Oregon Global Warming Commission

Report to the Legislature

2013

KeepOregonCool

Oregon Global Warming Commission

Oregon Global Warming Commission

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Representative Bob Jenson	Oregon State Legislature
Senator Jason Atkinson[3]	Oregon State Legislature
Senator Chris Edwards	Oregon State Legislature

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[1] One voting member position of the Commission remains vacant at the time of this report.
[2] No longer with the Legislature or the Commission, replacement to be appointed.
[3] No longer with the Legislature or the Commission, replacement to be appointed.

Report to the Legislature:

OREGON GLOBAL WARMING COMMISSION

State of Oregon, August 2013

For more information on the Oregon Global Warming Commission please visit the Commission's website at www.KeepOregonCool.org.

For electronic copies of this report visit the Commission's website or the Oregon Climate Change Portal at www.orclimatechange.gov. For printed copies of the report please contact:

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EXECUTIVE SUMMARY

This report is the first from the Commission to be able to report on Oregon's first greenhouse gas reduction goal as established in *ORS 468A.205* -- to arrest the growth of emissions and to begin reducing those emissions by 2010. For the first time the Report provides data for 2010 from multiple emissions tracking perspectives. Also for the first time, much of the emissions data being used are based on reports filed by emitting facilities and energy suppliers for 2010. These improved and up-to-date data indicate that Oregon met its 2010 greenhouse gas reduction goal, having arrested the growth of greenhouse gas emissions and, it appears, also establishing a downward emissions trajectory in which emission levels are expected to be reduced into the future. Moreover, it appears that emissions have been arrested regardless of whether one considers only emissions occurring within the State's boundaries or if we also include emissions from outside of Oregon that result from what Oregonians consume, how they travel or receive goods, or how they use energy that is imported into the State.

We can pause to applaud these gains, in which Oregon and a small group of other states lead the nation. Then we need to remember that progress toward Oregon's longer term greenhouse gas reduction goals – to reduce greenhouse gas emission by 10 percent below 1990 levels by 2020 and at least 75 percent below 1990 levels by 2050 – remains challenging (particularly as we emerge from recession, and recovery-related emissions may rise). As described in the Commission's last report to the Oregon Legislature the Commission created an interim "Roadmap to 2020" in 2010 to plot a course toward achieving these goals across good and bad economic times. The Roadmap was labeled interim in order to allow for a public input process and to integrate technical work that was ongoing when the Roadmap was adopted by the Commission. Valuable public input was gathered from a "Roadshow for the Roadmap" process in 2011, and a summary of those results is contained in this report. Technical and policy work integral to the Roadmap recommendations also occurred – most notably through the development of the Statewide Transportation Strategy and the Governor's 10-Year Energy Action Plan – and that work has provided an improved analytical foundation for making future Roadmap choices.

For this report the Commission provides an initial assessment of progress on the "Roadmap to 2020" for each of the forty key actions identified in that process. A summary of the progress assessment follows, with more detail available sector by sector noting key accomplishments in recent years and highlighting what remains to be accomplished in order to stay on the course toward Oregon's 2020 and 2050 goals. These scores reflect an assessment of overall forward progress, or lack thereof, for each key action on a *statewide* level and are *not a performance measure for any particular agency, company, or organization*.

Work on preparing for and adapting to climate change this past biennium has been limited by budget and other constraints. Accomplishments include adoption of the Oregon Integrated Water Resources Strategy and adaptation and vulnerability planning done by the Oregon Department of Transportation.

This report, as well as all the "Roadmap to 2020" process materials, can be found on the Commission's website, www.keeporegoncool.org, which remains an important archive of the Commission's activities.

Progress Summary: Key Sector Actions by 2020 from "Roadmap to 2020" Process

Sector	Action	Score	Page
Energy	Develop State Energy and Climate Policy	B	Page 14
	Energy Efficiency	A-	
	Support and Plan for New Transmission	B-	
	Ramp Down Emissions Associated with Coal Generation	B/C	
	OUS Energy Research Priorities	B	
	Modern Gas Infrastructure	C	
	Smart Grid and Integration of Resources	C+	
Transportation and Land Use	Change the Way We Fund Transportation	C+	Page 21
	Develop New Funding Sources	C	
	Expand Urban Transit	B-	
	Create Complete Communities	C+	
	Keep Urban Footprints Compact	A	
	Move Freight the Low-Carbon Way	B-	
	Embed Climate Change in Transportation Planning	B+	
	Expand Intercity Transportation Options/Choice	C+	
	Reduce Demand by Increasing Options	B	
	Manage and Price Parking	C	
	Support Electric Vehicles	B	
	Adopt Low-Carbon Fuel Standard (now referred to as the Clean Fuels Program)	D+	
Industrial	Accelerate Use of Energy Efficient Technology and Practice	B	Page 28
	Establish Greenhouse Gas Leadership Recognition Program	A	
	Improve Access To Financing and Incentives	C	
	Build Human Capacity To Innovate and Execute Industry Process Improvements	C+	
Agriculture	Increase Nutrient Use Efficiency	C	Page 30
	Increase Carbon Sequestration in Crop Management	B	
	Develop Manure to Energy Methods	A-	
	Proactively Prepare for and Adapt to Climate Change Impacts on Water Supply	B+	
Forestry	Carbon Inventory	B	Page 32
	Reforestation/Afforestation/Acquisition	C+	
	Research	B	
	Biomass	B	
Materials Management	Advocate for Carbon Price Signal Across Life Cycle of Products & Materials (either by an emissions cap and/or a carbon tax), Including Imports (border adjustment mechanism/carbon tariff if necessary)	C	Page 36
	Conduct Research To Develop a Consumption-Based GHG Inventory and Inventory Methodology; Consider Integration with State's Conventional Inventory, Identify High-Carbon Product Categories	A	
	Develop and Disseminate Information: Easy-To-Use Life Cycle Metrics for Different Food Types	C	
	Standards, Incentives, and/or Mandates For Carbon Footprinting, Labeling of Products	C+	
	Focus Product Stewardship on Upstream Emissions, and Design For Appropriate Durability, Repairability, Reusability, Efficiency, and Recovery	C+	
	Establish Higher Standards For New Buildings: "Net Zero" Plus Offset of Materials	C	
	Provide Information and Outreach to Consumers on Product Impacts and Opportunities to Reduce Those Impacts	C	
	Reduce (Prevent) Waste of Food at the Retail and Consumer Level By 5 to 50 Percent	C+	
	Conduct Research on Highest/Best Use for Organic Wastes and Waste To Energy and the Carbon Impact of Different Conversion Technologies	C+	

Progress Scores

- **A** On track to meet State goals or Roadmap outcomes
- **B** Partial but significant GHG reductions or progress toward outcomes
- **C** Business as usual; insignificant or no reductions or progress
- **D** Significant measurable slippage away from goals or outcomes

FROM THE CHAIR

> ***468A.205 Policy; greenhouse gas emissions reduction goals.*** *(1) The Legislative Assembly declares that it is the policy of this state to reduce greenhouse gas emissions in Oregon pursuant to the following greenhouse gas emissions reduction goals:*
> *(a) By 2010, arrest the growth of Oregon's greenhouse gas emissions and begin to reduce greenhouse gas emissions.*
> *(b) By 2020, achieve greenhouse gas levels that are 10 percent below 1990 levels.*
> *(c) By 2050, achieve greenhouse gas levels that are at least 75 percent below 1990 levels.*

Readers of this 2013 Global Warming Commission Biennial Report to the Legislature may find its "good news/bad news" data and commentary sometimes difficult to make sense of. It's been that kind of biennium for climate policy and climate data: sometimes pathbreaking progress, and sometimes discouraging slippage; in Oregon and nationally. The detail follows in the table of Key Sector Recommendations, their current status and pending needs, beginning on page 14. The following examples will give you a selective taste of what awaits.

Meeting Goals; Acting on Recommendations

Achieving greenhouse gas reduction goals: On the one hand, Oregon met its Legislatively-directed 2010 goal for greenhouse gas emissions (GHG's), including three years (2008-2010) that closely track the trajectory needed to reach the 2020 and 2050 goals. On the other hand, those three years almost surely reflect the effects of economic recession more than they do durable policy and behavioral responses. Absent such durable responses, we have to be concerned that the emissions line will bend back upwards as economic activity recovers.[4]

Ending Coal Burning at Boardman: Portland General Electric came to an agreement with its regulators and important stakeholders to terminate coal combustion at its Boardman power plant – and Oregon's only in-state coal plant – by the end of 2020, some two decades earlier than the utility's alternative plan. The agreement influenced similar such resolutions, for similar plants, in states as close as Washington, and as distant as New Mexico and Oklahoma. On the other hand, in 2021 PGE will still meet about 9 percent of its load with coal,[5] and possibly as much as 53 percent from gas combustion (up from about 33 percent today). For Oregon's other large electric utility, PacifiCorp, two-thirds of the power it supplies to Oregon customers is coal-generated; and there is little indication the company is planning to draw down its reliance on coal in any significant degree.

Vehicle Miles Traveled (VMT): Oregonians are driving fewer overall miles despite population gains (in Oregon, 6 percent fewer miles since 2005 while adding some 250,000 new inhabitants). While national VMT counts have been leveling off since 2003, Oregon VMT has been *declining* since 1996; and has been doing so across the State, not just in urban areas and not just correlated with higher gasoline prices. This

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[4] Note that overall US emissions declined similarly in concert with the recession beginning in 2008. Gas displacement of coal for power generation, and milder than usual winter weather also contributed.
[5] Down from 20 percent in 2020 with Boardman operating; this properly gives PGE credit for meeting 10 percent of its 2021 load from energy efficiency gains since 2009 (per PGE presentation 12/17/12).

VMT effect, combined with expected improvements in vehicle fuel economy[6] and continued success in maintaining urban growth boundaries, creates for Oregon a real opportunity for substantial and growing reductions in transportation carbon emissions.[7] In 2011, per capita use of gasoline by Oregonians fell to its lowest level since 1962.[8] In long-haul trucking and air travel, emissions reductions are more elusive as miles traveled numbers grow, but there are some promising fuel and technology leads.

The good news notwithstanding, Oregon is not on track. "On track" would mean a GHG reduction trajectory that reduced emissions some 20 percent between 2010 and 2020 (only seven years away) net of emissions growth from a recovering economy.[9]

While GHG emissions from electricity generation will dip in 2020 when Boardman ends coal burning there, emissions growth in utilities will resume if: (a) PGE relies largely on gas to fill its needs (including backfilling Boardman); and, (b) PacifiCorp does not reduce its dependence – and ours – on coal.

Oregon industrial emissions are down since 2000, but most of that resulted from aluminum leaving the region[10]; further reductions must come from efficiency gains.

Only in transportation do we see downward-trending emissions curves that look sustainable, and these are still not dropping sharply enough to track Oregon's goals. A contrarian note was struck by the Legislature's decision not to extend the Clean Fuels Standard for vehicles beyond its current 2015 sunset date, which will weaken Oregon's ability to achieve needed carbon efficiencies in transportation. Tri-Met's 2012 service reductions were also unwelcome, coming when further emissions reductions in this sector depend in important part on increasing transit service levels faster than the rate of population growth.[11] Improving transit, bike, pedestrian and car-share modes are essential to our region's economic and equity goals as well as our environmental ones.

Planning and Tools

If there are two phases of governing that we do well in Oregon – or even over the top sometimes, in a Portlandia kind of way – it's putting together stakeholder groups and creating planning documents and tools. The last two years (since adoption of this Roadmap plan) have reinforced this stereotype . . . but in generally positive ways.

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6 Including personal and short-haul commercial vehicles; and including the advent of electric vehicles, where Oregon is a national leader (Portland boasts more hybrids per capita of any American city). New national fuel economy standards require manufacturers to produce 5 percent vehicle efficiency gains every year through 2025 to 54.5 mpg, or nearly double today's levels.

7 The current (2010) sector distribution of Oregon's GHG emissions is: 36.1% Transportation; 35.6% Residential/Commercial; 19.8% Industrial; and 8.5% Agriculture

8 . . . when gasoline cost 31¢/gallon. For OR and WA combined, Sightline reports per capita VMT declining by 13 percent since 2002, while gasoline consumption per capita is at its lowest level in 50 years (after peaking in the late 1970's). Total gasoline consumption for the two states is down 5 percent since its 2002 peak. [Sightline August, 2012]

9 But Oregon's GHG levels are ***down*** 10 percent from their 2000 peak.

10 Large-scale aluminum production in Oregon had effectively ended by 2001.

11 In 2010, TriMet ranked 13th in total transit miles while serving the nation's 26th largest urban area.

Governor's Ten Year Energy Action Plan[12]: Toward the end of 2011, Governor Kitzhaber assembled several task forces to develop a recommended State energy strategy. A year later the Governor released a final document setting goals for energy efficiency ("meet 100 per cent of new electric load growth"), clean-and-smart energy infrastructure, and a greener, more efficient transportation system. The Plan reflected many "Roadmap to 2020" priorities (e.g., integrating new renewables; shifting transportation funding from the gas tax to a "Vehicle Miles Traveled X vehicle efficiency" system). In parallel, the State commissioned a "McKinsey Curve" analysis of the cost-effectiveness of over 200 options for reducing GHG emissions.[13]

MOSAIC, MPO Planning and Statewide Transportation (greenhouse gas reduction) Strategy: Oregon's Department of Transportation (ODOT) distinguished itself in implementing directions from the 2009 and 2011 legislature, beginning by developing MOSAIC, the country's first "least cost planning" tool for transportation.[14] This tool will allow the State and local governments to systematically evaluate different transportation solutions for critical corridors against nine indicators of "cost-effectiveness" construed broadly to include both costs/benefits that can be monetized, and those that cannot (e.g., many environmental impacts) but that are important to Oregonians. In parallel, ODOT developed a set of strategies for what it would take to meet the State's 2050 GHG reduction goals, in transportation. It gave Metropolitan Planning Organizations (MPO's, e.g., the State's six largest urban areas) both GHG reduction goals[15] and a "toolkit" of ways and means to achieve these.

Other Planning Exercises: Portland General Electric commissioned the development of two low-carbon scenarios for meeting future load growth and replacing lost resources (including Boardman coal) that will inform its future resource procurement, and materially affect our ability to meet Oregon's goals (see "Ending Coal Burning at Boardman," above). Portland, Multnomah County, Metro, Eugene, Corvallis and other local governments have made or are revising their own combined community livability and GHG reduction strategies. The Department of Environmental Quality (ODEQ) and ODOT examined the costs and (extensive) benefits to Oregonians of shifting to lower carbon vehicle fuels, concluding that such shifts should be cost-effective for most Oregonians while adding new green businesses and jobs to the State. The leaders of the Pacific Coast Collaborative jurisdictions (OR, WA, CA, BC) have challenged themselves to "account for the cost of carbon"[16] and the Oregon Legislature agreed this year to authorize a carbon tax study (SB 306).

GHG Inventories

Making progress toward GHG goals is difficult to assess if we don't have a baseline we're confident in. As of this Report, we have two. The first is the inside-Oregon's-boundaries calculation of emissions originating in Oregon (plus emissions associated with out-of-state electricity sent to Oregon loads), historically calculated by the Oregon Department of Energy (ODOE) with help from ODEQ. We've seen

[12] http://www.oregon.gov/energy/pages/ten_year/ten_year_energy_plan.aspx
[13] Described in more detail on page 52 of this report.
[14] http://www.oregonmosaic.org/
[15] The goals are binding only on the Portland area's Metro government, but the other MPO's are expected to enter voluntarily into their individual commitments.
[16] Statement by Leaders of the Pacific Coast Collaborative, November 14, 2012.

this inventory before and planned against it, while recognizing that there was a fair bit of educated estimating in the numbers. It was pretty good ODOE estimating overall, we discovered; because now we can compare it to numbers being reported to ODEQ by Oregon's largest emitters, and integrated into the inventory to provide the majority of the 2010 results. On closer examination there are instances where the earlier estimates were too high or too low, but they largely cancel each other out.

ODEQ also is reporting to the Commission on the status of Roadmap Recommendation MM-2: to develop a "consumption-based" GHG inventory. In contrast to the conventional in-boundary inventory, this looks at emissions associated with the consumption of goods and services by Oregonians, whether or not the associated emissions originated inside the State. And it nets out those emissions released *inside* the State in the production of goods and services exported. In other words, it counts the emissions Oregonians *are responsible for* through their purchase and lifestyle choices. Counting this way, Oregon's emissions are some 16 percent higher (75 $MMTCO_2e$[17] vs. 63 $MMTCO_2e$) than the in-boundary inventory. This shouldn't be surprising, since Oregon is a relatively wealthy society on a global scale, thus a net importer of goods and services. Neither should the data be construed as slippage, but rather as additional information that will help us attack this problem. For example, although the in-boundary inventory shows a decline in GHG emissions since 2005, the consumption-based budget doesn't . . . um, budge, between 2005 and 2010.

So there's work to do.

Still No Carbon Signal

In 2009 the Commission adopted Resolution 2009-3-012, calling upon Congress to adopt a carbon emissions reduction mechanism that would be "sound, equitable and timely." But the Congress has failed us, and the country, in moving to address the threat of disruptive climate change, even as states and communities like ours have stepped up our games.[18] We can credit the Obama Administration with acting to dramatically boost new car fuel economy standards, imposing GHG limitations on new power plants, and now proposing to limit GHG emissions from existing power plants. But as the Commission understood, only an economy-wide signal – a carbon cap or carbon tax – will truly change the rules of the game in meaningful ways. And I mean multiple "meaningful ways"; not only ramping down vehicle and power plant emissions in predictable, scheduled, systematic and non-disruptive ways, but also – and more importantly – releasing the creative genius of American inventors, businesses and yes, even our oft-maligned – and often deservedly -- financial wizards, onto the problem. When we do this as a country, there is little we cannot accomplish. And through the kind of ingenuity a clear carbon signal would unleash we will do it at a cost far lower than we can guess at today. With collateral benefits we can't yet know.

We just have to decide to do it.

Angus Duncan, Chair

[17] Million metric tons of greenhouse gases ($MMTCO_2e$)
[18] While US GHG emissions have declined by ±7 percent since 2005 due to recession and other factors, the same emissions in Europe – which has a troubled but functioning carbon cap – dropped by 14 percent.

CLIMATE CHANGE SOLUTIONS

The Port of Portland is ranked by the EPA as one of the Top 25 purchasers of 100 percent renewable power

The Port's Commission set an aggressive goal in 2009 for the organization to reduce its carbon footprint 15 percent below 1990 levels by 2020. The Port has met and consistently outperformed this goal through purchasing renewable power, pursuing substantial energy efficiency projects, and transitioning to alternative fuels and cleaner burning engines.

The Port began by completing an inventory of its greenhouse gas emissions using The Climate Registry protocol for all Port-controlled direct emissions and indirect emissions associated with the electricity used by the Port. The Port was a founding reporter of The Climate Registry, an organization that provides a third-party verified reporting system for greenhouse gas emission inventories.

The findings from the Port's TCR inventory showed that the largest source of Port-owned and controlled greenhouse gas emissions—about 55 percent—comes from purchased electricity. This supported the Port's decision to move to 100 percent renewable power, and the Port now consistently ranks in the Top 25 in the Environmental Protection Agency's list of 100 percent renewable power purchasers in the country. The Port is also listed in the Top 10 in the Local Governments category. These rankings are higher than any other airport or marine port in the United States.

In addition to purchasing renewable power, the Port has identified strategies focusing on energy conservation and reducing emissions of criteria air pollutants, hazardous air pollutants and greenhouse gases from Port-owned sources. Using a Port-wide Energy Management Strategy, the Port is in the process of completing prioritized efficiency projects that address lighting and heating, cooling and ventilation systems. The Port is also in the midst of an engine repowering project for the Dredge Oregon, which maintains the Columbia River Navigation Channel on behalf of the U.S. Army Corps of Engineers and Columbia River ports. Upon completion, the project will result in significant fuel savings and reductions in emissions.

UPDATE ON THE "ROADMAP TO 2020" PROCESS

The Commission undertook a "Roadmap to 2020" Project in 2010 that offered a strategy and recommendations for how Oregon can meet its 2020 greenhouse gas reduction goal (10 percent below 1990 levels), get a head start toward its 2050 goal (at least 75 percent below 1990 levels), and build a prosperous, clean energy-based 21st century state economy. Six technical committees were convened to work on sector-based strategies for meeting these two emission reduction goals. These committees represented stakeholders and other experts from the energy, land use & transportation, industrial, agricultural, forestry, and materials management sectors.

As a first step these committees envisioned what their sector might look like in 2050 in an Oregon that had met its long-term reduction goal. The committees then worked backward from these visions to 2020 by brainstorming, sorting through, and highlighting key actions to help meet the 2020 and 2050 reduction goals. The "Roadmap to 2020" project was authorized by the Commission in April of 2010 through the passage of Resolution #2010-1-013. Results from the "Roadmap to 2020" project were summarized in the Commission's 2011 Report to the Legislature, with the full results compiled in a report available on the Commission's web site.[19]

However, when the "Roadmap to 2020" was adopted it was done so on an interim basis, with specific follow-up tasks designated by the Commission in Resolution # 2010-3-014:

> *The report is labeled "interim" to acknowledge the desire of the Commission to further refine the "Roadmap to 2020" over time by, (1) conducting a public comment process in early 2011 on the Roadmap elements, (2) improving the quantitative basis for the Roadmap with more in-depth analysis, and (3) revisiting the balance of actions among sectors as additional quantitative analysis is done and with the benefit of viewing the Roadmap holistically, in contrast to the sector-specific manner in which it was created.*

This section highlights the progress that has been made since adoption of the "Roadmap to 2020" on an interim basis. A summary of the progress on each of the 40 "Key Actions" from that process, as well as areas that remain to be addressed is compiled in the narratives and tables that follow (including the integrating recommendations that were part of that report). The progress summary includes a scoring system based on letter grades for each of the "Key Actions". It is important to keep in mind that the scores attributed to these actions reflect an assessment of overall forward progress, or lack thereof, for each key action on a statewide level and are not a performance measure for any particular agency, company, or organization. It is no less important to remember that the scoring provided is not weighted, although recommendations vary widely in their impact on emissions. Thus, since transportation activities and the use of electricity and natural gas are responsible for more than 80 percent of overall emissions, progress or failure in these areas should be weighed commensurately.

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[19] Oregon Global Warming Commission, *Interim Roadmap to 2020*, October 29, 2010.

Finally, at the end of this section, the summary report from the “Roadmap to 2020” public input process that took place in 2011 is integrated into this report, providing the outputs from that process and interesting observations from Oregonians on their opinions about climate change. With the public input process for the Roadmap now complete, and with a much stronger quantitative basis from which to view the Roadmap, the Commission is in a strong position to continue to track progress toward and refine as necessary the “Roadmap to 2020” as it moves toward finalizing the Roadmap over time.

I. Status of Recommended Energy Key Actions

The Governor’s Ten Year Energy Action Plan, while addressing important issues raised by the Roadmap, leaves important tasks incomplete.[20] Neither the State nor the region have 2050 planning horizons for energy, notwithstanding that Oregon and Washington both have 2050 GHG goals that cannot be met absent such planning (the Roadmap calls for a “>20 year planning horizon”). *The Oregon Department of Energy, in collaboration with the Oregon Public Utility Commission, other State agencies and the Northwest Power Planning Council, should undertake the long-term planning exercise and benchmarking called for in the Roadmap. This exercise can build on the MACC[21] supply curve analysis, the Department of Transportation STS the Roadmap and other sources to describe and evaluate costs of one or more scenarios, including stranded cost analysis of investments in carbon-intensive resources and infrastructure.[22]*

The contributions of electric and gas utilities to meeting Oregon’s 2020 and 2050 GHG goals still needs clarification (see also the discussion of ramping down coal emissions, below). As of this report, and notwithstanding the important step of terminating coal operations at Boardman, the sector is not on a compliance pathway; and the Governor’s Plan does not identify such a pathway.

Energy efficiency investments in Oregon today meet less than 50 percent of load growth (the Governor’s Plan calls for meeting 100 percent). While the overall impact of energy efficiency measures is critically important, to slowing the *rate of increase* in statewide GHG emissions, the current level of effort cannot by itself deliver the necessary emission reductions to meet State goals for utility emissions (nor should it be expected to; backing out emissions from carbon intensive fuels like coal is of equal or greater importance). But it is essential that we not leave a single opportunity for carbon savings from energy efficiency unexploited. In this regard, we note that the Energy Trust has raised concerns about its ability to maintain even the current savings trajectory. *The State, the ETO and the electric utilities with significant GHG emissions need to evaluate the costs, benefits and operational requirements for*

[20] The Roadmap to 2020 called for this more detailed level of planning for GHG compliance, including across fuels and sectors, with benchmarks. To date, only the Oregon Department of Transportation’s Statewide Transportation (Greenhouse Gas Reduction) Strategy (STS) provides analysis and planning at this level of granularity.
[21] “Marginal Abatement Cost Curve” describing costs of measures available to meet Oregon’s GHG reduction goals, prepared for the Governor’s Office by the Center for Center for Climate Strategies in 2012 (project described in more detail on page 52 of this report).
[22] The analysis would be expected to encompass other critical planning considerations; e.g., reliability, power quality, resource diversity, grid access, etc.

adopting a more aggressive efficiency strategy such as that described in the '"PGE Low Carbon IRP Scenarios" Report to PGE from the E3 consulting firm for PGE's 2013 Integrated Resource Plan.

Smart Grid technologies offer opportunities to utilities and customers to more effectively manage electric energy demand. While the immediate direct benefits to be realized are more system capacity than energy-related, there will be opportunities to fine-tune and so reduce energy consumption – and its carbon consequences – in homes and businesses both. *To leverage real GHG reductions from Smart Grid technologies, the State, the utilities, ETO, NEEA and consumer advocates need to focus on identifying and developing a portfolio of applications that offer near-term energy reduction opportunities for customers, as well as longer term load-to-grid demand response capabilities that can contribute to integrating variable renewable resources (e.g., wind and solar). Transmission planning and investment should build on recent BPA and utility initiatives to add system flexibility and resource integrating capability, not just bulk power transfer, as the preferred system strategy.*

The Roadmap calls out a larger role for natural gas in direct applications (e.g., heating loads) where such uses are less carbon-intensive ways to meet loads than is electricity from marginal fossil fuel generating plants, subject to technology advances (e.g., heat pump space and water heaters) that may enable gas and electricity to compete in offering low-carbon content options. The Roadmap also encourages unconventional uses of natural gas, particularly in fueling vehicle fleets where gas infrastructure can compete with electricity as a low-carbon fuel. Few of these opportunities have been actively developed, despite the current low gas costs and increasing availability that have come about together with serious questions about upstream (wellhead and pipeline) methane leakage. *The State and gas utilities serving Oregon, in collaboration with stakeholders, should be actively developing carbon-efficient direct gas applications, conventional and unconventional, while also effectively and persuasively addressing leakage issues that otherwise can undermine the important role of gas in reducing GHG emissions.*

In addition, the university system has ongoing research in renewable (wave/tidal), wind, Smart Grid, energy storage and transmission-distribution efficiency, all of which can contribute to a lower carbon-intensity in utility-supplied energy. *The Commission supports Oregon BEST, acting as a nexus for OUS clean energy technology enquiries, identifying and prioritizing those activities that appear to have the greatest promise for delivering low-carbon energy at competitive costs and high levels of reliability.*

Notwithstanding the importance of the above agenda, Oregon cannot hope to reach its GHG reduction targets if it cannot reduce GHG emissions associated with coal burned to supply electricity to Oregon loads.

The reason is simple: approximately 25 percent of Oregon's overall GHG emissions (and 33 percent of its CO2 emissions) today come from coal combusted to generate electricity. This makes it all but mathematically impossible to meet the State's 2050 GHG reduction goal – at least a 75 percent reduction in emissions below 1990 levels – if coal combustion is not substantially reduced and replaced with a mix of generating resources with a substantially lower emissions profile.

Utility-supplied energy in Oregon[23], serving residential, commercial, industrial and some transportation loads (e.g., MAX Light Rail) is the source of almost half (45 percent) of Oregon's overall Greenhouse Gas (GHG) emissions.[24] Even if all load growth of electric and gas utilities were met through 2020 and 2050 from energy efficiency and there is full compliance with Oregon's Renewable Portfolio Standard (RPS; 25 percent new renewables by 2025), but no further change in resource mix, utility-associated emissions will frustrate any ability to meet the Legislature's adopted future GHG reduction goals. Based on currently-filed Integrated Resource Plans (IRP), emissions are unlikely, in fact, to show any significant declines from today's levels, notwithstanding the temporary dip that should result when coal operations at PGE's Boardman plant cease in 2020 (an outcome for which PGE and its stakeholders deserve considerable credit).

If new large electric loads materialize, such as the computer server facilities now emerging in the Portland area and central Oregon, this failure to make significant progress toward State goals will only be compounded.

The cooperative work of PGE, its stakeholders and State and Federal agencies in setting an end point for coal combustion at Boardman was a signal achievement for Oregon. Requiring carbon scenario analysis through the integrated resource planning process, and facilitating the utility rate impact analysis requirements of SB 101 (2009),[25] continue to be important steps the State is taking in addressing the risks of Oregon's over-reliance on coal. But there is a need for a greater State effort to enable – and encourage – the utilities to actively search for ways to deliberately and cost-effectively ramp down coal, consistent with the conditions in the Roadmap (EN-4).

The Emissions Performance Standard, as amended by the 2013 Legislature, addresses only *new* coal acquisitions or contract purchases; few or none of these are likely to occur. The Federal Environmental Protection Agency (EPA) also proposes to regulate GHG emissions from *new* coal plants; that regulation is delayed, and is itself increasingly a symbolic gesture in a national market shifting dramatically to gas and supporting few, if any, new coal facilities. The President has announced his administration's intention to regulate GHG's from existing power plants, with an EPA Clean Air Act (CAA) rule scheduled to be in place by 2016. If this initiative is carried out effectively, it may pre-empt independent state action for the nation's thousand or so existing coal units (but will also rely on compliance plans drawn up by each state, subject to EPA acceptance).

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[23] This figure includes emissions from utility-associated emissions from coal and gas power plant combustion, from direct customer use of natural gas, oil and propane, and a relatively small amount of emissions from gas or fossil-fuel-based electricity purchased directly from national market sources by certain larger in-state users, mostly industrial facilities.

[24] The bulk of these emissions come from Oregon's three largest investor-owned electric (PGE; PAC) and gas (NNG) utilities. Power to the third of Oregon's electric loads served by consumer-owned utilities is predominantly hydro-based and contributes minimal emissions. This difference is an outcome of the history of the Pacific Northwest, Oregon politics and federal law. This history includes giving legal preference to COUs for the carbon-free power from the federal hydro system and leaving IOUs, in the 1970's, with few supply-side choices other than coal power to meet customer needs.

[25] A key portion of this law requires the utilities to model the emissions reductions necessary and resulting costs to ratepayers of meeting Oregon's 2020 greenhouse gas reduction goal.

Recommendations to facilitate transmission system upgrades may support delivery and integration of expected levels of renewables but will not by themselves stimulate additional contributions to lower GHG emissions.

The State has several options for moving forward on a coal ramp-down (not mutually exclusive; could be combined):

1. *One option the Legislature and Governor have to acknowledge the difficulties coal combustion presents for meeting the State's GHG reduction goals is choosing to modify those goals. This has the virtue of candor, and the downside of disregarding the general findings of climate science.*

2. *The Legislature and Governor could withhold State action, and defer to Federal regulatory action that would establish GHG emissions limits for utilities, set standards for GHG outcomes to be achieved in utility resource planning, and/or mandate efficiency and renewable energy standards. In electing this course, Oregon would be deferring also to other states*[26] *that are affirmatively choosing to address climate in state policy affecting utility resource planning and to a Federal government that to date has shown little appetite for requiring or enabling significant GHG reductions in utilities (but that may finally be mobilizing with the President's proposed EPA rulemaking on GHG emissions from existing power plants).*

3. *The Legislature and Governor could withhold State action, and defer to national market forces to drive more competitive low-GHG technologies and/or resources into utility portfolios without further State or Federal government intervention.*[27]

4. *The Legislature and Governor could charge the Oregon Department of Energy, the Oregon Public Utility Commission or another lead agency, together with an interim agency/stakeholder collaborative,*[28] *to describe a utility resources trajectory —investments and operating strategies -- to 2050 that would result in utility emissions reductions that will substantially contribute to the State meeting its goals, with actions on a benchmarked schedule and at a scale required to meet the goals.*[29]

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[26] E.g., California's launched economy-wide carbon cap-and-trade; the Northeast RGGI states utilities carbon cap-and-trade; British Columbia's carbon tax.

[27] This hands off approach has been successful recently in gas markets, where new recovery techniques have increased supplies and reduced market costs of the fuel. It remains unclear, however, whether gas-fired generation will supplant, or only augment, the nation's existing coal fleet; while even in the former case, Oregon's GHG emissions are unlikely drop to levels approximating Oregon's 2020 and 2050 goals. Market forces alone have not succeeded in moving large quantities of low-carbon technologies (wind, solar, and other renewables) into mainstream competitiveness, nor have they succeeded in propelling Carbon Capture and Storage (CCS) technologies to widespread adoption. There are outstanding questions about whether fugitive methane emissions from gas well and pipeline operations may be significantly offsetting the GHG efficiency gains from substituting gas for coal in power plant use.

[28] Similar to the process by which ODOT and the OTC developed, tested and accepted the Statewide Transportation GHG Reduction Strategy (STS), as mandated by the Legislature.

[29] The above-referenced '"PGE Low Carbon IRP Scenarios" Report to PGE from the E3 consulting firm may be useful in such a process.

Table 1: Status of Key Energy Sector Actions by 2020 from "Roadmap to 2020" Process

Progress Score:
A On track to meet State goals or Roadmap outcomes
B Partial but significant GHG reductions or progress toward outcomes
C Business as usual; insignificant or no reductions or progress
D Significant measurable slippage away from goals or outcomes

Progress Score	Key Action for 2020	Sub-Action Link[30]	Accomplishments	To Be Accomplished
B	**EN-1** Develop State Energy and Climate Policy	1	• Ten Year Energy Action Plan adopted by Governor. • Interim "Roadmap to 2020" adopted by OGWC. • Transportation GHG Reduction "Statewide Transportation Strategy" accepted by ODOT/OTC. • Initial "McKinsey Curve"-type analysis completed; shows GHG reductions from menu of measures.	The Oregon Department of Energy, in collaboration with the Oregon Public Utility Commission, other State agencies and the Northwest Power Planning Council, should undertake the long-term planning exercise and benchmarking called for in the Roadmap. This exercise can build on the MACC[31] supply curve analysis, the Department of Transportation STS the Roadmap and other sources to describe and evaluate costs of one or more scenarios, including stranded cost analysis of investments in carbon-intensive resources and infrastructure.[32] The State, the ETO and the electric utilities with significant GHG emissions need to evaluate the costs, benefits and operational requirements for adopting a more aggressive efficiency strategy such as that described in the '"PGE Low Carbon IRP Scenarios" Report to PGE from the E3 consulting firm.
A-	**EN-2** Energy Efficiency	2 3 4 5 6 7 8 9 10 11 12 13 15 26	• From the start of the Energy Efficient Schools program in 2002 through the end of 2011, savings total about 1.2 trillion Btu, about enough energy to meet the needs of about 15,676 Oregon homes. • Oregon passed the Cool Schools initiative in 2011. This four-year-pilot is designed to expand technical and business services for K-12 public schools, giving them greater access to energy expertise as they plan for energy efficiency upgrades. • ETO provides 46.9 average megawatts of electric savings and 5.4 million annual therms of gas savings in 2011. • Clean Energy Works Oregon weatherized more than	

[30] These are references to the "inventory of actions" that accompany each of the sector roadmaps in the full "Interim Roadmap to 2020" report. Note that in many cases the "Key Actions" embody slightly different language, or additional actions beyond those in the "inventory of actions", that resulted from further discussion in stakeholder groups once the overall "inventory of actions" was compiled as part of the Roadmap to 2020 process.
[31] "Marginal Abatement Cost Curve" describing costs of measures available to meet Oregon's GHG reduction goals, prepared for the Governor's Office by the Center for Center for Climate Strategies in 2012.
[32] The analysis would be expected to encompass other critical planning considerations; e.g., reliability, power quality, resource diversity, grid access, etc.

			2,800 homes through May of 2013. • EEAST has provided easy-to-use financing for residential and commercial energy efficiency and renewable energy projects in Oregon. • From 2003 through 2013 Oregon Housing and Community Services and partners weatherized 44,580 homes for low-income Oregonians.	To leverage real GHG reductions from Smart Grid technologies, the State, the utilities, ETO, NEEA and consumer advocates need to focus on identifying and developing a portfolio of applications that offer near-term energy reduction opportunities for customers, as well as longer term load-to-grid demand response capabilities that can contribute to integrating variable renewable resources (e.g., wind and solar). The State and gas utilities serving Oregon, in collaboration with stakeholders, should be actively developing carbon-efficient direct gas applications, conventional and unconventional, while also effectively and persuasively addressing leakage issues that otherwise can undermine the important role of gas in reducing GHG emissions. See narrative, above, for recommendations regarding coal ramp-down. The Commission supports Oregon BEST, acting as a nexus for OUS clean energy technology enquiries, identifying and prioritizing those activities that appear to have the greatest promise for delivering low-carbon energy at competitive costs and high levels of reliability.
B-	**EN-3** Support and Plan for New Transmission	18	• Governor's Ten Year Plan includes recommendations for efficient, comprehensive transmission siting with provision for "right-sizing" facilities.	
B/C	**EN-4** Ramp Down Emissions Associated with Coal Generation	20	• PGE's Boardman Generating Plant scheduled to close by end of 2020. • PP&L to convert one or more coal plants to gas (but proposes to retrofit other coal plants serving Oregon loads to meet currently-applicable Clean Air Act requirements and continue to operate these indefinitely, notwithstanding the proposed EPA regulations governing GHG emissions from existing power plants). • Emissions Performance Standard creates a backstop against coal-generated imports.	
B	**EN-5** OUS Energy Research Priorities	30	• Electric Avenue, a joint research and development initiative with Portland State University, Portland General Electric, and the City of Portland, studies clean and active alternatives to the transportation of people, goods, and services. • Oregon State University's Northwest National Marine Renewable Energy Center received a multi-million dollar federal grant to pursue the first grid-connected utility-scale open ocean test bed for marine renewable energy, called the Pacific Marine Energy Center, off the coast of Newport. • An Oregon State University research team worked	

			with an Oregon startup (Applied Energy) to develop an energy storage technology that captures and stores energy as an icy slush, then uses a heat source to discharge the stored energy when needed. • At OSU, a research team has created a one-of-a-kind, lab-scale power grid that is being used to test storage devices and to determine how best to integrate wind power into the existing grid alongside energy from other sources. • Standing almost floor-to-ceiling and wrapped along all four walls, a massive wind tunnel at Portland State University fills most of the 1,500-sq.-ft. Wind Energy and Turbulence Research Laboratory, where researchers can capture, manipulate and analyze the impacts of the finely-controlled wind conditions the one-of-a-kind tunnel generates. • Oregon State University is testing the deployment of syncrhophasors on campus to better evaluate their Transmission-Distribution system.	
C	**EN-6** Modern Gas Infrastructure	19	• Biogas potential assessment completed in 2011 by The Climate Trust and The Energy Trust of Oregon. • More than 1,600 natural gas vehicles in use in Oregon.	
C+	**EN-7** Smart Grid and Integration of Resources	16 17	• Recommendations included in Governor's Ten Yr. Energy Strategy; some utility deployment of first generation Smart Meters (for remote data read). • BPA, utilities moving to 30 minute dynamic scheduling, wider virtual balancing area operations, to better integrate variable generation. • SnoPUD testing one MW storage battery for integration application. • WIC/OTOC identifies oversupply management options but no systematic regional plan to develop solutions Regulatory policy- Through a formal docket	

			on Smart Grid Assessment, Oregon PUC developed a new planning requirement per Order 12-158 that calls for Oregon Investor-owned utilities to submit an annual "Smart Grid Report" that will inform the Commission of any smart grid related investments or efforts underway by the utilities. • ARRA Smart Grid Investment Grant- Smart meters- A number of Oregon utilities have either completed or are in the midst of replacing their traditional customer meters with smart meters that should enable faster and accurate tracking of energy usage.	

II. Status of Recommended Transportation and Land Use Key Actions

The ODOT Statewide Transportation (Greenhouse Gas Reduction) Strategy (STS), completed in 2012, sets out goals, ways and means for meeting Oregon's GHG goals in transportation. Generally these fall into six categories:

- vehicle and engine technology gains;
- low-carbon fuels;
- more efficient transportation system operations;
- more low-carbon transportation choices (e.g., transit, car-shares, bikes, walking);
- more efficient land use and urban design;
- pricing and funding mechanisms that encourage and reward efficiency;

Within these categories, the Oregon Global Warming Commission puts most immediate priority on the following:[33]

- Integrate STS findings and measures into the Oregon Department of Transportation's ongoing planning and decision-making tools and processes; specifically, the Oregon Transportation Plan (OTP), the Statewide Transportation Improvement Program (STIP) and ODOT's newly-developed least cost planning tool (MOSAIC)[34];

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[33] Priorities in the Governor's 2012 Ten Year Energy Action Plan overlap substantially with the Commission's, including: (1) Continued Investment in Compact, Multimodal and Mixed-use Communities; (2) Accelerated Fleet Turnover to Alternative Fuels; (3) Implement ITS; (4) Innovative Financing for a Clean Transportation System.

- Move forward with innovative transportation financing tools and practices, particularly: a "Vehicle Miles Traveled (VMT) + Energy/Carbon Efficiency" tax, operating in parallel with or as a replacement tax for the gas tax; and increase unrestricted non-roadway funding for transit/bike/ped and other lower-carbon transportation options;
- Identify early actions within the STS that are low-cost, low-entry barrier options that deliver significant GHG savings; and specifically, an ongoing Intelligent Transportation Systems (ITS) strategy for realizing system efficiencies and carbon reductions;
- Adopt the proposed extension for Oregon's Clean Fuels Program (aka Low Carbon Fuel Standard) past its current 2015 sunset date.

Developing many of the emerging T&LU technology and fuel choices at meaningful scale will be a function of national incentives and regulation, but there is much Oregon can do to accelerate their uptake. The State is already considered a lead market for electric and high-efficiency vehicle technologies due to State and metro region policies on refueling infrastructure and other enabling actions.

For the balance of the Commission's T&LU agenda, the State and local governments are the primary actors (albeit continuing to rely in important ways upon technical and funding assistance from federal agencies). Unfulfilled Roadmap recommendations for State and local governments and communities, including those detailed above and below, will enable Oregon to make continued progress toward STS and Legislative GHG reduction goals. Many of the actions will also contribute to community livability, and to cost management for both local governments and travelers.

And while the STS does not rely on new "black box" technologies emerging, we can be confident those technologies will continue to do so. The development curve may in fact be steeper as and when the country adopts meaningful carbon reduction tools – a carbon tax or cap.[35] When we see these policies taking shape, Oregon will need to be prepared to adopt and adapt technologies rapidly into existing vehicle, fuel and systems strategies.

The Commission prioritizes, and encourages continued progress on the additional recommendations the table below, drawn from its 2010 "Roadmap to 2020":

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[34] MOSAIC (www.oregonmosaic.org) is a "least cost planning" tool for transportation corridor analysis, developed by ODOT at the direction of the 2009 Legislature. Least cost planning, as it has been used in the electric utility industry since the 1980's, looks at all costs and benefits of different scenarios for transportation infrastructure and operations in a designated corridor, including costs and benefits that may previously have been "externalized", or left out of the analysis because they were not project dollar costs actually incurred (e.g., health and safety; environmental) or because they could not easily be monetized (deaths from accidents; species extinction). MOSAIC will not make transportation investment decisions, but it will illuminate, for decision makers, a more complete picture of the relative merits of different scenarios. MOSAIC was developed by the Oregon Department of Transportation, will substantial stakeholder participation; and is currently in "beta" testing to refine and calibrate its capabilities.

[35] Prior such Obama Administration initiatives, included ramping up EPA vehicle fuel efficiency standards (to 54.5 mpg by 2025 for new cars), are already driving improved vehicle fuel efficiency, up almost 20 percent since 2007.

Table 2: Status of Key Transportation and Land Use Actions by 2020 from "Roadmap to 2020" Process

<table>
<tr><td rowspan="2">Progress Score</td><td colspan="4">**A** On track to meet State goals or Roadmap outcomes
B Partial but significant GHG reductions or progress toward outcomes
C Business as usual; insignificant or no reductions or progress
D Significant measurable slippage away from goals or outcomes</td></tr>
<tr><td>**Key Action for 2020**</td><td>**Sub-Action Link[36]**</td><td>**Accomplishments**</td><td>**To Be Accomplished**</td></tr>
<tr><td>C+</td><td>Change the Way We Fund Transportation</td><td>7
9
28
43
44</td><td>• ODOT completed two demonstrations of Road User Fees which included Vehicle Miles Traveled (VMT) data collection, pricing, technologies.
• ODOT is moving towards a new, flexible, solution-driven Statewide Transportation Improvement Program (STIP) process for state and federal funds, called Fix-It and Enhance-It. This new process allows ODOT and its local partners in the Area Commissions on Transportation to identify and fund multi-modal projects based on needs, rather than a "silo-ed" fiscal approach.</td><td rowspan="3">In addition to the recommendations in the narrative above, the Commission seeks progress on the following:

<u>Transportation Funding</u>
• ConnectOregon V, which would increase lottery funds for rail and transit is before the legislature in 2013, and there is a proposed amendment that would allow bike and pedestrian modes.
• The Legislature is considering, and should adopt, language that would apply a mileage tax to certain high-efficiency (≥ 55 mpg) vehicles, and would also authorize broader demonstration projects relying on VMT and enabling congestion and efficiency pricing, and other variations.

<u>Transit</u>
• Transit providers in Oregon continue to struggle to secure sustainable funding for transit operations. Need to solve financial</td></tr>
<tr><td>C</td><td>Develop New Funding Sources</td><td>50
51</td><td>• At this time, no new multi-modal flexible funding for transit/non-roadway has been identified, but ConnectOregon lottery-based funding, in limited amounts, has continued to be available.</td></tr>
<tr><td>B-</td><td>Expand Urban Transit</td><td>19
21
23
46</td><td>• Transit Ridership in the nation and in Oregon continues to grow, with national ridership hitting its highest level since 1957. In Oregon Transit Ridership is almost doubled since 2000.
• Lane County Transit District continues to grow and add on segments to their bus rapid transit line. The implementation and management of the new EmX</td></tr>
</table>

[36] These are references to the "inventory of actions" that accompany each of the sector roadmaps in the full "Interim Roadmap to 2020" report. Note that in many cases the "Key Actions" embody slightly different language, or additional actions beyond those in the "inventory of actions", that resulted from further discussion in stakeholder groups once the overall "inventory of actions" was compiled as part of the Roadmap to 2020 process.

			bus system in Lane County has received international recognition for service and delivery. • In Portland, approximately 12% of commuters take transit. Portland region moving ahead on Milwaukie MAX Light Rail in Portland East Side streetcar service initiated. • Corvallis funds free city transit with revenues from an innovative municipal utility fee.	constraints, enable transit gains faster than population gains. • Encourage communities to consider "bus rapid transit" deployment with priority or dedicated lanes, using Lane County as an example. • Seek technology solutions to providing cost-effective transit service in medium-density neighborhoods.
C+	Create Complete Communities	17 18	• "Complete Communities" concepts are part of the Metro scenario planning process for the Oregon Sustainability Transportation Initiative (e.g., Portland/Multnomah County Climate Action Plan) and may be explored by other MPO areas as part of their scenario planning process. • Eugene in its Envision Eugene process includes and is moving forward with complete communities and "20 Minute Neighborhoods" plans, and has mapped out all of the key metrics on over-laying map layers for the entire city.	<u>Land Use/Urban Design</u> • Need schedule, standards and goals set for developing "Complete Community" neighborhoods in at least Oregon's urban MPO's. • Land use, transportation, transit investments and rules need to be defended and reinforced to ease pressure on UGBs while improving mobility, accessibility.
A	Keep Urban Footprints Compact	14	• Oregon's Urban Growth Boundaries (UGBs) are stable, supporting growth inside the UGBs. However, while both Eugene and Springfield have not changed their UGBs in over 20 years, they are both in the process of expanding their UGBs.	<u>Freight/Air</u> • Alternate fuels for aircraft still unavailable, other efficiencies (e.g. low-weight composite materials) ramping in, but more slowly than increased air miles flown so emissions (± 5% of global totals) still rising.
B-	Move Freight the Low-Carbon Way	29 30 31 32 33 34 35	• ODOT produced a "Freight and Climate Change Report" (2010) which identifies strategies to reduce GHG emissions from freight. Many of these strategies are currently being implemented, such as advancing technology to decrease aerodynamic drag on trucks and to reduce idling. • Port of Portland at or under 1990 GHG emissions levels (excluding private carriers using facilities). • IMO (International Maritime Organization) requiring ships to reduce GHG emissions by 20% by 2020 and	• Continue to implement the "low hanging fruit" strategies identified in the STS and the Freight Plan. <u>Planning/Technology</u> • Complete ODOT testing of the MOSIAC tool on a metropolitan Portland corridor; conduct a "lessons learned" phase; and make the planning tool available statewide as a preferred

		36	50% by 2050. • The Go Green Shipper project by the Northwest Food Processors Association aims to expand freight opportunities leading to reduced fuel use, greenhouse gas emissions and freight costs.	analytic planning tool. • Encourage communities to use the Toolkit as a resource in their planning and decision-making processes. • ODOT, Metro, OTREC and other interested parties (including other MPO's) complete ITS (Intelligent Transportation Systems) project agenda including Integrated Corridor Management planning and predictive traveler information services. <u>Intercity Rail</u> • Join with CA, WA and USDOT in planning the infrastructure and alignment needs for a west coast high speed rail corridor. • Identify near-term opportunities to improve speed, quality and frequency of passenger rail service in the existing Eugene – Vancouver BC corridor using existing alignments, track and rolling stock. <u>Alternatives to SOV (Single Occupant Vehicle) Travel</u> • Identify sustainable funding sources for on-going transportation demand management programs. • Encourage communities in Oregon to make their cities friendly to car-sharing by allowing on-street parking and/or providing parking spaces throughout the communities in order for use by car sharing companies. <u>Parking Policies</u>
B+	Embed Climate Change in Transportation Planning	41	• GHG is considered in many of the transportation planning processes in Oregon. The ODOT Statewide Strategy is the primary planning document in Oregon that lays out a vision on how to reduce GHG from transportation, and identifies strategies to reduce GHG. • Also in response to the 2009 Jobs and Transportation Act, ODOT developed MOSAIC (a least cost planning tool) and GHG is an indicator, or a consideration, in that tool. The JTA also directed ODOT to consider GHG as a factor in the State Transportation Improvement Program (STIP) in selecting potential projects for funding. • As part of OSTI, ODOT developed a Transportation and Land Use Greenhouse Reduction Toolkit (Toolkit), intended to help local jurisdictions in Oregon identify the actions and programs which can be implemented at the local level to reduce GHG emissions. The toolkit includes a wide range of strategies, from freight to public transportation. • All of the MPOs in Oregon have an ITS plan and work closely with ODOT's ITS manager to make sure that State technology and MPO technology are coordinated. ODOT and MPO continue to fund more ITS projects. • SB1059 required Scenario Planning to identify mechanism and polices that would reduce GHGs to be done by METRO and the Lane County MPO, and both are underway with funding from ODOT.	

C+	Expand Intercity Transportation Options/Choice	19 20	• Passenger rail in Oregon has increased by 400% since 2000. ODOT is currently undertaking the Rail Modal Plan which will examine passenger and freight rail. ODOT is also conducting the Oregon Passenger Rail EIS as a next step in improving passenger rails service in the Pacific Northwest Rail corridor between Eugene and Portland.	• Encourage those communities who have not yet adopted parking ordinances to do so by using other ordinances as a model. • Design and demonstrate parking pricing models to encourage shifts to transit and other modes, where these are practical options in Oregon communities. <u>Electric Vehicles</u> • Move forward proposed legislation (introduced in 2013) that could further the use of EVs in Oregon; including a revolving loan fund for public fleets and tribes, public charging on State property, and tax credits for vehicles under the Energy Incentives Program. • Design and adopt incentives to strengthen take up of EV/PEV by residents and commercial fleets.
B	Reduce Demand by Increasing Options	15 16 22 23 24	• ODOT is partnering with communities around Oregon on their Transportation Demand Management programs, such as *CommuteOptions* in Bend and *Drive Less Connect* in Oregon. • Based on Census data about commuting, Corvallis and Eugene have the highest bike mode share in the nation (#1 and #2) and the highest walk mode share in the nation. Together, over 20% of people in Eugene and Corvallis bike or walk to work. In the fall of 2013, ODOT will kick off its Bike and Pedestrian Modal Plan process. • Car-sharing continues to increase in Oregon, and has been welcomed by cities like Salem and Corvallis. In Portland, there are five private car sharing companies to choose from: Car2go, Getaround, ZipCar, UhaulCarShare, and Relay Rides (a peer-to-peer car exchange). Eugene has several WeCar vehicles in the downtown and around the University of Oregon campus. • Lane Transit District and the University of Oregon are both investigating bike share programs.	
C	Manage and Price Parking	25	• Many cities in Oregon have adopted a parking strategies or parking ordinances, from Ashland to Portland. DLCD dedicated a large chapter to Parking Strategies in the "Cool Planning: A Handbook for Communities to Slow Climate Change" (2011) as a resource for local Oregon cities. Examples: Corvallis	

			Land Development Code 4.1.30(c) (25) (One space per 400 sq. ft. of floor area); Keizer Development Code 2.303.06: (One space per 300 sq. ft.) and McMinnville Zoning Ordinance 17.60.060(C) (17): (One space per 250 sq. ft).	
B	Support Electric Vehicles	4	• Oregon leads the nation on EV introductions and adoptions; Portland leads all cities in hybrid purchases per capita (SF is second). • As of February 2013, there are 2,074 Electric Vehicles in Oregon. ODOT, along with its partners, has installed hundreds of charging stations along I-5 and the Coast in 2012 and 2013. The West Coast Electric Highway has installed fast chargers every ≤ 50 miles along I-5. • Drive Oregon and the West Coast Electric Highway initiatives are forming public-private partnerships to spur the growth of electric vehicles in Oregon. In 2013 The Governor signed a Memorandum of Understanding to create a comprehensive plug-in EV market and community plan to target EV deployment.	
D+	Adopt Low-Carbon Fuel Standard (now referred to as the Clean Fuels Program)	10	• The Environmental Quality Commission conducted a rulemaking in 2012 for Phase I reporting program, to implement the first part of the Low Carbon Fuels statute passed in 2009. The original statute contains a sunset date of 2015. The 2013 Oregon Legislature elected not to lift the 2015 sunset language on this measure. Unless it revisits this choice in 2014 or 2015, the Clean Fuel Standard will not be activated, a significant setback for this recommendation.	

III. Status of Recommended Industrial Key Actions

Oregon's diverse economy includes a robust industrial sector. Manufacturing in Oregon has a greater impact on the State's economy (28.7 percent of gross state product) than in any other state.[37] However, from a greenhouse gas emissions perspective the sector has less of an impact on greenhouse gas emissions, typically comprising about 20 percent of statewide emissions in recent years. Despite considerable progress in increasing efficiency and reducing emissions in some sectors (e.g., food processing), and making headway on some aspects of the industrial sector key actions in the "Roadmap to 2020" – most notably establishment of the Oregon Leaders Award for industrial energy efficiency -- much more remains to be done. State-based incentives for industrial efficiency have changed dramatically since the last biennium. Early indications are that the industrial sector may have a similar level of funding opportunity, but the expansion of incentive availability envisioned in the Roadmap does not appear to have come to fruition. Initiatives aimed at industrial combined heat-and-power are ongoing, but need continued support and resources into the future. Industrial benchmarking and energy road-mapping needs remain largely unmet outside of the food processing sector. Specific needs to be addressed are identified in the table below.

Table 3: Status of Key Industrial Sector Actions by 2020 from "Roadmap to 2020" Process

Progress Score	Key Action for 2020	Sub-Action Link[38]	Accomplishments	To Be Accomplished
	A On track to meet State goals or Roadmap outcomes **B** Partial but significant GHG reductions or progress toward outcomes			**C** Business as usual; insignificant or no reductions or progress **D** Significant measurable slippage away from goals or outcomes
B	Accelerate Use of Energy Efficient Technology and Practice	1 2 3 4	• Energy Trust of Oregon helped 22 manufacturers adopt strategic energy management with expected average energy savings of 5 to 10 percent. • Energy Trust of Oregon motivates savings in the industrial sector of 13.8 million MWa of electricity and about a million therms of natural gas for 2011.	• As server farms increasingly gravitate to PNW locations as new large single loads, efficiency strategies aimed at both HVAC and computer operations loads are required. • Need additional targeted approaches to greenhouse gas reductions for large industrial

[37] The Oregonian, *Manufacturing makes bigger impact on Oregon's economic output than any other state*, Molly Young, Oregonlive.com, March 15, 2013.
[38] These are references to the "inventory of actions" that accompany each of the sector roadmaps in the full "Interim Roadmap to 2020" report. Note that in many cases the "Key Actions" embody slightly different language, or additional actions beyond those in the "inventory of actions", that resulted from further discussion in stakeholder groups once the overall "inventory of actions" was compiled as part of the Roadmap to 2020 process.

			• NEEA and Northwest utilities work with industries through "25inTENsity Challenge" helps industries cut energy intensity by 25 percent in 10 years. • Food processing, the third largest industrial PNW energy consumer, developed and is applying a Continuous Energy Improvement framework for ramping efficiency technologies and practices into industry operations. The industry set a goal of 25% reduction in energy intensity by 2018, and 50% by 2038.	customers and processes. • Restoration or substitution of like incentives for some proportion of the industrial energy efficiency incentives that have been reduced or eliminated in recent years. • Additional industry-specific greenhouse gas reduction plans need to be created for Oregon. • Creation of private/public research ventures with Oregon higher education system to create centers of industry excellence. • Expand lean manufacturing and process innovations studies into engineering curriculum and research agendas of Oregon universities.
A	Establish Greenhouse Gas Leadership Recognition Program	5	• Complete. The Oregon Department of Energy, in collaboration with Energy Trust of Oregon, the Bonneville Power Administration and the Northwest Energy Efficiency Alliance launched an annual, state-wide program in 2011 to recognize the leading industrial energy efficiency efforts in the State of Oregon (Oregon Leaders Award).[39]	
C	Improve Access To Financing and Incentives	9 - 17	• No significant progress in increasing the level of incentives available for industrial energy efficiency. Some progress in education, outreach, and diversity of customers in regards to existing incentives.	
C+	Build Human Capacity To Innovate and Execute Industry Process Improvements	18 19 20 21 22	• Some material process innovation in industries such as semiconductor manufacturing. • Little or no evidence of major progress in other sectors in terms of material input or process changes.	

[39] www.oregonindustrialEEleaders.org

IV. Status of Recommended Agricultural Key Actions

Oregon's agricultural sector remains a small but significant part of the State's greenhouse gas footprint, typically representing about 8 percent of statewide emissions. However, the agricultural sector also represents a significant potential source for greenhouse gas reduction opportunities – particularly if opportunities for carbon sequestration are considered. Progress has been made in the time since the Interim "Roadmap to 2020" was adopted by the Commission in terms of putting in place anaerobic digesters (i.e., manure to energy systems) and establishing incentives to make these projects a reality. Many agricultural greenhouse gas reduction opportunities remain. Accomplishments since the Interim Roadmap was adopted, and some of the key things that still need to be accomplished, are described in the table below.

It should be noted that it is difficult to track and report many accomplishments that occur in agriculture because farmers often implement improvements in soil and nutrient management on their own. Other projects are funded by USDA and the information is protected by federal privacy laws. A more fundamental problem is the continuing lack of basic science and applied research that needs to be done on Oregon's soils and agricultural systems. Many of the approaches to carbon sequestration in this sector must rely on solid baseline data in order to measure the greenhouse gas reductions that are achieved. By and large these data don't exist for Oregon soils, especially in light of the incredible diversity of soils and agricultural systems that exist in this state (and the market value of sequestered carbon continues to be too low to support significant investment in research, metric development and baseline-setting). Finally, at the intersection of climate change adaptation and mitigation lies issues of water use in the agricultural sector. With shrinking and more seasonally-affected water supplies looming due to the impacts of climate change the need for increased water use efficiency will become even more important, and proper planning and incentives for encouraging efficiency and low-impact irrigation water developments all the more important.

Table 4: Status of Key Agricultural Sector Actions by 2020 from "Roadmap to 2020" Process

Progress Score				
	A On track to meet State goals or Roadmap outcomes **B** Partial but significant GHG reductions or progress toward outcomes		**C** Business as usual; insignificant or no reductions or progress **D** Significant measurable slippage away from goals or outcomes	
	Key Action for 2020	**Sub-Action Link[40]**	**Accomplishments**	**To Be Accomplished**

[40] These are references to the "inventory of actions" that accompany each of the sector roadmaps in the full "Interim Roadmap to 2020" report. Note that in many cases the "Key Actions" embody slightly different language, or additional actions beyond those in the "inventory of actions", that resulted from further discussion in stakeholder groups once the overall "inventory of actions" was compiled as part of the Roadmap to 2020 process.

C	Increase Nutrient Use Efficiency	n/a	• Climate Friendly Nurseries Project in partnership with OAN, OSU and Ecova created outreach materials and programs to increase nutrient use efficiency in Oregon.	• Planning needed to address agricultural lands at long-term/chronic risk of water shortage; consider alternate crops or land uses. • More work to create targeted research, outreach programs, technical assistance and tools that increase nutrient use efficiency in agriculture. • Research soil emission coefficients for all or most of Oregon to establish baseline and future emissions data. • Create an incentive to identify strategies and actions to close the nutrient loop. • Bring together the waste management industry and the agricultural sector to determine how to more efficiently use organic materials in an economically viable way. • Determine irrigated soil carbon sequestration rates throughout all or most Oregon areas. • Better encourage practices that sequester carbon in the soil and build soil quality. • Increase outreach and incentives to protect and restore native habitat, vegetation, and riparian areas near agricultural lands. • Better promote irrigation efficiency. • Continue to help facilitate water storage projects at all scales that are protective of Oregon's watersheds and natural resources.
B	Increase Carbon Sequestration in Crop Management	n/a	• Work in ongoing by local conservation districts, USDA, watershed councils and private landowners to protect and restore native vegetation, habitats and riparian areas along agricultural lands. Over 40,000 acres of streamside areas have been restored along agricultural lands in Oregon since 1999. In addition, research and conservation partners, and private landowners, continue to work together to implement reduced tillage cropping systems.	
A-	Develop Manure to Energy Methods	n/a	• There are now nine operational anaerobic digesters utilizing livestock manure as a feedstock in Oregon. Six of these have been constructed within the last two years. • Total anaerobic digester capacity has grown from approximately 0.66 MW in 2009 to about 8.5 MW in Q1 2013 with 3.6 MW of additional capacity under construction and the same amount in the planning and development stage.	
B+	Proactively Prepare for and Adapt to Climate Change Impacts on Water Supply	n/a	• Integrated Water Resources Strategy adopted by the Water Resources Commission in 2012 includes extensive consideration of climate change. • Progress on ground-water recharge through winter injection where east-side water table declines are severe. • Development of training on water efficiency opportunities and on the use of metrics in tracking progress to sustainability targets and goals. • The Oregon Department of Energy has developed conservation incentives that target agriculture irrigation improvements.	

V. Status of Recommended Forestry Key Actions

Forest carbon researchers at OSU have shown that there is a high potential for increased land-based carbon storage through increasing rotation age in forested systems in Western Oregon where forests are among the most productive in the world. However, viable markets that supply equitable compensation to private forest landowners must develop in order to increase carbon storage on non-federal forests. The emergence and development of viable carbon markets will be fundamental for this process to begin. For example, the State Forester has the authority to enter into agreements with nonfederal forest landowners for marketing, registering and transferring forestry carbon offsets assuming the markets exist to support this activity. In addition, it is important that the development of a funding mechanism for land acquisition is integrated within the broader context of acquiring conservation easements to conserve working forests and forests of high conservation value.

In addition to developing viable carbon markets, there still remains the need to establish and facilitate a collaborative effort to establish baselines for long-term and intermediate carbon storage goals across ownerships and forest types. Connected with this need is the development of an accurate and precise carbon inventory and monitoring system that can be used across ownerships and forest types for reliable carbon marketing and accounting. Much more work remains to be done in terms of understanding Oregon's carbon storage profile and establishing metrics to maintain that profile. Currently, even existing work in this area is threatened. For example, the Department of Forestry and State Forester have communicated concern to USDA PNW Research Station executives over the uncertainty if the current effort to monitor, model and map Oregon's forest vegetation will be maintained. The State of Oregon must maintain a commitment to supporting this research and analysis which is fundamental to assessing the status and trends in Oregon's forest vegetation. There also needs to be integrated support (across natural resource management agencies, universities, and other entities) to landscape-level monitoring and mapping changes in forest (and rangeland) plant species, wildlife and other taxa as climate changes. This integrated monitoring and analyses is fundamental to reliable adaptive management planning, validating or modifying dynamic vegetation models, allocation of wildfire resources, and successful forest carbon management.

The need to develop and expand biomass opportunities has perhaps never been greater. Forest health, especially within federal forests, continues to decline with large areas at increasing risk of catastrophic wildfire. Rural communities that are connected to these forests are experiencing lingering, high unemployment. It is critical to enable the conditions where markets for biomass can be developed to help support forest health restoration treatments, replace imported fossil fuel sources, and reduce the greenhouse gas emissions associated with alternative fates for the residual materials from restoration activities and other forest management and harvest activities.

Four market development initiatives that target specific growth opportunities and industry sectors, support and enhance existing forest industries, and create additional market opportunities for forest landowners and forest-based businesses have been identified.[41] The initiatives target the generation of on-site heat at commercial and institutional facilities, the generation of heat and electricity at existing wood product facilities, expansion of existing markets such as landscape bark, shavings, bedding, and other commercial products; and a focus on emerging markets like biofuels, biochar, cellulosic ethanol and other nascent markets. Implementing these initiatives will create a setting in Oregon that is conducive to successful commercial enterprises utilizing biomass. The combination of forest restoration and economic development along with the opportunities to grow the biomass industry into new and advanced markets will diversify and improve Oregon's energy system.

Table 5: Status of Key Forestry Sector Actions by 2020 from "Roadmap to 2020" Process

Progress Score	Key Action for 2020	Sub-Action Link[42]	Accomplishments	To Be Accomplished
	A On track to meet State goals or Roadmap outcomes **B** Partial but significant GHG reductions or progress toward outcomes **C** Business as usual; insignificant or no reductions or progress **D** Significant measurable slippage away from goals or outcomes			
B	Carbon Inventory	1	• The USDA Forest Service PNW Research Station is scheduled to complete a monitoring report in 2013 that will include estimates of the volume, biomass, and carbon storage of wood in Oregon's forests. • The USDA Forest Service's Carbon Online Estimator is a web-based tool for generating carbon estimates for any area of the United States. • OSU's LandCarb forest carbon simulation modeling system produces historical trends and future projections of carbon storage and flux based on alternative forest management policy scenarios. • Forest carbon researchers from OSU and USDA PNW Research Station have created The Forest Sector	• A collaborative effort to establish baselines for long-term and intermediate carbon storage goals across ownerships and forest types, and mechanisms for calculating the comparative economic, social and environmental benefits and costs of forest carbon storage and access by forests to carbon markets is still needed. • Oregon should initiate a policy similar to Forest Resource Trust that identifies non-forested private land that could potentially be stocked with trees for the purpose of carbon storage and provide owners of those lands with incentives

41 Growing Oregon's Biomass Industry: Oregon's Forest Biomass Strategy, Oregon Forest Biomass Working Group, November 1, 2012.
42 These are references to the "inventory of actions" that accompany each of the sector roadmaps in the full "Interim Roadmap to 2020" report. Note that in many cases the "Key Actions" embody slightly different language, or additional actions beyond those in the "inventory of actions", that resulted from further discussion in stakeholder groups once the overall "inventory of actions" was compiled as part of the Roadmap to 2020 process.

<table>
<tr><td></td><td></td><td></td><td>Carbon Calculator, an online tool to a set of carbon models that lets users examine how carbon stores in the forest sector change over time.</td><td rowspan="3">and management assistance.
• The Board of Forestry has not adopted Administrative Rules for the acquisition of forestland under the Forest Resource Trust authority provided in ORS 526.725 to enhance carbon storage in Oregon.
• Oregon needs a funding mechanism for land acquisition integrated within the broader context of acquiring conservation easements to conserve working forests and forests of High Conservation Value.
• Support for landscape-level monitoring and mapping changes in forest (and rangeland) plant species, wildlife and other taxa as climate changes.
• A significant effort to identify Indicators of climate change and establish projects for features of concern not represented in current monitoring efforts is still needed in Oregon.
• Extend the Landcarb analysis for the carbon indicator to all forestland in Oregon beyond the six subregions currently represented.
• Added research into the potential for reuse of tree wood fiber in various existing and new products (such as material for 3D printing technology).
• Additional research to understand the limits to biomass production from forestlands and sustainability of the spectrum of ecosystem services.
• Establish near/mid-term carbon debt effect of different forest biomass fuel extraction practices in different forest conditions (e.g., east/west-side forests).</td></tr>
<tr><td>C+</td><td>Reforestation/ Afforestation/ Acquisition</td><td>13
14
15
16</td><td>• The Forest Resource Trust provides funds for financial, technical and assistance to private forestland owners for stand establishment and improved management of forestlands.
• Oregon's Forest Practices Act requires landowners to reforest if the post-harvesting numbers of residual seedlings, saplings, and trees are below rule-specified levels.
• In FY 2013, the Forest Service in Oregon and Washington has about $8,000,000 budgeted for reforestation activities, which translates to about 20,000 acres of reforestation work and for afforestation, about 200-300 acres.
• The State of Oregon recently acquired forestland in Central Oregon (Gilchrist State Forest) for improved management for carbon sequestration.</td></tr>
<tr><td>B</td><td>Research</td><td>17
18
19
20</td><td>• Department of Forestry has supported collaboration with OCCRI and USDA FS PNW Research Station to statistically model and map historical and contemporary fire susceptibility of Oregon's forests.
• USDA forest inventory and monitoring data being used to statistically detect, quantify, and map changes in the geographic distribution of individual tree species and account for changes that occur.
• DOF collaborates with OCCRI and USDA to add a sustainability indicator based on growth and mortality for major tree species in the Pacific Northwest to the current set of such indicators.
• Business Oregon has developed a short and long term plan for advancing the development and commercialization of innovative wood products.</td></tr>
</table>

B	Biomass	6 9 11	• Oregon Department of Energy is implementing a Wood Energy cluster project that has completed a statewide market assessment and provided grants to projects in six areas of the State to develop biomass projects that would utilize material from forest health treatments as an alternative to fuel oil. • ODF is providing federal grant dollars for four proposed projects to use woody biomass from area forests to heat northeastern Oregon schools and local government buildings. • Oregon's Forest Biomass Working Group has adopted a new Forest Biomass Strategy and taken action on key market development initiatives and policy recommendations. • The Oregon Department of Energy has designed a renewable thermal incentive that is offered to projects that will use biomass as a heat source for public or private buildings. ODOE has authorized over $1 million with this incentive. • The Oregon Department of Energy has established a new public-private partnership to manage a fund targeted at financing small wood energy projects in Oregon. • The Oregon Department of Energy administers a production based incentive for biomass that is used for energy production. • In 2011 the Department of Forestry updated a 2008 report on the Environmental Effects of Woody Biomass Collection and Conversion from direction in the 2005 Senate Bill 1072. • State legislative incentives passed in the 2007 and 2009 sessions are intended to increase the amount of forest biomass being utilized in Oregon.	

VI. Status of Recommended Materials Management Key Actions

The production, transportation and disposal of materials offer significant opportunities to reduce greenhouse gas emissions. Somewhere between 35 and 48 percent of Oregon's 2010 consumption-based greenhouse gas emissions is a result of the purchase of materials. Most of these emissions are associated with production; freight and disposal also add to the emissions footprint of products and other materials.

Limited progress has been made on several of the materials management recommendations in the Interim "Roadmap to 2020". A carbon price signal across the life cycle of products and materials remains the single untapped policy option with the greatest potential for emissions reductions. To be most effective, such a price signal should address not only in-state production but also imports. At the same time, much more can be done by producers of high-impact products, including food, to identify emissions hot spots and work to reduce emissions through supply chain, process, and other changes.

Understanding how materials contribute to emissions is a prerequisite to effective action, and a research project starting in the fall of 2013 will specifically examine the potential benefits of product-level "carbon footprinting" by brand owners, as well as program and policy approaches that might advance footprinting of products both made and sold into Oregon. Consumer engagement, if done effectively, also holds potential.

Policy options as well as voluntary actions by producers can also make "low carbon" consumption easier and more effective, for example, by increasing the supply of buildings that are "net zero" when viewed holistically (materials + energy use), reducing the carbon footprint of products through material substitution as well as enhanced durability, reusability and efficiency, and addressing both the systemic and behavioral drivers that result in significant quantities of edible food being produced but never used.

Finally, while waste recovery in Oregon already yields significant reductions in greenhouse gas emissions, more potential exists to conserve energy and reduce emissions by redirecting resources away from landfills and towards alternative uses.

Recent accomplishments and plans for the next few years are highlighted below.

Table 6: Status of Key Materials Management Actions by 2020 from "Roadmap to 2020" Process

Progress Score:
A On track to meet State goals or Roadmap outcomes
B Partial but significant GHG reductions or progress toward outcomes
C Business as usual; insignificant or no reductions or progress
D Significant measurable slippage away from goals or outcomes

Progress Score	Key Action for 2020	Sub-Action Link[43]	Accomplishments	To Be Accomplished
C	Advocate for Carbon Price Signal across Life Cycle of Products & Materials, Including Imports	1	• EQC adopted "Materials Management in Oregon: 2050 Vision and Framework for Action", which envisions a future where "prices reflect environmental and social costs, and incentives and regulations support sustainable producers and products."	• DEQ research project in 2013 will demonstrate the "cost of carbon" embedded in materials and waste. • Research project into business opportunities, co-benefits, challenges, and perceptions regarding carbon footprinting of products will begin later in 2013. • Limited funding secured for a possible food footprint pilot project in 2014, likely to focus on helping producers identify "hot spots" for potential improvement. • Ongoing work by DEQ and others to better understand and document the carbon footprint of
A	Conduct Research To Develop a Consumption-Based GHG Inventory and Inventory Methodology; Consider Integration with State's Conventional Inventory, Identify High-Carbon Product Categories	2	• Consumption-based GHG inventory for 2005 completed and published. • Consumption-based inventory updated for 2010 and published alongside in-boundary and expanded transportation sector emissions as part of new multi-agency inventory report. • New analysis in 2010 inventory update includes change in consumption-based emissions from 2005, and how consumption-based emissions vary with household incomes. • DEQ contributed to the new U.S. Community Protocol for Accounting and Reporting GHG Emissions, which encourages the use of consumption-based accounting. • DEQ also contributed to an informational Toolkit to help local governments understand consumption-based inventories. • Several local governments in Oregon have included or	

[43] These are references to the "inventory of actions" that accompany each of the sector roadmaps in the full "Interim Roadmap to 2020" report. Note that in many cases the "Key Actions" embody slightly different language, or additional actions beyond those in the "inventory of actions", that resulted from further discussion in stakeholder groups once the overall "inventory of actions" was compiled as part of the Roadmap to 2020 process.

<table>
<tr><td></td><td></td><td></td><td>are working to include consumption-based emissions in either or both of their operational and/or community inventories.</td><td rowspan="8">building materials.
• Oregon is watching related whole-building policy work in Washington and Europe.
• Revisions planned to DEQ's website for 2013 include new content on carbon and other environmental impacts of materials.
• Several local governments have expressed interest in conducting food waste prevention pilot projects.
• Research into conversion technologies specific to plastics wastes is funded and will commence in 2013.
• Research into organic waste management is funded and should commence later in 2013.</td></tr>
<tr><td>C</td><td>Develop & Disseminate Information: Easy-To-Use Life Cycle Metrics for Different Food Types</td><td>3</td><td>• No action statewide, although some food producers (e.g., Truitt Brothers, Turtle Mountain) have conducted carbon footprints of specific brands.</td></tr>
<tr><td>C+</td><td>Standards, Incentives, and/or Mandates For Carbon Footprinting, Labeling of Products</td><td>4</td><td>• International accounting standard for product carbon footprints developed by the GHG Protocol.</td></tr>
<tr><td>C+</td><td>Focus Product Stewardship on Upstream Emissions, and Design For Appropriate Durability, Repairability, Reusability, Efficiency, and Recovery</td><td>5</td><td>• DEQ published Recommendations for Product Stewardship in Oregon in December 2010.
• Limited technical assistance to producers, designers and retailers provided by DEQ on an ongoing basis.</td></tr>
<tr><td>C</td><td>Establish Higher Standards For New Buildings: "Net Zero" Plus Offset of Materials</td><td>6</td><td>• No Oregon action specific to including GHG impacts of materials in building assessments, but code relating to impacts of operational use of energy has improved.</td></tr>
<tr><td>C</td><td>Outreach to Consumers on Product Impacts and Opportunities to Reduce those Impacts</td><td>7</td><td>• Very limited new action, although DEQ continues to provide an on-line consumption-based carbon footprint calculator.</td></tr>
<tr><td>C+</td><td>Reduce (Prevent) Waste of Food at the Retail and Consumer Level By 5 to 50 Percent</td><td>8</td><td>• DEQ has supported development of a Toolkit to help local communities design and evaluate pilot projects to prevent food waste.</td></tr>
<tr><td>C+</td><td>Conduct Research on Highest/Best Use for Organic Wastes and Waste To Energy and the Carbon Impact of Different Conversion Technologies</td><td>9</td><td>• Guidelines specific to waste to energy technologies not developed, but recently-adopted "Materials Management in Oregon: 2050 Vision and Framework for Action" provides a robust framework for evaluating such technologies.</td></tr>
</table>

VII. Status of Integrating Recommendations from "Roadmap to 2020" Process

In the "Roadmap to 2020" process the Commission chose to provide a set of recommendations that were not specific to any one sector. These "Integrating Recommendations" broadly address climate change policy at the state and national level, as well as the analytical needs necessary to support well substantiated climate change policy development. Because these recommendations don't lend themselves to progress scores they aren't provided here. Instead the table notes key accomplishments related to the recommendations and areas that still remain to be addressed in regards to the recommendation. Note that in relation to IR-2, Greenhouse Gas Inventories, substantial additional detail on this topic is included throughout this report.

Table 7: Status of Integrating Recommendations from "Roadmap to 2020" Process

Code	Integrating Recommendation	Accomplishments	To Be Accomplished
IR-1	Greenhouse Gas Reduction Goal for 2030	• In 2012 the State contracted to develop a GHG Marginal Abatement Cost Curve (MACC) to assess cost-effectiveness of different GHG reduction strategies to 2035; additional analysis is underway that will assist in associating actions, costs and GHG reduction potential to illuminate implications of an intermediate goal. • ODOT completed its Statewide Transportation GHG Reduction Strategy (STS) in 2012, identifying actions and GHG outcomes to 2050 (but a 2030 interim strategy was not produced).	• Oregon needs to refine existing MACC and STS research into cost-effectiveness of different GHG reduction trajectories in different sectors; and from this, interpolate intermediate (e.g., 2030; 2040) reduction goals.
IR-2	Greenhouse Gas Inventories	• Multiple inventory perspectives now available as described in this report. • ODEQ's Greenhouse Gas Reporting Program allows one to sort emissions data from large emitters by geopolitical division, end user types, or by types of emissions. • Development of greenhouse gas marginal abatement cost curves for emission reduction options lays foundation for cost analysis.	• Future iterations of the multiple perspective inventory approach will be necessary to ensure continued understanding of how emissions are changing.

IR-3	Advocating for a national carbon cap or other equally effective national carbon reduction measure	• Commission passed Resolution 2009-1-009, remains Commission's statement of record on topic. • Carbon tax study bill (SB 306) passed by Oregon legislature and signed into law in August 2013. • On March 12, 2013, Representative Blumenauer (with Rep Waxman, Senators Whitehouse and Schatz) introduced a "carbon pollution fee" approach to monetizing carbon emissions. • Senators Boxer and Sanders have also introduced a carbon fee bill.	• Federal activity on this topic has been, and looks to continue to be, minimal apart from a small bubble of interest in a carbon tax for its revenue-raising potential as much as for carbon reduction outcomes. • Prospects for the Blumenauer et al bill and Boxer/Sander bill are not bright, but at least re-introduce climate solutions into Congressional discourse, consistent with the Commission's Resolution.
IR-4	Energy and Infrastructure Research Funding Priority	• Obama proposed FY 2014 budget proposes a 5% increase in overall Energy RD&D (weighted toward renewables, efficiency); and a 38% increase in ARPA-E funding.	• National energy and GHG research remains underfunded relative to other research budgets; prospects even for Obama budget levels are uncertain.

VIII. The "Roadmap to 2020" Public Input Process[44]

Introduction

The Commission authorized a "roadshow" initiative to communicate key recommendations from the interim "Roadmap to 2020" to Oregonians, and elicit their reactions and comments. This first – "Phase 1"– outreach strategy had ambitious goals with limited resources. With guidance from the OGWC Chair, assistance from a Portland State University graduate intern, and with logistical and facilitation support by the firm of Cogan Owens Cogan, LLC, the following were accomplished in the late spring and early fall of 2011.

- Six public workshops were held in Bend, Medford, Eugene, Portland/Multnomah County (2), and Clackamas County (Oregon City) that engaged more than 125 participants.
- Eighty eight (88) completed detailed feedback forms on key roadmap themes, or propositions.
- More than 15 additional Roadmap presentations and discussions to State and local government elected officials, citizen boards and staff; legislators; University classes; and business, labor and faith organizations.
- Outreach to and through 40 listserves and associated organizations representing a broad cross-section of Oregon stakeholders and perspectives.
- More than 2,200 online survey responses.

Funding for the "Roadmap to 2020 Roadshow" was provided by the Bullitt Foundation and the Lazar Foundation. Both of these entities also helped fund the "Roadmap to 2020" project along with the Lemelson Foundation, Portland General Electric, and Northwest Natural Gas.

Survey Results

The online survey was conducted using survey technology from Portland-based Fuse Insight Labs and survey design by Portland-based Mesh Strategic Partners in consultation with Cogan Owens Cogan, LLC and the OGWC Chair. The survey technology enabled the OGWC to replicate an interview experience with over 2,200 Oregonians from all over the State. This allowed the OGWC to gain insights about ways to approach climate change that resonate with Oregonians from a variety of geographic, political and ideological perspectives.

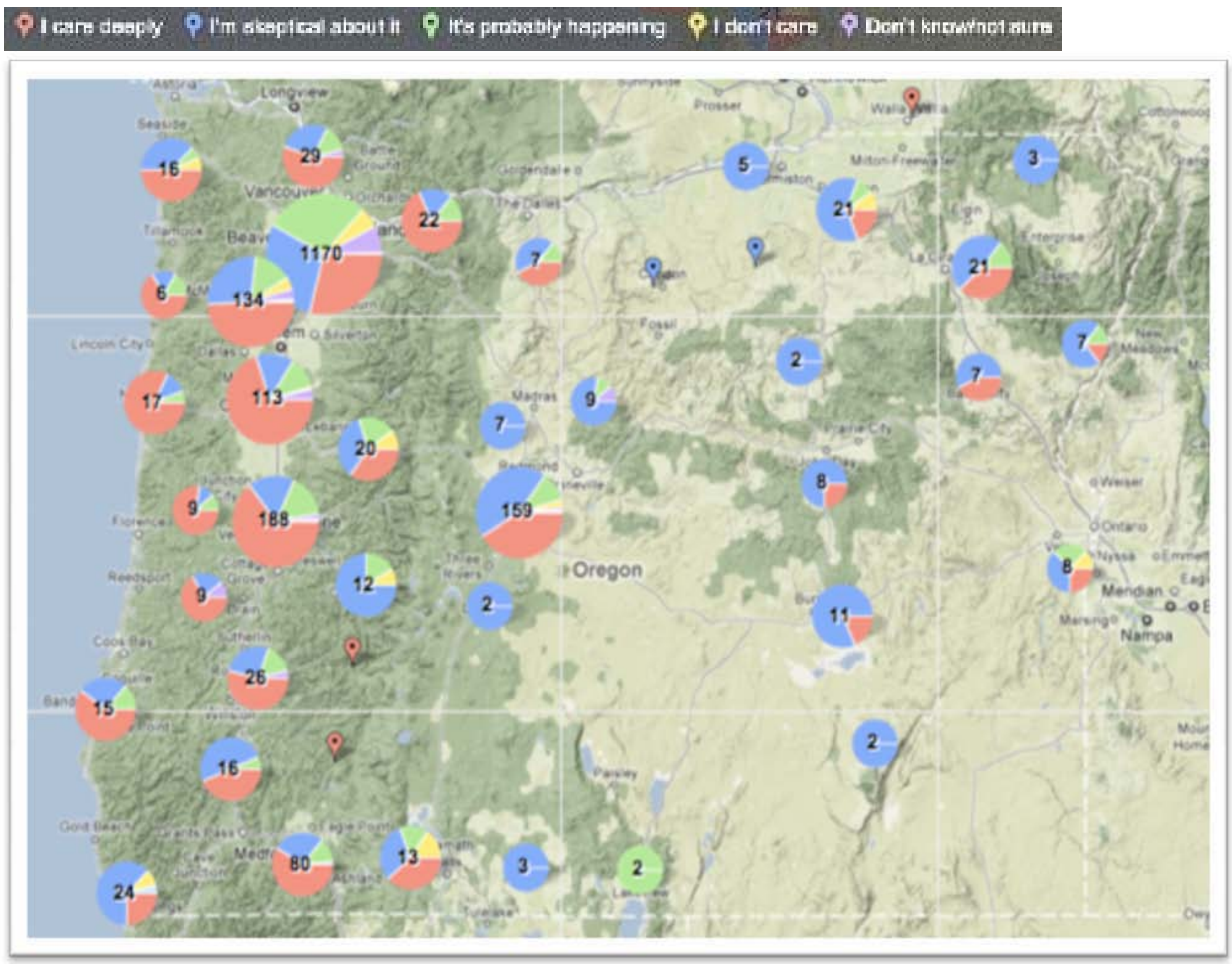
Each answer to a question creates a "pathway" down which related follow-on questions can be put in order to deeply understand the user's point of view. In this survey, over 90 questions were designed. Respondents saw about 40 of them on average, depending on the "path" they chose. Respondents were asked each question one at a time, and then sent to the next question depending on their answer. Opportunities for open-ended responses were liberally afforded, and respondents took full advantage of

[44] This is a condensed and updated version of the final project report submitted by Cogan Owens Cogan LLC. The full version of this report, along with numerous appendices, can be found on the Commission website.

these with over 3,000 written comments). The results of this design on the respondents' experience are significant: since they feel "listened to", completion rates are two to three times higher than an average survey (a 68 percent completion rate in this case). The time respondents took to thoughtfully write responses was significant. The average completion time was 17 minutes.

Figure 1: Survey - Geographic Distribution

Key: General attitude toward the topic of climate change among 2,231 Oregon respondents:[45]



In order to design a survey with this level of engagement, a review of other studies and topical literature informed the "pathways" that needed to have follow-up questions. The Climate Leadership Initiative and the Social Capital Project's, Climate Communications and Behavior Change report, which grouped voters into three major groups and 10 subgroups, ranging from "Green" to "Indifferent" to "Highly skeptical" was useful. Communications specialists Renee Lertzman, PhD and Leslie Carlson, Carlson Communications also provided important input about the sensitivity of climate-related communications.

45 Respondents mapped by respondent-provided zip code.

Recruitment

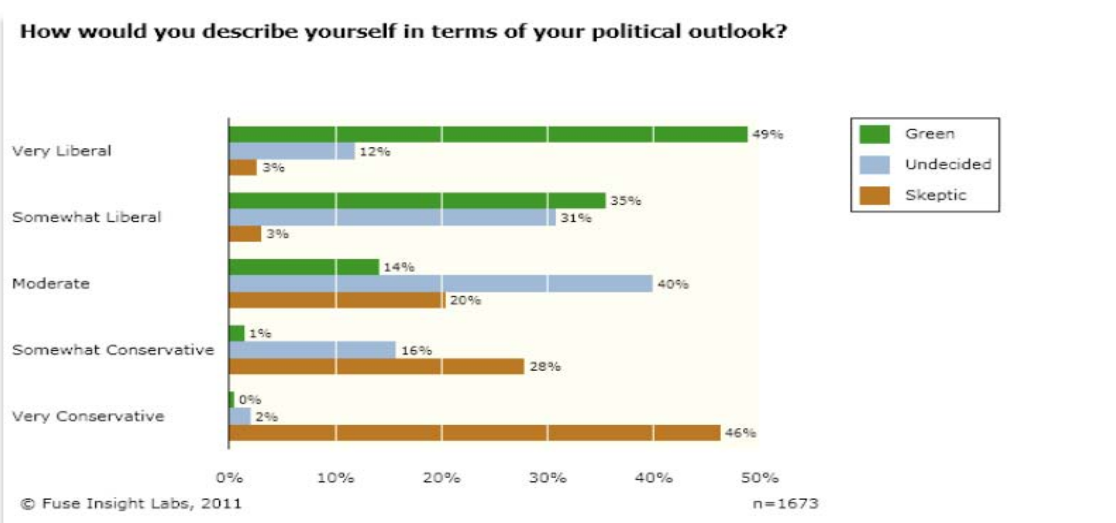
This survey was deployed via newsletters, emails and traditional media with the help of more than 40 community partners representing a spectrum of business, labor, government and other advocacy groups. More than 20 groups in total brought in over 2,200 responses to this survey from all over the State. Each partner group was given a unique URL to share with their list, which allowed the OGWC to have visibility regarding the origin of the respondents without identifying individuals and their responses. Of the 2,200 respondents, over 1,400 provided their email addresses to the Commission and invited an ongoing dialogue.

The primary purpose of the workshops and online survey was to communicate Roadmap recommendations, invite responses, and open such a dialogue with what is hoped will be an expanding population of interested Oregonians. While the survey would strive for geographic, political, occupational and demographic diversity (and at least across the political spectrum, largely achieve it), the resulting set of responding Oregonians should not be considered a statistically representative sample. The survey results need to be viewed with this caveat in mind. The upside of the chosen approach was inclusiveness. The downside was that respondents were more likely than the population as a whole to have strong feelings about climate issues, and more strongly favor or oppose State actions than would Oregonians as a whole. While future such Commission surveys will endeavor to develop a broader spectrum of respondents and opinions, it will continue to favor more participation over more statistically representative responses.

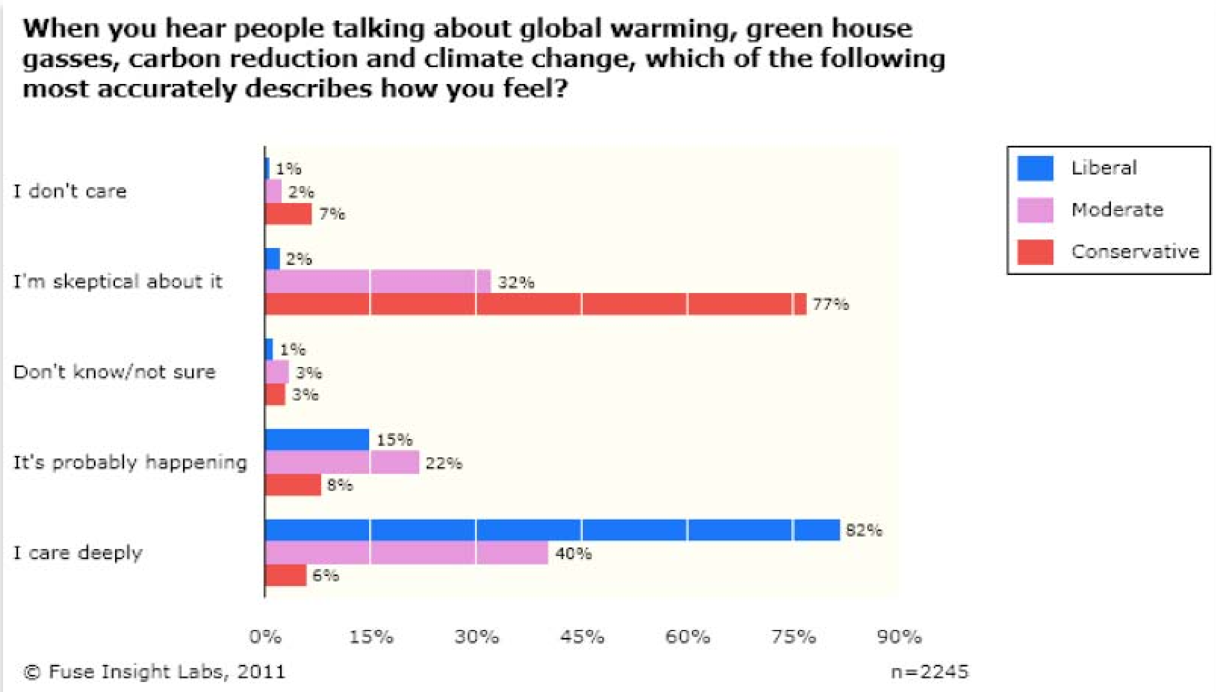
Survey Results -- Key Findings

<u>Finding #1: Respondent's behavioral attitudes toward climate change correlated with their political ideologies</u>.

Predictably, when viewed through a behavioral analysis, most self-identified "Green" respondents were Liberal, most "Skeptical" respondents were conservative and most "Undecideds" were Moderates.



Very few Liberals were skeptic and no self-identified Conservative respondents were green.



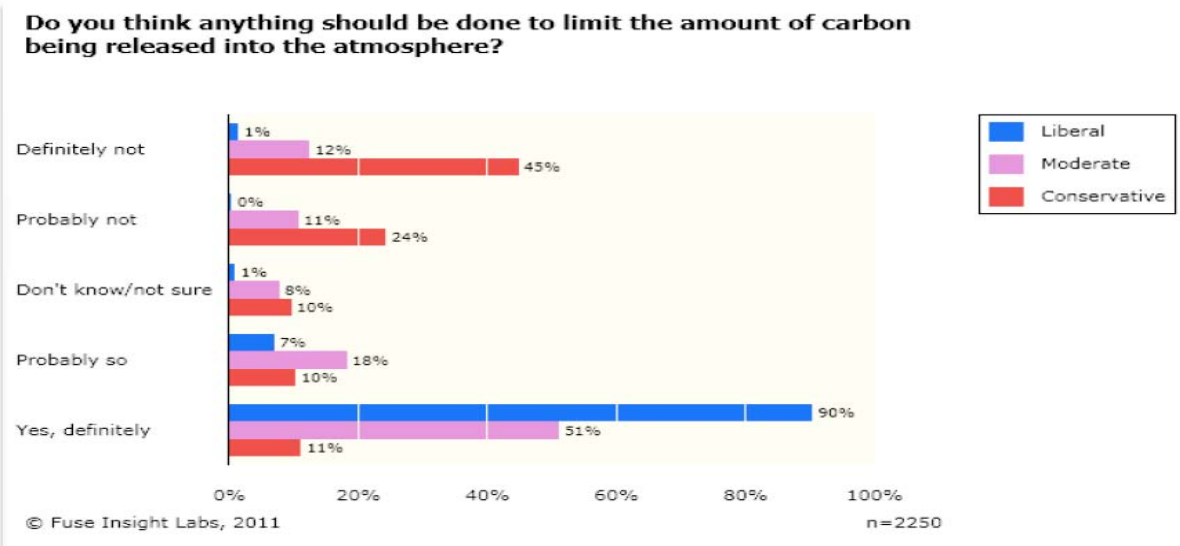
When viewed politically, Conservatives were highly skeptical of climate change in general, while most Liberals cared deeply about it. Moderates were divided but on balance acknowledged the reality of the issue.

While this finding confirms many existing stereotypes, it is very valuable because it enables us to view results in terms of both political and communications contexts. It may also allow us to identify areas where, climate beliefs aside, there are opportunities for citizens to agree on actions that serve more than just climate objectives.

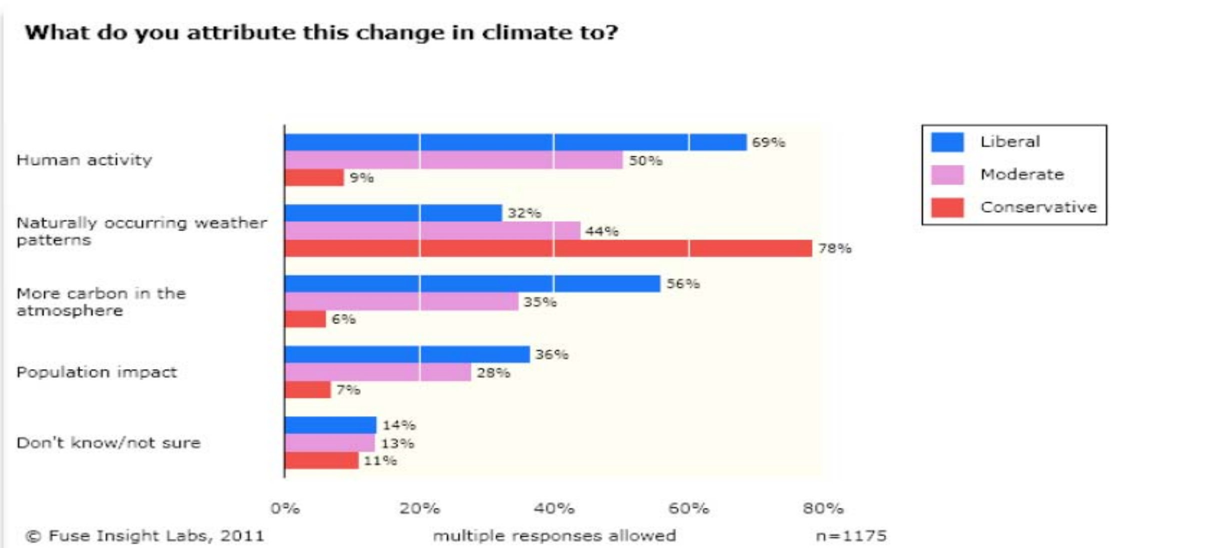
Areas where there is strategic political alignment are also areas where strategic communications designed to inform and educate will be most effective.

Finding #2: Ideologies create separate realities.

Conservatives thought that nothing needed to be done to limit carbon in the atmosphere. Liberals felt strongly that something should be done. Moderates aligned decidedly more with acting on climate issues than doing nothing.



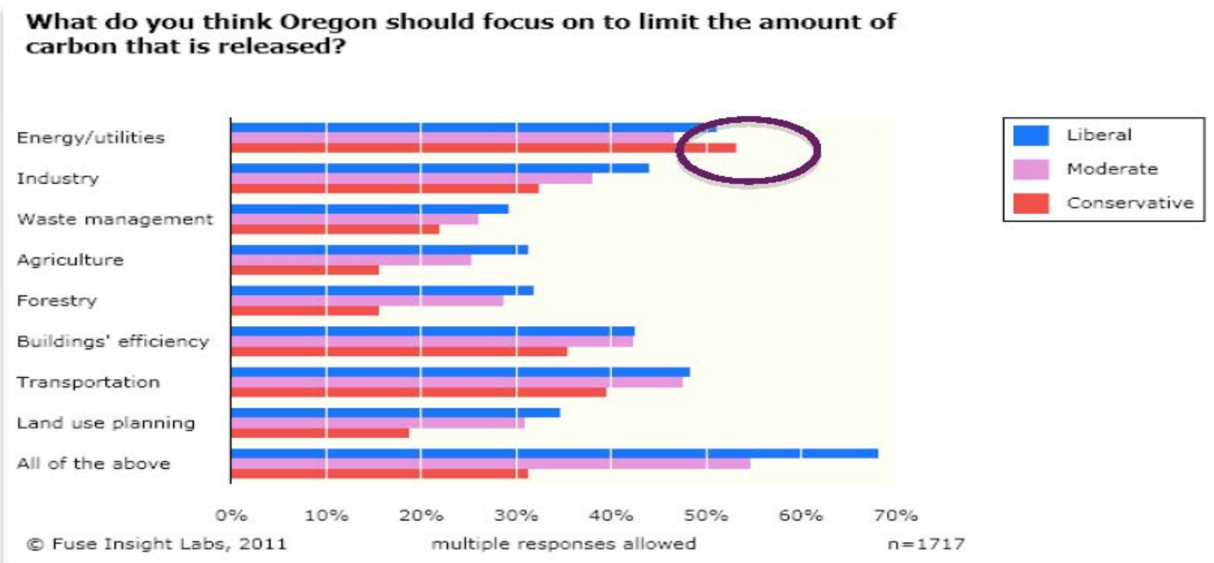
Even when respondents reported to have seen physical evidence of climate change over the last 15 to 20 years, they attributed this change to different factors based on their political perspectives. Conservatives in particular resisted the idea that human activities might be influencing climate change even as some of them acknowledged that such change might be occurring. Moderates' responses aligned more closely with Liberals, but likely with less conviction and commitment to a vigorous response.



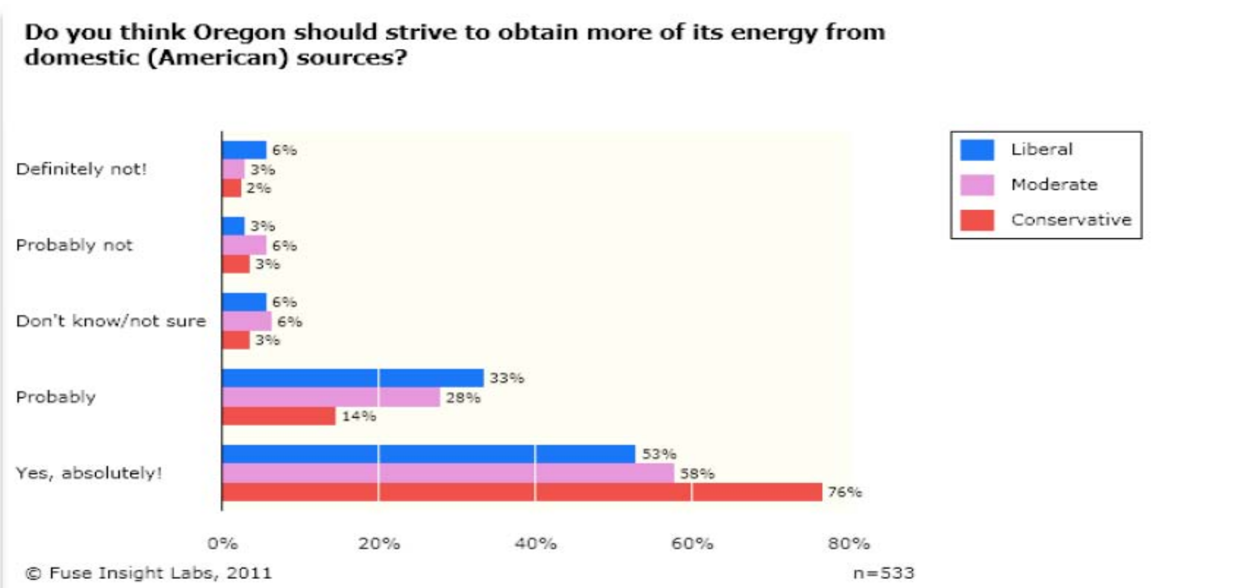
On one hand, this finding confirms a stereotypical view of how politics and environmental outlooks relate – about how we may select and weigh opinions and evidence based on our political predispositions -- but it also is an important insight for us to consider as we develop a communications and messaging strategy that will build grassroots support for climate change initiatives. Communications about evidence may only affect a small subset of Moderates.

Finding #3: Several issues related to energy generation and conservation will enjoy the support of a majority of Oregonians, regardless of their environmental or political views.

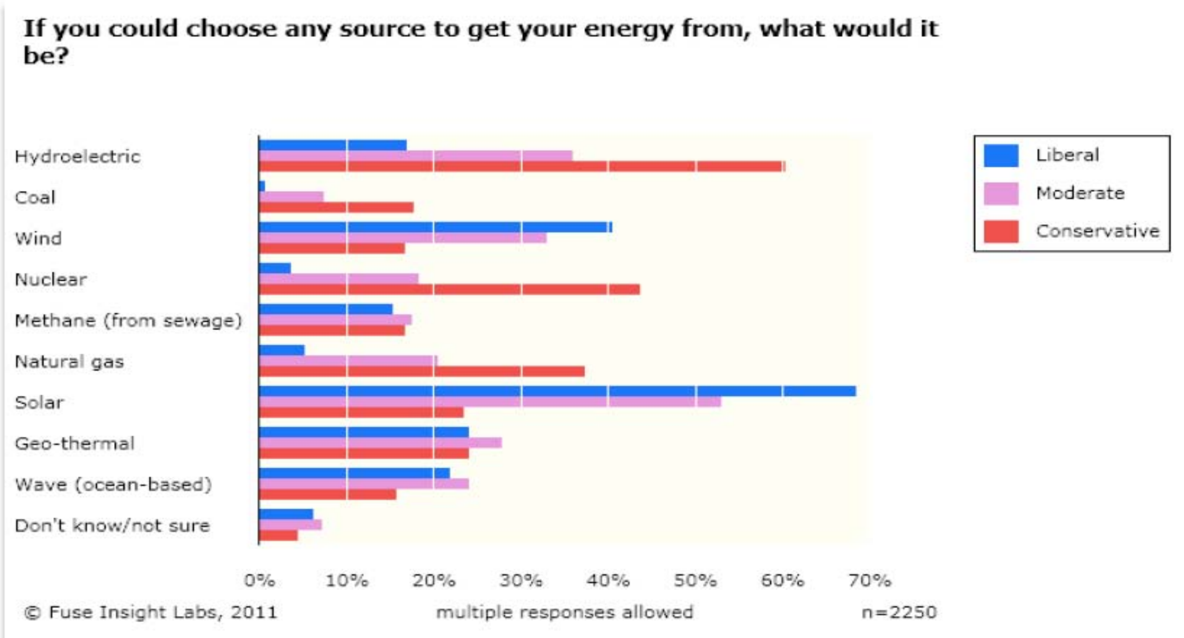
A majority of Liberal and Conservative respondents who thought something should be done about carbon emissions believed that Oregon should focus on energy & utility issues to limit carbon emissions.



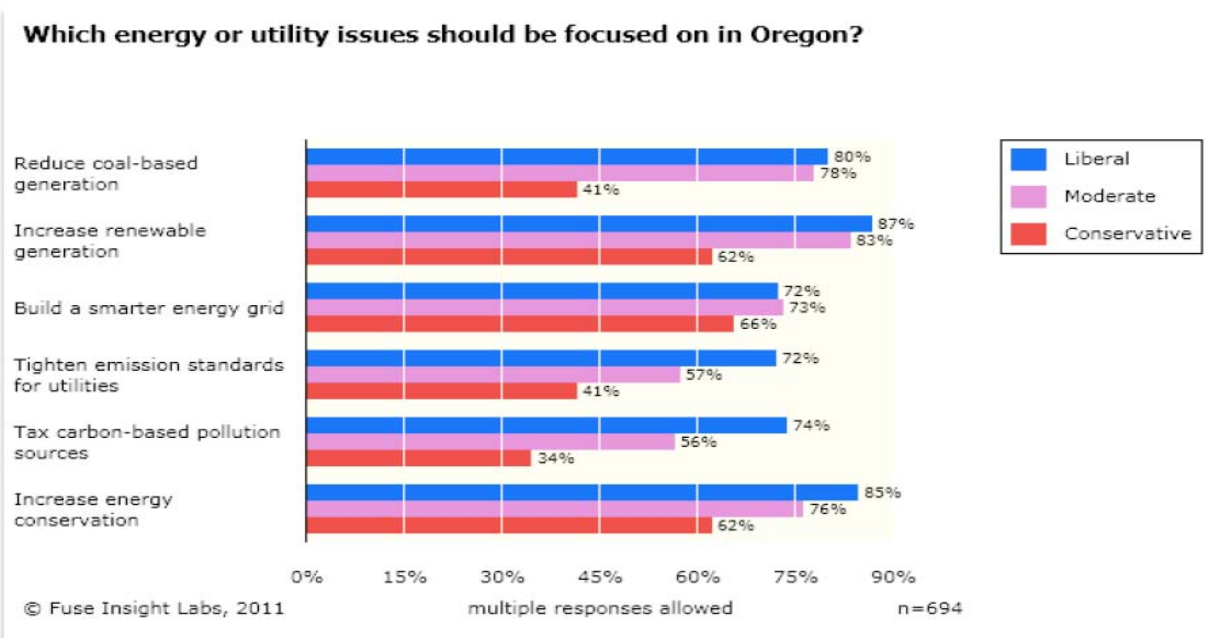
Even among those who don't believe anything should be done about climate change, there was a strong value placed on domestically produced energy.



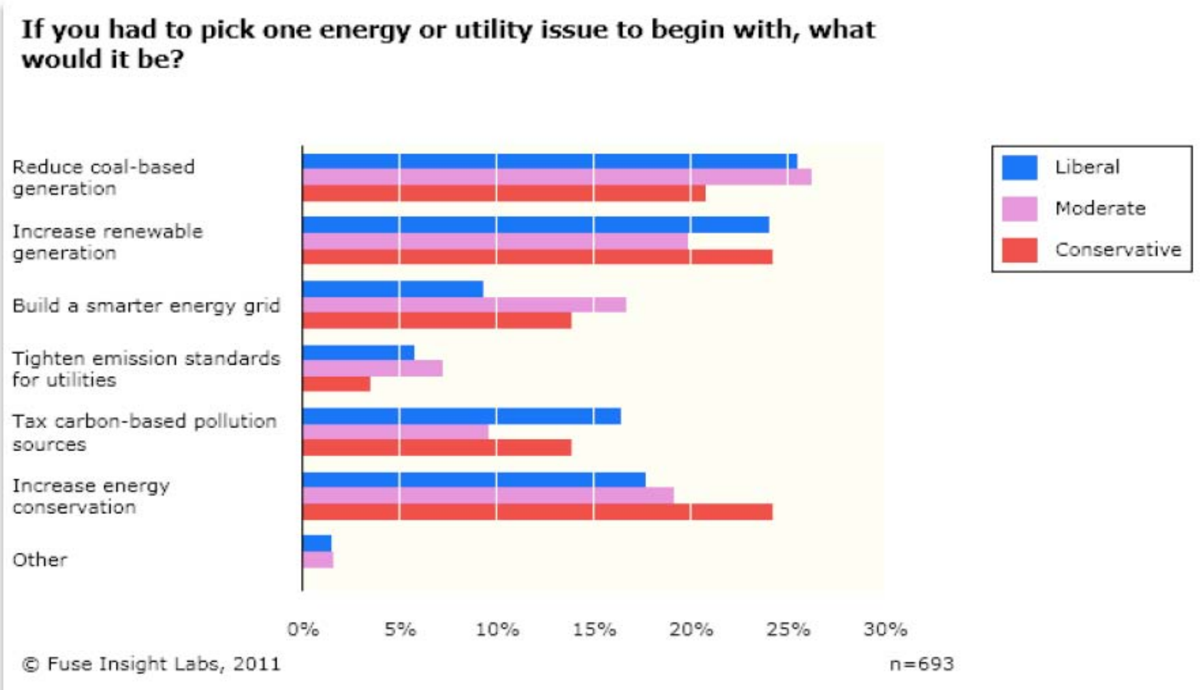
The preferred sources of domestic energy divided on political lines, but it is notable that coal was in the lowest percentile of choices for all groups; and among Conservatives, it was ranked with wind, methane and wave energy.



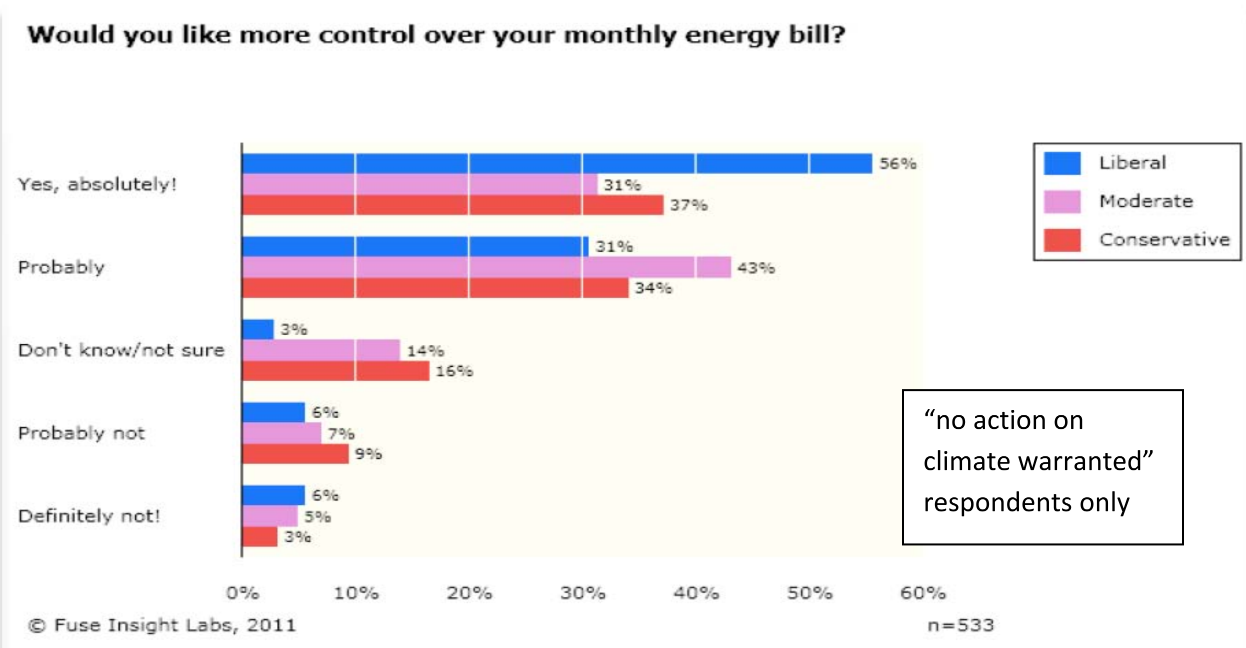
For those who believe that something should be done about carbon emissions, there was agreement on three priorities: renewables, smart grid and conservation.



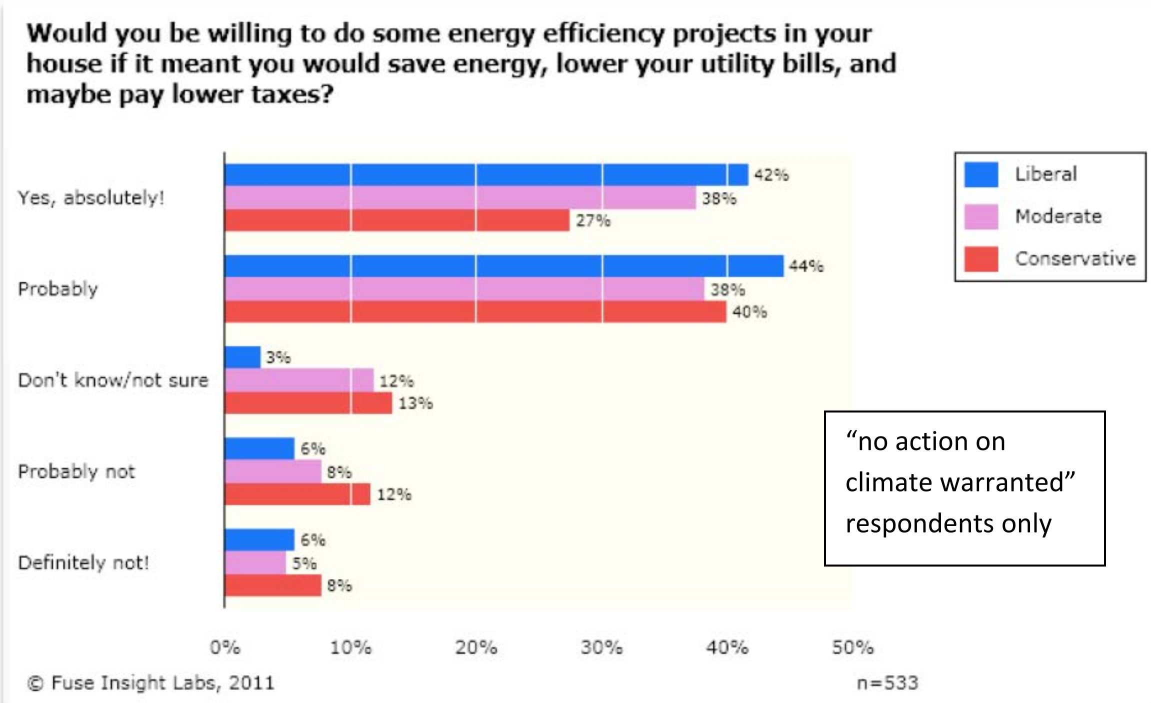
When forced to select only one issue, respondents emphasized renewables and conservation, but dropped smart grid in lieu of coal energy reduction.



Even the respondents who don't believe anything should be done about climate change still indicate a strong interest in controlling personal energy costs among those, regardless of their political ideology (however, they may have very different ideas about what choices would best control their costs).



This same group was very interested in efficiency projects that had a positive financial impact but quickly lost interest if financial incentives were removed.



Workshops

Six workshops were held to discuss the Roadmap recommendations and elicit feedback on the primary themes and ideas in the Roadmap. It is important to note here that public workshops are generally attended by those who feel strongly about an issue. In these workshops, supporters of taking action to reduce greenhouse gas emissions predominated. The two sessions in Portland drew a small but vocal (and clearly organized) representation of those who deny the evidence of climate change and the need to take action. The workshops were as follows:

- Medford – This session attracted several elected and appointed officials from the Rogue Valley Council of Governments. Given the small (but high-caliber) turnout, participants stayed in one full group and mainly discussed tax implications in a question and answer format with Angus.
- Eugene – This well attended session was promoted and organized by City of Eugene Sustainability and Climate Change staff, assisted by a graduate intern from the University of Oregon. Participants discussed six of the seven propositions.
- Bend – After a Roadmap briefing for the Bend City Council briefing the prior evening(June 1), more than 30 participants engaged in three group discussions facilitated by local planning staff and volunteers
- Portland/Multnomah County – The City of Portland and Multnomah County co-hosted this event with Mayor Sam Adams, County Commission Chair Jeff Cogen and Metro Councilor Rex Burkholder all in attendance. Participants discussed six of the seven proposition themes.
- Portland/Apollo Alliance – This coalition of labor, business, environmental, and community leaders working to catalyze a clean energy revolution hosted a workshop that attracted 30

participants, including a small but organized group of participants who did not believe responding to climate change was an appropriate action. Other participants focused on meeting the State's reduction targets.

- Clackamas County – This session was well attended and hosted by the County's sustainability staff.

Volunteer facilitators were given a short discussion leader training based on best practices of communicating about climate change. Discussions were held on seven key thematic areas, or propositions. More detailed comments on these propositions were sought through a written feedback form. Numeric results from feedback form comments are detailed in Appendix 1: "Roadmap to 2020" Roadshow Materials. Participants could rank recommendations as High Priority/Near Term (next 1 – 3 years), High Priority/Mid Term, or degrees of lower priority. Both the feedback forms and the handouts that described the propositions are included in Appendix 1 for those interested in viewing the materials.

Summary and Findings

Creating alignment among a variety of political points of view is never an easy proposition, and it is especially challenging when political interests have already defined an issue as with climate change. Nevertheless, participants have shown a common framework of interests that, if acted upon, can have real and meaningful impacts on Oregon's GHG emission policies. Respondents have also given ideas about how we can communicate more effectively to Oregonians on issues of climate change without directly challenging their values and beliefs.

Some of the key findings include that the Commission may have more success building and implementing an outreach strategy that focuses on the issues where alignment exists among majority of respondents regardless of their political or environmental point of view, namely: utility policies, energy generation and energy conservation. Currently energy is one of five topics upon which the OGWC is focusing; this issue could be more prominently positioned on the website and in other communications. Within the five areas, topics relating to utility policies, energy generation and energy conservation are referred to as "Energy and Buildings". Changing this to be more appealing to respondents' personal interests surrounding reducing their energy bill, efficiency projects, building renewable generation capacity and decreasing coal dependency would be helpful. Updating the website to a more assertive educational stance would create a matrix of opportunities and action steps that would help Oregonians quickly decide which projects fit their financial abilities and level of environmental interest.

A recommendation for follow up work is that a phase two survey can drill down to gain further insights into how Oregonians are interested in responding to the effects of climate change utilizing the results above. Test messaging can then be created for an updated OGWC outreach strategy. Gathering suggestions for policies that will maintain our quality of life as climate change occurs. Also, uniting the survey with in-person discussions in meetings and focus groups would be helpful. In addition, a statewide summit could be convened to discuss these policy issues, co-hosted by the Oregon Global Warming Commission and other state agencies, foundations and interest groups.

It was suggested that the Commission may consider creating targeted outreach strategies for each group (Green, Undecided & Skeptics) and appeal to each in terms of actions that they are receptive to and that can lower their carbon footprint regardless of whether they believe in climate change or are skeptical of it. The Commission can then work with diverse political interest groups to help educate them regarding their constituents' values within discreet political districts in order to promote a higher level of political discourse about climate change.

CLIMATE CHANGE SOLUTIONS

Oregon Department of Transportation: *ODOT is actively working toward reducing the amount of greenhouse gas emissions emitted by its operations and the transportation sector*

ODOT is making great progress in implementing strategies which may help to reduce its greenhouse gas emissions emitted by its operations and the transportation sector. ODOE collaborates with others to develop innovative responses, minimize energy use in facilities, increase fuel efficiency and use of low carbon fuels in the fleet and encourage employees to reduce their commuting energy use.

Reduced building energy use: In Calendar Year 2012, ODOT achieved a 17.2 percent reduction in kWh per square footage of facility space over the CY 2004 baseline. This was achieved through energy efficiency upgrades and ODOT employees who conserve energy by turning off computers and lights. Overall, energy use at ODOT's primary facilities was reduced, down from 16 to 13 (kWh per square foot) over baseline. In 2012, ODOT took advantage of energy incentive programs such as those offered through Energy Trust of Oregon. These programs helped implement energy saving projects like energy efficient lighting retrofits (Buildings L and M), window upgrades, insulation upgrades and HVAC.

Arrested growth in emissions from ODOT fleet and facilities. ODOT is committed to minimizing its impact on the environment through the reduction of emissions from all agency activities and sources. Implementing strategies from the various focus areas in Volume II, such as reducing facility energy use, increasing recycling and using alternative commuting options will help ODOT reach its goal of reducing its overall greenhouse gas emissions.

Carbon emissions from ODOT's vehicle fleet achieved an 8 percent reduction over 2012.

As an example, ODOT's Region 1 has added a Freightliner M-2 diesel/electric hybrid bucket truck to its fleet. The truck's fuel capability is estimated between 9-to-12 miles per gallon, compared to an equivalent sized non-hybrid unit, which gets 7-to-9 miles per gallon. The truck also incorporates idle reduction technologies that include a 340 volt battery pack, which runs the hydraulic system. The battery pack helps reduce the idle time by nearly 3.5 hours on a 4-hour project and provides huge monetary savings by reducing fuel consumption. Running the truck for 32 minutes costs only about $2.25 compared to $18.00. The significant reduction of idle time also represents a reduction of exhaust emissions, which benefits the environment and the health and safety of ODOT workers.

PLANNING TO ACHIEVE OREGON'S CLIMATE CHANGE GOALS

The "Roadmap to 2020" process was undertaken to chart a clear course toward achieving Oregon's climate change goals – both the near-term 2020 goal and staying on course for Oregon's 2050 greenhouse gas reduction goal. However, other planning initiatives during the last biennium will lay a critical foundation for achieving the greenhouse gas reduction goals and provide a framework under which the State's preparation for and adaption to climate change can occur. Key outcomes specific to climate change mitigation and adaptation activities from all of these processes are summarized below:

I. Oregon 10-Year Energy Action Plan

Issued in December 2012, Governor Kitzhaber's 10-Year Energy Action Plan[46] cites the Roadmap as a source document, and directly incorporates important recommendations from the Roadmap. The Plan has three core strategies:

1. Maximize energy efficiency and conservation to meet 100 percent of new electricity load growth.

2. Enhancing clean energy infrastructure development by removing finance and regulatory barriers.

3. Accelerate the market transition to a more efficient, cleaner transportation system.

In support of the Governor's 10-Year Energy Action Plan the Oregon Department of Energy contracted, after a competitive bid process, with the Center for Climate Strategies (CCS) to conduct foundational analysis and modeling for a suite of energy and greenhouse gas reduction measures. The project had two major objectives which, due to the funding source, had to be completed in about three months.

- To produce marginal abatement cost curves (MACCs) that show the greenhouse gas emissions abatement potential relative to the cost of that abatement over a range of emission reduction measures. Multiple cost curves were produced representing differing assumptions about levels of commitment and action toward greenhouse gas abatement by external drivers, such as federal policy and technological progress, for two points in the future – the 10-Year Energy Action Plan horizon of 2022 and an end point of 2035. Over 200 emission reduction measures were analyzed and included in the MACCs.

- To complete foundational macroeconomic modeling using the REMI PI+ model. Forecasts were done for the Renewable Portfolio Standard in its current form and two "least cost" forecasts of maintaining a trajectory to achieve Oregon's greenhouse gas reduction goals by using different MACCs and assuming that the emission reduction measures chosen are cumulatively implemented, from most cost-effective to least, so that the State remains on track to meeting Oregon's greenhouse gas emission reduction goals.

[46] *Governor's 10-Year Energy Action Plan*, State of Oregon, December 17, 2012.

The cost curves provide a means of weighing emission reduction measures against each other across sectors to compare their potential impact on greenhouse gas reduction with their cost effectiveness. This comparison is more difficult from a state policy perspective, because external forces (particularly federal action) may drive reductions regardless of what the State does. Thus an important component of this project was to provide different cost curves so that emission reduction measures could be understood in the context of different potential futures – in this case one future where little is done at the federal level (low effort) and one where a moderate amount of effort is made at the federal level. A third future is considered, one in which both external action (e.g., federal policy) and state action are significant, but moderate, and taken together result in more greenhouse gas abatement than either alone. This vision of a shared commitment between Oregon and the federal government is assumed to be the most likely future and receives the most attention in this report. The project results provide a reasonable analog to the McKinsey study[47] – particularly in the use of three scenarios to define increasing levels of effort and commitment toward greenhouse gas reduction.

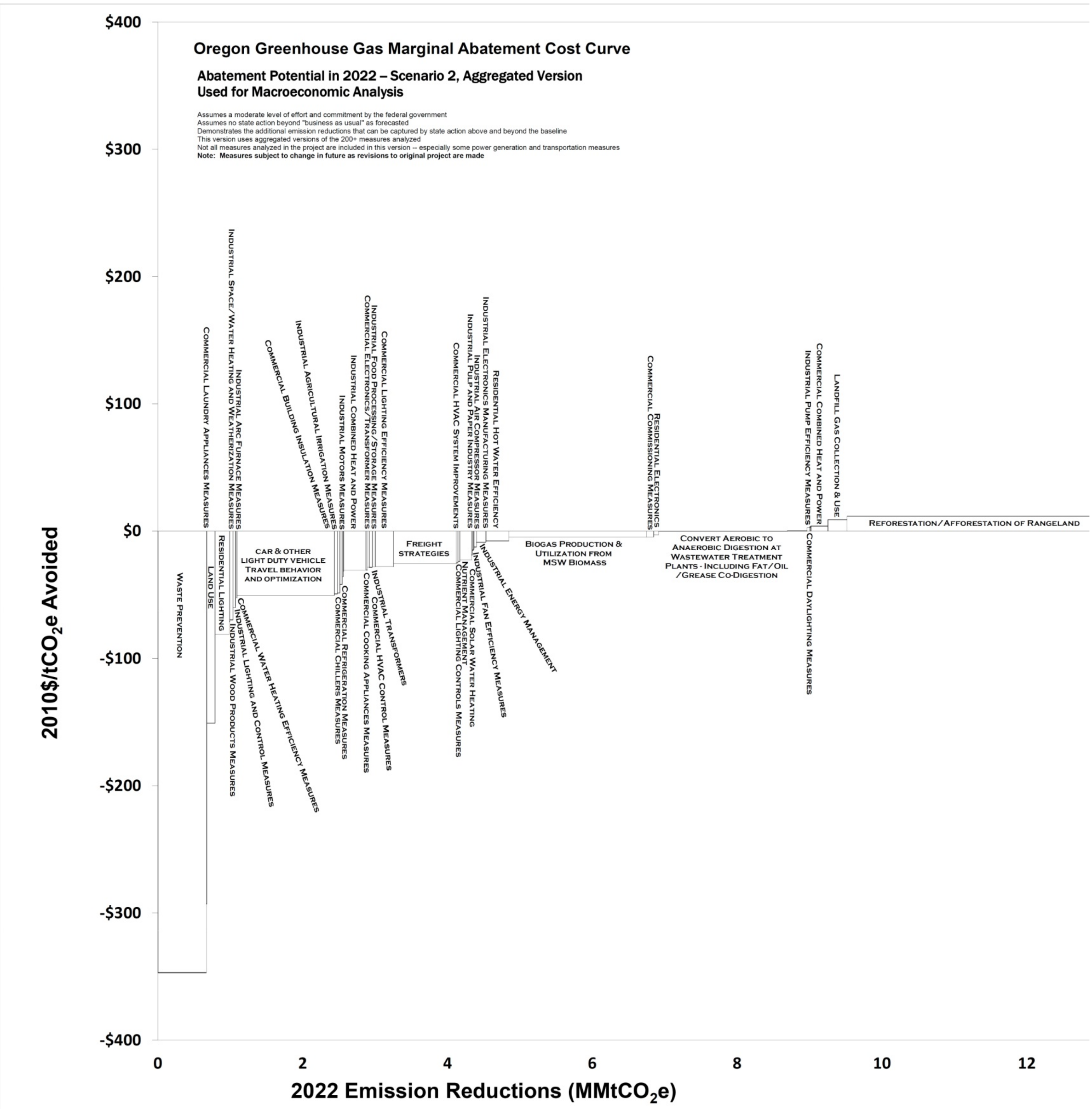
The results of the project[48] demonstrate that some degree of emission reductions will be driven by external action, and in particular federal policy, but there is still substantial opportunity for Oregon to amplify those reductions or find its own policy niches. Many measures -- especially in the energy efficiency, agricultural, transportation, and forestry sectors -- are largely independent of federal action and thus the abatement potential for state action is high. Therefore, the analysis clearly shows there is still "low hanging fruit" in every sector – not just with energy efficiency. Moreover, in the timeframe of the Governor's 10-Year Energy Action Plan (through 2022), that analysis shows that positive economic results can be expected from pursuing the State's greenhouse gas reduction goals through a least-cost approach. The hypothetical scenarios used for the macroeconomic modeling end up projecting some negative economic consequences in the longer term (2035). However, these negative impacts stem almost entirely from a few non-energy emission reduction measures. The energy-related emission reduction measures of most interest to energy and climate planning remain economically positive.

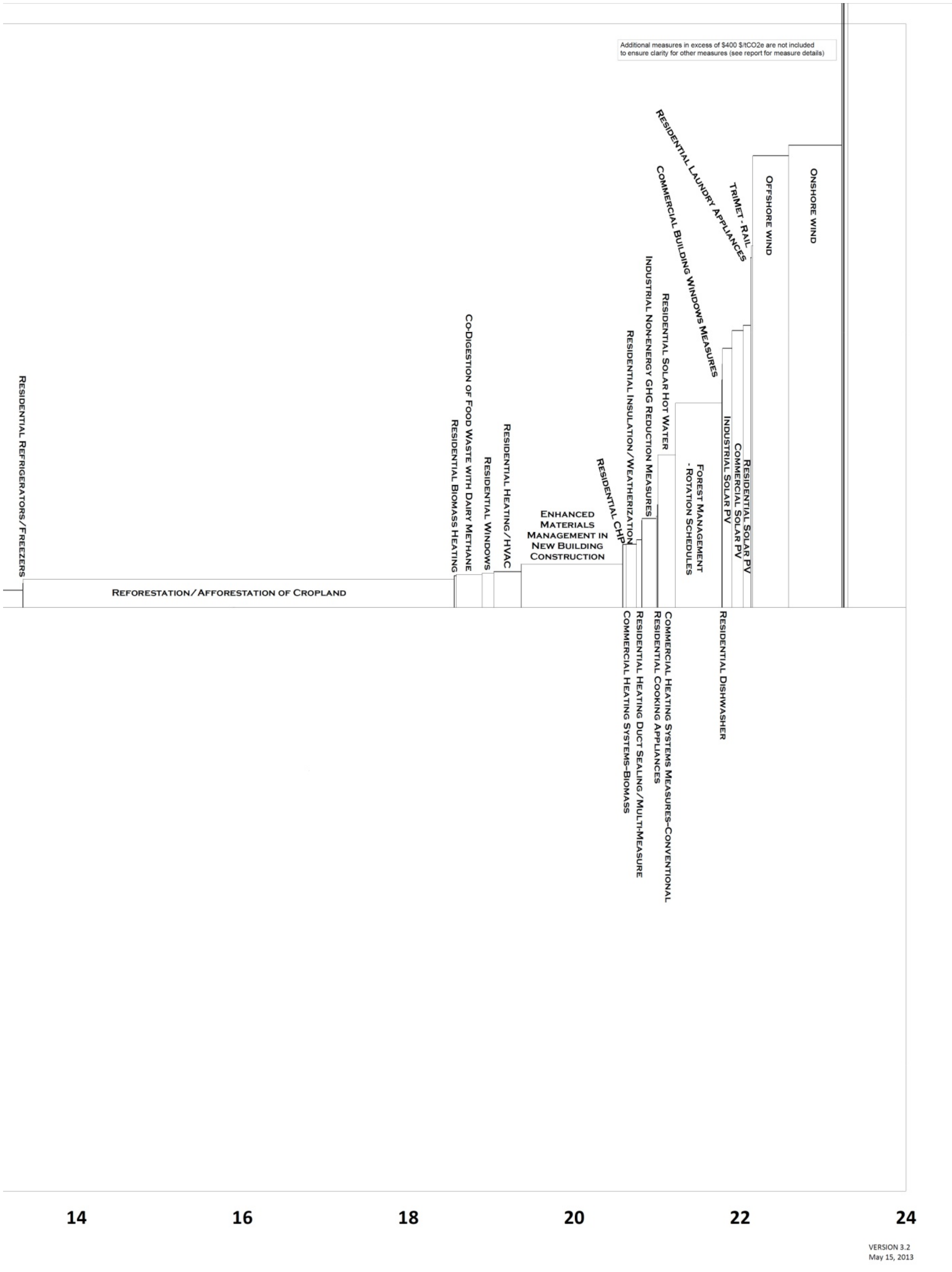
One of the resulting marginal abatement cost curves from the original project is presented in Figure 2. This MACC is an aggregated version that represents a somewhat smaller subset of measures that the full 200+ that were analyzed for the project. The most cost-effective measures fall to the left on the curve, while those that are less cost-effective fall to the right. The total abatement is measured across the X-axis, although caution should be used since there is known double counting between measures.

In spite of the time and resource constraints a substantial amount of work was done for the initial project and an excellent data foundation was created. Additional work will be conducted in the fall and winter of 2013 to expand the data foundation that was laid with this project. The next phase of work will include refinements and improvements to the original project work with the help of stakeholders. Although it is unfair to expect that the Oregon MACC work can achieve the same level as the McKinsey work given the disparity of resources available, it is hoped that with the help of stakeholders Oregon can construct greenhouse gas marginal abatement cost curves that satisfy the concerns of a broad array of interested parties and that can inform climate and energy policy in Oregon for years to come.

[47] McKinsey & Company, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?*, December 2007.
[48] *10-Year Energy Action Plan Modeling: Greenhouse Gas Marginal Abatement Cost Curve Development and Macroeconomic Foundational Modeling for Oregon*, Center for Climate Strategies, July 30, 2012.

Figure 2: Example Marginal Abatement Cost Curve (Scenario 2 Results for 2022 – Aggregated Version Used for Macroeconomic Analysis)




Additional measures in excess of $400 $/tCO2e are not included
to ensure clarity for other measures (see report for measure details)
Residential Refrigerators/Freezers
Reforestation/Afforestation of Cropland
Residential Biomass Heating
Co-Digestion of Food Waste with Dairy Methane
Residential Windows
Residential Heating/HVAC
Enhanced Materials Management in New Building Construction
Residential CHP
Residential Insulation/Weatherization
Industrial Non-energy GHG Reduction Measures
Residential Solar Hot Water
Commercial Building Windows Measures
Residential Laundry Appliances
Forest Management - Rotation Schedules
Industrial Solar PV
Commercial Solar PV
Residential Solar PV
TriMet - Rail
Offshore wind
Onshore wind
Commercial Heating Systems-Biomass
Residential Heating Duct Sealing/Multi-Measure
Residential Cooking Appliances
Commercial Heating Systems Measures-Conventional
Residential Dishwasher
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Version 3.2
May 15, 2013

II. Oregon Statewide Transportation Strategy

Background

The Statewide Transportation Strategy (STS) was developed in response to legislative direction. In 2010, the Oregon Legislature passed Senate Bill 1059 (Chapter 85, Oregon Laws 2010, Special Session) which requires:

> *"…the Oregon Transportation Commission, after consultation with and in cooperation with metropolitan planning organizations, other state agencies, local governments and stakeholders…shall adopt a statewide transportation strategy on greenhouse gas emissions to aid in achieving the greenhouse gas emissions reduction goals set forth in ORS 468A.205 [a 75 percent reduction below 1990 levels by 2050]..."*

In accordance with the legislative direction, the Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas (GHG) Emissions Reduction describes what it would take for the transportation sector to get as close to the State's 2050 goal as is plausible. The STS, itself, is neither directive nor regulatory, but rather points to promising approaches for policymakers at the national, state, regional, and local levels to further consider.

The STS examines all aspects of the transportation system including the movement of people and goods and identifies transportation system, vehicle and fuel technology, and urban land use pattern strategies. The STS found that substantial reductions are plausible. More specifically, the STS Vision results in a future with 60 percent fewer GHG emissions than 1990,[49] but actions by the transportation sector alone cannot reduce transportation emissions enough to meet Oregon's 75 percent reduction goal. The broad 40 year course of action charted in the STS is agile and can be adapted to an evolving future and unforeseen opportunities. Progress will be monitored over time and the course adjusted accordingly. The STS allows flexibility in what strategies and actions may be pursued and points to those projected to be effective at achieving the intent of the legislation. The STS does not assign responsibility for implementation. By mandate, the STS focus is on prevention and mitigation of climate impacts rather than adaptation.[50]

GHG Reduction Strategies

In line with the legislative direction, the STS identifies a possible path forward for the transportation sector to aid the State in achieving its GHG emissions reduction goal. Transportation and land use strategies are included that modeling and analysis have shown to have measurable results. Those chosen for inclusion reflect the mix of options that advisory committees and researchers considered to be plausible and that had the fewest apparent negative impacts. The Oregon Transportation Commission (OTC) is an important decision making body in the effort, for those strategies falling under

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[49] The 60 percent reduction in emissions is projected to occur from the implementation of the entire STS, meaning, to reach even this level, all of the strategies would need to be considered.
[50] Separate from the STS, ODOT has engaged in adaptation planning activities which are further described on the following site*:* http://www.oregon.gov/ODOT/TD/CLIMATECHANGE/Pages/cc_adaptation.aspx.

the authority of the Oregon Department of Transportation, and their approval is required before strategies are further explored or action taken. Additionally, many other strategies will require buy off and commitment by other decision making bodies at the national, state, regional, local, and private sector levels.

Many of the strategies in the document are about providing low carbon transportation options which allow individual choice of the alternative that works best for the situation. Some strategies may be well understood and have the support to move directly into implementation (e.g. eco-driving), while others will require further analysis to determine economic impacts (e.g. pricing) and the appropriate course of action, if any. The STS contains 18 distinct strategies, with 133 potential elements, that fall into six categories:

Vehicle and Engine Technology Advancements

Strategy 1 – More Efficient, Lower-Emission Vehicles and Engines

Fuel Technology Advancements

Strategy 2 – Cleaner Fuels

Systems and Operations Performance

Strategy 3 – Operations and Technology
Strategy 4 – Airport Terminal Access
Strategy 5 – Parking Management
Strategy 6 – Road System Growth

Transportation Options

Strategy 7 – Transportation Demand Management

Strategy 8 – Intercity Passenger Growth and Improvements

Strategy 9 – Intracity Transit Growth and Improvements

Strategy 10 – Bicycle and Pedestrian Network Growth

Strategy 11 – Carsharing

Strategy 12 – More Efficient Freight Modes

Efficient Land Use

Strategy 13 – Compact, Mixed-Use Development

Strategy 14 – Urban Growth Boundaries

Strategy 15 – More Efficient Industrial Land Uses

Pricing, Funding and Markets

Strategy 16 – Funding Sources

Strategy 17 – Pay-As-You-Drive Insurance

Strategy 18 – Encourage a Continued Diversification of Oregon's Economy

Many of these strategies are not new concepts but rather continue the direction brought forward in the Oregon Transportation Plan.[51] Additionally, the Governor's 10-Year Energy Action Plan[52] calls for many

[51] The Oregon Transportation Plan, adopted by the Oregon Transportation Commission, is the statewide policy document guiding transportation decisions and investments. For additional information, visit the Plan website at: http://www.oregon.gov/ODOT/TD/TP/pages/otp.aspx.

of the same strategies highlighted in the STS including: increasing the proportion of fuel efficient vehicles; continuing investment in compact, multimodal, mixed use communities; implementing intelligent transportation system (ITS) technology; and innovatively financing a cleaner transportation system.

Oregon's Future with the STS

The STS represents an aspirational vision for a cleaner future that would greatly aid Oregon in achieving its 2050 GHG emission reduction goal, and achieve other benefits. Performance indicators were used to help understand the impacts of the STS Vision on travel and system performance, land use and natural resources, public health, and the economy, in addition to GHG emissions. Results were compared to what Oregon's future would look like if the trends and plans of today continue. Overall, the STS Vision shows Oregonians better off than the status quo. However, the STS will produce greater benefits for some activities and greater costs for others. Analysis showed that the STS Vision would likely produce the following benefits relative to today and the trends of tomorrow:

- Improved public transportation service, bicycling and walking;
- Fuel-efficient / alternative energy vehicles;
- Enhanced information technology;
- More efficient movement of goods; and
- Walkable mixed-use communities.

While there are benefits of the STS Vision, there are also costs. For example, building infrastructure and providing services necessary to make multimodal travel options available would be costly. The total magnitude and effect of the various costs on Oregon's economy could not be predicted because of the uncertainty of economic changes across the nation and world and technological and social changes that occur. These things are very uncertain, and therefore, the STS's pathway forward requires a flexible approach that allows for change.

STS Implementation

By accepting the STS on March 20, 2013, the OTC agreed that the general course of action presented in the STS, for reducing transportation related emissions, is in line with fulfilling the legislative requirements and that the strategies should be further considered. Before any one strategy or group of strategies move forward, however, further buy-in may be required from appropriate decision making groups, including not only the OTC but other public and private sector bodies as well. Some strategies are well understood and are likely to have a high-degree of political acceptance, which can then be acted on quickly. Other strategies, however, will require additional exploration to better understand economic and societal impacts, and if, when, or how it should be pursued. An STS Implementation Plan (i.e. ODOT work plan) will be developed detailing potential next steps, including an approach to monitoring progress.

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[52] The Governor's 10-Year Energy Action Plan can be accessed at the following website: http://www.oregon.gov/energy/pages/ten_year/ten_year_energy_plan.aspx.

Oregon is already pursuing some of the strategies in the STS, but the STS identifies ways to augment and build on the good work already being done and planned, and provides additional and new approaches to consider. Current local and regional plans provide a strong foundation for achieving GHG emissions reductions. Additionally, cities and counties in Oregon are already implementing many of the elements to achieve other economic, social or environmental goals. Lastly, industries and companies are making business-driven decisions that have an added co-benefit of emissions reduction. The work that has been done and ongoing efforts provide a foundation to build on as Oregonians move forward to further reduce transportation related GHG emissions.

As some of the strategies may be controversial, especially in the short-term, a key to success of the STS will be public acceptance and support that result from participation in implementation planning. Transportation related GHG emissions reduction will require strong partnerships and close collaboration between jurisdictions at the local, regional, state and national levels as well as with businesses and individuals.

Potential Impacts of the Statewide Transportation Strategy

The STS looks out 40 years into the future to the year 2050. In projecting out so far, there are many uncertainties and unknowns. However, through modeling, analysis, and consultation with experts and stakeholders a relative picture was drawn to better understand what the future may look like with and without the STS. Precise projections could not be established but the amount of GHG emissions could be well approximated.

Greenhouse Gas Emissions Results

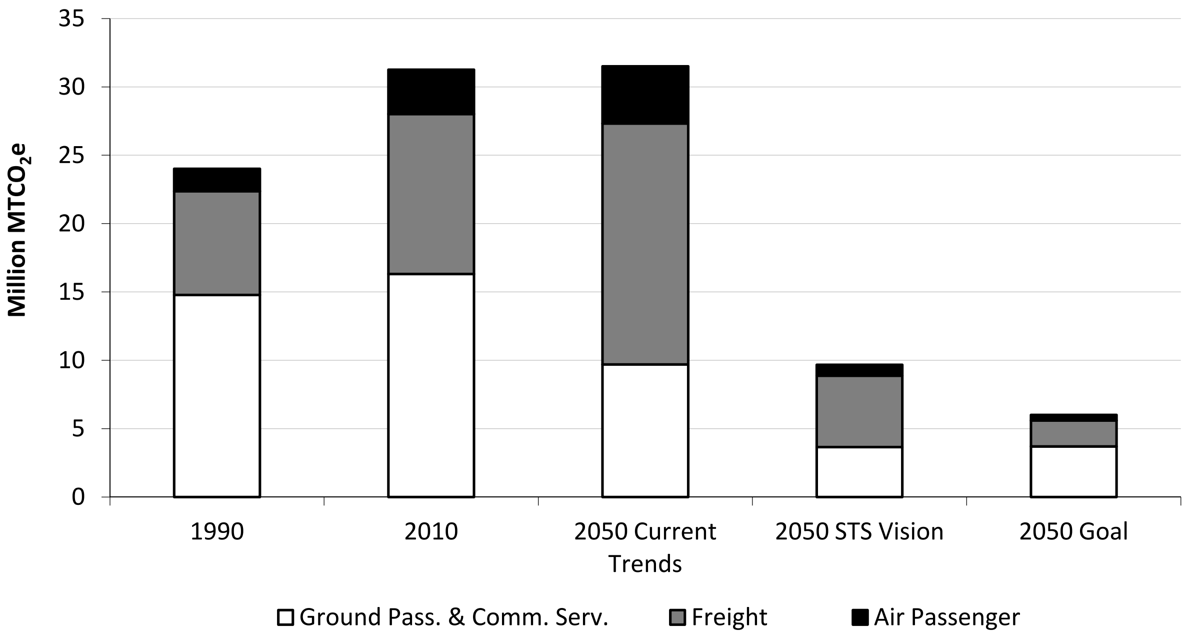
The STS attempts to explore all aspects of the transportation system, including the movement of both people and goods over short and long distances. Three distinct travel markets are identified for the purposes of analyzing GHG emissions: 1) Ground Passenger and Commercial Services Travel Market, 2) Freight Travel Market, and 3) Air Passenger Travel Market.

Combined, the STS strategies are projected to achieve a 60 percent total reduction (81 percent per capita) in transportation-related GHG emissions by 2050, as compared to 1990 levels. Although the STS Vision by itself would not achieve the legislative goal of reducing GHG emissions by 75 percent[53], the reduction would be substantial and would be a marked change in course from current trends.

Figure 3 compares estimated 1990 GHG emissions by travel market segment with 2050 projections for the continuation of current trends, the STS Vision, and what emissions would be if each transportation market segment reached the State's 2050 goal.

[53] The STS recommendations, together, do not meet 2050 legislative GHG reduction goals. However, the GHG reduction goals are not sector-specific, so a lesser reduction in transportation might be offset by a greater reduction in another sector (e.g., power generation). Failing to meet the state's reduction targets in the power generation sector would result in higher emissions attributed to electric and hybrid-electric vehicles, though advancements in technology could enable greater reductions than current technology allow.

Figure 3: Transportation sector greenhouse gas emissions trends, past and projected[54]



As Figure 3 shows, reductions in transportation-related GHG emissions are anticipated for the Ground Passenger and Commercial Services travel market even under current trends. The STS Vision identifies the potential for additional emission reductions from future improvements to vehicle fuel economy; cleaner fuels; alternative energy sources (electric vehicles); walkable, mixed-use land configurations; transportation mode options; and efficiencies in the transportation system. The ability to pair these actions with existing trends allows opportunities for greater reductions in the Ground Passenger and Commercial Services travel market than can be achieved in the other two travel markets. The STS Vision for Ground Passenger and Commercial Services leads to GHG emission reductions around 75 percent below 1990 levels. The relative effect can be seen in Figure 5 by comparing the STS Vision share with the results needed to meet the State's 2050 goal.

Unlike the Ground Passenger and Commercial Services travel market, GHG emissions from the Freight and Air Passenger travel markets is expected to grow. The growth of freight emissions is outpacing the other two markets. Moreover, freight emissions are not limited by saturation in the ownership or use of a particular transportation mode. Freight travel will grow as long as current consumption activities and trends continue and trading distances increase. There are similar challenges for reducing air passenger emissions. Air travel is growing in market share and there are inherent difficulties in improving the fuel economy of airplanes.

Under the STS Vision, the emissions of the Freight and Air Passenger travel markets, though substantially reduced, would not be reduced enough to meet the State's 2050 goal. Further reductions

[54] Oregon Department of Transportation, *Oregon Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Emissions Reduction (Volume1)*, March 2013.

in freight GHG emissions will take more than transportation sector actions. It is unlikely that freight emissions could be reduced sufficiently by factors that are under the control of freight carriers, vehicle manufacturers, and others in the transportation sector. Achieving a 75 percent reduction in freight emissions will require a broader effort that addresses the efficiency with which consumer and manufacturing materials are used and the total amount of materials used.

These unpaid costs include the health and environmental impacts caused by motor vehicle pollution (including GHG emissions) as well as the costs of maintaining secure petroleum fuel sources, among other things. This results in marketplace distortions and inefficient uses of resources. A "user pays true cost" approach ensures that less efficient modes are responsible for the true cost of their impacts to the transportation system and environment.

III. Materials Management in Oregon: 2050 Vision and Framework for Action

The Environmental Quality Commission adopted "Materials Management in Oregon: 2050 Vision and Framework for Action" in December of 2012. While serving in part as a statutorily-required update to Oregon's statewide solid waste management plan, the 2050 Vision signals a fundamental shift in approach away from the historic but limited focus on managing wastes. Instead, the 2050 Vision proposes using actions across the full life cycle of materials to manage the impacts of materials across their full life cycle, including waste recovery and disposal but also design and extraction, manufacturing, consumption, and use.[55]

Materials matter, contributing as much as 48 percent to Oregon's 2010 greenhouse gas emissions, when viewed through the accounting framework of consumption. The 2050 Vision addresses both materials made in Oregon as well as those used in Oregon. Its scope includes greenhouse gas emissions, but also addresses other pollutants as well as social and economic concerns. The 2050 Vision references the Global Warming Commissions Interim "Roadmap to 2020", and incorporates many of the Roadmap's important recommendations specific to materials.

The 2050 Vision describes a state where "Oregonians produce and use materials responsibly – conserving resources – protecting the environment – living well." As part of that vision, Oregonians live within the limits of our sustainable share of the world's natural resources, including the environment's ability to absorb the impacts of pollution. The release of greenhouse gases and other pollutants are minimized, the resiliency of natural systems is maintained, and all Oregonians have access to a prosperous and clean economy that allows them to live fulfilling lives.

The accompanying Framework for Action includes pathways to lead Oregon to achieving the Vision, including foundational goals and research, policies and regulations, collaboration and partnerships, and education and information. The Framework for Action includes actions across the full life cycle of materials. Examples include establishing new goals for sustainable materials management, focusing on high-impact materials and processes, advancing carbon and other environmental footprinting of

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[55] Materials Management in Oregon2050: Vision and Framework for Action, Oregon Department of Environmental Quality, December 2012.

products, advancing product stewardship by brand owners, implementing environmental standards for high-impact products, supporting collaborative and sustainable consumption, advancing "net zero" buildings, changes to state procurement and building codes, and increasing waste recovery in order to achieve the highest and best next use of discarded materials.

IV. Oregon Integrated Water Resources Strategy

The Oregon Water Resources Commission adopted the State's first Integrated Water Resources Strategy[56] on August 2, 2012. The Strategy provides a blueprint to help the State better understand and meet its instream and out-of-stream needs, taking into account water quantity, water quality, and ecosystem needs. The IWRS makes recommendations in 13 different issue areas with two of its recommended actions specific to climate change. The discussion of those recommendations is excerpted below.

> *Oregon should continue collaborating with existing climate change research organizations and institutions to improve climate change projections at a basin scale. Basin-scale data is needed to help Oregonians begin preparing responses and strategies to address climate change.*
>
> *Collaboration includes working with the Oregon Climate Change Research Institute and Pacific Northwest Climate Impacts Research Consortium on basin-specific studies. Oregon's natural resource agencies at the local, state, and federal level should invest and make improvements in the long-term monitoring of surface water and groundwater resources, including the NRCS's SNOTEL network.*
>
> *Investments are also needed to improve the real-time forecasting of water deliveries, basin yields, monthly streamflow, flood frequency projections, and drought frequency projections. Oregon needs to develop reliable climate change projections for hydrology at a basin scale, and determine the associated impacts to built and natural systems, such as:*
>
> - *the flooding potential with precipitation arriving as rain instead of snow;*
> - *the effects on groundwater recharge from loss of snowpack;*
> - *changes in timing and streamflow as well as potential impacts to water quality;*
> - *the impacts on various life stages of aquatic species, including species abundance and distribution;*
> - *changes in municipal and agricultural demand, shifts in water-related infrastructure needs (e.g., treatment, storage, transmission); and*
> - *the impacts on wetland and floodplain restoration efforts.*

Recommended Action 5.A: Support Continued Basin-Scale Climate Change Research Efforts

- Improve climate change projections at a basin scale
- Develop reliable projections of basin-scale hydrology, and their impacts on other systems

[56] Oregon's Integrated Water Resources Strategy, Oregon Water Resources Department, August 2012.

Recommended Action 5.B: Assist with Climate Change Adaptation and Resiliency Strategies

- Provide support to communities to incorporate climate change into their planning decisions
- Look for more efficient ways to conserve, store, and reuse water in anticipation of climate change
- Invest and make improvements in surface water and groundwater monitoring
- Invest in real-time forecasting of water deliveries, basin yield, streamflow, flood and drought frequency projections
- Analyze how instream and out-of-stream water rights will fare with hydrologic changes
- Analyze how water rights will fare with changing crop needs
- Use the U.S. Environmental Protection Agency's Climate Ready Water Utilities Program
- Increase ecosystem resiliency to climate change
- Ensure continued water and wastewater services in a changing climate

V. Oregon Department of Transportation Adaptation Planning

The State of Oregon and ODOT have been engaged in climate change adaptation planning since 2008. In 2011, ODOT worked with scientists from the Oregon Climate Change Research Institute (OCCRI) to take a closer look at impacts specific to the transportation system. This preliminary scientific information was shared with ODOT staff in all aspects of the agency, from Bridges to Geo-hydro. Based on input from OCRRI, other state agencies and ODOT's experience in the field, ODOT published the *Climate Change Adaptation Strategy Report*[57] (Adaptation Strategy) in April of 2012, with the Oregon Transportation Commission's approval.

The Adaptation Strategy provides a preliminary assessment of climate change impacts on ODOT's assets and system operations, and underlines the need for a vulnerability assessment and long-term adaptation. ODOT is currently doing a state-wide vulnerability assessment which is based on GIS layers of both ODOT's assets and existing conditions, and future scenarios. In 2013, FHWA announced that it would fund ODOT's work in order to conduct a pilot on the North Coast of Oregon:

ODOT's pilot will use the climate science and asses data from ODOT's vulnerability assessment and scale it to the northern coast of Oregon. From this work ODOT will develop a corridor specific Coastal Hazards Adaptation Implementation Plan for the Clatstop Region. ODOT plans to collaborate with other local and state agencies as part of Coastal Community Resilience Network Pilot, led by DLCD. A key part of this work will be for ODOT to identify strategies to address infrastructure that is highly vulnerable and at risk. The work is planned for completion by the end of 2014.

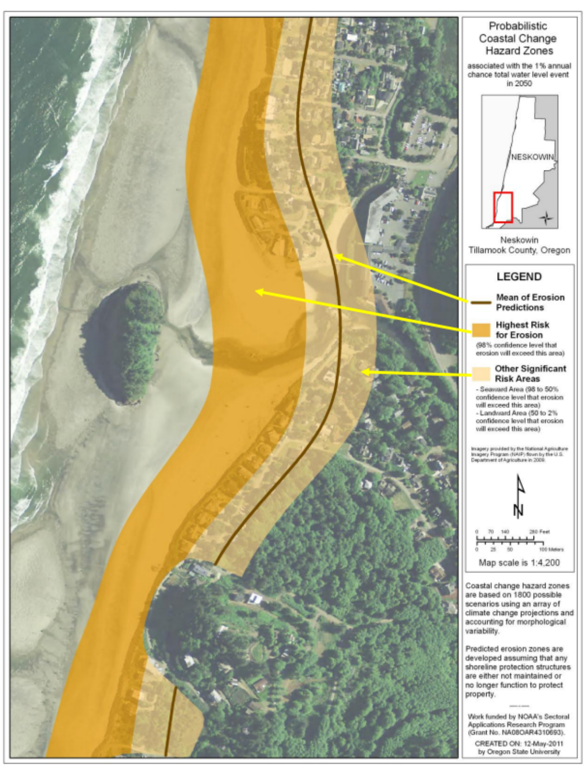
[57] http://www.oregon.gov/ODOT/TD/CLIMATECHANGE/Pages/cc_adaptation.aspx

CLIMATE CHANGE SOLUTIONS

Neskowin has lost 50 meters of beach between 1998 and 2008 as the normal cycle of winter erosion and summer restoration of sand has been disrupted, at least in part, by climate change.

Neskowin is taking action by combating erosion and dune corruption through the construction of riprap along the shoreline. Riprap is a shoreline revetment, typically built out of stone or rock intended to protect the shore against erosion. Currently, 85 percent of the shoreline from Cascade Head to North Neskowin has riprap constructed along it, up from 15 percent in 1967.

The Neskowin Coastal Hazard Committee (NCHC), formed in 2009, acknowledges that climate change is affecting wave height, storm intensity, and sea level. In 2010, Tillamook County received a grant from the Oregon Department of Land Conservation and Development to develop a plan identifying areas subject to coastal erosion and an adaptation plan. Neskowin was identified as a high priority area for the county. The committee has also developed the "Adapting to Coastal Erosion Hazards: A Plan for the Community of Neskowin," which details actions to be taken to adapt to the potential future changes in the Neskowin coastal area.



Beginning the late 1990s residents noticed that winter storm waves occasionally would wash over the top of the revetment damaging the riprap and the property it was built to protect. With winter wave heights increasing, residents have begun to question whether to fortify the riprap with an overtopping seawall construction. However, implementation of these larger structures has yet to occur on a great scale and require an Ocean Shoreline Alteration permit from the Oregon Parks and Recreation Department.

Neskowin acknowledges that riprap is a temporary, short-term adaptation solution with a design life of 20-25 years and is searching for the most effective, long-term solution to shoreline and beach protection for future generations.

PROGRESS TOWARD OREGON'S CLIMATE CHANGE GOALS

I. Oregon Greenhouse Gas Emissions: Multiple Perspectives

The manner in which Oregon residents, businesses, governments, and other entities contribute to greenhouse gas emissions span nearly all activities that Oregonians engage in. These emissions occur both in-state and out-of-state, and as a consequence of both production and consumption. No single emissions accounting method adequately captures all of the emissions. As a result, no single approach to inventorying greenhouse gas emissions at the state level is necessarily the "right" method for all contexts. As noted in the Commission's last report to the legislature, different inventory approaches have been under development by different agencies for some time. Most recently, a technical report was produced by the Oregon Departments of Environmental Quality, Energy, and Transportation which represents the first attempt by a state government to provide a greenhouse gas inventory using multiple emission accounting methodologies. Three separate inventories were developed for the report with a primary focus on the year 2010, but also with varying historical data included depending on the inventory approach. These three inventory approaches are as follows:

1. **In-boundary emissions**: Emissions that occur within Oregon's borders and emissions associated with the use of electricity within Oregon. For the year 2010 this inventory combines for the first time the "top down" modeling and estimation data which has historically comprised the Oregon greenhouse gas inventory with "bottom up" data reported to the State from emitting facilities and energy providers as part of the State's greenhouse gas reporting program.
2. **Consumption-based emissions**: Global emissions associated with satisfying Oregon's consumption of goods and services, including energy. This inventory includes life-cycle emissions associated with the food, vehicles, appliances, furnishings, electronics, other goods, services, fuels and electricity that comprise final demand.
3. **Expanded transportation sector emissions**: An expanded evaluation of the emissions associated with the transportation sector using life-cycle emissions from fuel use by ground and commercial vehicle travel, freight movement of in-bound goods by all other modes of transportation (heavy trucks, railroads, ships, airplanes, and pipelines), and air passenger travel.

Key portions of the multi-agency inventory report have been excerpted below, and the data that comprise the "in-boundary" inventory are contained in Appendix 2 of this report. Those interested in more information are encouraged to read the full inventory report, *Oregon's Greenhouse Gas Emissions Through 2010: In-Boundary, Consumption-Based and Expanded Transportation Sector Inventories*, and the technical appendices associated with the report. [58]

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[58] Oregon's Greenhouse Gas Emissions Through 2010: In-Boundary, Consumption-Based and Expanded Transportation Sector Inventories, Oregon Departments of Environmental Quality, Energy, and Transportation, July 18, 2013.

II. In-Boundary and Electricity Use Emissions Inventory

1. Inventory Overview

Oregon's in-boundary and electricity use inventory estimates greenhouse gas emissions that occur within the State's jurisdictional boundary and that are associated with the generation of electricity used by Oregonians within that boundary. This inventory includes emissions from the combustion of fuel used in Oregon, the processing and disposal of waste and other materials, the generation and transmission of electricity used in Oregon, agricultural and industrial operations, and as a result of a variety of other processes. Most of these emissions occur within the State, though some electricity used by Oregonians is generated out of state, and the emissions from this out of state generation are included in this inventory. Similarly, emissions from electricity generation occurring in Oregon that is used out of state are presented separately and not included in the statewide emission totals of this inventory.

The 2010 in-boundary inventory was conducted by ODOE and DEQ using data collected by DEQ through the Greenhouse Gas Reporting Program, output and analysis generated by ODOE using the US EPA State Inventory Tool (SIT), and other estimates generated by DEQ. Greenhouse gas emissions reported to DEQ represent a new source of "bottom up" emissions data that improve the accuracy of efforts to track Oregon's greenhouse gas emissions. The data reported to DEQ includes actual fuel volumes and electricity supplied in Oregon and emissions from industrial facilities. The reported data were integrated with the "top down" inventory data that ODOE has historically compiled using the SIT, creating a combined "bottom up" and "top down" inventory for 2010.

The "top down" inventory is based on a wide range of modeling, estimation, and quantification techniques using energy, agricultural, waste, and socioeconomic data. Integrating the two approaches provides a more comprehensive inventory because it contains estimation and modeling of emissions in certain sectors not fully covered by the reported data. For example, emissions from agricultural activities are not reported to DEQ, but are provided through the inventory work done by ODOE using statistics from the Oregon Department of Agriculture and the modeling tools available through the SIT. Finally, all of the historical data from 1990 to 2009, which is derived largely from the SIT and custom analysis work done at both ODOE and DEQ, was combined with the 2010 data to create a complete time series of greenhouse gas emissions data from 1990 through 2010.

1. In-Boundary Emissions

Following is a discussion of the 2010 inventory, how it compares with prior years, and how the new reported data differ from the modeled estimates. First, we compare key economic sectors and their trends in recent years, and then we examine the sectors in greater detail. ODOE has developed the in-boundary inventories for Oregon from 1990 through 2009. This 2010 inventory is the first to use the data reported to DEQ's greenhouse gas reporting program as the primary basis for measuring emissions.

Table 8: Oregon emissions by sector, 1990 – 2010 (Million MTCO2e)

Sector	1990	1995	2000	2005	2006	2007	2008	2009	2010
Transportation	21.0	22.5	24.3	24.7	25.2	25.7	24.2	24.0	22.6
Residential & commercial	16.3	19.7	22.9	23.7	22.4	24.1	24.1	23.4	22.3
Industrial	14.1	16.9	18.1	14.3	14.3	14.4	14.0	12.4	12.4
Agriculture	4.8	5.2	5.1	5.5	5.7	5.7	5.3	5.0	5.4
Total	**56.2**	**64.4**	**70.3**	**68.3**	**67.6**	**69.9**	**67.6**	**64.8**	**62.8**

Table 8 summarizes greenhouse gas emissions by economic sectors since 1990. Transportation remains the largest contributor to the State's in-boundary emissions, closely followed by residential and commercial activities. The industrial sector is the third largest contributor, with about half the emissions associated with the transportation or the residential and commercial sectors. Finally, agricultural activity is a distant fourth. Overall, emissions have declined approximately eight percent or 5.5 million$MTCO_2e$ between 2005 and 2010.

Figure 4: Oregon in-boundary greenhouse gas emissions by sector, 1990 - 2010

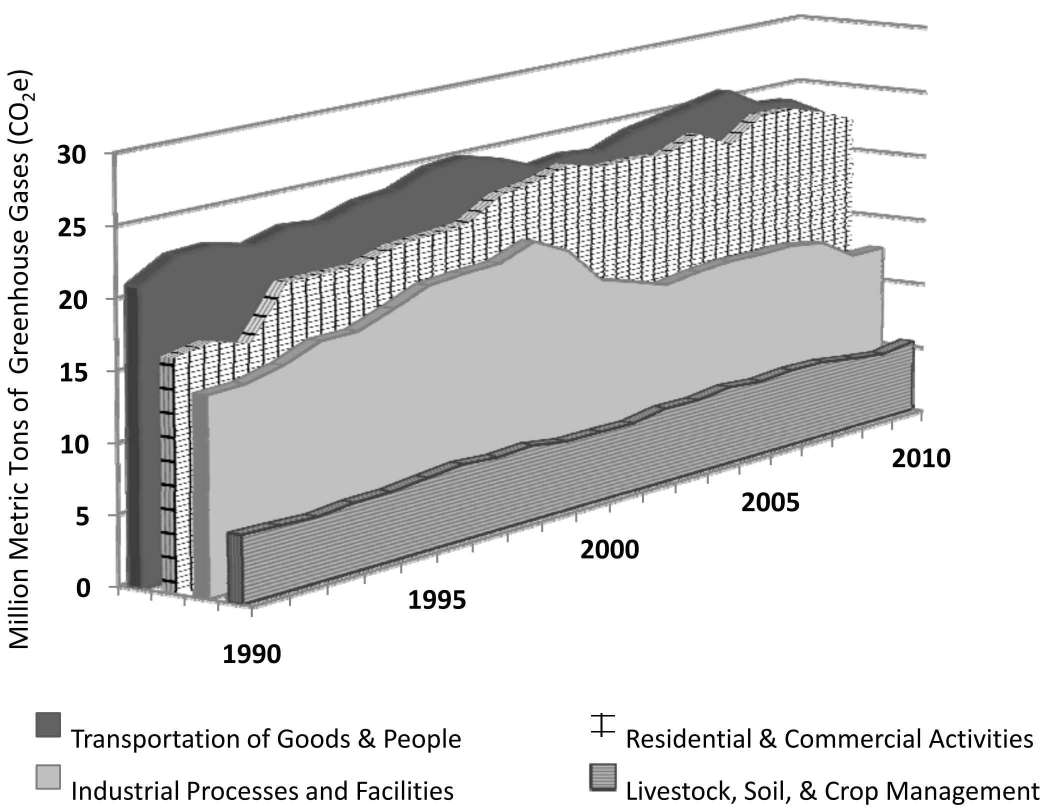
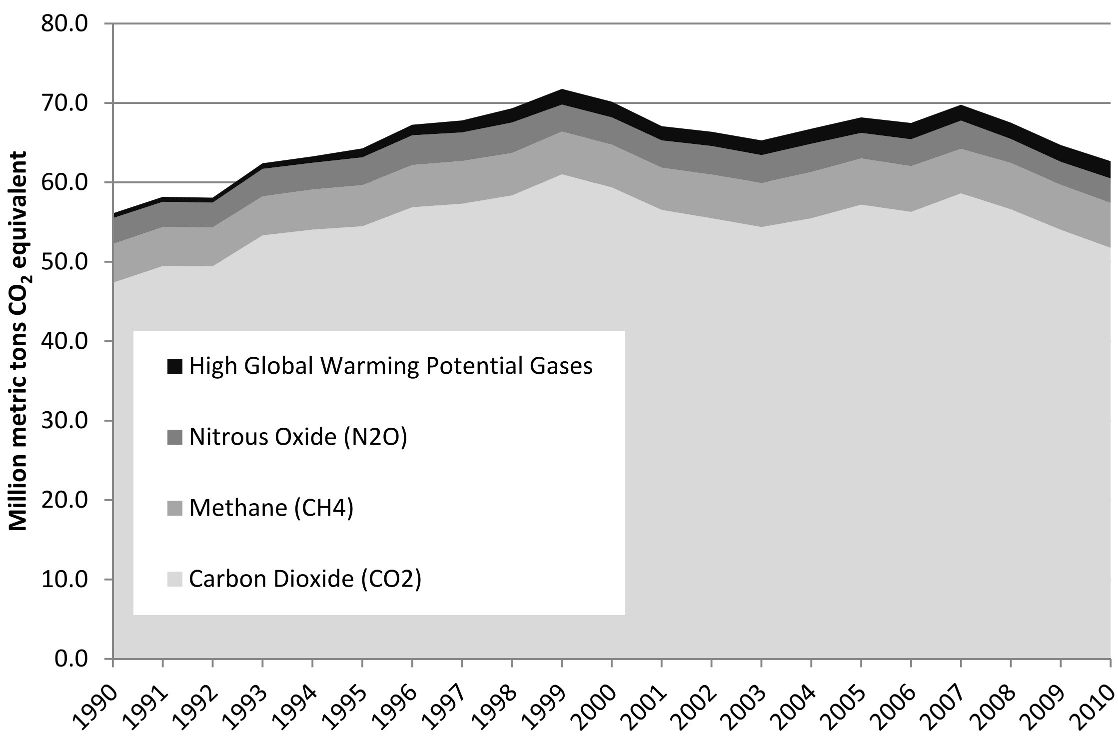


Figure 4 illustrates how the State's emissions have changed in each economic sector since 1990. Emissions from agriculture have been somewhat constant, at slightly above 5 million $MTCO_2e$ each year. The transportation sector has fluctuated just above 20 million $MTCO_2e$, while the residential and commercial sector has grown from approximately 16 million $MTCO_2e$ in the early 1990s to over 20 million $MTCO_2e$ in 2000, and remained somewhat constant from 2000 to 2010. The industrial sector's emissions rose gradually through the 1990s to a peak in 1999 of 19.3 million $MTCO_2e$, and declined most years since then, and were just 12.4 million $MTCO_2e$ in 2010.

Figure 5 illustrates how the State's emissions have changed since 1990 by the relative contribution of each greenhouse gas type. The relative contributions of carbon dioxide, methane, and nitrous oxide have been somewhat constant, comprising 82.6 percent, 9 percent and 5 percent of the total emissions in 2010, respectively. High global warming potential gases, composed of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) have risen from about one percent of the State's emissions in the early 1990s to over three percent in 2010. This increase can be partially accounted for by the rise of the electronics manufacturing industry in Oregon and the increased use of air conditioning in Oregon.

Figure 5: Oregon in-boundary emissions by greenhouse gas type



Emissions from the transportation sector

Emissions attributed to transportation are primarily from fuel used by on-road vehicles, including passenger cars and trucks, as well as freight and commercial vehicles. This sector also includes aviation fuel and off-road transportation such as farm vehicles, locomotives, and boats.

Figure 6: Oregon emissions from transportation fuel use

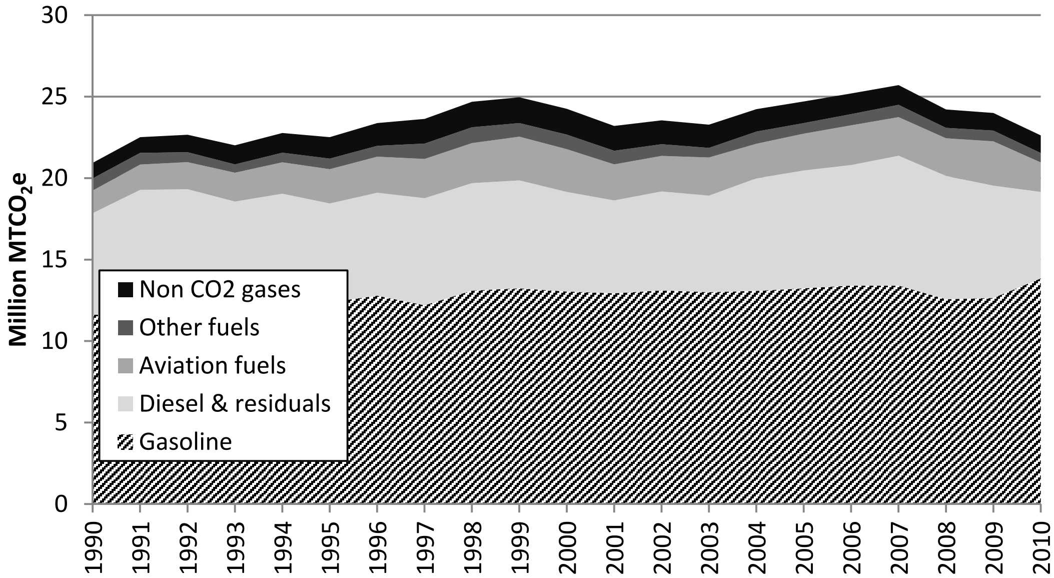


Figure 6 illustrates how the State's emissions from transportation fuel have changed since 1990 by the relative contribution of each fuel type. Non CO_2 gases include methane and nitrous oxide that are by-products of fuel combustion and fluorinated gases with high global warming potential from air conditioning and other auxiliary systems on vehicles. The other fuels category includes propane, natural gas, lubricant emissions and electricity. Aviation fuels include kerosene jet fuel, aviation-grade gasoline, and naphtha jet fuel. Diesel & residuals include all distillate and residual fuels used for transportation.

Total emissions from transportation have changed modestly between 1990 and 2010. During this period, emissions peaked in 2007 at 25.7 million $MTCO_2e$, and have since declined 12 percent to 22.6 million $MTCO_2e$. It is important to note the shift in fuel proportions from 2009 to 2010 for gasoline and diesel fuels. The 2010 data are from reports by companies that supply fuel in Oregon, while the 2009 data are estimates from EPA's State Inventory Tool based on data from the EIA. The reported data show an increase in emissions from gasoline use from the 12.7 million $MTCO_2e$ estimated by EPA's SIT model for 2009 to 13.9 million $MTCO_2e$ in 2010. Conversely, the reported data show a decrease in emissions from diesel use from 6.5 million $MTCO_2e$ estimated by the SIT for 2009 to 5.0 million $MTCO_2e$ in 2010. The reported data should be more accurate than estimates from SIT, but it's possible that some of the changes in emissions from 2009 to 2010 are partly due to changes in methodology, from "top down" quantification techniques to "bottom up" reported data. DEQ is working to ensure companies report fuel volumes and emissions correctly. If DEQ discovers changes to the reported data or ways to improve the accuracy of the data, it will update the values in this inventory.

1. Residential and commercial activities

Emissions from residential and commercial activities come primarily from generation of electricity and natural gas combustion to meet the energy demand from this sector. Other sources of emissions from this sector include small amounts of petroleum fuels burned primarily for heating, decomposition of waste in landfills, waste incineration, wastewater treatment, and fugitive emissions associated with the distribution of natural gas and from the fertilization of landscaped areas. Fluorinated gases from refrigerants, aerosols, and fire protection are also a small but increasing source of emissions from this sector.

Figure 7: Oregon residential and commercial emissions from electricity, natural gas, and petroleum use

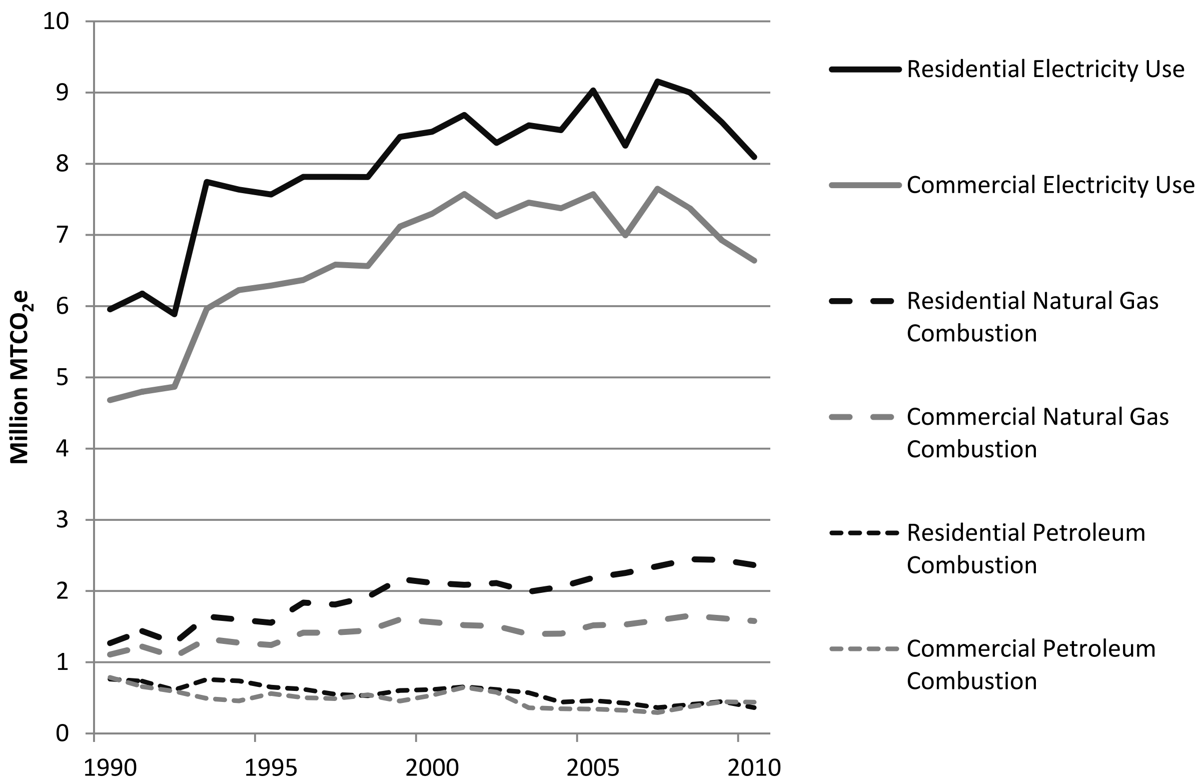
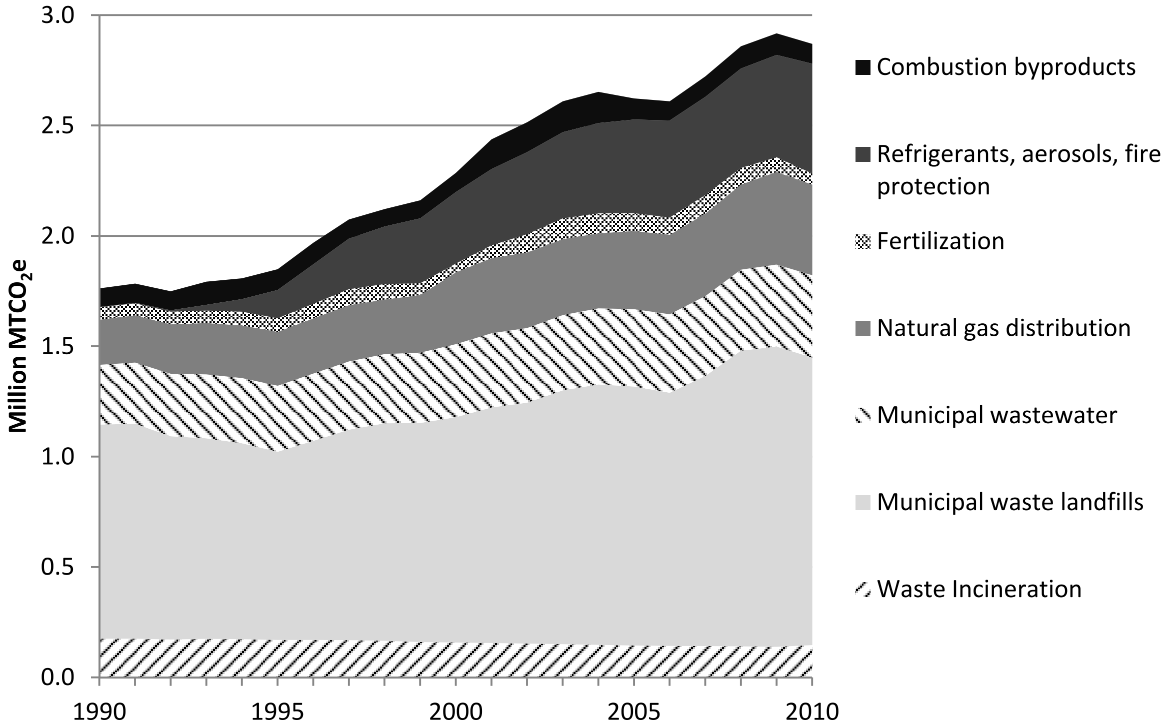


Figure 7 illustrates how the State's emissions from electricity, natural gas, and petroleum use in residential and commercial activities have changed since 1990. Emissions from residential and commercial electricity use have followed a similar trend during this period, with residential use consistently between one and two million $MTCO_2e$ higher each year. Annual variation in weather influences both electricity demand and the supply of renewable energy from wind and hydro sources. Thus, it is important not to interpret too much from changes year-to-year and to assess these data for broad trends. Emissions associated with electricity use rose during the 1990s, and have generally leveled off since 2000 with annual fluctuation. The combined emissions from natural gas and petroleum use in residential and commercial activities are approximately one third of the emissions from electricity generation. Residential and commercial petroleum use has slowly declined and natural gas use has gradually increased.

Figure 8: Oregon emissions from other residential and commercial activities

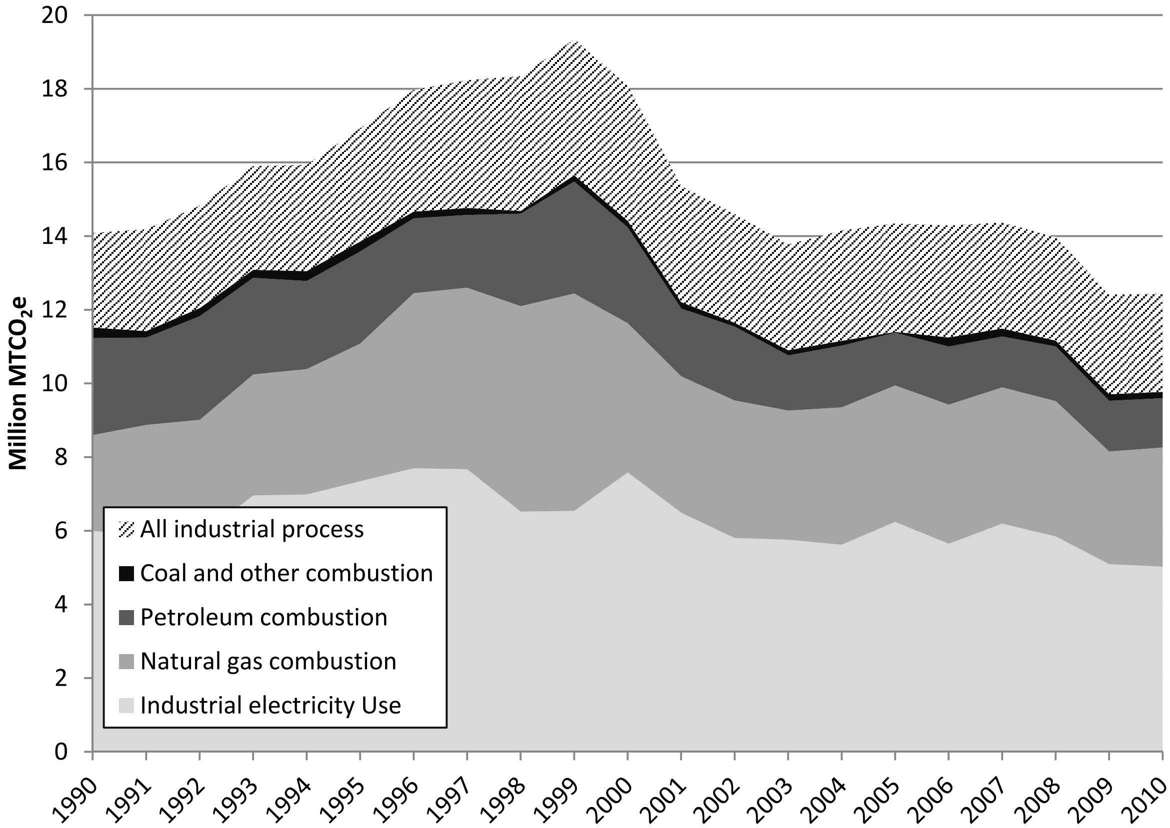


In addition to emissions from energy demand shown in Figure 7, Figure 8 illustrates the change in emissions from other residential and commercial activities since 1990. Emissions of fluorinated gases from refrigerants, aerosols, and fire protection use have increased steadily from less than 0.1 million $MTCO_2e$ in 1990 to 0.5 million $MTCO_2e$ in 2010. Emissions from municipal waste landfills have also increased, from 1 million $MTCO_2e$ in 1990 to 1.3 million $MTCO_2e$ in 2010. Emissions from most other residential and commercial activities shown in this figure have remained approximately the same between 1990 and 2010.

2. Industrial activities

Similar to residential and commercial activities, emissions from the industrial sector come primarily from electricity generation and natural gas combustion. Emissions from petroleum combustion have declined since the late 1990s largely because many facilities transitioned from distillate fuels to natural gas and from structural changes in Oregon's industrial base. Emissions from coal combustion are nominal as there are very few facilities in Oregon using coal onsite. Emissions from coal used to generate electricity, such as PGE's facility in Boardman, Oregon are excluded from this section and data on in-state power generation is available in Appendix 2: Oregon "In-Boundary" Greenhouse Gas Inventory Data 1990-2010.

Figure 9: Oregon emissions from industrial processes and fuel use



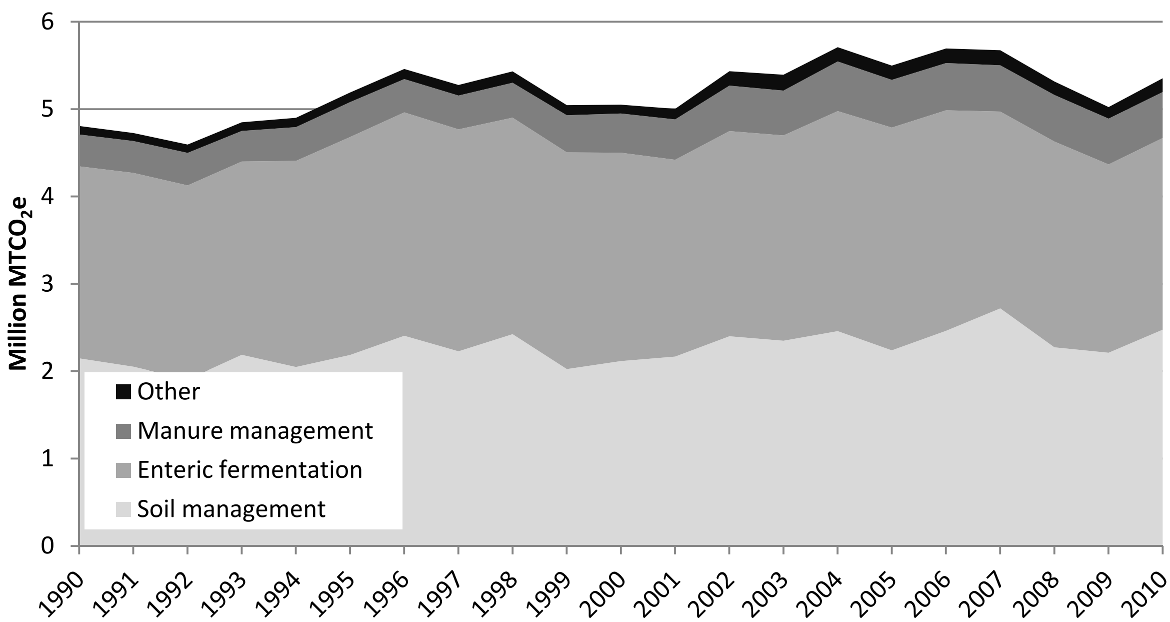
Certain industries emit greenhouse gases from processes other than fuel combustion. In Oregon, these industrial processes are chiefly cement manufacturing, pulp and paper manufacturing, and semiconductor manufacturing. Emissions from these processes collectively account for approximately 2.5 million $MTCO_2e$ in 2010, which is about four percent of Oregon's total in-boundary emissions.

Changes in emissions from 2005 to 2010 could be due to different methodologies, in addition to actual changes in emissions. DEQ's reporting program is designed to more accurately reflect Oregon's emissions than estimates from EPA's SIT used prior to 2010. In some cases, EPA's tool estimates states' emissions as a portion of the national data collected by EPA. Sometimes the state level appropriation of these emissions has proven to be inaccurate now that source-level reporting is available from the Oregon Greenhouse Gas Reporting Program. For example, the SIT has estimated a small amount of emissions in Oregon from aluminum production, while the reported data confirm there are no emissions as there is no known aluminum production occurring in the State. In a few cases where the SIT is unable to provide historical estimates of emissions the results from the 2010 inventory are applied to all years so that there is at least an estimate of those emissions through the entire time series. In the future it is hoped that these data, as well as all of the historical industrial process data, can be refined and improved by the higher quality data from the Oregon Greenhouse Gas Reporting Program.

3. Agriculture

Agricultural activities have consistently accounted for approximately 5.5 million $MTCO_2e$ since the mid 1990s. In contrast to other sectors, most of these greenhouse gas emissions are from methane and nitrous oxide rather than carbon dioxide. Slightly more than 2 million $MTCO_2e$ is from methane that results from enteric fermentation (i.e. digestion of feed from livestock). About 2 million $MTCO_2e$ is from nitrous oxide, estimated from nitrogen-based fertilizers used for soil management. Methane and nitrous oxide from management of livestock manure have accounted for roughly 0.5 million $MTCO_2e$ since 2000. Other agricultural sources of emissions, including urea fertilization, liming of soils, and residue burning, produce less than 0.2 million $MTCO_2e$.

Figure 10: Oregon emissions from agriculture



III. Consumption-Based Inventory

1. Inventory Overview

Oregon's consumption-based emissions inventory estimates the global emissions of greenhouse gases associated with satisfying Oregon's consumption of goods and services (including energy). Consumption is defined in economic terms consistent with "final demand" of goods and services by Oregon households, government (federal, state, and local) facilities located in Oregon, and one small category of business expenditures: investment (including capital and inventory formation). This inventory includes global emissions associated with the wide range of “stuff” that Oregonians purchase, including food, vehicles, appliances, furnishings, and electronics, as well as services, fuels and electricity. Consumption-based greenhouse gas emissions are included in this inventory regardless of whether they physically originate in Oregon or elsewhere.

The consumption perspective is informative because, in economic terms, consumption is the root driver of all economic activity. By extension, understanding the emissions associated with Oregon's consumption provides valuable perspective on root drivers of greenhouse gas emissions. The consumption-based inventory also compliments other inventory perspectives. For example, while the in-boundary inventory described in Chapter 2 estimates the energy used by Oregon buildings, the consumption-based inventory shows the emissions associated with producing the materials and furnishings used during construction and remodeling.

The consumption-based inventory reveals additional information about emissions. It estimates the emissions associated with all government procurement. It includes life cycle emissions of goods and services (including electric power and fuels) consumed in Oregon, and explores where in the life cycle, and where in the world, most of these emissions actually occur. It can be used to understand how households with different consumption patterns – and incomes – contribute to climate change, as well as the relative "emissions intensity" (emissions per dollar spent) for different types of consumption. The inventory, and the underlying analysis that informs it, may be used to help prioritize consumer actions, to communicate to consumers how they contribute to emissions, and to help businesses better understand the average carbon footprints of different types of products.

Changes in the atmospheric concentration of greenhouse gases associated with land-use change are not included in the consumption-based inventory. For example, carbon storage by regional forests, or carbon releases as tropical forests are replaced with plantations are not included. Emissions that originate from sources inside Oregon are also not included if they don't contribute to satisfying consumption by Oregon, as Oregon businesses produce many goods and services that are exported for consumption elsewhere.

The 2010 consumption-based inventory builds on a 2005 inventory that was developed under contract by Stockholm Environment Institute's US Center. Reports associated with the 2005 inventory (which was completed and published in 2011) are available on DEQ's website. The 2010 consumption-based inventory was conducted in-house by DEQ staff, with some changes to data sources and methodology, as documented in Appendix B. More information on the general approach and methodology are also provided in Appendix B and these previously published reports.

Consumption-based inventories have only been developed for Oregon for calendar years 2005 and 2010. A 1990 baseline estimate has not been developed. DEQ plans to update the full consumption-based inventory at least every five years (for 2015, 2020, etc.). Simpler estimations of the consumption based inventory may be developed for intervening years.

2. Classification of emissions

The model used to construct the consumption-based inventory produces complex results. Certain variables, some of which can be aggregated or disaggregated for varying amounts of detail, allow the emissions from consumption to be shown in different ways. Before presenting the results, it is important to describe the classification systems that afford this flexibility. These classifications fall in to four categories:

- ***Type of consumer***: Emissions are estimated for four different categories of consumption (household, federal government, state/local government, and investment)
- ***Commodity type***: 440 different commodities are grouped into 62 subcategories, 16 categories, and 4 meta-categories (materials, services, fuel, and electricity). For example, the commodity "computers" is part of the subcategory "computers and peripherals", which is in the "electronics" category. It is classified as a "material". In contrast, the commodity involving internet service providers, while also part of the "electronics" category, is assigned to the subcategory "computer service and equipment" and the meta-category of "services."
- ***Life-cycle phase***: Emissions are further divided into five life-cycle phases (production, pre-purchase transportation, wholesale/retail, use, and post-consumer disposal).
- ***Location of emission***: Emissions are divided into the locations in which they occur (in-state, other-US, and foreign). The wide range of variables used in this model allow estimation of fairly specific types of emissions such as the foreign emissions associated with production of tires (one of the 440 commodities) purchased by Oregon households.

Following are further descriptions of these classification types.

Type of consumer:

- Oregon **households** purchase commodities for their final use, including goods, services, fuel for vehicles and home heating, and electricity. In 2010, 71 percent of Oregon's consumption (in dollars) came from households (up from 68 percent in 2005).[59]
- Oregon-based local, state and federal **government** entities purchase commodities including goods, services, fuel, and electricity. Oregon-based federal government activities are responsible for 4 percent of Oregon's final demand (up from 2 percent in 2005), while local and state government activities account for 13 percent (up from 12 percent in 2005). Transfer payments are not included in Oregon-based federal government activities, except to the extent that the revenue from such payments is used by Oregon households or local/state governments to engage in consumption. Federal government consumption does not include Oregon's "share" of or "contribution" to (via taxes or voting) out-of-state emissions associated with federal government activities such as foreign affairs and military activities.
- Most business purchases are not consumption, but one category is: **investment** purchases or the equipment and inventory that businesses purchase but don't sell in the same year. The inventory that firms purchase or produce and then sell in the same year create emissions that are measured in the consumption-based inventory, but these purchases do not constitute final consumption and therefore only enter into the inventory when the resulting final good is purchased by an Oregon consumer. Business investment accounts for 13 percent of Oregon's final demand in dollars, down from 18 percent in 2005. Emissions associated with construction of nonresidential buildings are included as "investment", while emissions associated with construction of residential buildings are modeled as "investment" expenses but portrayed in results as "household" consumption.

[59] Consumption is sometimes referred to as "final demand."

Commodity type:

- **Commodities:** Data are calculated and reported in 440 types of commodities. Roughly 8 percent of these commodities have no "final demand" in Oregon, that is, Oregon's consumers do not purchase these products; instead, many products have an "intermediate" use in production and are purchased by businesses that use them to make other products, both additional intermediate products and commodities for final consumption.[60,61]
- **Sub-categories:** The 440 commodity sectors are grouped into 62 sub-categories.
- **Categories:** The 62 sub-categories are grouped into 16 categories: appliances, clothing, construction, electronics, food and beverages, furnishings and supplies, healthcare, lighting and fixtures, other manufactured goods, services, transportation services, vehicles and parts, retailers, wholesale, water and wastewater, and other.
- **Meta-categories:** The 440 commodity sectors are also grouped into 4 meta-categories: materials, services, fuels and electricity. A few commodities, such as restaurants and construction-related activities are simultaneously classified as both “materials” and “services.”

Life-cycle phase:

- **Pre-purchase phase:** The pre-purchase phase is an umbrella that includes three phases that occur prior to final purchase:
    - **Production phase:** Emissions from the manufacture of goods are classified as production phase emissions. For example, in the case of a cookie, this phase includes not only the emissions from the cookie factory itself, but also the emissions that resulted from making all of the supplies purchased by the factory, including flour, sugar, chocolate, oils, water, electricity, and packaging. For services, such as a haircut, production phase emissions include the emissions associated with providing the service (e.g., operating the hair salon) as well as emissions resulting from making all of the supplies purchased by the service provider (e.g., smocks, shampoo, scissors, brooms, electricity, water, etc.).
    - **Pre-purchase transportation phase:** Consumer products, and the supplies used to manufacture them, often make several stops on their way from factory to retail store. Transportation emissions from intermediate producer (the makers of the flour and chocolate in the cookie example above) to the final producer (the cookie factory) to wholesale warehouse to retail store are all classified as pre-purchase transportation. Transportation in the supply chain, prior to final production, is assigned to the commodity being consumed.[62] In contrast, transportation from the final producer

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60 Another 8 percent have final demand between $1 and $1,000,000, which is still very small when compared to total final demand in excess of $160 billion.

61 Considering only household consumption, approximately 34 percent of the commodities in IMPLAN’s model have no household demand. For many commodities, final demand is limited to capital and inventory purchases by businesses.

62 This represents a change in presentation of results from the original (Stockholm Environment Institute) report (2005 inventory). The 2005 inventory assigned supply chain transportation (prior to final production) to the “production” stage of the life cycle, thus mixing it with manufacturing other process-related emissions.

through wholesale to retail is assigned to the "transportation services" commodities.[63] For example, consider a bakery that purchases flour from a flour mill and ships bread to a retailer. Both sets of transportation-related emissions are assigned to the pre-purchase transportation phase. The upstream supply chain emissions (transporting wheat to the flour mill and flour to the bakery) are assigned to the commodity "bread and bakery product manufacturing". The emissions from transportation of the finished bread to the retailer are assigned to the commodity "truck transport." To be clear, emissions from post-purchase transportation (bringing the bread home from the store) are assigned to the "use" phase of vehicles, below.

  - **Wholesale and retail phase:** Warehouses and retail stores cause greenhouse gas emissions primarily from lighting, electronics and temperature control. This phase includes direct and upstream (including electricity and fuel) emissions of wholesalers and retailers. As with pre-purchase transportation, once a final good is produced, the wholesale and retail emissions are assigned to the "wholesale" and "retail" commodities. In contrast, wholesale and retail activities upstream of the final producer (for example, a law office purchasing paper from a retailer, or a manufacturer of car parts purchasing packaging from a wholesaler) are still assigned to the wholesale and retail phase, but for the final commodity being produced (e.g., legal services, vehicle parts).

- **Use phase:** Some products cause emissions when used by the final consumer. For example, heating fuel causes emissions when burned in the consumer's furnace, and gasoline causes emissions when burned in the consumer's car engine. The use phase also includes emissions associated with electricity used by consumers, such as for lighting or computers. Use phase emissions include emissions at the point of combustion, as well as supply chain emissions associated with fuels that are combusted (e.g., emissions from petroleum refineries and coal mines).
- **Post-consumer disposal phase:** The final life-cycle phase is disposal. This phase includes only the emissions that result from the post-consumer landfilling or combustion of products. This phase does not include emissions from industrial or commercial waste, which are instead classified as production emissions (but only to the extent that they occur as a result of Oregon consumption). This phase does not include any "credits" for emissions reductions resulting from recycling or composting, except to the extent that recycling and composting reduce emissions from landfilling and combustion. To the extent that materials purchased for consumption in Oregon already contain "average" levels of recycled content, these benefits are already reflected in the pre-purchase emissions.

Location of emission:

- **Oregon in-state:** emissions occurring in Oregon associated with Oregon consumption. These include upstream requirements of production for Oregon consumption but only when the intermediate products are made in Oregon.

[63] This is a consequence of the underlying economic model, which treats any consumer purchase of a finished good as four discrete purchases: one of the good itself, a separate purchase of transportation (from the final producer to the point of sale), and separate purchases of wholesaling and retailing services.

- **Other-49-state:** emissions in other U.S. states associated with Oregon consumption. These include U.S.-made upstream requirements of production for Oregon consumption.
- **Foreign** emissions are foreign production for Oregon consumption, both final production (e.g., cars) as well as production of intermediate commodities (e.g., steel) that are subsequently used in production of other goods and services.

3. Consumption-based emissions

Table 9 and Table 10 summarize Oregon's consumption-based emissions for 2005 and 2010. Emissions are shown for 16 categories (Table 9) and 4 meta-categories (Table 10). For ease of comparison and review, life-cycle stages in Table 9 are condensed from five to three, with production, pre-purchase transportation, and wholesale/retail combined into a single "pre-purchase" phase. Emissions by meta-category are also portrayed in Figure 11.

Table 9: Oregon consumption-based emissions, by category, 2005 and 2010 (Million MTCO_2e)

	2005[64]				**2010**			
	Pre-purchase	**Use**	**Post-consumer disposal**	**Total**	**Pre-purchase**	**Use**	**Post-consumer disposal**	**Total**
Vehicles and parts	2.6	13.0	<0.1	15.6	1.4	12.6	<0.1	13.9
Appliances	0.3	11.4	<0.1	11.7	0.3	11.9	<0.1	12.2
Food and beverages	8.9	*	0.3	9.2	10.1	*	0.2	10.3
Services	5.5	*	0.1	5.6	6.9	*	<0.1	6.9
Construction	5.1	*	0.1	5.2	5.3	*	0.1	5.4
Healthcare	4.0	*	<0.1	4.0	5.0	*	<0.1	5.0
Other manufactured goods	5.3	*	<0.1	5.3	4.5	*	<0.1	4.5
Transportation services	3.4	*	<0.1	3.4	3.7	*	<0.1	3.7
Electronics	2.1	1.4	<0.1	3.5	1.5	1.3	<0.1	2.8

[64] The 2005 results shown in Table 3.1 deviate from the results published in the original technical and summary reports prepared by Stockholm Environment Institute for two reasons. First, the original 2005 inventory (as published) used a model to estimate the emissions associated with use of vehicles. The 2010 inventory combines an update to this model with results from ODOT's GreenStep Model. 2005 results in Table 3.1 for "vehicle use" are adjusted from SEI's original model to be comparable with the estimate for 2010. The second change is a result of changes to the underlying economic modeling system. Both 2005 and 2010 inventories use the IMPLAN economic modeling system to populate the emissions model. However, IMPLAN's 2005 model used a different economic categorization system than the 2010 model. This required a reclassification of some commodities. Further, Stockholm Environment Institute reclassified a few commodities between its technical and summary reports. In addition, DEQ, upon closer review of the 2005 categorization scheme, also reclassified a few commodities and subcategory names when producing the 2010 model. Additional details are provided in the "Technical Note" in Appendix B.

	2005[64]				2010			
	Pre-purchase	Use	Post-consumer disposal	Total	Pre-purchase	Use	Post-consumer disposal	Total
Furnishings and supplies	2.7	*	0.3	3.0	2.7	*	0.1	2.8
Retailers	2.1	*	0.0	2.1	2.3	*	0.0	2.3
Lighting and fixtures	<0.1	2.9	<0.1	2.9	<0.1	1.9	<0.1	1.9
Clothing	1.8	*	<0.1	1.8	1.4	*	<0.1	1.4
Wholesale	0.8	*	0.0	0.8	0.6	*	0.0	0.6
Water and wastewater	0.3	*	<0.1	0.3	0.3	*	<0.1	0.3
Other	0.4	*	<0.1	0.4	0.6	*	<0.1	0.6
Total	**45.3**	**28.7**	**0.8**	**74.8**	**46.5**	**27.7**	**0.5**	**74.7**

Totals may not add exactly due to rounding.
*Use phase emissions from these product categories are zero, though in some cases emissions may be associated with the use of products in these categories but are assigned to another category. For example, emissions associated with washing clothing (e.g., use of a washing machine) are included under the use phase of appliances, as are the emissions associated with home heating and food preparation (e.g., a refrigerator, range oven, microwave, or blender).

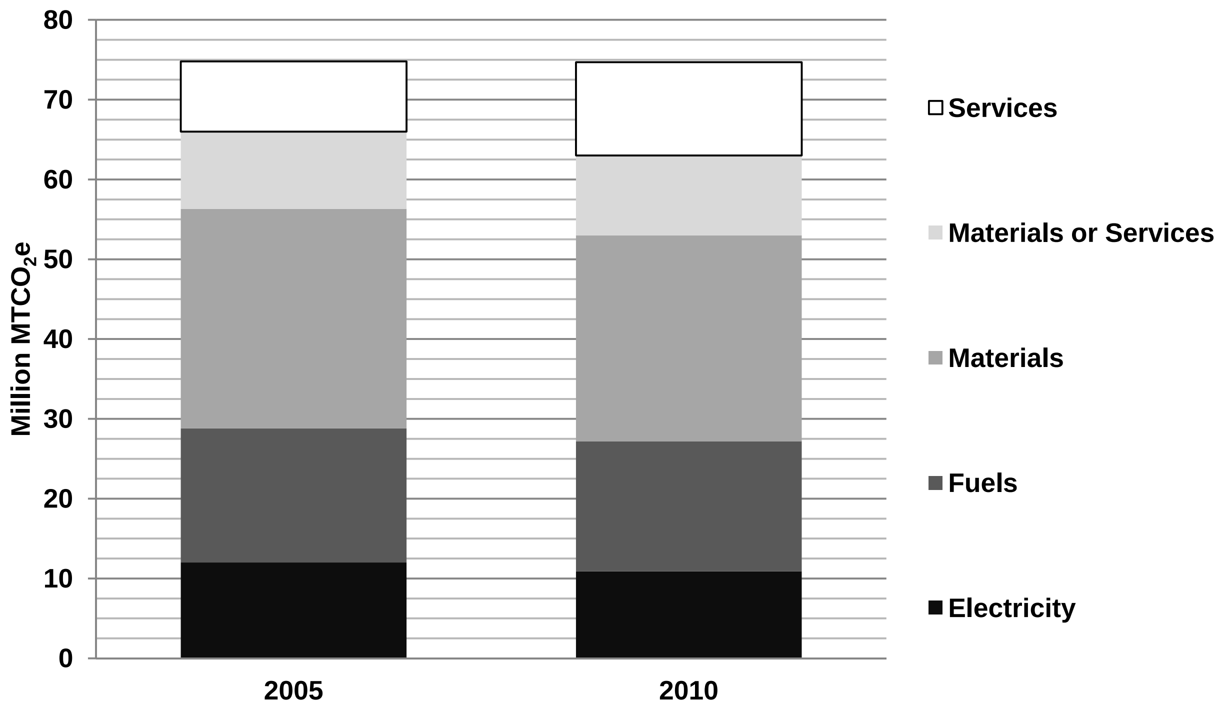
Just three broad categories represent almost half of all consumption-based emissions: vehicles and parts (19 percent), appliances (16 percent), and food and beverages (14 percent). Emissions associated with vehicles and appliances are largely related to their use, although there are significant emissions associated with production of vehicles. In contrast, emissions associated with food are primarily related to production.

Table 10: Oregon consumption-based emissions by meta-category[65,66]

	2005 Million MTCO$_2$e	Percent of total	2010 Million MTCO$_2$e	Percent of total
Electricity	12.0	16%	10.9	15%
Fuels	16.8	22%	16.3	22%
Materials	27.5 – 37.1	37% – 50%	25.8 – 35.8	35% – 48%
Services	8.8 – 18.5	12% – 25%	11.7 – 21.7	16% – 29%
Total	**74.8**	**100%**	**74.7**	**100%**

65 As noted in the previous section, 2005 emissions associated with "fuels" have been adjusted downward from the original (published) estimate to reflect a change in methodology in estimating emissions associated with vehicle use.
66 "Materials" and "services" are expressed as ranges because certain commodities can be classified as either "materials" or "services". These include consumption at restaurants and the purchase of buildings and building-related services (e.g., roof replacement).

Figure 11: Oregon consumption-based emissions by Meta-category



4. Changes in consumption-based emissions from 2005 to 2010

Table 9 illustrates very little change in overall consumption-based emissions between 2005 (74.8 million $MTCO_2e$) and 2010 (74.7 million $MTCO_2e$) - a decrease of 0.1 million $MTCO_2e$. While nominal statewide consumption, reflected by spending, grew roughly 15 percent between 2005 ($146 billion) and 2010 ($168 billion), real consumption after adjusting for inflation only grew about 3 percent. In other words, consumption-based emissions were essentially flat despite a small increase in real consumption.

Despite the relative stability in overall consumption-based emissions, certain emissions changed more significantly. Pre-purchase emissions grew by 1.2 million $MTCO_2e$ while use-phase emissions fell by 1 million $MTCO_2e$ and emissions associated with post-consumer waste disposal fell 0.3 $MTCO_2e$. Some of the underlying drivers behind each of these changes are discussed below.

Pre-purchase emissions increased 1.2 million $MTCO_2e$ from 2005 to 2010. Among the 16 categories of commodities, six saw changes in excess of 0.5 million $MTCO_2e$: services (+1.4 million), vehicles and parts (-1.2 million), food and beverages (+1.2 million), healthcare (+1.0 million), other manufactured goods (-0.8 million) and electronics (-0.6 million). Underlying drivers of these changes include the following:

- Pre-purchase emissions associated with consumption of services increased by 1.4 million $MTCO_2e$.
  - After adjusting for inflation (that is, in real terms), consumption of services was 15 percent higher in 2010. One significant increase occurred in consumption of higher education services, reflecting increasing enrollment in college associated with the soft employment market.

- Even as consumption of services rose, the emissions intensity (emissions per dollar, again, in real terms) also rose, by 8 percent. The underlying cause of this is unclear, although some of this increase may be a result of a change in the emissions modeling methodology between the 2005 and 2010 inventories.[67]

- Pre-purchase emissions associated with vehicles and parts fell by 1.2 million $MTCO_2e$, reflecting weakened demand for cars and light trucks among all types of consumers, including households as well as businesses (where vehicle purchases are considered to be capital/investments and as such counted as "consumption"). Real emissions intensities (emissions per dollar) were essentially unchanged.

- Pre-purchase emissions of food and beverages increased 1.2 million $MTCO_2e$.
    - Overall consumption (purchases) of food and beverages rose 7 percent in real (inflation-adjusted) terms. This coincides with changes in Oregon's population, which grew 6 percent during the same time period.
    - At the same time, the emissions intensity of food consumed by Oregonians (emissions per dollar, in real terms) also rose 7 percent.
    - Subcategories showing the greatest increases in emissions included grains/baked goods/cereals, beverages (emissions increased for both non-alcoholic and alcoholic beverages), and pet food.

- Pre-purchase emissions associated with healthcare rose 1.0 million $MTCO_2e$.
    - Consumption in real terms was 13 percent higher in 2010 than 2005. Increases were observed in both medical services (hospital stays, doctor visits) and in purchases of pharmaceuticals.
    - Real emissions intensities were 12 percent higher in 2010 than 2005. However, while emissions intensities rose for healthcare services, they fell for medicines.

- Pre-purchase emissions associated with the category "other manufactured goods" fell by 0.8 million $MTCO_2e$. This was largely due to a decline in real consumption, particularly purchases of heavy-duty trucks and other capital equipment by Oregon businesses. Real emissions intensities were essentially unchanged.

- Pre-purchase emissions of electronics fell by 0.6 million $MTCO_2e$. Overall consumption in real terms was relatively stable (up 3 percent between 2005 and 2010). But this masks large changes in the composition of this spending. Between 2005 and 2010 there were significant declines in spending on hardware (which tends to be more emissions intensive to produce), compensated by nearly equivalent increases in spending on services, such as web hosting and programming. These service-related commodities tend to have much lower emissions intensities, thus the overall decline in emissions.

Use phase emissions fell 1.0 million $MTCO_2e$. Key factors influencing this change include:

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[67] Specifically, commercial sector energy-related emissions for the U.S. were estimated in 2005 using economic allocation. In 2010, these same emissions were allocated using both economic allocation and application of the Commercial Building Energy Consumption Survey (see Appendix B for details). This methodological change resulted in more commercial-sector energy-related emissions being allocated to private colleges, which also happen to be a commodity with relatively high consumption (in dollars).

- The most significant change was in the category of "lighting and fixtures", where emissions fell from 2.9 million $MTCO_2e$ to 1.9 million $MTCO_2e$. Overall consumption of electricity fell between 2005 and 2010, although use for non-lighting applications (e.g., plug loads) increased even as electricity use for lighting decreased.[68]
- Emissions associated with vehicle use declined 0.4 million $MTCO_2e$, despite a growing population. Higher gasoline prices probably contributed some to this decline, by stimulating improvements in fuel economy.
- Emissions associated with the use of appliances increased by 0.5 million $MTCO_2e$. Most of the gain was in the use of appliances for heating and cooling (furnaces, air conditioning, and hot water) and may have been driven in part by increasing population. Weather did not drive this increase; heating degree days for Oregon (population-weighted) in 2010 were within 1 percent of the value for 2005.[69]

Disposal phase emissions fell 0.3 million $MTCO_2e$. Some of this apparent decrease was caused by a change in how disposal-related emissions were modeled in 2010.[70] However, some of the decrease is real, both in reduced consumption and reduced emission intensity. Overall disposal tonnage was 16 percent lower in 2010 than in 2005. Further, most of Oregon's solid waste goes to landfills and significant improvements in landfill gas capture systems between 2005 and 2010 means that less of the gas that is generated will be emitted to the atmosphere. In addition, changes to the types of materials being used and thrown away means that Oregon's landfilled waste is slowly becoming less methanogenic (methane-producing) over time as, for example, Oregonians use and dispose of less paper products.

IV. Expanded Transportation Inventory

In order to develop the STS vision and strategies described earlier in this report, ODOT staff worked with staff from the Oregon Department of Environmental Quality and the Oregon Department of Energy, and consultants to estimate past and present transportation sector greenhouse gas emissions and to evaluate emissions reductions that might be achieved in the future. New analytical tools, including ODOT's GreenSTEP[71] model, were developed to quantify and model greenhouse gas emissions from the transportation sector and to estimate the effects of a number of potential future changes to the transportation system, as described earlier in the description of the STS.

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68 This large of a decrease over a relatively short period may be due in part to allocation or other modeling errors.
69 National Climatic Data Center, NOAA.
70 See Appendix B for details.
71 GreenSTEP (Greenhouse gas Strategic Transportation Energy Planning) is a peer-reviewed model which calculates energy consumption and GHG emissions from light duty vehicles in response to a large number of vehicle, fuel, economic, demographic land use and other inputs.
http://www.oregon.gov/ODOT/TD/TP/Pages/GreenSTEP.aspx

The STS analysis of greenhouse gas emissions divided the transportation sector into three travel market segments as follows:

1. Ground Passenger and Commercial Service Vehicle Travel: This market segment includes passenger travel by light duty vehicles (automobiles, sport utility vehicles, vans, pickup-trucks), buses, and trains. Walking and bicycling are also included as alternatives although these modes do not produce greenhouse gas emissions. Commercial use of light-duty vehicles for service calls, deliveries, etc. is also included in this category.
2. Freight: This market segment includes the movement of goods by all modes of transportation other than light duty vehicles (e.g. heavy trucks, railroads, ships, airplanes, pipelines).
3. Air Passenger: This market segment includes all commercial air travel, including aircraft, and ground access and support equipment at airports.

The approach taken in the STS to inventorying transportation emissions and assessing potential future outcomes was a departure from past practices regarding the estimation of other transportation emissions. In the case of criteria air pollutants, the practice and requirements are to estimate emissions for areas in which the emissions exceed standards and are causing harm; for example within the air quality management area of a metropolitan area. Generally, the adverse effects of the emissions occur primarily in the area where the emissions occur. But greenhouse gasses are different. Their effects are global, regardless of where they are emitted. It does not matter whether a person drives within the metropolitan area where they live, or whether they drive to another city or state. The effects on global warming and climate change are the same. For this reason, the STS analysis used a household approach to assessing emissions from passenger travel. Estimates were made of the emissions resulting from the travel of Oregon households regardless of where they travel (in-state or out-of-state). Conversely, the emissions of the residents of other states were not assessed, even if those emissions occurred or are projected to occur within Oregon's boundaries.

An analogous, borderless, approach was used for the assessment of freight greenhouse gas emissions. Those emissions were estimated for the movement of goods transported to Oregon from wherever they are produced, whether in the State, in other states, or other countries. This approach provides a more holistic view of freight emissions that is consistent with how passenger travel emissions are considered. In the case of passenger travel, emissions are a function of choices about where and how far to travel as well as by what mode to travel (e.g. car, bus, bicycle) and the emissions characteristics of the modes used. Likewise, freight emissions are a function of choices about what goods to purchase, where goods are purchased from (how far they are shipped) as well as by the mode and the emissions characteristics of the modes used. As with passenger travel, this approach enables broader consideration of ways in which transportation emissions can be reduced.

Transportation greenhouse gas emissions were assessed on a fuel lifecycle (i.e. well-to-wheels) basis for the STS. These include emissions from combusting fuels to power vehicles as well as the emissions from producing and transporting the fuels that are used, and the emissions to produce the electrical power used by electric vehicles including trains (e.g. light rail). The emissions assessments did not include emissions from building or maintaining transportation infrastructure or vehicles. The STS approach to estimating transportation sector emissions is described in more detail in the technical appendices of the STS, which are available on the ODOT web site.[72]

Earlier in this report, in the section describing the STS, Figure 3 showed the estimated emissions values by travel market segment for 1990 (base year for statutory goal) and 2010 (model year), as well as the projected values for 2050 (target year for statutory goal) under current trends (business as usual). Results are also shown in that figure for full implementation of the STS Vision by the year 2050. Additionally, the emission profile is shown for proportional reductions in each travel that would be needed to individually meet the 2050 goal of reducing emissions by 75 percent below 1990 levels.

Table 11 shows the corresponding values for 2010 along with the market segment percentages of total transportation emissions, and estimated percentage changes in emissions by market segment.

Table 11: Annual 2010 greenhouse gas emissions by transportation market segment, percentage by market segment, and percentage change from 1990

	Ground Pass. & Comm. Svc.	Freight	Air Passenger	Total
Million $MTCO_2e$	16.3	11.7	3.2	31.2
Percentage	52%	37%	10%	100%
Change from 1990	+10%	+54%	+97%	+30%

The earlier figure and Table 11 illustrate several significant trends. First, emissions from the freight and air passenger market segments grew at higher rates than emissions from the ground passenger and commercial services market. Freight emissions grew by over 50 percent from 1990 to 2010 and air passenger emissions almost doubled while ground passenger and commercial services emissions grew by about 10 percent. Second, the faster growth of freight and air passenger emissions resulted in a declining share of emissions from the ground passenger and commercial services market segment which is expected to continue to decline in the future.

The split in greenhouse gas emissions among travel markets differs from national values reported by the EPA. According to the EPA, light duty vehicles, motorcycles, and buses (most of the ground passenger and commercial services market segment) produced 64 percent of emissions, freight transportation (excluding air freight) produced 29 percent of emissions, and air transportation produced 7 percent of emissions in 2010.[73] The EPA and STS values do not match because of differences in inventory methods, the way emissions were counted, and the characteristics of transportation in Oregon and the U.S.

The EPA calculates transportation emissions from the amounts of fuel consumed by mode. In contrast, the STS-based analysis calculated emissions using the models that were developed in order to test various prospective policies for reducing transportation sector emissions (described below). These

[72] http://www.oregon.gov/ODOT/TD/OSTI/pages/sts.aspx

[73] "Fast Facts, U.S. Transportation Sector Greenhouse Gas Emissions, 1990-2010", U.S. Environmental Protection Agency, Office of Transportation and Air Quality, EPA-420-F-12-063, December 2012, http://www.epa.gov/otaq/climate/documents/420f12063.pdf

models computed amounts of travel by mode and emissions rates per mile of travel. These values were then used to compute emissions.

The EPA and STS estimates also differ in the scope of what is counted. The EPA estimates, following international reporting protocols, do not include emissions from international freight and passenger movements, whereas the STS inventory does include these emissions. The inclusion of international freight and passenger travel in the STS inventory increases the freight and air percentages of greenhouse gas emissions and decreases the ground passenger percentage relative to the EPA inventory. For example, according to the STS analysis, emissions from international freight movements bound for Oregon make up 8 percent of the total emissions from all freight bound for Oregon.

Finally, the characteristics of Oregon freight transportation differ significantly from the national average in several ways. A higher percentage of Oregon's emissions are from the freight market because:

1. More tonnage per capita is shipped than the national average;
2. The State's location and relatively large size results in longer than average freight shipping distances; and,
3. Average greenhouse gas emission rates (per ton-mile) are higher because truck travel dominates shipments within the State and are a majority for shipments from other Western states.

5. Ground Passenger and Commercial Service Vehicle Travel

The Ground Passenger and Commercial Services transportation market segment includes passenger travel using light duty vehicles (e.g., automobiles, pickup trucks, sport utility vehicles, vans) and commercial service travel using light duty vehicles. It also includes travel by modes that provide alternatives to light duty vehicles, such as public transportation, bicycling (and other light weight vehicles), and walking.

Ground passenger and commercial service vehicle emissions were estimated using the GreenSTEP model. The GreenSTEP model estimates vehicle ownership, vehicle travel, fuel consumption, and greenhouse gas emissions at the individual household level. This structure was chosen to account for the synergistic or antagonistic effects of multiple policies and factors (e.g. gas prices) on vehicle travel and emissions. For example, because a household residing in a more compact mixed-use neighborhood will tend to drive fewer miles each day, a higher percentage of their driving would be powered by electricity if they use a plug-in hybrid-electric vehicle. Modeling at this level makes it possible to evaluate the relationships between emissions and the characteristics of households, land use, transportation systems, vehicles, and other factors of interest. In addition, household level analysis makes it possible to evaluate the equitability of the costs and benefits of different emission reduction strategies.

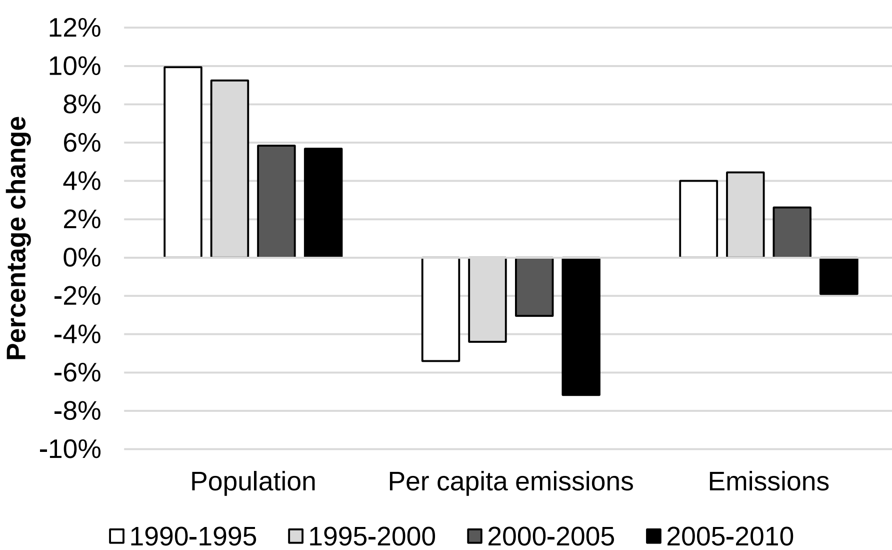
Table 12 shows the emissions from the three most significant components of this market segment. Overall greenhouse gas emissions increased by about 9 percent from 1990 to 2010. Household travel using light-duty vehicles produced the majority of emissions of this market segment, almost 90 percent. Emissions from urban public transportation were a very small fraction of the total.

Table 12: Estimates of annual ground passenger and commercial services market segment emissions (MMTCO2e)

Year	Household Light-Duty Vehicles	Commercial Light-Duty Vehicles	Urban Public Transit	Total
1990	13.1	1.6	0.1	14.8
2010	14.3	1.8	0.2	16.3

Household light-duty vehicle emissions are affected by the growth in population and by the light-duty greenhouse gas emissions of each person. The relative changes in these quantities affect the relative change in total light-duty vehicle emissions. Figure 12 compares changes in these quantities from 1990 to 2010. While per capita emissions were declining over the period, total population was increasing. Declines in per capita emissions were not sufficient to overcome population increases until after 2005. Then a large decrease in per capita emissions exceeded the more modest population increase to result in a net decrease in emissions from household vehicle travel.

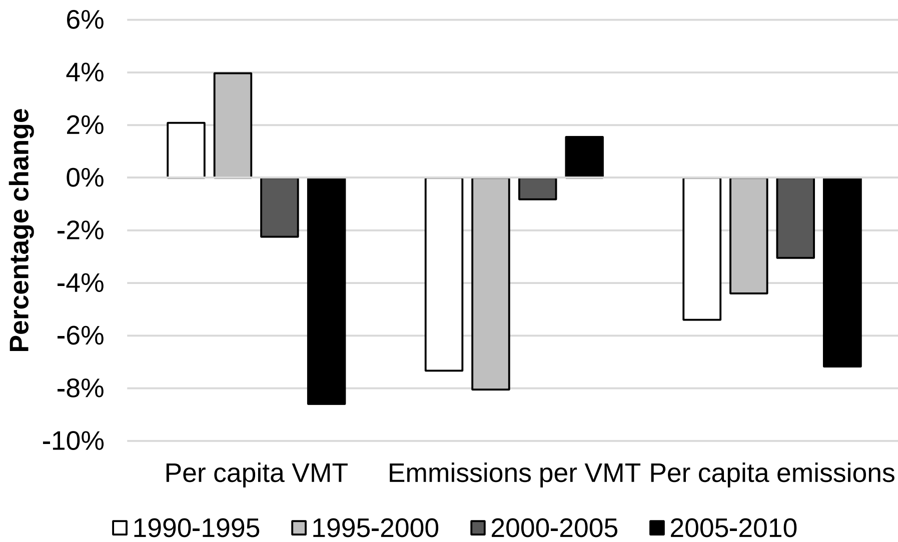
Figure 12: Changes in population, per capita household light-duty vehicle emissions, and total emissions



The observed declines in per capita light vehicle emissions are affected by changes in household VMT and by changes in vehicle emissions rates. Figure 13 shows how these quantities have changed over the period. Although per capita emissions decreased over the entire period, changes in travel and changes in vehicle emissions rates acted in opposite directions over most of the period. Prior to 2000, per capita

VMT increased, but was more than offset by decreases in vehicle emissions rates. After 2005, large decreases in per capita VMT offset small increases in emissions rates. More modest decreases in per capita emissions occurred between 2000 and 2005 as a consequence of small declines in both per capita VMT and CO_2e per mile.

Figure 13: Changes in per capita VMT, emissions per VMT, and per capita emissions

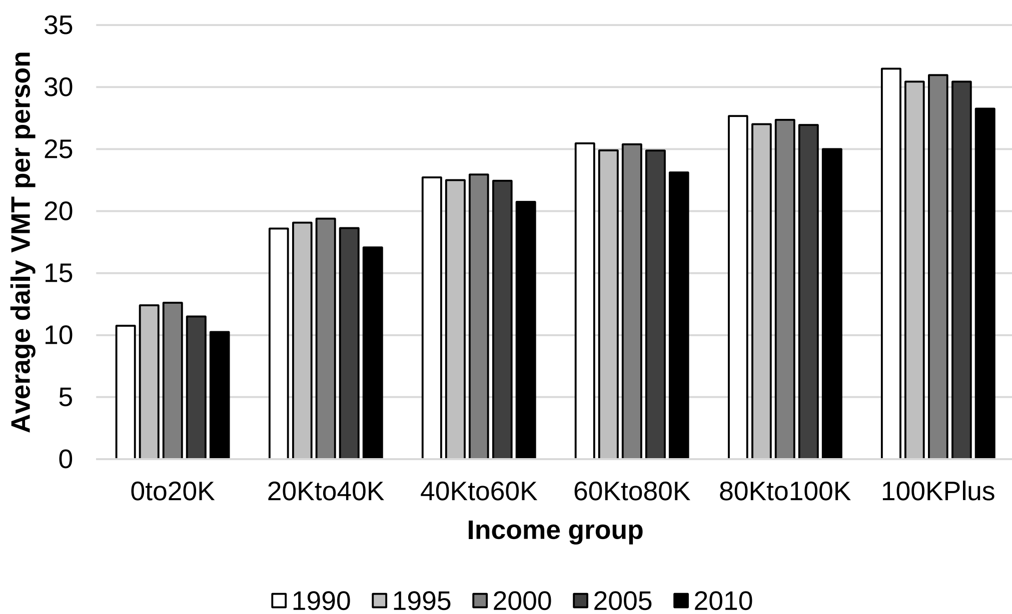


The Great Recession, which had officially started in December of 2007 and officially ended in June of 2009, was undoubtedly a leading cause of the sharp downturn in per capita VMT in the period between 2005 and 2010 since household employment and income have a substantial effect on household vehicle travel. The recession greatly increased unemployment, which more than doubled in Oregon from a low of about 5 percent in 2007 to a high of almost 12 percent in 2009. Although the recession officially ended in 2009, the unemployment rate in 2013 is several percentage points above the pre-recession rate. Figure 14 shows how average per capita VMT rises with income and how per capita VMT decreased after 2000 across all income groups.

It should be noted, that the values shown in Figure 14 are based on model outputs, and are not direct measures of per capita VMT by income group. Annual estimates of per capita VMT by income are not available, so these changes must be inferred using models of the relationships between household income and other factors which affect household VMT. This is what the GreenSTEP model does.

Figure 14 shows a similar pattern of changes in per capita VMT across all income groups with some notable differences. First, the decline in VMT from 2000 to 2010 was, in percentage terms, greater for lower income households than for higher income households. This is understandable since lower income households are affected more by bad economic times and because their budgets are more constrained. The second difference is that while per capita VMT rose on average for lower income households between 1990 and 1995 it decreased for higher income households. This may have been the consequence of how incomes and changes in VMT vary across the State. Incomes are higher on average in metropolitan areas of the State (particularly the Portland metropolitan area) than in other areas and per capita VMT in metropolitan areas changed very little from 1990 to 1995 compared to other areas of the State. Also, per capita VMT is higher in less dense and more rural parts of the State because of longer distances between places and fewer available alternatives to driving. The increase in per capita VMT from 1990 to 2000 was more pronounced in rural areas, but the declining trends in per capita VMT after 2000 were similar for all areas.

Figure 14: Average daily per person light-duty vehicle travel by annual household income



6. Freight

The Freight travel market considers the movement of goods by all transportation modes (i.e. road, air, rail, water and pipeline) using vehicles greater than 10,000 pounds gross vehicle weight (GVW) or pipelines. The approach taken in the STS for analyzing and identifying options for mitigation of freight emissions was different than the in-boundary approach and the consumption-based approach described earlier. The approach is similar to that taken for passenger travel emissions where all travel of Oregonians is considered, regardless of whether the travel occurs in Oregon. In the case of freight emissions, the approach is to tabulate the emissions to transport unfinished and finished goods to people and businesses in Oregon regardless of where the goods come from. Although this approach may appear to be the same as the consumption-based inventory approach, there are some key differences.

The STS inventory approach was made possible by the U.S. Department of Transportation's Freight Analysis Framework version 3 (FAF3) database.[74] The FAF3 database provides year 2007 estimates of

[74] U.S. Department of Transportation, Federal Highway Administration, *Freight Analysis Framework*, http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/

commodity flows by tonnage, value, origin region, destination region, commodity type, and transportation mode. The database includes estimates of international flows to and from regions of the U.S. as well as domestic flows. The FAF3 database was used to tabulate the values, weights and distances of all commodities shipped to Oregon. Greenhouse gas emissions were calculated from the weights and distances that commodities were shipped as well as the average emissions rates by mode.

Greenhouse gas emissions rates (grams CO_2e per ton-mile) vary widely among the different freight modes. Table 13 compares the average rates for the freight mode categories included in the FAF3 database. It can be seen that the rates fall into three groupings. Rail, water, and pipeline emissions rates are all relatively low; in the range of 24 to 35 grams CO_2e per ton-mile. The average truck emission rate is about 10 times higher. The same is true for the "multiple modes and mail" and "other" mode categories which are most similar to the truck mode in their distance and commodity value characteristics. Air transportation has the highest average emission rate; over four times higher than the truck rate.

Table 13: Greenhouse gas emission rates by freight mode (grams CO_2e per ton-mile)[75]

Freight mode	Average emission rate	Mode emission rate category
Truck	313	Medium
Rail	28	Low
Water	24	Low
Air	1,472	High
Multiple modes & mail	324	Medium
Pipeline	35	Low
Other	313	Medium

Table 14 shows that the shipment of freight within Oregon produces a relatively small portion of total freight greenhouse gas emissions (27 percent). A large majority of the emissions come from the shipment of goods to the State from outside its boundaries. This is the case despite the fact that almost three-quarters of the goods (71 percent of the weight) are shipped from origins in Oregon to

[75] Emissions rates for truck, rail, water, air and pipeline from Table 2.1 in Cambridge Systematics, *Freight and Climate Change: Background Paper for the Oregon Freight Plan*, June 2010 (http://www.oregon.gov/ODOT/TD/TP/docs/ofp/freightclimate.pdf). Emissions rates for multiple modes & mail and other estimated from evaluation of FAF3 data regarding the similarity of commodity values and distances shipped by these modes to the other modes.

destinations in Oregon. Although more goods are shipped within the State than to the State, the distances that goods are shipped from places outside the State are many times greater than the distances shipped within the State. This results in many fewer ton-miles of freight shipments within the State than to the State from other regions. Although 71 percent of the freight tonnage is shipped within the State, this only accounts for 12 percent of the ton-miles of freight shipments to destinations in Oregon. This is a key reason why a large majority of Oregon's freight GHG emissions come from the shipment of goods from out of State, because the total amount of emissions depends on the distances that goods are shipped as well as the weight of goods shipped.

Table 14: Percentage of commodity value, tons and ton-miles shipped and emissions from shipping goods to Oregon by originating region (2007)

Originating Region	Value	Tons	Ton-Miles	CO2e
Oregon	47%	71%	12%	27%
Western US	23%	15%	12%	21%
Other US	22%	10%	37%	34%
Non US	8%	5%	39%	18%
Total	100%	100%	100%	100%

The "Ton-Miles" and "CO_2e" columns of Table 14 show that there is more to freight greenhouse gas emissions than the ton-miles of cargo moved. The percentage of emissions produced by shipping goods within Oregon is over two times greater than the percentage of ton miles. Similarly, the percentage of emissions produced by shipping goods to Oregon from other western states is 75 percent greater than the ton-mileage. On the other hand, the percentage of emissions produced by shipping goods to Oregon from places outside the U.S. is less than half the ton mileage. The reason for this difference has to do with how the mix of transportation modes used to transport goods to Oregon varies with distance and the type of cargo shipped. Overall, about 60 percent of the ton-mileage of freight movement is carried out by relatively low emitting modes and 40 percent is carried out by medium emitting modes. Freight movement by high emission modes (i.e. airplanes) represents a tiny fraction of the total ton mileage.

4. Air Passenger

The Air Passenger travel market refers to commercial air passenger travel, including aircraft, ground access and support equipment. The STS approach to inventorying air passenger travel emissions is much like the approach to inventorying ground passenger travel emissions. Greenhouse gas emissions are estimated for the plane trips of Oregonians, regardless of where they travel. This approach, while consistent with the approaches for the other transportation market segments, is different than the standard approach for accounting for air passenger emissions. The standard approach is to estimate emissions based on the usage of aviation fuels. That approach, when applied to airports in the State, includes the emissions from all air passenger travel which departs from the State's airports, whether of Oregonians or others. It excludes the emissions of Oregonians traveling home from other places.

Amounts of air passenger travel were estimated using a model of air passenger trip-making and recorded flight distances. The number of air passenger trips was estimated from a model developed using national long-distance travel survey data from the 2001 National Household Travel Survey.[76] This model forecasts numbers of trips in two distance categories (long-haul, short-haul) and two purpose categories (business, leisure). The model was calibrated using 2009 passenger survey data from the Port of Portland[77] and 2009 Airline Origin and Destination Survey (DB1B) database from the Bureau of Transportation Statistics.[78] After calibration, it was validated using year 2000 data from the DB1B database. Passenger trip distances were summarized from the DB1B database. Together, these estimates were used to estimate short haul and long haul air passenger miles of travel.

Short haul and long haul air passenger miles traveled were tabulated separately because the emissions rates are different for those trips and the potential policy actions may be different as well. Short-haul air trips (e.g. Portland to Seattle) produce more greenhouse gas emissions per passenger mile because taxi, take-off, and climb are a larger proportion of the total trip emissions, and the aircraft type, often regional jets, are less efficient per passenger mile (e.g., 0.2477 Kilograms CO2e per Passenger Mile vs. 0.1818 Kilograms CO2e per Passenger Mile for 2010) .

Greenhouse gas emissions also occur as a result of ground-based airport operations. These include surface traffic, which includes ground access vehicles, such as vehicles related to passenger, employee, service and cargo delivery activities); and ground support (including all operations, service and maintenance vehicles on the air-side of the gate).

A kilogram-per passenger-trip (kg/passenger-trip) emission rate was calculated based on the 2009 greenhouse gas emissions inventory from the Port of Portland Aviation Division and passenger trip information from Portland International Airport for the same inventory year.

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[76] U.S. Department of Transportation, Federal Highway Administration, 2001 National Household Travel Survey, http://nhts.ornl.gov/publications.shtml

[77] The survey by Aviation Research at Port of Portland to departing passengers in the terminal building shows that 43.5 percent passengers lived in Oregon in 2009. The total passengers were 6,472,267 enplanements including transfers. The U.S. DOT DB1B database shows that 5,082,320 passengers traveled from Portland International Airport (PDX), not including transfers. So the percentage of Oregonians is (6,472,267 × 43.5%) / 5,082,320, equal to 55 percent.

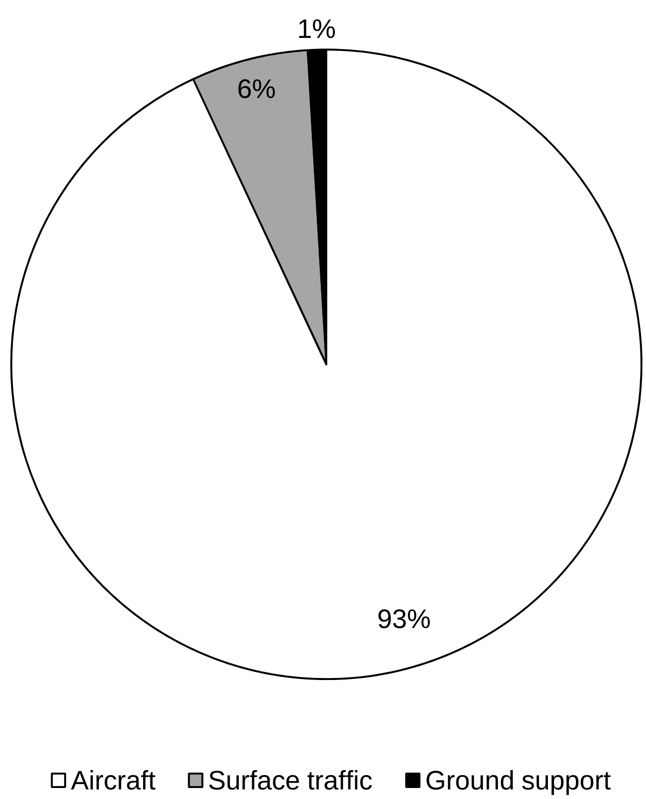
[78] U.S. Department of Transportation, Bureau of Transportation Statistics, *Data Profile: Airline Origin and Destination Survey (DB1B)*, http://www.transtats.bts.gov/DatabaseInfo.asp?DB_ID=125&DB_Name=Airline%20Origin%20and%20Destination%20Survey%20(DB1B)

Table 15 shows estimated air passenger emissions for the years 1990, 2000, and 2010 by type of emission. Figure 15 shows that aircraft emissions comprise over 90 percent of total air passenger emissions. Aircraft emissions also contributed the most to the substantial growth in air passenger emissions from 1990 to 2010.

Table 15: Estimated air passenger emissions by source type: 1990-2010 (Million MTCO2e)

Year	Aircraft Emissions	Surface Traffic	Ground Support	Total
1990	1.48	0.15	0.02	1.65
2000	2.71	0.18	0.02	2.91
2010	3.00	0.21	0.03	3.25

Figure 15: Percentage of air passenger emissions by source type (2010)



V. Progress Toward Oregon's Greenhouse Gas Reduction Goals

This report marks an important milestone in that it is the first from the Commission to be able to report on Oregon's first greenhouse gas reduction goal -- to arrest the growth of emissions and to begin reducing those emissions by 2010 – using available inventory data. In its 2009 Report to the Legislature the Commission reported that Oregon appeared to be on track to meet the first legislated greenhouse gas reduction goal, and in its 2011 report it was noted that the available data (through 2008) demonstrated a, "flat emission trajectory trend [that] is expected to continue through 2010". As a result of having not only inventory data available for 2010, but arguably the highest quality data yet due to the use of reported greenhouse gas emission data for that year, the Commission is now able to address whether Oregon did in fact achieve this first greenhouse gas reduction goal, or at least the first part of it.

As noted in the Commission's previous report, although the law that established Oregon's greenhouse gas reduction goals (*ORS 468A.205*) does not provide a specific standard by which to judge whether greenhouse gas emissions growth has been arrested by 2010, it seems logical to assume that holding emissions more or less level over a reasonable period of time by 2010 – with a similarly flat or decreasing trajectory after 2010 – should suffice as "arresting" those emissions. As demonstrated by the "in-boundary" emissions inventory described earlier in this section greenhouse gas emissions over the past decade have remained relatively level (with some oscillation) and for the past three years have declined sharply. Importantly, the inventory data available at this time are absolutely clear that Oregon has indeed, at a minimum, "arrested" greenhouse gas emissions through the year 2010. Moreover, if one chooses to assess progress based on the consumption-based inventory presented earlier, it is important to note that those data also demonstrate a near-term trend of having arrested emissions.

Arresting emissions by 2010 is only the first part of the 2010 greenhouse gas reductions goal. The second part of the goal is to begin reducing emissions, making progress toward Oregon's 2020 and 2050 greenhouse gas reduction goals. A first glance at the data for the past three years in particular would seem to indicate that not only has Oregon arrested emissions growth, but that it did so by 2008 or so and started a downward trajectory shortly thereafter. Some caution is in order for two reasons. First, the period 2008 through 2010 was not typical in that there were clearly some effects associated with the large-scale recession at the time (although there were also other effects leading to emission reductions). Second, as described previously in the description of the "in-boundary" inventory there was a change in the inventory technique between 2009 and 2010. The data from 2009 and before were derived in the same manner that previous reports from this Commission have provided, using a variety of "top down" estimation techniques whereas the 2010 inventory year is the product of largely "bottom up" reporting from greenhouse gas emitters.[79] Therefore, extending a trend line based on these past three years may not be the best indicator of the future emission trajectory facing Oregon.

Instead, by using a more sophisticated forecasting tool from US EPA and calibrating it to Oregon's 2010 emissions data, we can get a sense of what direction greenhouse gas emissions would be heading in the absence of policy intervention, i.e., a "business as usual" forecast of emissions. By cumulatively adding

[79] Any discontinuity resulting from the change in methodology is likely very small. The data for 2010 were also calculated in the same manner as the historical data and the results were very close, within 1 percent.

the impact of some of the key policies that are either in place or are being seriously considered at this time we can also demonstrate whether in fact emissions are expected to begin the downward trajectory over the coming years that would meet the second criterion of the 2010 emissions reduction goal, i.e., to begin reducing emissions after the growth of emissions has been arrested. Figure 16 provides an overview of the results of this process, as well as demonstrates the emission reductions necessary for Oregon to achieve its 2020 and 2050 greenhouse gas reduction goals.

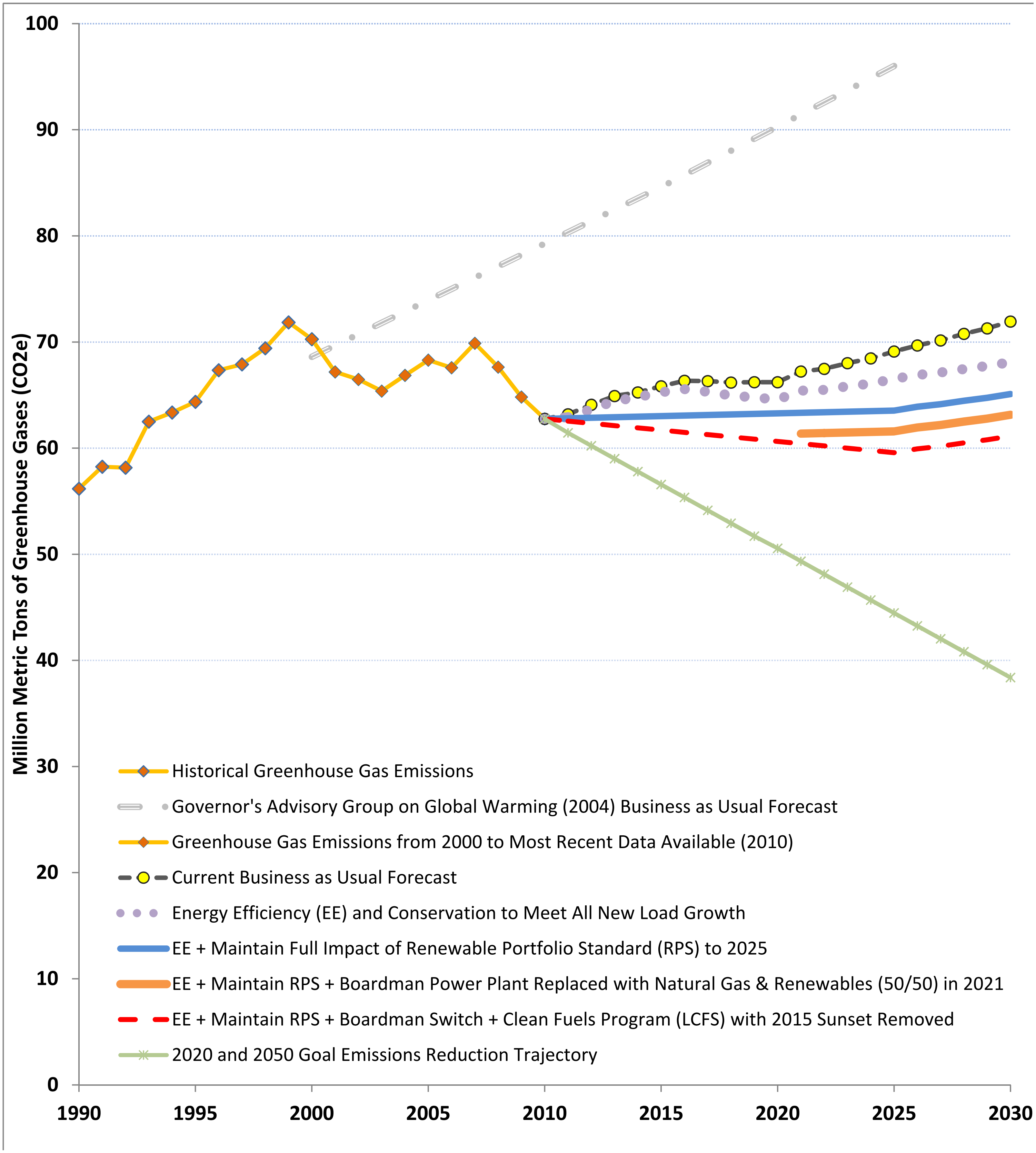
The current "business as usual" forecast is shown in Figure 16 and does indicate that, in the absence of key policies, greenhouse gas emissions would be expected to rise. Note that emissions are not expected to rise above their recent peak levels (70 million metric tons in 2007) until after 2025 in this forecast. In contrast the Governor's Advisory Group on Global Warming (GAGGW) created a similar "business as usual" forecast in 2004 to measure the impact of their recommended policies. That forecast, which began in the last year inventory data were available (2000), rose much more steeply, to almost 100 million metric tons by 2025, although actual inventoried emissions turned out to be sharply lower than forecast. One encouraging measure of progress is that with the programs, policies, and practices in place as of today (in contrast to 2004) the expected rise in emissions (based on this recent forecast) is substantially lower than the baseline forecast used earlier by the GAGGW in their analysis.

Figure 16 demonstrates the cumulative impacts of four large-scale policies using the current "business as usual" forecast as a baseline. The reductions necessary to achieve the 2020 and 2050 goals are also plotted to provide perspective. The four key policies illustrated in Figure 16 are as follows:

<u>Governor's 10-Year Energy Action Plan Energy Efficiency Goal:</u> One of the key three goals of the Governor's 10-Year Energy Action Plan is to: "Maximize energy efficiency and conservation to meet 100 percent of new electricity load growth." Although this goal has not yet been formulated into a single policy or legislative act it is widely expected to form the basis of any number of future initiatives and efforts in the upcoming years. As such it is useful (and relatively straightforward from an analytical perspective) to plot the impact of a foundational policy such as this. Therefore this new "key policy" (relative to the Commission's last report) is included here. Even if one or more overarching policies does not emerge from this goal it serves, at a minimum, as a useful proxy for the universe of potential energy efficiency and conservation actions that could lead to flat load growth for Oregon into the near future.

<u>Renewable Portfolio Standard (RPS):</u> The current "business as usual" forecast captures the gains made thus far in increasing the share of renewable energy used in the State's power mix – some of which was undoubtedly steered by the Oregon RPS. However, those gains will clearly increase if Oregon remains on track to meet its 2025 RPS goals as they currently exist in law. Conversely, those gains may not materialize if the RPS is eliminated or modified so that existing generation capacity is substituted for new renewable energy growth in the future. Thus the incremental gain between where we are today, as reflected in the current BAU forecast, and what we will attain if we remain on track with the RPS is a key emissions reduction policy below the energy efficiency goal impact in Figure 16. Note that the RPS' impact is based on load, and the inclusion of the energy efficiency measure that leads to flat load growth means that the 25 percent of load affected by the RPS in 2025 is less than it would have been without the energy efficiency policy – although the combined effect is even greater than before.

Figure 16: Historical Greenhouse Gas Emissions and the Impact of Key Policies toward Achieving Reduction Goals



Boardman Power Plant: The agreement to end coal combustion at PGE's Boardman power plant by the end of 2020 will clearly have an impact on the State's greenhouse gas footprint. That impact will not be felt until 2020, and the precise emissions impact is uncertain at this time. In the Commission's last report it was assumed that the replacement power for Boardman would be natural gas. Since that time some progress has been made in the investigation of reuse of the Boardman facility as a renewable facility. In light of what is now even greater uncertainty as to what the Boardman carbon profile may look like in the future this report takes a more probabilistic approach. The emissions trajectory associated with a replacement option for Boardman is derived from a 50/50 split between the natural gas replacement assumption used in the last report and a zero-emissions possibility reflecting the use of renewable energy. This compromise acknowledges the possibility that replacement power for Boardman could, at least in part, be derived from renewable sources.[80] This emission trajectory is located below the "Incremental RPS Forecast" line in Figure 16 and begins in 2021.

Clean Fuels Program (aka Low Carbon Fuel Standard (LCFS)): Legislation passed in 2009 authorizes Oregon's Environmental Quality Commission (EQC) to put in place a low carbon fuel standard (now known as the Clean Fuels Program) that would reduce the carbon intensity of the transportation fuel mix used in this State by 10 percent (on a life-cycle emissions basis). The Clean Fuels Program currently is set to expire in 2015, and has not yet been put in full force by the EQC. However, if the Oregon Legislature chooses to continue this program by dropping the sunset, and assuming a start date of 2015, substantial reductions can be expected by 2025 and beyond. This emission trajectory is mapped out in Figure 16 with a dashed lines based on an approximate translation of the point estimates for the program available for 2022 (with that estimate further delayed until 2025 given the added assumption of a 2015 start date).[81] Reductions past 2025 are assumed to remain at roughly the same level achieved in 2025 through at least 2030 (although it is important to note that the modeling exercise used to generate this estimate did not model past the 10 year horizon used as the basis for the point estimate).

Given the results of the forecasting exercise in Figure 16, does it appear that Oregon will begin to reduce greenhouse gas emissions after 2010, as per Oregon's first greenhouse gas reduction goal? The answer seems to be a strong yes. Even in the absence of other greenhouse gas reduction policies that may help reduce emissions in the coming years the impacts of the RPS, the end of coal combustion at Boardman, and the likely achievement of some or all of the Governor's energy efficiency goal are anticipated to put Oregon on an emission trajectory that remains at or below 2010 levels into the coming years. There may be some oscillation around the 2010 level, as the historical data illustrate is typical, but the overall trend can be expected to be downward from 2010 into the 2020s if the key policies that Oregon has put in place to reduce greenhouse gas emissions remain in place. Therefore, the Commission can report to the Legislature that all indications are that Oregon has met its 2010 greenhouse gas reduction goal, having both arrested emissions and, it appears, having established a downward emissions trajectory where emission levels are expected to be reduced into the future.

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[80] The range of estimated reductions is roughly 1.2 to 2.4 MMTCO2e, depending on whether the power is assumed to be replaced with market (system) power, natural gas, or renewable options. The reduction assumed here is ~2 MMTCO2e which is representative of the 50/50 "probabilistic" split discussed.

[81] Oregon Department of Environmental Quality, "Final Report: Oregon Low Carbon Fuel Standards Advisory Committee Process and Program Design", January 25, 2011, page 163.

But having achieved the 2010 greenhouse gas reduction goal does not mean that Oregon is on track to meet either its 2020 or 2050 emission reduction goals. As Figure 16 clearly demonstrates, even if all the "key policies" plotted here either remain in place or are put into effect Oregon would be far off the emissions trajectory necessary to meet both its 2020 and 2050 greenhouse gas emission reduction goals. As noted in the Commission's last report, the "Roadmap to 2020" project is an attempt to begin to plot a path toward meeting those goals. Important progress has been made in the quantitative exercises that accompanied the 10-Year Energy Action Plan and the Statewide Transportation Strategy to further map out how to achieve these goals. But with Oregon only seven short years away from its 2020 greenhouse gas emission reduction goal of falling 10 percent below 1990 emission levels much more needs to be done. Otherwise the seeming victory of having achieved the 2010 emission reduction goal may seem a small victory indeed as the gap toward the 2020 and 2050 goals widens over time.

UPDATE ON GLOBAL WARMING COMMISSION ACTIVITY

I. Summary of Commission Activity

The Oregon Global Warming Commission met three times in the two-year period since the Commission's last report to the Legislature. The "Roadmap to 2020" public input process that took place in 2011 dominated the Commission's attention, minimizing the need for formal meetings during this time period. Similarly, the major stakeholder processes involved with development of both the 10-Year Energy Action Plan and the Statewide Transportation Strategy involved a number of Commission members and since they were addressing topics of key relevance to the Commission scheduling additional Commission meetings that competed with these processes was not seen as beneficial.

The biennium began with a special joint meeting of the Oregon Sustainability Board and the OGWC, recognizing the similar interests of the two Commissions and allowing for efficiencies in sharing information relevant to both commissions. Discussion with OSB members and OGWC members included presentations on the Oregon Climate Assessment Report, the Oregon Climate Change Adaptation Framework and a short introduction for OSB members on the Interim "Roadmap to 2020". The members of both commissions also discussed the ongoing work of the state agency sustainability teams and climate change aspects of that work.

In the latter part of 2011 the Commission discussed some key research ongoing in the Oregon University System that helps to map climate change impacts. It also received updates on the climate change actions recommended in Oregon's Integrated Water Resources Strategy and the Oregon Least Cost Planning transportation planning methodology development and the Sustainable Transportation Initiative. The Commission also received results and analysis from the Commission's "Roadmap to 2020 Roadshows" and online survey process that is described in this report.

Finally, in 2012 the Commission focused on the development process of Oregon's 10-Year Energy Action Plan and Oregon's Statewide Transportation Strategy, discussing these processes and results with the key officials in charge of the processes and providing comments from the Commission. The Commission also was able to learn about ODOT's Climate Change Adaptation Strategy and utilized the expertise available at the Oregon Climate Change Research Institute to learn more about how climate change impacts data are being made increasingly relevant to Oregon's specific needs and the manner in which extreme events should be understood in the context of Oregon's adaptation planning.

The Commission web site, www.keeporegoncool.org, continued to be a resource for all Oregonians to learn more about climate change in Oregon and to engage in the "Roadmap to 2020" process as the public input process evolved. It remains active and well-received by Oregonians interested in the topic.

CLIMATE CHANGE SOLUTIONS

Portland's Montgomery Park conserves energy and doubles goal to reduce annual CO_2 emissions

McKinstry, a local energy management firm, completed an audit on Montgomery Park, incorporating energy efficiency measures. These measures ensure that building improvements will result in reduced energy use and associated costs.

With support from ODOE's Small-scale Energy Loan program, Montgomery Park performed the following upgrades, which led to its energy conservation and emissions reduction successes:

- Replaced the cooling towers.
- Upgraded building web-based controls.
- Installed variable frequency drives on building HVAC pumps.
- Performed lighting upgrades to stairwells, halls and parking structure.

Montgomery Park energy use and savings after renovations in 2010, dropped significantly by 2011 – the lowest ever. The decline saves the company nearly $200,000 a year with future annual savings estimated at more than $250,000. McKinstry noted that the energy upgrades would also reduce CO_2 emissions by 1,296 metric tons annually – equivalent to removing 173 cars from the road or planting 350 acres of trees.

Currently, Montgomery Park has nearly doubled its CO_2 emissions reduction goals to 2,241 metric tons. This means, removing 300 cars off the road or planting nearly 611 trees. Additionally, in 2012, Montgomery Park's energy costs reached a record low with a total savings of $331,000 annually, constituting a 28 percent savings from the projected cost savings of 23 percent.

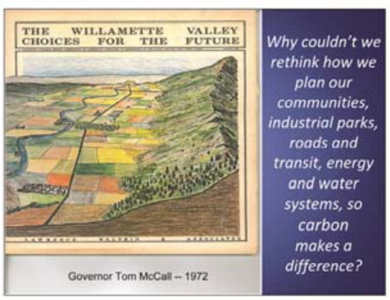
APPENDIX 1: "ROADMAP TO 2020" ROADSHOW MATERIALS

Figure 17: "Roadmap to 2020" Roadshow Handout Page 1

Roadmap to 2020 – Seven Propositions

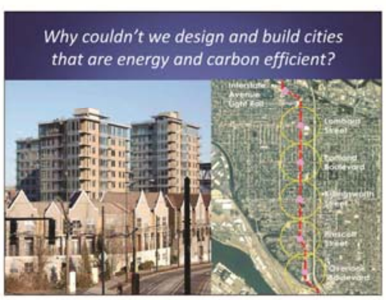
Spring 2011

The State of Oregon has set ambitious greenhouse gas (GHG) emissions reduction goals: a 10% reduction from 1990 levels by 2020 and a 75% reduction from 1990 levels by 2050. Carbon dioxide is the most prevalent GHG; others include methane, ozone, and other heat-trapping gasses. Meeting our reduction goals will require all our efforts.



1 Embed Carbon in the Planning Process

- Include carbon generated by local transportation and land use decisions in the community planning process.
- Incorporate meeting Oregon's GHG reduction goals into State transportation and land use planning.
- Set 5 to 10 year benchmarks to meet ultimate GHG reduction goals.
- Incorporate State GHG goals into gas and electric utility planning.



2 Maximize the Energy Efficiency of Cities

- Redesign neighborhoods so schools, services, and shopping are easily accessible by walking, biking or transit.
- Maintain existing Urban Growth Boundaries through 2050.
- Make public transit more convenient, frequent, accessible, affordable.
- Transport more freight by rail, less in trucks.
- Create "smarter" roadways to manage traffic flow and to boost efficiency.

3 Increase Efficiency of Buildings

- Achieve zero total GHG emissions for new buildings.
- Require existing buildings to meet retrofit efficiency standard.
- Require the most carbon-efficient fuel for heating and cooling of new buildings.

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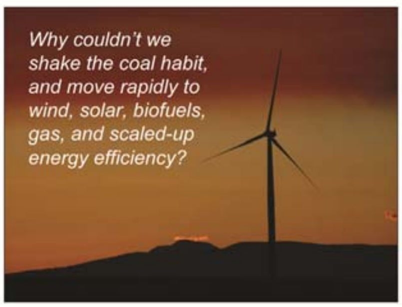
Figure 18: "Roadmap to 2020" Roadshow Handout Page 2

Roadmap to 2020 – Seven Propositions (continued)

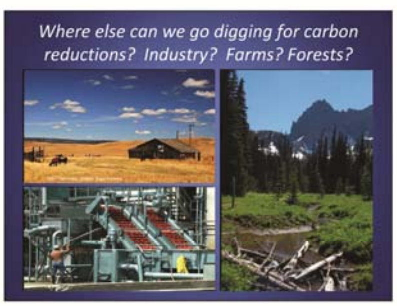
4 Shift to Lower Carbon Transportation Fuels

- Increase investment in infrastructure for electric vehicles such as recharging stations.
- Introduce electric, gas, and other low emissions vehicles in Oregon at double the national rate.
- Support vehicle biofuels production, requiring that biofuels result in a net reduction in GHG emission over their life cycle.



5 Ramp Down Coal Emissions Ramp Up Efficiency, Renewables

- Build a smart grid to integrate new energy generation and distribution technologies with new homes, machines, and vehicles designed to save and store energy.
- Replace coal generation with increased efficiency, renewable power sources (wind, solar, other), and gas turbines.



6 Reduce and Capture Carbon Across the Board

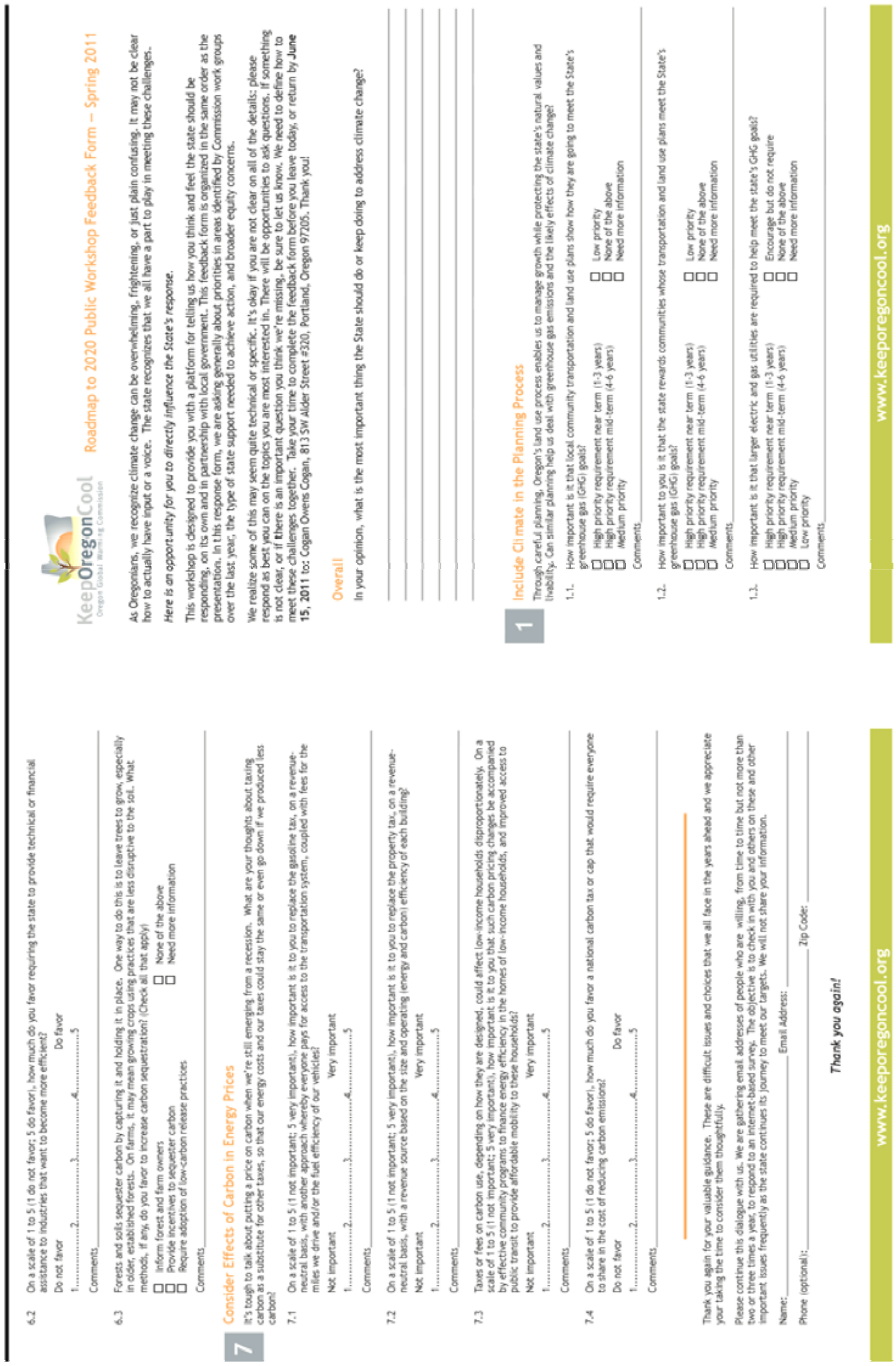
- Strengthen community programs to reduce, reuse, recycle materials.
- Label goods with their carbon content across their full lifecycle from manufacture to disposal.
- Align forest management practices to reduce and store carbon, e.g. conservation, harvest, fire management.
- Align agricultural practices with carbon reduction and storage, e.g. soil disturbance, fertilizer use, methane generation.
- Support industrial efficiency improvements.

7 Embed Carbon in Energy Prices

- Replace property taxes based on market value with tax based on carbon inefficiency of buildings.
- Implement fees for using highways at rush hour.
- Replace gas tax with a fee for miles traveled, discounted for more fuel efficient vehicles.
- Charge for parking.

For more information:
www.keeporegoncool.org

Figure 19: First Page of Handout at "Roadmap to 2020" Roadshows



KeepOregonCool
Oregon Global Warming Commission

Roadmap to 2020 Public Workshop Feedback Form – Spring 2011

As Oregonians, we recognize climate change can be overwhelming, frightening, or just plain confusing. It may not be clear how to actually have input or a voice. The state recognizes that we all have a part to play in meeting these challenges.

Here is an opportunity for you to directly influence the State's response.

This workshop is designed to provide you with a platform for telling us how you think and feel the state should be responding, on its own and in partnership with local government. This feedback form is organized in the same order as the presentation. In this response form, we are asking generally about priorities in areas identified by Commission work groups over the last year, the type of state support needed to achieve action, and broader equity concerns.

We realize some of this may seem quite technical or specific. It's okay if you are not clear on all of the details: please respond as best you can on the topics you are most interested in. There will be opportunities to ask questions. If something is not clear, or if there is an important question you think we're missing, be sure to let us know. We need to define how to meet these challenges together. Take your time to complete the feedback form before you leave today, or return by **June 15, 2011** to: Cogan Owens Cogan, 813 SW Alder Street #320, Portland, Oregon 97205. Thank you!

Overall

In your opinion, what is the most important thing the State should do or keep doing to address climate change?

1 Include Climate in the Planning Process

Through careful planning, Oregon's land use process enables us to manage growth while protecting the state's natural values and livability. Can similar planning help us deal with greenhouse gas emissions and the likely effects of climate change?

1.1. How important is it that local community transportation and land use plans show how they are going to meet the State's greenhouse gas (GHG) goals?
- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ None of the above
- ☐ Need more information

Comments____

1.2. How important to you is it that the state rewards communities whose transportation and land use plans meet the State's greenhouse gas (GHG) goals?
- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ None of the above
- ☐ Need more information

Comments____

1.3. How important is it that larger electric and gas utilities are required to help meet the state's GHG goals?
- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ Encourage but do not require
- ☐ None of the above
- ☐ Need more information

Comments____

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6.2 On a scale of 1 to 5 (1 do not favor; 5 do favor), how much do you favor requiring the state to provide technical or financial assistance to industries that want to become more efficient?

Do not favor ... Do favor
1.........2.........3.........4.........5

Comments____

6.3 Forests and soils sequester carbon by capturing it and holding it in place. One way to do this is to leave trees to grow, especially in older, established forests. On farms, it may mean growing crops using practices that are less disruptive to the soil. What methods, if any, do you favor to increase carbon sequestration? (Check all that apply)
- ☐ Inform forest and farm owners
- ☐ Provide incentives to sequester carbon
- ☐ Require adoption of low-carbon release practices
- ☐ None of the above
- ☐ Need more information

Comments____

7 Consider Effects of Carbon in Energy Prices

It's tough to talk about putting a price on carbon when we're still emerging from a recession. What are your thoughts about taxing carbon as a substitute for other taxes, so that our energy costs and our taxes could stay the same or even go down if we produced less carbon?

7.1 On a scale of 1 to 5 (1 not important; 5 very important), how important is it to you to replace the gasoline tax, on a revenue-neutral basis, with another approach whereby everyone pays for access to the transportation system, coupled with fees for the miles we drive and/or the fuel efficiency of our vehicles?

Not important ... Very important
1.........2.........3.........4.........5

Comments____

7.2 On a scale of 1 to 5 (1 not important; 5 very important), how important is it to you to replace the property tax, on a revenue-neutral basis, with a revenue source based on the size and operating (energy and carbon) efficiency of each building?

Not important ... Very important
1.........2.........3.........4.........5

Comments____

7.3 Taxes or fees on carbon use, depending on how they are designed, could affect low-income households disproportionately. On a scale of 1 to 5 (1 not important; 5 very important), how important is it to you that such carbon pricing changes be accompanied by effective community programs to finance energy efficiency in the homes of low-income households, and improved access to public transit to provide affordable mobility to these households?

Not important ... Very important
1.........2.........3.........4.........5

Comments____

7.4 On a scale of 1 to 5 (1 do not favor; 5 do favor), how much do you favor a national carbon tax or cap that would require everyone to share in the cost of reducing carbon emissions?

Do not favor ... Do favor
1.........2.........3.........4.........5

Comments____

Thank you again for your valuable guidance. These are difficult issues and choices that we all face in the years ahead and we appreciate your taking the time to consider them thoughtfully.

Please continue this dialogue with us. We are gathering email addresses of people who are willing, from time to time but not more than two or three times a year, to respond to an internet-based survey. The objective is to check in with you and others on these and other important issues frequently as the state continues its journey to meet our targets. We will not share your information.

Name:____ Email Address:____

Phone (optional):____ Zip Code:____

Thank you again!

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Figure 20: Second Page of Handout at "Roadmap to 2020" Roadshows

2 Leverage the Energy Efficiency of Cities

Close to 70% of global greenhouse gas emissions come from our urban areas. By the same token, with their more compact form and efficient buildings and transportation systems, cities are where the greatest savings are possible. What are the best ways to capture these gains?

2.1 Retain the Urban Growth Boundaries (UGB) in Oregon's six largest urban areas as they now exist, focusing development and growth where they will support more efficient buildings and services.

- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ Encourage but do not require
- ☐ None of the above
- ☐ Need more information

Comments___

2.2 Keep the UGBs as they currently exist, while allowing exceptions for new industrial facilities adjacent. ___ Yes ___ No

Comments___

2.3 How important is it to you that cities be encouraged to plan and redevelop "20-minute" neighborhoods, where shopping, services, entertainment and access to transit are accessible by walking?

- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ Encourage but do not require
- ☐ None of the above
- ☐ Need more information

Comments___

3 Leverage Efficiency of Buildings

Half the buildings that will exist in 2050 have yet to be constructed. New structures can be designed to be energy and carbon efficient or even carbon neutral. Existing buildings can be retrofitted to realize energy savings.

3.1 How important is it that we amend building codes to require new buildings to increase energy and carbon efficiency by at least 50% by 2030?

- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ Encourage but do not require
- ☐ None of the above
- ☐ Need more information

Comments___

3.2 Solar roofs are another way to reduce emissions.

On a scale of 1-9, do you favor incentives or regulations to install them on all new buildings?

(Circle one)

Incentives ... Both ... Regulations

1.........2.........3.........4.........5.........6.........7.........8.........9

Comments___

3.3 Electricity and natural gas are available to heat homes and businesses in much of Oregon. How important is it that we require building owners to select the most carbon-efficient fuel if costs (equipment and operating) are about the same?

- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ Encourage but do not require
- ☐ None of the above
- ☐ Need more information

Comments___

4 Alternative Transportation Fuels

Mobility is important to all Oregonians. Nearly 40% of total greenhouse gas emissions are related to transportation. How to preserve our transportation choices while decreasing vehicle emissions is the challenge.

4.1 What percentage of the time do you use the following types of transportation?

____private auto ____public transit ____bicycle ____walking

4.2 If you wanted to leave your car at home more often, what would need to change? ___

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4.3 How important is it that Oregon encourages electric and similar alternative fuel vehicles with incentives such as tax credits for buyers and subsidies for recharging stations?

- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ Encourage but do not require
- ☐ None of the above
- ☐ Need more information

Comments___

4.4 Currently, our federal and state gas taxes support highway construction. How important is it that they also support public transit, and perhaps new inter-city high-speed rail service as well?

- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ None of the above
- ☐ Need more information

Comments___

4.5 How important is it that the federal government requires a doubling in the fuel efficiency for new vehicles by 2020, and invests in new low-carbon vehicle technologies like electric vehicles?

- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ Encourage but do not require
- ☐ None of the above
- ☐ Need more information

Comments___

5 Replace Coal Emissions with Renewable Energy

Twenty-five percent of Oregon's greenhouse gas emissions comes from conventional coal power plants; most of them deliver electricity into Oregon from out of state. Closing coal operations by 2020 at Oregon's only in-state coal plant – PGE's Boardman facility – will reduce coal's contribution to Oregon's greenhouse gas emissions by about 4% (to 21%).

5.1 How important is it that Oregon shift rapidly – e.g. by 2030 – away from conventional coal-generated electricity sources and toward more energy efficiency and both small- and large-scale renewables like wind and solar?

- ☐ High priority requirement near term (1-3 years)
- ☐ High priority requirement mid-term (4-6 years)
- ☐ Medium priority
- ☐ Low priority
- ☐ None of the above
- ☐ Need more information

Comments___

5.2 Wind, solar and other new renewable technologies have higher up-front expenditures for capital costs, but lower fuel and operating costs over their lifetime. For many of these technologies, the higher front-end costs can be expected to drop over time, but there are no guarantees. On a scale of 1 to 5 (1 not willing; 5 very willing), how willing are you to pay somewhat higher power costs – possibly up to 10% higher – as a tradeoff to reduce carbon emissions?

Not willing ... Very willing

1.........2.........3.........4.........5

Comments___

5.3 Many of these technologies will be more useful and cost less if we expand the high-voltage transmission system. This may raise issues with some households and communities or affect scenic or ecologically sensitive areas. On a scale of 1 to 5 (1 not important; 5 very important), how much do you support expanding the transmission system, otherwise known as "the grid?"

Not important ... Very important

1.........2.........3.........4.........5

Comments___

6 Capture Carbon from all Sources

Greenhouse gas emissions also come from growing food, manufacturing consumer goods, packaging, and transporting these goods to consumers in Oregon.

6.1 On a scale of 1 to 5 (1 not important; 5 very important), how important is it to you that the state requires calculation of the estimated carbon that results from producing, shipping, selling, using and disposing the goods we buy and labeling the carbon content?

Not important ... Very important

1.........2.........3.........4.........5

Comments___

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Table 16: Summary of Responses on Feedback Forms

1.1 How important is it that local community transportation and land use plans show how they are going to meet the State's greenhouse gas (GHG) goals?

High 1-3 yrs	Hi 4-6 yrs	Med	Low	None	Need More Info
94	**47**	**6**	**4**	**4**	**2**

1. 2 How important to you is it that the state rewards communities whose transportation and land use plans meet the State's greenhouse gas (GHG) goals

High 1-3 yrs	Hi 4-6 yrs	Med	Low	Encourage but don't require	None	Need More Info
97	**37**	**2**	**2**	**2**	**2**	**7**

1.3 How important is it that larger electric and gas utilities are required to help meet the state's GHG goals?

High 1-3 yrs	Hi 4-6 yrs	Med	Low	None	Need More Info
70	**41**	**20**	**8**	**2**	**5**

2.1 Retain the Urban Growth Boundaries (UGB) in Oregon's six largest urban areas as they now exist, focusing development and growth where they will support more efficient buildings and services.

High 1-3 yrs	Hi 4-6 yrs	Med	Low	Encourage but don't require	None	Need More Info
88	**29**	**6**	**6**	**11**	**0**	**3**

2.2 Keep the UGBs as they currently exist, while allowing exceptions for new industrial facilities adjacent.

Yes	No
34	**67**

3.1 How important is it that we amend building codes to require new buildings to increase energy and carbon efficiency by at least 50% by 2030?

High 1-3 yrs	Hi 4-6 yrs	Med	Low	Encourage but don't require	None	Need More Info
94	**40**	**5**	**0**	**5**	**2**	**0**

3.2 Solar roofs are another way to reduce emissions. On a scale of 1-9, do you favor incentives or regulations to install them on all new buildings?	Average response: 7.7

3.3 Electricity and natural gas are available to heat homes and businesses in much of Oregon. How important is it that we require building owners to select the most carbon-efficient fuel if costs (equipment and operating) are about the same?

High 1-3 yrs	Hi 4-6 yrs	Med	Low	Encourage	None	Need More Info
56	**33**	**17**	**2**	**19**	**3**	**9**

4.1 What percentage of the time do you use the following types of transportation?

Private	Public	Bicycle	Walking
59.8	**4.1**	**22.2**	**13.8**

4.2 If you wanted to leave your car at home more often, what would need to change?
- More frequent/convenient transit - Safe walking/biking -More park and ride - Better urban

design/20 minute neighborhoods

4.3 How important is it that Oregon encourages electric and similar alternative fuel vehicles with incentives such as tax credits for buyers and subsidies for recharging stations?

High 1-3 yrs	Hi 4-6 yrs	Med	Low	Encourage but don't require	None	Need More Info
76	**31**	**17**	**7**	**6**	**7**	**5**

4.4 Currently, our federal and state gas taxes support highway construction. How important is it that they also support public transit, and perhaps new inter-city high-speed rail service as well?

High 1-3 yrs	High 4-6 yrs	Med	Low	None	Need More Info
97	**31**	**6**	**7**	**5**	**4**

4.5 How important is it that the federal government requires a doubling in the fuel efficiency for new vehicles by 2020, and invests in new low-carbon vehicle technologies like electric vehicles?

High 1-3 yrs	High 4-6 yrs	Med	Low	Encourage but not req'd	None	Need More Info
95	**38**	**8**	**2**	**3**	**4**	**0**

5.1 How important is it that Oregon shift rapidly – e.g. by 2030 – away from conventional coal-generated electricity sources and toward more energy efficiency and both small and large scale renewable like wind and solar?

High 1-3 yrs	High 4-6 yrs	Med	Low	None	Need More Info
87	**43**	**7**	**4**	**3**	**0**

5.2 Wind, solar and other new renewable technologies have higher up-front expenditures for capital costs, but lower fuel and operative costs over their lifetime. For many of these technologies, the higher front-end costs can be expected to drop over time, but there are no guarantees. On a scale of 1-5 (1 not willing; 5 very willing), how willing are you to pay somewhat higher power costs – possibly up to 10% higher – as a tradeoff to reduce carbon emissions?	Average response: **4.3.**
5.3 Many of these technologies will be more useful and cost less if we expand the high-voltage transmission system. This may raise issues with some households and communities or affect scenic or ecologically sensitive areas. On a scale of 1 to 5 (1 not important; 5 very important), how much do you support expanding the transmission system, otherwise known as "the grid?"	Average response: **3.8**
6.1 On a scale of 1 to 5 (1 not important; 5 very important), how important is it to you that the state requires calculation of the estimated carbon that results from producing, shipping, selling, using and disposing the goods we buy and labeling the carbon content?	Average response: **4.0.**
6.2 On a scale of 1 to 5 (1 do not favor; 5 do favor), how much do you favor requiring the state to provide technical or financial assistance to industries that want to become more efficient?	Average response: **3.9**

6. 3 Forests and soils sequester carbon by capturing it and holding it in place. One way to do this is to leave trees to grow, especially in older, established forests. On farms, it may mean growing crops using practices that are less disruptive to the soil. What methods, if any, do you favor to increase carbon sequestration? (Check all that apply)

Inform	Provide	Require	None	Need

53	52	41	5	10

7.1 On a scale of 1 to 5 (1 not important; 5 very important), how important is it to you to replace the gasoline tax, on a revenue-neutral basis, with another approach whereby everyone pays for access to the transportation system, coupled with fees for the mils we drive and/or the fuel efficiency of our vehicles?	Average response: **3.7**
7.2 On a scale of 1 to 5 (1 not important; 5 very important), how important is it to you to replace the property tax, on a revenue neutral basis, with a revenue source based on the size and operating (energy and carbon) efficiency of each building?	Average response: **3.4**
7.3 Taxes or fees on carbon use, depending on how they are designed, could affect low-income households disproportionately. On a scale of 1 to 5 (1 not important; 5 very important), how important is it to you that such carbon pricing changes be accompanied by effective community programs to finance energy efficiency in the homes of low-income households, and improved access to public transit to provide affordable mobility to these households?	Average response: **4.4.**
7.4 On a scale of 1 to 5 (1 do not favor; 5 do favor), how much do you favor a national carbon tax or cap that would require everyone to share in the cost of reducing carbon emissions?	Average response: **4.2**

Appendix 2: Oregon "In-Boundary" Greenhouse Gas Inventory Data 1990-2010

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$)

Table 17: Oregon Gross Greenhouse Gas Emissions, including Emissions Associated with the Use of Electricity[82]

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
56.177	58.249	58.158	62.498	63.357	64.365	67.344	67.894	69.413	71.851	70.264	67.181	66.473	65.379	66.859	68.296	67.579	69.880	67.634	64.816	62.760

Table 18: Oregon Greenhouse Gas Emissions, Proportional by Key Economic Sector and by Type of Greenhouse Gas

	Proportion by Key Sectors				Proportion by Greenhouse Gas			
	Transportation	Residential & Commercial	Industrial	Agriculture	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	High Global Warming Potential (HGWP) Gases
1990	37.3%	29.1%	25.1%	8.6%	84.3%	8.7%	5.9%	1.1%
1991	38.7%	28.9%	24.4%	8.1%	84.9%	8.4%	5.6%	1.1%
1992	39.0%	27.6%	25.5%	7.9%	85.0%	8.4%	5.5%	1.1%
1993	35.2%	31.6%	25.5%	7.8%	85.3%	7.9%	5.7%	1.1%
1994	36.0%	31.2%	25.2%	7.7%	85.3%	8.0%	5.4%	1.3%
1995	35.0%	30.6%	26.3%	8.1%	84.6%	8.1%	5.6%	1.7%
1996	34.7%	30.5%	26.7%	8.1%	84.5%	7.9%	5.7%	2.0%
1997	34.8%	30.6%	26.9%	7.8%	84.4%	7.9%	5.5%	2.2%
1998	35.6%	30.2%	26.4%	7.8%	84.1%	7.7%	5.6%	2.6%
1999	34.8%	31.3%	26.9%	7.0%	84.9%	7.5%	4.9%	2.7%
2000	34.5%	32.5%	25.7%	7.2%	84.5%	7.6%	5.0%	2.8%
2001	34.5%	35.1%	22.9%	7.4%	84.1%	7.9%	5.3%	2.7%
2002	35.4%	34.4%	22.0%	8.2%	83.4%	8.3%	5.6%	2.7%
2003	35.6%	35.1%	21.1%	8.2%	83.2%	8.5%	5.5%	2.8%
2004	36.3%	34.0%	21.2%	8.5%	83.0%	8.7%	5.5%	2.8%
2005	36.2%	34.8%	21.0%	8.0%	83.7%	8.5%	4.9%	2.9%
2006	37.3%	33.1%	21.1%	8.4%	83.3%	8.5%	5.2%	3.0%
2007	36.8%	34.5%	20.6%	8.1%	83.9%	8.0%	5.3%	2.8%
2008	35.8%	35.7%	20.7%	7.9%	83.7%	8.6%	4.6%	3.0%
2009	37.0%	36.1%	19.2%	7.7%	83.3%	8.7%	4.6%	3.3%
2010	36.1%	35.6%	19.8%	8.5%	82.5%	9.0%	5.1%	3.4%

[82] See *Oregon Greenhouse Gas Emissions: Multiple Perspectives* on page 65 for more information on the derivation of these data.

Table 19: Greenhouse Gas Emissions from the Transportation Sector, Part I: Carbon Dioxide Emissions

	Carbon Dioxide									
	Motor Gasoline	Distillate Fuel	Jet Fuel, Kerosene	Natural Gas	Residual Fuel	Lubricants	Aviation Gasoline	LPG	Light Rail Electricity Use	Jet Fuel, Naphtha
1990	11.6104	4.5288	1.2537	0.4886	1.7278	0.2189	0.0422	0.0433	0.0035	0.0815
1991	11.7816	4.8445	1.3931	0.4818	2.6627	0.1959	0.0439	0.0374	0.0039	0.1122
1992	11.7012	4.9305	1.5152	0.3760	2.6942	0.1997	0.0450	0.0346	0.0040	0.0977
1993	12.1555	4.6565	1.6608	0.2704	1.7566	0.2033	0.0382	0.0340	0.0047	0.0723
1994	12.3698	4.8754	1.8658	0.3226	1.8064	0.2125	0.0543	0.0521	0.0049	0.0045
1995	12.3928	4.5715	2.0530	0.4039	1.4872	0.2089	0.0498	0.0261	0.0063	0.0034
1996	12.7959	4.9019	2.1426	0.4420	1.4135	0.2027	0.0666	0.0235	0.0050	0.0014
1997	12.2033	5.0684	2.3430	0.7066	1.5080	0.2141	0.0614	0.0156	0.0050	0.0007
1998	13.1045	4.8898	2.4026	0.7451	1.7043	0.2242	0.0523	0.0002	0.0064	0.0000
1999	13.2495	5.4957	2.6364	0.5785	1.1181	0.2265	0.0559	0.0055	0.0153	0.0000
2000	13.0482	5.5242	2.5710	0.6468	0.5880	0.2231	0.0483	0.0149	0.0163	0.0000
2001	12.9442	5.1451	2.1367	0.6032	0.5479	0.2044	0.0789	0.0050	0.0169	0.0000
2002	13.1203	5.5096	2.1196	0.4993	0.5642	0.2020	0.0542	0.0055	0.0168	0.0000
2003	13.0096	5.2141	2.2893	0.3835	0.7090	0.1868	0.0473	0.0202	0.0074	0.0000
2004	13.0864	6.1045	2.0877	0.5240	0.8006	0.1892	0.0441	0.0193	0.0073	0.0000
2005	13.2412	6.3602	2.2124	0.4098	0.8772	0.1882	0.0503	0.0406	0.0083	0.0000
2006	13.4130	6.7104	2.3609	0.4622	0.6887	0.1834	0.0710	0.0341	0.0079	0.0000
2007	13.4161	6.9443	2.3059	0.5311	1.0175	0.1894	0.0703	0.0246	0.0087	0.0000
2008	12.5765	6.8562	2.2377	0.4096	0.7135	0.1758	0.0646	0.0508	0.0086	0.0000
2009	12.6586	6.5222	2.6723	0.4486	0.3671	0.1581	0.0468	0.0380	0.0103	0.0000
2010	13.8583	5.0148	1.7670	0.3523	0.2834	0.1756	0.0463	0.0390	0.0107	0.0000

Data continued in Table 20 on next page

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$)

Table 20: Greenhouse Gas Emissions from the Transportation Sector, Part II: Methane, Nitrous Oxide and HGWP Gas Emissions

	Methane			Nitrous Oxide				HGWP	
	Passenger & Light Vehicles	Non-Road Vehicles & Equipment	Heavy-Duty Vehicles	Natural Gas Distribution (sector share)	Passenger & Light Vehicles	Non-Road Vehicles & Equipment	Heavy-Duty Vehicles	Refrigerants, A/C, Fire Protection	Transportation Sector Emissions
1990	0.0799	0.0091	0.0059	0.0001	0.7885	0.0477	0.0196	0.0019	20.9512
1991	0.0740	0.0111	0.0057	0.0001	0.7907	0.0595	0.0208	0.0037	22.5225
1992	0.0771	0.0110	0.0058	0.0001	0.8831	0.0605	0.0228	0.0101	22.6686
1993	0.0790	0.0087	0.0057	0.0001	0.9608	0.0504	0.0244	0.0365	22.0181
1994	0.0745	0.0093	0.0056	0.0001	0.9591	0.0536	0.0251	0.0819	22.7775
1995	0.0713	0.0091	0.0054	0.0001	0.9735	0.0527	0.0256	0.1839	22.5247
1996	0.0670	0.0090	0.0051	0.0001	0.9717	0.0533	0.0267	0.2560	23.3840
1997	0.0661	0.0099	0.0048	0.0001	1.0162	0.0590	0.0300	0.3274	23.6398
1998	0.0635	0.0101	0.0045	0.0002	1.0244	0.0608	0.0324	0.3721	24.6975
1999	0.0594	0.0085	0.0043	0.0002	1.0103	0.0543	0.0332	0.4201	24.9717
2000	0.0552	0.0076	0.0038	0.0003	0.9722	0.0487	0.0321	0.4626	24.2631
2001	0.0523	0.0075	0.0031	0.0004	0.8966	0.0441	0.0275	0.4944	23.2081
2002	0.0447	0.0076	0.0030	0.0004	0.8038	0.0458	0.0283	0.5309	23.5561
2003	0.0410	0.0061	0.0028	0.0005	0.7401	0.0428	0.0286	0.5584	23.2872
2004	0.0378	0.0076	0.0028	0.0005	0.6738	0.0471	0.0279	0.5846	24.2454
2005	0.0342	0.0081	0.0036	0.0010	0.6000	0.0497	0.0262	0.6064	24.7175
2006	0.0316	0.0083	0.0026	0.0009	0.5390	0.0499	0.0142	0.6274	25.2056
2007	0.0282	0.0089	0.0028	0.0009	0.4600	0.0536	0.0143	0.6357	25.7123
2008	0.0251	0.0078	0.0030	0.0010	0.3850	0.0481	0.0141	0.6435	24.2211
2009	0.0233	0.0071	0.0033	0.0010	0.3225	0.0486	0.0176	0.6625	24.0080
2010	0.0219	0.0070	0.0034	0.0011	0.2815	0.0414	0.0166	0.7108	22.6312

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$)

Table 21: Greenhouse Gas Emissions from the Residential and Commercial Sector, Part I: Carbon Dioxide Emissions

	Carbon Dioxide								
	Residential Electricity Use	Commercial Electricity Use	Residential Natural Gas Combustion	Commercial Natural Gas Combustion	Commercial Petroleum Combustion	Residential Petroleum Combustion	Waste Incineration	Residential Coal Combustion	Commercial Coal Combustion
1990	5.9550	4.6816	1.2676	1.1085	0.7870	0.7616	0.1459	0.0009	0.0034
1991	6.1758	4.7995	1.4382	1.2198	0.6576	0.7339	0.1458	0.0004	0.0018
1992	5.8864	4.8690	1.2717	1.0769	0.5929	0.6120	0.1427	0.0004	0.0018
1993	7.7430	5.9635	1.6424	1.3263	0.4919	0.7592	0.1454	0.0008	0.0038
1994	7.6351	6.2269	1.6000	1.2734	0.4577	0.7375	0.1442	0.0003	0.0020
1995	7.5679	6.2891	1.5539	1.2412	0.5606	0.6510	0.1410	0.0003	0.0019
1996	7.8149	6.3683	1.8384	1.4159	0.5012	0.6220	0.1412	0.0000	0.0000
1997	7.8154	6.5840	1.8109	1.4180	0.4887	0.5488	0.1405	0.0002	0.0019
1998	7.8133	6.5630	1.9154	1.4462	0.5431	0.5289	0.1383	0.0000	0.0000
1999	8.3772	7.1196	2.1673	1.6023	0.4551	0.6042	0.1337	0.0001	0.0004
2000	8.4494	7.2981	2.1153	1.5627	0.5367	0.6169	0.1321	0.0000	0.0000
2001	8.6867	7.5752	2.0872	1.5207	0.6474	0.6546	0.1303	0.0000	0.0000
2002	8.2918	7.2601	2.1119	1.5063	0.5784	0.6168	0.1280	0.0000	0.0000
2003	8.5391	7.4547	1.9910	1.3937	0.3611	0.5718	0.1267	0.0000	0.0000
2004	8.4728	7.3742	2.0598	1.4013	0.3462	0.4400	0.1226	0.0000	0.0000
2005	9.0299	7.5728	2.1860	1.5174	0.3434	0.4615	0.1206	0.0000	0.0000
2006	8.2537	6.9946	2.2534	1.5286	0.3237	0.4251	0.1200	0.0000	0.0000
2007	9.1555	7.6490	2.3475	1.5880	0.2930	0.3629	0.1189	0.0000	0.0000
2008	9.0007	7.3748	2.4475	1.6539	0.3770	0.4049	0.1177	0.0000	0.0000
2009	8.5810	6.9229	2.4363	1.6168	0.4433	0.4492	0.1160	0.0000	0.0000
2010	8.0943	6.6399	2.3645	1.5782	0.4399	0.3625	0.1314	0.0000	0.0000

Data continued in Table 22 on next page

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$)

Table 22: Greenhouse Gas Emissions from the Residential and Commercial Sector, Part II: Methane, Nitrous Oxide and HGWP Gas Emissions

	Methane						Nitrous Oxide					HGWP	
	Municipal Solid Waste Landfills	Natural Gas Distribution (sector share)	Municipal Wastewater	Residential Combustion Byproducts	Commercial Combustion Byproducts	Waste Incineration	Municipal Wastewater	Fertilization of Landscaped Areas	Waste Incineration	Residential Combustion Byproducts	Commercial Consumption Byproducts	Refrigerants, Aerosols, Fire Protection	Residential & Commercial Sector Emissions
1990	0.9702	0.2043	0.1923	0.0514	0.0162	0.0102	0.0782	0.0565	0.0118	0.0197	0.0049	0.0013	16.3285
1991	0.9739	0.2138	0.1963	0.0539	0.0162	0.0102	0.0806	0.0546	0.0123	0.0197	0.0047	0.0026	16.8116
1992	0.9208	0.2233	0.2000	0.0556	0.0141	0.0100	0.0836	0.0572	0.0124	0.0193	0.0041	0.0071	16.0613
1993	0.9088	0.2328	0.2041	0.0678	0.0176	0.0101	0.0853	0.0565	0.0151	0.0196	0.0047	0.0255	19.7240
1994	0.8877	0.2383	0.2076	0.0644	0.0118	0.0100	0.0875	0.0620	0.0144	0.0194	0.0034	0.0573	19.7412
1995	0.8526	0.2439	0.2113	0.0641	0.0121	0.0098	0.0883	0.0613	0.0142	0.0190	0.0037	0.1287	19.7158
1996	0.9017	0.2494	0.2149	0.0668	0.0126	0.0098	0.0906	0.0660	0.0147	0.0189	0.0037	0.1792	20.5302
1997	0.9536	0.2549	0.2181	0.0574	0.0128	0.0097	0.0912	0.0719	0.0127	0.0188	0.0037	0.2292	20.7426
1998	0.9851	0.2467	0.2208	0.0517	0.0119	0.0095	0.0931	0.0705	0.0116	0.0185	0.0037	0.2605	20.9318
1999	0.9922	0.2608	0.2230	0.0537	0.0124	0.0092	0.0957	0.0534	0.0121	0.0179	0.0036	0.2941	22.4879
2000	1.0204	0.3256	0.2308	0.0573	0.0131	0.0091	0.0999	0.0397	0.0129	0.0176	0.0039	0.3238	22.8651
2001	1.0664	0.3404	0.2334	0.0900	0.0195	0.0089	0.1028	0.0578	0.0194	0.0173	0.0054	0.3461	23.6096
2002	1.0914	0.3425	0.2366	0.0912	0.0197	0.0088	0.1016	0.0824	0.0196	0.0170	0.0053	0.3716	22.8809
2003	1.1485	0.3441	0.2389	0.0954	0.0195	0.0086	0.1025	0.0937	0.0203	0.0167	0.0048	0.3909	22.9220
2004	1.1807	0.3397	0.2405	0.0973	0.0191	0.0084	0.1042	0.0901	0.0204	0.0162	0.0047	0.4092	22.7473
2005	1.1737	0.3546	0.2436	0.0648	0.0134	0.0082	0.1065	0.0800	0.0141	0.0159	0.0036	0.4245	23.7343
2006	1.1458	0.3599	0.2474	0.0581	0.0127	0.0081	0.1087	0.0783	0.0127	0.0157	0.0034	0.4392	22.3891
2007	1.2234	0.3738	0.2511	0.0622	0.0132	0.0080	0.1108	0.0842	0.0134	0.0156	0.0034	0.4450	24.1190
2008	1.3394	0.3855	0.2544	0.0681	0.0141	0.0079	0.1126	0.0751	0.0146	0.0154	0.0038	0.4505	24.1179
2009	1.3600	0.4196	0.2573	0.0654	0.0142	0.0078	0.1144	0.0665	0.0142	0.0151	0.0039	0.4638	23.3678
2010	1.3026	0.4106	0.2577	0.0601	0.0116	0.0052	0.1150	0.0504	0.0138	0.0101	0.0040	0.4976	22.3496

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$)

Table 23: Greenhouse Gas Emissions from the Industrial Sector, Part I: Carbon Dioxide Emissions

	Carbon Dioxide										
	Industrial Electricity Use	Natural Gas Combustion	Petroleum Combustion	Iron & Steel Production	Cement Manufacture	Coal Combustion	Ammonia Production & Urea Consumption	Lime Manufacture	Soda Ash Production & Consumption	Waste Incineration	Limestone and Dolomite Use
1990	6.0009	2.6043	2.6300	0.2161	0.1370	0.0770	0.0653	0.7042	0.0311	0.0087	0.0855
1991	5.9232	2.9530	2.3697	0.2251	0.1802	0.0763	0.0653	0.7042	0.0302	0.0087	0.1076
1992	5.8558	3.1605	2.8142	0.2283	0.2212	0.0797	0.0653	0.7042	0.0306	0.0087	0.1246
1993	6.9620	3.2850	2.6262	0.1962	0.2143	0.0734	0.0601	0.7042	0.0307	0.0087	0.1397
1994	6.9903	3.4015	2.3911	0.2136	0.2724	0.0770	0.0637	0.7042	0.0308	0.0070	0.1466
1995	7.3473	3.7384	2.5000	0.2069	0.2700	0.0798	0.1048	0.7042	0.0322	0.0118	0.1574
1996	7.6992	4.7542	2.0308	0.3589	0.1855	0.0818	0.0467	0.7042	0.0319	0.0056	0.1720
1997	7.6768	4.9254	1.9766	0.3791	0.1876	0.0804	0.0275	0.8110	0.0326	0.0115	0.1559
1998	6.5257	5.5782	2.5089	0.3972	0.0724	0.0823	0.0250	0.7470	0.0330	0.0114	0.1710
1999	6.5438	5.9038	3.0355	0.4566	0.1750	0.0809	0.0137	0.6401	0.0325	0.0126	0.1598
2000	7.5872	4.0526	2.6003	0.4449	0.1751	0.0742	0.0159	0.7503	0.0322	0.0084	0.1452
2001	6.4938	3.7015	1.8416	0.4282	0.1751	0.0570	0.0126	0.5726	0.0322	0.0062	0.0978
2002	5.8081	3.7330	2.0075	0.4292	0.1037	0.0747	0.0135	0.4400	0.0326	0.0081	0.0739
2003	5.7586	3.5111	1.4974	0.3698	0.1391	0.0659	0.0110	0.4286	0.0318	0.0051	0.0771
2004	5.6265	3.7288	1.6732	0.4220	0.1306	0.0722	0.0122	0.4294	0.0317	0.0072	0.0973
2005	6.2454	3.7056	1.4316	0.4434	0.0194	0.0715	0.0141	0.3403	0.0315	0.0096	0.0948
2006	5.6500	3.7773	1.5772	0.4545	0.2476	0.0781	0.0134	0.3640	0.0312	0.0067	0.0829
2007	6.1987	3.7009	1.3783	0.4506	0.2163	0.0773	0.0125	0.3687	0.0305	0.0067	0.0000
2008	5.8522	3.6701	1.4852	0.3203	0.1567	0.0718	0.0275	0.3651	0.0294	0.0067	0.0000
2009	5.0960	3.0587	1.3768	0.3138	0.1795	0.0702	0.0456	0.2336	0.0260	0.0067	0.0000
2010	5.0304	3.2334	1.3387	0.4554	0.1727	0.1126	0.0386	0.0298	0.0145	0.0097	0.0000

Data continued on next page in Table 24

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$)

Table 24: Greenhouse Gas Emissions from the Industrial Sector, Part II: Methane, Nitrous Oxide and HGWP Greenhouse Gas Emissions

	Methane					Nitrous Oxide			HGWP			
	Natural Gas Distribution & Production	Industrial Landfills	Combustion Byproducts	Food Processing Wastewater	Pulp & Paper Wastewater	Combustion Byproducts	Waste Incineration	Nitric Acid Production	Semiconductor Manufacturing	Refrigerants, Foam, Solvents, Aerosol Use	Aluminum Production	Industrial Sector Emissions
1990	0.4378	0.3226	0.0696	0.0271	0.0098	0.0548	0.0031	0.0005	0.2913	0.0006	0.3129	14.0900
1991	0.4378	0.3369	0.0717	0.0260	0.0094	0.0522	0.0031	0.0005	0.2913	0.0011	0.3158	14.1891
1992	0.4378	0.3518	0.0741	0.0207	0.0091	0.0422	0.0031	0.0005	0.2913	0.0030	0.3075	14.8342
1993	0.4378	0.3672	0.0748	0.0185	0.0096	0.0377	0.0036	0.0005	0.3641	0.0109	0.2813	15.9064
1994	0.4378	0.3762	0.0779	0.0192	0.0100	0.0390	0.0042	0.0005	0.4006	0.0246	0.2499	15.9380
1995	0.4378	0.3845	0.0812	0.0193	0.0098	0.0391	0.0039	0.0005	0.4950	0.0552	0.2557	16.9348
1996	0.4378	0.3935	0.0853	0.0227	0.0104	0.0453	0.0072	0.0005	0.5498	0.0768	0.2703	17.9705
1997	0.4378	0.4019	0.0898	0.0243	0.0099	0.0483	0.0072	0.0005	0.5809	0.0982	0.2723	18.2354
1998	0.4378	0.4237	0.0947	0.0213	0.0094	0.0426	0.0093	0.0005	0.7694	0.1116	0.2793	18.3517
1999	0.4378	0.4248	0.0992	0.0197	0.0100	0.0395	0.0104	0.0005	0.8448	0.1260	0.2803	19.3472
2000	0.4378	0.3735	0.1053	0.0210	0.0077	0.0424	0.0091	0.0005	0.7910	0.1388	0.2720	18.0854
2001	0.4378	0.3647	0.1100	0.0204	0.0070	0.0409	0.0118	0.0005	0.6103	0.1483	0.1911	15.3612
2002	0.4378	0.3675	0.1158	0.0170	0.0071	0.0343	0.0125	0.0005	0.6415	0.1593	0.0840	14.6017
2003	0.4378	0.3703	0.1141	0.0131	0.0082	0.0262	0.0150	0.0005	0.6450	0.1675	0.0835	13.7766
2004	0.4378	0.3800	0.1193	0.0181	0.0090	0.0362	0.0168	0.0005	0.6460	0.1754	0.0870	14.1572
2005	0.4378	0.3700	0.1265	0.0179	0.0082	0.0356	0.0179	0.0005	0.6569	0.1819	0.0858	14.3464
2006	0.4378	0.3698	0.1358	0.0190	0.0088	0.0378	0.0221	0.0005	0.7090	0.1882	0.0790	14.2909
2007	0.4378	0.3625	0.1483	0.0191	0.0105	0.0379	0.0176	0.0005	0.7101	0.1907	0.0000	14.3753
2008	0.4378	0.3567	0.1624	0.0170	0.0098	0.0338	0.0181	0.0005	0.7657	0.1931	0.0000	13.9796
2009	0.4378	0.3288	0.1762	0.0167	0.0094	0.0334	0.0141	0.0005	0.7945	0.1988	0.0000	12.4170
2010	0.4378	0.3435	0.1875	0.0167	0.0097	0.0333	0.0125	0.0005	0.8025	0.1453	0.0000	12.4251

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent (MMTCO_2e)

Table 25: Greenhouse Gas Emissions from the Agricultural Sector

	Carbon Dioxide		Methane			Nitrous Oxide			
	Urea Fertilization	Liming of Agricultural Soils	Enteric Fermentation	Manure Management	Agricultural Residue Burning	Agricultural Soil Management	Manure Management	Agricultural Residue Burning	Agriculture Sector Emissions
1990	0.0628	0.0295	2.1966	0.2613	0.0033	2.1480	0.1044	0.0012	4.8069
1991	0.0623	0.0247	2.2160	0.2623	0.0027	2.0530	0.1038	0.0010	4.7258
1992	0.0635	0.0271	2.2209	0.2682	0.0028	1.9053	0.1054	0.0010	4.5941
1993	0.0652	0.0289	2.2138	0.2581	0.0037	2.1869	0.0920	0.0013	4.8499
1994	0.0707	0.0305	2.3603	0.2731	0.0034	2.0479	0.1131	0.0012	4.9001
1995	0.0718	0.0327	2.4945	0.2784	0.0034	2.1859	0.1213	0.0012	5.1892
1996	0.0742	0.0352	2.5577	0.2692	0.0038	2.4055	0.1118	0.0013	5.4588
1997	0.0785	0.0378	2.5405	0.2734	0.0035	2.2282	0.1126	0.0012	5.2758
1998	0.0850	0.0405	2.4781	0.2746	0.0034	2.4242	0.1256	0.0012	5.4325
1999	0.0703	0.0417	2.4804	0.2912	0.0022	2.0243	0.1336	0.0008	5.0444
2000	0.0525	0.0437	2.3848	0.3042	0.0032	2.1166	0.1446	0.0011	5.0507
2001	0.0803	0.0375	2.2536	0.3117	0.0019	2.1670	0.1498	0.0007	5.0025
2002	0.1292	0.0327	2.3485	0.3682	0.0020	2.4001	0.1527	0.0007	5.4340
2003	0.1440	0.0335	2.3502	0.3568	0.0030	2.3491	0.1554	0.0010	5.3931
2004	0.1202	0.0394	2.5173	0.4044	0.0031	2.4592	0.1649	0.0011	5.7095
2005	0.1169	0.0428	2.5499	0.4047	0.0029	2.2389	0.1407	0.0010	5.4976
2006	0.1218	0.0407	2.5231	0.3946	0.0024	2.4626	0.1473	0.0008	5.6934
2007	0.1281	0.0397	2.2530	0.3855	0.0025	2.7187	0.1447	0.0009	5.6731
2008	0.1134	0.0368	2.3542	0.3883	0.0029	2.2743	0.1450	0.0010	5.3158
2009	0.0983	0.0297	2.1561	0.3820	0.0028	2.2112	0.1417	0.0009	5.0228
2010	0.1253	0.0275	2.1939	0.3855	0.0036	2.4755	0.1415	0.0012	5.3538

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent (MMTCO$_2$e)

Table 26: In-State Electric Power Generation Emissions and Adjustment to Derive Production-Based Gross Inventory for Oregon

	Carbon Dioxide			CH_4	N_2O	HGWP		Production-Based Adjustment	
	OR Power Plant Natural Gas Combustion	OR Power Plant Coal Combustion	OR Power Plant Petroleum Combustion	OR Power Plant Combustion Byproducts	OR Power Plant Combustion Byproducts	Transmission and Distribution Systems	Electric Power Generation Sub-total	Remove Total Electricity Use Emissions	Gross GhG Emissions, Production Basis
1990	0.4021	1.3689	0.0241	0.0037	0.0132	0.4225	2.2345	(16.64)	41.7703
1991	0.6224	2.9778	0.0099	0.0035	0.0198	0.4039	4.0373	(16.90)	45.3837
1992	0.7917	3.7130	0.0080	0.0036	0.0232	0.3954	4.9350	(16.62)	46.4780
1993	0.9270	3.3585	0.0240	0.0034	0.0214	0.3846	4.7189	(20.67)	46.5439
1994	1.4347	4.0140	0.0047	0.0040	0.0253	0.3563	5.8390	(20.86)	48.3387
1995	1.0453	1.6742	0.0050	0.0040	0.0151	0.3252	3.0688	(21.21)	46.2228
1996	1.4236	1.7689	0.0044	0.0039	0.0152	0.3059	3.5220	(21.89)	48.9782
1997	1.3017	1.3885	0.0100	0.0037	0.0132	0.2774	2.9945	(22.08)	48.8070
1998	2.8563	3.3076	0.0253	0.0050	0.0242	0.2196	6.4379	(20.91)	54.9430
1999	2.6752	3.5390	0.0066	0.0040	0.0237	0.2242	6.4727	(22.06)	56.2681
2000	3.7458	3.5483	0.0450	0.0050	0.0254	0.2216	7.5910	(23.35)	54.5044
2001	4.4663	3.9760	0.0783	0.0054	0.0280	0.2039	8.7578	(22.77)	53.1666
2002	3.0103	3.3584	0.0060	0.0039	0.0226	0.1887	6.5900	(21.38)	51.6859
2003	4.0271	3.9775	0.0432	0.0052	0.0278	0.1795	8.2603	(21.76)	51.8795
2004	4.7993	3.2139	0.0171	0.0058	0.0253	0.1787	8.2400	(21.48)	53.6186
2005	4.7578	3.2472	0.0402	0.0063	0.0265	0.1768	8.2547	(22.86)	53.6940
2006	4.0834	2.2215	0.0049	0.0057	0.0206	0.1704	6.5065	(20.91)	53.1792
2007	5.5589	3.9546	0.0039	0.0062	0.0293	0.1575	9.7102	(23.01)	56.5779
2008	6.3092	3.6418	0.0092	0.0049	0.0252	0.1605	10.1509	(22.24)	55.5491
2009	5.8887	2.8622	0.0024	0.0050	0.0218	0.1566	8.9367	(20.61)	53.1422
2010	5.9694	4.0447	0.0025	0.0137	0.0275	0.1448	10.2026	(19.78)	53.1868

ADD POWER GENERATION SUB-TOTAL TO TOTAL

All emissions data are expressed in Million Metric Tons of Carbon Dioxide Equivalent ($MMTCO_2e$)

The Capture and Storage of Carbon in Oregon: The "Net Inventory" Framework

An additional perspective on Oregon's contribution to greenhouse gas emissions can be obtained by taking into account not only the emissions of greenhouse gases from anthropogenic sources, but also the removal and storage of carbon from the atmosphere. The storage of carbon in trees, vegetation, and soil are the best known "sinks" but there are other important points where carbon is captured and stored, i.e., sequestered, and therefore delayed from being released into the atmosphere. International greenhouse gas accounting standards require this type of "net inventory" for national reporting and utilize complex protocols to estimate these removals. At the state level, however, creating a net inventory is challenging. Few data are available that conform to state boundaries and the increased resolution necessary for state-level analysis taxes most data sources.

Oregon is fortunate to have access to several data sources for carbon sequestration that are scaled to Oregon's boundaries. However, there is no single definitive data set for forest sequestration. Different approaches utilize different modeling assumptions and techniques. The results from two modeling initiatives at Oregon State University (OSU) are provided here so that users of these data can consult the references and decide which of the two data sources to use. Given the substantial year-to-year variability of these estimates it is recommended that multiple year averages be used wherever possible. A selection of sequestration data estimates is given below in Table 27 so that those interested in creating a net inventory for Oregon can utilize the data appropriate for their needs to do so.

Table 27: Annual Estimates of Carbon Sequestration in Oregon

(million metric tons of carbon dioxide, negative means sequestration)		1990 - 2000	2001 - 2007	2001-2010
Different Estimates	OSU ORCA Project Forest Net Biome Production[83] (modified to include product carbon sink estimate = ¼ of timber harvest)[84]	(24.42)	(22.71)	n/a
	OSU Forest LandCarb Data (ecosystem estimate + product sink)[85]	(17.05)		0.47
	OSU Forest LandCarb Data (same with 5-year rolling average)	(19.78)		(7.08)
Urban Trees (estimate from US EPA State Inventory Tool land use module)		(0.60)		(0.73)
OSU ORCA Project Net Biome Production of Non-Forest Systems (croplands, wetlands, and other ecosystems)[86]		(7.72)	(1.68)	n/a
Disposal in Landfills of Waste Originating from Oregon (portion of food discards, yard trimmings, wood and paper expected not to decompose)[87]		(0.87)		(0.86)

[83] Turner, D.P., W.D. Ritts, Z. Yang, R.E. Kennedy, W.B. Cohen, M.V. Duane, P.E. Thornton, B.E. Law. 2011. Decadal trends in net ecosystem production and net ecosystem carbon balance for a regional socioecological system. Forest Ecology and Management 262: 1

[84] Peter Kelly, A Greenhouse Gas Inventory of Oregon's Forests, Oregon Department of Energy, 2009. http://www.Oregon.gov/ENERGY/GBLWRM/docs/Oregon_Forests_GHG_Inventory_OGWC_Report_Final.pdf

[85] Final Report - LandCarb Simulation of Forest Carbon Flux in Oregon; Mark E. Harmon and Frank Schnekenburger, Department of Forest Ecosystems and Society, Oregon State University, December 2009. (http://www.oregon.gov/odf/indicators/pages/indicatorga.asp)

[86] Turner, D.P, W.D. Ritts, B.E. Law, W.B. Cohen, Z. Yang, T. Hudiburg, J.L. Campbell, M. Duane. 2007. Scaling net ecosystem production and net biome production over a heterogeneous region in the western United States. Biogeosciences 4:597-612.

[87] http://www.deq.state.or.us/lq/pubs/docs/sw/Number09Materials.pdf

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