Oregon Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Emission Reduction

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ABSTRACT
Challenged by the Legislature with figuring out a way to substantially reduce greenhouse gas (GHG) emissions, the Oregon Department of Transportation (ODOT) embarked on a two-year effort to determine the best strategies for reducing transportation-related emissions. The resulting *Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Reduction* (STS) was accepted by Oregon's Transportation Commission in early 2013, and acts as a potential path forward to help meet Oregon's 2050 GHG reduction goal of 75 percent fewer emissions than 1990. The process undertaken to develop the STS was inventive and rigorous. A new policy-level analysis model, GreenSTEP, was created and enhanced throughout the effort and is now being used by several metropolitan areas throughout the state, and has been adapted nationally. During the development of the STS analytical and political hurdles were overcome and lessons were learned. This paper shares some of those lessons learned and offers a methodological approach for others to follow.

INTRODUCTION

In 2010, the Oregon Legislature passed Senate Bill 1059, a comprehensive bill aimed at planning for ways to reduce greenhouse gas (GHG) emissions from the transportation sector (*1*). One of the requirements included the development of a statewide strategy to aid Oregon in achieving its statutory GHG reduction goals to arrest growth in GHG emissions by the year 2010, reduce them to 20 percent below 1990 levels by 2035, and reduce them to 75 percent below 1990 levels by 2050 (*2*). The requirement for a statewide strategy grew out of discussions of a legislative task force that was directed to propose legislation to require Metropolitan Planning Organizations (MPOs) to plan for reducing GHG emissions from light-duty vehicle travel. The task force recognized that MPO planning efforts alone would be inadequate and that a statewide strategy was needed to provide broader direction and a context for metropolitan level planning.

The Oregon Department of Transportation (ODOT), with assistance of Cambridge Systematics and other supporting consultants, developed the Statewide Transportation Strategy (STS) over a two year period and the Oregon Transportation Commission accepted the resulting document in March 2013. Throughout the process, ODOT worked closely with technical and policy-level stakeholders, and released drafts for public review. A new policy-level analysis tool, GreenSTEP was created for the effort and helped to inform the selection of strategies. An overview of the methodological approach and analytical tools, findings, and challenges encountered and lessons learned are summarized below.

APPROACH

Senate Bill 1059 established general requirements for the STS. It only specified that the strategy be developed as part of the Oregon Transportation Commission's statutory planning requirements; that it "aid in achieving" the statutory GHG reduction goals; and that its development be coordinated with MPOs, local governments, state agencies, and stakeholders, It was left to ODOT to figure out what a GHG reduction strategy is, what it should accomplish and how it should relate to the statewide transportation plan. Some of the following key questions had to be answered in order to move forward:

1. What is a strategy and how is it different than a plan? What is the planning horizon, how does it fit within the hierarchy of plans in the State, and is it regulatory?
2. How should the STS address potential actions that are beyond the control of state government (e.g. federal fuel economy standards)?
3. How should the STS address the uncertainty that is associated with projecting into the future many of the factors (e.g. electric vehicle technology) that affect GHG emissions?
4. What GHG reduction targets should the STS aim for given that there are no corresponding requirements for other sectors of the economy?
5. What parts of the transportation sector (e.g. movement of people; movement of goods) should be considered and how should they be analyzed or addressed?
6. How should the emissions accounting be done (e.g. emissions within the boundaries of Oregon or those produced by Oregonians)?

The process used to answer these questions and develop the STS relied heavily on close coordination with a number of advisory committees. A Technical Advisory Committee (TAC) composed of staff from local, MPO, state and federal agencies, and other key stakeholders was formed to develop assumptions for the scenarios, assess the technical plausibility of assumptions, and review modeling and analysis results. Work of the TAC helped to inform the Policy Committee, which included high-level officials such as commissioners, heads of interest organizations, state agency executive-level staff, and elected officials. The Policy Committee was used to provide advice and consent on the STS and recommendations forwarded to the Oregon Transportation Commission. They assessed the political plausibility of assumptions, revised scenarios, made policy recommendations, and helped to craft the STS document. These two committees were the primary advisory bodies to the plan and helped to assure a diversity of perspectives were considered and helped to secure buy-in across the state and among stakeholder groups. Two secondary advisory groups were utilized which included key interagency technical and management personnel from state transportation, energy, environmental quality, and land use planning agencies. Regular meetings of both committees were held in order to coordinate technical analysis and management decisions.

Early in the process, ODOT staff developed a one-page description of the STS in order to create the basis for a common understanding of what the STS would be and would do. It was reviewed and approved by ODOT's agency partners and the Policy Committee. The following excerpt from this document succinctly describes the nature of the STS (*3*):

- "The Statewide Transportation Strategy will include a long-range vision (to 2050) for substantially reducing GHG emissions from the transportation sector to aid in achieving the GHG emission reduction goals set forth in ORS 468A.205."
- "The strategy will describe the general characteristics of transportation systems, vehicle and fuel technologies and land use patterns (…) anticipated to be necessary to achieve the reductions in transportation sector greenhouse gas emissions."
- "The strategy will make recommendations regarding new policies or significant changes to existing policies that are anticipated to be necessary to carry out the vision, and will integrate into existing transportation planning processes (…)."
- "The strategy is not a deterministic plan, rather it plots out a general course for achieving goals based on current knowledge, analysis, and reflection. It is one step in an iterative management process that also includes the monitoring of transportation and land use system changes that affect greenhouse gas emissions, the evaluation of the relative success of policies and actions put into place to reduce emissions, and the improvement of methods and tools for evaluating prospective actions to reduce emissions."

This one-page description answered the first three of the key questions presented above. As a strategy the STS was intended to provide a non-regulatory context for transportation planning in Oregon and to make recommendations for changes to transportation and land use in order to achieve substantial reductions in transportation sector GHG emissions. The STS would provide a comprehensive 40-year vision of what needs to be done in order to reduce GHG emissions, regardless of who would do it. Finally, because of uncertainties in how the future will unfold in a number of respects, the STS would not be a deterministic, but would instead be part of an iterative management process.

The question of what the transportation emission reduction goal should be for the STS was a topic of discussion early in the process. While Oregon had a 75 percent reduction goal in statue, it was not broken down by sector. Additionally, transportation was the first, and to date only, sector mandated to plan for ways to help achieve the State goal and no other sectors had done work to apportion emission goals. Without knowing other sector goals, the decision was made to try and achieve the 75 percent reduction within the transportation sector alone. If all sectors were to take such an approach it was thought that the overall state goal could be achievable. Also, this helped to limit analysis to the transportation sector and related land uses, which might have otherwise become burdensome and unwieldy by needing to also assess other sectors. While it was decided that transportation shoot for a 75 percent reduction, throughout the process stakeholders continued to wonder if there may be more cost-effective ways to reach higher reductions in other sectors of the economy.

In considering what parts of the transportation sector to address, ODOT elected to be comprehensive and look at all modes of transportation including the movement of people on the ground and in the air, and the movement of freight by truck, rail, water, and air. While each of these parts of transportation relate to one another, there exists significant market differences and different strategies for moving people on the ground as opposed to the air, and between moving people and moving freight. Consequently, the STS analysis was segmented into three travel markets: ground passenger and commercial service travel, freight travel, and air passenger travel. This distinction helped in the modeling and analysis work to be able to better distinguish discrete potential actions to discrete probable outcomes. Although the processes of scenario development, modeling and analysis were carried out separately for each travel market, consideration was given to similarities and interactions between the markets, and the resulting recommendations were integrated in the final document.

The final question about how the GHG emissions accounting should be done was a topic of considerable discussion. Within the ground passenger and commercial services travel market, the first to be analyzed, it was decided that emissions should be accounted for Oregonians and at a household level, as opposed to tracking emissions for everyone traveling within the boundary of Oregon. In this way, actions to reduce GHG could be targeted more specifically within the sphere of influence of the State, to the households contained within Oregon. Additionally, the emissions produced within Oregon would not be confined to Oregon and have a much broader impact. This global impact is more easily tracked when accounted by total household travel, not travel within certain geographic boundaries. For the freight travel market a similar approach was adopted, where emissions were tracked at the household level. In this approach, emissions were looked at from a consumption basis, tracking the movement of a finished good from the distribution center (within Oregon, nationally, or internationally) to the household consumer in Oregon. Likewise in the air passenger travel market, emission were tracked at the household level, looking at the total trip of an Oregonian to their destination and back (within Oregon, nationally, or internationally).

With the key questions answered, ODOT was ready to move forward with crafting alternative scenarios and projecting the outcome of strategies to determine which combination would help to achieve the 75 percent goal. New modeling tools were developed to enable the analysis for each travel market. ODOT staff developed the GreenSTEP model to assess emissions from the ground passenger and commercial services travel market (*4*).

The GreenSTEP model simulates, at the household level, vehicle characteristics (e.g. type, age, powertrain) and vehicle use (e.g. average daily miles, single occupant vehicle miles), and is sensitive to a large number of factors including household characteristics (persons, ages, income), land use (density & mixed use), transportation supply, pricing, driving styles (e.g. eco-driving), travel demand management, vehicle technology, and fuel carbon intensity. In this way, the model could test different transportation and land use strategies, like telecommuting, carsharing, increased public transportation service, parking pricing, and more compact mixed use land development. GreenSTEP was then able to provide results on how much GHG emissions would likely be produced from different combinations of these strategies, or scenarios. The model was also able to provide other results, including information on changes to public health and household costs associated with vehicle ownership and use.

A separate freight emissions model was built to account for the origin to destination emissions of all freight modes. The freight flow component of this model (commodities, value densities, modes, and distances) was built using data from USDOTs Freight Analysis Framework (*5*) and ODOTs Statewide Integrated Model (SWIM2) (*6*). Likewise an air passenger emissions model was built on top of an air travel model that was constructed for GreenSTEP.

The STS vision and recommendations were developed following a scenario planning process. Each travel market analysis involved working with the TAC and Policy Committee to come up with a list of potential transportation and land use actions to test, bundle those actions into scenarios, define how hard to push each action within a scenario and the associated numerical value by different geographies in the State, and assess plausibility of those values. Evidence of plausibility included the observation of similar values in other places and through literature written by experts in the field. In a number of instances, however, the determination of plausibility was based on judging trends and analogous circumstances and considering what circumstances might prohibit the proposed values from being realized.

After scenarios were defined, they were modeled and the results were presented to the advisory committees for their review and consideration. This then lead to a refinement of scenarios and further analysis. The process continued until either the goal was met or it was concluded (as in the case of the freight) that there was no plausible way to reduce emissions further through transportation sector actions alone. Following is a more detailed description of the scenario planning approach for the ground passenger and commercial services travel market which was the most involved of the three markets.

The ground passenger and commercial service travel market scenario planning process was initiated by creating and modeling over 150 scenarios, representing changes in land use, mode shares, technology, the vehicle fleet mixture, pricing, marketing programs, and road growth. Different levels were estimated for each of the categories and scenarios were created by combining each level. These results provided information on the sensitivity of the categories and the relative importance of their contribution for GHG reductions.

While this approach was useful for understanding policy sensitivities and bounds, the results did not offer a clear way forward towards developing a final strategy. The next step, therefore, involved presenting a simplified small set of scenarios. With input from advisory committees, the consultant and ODOT worked to craft four very distinct scenarios, which included the following:

- *Urban*, which focused on land use and the built environment, marketing programs, mode shares, and parking pricing;
- *Technology*, which focused on lower or zero emission engines, fleet mix (proportion of light and heavy vehicles on the road), and some shift in mode shares;
- *System optimization*, which focused on mode shifts, enhanced deployment of Intelligent Transportation Systems (ITS) technology, transportation demand management strategies and carsharing; and
- *Pricing*, which focused on true cost pricing (users pay full cost of road system and externalities), pay-as-you-drive (PAYD) insurance, parking pricing, and congestion pricing.

For each of these scenarios, forms were created for the advisory members to complete, allowing them to indicate levels of emphasis they wanted to place on each of the categories within the scenario. Technical experts and ODOT put quantitative estimates to each of the levels agreed to by the committees, establishing, for example, no expansion of urban growth boundaries, a quadrupling of transit service in metropolitan areas, and a 30 percent increase in parking pricing for the *Urban* scenario (see Figure 1).

Overall GHG emission reductions for these scenario were found to range from about 43%-49%, far short of the 75 percent reduction target. Even when combined, the scenarios proved short of the goal, forcing more aggressive assumptions to be made in order to get as close to the 75 percent target as possible. An enhanced combination was created, and two spin-offs were developed to get closer to the goal: 1) High Pricing – where in addition to paying for the full cost of the road system, carbon emissions, and all other externalities, drivers would be taxed in order to reduce VMT to meet the goal; 2) High Technology – where about 50 percent of the vehicle fleet in 2050 would be composed of plug-in hybrid electric vehicles (PHEV) and electric vehicles (EV) and emissions from the electric power sector would be reduced by 75 percent as well (see Figure 1). Ultimately the enhanced scenario with technology was selected as the preferred scenario.

Throughout the evolution of scenarios, the outcome data aside from GHG was viewed and used to make decisions. Measures such as changes in household costs and business costs proved most effective at assuring that selected scenarios did not have significant unintended consequences and that co-benefits (such as improved air quality and more active transportation and therefore health improvements) could be seen. The preferred scenario for ground transportation and commercial services was the one with lower apparent economic impacts, as compared to the scenario with higher pricing, and even apparent positive economic impacts through lower household costs.

Also throughout the evolution of scenarios, some strategies were dropped from further consideration, either due to minimal amounts of GHG emissions reduced and/or indication of unintended consequences (i.e. negative results in other outcome areas). An example of such a strategy is bottleneck removal. Bottleneck removal is a high capital expense and may not be a cost-effect strategy for reducing GHG emissions in the long run if the vehicle fleet comes to be dominated by hybrid electric vehicle, electric vehicles and high efficiency internal combustion engine vehicles whose fuel economy is minimally affected by congestion. Another example is congestion pricing. While congestion pricing was kept as a potential strategy for the largest metropolitan area of the State, Portland, it was dropped from consideration elsewhere. Modeling projections show that congestion pricing in contrast to across-the-board pricing of vehicle miles traveled may not reduce emissions significantly because motorists may produce more emissions as a consequence of traveling to avoid the fees.

The other travel markets (freight and air passenger) followed a very similar methodological approach as described above for ground, and as summarized in Figure 2. The results helped committee members and stakeholders sort through the combination of strategies needed and the level of effort that it would take to substantially reduce emissions.

Nearly three-quarters of the project time and effort was consumed by technical analysis and the remaining quarter was spent in policy-level discussions. Categories like ITS (e.g. ramp metering and transit signal priority) were transformed into policy language, with specific potential actions. Other statewide policy documents, like the Oregon Transportation Plan were reviewed to make language and direction consistent. In the end a policy level document was produced: *Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Reduction*, which was comprised of 18 different strategies (Table 1) and 133 different potential actions, referred to in the document as elements (*7*). The strategies were directly linked to categories analyzed in the model while the elements were at a much higher level of granularity and were generated primarily through research of effective ways to achieve each individual strategy, as well as stakeholder and public suggestions.

FINDINGS

Modeling and analysis done as part of the STS found that achieving higher levels of GHG emission reductions required an aggressive mix of strategies: a vehicle fleet dominated by much cleaner vehicles (such as electric cars), greater use of lower emission fuels, more compact urban areas with a greater mix of land uses, more intensive deployment of ITS to optimize efficiency across the transportation sector, true-cost pricing, and much greater availability and use of alternate transportation modes. At the onset of the project, some stakeholders believed that technology or changes to the urban form alone would solve the GHG emissions problem, but analysis showed that a multi-front approach was needed. Using the GreenSTEP model and the other models developed for this study, it was estimated that by 2050 the proposed STS vision would result in a 75 percent reduction in emissions from the ground passenger and commercial services travel market, and from the air passenger travel market combined. Extra reductions for the ground passenger and commercial service travel market offset lesser reductions for the air passenger travel market. Reductions for the freight travel market, however, fell far short of the 75 percent goal. As a results, the forecast for the entire STS vision is a 60 percent total reductions below 1990 levels, which corresponds to about 80 percent reduction in per capita emissions. The total reductions fall short of the 75 percent State target.

Under current trends (reference case) the emissions from ground passenger and commercial services travel are expected to decrease, while those from air and especially freight are expected to grow (Figure 3).

Several trends contribute to anticipated reductions in ground passenger emissions:

- *Market saturation* - Current estimates show vehicle ownership at or near saturation levels and thus not growing in market share.
- *Planning and implementation work completed to date in Oregon's metropolitan areas* - Oregon's transportation and land use planning has helped increase the practicality of other travel modes like walking, bicycling, or taking public transportation. As these trends continue, and spread to a larger proportion of the state's population, market share for light-duty vehicle travel will decrease.
- *Aging population* - The increasing share of elderly in the population will result in reduced amounts of driving.
- *Technology* - Several recent policy changes that increase the fuel economy and reduce the GHG emissions of light vehicles will greatly assist in decreasing GHG emissions.

The preferred scenario for ground passenger and commercial travel was able to achieve significant reductions in GHG emissions, greater than both air passenger travel and freight movement (Figure 3). One of the key strategies for reducing ground passenger emissions is the transition to very low emission vehicles, targeting around 90 percent share of all automobiles sold in 2050 to be plug-in hybrid electric vehicles (PHEV) or electric vehicles (EV). This would increase the share of PHEVs and EVs in the fleet to about 50 percent in 2050. This is a very aggressive assumption, but the Policy Committee felt that it was preferable to the aggressive pricing alternative. Although the Committee sought not to pursue aggressive pricing, they did include many substantial pricing elements such as PAYD insurance, parking pricing, moving to a sustainable funding source (such as moving from the gas tax to a user fee), congestion pricing, and "true cost pricing" to pay the full cost of travel and internalize current externality costs (e.g. climate change, air pollution, etc.).

Two other strategies of note for the movement of people on the ground included public transportation and eco-driving. Both of these strategies were found to be effective at GHG emission reduction and are essential parts of the STS. To achieve the 75 percent reduction for the ground passenger travel market, transit service levels would need to increase three to four-fold in metropolitan areas of the State, requiring substantial long term infrastructure and operational investments. Although challenges were noted with achieving these levels, it was determined that they are likely necessary, thus making the pricing strategy of moving to a sustainable funding source all the more important. While increased transit service levels is one of the most costly strategies in the STS to implement, eco-driving is one of the cheapest. Eco-driving, or promoting fuel efficient driving practices, helps to improve overall fuel economy and reduce GHG emissions at a fairly low cost (*8*).

Similar strategies, described above for ground passenger, were also selected to target emissions reduction in freight. However, freight proved the most challenging travel market to reduce overall emissions and modeling projections show it to be the largest emitting segment of the transportation sector in the future (see Figure 3). Unlike ground passenger travel, 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. Moreover, as can be seen from Figure 3, unlike the case with air passenger emissions, it is not possible to offset freight emissions with further reductions from the ground passenger and commercial services travel market. Freight strategies such as increasing operational efficiencies and technological improvements for cleaner fuels were found to help reduce emissions, as did urban consolidation centers and true cost pricing, which were strategies all included in the STS. However substantial reductions were not reached, as freight emissions depend on the weights and distances of commodities moved. While the STS vision assumes that Oregon's economy will increase growth of value-added industries the assumed changes do not overcome the projected growth in commodity movements. This outcome strongly suggests that in the future, GHG emissions from the movement of freight need to be evaluated in a broader economic context. This is what consumption-based GHG analyses do.

Challenges were found for reducing air passenger emissions as well. Air travel is growing in market share and there are inherent difficulties in improving the fuel economy of airplanes. Strategies such as telecommunications and higher-speed rail were identified as alternatives that can be enhanced as options for air travel. The larger reductions in emissions from the air industry were expected from technological improvements and cleaner fuels, including heavy reliance on NextGen technology. As mentioned previously, the GHG emissions from the air travel market are forecasted to be small enough that the deficit in reductions can be made up for by enhanced reductions from the ground passenger and commercial services travel market.

Co-Benefits and Other Non-GHG Indicators

While the legislative directive for the STS was focused on reducing transportation GHG emissions, the analysis was done to consider a range of other potential benefits and adverse impacts that might result from implementation of aggressive GHG reduction strategies. These potential co-benefits and impacts were assessed using a number of quantitative indicators suggested by the advisory committees. The indicators addressed the following performance criteria:

- Travel and System Performance (vehicle miles traveled and delay for the movement of people and goods on roadways).
- Energy Consumption and GHG Emissions (changes in energy (fuel) consumption and GHG emissions).
- Land Use and Natural Resource Impacts (use and preservation of land; and changes in water consumption as a result of sprawl or densification).
- Public Health Impacts (overall change in criteria pollutants from the entire transportation system; and the change in non-motorized travel for people on the ground to active transportation).
- Infrastructure and Implementation Costs (capital and operating costs).
- Economic Impacts (changes in household costs, social costs, freight shipping costs, and general revenues).

These performance indicators helped to identify several potential benefits of the STS beyond GHG reduction, including the following:

- *Lower levels of vehicle delay* - With compact, mixed-use land use patterns which enable shorter vehicle trips and travel by other modes, provision of travel options, demand management programs, efficient transportation pricing, and deployment of ITS technologies, total vehicle delay on metropolitan roadways is expected to decline by about 10 percent in comparison to the reference case. In addition, despite a doubling of metropolitan truck vehicle miles traveled (VMT), truck delay would only, increase by about 25 percent. These methods of demand management could help to save transportation dollars that might otherwise be spent on road capacity expansion to relieve congestion.
- *Reduced fuel consumption and greater energy security* - More efficient vehicles, greater use of electricity and alternative fuels, shorter trip distances, and greater use of transportation options results in a near 90 percent drop in petroleum fuel consumption from today's level. This would result in less dependence on imported fuel and potentially more money available to purchase goods and services produced by Oregon workers and manufacturers. It would also mean that Oregon's economy could be more insulated from disruptions in international oil markets and price spikes.
- *Reduced land consumption* - Development of more compact urban areas and supportive transportation systems, will reduce consumption of agricultural and forest land, as well as reduce use of water, energy, and other natural resources.
- *Improvements in public health* - Air pollution per mile of vehicle travel will decline substantially as vehicles and fuels become cleaner. Compact community development, increased transportation options, and efficient pricing will keep VMT growth from counteracting these gains. Transportation and land use changes will also contribute to more walking and bicycling by urban households, increasing physical exercise known to have overall personal health benefits.

In addition to benefits, there are costs and other impacts associated with the STS. Costs for transit operations would increase substantially under the STS vision. Cost savings may occur from greater use of alternative modes and an associated drop in VMT and thus less potential need for frequent road maintenance. Other costs would be expected for implementation of ITS and alternative mode infrastructure expansion or enhancement.

Overall impacts to the economy are uncertain. The STS is a high-level policy document that looks out 40 years into the future. There are a number of unknowns relative to technological and structural changes that make long-range economic forecasting of the effects of the STS impossible. However, the economic performance indicators (household costs, shipping costs, etc.) did not indicate any negative economic effects, most proved negligible.

Even though the STS assumes that drivers will pay the full cost of driving, the total annual vehicle ownership and operation costs per residential household would decrease relative to today, except for the very highest income households. Increases in road-use and parking charges would be offset by reduced VMT due to shorter trip distances, increased use of other modes, improved fuel economy, and substitution of lower cost electricity for higher cost gasoline. For businesses, lower future shipping costs per dollar of commodities moved are projected, primarily due to vehicle efficiency savings and increasing value density of shipments. However, various commodity types and associated sectors may be impacted differently and may result in some being advantaged while others are disadvantaged. For aviation, advancements in fuel, airframe technology, and more efficient ground operations are anticipated to save the air industry money. Overall passenger air travel is expected to grow significantly under the Reference Case, but the rate of growth may diminish with the increase of travel options.

CHALLENGES AND LESSONS LEARNED

Creation of the STS was a challenging endeavor, as there was no template or blueprint for developing it. The STS was unique in a number of important ways. Relative to traditional state transportation plans, the STS looked out twice as far as a typical planning horizon (40 years instead of 20 years), addressed aspects of transportation not typically dealt with such as vehicle technology and fuels, and was aimed at achieving a single overall target or goal (*9*). The STS differs from state climate action plans in that it address the transportation sector more comprehensively and in much more detail (*10*). As a consequence, successful completion of the STS required the development of new methods and new analytical tools such as the GreenSTEP model. ODOT relied heavily on an analytical process to transparently and defensibly identify strategies effective at reducing GHG emissions. Along the way, several analytical and political challenges were encountered and lessons learned.

First and foremost, the development of the STS was legislatively mandated and as such carried with it stigmatism of a forced initiative. Although required, ODOT saw value in the effort and worked to discuss the benefits and potential contributions of the work with stakeholders. In so doing, a significant obstacle was the focus on GHG emissions. (Global warming is a politically contentious and polarizing issue even in environmentally-conscious Oregon.) With the help of communication consultants, ODOT found ways to "lead with outcomes and benefits" instead of focusing on climate change (*11*). Although GHG emissions remained an important component of discussions throughout the process of developing the STS, discussions were broadened to include related matters and "co-benefits" of actions to reduce GHG emissions. In addition, many of the strategies assessed in the STS were not new to the State and were activities that had been investigated or implemented for reasons other than GHG. These served as talking points with stakeholders in engaging them in the process and gaining support. The GreenSTEP model was enhanced to help illuminate co-benefits by including calculations of performance measures in addition to GHG emissions such as household auto ownership costs and public health impacts. This information proved valuable in showing that in a "business-as-usual" future, congestion would get worse and household costs would rise. This data helped to provide a compelling argument for wanting to initiate the STS.

Once the STS was initiated, stakeholders, and local jurisdictions in particular, had a number of questions about how the analysis would or would not consider their current plans. A key concern was that they get credit for the work they had already done to reduce GHG emissions. Data was gathered from and reviewed by the MPOs and local jurisdictions to assure current plans and trends within their area were captured in the analysis of the "business as usual" scenario, known as the reference case. The results of the reference case showed a decrease in future emissions within the ground passenger and commercial services travel market. Emphasizing the "good work jurisdictions are already doing" became a key communication component when talking to MPOs and local governments. It helped to focus on the positive first and then communicate that "more good work is needed." Additionally the information proved useful in talking to people who felt trying to reduce GHG emissions was an insurmountable problem. Through the reference case it could be demonstrated that progress has been made and is likely to continue. Subsequent analysis of alternative scenarios further showed that substantial reductions were plausible.

The analytical aspects of the project were complex and lengthy (about 1.5 years of a 2 year project), and proved frustrating at times to some of the policy level stakeholders who were anxious to come up with solutions and develop policies. However, the Policy Committee developed for the project included a mix of believers and non-believers in climate change, requiring full vetting and discussion of policies. Several people came into the conversation with fairly strong notions of what could or should be done or not done to reduce GHG emissions. The rigorous analysis process helped to provide data and information to facilitate the conversation and proved useful in bringing disparate viewpoints to consensus. Committee members weighed in on the elimination of strategies that indicated potential adverse impacts or led to unintended consequences in other goal areas important to the State, and were more aggressive with other strategies that showed benefits. By the end of the process, the willingness of committee members to push assumptions had changed substantially, resulting in fairly aggressive target assumptions for a majority of the strategies.

While the advisory committees had the benefit of working through this process and had the time to become comfortable with the aggressive assumptions, when the STS went out for public review it was challenging to condense down the large volume of background information and discussions to people who were not part of the STS development process. When the STS was presented or reviewed by groups or jurisdictions thought to be skeptics, it proved extremely helpful to have advisory committee members present who held credibility with the respective group and who could talk through the process used to develop the STS and the results.

The modeling and analysis work was a necessity in order to determine the mix of strategies to help achieve Oregon's GHG reduction target, but the associated transparency it provided added an unforeseen challenge. The modeling results helped to show the level of effort needed in specific areas to substantially reduce GHG emissions. This raised concerns in some transportation circles about how growth of their travel market segment might be affected if the STS vision comes to fruition. For example, there was concern around strategies like improved telecommunications capabilities and high-speed rail which may decrease the market share of some modes. While these strategies have been included in ODOTs policy documents for years, the transparency provided in the STS for how these travel options may result in mode shift raised concerns for the first time. The intent of the modeling was to assess what it would take and point ODOT in the direction of effective actions. The targets provide something to aim for but ODOT made it very clear that strategies like telecommuting, enhanced public transportation service, and infrastructure improvements for bicycling and walking were about providing transportation options, not about forcing mode shifts.

Related, ODOT also worked to emphasize that all transportation options are important, including roadway vehicles. This was amidst some stakeholder concerns that GHG reduction strategies would focus on “getting people out of their cars.” The STS includes a mix of strategies that recognize that the car and truck will continue to be an important mode of transportation in the future, and thus focuses on engine and fuel technologies and efficient driving techniques.

The resulting document includes a mix of strategies targeting nearly all aspects of transportation and related land use components. The STS, consistent with the initial statement of purpose, is jurisdictionally blind in describing what needs to be done in order to address GHG reduction goals. While ODOT, other state agencies and MPOs can move forward on a number of strategies, others will require action by the state legislature, federal government, or the private sector. The STS was not intended or designed to be a regulatory document which directs the actions of others. Rather, it makes the case for how public sector agencies and the private sector need to move forward to address this serious and challenging matter.

The STS was accepted by the Oregon Transportation Commission in March 2013, giving ODOT approval to develop an implementation plan. The implementation plan will identify what actions ODOT will take within its authority to carry out the strategy. Performance measures will be included in the implementation plan and will be tracked over time to determine progress relative to the level of effort needed for each strategy. Depending on results, adjustments to the overall STS will be made. Additional adjustments may occur as a result of continuing conversations with other agencies and stakeholders relative to opportunities for implementing the strategies in the STS. The STS was designed to be part of an iterative management approach to address the ongoing challenges of mitigating GHG emissions from the transportation sector.

REFERENCES

1. Oregon Legislature. *Enrolled Senate Bill 1059, 75th Oregon Legislative Assembly, 2010 Special Session*. 75^{th} Oregon Legislative Assembly, 2010. http://www.oregon.gov/ODOT/TD/OSTI/docs/sb1059en.pdf. Accessed Nov. 10, 2013.
2. Oregon Revised Statutes Chapter 468A, Section 205, *Greenhouse Gas Reduction Goals*. http://www.oregonlaws.org/ors/468A.205. Accessed Nov. 10, 2013.
3. Oregon Department of Transportation. *Statewide Strategy Description: Oregon SB 1059 Statewide Transportation Strategy to Reduce Greenhouse Gas Emissions in the Transportation Sector.* Oregon Department of Transportation. October 27, 2010. http://www.oregon.gov/ODOT/TD/OSTI/PC/2010Nov2/StrategyDesc.pdf. Accessed Nov. 10, 2013.
4. Oregon Department of Transportation. *Oregon Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Emissions Reductions, Volume 2, Technical Appendices.* December 2012. pp. 33-38. http://www.oregon.gov/ODOT/TD/OSTI/docs/STS/STS_TechAppendices.pdf. Accessed Nov. 10, 2013.

5. *Freight Analysis Framework, FAF³ Origin-Destination Data.* U.S. Department of Transportation, Federal Highway Administration. http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/. Accessed Nov. 10, 2013.
6. Oregon Department of Transportation. *Statewide Model.* Oregon Department of Transportation Planning Section. http://www.oregon.gov/ODOT/TD/TP/Pages/Statewide.aspx. Accessed Nov. 10, 2013.
7. Oregon Department of Transportation, *Oregon Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Emissions Reductions, Volume 1.* March 20, 2013. http://www.oregon.gov/ODOT/TD/OSTI/docs/STS/STS%20Report%20-Clean_March%202013_AP%20Final_for%20website_2.pdf. Accessed Nov. 10, 2013.
8. Cambridge Systematics, Inc. *Technical Appendices, Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions.* Urban Land Institute. October, 2009. pp. B61-B63.
9. Volpe National Transportation Systems Center. *Analysis of Statewide Transportation Plans.* FHWA-HEP-07-009, U.S. Department of Transportation, Federal Highway Administration. http://www.fhwa.dot.gov/planning/processes/statewide/practices/anaswplans.cfm. Accessed Nov. 10, 2013.
10. State and Local Climate Energy Program. *Climate Change Action Plans*. U.S. Environmental Protection Agency. http://www.epa.gov/statelocalclimate/state/state-examples/action-plans.html. Accessed Nov. 10, 2013.
11. Millar, S. L., L. Carlson, and N. Marshall. *More than Climate Change: Best Communications Practices*. Document for Oregon Department of Transportation and Department of Land Conservation and Development. http://www.oregon.gov/ODOT/TD/TP/docs/toolkit/communications.pdf. Accessed Nov. 14, 2013.

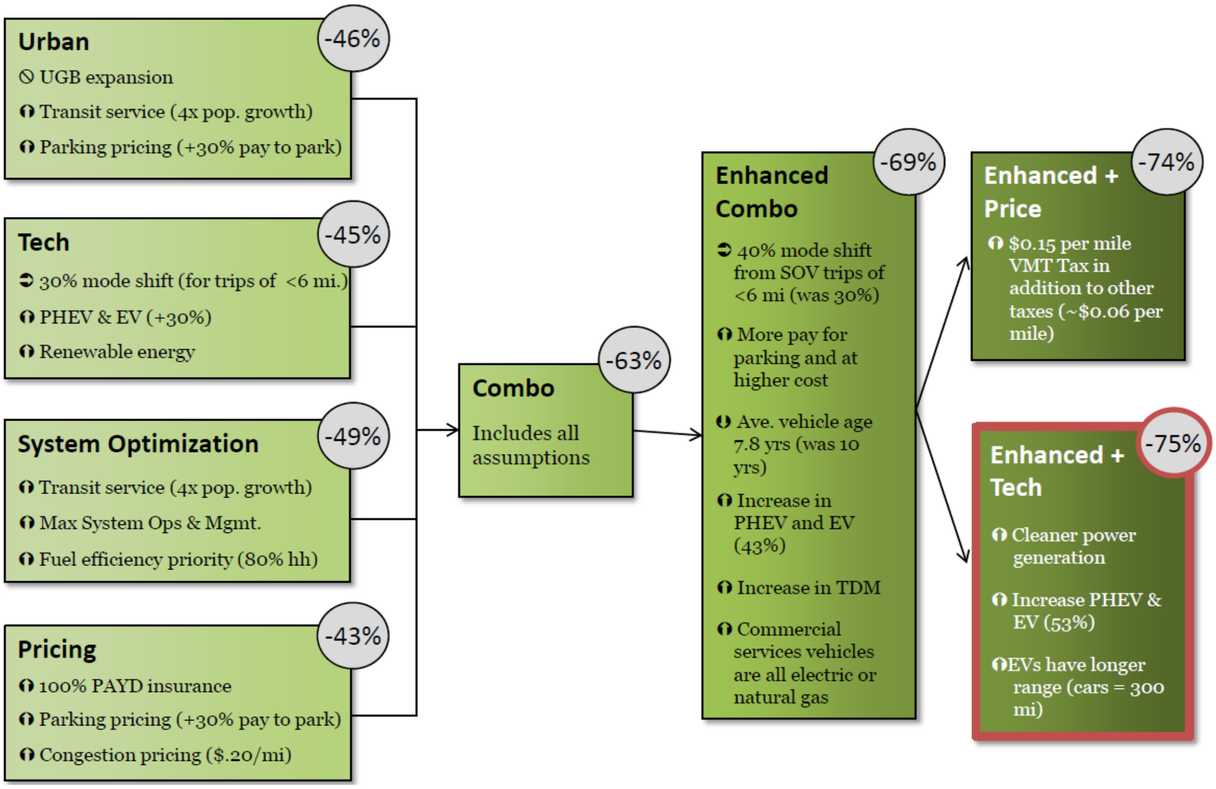

FIGURE 1 Evolution of STS ground passenger scenarios.

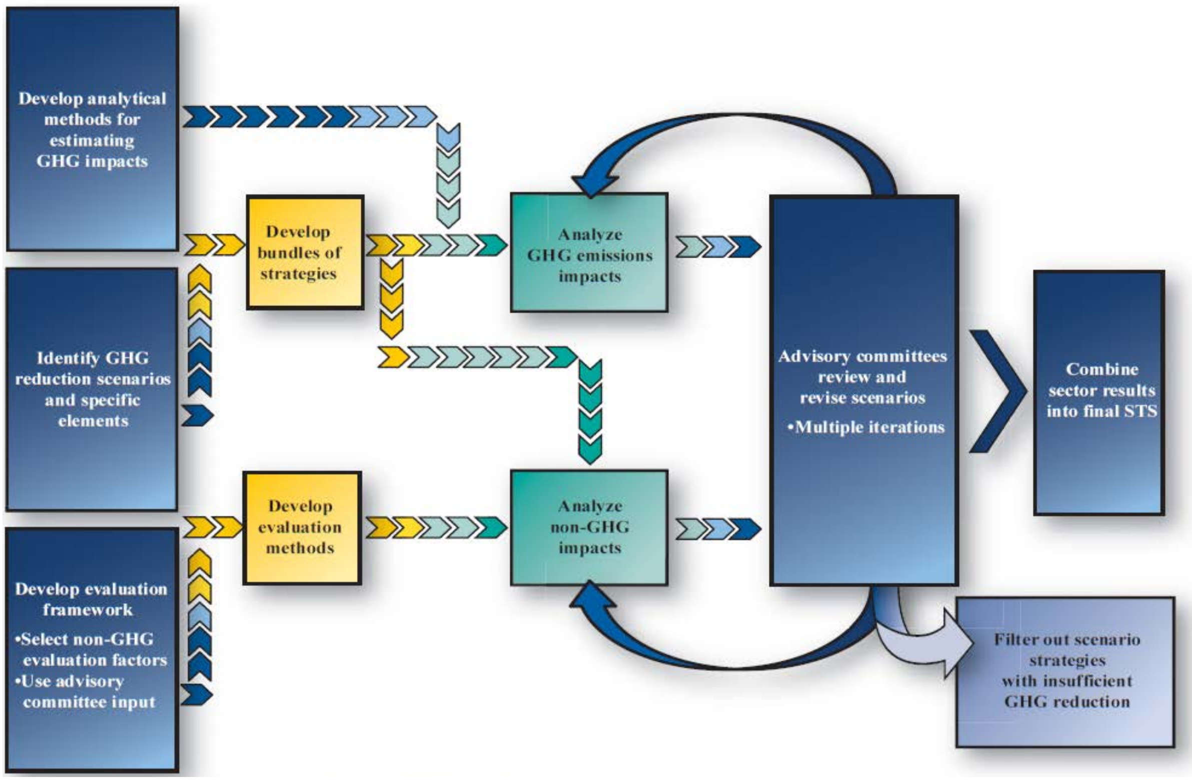

FIGURE 2 STS methodological process diagram.

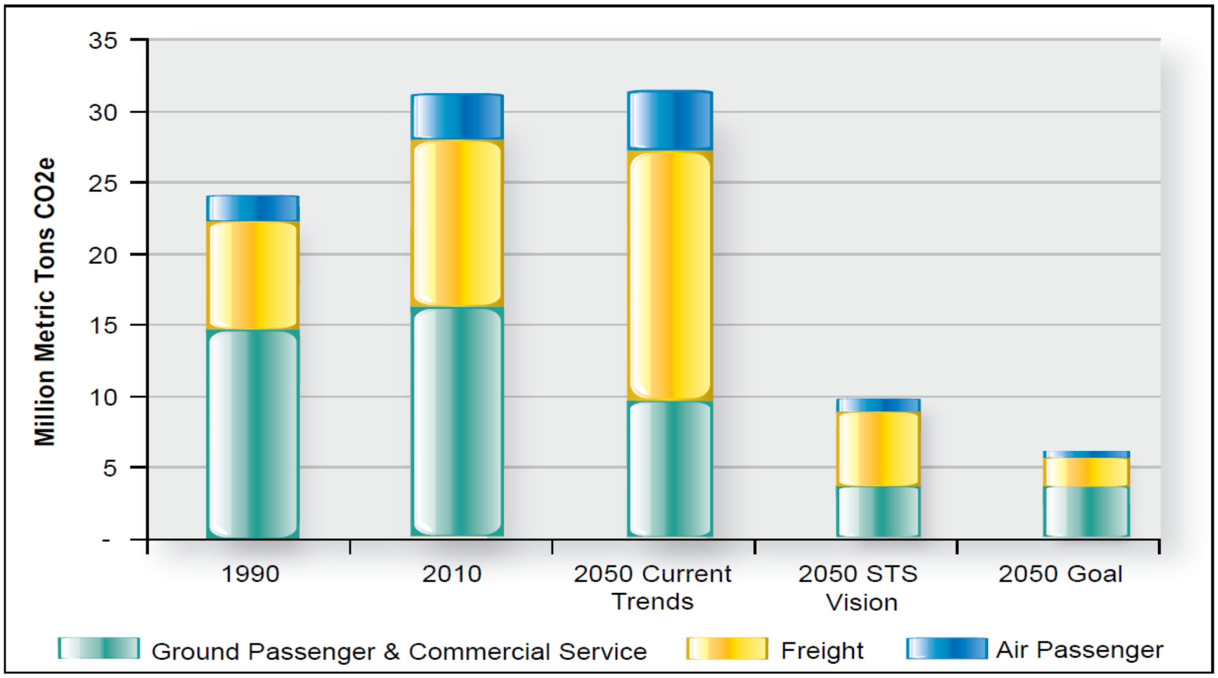

FIGURE 3 Current and projected transportation sector emissions in Oregon with and without the STS.

TABLE 1 STS Strategies

Vehicle and Engine Technology Advancements
Strategy 1 – More Efficient, Lower-Emission Vehicles and Engines
Transition to lower emission and fuel-efficient vehicles, enhanced engine technologies, and efficient vehicle designs.
Fuel Technology Advancements
Strategy 2 – Cleaner Fuels
Support the development and use of cleaner fuels, including reduction of the carbon intensity of fuels.
Systems and Operations Performance
Strategy 3 – Operations and Technology
Enhance fuel efficiency and system investments, and reduce emissions by fully optimizing the transportation system through operations and technology.
Strategy 4 – Airport Terminal Access
Increase efficiency in all airport terminal access activities, including shifting to low- and zero-emission vehicles and modes for passengers, employees and vendors.
Strategy 5 – Parking Management
Promote better management and use of parking in urban areas to support compact, mixed-use development and use of other modes, including transit, walking and bicycling.
Strategy 6 – Road System Growth
Design road expansions to be consistent with the objectives for reducing future GHG emissions by light duty vehicles.
Transportation Options
Strategy 7 – Transportation Demand Management
Support and implement technologies and programs that manage demand and make it easier for people to choose transportation options.
Strategy 8 – Intercity Passenger Growth and Improvements
Promote investment in intercity passenger public transportation infrastructure and operations to provide more transportation options that are performance and cost competitive.
Strategy 9 – Intracity Transit Growth and Improvements
Investing in public transportation infrastructure and operations to provide more transportation options and help reduce single-occupancy vehicle travel.
Strategy 10 – Bicycle and Pedestrian Network Growth
Encourage local trips, totaling twenty miles or less round-trip, to shift from single-occupant vehicle (SOV) to bicycling, walking, or other zero-emission modes.
Strategy 11 – Carsharing
Enhance the availability of carsharing (short-term self-service vehicle rental and/or peer-to-peer) programs to reduce the need for households to own multiple vehicles and to reduce household vehicle miles traveled.
Strategy 12 – More Efficient Freight Modes
For the commodities and goods where low-carbon modes are a viable option, encourage a greater proportion of goods to be shipped by rail, water, and pipeline modes.
Efficient Land Use
Strategy 13 – Compact, Mixed-Use Development
Promote compact, mixed-use development to reduce travel distances, facilitate use of zero- or low energy modes (e.g., bicycling and walking) and transit, and enhance transportation options.
Strategy 14 – Urban Growth Boundaries
Create full-service healthy urban areas to accommodate most expected population growth within existing Urban Growth Boundaries (UGB) through infill and redevelopment.
Strategy 15 – More Efficient Industrial Land Uses
Encourage and incentivize more efficient use of industrial land through closer proximity of shippers and receivers, consolidated distribution centers, and better access to low-carbon freight modes.
Pricing, Funding and Markets
Strategy 16 – Funding Sources
Move to a more sustainable funding source that covers the revenue needed to maintain and operate the transportation system and accounts for the true cost of travel.

Strategy 17 – Pay-As-You-Drive Insurance
Promote Pay-As-You-Drive Insurance (PAYD) programs that allow drivers to pay per-mile premiums, encouraging less driving through insurance savings.
Strategy 18 – Encourage a Continued Diversification of Oregon's Economy
Maintain economic prosperity through an increase in the value per ton (the "value-density") of goods produced in the state, which is projected to reduce shipping costs and GHG emissions for any given level of economic output.