



DEPARTMENT OF
ECOLOGY
State of Washington

Washington State Greenhouse Gas Emission Reduction Limits

Report prepared under RCW 70.235.040

December 2019

Publication 19-02-031

Publication and Contact Information

This document is available on the Department of Ecology's website at:
<https://fortress.wa.gov/ecy/publications/summarypages/190231.html>

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Executive Office

Washington State Department of Ecology

Olympia, Washington

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Acknowledgements

The Department of Ecology acknowledges and thanks the following people for contributing to this report:

- Stuart Clark, Special Assistant to the Director, WA Department of Ecology
- Ben Blank, Climate Policy Section Manager, WA Department of Ecology
- Gail Sandlin, PhD, Environmental Specialist, WA Department of Ecology
- Emily Bruns, PhD, Environmental Specialist, WA Department of Ecology
- Andrew Wineke, Communication Manager, WA Department of Ecology
- Reed Schuler, Senior Policy Advisor, Climate & Sustainability, Governor's Office
- Chris Davis, Senior Policy Advisor, Climate & Energy Affairs, Governor's Office
- Amy Snover, PhD, Director, Climate Impacts Group, College of the Environment, University of Washington

Executive Summary

In 2008, the Washington Legislature recognized that anthropogenic climate change poses serious threats to the economic wellbeing, public health, natural resources and the environment of the state and responded by establishing, in state law, limits on the state's greenhouse gas (GHG) emissions. As described in RCW 70.235.020, Washington's current greenhouse gas limits are:

- 1990 levels by 2020
- 25% below 1990 by 2035
- 50% below 1990 by 2050

Under RCW 70.235.040, the Legislature requires the Department of Ecology (Ecology) to consult with the Climate Impacts Group (CIG) at the University of Washington to review the science on human-caused climate change within eighteen months of the “next and each successive global or national assessment of climate change science,” and to make recommendations “whether the greenhouse gas emissions reductions under RCW 70.235.020 need to be updated.”

The Intergovernmental Panel on Climate Change released its most recent assessment of global climate impacts in October 2018. This Special Report, *Global Warming of 1.5°C* (SR15), described the expected impacts of 1.5°C and 2°C of warming.¹ At the national level, the *Fourth National Climate Assessment* was released in 2018 and included a chapter on climate impacts in the Northwest.² The consequences to Washington State of 1.5°C and 2°C of warming were summarized in 2019 by the University of Washington Climate Impacts Group.³

The IPCC's SR15 climate science assessment, the Fourth National Climate Assessment, and CIG's brief on the potential impacts for Washington State, demonstrate the need for significant additional greenhouse gas reductions beyond those in RCW 70.235.020 to moderate the most damaging effects of climate change.

¹ IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)

² USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 151 pp. doi: 10.7930/NCA4.2018

³ Snover, A.K., C.L. Raymond, H.A. Roop, H. Morgan, 2019. No Time to Waste. The Intergovernmental Panel on Climate Change's Special Report on Global Warming of 1.5°C and Implications for Washington State. Briefing paper prepared by the Climate Impacts Group, University of Washington, Seattle. Updated 02/2019.

Based on these reports, Ecology recommends substantial strengthening of the statutory greenhouse gas emissions limits, creating new interim milestones, and setting a carbon-neutral target in addition to the reduction limit for 2050.

Climate Change is affecting Washington

Climate science has continued to advance since Washington established greenhouse gas emission limits in 2008. In both 2013 and 2015, the University of Washington Climate Impacts Group (CIG) published a State of Knowledge Report which further detailed impacts and trends being experienced in, and expected for, the Pacific Northwest.^{4,5} These reports provide additional detail about worsening impact trends that will affect Washington’s economy and environment. Most recently, the Climate Impacts Group’s 2019 brief, *No Time to Waste*, based on the 2018 IPCC Special Report, *Global Warming of 1.5°C*, discusses the related consequences for Washington State. The findings of these accumulated reports indicate that, for Washington State, a warming of 1.5°C will result in “more very hot days, reduced snow pack, higher winter streamflow, lower summer streamflow, and increased sea level rise.” These changes have severe consequences such as “more heat-related illness and deaths, warmer streams stressing salmon, more frequent algal blooms, reduced water storage, irrigation shortages, winter and summer recreation loses, increased river flooding, increased stormwater management and flood protection costs, negative effects on salmon populations, reduced summer hydropower, more conflicts over water resources, increased coastal flooding and inundation, damage to coastal infrastructure and communities, and bluff erosion.”

Context for GHG reduction limits in Washington

In 2008, the Washington State Legislature set greenhouse gas emission reduction limits for three timeframes: 2020, 2035, and 2050.⁶ The Legislature reviewed limits in other states and what, at that time, was thought necessary to stabilize global carbon levels in the atmosphere by the end of the century. The Legislature considered the appropriate level of reductions for Washington given our clean power sector relative to other states and industrialized countries that are reliant on gas and coal-fired power.

The IPCC’s 4th Assessment Report (AR4) suggests that for the Annex 1 region (a region that includes Washington State) to achieve a stabilization scenario of 450 ppm CO₂-eq, emission reductions need to be in the range of 80–95 percent by 2050 compared to 1990 levels. The 5th

⁴ Snover, A.K., Mauger, G.S., Whitely Binder, L.C., Krosby, M., Tohver, I. 2013. Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers – Executive Summary. State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle.

⁵ Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover. 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

⁶ Engrossed Second Substitute House Bill 2815, Chapter 14, Laws of 2008. Codified in RCW 70.235.020

Assessment Report (AR5) stops short of recommending specific emission reduction targets on a regional basis.⁷ Instead, AR5 provides a range of global emission reduction targets necessary to limit warming by the end of the century based on a set of potential mitigation scenarios.

AR5 recommendations:

- A 40–70 percent reduction below 2010 global levels by 2050 to *likely* limit warming below 2°C.
- A 70–95 percent reduction below global 2010 levels to *more likely than not* limit warming below 1.5°C.⁸

This IPCC report was followed by an historic agreement reached in 2015 at the 21st Conference of Parties in Paris (Paris Agreement). At this conference, countries pledged to reach a long-term goal limiting increases in global temperatures to 2°C relative to pre-industrial levels, and to further aim to limit temperature increases to 1.5°C. In 2017, the U.S. announced its intentions to withdraw from the Agreement that it previously accepted in 2015. This announcement led to a coalition of states supporting the Paris Agreement by forming the U.S. Climate Alliance, with Washington State as a founding member.

More recently, the 2018 IPCC fifteenth Special Report (SR 15), *Global Warming of 1.5° C* warns of the consequences of failing to drastically reduce greenhouse gas emissions.

The reports noted above, collectively, emphasize the urgency to take strong action. The reports stress the importance of achieving substantial emission reductions in earlier years to more quickly transition to a low carbon future and, in addition to overall emission reductions, to reach carbon neutrality or net zero greenhouse gas emissions by mid-century. Carbon neutrality or net zero means that any remaining emissions would be offset by carbon capture processes that remove greenhouse gases from the atmosphere.

In response, many national, state, and local governments have set stringent greenhouse gas emission limits.

In 2019, the University of Washington’s Climate Impact Group described the specific impacts of the SR15 findings on Washington State showing increasing harm to Washington’s economy and environment.

Recommendations

Anthropogenic, human caused, climate change poses an immediate and urgent threat. We are already seeing effects globally. On a regional level in the Pacific Northwest, we have observed devastating wildfires, drought, lack of snowpack, and increases in ocean acidification. These events are examples of what our future will look like if we fail to take action. While Washington cannot singlehandedly solve climate change, we can do our part, and set an example for other

⁷ IPCC 2007. Fourth Assessment Report, Working Group III, “Mitigation of Climate Change”, Chapter 13. Box.13.7

⁸ The terms “likely” and “more likely than not” indicate IPCC’s level of confidence in the result of a given modeled scenario; specifically: *-likely* >66% probability of occurrence, *More likely than not* > 50%

states and jurisdictions. This is especially important if there is a lack of action at the federal level.

Current science indicates that sharp reductions in greenhouse gas emissions are required to stabilize carbon in the atmosphere and minimize future risks. This requires both short-term and longer-term reductions. Washington’s existing statutory greenhouse gas emission limits should be strengthened to reflect current science, to be consistent with recent enacted state climate policy including the Clean Energy Transformation Act, and to better align with the limits that other jurisdictions are setting to combat climate change.

After careful evaluation of the scientific evidence, Ecology reached the conclusion that the state’s greenhouse gas reduction limits should be strengthened, new interim milestones should be created, and a carbon neutral or net zero carbon target should be established.

Ecology’s recommended greenhouse gas limits are listed below. They include aggressive greenhouse gas reduction targets for 2030, 2040, and 2050, including net zero emissions by 2050. “Net zero emissions” is a term to describe the scenario where anthropogenic greenhouse gas emissions are balanced by removals such as “enhancement of biological or geochemical sinks and direct air capture and storage.”⁹ The recommended limits reflect the latest science and would set Washington State on a path to do its part to stabilize atmospheric carbon in a way that limits global temperature increases to below 2°C, and preferably below 1.5°C.

Current limits:

- By 2020, reduce overall emissions of greenhouse gases in the State to 1990 levels.
- By 2035, reduce overall emissions of greenhouse gases in the State to 25 percent below 1990 levels.
- By 2050, the state will do its part to reach global climate stabilization levels by reducing overall emissions to 50 percent below 1990 levels, or 70 percent below the State's expected emissions that year.¹⁰

Recommended limits:

- By 2020, reduce overall emissions of greenhouse gases in the State to 1990 levels
- By 2030, reduce greenhouse gas emissions in the State to 45% below 1990 levels
- By 2040, reduce greenhouse gas emissions in the State to 70% below 1990 levels

⁹ IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.) pg. 24

¹⁰ RCW 70.235.020(1)(a).

- By 2050, reduce greenhouse gas emissions in the State to 95% below 1990 levels and achieve net zero greenhouse gas emissions in the State

Emission Reduction Targets

Background on the IPCC and Process

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change. It was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP). The purpose of the IPCC is to provide policy and decision makers with evaluations and updates on the current state of climate science, projections of likely future impacts, and options for reducing emissions (mitigation) and for addressing the impacts from climate change (adaptation). The scientists on the IPCC are from all 195 member countries, and the IPCC represents the consensus body on the state of climate science to inform negotiations at the United National Framework Convention on Climate Change (UNFCCC).

The IPCC prepares comprehensive Assessment Reports about the state of scientific, technical, and socio-economic knowledge on climate change. The most recent report, the 5th Assessment (AR5), was completed in 2014. The IPCC is currently working on its 6th Assessment, slated to be released in 2022.

A key objective in IPCC assessments is evaluating what it will take to stabilize global climate. Stabilization refers to the maximum concentration of greenhouse gases in the atmosphere associated with limiting global warming to a specific level. In AR5, the IPCC concluded that atmospheric concentrations of CO₂e¹¹ (carbon dioxide equivalent) of about 450 ppm (parts per million) in 2100 would provide at least a 66% chance of stabilizing global temperatures and limiting temperature increases to less than 2°C above pre-industrial levels.

The IPCC also produces Special Reports, which are an assessment on a specific issue. *Global Warming of 1.5°C* is a Special Report released in October 2018. It describes the impacts of global warming of 1.5°C above pre-industrial levels.

Below we summarize key findings from the IPCC AR5, the Paris Agreement, the Under2MOU and the IPCC *Global Warming to 1.5°C* Special Report regarding emission reductions needed to stabilize atmospheric carbon levels and limit global warming.

Key mitigation findings from the IPCC 5th Assessment (AR5)

The IPCC AR5 supports the work of the previous assessments, noting that while there are a range of mitigation approaches in reducing greenhouse gas emissions to limit warming to below 2°C relative to pre-industrial levels, all of these approaches would require “substantial emission

¹¹ Note: CO₂-eq is commonly used in IPCC documents and is an interchangeable term with CO₂e

reductions over the next few decades and near zero emissions of CO₂ and other long-lived greenhouse gases by the end of the century.”¹²

In AR5, the IPCC evaluates global emission reductions required to achieve three scenarios by 2100: 1) below 430 ppm CO₂-eq, 2) 450 ppm CO₂-eq, and 3) 500 ppm CO₂-eq., (Table 1). These scenarios are associated with model results limiting global temperature increases to 1.5°C or 2°C by 2100, with varying degrees of confidence. See footnote 12 explaining the IPCC degree of confidence terms.

Table 1: Emission Reductions Targets to Limit Global Temperatures

| AR5 Global CO ₂ -eq Concentration Target | Projected limits on warming in 2100 ¹³ | Global Emission Reduction Targets by 2050 |
|---|---|---|
| 1. Below 430 ppm | More likely than not below 1.5°C ¹⁴ | 70-95% below 2010 levels |
| 2. 450 ppm | Likely (66 to 100% chance) below 2°C | 41-72% below 2010 levels |
| 3. 500 ppm | More likely than not (>50 to 100% chance) below 2°C | 42-57% below 2010 levels |

Paris Agreement

The Paris Agreement (Accord de Paris) was negotiated at the 21st Conference of Parties to the UNFCCC in December 2015. Currently it has been ratified by 187 of the 197 UNFCCC members. The countries that have not formally ratified as of September 2019: Angola, Eritrea, Iran, Iraq, Kyrgyzstan, Lebanon, Libya, South Sudan, Turkey, and Yemen, have all signed the Paris Agreement, indicating their intention to ratify. In 2017, the U.S. announced its intentions to withdraw from the Agreement that it previously joined in 2016. This announcement led to a coalition of states forming the U.S. Climate Alliance, with Washington State as a founding member, in order to support the Paris Agreement and continue to work toward its goals. On November 4, 2019, the United States formally communicated its intention to withdraw from the Agreement, which will take effect November 4, 2020.

¹² IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], Summary for Policy Makers, SPM 3.4.

¹³ The expressions “likely” and “more likely than not” are terms used by the IPCC to portray their confidence in a given set of modeled outcomes, or terms to express assessed likelihood e.g. “virtually certain 99-100%, very likely 90-100%; likely 66-100%; about as likely as not 33-66%; unlikely 0-33%; very unlikely 0-10%; exceptionally unlikely 0- 1.0%; Additional terms: extremely likely 90-100%; more likely than not >50-100%; more unlikely than likely 0-50%; extremely unlikely 0-5%”...page 2.

¹⁴ Ibid. Page 21 “limited number of studies provide scenarios that are *more likely than not* to limit warming to 1.5°C by 2100; these scenarios are characterized by concentrations below 430 ppm CO₂-eq by 2100 and 2050 emission reduction between 70% and 95% below 2010”

The central goal of the Paris Agreement is for participants to take all efforts to limit the amount of global warming to 2°C by 2100 compared to pre-industrial levels, to take best efforts to limit warming to 1.5°C, and to achieve net-zero emissions as early as possible in the second half of the century. Participants indicate the emission reductions they intend to achieve through their Nationally Determined Contributions (NDCs), which are levels of emission reductions that each member country self-determines.

While the Paris Agreement represents a substantial step forward in addressing climate on a global scale, the emission reductions pledged in the NDCs likely will not be sufficient to meet the goals of the agreement, with some estimates predicting that with the NDCs in place, warming will be limited to 2.8°C-3.1°C relative to pre-industrial levels.¹⁵

Under 2MOU

Another consideration in evaluating limits is the guidance from the Memorandum of Understanding on Subnational Global Climate Leadership (Under 2MOU). This agreement evolved from a partnership between California and the German state of Baden-Württemberg, and is aimed at promoting action to address climate change at the subnational level. Signatories to the Under 2MOU agree to:

1. Work to limit global warming to less than 2°C by 2050,
2. Commit to reducing emissions to 80 to 95% below 1990 levels by 2050 or limiting per capita emissions to 2 MTCO₂e, and
3. Commit to establishing intermediate emission reduction targets at 2030.¹⁶

To date, a total of 220 jurisdictions from at least 33 countries and six continents have signed the Under 2MOU. Washington State is a founding signatory of the MOU, (Table 2). Besides California and Washington, other U.S. states that have signed include Connecticut, Hawaii, Massachusetts, Minnesota, New Hampshire, New York, Oregon, Rhode Island, and Vermont. In addition, several U.S. cities have also signed, including Seattle, Portland, San Francisco, Oakland, and Los Angeles.

¹⁵ <http://climateactiontracker.org/global.html>

¹⁶ See <http://under2mou.org/wp-content/uploads/2015/04/Under2-MOU-English.pdf>.

Table 2: National and International Agreements

| Agreement | Emissions Reduction | Reference Year | Year Established |
|----------------------------|---------------------------|----------------|----------------------------|
| Under 2MOU | 80-95% below 1990 by 2050 | 1990 | 2015 WA founding signatory |
| US Climate Alliance | 26-28% below 2005 by 2025 | 2005 | 2017 WA founding member |

IPCC Special Report: Global Warming of 1.5°C (SR15)

This special report emphasizes the urgency of taking dramatic steps to reduce greenhouse gas emissions in order to limit warming to internationally-agreed targets. Recently the University of Washington Climate Impacts Group summarized key findings of this report in their brief, “No Time to Waste.”¹⁷ It states, “human-caused warming resulting from continuing emissions of greenhouse gases is adding around 0.2°C to global average temperatures every decade. If this continues, global average warming is likely to reach 1.5°C between 2030 and 2052, which is within the lifetime of most people on Earth.”

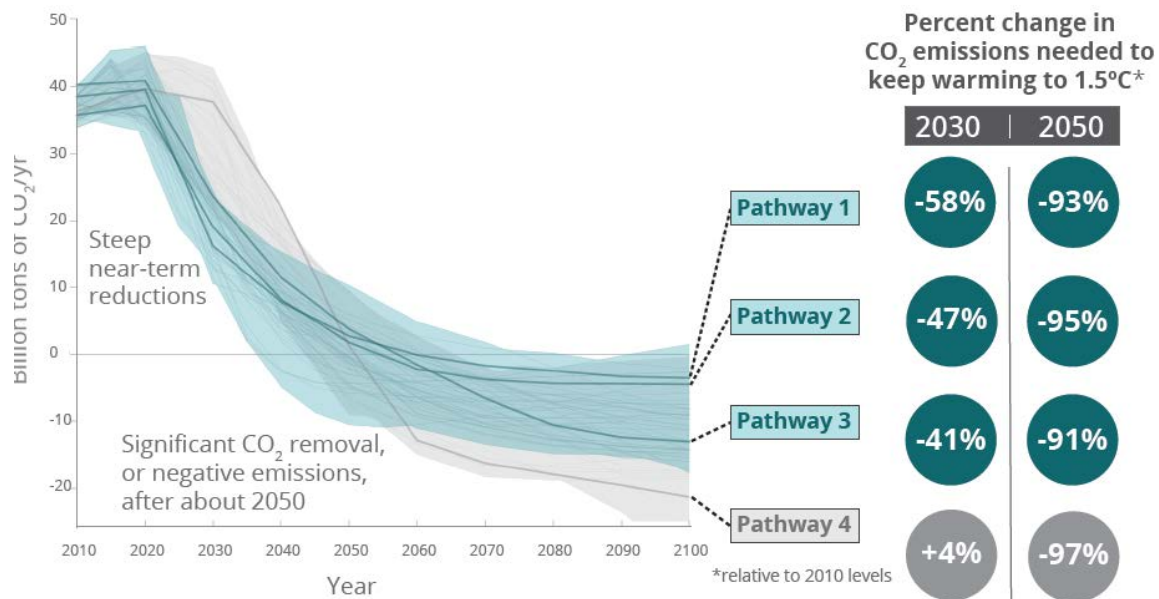


Figure 1: Global CO₂ emission reduction pathways (relative to 2010) to limit warming to 1.5°C.

Source: Snover, A.K., C.L. Raymond, H.A. Roop, H. Morgan, 2019. No Time to Waste. (modified from the IPCC SR15).

¹⁷ Snover, A.K., C.L. Raymond, H.A. Roop, H. Morgan, 2019. No Time to Waste. The Intergovernmental Panel on Climate Change’s Special Report on Global Warming of 1.5°C and Implications for Washington State. Briefing paper prepared by the Climate Impacts Group, University of Washington, Seattle. Updated 02/2019. (modified from the IPCC SR15).

Figure 1 presents global greenhouse gas emission pathways associated with limiting global warming to 1.5°C above pre-industrial levels. According to the IPCC, although “the energy system transition that would be required to limit global warming to 1.5°C is underway in many sectors and regions around the world, limiting warming to 1.5°C would require rapid escalation in the scale and pace of transition, particularly in the next 10-20 years.”¹⁸ Pathways 1-3 (all shown in blue) limit warming to 1.5°C without overshooting that level of warming; Pathway 4 (shown in gray) leads to global temperatures ‘overshooting’ 1.5°C for a few decades and returning to below 1.5°C before 2100. The reduction limits proposed by Ecology for Washington State, align most closely with reduction pathway 2 which is described in the SR15 as,

“a scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption pattern, low-carbon technology innovation and well-managed land systems...”¹⁹

GHG reduction limits

After careful evaluation of the scientific evidence, Ecology reached the conclusion that the state’s greenhouse gas reduction limits should be strengthened, new interim milestones should be created and a carbon neutral or net zero carbon target should be established.

Table 3 provides a summary of greenhouse gas emission reduction targets relative to Washington’s participation in international or national agreements. As specified in RCW 70.235.020, Washington State’s current 2050 reduction limit falls significantly short of the emissions reductions necessary to address urgent scientific concerns on global warming. As founding participants in the U.S. Climate Alliance and Under2MOU, Washington State has positioned itself as a leader promoting science driven greenhouse gas reduction goals to hold global warming to 1.5°C.

A ‘net-zero’ target recognizes that anthropogenic emissions can in part be balanced by anthropogenic greenhouse gas removals, such as CO₂ storage in geological, terrestrial, or ocean

¹⁸ IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.) pg. 392

¹⁹ IPCC, SR15, Global Warming of 1.5°C (Oct 2018) Summary for Policymakers, pg.14.

reservoirs, or in products. These removals include “existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage...”²⁰

Table 3: GHG emission reduction targets, national and international

| National and International GHG targets | 2020 | 2025 | 2030 | 2035 | 2040 | 2050 |
|---|---------------|-----------------------|----------------|----------------|----------------|---------------------------|
| WA state current-RCW 70.235.020 1990 by 2020; 25% below 1990 by 2035; 50% below 1990 by 2050 | 1990 baseline | | | 25% below 1990 | | 50% below 1990 |
| US Climate Alliance (Paris Agreement) 26 to 28 % below 2005 levels by 2025 | | 26 to 28 % below 2005 | | | | |
| Under2MOU: 80-95% below 1990 levels by 2050 (WA state founding signatory) | | | | | | 80 to 95% below 1990 |
| IPCC SR15 Pathway 2: Relative to 2010; 47 % reduction by 2030; 95% reduction by 2050 | | | 47% below 2010 | | | 95% below 2010, net zero |
| WA 2019 recommended targets: 1990 levels by 2020; 45% below 1990 by 2030; 70% below 1990 by 2040 and 95% below 1990 by 2050 | 1990 baseline | | 45% below 1990 | | 70% below 1990 | 95 % below 1990, net zero |

Established GHG Limits

This section compares the current GHG limits of Washington State to other jurisdictions. When first established, most limits were influenced by the Kyoto protocol. More recently, in keeping with best available science described in IPCC’s AR4 and AR5 assessments and special report SR15, several states and cities have moved to 80% or greater reductions from 1990 levels by 2050 and net zero emission targets.

Table 4 shows current reduction limits for several Washington State jurisdictions.

²⁰ Ibid, pg 24

Table 4: GHG Limits for Washington State and Jurisdictions^{21, 22}

| Jurisdiction | Limits | Reference Year | Year Established / Revised |
|-------------------------------------|--|-----------------------|--|
| Washington State-current | 1990 levels by 2020 25% below 1990 by 2035 50% below 1990 by 2050 | 1990 | 2008 in Statute |
| Seattle | 58% below 2008 by 2030 87% below 2008 by 2050 Net zero emissions by 2050 | 2008 | 2008, 2011 |
| Tacoma | 40% below 1990 by 2020 80% below 1990 by 2050 | 1990 | 2008 |
| King County | 25% below 2007 by 2020 50% below 2007 by 2025 80% below 2007 by 2030 | 2007 | 2019 - 80% reduction by 2030 recommended to County Council |
| Puget Sound Clean Air Agency | 50% below 1990 by 2030 80% below 1990 by 2050 | 1990 | 2017 |

U.S. states listed in Table 5 are members of the U.S. Climate Alliance. Most have established an 80% or greater reduction below 1990 levels by 2050, with both California and Hawaii introducing net zero emission targets by 2045.

²¹ Community and Government Operations, Greenhouse Gas Emissions Inventory, 2016 Office of Environmental Policy and Sustainability, Tacoma, Table 1, pg 5

²² Washington Governor, News and Media, December 1, 2015

Table 5: GHG Limits for Other U.S. States²³

| State | Current Limits | Reference Year | Year Established/Revised |
|-------|---|----------------|---------------------------------------|
| CO | 26% below 2005 levels by 2025 50% below 2005 by 2030 90% below 2005 by 2050 | 2005 | 2019 |
| CA | Year 1990 levels by 2020 40% below 1990 levels by 2030 Net zero by 2045 80% below 1990 levels by 2050 | 1990 | 2006, 2016, 2018 |
| CT | 10% below 1990 levels by 2020 80% below 1990 levels by 2050 45% below 2001 levels by 2030 | 1990, 2001 | 2008, 2018 |
| DE | 26-28% below 2005 levels by 2025 | 2005 | 2016 |
| FL | 2000 levels by 2017 1990 levels by 2025 80% below 1990 levels by 2050 | 1990 | 2007 |
| HI | Net zero by 2045 | 2005 | 2017 |
| IL | 1990 levels by 2020 60% below 1990 levels by 2050 | 1990 | 2007; 2019: 100% clean energy by 2050 |
| MA | 25% below 1990 levels by 2020 80% below 1990 levels by 2050 | 1990 | 2008 |
| MD | 25% below 2006 levels by 2020 40% below 2006 levels by 2030 | 2006 | 2009, 2015 |
| ME | 1990 levels by 2010 10% below 1990 by 2020 75 to 80% below 2003 levels, long term | 1990 | 2003 |
| MI | 20% below 2005 levels by 2025 80% below 2005 levels by 2050 | 2005 | 2009 |
| MN | 30% below 2005 by 2025 80% below 2005 by 2050 | 2005 | 2007 |
| NJ | 1990 levels by 2020 80% below 2006 levels by 2050 | 2006 | 2007 |
| NM | Year 2000 levels by 2012 10% below 2000 levels by 2020 75% below 2000 levels by 2050 45% below 2005 levels by 2030 | 2000; 2005 | 2005; 2019 EO |
| NY | 5% below 1990 levels by 2010 40% below 1990 levels by 2030 85% below 1990 levels by 2050, plus net zero | 1990 | 2002, 2009, 2019 |
| OR | 10% below 1990 levels by 2020 75% below 1990 levels by 2050 | 1990 | 2007 |
| PA | 26 % below 2005 levels by 2025 80 % below 2005 levels by 2050 | 2005 | 2019 |
| VT | 50% below 1990 levels by 2028 75% below 1990 levels by 2050 | 1990 | 2007 |

²³ US Climate Alliance, State Policies

Summary of Recent Advances in Climate Science

Global Impacts

In its Fifth Assessment Report (AR5), the IPCC stated that “[h]uman influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history.”²⁴ Current atmospheric concentrations of carbon dioxide are “unprecedented in at least the last 800,000 years.”²⁵ The IPCC further stated that “[w]arming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.”²⁶

In October 2018, IPCC released the *Special Report on Global Warming of 1.5°C*, which states that “climate related risks to health, livelihoods, food security, water supply, human security, and economic growth are projected to increase with global warming of 1.5°C and increase further with 2°C.”²⁷

Consequences for Washington State

Global climate change will have damaging impacts in the Pacific Northwest. The University of Washington’s Climate Impacts Group (CIG) has issued several reports detailing current observations and predicted future impacts from climate change in the Puget Sound region, including the *Washington State Climate Change Impacts Assessment (2009)*²⁸, and *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers (2013)*.²⁹ In 2015, CIG published a report summarizing the current state of knowledge regarding observed and likely future climate impacts in the Puget Sound area.³⁰ This report described expected changes in key climate-related factors driving local change, including increasing temperature and heavy rainfall, declining spring snowpack, sea level rise, higher storm surge

²⁴ IPCC, 2014 Climate Change 2014, Synthesis Report, Core Writing Team, R. Pachauri and L. Meyer.

²⁵ Id. at SPM 1.2.

²⁶ Id. at SPM 1.1.

²⁷ IPCC, 2019. Global warming of 1.5°C.

²⁸ Climate Impacts Group. 2009. The Washington Climate Change Impacts Assessment. M. McGuire Elsner, J. Littell, and L. Whitely Binder (eds). Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, Washington.

²⁹ Snover, A.K., Mauger, G.S., Whitely Binder, L.C., Krosby, M., Tohver, I. 2013. Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers – Executive Summary. State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle.

³⁰ Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover. 2015. State of Knowledge: Climate Change in Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D

reach, and ocean acidification. Area trends in long term warming are presented in Figure 2 below. Figure 3 illustrates the loss of mass in the South Cascade Glacier with “most Washington glaciers in decline. Declines range from a 7% loss of average glacier area in the North Cascades (1958-1998) to a 49% decline in average area on Mount Adams (1904-2006)”.³¹

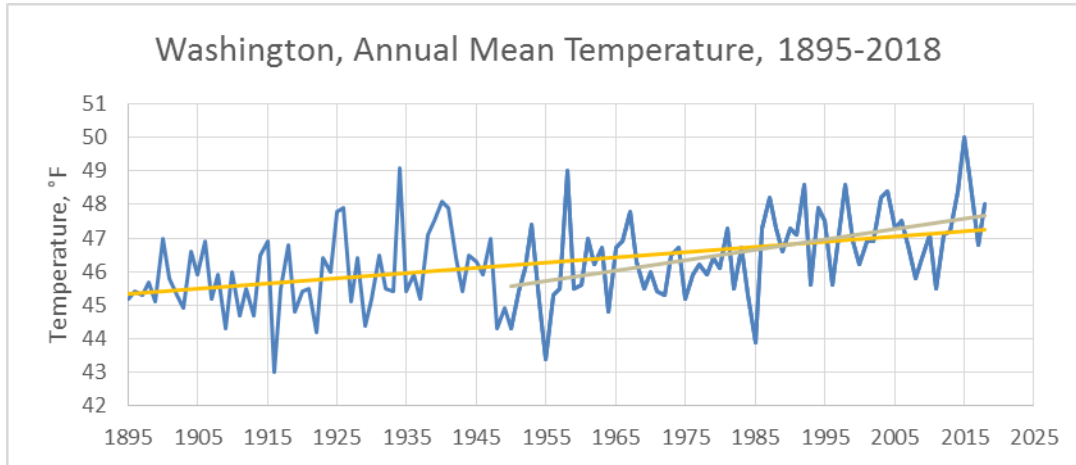


Figure 2: Washington Annual Mean Temperature Trend

Source: NOAA National Centers for Environmental Information, Climate at a Glance: Statewide Time Series, 2019

³¹ State of Knowledge Report, Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers, Climate Impacts Group, University of Washington, December 2013. Snover et. al.

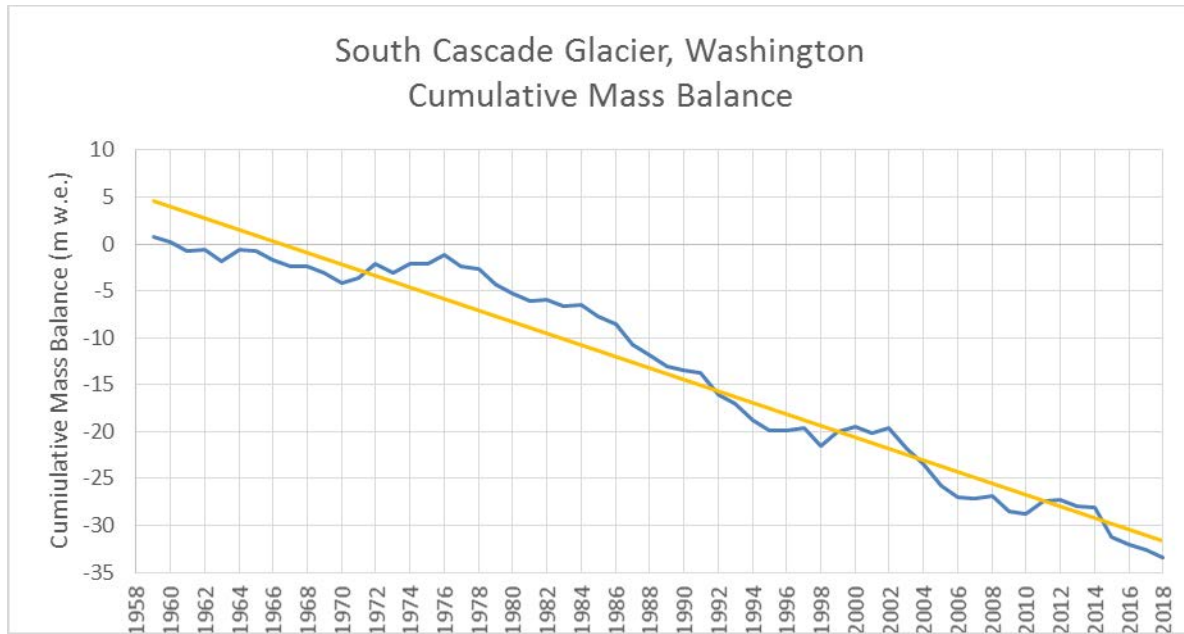


Figure 3: Loss of Mass in South Cascade Glacier, 1959-2018

Source: Glacier-Wide Mass Balance and Compiled Data Inputs: USGS Benchmark Glaciers, (ver. 3.0, July 2019): U.S. Geological Survey data release, <https://doi.org/10.5066/F7HD7SRF>

More recently CIG (2019) published a summary of the potential impacts to Washington State based on the findings of IPCC’s 2018 Special Report, *Global Warming to 1.5°C*. The key challenges for Washington at global warming of 1.5°C (about 0.5°C more warming than the 1.0°C the earth has already warmed since pre-industrial times) are shown in Figure 4; however, without significant near-term emissions reductions, both the globe and the state are on track for significantly more warming than 1.5°C.

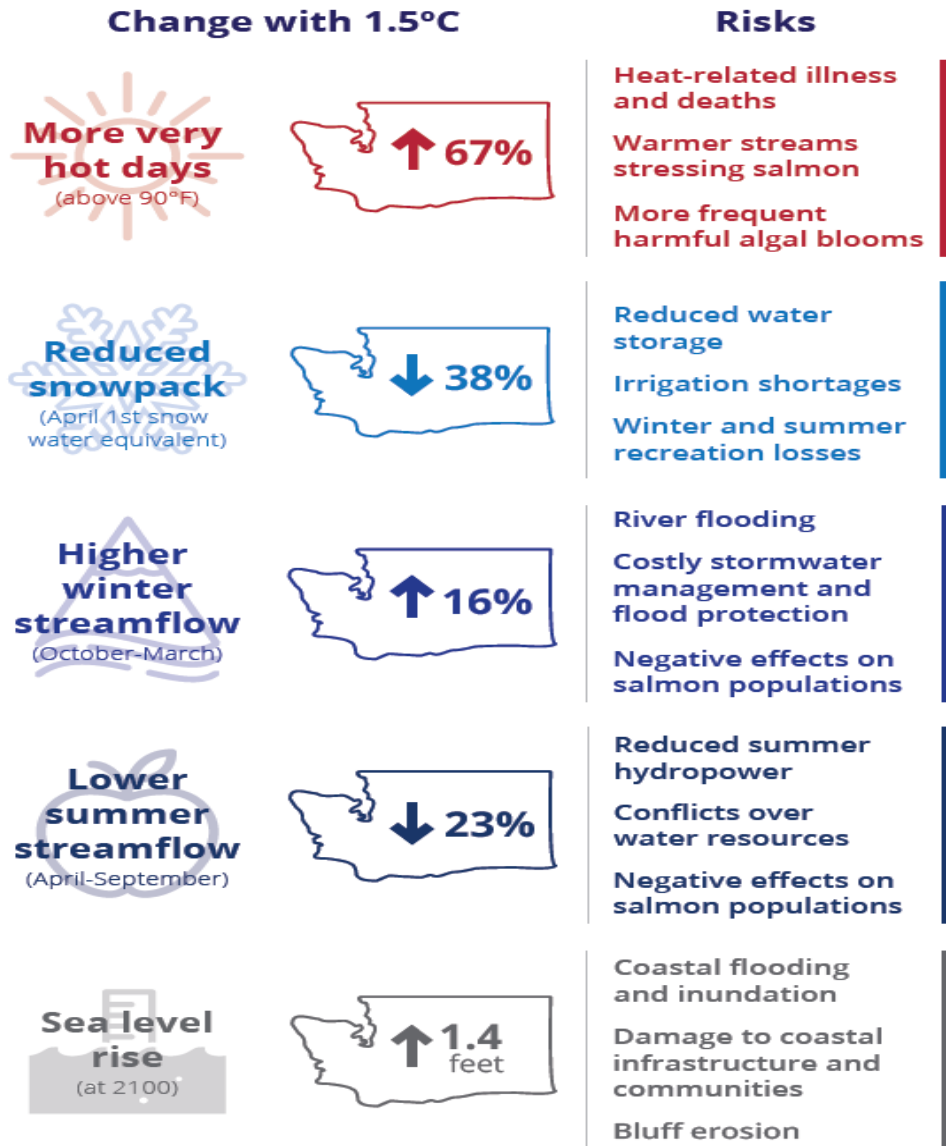


Figure 4: Warming of 1.5°C will bring increasing challenges to Washington.

Source: Snover, A.K., C.L. Raymond, H.A. Roop, H. Morgan, 2019. No Time to Waste. The Intergovernmental Panel on Climate Change’s Special Report on Global Warming of 1.5°C and Implications for Washington State. Briefing paper prepared by the Climate Impacts Group, University of Washington, Seattle. Updated 02/2019.

Figure 4 shows projected changes in hot days relative to 1976-2005, changes in sea level rise relative to 1991-2010, all others relative to 1970 -1999. Data from: Fourth National Climate Assessment; Climate Change Impacts and Adaptation in Washington State: State of Knowledge: Climate Change in Puget Sound; Projected Sea Level Rise for Washington State–A 2018 Assessment.

Current Trends in Greenhouse Gas Emissions

Global and national trends

Global carbon dioxide emissions have increased in the last half of the 20th century, and increased sharply since 1990, see Figure 5 below.

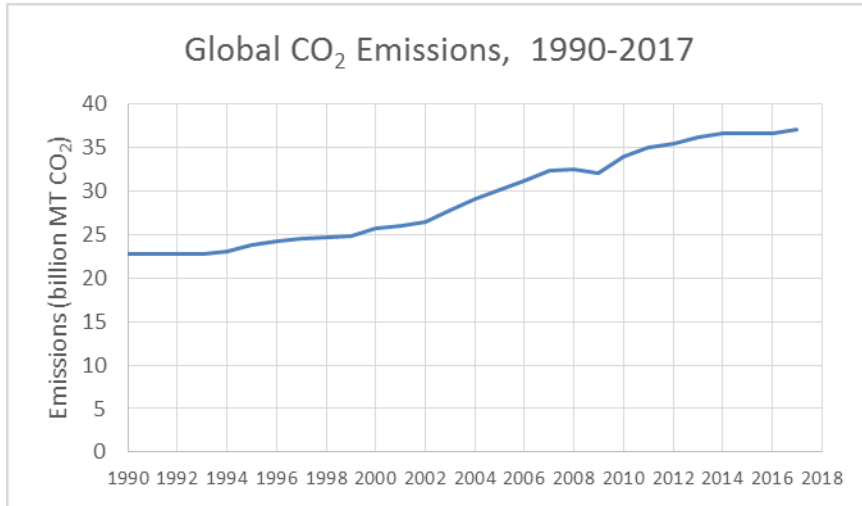


Figure 5: Global CO₂ Emissions, 1990 – 2017

Source: European Commission, Joint Research Centre, Emissions Database for Global Atmospheric Research (EDGAR).³²

In terms of global emissions, today China leads the world in releasing carbon dioxide to the atmosphere, followed by the U.S., the European Union, India, Russia, Japan, and Canada. See Figure 6 below.

³² The Joint Research Center is the European Commission's in-house scientific service to provide data to inform policy decisions. PBL Netherlands Environmental Assessment Agency is the Dutch national institute for environmental policy analyses. Both these organizations developed and manage the Emissions Database for Global Atmospheric Research (EDGAR), which is the dataset for greenhouse gas emissions used by the UN.

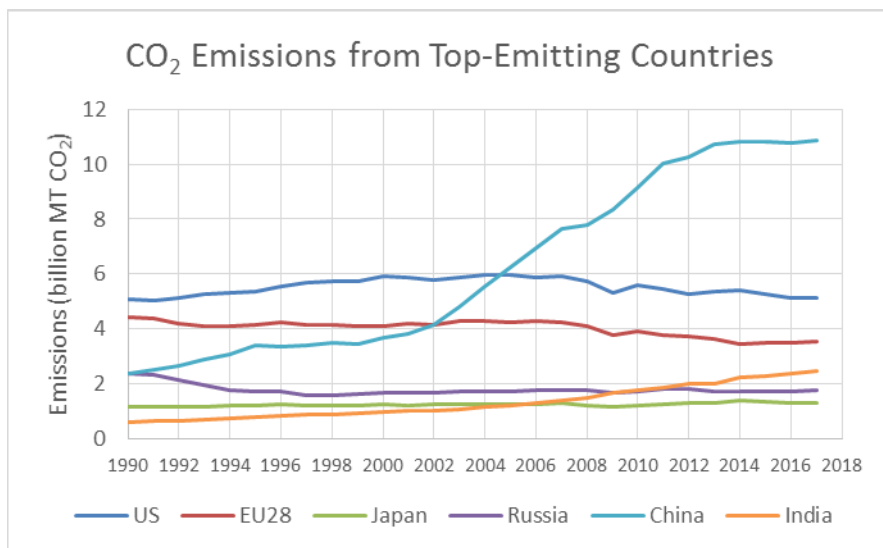


Figure 6: CO₂ Emissions from Top-Emitting Countries

Source: Fossil CO₂ emissions of all world countries - 2018 Report, EUR 29433 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97240-9, doi:10.2760/30158, JRC113738.

In addition to being the second largest overall contributor to global carbon dioxide emissions, the U.S. far outpaces the rest of the world in total emissions over time and in per capita carbon dioxide emissions. As illustrated in Figure 7 below, U.S. per capita carbon dioxide emissions were almost triple the global average, and over double that of the European Union, which has the second highest per capita carbon dioxide rate.

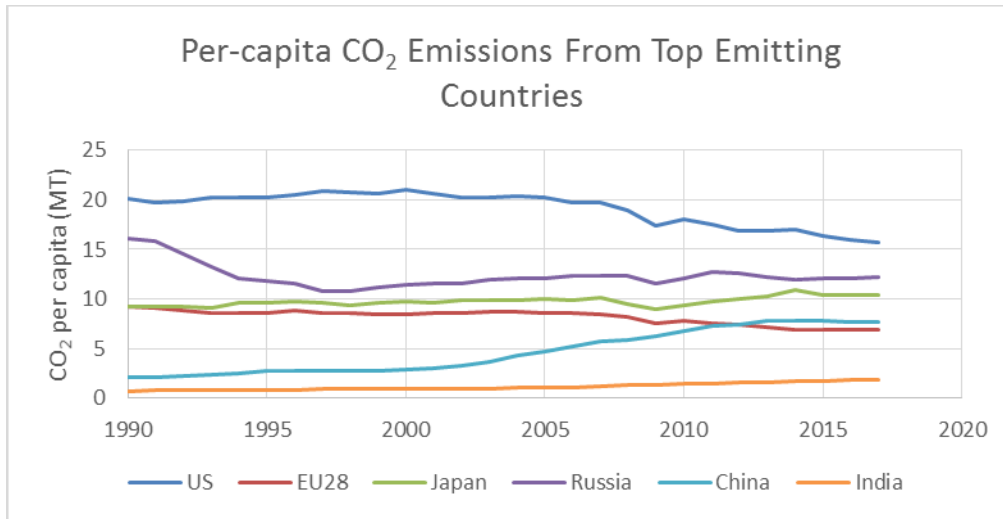


Figure 7: Per-Capita CO₂ Emissions from Top Emitting Countries

Source: Fossil CO₂ emissions of all world countries - 2018 Report, EUR 29433 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97240-9, doi:10.2760/30158, JRC113738; <https://ec.europa.eu/eurostat/>

Atmospheric carbon dioxide continued its rapid rise in 2019, with the average for May peaking at 414.7 parts per million (ppm) at NOAA's Mauna Loa Atmospheric Baseline Observatory. This is the highest seasonal peak recorded in 61 years of observations. The total atmospheric concentration of carbon dioxide measured at this monitoring station was 316 ppm in 1958. Starting in 2015, that level averaged over 400 ppm and continues to increase, with the mean average for 2018 at 408.5 ppm, Figure 8.

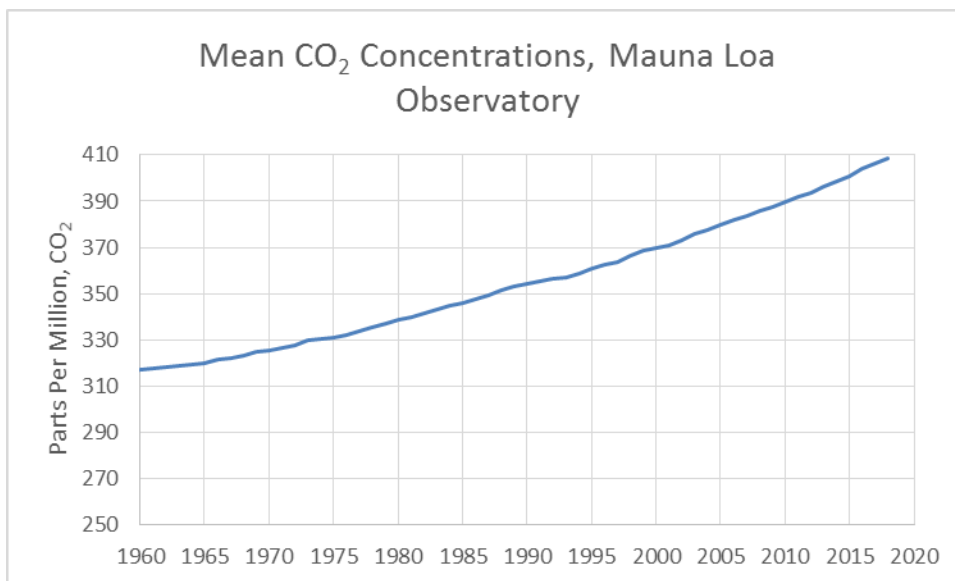


Figure 8: Mean CO₂ Concentration, Mauna Loa Observatory

Source: Dr. Pieter Tans, NOAA/ESRL (www.esrl.noaa.gov/gmd/ccgg/trends/) and Dr. Ralph Keeling, Scripps Institution of Oceanography (scrippsco2.ucsd.edu/).

U.S. and Washington State Emissions

While the U.S. is the second largest contributor to global carbon dioxide emissions, the rate of U.S. emissions decreased from 2007 to 2012, consistent with the economic downturn, and has since remained relatively flat. See Figure 9.

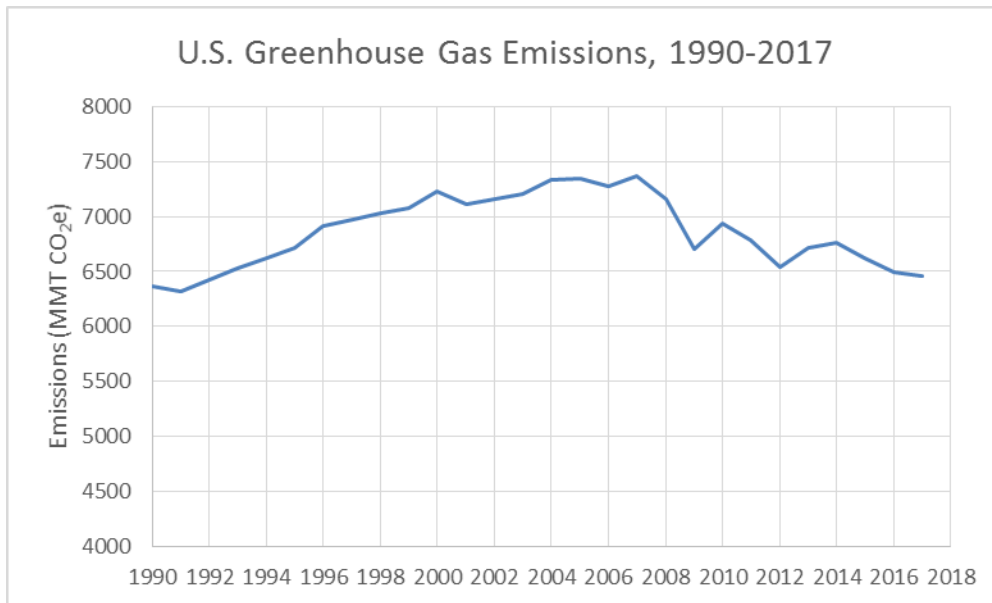


Figure 9: U.S. Greenhouse Gas Emissions, 1990–2017

Source: U.S. EPA, EPA 430-R-19-001, Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990–2017

Figure 10 below provides the greenhouse gas emissions profile for Washington State. In 2017, Washington emitted 97.5 MMTCO₂e. In terms of progress towards the greenhouse gas emission limits currently in statute, as of 2017, Washington is 7.0 MMTCO₂e or 7.7% higher than the 2020 target.

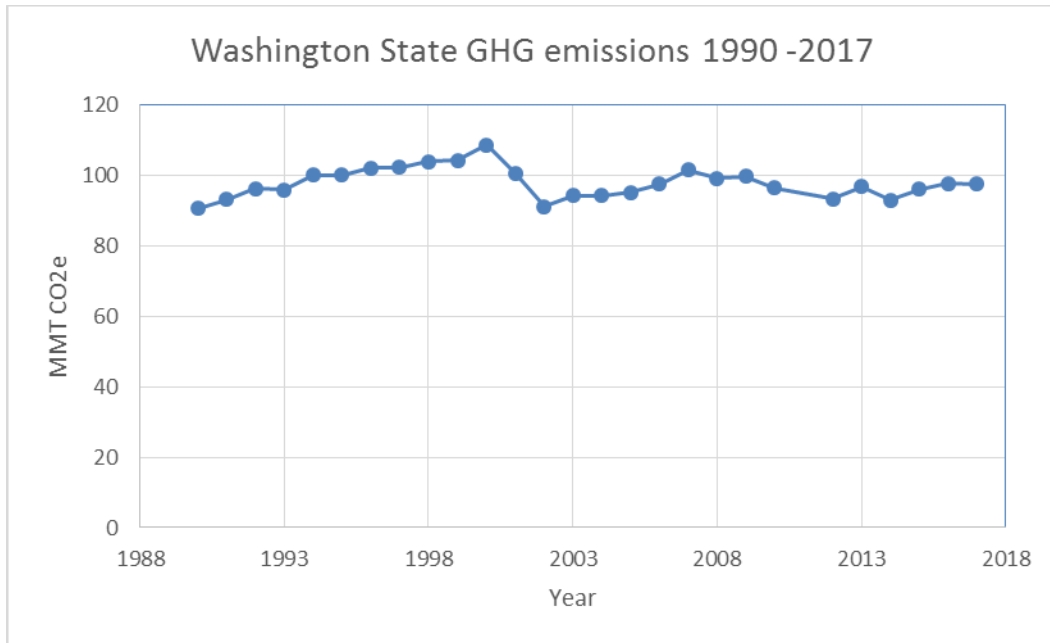


Figure 10: Washington State GHG emissions 1990-2017

Source: Washington Department of Ecology

Washington’s emission profile is somewhat different from that of the U.S. and many other states. Historically, U.S. emissions have been dominated by electricity generation, but in 2017 for the first time transportation emissions (28.9% of total U.S. emissions) outpaced power emissions (27.7% of total U.S. emissions).³³ By contrast, transportation emissions have always dominated Washington’s emission profile, constituting 45% of total statewide emissions in 2017. The primary reason for this difference is that the dominant source of electricity in Washington is hydropower.

³³ U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 - 2017.

Recommendations for Washington State

This report provides an overview of current climate science, the likely current and future impacts to Washington from further warming, greenhouse gas emission trends, and global and domestic emission reduction targets.

After careful evaluation of the scientific evidence, Ecology reached the conclusion that the state's greenhouse gas reduction limits should be strengthened, new interim milestones should be created and a carbon neutral or net zero carbon target should be established.

In developing its recommendations, Ecology considered three key questions:

1. Should Washington's emission limits be modified to better reflect current science and address our state's fair share of emission reductions relative to the suggestions provided by the IPCC and to the emission limits that similar jurisdictions have committed to meet?
2. Are the current target years still appropriate?
3. Should a carbon neutrality goal be established?

Recommendations on adequacy of the current limits

The recent IPCC Special Report¹⁵, *Global Warming of 1.5°C* describes the expected global impacts of warming and the University of Washington's Climate Impacts Group's brief, *No Time to Waste*, relates climate warming impacts specifically to Washington State. These documents emphasize the sense of urgency to act.

The SR15 report proposes various greenhouse gas emission reductions pathways, all requiring much more aggressive reductions than those currently in Washington statute. Washington's current greenhouse gas emissions limits should be strengthened to meet the urgent challenge of climate change. Ecology's recommended limits for Washington State, listed earlier in Table 3, meet the criteria and direction outlined in the SR15 report, most closely aligning with Pathway 2. Those proposed limits are repeated below.

- By 2020, reduce overall emissions of greenhouse gases in the State to 1990 levels
- By 2030, reduce greenhouse gas emissions in the State to 45% below 1990 levels
- By 2040, reduce greenhouse gas emissions in the State to 70% below 1990 levels
- By 2050, reduce greenhouse gas emissions in the State to 95% below 1990 levels and achieve net zero greenhouse gas emission in the State

Recommendation on target years

Ecology recommends changing the current 2020, 2035 and 2050 limit years by introducing targets for 2030 and 2040 and removing the 2035 target.

Ecology recommends keeping the 2020 limit given the need to reduce emissions earlier rather than later. Ecology also recommends keeping a 2050 limit, which is consistent with the Intergovernmental Panel on Climate Change's recommendation that substantial emission reductions need to be achieved by the middle of the century to provide a cost-effective pathway to limit warming by 2100.

The IPCC also stresses the importance of emission reductions prior to 2050, and that earlier emission reductions are both more cost-effective and increase the likelihood of limiting warming to 2°C or less by the end of the century. The addition of limits for 2030 and 2040 would create a series of 10-year windows that allow for policy adjustments and keep the pending targets more visible. They also better align with recently enacted legislation, including from the Laws of 2019: Chapter 109 (transportation electrification), Chapter 284 (hydrofluorocarbons), Chapter 285 (energy efficiency), Chapter 287 (green transportation), and Chapter 288 (clean energy transformation). Establishing limits for 2030, 2040, and 2050 would be consistent with monitoring the success of those policies and allow for changes or additions, as necessary.

Recommendation on a carbon neutrality limit

Ecology recommends adding a new concept, to achieve net zero greenhouse gas emissions in the State by 2050. To provide consistency in meaning, we rely on SR15, where carbon neutrality is synonymous with “net zero emissions,” defined as:

“Net zero emissions are achieved when anthropogenic emissions of greenhouse gases to the atmosphere are balanced by anthropogenic removals over a specified period.”³⁴

Anthropogenic removals include “enhancement of biological or geochemical sinks and direct air capture and storage.”³⁵ The addition of the ‘net zero’ language recognizes the full suite of strategies, from emissions reductions to carbon sequestration, necessary to keep warming in check and stabilize the climate. The SR15 makes clear that success requires carbon neutrality and significant carbon removal, or negative emissions, beyond 2050. To align with IPCC, Ecology recommends the inclusion of net zero greenhouse gas emissions by 2050.

³⁴ IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.) pg. 555

³⁵ Ibid pg. 24