



DEPARTMENT OF  
**ECOLOGY**  
State of Washington

# **Washington Greenhouse Gas Emission Reduction Limits**

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*Report prepared under RCW 70.235.040*

*by  
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Washington State Department of Ecology  
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# Executive Summary

Washington has long recognized the urgent threat anthropogenic climate change poses to our state's economic well-being, public health, natural resources, and environment. In 2008, the Washington Legislature recognized the severity of this threat, and established limits on the state's greenhouse gas emissions in state law. The Legislature further required the Department of Ecology (Ecology) to review these limits and make recommendations regarding revisions using the best available science from the University of Washington's Climate Impacts Group (CIG).

Ecology published the last report regarding the state of climate science and the sufficiency of the greenhouse gas emission limits in 2014.<sup>1</sup> In that report, Ecology acknowledged that the limits currently in state law needed to be revised to reflect the latest scientific findings, but did not recommend specific changes. Instead, Ecology recommended waiting until the negotiations at the United Nations climate conference in December 2015 were concluded to allow the results of that process to inform our recommendation. This report updates Ecology's December 2014 report and provides our recommendation on revised greenhouse gas emission limits.

## Climate change is affecting Washington

As discussed in our December 2014 report, climate science has continued to advance since Washington established greenhouse gas emission limits in 2008. Today, we better understand both the impacts from climate change we are already seeing in our state and what we can expect if we fail to act to limit greenhouse gas emissions.

Our December 2014 report summarized some of the long-term impacts Washington is already experiencing that are consistent with what is expected as a result of climate change. These impacts include sea level rise, an increase in ocean acidification, long-term warming trends, and decline of snowpack and glaciers. In November 2015, the University of Washington's Climate Impacts Group (CIG) published their State of Knowledge Report,<sup>2</sup> which further details impacts and trends being experienced in the Pacific Northwest. Ecology asked CIG to review and update data from the report to inform our recommendation on revised greenhouse gas emission limits. CIG's update finds additional evidence supporting trends that will affect Washington's economy and environment, including long-term warming, reduction in snowpack and glaciers, and increases in ocean acidification.

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<sup>1</sup> Washington Department of Ecology, 2014, Washington Greenhouse Gas Emission Reduction Limits, Publication no. 14-01-006, <https://fortress.wa.gov/ecy/publications/SummaryPages/1401006.html> (accessed 12/15/16).

<sup>2</sup> Mauger et. al., 2015, State of Knowledge: Climate Change in Puget Sound, Climate Impacts Group, <https://cig.uw.edu/publications/state-of-knowledge-climate-change-in-puget-sound/> (accessed 12/15/16).

## Greenhouse gas reduction limits in Washington

In 2008, the Washington State Legislature set greenhouse gas emission reduction limits for three timeframes: 2020, 2035, and 2050.<sup>3</sup> The limits were set consistent with limits that other states were considering at that time, and in accordance with what was thought necessary to stabilize global carbon levels in the atmosphere by the end of the century. Considerations for the limits included the appropriateness of Washington's fair share of reductions, given our clean power sector relative to other states and industrialized countries that are reliant on gas and coal-fired power.

In 2014, the Intergovernmental Panel on Climate Change (IPCC) issued its 5<sup>th</sup> Assessment Report (AR5) updating the current global understanding of climate impacts and future projections. Unlike the IPCC's 4<sup>th</sup> Assessment Report (AR4), which suggested emission reductions in the range of 80 – 95 percent compared to 1990 levels by 2050 would be necessary for most industrialized countries to prevent dangerous climate change, AR5 stops short of recommending specific emission reduction targets on a regional basis. Instead, AR5 suggests global emission reduction targets needed to limit warming by the end of the century for different scenarios, with:

- 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.<sup>4</sup>

In establishing limits for specific jurisdictions and fair share contributions, AR5 stresses that such a decision is inherently a question of policy and should factor in how much a particular jurisdiction has already emitted, steps taken to reduce emissions, and economic development concerns.

More recently, a historic agreement was reached in 2015 at the 21<sup>st</sup> 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. The U.S. pledged a reduction in greenhouse gas emissions of 26 – 28 percent relative to 2005 levels by 2025.

While the Paris agreement represents a substantial step toward addressing climate change globally, it is important to note that 1) there is no enforcement mechanism to ensure that each country meets its pledged emission reductions, and 2) even if all the pledged contributions required by the Paris agreement were met, the combined contributions would still be insufficient to meet the goals limiting global temperature increases.<sup>5</sup>

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<sup>3</sup> Engrossed Second Substitute House Bill 2815, Chapter 14, Laws of 2008. Codified in RCW 70.235.020

<sup>4</sup> The terms “likely” and “more likely than not” indicate IPCC's level of confidence in the result of a given modeled scenario.

<sup>5</sup> United Nations Framework Convention on Climate Change (UNFCCC), 2016, Report of the Conference of the Parties on its twenty-first session, UNFCCC/CP/2015/10/Add. 1, Decision 1/CP.21, Article 17.

Given the urgency to take action, Ecology looked to the AR4 and AR5 guidance, the impact of the U.S. pledge in the Paris Agreement, the likelihood that anthropogenic climate change will negatively impact Washington's economy and environment, and the emission limits adopted by similar jurisdictions when we evaluated revisions to the Washington greenhouse gas emission limits.

## 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, in recent years 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 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 need to be strengthened to reflect current science, and to align with the limits that other jurisdictions are setting to combat climate change.

Given the need to stabilize atmospheric carbon in a way that limits global temperature increases to below 2°C, and preferably below 1.5°C, Ecology recommends adjusting the current state limits.

### 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.<sup>6</sup>

### Recommended limits:

- By 2020, reduce overall emissions of greenhouse gases in the State to 1990 levels.
- By 2035, reduce overall greenhouse gas emissions in the state to 40 percent below 1990 levels.
- By 2050, reduce overall greenhouse gas emissions in the state to 80 percent below 1990 levels.

This recommendation is consistent with limits that other industrialized jurisdictions that are committed to addressing climate change are pursuing.

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<sup>6</sup> RCW 70.235.020(1)(a).

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# Introduction and Purpose of the Report

In 2007, former Governor Gregoire established goals for greenhouse gas emissions limits for Washington State through Executive Order 07-02.<sup>7</sup> The statewide goals were adopted into law in 2007 by passage of Engrossed Substitute Senate Bill 6001 (Chapter 80.80 RCW). When enacting the statewide goals, the Legislature stated in section 1(b) that:

*Washington's greenhouse gas emissions are continuing to increase, despite international scientific consensus that worldwide emissions must be reduced significantly below current levels to avert catastrophic climate change.*<sup>8</sup>

In 2008, with the enactment of the Limiting Greenhouse Gas Emissions Act (Chapter 70.235 RCW), the goals were adopted as *limits* that the Legislature expected Washington to achieve statewide by 2020, 2035, and 2050.

The greenhouse gas emissions limits established in RCW 70.235.020 are the same as those adopted in Executive Order 07-02 and RCW 80.80.020 (2007):

*The State shall limit emissions of greenhouse gases to achieve the following limits for Washington State:*

- *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.*<sup>9</sup>

The Legislature recognized that scientific understanding of the causes and consequences of climate change was rapidly expanding, and the 2008 legislation required Ecology to periodically report to the Legislature. The statute required Ecology to summarize climate science and make recommendations regarding Washington's statutory greenhouse gas emissions limits. Specifically, RCW 70.235.040 states that:

*Within eighteen months of the next and each successive global or national assessment of climate change science, the department shall consult with the climate impacts group at the University of Washington regarding the science on human-caused climate change and provide a report to the legislature summarizing that science and make recommendations regarding whether the greenhouse gas emissions reductions required under RCW 70.235.020 need to be updated.*<sup>10</sup>

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<sup>7</sup> Executive Order 07-02, 2007, Washington Climate Change Challenge, [http://www.governor.wa.gov/sites/default/files/exe\\_order/eo\\_07-02.pdf](http://www.governor.wa.gov/sites/default/files/exe_order/eo_07-02.pdf), (accessed 12/15/16).

<sup>8</sup> RCW 80.80.005(1)(b).

<sup>9</sup> RCW 70.235.020(1)(a).

<sup>10</sup> RCW 70.235.040.

Ecology prepared a report in response to the legislative requirement in December 2014.<sup>11</sup> At the time, Ecology recognized that the current limits in statute needed to be strengthened to better reflect current scientific understanding of the amount of emission reduction required to stabilize levels of carbon dioxide in the atmosphere and slow the rate of warming. However, Ecology declined to make specific recommendations in light of the upcoming United Nations climate negotiations in Paris in December 2015. Delaying issuing limit recommendations allowed for the results of the climate negotiations to better inform our recommendation. This report updates the December 2014 report and provides a summary of observed and projected climate impacts globally and in the Pacific Northwest. Our summary was informed by the most current science; an overview of the greenhouse gas emission reduction limits imposed by other jurisdictions, and provides recommendations to strengthen the statutory greenhouse gas emission limits established in RCW 70.235.020.

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<sup>11</sup> Washington Department of Ecology, 2014, Washington Greenhouse Gas Emission Reduction Limits, Publication no. 14-01-006, <https://fortress.wa.gov/ecy/publications/SummaryPages/1401006.html> (accessed 12/15/16).

# Summary of Recent Advances in Climate Science

## Global impacts

As described in Ecology's December 2014 report, the Intergovernmental Panel on Climate Change (IPCC) has become increasingly certain about the role of anthropogenic climate change and the resulting impacts on the environment. In 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."<sup>12</sup> Current atmospheric concentrations of carbon dioxide are "unprecedented in at least the last 800,000 years."<sup>13</sup> 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."<sup>14</sup> Examples of this warming include the fact that 1983 – 2012 was likely the warmest 30-year period in the last 1,400 years, and that annual mean Arctic sea ice has decreased in the range of 3.5 – 4.1 percent per decade since 1979.<sup>15</sup>

Given this background and the projected continued increase of surface temperatures, the IPCC predicts that:

*It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea levels to rise.*<sup>16</sup>

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<sup>12</sup> 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.)]. IPCC, Geneva, Switzerland, Summary for Policy Makers, SPM1, [https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5\\_SYR\\_FINAL\\_SPM.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf) (accessed 12/15/16).

<sup>13</sup> Ibid. at SPM 1.2.

<sup>14</sup> Ibid. at SPM 1.1.

<sup>15</sup> Ibid.

<sup>16</sup> Ibid. at SPM 2.2.

## Impacts in the Pacific Northwest

Climate change at the global level will have specific 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 Washington State. Those reports include the *Washington State Climate Change Impacts Assessment* (2009),<sup>17</sup> and *Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers* (2013).<sup>18</sup> In 2015, CIG published a report summarizing the current state of knowledge regarding observed and likely future climate impacts in the Puget Sound area.<sup>19</sup> This report described key climate-related factors driving change, including temperature, heavy rainfall, declining spring snowpack, sea level rise, higher storm surge reach, and ocean acidification. Specific findings of projected changes include:

- **Increases in average annual temperatures:** By the mid-century mark, average annual temperatures are predicted to be 2.9 – 5.4°F warmer under a low greenhouse gas emissions scenario and 5.5 – 7.1°F warmer under a high greenhouse gas emissions scenario, compared to 1970 – 1999. This warming is projected to lead to increases in stream and river temperatures, with Puget Sound rivers projected to increase 4.0 – 4.5°F by the 2080s compared to 1970 – 1999. Those temperatures could be incompatible with cold-water fish species such as salmon.<sup>20</sup> Water temperatures are also projected to rise in Puget Sound itself and in the Northeast Pacific Ocean.<sup>21</sup>
- **Declining spring snowpack:** By the 2040s, April 1<sup>st</sup> snowpack is predicted to be 6 to 47 percent less than during 1970 – 1999, depending on the greenhouse gas emissions scenario used.
- **Increases in sea level:** By 2050, there is projected to be a 6.5 inch rise in relative sea level in Seattle compared to 2000. This translates to projected increases in flooding in some major floodplains, including the Skagit and Snohomish rivers.<sup>22</sup>

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<sup>17</sup> Climate Impacts Group, 2009, The Washington Climate Change Impacts Assessment. M. McGuire Elsner, J. Littell, and L. Whitely Binders (eds), Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, <https://cig.uw.edu/publications/the-washington-climate-change-impacts-assessment/> (accessed 12/15/16).

<sup>18</sup> Snover et. al., 2013, Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers, Report prepared for the Washington State Department of Ecology, Climate Impacts Group, University of Washington, Seattle, <https://cig.uw.edu/publications/climate-change-impacts-and-adaptation-in-washington-state-technical-summaries-for-decision-makers/> (accessed 12/15/16).

<sup>19</sup> Mauger et. al., 2015, State of Knowledge: Climate Change in Puget Sound, Climate Impacts Group, <https://cig.uw.edu/publications/state-of-knowledge-climate-change-in-puget-sound/> (accessed 12/15/16).

<sup>20</sup> Ibid. p. 3-8.

<sup>21</sup> Ibid. p. 7-3.

<sup>22</sup> Ibid. p.3-7.

When evaluating recommendations for revised greenhouse gas emission limits, Ecology asked CIG to review any changes or updates to the state of climate science in Washington since the group issued the 2015 state of knowledge report. CIG provided a summary of observed trends in climate variables or physical indicators of climate impacts. Significant trends observed include the long-term warming seen in Figure 1, with annual temperatures in Washington warming 0.15°F per decade since 1895 (orange line), which then increased to a 0.30°F increase per decade starting in 1950 as illustrated by the grey line in Figure 1.

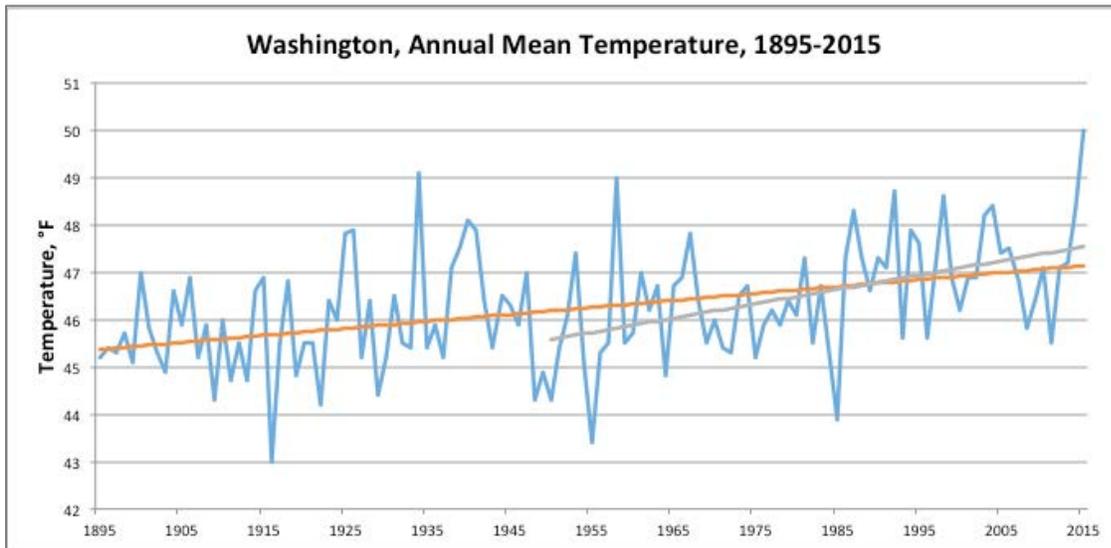


Figure 1: Washington Annual Mean Temperature Trend

Source: Monthly and Annual Temperatures for Climate Divisions and the State, Climate at a Glance, NOAA (<http://ncdc.noaa.gov/cag/>)

Washington also suffered a substantial loss of snowpack mass in glaciers during the 20<sup>th</sup> century, shown in Figure 2 below. Similarly, Washington is experiencing long-term, sea level rise everywhere but Neah Bay. Sea level rise ranges from 0.05 inches per decade to 0.79 inches per decade depending on the rate of subsidence or uplift due to plate tectonics. Concurrently, ocean acidification is increasing and projected to continue to increase. The pH of Northeast Pacific Ocean surface waters decreased by -0.1, corresponding to a 26-percent increase in the hydrogen ion concentration since the pre-industrial era (since about 1750), and by -0.027 from 1991 to 2006.<sup>23</sup> In addition, 20 – 25 percent of the pteropods (free swimming sea snails that comprise a critical part of the marine food web along the west coast of the continental U.S.) are experiencing dissolution of their shells because of anthropogenic increases in ocean acidity, compared to pre-industrial conditions.<sup>24</sup>

<sup>23</sup> Byrne, R.H. et al., 2010, Direct observations of basin-wide acidification of the North Pacific Ocean, *Geophys. Res. Letts.*, 37(2), L02601 Cited in Puget Sound Knowledge Report

<sup>24</sup> Feely et al, 2016, Chemical and biological impacts of ocean acidification along the west coast of North America, *Estuarine, Coastal, and Shelf Science*, 183, Part A, 26—270.

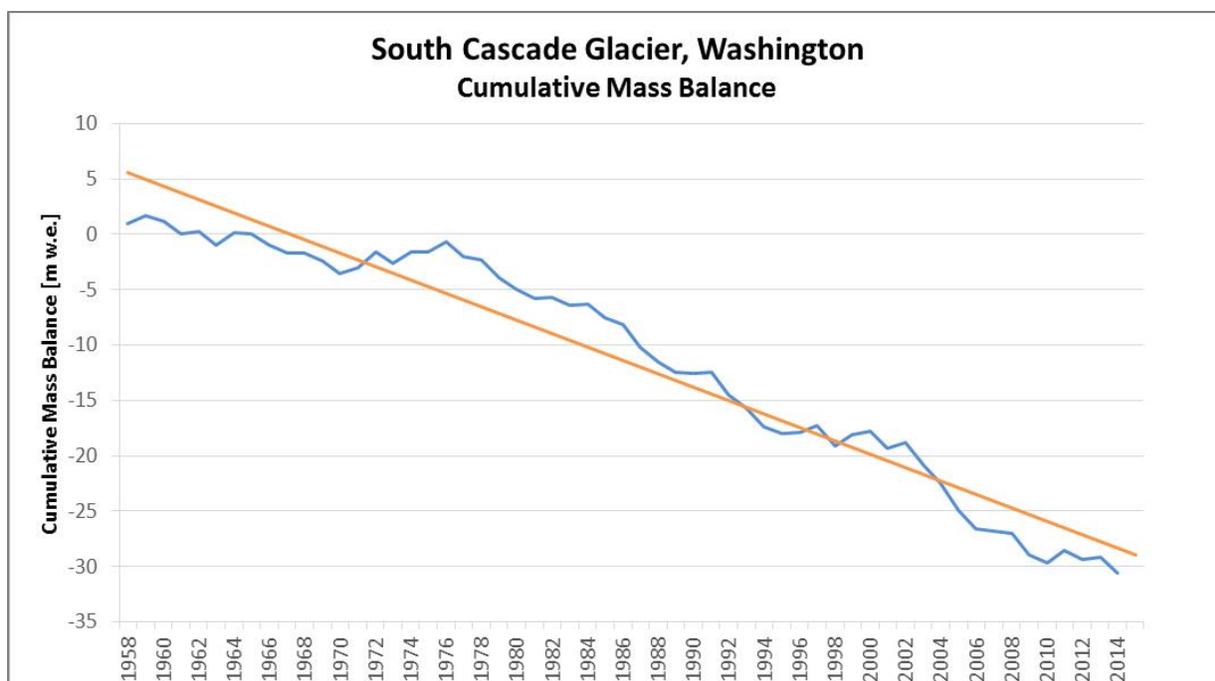


Figure 2: Loss of Mass in South Cascade Glacier, 1958-2015

Source: USGS, [https://www.epa.gov/sites/production/files/2016-08/glaciers\\_fig-2.csv](https://www.epa.gov/sites/production/files/2016-08/glaciers_fig-2.csv).

While there are other drivers to these trends besides human-caused climate change, these trends are important in evaluating what our future could look like in the Pacific Northwest and globally if the level of greenhouse gases in the atmosphere continues to increase at its current pace.

These types of impacts are particularly damaging to Washington State. For example, salmon die-off in the Columbia River was observed in the summer of 2015<sup>25</sup> because of warmer water temperatures. A continuation of the long-term warming trend will result in warmer in-stream water temperatures. Warmer ocean temperatures will increase the likelihood of harmful algal blooms also known as “red tides.”

These blooms damage ecosystems and increase toxins in shellfish, leading to greater public health risks.<sup>26</sup> Warmer air temperatures combined with a loss of snowpack will contribute to wildfires and drought, much like the historic fires and drought observed in 2014 and 2015. Sea level rise impacts coastal residents through increased flooding from storm surges, particularly impacting coastal tribal villages. And, ocean acidification upsets the chemistry of coastal waters, dissolving and hindering the formation of shells for shellfish.

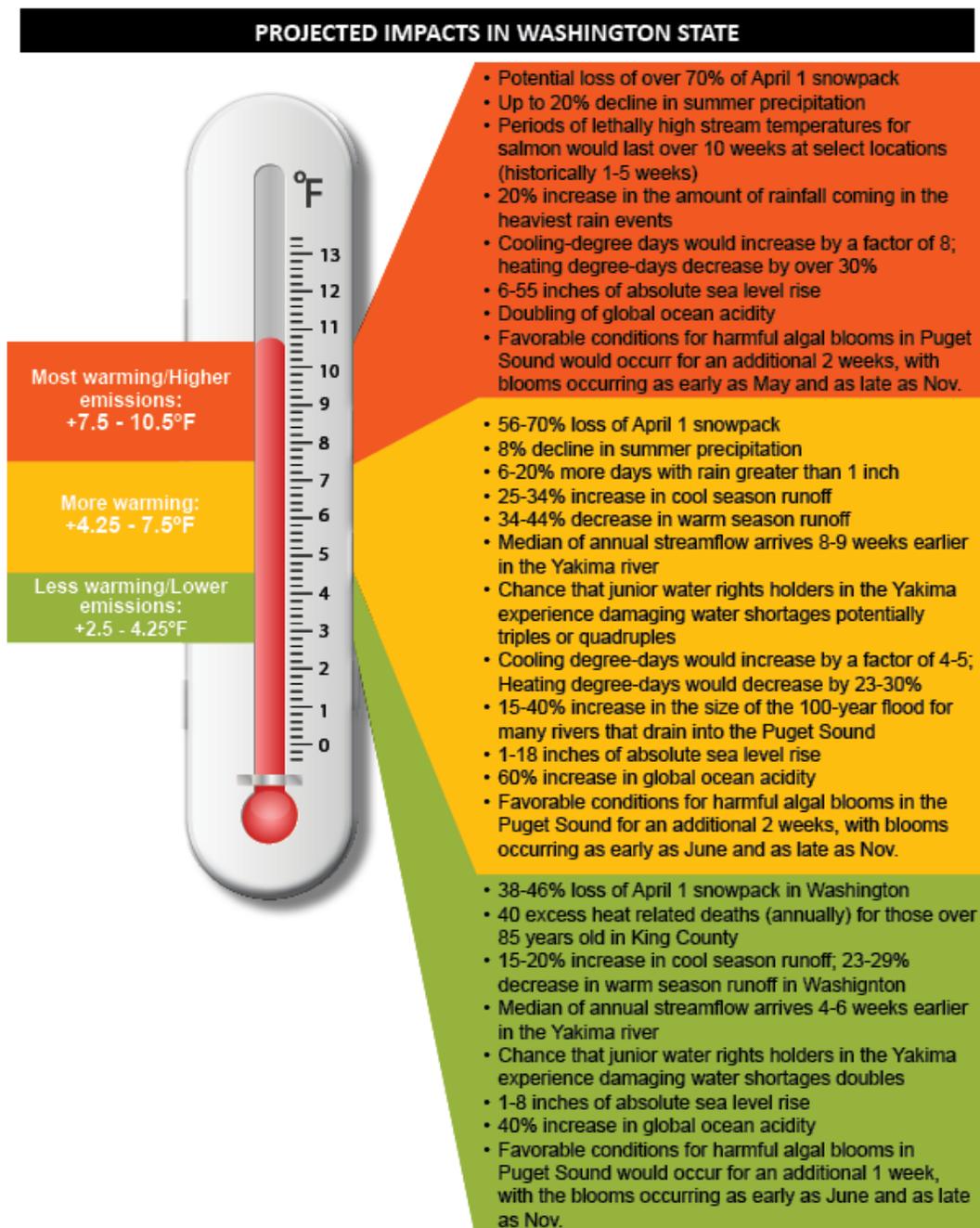
<sup>25</sup> Northwest Power Council, 2015, “Warm Water Blamed for Huge Columbia River Sockeye Die-Off,” <https://www.nwcouncil.org/news/blog/sockeye-die-ff-july-2015/> (accessed 12/15/16).

<sup>26</sup> Mauger et. al., 2015, p.7-4.

As indicated by Figure 3, at the higher ranges of warming temperatures, Washington will face significant impacts to snowpack, water supplies, salmon mortality, and ocean acidity. Extreme weather such as heavy rainfall events increase the risk of flooding.

If global emissions continue to grow in a business-as-usual fashion, Washington is projected to experience the “green” conditions in the coming decades, the “yellow” conditions around the mid-21st-century, and the “red” conditions toward the end of the 21st-century. Reducing emissions, in Washington and around the world, can delay or prevent greater levels of warming.

Figure 3: Projected impacts of global greenhouse gas concentration scenarios <sup>i</sup>



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# Current Trends in Greenhouse Gas Emissions

## Global and national trends

As discussed in Ecology's December 2014 report, global emissions of carbon dioxide increased rapidly in the last half of the 20<sup>th</sup> century, and sharply increased beginning about 1990, as illustrated in Figure 4 below. Over the past decade, global carbon dioxide emissions increased at an average rate of 4 percent per year.<sup>27</sup> This rate slowed to about 1 percent per year in 2012 and 2013, and effectively flattened out in 2014, increasing only 0.5 percent compared to 2013 emissions.<sup>28</sup>

While economic and population growth have historically been responsible for driving increases in emissions, that trend changed starting in 2013, when the rate of carbon dioxide emissions increase slowed relative to economic and population growth.<sup>29</sup> The slowing of carbon dioxide emissions is thought to be mostly because of:

- Decrease in global per capita energy consumption, driven mainly by warm winter conditions in 2014 and a slowing in the rate of growth of power generation.
- Increase in penetration of renewable and lower carbon forms of power generation.<sup>30</sup>

Despite these promising trends, we will need to do more to slow or stabilize growth of emissions to minimize the risks of warming.

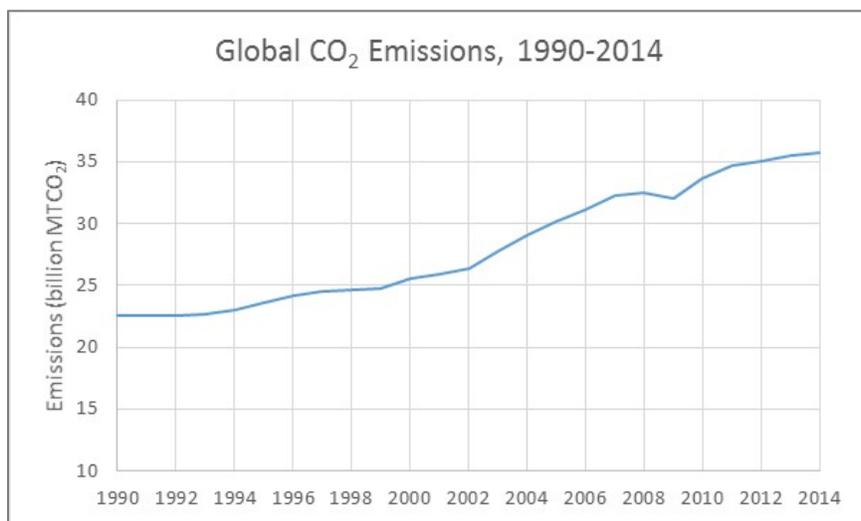


Figure 4: Global CO<sub>2</sub> Emissions, 1990 - 2014

Source: European Commission, Joint Research Centre, Emissions Database for Global Atmospheric Research (EDGAR).<sup>31</sup>

<sup>27</sup> Olivier J.G.J. et al., 2015, Trends in global CO<sub>2</sub> emissions; 2015 Report, The Hague: PBL Netherlands Environmental Assessment Agency; Ispra: European Commission, Joint Research Centre, [http://edgar.jrc.ec.europa.eu/news\\_docs/jrc-2015-trends-in-global-co2-emissions-2015-report-98184.pdf](http://edgar.jrc.ec.europa.eu/news_docs/jrc-2015-trends-in-global-co2-emissions-2015-report-98184.pdf) (accessed 12/15/16).

<sup>28</sup> Ibid.

<sup>29</sup> Ibid. For example, global economic growth increased by 3% in 2014 relative to 2013, while carbon dioxide emissions increased 0.5% over the same period.

<sup>30</sup> Ibid.

<sup>31</sup> 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

China leads the world in producing carbon dioxide emissions, followed by the U.S., the European Union, India, Russia, and Japan. See Figure 5 below. In 2014, China was responsible for 30 percent of global carbon dioxide emissions, with the U.S. contributing 15 percent, the European Union 10 percent, and India 6.5 percent. The share of emissions increased slightly for both China and the U.S. compared to 2013 data, which found the two nations were responsible for 28 percent and 14 percent of global carbon dioxide emissions, respectively.

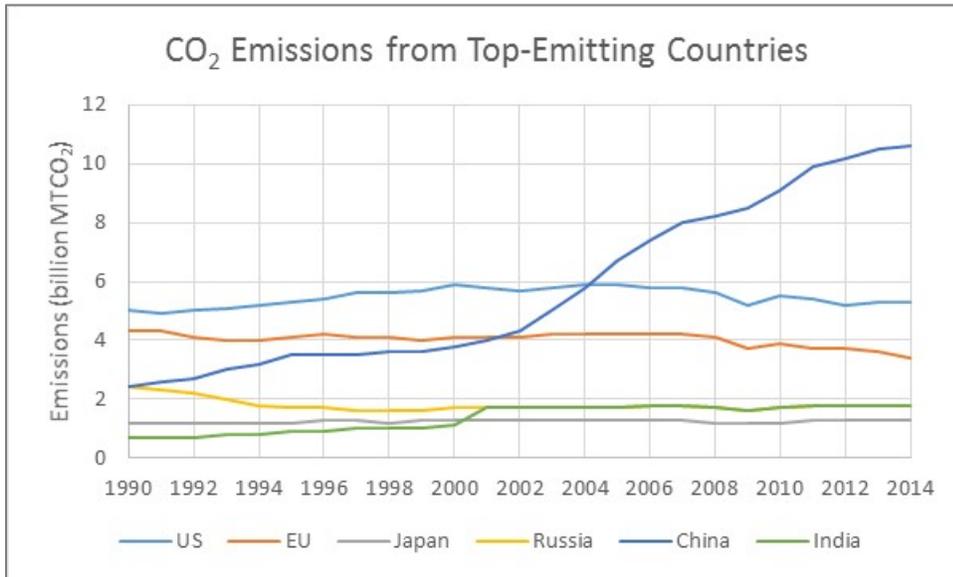


Figure 5: CO<sub>2</sub> Emissions from Top-Emitting Countries 2014

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

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 per capita carbon dioxide emissions. As illustrated in Figure 6 below, U.S. per capita carbon dioxide emissions were almost triple the global average, and more than double that of the European Union, which has the second highest per capita carbon dioxide emissions.

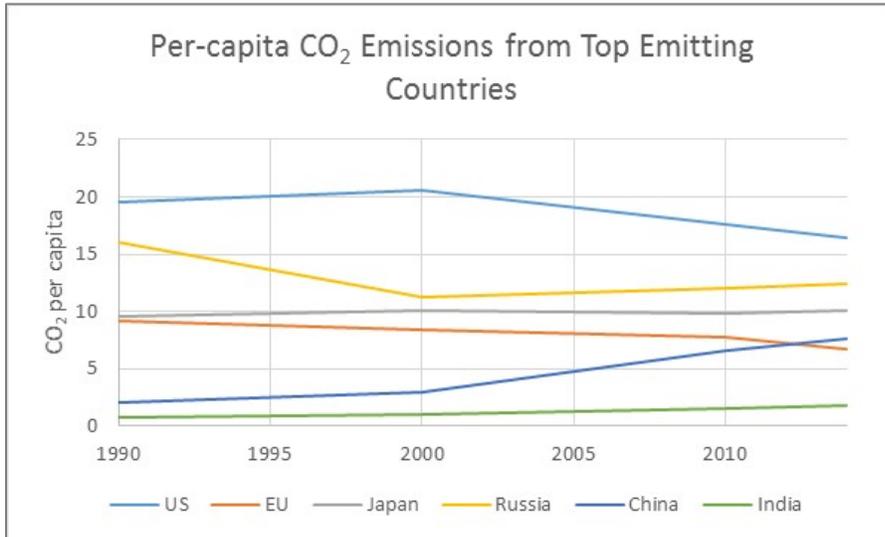


Figure 6: Per-capita CO<sub>2</sub> Emissions from Top Emitting Countries

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

China’s per capita carbon dioxide emissions are up 262 percent since 1990. In the U.S., per capita carbon dioxide emissions have been declining since 2000, and are down 16 percent since 1990.

In keeping with the sharp increase in annual carbon dioxide emissions beginning in the mid-20<sup>th</sup> century, global concentrations of greenhouse gases have increased to an unprecedented level.<sup>32</sup> Atmospheric carbon dioxide levels have increased 40 percent above the pre-industrial level of 270 parts per million. In 1958, the total atmospheric concentration of carbon dioxide measured at the National Oceanic and Atmospheric Administration’s monitoring station in Mauna Loa, Hawaii, was 316 parts per million. Starting in 2015, that level averaged over 400 parts per million and continues to increase. Note that the scenario modeled by Intergovernmental Panel on Climate Change to limit warming to under 2°C assumes maintaining atmospheric concentrations of carbon dioxide of 450 parts per million or lower.

<sup>32</sup> Refer to Ecology’s December 2014 report for a full discussion.

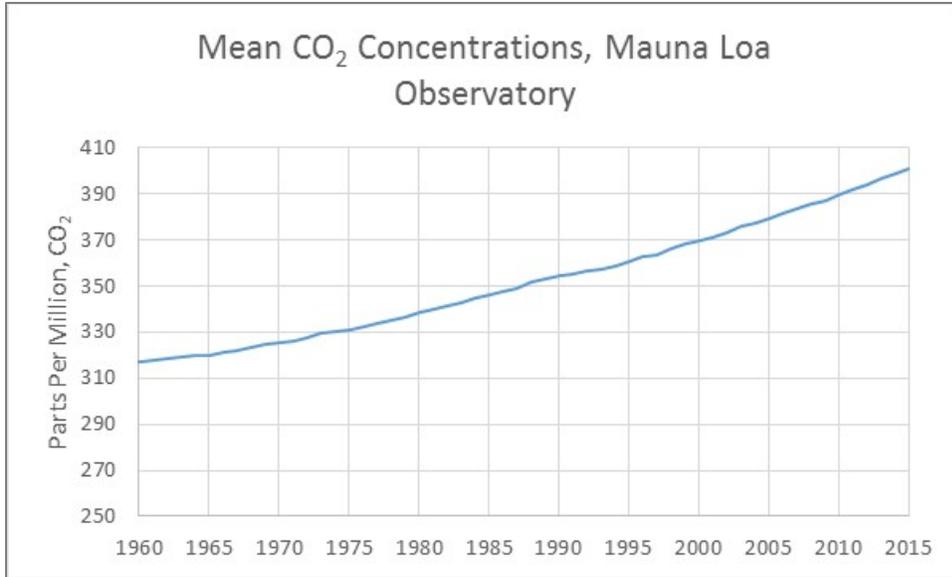


Figure 7: Mean CO<sub>2</sub> Concentration, Mauna Loa Observatory

Source: [NOAA Earth Research Systems Laboratory, Global Monitoring Division, November, 2016.](#)

## The United States 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 slightly from 2007 to 2012, which is consistent with the economic downturn and increased use of natural gas to generate power.

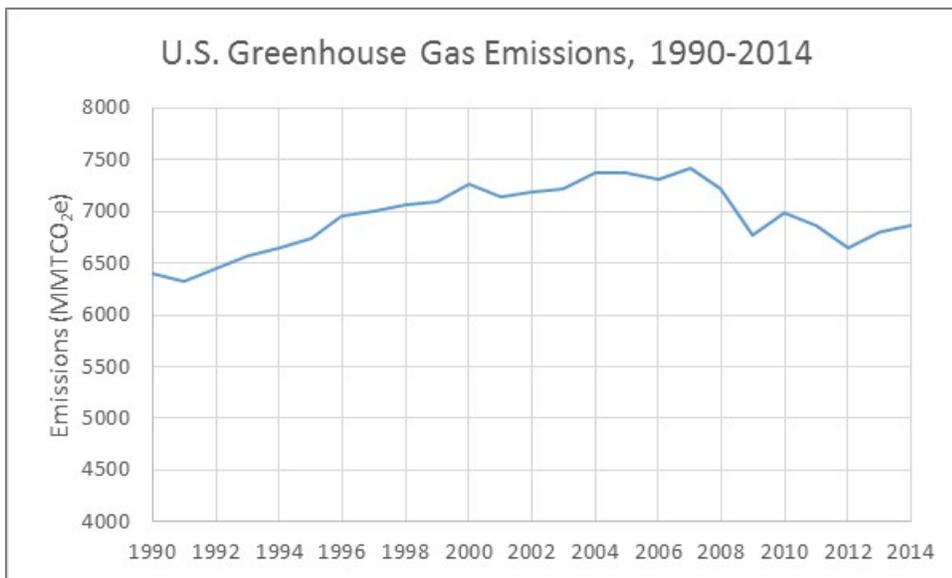


Figure 8: U.S. Greenhouse Gas Emissions, 1990-2014

Source: [U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2014.](#)

In 2013, Washington emitted 94.4 million metric tons of carbon dioxide equivalent (CO<sub>2</sub>e). That was 0.8 million metric tons of CO<sub>2</sub>e greater than the state's 2012 emissions.<sup>33</sup> As Figure 9 shows, Washington's emissions have been relatively flat over the past several years.<sup>34</sup> In terms of progress toward the greenhouse gas emission limits currently in statute, Washington is 6 million metric tons of CO<sub>2</sub>e, or 6.8 percent, higher than the 2020 emissions target.

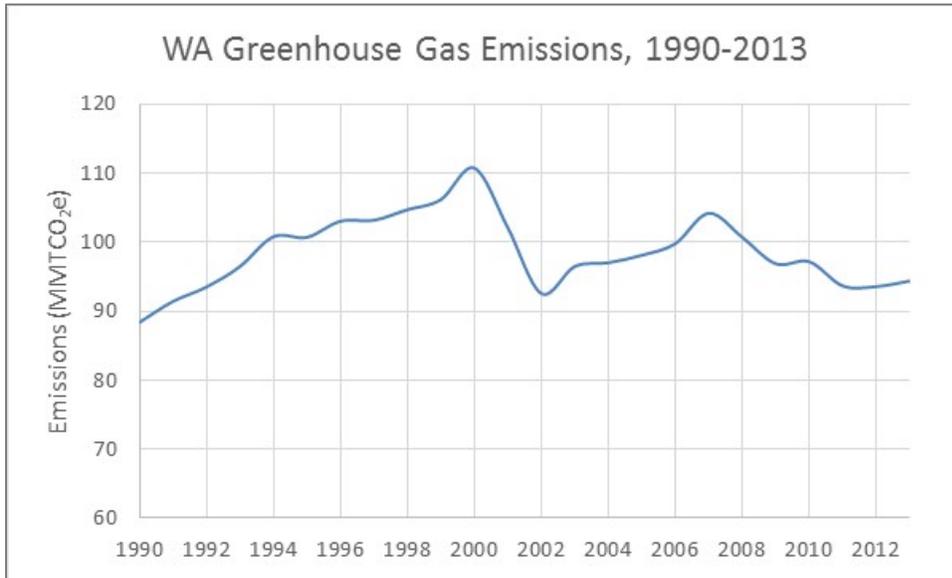


Figure 9: Washington Greenhouse Gas Emissions, 1990-2013

Source: [Washington A Greenhouse Gas Emissions Inventory, 1990-2010 – 2013](#).

<sup>33</sup> Washington Department of Ecology, 2016, Washington Greenhouse Gas Emissions Inventory: 2010-2013, Pub no. 16-02-025, <https://fortress.wa.gov/ecy/publications/SummaryPages/1602025.html> (accessed 12/15/16).

<sup>34</sup> The dip in emissions observed between 2000 and 2002 represents a downturn in Aluminum production, as well as a change in accounting methodologies.

While Washington is pursuing several initiatives to reduce greenhouse gas emissions, our current business as usual (BAU) projection shows that under existing state and federal policies, our state's emissions will only decline slightly and we are not on track to meet the limits set by the Legislature, as illustrated by Figure 10 below:

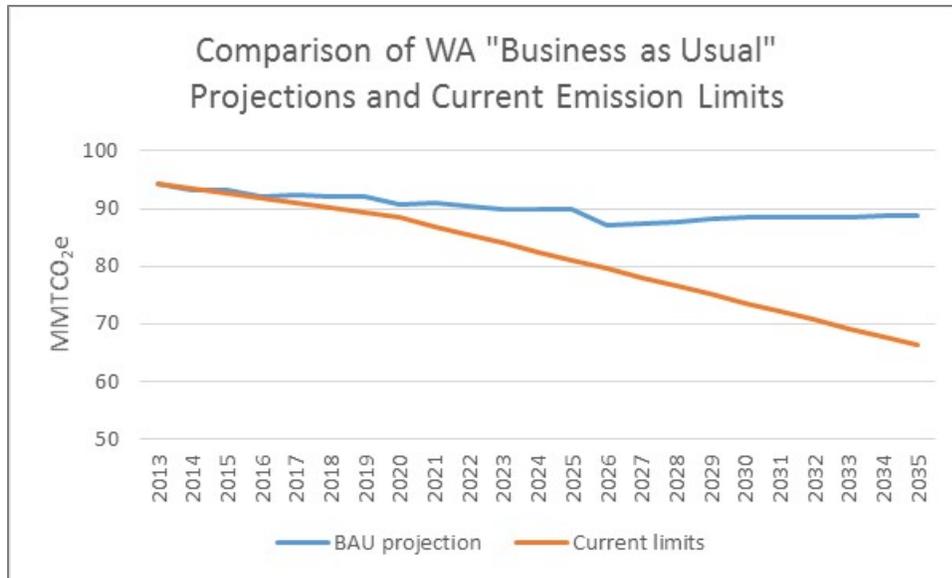


Figure 10: Comparison of WA "Business as Usual" Projections and Current Emissions Limits

Source: Washington Department of Ecology.

It is important to note that our current BAU projection for Washington State does not include anticipated emission reductions from the recently-adopted Clean Air Rule. The Clean Air Rule establishes an economy-wide cap on carbon emissions in Washington, and then requires companies and organizations covered by the cap to reduce their greenhouse gas emissions at a rate of 1.7 percent per year. Implementation of the Clean Air Rule is projected to reduce over 16 million metric tons of CO<sub>2</sub>e from 2013 levels by 2035.

While this is a substantial reduction, it is not included in the BAU projection because the Clean Air Rule allows for a variety of compliance options, including purchasing allowances from external carbon markets. External market allowances are associated with emission reductions that occur outside Washington State. So, until we have more information about how companies covered by the rule will comply and the proportion of their compliance obligation that will be met by external allowances, it is difficult to project the impact on Washington's emissions.

A key point in evaluating Washington's emission profile is that it is different from that of the U.S. and other states. In the U.S., emissions from the power sector are dominant, comprising 30 percent of total U.S. greenhouse gas emissions in 2014.<sup>35</sup> The second largest source of greenhouse gas emissions is transportation. By contrast, transportation emissions have dominated Washington's emission profile, making up 43 percent of total statewide greenhouse gas emissions in 2013. The main reason for this difference is that Washington has a relatively clean power sector, with substantial hydropower assets.

<sup>35</sup> U.S. EPA, 2016, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014, EPA 430-R-16-022, <https://www.epa.gov/ghgemissions/us-greenhouse-gas-inventory-report-1990-2014> (accessed 12/15/16).

# Emission Reduction Targets

## Recommendations from the IPCC 4<sup>th</sup> and 5<sup>th</sup> Assessments and the Paris Agreement

### Background on the Intergovernmental Panel on Climate Change and Process

The Intergovernmental Panel on Climate Change (IPCC) is an international body established in 1988 by the World Meteorological Organization (WMO) and the United National Environmental Programme (UNEP). Its purpose is to provide policy and decision makers with evaluations and updates to the current state of climate science, projections of likely future impacts, and recommendations for reducing emissions (mitigation) as well as ways to adapt to the impacts from climate change (adaptation). The scientists on the IPCC are from all 197 countries that are members, and it represents the consensus body on the state of climate science to inform negotiations at the United National Framework Convention on Climate Change (UNFCCC).

To date, the IPCC has completed five of these evaluations, called “assessment reports” or “assessments.” The most recent are the 4<sup>th</sup> and 5<sup>th</sup> Assessments (AR 4 and AR 5), completed in 2007 and 2014 respectively. The IPCC is currently working on its 6<sup>th</sup> Assessment; this is slated to be finalized in 2022.

The IPCC assessments provide key scientific information and data at a global level to inform decision makers involved in developing climate policy. It is important to note that the assessments are not intended to be prescriptive, but instead to provide a robust scientific basis regarding the state of climate science which decision makers would then weigh with other factors in developing climate policy.

A key objective in IPCC assessments is evaluating what it will take to stabilize atmospheric carbon levels. Stabilization refers to the concentration of global carbon emissions in the atmosphere required to reach a stable global temperature. In AR 4, the Intergovernmental Panel on Climate Change concluded that a carbon concentration of 450 parts per million would have at least a 50 percent chance of stabilizing global temperatures and limiting temperature increases to below 2°C.

Below, we provide key findings from AR 4 and AR 5 regarding emission reduction (mitigation) pathways needed to stabilize atmospheric carbon levels and limit global warming.

### Key mitigation findings from the 4th Assessment (AR4)

While AR 4 has now been superseded by the 5<sup>th</sup> Assessment (AR5), AR4 provided a level of detail regarding regional greenhouse gas emission limits to meet stabilization levels that is absent in AR5. These findings are helpful in framing a discussion for revised emission limits in Washington, particularly as it is clear that industrialized jurisdictions that have historically been the largest emitters of greenhouse gases should make far deeper cuts to their emission rates than global averages to meet their fair share.

In addition to looking at global scenarios, AR4 evaluated likely emission reductions at three different modeled emission stabilization concentrations for Annex I parties to the United National Framework Convention on Climate Change (industrialized) and non-Annex I countries.<sup>36</sup> To keep global carbon concentrations at a 450 parts per million scenario, industrialized countries should aim for a 25 – 40 percent reduction relative to 1990 levels by 2020, and an 80 – 95 percent reduction relative to 1990 levels by 2050.<sup>37</sup> For non-Annex I parties, AR 4 recommends “substantial deviation from baseline in Latin America, the Middle East, East Asia, and Centrally-Planned Asia” by 2020, with a “substantial deviation from baseline” for all parties by 2050. This reflects the IPCC’s recommendation that industrialized countries need to make a greater proportion of emission reductions compared to global averages in order to contribute their fair share of emissions and not disproportionately burden developing countries. This finding in AR4 was key in influencing many jurisdictions to adopt emission reduction targets of at least 80 percent by 2050, including the European Union, the U.S.<sup>38</sup>, and states such as California.

### **Key mitigation findings from the 5th Assessment (AR5)**

The 5<sup>th</sup> Assessment further supports the work of AR4. The 5<sup>th</sup> Assessment noted 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 reductions over the next few decades and near zero emissions of CO<sub>2</sub> and other long-lived greenhouse gases by the end of the century.*<sup>39</sup> In evaluating AR5 relative to AR4, it is important to note that AR5 uses an updated base year of 2010 to reference emissions, compared to the 1990 base year in AR4. This makes comparisons between the percentage emission reductions outlined in AR4 and AR5 difficult unless viewed in terms of actual tons of emissions.

According to the IPCC, “[m]itigation scenarios reaching about 450 or 500 parts per million CO<sub>2</sub>e by 2100 show reduced costs for achieving air quality and energy security objectives, with significant co-benefits for human health, ecosystem impacts and sufficiency of resources and resilience of the energy system.”<sup>40</sup>

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<sup>36</sup> Annex I covers 43 jurisdictions, including the U.S. For more detail, see

[http://unfccc.int/parties\\_and\\_observers/parties/annex\\_i/items/2774.php](http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php).

<sup>37</sup> Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007, B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Box 13-7, 13.3.3.3,

[https://www.ipcc.ch/publications\\_and\\_data/ar4/wg3/en/ch13-ens13-3-3-3.html](https://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch13-ens13-3-3-3.html) (accessed 12/15/16).

<sup>38</sup> The U.S. pledged a reduction of 83% below 2005 levels by 2050 in the Copenhagen Accord negotiated at the 15th Conference of Parties to the UNFCCC in 2009. See

[http://unfccc.int/files/meetings/cop\\_15/copenhagen\\_accord/application/pdf/unitedstatescphaccord\\_app.1.pdf](http://unfccc.int/files/meetings/cop_15/copenhagen_accord/application/pdf/unitedstatescphaccord_app.1.pdf) (accessed 12/15/16).

<sup>39</sup> 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.)]. IPCC, Geneva, Switzerland, Summary for Policy Makers, SPM 3.4,

[https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5\\_SYR\\_FINAL\\_SPM.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf) (accessed 12/15/16).

<sup>40</sup> IPCC, 2014: Climate Change 2014: Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlomer, s., von Stechow, C., Zwickel, T., Minx, J.C. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, SPM 1, [https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc\\_wg3\\_ar5\\_summary-for-policymakers.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policymakers.pdf) (accessed 12/15/16).

In AR5, the Intergovernmental Panel on Climate Change evaluated global emission reductions required to achieve three scenarios by 2100:

- 430 parts per million CO<sub>2</sub>e
- 450 parts per million CO<sub>2</sub>e
- 500 parts per million CO<sub>2</sub>e.

Those scenarios were associated with modeled results limiting global temperature increases to 1.5°C or 2°C by 2100, with varying degrees of confidence.

The 450 parts per million scenario is considered “likely” to limit global warming to below 2°C. This scenario is characterized by a 40 – 70 percent reduction in global atmospheric greenhouse gas emissions by 2050 compared to 2010.<sup>41</sup>

Increasing global concentrations to 500 parts per million makes it less likely to limit warming to 2°C than the 450 parts per million scenario, but still “more likely than not” to achieve that target. Meeting that scenario requires reducing global emission levels 25 to 55 percent by 2050, relative to 2010 levels.

The 430 parts per million scenario is aimed at limiting global temperature increases to 1.5 °C. While supported by a more limited number of studies than the previous two scenarios, the IPCC found that this concentration is “more likely than not” to limit warming by 1.5°C by 2100 relative to pre-industrial levels.<sup>42</sup> These modeled scenarios required global emission reductions between 70 – 95 percent by 2050 relative to 2010 levels.

A summary of these findings, along with what these emission reductions would look like if applied to Washington State in 2050, along with what our current greenhouse gas emission reduction limits require are in Table 1 below.

Table 1: Summary of Key Mitigation Findings from the 5th Assessment (AR5)

<b>AR5 Global CO<sub>2</sub>-eq Concentration Target</b>	<b>Projected limits on warming in 2100<sup>43</sup></b>	<b>Global Emission Reduction Targets by 2050</b>	<b>Global Emission Targets Applied to WA (MMTCO<sub>2</sub>e/yr)</b>	<b>Current WA GHG Limits in Law for 2050 (MMTCO<sub>2</sub>e/yr)</b>
Below 430 ppm	More likely than not below 1.5°C	70-95% below 2010 levels	4.8-28.9	44.2
450 ppm	Likely below 2°C	40-70% below 2010 levels	28.8-57.7	
500 ppm	More likely than not below 2°C	25-55% below 2010 levels	43.2-72.1	

Source: Intergovernmental Panel on Climate Change’s 5<sup>th</sup> Assessment; Department of Ecology calculations.

<sup>41</sup> Ibid.

<sup>42</sup> Pre-industrial levels are considered global temperatures from the 1850-1900 timeframe, corresponding to approximately 270 ppm CO<sub>2</sub>e.

<sup>43</sup> 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.

Note that unlike AR4, AR5 provides guidance on global emission reductions that are needed to limit warming under different scenarios. The IPCC declined to provide specific recommendations at a regional level. This is likely because the IPCC did not intend the work to provide absolute recommendations to countries, given its finding that developing climate policy requires the weighing of multiple socioeconomic and ethical judgements, such as historic responsibility for emissions, resources and ability of a particular country to take action, per capita emission rates, and the need to provide a pathway forward for developing economies.<sup>44</sup> However, in terms of applying the findings of AR5 in revising national and subnational greenhouse gas emission reduction limits, they are useful in informing decisions, as they illustrate cost-effective steps to achieve ultimate limits on the amount of warming.

### **Need for an intermediate goal**

In addition to a long-term emission limit at 2050, there is a need for a more intermediate limit in order to increase the likelihood of achieving limits on increases in global temperature by 2100, as well as minimizing the cost impacts of the level of mitigation needed. “Delaying additional mitigation to 2030 will substantially increase the challenges associated with limiting warming over the 21<sup>st</sup> century to below 2°C relative to pre-industrial levels.” This delay will increase the pressure to make sharp emission reductions from 2030 to 2050, and will result in higher economic impacts.<sup>45</sup> Effectively, earlier reductions in greenhouse gas emissions are both cheaper and more effective than reductions made in the latter part of the century.

The Intergovernmental Panel on Climate Change did evaluate emission reduction scenarios by 2030 likely to achieve global concentrations of 430 – 530 parts per million CO<sub>2</sub>e, and further differentiated this by economic regions. For the Organisation for Economic Co-operation and Development-1990 countries (which includes the U.S.), greenhouse gas emission reductions in the range of 23 – 40 percent relative to 2010 levels by 2030 are consistent with model results that achieve concentrations of 430-530 parts per million by 2100.<sup>46</sup> Applying that number to Washington’s emissions would result in a 2030 target of 57.7 – 74.0 million metric tons of CO<sub>2</sub>e per year in 2030, with an average value of 65.3 million metric tons of CO<sub>2</sub>e per year.<sup>47</sup>

Washington has an intermediate limit of a 25 percent reduction relative to 1990 levels by 2035. This translates to a target of 66.3 million metric tons of CO<sub>2</sub>e per year. While this level is in the range of that described in AR5, it is slightly above the average value of the model runs. More significantly, it is five years later than 2030.

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<sup>44</sup> For a full discussion of equity principles regarding climate policy see Ch. 4.6.2.1 of IPCC AR5 Working Group III, [https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc\\_wg3\\_ar5\\_chapter4.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter4.pdf) (accessed 12/15/16).

<sup>45</sup> See IPCC AR5, Working Group III, Ch 3, 3.4, [http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc\\_wg3\\_ar5\\_chapter3.pdf](http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter3.pdf) (accessed 12/15/16).

<sup>46</sup> See IPCC AR5, Working Group III, Ch 6, Table 6.4, [https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc\\_wg3\\_ar5\\_chapter6.pdf](https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter6.pdf) (accessed 12/15/16).

<sup>47</sup> The range for OECD-1990 countries is a reduction of 23-40% relative to 2010 emissions, with the average across all models at a 32 percent reduction.

## Paris Agreement

The Paris Agreement (Accord de Paris) was negotiated at the 21<sup>st</sup> Conference of Parties to the UNFCCC in December 2015. Currently it has been ratified by 111 of 197 UNFCCC members, including the U.S. The central goal of the agreement is for signatories 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 by the end of the century. This goal is to be achieved by signatories making emission reductions as pledged in their Nationally Determined Contributions (NDCs), which are the levels of emission reductions that each member country self-determined. The U.S. pledged to reduce emissions by 26 – 28 percent relative to 2005 levels by 2025, and did not provide a longer-term emission reduction target.<sup>48</sup>

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. Some estimates predict that with the NDCs in place, warming will be limited to 2.8°C-3.1°C relative to pre-industrial levels.<sup>49</sup>

## National and state reduction targets

The following provides an overview of the current state of national and state greenhouse gas emission limits for purposes of understanding how Washington’s current limits align on a national level.

### U.S. national pledge in the Paris Agreement

As described above, the U.S. pledged to reduce emission by 26 – 28 percent relative to 2005 levels by 2025. In 2005, Washington’s greenhouse gas emissions were 98.2 million metric tons of CO<sub>2</sub>e per year. Applying that commitment to Washington would result in statewide emissions of 70.1 – 72.7 million metric tons CO<sub>2</sub>e per year in 2025. While Washington does not have an emissions target in 2025, a linear glide-path between the current 2020 and 2035 targets places the 2025 emissions rate at 81.0 million metric tons CO<sub>2</sub>e per year, significantly higher than where we would be if Washington attempted to match the rate of reduction established by the U.S. pledge.

Note, however, that the bulk of the emission reductions associated with the U.S. pledge are anticipated to come from the power and oil and natural gas sectors, as the Federal Clean Power Plan and other market forces decrease coal-fired generation, and new oil and gas emission standards reduce methane emissions from that sector.

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<sup>48</sup> See U.S. Submission to the UNFCCC, Intended Nationally Determined Contribution, <http://www4.unfccc.int/submissions/INDC/Published%20Documents/United%20States%20of%20America/1/U.S.%20Cover%20Note%20INDC%20and%20Accompanying%20Information.pdf> (accessed 12/15/16).

<sup>49</sup> See <http://climateactiontracker.org/global.html>.

## Limits established in other states

Many U.S. states already have established greenhouse gas emission limits. California has recently revised its emission limit to add an intermediate target in 2030; and Maryland is currently in the process of revising its limits. The following table outlines emission limits currently established by U.S. states:

Table 2: Emission limits currently established by U.S. states:

State	Limits	Reference Year	Year Established/Revised
AZ	Year 2000 levels by 2020 50% below 2000 levels by 2040 <sup>50</sup>	2000	2006
CA	Year 2000 levels by 2010 Year 1990 levels by 2020 40% below 1990 levels by 2030 80% below 1990 levels by 2050 <sup>51</sup>	1990	2006, 2016
CT	10% below 1990 levels by 2020 80% below 1990 levels by 2050 <sup>52</sup>	1990	2008
FL	2000 levels by 2017 1990 levels by 2025 80% below 1990 levels by 2050 <sup>53</sup>	1990	2007
IL	1990 levels by 2020 60% below 1990 levels by 2050 <sup>54</sup>	1990	2007
MA	25% below 1990 levels by 2020 80% below 1990 levels by 2050 <sup>55</sup>	1990	2008
MD	25% below 2006 levels by 2020 40% below 2006 levels by 2030 as long as there are net positive impact to jobs and the economy <sup>56</sup>	2006	2009, 2016
MI	20% below 2005 levels by 2025 80% below 2005 levels by 2050 <sup>57</sup>	2005	2009
NJ	80% below 2006 levels by 2050 <sup>58</sup>	2006	2007
NM	Year 2000 levels by 2012 10% below 2000 levels by 2020 75% below 2000 levels by 2050 <sup>59</sup>	2000	2005
NY	5% below 1990 levels by 2010 10% below 1990 levels by 2020 <sup>60</sup> 80% below 1990 levels by 2050 <sup>61</sup>	1990	2002, 2009

<sup>50</sup> [Arizona Executive Order 2006-13, Climate Change Action.](#)

<sup>51</sup> [California Global Warming Solutions Act of 2006 \(AB32\).](#)

<sup>52</sup> [Connecticut Global Warming Solutions Act of 2008 \(Public Act 08-98\).](#)

<sup>53</sup> [Florida Executive Order 07-127.](#)

<sup>54</sup> [Announcement by Governor Blagojevich, February 13, 2007.](#)

<sup>55</sup> [Global Warming Solutions Act \(Ch 298\).](#)

<sup>56</sup> [Greenhouse Gas Emissions Reduction Act of 2009 \(Ch 171\), SB 323/HB 610.](#)

<sup>57</sup> [Michigan Executive Directive 2009-4.](#)

<sup>58</sup> [Global Warming Response Act \(A3301\).](#)

<sup>59</sup> [New Mexico Executive Order 2005-033.](#)

<sup>60</sup> [New York 2002 State Energy Plan.](#)

<sup>61</sup> New York [Executive Order No. 24 \(2009\).](#)

State	Limits	Reference Year	Year Established/Revised
OR	10% below 1990 levels by 2020 75% below 1990 levels by 2050 <sup>62</sup>	1990	2007
VT	50% below 1990 levels by 2028 75% below 1990 levels by 2050 <sup>63</sup>	1990	2005
New England Governors/Eastern Canadian Premiers	Passed resolution requiring: 35-45% below 1990 levels by 2030 <sup>64</sup>	1990	2015

There are several patterns in the data from the above table. First, most jurisdictions use 1990 as the reference year. 1990 was the year of the [Kyoto Protocol](#), and was the reference year used in the IPCC’s AR 4.<sup>65</sup> Second, while Washington was an early adopter in establishing intermediate limits, other jurisdictions are now following suit. California, Maryland, and the New England Governors/Eastern Canadian Premiers recently adopting 2030 targets. Finally, Washington’s current long-term target of a 50 percent reduction relative to 1990 levels by 2050 is less stringent than most other states with emission limits, with many requiring an 80 percent reduction in emissions by that point.

**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 percent below 1990 levels by 2050, or limiting per capita emissions to 2 metric tons CO<sub>2</sub>e.
3. Commit to establishing intermediate emission reduction targets at 2030.<sup>66</sup>

To date, a total of 165 jurisdictions from 33 countries and six continents have signed the Under 2MOU. Washington State is a founding signatory of the MOU. Besides California, other U.S. states that have signed include Connecticut, 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.

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<sup>62</sup> [Oregon House Bill 3543](#).  
<sup>63</sup> [S. 259](#).

<sup>64</sup> [Resolution 39-1](#).

<sup>65</sup> See Ecology’s December 2014 report for a broader discussion of the 1990 reference year.

<sup>66</sup> See Global Climate Leadership Memorandum of Understanding (MOU), <http://under2mou.org/wp-content/uploads/2015/04/Under2-MOU-English.pdf> (accessed 12/15/16).

## Recommendations for Washington

The above information provides context regarding current climate science and the need to reduce emissions, the likely current and future impacts to Washington from further warming, global, national and state emission patterns, and global and domestic emission reduction targets. This context guides Ecology's evaluation of whether to recommend revising the current Washington greenhouse gas emission limits.

Reviewing this information prompts three key questions:

1. Should we change the target years, e.g., use different years than 2020, 2035, and 2050?
2. Should we change the baseline year for emissions from 1990 to the 2010 reference year used in AR5, or to some other year?
3. Given its status as an industrialized state, high per capita emissions, and relatively clean power sector, should Washington's emission limits be tightened to better reflect 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?

### Whether to change the target years

Ecology recommends maintaining the current 2020 and 2050 target years.

The 2020 target is only three years away. While Washington is currently on track to exceed the 2020 limit (88.4 million metric tons of CO<sub>2</sub>e per year), it makes sense to keep that goal given the need to reduce emissions earlier rather than later. Ecology also recommends keeping a 2050 limit which is consistent with emission reduction targets established by many other jurisdictions. A 2050 limit also 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.

However, there is an argument for changing the 2035 target year to 2030. First, the IPCC 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 IPCC therefore evaluated emission reduction scenarios in 2030 that would be likely to limit warming. Also, other jurisdictions, including California, have recently established 2030 limits. By contrast, in its pledge in the Paris Agreement, the U.S. committed to emission reductions by 2025. Ecology is recommending maintaining the 2035 target year as an appropriate mid-point between the 2020 and 2050 targets largely because of existing policy to reduce greenhouse gases. However, additional emission reductions are needed, and can be addressed by setting more stringent 2035 emission limit as outlined in more detail below.

### Whether to change the reference year from 1990

Ecology recommends maintaining the reference year as 1990. While the IPCC changed their reference year from 1990 to 2010, and others use a reference year closer to peak emissions (2005-2010), 1990 still appears to be an appropriate starting point, as it marked the base year for international benchmarking of emissions under the Kyoto Protocol. Maintaining 1990 as the reference year harmonizes with the reference year many other jurisdictions with emission limits have adopted, and also aligns with the reference year in the Under 2MOU.

## Whether to strengthen the current limits

Ecology recommends strengthening the 2035 emission limit. We make this recommendation based on the fact that the current 2035 limit of 25 percent below 1990 levels (66.3 million metric tons of CO<sub>2</sub>e per year) is less stringent than what the IPCC suggested as an intermediate target for industrialized countries. Our recommendation also takes into account what the U.S. pledged in Paris, what other states have recently adopted, and doing our fair share to reduce greenhouse gases.

In AR5, the IPCC looked at different emission reductions for different economic regions in 2030 that would limit warming below 1.5-2°C. For the U.S., this would be a reduction of 23-40 percent relative to 2010 emissions. Applying that number to Washington would result in a level of 65.3 MMTCO<sub>2</sub>e/yr. at the mid-point of the range in 2030, 1 MMTCO<sub>2</sub>e/yr. lower and five years earlier than the current limit.

Applying the recently adopted California limit of 40 percent below 1990 levels by 2030 in Washington would result in a level of 52 million metric tons CO<sub>2</sub>e per year. Meanwhile, the U.S. Paris pledge would result in statewide emissions of 70.1 – 72.7 -72.7 million metric tons CO<sub>2</sub>e per year in 2025 if applied to Washington. This is 8.3 million metric tons CO<sub>2</sub>e per year lower than what Washington’s emissions would be in 2025 following the linear glidepath for the current emission limits.

Table 3 Comparison of Intermediate Emission Limits from IPCC and California applied to Washington (MMTCO<sub>2</sub>e/yr.)

Entity	2030	2035
Current Washington limit		66.3
IPCC AR5 Guidance	65.3	53.8 <sup>67</sup>
California	52.0	

Based on the above, Ecology concluded that the emissions limit for 2035 should be strengthened to 40 percent below 1990 levels. This is consistent with the IPCC analysis, as extrapolating the 2030 level of 65.3 million metric tons CO<sub>2</sub>e per year to 2035 results in a level of 53.75 million metric tons CO<sub>2</sub>e per year, approximately a 40 percent reduction from Washington’s 1990 levels.

While California has adopted this same limit for 2030, Ecology concludes that it is reasonable to account for Washington’s clean energy sector and reliance on hydropower by setting a slightly less stringent limit.

Ecology also recommends strengthening the 2050 limit. While the IPCC suggested global emission reductions by 2050 for different modeling scenarios in AR5, it did not do this on a regional/economic basis as it did for 2030. Because of Washington’s status as an industrialized state, it is appropriate that emission reductions here should be greater than global averages.

<sup>67</sup> Extrapolated linearly from the 2030 limit.

Washington’s current 2050 limit of a 50 percent reduction below 1990 levels by 2050 is 44.2 million metric tons CO<sub>2</sub>e per year. Many other jurisdictions, including California, have established a limit of 80 percent below 1990 levels by 2050, which would be 17.7 million metric tons of CO<sub>2</sub>e per year in Washington. That emission limit also aligns with the commitments made by signatories to the Under 2MOU. Applying the rate of emission reductions from the IPCC 2030 analysis through linear extrapolation from 2030 to 2050 would result in a level of 19.1 million metric tons CO<sub>2</sub>e /per year, just slightly above the 80 percent reduction level.

Table 4 Comparison of 2050 Emission Limits from IPCC, California, and the Under 2 MOU Applied to Washington (MMTCO<sub>2</sub>e/yr.)

<b>Entity</b>	<b>Limits</b>
Current Washington limit	44.2
IPCC AR5 Guidance	19.1 <sup>68</sup>
California	17.7
Under 2MOU	17.7

Ecology is therefore recommending that the 2050 emission limits be strengthened to 80 percent below 1990 levels by 2050. This level of emission reduction is consistent with what will be required from industrialized countries to avoid the damage and impacts that Washington will otherwise face.

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<sup>68</sup> Extrapolated linearly from the 2030 limit.

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<sup>i</sup> **Figure 3 Data sources:** Elsner, M.M. et al., 2010. Implications of 21st century climate change for the hydrology of Washington State; *Climatic Change* 102(1-2): 225-260; “Hamlet, A.F. et al., 2010. Effects of projected climate change on energy supply and demand in the Pacific Northwest and Washington State. *Climatic Change* 102(1-2): 103-128;” Hamlet, A.F. et al., 2013. An overview of the Columbia Basin Climate Change Scenarios Project: Approach, methods, and summary of key results. *Atmosphere-Ocean* 51(4): 392-415. doi: 10.1080/07055900.2013.819555; “Isaksen, T. et al., 2014. Rev Environ Health DOI 10.1515/reveh-2014-0029 Washington State associated with climate change; “Kunkel, K.E. et al., 2013. Part 6. Climate of the Northwest U.S., NOAA Technical Report NESDIS 142-6, 76 pp; Mantua, N. et al., 2010. Climate change impacts on streamflow extremes and summertime stream temperatures and their possible consequences for freshwater salmon habitat in Washington State. *Climatic Change*, 102,187-223; Moore, S.K. et al., 2011. Past trends and future scenarios for environmental conditions favoring the accumulation of paralytic shellfish toxins in Puget Sound shellfish. *Harmful Algae*, 10, 521-529; “Mote, P. W. et al., 2013. Climate: Variability and Change in the Past and the Future. Chapter 2, 25-40, in M.M. Dalton, P.W. Mote, and A.K. Snover (eds.) *Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities*, Washington D.C.: Island Press; “Warner, M.D. et al., 2015. Changes in Winter Atmospheric Rivers along the North American West Coast in CMIP5 Climate Models. *J. Hydrometeor*, 16, 118–128. doi: <http://dx.doi.org/10.1175/JHM-D-14-0080.1>; IPCC Synthesis Report, [www.ipcc.ch/report/ar5/syr/](http://www.ipcc.ch/report/ar5/syr/); Washington State of Knowledge Report, [cig.uw.edu/resources/special-reports/wa-sok/](http://cig.uw.edu/resources/special-reports/wa-sok/); Puget Sound State of Knowledge Report, [cig.uw.edu/resources/special-reports/ps-sok/](http://cig.uw.edu/resources/special-reports/ps-sok/).