Rulemaking Advisory Committee Recommendations on Metropolitan Greenhouse Gas Reductions Targets

Department of Land Conservation and Development **January 2017**

Contents

Rulemaking Advisory Committee Process

In May 2015, the Land Conservation and Development Commission (LCDC) directed the Department of Land Conservation and Development (DLCD) to begin the rulemaking process to amend the Metropolitan Greenhouse Gas Reduction Targets (OAR 660-044). The Rulemaking Advisory Committee (RAC), is comprised of members representing metropolitan planning organizations (MPO), local governments, and other groups that will be affected by the amended rules. The RAC's charge was to assist DLCD in drafting rule amendments. The RAC met six times between May and December 2016. The RAC members are:

- Jerry Lidz, Committee Chair, LCDC
- Ali Bonakdar, Corvallis Area MPO
- Sam Brentano, Marion County
- Theresa Conley, Albany Area MPO
- Tyler Deke, Bend MPO
- Steven Dickey, Oregon Transit Association
- Steve Faust, Citizen Involvement Advisory Committee
- Darin Fowler, Grants Pass
- Eric Hesse, TriMet
- Annabelle Jaramillo, Benton County
- Mike Jaffe, Salem Keizer MPO
- Rebecca Lewis, University of Oregon
- Mary Kyle McCurdy, 1000 Friends of Oregon
- Tonia Moro, Rogue Valley MPO
- Amanda Pietz, Oregon Department of Transportation
- Ted Reid, Metro
- Richard Ross, Oregon Chapter of the American Planning Association
- Tom Schwetz, Lane Transit District
- Karen Swirsky, City of Bend
- Paul Thompson, Central Lane MPO
- Karl Welzenbach, Rogue Valley MPO
- Alan Zelenka, Global Warming Commission

During the RAC meetings, the committee reviewed technical information and identified and discussed the issues to be addressed in the rule amendment. In the course of its meetings the RAC:

- Identified and discussed the issues pertaining to targets setting;
- Reviewed modeling and analysis of greenhouse gas emissions;
- Reviewed and discussed the target setting technical memos; and
- Reviewed and commented on the Statement of Need and Fiscal Impact and the Housing Cost Impact Statement.

The RAC reached a consensus on most recommendations. The RAC meetings were noticed, open to the public, and the RAC's agenda provided an opportunity for input from members[1].

Core Technical Team

The Core Technical Team is responsible for guidance on the technical aspects of the analysis required to update the targets. The workgroup is comprised of technical experts from the Department of Environmental Quality (DEQ), Department of Energy (ODOE), Department of Transportation (ODOT), and DLCD, many of whom supplied agency data and assumptions about future vehicle fleets and fuels. The member of the Core Tech Team are:

- Dave Nordberg, DEQ
- Rick Wallace, ODOE
- Tara Weidner, ODOT
- Cody Meyer, DLCD

Background

Oregon's greenhouse gas goals

In 2007, the Oregon legislature passed House Bill 3543 which established three goals for reducing the state's greenhouse gas (GHG) emissions:

- by 2010 to begin to reduce GHG emissions
- by 2020 to achieve GHG levels 10% below 1990 levels
- by 2050 to achieve GHG levels 75% below 1990 levels

Targets Rules

House Bill 2001, adopted by the 2009 legislature, and Senate Bill 1059 adopted by the 2010 legislature, directed LCDC to adopt greenhouse gas emission reduction targets to guide the state's metropolitan areas as they conduct land use and transportation scenario planning. The legislation directed that targets identify the level of GHG reduction that each metropolitan area needs to achieve in order for the state to be on a trajectory to meet its 2050 goal of reducing emissions to 75% below 1990 levels. The two statutes require that the metropolitan emission reduction targets:

- Must be consistent with achieving Oregon's greenhouse gas emissions reduction goals;
- Must be for 2035;
- Must be for light vehicle travel;
- Must equitably allocate responsibility for meeting targets considering differences in population growth rates;

[1] Meeting materials are available at: http://www.oregon.gov/LCD/Pages/GHGTargetReview.aspx#Advisory_Committee_Meetings

- Must consider expected improvements in vehicle technologies and fuels; and
- Should be informed by the information and recommendations from the ODOT, DEQ and the ODOE.

2011 Target Rules

In addition, the Legislature directed that targets should identify the emission reduction needed above and beyond the reductions expected from improvements in vehicle technology and fuels and changes to the vehicle fleet. The target rules (OAR 660-044) adopted in May 2011 fulfilling the legislative requirement included detailed assumptions about the vehicle technology, fleets and fuels expected to be in place in 2035. State and federal laws and regulations set requirements which affect each of these factors.

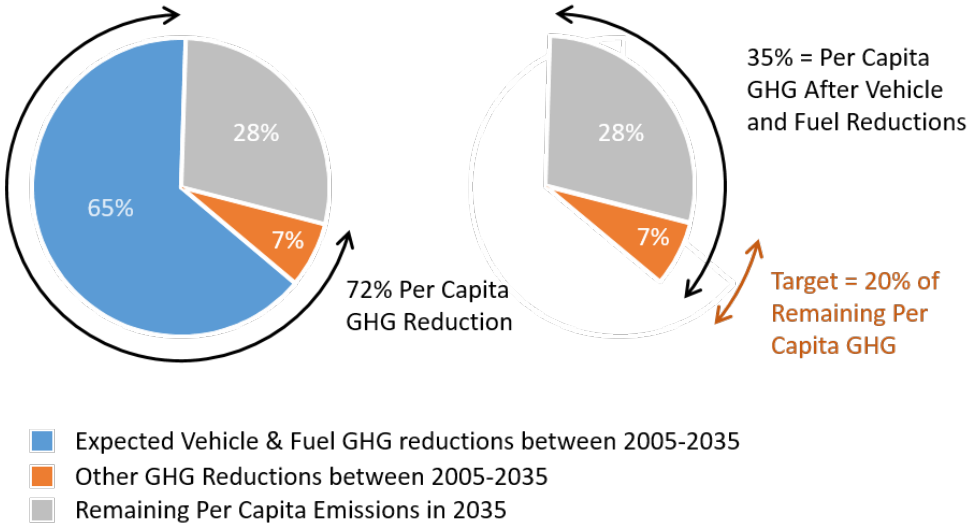
The target rules adopted in 2011 establish the percentage reductions (from 2005 to 2035) in metropolitan area light vehicle GHG emissions beyond the reductions expected to occur due to changes to light vehicles and the fuels they use. The targets are expressed as the percentage reduction in per capita emissions rather than the percentage reduction in total emissions to account for different metropolitan area population growth rates. The establishment of these targets was informed by technical analysis performed by ODOT, DEQ, and ODOE as directed by provisions of HB 2001 and SB 1059. In short, the analysis made recommendations on:

1. An overall light vehicle **per capita emissions reduction goal**.
2. A range of forecasts for **reductions in light vehicle emission rates** due to changes in light vehicles and the fuels they use.
3. The **target** percentage reductions needed to meet the per capita emissions reduction goal given the vehicle emission rate forecasts.

Development of the targets was supported by the Agencies Technical Report (ATR) and the Target Rulemaking Advisory Committee (TRAC) in 2011. The TRAC selected an emissions rate forecast they thought to be sensible and would result in achievable metropolitan area targets. This low-end emission forecast and the resulting targets were then adopted in the target rules.

Figure 1 below illustrates how a metropolitan area GHG reduction target is calculated from the per capita emissions reduction goal and the forecast for reduction in the light vehicle emissions rate. The circle represents total metropolitan area per capita emissions in 2005 while the light grey slice shows per capita emissions in 2035 that would remain when the emissions reduction goal are met. Since the goal is to reduce per capita emissions by 72% from 2005 to 2035, the per capita emissions in 2035 would be 28% of the 2005 emissions. The dark blue slice indicates the reduction in per capita emissions due to the forecasted change in the light vehicle emissions rate. Since forecasted change in the emission rate would reduce per capita emissions by 65%, the emissions in 2035 would be 35% of the 2005 emissions if only the forecasted changes to light vehicles and the fuels they use occur. An additional seven percentage point reduction is necessary to meet the 72% reduction goal (72% – 65%). That is 20% of the remaining emissions (7% ÷ 35%). This is the target; the percentage reduction in emissions beyond the reductions expected from changes in vehicles and fuels.

Figure 1. Calculating Metropolitan Area Target from the Goal for Reducing 2005 Per Capita GHG Emissions and the Forecast for Emissions Reductions from Vehicle and Fuel Changes



Target Rules Review

The 2011 target rules required LCDC to decide by June 1, 2015, whether the GHG reduction targets should be amended. In May of 2015, LCDC completed its review of the Metropolitan Greenhouse Gas Targets Rules and approved the Target Rule Review report, identifying two key factors that indicate changes to the target rules are needed:

- The state's metropolitan areas are updating long-range plans to accommodate growth beyond 2035. If targets and scenario planning are to be useful and relevant to these plans, then updated targets for 2040 and beyond will be needed; and,
- There is new information about vehicle technology, fleet and fuels that could lead to adjustments in metropolitan area targets.

LCDC directed the department begin work with other agencies to develop updated technical information and appointed an advisory committee to assist in developing proposed targets for the years beyond 2035. The advisory committee was also tasked to consider whether targets should be proposed for newly designated metropolitan areas that include the Albany and Grants Pass metropolitan areas.

Target Update

A number of things have happened since the target rules were adopted in 2011 that informed the update to the targets:

- MPOs, DLCD, and ODOT gained experience in implementing the targets
  - Metro adopted its Climate Smart Strategy
  - The Central Lane MPO completed scenario planning
  - The Corvallis and Rogue Valley MPOs completed Strategic Assessments
- ODOT completed a Statewide Transportation Strategy (STS) for reducing GHG emissions as required by statute

- New federal and state vehicle emissions standards were adopted

As a result of these events and the experience gained during rule implementation, the Core Tech Team identified six issues be considered in the target rule update:

1. Whether or not to distinguish targets among metropolitan areas
2. Potential targets for the two new MPOs: Albany Area, and Middle Rogue (Grants Pass)
3. Using findings from the STS for future assumptions
4. Developing targets for interim years between 2035 and 2050
5. The effect of newer 2050 population growth assumptions
6. Different ways of expressing the targets

These issues were reviewed and discussed by the RAC with analysis provided in two technical memos. The technical memos are included as appendices of this report. RAC recommendations on the updates to the targets rules are presented in the following section.

Target Setting Recommendations

I. Separated Targets

Separating targets between metropolitan areas consists of two issues. The first is an adjustment to the base year that resulted in separated targets for metropolitan areas in the 2011 target rules, and the second issue is whether or not targets should be set to account for the differences in capabilities between metropolitan areas.

a) Base Year Adjustments

In setting targets, 2005 is used as a reference year for greenhouse gas emissions reduction targets. The emissions reduction targets are set as reductions to be achieved from 2005 emissions levels. 2005 is specified as a reference year for greenhouse gas reduction targets because more detailed data on emissions and light vehicle travel in metropolitan areas is available for this date than for 1990, the base year set by statute, and because it corresponds better with adopted land use and transportation plans and will thus enable local governments to better estimate what changes to land use and transportation plans might be needed to achieve the emissions reduction targets. While the targets are specified as reductions from 2005 emissions levels, the targets are set at a level that corresponds to the required reduction from 1990 levels to be achieved by 2035.

Although the 2035 targets were based on the assumption that the reduction in per capita GHG between 1990 and 2035 should be the same for all metropolitan areas, the metropolitan area targets differ by up to four percent. The target rules adopted in 2011 established individual metropolitan targets primarily because the targets were measured from 2005 as the base year, but the overall goal is measured from 1990. The shift of the base year affected the targets because the estimates of change in emissions from 1990 to 2005 varied among metropolitan areas. The reason for the differences were due to different changes in estimated per capita emissions between 1990 and 2005, and different projections of emissions rates.

Analysis reviewed by the Core Tech Team indicates that there is considerable uncertainty in those area specific estimates for 1990 and the adjustment process. The adjustment process assumed that the per capita emissions estimates for 1990 and 2005 were relatively accurate for each metropolitan area, but the accuracy of the metropolitan area estimates depended substantially on the accuracy of a number of key inputs which were difficult to obtain for 1990. The Core Tech Team recommended averaging the data across metropolitan areas to adjust from 1990 emission estimates to a uniform 2005 goal, rather than making individual metropolitan area adjustments. The RAC reviewed this recommendation at its third meeting and agreed with this recommendation.

b) Capability Adjustments

The results of the scenario planning efforts carried out over the last five years suggest that it may be appropriate to set different targets from some metropolitan areas based on demonstrated capabilities to reduce GHG emissions. Three options were discussed by the committee. Based upon the final recommendations of the committee, each of the options as presented below include a uniform adjustment to the 2005 base year, a per capita GHG reduction, and the inclusion of the two new MPOs.

1. Establish the same target for all metropolitan areas
2. Establish one target for the Portland metropolitan area, and another target for all other metropolitan areas
3. Establish an individual target for each metropolitan area

Options one and two would rely on information in the Statewide Transportation Strategy (STS) that would be easier to implement than option three, while remaining consistent with other state and federal plans and policies. Option three would be the most difficult to implement and would require a substantial amount of analysis in order to justify differences in targets for each metropolitan area. Analysis similar to what has been done for the Strategic Assessments would need to be done for each of the metropolitan areas in order to get the information needed to accurately differentiate the targets. For this reason, the committee did not support further consideration of option three. Options one and two are discussed below.

1. Establish the same target for all metropolitan areas

A single statewide target would be a 21.5% reduction in 2040, and a 33.4% reduction in 2050 (section 5.1 of Technical Memo #2). This option would result in the simplest set of rules, with one schedule of targets to cover metropolitan areas throughout Oregon.

2. Establish one target for the Portland metropolitan area, and another target for all other metropolitan areas

Section 5.2 of Technical Memo 2 presents four options for differentiating targets between Portland Metro and the other seven metropolitan areas. Based upon feedback from the RAC, DLCD staff put forth a recommendation to set a higher target for the Portland area that resulted in the smallest difference. Section 5.2.4 presents this option where the Portland metropolitan area has a 20% reduction target in 2035 and the other metropolitan areas have a 20% reduction target in 2040. This option is consistent with the findings from the Climate Smart Communities Strategy, the findings from the Central Lane Scenario Plan, and the Strategic Assessment findings from Corvallis and Rogue Valley, which indicate that Metro could meet the 20% reduction by 2035 and meeting a 20% reduction target by 2040 for the other metropolitan areas could be achieved when combined with other state actions. It is assumed that per capita emissions for all metropolitan areas will decline at the same annual rate thereafter, such that the overall metropolitan emissions in 2050 will be on track to meet statewide absolute GHG reduction goals. Target reductions from this option are shown in the table below.

Year	Portland metropolitan area	Other metropolitan areas
2040	25%	20%
2050	35%	30%

Recommendation:
The RAC recommends splitting the target using the fourth option from section 5.2.4 of Technical Memo 2. This option uses assumptions informed by the scenario planning efforts conducted over the last five years, and results in a challenging but reasonable reduction targets for both the Portland metropolitan area and the other metropolitan areas.

II. Targets for the two new MPOs: Albany Area, and Middle Rogue (Grants Pass)

In 2013, two new metropolitan areas were designated within Oregon: Albany Area, and Middle Rogue (Grants Pass area). These metropolitan areas were not included in the original 2011 target rule making, and LCDC directed the advisory committee to address whether or not targets should be set for these two new metropolitan areas. The considerations that the RAC addressed in this question were:

1. Would it be fair to set targets for these metropolitan areas?
2. Would excluding these metropolitan areas make much difference to GHG emission reduction?
3. How difficult would it be to set targets for these metropolitan areas?

The first question is addressed in the intent of the original legislation where SB1059 directed DLCD to set targets "to be met by each region served by a metropolitan planning organization." Albany Area MPO and the Middle Rogue MPO stated that they would object to setting targets for their metropolitan areas if it required MPO staff resources or was a mandated requirement. Outside of this feedback, the RAC generally concluded that given the legislative mandate, it would be fair to include these metropolitan areas in the combined targets.

The second question is addressed in section 3 of Technical Memo 2. To determine the relative effects of the inclusion of the Albany and Grants Pass metropolitan areas in the targets, the model results were factored both including the Albany and Grants Pass metropolitan areas in the metropolitan area totals, and excluding those areas from the metropolitan area totals. Given that the 2050 forecasted urban populations in those counties is about three percent of the forecasted total state population, and that the metropolitan area populations in the counties would be less than the total county populations, the effect of the per capita GHG reduction would be to reduce total statewide metropolitan area GHG from light vehicle travel by about half of one percent.

The answer to the third question is dependent upon the decision regarding the establishment of individual or separated metropolitan area targets. If either the first or second option from section I (b) is chosen, then the two new metropolitan areas would be included in the same targets as the existing metropolitan areas and there would be no additional difficultly to establish targets. If the third option is chosen however, then a substantial effort would be required to evaluate the GHG reduction capabilities for the new areas compared to the capabilities of other metropolitan areas. Since the RAC

recommends against option three, setting individual targets for metropolitan areas, including the new metropolitan areas into the targets would be straightforward.

Recommendation:
Most members of the RAC recommend including the Albany and the Middle Rogue metropolitan areas in the group target for the reasons below; however, representative of the Albany Area and Middle Rogue MPOs continued to express concerns, especially concern about any potential future requirement to take actions to reduce GHG.

1. Targets for these two metropolitan areas would be voluntary.
2. Targets would be a group target for the non-Portland metropolitan areas, which will require no resources from the MPO staff to set.
3. Analysis demonstrates an insignificant effect on the targets by including the two metropolitan areas.

III. Using the Statewide Transportation Strategy (STS) for future assumptions

The legislation that established the requirement that LCDC adopt target rules addressing all metropolitan areas also directed the ODOT to create the STS. The STS was developed by testing several hundred scenarios and through extensive stakeholder engagement, identifying strategies to substantially reduce transportation-related GHG emission and help achieve 2050 state reduction goals. The two year STS development process concluded in 2013, when the final product was accepted by the Oregon Transportation Commission. Within that timeframe more was learned about vehicle fleet, fuels and technology than was known when LCDC adopted the target rule in 2011.

Since the 2035 target rules were adopted, new information on vehicles and fuels are available that allow us to set the explicit GHG/mile trajectories, rather than specify the details on vehicle and fuels that are modeled to produce GHG/mile trajectories. This simplifies the updated rules for the years 2040 through 2050. Relying on the STS for future assumptions of fleet, fuel, and technology changes not only integrates the targets with other state agency policy direction, it streamlines the target setting process by removing much of the modeling exercise that was used to develop the 2035 targets. If the STS is adjusted to account for changing assumptions to vehicles, fuels, and technology, the targets can be similarly adjusted to compensate for the updated assumptions.

In addition to the STS, two other relevant policies have been adopted at the state and federal level. Oregon has joined with 7 other states to adopt California's zero emissions vehicle (ZEV) rules. In March of 2012, the California ZEV rules were extended to include model years out to 2025 and beyond. Also in August of 2012, the U.S. Environmental Protection Agency and the U.S. Department of Transportation adopted fuel economy and GHG emission (CAFE) standards covering vehicle model years out to the year 2025.

Section 4 of Technical Memo 2 demonstrates how the assumptions of future vehicle emission rates in the STS closely align with the adopted target rules assumption and

remains consistent with more recent state and federal policies, including the U.S. Corporate Average Fuel Efficiency standards (CAFE) and the Zero Emission Vehicle (ZEV) standards. The members on the Core Tech Team from DEQ and ODOE agreed that the STS vehicle emissions assumption are a reasonable reflection of goals that the federal government, Oregon, and other states wish to achieve.

A consideration that several members of the RAC expressed was to allow for local flexibility in achieving the target. As such, staff has proposed amendments to the target rules that explicitly grant flexibility for estimating local greenhouse gas emission reductions. Local variance from the assumptions in the STS are found in two areas: vehicles and fuels, and state-led policies. RAC members expressed the importance of allowing local areas to demonstrate efforts that go above and beyond state and federal policies found in the STS toward meeting their target. One example would be a program to add public charging stations that is estimated to result in use of hybrid or electric vehicles greater than the statewide assumption in the STS.

It is important to note that the STS includes aggressive assumptions of state-led policies that are critical to meeting the statewide GHG reduction goal. These state-led pricing policies include:

- Pay as you drive insurance
- True cost pricing, including transportation system costs and social costs
- Congestion pricing
- Vehicle miles traveled (VMT) tax

The proposed rules leave it to the discretion of each metropolitan area whether or not to include the state-led actions in the STS in projecting future emissions. Some of these state-led policies, may not be supported in some areas. By including these actions, a metropolitan area would essentially be giving their support. If they do not support such policies, they have the flexibility to remove the assumption. Metropolitan areas can evaluate alternative sets of policies to meet the target.

Recommendation:

The RAC recommends relying on the STS as the basis for calculating targets as it aligns with other important state and federal policies.

IV. Updating targets as a schedule of targets for the years 2040-2050

The 2011 target rules set targets for the year 2035. The limitation of having a target set for one specific year arose during the course of the Rogue Valley Strategic Assessment, where the region has an adopted planning horizon of 2038 which prevented a direct comparison of adopted plans to the target. In order to prevent this from occurring again and to limit the need for setting targets frequently as planning horizons are updated, a schedule of targets for the years 2040-2050 is proposed.

Recommendation:

The RAC recommends updating the target rules with a schedule of targets for the years between 2040 and 2050. Using a schedule will provide flexibility for metropolitan area planning horizons.

V. Updating the 2050 population growth assumptions

The analysis done for the 2035 target and for the STS assumed a slightly higher population growth for the state than is now assumed in state forecasts. Section 2.2.2 in Technical Memo 2 outlines the new population growth forecasts using updated numbers from the Office of Economic Analysis, the Population Research Center at Portland State University, and Metro. The current state and metropolitan area population forecasts for 2050 are 5% and 4.5% lower respectively than the forecasts assumed during the development of the target rules and the STS. Since the GHG reduction goal is expressed as the reduction in per capita emissions given a 75% reduction in total emissions from 1990 by 2050, a lower population forecast means that the target for reducing per capita emissions will be lower as well.

Recommendation:

The RAC recommends incorporating the updated population growth assumptions found in Technical Memo 2 in the target rules update.

VI. How to express targets

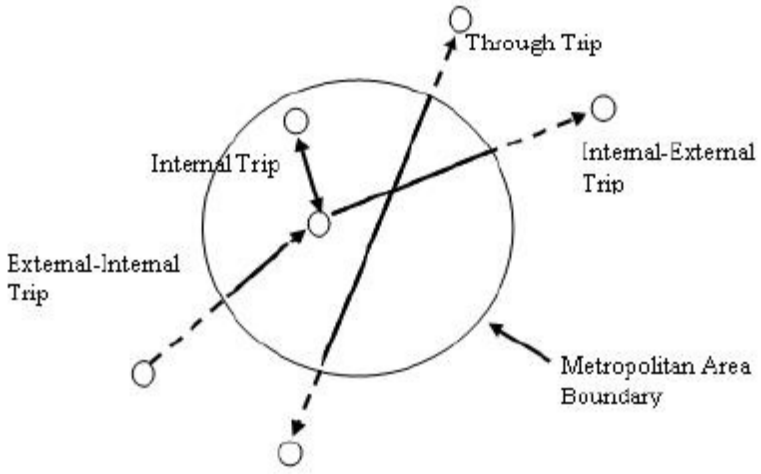
The RAC discussed two issues regarding how the targets are modelled and expressed.

a) Geography: Households versus Driving

The first issue addresses how the emission are counted. The targets could measure driving on streets and roads within the metropolitan area (regardless of who does the driving) or the targets could measure driving by households that live within the metropolitan area (regardless of where the driving occurs).

The original target rules defines travel using the first approach. This would include trips passing through a metropolitan area, trips by people who live outside a metropolitan area but come into the area, and trips by people who live within a metropolitan area. Figure 2 below from the adopted target rules illustrates the different types of trips, with the solid lines showing which portions of the trips should be counted.

Figure 2: Light Vehicle Travel within a Metropolitan Area



The model used in scenario planning in Oregon (Regional Strategic Planning Model or RSPM), estimates GHG emissions based on households, not roadway location. This is a more practical, less expensive, and more reliable approach. Scenario planning using these type of models has translated household estimates into roadway estimates by applying a constant multiplication factor that is calibrated based on 2005 travel. The factor is the ratio of recorded metropolitan roadway vehicle miles traveled (VMT) to modeled metropolitan household VMT in 2005. This factor is held constant for future forecasts because the model does not have any way to forecast how it might change. Since the roadway factor is held constant, and since the targets are expressed as the ratio of future year to base year travel, the travel by people who do not live in the area does not have any effect on meeting the target. As a practical matter, only travel by metropolitan area households is counted.

The references in the rule to metropolitan area roadway travel causes confusion and concerns. Confusion is caused by the questions of how the travel from external sources is to be accounted for. Concern is caused by perceptions that local governments in metropolitan areas are being held accountable for external travel that they have limited ability to affect.

Recommendation:

The RAC recommends that the targets rules be amended to apply to changes in travel by households living within the metropolitan area rather than to travel on roadways within the metropolitan area. The definition should also include light duty commercial vehicles based within the metropolitan area. This would allow metropolitan areas to get credit for fleet programs such as compressed natural gas and renewable natural gas, and is consistent with the modeling methods that have been implemented in the previous scenario planning exercises.

b) Target Expression:

Senate Bill 1059 directs LCDC to set GHG emission reduction targets for metropolitan areas that "must take into consideration the reductions in vehicle emissions that are likely to result by 2035 from the use of improved vehicle technologies and fuels."

The adopted targets rules define the GHG reduction targets as "a percentage reduction in emissions per capita from 2005 emissions levels **but not including reductions in vehicle emissions that are likely to result by 2035 from the use of improved vehicle technologies and fuels**." (emphasis added)

The application of this expression of the target and how it is modeled has been complicated to explain and model. Explaining the MPO share separate from the combined goal that includes vehicles and fuels (see Figure 1), is not intuitive and is often misunderstood or misrepresented by even those administering or involved in the scenario analysis.

In terms of modeling, measuring progress against the target for all of the scenario planning work has involved the creation of a 2005 'hybrid scenario' that has all the 2005 characteristics except for the vehicle and fuel technologies which are future year. Then by calculating the rate of change between this 2005 hybrid scenario and the future year, the contributions of improvements in vehicles and fuels are removed. The problem is that as modeled, vehicle technology does not just affect the emissions rates, it also affects the amount of vehicle travel. For example, if fuel economy increases, the emissions per mile goes down but the miles driven goes up because of significantly lower operating costs. This is called the rebound effect and is important to account for in emissions models, which the GreenSTEP and RSPM models do. The issue will become more problematic as the planning horizon extends farther into the future because the reductions relative to 2005 technology will become greater and greater.

Section 6.2 of Technical Memo 2 presents two alternative options for expressing the target, to avoid the problematic 2005 hybrid scenario. One would include the improvements to vehicles and fuels into the target, the other would maintain the status quo of removing vehicles and fuels, but do so with a different modeling implementation of the definition. Both options would replace the detailed table of baseline assumptions in the 2035 rule with a simpler schedule of percentage decrease in the average vehicle emissions rate. This would simplify the rules, while allowing this modeling step in future target setting to be avoided.

Option 1 – Establish goals rather than targets

This option would specify the overall goals for reducing emissions that would include the assumed change in average vehicle emissions rate. Analysis in Technical Memo 2 demonstrate that the resulting goals would range from -73% in 2040 to a -83% reduction in 2050 for a unified statewide goal. This option would be easy to apply and easier to explain, but would not explicitly separate out the effects of local actions.

Option 2 – Establish targets, but change how they are implemented

The second option would specify the targets similar to what is in the existing rules. As with the first option, the rules would be changed to specify the default assumptions for the change in the average vehicle emissions rate. The procedure for calculating the target would be the same as option 1 above, but adds an additional step to calculate an equivalent target from the goal. The implemented modeling approach avoids the use of the 2005 hybrid scenario, instead using ratios of base and future scenarios and the allowed average emission rate schedule. This step is necessary to separate out the contributions in emissions reductions from vehicles and fuels.

Recommendation:

The RAC recommends that the existing methods to isolate the effects of vehicle technologies and fuels should not be continued due to the distortion that will amplify as the planning horizon moves farther out. Option 2 is a reasonable approach; therefore, no changes to the rule language are needed.

Appendix 1 – Targets Technical Memo 1

August 23, 2016
From: Brian Gregor, Oregon Systems Analytics LLC
To: Oregon Department of Land Conservation and Development

Target Background

The metropolitan area greenhouse gas (GHG) reduction targets adopted by LCDC in OAR 660-044 establish the percentage reductions (from 2005 to 2035) in metropolitan area light vehicle GHG emissions beyond the reductions expected to occur due to changes to light vehicles and the fuels they use. The establishment of these targets was informed by technical analysis performed by ODOT, DEQ, and ODOE as directed by provisions of HB 2001 and SB 1059. In short, the analysis made recommendations on:

4. An overall light vehicle **per capita emissions reduction goal**.[2]
5. A range of forecasts for **reductions in light vehicle emission rates** due to changes in light vehicles and the fuels they use.[3]
6. The **target** percentage reductions needed to meet the per capita emissions reduction goal given the vehicle emission rate forecasts.

Development of the targets was supported by the Target Rulemaking Advisory Committee (TRAC) in 2011. The TRAC selected an emissions rate forecast they thought to be sensible and would result in achievable metropolitan area targets. This forecast and the resulting targets were then adopted in the target rules.

Figure 1 illustrates how a metropolitan area GHG reduction target is calculated from the per capita emissions reduction goal and the forecast for reduction in the light vehicle emissions rate. The circle represents total metropolitan area per capita emissions in 2005 while the grey slice shows per capita emissions in 2035 given the emissions reduction goal. Since the goal is to reduce per capita emissions by 72% from 2005 to 2035, the per capita emissions in 2035 would be 28% of the 2005 emissions. The blue slice indicates the reduction in per capita emissions due to the forecasted change in the light vehicle emissions rate. Since forecasted change in the emission rate would reduce per capita emissions by 65%, the emissions in 2035 would be 35% of the 2005 emissions if only the forecasted changes to light vehicles and the fuels they use occur. An additional 7 percentage point reduction is necessary to meet the 72% reduction goal (72% – 65%).

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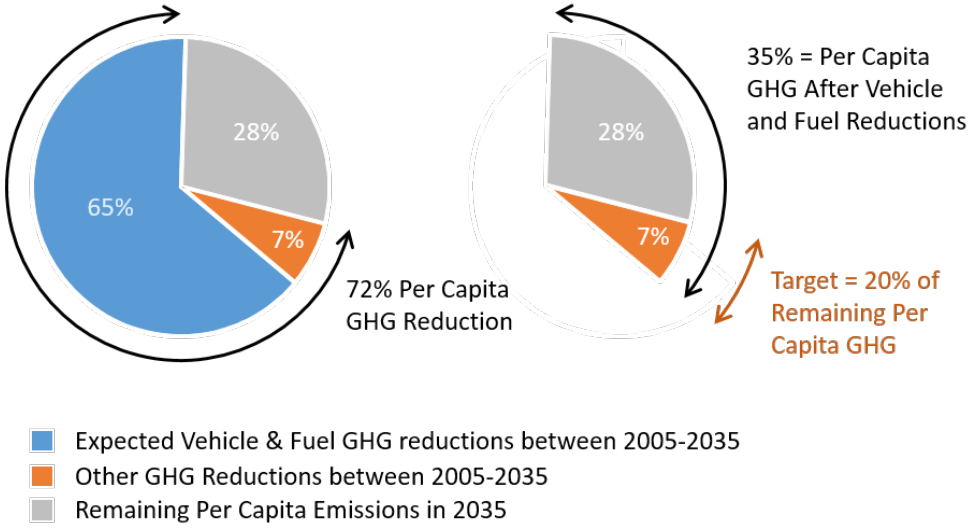
[2] The goal was established as the percentage reduction in per capita emissions rather than the percentage reduction in total emissions to account for different metropolitan area population growth rates. The units of measure are metric tons of carbon dioxide equivalents per person per year. Since several types of molecules are greenhouse gases and each has different warming potential, the measure is standardized by putting it in terms of the equivalent amount of carbon dioxide that has the same warming potential.

[3] A range of forecasts was made because at the time there was little policy guidance to rely on. That has now changed. Oregon has joined with 7 other states to adopt California's zero emissions vehicle (ZEV) rules. In March of 2012, the California ZEV rules were extended to include model years out to 2025 and beyond. Also in August of 2012, the U.S. Environmental Protection Agency and the U.S. Department of Transportation adopted fuel economy and GHG emission (CAFE) standards covering vehicle model years out to the year 2025. The units of measure for vehicle emissions rates are grams of carbon dioxide equivalents per mile of travel.

That is 20% of the remaining emissions (7% ÷ 35%). This is the target; the percentage reduction in emissions beyond the reductions expected from changes in vehicles and fuels.

Figure 1. Calculating Metropolitan Area Target from the Goal for Reducing 2005 Per Capita GHG Emissions and the Forecast for Emissions Reductions from Vehicle and Fuel Changes



A number of things have happened since the target rules were adopted in 2011:

- MPOs, DLCD, and ODOT gained experience in implementing the targets:
  - Metro adopted its Climate Smart Strategy.
  - The Central Lane MPO completed its scenario planning.
  - The Corvallis and Rogue Valley completed strategic assessments.
- ODOT completed a Statewide Transportation Strategy (STS) for reducing GHG emissions as required by statute.
- New federal and state vehicle emissions standards were adopted.

As a result of these events and the experience gained during rule implementation, the Core Tech Team (DLCD, ODOT, DEQ, & ODOE) identified several issues be considered in the target rule update:

1. Whether or not to distinguish targets among metropolitan areas;
2. Potential targets for the two new MPOs: Albany Area, and Middle Rogue (Grants Pass);
3. Using findings from the STS for future assumptions;
4. Developing targets for interim years between 2035 and 2050;
5. The effect of newer 2050 population growth assumptions (MPO share); and,
6. Different ways of expressing the targets.

This memo provides analysis regarding the first two issues: whether or not to distinguish targets among metropolitan areas, and potential targets for the two new MPOs. The other issues will be addressed in subsequent memos.

Distinguishing Targets among Metropolitan Areas

The target rules established individual MPO targets. These targets were based on a common goal for reducing per capita GHG emissions from 1990 to 2035 by 74%. Much of the difference in the targets resulted from shifting the target reference year from 1990 to 2005.[4] Differences also resulted from individualized forecasts of changes in light vehicle emissions rates.

The approach of making the 1990-based goal the same for all metropolitan areas and then adjusting the goal individually for each metropolitan area deserves additional thought. The adjustment process assumed that the per capita emissions estimates for 1990 and 2005 were relatively accurate for each metropolitan area, but the accuracy of the metropolitan area estimates depended substantially on the accuracy of a number of key calculation inputs which were difficult to obtain for 1990. This was particularly a problem for the Corvallis and Bend metropolitan areas which didn't become MPOs until the year 2000. Given uncertainties about the 1990 metropolitan area estimates it might have made more sense to adjust the 1990-based per capita emissions goal to be a uniform 2005-based goal rather than to make individual metropolitan area adjustments. Similarly, the calculation of metropolitan area-specific percentage changes in light vehicle emissions rates depended on metropolitan area light vehicle data for 1990 that were uncertain in a number of respects.

It might also be reasonable for the targets to vary because of differences in the capabilities of metropolitan areas to reduce emissions. In particular, the Portland metropolitan area is substantially larger than all other metropolitan areas combined and can implement policies that would be difficult to implement in other metropolitan areas. For example:

- Portions of the Portland metropolitan area will achieve much higher densities than the other metropolitan areas will ever achieve in the foreseeable future.
- Parking is inherently limited in dense central areas of the Portland metropolitan area, so parking pricing is easier to implement there.
- The Portland metropolitan area public transit network is much more extensive.

Following are three options for addressing this issue:

1. Establish the same target for all metropolitan areas;
2. Establish one target for the Portland metropolitan area and another target for all other metropolitan areas; and,
3. Establish a set of different targets for each metropolitan area.

[4] Since 1990 is the statutory reference year for GHG emission reduction goals, it was used as the reference year for establishing the per capita emissions reduction goal. However, it became apparent during the development of the target rules that 1990 would be a difficult year for the MPOs to model because of missing data. The target reference year was established as 2005 because much better metropolitan area data would be available for 2005 than for 1990, and because 2005 corresponded more closely to then current metropolitan area plans. Although 2010 would have been a more current year to use, it was not used because some economic data needed to estimate 2010 benchmarks was not yet available, and because the lingering effects of the great recession could make 2010 a poor benchmark year.

Option 1: Establish the same target for all metropolitan areas

The first option would be the easiest to implement and would result in the simplest rules. It would also avoid the need to establish targets for new MPOs since the same set of targets would apply to all metropolitan areas. The main disadvantage of this approach is that would probably result in more stringent standards for the non-Portland metropolitan areas than would be the case if separate standards were developed because:

- The STS forecasted that the Portland metropolitan area could reduce per capita emissions more than other metropolitan areas; and,
- The Portland metropolitan area is forecasted to have a larger population than all other metropolitan areas combined.

A cursory examination of the STS modeling results indicates that the emissions reduction goal for non-Portland metropolitan areas could be a few percentage points higher with this option than with the second option. The per capita goal for the Portland metropolitan area would be about a percentage point lower than it would be with the second option.

Option 2: Establish one target for the Portland metropolitan area and another target for all other metropolitan areas

The second option would be a little more difficult to implement and would be somewhat more complex because two sets of targets would need to be produced; one for the Portland metropolitan area and another for all other metropolitan areas. As with the first option, this option would avoid the need to establish targets for new MPOs. The targets would be easier for the smaller metropolitan areas to achieve than with the first option, but harder for the Portland metropolitan area to achieve. It is worth noting that Metro found with its Climate Smart Strategy that the metropolitan area could achieve significantly more than the target reduction if their plans are adequately funded. On the other hand, three smaller MPOs have found meeting the targets to be a more substantial challenge. A cursory examination of the STS modeling results indicates that the emissions reduction goal for non-Portland metropolitan areas could be a few percentage points lower with this option than with the first option. The per capita goal for the Portland metropolitan area would be about a percentage point higher than it would with the first option.

Option 3: Establish a set of different targets for each metropolitan area

The third option would be the most difficult to implement and would produce a significantly more complex set of rules. A substantial amount of analysis would be required in order to justify differences in targets for the smaller metropolitan areas. It would not be advisable to just use STS analysis because the STS was developed to be a statewide strategy, not a strategy for each metropolitan area individually. Analysis similar to what has been done for the strategic assessments for the Corvallis and Rogue Valley metropolitan areas would need to be done for each of the metropolitan areas in order to get the information needed to compare individual metropolitan area capabilities for reducing light vehicle GHG emissions. This analysis could easily take a year to complete and would require cooperation and effort on the part of each of the MPOs. Whether or

not better targets would result from this option than from Option 2 could not be determined until the analysis is completed.

Potential Targets for Two New MPOs

In 2013, two new metropolitan areas were designated within Oregon: Albany Area, and Middle Rogue (Grants Pass area). These MPOs were not included in the original target rule making, and in May 2015, LCDC directed the advisory committee to address whether or not targets should be set for these two new metropolitan areas.
There are several aspects to this issue:

4. Is it fair to have targets for other metropolitan areas and not these metropolitan areas?
5. Would excluding these metropolitan areas make much difference to GHG emission reduction?
6. How difficult would it be to set targets for these metropolitan areas?

The first question is a policy question and therefore not addressed in this memo.
The second question is one for which some rough estimates can be made, but would require a substantial amount of time and effort to be more specific because of a lack of specific information on light-vehicle GHG emissions from these areas. We can get a rough idea by comparing the STS 2050 forecast of per capita household light-vehicle emissions for metropolitan and non-metropolitan urban populations in Linn and Josephine counties with the corresponding forecast of per capita emissions for the non-Portland metropolitan area households.[5] If the 2050 per capita emissions for the Albany and Grants Pass metropolitan areas were reduced to be the same as the small metropolitan area forecast average, the GHG emissions for those areas would decrease by about 18%. Given that the 2050 forecasted urban populations in those counties is about 3% of the forecasted total state population, and that the metropolitan area populations in the counties would be less than the total urban populations, the effect of the per capita GHG reduction would be to reduce total state GHG from light vehicle travel by about half of a percent. If instead of reducing the statewide emissions forecast, the metropolitan area targets were relaxed so as to keep the forecasted state emissions unchanged, the metropolitan area targets would be reduced by less than a percentage point. The amount of change would be much less than what would occur with small changes to a number of state and federal policies that affect GHG emissions.

The answer to the third question depends on the decision that is made regarding the establishment of individual or separated metropolitan area targets. If either the 1st or 2nd option is chosen, then the two new metropolitan areas would have the same targets as the existing metropolitan areas and therefore would not be difficult to establish. If the 3rd

[5] Estimates of light vehicle emissions on roadways within metropolitan areas are made from estimates of metropolitan area household emissions using metropolitan area-specific factors that convert metropolitan area household travel to metropolitan area roadway travel. The STS analysis did not identify the Albany and Grants Pass metropolitan areas and therefore did not include roadway factors for those areas. Moreover, the STS analysis does not distinguish between metropolitan and non-metropolitan urban areas in Linn and Josephine counties. Therefore, as of now, it is only possible to make approximations using forecasts of GHG emissions for urban area populations of those counties.

option is chosen however, then a substantial amount of effort would be required to evaluate the capabilities for those areas to make reductions compared to the capabilities of other metropolitan areas to make reductions. The analysis would likely take a year to complete and would require the cooperation and staff involvement of the Albany Area and Middle Rogue MPOs as well as the other MPOs. Whether that process would improve the result would not be known until the analysis has been completed.

Appendix 2 – Targets Technical Memo 2

October 6, 2016
From: Brian Gregor, Oregon Systems Analytics LLC
To: Oregon Department of Land Conservation and Development

1. Purpose

The purpose of this memo is to develop a technical basis for establishing a series of annual targets for the years 2040 through 2050. Section 2 of this memo provides an explanation of how the targets are calculated and describes changes in circumstances since the target rules were adopted which affect the calculations. The section explains the basic mathematical relationship between the ***goal*** for reducing per capita greenhouse gas (GHG) emissions from light-duty vehicles in metropolitan areas, the forecast for the change in the vehicle emissions ***rate*** due to improvements to vehicle technologies and fuels, and the corresponding ***target*** for reducing per capita vehicle miles traveled (VMT).[6] Section 3 focuses on how the ***goal*** for reducing per capita GHG emissions is calculated and compares the result of the calculations with the result from the original target rule calculations. The section also evaluates the relative effects of updated population projections, different metropolitan area aggregations, and inclusion of the Albany and Grants Pass metropolitan areas on the results. Section 4 focuses on updating the forecasts of vehicle emissions ***rates*** based on the Oregon Department of Transportation's adopted Statewide Transportation Strategy (STS) for reducing greenhouse gas emissions from the transportation sector, updated federal CAFE standards, and the multi-state Zero Emissions Vehicle standards that have been adopted by Oregon.[7] Section 5 develops several alternative sets of annual goals and ***targets*** for metropolitan areas as a whole and separated between the Portland metropolitan area and the smaller metropolitan areas using outputs from the GreenSTEP model runs for the STS preferred alternative.[8] Finally, Section 6 explores issues relating to how the targets are expressed in the rules given that in practice many actions which affect the ***target*** for reducing per capita VMT also affect the vehicle emissions ***rate*** and vice versa.

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[6] Section 5 of Chapter 85 of Oregon Laws 2010 directed the Departments of Transportation, Environmental Quality, and Energy to jointly develop technical information that the LCDC would use to establish GHG reduction targets. The laws established the methodological steps the agencies were to use in developing the information. Those steps can be summarized as establishing goals for reducing metropolitan area emissions, forecasting future changes in future vehicle emissions rates, and computing the reduction in VMT that must be achieved in order to meet the goal given the forecasted vehicle emissions rates.

[7] The STS was developed in response to Oregon legislation (Chapter 85, Oregon Laws 2010). The National Highway Traffic Safety Administration (NHTSA) in cooperation with the Environmental Protection Agency (EPA) and the State of California have developed CAFE (Corporate Average Fuel Economy) standards for model year vehicles out to the year 2025 with the objective of reducing GHG emissions (http://www.nhtsa.gov/fuel-economy). Oregon has adopted California's program for zero-emission vehicles (http://www.deq.state.or.us/aq/orlev/).

[8] The GreenSTEP model was developed by the Oregon Department of Transportation to evaluate the potential effects of a variety of trends and actions on GHG emissions. The GreenSTEP model was used developing the target rules and the STS (https://www.oregon.gov/ODOT/TD/TP/pages/greenstep.aspx).

2. Background on Calculating Targets

2.1. Overview

It is important to understand how the targets are calculated in order to understand their meaning. This section starts with a simple visual presentation. It then presents a slightly more complicated mathematical equation.

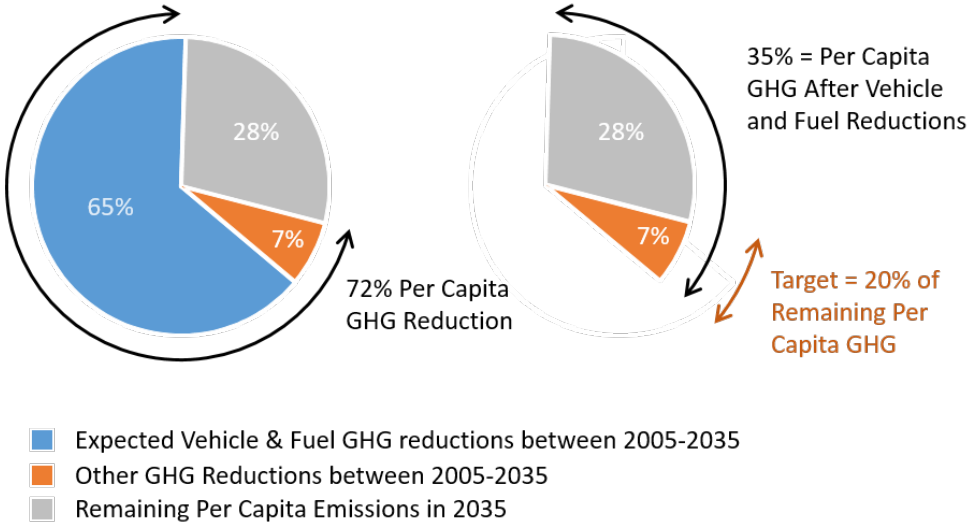
GHGs are molecules that absorb and emit infrared (heat) radiation. Because of this property, these molecules enable the earth's atmosphere to retain heat. While most GHGs are naturally occurring, man-made GHG emissions since the start of the industrial age have significantly increased atmospheric heat retention. There are a number of man-made GHGs that have different heat retention capabilities, but the most prevalent is carbon dioxide created by the combustion of fossil fuels.[9] Consequently, GHG emissions are measured in carbon dioxide equivalents (CO_2e); the amount of carbon dioxide that would produce the same warming effect. The quantity of man-made GHG emissions is typically represented in terms of the weight of CO_2e emitted. Total emissions are most often expressed in metric tons or in terms of metric tons per person. Emission rates are usually expressed in grams per mile of travel. For example, the Statewide Transportation Strategy (STS) for reducing GHG emissions estimated that the average emissions rate for light vehicles traveling in Oregon in 1990 was approximately 600 grams (about 1.3 pounds) of CO_2e per mile of travel. The total quantity of GHG light vehicle emissions in 1990 was estimated to be about 14 million metric tons (about 31 billion pounds).

2.1.1 Visual Explanation of Relationship between Emission Reduction Goals, Emission Rates, and Targets

Figure 1 illustrates how a hypothetical metropolitan area GHG reduction target is calculated from the per capita emissions reduction goal and the forecast for reduction in the light vehicle emissions rate. The circle represents total metropolitan area per capita emissions in 2005 while the grey slice shows per capita emissions in 2035 given the emissions reduction goal. Since the goal is to reduce per capita emissions by 72% from 2005 to 2035, the per capita emissions in 2035 would be 28% of the 2005 emissions. The blue slice indicates the reduction in per capita emissions due to the forecasted change in the light vehicle emissions rate. Since forecasted change in the emission rate would reduce per capita emissions by 65%, the emissions in 2035 would be 35% of the 2005 emissions if only the forecasted changes to light vehicles and the fuels they use occur. An additional 7 percentage point reduction is necessary to meet the 72% reduction goal (72% – 65%). That is 20% of the remaining emissions (7% ÷ 35%). This is the target; the percentage reduction in emissions beyond the reductions expected from changes in vehicles and fuels.

[9] Carbon dioxide accounts for about 85% of GHGs produced by Oregonians. http://www.keeporegoncool.org/content/goals-getting-there

Figure 1. Calculating Metropolitan Area Target from the Goal for Reducing 2005 Per Capita GHG Emissions and the Forecast for Emissions Reductions from Vehicle and Fuel Changes



2.1.2. Simple Introduction to Mathematics of Calculating Targets

The following simple equation relates the three quantities of emissions, vehicle emissions rate, and vehicle miles traveled (VMT).

Equation 1: Relationship between Per Capita Emissions, Vehicle Emissions Rate, and Per Capita VMT

$$\frac{Emissions}{Persons} = \frac{Emissions}{Miles} * \frac{Miles}{Persons} \qquad (1)$$

On the left side of the equation we have the average per capita emissions. On the right side of the equation we have the product of the average emissions produced per mile of vehicle travel, and the average miles of vehicle travel per person. [10]

This equation is the starting point for relating the metropolitan area targets to the goal for reducing emissions and to the forecasted improvements to vehicle technologies and fuels. The goal, forecasted improvements, and target are all expressed in terms of the change from the base year (i.e. 2005) values. In the hypothetical example above, the goal is to reduce per capita emissions by 72%, the forecast is that improvements to vehicles and the fuels they use will reduce emissions per mile of travel by 65%, and the target is for miles of vehicle travel per person to be reduced by 20%. You'll notice that expressed in this way, it is not so simple to relate these changes, however, if the changes are expressed in terms of the ratio of future year to base year values, there is a simple mathematical relationship. If you divide Equation 1 for the future year by the same equation for base year, you get the following equation that is also true.

[10] A conversion factor is also needed when emissions are measured in metric tons and vehicle emissions rates are measured in grams. One million grams equals one metric ton.

Equation 2: Relationship between the Goal for Reducing Per Capita Emissions, the Change in the Vehicle Emissions Rate, and the Change in VMT.

$$Goal = Rate * Target \quad (2)$$

Where the *Goal* is the ratio of the future year to the base year per capita emissions, the *Rate* is the ratio of the future year to base year emissions per mile of vehicle travel, and the *Target* is the ratio of future year to base year vehicle miles traveled per capita. When the percentage reductions from the example above are converted into ratios, we see that this relationship holds true as follows:

Goal = GHG emissions per capita
Rate = GHG emissions per mile
Target = Miles per capita

$$0.28 = 0.35 * 0.8$$

- A ratio of 0.28 of future to base year per capita emissions is equivalent to a 72% reduction.[11]
- A ratio of 0.35 of future to base year vehicle emissions per mile is equivalent to a 65% reduction.
- A ratio of 0.8 of future to base year vehicle miles traveled per capita is equivalent to a 20% reduction.

There are several reasons why it is important to understand this mathematical relationship. The first is to dispel incorrect interpretations of the combined effects of reductions. It is common for people to incorrectly add the percentages of reductions to calculate the total reduction. For example a person might incorrectly reason that if new vehicle technologies will reduce vehicle emission rates by 65% and various policies will reduce per capita vehicle miles traveled by 20%, total per capita GHG emissions will be reduced by 85%. This reasoning is wrong and it overestimates the total effect. The correct reduction, as shown by the equation and the graphic above is 72%. The second reason for understanding this mathematical relationship is to be able to understand and check the calculations that are presented later in this memo.

2.2. Summary of Calculation Methods

Several considerations entered into the calculation of the goals, emissions rates, and targets that are discussed below. These include the Statewide Transportation Strategy (STS) for reducing GHG emissions from the transportation sector, more recent county-level population forecasts, the approach to distinguishing targets by metropolitan area, and whether the Albany and Grants Pass metropolitan areas are included in the calculations.

2.2.1. Statewide Transportation Strategy

The legislation that established the requirement that LCDC adopt target rules addressing all metropolitan areas also directed the Oregon Transportation Commission of adopt a statewide transportation strategy for reducing GHG emissions.[12]

[11] The formula to calculating the percentage reduction from the ratio is 100 * (1 – ratio).
[12] Chapter 85, Section 2, Oregon Laws 2010.

Development of the STS started prior to the development and adoption of the target rules but was not completed until 2013. Extensive scenario testing was carried out to test various ways for reducing transportation sector GHG emissions to reach a 75% reduction in total emissions by 2050. The completed strategy includes ambitious assumptions for land use planning, alternative modes, systems management, pricing, as well as improvements to vehicle and fuels technologies. This is the scenario that was incorporated into the final strategy. The STS will serve as the basis for calculations that follow. Assumed vehicle emissions reductions are compared with adopted policies to assure that they are reasonable assumptions.

Results of GreenSTEP model runs for the STS recommended scenario were the starting point of the analysis. Tabulations of outputs from the GreenSTEP model of estimated and projected population, daily vehicle miles traveled (DVMT) by light-duty vehicle, and light-duty vehicle CO_2e emissions were made by county and development type (i.e. metropolitan, town, rural). From the tabulations of light-duty vehicle travel, which represent the travel demand of households, the light-duty vehicle travel on metropolitan area roadways was calculated using the conversion factors used for the STS and the analysis done for the original target rules.[13] Factors were estimated for the Albany and Grants Pass metropolitan areas as described below. The conversion factors were also used to convert tabulations of light-duty vehicle CO_2e into tabulations of metropolitan area roadway emissions.

2.2.2. New County-Level Population Forecasts

The analyses that were done for the original target rules and for the STS assumed slightly higher population growth for the state than is now assumed in state forecasts.[14] The current state and metropolitan area population forecasts for 2050 are 5% and 4.5% lower respectively than the forecasts assumed during the development of the target rules and the STS. Since the GHG reduction goal is expressed as the reduction in per capita emissions

[13] Light-duty vehicle travel includes travel by households by light-duty vehicles and travel by light-duty commercial service vehicles (e.g. delivery and service vehicles). The GreenSTEP model calculates household light duty vehicle travel and tabulates the travel where the household resides rather than where the household drives, which is not modeled. Commercial service vehicle travel is calculated as a function of household light-duty vehicle travel and is allocated to places in proportion to the allocation of the household light duty vehicle travel. Travel on roadways within a metropolitan area is calculated by factoring the light-duty vehicle travel attributed to the metropolitan area. This metropolitan area factor is estimated for the year 2005 by dividing an estimate of light-duty DVMT on metropolitan area roads by the GreenSTEP model estimate of light-duty DVMT attributable to the metropolitan area households and businesses using the calibrated model. Factors are individual to metropolitan areas. They are held constant for all years.

[14] The STS population forecast was based on two sources. The first was an interim county-level population forecast by age cohort prepared by the Oregon Office of Economic Analysis (OEA). That forecast was developed prior to the release of the 2010 Census population counts. The second was the population forecast for Clackamas, Multnomah, and Washington Counties prepared by Metro. Those forecasts only extended to 2040 so ODOT staff extrapolated the forecasts out to 2050. The current forecasts are from 3 sources. Metro staff provided forecasts out to 2050 for Clackamas, Multnomah, and Washington Counties. The forecasts for Benton, Clatsop, Columbia, Lincoln, Linn, Polk, Tillamook, and Yamhill Counties are from the OEA official forecasts from 2010 to 2050 published in 2013 (https://www.oregon.gov/das/OEA/Pages/forecastdemographic.aspx). The forecasts for all other counties are more recent forecasts prepared by the Portland State University Population Research Center (https://www.pdx.edu/prc/opfp).

given a 75% reduction in total emissions from 1990 by 2050, a lower population forecast means that the goal for reducing per capita emissions will be lower as well.
The new county-level forecasts were allocated by development type (i.e. metropolitan, town, rural) by assuming that the proportional allocation by development type in each county would be unchanged. Light-duty vehicle DVMT and CO_2e forecasts corresponding to the lower population projection were calculated by scaling the STS forecasts using the ratio between the new population projection and the STS population projection. This was done by county and development type.

2.2.3. How Targets are Distinguished by Metropolitan Area

Three options were presented to the Rules Advisory Committee for how to specify metropolitan area targets. They were:

1. All metropolitan areas have the same targets.
2. There is one set of targets for the Portland metropolitan area and another set of targets for all other metropolitan areas.
3. Every metropolitan area has its own set of targets.

There was very little support for the third option which would require an extensive amount of time and money to provide a strong basis to make distinctions between the targets for the smaller metropolitan areas. The first two options had the most support, but there was no decision as to which should be used.
Since no decision was made whether the first or second option should be used, the analysis for this memo was done for both options. To do this, the tabulations of population, DVMT, and CO_2e by county and development type were summed for all metropolitan areas, for just the Portland metropolitan area, and for just the smaller metropolitan areas. This enabled the results of the two options to be compared.

2.2.4. Including Albany and Grants Pass

Since the target rules were adopted, the populations of the Albany and Grants Pass areas exceeded the threshold for the areas being classified as urbanized by the U.S. Census Bureau. Consequently the areas qualified for having designated metropolitan planning organizations to coordinate transportation planning and federal transportation funding.
Analyzing the option where Albany and Grants Pass are included in the target calculations requires splitting out the estimates of population, DVMT, and CO_2e from those areas from the estimates for other urban areas in Linn and Josephine counties respectively. Proportional splits were calculated using 2010 population estimates for incorporated cities within the counties.[15] The population proportions were used to split DVMT and CO_2e as well.
Analyzing this option also requires the estimation of metropolitan area factors to calculate roadway DVMT and CO_2e from household and commercial service vehicle DVMT and CO_2e. Given the paucity of information available to calculate these factors and limited time available to calculate them, factors were estimated from the estimated

[15] The Albany metropolitan area proportion was calculated by dividing the sum of the Albany, Millersburg, and Tangent city population estimates by the sum of the population estimates for all incorporated cities in Linn County. The Grants Pass metropolitan area proportion was calculated by dividing the Grants Pass population estimate by the sum of the population estimates for all incorporated cities in Josephine County.

factors for other metropolitan areas. Since both Albany and Grants Pass are located on I-5 and the ratio of roadway DVMT to metropolitan household and commercial service DVMT is likely to be affected by I-5 traffic, the roadway factor for these metropolitan areas was calculated as the average of the roadway factors calculated for the Salem-Keizer, Eugene-Springfield, Rogue Valley metropolitan areas.
The relative effects of including the Albany and Grants Pass metropolitan areas in the metropolitan area calculations are explored in the next section of this memo.

3. Comparison of STS-Based Calculations of 2035 Emission Goal and Target with Target Rules and Evaluation of the Effect of New Population Projections

The analysis of emissions goals and targets in this memo uses outputs from GreenSTEP model runs for the STS recommended scenario. In this section, the calculations of per capita emissions goals and targets for 2035 based on the STS are compared with the calculations carried out in 2011 for the target rules. This is done to determine whether improvements to the GreenSTEP model, changes to vehicle and fuels technology forecasts, or policy assumptions in the STS result in significantly different conclusions about what emissions reduction goals and travel targets should be.
The target rules calculations and the STS calculations were based on GreenSTEP model runs that used the same population projections, so the comparison of results is exclusive of the effects of changes to population forecasts. As explained in Section 2.2.2 above, current state and metropolitan area population forecasts are lower respectively than the forecasts assumed during the development of the target rules and the STS. Since the GHG reduction goal is expressed as the reduction in per capita emissions given statutory goals for reducing total emissions, a lower population forecast means that goal for reducing per capita emissions and corresponding target will be lower as well. The effects of population projections also depends on whether or not the Albany and Grants Pass metropolitan areas are included in the calculation of metropolitan area emissions. The effects of alternative population projections on per capita emission reduction goals and travel targets are shown at the end of this section.
Table 1 shows the calculation of the 2035 metropolitan area average per capita emissions, the goal for reducing per capita emissions, and the corresponding target for reducing VMT. These calculations are based on the STS model results for the population projections assumed for the STS and target rules. The calculation steps are as follows:

1. Calculate the metropolitan area proportions of total state roadway CO_2e 2020 and 2050 from STS model run outputs.
2. The goals for 2020 and 2050 total state roadway CO_2e are calculated by reducing 1990 estimated total state roadway CO_2e by 10% and 75% respectively to reflect statutory goals.
3. The metropolitan area roadway CO_2e for 2020 and 2050 are calculated by multiplying the state goals (step 2) by the metropolitan proportions (step 1).
4. Sum up the forecasted metropolitan area populations for 2020 and 2050.
5. The metropolitan area roadway CO_2e per capita for 2020 and 2050 are calculated by dividing the metropolitan area roadway CO_2e (step 3) by the projected metropolitan area population for 2020 and 2050.

6. The rate of decline (% per year) in metropolitan area CO_2e per capita from 2020 to 2050 is calculated from the metropolitan area roadway CO_2e per capita for 2020 and 2050 (step 4).
7. The rate of decline calculated in step 5 is used to calculate metropolitan area roadway CO_2e per capita by year in 2035 and annually for the years from 2040 to 2050.
8. The ratio of future metropolitan area roadway CO_2e per capita (step 6) to base year (i.e. 2005) metropolitan area roadway CO_2e per capita is calculated.
9. From 2005 and 2035 summations of CO_2e and DVMT, calculate the emissions rates (CO_2e per mile) and the ratio of future to base year emissions rates (see Section 4 below).
10. Calculate an overall average target by dividing the CO_2e per capita ratio by the emissions rate ratio.

Table 1: Calculations of Average Metropolitan CO_2e Per Capita Reduction Goal and Corresponding Target Using STS Population Forecast Assumption

Calculation Step	**1990**	**2005**	**2020**	**2035**	**2050**
1. Metropolitan roadway CO_2e proportions of total state roadway CO_2e			0.461		0.372
2. Goals for total state roadway CO_2e for 2020 and 2050 (metric tons per day)	43,584		39,226 (-10%)		10,896 (-75%)
3. Metropolitan area roadway CO_2e for 2020 and 2050 (metric tons per day)			18,089		4,052
4. Metropolitan area population			2,642,300		3,700,467
5. Metropolitan area roadway CO_2e per capita for 2005, 2020 and 2050 (metric tons per year)			2.5		0.4
6. Percentage rate of decline in metropolitan area roadway CO_2e between 2020 and 2050			5.9		
7. Metropolitan area 2035 CO_2e per capita (metric tons per year) and 2005 value for comparison		3.75		1.0	
8. Ratio of 2035 to 2005 metropolitan area roadway CO_2e and percentage reduction				0.27 73.3%	
9. Ratio of 2035 to 2005 vehicle emissions rates (see Section 4)				0.33	
10. Target ratio and percentage reduction				0.81 -19.5%	

The results of the calculations shown in Table 1 are close to the results calculated for the original target rules. The target rule calculations also established a 2035 goal for all metropolitan area roadway CO_2e per capita that was also about 1 metric ton per person per year. The percentage reduction in per capita emissions from the 2005 level was

calculated to be 73.7% for the target rules. Furthermore, when an all metropolitan area target is calculated using the assumed change in the vehicle emissions rate (Section 4), the result is close to the average in the target rules (-19.5% vs. -19.7%). These findings are significant because they show that despite upgrades to the GreenSTEP model, revisions to the assumptions about base year and future year vehicle characteristics, and more research into potential state and local policies to reduce GHG emissions, there are very similar outcomes for metropolitan areas as a whole.

To determine the relative effects of the new population projections and inclusion of the Albany and Grants Pass metropolitan areas in the metropolitan area averages, the calculations outlined above were carried on the STS GreenSTEP model results that were factored to reflect the new projections. This was done with both including the Albany and Grants Pass metropolitan areas in the metropolitan area totals, and excluding those areas from the metropolitan area totals. Table 2 compares the 2035 CO_2e per capita, the percentage reduction in the goal (CO_2e per capita)m and the corresponding percentage reduction in the target (VMT per capita) for the original targets, the STS, and the current population projections with and without the inclusion of the Albany and Grants Pass metropolitan areas.

Table 2: Comparison of Average Metropolitan CO_2e Per Capita Reduction Goals and Corresponding Targets for Target Rules, STS, and New Population Projections

Percentage Change from 2005	Target Rules	STS	New Population Forecast	
			Albany and Grants Pass NOT Included	Albany and Grants Pass Included
Goal (MT CO_2e per capita)	1.00	1.00	1.04	1.06
Goal Percent Change	-73.7%	-73.3%	-72.2%	-71.8%
Target Percent Change	19.7%	-19.5%	-16.2%	-14.8%

It can be seen that the STS value for CO_2e per capita is identical (out to 2 decimal points) to the value calculated for the original target rules. Moreover the other values for the STS are very close to the target rules values. The new population projections increase the allowable emissions per capita by 4% to 6%. This corresponds to the difference in the population projections. The differences in the population projections translate into differences in the percentage change in the goal and the target. There is a greater difference in the target percentage change than the goal percentage change because of how the target is defined. This can be understood by reviewing Figure 1.

The bottom line is that the STS results for metropolitan areas as a whole are very close to the results calculated for the original targets. Updating the calculations to account for newer population projections increases the allowable per capita emissions in 2035 by 4% to 6%. This change in allowable per capita emissions results in a significant reduction in the target percentage change.

Section 5 of this memo examines several alternative methods for establishing future targets using these results. That analysis is based on the calculations which reflect the

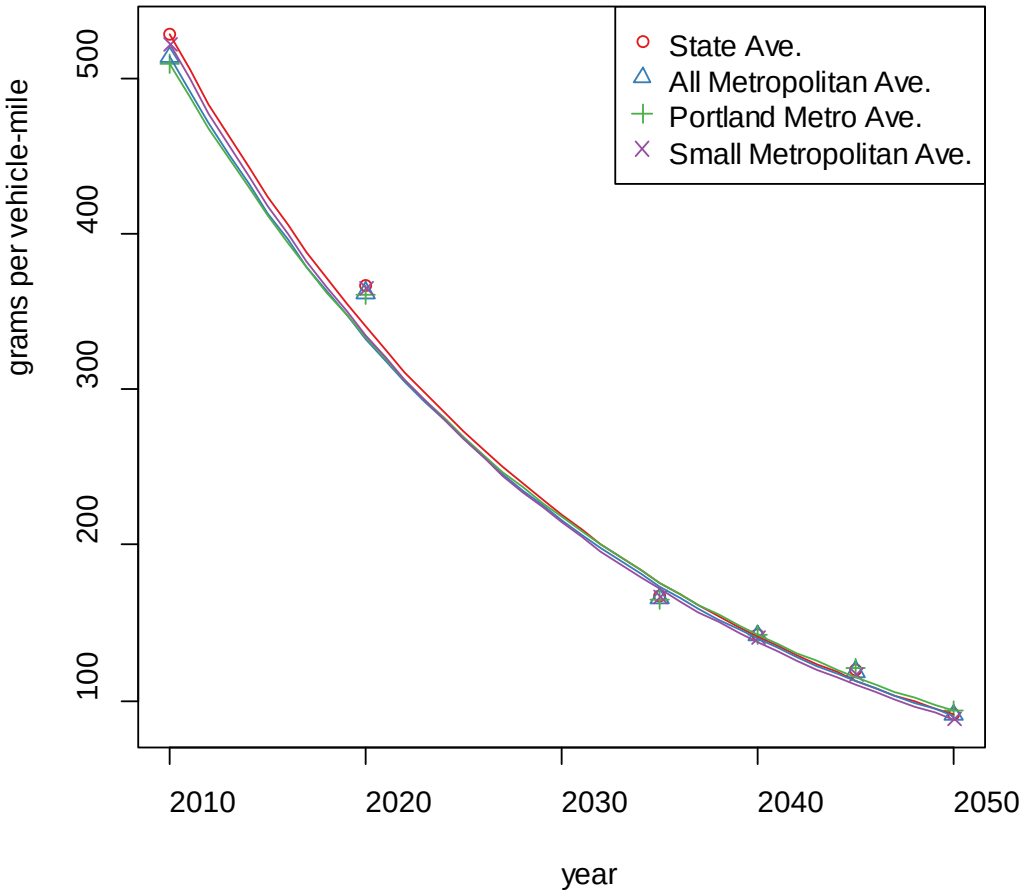
new population projections and the inclusion of the Albany and Grants Pass metropolitan areas in the metropolitan area calculations based on the recommendation of DLCD staff.

4. Vehicle Emission Rates

During the process of developing the STS, ODOT and its technical and policy committees concluded that ambitious improvements to vehicle fuels and technology along with local transportation and land use actions and other state policies would be necessary to meet the goal of reducing GHG emissions from light-duty vehicles by 2050. The recommended scenario assumed that by 2050 over half of the light-duty vehicle fleet would be composed of either electric vehicles or plug-in hybrid electric vehicles. The improvements envisioned by the recommended STS scenario as well as further clean fuels improvements would drastically reduce vehicle emissions rates. Figure 2 shows the modeled fleet average emissions rates (grams of CO_2e per vehicle mile) given the recommended scenario assumptions about deployment of future vehicle technology and clean fuels. The points show the values at key benchmark years for the different levels of metropolitan aggregation. Trend lines are overlaid on the graph.[16] Average vehicle emissions rates would need to decline by a little over 4% per year from the 2010 estimated average in order to achieve the recommended level in 2050. It can be seen that the modeled values vary very little by aggregation level. It can also be seen that the trend lines approximate the modeled values reasonably well.

Figure 2: Fleet-wide Average Light-duty Vehicle Emissions Rates Modeled for the STS Recommended Scenario and Future Trend Lines

[16] It is important to note that these 'trend lines' represent the trend in the model results given the vehicle assumptions in the STS recommended scenario. They do not represent an extrapolation of past trends. In other words, they represent the trend that needs to occur, not the trend that has occurred.



Although the technology assumptions in the STS are ambitious, they are not out of line with other state and federal policies that have been developed since the adoption of the target rules, including the US CAFE standards and California Rule/multi-state Zero Emission Vehicle (ZEV) standards. The CAFE standards equate to an average emissions rate for new vehicles of 163 grams per mile in 2025. The ZEV standards equate to average emissions rates for new vehicles of 125 and 100 grams per mile in 2030 and 2035 respectively.[17] Figure 3 compares the STS emission rate "trend line" for all metropolitan areas with the assumed value for the target rules, and with CAFE and ZEV emissions rates. To make the CAFE and ZEV standards, which are new car standards, comparable with the STS values, which are average fleet values, it is assumed that the new car standards will reflect average fleet values when the vehicles sold in those years reach the average vehicle age. The Bureau of Transportation Statistics reports that the national average vehicle age in 2014 (the latest year reported) was 11.4 years.[18] Thus the US CAFE standard for 2025 would reasonably represent the average fleet value in 2036 and the California Rule standards for 2030 and 2035 would represent average fleet values in 2041 and 2046.

[17] Email communication from Dave Nordberg, Oregon DEQ, dated September 22, 2016.

[18] http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_26.html_mfd

It can be seen that the STS emissions rate trend line values are close to the target rule, CAFE, and ZEV rule values. Table 3 shows the average projected rates for all years from 2040 to 2050 based on the all metropolitan area future trend line. The members on the Core Tech Team from the Departments of Environmental Quality and Energy agreed that the STS "trend line" is a reasonable reflection of goals that California, Oregon, and other states participating in the multi-state ZEV standards wish to achieve. They caution, however, that this planning trend does not reflect recent trends in vehicle fuel economy. Substantial efforts on the part of states and the federal government will be necessary to make this planning trend a reality.

Figure 3: Comparison of STS Metropolitan Trend Line Vehicle Emissions Rates and Target Rule, CAFE, and ZEV Standard Rates: 2035 to 2050

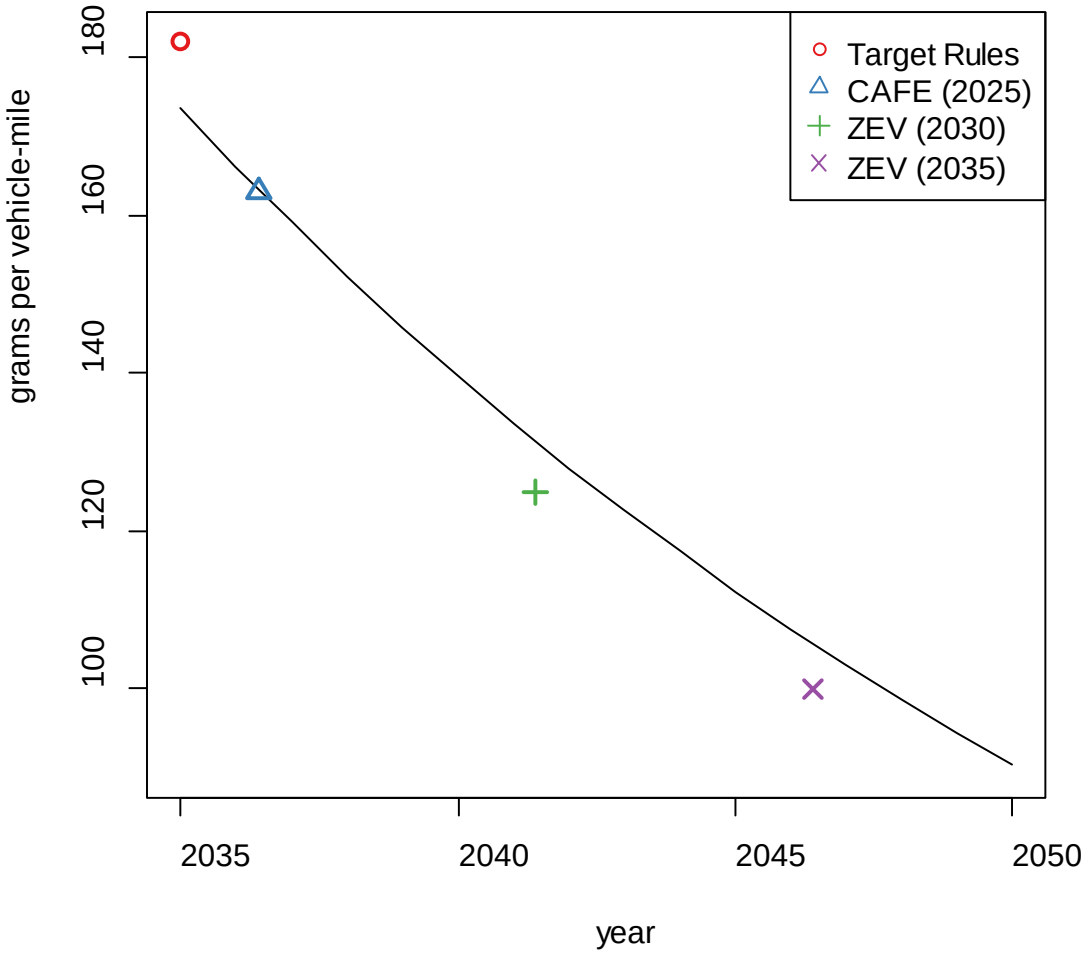


Table 3: Projected Metropolitan Area Vehicle Emissions Rates (CO_2e per vehicle-mile)

Year	Emission Rates (grams / mile)	Ratio With 2005 Value	Percentage Change from 2005 Value
2040	140	0.267	-73.3
2041	134	0.255	-74.5
2042	128	0.244	-75.6
2043	123	0.234	-76.6
2044	117	0.224	-77.6
2045	112	0.215	-78.5
2046	108	0.205	-79.5
2047	103	0.197	-80.3
2048	99	0.188	-81.2
2049	94	0.180	-82.0
2050	90	0.173	-82.7

5. Target Calculations for the Years 2040 to 2050

This section presents several alternative ways of calculating targets for the years 2040 to 2050 starting with information from the STS. This is done for two of the options previously discussed by the Rules Advisory Committee for allocating emissions reductions between the metropolitan areas:

1. Single statewide target
2. One target for the Portland region and another single target for all other metro areas

5.1. Option 1: Common Targets for All Metropolitan Areas

Table 4 shows the "all metropolitan area" values calculated from STS model results and adjusted to reflect the current county-level population projection and inclusion of the Albany and Grants Pass metropolitan areas in the metropolitan area numbers.

Table 4: Calculation of Uniform Targets for All Metropolitan Areas

Year	Per Capita Emissions		Emissions Rate Change Ratio	Target	
	MT CO2e	Change Ratio		Change Ratio	Percentage Decrease
2040	0.783	0.209	0.267	0.785	-21.5
2041	0.738	0.197	0.255	0.772	-22.8
2042	0.695	0.186	0.244	0.760	-24.0
2043	0.655	0.175	0.234	0.747	-25.3
2044	0.617	0.165	0.224	0.735	-26.5
2045	0.581	0.155	0.215	0.723	-27.7
2046	0.547	0.146	0.205	0.711	-28.9
2047	0.515	0.138	0.197	0.700	-30.0
2048	0.485	0.130	0.188	0.689	-31.1
2049	0.457	0.122	0.180	0.677	-32.3
2050	0.431	0.115	0.173	0.666	-33.4

The per capita emissions are calculated at the same annual rate of decline as shown in line 6 of Table 1. The change ratio for per capita emissions is calculated by dividing the

per capita emissions by the average per capita emissions in 2005 (Table 1, line 7). The emissions rate change ratio is from the third column of Table 3. The target change ratio is calculated by dividing the per capita emissions change ratio by the emissions rate change ratio. Finally, the target percentage decrease is calculated from the target change ratio.[19]

5.2 Option 2: Separate Targets for the Portland Metropolitan Area and Other Metropolitan Areas

In this section, several alternative scenarios are presented for targets that are different for the Portland metropolitan area and smaller metropolitan areas. All achieve the same overall emissions in 2050 as Option 1. The scenarios are:

- Assume STS values;
- Assume STS 2035 starting values and equal rates of per capita emissions decline for all metropolitan areas after 2035;
- Assume the Portland metropolitan area achieves a -29% target in 2035 based on the Climate Smart Strategy, the small metropolitan areas make up the difference in emissions in 2035, and after 2035 the rate of decline in per capita emissions is the same for all metropolitan areas;
- Assume the Portland metropolitan area achieves a -20% target in 2035 based on the existing target, the small metropolitan areas make up the difference in emissions in 2035, and after 2035 the rate of decline in per capita emissions is the same for all metropolitan areas;
- Assume the Portland metropolitan area achieves a -20% target in 2035, smaller metropolitan areas achieve a -20% target in 2040, and the rate of decline in per capita emissions is the same for all metropolitan areas.

The results for each alternative are presented without showing all of the intermediate calculations shown in Table 4. Each table shows the target percentage reductions for the Portland metropolitan area and small metropolitan areas, the average per capita emissions for all metropolitan areas, and the average per capita emissions from Table 4 for comparison.

5.2.1 Calculations from the STS

Table 5 shows the results of calculating targets from the population-adjusted model results for the STS. It is important to note that the STS was developed for the purpose of exploring what actions need to occur in order for the transportation sector to achieve the statutory goals for reducing GHG emissions. STS was not developed to determine what the policies of individual metropolitan areas should be to achieve emissions reductions. That is the purpose of metropolitan area scenario planning.

As can be seen, almost all of the burden for reducing CO_2e, beyond reductions due to forecasted improvements to vehicle technology and fuels, falls on the Portland metropolitan area. These results suggest that the STS assumptions may have been too ambitious for the Portland metropolitan area and not ambitious enough for the smaller metropolitan areas. By 2050 per capita VMT in the Portland metropolitan area would be

[19] 100 * (ChangeRatio – 1)

almost cut in half from what it was in 2005. Smaller metropolitan area VMT would only be reduced by 5%. The large difference in targets is due to two things:

1. The reductions in the Portland metropolitan area by 2035 are much greater (-26% vs. +4%); and,
2. Per capita emissions decline at a much faster rate in the Portland metropolitan area (-6.6% per year vs. -4.8% per year).

Table 5: Target Reductions Calculated from Populated-Adjusted STS Model Run Outputs

Year	Target % Reductions		Average Per Capita Emissions	
	Portland Met.	Small Met	Alternative	Average from Table 4
2040	-34.8	1.2	0.783	0.783
2041	-36.4	0.6	0.738	0.738
2042	-37.9	0.0	0.695	0.695
2043	-39.4	-0.6	0.655	0.655
2044	-40.8	-1.2	0.617	0.617
2045	-42.3	-1.7	0.581	0.581
2046	-43.7	-2.3	0.547	0.547
2047	-45.0	-2.9	0.515	0.515
2048	-46.3	-3.5	0.485	0.485
2049	-47.6	-4.0	0.457	0.457
2050	-48.9	-4.6	0.431	0.431

The burden on the Portland metropolitan area would decrease significantly and the burden on the smaller metropolitan areas would increase significantly if it is assumed that per capita emissions decline at the same rate for all metropolitan areas after 2035. Table 6 shows the results.

Table 6: Assume STS 2035 Starting Values and Equal Rates of Decline

Year	Target % Reductions		Average Per Capita Emissions	
	Portland Met.	Small Met	Alternative	Average from Table 4
2040	-32.1	-2.0	0.783	0.783
2041	-33.2	-3.6	0.738	0.738
2042	-34.3	-5.2	0.695	0.695
2043	-35.4	-6.7	0.655	0.655
2044	-36.4	-8.2	0.617	0.617
2045	-37.4	-9.7	0.581	0.581
2046	-38.4	-11.2	0.547	0.547
2047	-39.4	-12.6	0.515	0.515
2048	-40.4	-14.0	0.485	0.485
2049	-41.4	-15.4	0.457	0.457
2050	-42.3	-16.8	0.431	0.431

The all metropolitan area average per capita emissions for these alternatives match the averages from Option 1.

5.2.2 Assume Portland Metropolitan Area Achieves a 29% Reduction Target in 2035

In this alternative it is assumed that the Portland metropolitan area achieves a 29% reduction target in 2035 as a result of implementing the Climate Smart Strategy (CSC). The small metropolitan areas are assumed to make up the difference between the Portland metropolitan area emissions in 2035 and the emissions calculated for all metropolitan areas in 2035. After 2035, it is assumed that per capita emissions for all metropolitan areas will decline at the same annual rate and that the emissions in 2050 will be the same as in Option 1. The results for this alternative are shown in Table 7.

This alternative scenario would have a lower burden on the Portland metropolitan area than the STS alternative (Table 5) even though the assumed reduction for the Portland metropolitan area in 2035 is greater than the STS value (-29% vs. -26%). The smaller reductions for this scenario relative to the STS are due to the assumption that per capita emissions decline at an equal rate in all metropolitan areas. The burden on the Portland metropolitan area is greater with this scenario than with the modified STS alternative shown in Table 6 because of the higher starting reduction in 2035.

Table 7: Assume Portland Metropolitan Area Achieves 29% Reduction Target in 2035

Year	Target % Reductions		Average Per Capita Emissions	
	Portland Met.	Small Met	Alternative	Average from Table 4
2040	-34.5	2.4	0.783	0.783
2041	-35.6	0.8	0.738	0.738
2042	-36.6	-0.9	0.695	0.695
2043	-37.7	-2.5	0.655	0.655
2044	-38.7	-4.0	0.617	0.617
2045	-39.7	-5.6	0.581	0.581
2046	-40.6	-7.1	0.547	0.547
2047	-41.6	-8.6	0.515	0.515
2048	-42.5	-10.1	0.485	0.485
2049	-43.5	-11.5	0.457	0.457
2050	-44.4	-13.0	0.431	0.431

The all metropolitan area average per capita emissions for this alternative match the averages from Option 1.

5.2.3 Assume that the Portland Metropolitan Area Achieves the 20% Target in 2035

The target rules establish a target of a 20% reduction for the Portland metropolitan area in 2035. The small metropolitan area reduction in 2035 is calculated in the same way as in the previous alternative. After 2035, it is assumed that per capita emissions for all metropolitan areas will decline at the same annual rate and that the emissions in 2050 will be the same as in Option 1. Changing the 2035 target assumption for the Portland metropolitan area from -29% to -20% substantially reduces the burden on the Portland metropolitan area and increases it for the smaller metropolitan areas. The results are shown in Table 8.

Table 8: Assume Portland Metropolitan Area Achieves 20% Reduction Target in 2035

Year	Target % Reductions		Average Per Capita Emissions	
	Portland Met.	Small Met.	Alternative	Average from Table 4
2040	-26.3	-12.8	0.783	0.783
2041	-27.5	-14.2	0.738	0.738
2042	-28.6	-15.6	0.695	0.695
2043	-29.8	-16.9	0.655	0.655
2044	-30.9	-18.3	0.617	0.617
2045	-32.1	-19.6	0.581	0.581
2046	-33.2	-20.9	0.547	0.547
2047	-34.2	-22.2	0.515	0.515
2048	-35.3	-23.5	0.485	0.485
2049	-36.4	-24.7	0.457	0.457
2050	-37.4	-25.9	0.431	0.431

The all metropolitan area average per capita emissions for this alternative match the averages from Option 1.

5.2.4 Assume Portland Metropolitan Area Achieves a 20% Target in 2035 and Small Metropolitan Areas Achieve a 20% Target in 2040

As with the previous alternative, this one assumes that the Portland metropolitan area achieves a 20% reduction target in 2035, but rather than assume that the small metropolitan areas make up the difference in emissions, this alternative assumes that the smaller metropolitan areas achieve a 20% reduction target in 2040. As with the other alternatives, it is assumed that the rate of reduction in per capita emissions is the same for all areas and that the emissions in 2050 will be the same as in Option 1. Table 9 shows the results.

Table 9: Assume Portland Metropolitan Area Achieves 20% Reduction Target in 2035 and Smaller Metropolitan Areas Achieve a 20% Reduction Target in 2040.

Year	Target % Reductions		Average Per Capita Emissions	
	Portland Met.	Small Met.	Alternative	Average from Table 4
2040	-25.3	-20.0	0.764	0.783
2041	-26.4	-21.1	0.721	0.738
2042	-27.4	-22.2	0.681	0.695
2043	-28.4	-23.3	0.643	0.655
2044	-29.4	-24.3	0.607	0.617
2045	-30.3	-25.3	0.574	0.581
2046	-31.3	-26.4	0.542	0.547
2047	-32.2	-27.4	0.511	0.515
2048	-33.2	-28.4	0.483	0.485
2049	-34.1	-29.4	0.456	0.457
2050	-35.0	-30.3	0.431	0.431

Unlike the previous alternatives, this alternative does not match the average per capita emissions for Option 1 except for the year 2050. Assuming the smaller metropolitan areas will achieve a 20% reduction by 2040 results in lower per capita emissions. The difference in the per capita emissions decreases as the year 2050 is approached.

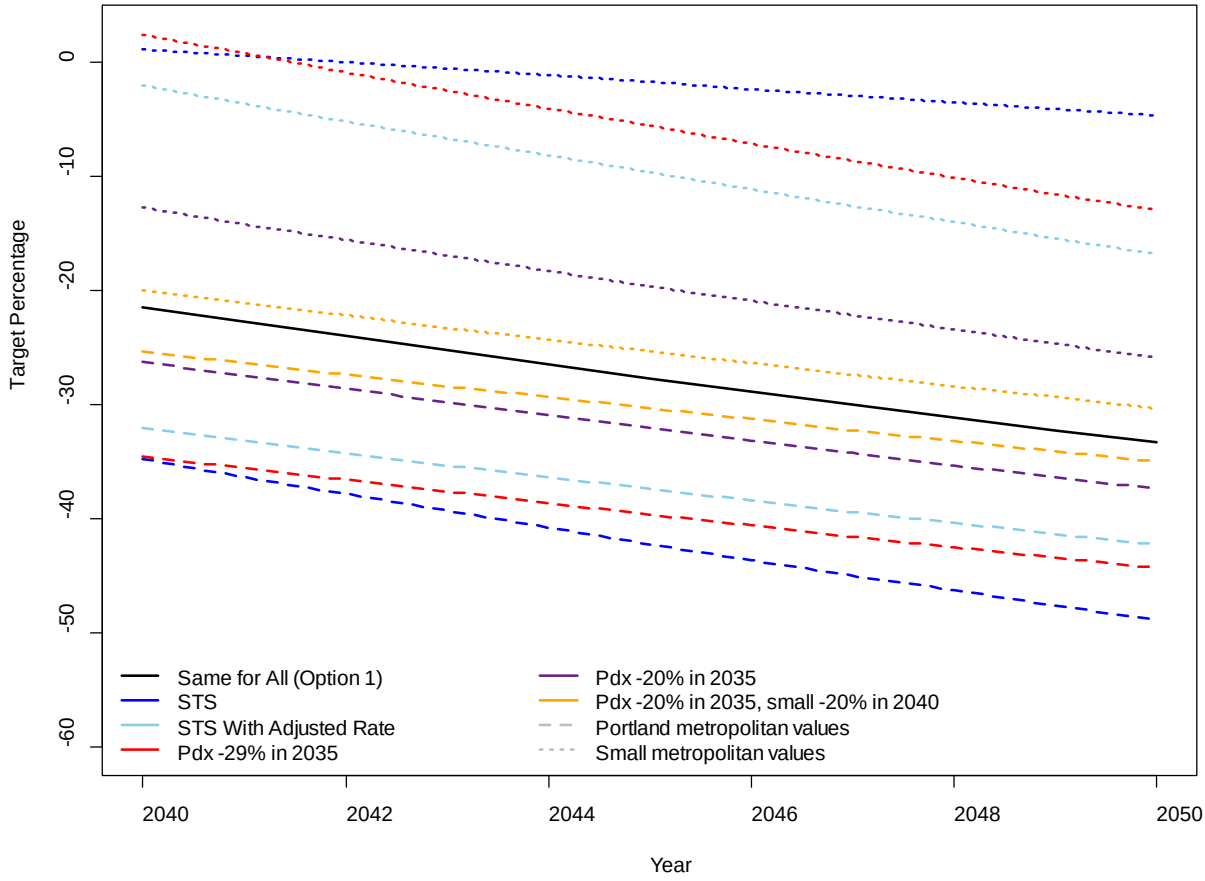
5.3 Summary Comparison

Figure 4 compares the target alternatives presented in Sections 5.1 and 5.2. The solid black line in the middle of the graph shows the alternative where all the metropolitan area targets are the same (Option 1). The dashed lines show the alternatives where the Portland metropolitan area targets and the small metropolitan area targets differ. The wide dashed lines below the solid black line are the Portland metropolitan area targets. The narrow dashed lines above the solid black line are the small metropolitan area targets. The lines are color-coded to identify the values for each alternative as follows:

- Dark Blue: Assuming STS values
- Light Blue: Assuming STS 2035 starting values and equal rates of decline after 2035
- Red: Assuming Portland metropolitan area achieves a -29% target in 2035
- Violet: Assuming Portland metropolitan area achieves a -20% target in 2035
- Yellow: Assuming Portland metropolitan area achieves a -20% target in 2035 and smaller metropolitan areas achieve a -20% target in 2040.

In all but the first alternative in this list, it is assumed that the rates of decline in per capita emissions is the same for all metropolitan areas after 2035. In all but the last alternative in the list, the total metropolitan area emissions every year are the same as the metropolitan area emissions for Option 1. For the last alternative in the list, the total metropolitan area emissions are lower than Option 1 except for the last year (2050).

Figure 4: Comparison of Alternative Targets



6. Target Specification Issues

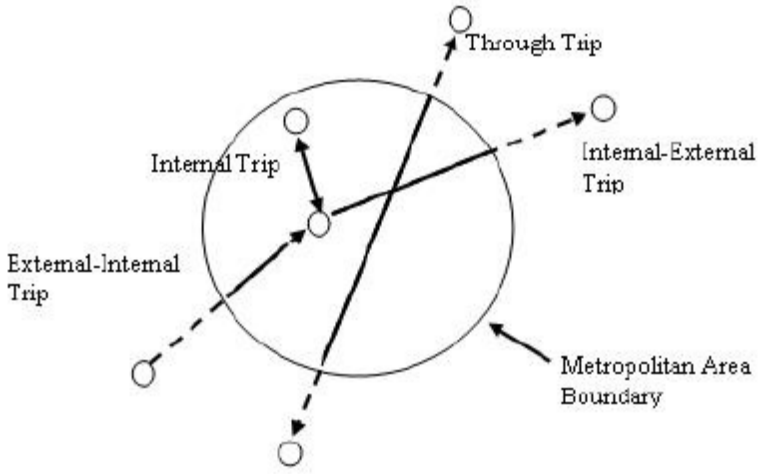
This section addresses two issues that have arisen regarding how the targets are specified and how they can be practically applied.

6.1 Application of the Targets to Metropolitan Area Roadway Emissions Rather than to Metropolitan Area Household Emissions

The first of these issues regards the application of the targets to changes in light-duty vehicle travel on metropolitan area roadways rather than by metropolitan area households. Applying the targets to metropolitan area roadway travel necessitates consideration of travel passing through the metropolitan area and travel by persons who live outside the metropolitan area, as well as travel by persons who live within the metropolitan area. Figure 5 illustrates the different categories of travel occurring within a metropolitan area and the portions of that travel which the target rules define the targets as applying to. The small circles in the figure represent different types of origins and destinations of light vehicle trips. The solid lines indicate the portions of the trips that the targets apply to.

Figure 5: Light Vehicle Travel within a Metropolitan Area[20]

[20] OAR 660-044-0005(10)



As a practical matter, modeling future trends of traffic and GHG emissions from external trip sources and the potential effects of metropolitan area policies on those trends is very difficult, expensive, and time consuming as doing so requires:

- Projecting the populations of all urban and rural areas that would produce travel either destined for the metropolitan area or traveling through the metropolitan area;
- Forecasting how the travel interactions between all the different urban and rural areas would change as their respective populations change;[21]
- Forecasting how different metropolitan area policies in combination with the policies of other metropolitan areas would affect travel interactions and the amount of travel on metropolitan area roadways.

There are models that attempt to do this, but those models cost a lot to develop, require a lot of staff time to run, take a long time to run, and address a limited number of factors that affect GHG emissions.

The GreenSTEP model and Regional Strategic Planning Model (RSPM) that have been used to date for strategic assessments in CAMPO and RVMPO and scenario planning in Metro and CLMPO, model metropolitan area household-related travel emissions, not roadway emissions. This is a more practical, less expensive, and more reliable approach. In addition, it has a stronger relationship to the effects of GHG emissions which, unlike criteria air pollutants, have effects that are minimally related to where they occur. Scenario planning to date using these models, have translated metropolitan area household travel and emissions to metropolitan area roadway travel and emissions by applying a factor that is calculated as the ratio of metropolitan roadway VMT to metropolitan household VMT in 2005. This factor is held constant for future forecasts because there is no practical way to forecast how it will change. Since the roadway factor

[21] For example, as the population of Woodburn grows along with the populations of the Portland and Salem metropolitan areas, will the travel of Woodburn residents grow in equal measure to the two metropolitan areas or will it grow more rapidly to one than the other?

is held constant and since the targets are expressed as the ratio of future year to base year (2005) roadway travel, the roadway travel considerations are superfluous. What is calculated is the ratio of metropolitan area household travel.
Although the targets are practically applied by modeling how metropolitan area household travel would be affected by policies and other changes, the rule's reference to metropolitan area roadway travel causes confusion and concerns. Confusion is caused by the questions of how the travel from external sources is to be accounted for. Concern is caused by perceptions that local governments in metropolitan areas have limited abilities to affect travel from external sources. These would be resolved if the targets rules were restated to apply to changes in metropolitan area household-related travel rather than to metropolitan area roadway travel. There are two types of household-related light vehicle travel that are modeled by the GreenSTEP and RSPM models:

- Travel by household members in light vehicles;
- Commercial vehicle travel using light-duty vehicles that is a function of household labor and/or demand (e.g. delivery and service vehicle travel, travel to business meetings/jobsites, but not commuting to work)

Travel by household members is about 90% of the household-related light vehicle travel. These two categories of travel are modeled separately because commercial vehicle fleets have somewhat different characteristics and potentials for reducing GHG emissions. In practice, the amount of household-related commercial vehicle travel has been modeled by assuming it is a fixed proportion of travel in household vehicles.

6.2 How to Express and Calculate the Target

The target rules define the GHG reduction targets as follows:

> *Greenhouse gas emissions reduction target" or "target" means the percent reduction in greenhouse gas emissions from light vehicle travel within a metropolitan area from 2005 emissions levels that is to be met by the year 2035 through scenario planning. Greenhouse gas emissions reduction targets are expressed as a percentage reduction in emissions per capita, i.e., total emissions divided by the population of the metropolitan area.* ***Targets represent additional reductions from 2005 emissions levels beyond reductions in vehicle emissions that are likely to result by 2035 from the use of improved vehicle technologies and fuels and changes to the vehicle fleet.*** …[22]

The rules define future vehicle technologies and fuels by specifying a number of detailed characteristics such as average fuel economy, the proportion of electric vehicles, the average vehicle age, changes in the carbon content of fuels, etc. Although the requirement seems simple enough, it has been challenging to implement for a couple of reasons. First, it is not possible to separate the effects of some policies on vehicle travel and on average vehicle emissions. Second, the meaning of the target is not readily understandable and is difficult to communicate. This poses a problem for how to compute whether a plan would achieve the target. These challenges are discussed below.
Equation 2, which translates the target definition into a mathematical relationship, makes the process of determining whether a plan does or does not meet the target seem simple.

[22] OAR 660-044-0005(6)

It has not been so simple in practice because policies that affect vehicle emissions rates also affect vehicle travel and vice versa. For example:

- If fuel economy is increased, the cost of travel (per mile) is reduced. This in turn results in some increase in the miles traveled (i.e. the rebound effect).
- If urban area densities increase, vehicle miles traveled decrease. This would also affect that amount of future travel powered by electricity when plug-in hybrid electric vehicles and battery electric vehicles become more common.

The way in which future vehicle technology and fuel assumptions are specified in the rules add to the problem. Table 10, excerpted from the target rules, shows the baseline assumptions.

Table 10: Table of Baseline Vehicle Technology and Fuel Assumptions in Target Rules[23]

Vehicle Technologies			
Characteristic	**1990 Model Year**	**2005 Model Year**	**2035 Model Year**
Auto fuel economy—internal combustion engine	28 mpg	28 mpg	68 mpg
Light truck fuel economy—internal combustion engine	20 mpg	20 mpg	48 mpg
Auto fuel economy—plug-in hybrids in charge sustaining mode	—	—	81 mpg
Light truck fuel economy—plug-in hybrids in charge sustaining mode	—	—	56 mpg
% of autos that are plug-in hybrids or electric vehicles	—	—	8%
% of light trucks that are plug-in hybrids or electric vehicles	—	—	2%
Plug-in hybrids battery range	—	—	35 miles
Electric vehicles battery range	—	—	175 miles
Vehicle Fuels			
Characteristic	**1990**	**2005**	**2035**
% reduction in fuel carbon intensity from current levels	—	—	20%
Electric power sources compared to current Renewable Portfolio Standard	—	—	Meet
Vehicle Fleet			
Characteristic	**1990**	**2005**	**2035**
Average vehicle replacement rate	10 years	10 years	8 years

The origin of this table was the GreenSTEP model inputs for one of 12 vehicle and fuels scenarios considered by the target rules advisory committee at the time the rules were being developed. The committee recommended that this scenario be used in calculating the targets. The data in the table was summarized from the more detailed vehicle and fuel inputs to the GreenSTEP model. Although the table provides a convenient summary of the model inputs, it can't be used directly in the GreenSTEP or RSPM models. Instead the input files that this summary was based on have been used in metropolitan area scenario planning and strategic assessments.[24]

This approach to specifying the future inputs makes it fairly simple to use a model to calculate the emissions for a future scenario and, by also modeling the base year (2005) conditions, calculate the change in CO_2e emissions from base year to the future year. But since the results used in the calculation include the effects of forecasted changes to

[23] OAR 660-044-0010(2)

[24] Changes were made to the input files to support upgrades to the GreenSTEP and RSPM models. The changes were done in a way to maintain consistency with the target rules assumptions.

vehicle and fuel technology, they do not correspond to what the rule is asking for. In order to calculate what the rule is asking for, a third scenario is needed which allows one to remove the technological effects but keep all the other non-technological effects. So, for example, what has been done for all of the scenario planning and strategic assessment work is to create a "2005 hybrid" scenario that has all the 2005 characteristics except for the vehicle and fuel technology characteristics which are the future year characteristics instead. Then by calculating the change between the "2005 hybrid" scenario and the future year scenario we would (ideally) be calculating the change that is due to everything but changes in the emissions rate.

However, the real world and how it is modeled is not the ideal for calculating rule compliance. The problem is that vehicle technology doesn't just affect the emissions rate (grams CO_2e per mile), it also affects the amount of vehicle travel (miles per capita). For example, if fuel economy increases, the emissions per mile goes down but the miles driven goes up because of significantly lower operating costs (on average gas-powered cars cost around three times as much per mile as electric vehicles, depending upon gas prices).[25] This is called the rebound effect and is important to account for in emissions models, which the GreenSTEP and RSPM models do. This means that by using the "2005 hybrid" we are altering the amount of vehicle travel in the process of attempting to remove the effect of technology. Alternatively, calculating the change by using a "future hybrid" which substitutes 2005 technology for the future technology would be no better because it would eliminate any consideration of the effect that future technology will have on the amount of vehicle travel; which could be significant, especially if future fuel costs are high. The issue will become more problematic as the planning horizon extends farther into the future because the reductions relative to 2005 technology will become greater and greater. Referring back to Figure 1 pie chart of 2005 emission reductions, the line between the "Vehicle & Fuel GHG reduction" and the "Other GHG reduction" pie pieces is blurry in real-life and the models.

Two approaches for addressing this problem are described. Both would simplify the rules. In short they are:

1. Establish goals (i.e. change in per capita emissions) rather than targets as they are now defined.
2. Establish targets, but change how they are defined.

Both approaches would replace the table of baseline assumptions in the rule (e.g. Table 10) with a schedule of percentage decrease in the vehicle emissions rate (e.g. Table 3). This would simplify the rules and the procedures for calculating whether the specifications are met. This reflects the fact that during the development of the original target rule, few studies were available that identified future emission rates, meaning they had to be developed using the models with detailed input assumptions like Table 10. Today, studies of Federal CAFÉ standards, California ZEV rules, and elsewhere provide estimates of emission rates directly, allowing us to avoid this modeling step in target setting. Furthermore, if the Table 10 approach were to be used in the new rules and if the

[25] Fortunately the proportional increase in miles driven is substantially less than the proportional decrease in emissions so the net effect of improving fuel economy is to reduce total emissions.

rules are to establish targets for every year from 2040 to 2050, a table would need to be included for each of those years.

Approach #1

In the first approach, the rules would specify the overall goals for reducing per capita emissions by year as a percentage reduction from 2005. Table 11 shows an example, consistent with the target reductions in Table 9 and the emissions rate reductions in Table 3. In addition, the rules would specify the default assumptions for the change in the average vehicle emissions rate also shown in Table 11 (from Table 3). The steps for determining whether a scenario meets the goal would be:

1. Model the 2005 and the future scenario. Use the technology and fuels input files from the STS recommended scenario (as discussed in Section 4).
2. Calculate the percentage change in **per capita emissions** relative to 2005 from the model results.
3. Compare the calculated change in **per capita emissions** to the rule specifications. The calculated reduction from the model runs should be greater than or equal to the specified reduction.
4. Calculate the change in the average vehicle **emissions rate** from the model results.
5. Compare the calculated change in the average **emissions rate** with the percent reduction specified in the rule. The calculated emissions rate percent reduction should be equal to or greater than the percent reduction specified in the rule.

Table 11: Approach #1 Example: Set Goals for Reducing Total Per Capita Emissions

Year	Percent reduction relative to 2005		
	Reductions in Per Capita Emissions (based on Table 9 option)		Emission Rate Per Mile Reduction (Table 3)
	Portland Met.	Small Met.	All areas
2040	-80.1	-78.7	-73.3
2041	-81.2	-79.9	-74.5
2042	-82.3	-81.0	-75.6
2043	-83.2	-82.0	-76.6
2044	-84.2	-83.0	-77.6
2045	-85.1	-84.0	-78.5
2046	-85.9	-84.9	-79.5
2047	-86.7	-85.7	-80.3
2048	-87.4	-86.5	-81.2
2049	-88.1	-87.3	-82.0
2050	-88.8	-88.0	-82.7

Approach #2

In the second approach, the rules would specify targets similar to what is now in the rules. As with the first approach, the rules would also specify the default assumptions for the change in the average vehicle emissions rate (e.g. Table 3). Table 12, which is based

on Table 9 shows what this would look like. The steps for determining whether a scenario meets the target would be:

1. Model the 2005 and the future scenario. Use the technology and fuels input files from the STS recommended scenario (as discussed in Section 4).
2. Calculate the ratio of change in **per capita emissions** relative to 2005 from the model results.
3. Calculate the ratio of change in the **average emissions rate** relative to 2005 from the model results.
4. Calculate the **equivalent target** by dividing the ratio of change in per capita emissions (Step 2) by the ratio of change in the emissions rate (Step 3). This is a reworking of Equation 2, which states: *Goal = Rate * Target* therefore:
   Target = Goal / Rate
5. Compare the calculated **equivalent target** to the rule specifications (such as Table 9). The calculated reduction from the model runs should be greater than or equal to the specified reduction in the table (such as Table 9).
6. Compare the calculated change in the average emissions rate with the percent reduction specified in the rule. The calculated emissions rate percent reduction should be equal to or less than the percent reduction specified in the rule (last column of Table 11).

Table 12: Approach #2 Example: Set Targets for Additional Reductions in Emissions Beyond the Reductions that are Likely to Result from Improved Vehicle Technology and Fuels

Year	Percent reduction relative to 2005		
	"Target" Reductions (based on Table 9 option)		Emission Rate Per Mile Reduction (Table 3)
	Portland Met.	Small Met.	All areas
2040	-25.3	-20.0	-73.3
2041	-26.4	-21.1	-74.5
2042	-27.4	-22.2	-75.6
2043	-28.4	-23.3	-76.6
2044	-29.4	-24.3	-77.6
2045	-30.3	-25.3	-78.5
2046	-31.3	-26.4	-79.5
2047	-32.2	-27.4	-80.3
2048	-33.2	-28.4	-81.2
2049	-34.1	-29.4	-82.0
2050	-35.0	-30.3	-82.7

In comparing the two approaches, the 2nd approach has one more step (calculating an equivalent target) than the 1st approach. All that that step does is place the value that is to be compared on a different scale which magnifies the apparent effect of policies and actions other than improving vehicle technology and fuels. Rather than comparing the change in per capita emissions directly (Table 11), that change is divided by the change in the emissions rate to produce a target.

The last step in each approach is necessary in order to determine that the goal (Approach #1) or equivalent target (Approach #2) are not being met just because more ambitious assumptions are being made about improvements to vehicle and fuels technologies. However, having a greater reduction in the vehicle emissions rate than the rule default should not necessarily disqualify a scenario because it may be caused by synergistic interactions between policies, i.e., local actions are further improving the emissions rate. In addition to being simpler, the first approach would be easier to describe in the rules and explain to planners, the public, and decision makers. Communicating what the existing targets mean and how they relate to other expressed goals (e.g. reduce emissions by 75%) has been very challenging. The targets are not a percent of total emission reductions or a percentage point portion of the overall reduction. Understanding how the targets are calculated requires one to work through an example such as that shown in Figure 1 or to understand the equivalent algebraic relationships. It would be easier to define and explain a goal for reducing total per capita emissions and to explain how that goal relates to the statutory goal for reducing GHG emissions.