EARTHJUSTICE – NATURAL RESOURCES DEFENSE COUNCIL
THE WILDERNESS SOCIETY

August 29, 2022

Sent via e-mail and ePlanning portal[1]

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Re: Assessment of Greenhouse Gas Emissions Significance in the Willow Master Development Plan Draft Supplemental Environmental Impact Statement

Dear Ms. Rice:

On behalf of our members and supporters, we urge the Bureau of Land Management (BLM) to more carefully evaluate the significance of the climate impacts of the proposed Willow Master Development Plan (Willow) than has been done in the draft Supplemental Environmental Impact Statement (DSEIS). The evaluation must be performed in the context of an escalating climate crisis. BLM must make an informed choice, consistent with national climate policy and commitments and protection of resource values on the National Petroleum Reserve-Alaska (Reserve). In light of the highly significant impacts we document in these comments, we ask that BLM deny the project.

Climate change poses an existential threat to our society. The U.S., along with most countries in the world, has committed to efforts to limit warming to no more than 1.5°C in order to avoid catastrophic consequences. The Biden Administration has committed to act with urgency to reduce U.S. greenhouse gas (GHG) emissions by 50 percent below 2005 levels by 2030, and to achieve net-zero GHG emissions by 2050. Meeting those goals requires, among other things, reducing emissions from fossil fuel development on federal land, which account for a considerable portion of all U.S. emissions.

In this context, when considering whether and with what restrictions to approve fossil fuel development projects, agencies must thoroughly analyze the significance of the projects' GHG emissions and should act to the maximum extent of their authority to ensure that any development approved is consistent with achieving climate goals and protecting the Reserve's resources. There can be no exceptions. Willow would add approximately 280 million metric tons of carbon dioxide equivalent to the atmosphere over the next 30 years. As the largest single proposed oil development project on U.S. federal land, the project, if approved, would drastically undercut the nation's climate commitments.

Evaluating the impact of project GHG emissions requires more than quantifying those emissions or even estimating and presenting monetized costs of the emissions. Those numerical values, unless contextualized, provide no way to determine if the figure is significant in the context of the global warming crisis. Instead, agencies must evaluate project emissions over time and in the context of the

[1] Due to size, attachments will be mailed by U.S. Mail on a thumb drive.

entire energy system, to objectively determine the project's significance by measuring its consistency with achieving the goal of limiting warming.

This comment letter presents a quantitative and scientific tool that BLM can and should use to assess the impact and significance of quantified GHG emissions for individual projects, including Willow. This tool, the "climate test," provides a metric to determine the extent to which the anticipated project GHG emissions are consistent or inconsistent with holding warming to 1.5°C. Applying this tool to the Willow project demonstrates that the project's emissions are significantly inconsistent with limiting warming to 1.5°C.

I. The escalating climate crisis demands immediate action from the federal government, which includes considering whether fossil fuel development projects can be permitted consistent with national climate goals and commitments.

An overwhelming international scientific consensus has established that human-caused climate change is already causing unprecedented, severe, and widespread harms and that climate change threats are becoming increasingly dangerous.[2] Fossil fuel-driven climate change has already led to more frequent and intense heat waves, floods, and droughts; more destructive hurricanes and wildfires; rising sea levels and coastal erosion; increased spread of disease; food and water insecurity; acidifying oceans; and increased species extinction risk and collapse of ecosystems.[3] The climate crisis is killing people across the nation and around the world, accelerating the extinction crisis, and costing the U.S. economy billions in damages every year. The pace of climate change and its consequences are especially severe in the Arctic, where warming is occurring at up to four times the global average.[4] Without limits on fossil fuel production and deep and rapid emissions reductions, global temperature rise will exceed 1.5°C and will result in catastrophic damage in the U.S. and around the world.[5]

The U.S. federal government has recognized the urgent threat posed by climate change and President Biden has committed the government to taking decisive action. As President Biden stated at the United Nations climate summit in Glasgow, we are at an "inflection point" in the fight against climate

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[2] U.S. Global Change Research Program, *Executive Summary*, CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT, VOL. I (2017), https://science2017.globalchange.gov/ (NCA4, Vol. I); U.S. Global Change Research Program, FOURTH NATIONAL CLIMATE ASSESSMENT, VOL. II: IMPACTS, RISKS, AND ADAPTATION IN THE UNITED STATES (2021), https://nca2018.globalchange.gov/ (NCA4, Vol. II); Intergovernmental Panel on Climate Change (IPCC), *Summary for Policymakers*, CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS (2021), https://www.ipcc.ch/report/sixth-assessment-report-working-group-i (IPCC 2021, *Summary for Policymakers*); Alaska Soles – Great Old Broads for Wilderness *et al.*, Comments on the Willow Master Development Plan Draft Supplemental Environmental Impact Statement at 84-89 (Aug. 29, 2022) (Alaska Soles *et al.*, Willow Comments).

[3] *See* NCA4, Vol. II; NATIONAL INTELLIGENCE COUNCIL, NIC-NIE-2021-10030-A, NATIONAL INTELLIGENCE ESTIMATE: CLIMATE CHANGE AND INTERNATIONAL RESPONSES INCREASING CHALLENGES TO US NATIONAL SECURITY THROUGH 2040 at 2 (Oct. 2021), https://www.dni.gov/files/ODNI/documents/assessments/NIE_Climate_Change_and_National_Security.pdf.

[4] M. Rantanen *et al.*, *The Arctic has Warmed Nearly Four Times Faster Than the Globe Since 1979*, 3(168) COMMUNICATIONS EARTH & ENVIRONMENT 2 (Aug. 11, 2022); Alaska Soles *et al.*, Willow Comments at 87-89.

[5] IPCC, *Summary for Policymakers, Special Report: Global Warming of 1.5°C* (V. Masson-Delmotte *et al.* eds., 2018), https://www.ipcc.ch/sr15/ (IPCC 2018).

change and have only a "brief window" to act.[6] Executive Order 14008 recognizes that acting to address the climate crisis is "more necessary and urgent than ever."[7]

> The scientific community has made clear that the scale and speed of necessary action is greater than previously believed. There is little time left to avoid setting the world on a dangerous, potentially catastrophic, climate trajectory. Responding to the climate crisis will require both significant short-term global reductions in greenhouse gas emissions and net-zero global emissions by mid-century or before.[8]

Executive Order 14008 also establishes national policy that places the climate crisis "at the center of United States foreign policy and national security."[9]

The U.S. has also committed to reducing GHG emissions by 50–52 percent below 2005 levels in 2030,[10] and to reach net-zero emissions by 2050.[11] President Biden has ordered all agencies "to immediately commence work to confront the climate crisis,"[12] and committed to deploying the "full capacity" of agencies "to implement a Government-wide approach" to combat the climate crisis.[13]

To reach these goals and to protect resources that BLM manages, it is essential that the U.S. limit new fossil fuel development on federal lands. There is very little space in the global carbon budget for new fossil fuel infrastructure and extraction if we are to avoid the worst dangers from climate change.[14] Based on a 1.5°C Intergovernmental Panel on Climate Change (IPCC) pathway, U.S. production alone would exhaust nearly 50 percent of the world's total allowance for oil and gas by 2030 and exhaust more than 90 percent by 2050.[15] In 2018, the U.S. Geological Survey and Department of the Interior (DOI) estimated that carbon emissions released from extraction and end-use combustion of fossil fuels produced on federal lands alone accounted for approximately one quarter of total U.S. carbon emissions during 2005 to 2014.[16] A 2015 analysis of U.S. fossil fuel resources shows that the potential carbon emissions from already leased fossil fuel resources on federal lands would essentially exhaust the world's carbon

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[6] M. Chalfant & R. Frazin, *Biden Warns of 'Existential' Climate Threat at Glasgow Summit*, THE HILL (Nov. 1, 2021), https://thehill.com/policy/energy-environment/579403-biden-calls-for-collective-action-at-glasgow-climate-summit?rl=1.
[7] Executive Order No. 14008, 86 Fed. Reg. 7619, 7619 (Jan. 27, 2021) (Executive Order 14008).
[8] *Id.*
[9] *Id.*
[10] The United States of America Nationally Determined Contribution, Reducing Greenhouse Gases in the United States: A 2030 Emissions Target at 1 (undated).
[11] Executive Order No. 14057, 86 Fed. Reg. 70,935, 70,935 (Dec. 8, 2021).
[12] Executive Order No. 13990, 86 Fed. Reg. 7037, 7037 (Jan. 20, 2021).
[13] Executive Order 14008, 86 Fed. Reg. at 7622.
[14] *See* D. Tong *et al.*, *Committed emissions from existing energy infrastructure jeopardize 1.5 °C climate target*, 572 NATURE 373, 373 (2019) (Tong *et al.* 2019); P. Achakulwisut & P. Erickson, Stockholm Environment Institute, *Trends in Fossil Fuel Extraction: Implications for a Shared Effort to Align Global Fossil Fuel Production with Climate Limits* at 4 (SEI Working Paper, 2021).
[15] Oil Change International, *et al.*, *Drilling Toward Disaster: Why U.S. Oil and Gas Expansion Is Incompatible with Climate Limits* at ES-6, 21 (Jan. 2019) (Oil Change International 2019).
[16] M. D. Merrill *et al.*, U.S. Geological Survey, Scientific Investigations Report 2018-5131, *Federal Lands Greenhouse Emissions and Sequestration in the United States—Estimates for 2005–14* at 1(2018).

budget consistent with the 1.5°C target. This analysis estimated that recoverable fossil fuels from U.S. federal lands would release up to 349 to 492 gigatons of GHG emissions, if fully extracted and burned.[17]

As explained in separately submitted comment letters, BLM has the authority to deny authorization of or limit individual proposed development projects in the Reserve, including Willow, if the project will have unacceptable climate impacts, including on the Reserve's resources.[18] Accordingly, BLM should carefully consider what action to take on the proposed Willow project based on the significance of the project's potential climate and other impacts. Given the significance of those impacts demonstrated below, we ask that BLM deny the project.

II. BLM can and must do more to analyze and disclose the impact of project GHG emissions.

The DSEIS includes improved analysis quantifying the total downstream GHGs associated with the various Willow project alternatives.[19] That quantification is necessary but not sufficient. BLM has, at this point, merely presented numbers, with no meaningful analysis to inform the public of their significance in the context of global climate change.

Commenters present here a quantitative and scientific tool that BLM can and should use to assess the impact and significance of the quantified GHG emissions. This tool, the "climate test," provides a metric to determine the extent to which anticipated project GHG emissions are consistent or inconsistent with holding warming to 1.5°C.

A. BLM must do more than merely quantify GHG emissions associated with the various alternatives.

BLM's approach in the DSEIS to assessing GHG emissions consists of little beyond quantification. Its approach is simply to take the quantified GHG emissions and compare them to the state and national GHG inventories.[20] While BLM also appropriately monetizes the cost of these emissions using the social cost of GHG emissions (DSEIS Table 3.2.7-3.2.8), this monetization, while useful in general, does not fully disclose the impact and significance of the emissions.[21] Without context, it merely provides a dollar figure, which does not by itself enable a reader to assess whether that figure is significant in the context of the climate crisis.[22]

Simple quantifications of this nature, and comparisons to larger GHG datasets, are analytically and legally deficient as a means of disclosing and assessing GHG impacts and their significance. No matter how large a given project's emissions – and in the case of Willow, they are extraordinarily large –

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[17] Ecoshift Consulting, *The Potential Greenhouse Gas Emissions of U.S. Federal Fossil Fuels* at 2 (2015); *see* Oil Change International, *The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production* at Tbl. 1 (Sept. 2016) (estimating global carbon budget for limiting warming to 1.5°C at 393 gigatons).

[18] *See* Alaska Soles *et al.*, Willow Comments at 8-9, 33-34, 69-71, 110-114; Earthjustice, Comments on Willow Master Development Plan Draft Supplemental Environmental Impact Statement – BLM's Decision-Making Authority at 2-4, 6-7 (Aug. 29, 2022).

[19] DSEIS at 41-49; *id.*, App. E.2A at 10-15.

[20] DSEIS at 41-43.

[21] *Id.* at 43-50.

[22] Additionally, the DSEIS's social cost of GHG figures are likely underestimates, and the economic benefits against which they might be compared are likely inflated. *See* Institute for Policy Integrity *et al.*, Comments on Willow Master Development Plan Draft Supplemental Environmental Impact Statement (Aug. 29, 2022).

those emissions will always appear "individually minor" when compared against larger totals, as BLM has done here.[23] Dwarfing project emissions in this manner not only tells the reader nothing of consequence regarding the impact of the project on meeting the 1.5°C warming-limited goal, but worse, by its nature makes the emissions appear less significant than they actually are.

Accordingly, the Ninth Circuit recently evaluated a simple quantitative comparison of GHG emissions of the type used by BLM here and found it wanting. Where DOI had calculated emissions from a proposed mine expansion, compared them to global GHG emissions, and concluded that its "contribution relative to other global sources [of GHGs] would be minor," the court rejected that conclusion as insufficient.[24] The court observed,

> [DOI] did not cite any scientific evidence supporting the characterization of the project's emissions as "minor" compared to global emissions, nor did it identify any science-based criteria the agency used in its determination. "Without some articulated criteria for significance in terms of contribution to global warming that is grounded in the record and available scientific evidence," Interior's conclusion that the Mine Expansion's GHG emissions will be "minor" is deeply troubling and insufficient to meet Interior's burden.[25]

The court observed that "if a project of this scale can be found to have no significant impact, virtually *every* domestic source of GHGs may be deemed to have no significant impact as long as it is measured against total global emissions."[26]

While these findings were in the context of evaluation of an environmental assessment, the same rationale and concerns are equally valid here. In the context of an environmental impact statement, agencies are required to take a "hard look" at the environmental consequences of a proposed action and assess their significance.[27] "Taking a 'hard look' includes 'considering all foreseeable direct and indirect impacts[,]'"[28] which must be done in a manner that achieves meaningful disclosure. In any National Environmental Policy Act (NEPA) context, this means meaningful analysis of Willow and other projects in combination with each other, to determine "'whether, or how, to alter the program to lessen cumulative impacts' on climate change."[29]

In invalidating the simple comparison approach, the Ninth Circuit held that it was the agency's responsibility to identify a methodology "that satisfies NEPA and the [Administrative Procedure Act]."[30]

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[23] *Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, 538 F.3d 1172, 1216-1217 (9th Cir. 2008); *see also Klamath-Siskiyou Wildlands Ctr. v. Bureau of Land Mgmt.*, 387 F.3d 989, 995 (9th Cir. 2004) (agencies must analyze the "degree that each [environmental] factor will be impacted"); *California v. Bernhardt*, 472 F. Supp. 3d 573, 623 (N.D. Cal. 2020) ("[Agencies] must communicate the '*actual* environmental effects resulting from . . . emissions' of greenhouse gas, not just quantify [those emissions]." (quoting *Ctr. for Biological Diversity*, 538 F.3d at 1216)).

[24] *350 Montana v. Haaland,* 29 F.4th 1158, 1170 (9th Cir. 2022) (quoting agency's environmental assessment).

[25] *Id.* (quoting *Ctr. For Biological Diversity*, 538 F.3d at 1224-25).

[26] *Id.* at 1171 (citation omitted) (emphasis in original).

[27] *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989); 40 C.F.R. § 1502.16.

[28] *League of Wilderness Defs.-Blue Mountains Biodiversity Project v. U.S. Forest Serv.*, 689 F.3d 1060, 1075 (9th Cir. 2012) (quoting *N. Alaska Envt. Ctr. v. Kempthorne*, 457 F.3d 969, 975 (9th Cir. 2006)).

[29] *WildEarth Guardians v. U.S. Bureau of Land Mgmt.*, 457 F. Supp. 3d 880, 894 (D. Mont. 2020) (quoting *Churchill Cty. v. Norton*, 276 F.3d 1060, 1080 (9th Cir. 2001).

[30] *350 Montana,* 29 F.4th at 1176.

In response to DOI's claim that it "could not define, with precision, the incremental impacts of the project's emissions," the court noted that "the scientific community's understanding has advanced considerably" in recent years.[31] While that specific reference was to an IPCC report, the observation applies as well to the climate test, which we urge BLM to apply in the manner demonstrated below in these comments.

B. The climate test is an available tool that BLM can and should use to assess the significance of quantified project GHG emissions.

Scientists and attorneys at the Natural Resources Defense Council developed the climate test as a method of evaluating the significance of individual project GHG emissions that achieves what the simple quantitative comparison presented by BLM does not: evaluating project emissions over time and in the context of the entire energy system, to objectively determine the project's significance by measuring its consistency with achieving the goal of limiting warming to 1.5°C. The climate test uses a set of quantitative metrics that assess whether, and to what degree, a project is consistent with the constraints and characteristics of a decarbonizing world.

The climate test assesses the impact and significance of project's carbon emissions by evaluating its anticipated future releases in the context of U.S. energy system characteristics, as judged by best available science at the time of assessment. Put in simplest form, the concept of the climate test is to compare the extent to which an individual fossil fuel project, viewed over time, would operate within the central constraints of emission pathways for meeting the 1.5°C climate goal and whether its impacts would be in proportion to its contributions to the energy system. Rather than simply presenting raw quantifications of lifecycle emissions and comparison to a larger universe of emissions, the test measures the *significance* of those emissions in terms of the project's figurative 'cost' of consuming a portion of the small and declining carbon budget, as compared with the project's contribution in terms of the portion of fossil energy it would provide over the project's lifespan toward a modeled total need. The test takes into account how much of the emissions pathways consistent with that budget are already committed to future operation of existing energy infrastructure. Then, via an equation, the test provides a metric to judge whether the project's share of the remaining budget is in balance with the share of fossil energy the project would supply toward meeting demand in a 1.5°C future — again, accounting for existing sources of supply that could otherwise meet the projected demand.

The test, in this way determines emissions significance of a project by measuring its balance of carbon emissions "impact" within this limiting warming context against its energy "contribution" provided to the evolving energy system, in an approach analogous to cost-benefit analysis. The equation generates an easy-to-interpret score: if the solution is greater than 1, then the project is significant because building it is inconsistent with the balance of emissions and energy necessary to meet our climate goals.

The climate test methodology—which can be applied to any fossil fuel project with the right data—is grounded in the robust causal relationship established between CO_2 emissions and temperature increase,[32] and the functional, causal relationship between fossil fuel infrastructure and its stated purpose of meeting demand for fossil fueled energy end uses. The temperature target of 1.5°C was selected as the

[31] *Id.*

[32] *See* IPCC 2021, *Summary for Policymakers* (summarizing scientific support showing changes in CO_2 emissions and increasing temperatures).

threshold for significance because of (a) its use in international policy agreements to which the U.S. is party,[33] as well (b) the scientific assessments in support of those policy positions.[34]

The inputs into the climate test model are project-specific data (e.g., fuel type, project type, operating capacity or projected utilization, direct emissions, upstream and/or downstream emissions or emission factors, etc.) and representative default values when such data are unavailable, not provided, or improperly assessed by the project applicant. The test uses the reported or default data in conjunction with projections of climate and energy systems pathways from best-available published scientific literature (e.g., carbon budgets and consistent time-series trajectories of annual emissions and fossil energy demand) and committed emissions and energy from continued operation of existing infrastructure to contextualize the project in terms of its alignment with both criteria. As illustrated in Figure 1, together these form the inputs for the two analogous component metrics: *emissions impact* and *energy contribution*, and the final, composite decision metric of *emissions significance*, which is the ratio of the former to the latter. Together, this emissions significance metric functions as a test of whether the project is simultaneously consistent with a carbon budget for limiting warming to 1.5°C and in balance with its contribution within a shifting future energy demand over the expected lifetime of the project. This final quantitative metric is structured to yield a simple and easily interpretable result: ≤ 1 for projects that are consistent with the 1.5°C goal and >1 for projects that are. As such, the *degree* of a project's compatibility is also communicated by the metric's value and its distance from the tipping point of 1. Thus, the climate test most basically informs as to whether a fossil fuel project is significant in terms of being inconsistent with climate goals; but also informs comparisons between project alternatives and between different projects to assess which are the most severely out of step with those goals.

[33] Paris Agreement to the United Nations Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No 16-1104 (2015), https://unfccc.int/sites/default/files/english_paris_agreement.pdf; *see also* United Nations Depositary, *Status of Treaties*, https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en (visited Aug. 26, 2022) (showing the United States has accepted the Paris Agreement).
[34] IPCC 2021, *Summary for Policymakers*; IPCC 2018. /

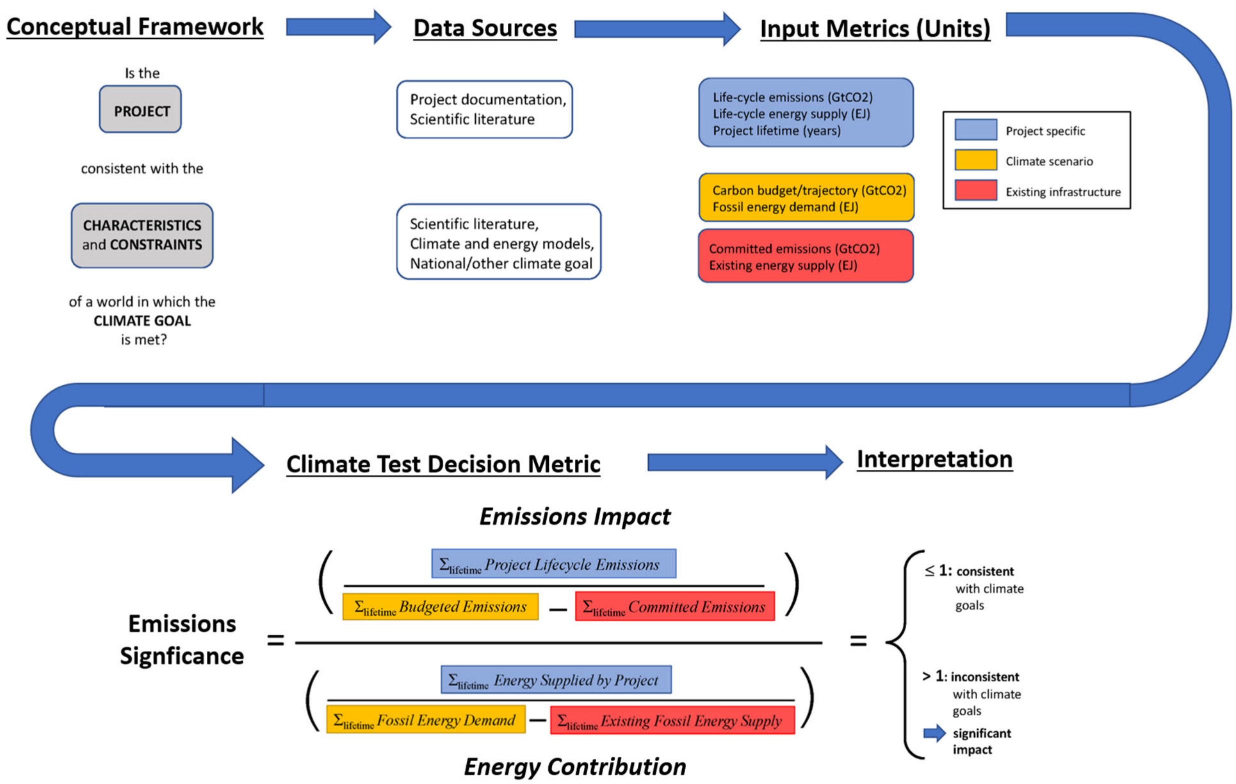

Figure 1. Conceptual diagram of climate test decision support metric, as presented in climate test manuscript, currently under review.

The climate test methodology is currently undergoing formal, scientific peer-review at a top environmental science and policy journal. We provide this manuscript and supplemental materials for BLM's consideration. Until this process is complete, and the final version accepted, there is always a possibility that the results could change as we evaluate and respond to any necessary methodological revisions identified by reviewer comments. However, especially in this time of emergent crises, like the COVID-19 pandemic and worsening climate change, to which decisionmakers must respond in real time, the value of pre-print research to informing decisions cannot be overstated. Science publication cannot always proceed at the rate of public policymaking, let alone world events, but it does not mean that sound, well developed and supported analysis cannot provide meaningful tools and conclusions when decisions must be made. Improvement over time in our understanding of the world, and of tools we build, is a natural part of the scientific process, and does not mean that a work of scholarship is without value until it is published in a peer-reviewed scientific journal. While that method of knowledge creation and communication is among our most trusted – and for good reason – we can, and sometimes must, offer actionable findings on decisions with potential to cause as much climate-warming, potent pollution as oil and gas supply-enabling infrastructure does, at the stage of pre-print. We offer the following analysis based on years of scholarship and peer-to-peer expert review throughout development of this tool and are prepared to defend the assumptions within it.

We note that the climate test serves a distinct and complementary purpose to the social cost of carbon (SCC) and social cost of GHGs more generally. Thus, the tool is not so much an alternative to the SCC as a supplement to it, designed to answer questions that the SCC is not. SCC and the social cost of methane (SCM) are valuable because they enable agencies to monetize the cost of GHG emissions authorized by any of their decisions in economic terms. The social cost of GHG metrics are not, however, designed to provide a benchmark for the significance of GHG emissions or determine their consistency with climate goals. They assign a dollar figure to climate impacts, but are not set up to provide context as to whether that dollar figure is significant from a decision-making perspective, and the dollar figure standing alone cannot tell us whether the emissions and their associated costs are consistent with a 1.5°C warming world.

For full description of the methodology underlying this climate test tool, please review the attached preprint manuscript and supplemental materials, including the technical appendix. We have also included a beta version of the workbook tool developed in conjunction with the test, designed to enable agencies – including BLM here – to input available project data in order to run the test for a domestic oil project. The following subsection, which explains the application of the test to the Willow project, endeavors to document all steps taken and data sources used beyond those provided in the manuscript, which focused on a gas pipeline example. We are happy to follow up with staff to address any outstanding questions.

III. The climate test as applied to the Willow project demonstrates that the Willow project is highly significant and inconsistent with the goal of a 1.5ºC warming-limited world.

In this section, we will demonstrate the application of the climate test to the Willow project. We document the manner and results of the application, using the spreadsheet tool referenced above and provided in the Appendix.

All data on the Willow project used in our test run were collected from the DSEIS and its appendices. Much of the data were available in Appendix E.2 on climate and climate change as well as the BLM EnergySub modeling used to estimate displaced emissions. Table 1 offers a more detailed overview of the project-specific inputs that we collected on Willow for this analysis.

Table 1. Overview of project related climate test inputs for Willow.

Input category	Project-related inputs		Input value for Willow[35]	Source
Overarching scoping determinants *(sets time period for analysis)*	Fossil fuel type		Oil	DSEIS Appendix D.1 at Table D.4.7 and Appendix E.15 at Table 3 show planned production for oil only
	Project lifecycle stage		Upstream, production	N/A
	Project construction start year		Year 0 = 2023	DSEIS at ES-3; Described as Winter 2022/23 or Winter 2023/24, chose to go with earlier date
	Project operation start date[36]		Alt B, C, and E: Year 6 (=2029); Alt D: Year 7 (2030)	DSEIS, Appendix D.1 at Table D.4.7 and Appendix E.15 at Table 3. Planned oil production operation schedule runs from year 6 – 30 or 7 – 31 depending on the alternative.
	Project operating duration		25 years (through 2052 or 2053)	
Project emissions data	Lifecycle emissions data: CO_2 only, domestic only; including:		See below	See below
			From construction and operation of Willow;	DSEIS Appendix E.2A at 12-13, tables E.2.3 – E.2.5; emissions listed only as gross,

[35] Unless otherwise specified, these values are used for all alternatives, except the No Action Alternative.
[36] In the manuscript, we use construction duration to estimate project operation start date based on the absence of this data in certain projects. In this case we had clearer data to set operation start date based on a planned production schedule, rather than assume it begins following a complete and wholly separate construction period, which was not the case for this project.

		- Direct emissions from construction and operation of the project	*See* Table 2 (below), row 1	domestic, annual average over project lifespan of 30 or 31 years. Modeled as constant over time.
			From construction and operation of module delivery options[37]; *See* Table 2, row 5 (below)	DSEIS, Appendix E.3B at Tables 2.1-29 through 2.1-34. Options were presented as time series.
		- Indirect emissions[38] (gross)[39] associated with project's fuel lifecycle	*See* Table 2, row 3 (below)	DSEIS, Appendix E.2A at 12-13, tables E.2.3 – E.2.5; emissions listed only as gross, domestic, annual average over project lifespan of 30 or 31 years. Modeled as constant over time.
Project energy data	Annual fuel production[40]		*See* Figure 2 (below)	DSEIS, AppendixD.1 at Table D.4.7 and Appendix E.15 at Table 3; Planned oil production operation schedule
	Energy content of fuel type		6E-9 EJ/bbl crude = 5.691 MMBTU/bbl crude * 1.005E9 EJ/MMBTU	EIA[41]

[37] Assumes all CO_2e is CO_2 since breakdown not provided.
[38] Downstream only: In this case, because drilling-related infrastructure projects occur at the beginning of the fuel lifecycle, all indirect emissions occur downstream of production. In the manuscript, indirect greenhouse gas emissions were estimated because they were not reported by project documentation as they are in the Willow project.
[39] BLM also reports a second category of indirect emissions, called "CO_2e from Energy Sources Displaced by Project", which are used to produce a "net" emissions estimate for each alternative. It is estimated using the substitution rates modeled by BLM EnergySub (Appendix E.2B) and in GLEEM with updates. This is not included as part of project emissions because it is not, in fact, an emission associated with operation of this new project, but rather an effect elsewhere in the energy system. Existing energy system effects are represented elsewhere in the climate test framework and are discussed separately.
[40] In the manuscript, this was estimated from project capacity and average utilization factor, but since time series oil production is provided as part of this DSEIS, we take that data directly as the starting point for energy contribution estimation.
[41] EIA, Units and calculators explained, https://www.eia.gov/energyexplained/units-and-calculators/ (last updated June 29, 2022) (citing *Monthly Energy Review,* May 2022).

Table 2. Summary of gross emissions data used in climate test analysis.

Reported Project Emissions (Gross, Domestic)	**Unit**	**Alternatives**				
		A	**B**[42]	**C**[43]	**D**[44]	**E**[45]
Direct - Project	kt CO_2/yr	0	779	851	758	780
Indirect	kt CO_2/yr	0	8,651	8,651	8,372	8,439
Annual Total (Gross Domestic)	**kt CO_2/yr**	**0**	**9,430**	**9,502**	**9,130**	**9,219**
Lifespan	yrs	0	30	30	31	30
Lifespan Total[46] **(Gross Domestic)**	**kt**	**0**	**282,900**	**285,060**	**283,030**	**276,570**
Total Additional Direct – Module Delivery Option 1[47]	kt	0	154.6	154.6	154.6	154.6
Lifespan total, including MO1[48] **(Gross Domestic)**	**kt**	**0**	**283,055**	**285,215**	**283,185**	**276,725**

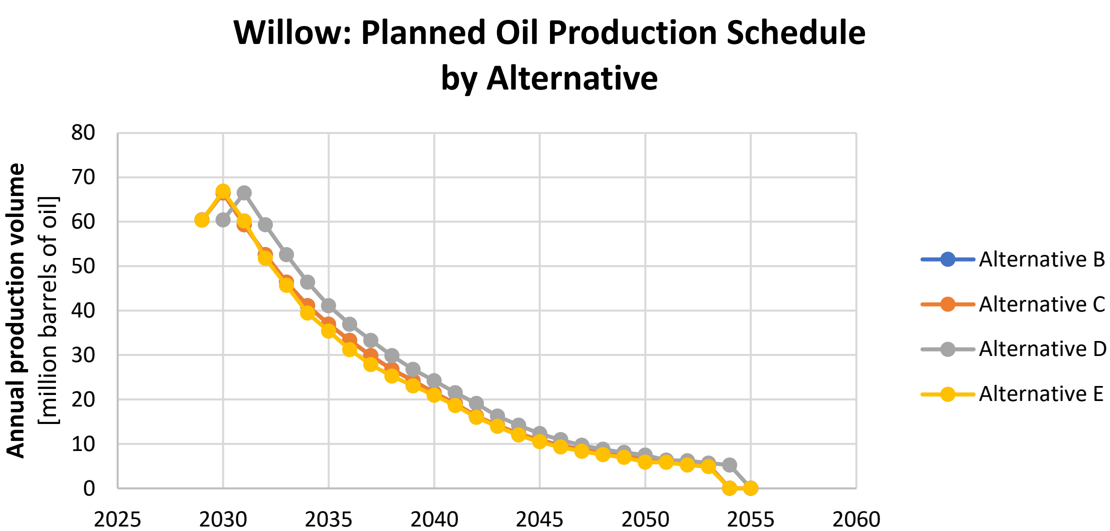

Figure 2. Planned oil production reported in Willow DSEIS for each NEPA alternative.

All other data on climate scenario characteristics (i.e., trajectories for carbon emissions and fossil energy demand in the U.S. consistent with 1.5°C modeling) and existing energy system characteristics (i.e., committed emissions and supply from existing infrastructure in the absence of further development)

[42] Unless otherwise specified, values in column are from DSEIS app. E.2A at 10, tbl. E.2.2.
[43] Unless otherwise specified, values in column are from DSEIS app. E.2A at 12, tbl. E.2.3.
[44] Unless otherwise specified, values in column are from DSEIS app.E.2A at 13, tbl. E.2.4.
[45] Unless otherwise specified, values in column are from DSEIS app.E.2A at 13, tbl. E.2.5.
[46] Calculated as lifespan x average annual CO_2.
[47] Module delivery option 1 produces the same total emissions across all alternatives, however, with different timing for alternative D. Unless otherwise specified, values in row are from DSEIS app. E.3B, tbls. 2.1-29 through 2.1.34
[48] Calculated as Lifespan Total + Total Additional Direct – Module Delivery Option 1.

were sourced from the same version of data as described in the manuscript and appendix. As in the manuscript, the Willow alternatives were assessed with respect to two common but distinct climate goals: (1) global warming limited to 1.5°C with low- or no-overshoot, as modeled for the IPCC's Special Report on 1.5°C of warming[49], and (2) net-zero CO_2 emissions by 2050, as modeled for Princeton University's Net Zero America study (Princeton).[50] These studies provided data on budgeted CO_2 emissions and fossil energy demand over time for use in our equations, while data for committed emissions and existing energy supply came from Tong *et al.*[51] and the U.S. Energy Information Administration (EIA).[52]

We offer four major sets of analyses. First, we offer a single baseline scenario estimate of significance for each project alternative (B-E), derived from using the best single point estimates of each alternative project-related variable available from the DSEIS, and baseline values for climate scenario and existing infrastructure-related inputs as in the manuscript, focused on only those emissions directly linked to the project lifecycle (reported as "gross" emissions)[53] and only those that are domestic. This is the approach that is most consistent with the geographic scope of the current beta climate test workbook tool (currently populated with US-focused data), and default method employed in the analysis currently under peer review in our manuscript. Additionally, focusing on just the "gross" emissions of the project, and activities occurring as the fuel moves downstream to ultimate end use for energy, reflects the least ambiguous evaluation of the project's impacts on potentially worsening warming because it avoids prediction of other secondary effects elsewhere. However, we still offer a preliminary demonstration of how our tool can also be used to consider "net"[54] effects when assessing climate significance of a project,

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[49] D. Huppmann *et al.*, "IAMC 1.5°C Scenario Explorer and Data Hosted by IIASA (release 1.x)," International Institute for Applied Systems Analysis & Integrated Assessment Modeling Consortium (2018), https://doi.org/10.22022/SR15/08-2018.15429; *see also* IPCC 2018, "SR1.5," 5.

[50] E. Larson *et al.*, *Net-Zero America: Potential Pathways, Infrastructure, and Impacts*, Final Report, Princeton University, Princeton, NJ (Oct. 29, 2021), https://netzeroamerica.princeton.edu/the-report.

[51] Tong *et al.* 2019.

[52] EIA, *April 2019: Monthly Energy Review* (Apr. 2019), https://www.eia.gov/totalenergy/data/monthly/archive/00351904.pdf.

[53] DSEIS at 40 ("The gross indirect GHG emissions from domestic sources were calculated using GLEEM (with updates described in Appendix E.2A) and represent emissions that would result from the processing and consumption of Project oil if no market effects were considered. In addition to the emissions calculated using GLEEM, emissions from the transport of Project oil from the North Slope through the TAPS to the Valdez Marine Terminal and then to refineries via CPAI polar tankers were estimated along with emissions from the transport of liquid fuels to the Project via barge, rail, and tanker. These emissions were added to the indirect emissions calculated with GLEEM. See Appendix E.2A for a description of the methods used to estimate these emissions.").

[54] *Id.* at 3.2.2.3. The DSEIS explains:

> The emissions, in CO_2e, produced from energy sources displaced by the Project accounting for market effects are also shown in Table 3.2.2 to Table 3.2.4. These emissions are derived using the updated GLEEM model with substitution rates estimated by the BLM EnergySub Model. The methods and assumptions of the EnergySub Model are discussed in Appendix E.2B. The net CO_2e change shown in Table 3.2.2, Table 3.2.3 and Table 3.2.4 is the difference between the previous columns and reflects the net change in CO_2e under each alternative with respect to the baseline No Action Alternative (Alternative A).
>
> The Project would increase total U.S. crude oil production which would reduce prices for oil and other energy sources and result in changes in both domestic and foreign energy consumption. The changes in domestic and foreign oil consumption as a result of Project production are estimated using the EnergySub model (Appendix E.2B). The increases in oil consumption domestically and

i.e., including the substitution outcomes of BLM's EnergySub modeling, which predicts a total amount of displaced CO_2-equivalent GHGs for each project alternative due to changes elsewhere in the energy system. Finally, because uncertainty is an unavoidable challenge of any forward-looking analysis involving human activity, we employ a set of probabilistic simulations—called Monte Carlo analyses—like those conducted in the manuscript, to get a sense of the statistical likelihood of the project resulting in less significant climate impacts, i.e., getting an emissions significance result of greater than 1, under conditions other than the baseline. This was done for one illustrative project alternative (Alternative B), for each of the two climate goals (IPCC 1.5°C and Princeton Net0x2050), and for each of the "gross" and "net" effect regimes, resulting in four Monte Carlo analyses.

A. Results – gross emission regime

Willow's planned oil production would result in gross domestic CO_2 emissions, totaling between 277 and 285 million metric tons from direct and indirect downstream activities, over the course of its three-decade lifespan running from the early 2020s to the early 2050s.[55] During this time-period, it would provide oil containing between 3.649 and 3.745 Exajoules (EJ) of primary energy for use downstream to meet demand for fossil energy over that same duration.

Assuming the project begins construction in 2023 (year 0), for project alternatives B, C, and E, where oil production is scheduled to start in year 6, that means the scope for determining total budgeted carbon emissions and fossil energy demand is 2023 – 2052, and 2023 – 2053 for alternative D. The specific time-period can matter significantly because it determines what point and what portion of the rapidly decarbonizing 1.5°C pathways the project gets compared to in this tool. For this reason, the same amount of cumulative emissions could take place at different points in the future and result in different significance scores, due to dynamic interactions of the diminishing carbon budget, shrinking fossil demand, and declining effects of existing infrastructure emissions over time as they naturally phase out. In this case, the time periods were so similar the effect is minimal (<2% deviation for all factors across alternatives) within a given climate scenario.

Cumulative annual US emissions consistent with IPCC's 1.5˚C median scenario would total approximately 53.73 billion metric tons of CO_2 over the project alternatives' lifespan from 2023 to 2052, or 53.68 billion metric tons through 2053. The latter, which is a longer time period, represents a smaller cumulative emission budget for that period due to the 1.5˚C pathways requiring net negative emissions after 2050. Of that 53+ billion metric tons of budgeted emissions, we estimate committed emissions from existing infrastructure would consume 38.47 through 2052 or 38.63 billion metric tons through 2053 (~72%). This leaves just 15.26 billion metric tons of CO_2 over 30 years remaining for alternatives B, C,

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> abroad would result in GHG emissions. Emissions from the change in domestic consumption of oil and other energy sources (e.g., coal, natural gas) under the No Action Alternative are estimated using GLEEM with updates to model inputs as described above.

Id.

[55] Note that these values are slightly lower than what is presented elsewhere in the DSEIS documentation due to the fact that it represents only the portion of GHG emissions that are CO_2 directly. This is not a commentary on the importance or unimportance of non-CO_2 greenhouse gases and considering information about their effects when evaluating environmental impacts; however, unfortunately, existing global warming potential conversion factors do not work well to predict aggregate warming over time. Aggregated CO_2-equivalent GHGs as currently reported do not track linearly with temperature, a central relationship that makes cumulative CO_2 emissions such a useful proxy for measuring warming long-term (and therefore climate change). For this reason, the tool's creators made the decision to limit the first version of the climate test to only evaluate significance in terms of CO_2 emissions for the initial proposal. This represents a limitation of the existing methodology. Work is underway to resolve this limitation at the time of this comment.

and E, and 15.05 for alternative D. This remaining value is what the Willow project's lifetime gross emissions ought to be compared to, and what forms the basis of the *emissions impact* component of the climate test significance metric. Similarly, cumulative fossil energy demanded in IPCC's median 1.5˚C scenario over the project lifespan totals 1,230.21 EJ of primary energy through 2052 and 1253.57 EJ through 2053; of this, 553.95 EJ and 556.10 EJ of primary energy would be expected to be supplied from continued operation of existing energy infrastructure over those same time periods, respectively (~45%), leaving 676.26 EJ of unmet demand which the project's planned supply could help meet by 2052 for alternatives B, C, and E, and 696.26 EJ for alternative D by 2053. This is the second figure of merit against which the project alternatives should be evaluated, *i.e.* their *energy contribution*. The resulting values of each and of the emissions significance for the IPCC baseline scenario are presented in Table 3.

Table 3 summarizes the resulting value of all project-relevant components of the Willow climate test assessments under single value (baseline) conditions for each alternative in relation to both IPCC's 1.5˚C target and Princeton's net-zero by 2050 target. Figure 3 displays the results of final decision metric emissions significance for each project alternative, in each climate scenario, highlighting the threshold of 1 for ease of interpretation.

Notably, none of the alternatives, except for the no action alternative, would result in a less than significant impact as measured with respect to either climate goal. However, Alternative B always resulted in the lowest impact, although not by much. IPCC represents a slightly stricter target and therefore leads to consistently higher *emissions significance* for each given alternative. IPCC significance results varied between 3.35 – 3.50 among the project alternatives as compared to 2.66 - 2.77 with respect to the Princeton target. Because project characteristics – like lifespan, total CO_2 emissions, and total energy supplied – are not affected by the choice of climate scenario, these values remain constant across the two sections of the table on IPCC and Princeton. Changing the climate scenario only shifts the budgeted emissions and fossil energy demand to which this project is compared, leading to differing *emissions impact* submetric, *energy contribution* submetric, and final *emission significance* metric values for the same project alternatives relative to each climate goal. The other outstanding factor, existing energy infrastructure, remains consistent across all of the baseline results in the gross emission analysis regime.

Table 3. Summary results from baseline climate test assessment of Willow project alternatives, assuming Module Delivery Option #1. Gross, domestic emissions only.

ID	Description	Project Lifespan [yrs]	Project Total CO_2 Emissions [$GtCO_2$]	Project Total Energy Supplied [EJ]	Emissions Impact Submetric [%]	Energy Contribution Submetric [%]	Emission Significance Metric Result [%/%]	Climate test: Significant Climate Impact? [>1?]
Climate scenario #1 = IPCC: 1.5°C with no- or low-overshoot								
A	No Action Alternative	0	0	0	0	0	0	≤1; Not significant
B	Proponent's Project	30	0.283	3.745	1.855%	0.554%	3.349	>1; Significant
C	Disconnected Infield Roads	30	0.285	3.745	1.869%	0.554%	3.375	>1; Significant
D	Disconnected Access	31	0.283	3.745	1.881%	0.537%	3.503	>1; Significant
E	Three-Pad Alternative	30	0.277	3.649	1.813%	0.540%	3.361	>1; Significant
Climate Scenario #2 = Princeton: Net-Zero CO_2 emissions by 2050								
A	No Action Alternative	0	0	0	0	0	0	≤1; Not significant
B	Proponent's Project	30	0.283	3.745	1.186%	0.445%	2.662	>1; Significant
C	Disconnected Infield Roads	30	0.285	3.745	1.195%	0.445%	2.683	>1; Significant
D	Disconnected Access	31	0.283	3.745	1.210%	0.437%	2.766	>1; Significant
E	Three-Pad Alternative	30	0.277	3.649	1.159%	0.434%	2.671	>1; Significant

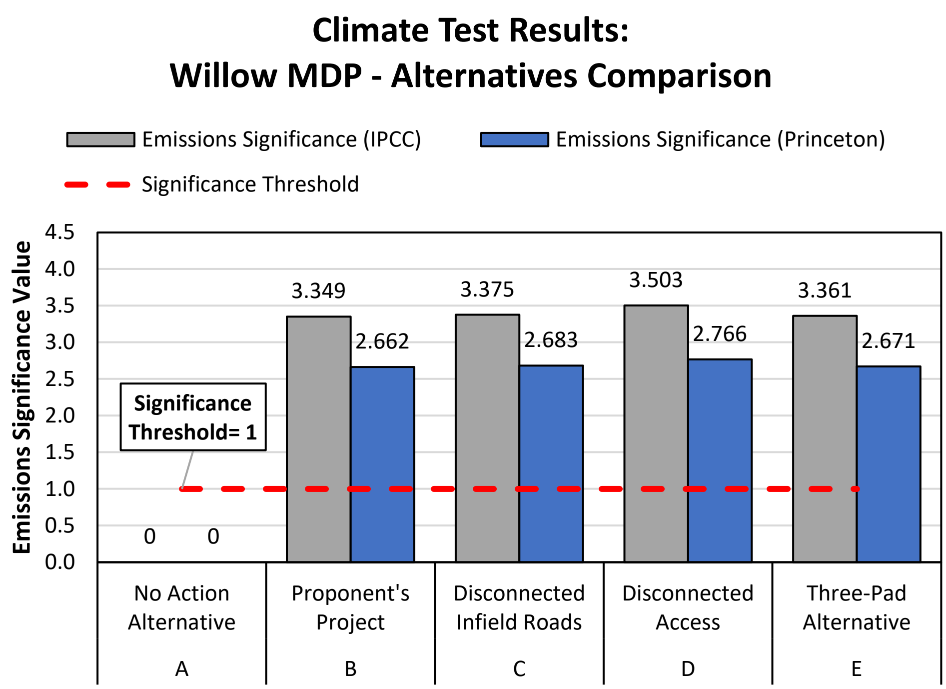


Figure 3. Summary result of emissions significance decision metric from baseline climate test assessment of Willow proposed alternatives.

B. Statistical results – taming uncertainty with Monte Carlo analysis

Application of the climate test will almost always be affected by uncertainty. This can be with respect to default assumptions, which may or may not accurately reflect present or future circumstances; or with respect to changes in the global energy system and committed emissions over time, which are by nature imperfect projections. In order to address this inherent uncertainty, we ran Monte Carlo simulations to determine the impact of uncertainty on our findings that all project alternatives are highly significant, as described above. As described below, our analysis concluded a very high probability that these alternatives would continue to be highly significant, even when assuming a wide range of possible values for the uncertain variables.

We generated 10,000 compound scenarios by randomly sampling values for each of the input parameters, using the distributions documented in the manuscript appendix. However, for this application we focused on a subset of the parameters, namely those which represented conditions *outside* the project itself (see Figure 4), for a few reasons. For starters, there was much less uncertainty surrounding the project operating lifespan, which is proposed to take place following some years of construction and proceed along a particular trajectory over 25 years beginning at year 6 or 7. Custom time-series emission inputs, such as these, are much more difficult to explore as they require indexing as well as more complex description of factors to manipulate in order to yield reasonable scenarios. Initially, we did not include project parameters like operating lifespan or operating capacity factor in the Monte Carlo analysis due to these practical limitations. However, the result also represents a better fit for providing information directly relevant to the scenarios BLM is charged with considering, rather than focusing on creating new ones.

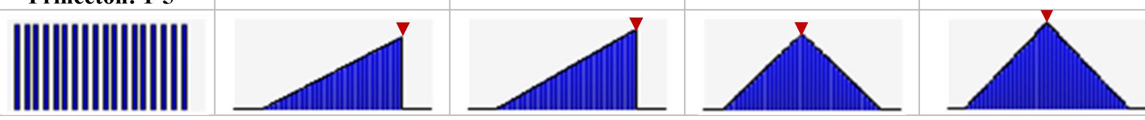
	Climate goal scenario ID	Share of annual committed emissions realized by target year	Years to target share of committed emissions realized	Change in emissions intensity of committed energy	Committed emissions - upstream correction factor
	IPCC: 1-18 Princeton: 1-5	0 – 100%	0 – 25 years	+/-20%	0% - 20%
PDF					

Figure 4. Visual depiction of input value distributions used in Monte Carlo analyses, where the blue shapes indicate the probability density function (PDF) for each input (i.e. the likelihood of each particular value being randomly generated). Baseline value of each is highlighted with a small red triangle.

The result is a distribution of *emissions significance* – as well as all intermediate variables – for each combination of project alternative, climate scenario, and scoping regime. Since there was little difference revealed in baseline estimates of emissions significance for project alternatives, we chose to focus on conducting Monte Carlo analyses on only one illustrative version, Alternative B. Similarly, because module delivery options only add between 0.015% - 0.056% to project gross emissions otherwise, we stuck with one module delivery option – Option #1, a module transfer island called Atigaru Point - for simplicity. Across all 10,000 scenarios generated, the median significance value for both the IPCC and Princeton sets of climate goal simulation conditions is well above 1 – at 2.38 and 2.27, respectively. No runs resulted in a significance value of less than or equal to 1, suggesting extremely high confidence that the project would lead to significant climate impacts. At the very least, the minimum result of 1.35 suggests 30% greater impact than would be consistent for a project of that size and required extreme assumptions about changes to the existing energy system.

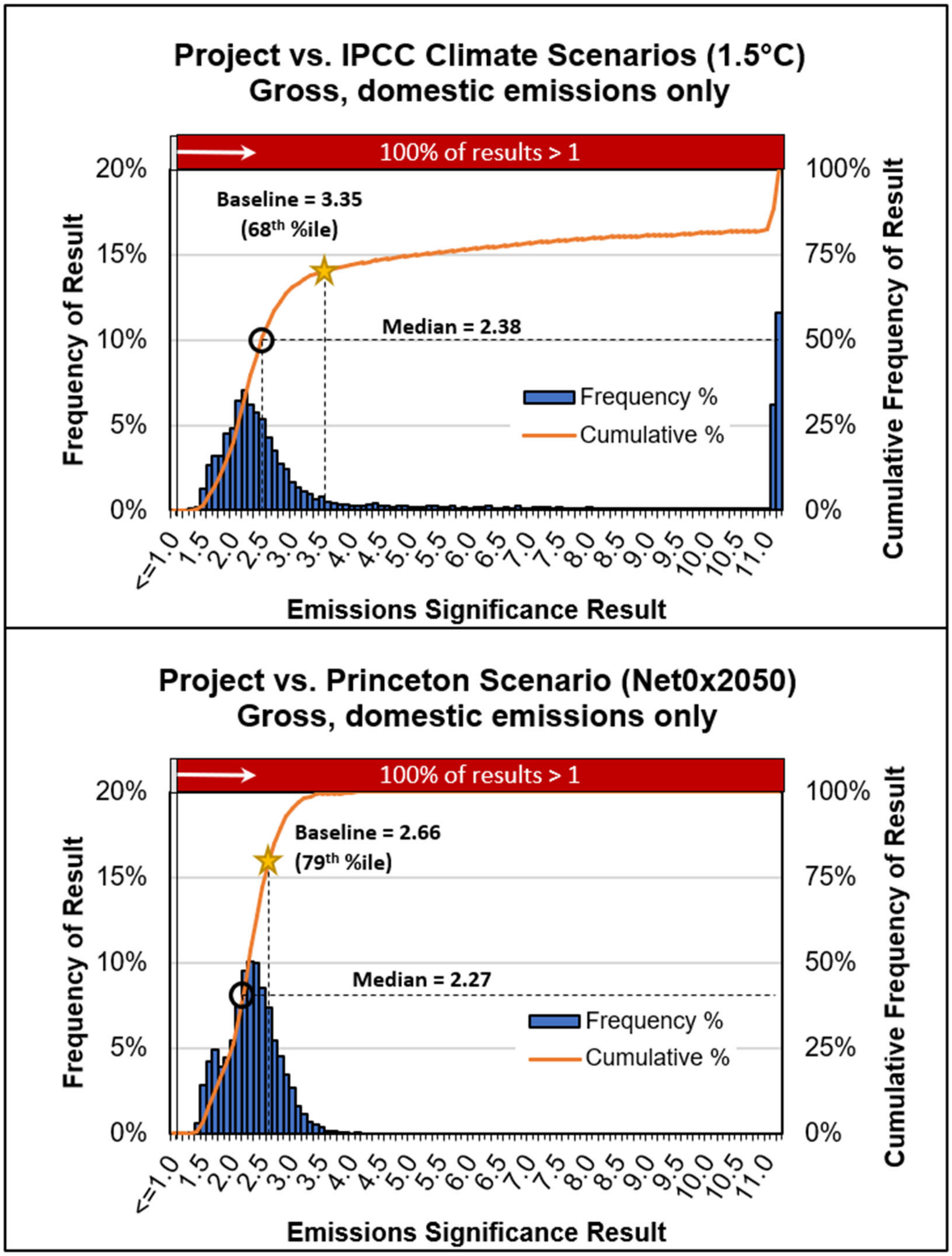


Figure 5. Result of partial Monte Carlo simulation for Willow, Alternative B with Module Transfer Option 1, gross domestic emissions only, as compared to (top) IPCC climate scenarios of 1.5°C with no- or low-overshoot and (bottom) Princeton climate scenarios of net-zero CO_2 emissions by 2050. Note: the rightmost value bucket represents a condition of no remaining budget at all.

It is worth emphasizing that the range of values explored in the Monte Carlo analysis were chosen to represent the largest possible range for most input parameters. Due to the starkness of the result – with no simulated conditions leading to a less than significant finding for this project – it would be reasonable to wonder whether the ranges were overrepresented with unfavorable assumptions that are also likely to be improbable. However, a closer look at each one would reveal the opposite, if anything (see Figure 4). Of the five non-project-related input variables explored in this set of simulations, one was completely neutral (climate scenario ID), two were evenly distributed around the baseline assumption leading to equal effects of over or underestimation (committed emissions change in energy intensity over time, and committed emissions upstream correction factor) and two others were defined in such a way that only alternatives with lesser impacts make sense to include (proxy modifiers affecting the level and timing of reduced levels of committed emissions, respectively).

In the case of the latter, the baseline assumption is that 100% of committed emissions, as modeled by Tong *et al.* in their 2019 publication, come to pass over time. Annual levels gradually decline over time, as different types of fossil energy infrastructure phase out over time, according to their age distributions, expected lifespans, and emission factors at the time of analysis. It is entirely plausible that less than the full expected level of committed emissions could turn out to be released over time due to policy or economic conditions that cause fossil technology to retire earlier or operate less than anticipated, and this change can be approximated in the model through a combination of the two committed emission modification factors leading to, say, only 60% of annual committed emissions being realized in years after 2040. It is also possible, and arguably not yet captured in our model, that the committed emissions are underestimated, and could in fact consume more of the budgeted emissions than put forth in Tong *et al*.[56] Certainly additional projects have been approved, and some retired early, since publication of that data, but overall committed emissions from existing infrastructure, once estimated in a given time period, by definition only decline over time. It is entirely possible that we underestimate, but this again would suggest a numerical skew that potentially produces more charitable results to projects (lower central tendencies), rather than one likely to artificially produce conditions that preclude a less than significant result. Further developments to refine and improve estimates of committed emissions are also underway by the authors.

C. Results – "net" emission regime accounting for displacement in climate test metrics

Net emissions analyses are intended to help reconcile multiple, often opposing, effects of activities resulting from development of a proposed project, such as displacement of other existing energy sources through direct substitution or indirect price effects. While the climate test tool is compatible with assessing significance in net emission regimes, we found that the values reported as net emissions in this DSEIS, *e.g.*, in Table 3.2.2,[57] were not appropriate for use in the climate test framework directly because they represent effects on multiple different components of the metric. Additionally, relevant information on the kind of displaced energy was missing from the DSEIS documentation and needed to be estimated before application could begin. As described below, when placed in the appropriate contexts, even the seemingly large amount of emissions that BLM's modeling suggests will be displaced by the Willow project's introduction do not lead to a different conclusion regarding its inconsistency with climate goals. This is true across all alternatives and only reduces the baseline *emissions significance* metric value by 0.9% - 1.4% as compared to the gross emissions regime estimated levels, suggesting further confidence in our findings regarding this project.

This DSEIS, like many climate impact assessments, goes beyond merely reporting gross emissions from the project by attempting to engage with a concept of "net" emissions analysis, as shown

[56] Tong *et al.* 2019 using data from Source Data Fig.1 available for download at https://www.nature.com/articles/s41586-019-1364-3#Sec23 (last visited Aug. 29, 2022).
[57] DSEIS at 41.

in DSEIS Table 3.2.2.[58] Net emissions analysis is an approach for reconciling multiple, related indirect effects associated with a project, especially where there is potential for counteracting effects. Specifically, when there is a change in activity outside of its own fuel lifecycle or supply chain *induced* by the project's operation. This is notably distinct from the practice of including indirect lifecycle emissions associated with enabling the delivery of the function for which the project is being proposed, i.e., to meet energy service needs of our society. Instead, the displaced emissions will be activities that affect another piece or pieces of existing infrastructure, e.g., through impacts on price of fuel, rather than affecting the expected downstream indirect activities associated with the fuel the project under consideration produces. As such, combining them directly and framing them as the resulting effect on warming misrepresents where these counterbalancing effects happen in the system, what they represent, and how they affect determination of a project's significance to driving warming.

Because this kind of example was not included in the manuscript on the climate test, we describe the application of net effects in greater detail before launching into results. Figure 6 is a new diagram produced by the authors of the climate test metric, depicting how each element of the displacement-related net effect analysis should be applied conceptually. Taking Table 3.2.2.[59] for example, "Gross CO2e Resulting from Project" includes both direct and indirect emissions that would get added as new emission sources from incremental activities associated with bringing Willow's energy resources to bear at the point of eventual combustion. Separately, "CO_2e from Energy Sources Displaced by Project" represents avoided emissions from a change in operation of existing energy infrastructure, and therefore does not belong in combination with gross project emissions as a measure of a project's lifecycle emissions. Rather, it represents a reduction in committed emissions from the existing energy system. Such a reduction does mean there is more remaining carbon budget against which the project's gross emission are measured to evaluate the *emissions impact* component of the *emissions significance* decision metric, suggesting a certain reduction in the resulting *significance* metric value. However, the change in emissions is explicitly described in this instance as resulting from a displacement of energy elsewhere in the system, meaning the corresponding energy variables in the *energy contribution* component of the *emissions significance* metric must also be adjusted to capture this effect.

[58] DSEIS at 41, tbl. 3.2.2.

[59] *Id.*

Table 3.2.2. Total (Gross and Net) Domestic Greenhouse Gas Emissions (thousand metric tons) over Project Duration for Each Action Alternative Based on 100-Year Time Horizon Global Warming Potential Values from the Intergovernmental Panel on Climate Change Fourth Assessment Report*

Alternative	GHG Emissions Type	Gross CO_2e Resulting from Project[a]	CO_2e from Energy Sources Displaced by Project[b]	Net CO_2e Change from Baseline CO_2e[c]
B: Proponent's Project	Direct	23,615	NA	+2[illegible],615
B: Proponent's Project	Indirect	260,790	213,419	+47,[illegible]71
B: Proponent's Project	**Total**	**284,405**	**213,419**	**+70,98[illegible]**
C: Disconnected Infield Roads	Direct	25,786	NA	[illegible]
C: Disconnected Infield Roads	Indirect	260,790	213,419	[illegible]
C: Disconnected Infield Roads	**Total**	**286,575**	**213,419**	[illegible]
D: Disconnected Access	Direct	23,739	NA	[illegible]
D: Disconnected Access	Indirect	260,790	213,419	+47,37[illegible]
D: Disconnected Access	**Total**	**284,530**	**213,419**	**+71,[illegible]11**
E: Three-Pad Alternative (Fourth Pad Deferred)	Direct	23,644	NA	+23,[illegible]44
E: Three-Pad Alternative (Fourth Pad Deferred)	Indirect	254,392	208,186	+4[illegible],206
E: Three-Pad Alternative (Fourth Pad Deferred)	**Total**	**278,036**	**208,186**	**+[illegible]9,850**

Do not use directly

Note: CO_2e (carbon dioxide equivalent); GHG (greenhouse gas) ; NA (not applicable). Project duration would be 30 years under Alternatives B, C, and E, and 31 years under Alternative D. The global warming potential values used [illegible] dioxide = 1; methane = 25; nitrous oxide = 298.

[a] Indirect gross CO_2e is from the Willow Project's indirect GHG emissions estimated using the Bureau of Ocean and Energy Management's (BOEM) Greenhouse Gas Life Cycle Energy Emissions Model (Wolvovsky 2021) with updates [illegible] in Appendix [illegible] may not match exactly due to rounding.

[b] CO_2e from Energy Sources Displaced by Project is estimated using the substitution rates modeled by BLM EnergySub (Appendix E.[illegible]B) and in GLEEM with updates. Numbers may not match exactly due to rounding. Substitution rates from EnergySub were rounded to the nearest whole percentage for use in GLEEM.

[c] The net CO_2e change is the difference between the previous columns. The + sign indicates an increase in emissions from baseline (i.e., as compared to the No Action Alternative).

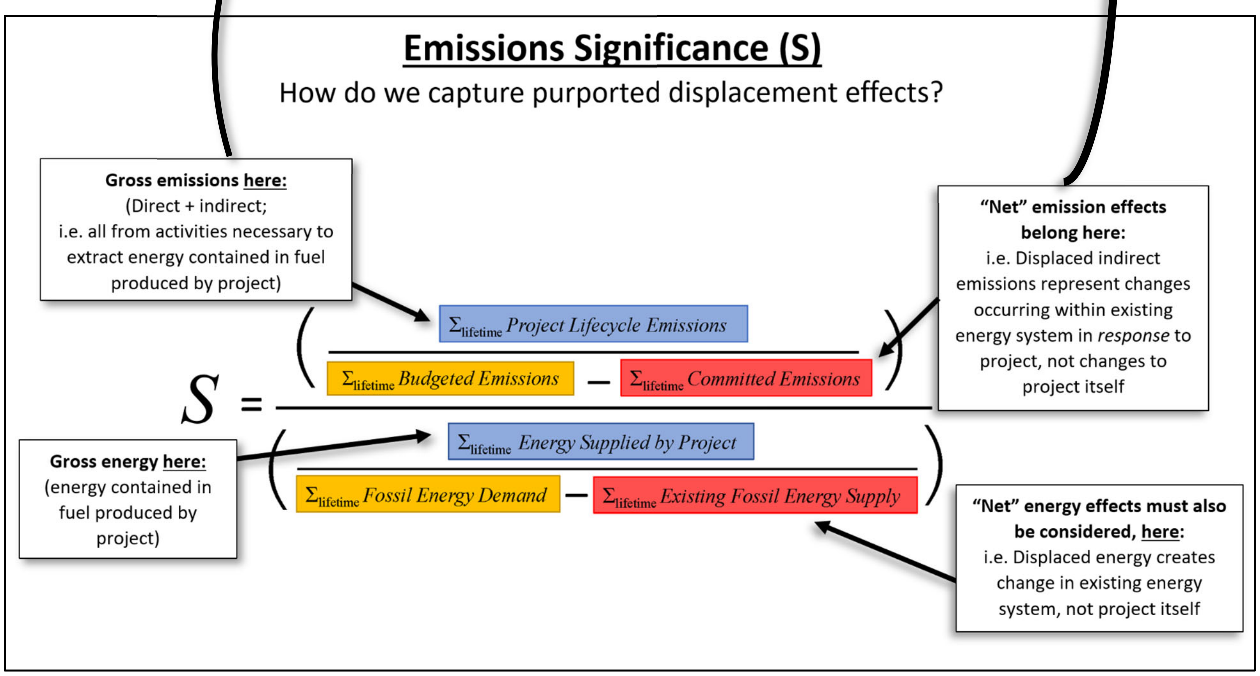


Figure 6. Diagram summarizing methodology to evaluate emissions significance in the "net" emissions regime, accounting for purported displacement effects, highlighting difference in how net emissions are presented in the DSEIS.

1. Baseline results: comparing gross and net emission regimes

Applying the above methodology to Willow produces the results shown in Figure 7. Emissions from this net regime are presented alongside the results for a gross emissions analysis regime to enable comparison of the effects for each project alternative and climate scenario. All alternatives remain at significance levels above 1 – ranging from 3.32 to 3.46 for IPCC and 2.64 to 2.74 for Princeton climate scenarios – indicating consistent findings of significant impacts for the project despite displacement effects. Values of significance are only minimally affected, remaining within roughly 1% of their gross emission determined levels in all cases. This is due to the use of energy contribution as a normalizing factor for judging significance of emission impact, and the commensurate effect of displacement activity on both numerator and denominator of the significance metric.

If given more information, a better net emission analysis of climate significance could be conducted with more accurate representation of the magnitude of energy displaced, but it is unlikely to result in the two to three-fold reduction necessary for conclusions to meaningfully change. BLM did not provide sufficient documentation of the results produced from its EnergySub modeling to support direct data collection regarding the kind of energy being displaced, so, to determine its effects, we chose to assume that all energy displaced was other oil, as opposed to coal or gas. Additionally, because no breakdown was provided as to the portion of total CO_2-equivalent GHGs avoided that were from CO_2 directly, as opposed to other gases, we estimated the same share of CO_2/CO_2e reflected for each alternative in DSEIS Appendix E.2A at Table E.2.2, which is nearly 100%. This factor was used to back calculate an estimate of energy displaced from the total lifetime emissions reported in DSEIS Table 3.2.2.[60]

[60] DSEIS at 41.

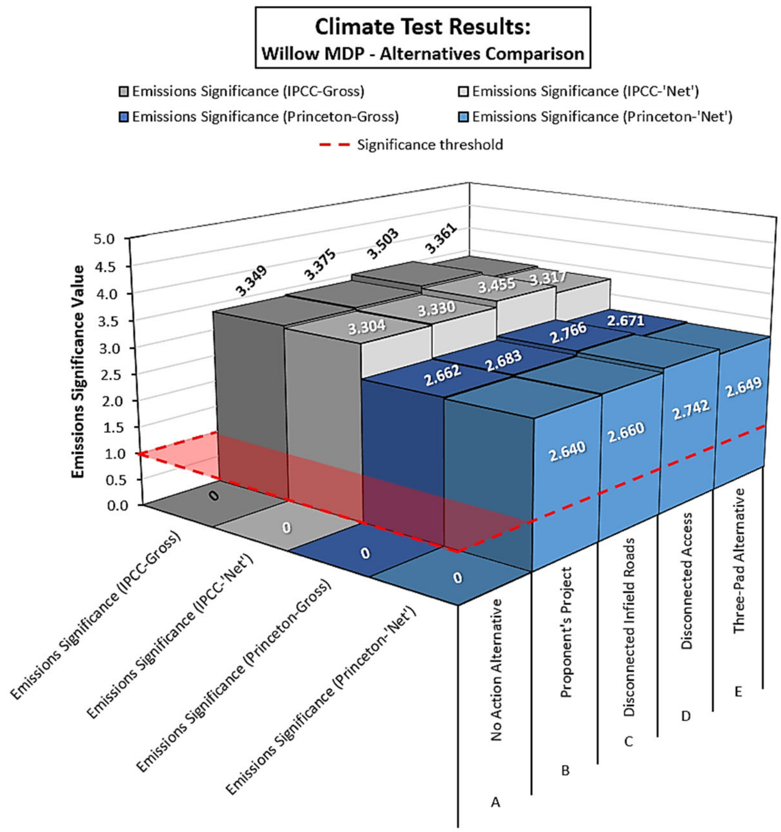


Figure 7. Summary baseline results for Willow, assuming module transfer option 1, for each NEPA alternative (A-E), for each climate goal scenario (IPCC-1.5°C or Princeton-net0x50), and DSEIS reported emissions scope (gross only, or gross with "net" adjustment to existing energy system for energy and emissions displaced by project).

2. Monte Carlo analyses: comparing gross and net emissions regimes

As with the comparable section above, Monte Carlo analysis was conducted to evaluate if and under what conditions the baseline assessment determination of significance would change, and we confirmed that none of the climate scenarios nor existing energy system input alternatives could overcome the high emissions intensity of this project enough to do so (see Figure 8). Median values did drop very slightly for each climate scenario under the net emission regime, from 2.38 to 2.36 for IPCC and from 2.27 to 2.25 for Princeton. No scenarios ever resulted in a value less than 1.27 for either climate scenario.

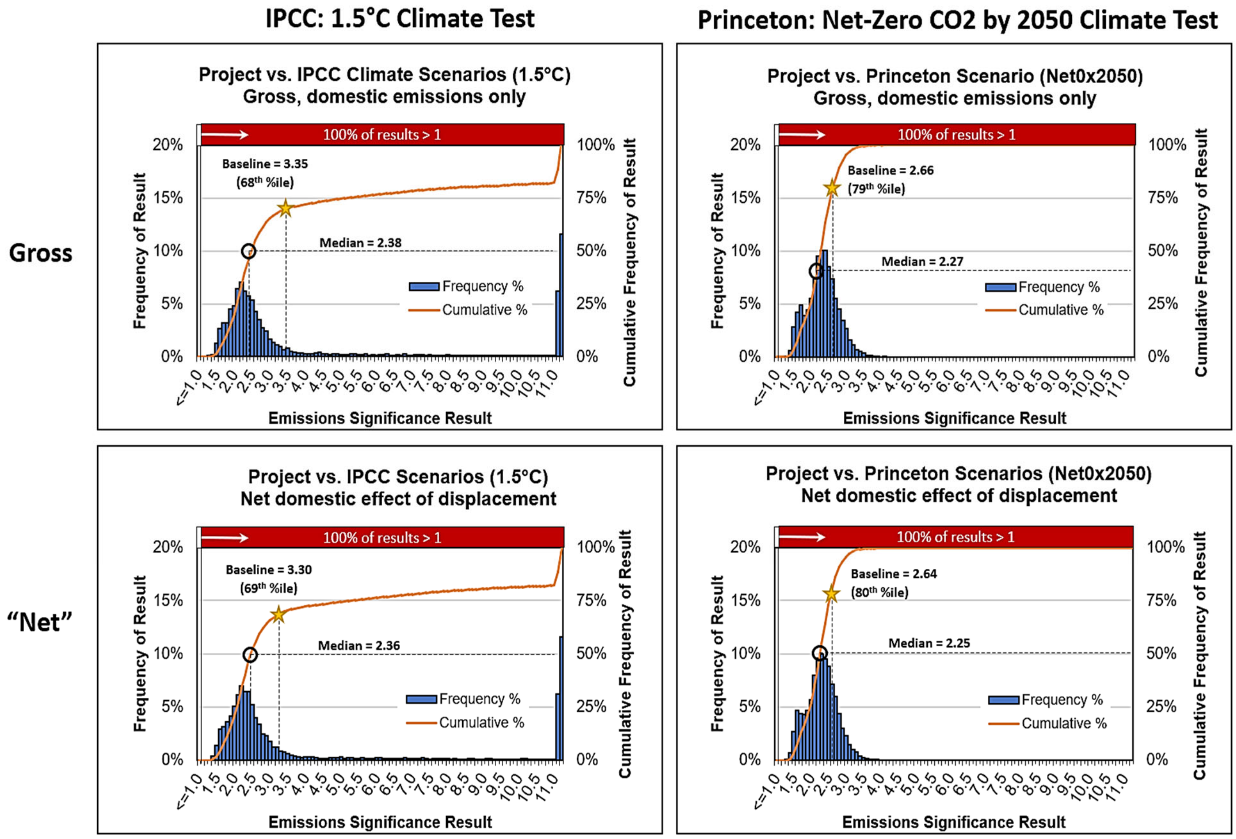


Figure 8. Resulting emissions significance distributions from four Monte Carlo simulations run on Willow, Alternative B with Module Transfer Option 1. Each distribution reflects a different combination of chosen climate scenario source, i.e. IPCC's 1.5°C with no- or low-overshoot scenarios (left column figures) or Princeton's net-zero CO_2 emissions by 2050 scenarios (right column figures), as well as chosen scope for indirect emission effects – i.e. gross emissions only (top row figures) or "net" effects from purported energy displacement in response to the proposed project. Bars all the way to the far right in each distribution represent scenarios where there is no remaining carbon budget, resulting in an indeterminant value, which is significant by definition.

IV. Willow's significant climate impacts justify denying the project.

All analyses of the Willow project indicate that it is inconsistent with any of the climate targets explored, even under the thousands of contingencies considered by our Monte Carlo analysis. To approve it would be to commit the U.S. to a new long-lived and expensive piece of fossil fuel infrastructure with 2-3 times more impacts from carbon emissions than the contributions it would make to meeting energy needs, increasing the probability that the U.S. will fail to achieve necessary climate commitments. Put another way, one would have to assume the project's emissions could be reduced by half to two-thirds to prevent driving us off course from the 1.5°C target. Is that being proposed? Is that reasonable to expect? Is such an outcome acceptable to risk? The rational conclusion to draw is that Willow's climate impacts are so significant that they justify denying the project or otherwise limiting it to the maximum extent allowable by law.

Even an additional scenario where fewer pads were constructed and lower volumes of oil were produced over the project lifespan is highly likely to produce a significant climate impact. This is a consequence of the inherent emissions intensity of oil, the advanced state of our warming, and entrenched fossil energy system in place. Accordingly, BLM should take action to mitigate the absolute impact of the project on the climate and the Reserve's resources to the maximum extent of its authority. In this case, that means selecting the no action alternative.

Sincerely,

Jeremy Lieb
Senior Attorney
EARTHJUSTICE

Michele Bustamante, Ph.D.
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