Choices for Edmonds Climate Targets

To: Shane Hope, Development Services Director, City of Edmonds
From: Joshua Proudfoot, Principal, Good Company, Joshua.Proudfoot@goodcompany.com, Aaron Toneys, Senior Assoc., Claudia Denton, Assoc. and Mark Johnson, ESA MJohnson@esassoc.com
Date: December 21, 2018

This memorandum is provided as part of the City of Edmonds Climate Action Plan Update. It is intended to assist City decision makers in setting a target for community climate actions. It was prepared by the ESA/Good Company team to give background on setting a science-based target and what the implications of various targets could be.

What is a Science-Based Target?

A science-based climate target sets a rate of climate action[1] that is aligned with keeping average global temperature increases below a specified level of increase (such as 2°C) compared to pre-industrial temperatures.[2] A science-based target is based on the physical characteristics of the earth's atmosphere and how atmospheric changes are expected to affect the biosphere. A science-based target represents an overarching global target that humanity can collectively work toward. Maintaining temperature increases below a 2°C threshold will allow the majority, but not all, of the global population to avoid the worst social and economic effects of climate change[3]. A target of 2°C is considered the "guardrail" target by numerous international organizations, including the United Nations[3], but any target equal to or more aggressive (e.g., 1.5°C or 1.0°C) would also be considered a science-based target. As a point of reference, the average temperature of the earth is approximately 1.2°C higher[4] today than at the beginning of the industrial revolution.

One advantage of adopting a science-based target is that it can remain constant. Over time, the rate of decarbonization necessary to meet the target may go up or down, depending on the success of the climate action plan. The science-based target is the desired endpoint, and decarbonization rates can be adjusted as the primary means of reaching it.

This report and all documents in the Edmonds Climate Action Plan update use the Celsius temperature scale, as this is the most common in scientific literature worldwide. Please see Table 1 for Fahrenheit conversion. Bold font indicates the commonly used science-based target numbers.

Table 1: Celsius to Fahrenheit conversion table.

	Science-based targets			*Other temperatures in this report*		
Celsius	**1°**	**1.5°**	**2°**	1.2°	3.3°	4.2°
Fahrenheit	**1.8°**	**2.7°**	**3.6°**	2.2°	6°	7.6°

[1] Climate actions include reducing fossil fuel and other man-made sources of greenhouse gas emissions as well as implementing negative emissions strategies. Negative emissions strategies provide more time to decarbonize.
[2] A 2°C target is roughly aligned with an atmospheric carbon dioxide concentration of 450 parts per million (ppm).
[3] United Nations Intergovernmental Panel on Climate Change, *Fifth Assessment Report* (IPCC AR5).
[4] World Meteorological Organization Press Release: *Provisional WMO Statement on the Status of the Global Climate in 2016*.

What are the Options?

An increase of 2°C is the target set forth by the Intergovernmental Panel on Climate Change (IPCC), the International Energy Agency (IEA), the Paris Climate Accord, and multiple states and cities across the United States. The Paris Climate Accord legally binds its signatories to the 2°C target. It also states that signatories will "pursue efforts" toward a 1.5°C target. Inclusion of the additional 1.5°C target is meant to acknowledge that the difference between a 1.5°C and 2°C temperature rise is that the latter will result in "a greater likelihood of drought, flooding, resource depletion, conflict and forced migration" and that "those most at risk will be individuals and communities experiencing multidimensional poverty, persistent vulnerabilities and various forms of deprivation and disadvantage."[5] Within a climate action plan, different temperature targets affect the rate at which greenhouse gas (GHG) emissions need to be reduced and the associated investments and activities required to achieve those reductions. A 2°C target requires less mitigation action per year than a 1.5°C target does.

What are the Trade-offs between Targets?

Modern human society built over the past 150 years relies heavily on fossil fuel energy sources; therefore, accelerating the deployment of renewable and low-carbon energy sources requires large-scale deployment of existing and pending technology as well as significant changes in personal consumption. The 2°C target is intended to strike a pragmatic political and technological balance between limiting the physical impacts of climate change and the time it will take to transition away from fossil fuels and reduce global GHG emissions. However, the 2°C target takes humanity right up to the edge of feedback loops, potentially beyond human control, that will further accelerate global warming, such as ocean and permafrost releases of methane, or the melting of the ice caps, which reflect solar heat from the oceans[6]. More aggressive targets, such as 1.5°C, move everyone closer to safety, but require that emissions reductions measures and negative emissions technologies[7] be implemented more quickly with a greater near-term investment.

What Rates of GHG Reduction are Required by the Different Options?

Table 2 presents three temperature target options or scenarios - a global average temperature increase of 1°C, 1.5°C, or 2°C. The decarbonization rates presented on Figure 2 for a 2°C target are based on an IPCC's decarbonization pathway (ARC RCP2.6 scenario). The decarbonization rates for a 1.5°C target is based on IPCC's recently released work on this target.[5] And 1°C is based on a paper by James Hansen, who is best known for his work as a climate scientist at NASA and his work with 350.org and Our Children's Trust.[8] IPCC does not have a published decarbonization pathway for IPCC

---

[5] Intergovernmental Panel on Climate Change (2018), *Special Report on Global Warming of 1.5°C*.
[6] Proceedings of the National Academy of Sciences, *Trajectories of the Earth System in the Anthropocene*.
[7] Negative emissions refer to the process of removing carbon dioxide from the atmosphere. Currently, land management options are available for biological carbon sequestration by forests and agricultural practices. Longer term, negative emissions technologies will need to be developed. The most likely of these technologies is bioenergy with carbon capture and sequestration.
[8] Hansen et. al. (2011). Scientific Case for Avoiding Dangerous Climate Change to Protect Young People and Nature. Downloaded online at http://www.columbia.edu/~jeh1/mailings/2013/20131202_PopularSciencePlosOneE.pdf.

1°C target. The Hansen paper is the best source available to guide decarbonization requirements consistent with the goals of organizations like 350.org, or Eugene, Oregon's Climate Recovery Ordinance.

These targets all assume global participation. In other words, the rates presented below are assumed to be complimented by reductions by other nations. A way to think about these rates are - Edmonds contributions will feed into Washington's contributions, which will feed into US contributions. US contributions will feed into global actions taken by other nations in accordance with the Paris Accord.

Additionally, to reduce to the 350 ppm GHG levels and the subsequent 1°C average temperature increase, the global community will need to utilize "negative emissions" actions and technologies. The most low-tech of these is to utilize existing means of "biological sequestration" – trees and soils. These actions could include protecting existing forests, planting new trees and forests, and integrating compost into soils to maximize carbon uptake potential. Depending on how rapidly we respond as a globe to mitigation emissions and increase carbon sequestration, we may also need "technological sequestration." These could include technologies currently being developed such as - bioenergy with carbon capture and sequestration which would use biological fuel sources and pump the CO2 underground for long-term storage. Other technologies capture carbon from the atmosphere and convert it into solid or liquid form. Unfortunately, these technologies are currently inefficient and therefore expensive to operate at the scale required.

Even some of IPCCs modeled decarbonization pathways to reach the Paris Climate Accord target of 2°C assumes that sequestration through negative emission technologies will be required at a large scale[9].

Table 2: Target options, associated rates of reduction, and other agencies using these temperatures.

Target			
+1.0°C 350 ppm		+1.5°C 400 ppm	+2.0°C 450 ppm
Average Annual Rate of Reduction to Meet Target (rounded)			
8%		5%	2%
Annual Reduction compared to 2010 (values are rounded for simplicity)			
By 2020	15%	13%	10%
By 2030	70%	50%	35%
By 2050	100%	100%	80%
Others Using These Temperatures			
Eugene, OR		Seattle, WA	Paris Climate Accord King County, WA
Notes:			

[9] United Nations Paris Agreement 2015, Article 4.1.

a. Washington State's 2008 goal of 50% below 1990 emission levels by 2050 is inadequate to meet a 2°C increase if adopted globally and is therefore not considered a science-based target. *b. Since the atmospheric concentration is already well above 350 ppm and we have passed a warming of 1°C, the 1°C Target also requires roughly 100,000 MT CO_2e of cumulative sequestration on behalf of the Edmonds community between 2030 and 2080 to return to 350 ppm. This is equal to conserving 1,000 acres of existing U.S. forest annually that would normally be cut for use.*

For example, if Edmonds wants to adopt a target of 1.5°C, it would need to be accompanied by a cumulative reduction goal similar to that established by the City of Seattle. That would mean reducing cumulative emissions to 50 percent below 2010 levels by 2030 and 100 percent by 2050. If Edmonds wanted to adopt the 1.0°C target, cumulative emissions would need to be reduced 70 percent by 2030, a much faster pace of reduction. The relative costs of offsetting 100 percent of emission under each of these options are discussed at the end of this memo.

Wealth, Consumption, and Responsibility

Wealthier nations and households have disproportionately high emissions per capita[10]. As basic needs are met and disposable income is accumulated, there is an increase in consumption of goods, travel, and services[10]. This is illustrated for Edmonds in the 2017 Community Greenhouse Gas Inventory report in the scale of imported or consumption emissions. On the global scale, supply and demand for goods, fuel, and services is also unbalanced[10]. Some nations have high total emissions due to high production of goods and fuel that are sold to other nations, while their own populations do not have high per capita emissions from consumption[10,11]. In contrast, some nations import high amounts of goods and fuel but do not emit high amounts of greenhouse gas emissions directly[10,11]. The United States is both a high emitter and a high consumer[10,11].

China, the United States, and India have the highest total emissions in the world[11]. However, China and India both have significantly larger populations, lower per capita emissions, lower Gross Domestic Product (total and per capita) and higher levels of poverty[10,11]. In contrast, the United States and Canada have the highest consumption footprints per capita[11], and among the highest per capita Gross Domestic Product. Figure 1 present a comparison of CO_2e emissions per household among the G20 nations for which data is available. Figure 1 also shows how the highest earning 10% of households have substantially higher footprints than the average in every country. Edmonds and the United States as a whole have better ability to decrease emissions, due to both the scale of emissions and relative affluence, as compared to the rest of the world population. Many people also consider the responsibility of the United States and affluent communities within the US to be greater for the same reasons.

[10] Oxfam 2015 Media Briefing, Extreme Carbon Inequality.
[11] The World Research Institute, World's Top 10 Emitters.

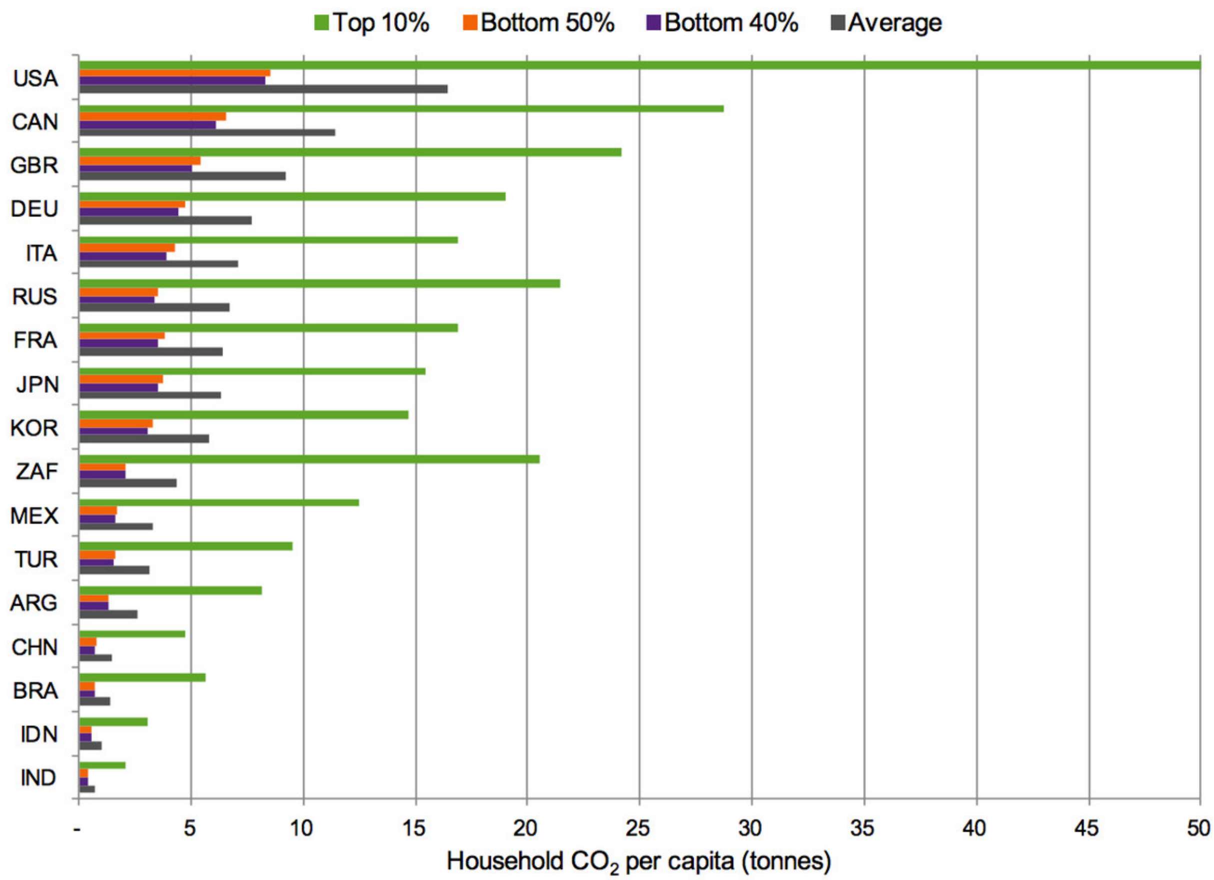


Figure 1: Per capita lifestyle consumption emissions in G20 countries for which data is available[10]. Note: tonnes = metric tons.

Turning the Temperature Target into Action

The science-based temperature targets discussed above represent the most commonly cited type of climate target – limiting average global temperature increases. There are a variety of climate targets in the region of this type.

- The Paris Climate Accord commits signatories to at least a 2°C target.
- King County, WA passed Ordinance 17270 limiting emissions consistent with a 2°C target.
- Seattle, WA passed Resolution 31312 adopting a target of net-zero GHG emissions by 2050 and a 1.5°C target.
- The City of Beaverton OR selected 1.5°C as their community target.
- The City of Eugene OR selected 1°C as their community target.
- Other groups, such as 350.org, are focused on a 1°C target to further limit the negative societal impacts of climate change.
- The Washington State legislature adopted reduction targets in 2008 for 50% below 1990 levels by 2050, which is insufficient to meet a 2°C target. *Note – Washington's target is not a science-based target.*

While science-based temperature targets are the convention – and should be included in Edmonds' target and goal setting discussion – they do not represent the only form of community climate action goals. A science-based temperature target can provide an overarching metric that can guide development of other goals, and especially the rate at which other goals need to be accomplished. Communities commonly set additional or complementary goals for specific mitigation opportunities. For example, Edmonds' existing goal to transition the entire community to 100% Renewable Electricity by 2030 is important and aligned with climate mitigation goals. The Portland, OR metro region recently set a goal of 100% renewable electricity by 2035, and 100% renewable energy for all energy sources by 2050 (e.g., replacing natural gas, gasoline, diesel, etc.). Another example is setting a goal around a percentage reduction in fossil fuel use, which is being used in Eugene, OR and Bend, OR (e.g., a 50% reduction in fossil fuel use by 2030). Additional goals may be set that are specific to and address other large sources of community emissions. The climate action planning process will highlight actions that fit Edmonds' unique community context. Ideally each of the actions in Edmonds' Climate Action Plan will include an action-specific goal/target, be assigned an organizational lead, establish a tracking metric, and identify a data stream to measure progress over time.

How Urgent is Our Situation and What Can We Expect Moving Forward?

Existing international and domestic activities and policies remain inadequate to prevent a 2°C warming, as can be seen in Figure 2. The Paris Climate Accord commitment period ending in 2030 aims for no more than a 2°C increase[12]. The United Nations project annual global emissions to reach 53-55 gigatons CO_2e in 2030, but in order to meet the 2°C target, emissions have to be at a maximum of 40 gigatons CO_2e[12]. Figure 2 also provides estimated temperature in year 2100 based on various emissions paths.

Since global political uncertainty is likely to continue, collective action beyond national plans, such as state and local efforts in the U.S., is essential in order to meet a 2°C or lower increase.

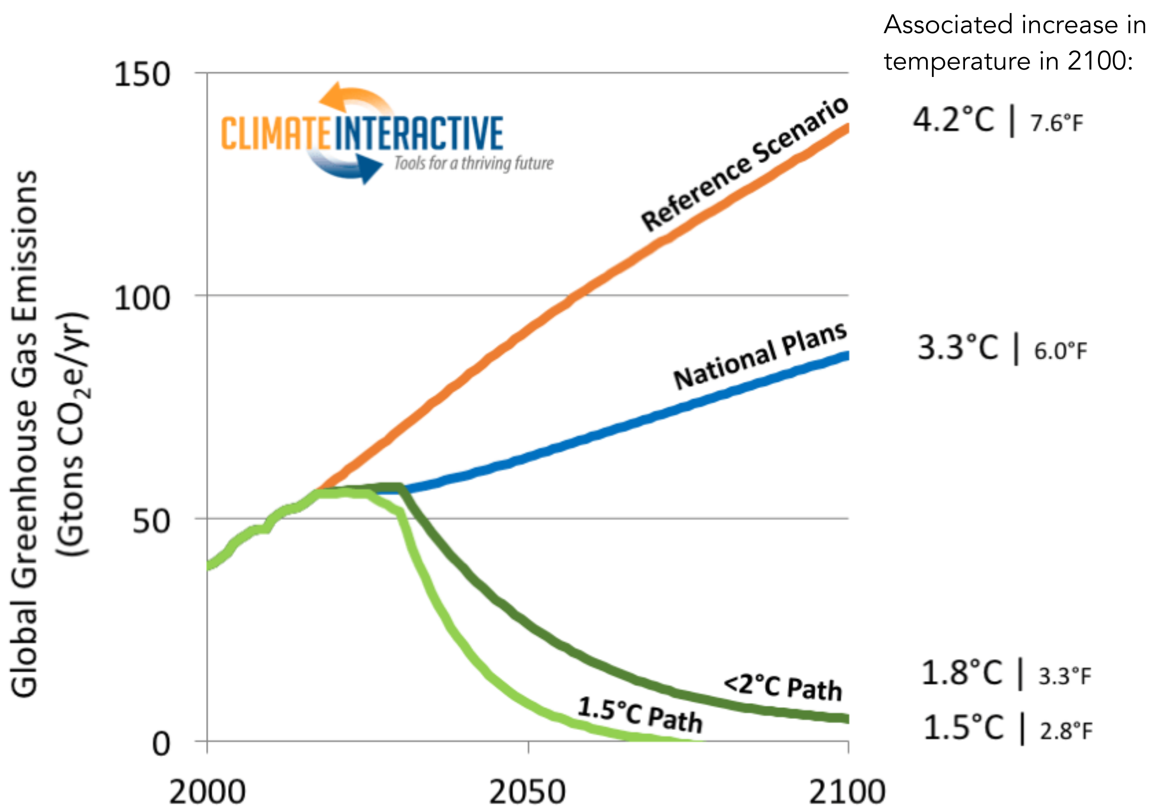


Figure 2: Climate Interactive estimated increase in temperature forecast based on UN modeling.

While average global temperature differences may seem small, even slight changes in average temperatures mean large changes in seasonal temperature and subsequently extreme weather[5]. Edmonds can expect milder, shorter winters and significantly hotter, longer summers[13,5]. With current policies and activities in place, it is estimated that by year 2100, average temperatures will have increased by 3.3°C[5].

---

[12] United Nations Environment Programme Emissions Gap Report 2018.

[13] Climate Central tools: Seasonal Warming Trends Across the US, Summers in 2100.

Additionally, Edmonds will have a summer climate similar to Laguna Niguel, CA – an Orange County city southeast of Los Angeles – an increase of 6°C (11°F) if we were to proceed globally as we are now[13,5]. See

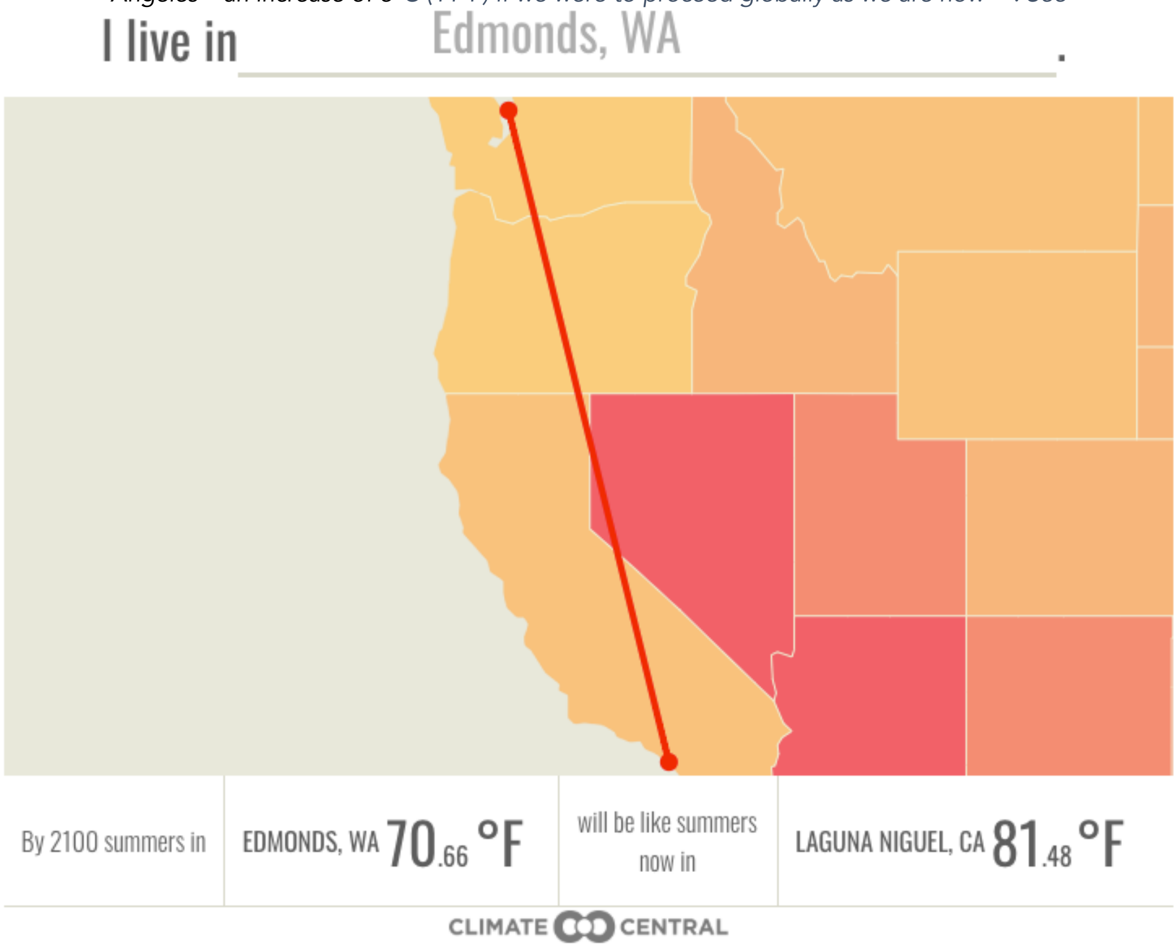


Figure 3. Table 3 (next page) describes some of the other changes in physical conditions that could result from different levels of temperature rise.

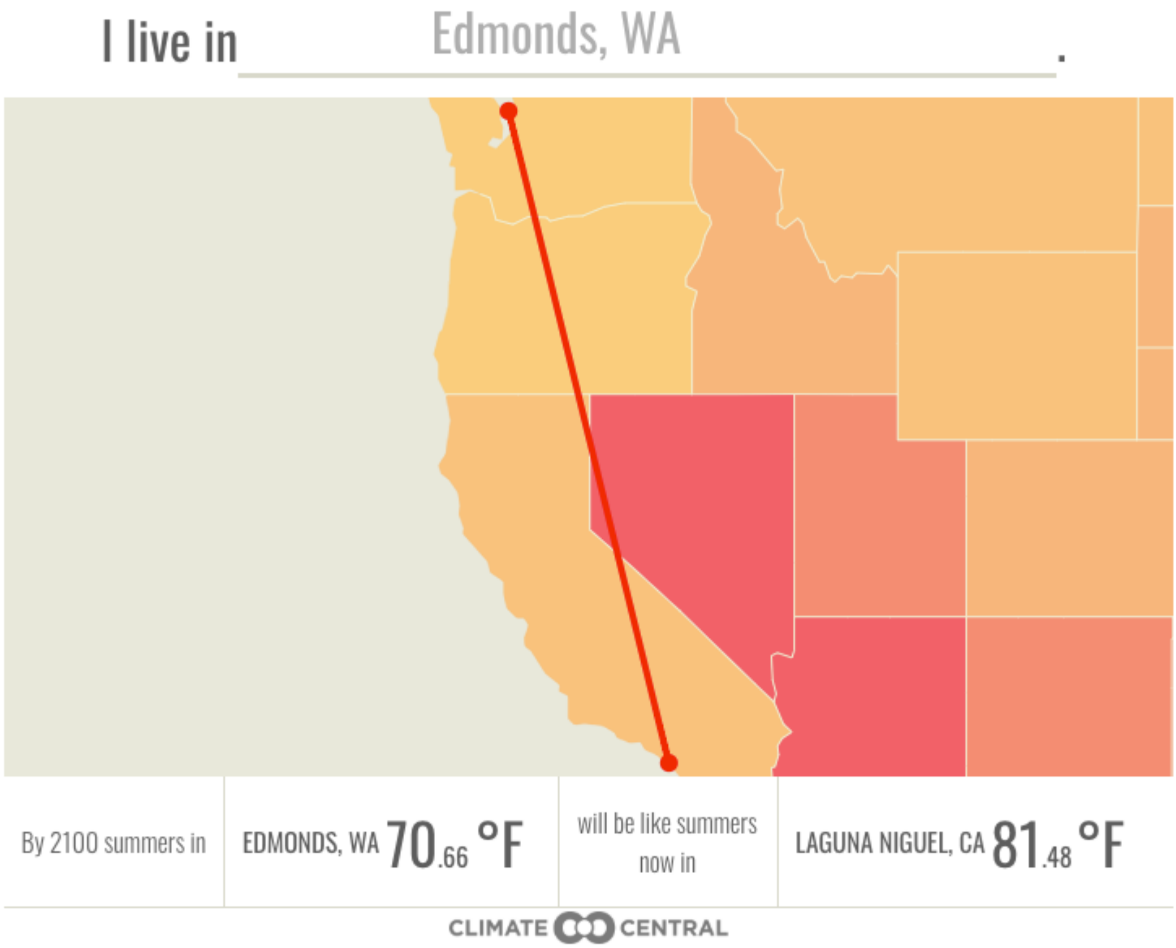
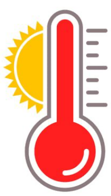


Figure 3: Summers in 2100, Climate Central tool.

Table 3: Differences in Physical Conditions.

Differences in Physical Conditions[14] (mainly available for 1.5° and 2°C)		
+1°C	+1.5°C	+2.0°C
7-ft sea level rise globally[15]	9.4-ft sea level rise globally[15]	15-ft sea level rise globally[15]
		
Figures 3-5: *Differences in sea level rise due to global temperature increases. Note how the sea level creeps up the hillside and gradually covers more of the low-lying areas. Other areas in Edmonds are also affected.*		
Physical Conditions[14]	+1.5°C	+2.0°C
	Ocean acidity increase 9%	Ocean acidity increase 24%
	Frequency of warm extremes over land (PNW) increase 131%	Frequency of warm extremes over land (PNW) increase 350%
	Extreme heat: 14% of global population exposed to severe heat at least once every 5 years	Extreme heat: 37% of global population exposed to severe heat at least once every 5 years
	Population exposed to water scarcity worldwide: 271 million	Population exposed to water scarcity worldwide: 388 million
	Sea-ice-free arctic: at least 1 summer every 100 years	Sea-ice-free arctic: at least 10 summers every 100 years
	Species loss: **4% of vertebrates** lose at least half of their range	Species loss: **8% of vertebrates** lose at least half of their range
	Species loss: **8% of plants** lose at least half of their range	Species loss: **16% of plants** lose at least half of their range
	Species loss: **6% of insects** lose at least half of their range	Species loss: **18% of insects** lose at least half of their range

What Does Daily Life Look Like by 2050?

[14] References available from CarbonBrief.org.
[15] Climate Central *Surging Seas Seeing Choices* tool.

Sample Community Changes – Refer to the Edmonds 2017 Community Greenhouse Gas Inventory for details on Edmonds significant local and imported emissions sources and terminology.

Impacted emissions source	*Change to:*	*Through:*
local local imported	• No fossil fuel combustion	• 100% renewable electricity and large-scale energy storage • Electrified transport
imported local	• Reduced consumption of goods, use of disposables, and subsequent waste	• Purchase of durable goods with a focus on reuse and repair
local local	• Reduced food waste	• Reduction of waste in processing and sales (pre-consumer) • Buying just what you need • Composting (post-consumer, to avoid methane production at landfills and as a means of increasing soil carbon storage)
imported	• Reduction in GHG-intensive foods	• More vegetables, fruits, legumes, grains, and fish • Reduced meat and dairy
imported local local	• Decreased household consumption of goods and energy	• Family education
ALL	• Negative emissions actions	• Mass sequestration via forests and technology

How Much Would It Cost to Offset 100% of Community Emissions?

Edmonds' 2017 community emissions were roughly 169,000 metric tons of greenhouse gases / carbon dioxide equivalent (MT CO_2e). This estimate includes GHG emissions generated within Edmonds plus the GHG emissions embodied in electricity consumed within Edmonds (using market-based electric accounting; see inventory for discussion) known as a "local" or a "sector-based inventory." This does not include upstream, "imported" emissions from the consumption of food, goods, fuel, and services made outside of Edmonds, which were estimated to be 444,000 MT CO_2e, for a combined total of 613,000 MT CO_2e. Regulatory-grade offsets in California's Cap-and-Trade market sold in January 2018 for an average of $15 per MT. Likewise, the Climate Trust produces high-quality, voluntary-market carbon offsets for about $15 per MT. Globally, the average offset price has hovered around $5 per MT for several years. The primary differences in price for carbon offsets depend on the supply relative to demand; "co-benefits" and the appreciation for these by the customer (forestry projects typically command a higher market price than a landfill gas project); and the rigor of the carbon offset verification process (e.g., regulatory market quality versus voluntary market quality). It should be noted to that the cost of carbon offsets is expected to rise if and when carbon markets are established, and the lowest costs offset options are exploited[16].

Unlike the emissions inventory, the purchase of offsets should be based on market-based accounting of electricity emissions. The City of Edmonds and Snohomish PUD are already focused on low-emission electricity. Note, however, that the current Pacific Northwest supply of low-emission electricity is limited – if Edmonds does not reduce demand, other communities may not have access to the same energy contracts.

Based on a price of $15 per MT and 2017 total community emissions, the annual cost for the community to be carbon neutral is about $526 per household or $9.2 million dollars per year for the entire community, if offsets were the only method of reducing community emissions. That said, the community does not need to be carbon neutral next year to meet a science-based target. If offset costs were paired with an assumed reduction pace towards a 1.5°C science-based target, the cost at $15 per MT in 2020 would be $1,195,350 for the entire community (about $68 per household). *See Table 4 (next page) for estimated cost scenarios and Table 2 for reduction rates and reference.* ***Note that these costs are only applicable if Edmonds does not make changes in ways that reduce emissions.***

[16] California Air Resources Board, January 2017 Proposed Plan, Appendix E.

Table 4: Estimated annual cost of offsets for cite-wide emissions in different pricing and target scenarios, using 2018 dollars.

1°C target offset costs	$5 per MT		$10 per MT		$15 per MT	
Note: *This table based on 100% offsets, with no behavior or policy changes.*	Local emissions	**Local + imported***	Local emissions	**Local + imported***	Local emissions	**Local + imported***
2020	$126,750	**$459,750**	$253,500	**$919,500**	$380,250	**$1,379,250**
2030	$591,500	**$2,145,500**	$1,183,000	**$4,291,000**	$1,774,500	**$6,436,500**
2050	$845,000	**$3,065,000**	$1,690,000	**$6,130,000**	$2,535,000	**$9,195,000**
1.5°C target offset costs	$5 per MT		$10 per MT		$15 per MT	
2020	$109,850	**$398,450**	$219,700	**$796,900**	$329,550	**$1,195,350**
2030	$422,500	**$1,532,500**	$845,000	**$3,065,000**	$1,267,500	**$4,597,500**
2050	$845,000	**$3,065,000**	$1,690,000	**$6,130,000**	$2,535,000	**$9,195,000**
2°C target offset costs	$5 per MT		$10 per MT		$15 per MT	
2020	$84,500	**$306,500**	$169,000	**$613,000**	$253,500	**$919,500**
2030	$295,750	**$1,072,750**	$591,500	**$2,145,500**	$887,250	**$3,218,250**
2050	$676,000	**$2,452,000**	$1,352,000	**$4,904,000**	$2,028,000	**$7,356,000**

**Local emissions refer to sector-based emissions; local + imported refer to sector-based plus consumption. Please refer to Edmonds 2017 Community Greenhouse Gas Inventory for details on terminology and accounting.*

Making the Choice for Edmonds

Edmonds' leadership is faced with an important choice about which science-based target to pursue. Essentially the choice between the 1°C target, the 1.5°C target and the 2°C target is a choice between local and global safety contrasted with the discomfort of taking on the effort at a slower or faster pace. Once the overarching target is embraced, the required pace of emission reductions becomes evident.

Once a target is selected, the next phase of the Climate Action Plan process we will examine which actions can get Edmonds to the target in the right timeframe. In the selection and testing of those actions, the chosen actions – for example energy efficiency and decreased food wasting – will require the development of more common tracking metrics such as: the number and percentage of Edmonds buildings that have been weatherized or the total tons of food waste reduced at the point of collection. These actions will need to be tracked over time to show progress against a periodic community carbon footprint. *The selection of a science-based target will guide Edmonds on a new path of continued climate action commitment.*