Eugene Sustainability Office

ATTACHMENT B

Methodology for Establishing a Community Carbon Budget for Eugene

Purpose

This memo summarizes the findings and methodology used to calculate a community-wide carbon budget consistent with achieving a stable climate.

Key Points

- In 2014 Eugene City Council requested a community-wide greenhouse gas target consistent with achieving 350ppm, a safe level of carbon dioxide in the atmosphere.
- Global emissions already exceed 350ppm and continued increases in CO_2 concentrations comes with an increasing risk of extreme climate impacts and runaway climate change.
- Given existing rates of emissions, achieving a stable climate will require community-wide emission reductions beyond the climate action goals currently established by the City of Eugene.
- In addition to emissions reductions, achieving 350ppm will require significant global reforestation.

Background

On July 28th, 2014, Eugene City Council passed a Climate Recovery Ordinance[1] (CRO) that codified a number of existing operational and community goals related to the reduction of greenhouse gas emissions and fossil fuel use. In addition to codifying goals, the CRO calls for the development of a community-wide greenhouse gas budget:

6.685 (2) The city manager shall propose for adoption by the city council, a numerical community-wide goal or "carbon budget" for greenhouse gas emission reductions consistent with achieving 350 parts per million of CO_2 in the atmosphere[2] by the year 2100. The community-wide goal shall include numerical targets and associated benchmarks.

This memo summarizes the methodology used to calculate the community-wide "carbon budget" consistent with achieving a 350-ppm goal. The purpose of calculating this budget is to provide immediate climate mitigation and adaptation planning guidance for the Eugene community.

Implications of Exceeding 350ppm

Achieving 350 ppm of carbon dioxide in the atmosphere is expected to limit average warming globally to about 1.8°F (1°C). This level of warming is considered relatively safe and expected to maintain a stable climate condition.

Global CO_2 concentrations are already above 400 ppm. Carbon dioxide concentrations beyond 350 ppm comes with an increasing risk of excessive and rapid warming beyond the levels human social systems and infrastructure are prepared to handle. At this point, there's greater risk of the global climate becoming unstable and passing "tipping points" beyond which changes are irreversible.

Scientific Basis for a Carbon Budget

The principal factor responsible for increasing average global temperature is total cumulative emissions of carbon dioxide (CO_2) and other non-CO_2 greenhouse gases since the industrial revolution. These gases concentrate in our atmosphere, trapping heat from the sun like a blanket. The relationship between global average temperature rise and cumulative carbon emissions has been found to be linear. In order to limit further temperature increases – we will need to limit cumulative emissions.

There are many science-based international and domestic carbon reduction goals and they vary in their targets. Most domestic reduction targets are based on what may be practically feasible – whereas this target is based on what is declared to be scientifically necessary. Eugene's 350ppm carbon budget is based on a global carbon budget developed by climate scientists at NASA's

[1] The complete, signed Climate Recovery Ordinance can be located online at: https://www.eugene-or.gov/DocumentCenter/View/19669

[2] 350 parts per million is a measure of the concentration of carbon dioxide in the atmosphere.

Goddard Institute for Space Studies and Columbia University.[3] The 350ppm global budget has been downscaled for Eugene using a methodology that has been peer-reviewed by specialists in the field (listed in table 1) and uses the best information currently available.

Table 1: Eugene 350 Budget Peer Review Team	
David Allaway	Senior Policy Analyst in the Oregon Department of Environmental Quality's Materials Management Program
Kyle Diesner	Policy Analyst with the City of Portland Bureau of Planning and Sustainability,
Pete Erickson	Senior Scientist in the Climate and Energy program in Stockholm Environment Institute's Seattle office.
Dr. Pushker Kharecha	Research scientist at the NASA Goddard Institute for Space Studies and Columbia University's Center for Climate Systems Research.
Dr. Andrew Rice	Associate Professor of Physics at Portland State University
Joshua Skov	Center for Sustainable Business Practices, University of Oregon
Aaron Toneys	Senior Associate at Good Company, a Sustainability consulting firm in Eugene, Oregon.

It is important to acknowledge that there is no existing protocol defining how to calculate and set this type of carbon budget at the community-level nor is there an existing international climate agreement from which to base a budget.

In addition to reducing greenhouse gas emissions, achieving 350ppm will require drawing down CO_2 out of the atmosphere through reforestation. The amount of reforestation required is included within the 350ppm global carbon budget and is described below under the heading *Reforestation: The carbon sequestration budget.*

[3] Hansen J, Kharecha P, Sato M, Masson-Delmotte V, Ackerman F, Beerling DJ, et al. (2013) Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature. PLoS ONE 8(12): e81648. doi:10.1371/journal.pone.0081648

Setting the Carbon Budget

The 350-ppm goal is generally considered the "safe" concentration by the scientific community, and would limit warming to approximately 1.8°F (1°C) increase in global average temperature compared to pre-industrial levels.

Formula
The formula used to calculate Eugene's Carbon Budget:

$$\frac{\textbf{\textit{Global Carbon Budget}}}{\textbf{\textit{Global Population}}} \textbf{\textit{ x Eugene's Population = Eugene's Carbon Budget}}$$

Global Carbon Budget

The global carbon budget for a 350-ppm goal is 419 Gt CO_2 for the period 2016 - 2100[4].

The budget includes a global reforestation requirement to remove 100 Gt C (367 Gt CO_2) from the atmosphere during the 2012 – 2050 time period.

Global Population

The 2013 global population is reported as 7.2 billion people[5].

Eugene Population

The 2013 Eugene population is reported at 159,190 people[6].

Eugene's carbon budget (from 2016 – 2100) based on a 350-ppm goal

$$\frac{419\ Gt^{7}\ CO2}{7.16\ billion\ people} \times\ 159{,}190\ Eugenians =\ 9{,}320{,}000\ MT\ CO2$$

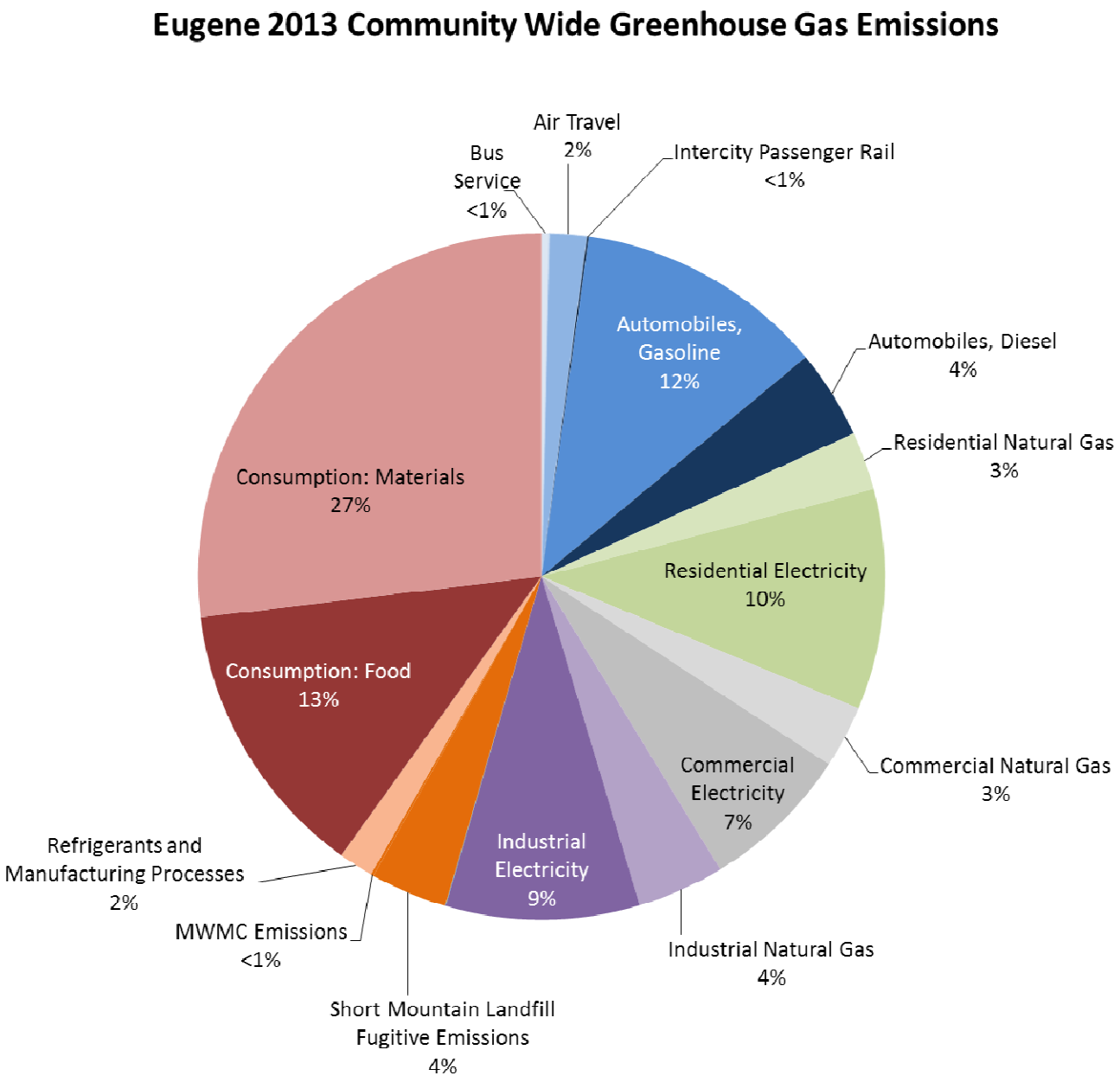
Accounting for population increase
Based on current projections, Eugene's population growth is expected to increase at a rate similar to global population; about 1.2% per year. While population growth *will* result in fewer emissions per person over time, the total *proportion* of global emissions that are allotted to Eugene will

[4] Global budget based on 2013 study, *Scientific Case for Avoiding Dangerous Climate Change to Protect Young People and Nature.* Authors: Hansen J, Kharecha P, Sato M, Masson-Delmotte V, Ackerman F, et al. (2013). PLoS ONE 8(12): e81648. doi:10.1371/journal.pone.0081648. Reduced initial 2012 budget by cumulative global emissions from 2012 to 2015.
[5] Source: United Nations Department of Economic and Social Affairs publication, *World Population 2012*.
[6] Source: U.S. Census Bureau publication, "*2013 Population Estimate for City of Eugene, Oregon*."
[7] Gt = Gigatonnes = 1 billion metric tonnes

remain the same. For this reason, no adjustment is necessary when looking at a *community wide* budget. This will have implications for *individual* GHG budgets.

Spending the Carbon Budget

Eugene's Consumption-Based Carbon Emissions in 2013 are estimated at 2,870,000 MT CO_2. This serves as the baseline year for Eugene's budget.

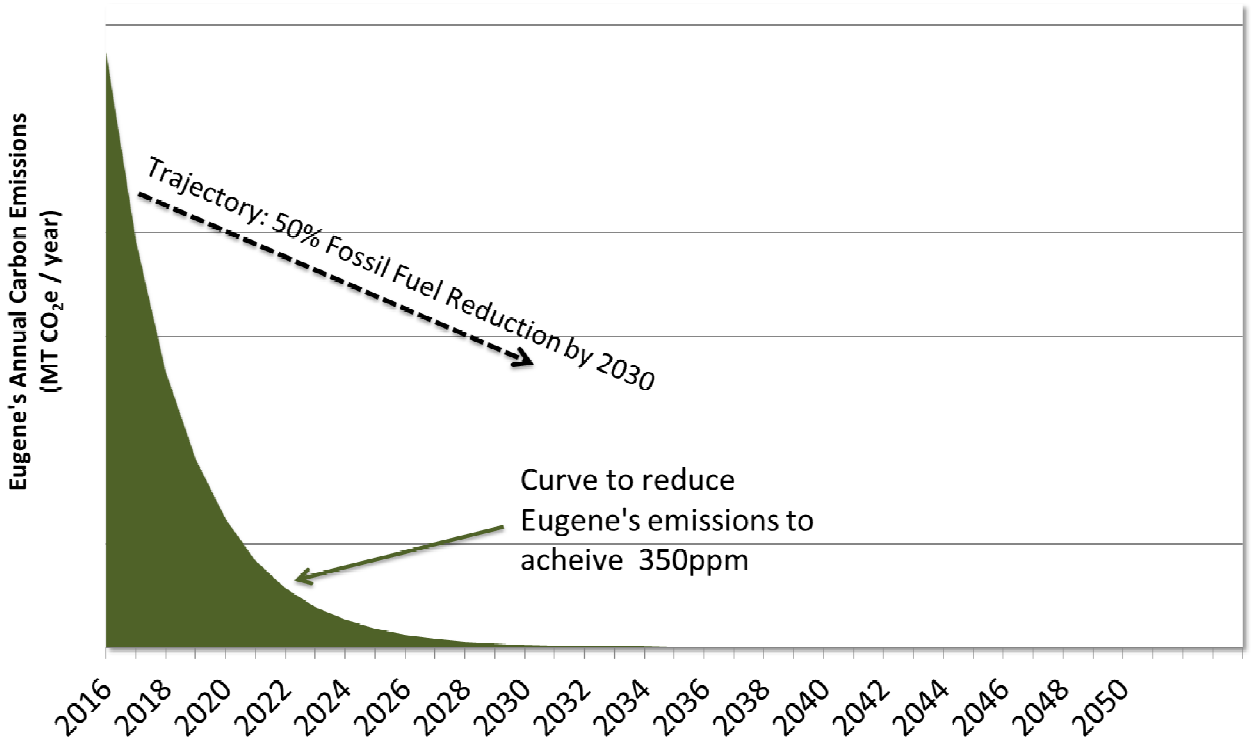


Eugene 2013 community wide greenhouse gas inventory results.

Staying within the Budget

Using Eugene's 2013 consumption-based emissions as a starting point, annual reductions required to stay within Eugene's Carbon Budget will be significant, beyond those required to meet the current community goal of reducing fossil fuel use 50% by 2030 (Figure 1: Spending Eugene's Carbon Budget).

Figure 1: Spending Eugene's Carbon Budget



These required emission reductions are extremely steep. The primary reasons such drastic reductions are required are that:

1) Globally we have already passed 350ppm so getting back to 350ppm requires putting the brakes on emissions as rapidly as possible.

2) While the average Eugenian's carbon footprint is low by U.S. standards, is still very high compared to the global average. Therefore, greater reductions are necessary to avoid overspending the budget as compared to communities that aren't rapidly consuming fossil fuels.

Figure 4: Summary of Eugene's Carbon Budget calculations.

Category Description	
Global Carbon Budget, 2016 - 2100 (MT CO_2)	419,266,666,666
2013 Global Population (# of people)	7,162,119,000
Global Average Per-Capita Budget (MT CO_2 / person)	58.5
2013 Eugene Population (# of people)	159,190
Eugene Carbon Budget, 2016 - 2100 (MT CO_2)	**9,318,899**
2013 Consumption-Based Emissions (MT CO_2)	**2,871,206**
Years budget will last based at Eugene's 2013 emissions rate	3.2

Reforestation: The carbon sequestration budget

Because CO_2 concentrations are already beyond 400ppm, achieving the 350ppm goal will require removing CO_2 from the atmosphere in addition to reducing emissions of greenhouse gases.

Using the same methodology as above, we apportion reforestation responsibility equally across the global population. Based on the same global prescription to achieve 350ppm, the global per capita carbon sequestration requirement from 2012 – 2050 is determined to be 51 Metric Tons CO_2, leading to an annual carbon sequestration requirement of 1.31 Metric Tons CO_2 per person. If we were to assume this reforestation were done with carbon credits alone and we assume the annual cost of reforestation carbon credits is \$15/ 1 $MTCO_2$, the annual cost (today) for each resident would be about \$20.

$$\frac{Global\ Carbon\ Sequestration\ Budget}{Global\ Population} = Per\ capita\ carbon\ sequestration\ budget$$