can Clean Materials also become a big driver of broadly shared prosperity in the Northwest? Clean Materials touches nearly all sectors in our economy, so the range of economic opportunities in Clean Materials excellence is potentially wide-reaching. Chapter 6 explores this question and opportunity in more detail.

Five Big Goals

The following Five Big Goals give focus to the overriding purpose of state Clean Materials framework legislation: to steer the Northwest into a global leadership role in Clean Materials that protects public health and our environment and generates rich economic benefits and tens of thousands of good job for Oregon and Washington. These 5 Big Goals constitute the ultimate success metrics for the legislation.

24 E2. Clean Jobs Washington. Dec. 2018.

Chapter 4: New State Clean Materials Framework Legislation

Tony Overman / The News Tribune

A recycling depot serving Tacoma residents and businesses.

The first two Goals are the highest-level outcomes that define environmental and economic excellence in the Northwest's Clean Materials system in 2040. The next three are key strategic Goals to drive progress toward the high-level outcomes:

- **Goal 1: Shrink the Health and Environmental Impacts of our Stuff by 80%:** Improve the aggregate life cycle Clean Score of products and packaging purchased in WA and OR in 2040 by 80% above 2020 scores.
- **Goal 2: Build a World-class Industry-Jobs Cluster in Clean Materials Solutions:** Grow total Clean Materials jobs and wages throughout the Northwest to place the region in the Top 5 globally by 2040.
- **Goal 3: Cut Discards by Half, Recycle Most of the Rest:** Reduce the total volume of materials discarded in 2040 to 50% below 2020 levels by investing in Clean Materials 'Diamond' solutions (see next section) that prevent waste and extend product life. Recycle 80% of what's left at clean production hubs creating new products that achieve top-tier (80th percentile) Clean Score.
- **Goal 4: Invest in Local Clean Materials Infrastructure, R&D and Jobs:** Ensure at least 80% of revenue from collection and processing of materials is re-invested into 'Diamond' solutions. Establish the Pacific Northwest as a recognized global leader in Clean Materials R&D.
- **Goal 5: Export Clean Materials Solutions Globally:** Foster a constellation of 'traded sector' companies delivering expert services and innovative products to other regions in 2040 that improve their customers' climate footprint, by more in total each year than the Northwest's climate footprint for the year 2020. (This is how we can redress our past environmental impact while growing jobs.)

These Five Big Goals set clear targets designed to define our 2040 destination, a set of fixed points we can use to navigate our way and track our progress, guided continuously as we go by our 'North Star', the Clean Materials system we want for the Northwest.

A Solutions Diamond to Replace the Waste Hierarchy

The solid waste management "hierarchy" was enshrined in 1970s-era framework legislation in Washington, Oregon and many other states. But this approach has three chronic problems that make it ripe for a rethink.

- **First**, the solid waste hierarchy sets priorities in state law, but it has failed to deliver the greatest share of the waste sector's resources, effort, investment and results into its highest priorities.
- **Second**, this hierarchy of priorities steers us to think in silos and devise programs in separate categories, such as waste reduction, reuse, or recycling. But these solutions often overlap and complement each other, which is why strategies developed in silos may not get the best economic and environment benefit for the buck.
- **Third**, the hierarchy can limit solutions by framing the problem to be one of solid waste alone, downplaying the importance of higher-order goals such as conserving resources, preventing toxics and reducing pollution.

To refresh the waste hierarchy, the Blueprint proposes that state Clean Materials framework legislation also enshrine a different metaphor to express the highest priority solutions and guide the greatest share of resources to flow into the most effective solutions strategies.

The metaphor we suggest is a **Clean Materials Diamond** – a set of priority solutions to unlock Pacific Northwest clean materials excellence. Diamond solutions are interconnected, essential facets of a whole – not ranked one above the other. Diamond solutions:

- Prevent waste at all stages
- Get longer life and more use from products
- Optimize recycling
- Develop clean production and processing hubs

Diamond solution sets are not meant to be pursued separately, but instead as integrated and mutually-reinforcing strategies to advance the 5 Big Goals for 2040. Diamond solutions encourage cross-over and coordination, and the best innovations often do more than one thing – for example, prevent waste, increase product sharing, and optimize recycling at the same the time.

While Diamond solutions should be designed in a coordinated way, the old solid waste hierarchy that prioritizes waste prevention and getting longer life and more use from products reflects a sound premise – these strategies

The Northwest Leadership Blueprint

typically offer the greatest potential to reduce life cycle environmental impacts. Yet they have been hampered by chronic underinvestment relative to strategies lower on the hierarchy, such as recycling, composting, and landfilling. Policymakers will need to ensure spending on Diamond solutions is well-balanced, and does not underinvest in waste prevention and longer product life, even though today these strategies are less developed.

State framework legislation should recognize that in a world-class 2040 Clean Materials system most of the money paid by the public and businesses for materials collection and processing, and for solid waste taxes and fees, will be re-invested into Diamond solutions.

Policymakers should establish metrics and mechanisms to ensure an increasing share of resources goes into Diamond solutions, and that spending delivers continuous improvement in the environmental and economic results called for in the 5 Big Goals.

Framework legislation could also refresh directives for local Solid Waste Management Plans to require a growing investment share into effective Diamond solutions.

The Clean Materials Diamond solutions are discussed in detail in Chapter 5 – World-Class Clean Materials Infrastructure.

5 Cross-Cutting Policies to Accelerate Diamond Solutions

New state Clean Materials framework legislation will set system-wide 2040 goals and performance metrics. To achieve these big targets and steer public and private action and investment into Diamond solutions, framework legislation will also set in motion **a set of 5 key cross-cutting policy elements:**

1. Extended Producer Responsibility 2.0
2. Standardize and Scale Clean Score Transparency
3. West Coast Clean Materials Alliance
4. Buy Clean
5. Clean Materials Industry-Jobs Action Strategy

Cross-Cutting Policy 1: *Extended Producer Responsibility 2.0*

Our neighbors to the North in British Columbia are among global leaders in putting producers in charge of their discarded products and packaging. The policy approach is called "**Extended Producer Responsibility**" (**EPR**), and to date it has focused primarily on improving recycling of materials.

This Clean Materials Blueprint proposes that Oregon and Washington policymakers build on the best of EPR recycling programs in BC and elsewhere, to adopt more comprehensive, next-generation EPR (EPR 2.0) that requires producers not simply to improve recycling, but to optimize across all four Clean Materials Diamond solutions to deliver continuous improvement in Clean Scores.

Under EPR-for-recycling, producers of goods are responsible for end-of-life management, meaning that they fund systems to recycle and dispose of their products when people are done with them. This takes financial burden off municipalities, and places it on producers, who typically join together in product categories to collect and manage the discards. Ideally, producers are incentivized to redesign their products to reduce waste and to improve recyclability.

Look North for a Global Leader

EPR is in effect in most European nations, Russia and Canada, and is going into effect in countries including Brazil, South Africa, China and India.[25] But Northwest states can look just north to one of the world's more comprehensive EPR systems in British Columbia (BC). Producers in BC, instead of handling their products alone, join in a wide variety of industry associations to manage collection, processing and marketing of their products when we discard them. They cover a wide spectrum including beverage containers, electronics and electrical goods, batteries, packaging and printed paper, paints, solvents, pesticides, gasoline, pharmaceuticals, tires, and used oil and antifreeze.[26] A pilot program is innovating recycling of

25 Bell, Victor. "Product Stewardship, What does Global EPR Currently Look Like?" *Environmental Packaging International*, 2 April, 2019.

26 British Columbia Provincial Government. Product Stewardship page. https://www2.gov.bc.ca/gov/content/environment/waste-management/recycling/product-stewardship. Accessed August, 2019.

Chapter 4: New State Clean Materials Framework Legislation

Photo Courtesy of Recycle BC

flexible packaging, important because trends are moving toward replacing cans and jars with these plastic laminates, which are unrecyclable in most systems.

With EPR, BC has achieved an impressive overall recycling recovery rate of 75%, with growth goals targeting 78% by 2022.[27]

BC's approach to EPR strongly emphasizes building local processing and markets for recycled materials, as opposed to exporting overseas. Says Scott Cassel, "British Columbia has the latest version of the law that most of us here in the US would like to see implemented."

With the caveat that waste reduction must be the priority, Heather Trim, Executive Director of Zero Waste Washington, sees the BC system as the target for recycling. "It is way better. The whole province is one waste-shed. It completely changes the system."

Northwest states have some meaningful experience with EPR, including some pioneering efforts dating back as far as the Oregon Bottle Bill. Washington State boasts the first fully-funded EPR in the U.S. for certain electronics, and also has EPR for solar panels, mercury-containing lights, pharmaceuticals, and paint. Oregon followed Washington with EPR for certain electronics, but in 2009 led the nation with the first EPR for paint. Washington followed only in 2019, adding to a list that now includes California, Colorado, Minnesota, Connecticut, Rhode Island, Maine, Vermont and Washington, D.C.[28] Oregon's legislature in 2019 added statewide EPR for waste pharmaceuticals.

Among King County, WA's **Responsible Recycling Task Force** (**RRTF**) highest priority policy recommendations include a comprehensive statewide EPR approach for all packaging and support for an initial EPR bill for just plastic packaging. That plastic packaging EPR bill in the 2019 Washington Legislature, HB 1204/SB 5397, which eventually passed as a study bill,[29] included several innovations:

- Producers fully fund and organize the plastic packaging management system.
- Fees paid by producers for their products modulated to reward design innovation.
- Addresses not just disposal and recycling, but also prevention of litter and ocean garbage, as well as plastic contamination in compost.
- Sets minimum recycled content standards and then allows a system to trade recycled content credits.
- Does not allow export outside OECD countries.
- Invests in infrastructure: facility upgrades, new facilities, and new technologies.
- Creates a new management hierarchy for plastics that includes chemical recycling.

Marc Daudon
The Caspian Group, LLC

> "The 2040 vision of the future is that producers are stewards of their materials through their entire life cycle – they are internalizing the costs and taking responsibility for their products and packaging."

27 Bell, Victor. "Product Stewardship, What does Global EPR Currently Look Like?" *Environmental Packaging International*, 2 April, 2019.

28 Scholwinski, Catelyn. "Washington becomes 10th state to pass EPR for paint." *Waste Dive*, 16 May, 2019.

29 WA Legislature. *Final Bill Report E2SSB 5397*. 28 July, 2019.

The Northwest Leadership Blueprint

Next-Generation EPR

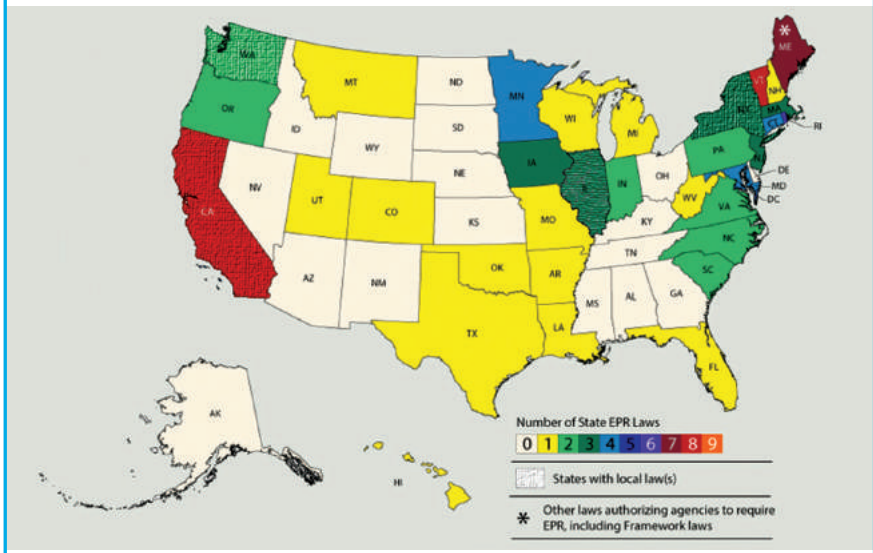
EPR 1.0 has accomplished some very important things. Under EPR today, industry is organized within product categories and required to design, pay for and deliver collection and recycling service. They submit Stewardship Plans for approval by state or provincial government that set performance targets that producers are accountable to achieve. Crucially, performance is expected to continuously improve over time.

EPR 2.0 builds on that remarkable foundation to optimize across all four Clean Materials Diamond solutions to deliver continuous improvement in Clean Scores.

EPR 2.0 broadens the performance measures for Stewardship Organizations beyond recycling to incentive Clean Materials Diamond solutions in a wide range of product categories, requiring improvement over time and driving Clean Materials excellence in the Northwest. For example, EPR 2.0 performance measures can include:

- Steady improvement in overall Clean Score of products sold in-state, to shrink the total life cycle, supply chain environmental impacts.
- Increase investment and improve return-on-investment in Diamond solutions.
- Establish Clean Score minimum performance standards for product categories, modeled on energy efficiency standards (for appliances, for example) that ratchet up at regular intervals as technology improves.
- Reward producers that redesign their product and packaging strategies to achieve substantial improvements in Clean Score.

States with Extended Producer Responsibility Laws (EPR)



State EPR laws apply to a variety of product categories: Auto Switches; Batteries; Carpet; Cell Phones; Electronics; Flourescent Lighting; Mattresses; Mercury Thermostats; Paint; Pesticide Containers; Pharmaceuticals

Source: Product Stewardship Institute, Inc. (PSI) 2020

Cross-Cutting Policy 2: *Standardize and Scale Clean Score Transparency*

A lynchpin of the Clean Materials framework are LCAs that are comprehensive, standardized, comparable, ubiquitous and therefore cheap. LCAs track environmental impacts of materials in products from resource extraction, through processing, production and delivery.

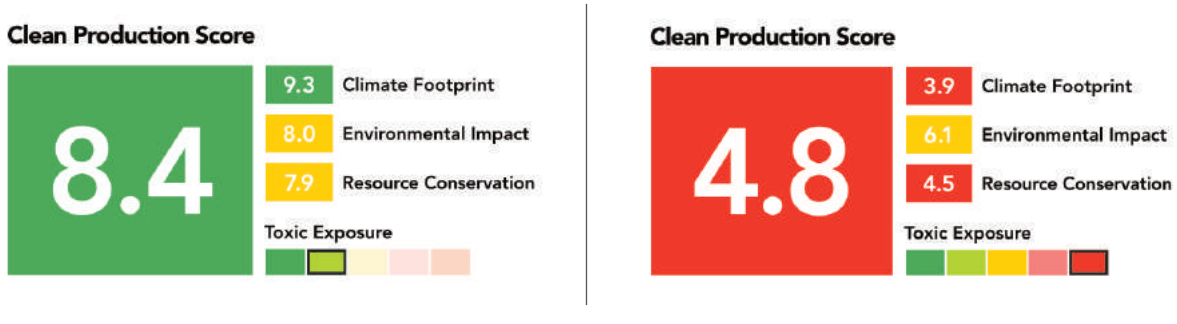
In a fully realized Clean Materials system, LCAs are standardized and required for all products and packaging sold in the Northwest, expressed in Clean Score labeling. This transparency of life cycle impacts is essential to inform action at all levels to achieve Big Goal #1, in particular, to shrink the health and environmental impacts of our purchases by 80%.

To be useful in the Clean Materials framework, LCAs need to be able to supply Clean Scores specific to individual product lines, based on life cycle health and environmental impacts, that are as standardized and transparent as nutritional labels on packaged foods. To get there, in the coming years LCAs will need to be increasingly required, routine and ubiquitous. That is key to bring down the cost (currently $30,000 or more for a single LCA), to standardize methods, and to scale up, so that LCAs can be used to calculate and differentiate impacts specific to the supply chains and manufacturing processes of specific companies' product lines.

The idea of Clean Score adapts the Walk Score model, which assigns a numerical walkability score to any U.S. address. Clean Score will assign numerical scores to any product and package, based on life cycle environmental impacts. Because those impacts are very diverse, a Clean Score algorithm factoring in all of them will be complex and challenging to develop. That is why we recommend that the initial version of Clean Score center on scoring the climate footprint of products, along with a toxicity 5-point color scale – gradations of red-yellow-green. That said, subsequent versions of Clean Score need to move rapidly to score other key categories of environmental impact necessary to conserve resources, prevent chemicals from entering human bodies, and reduce pollution.

Chapter 4: New State Clean Materials Framework Legislation

Imagining How Clean Score Labels Might Look



To build the needed capacity in LCA science and practice will require serious, focused upfront investment by Washington and Oregon, perhaps in partnership with California and BC, to stand up LCA protocols and practices within 5 years.

The credibility and impartiality of LCA science is essential to a workable Clean Score system. Development of the Clean Score scientific framework needs to be transparent and open to public participation. It needs to credit and incentivize excellence in Diamond solutions and smart design. And it needs to utilize and build on the best available science and robust methodologies and standards developed around the world.

Oregon and Washington's top environmental agencies, DEQ in Oregon and Ecology in Washington, can be assigned rulemaking to create LCA protocols, which can be effective and efficient. On the other hand, both agencies carry out a wide variety of regulatory functions which have resulted in complex political histories and baggage with many stakeholders that could affect credibility of protocols for LCA science. One alternative to agency rulemaking:

- Establish a Bi-State Board for Life Cycle Assessment that creates the protocols for what must be accounted for, and to standardize the conduct and reporting of LCAs.
- The Board could also administer a Professional Certification program, in partnership with certification programs of the American Council for Life Cycle Assessment to train professionals to comply with LCA protocols.

No matter which strategy is adopted to implement transparent LCA science and Clean Score accounting, our states should partner with universities and research institutions to make the Northwest a center of LCA excellence, as the region has become for energy efficiency.

Cross-Cutting Policy 3: *West Coast Clean Materials Alliance*

To maximize positive and lasting impact from spending and investment in Diamond solutions, the third of the Blueprint's cross-cutting policy recommendation is to establish a **West Coast Clean Materials Alliance** (**WC-CMA**), modelled on the **Northwest Energy Efficiency Alliance** (**NEEA**).

The role of a WC-CMA, like NEEA, will be to pool dollars from multiple agencies to pursue 'market transformation' opportunities. The goal is to achieve greater lasting impact and benefits for funder dollars than individual agencies could achieve on their own. WC-CMA could launch as a partnership of Oregon and Washington but will have greater impact as an alliance that includes California and British Columbia.

NEEA is an alliance of more than 140 energy utilities and energy efficiency organizations in Oregon, Washington, Idaho and Montana serving 13 million energy consumers. It was established in 1996 to accelerate the impact of energy efficiency investments in the Northwest's electricity sector by serving as a vehicle for multiple utilities to pool dollars. Their purpose: To achieve much greater and lasting energy savings at a lower cost than they could accomplish on their own.

NEEA's market transformation programs target opportunities to bring new technology and standards to specific markets that can catalyze an enduring shift toward using electricity more precisely and efficiently. When NEEA succeeds in spurring lasting shifts in the marketplace, the benefits of energy savings continue for years to come, while the need for ongoing funding from NEEA does not.

NEEA develops 5-year Business Plans that set energy savings and ROI targets which are tracked to measure performance of the various programs and initiatives in the investment portfolio. NEEA represents an excellent, transparent, proven model for WC-CMA.

Like NEEA, a WC-CMA would utilize a technology and market savvy staff, board and advisory groups that engage

The Northwest Leadership Blueprint

Regional Energy Efficiency Organizations

Like NEEA, a West Coast Clean Materials Alliance will pool dollars from multiple agencies to get greater bang for everyone's buck.

Copyright NEEA 2020

top innovators and experts, and the marketing capacity of its broad alliance, to strategically transform markets to achieve the twin goals of reducing environmental impacts at all stages and excelling in delivering cost-effective Clean Materials solutions.

Like NEEA, WC-CMA will have gravitational pull. It will provide a venue for coordinating efforts to spur and inform innovation on a regional and multi-state basis. It will serve as a magnet for Clean Materials expertise and rocket fuel for innovation in the sector. And a California-Oregon-Washington-British Columbia alliance will have enough market pull to convince national producers and brands to play ball.

How will WC-CMA be funded? In 2018, NEEA deployed an annual budget of $38 million to advance energy efficiency on behalf of 13 million customers. A West Coast-wide alliance will serve the interests of several times more customers, so a $40 million annual budget for the WC-CMA could be considered an initial annual budget floor.

One funding model for WC-CMA to consider adapting: Oregon's 3% 'public purpose charge' on electricity sales, which is used to fund energy efficiency, development of new renewable energy, and low-income weatherization projects throughout the state.

For Clean Materials, WC-CMA could be financed by a 1-1.5% 'public purpose charge' on solid waste. Currently, Washington charges a 3.6% 'Refuse Tax' on the collection, transfer, storage, or disposal of solid waste, which generates about $10 million per 1% tax.[30] California charges an Integrated Waste Management Fee of $1.40 per ton of solid waste entering disposal facilities, which totaled 42.7 million tons of waste in 2016, generating about $60 million. Currently, Oregon's solid waste disposal fee is $1.18 per ton. Each of these solid waste taxes and fees are currently directed to, arguably, important state purposes, so WC-CMA funding may best come from a new public purpose charge dedicated specifically to the WC-CMA.

The WC-CMA will track performance and return-on-investment of its market transformation initiatives to ensure smart and effective deployment of the pooled funds. Performance results will inform each new five-year WC-CMA Business Plan's design of the next wave of initiatives to accelerate lasting progress toward the 5 Big Goals.

Cross-Cutting Policy 4: *Buy Clean*

Government agencies and institutions influence a lot of purchasing decisions, which gives state policymakers opportunity to bump market demand toward Clean Materials. Policymakers can reform state purchasing policies to shrink health and environmental impacts, and spur market transformation by incentivizing others to follow the state's lead. This is in process in Washington State where Executive Order 18-01 created the **State Efficiency and Environmental Performance** (**SEEP**) Office. SEEP works with state agency partners to achieve reductions in greenhouse gas emissions and eliminate toxic materials from state agency operations.[31]

California's first-of-its-kind 'Buy Clean' legislation sets minimum standards for materials used in public construction projects. It covers carbon steel rebar, structural steel, flat glass, and mineral wool insulation board in state construction and refurbishment products. Bidders are required to submit Environmental Product Declarations, which are something like the nutritional labels on food. By July 2021, products and delivery emissions must not exceed a **Greenhouse Gas** (**GHG**) benchmark.[32] So far, California's Buy Clean focuses on life cycle carbon emissions, but it could be extended to other areas such as toxics. Buy Clean legislation is under consideration in Oregon and Washington as well.

30 DSM Environmental Services. *Analysis of the Potential to Raise Revenue By Imposing a Service Fee on All Solid Waste Management Transactions*. Report to Vermont Agency of Natural Resources. Final report submitted 23 June, 2015.

31 WA Dept. of Commerce. "State efficiency and environmental performance (SEEP). https://www.commerce.wa.gov/growing-the-economy/energy/state-efficiency-and-environmental-performance-seep/. Accessed Aug. 2019.

32 Killpack, Keith. "The 'Buy Clean California' Act Requires Increased Environmental Transparency from Building Product Manufacturers." *3BL Media*, 3 October, 2018.

Chapter 4: New State Clean Materials Framework Legislation

The next wave of Buy Clean policy strategies will build on this first groundbreaking legislation. Next-Gen Buy Clean will:

- Reform state purchasing across many more product categories.
- Establish performance targets to improve the Clean Score of state purchases steadily over time, by setting aggressive targets and timelines for continuous improvement.
- Form Buy Clean buyers' clubs to aggregate purchasing power, and incentivize local governments, companies, institutions, and residents to Buy Clean.

Cross-Cutting Policy 5: *Clean Materials Industry-Jobs Action Strategy*

A critical component of the Northwest Clean Materials 2040 vision is that it supports tens of thousands of good jobs throughout the region. The Northwest can become a global leader in the Clean Materials economy and thrive economically by fostering dense clusters of innovative manufacturing and service businesses that grow investment, revenues, and tens of thousands of new jobs.

To direct activity and investment toward Clean Materials jobs, the Blueprint recommends another cross-cutting policy action – to launch a robust, comprehensive 18-month statewide effort to create a comprehensive state Clean Materials industry-jobs strategy.

This pathway is fleshed out in Chapter 6.

Teresa Conner
British Columbia Provincial Government

"As we move toward a world with 10 billion people, we have to be more efficient in everything we do. To have a more efficient system, producing less waste has significant impact."

We Need to Change So Much! How Do We Get Started?

By Ted Sturdevant, Center for Sustainable Infrastructure

The policies called for in this report hold great promise for achieving Clean Materials excellence and jobs, but will clearly take time to develop, adopt and implement. But the need for change is urgent, so… *how should we proceed*?

We know we need to learn more in order to adopt some of these new, effective, cross-cutting policies. But **we also know enough, now, to set a clear new course** for our waste management system. While overarching framework legislation is needed to align our collective resources into a clear, unified direction for the coming two decades, many policy changes are envisioned and proposed, and can be advanced separately or together, as they become ripe for consideration and opportunity presents itself. As such, we propose the following approach:

- ***Set the Course.*** First, bring leaders, experts and stakeholders together in conversation to develop the proposed framework legislation. That conversation should consider what specific policies should be included in the legislation, what policies need further development for later proposal and consideration, and what policies do not require legislation to implement. As a clear legislative proposal takes shape in the coming months, work with partners to achieve consideration and adoption of framework legislation.
- ***Take Every Opportunity to Advance the Clean Materials Vision***. Adoption of framework legislation will get everyone moving in a clear direction, and will put wind in our sails for advancing specific elements of the vision. We should be opportunistic about when to push for adoption of specific policies, based on the ripeness of the policy and the readiness of partners to work for passage.

The Northwest Leadership Blueprint

Big Vision, Bold Leadership, and Fair and Open Competition

Let's be clear: This strategic blueprint proposes a dramatic transformation in the next 20 years. It is no easy lift, nor a challenge for the faint of heart.

It calls for a wholesale transition from today's waste and recycling system to a new and better Clean Materials system. It will be better for Northwest communities to the extent that it achieves our two highest Clean Materials 2040 goals: reduce our environmental footprint 80% and generate tens of thousands of jobs throughout the region.

Energy and water infrastructure are midway into a period of profound transition. That is uncomfortably disruptive to the status quo. But change can be good, and it has been in water and energy – because the new infrastructure provides better service at a lower cost and is much better for the environment.[1]

Arguably, the most important way Clean Materials framework legislation will challenge the status quo is by placing new responsibility on the producers and suppliers of the stuff we buy, wherever they are located. Under this framework, product makers will be responsible for reducing the environmental impacts of the materials they produce at all stages of the life cycle, from manufacturing and supply chain through to end-of-life. They are incentivized to maximize efficiency, shrink environmental impacts, and generate value. The policy framework lets industry do what it does best: *find innovative ways to solve problems, save money, and deliver results efficiently.*

Producers will not only pay for and manage collection of the discards in their product category, but they will see powerful market incentivizes that reward companies to clean up supply chains, rethink distribution and delivery strategies, and consider product redesign.

The Clean Materials approach to producer responsibility will indeed require something more of producers – continuous improvement in environmental performance – while promoting free and fair competition and rewarding innovation.

We anticipate a handful of obvious counter-arguments:

Objection: *Requiring product makers to improve their Clean Score will raise the cost of all the products we buy – that is like a big new statewide tax.*

- There is reason to believe otherwise, if Clean Energy is a good analogue for the Clean Materials sector. Clean Energy, in particular energy efficiency investment, has saved money and kept power costs down, in spite of predictions to the contrary.[2] Energy efficiency is – and increasingly wind and solar power are, too – the resource of choice for the utility industry due to its affordability and capacity to manage costs, deploy quickly in small increments, reduce risk, and shrink environmental footprints. Undoubtedly, Clean Materials will spur many product makers to take a good hard, supply chain-wide look at innovative ways to reduce their environmental footprints – and in the process, the smart ones will uncover ways to reduce costs and boost their bottom line.

Objection: *Life Cycle Assessment is a lynchpin of the Clean Materials framework; the system can't work if the science can't supply reliable, comparable scoring at the product level. That's too much to ask of this assessment tool.*

- It's absolutely true that this Clean Materials framework requires LCAs that are standardized and comparable, ubiquitous and therefore cheap. What LCAs need to be able to do is supply Clean Scores specific to individual product lines that are as standardized and transparent as nutritional labels on packaged foods. This will require focused upfront investment in a concentrated effort to stand up LCA protocols and practices within 5 years.

Objection: *This change is just too big to be politically viable.*

- That may be true, depending on the appetite of state policymakers for bold leadership. But one thing in its favor, no matter which communities a policymaker represents – rural, suburban or urban – this strategy can deliver better materials management services, more affordably, while increasing jobs and local economic opportunity than the status quo. That combination of better service and local jobs makes for strong potential bipartisan appeal.

Objection: *This Clean Materials framework amounts to a protectionist trade barrier that gives Northwest producers unfair advantage over those outside the region.*

- It is quite true that this blueprint's second Big Goal for 2040 is to create a Clean Materials industry-jobs cluster in the Northwest of hundreds of businesses, billions in investment, and tens of thousands of jobs. It's also true that the Northwest power grid is cleaner than most and our environmental regulations are strong, so producers here will

Chapter 4: New State Clean Materials Framework Legislation

tend to start with a higher Clean Score compared to producers elsewhere that use dirtier processes. But the Clean Materials framework centers on an open, transparent, fair marketplace that does require producers to meet environmental performance standards. But those standards are chosen and applied fairly to all market actors, irrespective of their locations within or outside the Pacific Northwest. The performance standards are clear and transparent, and they ratchet up gradually over time, providing all producers time to upgrade their environmental performance.

Objection: *The Clean Materials framework legislation would threaten the business model for our current waste management service providers.*

- Many waste haulers and management companies are doing well financially in the current system, in which landfilling is more lucrative than even recycling. The status quo is not delivering the environmental and economic results envisioned in the original 1970s-era solid waste framework legislation, let alone by our Clean Materials vision for environmental excellence and local economic vitality. The good news for waste companies willing to innovate and align their business strategies with the Clean Materials Diamond solutions is that these solutions open up a wide array of opportunities to provide valuable and potentially lucrative services.

The need is urgent to dramatically reduce the damage we collectively do to human health and our planet. Northwesterners are right to demand policies to take responsibility to shrink our footprint, including the impacts of the products we buy. And we are right to demand an infrastructure and jobs strategy that builds Clean Materials excellence and economic vitality in all our communities.

1 Center for Sustainable Infrastructure. *Rewiring the Northwest's Energy Infrastructure*. February 2016; Center for Sustainable Infrastructure. *A Northwest Vision for 2040 Water Infrastructure*. April 2017.

2 NW Energy Coalition. "Fact vs. inference: the truth about the economic impact of Washington's clean electricity standard." 29 Nov. 2018.

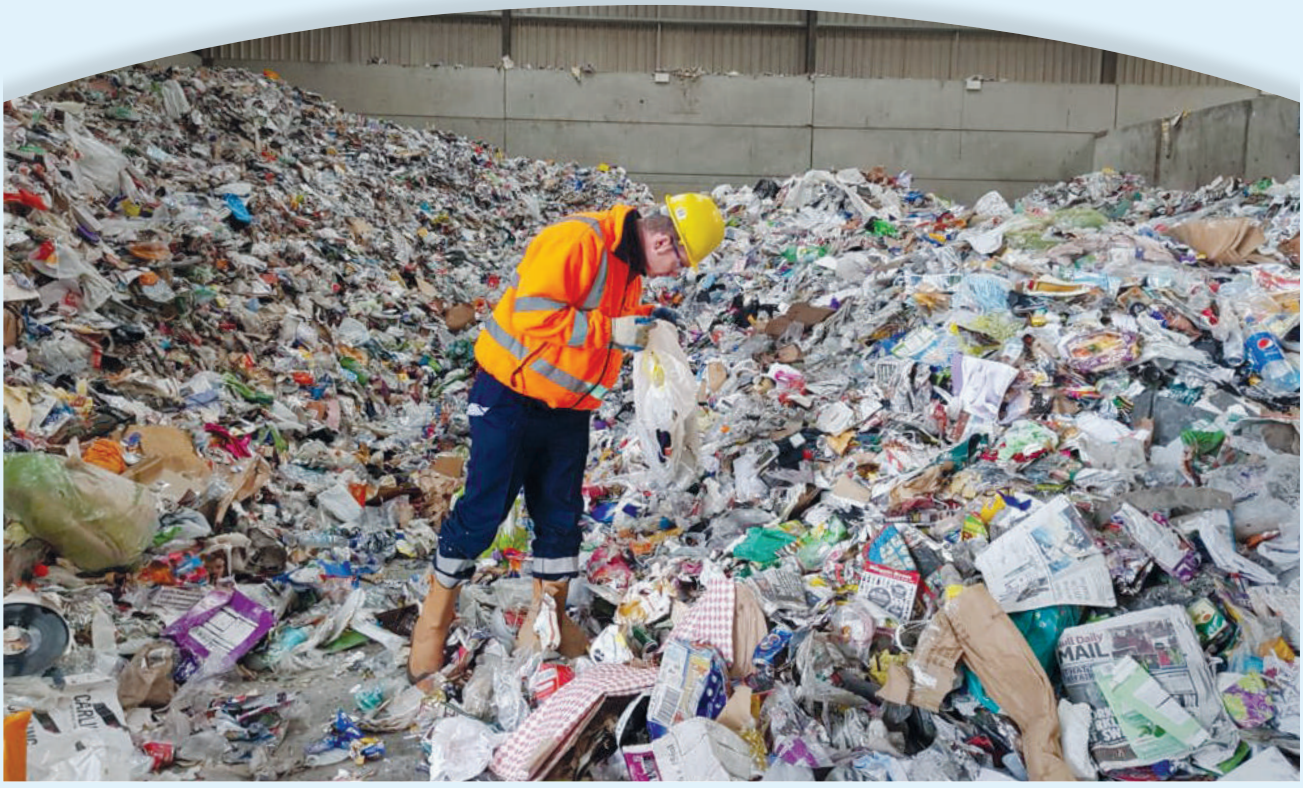


Photo Courtesy of Hull CC News

The Northwest Leadership Blueprint

Chapter 5 World-Class Clean Materials Infrastructure

Chapter 5 vaults into the future to show what a world-class Clean Materials system could look like in 2040.

Strong and sustained Clean Materials policy, designed to achieve bold and specific goals, will drive innovation that shrinks environmental footprints, controls costs for the public, and creates new clean industry and jobs. New and reimagined enterprises, both public and private, will deliver new types of services and infrastructure – Diamond solutions – that cut various waste streams; enable reuse, share and repair services; optimize recycling; and develop state-of-the-art clean production and processing hubs.

Some of the most important actors in developing world-class Clean Materials infrastructure in the Northwest will be the service providers whom we pay to collect and manage our stuff when we discard it. In Washington alone, the public pays about $1 billion a year for these services.[33] In a world-class system, these entities will deploy the lion's share of these funds to develop and operate Clean Materials infrastructure that advances Diamond solutions. These important infrastructure-makers include:

- Utilities and public agencies, both state and local
- Stewardship organizations established by producers under EPR mandates
- Waste and recycling service providers

Chapter 5 looks toward today's Clean Materials innovators and promising trends to begin to outline the kinds of Diamond solutions that will define world-class Clean Materials infrastructure in 2040.

Vaulting into the Future

The 2040 Clean Materials blueprint points the way for the Northwest to not only become a global leader in reducing impacts on the planet, but to leverage that leadership to build prosperity – new businesses and broadly accessible jobs for people in all parts of the region. Regions that lead the way in Clean Materials solutions will grow a wide variety of innovative programs, companies and jobs to deliver new types of services and infrastructure, *Diamond solutions*, that:

- Prevent Waste at All Stages
- Get Longer Life and More Use from Products
- Optimize Recycling
- Develop Clean Production and Processing Hubs

While some aspects of Clean Materials infrastructure in 2040 will look quite similar to today's, **we should expect surprising and disruptive changes in the culture, economy, and environment** that will impact materials streams in important ways. *So, Clean Materials infrastructure investment strategies need to be flexible and resilient in the face of disruptive change.*

New technologies and market shifts will undoubtedly disrupt the status quo in surprising ways, for better or for worse. For example:

- **3D Printing** is coming on quickly and could change the way everyone from individuals to manufacturers to construction firms build things. 3D Printing makes a three-dimensional object from a digital file by laying down successive layers of material, usually metal or plastic, from the bottom up. This layering is why it's also call Additive Manufacturing. Will 3D Printing result in new sources of toxic off-gassing is people's homes and workplaces? Will material feedstocks be clean, toxic-free and recyclable?
- **Carbon Capture and Utilization (CCU)** technologies pull carbon dioxide from the air, where it is a climate-warming pollutant, to feed value into products and services. By some estimates, it's a potentially $1 trillion market by 2030. CCU machines either pull CO2 from exhaust gases from power stations and industrial facilities, or suck outdoor air anywhere across an absorbing medium to which carbon sticks. Each has advantages and drawbacks, but both reduce carbon pollution in the atmosphere by converting it into valuable feedstock for productive uses.[34]

Strong and sustained Clean Materials policy, that sets bold targets, can drive innovation in technology and to redesign products and services, helping steer shifting markets to accelerate progress toward a 2040 world-class system.

Infrastructure When Clean Materials Solutions are the Top Priority

The 2040 Clean Materials infrastructure will in many ways look like today's waste and recycling infrastructure. There will still be curbside collection of trash, recyclables and organics. There will still be landfill disposal of trash, but much less if we do the job right. Some recyclables will likely still be sorted in Materials Recovery Facilities, but with much greater technological sophistication that minimizes contamination. Other recyclables will be collected separately, never mixed with other materials, with specialized pathways back into new clean production. Much composting may still take place in large facilities, but new "biorefineries" will also emerge that process multiple organic waste inputs and generate multiple products to maximize value.

But to meet the larger challenges, waste management agencies and service providers must reinvent themselves as part of a larger ecosystem of public and private institutions to create a clean materials infrastructure. In the Clean Materials system, stewardship organizations, utilities, and

33 Estimate based on state Refuse Tax revenues for 2014.

34 Roberts, David. "Pulling CO2 out of the air and using it could be a trillion-dollar business." *Vox*, 22 Nov. 2019.

Chapter 5: World-Class Clean Materials Infrastructure

other service providers will still collect funds paid by the public and businesses in order to provide services and build infrastructure. As the cross-cutting policies under state framework legislation take effect, the operating environment and business incentives will change for these service providers, as well as for product manufacturers, and their business strategies will need to align with our states' 5 Big Goals for 2040. Their infrastructure spending will steadily shift toward Diamond solutions, opening opportunities for innovative services and enterprises that can deliver superior results at lower cost.

Today's waste and recycling system is wired to invest most ratepayer resources in managing materials at end-of life – when we toss products and packaging. In spite of the waste management hierarchy written into law which prioritizes waste reduction and reuse over recycling and disposal, the persistent fact is that the lion's share of spending and investment is nevertheless directed to managing discards and recyclables.

In contrast, the Clean Materials framework will shift spending from lower priorities to higher. In fact, it replaces the solid waste hierarchy with an interconnected set of Clean Materials Diamond solutions. Diamond solutions represent the real priorities to deliver the greatest positive results, and so deserve the bulk of spending and investment.

This chapter explores world-class infrastructure of 2040 through the lens of our proposed Clean Materials Diamond solution sets. Remember, Diamond solutions are not meant to be pursued separately, but instead as integrated, mutually-reinforcing, well-balanced portfolios to advance the 5 Big Goals for 2040. Diamond solutions:

- Prevent Waste at All Stages
- Get Longer Life and More Use from Products
- Optimize Recycling
- Develop Clean Production and Processing Hubs

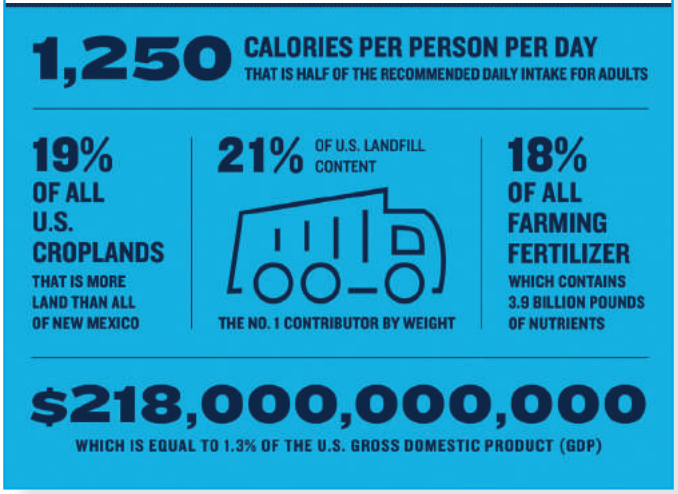
Diamond Solution: *Prevent Waste at All Stages*

Waste prevention exemplifies how interconnected these Diamond solutions are. Preventing waste can be achieved in a number of ways. Some of the best include strategies to get longer life and more use from products, such as lending libraries, lease models, and product reuse, including refillable, returnable and reusable food service products and other packaging. Product redesign and clean production are also important ways to prevent waste.

The 2040 Clean Materials system will prevent waste at all stages of material life cycles. Key waste prevention strategies include:

- Incentivizing Product Redesign
- Preventing Food Waste
- Supporting Sustainable Consumption, Banning Wasteful Products

Food Waste in the US: By the Numbers



Source: Natural Resources Defense Council

Incentivizing Product Redesign

Life cycle thinking can be applied to the design of our products and packaging, and to the design of the supply chains and manufacturing processes which produce them. By considering all the stages holistically, product designers, industrial process designers, and business strategists can discover new, smarter ways to serve peoples' needs better, with less cost, risk, and environmental damage. Smarter designs do the job they exist to do as well or better, but reduce environmental impacts across the supply chain, and ensure easy, clean and valuable cycling of materials after their current useful life.

Product redesign includes rethinking packaging. In an early Northwest leadership example, Oregon DEQ in the early 2000s helped businesses – including Norm Thompson Outfitters, Williams-Sonoma and Office Max – reduce their packaging material. Together the companies saved nearly $1 million annually and reduced solid waste generation almost 500 tons. Around 10% of that reduction took place directly in Oregon.[35] Another example comes from France, where they charge modulated fees to discourage wasteful packaging, with higher producer penalties for less recyclable items.[36]

Preventing Food Waste

Wasted food represents a stunningly large portion of all food that is grown. **Natural Resources Defense Council** (**NRDC**) puts the overall loss at 40%, amounting to 1,250 calories per person per day and 20% of U.S. landfill content. Tremendous amounts of energy, labor, water and other resources are lost, not to mention money. NRDC puts

35 OR Dept. of Environmental Quality. Business Packaging Waste Prevention Project (2002-2005) – Project Evaluation Report. Feb. 2006, p. i.

36 Bell, Victor. "Product Stewardship, What does Global EPR Currently Look Like?" *Environmental Packaging International*, 2 April, 2019.

The Northwest Leadership Blueprint

the overall cost of food waste at $218 billion.[37] Project Drawdown, a scientifically rigorous assessment of climate change solutions, places food waste prevention third on the list of global carbon reduction opportunities.[38] An Oregon DEQ study finds that, of the 6.3 pounds of food that the average Oregon household throws away each week, 71% could have been eaten.[39]

"Food waste occurs at all levels of the supply chain," notes Dana Gunders of NRDC. "We leave entire fields unharvested, reject produce solely for cosmetic reasons, throw out anything past or even close to its 'use by' date, inundate restaurant patrons with massive portions, and let absurd amounts of food rot in the back of our fridges."[40]

Preventing food waste is a triple bottom line payback: reducing environmental impacts, building social equity by reducing food insecurity, and generating new industries.

Upcycling food waste into valuable new food products can be a major business and job creator. Beverage industries are finding new uses for damaged fruit. Bakers are finding new sources of flour. New marketing is underway for fruits and vegetables that do not meet standard cosmetic standards. Future Marketing Insights places the current value of the business at $46.7 billion globally. [41]

A federal 2030 goal to reduce food waste 50%, adopted in 2015, is being carried forward by USDA and the Environmental Protection Agency through the U.S. Food Waste Challenge. Washington's legislature passed HB 1114 unanimously in 2019, adopting the same goal. In 2016, France became the first nation in the world to mandate that grocery stores send all food past its sales date to hunger relief organizations.[42] Italy has taken an incentives-based approach, offering reductions in garbage fees to businesses that send post-dated food to charities.[43]

37 Gunders, Dana, et al. WASTED: *Second Edition of NRDC's Landmark Food Waste Report.* Natural Resources Defense Council. 17 August, 2017.

38 Project Drawdown. "Reduced Food Waste." https://www.drawdown.org/solutions/food/reduced-food-waste. Accessed Aug. 2019.

39 OR Department of Environmental Quality. *Oregon Wasted Food Study Summary of Findings*. Revised 22 April, 2019.

40 Gunders, Dana, et al. *WASTED: Second Edition of NRDC's Landmark Food Waste Report*. Natural Resources Defense Council. 17 August, 2017.

41 Devenyns, Jessi. "From trash to treasure: Upcycled food waste is worth $46.7B." *Food Dive*, 22 May, 2019.

42 McCarthy, Joe. "France Becomes First Country to Ban Supermarket Food Waste." *Global Citizen*, 5 Feb. 2016.

43 McCarthy, Joe. "Italy passes law to send unsold food to charities instead of dumpsters." *Global Citizen*, 15 March, 2016.

Supporting Sustainable Consumption, Banning Wasteful Products

Today's economy is built on consumption and the public is referred to as consumers. If a person consumes ever-increasing amounts of harmful foods, we know that their body will be harmed and eventually succumb to disease. At the planetary scale, continual growth in consumption of materials is not realistic or healthy for the Earth's ecosystems that we all rely on.

Sustainable consumption is an emerging concept designed to offer a healthier alternative vision to the economists' advocacy of ever-increasing material consumption. The Urban Sustainability Directors Network says that sustainable consumption calls for:

- "Absolute reductions in the material goods and energy we consume;
- A shift in values away from material wealth and consumerism toward new measures of progress and well-being;
- Technological innovation and efficiency gains that help us to refine production processes, creating less impact on the planet;
- Recognition that consumption will need to increase for those individuals and communities whose needs are not being met, and
- A transformation of our economy from one defined by continuous growth to one that functions within the very real limits of a finite planet."

Barring wasteful and harmful products from the marketplace can be a powerful tool to prevent waste and ensure a clean materials chain. Single-use plastic packaging and containers have been targeted by a wave of bans, with over 32 countries and eight U.S. states, including Oregon and Washington, enacting bans on single-use plastic bags. Other bans aim to prevent toxic pollution all along the value chain, from production to consumption. For instance, lamps and switches that contain mercury are banned in many states. Another example is flame retardants. In 2008, Washington state was the first to ban decaBDE flame retardant in mattresses. In 2017, Maine banned flame retardants in home furniture, while in 2018, California enacted a law to ban most flame retardants in furniture, mattresses and children's products. In 2018, flame retardant bans were under consideration in 16 states.

Chapter 5: World-Class Clean Materials Infrastructure

Northwest Innovations to Prevent Wasted Food

Food is perhaps the most essential product that we waste at large scale. The Northwest is a hotbed of innovation for strategies to prevent food waste.

Oregon Food Bank (**OFB**) rescues food for people that need it. They now prioritize healthy food, fresh produce, protein and pantry staples. The region's growers, packers and shippers have much produce that is "ugly," or not in the right size range, so it winds up in processing or waste streams. OFB has taken a national lead in rescuing fresh produce. In 2013, it was invited to join a peer-to-peer network of eight food banks across the U.S. trading tips on sourcing farm products in their regions.[1]

Another food rescue model is Portland's Urban Gleaners, which collects prepared food from restaurants, groceries and institutional kitchens, as well as gathering from farms and wholesalers. Food is repackaged into portions for use by families, and distributed to people in need at 40 locations including schools, parks and apartment complexes, and through hunger relief organizations.[2]

The West Coast Regional Voluntary Food Waste Agreement, an effort launched in late 2019 aimed at grocers, is being staged by the Pacific Coast Collaborative, a climate action alliance of Oregon, Washington, British Columbia, and California, along with ReFED, a food waste prevention group, and World Wildlife Fund. Four grocers have already signed on, Kroger, Albertsons, New Seasons, and Seattle co-op PCC. Participants are asked to commit to a 50% reduction in food waste by 2030 measured through standard methodology. The effort will also share best practices, offer technical assistance and mount demonstration projects.[3] It is modeled on the work of a fourth partner in the UK, WRAP. WRAP claims a 19% reduction in UK food waste, delivering $100 million in savings to grocers, and a 14:1 return on investment. Food redistribution for hunger relief has increased 50%, while climate pollution has decreased 550,000 tons.

Aiming at reducing waste from restaurants and other food service industries, Oregon DEQ and Metro have joined with the Oregon Restaurant and Lodging Association to educate members on waste prevention, food donation and composting. DEQ's Wasted Food Wasted Money campaign, offers flyers and guides for the food service industry underscoring the bottom line benefits. The partners offer workshops teaching businesses how to prepare food waste reduction blueprints. The efforts will be extended to the consumer level, based on a DEQ study of effective messaging now being conducted.

A seemingly humble but important innovation is the steel cow milk dispenser being placed in Northwest school cafeterias in Marion and Clackamas counties in Oregon, and Olympia and Vancouver in Washington. Dispensers eliminate milk cartons and wasted milk, as students are able to dispense only the milk they want. In 2016, dispensers reduced Olympia schools' milk use by 8,000-10,000 gallons while eliminating 350,000 to 400,000 cartons. That cut annual waste bills at Olympia High School alone by nearly $2,000 annually.[4]

On the North Olympic Peninsula, the Peninsula Food Coalition is overcoming rural logistics challenges. "To prevent food waste in remote places, logistics and transport planning and coordination are really important," says Meggan Uecker, Solid Waste Coordinator for Clallam County. "So logistically we needed a venue to coordinate with agencies such as Food Lifeline and Harvest Against Hunger to optimize delivery of surplus food to the right places." The coalition is organized around food distribution to spread-out locations such as Forks and Neah Bay, has a strong gleaning program, and is ramping up food rescue efforts.

Photo courtesy of the Oregon Food Bank

1 Oregon Food Bank. "A National Leader." https://www.oregonfoodbank.org/about-us/our-story/national-leadership. Accessed Nov. 2019.

2 Urban Gleaners. Home page. http://urbangleaners.org. Accessed Oct. 2019.

3 Pacific Coast Collaborative. West Coast Commitment to Reduce Wasted Food. Accessible via http://pacificcoastcollaborative.org/food-waste.

4 Seibel, Brendan. "Should we say goodbye to the school lunch milk carton?" *New Food Economy*, News Match, 17 June, 2019.

The Northwest Leadership Blueprint

The Role of Green Chemistry and Green Engineering

By Lauren Heine, Northwest Green Chemistry

Pressures are growing globally for industry to develop products and processes that prevent harmful toxic substances from entering the environment and human bodies. Green chemistry aims to help industry accomplish this through the design and development of products and processes that reduce the use and generation of toxic substances and eliminate waste from the very start.

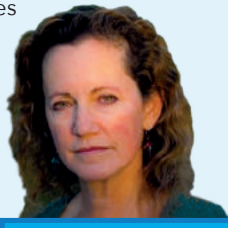
Green Chemistry and its sister field Green Engineering require systems thinking to avoid problems of waste and toxics. For example, synthetic detergents have been around for over 100 years. Early versions were created from highly branched molecular backbones, making them very slow to degrade. They would pass through wastewater treatment plants and form suffocating films on rivers and streams. Thanks to regulations and chemistry innovation, new detergents were developed based on linear molecular backbones. These molecules clean well and biodegrade quickly and completely, protecting aquatic life from chemical pollution in wastewater. Green chemistry is the deliberate design of such molecules to solve problems of pollution and waste.

The operative word for green chemistry and green engineering is DESIGN. On my first day as a Fellow with the American Association for the Advancement of Science, I arrived at work with a brand new degree in environmental engineering. I was placed at the US Environmental Protection Agency in the Division that housed the Green Chemistry and the Design for the Environment programs. The Director asked me, "So, how does it feel to know that your degree is obsolete?" Although the ink on my brand new diploma was still degassing, he explained, "cleaning up and disposing of waste at the end of pipe is history; the future is about eliminating waste through design."

Creative green chemistry and green engineering design solutions come in different forms. They may involve creating and substituting different chemicals, different materials, and/or entirely different product designs or business models. For example, let's say that laptop casings are made from plastics that contain flame retardant additives that interfere with the quality of recycled plastic due to chemical contamination. It may be possible to substitute safer and more sustainable flame retardant chemicals that do not interfere with recycling. But perhaps the alternative flame retardants are not as effective in the desired plastic.

Another solution could be to create the casing from an entirely different material. Think about laptops made from aluminum casings. Aluminum is light, sturdy, easy to machine into nice finishes, great at diffusing heat, and inherently flame retardant. The problem of toxic flame retardants in plastic laptop casings is eliminated by designing casings with a different material.

While aluminum has many benefits, laptops still eventually need to be replaced. Some manufacturers will take back their own laptops. If the laptop can be reused, customers may be able to earn some trade-in value. If not, then the manufacturer will recycle the materials. Having a business model that involves trade-ins and taking control of material recycling can benefit a manufacturer. First of all, it increases the likelihood that a customer will purchase a newer version from the same manufacturer. It also ensures some control over the quality of materials that are coming back for recycling. Those who make the product have the best knowledge of the materials that comprise it. When a manufacturer takes responsibility for the full life cycle of the products they create, it can bring benefits not only to the manufacturer, but also to customers, communities, and the environment.



Lauren Heine
Northwest Green Chemistry

> "Green chemistry design solutions come in different forms. They may involve creating and substituting different chemicals, different materials, and/ or entirely different product designs."

Chapter 5: World-Class Clean Materials Infrastructure

Optimizing Clean Materials in Our Built Environment

Buildings and infrastructure, which includes roads, bridges, parks, and utilities, are among society's greatest material demands. Buildings alone represent 11% of global CO2 emissions. Global building floor area is projected to double to five trillion square feet by 2060.[1] Around 20-30% of the Oregon waste stream is construction, demolition and renovation, half each from commercial and residential.[2] Concrete and asphalt wastes from infrastructure and buildings fall out of the regulated solid waste stream, and are often used as "clean fill" on other projects.

An Oregon DEQ study of the environmental impacts of residential construction practices found smaller house sizes reduce impacts substantially. An extra-small home of 1,150 square feet has 20-40% lower impacts than a medium standard home of 2,250 square feet. Only 6% of waste generation takes place during construction, while 50% happens during use, and 44% at end of life. Multiple family housing can cut impacts 10-15% compared to single family housing with the same square footage.[3]

"Reducing home size is among the best tier of options for reducing waste generation in the Oregon housing sector, while simultaneously achieving a large environmental benefit across many categories of impact," the study concludes.

That spurred DEQ to promote Accessory Dwelling Units (ADUs), small homes situated with regular single-family homes. Portland picked up on this concept and waived system development charges for ADUs. Seattle in July 2019 lifted many restrictions on ADUs, including eliminating parking requirements and allowing two ADUs on a lot in most zones.[4] Oregon also took an important legislative step in 2019, essentially banning single-family zoning by allowing duplexes on every lot. In cities over 25,000, multiple homes will be allowed on all lots.[5]

An innovation to reduce waste during construction is kit-built buildings. Sustainable Living, a spinoff of Seattle architectural firm CollinsWoerman aimed at reinventing the field, has developed a kit for apartment houses with pieces all manufactured and finished, shipped, and snapped into place on site. It differs from modular construction, which requires more packaging to ship in whole units. Nearly a dozen building projects are in process including a 16-story and 14-story building downtown.

"We create really beautiful living spaces and remove all the construction waste in the process," says CollinsWoerman Principal Steve Moddemeyer. The buildings use one-sixth the energy of comparable standard buildings, use DC low-wattage lighting, have radiant heat in floors, and provide on-site water treatment. "At our factory we are supplied by original equipment manufacturers. Even the parts that make up our panels are pre-cut at the other factories – like the sound insulation boards and lots of other parts. There is minimal waste at our factory. There is virtually zero waste at the construction site. All the parts are fitted and to spec. We use the same software as Boeing to track the project." A bottom-line advantage is that a building typically completed in two years now requires only nine months.

Courtesy of Cleary O'Farrell Photography

The life cycle carbon footprint of materials in the built environment, the 'embodied' carbon, is drawing new attention. For a new Seattle office building built to Washington's building code, one of the nation's best, using the city's carbon neutral electricity, embodied carbon will represent 80% of total building carbon over a 50-year cycle.[6] This underscores the importance of reducing embodied carbon in building materials to the greatest extent possible. A new tool to reduce construction carbon is the **Embodied Carbon and Construction Calculator**, or **EC3**, being developed through a partnership between the University of Washington-based Carbon Leadership Forum and 30 building industry leaders. The software measures carbon impacts of materials including concrete, steel, timber, aluminum framing, insulation, gypsum board, carpet, ceiling tile, and window glazing. Skanska has been beta-testing it on new buildings at Microsoft's Redmond campus.

Design plays a key role in cutting built environment impacts. For example, multi-modal transport planning for transit, bicycles and pedestrians is critical to reduce fuel use. Pavements with permeable functions provide additional services like water filtration or infiltration that reduce stormwater treatment costs. Sustainability ratings systems have been developed for infrastructure projects. Greenroads, a third-party certification system offered by the Greenroads Foundation, evaluates construction and design of roadways. GreenLITES is a self-certification program developed for the New York State Department of Transportation. Another self-certification scheme for roads is

The Northwest Leadership Blueprint

INVEST – Infrastructure Voluntary Sustainability Evaluation Tool. Envision certifies sustainability for a broad range of civil infrastructure projects.[7] For buildings, the LEED system rates impacts of various building practices, while the Living Buildings Challenge managed by the International Living Future Institute sets a high bar for building materials and resource use.

At the end of life, another waste prevention innovation emerging. Instead of demolition, buildings are systematically taken apart to facilitate maximum re-use of materials. In 2016, Portland became the first city in the U.S. to mandate deconstruction for an entire class of buildings, in this case homes built in 1916 or earlier, around one-third of the city's tear-downs. The practice reduces waste and materials, and creates new jobs and businesses. In the first 36 homes to be deconstructed, 27% of the material was salvageable, mostly softwood lumber used in framing. Climate pollution was reduced by 55% per home, or over 7 tons, compared to demolition.[8]

In seismic regions such as the Northwest, building codes have an important role to play in reducing waste. Current codes are written to ensure life safety in the event of a design-level earthquake. People must be able to get out, but that does not require that the building itself be recoverable. California, even with its advanced codes, only requires life safety except for buildings such as hospitals and schools. Legislation working its way through the California assembly, AB393, would require a state process to explore upgrading that to a functional recovery standard.

1 Architecture 2030. "Why the Building Sector?" https://architecture2030.org/buildings_problem_why/. Accessed Oct. 2019.

2 Palmeri, Jordan. OR Dept. of Environmental Quality. Personal communication, Fall 2019.

3 OR Dept. of Environmental Quality. "A Life Cycle Approach to Prioritizing Methods of Preventing Waste form the Residential Construction Sector in the State of Oregon." Phase 2 Report, Version 1.4, 29 Sept. 2010, Executive Summary, 10-LQ-022, p. 5.

4 Fesler, Stephen. "What Seattle's 'Best in the Nation' Mother-In-Law Apartment and Backyard Cottage Reform Does." *The Urbanist*, 3 July, 2019.

5 Anderson, Michael. "Oregon Just Voted to Legalize Duplexes on Almost Every City Lot." Sightline Institute, 30 June, 2019.

6 Smedley, Stacy. Director of Sustainability, Skanska. Personal communication, Summer, 2019.

7 US Dept. of Transportation – Federal Highway Admin. "State of the Practice On Sustainability Rating Systems."

8 Nunes, Andey et al. "Deconstruction vs. Demolition, An evaluation of carbon and energy impacts from deconstructed homes in the City of Portland." OR Dept. of Environmental Quality, March 2019, p. 4.

Richard-Eriksson-CC-BY-2.0

Tool libraries are a growing trend in the sharing economy.

Diamond Solution: *Get Longer Life and More Use from Products*

This Diamond solution is hard to separate from Preventing Waste. Getting longer life and greater use from products delivers more value from the products that we buy so that we need to buy less of them – which both saves us money and prevents waste. Key strategies for longer life and more use from products include:

- Product Sharing Models
- Re-use Products
- Repair and Refurbish Products

Product Sharing Models

Sharing models don't require people to purchase, store and maintain their own equipment; instead they can get what they need just when they need it, and return it when they are done. Many products we own are only occasionally used, or used only part of the time, while they remain idle for most of the time. Product owners must not only pay the entire purchase cost, but maintain and store the product. In contrast, the convenience, flexibility, and lower cost of sharing models can make them a more appealing option than individual ownership.

For example, we may all need a pipe wrench, saw, or lawn mower sometimes, but few of us need such tools on a daily basis. Tool libraries allow people to check out tools they need when they need them. The Vancouver Tool Library offers a range of tools for bicycles, carpentry, electrical, plumbing and more to residents of the BC city. [44]

Oregon is leveraging the existing library system to create a Libraries of Things offering a broader set of items. Hillsboro, a leader, offers over 265 items in bakeware, toys, musical instruments, party goods and a host of other categories, as

44 Vancouver Tool Library. Home page. http://vancouvertoollibrary.com. Accessed Aug. 2019.

Chapter 5: World-Class Clean Materials Infrastructure

well as more than 350 board games.[45] Clackamas County is starting something similar at eight county library locations. Traditional rental companies also play into this picture, for example, firms that rent tools or party supplies. Local Tools' "Find Your Local Tool Lending Library" app shows eleven lending libraries in Washington at the end of 2019.[46]

Car share services such as Car2Go, Zipcar and ReachNow represent a major element of the sharing economy. A large part of materials consumption is automobiles, which sit unused an average of 95% of the time.[47] Car shares reduce or eliminate the need for individual car ownership. C40 Cities, a global alignment of cities committed to carbon-reducing actions, estimates that reduced car ownership represents 24% of the overall urban consumption reduction needed to meet Paris climate goals holding global heating to no more than 1.5°C.[48]

Photo Courtesy of GO Box Portland

Portland's 'Go Boxes' make food trucks and takeout a more sustainable option.

Re-use Products

Another key strategy to get longer life and more use from products is to replace disposable products with ones that can be used again and again. Product re-use is nothing new. A large sector of thrift, secondhand and consignment stores promotes cycling products back into use after their original owners are done with them. New models are coming forward.

Berkeley set a national precedent in 2019 passing a law that requires reusable serviceware for all meals eaten in restaurants by July 2020. In January 2020, disposable cups for takeout will be charged a 25-cent fee, encouraging customers to bring their own reusable cups. The first stage of the law in effect in 2019 bars food service venues from giving customers napkins, utensils and lids as standard practice. Customers will pick them up as needed at a service counter.[49]

Oregon is another hotbed of innovation. The food truck movement for which Portland has become famous generates a tremendous amount of disposable food packaging. A solution is the "Go Box," a reusable plastic container. Food trucks contract with the Go Box service provider. Their customers receive their meals in the Go Box, and then deposit it at a central location in the food court. The provider collects, cleans and resupplies food trucks with the boxes.

Also, in Oregon, land of the first bottle bill, the idea of the reusable bottle is being reinvented in the microbrew industry. The collection system set up under the bottle bill gathers and recirculates bottles to the craft brewers. Meanwhile, Oregon DEQ has done an LCA to determine whether one-use PET plastic kegs or multiple use stainless steel kegs have lower life cycle impacts. "The steel kegs have greater upstream impacts, but when re-used 3-25 times (depending on the impact category) impacts are lower. Transported locally, around 140 miles, and reused multiple times, the LCA found steel kegs always are best."[50]

Zero-waste stores are another trend in this area. Bulk purchases have long been available in a range of markets. The website *Litterless.com* offers a state-by-state guide.[51] Now stores are encouraging or requiring customers to bring their own reusable bags and containers. Sainsbury's, the United Kingdom's third largest supermarket chain, is eliminating plastic bags for loose fruits and vegetables. The market will offer re-usable bags for purchase.[52] Public Goods and Services in West Seattle offers bulk goods ranging from soaps to toothpaste, none in plastic containers, and customers can purchase reusable containers or pick them up from a donation bin.[53]

45 Hillsboro Public Library. "Library of things." City of Hillsboro, Oregon. https://www.hillsboro-oregon.gov/departments/library/explore-the-collections/library-of-things. Accessed Aug. 2019

46 Local Tools. Home page. https://localtools.org/find/. Accessed Dec. 2019.

47 Schmitt, Angie. "It's True: The Typical Car Is Parked 95 Percent of the Time." *STREETSBLOGUSA*, 10 March 2016.

48 C40 Cities, ARUP, University of Leeds. *The Future of Consumption in a 1.5°C World*, June, 2019, p. 20.

49 Bitker, Janelle. "Berkeley Targets Disposable Foodware with Ordinance." *Eater San Francisco*, 24 Jan. 2019.

50 OR Dept. of Environmental Quality. *A Screening Life Cycle Assessment: Environmental Impacts of Single Use and Returnable Kegs*. Results published in 2017. Accessed via ECOS, https://www.ecos.org.

51 Literless. "Zero waste grocery guide." https://www.litterless.com/wheretoshop. Accessed Aug. 2019.

52 "First UK Supermarket Chain to Eliminate Plastic for Produce Will Save 1,300 Tons of Plastic from Landfill." *Good News Network*, 8 June, 2019.

53 Erickson, Anne. "Zero-waste Seattle store offers alternatives to plastic." *KING5 News*, 4 June, 2019.

The Northwest Leadership Blueprint

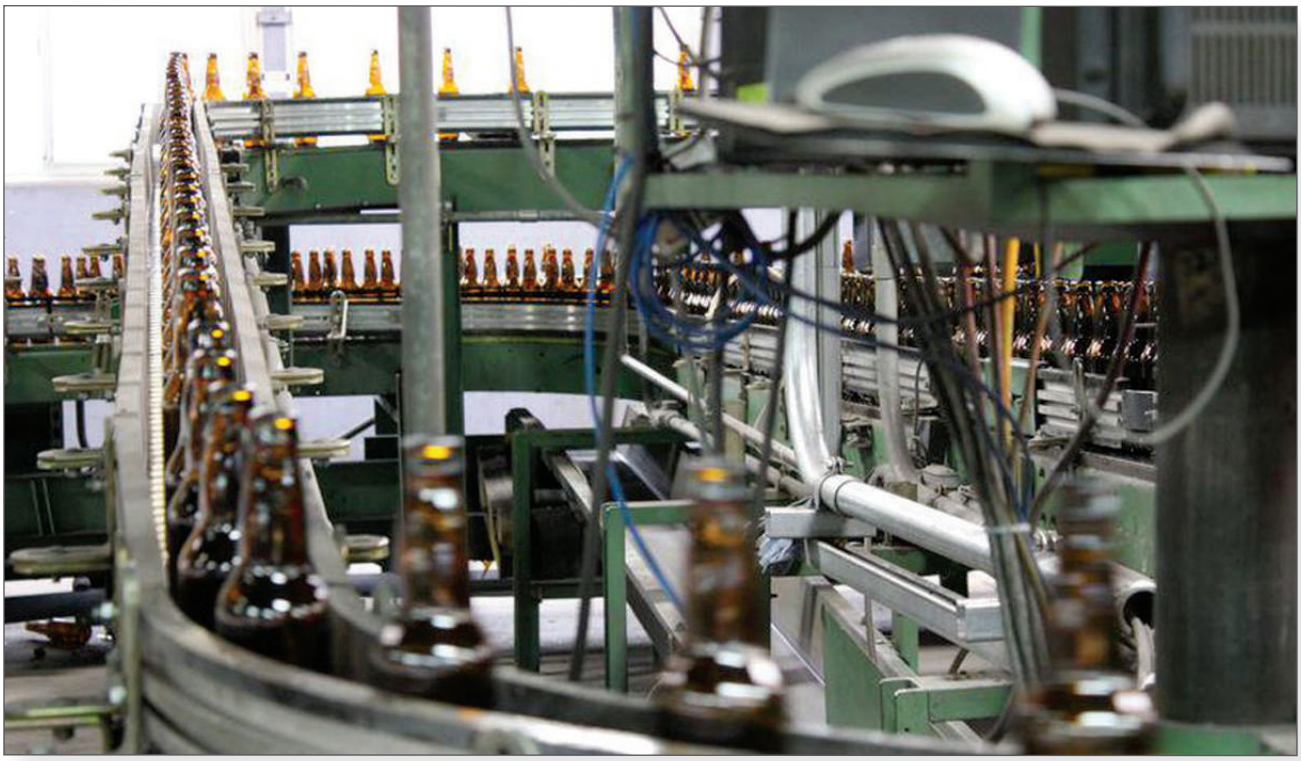


Photo courtesy of Oregon Beverage Recycling Cooperative

Several Oregon craft breweries now sell beer in reusable glass bottles as part of the nation's first statewide refillable bottle program."

A related model is Loop, a waste reduction initiative by consumer product companies including Unilever and Proctor & Gamble. It will ship products including Crest toothpaste and Haagen-Dazs ice cream via UPS in reusable containers for which they pay a deposit. Containers are delivered in a re-usable tote and can be picked up on request or dropped off at a UPS center.[54]

Repair and Refurbish Products

When products are repaired and refurbished, their useful life is extended, and the need to purchase replacement products is reduced. That avoids all the life cycle impacts of those new products, usually with only a small fraction of the materials demand.

Community repair events are an innovation to promote this option. Also known as repair cafes, they originated in The Netherlands in 2009. People bring reparable items to events, where they are assisted by skilled volunteers. They have since taken root in the Northwest. In Portland, Repair PDX has been staging cafes every month or so since 2013.[55] King County Solid Waste Division has organized over 60 community repair events since 2016, many at public libraries. At the first 50 events, residents brought in over 3,300 items ranging from lamps to laptops, pressure cookers to pants, and 78% were successfully repaired.[56] **Around the region, experience is showing that around 70% of items brought to events can be repaired.**[57]

An emerging thrust in this field is the burgeoning Fix-It, or Right to Repair movement, which asserts we all have "the right to repair everything we own." More specifically, this means we have the right to:

- "Fix our own things or choose which service shops to use;
- Manuals and diagnostic tools the dealers use; and
- Unlock and jailbreak the software on our devices."[58]

Right to Repair pushes back against manufacturers that try to limit the ability to repair products outside of channels they designate. "This is another important aspect of the picture," says Kyle Diesner, Portland Climate Action Plan Coordinator. "Right now with electronics, for example, we

54 Peters, Adele, "A coalition of giant brands is about to change how we shop forever, with a new zero-waste platform." *Fast Company*, 26 Jan. 2019.

55 Repair PDX. "About us." http://repairpdx.org/about-us/. Accessed Aug. 2019.

56 Watson, Tom. Project manager, King County EcoConsumer public outreach program. Personal communication, Summer, 2019.

57 Dobrowolski, Ana. "Community Repair Events: Common, Best and Better Practices for Building Community Through Repair." City of Eugene Waste Prevention and Green Building Service Department, April, 2017.

58 iFixit. Home page. www.ifixit.com. Accessed Aug. 2019.

Chapter 5: World-Class Clean Materials Infrastructure

don't have the capacity to repair products when companies proprietarily hold the information on how to repair."

As of this writing, Massachusetts is considering the 'Digital Right to Repair' act, which supporters describe as the nation's largest and most important state policy initiative yet.[59] Massachusetts is already a right to repair leader. In 2012, state voters passed a ballot initiative with 87% of the vote which gave people the right to repair cars outside of dealerships. It was forwarded by a coalition of local repair shops, now moving to strengthen the law.[60]

Electronic goods have been a major focus of right to repair. While some major tech companies have stepped up to oppose right to repair bills, Apple did announce a potentially positive step in September 2019. Apple will allow a broader range of independent repair shops to do some out-of-warranty repairs on iPhones, making parts, tools, training, manuals and diagnostics available, as long as the shop has an Apple-certified technician.[61]

Oregon DEQ addressed an obstacle to growth of re-use and repair – lack of resources and training for repair enterprises – with a pilot program that in 2017-18 offered $50,000 in microgrants for workforce development, training and expansion to organizations in electronics, wood products, textiles, shoes and tool reuse. "The pilot grant offering was successful in that it allowed for the sustainable growth of both for-profit and not-for-profit operations that provide valuable environmental benefits, while also providing social and economic benefits. These benefits have continued beyond the duration of the grants themselves."[62]

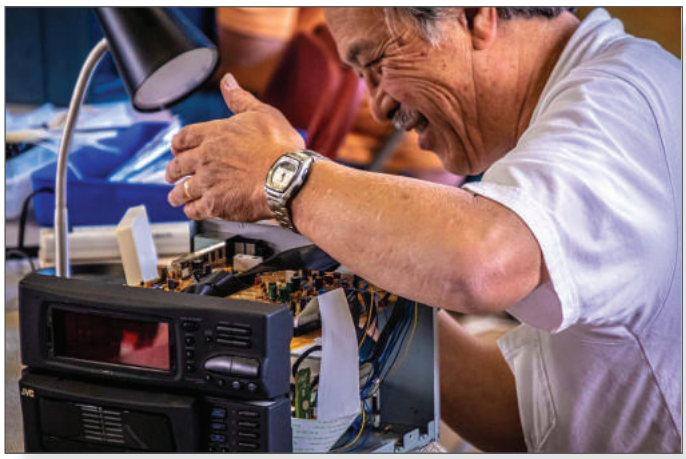


Photo Courtesy of King County

An event organized by King County Solid Waste Division teaches residents how to repair appliances and electronics.

59 Hamilton, Eric. "Massachusetts is about to fight a very important right-to-repair battle." *TechSpot*, 21 October, 2019.

60 Smith, Ernie. "Years After Success, Massachusetts Right To Repair Coalition Re-Forms To Close Loophole." *Associations Now*, 6 Feb. 2019.

61 Walk-Morris, Tatiana. "Apple will allow independent repair shops to fix its devices." *Retail Dive*, 3 Sept. 2019.

62 Allaway, David. Oregon Department of Environmental Quality. Personal Communication, Summer, 2019.

How Cities Can Promote the Sharing Economy

Product sharing is a crucial component of the Clean Materials economy because it enables more efficient use of goods, which means less raw materials, energy, water, and toxic inputs throughout the supply chain for the products we buy.

Cities are key actors in fostering sharing economy models. A blueprint put out by One Earth, *Local Governments and the Sharing Economy*, cites dozens of sharing models being implemented in cities and provides guidelines for city agencies to foster them.

City programs can enable a range of actions to extend product life and use products more efficiently, including making high-quality purchases, participating in the sharing economy, and reusing and repairing items. For example, Vancouver, B.C. offers loans for sharing economy start-ups such as the Vancouver Tool Library. West Hollywood, California has created a Shared Economy Task Force to advise the city on policies.

One of the most developed models is Portland's Resourceful PDX. Its website opens with the invitation, "Whether you're looking to borrow a tool, mend your favorite coat, salvage materials, or purchase a green gift, Resourceful PDX has ideas and tips to get you started!" Events such as repair fairs and clothing exchanges are promoted. Tips are offered to, for example, send children to school with no-waste lunches. Another example of advice Resourceful PDX provides is how to prevent waste when ordering at a restaurant:

- Take advantage of the discounts local businesses offer for bringing your own coffee mug and reusable shopping bag.
- For to-go orders, if you don't need the straw, fork, spoon, cup, condiments, containers, or a bag, say so!
- Make a to-go kit for your car, day bag or bike bag that includes grocery bags, a coffee mug, silverware or small containers for leftovers.

The Northwest Leadership Blueprint

Diamond Solution: *Optimize Recycling*

Recycling brings a next life to materials that make up discarded products and packaging. Recycling discarded materials into new products can reduce demand for raw materials and all the environmental impacts that result from extracting materials from nature.

But the recycling system is facing some of the greatest challenges since it was shaped in the 1970s and 1980s. The loss of South East Asian export markets due to contamination issues has exposed the lack of regional and domestic capacity to recirculate materials into useful products.

But Northwest jurisdictions are stepping up to the challenge. In the Seattle area, agencies including King County Solid Waste Division, City of Seattle, and other King County cities joined with waste haulers and other stakeholders to form the Responsible Recycling Task Force (RRTF), which developed a framework to address the recycling crisis and update the system to meet 21st century demands. [63]

As this framework was created by some of the Northwest's leading waste management thinkers, we adopt several RRTF suggestions in lining out a three-step Northwest agenda to reinvent recycling:

- Measure success based on actual recycling
- Clean up recycled material streams
- Redesign collection and processing systems

Measure Success Based on Actual Recycling

To reinvent recycling, we need to measure success by actual use of recycled feedstocks as opposed to the amount of material collected for recycling. Traditionally, the metric we have used to tell us whether we are hitting the mark on recycling goals is the amount of materials going into recycling bins. In fact, measuring success this way can encourage the addition of materials to recycling acceptance lists that don't really have viable end-markets. With China's ban on imports of contaminated recyclables, we are seeing increasing portions wind up disposed in landfills.

Real recycling success is in collection of clean and marketable feedstocks that actually make their way back into clean production streams. The best measure for recycling success can be found in the actual recycled materials used in new products, and the Clean Score of resulting products relative to use of raw materials.

Clean Up Recycled Material Streams

Creating truly sustainable Clean Materials infrastructure requires that discarded material streams flow easily into clean repair, recycling and remanufacture enterprises. Contamination challenges are a driver of the recycling crisis, including for organics. Diamond solutions to optimize recycling will clean up recycled materials and organics streams to make them clean and marketable.

One way to do this is to limit curbside collection to marketable materials that are readily processed in **MRF** and provide alternative collection options for materials that contaminate recycling streams. A number of materials have come in for special scrutiny. High on the list are plastic bags and plastic film, which lack good markets and create problems in MRFs. The King County task force reported that only around 25% of these plastic materials can be removed in the pre-sort process, while "remaining bags consistently contaminate other baled material." Even though these plastics are only around 0.2% of processed material by weight, 20-30% of labor is consumed in dealing with them, at a cost of $700-$1,000/ton. Shredded paper is another stream which does get processed well at the MRF and for which good markets do not exist. Poly-coated paper, cartons and aseptic packaging pose similar problems. Another problem material is glass. Bottles break in the system and contaminate other streams, notably paper.

Contamination problems rose to the forefront with the increase of commingled or single-stream recycling, where all materials are placed into one big bin instead of being sorted into separate bins. Some jurisdictions such as Bellingham,WA retained separation of recyclables at the

63 King County. *Responsible Recycling Task Force*, Final Recommendations. Transmittal Letter. 10 Jan. 2019.

Chapter 5: World-Class Clean Materials Infrastructure

The Renewal Workshop: Extending Life of our Clothes

In 2015, the global fashion industry generated over 100 billion articles of clothing for a global population of seven billion people.[1] This is a direct result of the "fast fashion" phenomenon, which has led to cheap prices for clothes with a short lifespan and a significant increase in waste volumes.

The Renewal Workshop is working to turn this unsustainable model into a circular solution. Nicole Bassett is a co-founder of The Renewal Workshop, an Oregon-based company that offers renewal and resale services for apparel and textile brands to give another life to merchandise that would otherwise be landfilled.

As of December 2018, The Workshop has saved over 100,000 pounds of textiles from landfills, by turning them into "renewed apparel," an entirely new category of apparel. These renewed garments are made from discards specifically selected from a larger pool of unsellable inventory. Revenue comes from both a partnership fee paid by participating brands and the service charge for "renewing" the apparel by repairing minor defects. Currently, The Workshop is helping 20 brand partners, including prAna, Toad&Co, Coyuchi, Mara Hoffman, and The North Face, to extend the life of their products and adopt a more circular business model.

It can be hard to incentivize brands to take responsibility for their products at end-of-life. "Today that burden is something we as the public have to carry – we have to pay to dispose of their products and our environment is polluted." At the end of the day, Bassett says, apparel brands are design, marketing and sales companies. "They don't own factories or make anything – they contract that out. The renewal/recycling business is not something they'll own – they'll have somebody manage that for them. That's the business model we'll morph into in the future."

Bassett argues that the optimal path is not diverting textile waste from the landfill, but incentivizing companies to take responsibility for their textile products, suggesting that "the smart brands will build out the infrastructure themselves to bring back their products." Currently most businesses grow by extracting more resources to sell more product. The companies of the future will decouple resource extraction from growing the company. "That's where you get new business models like selling a product two or three times, or rental models," Bassett suggests.

Courtesy of Renewal Workshop

A Renewal Workshop employee shows off a renewed clothing product's label – 'making discarded apparel into something new'.

In just four years, The Renewal Workshop has filled a gap in the region's textile industry and started to bend this traditionally linear model here in the Northwest. "When you think about the PNW role in this – you have this sustainability, care-about-the-Earth ethos," she says. "Why couldn't the PNW be the leader on policy and incentives for circular economy to foster innovative materials management?"

1 Segran, Elizabeth. "Your H&M addiction is wreaking havoc on the environment." *Fast Company*, 2 March, 2019.

source, and they have very low contamination rates as a result. For most jurisdictions single stream recycling systems are already in place, and there are substantial barriers to shifting back, at least in the short-term. But if the superior system for the long haul is separate recycling bins, then we should create transition strategies on a realistic horizon. Under an Extended Producer Responsibility system, producers may make this change.

An informed public is crucial to make sure the right materials go into recycling bins, and the wrong ones stay out. One of the King County task force's prime recommendations is to "harmonize recycling programs and messaging." Says the task force, "Consumer confusion drives contamination. All regional curbside programs should use consistent messaging about what is accepted in the curbside recycling container." In Coos County,

The Northwest Leadership Blueprint

St. Vincent de Paul: Recycling the Tough Stuff

St. Vincent de Paul Society of Lane County has put in place one of the most expansive networks of services and supports to address homelessness in the region. With more than 60 years in operation, the nonprofit operates 15 thrift stores, develops affordable housing, and provides overnight shelter and emergency services to about 1,000 people every night.[1]

St. Vincent de Paul earns about 60% of its revenue through waste diversion and materials management.[2] This revenue is directed back into the organization's homeless services, making it a uniquely self-sustaining nonprofit enterprise. Terry McDonald, Executive Director of St. Vincent de Paul, makes financial sustainability the priority for the organization: "If I don't have financially viable business lines, I don't have money for our charity work."

Terry McDonald
St. Vincent de Paul

> "I see Product Stewardship as one of the best tools to get the waste stream more regimented and disciplined."

One service that has garnered St. Vincent de Paul national attention are four financially-viable mattress recycling facilities that now collectively process about 45,000 discarded mattresses a month. "Mattresses make up 1% of the waste stream," says McDonald. "Landfill operators despise them – they take up a lot of space, don't compress, and they create cavities within the landfill."

When McDonald launched this venture in 2000, there was virtually no commercial market for recycling mattress materials. McDonald targeted auto companies and cotton exporters to create a buyer for the cotton from his mattresses. He also sells polyurethane foam and fabric to manufacturers of 'closed-loop' carpet.

Courtesy of St. Vincent de Paul Society of Lane County, Inc.

Now McDonald is working with the Oregon Legislature to put a Mattress Product Stewardship program in place. "Basically our proposal is a fee on the sale of new mattresses to pay for collection programs. I see Product Stewardship as one of the best tools to get the waste stream more regimented and disciplined," he says.

McDonald and St. Vincent de Paul also help lead efforts to recycle window glass to produce plaques, awards, and architectural glass; and they are the largest processor of polystyrene packing material in their area. Other product categories they are looking at sustainably cycling include furniture like couches, textiles, library books, and leftover soaps and shampoos from hotels.

1 St. Vincent de Paul. "Overview, mission, bylaws." https://www.svdp.us/about-us/mission-history/. Accessed Sept. 2019.

2 Roemeling, Alisha. "Lane County nonprofit leader offers his expertise at Harvard, MIT." The Register-Guard, 4 March 2019.

Oregon, contamination rates dropped from 30% to 10% due to a public education effort.[65] State and local waste management agencies should work together to create simple, customer-friendly messaging formats applicable across the Northwest. A new law in Washington in 2019, HB 1543, sets requirements for this.

Another key is to clean up organics streams to build high-quality compost and bio-recycling markets. Composting is facing market challenges similar to recycling, with contamination issues challenging market growth and hindering use of the finished compost by agriculture.

Liability under the Food Safety Management Act is a strong disincentive to farmer use of compost. If materials such as glass or plastics wind up in their harvest, they could be exposed.

An option to reduce contamination is to limit materials going into organics bins. In 2019, eight Oregon composters, including major waste management companies Recology and Republic Services, announced they would no longer process compostable packaging and serviceware. Among reasons given were that items do not always fully compost, non-compostable equivalents are often mistakenly thrown in

65 King County. *Responsible Recycling Task Force*, Final Recommendations. Transmittal Letter. 10 Jan. 2019.

Chapter 5: World-Class Clean Materials Infrastructure

bins, compost containing these items does not meet USDA Organic standards and some items contain chemicals that can endanger health.[66]

Is sending organics directly to composting facilities 'optimizing recycling' of these materials? Not necessarily. "When we talk about composting, our policy infrastructure has historically focused on landfill diversion, rather than a pull through the economic system of valued products that consumers and users of those products want," says Georgine Grace Yorgey, Associate Director, Center for Sustaining Agriculture and Natural Resources, Washington State University. "The incentives are to divert, but not necessarily to generate high value products."

Regional Recycling holds their annual 'Gift of Warmth' event, to collect winter gear at their drop-off depots throughout BC.

Problems at the end-of-life can often be reduced or eliminated with smart design at the supply chain and production levels.

The Northwest is home base for a number of global corporations with large global consumer markets, among them Microsoft, Amazon, Costco, Starbucks and Nike. Each has made some level of corporate social responsibility commitment. Local and state agencies can call out where their materials performance does not live up to their commitments. For example, Amazon's plastic pouches with paper labels are a problem in recycling facilities and could be redesigned to ease difficulties.

"We have international companies that recycle that operate in the region," notes Jeff Gaisford, King County's recycling manager. "We can become a global leader if we can find a way to engage with local companies. It would be a game changer. Amazon, but also Costco, Starbucks and others are thinking about all these things. Their first thought is the customer, making things easy and what the customers want. They know their customers want to recycle."

David Allaway
Oregon DEQ

> "If we explore materials analytically, we find that disposal often contributes only 1 – 2% of most types of environmental impacts. As much as 99% of the impacts can occur upstream of the consumer."

Optimizing recycling also means that innovation is incentivized throughout the system. Producers are rewarded for designing products and supply chains for easy and clean disassembly, reuse, and recycling of materials, to deliver significant improvements in Clean Score.

Clean Score is a valuable measure because it includes life cycle impacts comprehensively, so it can help avoid 'solutions' that cause more harm than good. Oregon DEQ's David Allaway says their research shows that design for recycling can sometimes result in packaging with higher overall environmental impacts, even when the benefits of recycling are factored in. "Design for recycling can help to ensure a more recyclable waste stream," he says. "But it needs to be done in parallel with broader assessment of full life cycle environmental impacts, to avoid unintentionally creating more recyclable, but also more impactful, materials."

66 "A Message from Composters Serving Oregon: Why We Don't Want Compostable Packaging and Serviceware." https://www.oregon.gov/deq/mm/Documents/MessagefromComposter-En.pdf

The Northwest Leadership Blueprint

Merlin Plastics: Working Magic in the Pacific Northwest

Merlin Plastics has become Western Canada's leading processor and marketer of industrial plastics scrap, currently accepting material from Recycle BC, Washington, and Oregon. Since 1987 Merlin Plastics has developed and refined their infrastructure to be capable of re-processing the ever-growing varieties of household and industrial plastics, like PE, PP, PET, and HDPE. The company is now investing in another mixed-plastics sorting line at their New Westminster, B.C. plant in order to increase intake capacity for LDPE, PP, and PS plastics.

Tony Moucachen
Merlin Plastics

> "If a product is designed to be recycled, then so long as the right infrastructure is in place for collection, then it will be recycled. But if it is not designed to be recycled, then regardless of the infrastructure, the product will not be recycled."

As founder and CEO of the company, Tony Moucachen is a pioneer in Canada's recycling industry. After 30 years in the field, Moucachen considers himself a capitalist with a social conscience. "I believe that you have to put a dollar cost on socially unaccountable behavior such as designing products that are not recyclable. Being socially un-responsible has to be monetized; it has to have a cost." His core goals with recycling are, "the reduction in our overall use of new non-renewable virgin resources, as well as preventing the disposal of plastic waste in landfills."

To achieve these goals Moucachen believes multiple actions must be taken, with the cornerstone being producer responsibility for end-of-life material processing. Another is 'Design for Recycling,' where producers are responsible for designing products and packaging to be compatible with regional recycling infrastructure. Product bans are another, more direct form of action that governments can take as are Extended Producers Responsibility laws. The Recycle BC program, for example, "requires businesses that supply packaging and paper product to BC residents to assume responsibility for the cost of collecting, sorting and recycling these materials."

Courtesy Revital Polymers and EmTerra

Tony of Merlin Plastics (left) joins the 'ribbon'-cutting ceremony" for ReVital Polymers.

Moucachen suggests that the PNW collaborate to increase the size and influence of their market share. "If we collaborate in the PNW, we have up to a 15 million person market share. Brand owners would hate to lose out in a market of that size," says Moucachen.

Redesign Collection and Processing Systems

A key objective for optimizing recycling is to develop regional capacity to collect and process clean materials, and to cycle them back into productive uses that achieve high Clean Scores.

The King County task force's top policy priority, informed by Recycle BC's success, centers on clean material collection:

> *"1A – Develop a comprehensive, statewide stewardship policy approach that helps achieve a funded, robust, and harmonized curbside recycling system throughout Washington State."*

Drink containers are one of our most direct connections to local recycling systems in our daily lives. Our lives are intertwined with drink containers – cans, bottles, cups, and increasingly pouches that we use every day.

The King County task force recommends that Washington "develop a feasible model for beverage container stewardship in Washington similar to the Oregon Beverage Recycling Cooperative model."

Encorp Pacific, beverage container manager under BC's EPR system, operates Return-It, a network of 171 depots to take in beverage containers. BC's range is broader than

Chapter 5: World-Class Clean Materials Infrastructure

Oregon's, which covers glass, aluminum and PET plastic containers. BC adds pouches, drink boxes, bag-in-the-box wine, bi-metal cans, all juice containers, pretty much everything except milk containers. Some depots also collect hard-to-recycle items that don't belong in curbside systems, including electronics, batteries, paint, light bulbs, small appliances, plastic bags and film, Styrofoam and non-deposit glass.[67]

Before curbside collection, recycling centers were prevalent. Reviving local depots in retail centers and at neighborhood tool libraries can make it convenient for people to consolidate trips. These depots will collect the things that don't belong in a curbside system, financed by industry Stewardship Organizations under EPR 2.0. Nestling recycling depots together with product share and repair services in multipurpose hubs will maximize public convenience and optimize Diamond solutions.

For most of us, our local recycling infrastructure asks us to throw paper, plastic, metal and glass together in one big recycling bin. The recycled materials are mixed together, or 'commingled' in industry parlance. In the past, most communities asked people to sort these materials into separate bins. Some still do and they boast much lower contamination rates and higher value for their recycle materials.

As long as we use commingled systems, curbside recycled materials will enter MRFs for processing. The Northwest lost SE Asian recycling markets because material coming from regional MRFs typically has contamination rates of 10-20%, while the new China National Sword rules require materials with no more than 0.5% contaminants.[68] But new optical scanning and automation technologies for MRFs hold the potential to dramatically drop those rates. With new technologies at its largest MRF at San Francisco Pier 96, Recology is achieving contamination rates at or close to Chinese requirements in its paper bales. The firm operates 10 other MRFs on the west coast, including one in Seattle.

In San Francisco, "We're making one of the cleanest fiber bales on the West Coast," says Recology's Derek Ruckman. "We are trying to get the new system installed in Seattle, but the risk is it's a multimillion investment. And we don't know what prices that paper will sell for. A large recovered paper mill in Oregon or Washington would help."

Generating new domestic industry that creates reliable demand for large volumes of recovered materials is crucial to ensuring economically viable collection and processing programs and to enabling the market confidence necessary to make major investments in infrastructure.

Optimizing recycling is also a matter of taking responsibility for our discards, rather than putting the burden on other nations. The King County task force calls on city and county governments to update recycling codes and contracts with waste haulers "to prioritize domestic sorting and processing and require documentation of the chain of custody from sorting facilities to legitimate end markets." Under EPR, this would become a producer responsibility.

Materials Recovery Facility (MRF)

MRFs sort out recycled materials – principally paper, plastic, metal and glass – that have been mixed together.

Verifying chain of custody is crucial. The necessity was underscored by the largest E-waste fraud in U.S. history, in which Seattle-area E-waste recycler Total Reclaim illegally shipped 8.3 million pounds of flat-screen monitors to Hong Kong. There, workers smashed them releasing mercury into the environment. Company co-founders Craig Lorch and Jeff Zirkle were sentenced to 28 months each in prison and $945,000 in restitution for fraud.[69]

The crisis of plastic garbage flooding into oceans worldwide is another example of why responsibility for discards and chain of custody is so important. A substantial amount of plastic garbage in oceans comes from nations that lack modern waste management systems, including SE Asian nations that have been a destination for exported discards from industrial nations. Chain of custody requirements should outright ban exports to nations that do not have adequate environmental, health and labor standards, or appropriate waste management arrangements.

"We cannot allow recycled materials generated in our region to contribute to environmental pollution or endanger human health and safety at home or elsewhere, including other countries," notes the King County task force.

67 Langdon, Allen. President and CEO, Encorp Pacific. Personal Communication, Summer, 2019.

68 King County. *Responsible Recycling Task Force, Final Recommendations*. Transmittal Letter. 10 Jan. 2019.

69 Rosenberg, Mike. "Largest e-recycling fraud in U.S. history sends owners of Kent firm to prison." *Seattle Times*, 23 April, 2019.

The Northwest Leadership Blueprint

McKinley Paper and the Comeback of Cardboard

The digital age was said to be the last nail in the coffin for paper. Yet two forces that are often blamed for the death of American employment in retail and manufacturing are now inadvertently reviving a centuries-old craft: making paper. The rise of Amazon, the world's largest e-commerce marketplace, created a demand for cardboard unlike any other. Amazon's Best of Prime 2017 report claims that over five billion packages were shipped worldwide using Prime services.[1] This is a significant boost in demand for cardboard that comes at a time when international borders are closing for recyclables. China's National Sword has created a surplus of domestic cardboard scrap that is allowing what's left of American paper mills to access their most important raw material at significantly reduced cost.

A paper mill in Port Angeles, previously used to produce and sell paper for telephone directories, began curtailing operations in early 2017 and officially closed its doors by April of that year.[2] Shortly after, McKinley Paper Company seized the opportunity and purchased the mill from Nippon Paper Industries. Work began in fall 2019 to dismantle the retired equipment and make way for over $6 million in improvements. These include a pulper unit and two paper machines to manufacture cardboard, or containerboard as it's known in the industry, and packaging-grade brown paper – using only recycled cardboard.[3]

Bio Pappel, the Mexico-based parent company of McKinley Paper, is by far the largest manufacturer of paper in Latin America and Mexico. It's commitment to environmental excellence is front and center, including its priority strategies to: use recycled feedstocks; optimize water, energy, and transport efficiency; capture carbon; and conserve nature.[4]

McKinley plans to replicate innovations from their New Mexico operations at the Port Angeles mill. "McKinley-New Mexico is one of the most efficient and sustainable paper mills in the United States," their website reads, "thanks to our circular sustainability model that allows us to produce 100% recycled paper, co-generate 100% of the green energy consumed, and recycle 100% of the water in its processes through an advanced 'zero effluent' system of closed circuit."

McKinley's business model doesn't require raw wood material, co-generates energy using steam from regular operations, and recycles water through industrial processes. McKinley's goal is to manufacture 300,000 tons of containerboard annually using 100 percent recycled cardboard and to develop biomass energy cogeneration with waste steam used in the papermaking process. In today's world it's not surprising when a paper mill closes, but it is when one reopens. And it's especially impressive when one reopens with industrial symbiosis in mind.

1 "Amazon's Best of Prime 2017 Reveals the Year's Biggest Trends." *Business Wire*, 02 Jan. 2018

2 "Nippon Paper Industries agree to sell Port Angeles paper mill to Bio-Papel." *Asia Paper Markets*, 2 March 2017.

3 Gottlieb, Paul. "McKinley Paper Co., plans to take applications July 11. *Peninsula Daily News*, 28 June 2019.

4 BioPappel. Home page.

Diamond Solution: *Develop Clean Production and Processing Hubs*

In a world-class Clean Materials future for the Northwest, we will see more and more clean production hubs, from small towns to mid-sized and bigger cities, in all parts of the region.

Clean production hubs are industrial areas where facilities co-locate to sort and process recycled and organic materials; clean, repair and redistribute reusable containers and products; and make clean products. Clean production hubs will utilize clean infrastructure like renewable energy, biorefining of organics and wastewater, and heat districts, and develop R&D partnerships with Northwest universities and research institutions. These hubs will also pursue non-toxic design, industrial symbiosis, and development of local processing and markets.

At the same time, each hub will be locally unique, growing from the particular resources, business opportunities, and capacities and ideas of local people.

Some key strategies to develop clean production and processing hubs include:

- Feed Clean Materials into Clean Production Hubs
- Adapt 'Industrial Symbiosis'
- Build Biorefineries and the Bio-economy

Feed Clean Materials into Clean Production Hubs

Real success in recycling means clean and marketable feed-stocks actually make their way back into clean production streams. The same is true for organics, and for repair and reuse. And truly clean production will be powered by clean, renewable energy; release little to no harmful compounds

Chapter 5: World-Class Clean Materials Infrastructure

to air, water or soil; conserve resources; and create a range of good quality, well paid blue collar and technical jobs.

To promote clean production hubs in the region, state and local governments can deploy a range of local and state economic development tools to encourage industry development. This includes supportive infrastructure investment and tax exemptions, low-cost financing where allowed by law, making sure regulations are updated to reflect new technologies, and providing 'barrier buster' support services to help companies navigate and overcome roadblocks that can hamstring innovative enterprises.

Lisa Sepanski with King County notes, for example, paper mills have been highly regulated, but, "there is new pulping equipment that requires much less energy, water, and hazardous chemicals. How does our regulatory system adjust to new technologies? We need a new recycling technology liaison through the state Commerce Department."

Washington took a potentially important step in this direction with passage of HB 1534, the Sustainable Recycling Act, in the 2019 legislative session. The bill created a Recycling Development Center to promote research and development, identify markets, and develop policies to grow the industry. It brings together the Departments of Ecology and Commerce along with public and private stakeholders. The bill also mandates a statewide plan to help reduce contamination in recyclables, and provides financial assistance to help local jurisdictions clean up their recycling streams.[70]

Lisa Sepanski
King County
Solid Waste Division

> "'Responsible Recycling' is a new way of thinking about recycling. Instead of just focusing on the end of life, it includes everything from product/packaging design to creating demand for recycled feedstock."

Heather Trim of Zero Waste Washington adds a caveat: "We don't want to create situations where there has to be a guaranteed quantity of feedstock or where facilities can't flex over time. We don't want to institutionalize a required waste stream."

Adapt 'Industrial Symbiosis'

Clean production hubs can sometimes develop their own 'ecology' where companies benefit by being part of a community of co-located facilities. Over 30 years ago, Kalundborg, Denmark pioneered an idea called "industrial symbiosis." Put simply, it connects co-located industries so that one's "waste" becomes another's resource. The result: big material-energy-water savings for industry, coupled with important environmental benefits. The Kalundborg Symbiosis is generating $28 million a year in economic value, in a city of just 17,000 people, while reducing greenhouse gas emissions by 600,000 tons/year.

Each community's clean production and recycling hub opportunities will be unique, depending on factors such as locally available recyclable material and renewable energy streams, the appetite for innovation of local utilities, and the capabilities and interests of local businesses and entrepreneurs.

In Spokane, the West Plains Public Development Authority, a partnership of the City, the County, and the Airport, is exploring how to develop a Clean Manufacturing Innovation Park. After Spokane area leaders visited Kalundborg's industrial symbiosis as part of a sustainability innovation tour of Scandinavia in September 2018,[71] they targeted the West Plains district for their Innovation Park – in part to potentially leverage the City's waste-to-energy plant and the regional MRF's supply of recycled materials. The goal is to make the area a magnet for leading edge companies in advanced materials-manufacturing, transport, and clean technology. These companies will be attracted not only to clean-and-green brand value, but also to cost savings from district-scale industrial symbiosis infrastructure, and the business benefits of close proximity to a growing industry cluster rich in R&D, technology, and workforce linkages.

Renewable Gas Plant

The Arial Renewable Gas Plant is one of over 100 throughout Denmark, a global leader in biogas technology.

Photo Courtesy of Nature Energy Biogas

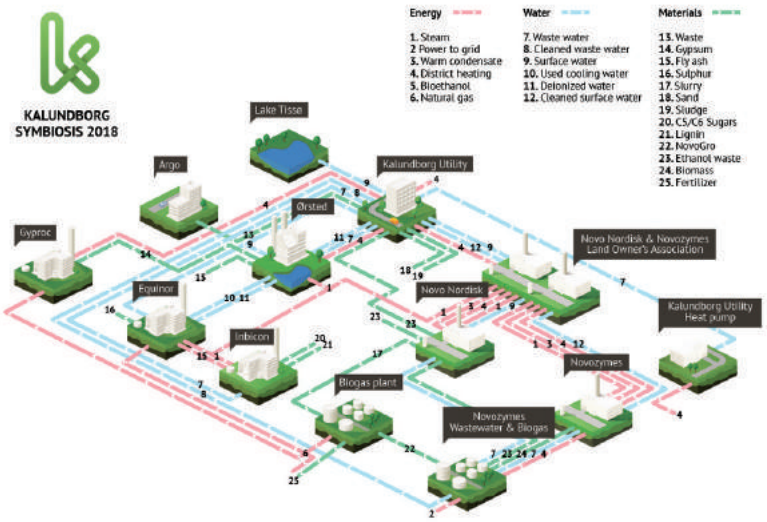
70 Bennett, Dave. "Sustainable Recycling Act of 2019 marks next chapter in *Washington's recycling story*." WA Ecology Blog. 29 April, 2019.

71 Center for Sustainable Infrastructure & i-SUSTAIN. Final grant report to Scan-Design Foundation. Denmark case studies based on personal communication and research. November, 2019.

The Northwest Leadership Blueprint

Denmark's Industrial Symbiosis Leadership Inspires the World

Denmark has long served as a world leader in clean energy and industrial symbiosis. For example, they were the first country worldwide to announce their transition to a clean growth economy entirely independent of fossil fuels by 2050. In 2017, 2018, and 2019, CSI helped lead bipartisan delegations of state legislators from Washington on a learning tour in Denmark to explore how industrial symbiosis might apply here in the Pacific Northwest. Here are a few of the major highlights:



Schematic diagram of the world's most famous industrial symbiosis hub.

Courtesy of Kalundborg Symbiosis

→ Kalundborg Symbiosis:

This small town pioneered the concept of industrial symbiosis some four decades ago, and has adapted and grown it over time into the world's leading model for industrial symbiosis innovation. Today the Kalundborg Symbiosis is a resource partnership between six private companies and three public operators, dedicated to full resource utilization, including water, energy and material. Begun as a collaboration of several private companies, in recent decades the municipally-owned Kalundborg Utility has evolved into the heart of the local Symbiosis. It is a multi-utility, with 80 employees, supplying 50,000 customers with several important services, including district energy, drinking water, process water, cooling water, and wastewater treatment. Today, the Symbiosis features 22 distinct resource agreements between facilities, each delivering mutual economic and environmental benefits. In a city of just 17,000 people, the Kalundborg Symbiosis is generating $28 million in yearly economic value, and at the same time reducing climate pollution by over 600,000 tons a year.

→ Solrød Biogas:

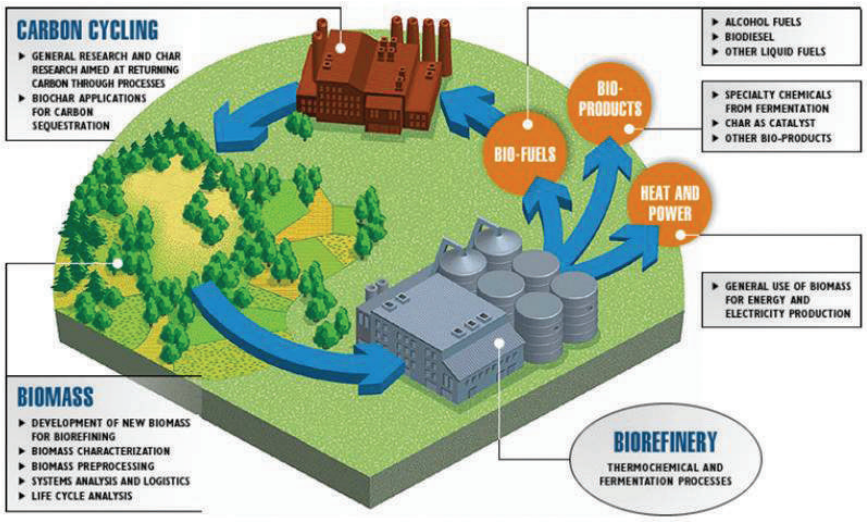
Denmark is investing heavily in renewable natural gas. Solrød Biogas utilizes over 190,000 tons of biomass feedstocks a year from several local industry and municipal waste streams to produce clean electricity and heat, organic fertilizer for farmers, and other key products. Their biogas digester utilizes a variety of local organic waste sources, including lemon-derived pectin and carrageenan from CPKelco (60%), eluate (biotech waste from lactic acid production) from ChrHansen (13%), biopulp (22%), manure from local livestock farmers, and seaweed overload from local beaches. The plant employs 15 full-time employees, and in 2018 delivered net greenhouse gas savings of 43,700 tons. They refer to their model as the "triple helix" partnership: the municipality has regulatory authority, companies benefit economically, and institutions for higher education are invited to conduct research and development.

→ Billund Biorefinery:

Wastewater treatment plants can actually serve as integrated community biorefineries that process multiple organic waste streams to generate multiple products of value. Denmark's Billund Biorefinery, owned by the municipality of Billund, is a model. The utility taps wastewater, organic wastes from local industry and agriculture, and the organic fraction of the municipal solid waste stream to produce energy and clean water. It produces 1.7 times the energy consumed in company operations – both heat for the local district system and electricity for the power grid – as well as 4,000 tons of clean fertilizer products a year.

Chapter 5: World-Class Clean Materials Infrastructure

Biorefinery System for Sustainable Economic Development



Biorefineries convert a variety of organic waste inputs into a variety of marketable products.

Build Biorefineries and the Bio-Economy

Organic waste, much of which still winds up in landfills, provides opportunities to grow industry and shrink carbon footprints. The opportunity is to combine organics from the regulated solid waste stream with other streams from agriculture, food processing, forestry and wastewater treatment to turn cost centers into economic value generation. For rural communities in particular, where some of the most abundant biomass supplies are located, this offers important economic benefits.

All sorts of products in our economy are derived from petroleum and petrochemicals, but many can be replaced with biobased equivalents. The US Department of Energy says, "Bio-based chemicals and materials can serve as renewable alternatives to many of the products derived from petroleum or natural gas, such as plastics, fertilizers, lubricants, and industrial chemicals. They also often require less energy during production and produce fewer greenhouse gases than their petroleum-based equivalents."[72]

"Biorefineries" can convert a variety of organic waste feedstocks into a variety of marketable products, similar to how petrochemical refineries work. Biorefineries can make fuels, plastics and a range of other materials including foams, rubber, fibers, cosmetics, pharmaceuticals, specialty chemicals, resins, paint, lubricants and solvents.

A wide variety of technologies are available. Current composting and wastewater treatment operations could be the seed of biorefineries that yield higher value products, building from today's technologies, such as anaerobic biodigesters that process organic matter through bacterial processes in an oxygen-free environment. Promising emerging technologies include thermal gasification, which processes biomass under high heat, employing steam, oxygen and carbon dioxide, to make valuable gases including carbon monoxide, hydrogen and methane.

Mark Fuchs of the Washington Department of Ecology sees us combining technologies to extract more value from organic wastes. "A composting facility could also include anaerobic digestion with thermal processing with composting as the final stage, while also reducing the greenhouse gases in the compost process itself."

The scenario is becoming reality. The Surrey, BC Biofuel Facility is the largest anaerobic biodigester in North America, processing 120,000 tons of Metro Vancouver organic wastes annually. It produces enough Renewable Natural Gas to power 8,500 cars annually, as well as 45,000 metric tons of compost.[73] A partnership of the California Energy Commission and University of California-Davis has implemented anaerobic biodigestion to process 40,000 tons of Sacramento food waste annually. The gas product is used to fuel the waste collection fleet.[74] In Oregon, the Gresham Wastewater Treatment Facility co-digests fats, oils, and grease with biosolids to produce biogas that has made the plant energy self-sufficient.[75]

Impact Bioenergy is a company that offers an example of smaller-scale, distributed processing of biomass, notes Srirup Kumar, the firm's Community Engagement Officer. In contrast to centralized facilities that take in hundreds of thousands of tons of biomass annually, the company's anaerobic biodigestion technologies start at 25 tons. The company installed its first unit at Fremont Brewery in Seattle and is now developing a 1,000 ton/year project on Vashon

72 US. Dept. of Energy. "Bioproducts basics." https://www.energy.gov/eere/bioenergy/bioproducts-basics. Accessed Dec. 2019.

73 City of Surrey. "Facility: a smart solution for a sustainable future." https://www.surreybiofuel.ca/facility. Accessed Dec. 2019.

74 Goldberg, Eleanor. "Sacramento Group Rescues 40,000 Tons of Food Waste, Turns It Into Fuel." *Huffington Post*, 12 July 2016.

75 Hayward, Greg. "Upgrading Treatment Plant to Energy Net Zero." *Biocycle*, November/December 2018.

The Northwest Leadership Blueprint

Island, in two 50-foot containers. The Vashon Bioenergy Farm will represent a step further toward a biorefinery by sitting next to Island Spring Organics, which makes organic tofu. Impact Bioenergy will process Island Spring's soybean pulp, reducing odors and the potential to attract pests. Products include biogas that could be upgraded to vehicle fuel, and a certified organic liquid fertilizer. Avoiding costs of transporting organic wastes off the island adds to the business case.

The region's potential to produce **Renewable Natural Gas**, (**RNG**) a product upgraded from biogas that can substitute for fossil gas, appears substantial. Oregon has the biomass potential, from organic wastes from agriculture, forestry, and wastewater, to produce 10 billion cubic feet of RNG annually, nearly 5% of current state fossil gas consumption, using anaerobic biodigestion. With the emerging process of thermal gasification, the potential is 40 billion cubic feet of RNG, or nearly 18% of state gas use.[76] For Washington, anaerobic biodigestion could produce up to 26 billion cubic feet of RNG annually from the range of biomass sources in the state, or 10% of state gas use, while thermal gasification could double that.

76 OR Dept. of Energy. "Biogas and Renewable Natural Gas Inventory SB 334 (2017) - 2018 Report to the Oregon Legislature." Sept. 2018, Executive Summary.

Photo Courtesy of Nature Energy Biogas

Nature Energy of Denmark makes substantial investments in R&D to improve RNG technologies and processes.

Plastics in the 2040 Clean Materials Economy

The problems with plastics have broken into public awareness. Seas filled with plastic waste are the poster child. Even at the ocean's deepest point, all creatures tested were found to have ingested plastic pollution.[1] Closer to home, a study found that each American adult ingests at least 50,000 microparticles of plastic annually in their food, and breathes about the same. Children eat around 40,000. The great unknown is what this is doing to human health.[2]

In terms of climate pollution, more than 850 million tons were released in plastics production and incineration in 2019. The petrochemical industry is ramping up 300 new facilities mostly dedicated to plastics production. On the current trajectory, annual plastics emissions will more than triple by 2050. Cumulative plastic production from now through 2050 is projected to release over 56 billion tons, amounting to 10-13% of all carbon that could be emitted to keep global heating under 1.5°C.[3]

Plastics are causing significant waste management problems including lack of recycling markets and plastics contamination in other recycling and composting streams. Most plastics in the U.S. end up incinerated or in landfills. Of 34.5 million tons generated in the U.S. in 2015, just 9% were recycled. Plastics make up 19% of all landfilled material.[4]

Concerns have spurred a wave of bans. Over 32 countries and eight U.S. states including Oregon have enacted single-use plastic bag bans.[5] Maryland and Maine have banned polystyrene cups and service ware, as have San Francisco and Seattle.[6] In July 2018 Seattle banned single-use plastic utensils and straws, the first major city to do so. California set a statewide plastic straw ban precedent in 2019.[7] A number of single-use plastic items will be banned in the European Union in 2021. Plastic bottles are to be 25% recycled content by 2025 and 30% by 2030.[8] Canada will ban some single-use plastics by 2021.[9]

Attracted by an estimated $120 billion in revenue opportunities in the U.S. and Canada, more than 60 industry developers are working on processes to transform waste plastics into valuable feedstocks for new plastics and chemicals, and 40 have reached commercial stage or will by 2021.[10] Mechanical recycling, which retains the polymer chain can, for example, be used for PET plastics. The Northwest currently has one PET recycling facility, ORPET in St. Helens, Oregon.

Plastics can also be chemically recycled to break them down into constituent monomers. Pyrolysis, which processes materials in an oxygen-starved environment, is being explored, notably to address the flexible packaging challenge. But pyrolysis has yet to be proven economically feasible.

Chapter 5: World-Class Clean Materials Infrastructure

Can transforming plastic waste into valuable feedstocks reduce its ecological impact?

Pioneer Project: Lodestar, a modeling exercise that is part of the Ellen MacArthur Foundation's New Plastics Economy, envisions a facility that combines chemical and mechanical processing to process 20,000-metric-tons of mixed plastics annually. In the model, the mechanical plant sent 43% to incineration and landfilled 5%. Adding a chemical stage could recover 84% as feedstocks for new plastics and other chemicals. Revenues increase 25% and payback time decreases 11% compared to the standard facility.[11]

Bio-plastics that provide alternatives to the dominant petroleum-based plastics are beginning to emerge in the marketplace. Bio-plastics can be produced from crops, organic waste, or other biomass sources such as fats-oils-grease, yard wastes, wood chips, sawdust, food processing wastes, and much more. The bigger category of bio-products could disrupt other materials sectors dominated by petro-chemicals now, too, including foams, fibers, cosmetics, pharmaceuticals, paint, and specialty chemicals like resins, lubricants and solvents. But there are concerns over environmental sustainability of feedstock crops such as corn, as well as the overall life cycle carbon balance. Another challenge is that the pathways for recycling discarded bio-plastics are likely incompatible with pathways for petroleum plastics. And bio-plastics also raise challenges similar to other plastics in terms of contaminating recycling streams in materials recovery facilities.

Bio-innovations will proliferate in the years ahead. For example, Lucy Hughes won the 2019 James Dyson award, competing with over 1,000 design and engineering innovators from 28 countries, for her fish waste-to-plastic invention. Hughes, 24, tested 1,000 combinations of fish waste to find an optimal formula to produce a bio-plastic sheeting that performs well, converts biomass efficiently, uses much less energy, and biodegrades quickly. [12] This is still early on the learning curve – undoubtedly, bio-material science and invention will continue to accelerate in the years ahead.

Another disruptive technology for the plastics and petrochemical industry, which could well scale on a 10-20 year horizon, is called Carbon Capture and Utilization (CCU). CCU actually sucks carbon out of the atmosphere, and converts it into value – mainly into feedstock for industry. Rather than extracting petroleum from the Earth's crust, CCU pulls carbon 'out of thin air.' CCU operators set up large fans, powered by renewable energy, to pull air through a filter that captures carbon, in a form that can be processed into plastics, fuels, specialty chemicals, and more. CCU can harvest thin air anywhere on Earth, in contrast to petroleum, which is concentrated in particular geographies and often in sensitive natural areas. By some estimate, the DAC market could reach $1 trillion annually by 2030.[13]

---

1 Yong, Ed. "A Troubling Discovery in the Deepest Ocean Trenches." *The Atlantic*, 27 Feb. 27 2019.

2 Carrington, Damian. "People eat at least 50,000 plastic particles a year, study finds." *The Guardian*, 5 June 2019.

3 Hamilton, Lisa Ann et al. "Plastic & Climate: The Hidden Costs of a Plastic Planet." Center for International Environmental Law, Environmental Integrity Project, Fracktracker, Global Alliance for Incinerator Alternatives, 5Gyres, #breakfreefromplastic. May 2019, Executive Summary.

4 U.S. Environmental Protection Agency. "Plastics: Material-Specific Data." Facts and Figures about Materials, Waste and Recycling. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data. Accessed Oct. 2019.

5 National Council of State Legislatures. "State plastic and paper bag bans." 1 Nov. 2019. http://www.ncsl.org/research/environment-and-natural-resources/plastic-bag-legislation.aspx. Accessed Nov. 2019.

6 Pyzyk, Katie. "Maryland passes statewide EPS foam ban bill." *Waste Dive*, 28 May 2019.

7 Brueck, Hillary. "The real reason why so many cities and businesses are banning plastic straws has nothing to do with straws at all." *Business Insider,* 22 Oct. 2018.

8 Arthur, Rachel. "EU sets out 30% recycled content target for plastic bottles." *Beverage Daily*, 21 May 2019.

9 "*Canada to ban single-use plastics as early as 2021*." BBC, 10 June 2019.

10 Lee, Rina. "Closed Loop report calls for increased investment in chemical recycling." *Waste Dive*, 10 April 2019.

11 Pioneer Project. *Lodestar: A case study for plastics recycling*. *Recycling Technologies*. https://www.newplasticseconomy.org/assets/doc/Lodestar.pdf

12 Matchar, Emily. "This bioplastic made from fish scales just won the James Dyson Award." *Smithsonian Magazine*, 14 Nov. 2019.

13 Roberts, David. "Pulling CO2 out of the air and using it could be a trillion-dollar business." *Vox*, 22 November 2019.

The Northwest Leadership Blueprint

Chapter 6 Building the Clean Materials Industry-Jobs Cluster

A critical component of the Northwest Clean Materials 2040 vision is that it supports tens of thousands of good jobs throughout the region. Chapter 6 outlines a near-term pathway for the Northwest to get organized and launch the first phase of a battle plan to become a global leader in the Clean Materials economy and thrive economically by fostering clusters of innovative enterprises that grow investment, revenues, and good jobs.

Chapter 6 proposes that Oregon and Washington focus first on building an industry-jobs strategy for Clean Materials, quickly through a concentrated 18-month effort. The chapter suggests several important elements that a smart strategy will consider and incorporate. And it explores the question of whether and how Clean Materials can create tens of thousands of jobs in the Pacific Northwest.

This part of the Blueprint connects directly to *Big Goal 2: Build a World-class Industry-Jobs Cluster in Clean Materials Solutions*, one of the two higher goals. It also connects to *Goal 4: Invest in Local Clean Materials Infrastructure and Jobs*; and *Goal 5: Export Clean Materials Solutions*.

Start with the Strategy, But Quickly

To direct activity and investment toward Clean Materials jobs, the blueprint's top action recommendation – prioritized as **Cross-Cutting Policy #5** is for state and local economic development leaders in Oregon and Washington to launch robust 18-month processes to create comprehensive state action strategies for Clean Materials industry and jobs.

Why 18 months? This is enough time to do the job well, given adequate investment of resources and political capital by leading policymakers. But it is also immediate enough to compel focus and urgency to bring stakeholders to the table and drive momentum.

A key principle to guide the industry-jobs strategy development is that Clean Materials excellence at home will breed exports abroad.

Developing world-class, signature projects, programs, and R&D initiatives throughout the Pacific Northwest will not only benefit our communities by delivering smart, affordable Diamond solutions, helping control waste costs for businesses and residents. It will also spur formation of new enterprises to deliver these solutions. The professionals in these enterprises will gain valuable experience and grow their portfolio of successful work. And great projects, programs and R&D will help brand the Northwest as a place where some of the world's most skilled and successful Clean Materials innovators are leading the way into the future.

Success metrics for a Clean Materials industry-jobs strategy should center on generating the kind of economic benefits that are needed and welcome in all kinds of Northwest communities. These include maximizing family-wage jobs, local business vitality, dollars recirculating in the local economy, and delivery of cost-effective services.

Heart and Lungs of a Clean Materials Cluster

The beating heart of a Pacific Northwest industry cluster is Clean Materials excellence at home, and the oxygenating lungs are companies that export Diamond solutions, proven at home, to other states, regions and nations.

The Northwest boasts a number of industry clusters that include aerospace, microprocessing and software, gourmet coffee and microbrew, and forestry and agriculture. An industry cluster is a group of similar and related firms in a defined geographic area that share common markets, technologies, worker skill needs, and are often linked by buyer-seller relationships, according to the Oregon Business Plan, a collaborative of that state's business community, elected officials and other stakeholders to achieve greater economic prosperity.

A Clean Materials industry-jobs cluster in the Northwest includes two symbiotic components, the heart and lungs, the local and the outward-facing, corresponding to Big Goals 4 and 5:

- Invest in Local Clean Materials Infrastructure, R&D and Jobs (Big Goal #4)
- Export Clean Materials Solutions (Big Goal #5)

The Heart: Clean Materials Excellence at Home

When the Northwest's Clean Materials system is hitting on all cylinders and investing robustly in Diamond solutions, local companies will spring up to offer needed services. Companies that prove effective will grow, creating jobs, as they build capacity to innovate. Local companies will cluster at clean production hubs that sort and process recycled and organic materials, repair and make clean products, and share clean infrastructure.

Chapter 6: Building the Clean Materials Industry-Jobs Cluster

Strong but simple policy action can spur investment in new businesses and services in local Clean Materials infrastructure. For example, after Massachusetts and Vermont banned landfilling of food scraps, food scrap recycling services increased 70% and 100%, respectively. Just two years into the program, Massachusetts found the ban had generated 900 new jobs and $175 million in economic activity.[77]

In the Clean Materials economy, new and reimagined enterprises, both public and private, will deliver a variety of services and infrastructure to help communities with Diamond solutions, all of which have job needs and opportunities:

- Prevent waste at all stages
- Get longer life and more use from products
- Optimize recycling
- Develop clean production and processing hubs

The Lungs: Export Diamond Solutions

If local Clean Materials excellence is the heart of an industry-jobs strategy, growing outward-facing export companies is the lungs.

A virtuous cycle is possible, where Northwest communities showcase innovation and excellence in delivering Diamond solutions, spawning companies and expertise that can go out and serve markets worldwide. Both will contribute to growing the Northwest's global reputation as a center of Clean Materials excellence and innovation.

Leveraging local excellence in delivering Diamond solutions to export our know-how and innovative services and technology to other regions will be especially valuable for economic development. That's because local companies that serve markets elsewhere bring outside dollars into the Northwest economy. Those dollars recirculate to a wide range of other local businesses, multiplying the benefits for Northwest jobs.

Business Oregon, the state's economic development agency, calls this a 'traded sector.' Traded sector industries, they say, are those that sell goods and services in markets outside the state.

A world-class Clean Materials traded sector will feature a constellation of companies delivering expertise in Diamond solutions, clean products, and innovative services that help business and government customers to prevent waste, extend product life, optimize recycling, and develop clean production facilities.

Develop the Taxonomy of Clean Materials Jobs

What we need to strategically build the Clean Materials industry-jobs cluster is, early on, a good workable and holistic taxonomy and understanding of Clean Materials services and businesses, the types of jobs and work skills involved. That is needed, but it hasn't yet been developed. But Oregon and Washington can get the ball rolling by taking a first cut at building this taxonomy while formulating their initial industry-jobs strategies.

77 "State, local food scrap bans lead to hauler growth." *Waste Today*, 3 April, 2019.

Northwest Companies Daylighting the Supply Chain

Preventing toxic chemicals from entering human bodies is an urgent need, but progress in changing rules and laws at the federal level, as well as cleaning up toxic contamination in our environment, has too often been agonizingly slow.

But when businesses decide to prioritize safety and transparency, they can often drive change faster, and we're seeing good examples here in the Northwest.

Leading companies are developing ways to 'daylight the supply chain,' to create transparency so manufacturers, retailers and consumers can know the ingredients and safety of their products.

Costco has adopted their "Smart Screening Program," in which they test various products against a list of hundreds of chemicals of concern in order to find safer alternatives and keep hazardous products off their shelves.

Amazon recently announced a new chemicals policy to reduce harmful toxics in products and offer customers better information on chemical ingredients. They are beginning by focusing on the reduction or elimination of 54 chemicals in its private label brand of baby and adult personal care and beauty products, as well as in its line of home cleaning products.

ECOS is a California-based cleaning products company that has responded to customer demand for safety by manufacturing products designed to be safe for the environment and people. This expanding market led to the opening of a manufacturing facility in Lacey, Washington, providing good (and clean) local jobs.

As businesses like these, with their vast market share, respond to customers' wishes and demand more transparency and safety from the producers in their supply chain, huge ripple effects can be felt as other businesses follow their lead and opt for safer, healthier choices.

The Northwest Leadership Blueprint

Diamond solutions prevent waste, get longer life and more use from products, optimize recycling, and develop clean production hubs. The most progress on mapping jobs taxonomy has been done on recycling, while there is little data so far on the other Diamond solutions.

For recycling, the U.S. Bureau of Labor Statistics[78] documents recycling industry jobs that include drivers, sorters, MRF managers, route managers, account managers, sales reps, and more, at an average salary for workers that exceeds $50,000 annually. The Institute for Local Self-Reliance produced a more detailed breakdown of jobs during the 1990s and found significant levels of employment not only in these traditional recycling jobs, but many more in areas such as computer reuse, textile reclamation, wood pallet repair, and in mills and factories that use recycled paper, glass and plastic feedstocks.[79] Based on US EPA data, recycling and reclamation in the construction and demolition sector have the greatest economic impact, followed closely by metals recycling.[80]

The US EPA released their latest Recycling Economic Information report in 2016. They found that recycling and reuse activities were responsible for over 750,000 jobs nationwide, producing $36.6 billion in wages, as well as $6.7 billion in tax revenues for local and state governments.

Each Diamond solution will generate Clean Materials jobs that need to be identified and tracked. As part of Northwest states' 18-month development of jobs-industry strategies, they can commission studies that map the range of jobs and economic opportunity in the Clean Materials economy.

Elements of a Smart Strategy

Because of our clean power grid and strong environmental laws, producers in the Northwest will start out with a competitive advantage over dirtier producers. But it won't last without concerted action.

In addition to the standard incentives and support that states provide for industry and economic development, a smart strategy to build a vibrant Clean Materials industry-jobs sector can consider a number of more specific action elements:

Accelerate Clean Production Hubs

Clean production hubs can be one of the most attractive, near-term opportunities for communities to generate good jobs in the Clean Materials sector, creating well-paid technical and blue-collar jobs.

Clean production hubs will co-locate companies that make clean products. These companies will sort and process recycled and organic materials, repair products, redistribute reusable containers and products, disassemble products to reutilize materials, and put recycled and recovered material back into productive use. Clean production hubs will rely on renewable power, circulate fossil-free heating and recycled water, and design out toxics and toxic processes.

States can provide tax incentives to companies and innovation grants to public entities to support local clean production hubs and symbiosis partnerships that demonstrate meaningful commitment and co-investment from multiple partners. States need to establish criteria for financial support to incentivize innovation, co-investment, and local capacity, such as:

- leveraging multiple sources of public and private investment;
- offering a compelling business case for multiple local businesses to participate;
- showing clear economic benefits for the local community;
- achieving compelling health and environmental benefits on a life cycle basis;
- advancing symbiosis in different types of communities – rural, suburban, and urban;
- integrating energy, water, and materials cycling to optimize cross-resource value; and
- demonstrate commitment to positive return-on-investment for all participants.

States can also invest in centers, or "accelerators", that deliver expertise, technical assistance, training, and best practices to support the success of local clean production hubs. 'Circuit riders' can actively assist local projects by providing facilitation, strategic advice, connection to appropriate funding programs, and other assistance.

Clean Production R&D

The Northwest boasts first-rate research institutions with expertise in an extraordinarily wide range of fields relevant to Clean Materials innovation. Relevant fields of Northwest expertise include materials science, waste prevention, CO2 capture-and-utilization, green chemistry, clean energy, wastewater treatment, green infrastructure, bio-energy, organics recycling, biochar, life cycle assessment, and more.

The West Coast Clean Materials Alliance (**Cross-Cutting Policy#3**) could serve as a primary locus for **research and development** (**R&D**), ensuring that R&D initiatives provide tangible value for market transformation and innovation efforts. Linking R&D to WC-CMA programs and goals will help R&D proposals to be smart, disciplined, broadly-supported, and attractive for federal and state R&D funding.

78 Liming, Drew. "Careers in recycling." U.S. Bureau of Labor Statistics. https://www.bls.gov/green/recycling/#occupations. Accessed Dec. 2019.

79 Institute for Local Self Reliance. "Recycling means business." 1 Feb. 2002. https://ilsr.org/recycling-means-business/. Accessed Dec. 2019.

80 U.S. Environmental Protection Agency. *Recycling Economic Information Report*, 2007.

Chapter 6: Building the Clean Materials Industry-Jobs Cluster

Can Clean Materials Support Tens of Thousands of Jobs?

It's an obvious question, and a crucial one for the blueprint: Can a world-class Clean Materials system in the Pacific Northwest really create tens of thousands of jobs, like the region's clean energy sector?

Clean Energy is now a driver of broadly-shared prosperity in the Northwest. According to E2, a national nonpartisan group of business professionals, Washington boasted 82,000 clean energy jobs and Oregon 55,000 in 2018 – in wind, solar, efficiency and related industries. In Washington, "That makes the clean energy industry a bigger employer in the state than Boeing (around 65,800 employees), Microsoft (46,000) or Amazon (50,000)," according to the report. Further, E2 found that 11% of Washington's clean energy workers are veterans, and that rural jobs represent over 10% of clean energy jobs in the state. Oregon figures for veteran and rural jobs are similar.

Development of the Northwest's Clean Energy sector has been two decades in the making. The Clean Materials sector is at the front end of what could be a decade or more of growth and maturation. Today we can't yet know whether Clean Materials will be as job-rich as Clean Energy has been for the region. But this new sector touches most other sectors in our economy, so the range of economic opportunities in Clean Materials excellence is potentially wide-reaching.

Economic analysts are just beginning to recognize that Clean Materials solutions can become a local jobs engine.

While EPA's latest data suggests that recycling already is responsible for 750,000 jobs nationwide, we should envision and pursue entirely new kinds of jobs, which will be called for in the new system. As we imagine solutions to the problem of massive food waste (a key contributor to climate change), solutions are necessarily local in nature and will create local jobs. As we develop expertise and solutions, new 'traded sector' jobs selling expertise and services to other markets will emerge. As infrastructure developers leave their silos to seek Diamond solutions, they will need help from skilled workers to bring other sectors to the table to search for innovative, cross-cutting approaches. As local "repair fairs" grow, people with repair skills can be employed to extend the life of their neighbors' products. As we educate engineers and chemists in integrated systems and green chemistry, we'll need to hire teachers with the proper expertise. What other new opportunities can we imagine?

82,000 Clean Energy Jobs in WA

13X There are 13X more clean energy jobs in Washington than fossil fuel jobs

8,500 RURAL JOBS rural Washingtonians now work in clean energy, more than every Washington metro area except Seattle

10.9% VETERANS of Washington clean energy workers are veterans

All 39 COUNTIES in Washington employ workers in clean energy

#9 Washington state ranks 9th in the U.S. for wind energy jobs, 16th in solar energy jobs, and 13th in total clean energy jobs

E2: Clean Jobs Washington 2019 Report

The Northwest Leadership Blueprint

Clean Materials Leadership Needs World-Class R&D

By Karl Englund and Lauren Heine

If the Northwest wants to be a leading hub for Clean Materials innovation, then support for research and development is crucial for success. Innovation in alternative feedstocks, creation of alternative materials, material recovery logistics, recycling technologies, materials management policies, and product stewardship business models, are both critical needs and areas of opportunity to create a vibrant circular economy.

The Northwest's world-class research universities can help our region innovate in the clean materials space.

University and government research labs in the Northwest provide basic and applied research. They also provide testing services for existing companies, and generate intellectual property that leads to new businesses and job opportunities. Universities play a key role in training people in ways that help them add value to their communities and the workforce. Because the Pacific Northwest is home to world-class universities and research labs, it is well positioned to be a leader in Clean Materials innovation.

With an effective vision, framework and set of incentives to guide university research and development, there is opportunity for greater coordination of the various pockets of research and development related to Clean Materials innovation. First of all, university leaders and policy makers need to signal the importance of a Clean Materials economy. An Advisory Board such as the Washington Department of Ecology's Recycling Development Center Advisory Board could be commissioned to drive Clean Materials innovation in the region. This board should include people who are connected to local, national and even global initiatives. The board could set high level state and regional priorities. These priorities will address challenges and opportunities unique to the Northwest. For example, use of agricultural or fishing waste as feedstock for new chemicals and materials could be a high priority for Washington, a state with an economy based in part on fishing and land-based agriculture. Clear regional priorities can help coordinate and align university research and development priorities. University policies can then support hiring of people who can best help achieve regional goals. These people may be experts in entrepreneurship, materials research, material logistics, product stewardship, materials science, engineering, chemistry and more.

While funding for targeted R&D is always desirable, we believe that great progress could be made just by setting and communicating a vision and a framework for Clean Materials innovation that is adopted by the world-class universities already operating in this region. Other economic incentives could also support growth, including tax breaks.

By doing so, there will be many benefits. Coordinated R&D will lead to recognized leadership in the Northwest that would further attract new and emerging businesses seeking access to research, testing labs and a talented and trained workforce. Businesses need funding to grow and investors need some confidence in the likelihood of their success. By locating near centers of excellence, businesses can demonstrate lower risk for investors. Companies can show they have reputable partners, a strong workforce, understanding of life cycle benefits and access to labs for testing and to solve research questions.

Clean Materials innovation will need input from all aspects of the materials value chain, everything from fundamental research, prototyping of ideas, commercial development, and policy management. By empowering our existing education and research infrastructure, we can provide the backbone of a successful green economy that will create smart materials management strategies and local jobs for the region.

Chapter 6: Building the Clean Materials Industry-Jobs Cluster

Help Economically Distressed Communities

There are many economically distressed communities in zip codes from every part of the Pacific Northwest – rural, suburban, and urban alike. A Northwest industry-jobs strategy can prioritize support for our economically-distressed communities, aiming to maximize family-wage jobs, local business vitality, and economic development in all parts of the state.

Market 'Made Clean in the Pacific Northwest'

Northwest economic development agencies can partner with environmental advocates to promote the Northwest as a world leader in Clean Materials. Imagine a "Made Clean in the Pacific Northwest" logo, sought after by producers, that certifies the region's top-tier clean producers. Buyers of products – whether individuals, institutions or corporations – could seek out and preference Northwest Clean products.

MADE CLEAN
in the
Pacific Northwest

Collaborate with Other Innovative Regions

Establish government-to-government cooperation agreements with states, regions and nations who are also leading in Clean Materials innovation. A model is the agreement signed in 2019 between Norway and Washington State to cooperate on sustainable and innovative maritime technologies.[81]

The Pacific Northwest can become a global leader in the Clean Materials economy and foster widely shared prosperity as a result. But it will require bold action, like the concentrated 18-month effort to build the initial battle plan, as proposed in this blueprint. If we succeed in the years ahead, the Northwest will foster hundreds of innovative enterprises and many thousands of good jobs in communities throughout the region. And at the same time, we will help lead the world toward a Clean Materials future, where a healthy economy can go hand-in-hand with healthy people and a healthy environment.

81 WA Dept. of Commerce. "Washington, Innovation Norway open summit with agreement to promote economic cooperation…" News release – 16 May, 2019.

Courtesy of Michael Singer Studio

Acknowledgements

Recognizing the Special Contribution of Pacific Northwest Innovators and Thought Leaders

The thought leaders and innovators listed here made vital contributions to **From Waste Management to Clean Materials**. *Throughout 2019 during the report interview and review processes, they were extraordinarily generous with both their time and ideas. These 54 leaders sat for an hour-long interview with the Center for Sustainable Infrastructure or they provided expert review of a draft of this report – and in some cases, both. People marked with an asterisk (*) both were interviewed and reviewed.*

Reviewers were especially valuable in helping to ground-truth the details of this report, identifying important gaps, and significantly reshaping conclusions and recommendations toward something closer to a shared vision. That said, the lead author maintains final responsibility for the report's content and any shortcomings.

David Allaway,* Senior Policy Analyst, Materials Management Program, Oregon Department of Environmental Quality

Jim Amonette, Senior Research Scientist, Battelle Pacific Northwest National Laboratory

Nicole Bassett, Co-Founder, Renewal Workshop

Janine Bogar,* State Plan & Policy Lead Solid Waste Management Program, Washington Department of Ecology

Arthur Bearden, President, Round Table Computing, LLC

Michael Brady, Assistant Professor and Extension Economist, School of Economic Sciences, Washington State University

Tamara Burns, Senior VP Western Operations, Recycle BC

Tracy Casavant, Managing Director, NISP Canada & Circular Economy, Light House Sustainable Building Centre

Scott Cassel, CEO & Founder, Product Stewardship Institute

Shulin Chen, Bioenergy & Bioproducts Researcher, Washington State University

Mannie Cheung, VP of Operations, Product Care

Teresa Conner, Senior Policy Analyst Extended Producer Responsibility, British Columbia Provincial Government

Marc Daudon, President, The Caspian Group, LLC

Kyle Diesner,* Climate Action Program Coordinator, Portland Bureau of Planning and Sustainability

Karl Englund, Associate Research Professor Composite Materials & Engineering Center, Washington State University

Ben Finkelstein, Manager Communities and Built Environment, BC Provincial Government

Mark Fuchs, Manager Waste-to-Fuels Technology Project, Washington Department of Ecology

Jeff Gaisford, Section Manager Recycling and Environmental Services, King County Department of Natural Resources

Michael Germeraad, Resilience Planner, Metropolitan Transportation Commission Association of Bay Area Governments

Terry Gillis, General Manager, Recovery 1

Juan Carlos González, Metro Councilor, Oregon Metro Regional Government

Avery Gottfried, Senior Policy Specialist Clean Communities, British Columbia Provincial Government

Roel Hammerschlag, Principal, Hammerschlag, LLC

Mary Harrington, Organics Lead Solid Waste Management Program, Washington Dept. of Ecology

Lauren Heine,* Senior Science Advisor, Northwest Green Chemistry

Jack Hoeck, Vice President, Rexius

Sego Jackson,* Strategic Advisor for Waste Prevention & Product Stewardship, Seattle Public Utilities

Alli Kingfisher, Recycling Materials Management Lead Solid Waste Management Program, Washington Department of Ecology

Srirup Kumar, Community Engagement Officer Operations & Partnerships, Impact Bioenergy

Mark Kurschner, President, Product Care

Allen Langdon, President & CEO, Encorp Pacific (Canada)

Acknowledgements

Gwen Lohbrunner, Acting Director Clean Communities, BC Provincial Government

Erik Makinson, Founder & President, Resource Synergy

Terry McDonald, Executive Director, St. Vincent de Paul of Lane County

Steve Moddemeyer, Principal, CollinsWoerman

Erin Moore, Associate Professor School of Architecture & Environment, University of Oregon

Tony Moucachen, CEO, Merlin Plastics

Gretchen Newman, Data & Performance Measures Solid Waste Management Program, Washington Department of Ecology

Vladimir Novotny, Author, *Integrated Sustainable Urban Water, Energy and Solids Management* (and other books)

Jordan Palmeri, Senior Policy Analyst Materials Management Program, Oregon Department of Environmental Quality

Craig Partridge, former Policy Director, WA Dept. of Natural Resources

Kenneth Porter, Senior Policy Analyst Science, BC Provincial Government

Paul Roberts, Author, *Growing the Green Economy in Washington State* AWC Center for Quality Communities

Susan Robinson,* Senior Director of Sustainability & Policy, Waste Management

Derek Ruckman, Vice President & Group Manager, Pacific Northwest, Recology

Lisa Sepanski, Team Lead, Responsible Recycling Taskforce and Program/Project Manager, King County Solid Waste Division

Kate Simonen, Founding Director, Carbon Leadership Forum and Associate Professor, Department of Architecture, University of Washington

Alando Simpson, CEO, City of Roses Disposal & Recycling

Stacy Smedley, Director of Sustainability, Skanska

Ted Sturdevant, Director of Strategic Initiatives, Center for Sustainable Infrastructure

Heather Trim,* Executive Director, Zero Waste Washington

Meggan Uecker,* Solid Waste Coordinator, Clallam County

Hanna Vovk, Senior Policy Analyst Extended Producer Responsibility, BC Provincial Government

Georgine Grace Yorgey, Associate Director, Center for Sustaining Agriculture and Natural Resources, Washington State University

Special Thanks

Craig Partridge, a member of the Center for Sustainable Infrastructure's Council of Advisors, helped synthesize executive review feedback and extract important feedback.

Gretchen Helpenstell, a student in The Evergreen State College's Graduate Program on the Environment, assisted with many elements of report production: coding and organizing interviews, extracting key thought leader insights, and helping to identify, source, and design images, charts and graphs.

Terry Carroll, CSI's Operations Manager helped organize the thought leader outreach process, assisted with communications to the steering committee and review team, and managed other key project elements during report synthesis and production.

Report design and layout by Alicia Kramer Graphic Design.
Original design concept for '5 Big Goals' by Anza Evans.

Sponsors

Co-Funding Steering Committee

An exemplary partnership of local and state public agencies from Oregon and Washington provided the funding to make this report possible, and served on the Steering Committee that guided the process at every stage. The report benefited immensely from the contributions of these public servants. Nevertheless, responsibility for the report's content resides entirely with the lead author.

David Allaway, Jordan Palmeri, and Shannon Davis,
Oregon Department of Environmental Quality

Janine Bogar,
Washington Department of Ecology

Matt Korot and Pam Peck,
Oregon Metro Regional Government

Lisa Sepanski,
King County Solid Waste Division, Washington

Deb Geiger and Rob Lindsay,
Spokane County, Washington

Cadie Olsen,
City of Spokane, Washington

Jeff Orlandini,
Lane County, Oregon

Kyle Diesner,
Portland Bureau of Planning and Sustainability, Oregon

Ron Jones and Gary Franks,
City of Olympia, Washington

DEQ
State of Oregon Department of Environmental Quality

Department of Ecology
State of Washington

Spokane County
Washington

Metro

City of Spokane

King County
Department of Natural Resources and Parks
Solid Waste Division

Lane County
Oregon

Bureau of Planning and Sustainability
Innovation. Collaboration. Practical Solutions.

City of Portland, Oregon

Olympia

FIVE BIG GOALS FOR 2040

FIVE BIG GOALS FOR 2040

Center for Sustainable Infrastructure
120 State Avenue, NE #303
Olympia, WA 98501

To learn more, visit:
www.sustaininfrastructure.org
www.centerforsi.org

Contact us at:
info@centerforsi.org
360-867-8819

The Center for Sustainable Infrastructure is a 501(c)3 tax-exempt Washington State nonprofit corporation. We are a Northwest-focused think-and-do tank that fosters innovative infrastructure systems that support prosperous and resilient communities, and help blaze the trail to infrastructure excellence and sustainability so others can follow.

CSI

Center for Sustainable Infrastructure

5/2020