The Wilderness Society ◆ Wilderness Workshop ◆ Rocky Mountain Wild ◆ Western Environmental Law Center ◆ Conservation Colorado ◆ San Juan Citizens Alliance ◆ Western Colorado Congress

November 14, 2016

Ruth Welch, State Director
BLM Colorado State Office□
2850 Youngfield Street
Lakewood, Colorado 80215-7093
Hand delivered

RE: Formal Protest of December 8, 2016 Oil and Gas Lease Sale

Dear Director Welch:

Please accept and fully consider this timely protest of BLM Colorado's fourth quarter oil and gas lease sale. This protest challenges BLM's Determination of NEPA Adequacy (DNA), DOI-BLM-CO-N040-2016-0044-DNA, and the agency's decision to proceed with the sale of new leases located in the Colorado River Valley and Grand Junction Field Offices, including parcels:

1. COC77994 (7584)
2. COC77995 (7585)
3. COC77996 (7586)
4. COC77997 (7587)
5. COC77998 (7588)
6. COC78000 (7598)
7. COC78001 (7599)
8. COC78010 (7600)
9. COC77989 (7602)
10. COC77987 (7603)
11. COC77988 (7604)
12. COC78002 (7611)
13. COC78003 (7612)
14. COC78004 (7613)
15. COC77990 (7614)
16. COC77991 (7615)
17. COC78005 (7616)
18. COC77992 (7617)
19. COC77993 (7618)
20. COC78006 (7620)
21. COC78007 (7622)
22. COC78008 (7625)
23. COC78009 (7626)
24. COC77981 (7629)
25. COC77999 (7917)

This protest is submitted on behalf of The Wilderness Society, Wilderness Workshop, Western Environmental Law Center, Conservation Colorado, Rocky Mountain Wild, San Juan Citizens Alliance, and Western Colorado Congress.

The undersigned groups previously submitted comments in February and June of 2016. In earlier comments we raised issues related to the appropriate level of analysis for these new proposed lease parcels, as well as issues related to specific values that must be considered and protected, and concerns about the adequacy of existing programmatic plans.

This protest underscores our concerns about BLM's decision not to undertake any site-specific analysis of proposed parcels, as well as BLM's failure to consider potential impacts of new oil and gas leasing on climate and the lack of existing analysis to support leasing these parcels. Our organizations are deeply invested in sound stewardship of our public lands. We ask that BLM not sell or issue the proposed parcels until an adequate analysis of potential impacts, including those related to climate, can be undertaken.

PROTESTING PARTIES

Wilderness Workshop ("WW") is a 501(c)(3) dedicated to preservation and conservation of the wilderness and natural resources of the White River National Forest and adjacent public lands, including the Colorado River Valley and the Grand Junction Field Offices. WW engages in research, education, legal advocacy and grassroots organizing to protect the ecological integrity of local landscapes and public lands. WW focuses on the monitoring and conservation of air and water quality, wildlife species and habitat, natural communities and lands of wilderness quality. WW was founded in 1967 and has approximately 800 members. Many of our members live, work, and recreate in and around, and otherwise use and enjoy lands managed by the BLM in the Colorado River Valley and Grand Junction Field Offices. All members have a great interest in the protection and enhancement of natural values in the area. WW has been closely monitoring proposals, developments, and management actions on local BLM lands for many years.

The Wilderness Society ("TWS") has a long-standing interest in the management of Bureau of Land Management lands in Colorado and engages frequently in the decision-making processes for land use planning and project proposals that could potentially affect wilderness-quality lands and other important natural resources managed by the BLM in Colorado. TWS members and staff enjoy a myriad of recreation opportunities on BLM-managed public lands, including hiking, biking, nature-viewing, photography, and the quiet contemplation in the solitude offered by wild places. Founded in 1935, our mission is to protect wilderness and inspire Americans to care for our wild places.

The **Western Environmental Law Center** ("WELC") uses the power of the law to defend and protect the American West's treasured landscapes, iconic wildlife and rural communities. WELC combines legal skills with sound conservation biology and environmental science to address major environmental issues in the West in the most strategic and effective manner. WELC works at the national, regional, state, and local levels; and in all three branches of government. WELC integrates national policies and regional perspective with the local knowledge of our 100+ partner groups to implement smart and appropriate place-based actions.

Western Colorado Congress ("WCC") is an alliance for community action empowering people to protect and enhance their quality of life in Western Colorado. We have been working for land conservation and the responsible use and development of our natural resources for 35 years. Our work is based in the local knowledge and experience of our members who live, work and play in western slope communities surrounded by public lands; WCC is here to empower their voices and concerns in regards to public land management.

Founded in 1986, **San Juan Citizens Alliance** ("SJCA") organizes people to protect our water and air, our lands, and the character of our rural communities in the San Juan Basin. SJCA focuses to

ensure proper regulation and enforcement of the oil, gas, and coal industry and transitioning to a renewable energy economy. SJCA has been active in BLM and National Forest oil and gas issues in western Colorado since the 1980's, and comments regularly on multi-well drilling program, lease sale, and programmatic environmental review conducted in the region by the federal land management agencies. SJCA's members live, work, and recreate throughout the San Juan Basin and San Juan Mountains. SJCA's members' health, use and enjoyment of this region is directly impacted by the decisions made by federal agencies.

Conservation Colorado is a grassroots organization working to protect our air, land, water, and people. We have a long and successful history in Colorado of collaborating on the key environmental issues of the day, and establishing strategic partnerships to find conservation success at the state and federal levels. Our organization has a long history of working on public lands issues across Colorado, but specifically on BLM lands on Colorado's western slope. Among our thousands of members are those that live, work, recreate and enjoy the BLM lands of the Colorado River Valley and Grand Junction Field Offices for a wide variety of activities and have a vested interest in the management of those lands.

Rocky Mountain Wild ("RMW") is a non-profit environmental organization based in Denver, Colorado, that works to conserve and recover the native species and ecosystems of the Greater Southern Rockies using the best available science. RMW has a well-established history of participation in BLM planning and management activities. RMW works to save endangered species and preserve landscapes and critical ecosystems. It achieves these goals by working with biologists and landowners, utilizing GIS technology to promote understanding of complex land use issues, and monitoring government agencies whose actions affect endangered and threatened species. RMW's members and supporters include approximately 1,200 outdoor enthusiasts, wildlife conservationists, scientists, and concerned citizens across the country.

RMW's staff and members visit, recreate on, and use lands on or near the parcels proposed for leasing. Our staff and members enjoy various activities on or near land proposed for leasing, including viewing and studying rare and imperiled wildlife and native ecosystems, hiking, camping, taking photographs, and experiencing solitude. Our staff and members plan to return to the subject lands in the future to engage in these activities, and to observe and monitor rare and imperiled species and native ecosystems. We are collectively committed to ensuring that federal agencies properly manage rare and imperiled species and native ecosystems. Members and professional staff of RMW are conducting research and advocacy to protect the populations and habitat of rare and imperiled species discussed herein. Our members and staff value the important role that areas of high conservation value should play in safeguarding rare and imperiled species and natural communities, and other unique resources on public land.

Our members' interests in rare and imperiled species and ecosystems on BLM lands will be adversely affected if the sale of these parcels proceeds as proposed. Oil and gas leasing and subsequent mineral development on the protested parcels, if approved without response to public comments made under the National Environmental Policy Act ("NEPA"), consultation required by the Endangered Species Act ("ESA"), and appropriate safeguards to minimize negative impacts, is likely to result in a greatly increased risk of significant harm to rare and imperiled species and native ecosystems. As a result, BLM's decision to lease the protested parcels is not based on the best available science and will result in significant harm to rare and imperiled species and native ecosystems. The proposed leasing of the protested parcels will harm our members' interests in the

continued use of these public lands, and the rare and imperiled species they support. Therefore protestors have legally recognizable interests that will be affected by the proposed action.

STATEMENT OF REASONS FOR PROTEST

I. BLM HAS FAILED TO TAKE THE HARD LOOK REQUIRED BY NEPA PRIOR TO ISSUING NEW OIL AND GAS LEASES.

The National Environmental Policy Act (NEPA) is our "basic national charter for the protection of the environment." 40 C.F.R. § 1500.1 NEPA achieves its purpose through "action forcing procedures. . . requir[ing] that agencies take a hard look at environmental consequences." Id.; *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989) (citations omitted) (emphasis added). This includes the consideration of best available information and data, as well as disclosure of any inconsistencies with federal policies and plans. BLM must comply with its legal obligation to take a hard look at potential impacts. The following pages demonstrate how BLM has failed to comply with its obligations under NEPA.

Federal agencies must comply with NEPA before there are "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented." 42 U.S.C. § 4332(C)(v); *see also* 40 C.F.R. §§ 1501.2, 1502.5(a).

The Tenth Circuit has held that site-specific analysis is required prior to issuing oil and gas leases where there is surface that is not protected by no-surface occupancy stipulations (NSOs) and where there is reasonable foreseeability of environmental impacts. *See e.g.*, *New Mexico ex rel. Richardson v. BLM*, 565 F.3d 683, 718 (10th Cir. 2009); *Pennaco Energy, Inc. v. United States DOI*, 377 F.3d 1147, 1160 (10th Cir. 2004). This is because oil and gas leases confer "the right to use so much of the leased lands as is necessary to explore for, drill for, mine, extract, remove and dispose of all the leased resource in a leasehold" and therefore would constitute an "irreversible and irretrievable commitment of resources." *New Mexico ex rel. Richardson*, 565 F.3d at 718; 40 C.F.R. § 3101.1-2; *see also Sierra Club v. Hodel*, 848 F.2d 1068, 1093 (10th Cir. 1988) (agencies are to perform hard look NEPA analysis "before committing themselves irretrievably to a given course of action so that the action can be shaped to account for environmental values").

Here, the BLM refused to perform site-specific analysis at the lease stage, and, once lease rights are conferred, BLM's authority will be limited to imposing mitigation measures consistent with the terms of the lease. Consequently, if BLM discovers significant impacts at the APD stage, it may no longer be able to prevent them. Because BLM is irretrievably committing resources at the lease sale stage, it must consider the impacts of its decision to lease parcels before it can confer public resources to a private developer in a lease.

NEPA further requires federal agencies to consider "any adverse environmental effects which cannot be avoided." 42 U.S.C. § 4332(C)(ii). In so doing, agencies must "identify and develop methods and procedures . . . which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations." Id. § 4332(B).

To accomplish these purposes, NEPA requires that all federal agencies prepare a "detailed statement" regarding all "major federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(C). This statement, known as an Environmental Impact Statement ("EIS"), must, among other things, rigorously explore and objectively evaluate all reasonable alternatives, analyze all direct, indirect, and cumulative environmental impacts, and include a discussion of the means to mitigate adverse environmental impacts. 40 C.F.R. §§ 1502.14 and 1502.16. Any analysis must include consideration of connected, cumulative and similar actions. Id., at § 1508.25.

"Connected actions" are those which "[a]utomatically trigger other actions which may require environmental impact statements," or which "[c]annot or will not proceed unless other actions are taken previously or simultaneously, or that "[a]re interdependent parts of a larger action and depend on the larger action for their justification." Id. "Cumulative actions" are those "which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement." Id. "Similar actions" are defined as those which, when viewed with other reasonably foreseeable or proposed agency actions, have similarities that provide a basis for evaluating their environmental consequences together, such as common timing or geography. Id.

Direct effects include those that "are caused by the action and occur at the same time and place." 40 C.F.R. § 1508.8(a). Indirect effects include effects that "are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." 40 C.F.R. § 1508.8(b). Cumulative effects are "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." 40 C.F.R. § 1508.7. "Effects" are synonymous with "impacts." 40 C.F.R. § 1508.8.

Effects that must be considered include "ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative." 40 C.F.R. § 1508.8.

BLM's analysis must do more than merely identify impacts; it must also "evaluate the severity" of effects. *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 352 (1989); 40 C.F.R. § 1502.16(a)-(b) (recognizing that agency must explain the "significance" of effects).

An agency may also prepare an EA to determine whether an EIS is necessary. 40 C.F.R. §§ 1501.3, 1508.9. An EA must include a discussion of alternatives and the environmental impacts of the action. 40 C.F.R. § 1508.9.

If an agency decides not to prepare an EIS, an EA must "provide sufficient evidence" to support a Finding of No Significant Impact ("FONSI"). 40 C.F.R. § 1508.9(a)(1). Such evidence must demonstrate that the action "will not have a significant effect on the human environment." 40 C.F.R. § 1508.13. An assessment of whether or not an impact is "significant" is based on a consideration of the "context and intensity" of the impact. 40 C.F.R. § 1508.27. "Context" refers to the scope of the proposed action, including the interests affected. 40 C.F.R. § 1508.27(a). "Intensity" refers to the severity of the impact and must be evaluated with a host of factors in mind, including but not limited to [u]nique characteristics of the geographic area[,]" "[t]he degree to which the possible effects on the human environment are highly uncertain or involve unique or

unknown risks[,]" and "[w]hether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment." 40 C.F.R. § 1508.27(b).

NEPA allows an agency to "tier" a site-specific environmental analysis for a project to a broader EIS for a program or plan under which the subsequent project is carried out. 40 C.F.R. § 1508.28. When an agency tiers a site-specific analysis to a broader EIS, "the subsequent statement or environmental assessment need only summarize the issues discussed in the broader statement and incorporate discussions from the broader statement by reference and shall concentrate on the issues specific to the subsequent action." 40 C.F.R. § 1502.20.

Here, though, BLM has not completed an EA to support issuing new leases but is instead relying on a Determination of NEPA Adequacy (DNA). DNAs, unlike EAs and EISs, are not NEPA documents. They do not analyze impacts, but rather determine the adequacy of existing NEPA documents. *See e.g., S. Utah Wilderness Alliance v. Norton*, 457 F. Supp. 2d 1253, 1261-62 (D. Utah 2006). In this case, BLM is relying on analysis undertaken in the Grand Junction and Colorado River Valley Field Office RMPs to support this leasing decision. As we stated in previous comments on this lease sale and as we discuss below, BLM's DNA cannot be used to support issuance of the proposed leases because existing analyses do not adequately consider potential impacts.

In March 2016, undersigned groups submitted scoping comments to BLM regarding the proposal to lease new parcels at the scheduled November sale (the sale was later rescheduled for December 8th and is the same lease sale at issue in this protest). The comments included a thorough lease-by-lease screen identifying important wildlife, wildland, and environmental values that could be impacted by issuance of the proposed parcels. The comments also included a list of recommended Best Management Practices (BMPs) for plants of concern. In addition the comments highlighted a number of issues that were not adequately addressed in applicable RMPs, including impacts related to climate change and potential impacts of oil and gas development on human health.[1] Our prior comments were submitted with the goal of helping inform BLM's site-specific analysis of the proposed lease sale.

There is no indication in the record that BLM did anything with our March 2016 scoping comments. The agency did not undertake any site-specific analysis of the proposed lease sale. Instead, last summer BLM released a draft DNA with no analysis at all. We commented on the draft DNA, raising concerns about the lack of analysis, values that had not been considered or protected, and about BLM's failure to address public comments received during scoping.[2]

A final DNA was then issued by BLM.[3] The final DNA acknowledged comments received during a 30-day public review period in June, but included no new analysis and still failed to acknowledge or

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[1] *See* Scoping Comments on BLM's Proposed November 16, 2016 Oil and Gas Lease Sale from Wilderness Workshop, et al., to BLM Northwest Colorado District Office (March 10, 2016) and attachments (on file with BLM).

[2] *See* Comments on Draft DNAs for GJFO, CRVFO and TRFO November 2016 Lease Sale (DOI-BLM-CO-N040-2016-0044-DNA and DOI-BLM-CO-S010-2017-0001-DNA) from Wilderness Workshop, et al., to BLM (June 13, 2016) and Exhibits A-E (on file with BLM).

[3] U.S. Department of Interior, BLM, Colorado State Office, Grand Junction and Colorado River Valley Field Offices, December 2016 Oil and Gas Lease Sale Determination of NEPA Adequacy DOI-BLM-CO-N040-

respond to issues raised during scoping. The only discussion of specific values in the DNA is less than a page related to cultural resources.[4] Aside from that, the DNA includes no consideration of values or the adequacy of protections for those values. The document simply asserts that NEPA was done at the RMP level and leaves it at that.

Importantly, the RMP-level analyses already undertaken were broad—encompassing millions of acres—and intended to inform land management goals Field Office-wide. Because of the scale of an RMP analysis, it is coarse. BLM's proposed sale of new leases, however, is a discrete action that requires additional and more granular analysis. Some of the parcels the agency is proposing to sell are as small as 80-acres. Site-specific analysis is reasonable and appropriate before issuance of these new leases. Now is the opportunity to ensure that specific resources within the proposed leases are adequately considered and protected. *See New Mexico ex rel. Richardson*, 565 F.3d at 717 ("assessment of all 'reasonably foreseeable' impacts must occur at the earliest practicable point, and must take place before an 'irretrievable commitment of resources' is made"; where environmental impacts are reasonable foreseeable at the leasing stage, issuance of an oil and gas lease without an NSO stipulation constitutes an irretrievable commitment of resources).

Our review of proposed parcels and stipulations in the DNA shows that the proposed leases fail to adequately protect values identified in public comments. For example, after requesting GIS layers for proposed stipulations from BLM and comparing the stipulations to our own data on resource values, there are several gaps. Our GIS experts found that none of the proposed stipulations line up with the critical habitat for Parachute penstemon and DeBeque phacelia. Our review also found that there were no stipulations around Colorado Natural Heritage Program Potential Conservation Areas.[5]

After raising these concerns with field staff, we heard that stipulation mapping is not an exact science and that BLM does not have knowledge of each species' habitat or distribution for the entire field office. That may seem reasonable when considering broad land use decisions at the RMP stage, but it is not reasonable when BLM is contemplating issuance of new leases in defined areas—on the cusp of making an irretrievable commitment of publicly owned resources. 42 U.S.C. § 4332(2)(C)(v); *New Mexico ex rel. Richardson*, 565 F.3d at 717-18.

It also appears that leasing parcels COC77995 (7585), COC77996 (7586), COC77998 (7588), and COC77990 (7614) will impact the federally listed Colorado hookless cactus (Sclerocactus glaucus).[6] The failure to adequately analyze how leasing these parcels will impact this threatened

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2016-0044-DNA (July 2016), *available at* http://www.blm.gov/style/medialib/blm/co/programs/oil_and_gas/Lease_Sale/2016/november.Par.5323.File.dat/DNA_Dec16_GJFO_CRVFO_LeaseSale.pdf (last accessed 11/13/16).

[4] Interestingly, in the few sentences BLM dedicates to cultural resources in the GJFO and CRVFO, the agency admits that 82% of the proposed lease area has not been surveyed for cultural resources and that it found 74 eligible or potentially eligible sites in the small portion of the lease area that actually has been inventoried. *See* DOI-BLM-CO-N040-2016-0044-DNA (July 2016), at 7-8.

[5] *See* Exhibit E filed with June 13, 2016 Comments on Draft DNAs for GJFO, CRVFO and TRFO November 2016 Lease Sale (DOI-BLM-CO-N040-2016-0044-DNA and DOI-BLM-CO-S010-2017-0001-DNA) from Wilderness Workshop, et al. (on file with BLM).

[6] An additional parcel, number 7619, was considered for lease in the draft DNA, but appears to have been dropped from the sale by BLM. Parcel 7619 overlapped with Colorado hookless cactus habitat and raised the

species is concerning. In 2009, the Fish and Wildlife Service (FWS) issued a "Taxonomic Change of Sclerocactus Glaucus to Three Separate Species." 74 Fed. Reg. 47112, 47117 (Sept. 15, 2009). However, since then the FWS has failed to analyze whether these three new species require uplisting to endangered status based on the smaller populations and habitat. FWS has also failed to designate critical habitat for this species, which means the information provided by the Colorado Natural Heritage Program – and used in our GIS analysis of these parcels – may be the best information available to protect, conserve, and recover this listed species.

It is true that BLM proposed to include NSO stipulations on some parcels to protect some resources. However, those stipulations are not uniform, and our review of those stipulations suggests that they may not adequately protect the existing values. Despite the fact that we raised these concerns in comments, the DNA provides no explanation or analysis to support a determination that the resources will be adequately protected. And our communications with BLM, suggesting that the stipulation mapping they have undertaken is not an exact science, only underscore the problem.

By selling leases without more granular analysis than was conducted at the RMP-level, BLM runs the risk of irretrievably committing resources without adequate protections. There is no reason that BLM could not undertake actual analysis at the leasing stage to ensure a more thorough understanding of the on-the-ground resources. The agency has done so before and continues to do so in other places. It is just good policy. As it is, BLM's DNA fails to explicitly address our concerns and lacks specificity necessary to satisfy NEPA's hard look standard.

Requested Remedy: Before selling the proposed parcels, BLM must take the hard look required by NEPA. This includes undertaking site-specific NEPA that discloses and analyzes potential impacts to resources within the proposed lease parcels. Adequate analysis must also be accompanied by meaningful opportunities for public comment.

II. BLM'S DECISION TO IGNORE RELEVANT GUIDANCE UNDERSCORES NEPA VIOLATIONS ASSOCIATED WITH THE SALE OF THESE LEASES.

A. Instruction Memorandum 2010-117 does not allow BLM to use DNAs to sell the leases at issue.

BLM reformed its onshore oil and gas leasing program in 2010 to ensure leasing of federal mineral resources is conducted in a more environmentally responsible and transparent manner. BLM's new process for oil and gas leasing is set forth in Instruction Memorandum (IM) 2010-117 (May 17, 2010).[7] The process has three primary goals: (1) "create more certainty and predictability" in the leasing process; (2) "protect multiple-use values"; and (3) "provide for consideration of natural and cultural resources as well as meaningful public involvement." To achieve those goals, the reforms instituted a new lease parcel review and issuance process that provides for increased public participation and more thorough site-specific analysis.

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same concerns discussed here. We specifically addressed parcel 7619 in our previous comments, but we omitted discussion of that parcel here because it was not included in BLM's most recent notice.

[7] *Available at* http://www.blm.gov/wo/st/en/info/regulations/Instruction_Memos_and_Bulletins/national_instruction/2010/IM_2010-117.html (last accessed 11/13/16).

A critical component of the new leasing process is that BLM typically prepares Environmental Assessments (EAs) to analyze potential parcels for lease:

> Most parcels that the field office determines should be available for lease will require site-specific NEPA analysis. This analysis will typically take the form of an EA, which would be tiered, as appropriate, to the RMP/EIS or a MLP/EA or EIS, if one has been completed for any of the parcels.

IM 2010-117 at III(E); *see also* 42 U.S.C. § 4332(2)(C)(v); *New Mexico ex rel. Richardson*, 565 F.3d at 717-18.

BLM's new guidance also requires the agency to provide a 30-day public review and comment period for the EA and unsigned Finding of No Significant Impact (FONSI) before forwarding the leasing recommendation to the State Director. IM 2010-117 at III(E). BLM notes that the "process outlined in this IM—which includes site-specific parcel analysis and increased public participation—will help identify, address, and resolve most issues before the lease sale." Id. at III(H) (emphasis added).

For the December 2016 lease sale, however, BLM Colorado is relying on a DNA to approve the sale of new oil and gas leases. As discussed above, the DNA includes no analysis at all. BLM's rationale for relying on the DNA is that the Grand Junction and Colorado River Valley Field Offices recently completed RMP revisions. In addition to violating BLM's obligation to take a hard look, this practice reflects an inappropriate interpretation of IM 2010-117, and does not comply with the intent or spirit of the agency's leasing reforms.

RMPs do not provide the site-specific analysis envisioned by the leasing reforms, even if they have been recently revised. RMPs make broad decisions about resource allocations based on a broad analysis. The intention of the reforms is to take a closer look at specific parcels and resources prior to leasing them. As BLM Colorado's FAQ on oil and gas leasing states: "An EA augments the decisions made in an RMP with current on-the-ground information."[8] Site-specific information and analysis is critically important to reviewing lease parcels regardless of the age of the governing RMP. We note that BLM Wyoming is still preparing EAs for all of its lease sales, even in areas with recently-completed RMPs.[9]

This argument is reinforced by the agency's own comparison of oil and gas decisions made in RMPs to those made in Master Leasing Plans (MLPs). According to BLM, MLPs are a "**stepped-down leasing analysis**" that evaluates "in **greater detail** than the RMP the impacts of leasing and likely development" and identifies "**key issues** such as protection of air quality, watersheds, wilderness, wildlife, and nearby land uses" and "**leasing and higher-level development mitigation measures**

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[8] BLM Colorado, Oil and Gas Leasing Program "Frequently Asked Questions", http://www.blm.gov/co/st/en/BLM_Programs/oilandgas/Frequently_Asked_Questions_Leasing.html (last accessed 11/13/16).

[9] *See* BLM Wyoming, Oil and Gas Lease Sale information, http://www.blm.gov/wy/st/en/programs/energy/Oil_and_Gas/Leasing.html (note: BLM continues to process all lease sales through EAs rather than DNAs. For example, the Bighorn Basin RMP was completed in 2015 and yet BLM completes EAs to support leasing in that district).

to protect the environment."[10] These types of analyses are not incorporated into RMPs and must be considered at the leasing stage, which necessitates additional analysis.

BLM's guidance is clear that while existence of a Master Leasing Plan may allow for the agency to complete a DNA rather than an EA, no such exception exists for "new" RMPs. IM 2010-117 states that a DNA may be prepared for a proposed leasing action if the action is "adequately analyzed in an existing NEPA document, such as that prepared during the MLP process, and is in conformance with the approved RMP." Id., at III(E) (emphasis added). This provision clearly states BLM's intention that a DNA could be used where an MLP has been completed, but not simply where the action is in conformance with the approved RMP. Therefore, only where BLM has a robust MLP in place that was developed and is being implemented in compliance with IM 2010-117 and Chapter V of BLM's Handbook on Planning for Fluid Mineral Resources, a DNA may be appropriate for evaluating parcels for oil and gas lease sales rather than an EA.

Requested Remedy: BLM must complete EAs for oil and gas lease sales, in compliance with IM 2010-117 which directs that most parcels field offices determine should be available for lease will require site-specific NEPA analysis—typically an EA. BLM Colorado should set as a threshold for preparing a DNA rather than an EA that a robust MLP is in place that was developed and is being implemented in compliance with IM 2010-117 and Chapter V of BLM's Handbook on Planning for Fluid Mineral Resources. The Shale Ridges and Canyons MLP does not yet meet that threshold, but could in the future once BLM completes additional implementation-level planning for the MLP.

B. BLM failed to consider potential climate impacts of selling the new leases, despite clear guidance on how to examine those impacts.

BLM has never adequately considered the potential climate impacts of selling the proposed leases despite the fact that clear guidance exists to guide such analysis. Earlier this year, the Council on Environmental Quality (CEQ) released the long-awaited final guidance on considering greenhouse gas (GHG) emissions and the effects of climate change in NEPA reviews (hereafter, "Final Guidance").[11] The overarching goal of the guidance is to provide greater clarity and more consistency in how federal agencies address climate change in their NEPA reviews and to facilitate compliance with existing NEPA requirements.

The guidance recognizes that "[c]limate change is a fundamental environmental issue, and its effects fall squarely within NEPA's purview." The Final Guidance applies to all proposed federal agency actions, "including site-specific actions, certain funding of site-specific projects, rulemaking actions, permitting decisions, and land and resource management decisions." Id. at 9, 3.

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[10] BLM, Washington Office, Presentation on "Oil and Gas Leasing Reform," http://www.blm.gov/style/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/leasing_reform.Par.54947.File.dat/Leasing_Reform_05-11-2011.pdf, at slide 8 (last accessed 11/13/16) (emphases in original).

[11] *See* CEQ, Memorandum for Heads of Departments and Agencies: "Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews," (Aug. 1, 2016), *available at* https://www.whitehouse.gov/sites/whitehouse.gov/files/documents/nepa_final_ghg_guidance.pdf (last accessed 11/13/16) (attached as Exhibit 1).

The Final Guidance underscores BLM's existing legal obligations to disclose and consider the foreseeable effects that, for example, oil and gas leasing and development has on climate change. In its Final Guidance, the CEQ recognized that:

> Climate change results from the incremental addition of GHG emissions from millions of individual sources, which collectively have a large impact on a global scale. CEQ recognizes that the totality of climate change impacts is not attributable to any single action, but are exacerbated by a series of actions including actions taken pursuant to decisions of the Federal Government. Therefore, a statement that emissions from a proposed Federal action represent only a small fraction of global emissions is essentially a statement about the nature of the climate change challenge, and is not an appropriate basis for deciding whether or to what extent to consider climate change impacts under NEPA. Moreover, these comparisons are also not an appropriate method for characterizing the potential impacts associated with a proposed action and its alternatives and mitigations because this approach does not reveal anything beyond the nature of the climate change challenge itself: the fact that diverse individual sources of emissions each make a relatively small addition to global atmospheric GHG concentrations that collectively have a large impact.

Id. at 10-11.

The guidance recognizes that identifying and analyzing the interactions between our changing climate and the environmental impacts from a proposed action can have a number of benefits, including identifying opportunities to reduce and mitigate GHG emissions, to improve environmental outcomes, and to help safeguard communities, infrastructure, and resources against the effects of climate change. Therefore, an analysis of climate change "should be similar to the analysis of other environmental impacts under NEPA." Id. at 2.

CEQ's Final Guidance also discusses the application of NEPA principles and practices to the analysis of GHG emissions and climate change, including: (1) that agencies quantify a proposed action's projected direct and indirect GHG emissions, taking into account available data and GHG quantification tools; (2) that agencies use projected GHG emissions as a proxy for assessing potential climate change effects when preparing a NEPA analysis; (3) where GHG emission tools, methodologies, or data inputs are not reasonably available, that agencies include a qualitative analysis in the NEPA document and explain the basis for determining that quantification is not reasonably available; (4) that agencies analyze foreseeable direct, indirect, and cumulative GHG emissions and climate effects; (5) that agencies consider reasonable alternatives and the short- and long-term effect and benefits in the alternatives and mitigation analysis; (6) that agencies consider alternatives that would make the actions and affected communities more resilient to the effects of a changing climate; and (7) that agencies assess the broad-scale effects of GHG emissions and climate change, either to inform programmatic decisions, or at both the programmatic and project-level. *See* id. at 4-6.

As a general approach, BLM should first assess and, wherever possible, quantify or estimate greenhouse gas (GHG) emissions by type and source by analyzing the direct operational impacts of their proposed actions. Assessment of direct emissions of GHG from on-site combustion sources is relatively straightforward. The indirect effects of a project may be more far-reaching and will require careful analysis. Within this category, agencies should evaluate, inter alia, GHG and GHG-precursor emissions associated with construction, electricity use, fossil fuel use, downstream

combustion of fossil fuels extracted or refined by the project, water consumption, water pollution, waste disposal, transportation, the manufacture of building materials, and land conversion.

Climate change effects must be integrated into the NEPA analysis as part of the environmental baseline. Agencies are required under NEPA to "describe the environment of the areas to be affected or created by the alternatives under consideration." 40 C.F.R. § 1502.15. The current affected environment sets the "baseline" for the impacts analysis and comparison of alternatives. As the Ninth Circuit held, "without establishing the baseline conditions . . . there is simply no way to determine what effect the proposed [action] will have on the environment and, consequently, no way to comply with NEPA." *Half Moon Bay Fisherman's Marketing Ass'n v. Carlucci*, 857 F.2d 505, 510 (9th Cir. 1988). Excluding climate change effects from the environmental baseline ignores the reality that the impacts of proposed actions must be evaluated based on the already deteriorating, climate-impacted state of the resources, ecosystems, human communities, and structures that will be affected. Accordingly, existing and reasonably foreseeable climate change impacts must be included as part of the affected environment, assessed as part of the agency's hard look at impacts, and integrated into each of the alternatives, including the no action alternative. Simply acknowledging climate impacts as part of the affected environment is insufficient. Rather, agencies must incorporate that information into their hard look at impacts and comparison of alternatives.

BLM cannot make an informed decision about how much disturbance issuing new oil and gas leases will have on the region or what the degraded ecosystem can withstand under changing conditions without fully understanding the baseline and adequately assessing the action's direct, indirect, and cumulative effects. Direct effects are those "which are caused by the action and occur at the same time and place." 40 C.F.R. § 1508.8(a). Indirect effects are those "caused by the action, and later in time or further removed in distance, but still reasonably foreseeable." *S. Fork Band Council of W. Shoshone of Nev. v. U.S. Dep't of the Interior*, 588 F.3d 718, 725 (9th Cir. 2009) (quoting 40 C.F.R. § 1508.8(b)). Cumulative effects are the effects of the action in combination with "other past, present, and reasonably foreseeable future actions." *See Klamath-Siskiyou Wildlands Ctr. v. Bureau of Land Mgmt.*, 387 F.3d 989, 993 (9th Cir. 2004) (quoting 40 C.F.R. § 1508.7). As a result, NEPA requires agencies to assess the climate effects of direct emissions from a project, such as emissions from construction activities, the indirect environmental impacts, such as degraded air quality, and the long-term collective impacts caused by the project's development and continued activity.

The NEPA requirement to consider climate change has been repeatedly upheld by the courts. In *Center for Biological Diversity v. NHTSA*, the Ninth Circuit assessed an agency's NEPA analysis for a rule requiring automobile manufacturers to increase the fuel efficiency of their vehicles, thereby lowering average tailpipe emissions per mile driven. The Court stated that "[t]he impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct." *Ctr. for Biological Diversity*, 538 F.3d at 1217. 1223-25 (9th Cir. 2008). Likewise, in *Mid States Coalition for Progress v. Surface Transportation Board*, the Eighth Circuit held that NEPA requires an agency to disclose and analyze the impacts of future combustion of mined coal when deciding whether to approve a railroad line providing access to coal mining areas. 345 F.3d 520, 549-50 (8th Cir. 2003).

The CEQ guidance on considering climate change in NEPA analyses also provides that agencies should analyze reasonable alternatives that would mitigate both direct and indirect GHG emissions

impacts, and the short- and long-term cumulative effects of climate change (e.g., enhanced energy efficiency, carbon sequestration, lower GHG-emitting technology). Final Guidance, at 13, 16.

BLM has never taken a hard look at the climate-related impacts of selling the proposed parcels in any existing analysis. The DNA that BLM is relying upon to support the sale of proposed leases contains no analysis of climate impacts at all. BLM claims that the Grand Junction and Colorado River Valley RMPs provide adequate analysis of potential climate impacts. BLM says that additional climate analysis, like calculating the social cost of carbon likely to result from development of the proposed leases, "would not be useful to the decisionmaker."[12] But this rationale fails because climate analyses in the underlying RMPs are inadequate and BLM has never actually considered the climate impacts of its oil and gas leasing activities on a programmatic scale.

The Colorado River Valley and Grand Junction RMPs never quantified or considered the full effects of oil and gas combustion emissions, and the costs that the full spectrum of oil and gas emissions impose on society. The RMPs also failed to quantify the scale of methane pollution from oil and gas emission sources, and underestimated by an order of magnitude the global warming potential of such emissions.

BLM excused the lack of analysis in the Colorado River Valley RMP/EIS by saying "[q]uantification of cumulative climate change impacts…is beyond the scope of this analysis." Colorado River Valley Proposed RMP at 4-56. BLM also stated, "It is not possible at this time to determine whether GHG emissions that would result from the project sources associated with the Proposed RMP would cause a significant impact" and that "it is not possible to determine the impact that GHG emissions from the Proposed RMP would have on global climate change." *Id.* at 4-52. These statements directly contravene the CEQ guidance; thus, supplemental climate analysis is necessary to support leasing under the Colorado River Valley RMP.

Similarly, the Grand Junction RMP/EIS lacks a full accounting of climate change impacts from decisions authorized under the RMP, including subsequent oil and gas leasing. The RMP states that "[t]he lack of scientific tools designed to predict climate change on regional or local scales limits the ability to quantify potential future impacts. Currently, the BLM does not have an established mechanism to accurately predict the effect of resource management-level decisions from this planning effort on global climate change." Grand Junction Proposed RMP at 6-15. Again, this statement directly contravenes the CEQ guidance and so supplemental climate analysis is necessary to support leasing under the Grand Junction RMP.

BLM is saying that site-specific analysis would not be useful prior to issuing the proposed leases and relying on RMPs that, by BLM's own admission, fail to assess all the impacts of new leasing. This approach could satisfy BLM's obligations under NEPA if there was a programmatic analysis that actually considered the cumulative impacts of BLM's leasing decisions, but BLM has never undertaken such a programmatic analysis of its oil and gas leasing program.

Several comments filed on the December 2016 lease sale raised concerns about cumulative impacts and asked BLM to undertake a programmatic analysis of its oil and gas leasing program to help resolve the lack of adequate analysis. BLM's response to those comments was simply: "The question whether BLM should prepare a programmatic analysis of GHG emissions and climate

[12] DOI-BLM-CO-N040-2016-0044-DNA (July 2016), at 165.

change impacts from federal fluid mineral leasing and development is outside the scope of the December 2016 leasing decision."[13] This response ignores the fact that continued leasing is part of a broader program for which the impacts have never been considered.

BLM's refusal to assess the impacts of selling these leases or the broader program is tantamount to a lease before you look, and that directly contravenes the intent of NEPA as well as relevant guidance issued under NEPA and other statutes. BLM has failed to take a hard look at the potential impacts of its decisions and, in so doing, appears to be overlooking the significant cumulative impacts associated with selling new oil and gas leases.

Requested Remedy: Because of the scale of the oil and gas leasing program and the nature of climate change, the appropriate way for BLM to consider impacts is at the nationwide, programmatic scale. Until BLM undertakes that broad, fact-based, hard look at the GHG pollution implications of oil and gas leasing, the agency should refrain from selling new leases. If BLM moves forward with leasing prior to completing programmatic analysis regarding climate change, BLM must at a minimum revise its analysis for this lease sale to include the following components before issuing these leases:

- Complete an EA or EIS to appropriately analyze climate change impacts and mitigation opportunities. This analysis must include methane emissions and social cost of carbon.
- Consider alternatives to mitigate GHG emissions and consider mitigation measures. Alternatives must allow the public and the decisionmaker to "compare the anticipated levels of GHG emissions from each alternative – including the no-action alternative – and mitigation actions. . . ."
- Evaluate direct/indirect impacts of GHG emissions, quantifying whenever possible.
- Evaluate end-use of fossil fuel extraction.
- Attach lease notices to preserve BLM's ability to impose mitigation or offsets at the APD stage, or to delay/disapprove development.

III. BLM'S FAILURE TO TAKE A HARD LOOK AT CLIMATE IMPACTS OF SELLING NEW LEASES IGNORES NATIONAL POLICY AND RECENT SCIENCE.

BLM has failed to internalize and consider national policy and science related to climate change. Some of this information is not new and the agency has ignored it. Some of this information is new and the agency has never considered it. Importantly, though, the agency's obligation to take a hard look necessitates consideration of relevant policy and science discussed below before selling the proposed leases.

National policy and statements addressing climate change have accelerated in recent years, as they should given the narrowing window of time to take meaningful action. Nonetheless, the federal government's recognition of climate change is not new. The Secretary of Interior stated, in Secretarial Order 3226, Evaluating Climate Change Impacts in Management Planning (January 19, 2001), that "[t]here is a consensus in the international community that global climate change is occurring and that it should be addressed in governmental decision making." Order 3226 established the responsibility of agencies to "consider and analyze potential climate change impacts when undertaking long-range planning exercises, when setting priorities for scientific research and

[13] DOI-BLM-CO-N040-2016-0044-DNA (July 2016), at 173.

investigations, when developing multi-year management plans, and/or when making major decisions regarding potential utilization of resources under the Department's purview."

In a 2007 report entitled *Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources*, the GAO concluded that the Department of the Interior had not provided specific guidance to implement Secretarial Order 3226, that officials were not even aware of Secretarial Order 3226, and that Secretarial Order 3226 had effectively been ignored.[14] This report led to Secretarial Order 3289, Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources (September 14, 2009), which reinstated the provisions of Order 3226, and recognized that "the realities of climate change require us to change how we manage land, water, fish and wildlife, and cultural heritage and tribal lands and resources we oversee," and acknowledged that the Department of the Interior is "responsible for helping protect the nation from the impacts of climate change." A month later, in Executive Order No. 13514, Federal Leadership in Environmental, Energy, and Economic Performance (Oct. 5, 2009), President Obama called on all federal agencies to "measure, report, and reduce their greenhouse gas emissions from direct and indirect activities." 74 Fed. Reg. 52,117 (Oct. 8, 2009). This directive was followed by Executive Order No. 13693, Planning for Federal Sustainability in the Next Decade (March 25, 2015), which reaffirmed the federal government's commitment to reducing GHG emissions. 80 Fed. Reg. 15,871 (March 25, 2015).

In 2009, the Environmental Protection Agency ("EPA") issued a finding that the changes in our climate caused by elevated concentrations of greenhouse gases in the atmosphere are reasonably anticipated to endanger the public health and welfare of current and future generations. EPA, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 2009). The D.C. Circuit upheld this decision as supported by the vast body of scientific evidence on the subject. *See Coal. for Responsible Regulation, Inc. v. EPA.*, 684 F.3d 102, 120-22 (D.C. Cir. 2012).

Climate change has been intensively studied and acknowledged at the global, national, and regional scales. Climate change is being fueled by the human-caused release of greenhouse gas emissions, in particular carbon dioxide and methane. The Intergovernmental Panel on Climate Change ("IPCC") is a Nobel Prize-winning scientific body within the United Nations that reviews and assesses the most recent scientific, technical, and socio-economic information relevant to our understanding of climate change. In a 2014 report to policymakers, the IPCC provided a summary of our understanding of human-caused climate change. Among other things, the IPCC summarized:[15]

- Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems.
- Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.

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[14] U.S. Government Accountability Office, Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources, GAO-07-863: (Aug 7, 2007), *available at* http://www.gao.gov/products/GAO-07-863 (last accessed 11/13/16).

[15] IPCC AR5, Summary for Policymakers (March 2014), *available at* http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf (attached as Exhibit 2) (last accessed 11/13/16).

- Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane, and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are extremely likely to have been the dominant cause of the observed warming since the mid-20th century.
- In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate.
- Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.
- Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. 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 level to rise.

Also in 2014, President Obama described climate change as an "urgent and growing threat . . . that will define the contours of this century more dramatically than any other."[16] That same year, the U.S. pledged to reduce its greenhouse gas ("GHG") emissions 26-28 percent below 2005 levels by 2020.[17] Since then, the President has also announced a new goal to cut methane emissions from the oil and gas sector by 40-45 percent below 2012 levels by 2025.[18]

In 2015, EPA acknowledged more recent scientific assessments that "highlight the urgency of addressing the rising concentrations of CO_2 in the atmosphere." 80 Fed. Reg. 64,661 (Oct. 23, 2015). President Obama also recognized, "ultimately, if we're going to prevent large parts of this Earth from becoming not only inhospitable but uninhabitable in our lifetimes, we're going to have to keep some fossil fuels in the ground rather than burn them and release more dangerous pollution into the sky."[19]

In his final State of the Union address earlier this year, President Obama again noted the federal government's commitment to fighting climate change, vowing "to accelerate the transition away from old, dirtier energy sources," and making a powerful promise "to change the way we manage

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[16] The White House, Remarks by the President at U.N. Climate Change Summit (Sept. 23, 2014), *available at* https://www.whitehouse.gov/the-press-office/2014/09/23/remarks-president-un-climate-change-summit (last accessed 11/13/16).

[17] U.S.-China Joint Announcement on Climate Change (Nov. 11, 2014), *available at* https://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change (last accessed 11/13/16) (attached as Exhibit 3).

[18] The White House, Climate Action Plan: Strategy to Reduce Methane Emissions (March 2014), *available at* https://www.whitehouse.gov/blog/2014/03/28/strategy-cut-methane-emissions (last accessed 11/13/16) (attached as Exhibit 4).

[19] The White House, Statement by the President on the Keystone XL Pipeline (Nov. 6, 2015), *available at* https://www.whitehouse.gov/the-press-office/2015/11/06/statement-president-keystone-xl-pipeline (last accessed 11/13/16) (attached as Exhibit 5).

our oil and coal resources so that they better reflect the costs they impose on taxpayers and our planet."[20]

The United States has also joined 194 other nations in recognizing "that climate change represents an urgent and potentially irreversible threat to human societies and the planet" and setting the goal of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C."[21] The President ratified the Paris Agreement, along with China, on September 3, 2016.[22] The agreement entered into effect earlier this month.[23]

As discussed above, earlier this year the White House Council on Environmental Quality ("CEQ")—the federal agency tasked with managing the federal government's implementation of NEPA—recognized the unique nature of climate change and the challenges it imposed on NEPA compliance. *See* supra Section II.B. In so doing, CEQ issued guidance to help federal agencies adequately consider impacts of their decisions on climate.

Since the dawn of the industrial revolution a century ago, the average global temperature has risen some 1.6 degrees Fahrenheit. Most climatologists agree that, while the warming to date is already causing environmental problems, another 0.4 degree Fahrenheit rise in temperature, representing a global average atmospheric concentration of carbon dioxide ("CO_2") of 450 parts per million ("ppm"), could set in motion unprecedented changes in global climate and a significant increase in the severity of natural disasters—and could represent the point of no return.[24] In August 2016, the atmospheric concentration of CO_2 was approximately 402.25 ppm, up from 398.93 ppm the same month a year earlier.[25]

According to the National Oceanic and Atmospheric Administration ("NOAA"), "[t]he combined average temperature over global land and ocean surfaces for August 2016 was the highest for

[20] President Barack Obama, State of the Union (Jan. 12, 2016), *available at* https://www.whitehouse.gov/sotu (last accessed 11/13/16).

[21] United Nations Framework Convention on Climate Change, Conference of the Parties (Nov 30-Dec. 11, 2015), Adoption of the Paris Agreement, Art. 2, U.N. Doc. FCCC/CP/2015/L.9 (Dec. 12, 2015), *available at* http://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf (accessed 11/13/16) ("Paris Agreement") (attached as Exhibit 6).

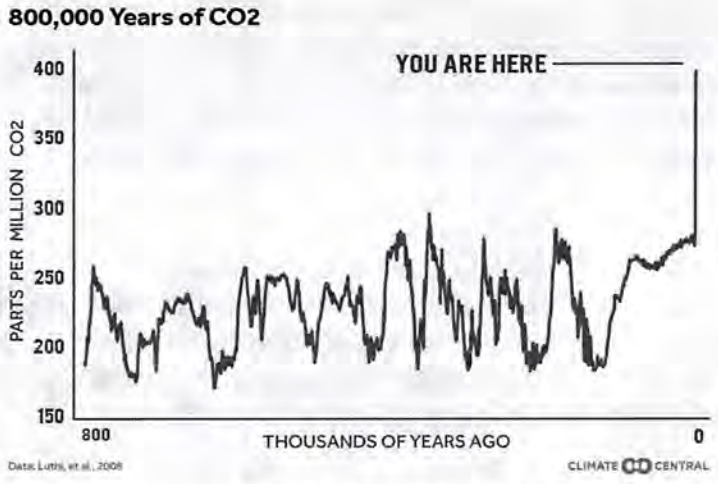
[22] The White House, President Obama: The United States Formally Enters the Paris Agreement (Sept. 3, 2016), *available at* https://www.whitehouse.gov/blog/2016/09/03/president-obama-united-states-formally-enters-paris-agreement (last accessed 11/13/16).

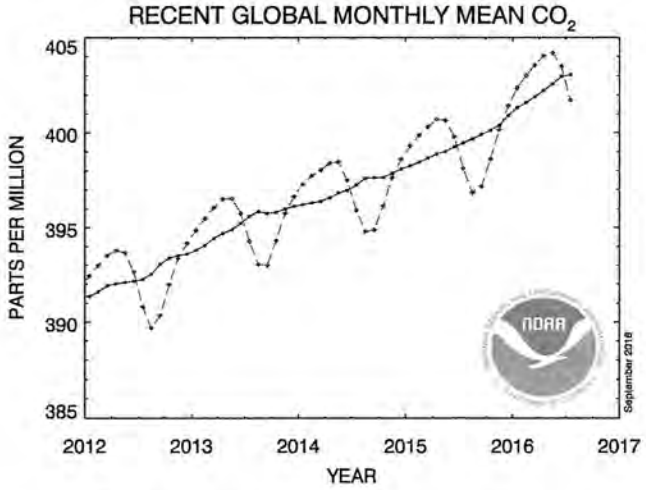
[23] Importantly, the President has recognized that "the Paris Agreement alone will not solve the climate crisis. Even if we meet every target embodied in the agreement, we'll only get to part of where we need to go." *See e.g,*. The White House, Office of the Press Secretary, Remarks by the President on the Paris Agreement (Oct. 5, 2016), *available at* https://www.whitehouse.gov/the-press-office/2016/10/05/remarks-president-paris-agreement (last accessed 11/13/16) (attached as Exhibit 7).

[24] *See* David Johnston, *Have We Passed the Point of No Return on Climate Change?*, Scientific American (April 2015), *available at* http://www.scientificamerican.com/article/have-we-passed-the-point-of-no-return-on-climate-change/ (last accessed 11/13/16) (attached as Exhibit 8).

[25] NOAA, Earth System Research Laboratory, Trends in Atmospheric Carbon Dioxide, *available at* http://www.esrl.noaa.gov/gmd/ccgg/trends/ (last accessed 11/13/16) (attached as Exhibit 9).

August in the 137-year period of record, marking the 16th consecutive month of record warmth for the globe."[26] The global climate crisis is happening and it is accelerating quickly.





The graphs show globally averaged historic and monthly mean carbon dioxide.

The IPCC has affirmed: "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased" causing "widespread impacts on human and natural systems."[27] This is consistent with the findings of the United States' 2014 Third National Climate Assessment, stating: "That the planet has warmed is 'unequivocal,' and is corroborated through multiple lines of evidence, as is the conclusion that the causes are very likely human in origin."[28] With particular regard to the Southwest Region—which includes Colorado, New Mexico,

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[26] NOAA, Global Analysis – August 2016, *available at* https://www.ncdc.noaa.gov/sotc/global/201608 (last accessed 11/13/16) (attached as Exhibit 10).

[27] IPCC AR5 Synthesis Report at 2 (attached as Exhibit 2).

[28] Jerry M. Melillo, et al., Climate Change Impacts in the United States: The Third National Climate Assessment (2014) at 61, *available at* http://nca2014.globalchange.gov (last accessed 11/13/16) (attached as Exhibit 11).

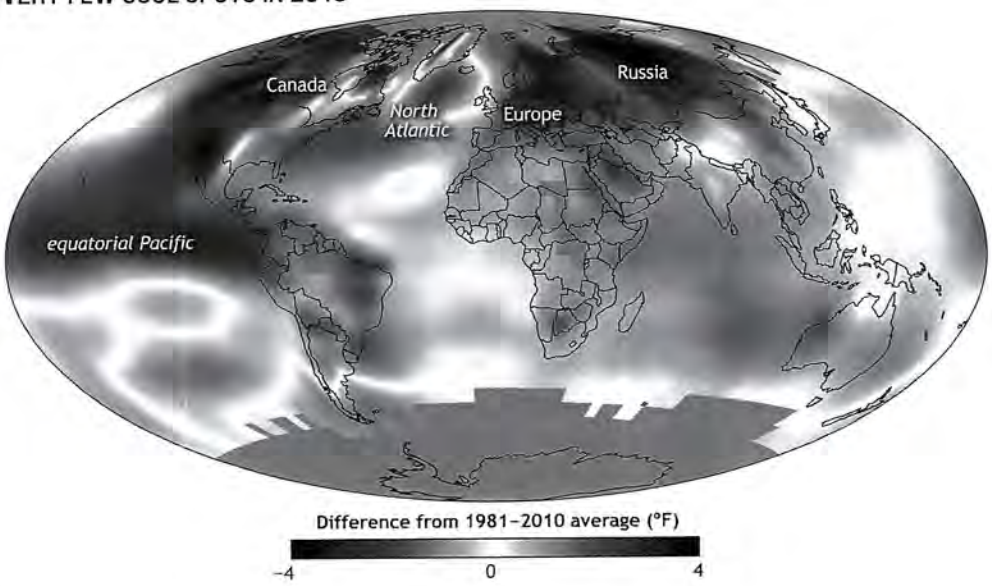
Utah, Arizona, Nevada, and California—the National Climate Assessment included in the following overview:[29]

- Snowpack and streamflow amounts are projected to decline in parts of the Southwest, decreasing surface water supply reliability for cities, agriculture, and ecosystems.
- The Southwest produces more than half of the nation's high-value specialty crops, which are irrigation-dependent and particularly vulnerable to extremes of moisture, cold, and heat. Reduced yields from increasing temperatures and increasing competition for scarce water supplies will displace jobs in some rural communities.
- Increased warming, drought, and insect outbreaks, all caused by or linked to climate change, have increased wildfires and impacts to people and ecosystems in the Southwest. Fire models project more wildfire and increased risks to communities across extensive areas.
- Flooding and erosion in coastal areas are already occurring even at existing sea levels and damaging some California coastal areas during storms and extreme high tides. Sea level rise is projected to increase as Earth continues to warm, resulting in major damage as wind-driven waves ride upon higher seas and reach farther inland.
- Projected regional temperature increases, combined with the way cities amplify heat, will pose increased threats and costs to public health in southwestern cities, which are home to more than 90% of the region's population. Disruptions to urban electricity and water supplies will exacerbate these health problems.

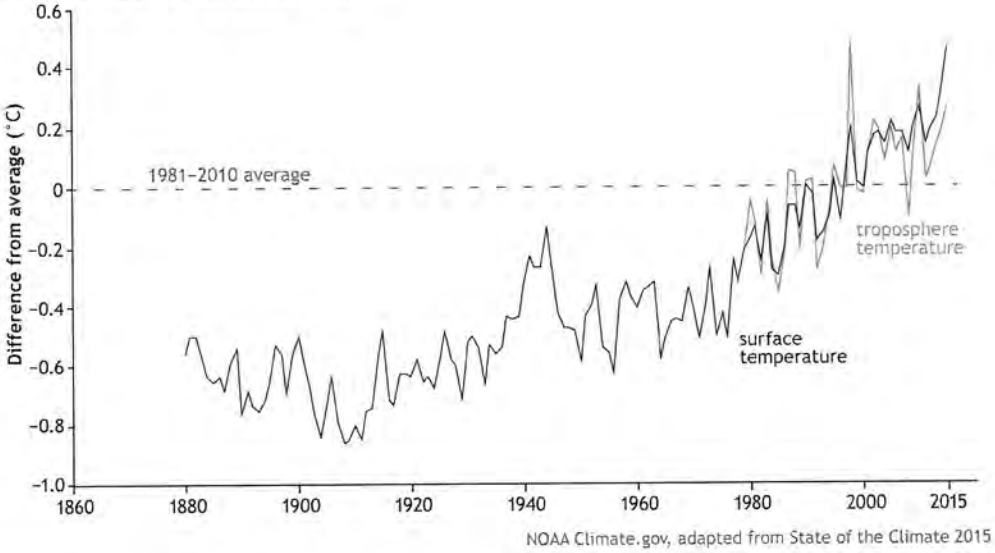
Immediate and substantial GHG reductions are required to avoid catastrophic impacts to people and communities. "Following the warmest year on record in 2014 according to most estimates, 2015 reached record warmth yet again, surpassing the previous record by more than 0.1°C."[30]

[29] *See* Third National Climate Assessment at 463-86 (attached as Exhibit 11).
[30] American Meteorological Society, State of the Climate in 2015, Vol.97, No.8 (Aug. 2016), at S7 (attached as Exhibit 12).

VERY FEW COOL SPOTS IN 2015



NEW HOTTEST YEAR ON RECORD



NOAA Climate.gov, adapted from State of the Climate 2015

As noted above, the Paris Agreement commits all signatories—including the United States—to a target holding long-term global average temperature "to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels."[31] As articulated by a team of international climate scientists, including Dr. James Hansen, in a 2013 report: "The widely accepted target of limiting human-made global warming to 2 degrees Celsius (3.6 degrees Fahrenheit) above preindustrial level is too high and would subject young people, future generations and nature to irreparable harm.... Observational data reveal that some climate extremes are already increasing in response to warming of several tenths of a degree in recent

[31] Paris Agreement at Art. 2 (attached as Exhibit 6).

decades; these extremes would likely be much enhanced with warming of 2°C or more."[32] "Runaway climate change—in which feedback loops drive ever-worsening climate change, regardless of human activities—are now seen as a risk even at 2°C of warming."[33] Indeed, the impacts of 2°C temperature rise have been "revised upwards, sufficiently so that 2°C now more appropriately represents the threshold between 'dangerous' and 'extremely dangerous' climate change."[34]

Although the Paris Agreement underscores the need for immediate action to avoid 'extremely dangerous' warming, meeting the voluntary commitments adopted in Paris alone will be insufficient to meet goal of limiting temperature change to between 1.5°C and 2.0°C above pre-industrial levels. In fact, the potential carbon emissions from *existing* fossil fuel reserves—the known belowground stock of extractable fossil fuels—considerably exceed both 2°C and 1.5°C of warming. "Estimated total fossil carbon reserves exceed this remaining [carbon budget] by a factor of 4 to 7."[35] "For the 2°C or 1.5°C limits, respectively 68% or 85% of reserves must remain in the ground."[36] The reserves in currently operating oil and gas fields alone, even with no coal, would take the world beyond 1.5°C.[37]

With specific regard to United States commitments under the Paris Agreement, the U.S. INDC set specific greenhouse gas emissions reduction target for 2025 of a 26% to 28% reduction below the 2005 emission levels, producing a range in 2005 net GHG emissions from 6,323 to 7,403 $MTCO_2e$.[38] The difference between this target and the estimated 2025 emissions without INDC policies results in an 'emissions gap' ranging from 896 to 2,121 $MTCO_2e$.[39]

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[32] James Hansen, *et al., Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature,* 8 PLoS ONE 8 e81648 (2013) (attached as Exhibit 13).

[33] Greg Muttitt, *et al., The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production*, Oil Change International (Sept. 2016) at 6 (attached as Exhibit 14); *see also* David Spratt, *Climate Reality Check: After Paris, Counting the Cost* (March 2016) at 8 (attached as Exhibit 15) ("there is an unacceptable risk that before 2°C of warming, significant "long-term" feedbacks will be triggered, in which warming produces conditions that generate more warming, so that carbon sinks such as the oceans and forests become less efficient in storing carbon, and polar warming triggers the release of significant permafrost and clathrate carbon stores. Such an outcome could render ineffective human efforts to control the level of future warming to manageable proportions.").

[34] Kevin Anderson and Alice Bows, *Beyond 'Dangerous' Climate Change: Emission Scenarios for a New World*, Phil. Trans. R. Soc. (2011) (attached as Exhibit 16).

[35] IPCC AR5 Synthesis Report at 63 (attached as Exhibit 2).

[36] The Sky's Limit at 6 (attached as Exhibit 14); *see also* Kevin Anderson and Alice Bows, *Reframing the climate change challenge in light of post-2000 emission trends*, Phil. Trans. R. Soc. (2008) (attached as Exhibit 17) ("to provide a 93% mid-value probability of not exceeding 2°C, the concentration (of atmospheric greenhouse gases) would need to be stabilized at or below 350 parts per million carbon dioxide equivalent (ppm CO_2e)" compared to the current level of ~485 ppm CO_2e.).

[37] The Sky's Limit at 5, 17 (attached as Exhibit 14).

[38] Jeffery Greenblatt & Max Wei, Assessment of the climate commitments and additional mitigation policies of the Unites States, Nature Climate Change (Sept. 2016), *available at* http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate3125.html (last accessed 11/13/16) (attached as Exhibit 18).

[39] Greenblatt at 2 (attached as Exhibit 18); *see also* UNEP, The Emissions GAP Report (Nov. 2015) (attached as Exhibit 29).

Both the IPCC and National Climate Assessment recognize the dominant role of fossil fuels in driving climate change:

> While scientists continue to refine projections of the future, observations unequivocally show that climate is changing and that the warming of the past 50 years is primarily due to human-induced emissions of heat-trapping gases. These emissions come mainly from burning coal, oil, and gas, with additional contributions from forest clearing and some agricultural practices.[40]
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> ***
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> CO_2 emissions from fossil fuel combustion and industrial processes contributed about 78% to the total GHG emission increase between 1970 and 2010, with a contribution of similar percentage over the 2000–2010 period (high confidence).[41]

As summarized in a recent report:

> The Paris Agreement aims to help the world avoid the worst effects of climate change and respond to its already substantial impacts. The basic climate science involved is simple: cumulative carbon dioxide (CO_2) emissions over time are the key determinant of how much global warming occurs. This gives us a finite carbon budget of how much may be emitted in total without surpassing dangerous temperature limits.[42]

According to the IPCC, as of 2011, the remaining carbon budget of cumulative CO_2 emissions from all anthropogenic sources must remain below 1,000 $GtCO_2$ to provide a 66% probability of limiting warming to 2°C above pre-industrial levels.[43] For years 2012-2014, approximately 107 $GtCO_2$ was emitted, averaging approximately 36 $GtCO_2$ per year, which left us at the start of 2016 with a carbon budget of only 850 $GtCO_2$.[44] These emissions were the highest in human history and 60% higher than in 1990 (the Kyoto Protocol reference year). Of course, the Paris Agreement's aim of limiting global warming to 1.5°C requires adherence to a more stringent carbon budget of only 400 $GtCO_2$ from 2011 onward, of which about 250 $GtCO_2$ remained at the start of 2016.[45] "With global annual emissions amounting to 36 $GtCO_2$ in 2015, scientists predict that at current rates global emissions will exceed the carbon budgets necessary to stay under the 1.5°C target by 2021 and the

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[40] Third National Climate Assessment at 2 (attached as Exhibit 11).

[41] IPCC AR5 Synthesis Report at 46 (attached as Exhibit 2).

[42] Greg Muttitt, et al., The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel Production, Oil Change International (Sept. 2016) at 6 (attached as Exhibit 14).

[43] IPCC AR5 Synthesis Report at 63-64 & Table 2.2 (attached as Exhibit 2). For an 80% probability of staying below 2°C, the budget from 2000 is 890 $GtCO_2$, with less than 430 $GtCO_2$ remaining. Malte Meinshausen et al., Greenhouse-gas emission targets for limiting global warming to 2°C, Nature (2009) at 1159 (attached as Exhibit 19).

[44] *See* Annual Global Carbon Emissions, *available at* https://www.co2.earth/global-co2-emissions (last accessed 11/13/16); *see also* C. Le Quéré, et al., Global Carbon Budget 2015, Earth Syst. Sci. Data (Dec. 2015) (attached as Exhibit 20).

[45] Dustin Mulvaney, et al., Over-Leased: How Production Horizons of Already Leased Federal Fossil Fuels Outlast Global Carbon Budgets, EcoShift Consulting (July 2016) (attached as Exhibit 21) at 2 (citing Joeri Rogelj, et al., Difference between carbon budget estimates unraveled, Nature Climate Change (2016) (attached as Exhibit 22).

2°C target by 2036.[46]

In order for the world to stay within a carbon budget consistent with Paris Agreement goals—"holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C"[47]—significant fossil fuel resources must remain in the ground. More specifically, to meet the target of 2°C, globally "a third of oil reserves, half of gas reserves and over 80 percent of current coal reserves should remain unused from 2010-2050."[48] Studies estimate that global coal, oil and gas resources considered currently economically recoverable contain potential greenhouse gas emissions of 4,196 $GtCO_2$,[49] with other estimates as high as 7,120 $GtCO_2$.[50]

Critically, the United States carbon quota—equivalent to 11% of the global carbon budget needed for a 50% chance of limiting warming to 2°C—allocates approximately 158 $GtCO_2$ to the United States as of 2011.[51] By way of comparison, federal and non-federal fossil fuel emissions together would produce between 697 and 1,070 $GtCO_2$.[52] Regarding just federal fossil fuel resources, the United States contains enough recoverable coal, oil and gas that, if extracted and burned, would result in as much as 492 $GtCO_2$, surpassing the entire global carbon budget for a 1.5°C target and nearly eclipsing the 2°C target—to say nothing of the United States 'share' of global emissions.[53] Unleased federal fossil fuels comprise 91% of these potential emissions, with already leased federal fossil fuels accounting for as much as 43 $GtCO_2$.[54]

In 2012, "the GHG emissions resulting from the extraction of fossil fuels from federal lands by private leaseholders totaled approximately 1,344 $MMTCO_2e$."[55] Between 2003 and 2014, approximately 25% of all United States and 3-4% of global fossil fuel greenhouse gas emissions are attributable to federal minerals leased and developed by the Department of the Interior.[56] Continued leasing and development of federal fossil fuel resources commits the world to 'extremely dangerous' warming well beyond the 2°C threshold. As one study put it, "the disparity between what resources and reserves exist and what can be emitted while avoiding a temperature rise greater

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[46] Mulvaney at 2 (attached as Exhibit 21) (citing Oak Ridge National Laboratories, Carbon Dioxide Information Analysis Center (2015), available at: http://cdiac.ornl.gov/GCP/ (last accessed 11/13/16)).
[47] Paris Agreement Art. 2 (attached as Exhibit 6).
[48] Christophe McGlade & Paul Ekins, The geographical distribution of fossil fuels unused when limiting global warming to 2°C, Nature (Jan 2015) (attached as Exhibit 23).
[49] Michael Raupach, et al., Sharing a quota on cumulative carbon emissions, Nature Climate Change (Sept. 2014) (attached as Exhibit 24).
[50] IPCC AR5, Mitigation of Climate Change, Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2014) at Table 7.2 (attached as Exhibit 25).
[51] Raupach at 875 (attached as Exhibit 24).
[52] Dustin Mulvaney, et al., The Potential Greenhouse Gas Emissions from U.S. Federal Fossil Fuels, EcoShift Consulting (Aug. 2015) at 16 (attached as Exhibit 26).
[53] Mulvaney (2015) at 16 (attached as Exhibit 26).
[54] Mulvaney (2015) at 16 (attached as Exhibit 26).
[55] Stratus Consulting, Greenhouse Gas Emissions from Fossil Energy Extracted from Federal Lands and Waters: An Update (Dec. 2014) at 9 (attached as Exhibit 27).
[56] *See* Energy Information Administration, Sales of Fossil Fuels Produced from Federal and Indian Lands, FY 2003 through FY 2014 (July 2015) (attached as Exhibit 28); *see also* Stratus Consulting (attached as Exhibit 27).

than the agreed 2°C limit is therefore stark."[57] In short, any new leasing of federal fossil fuel resources is inconsistent with a carbon budget that would seek to avoid catastrophic climate change.

The production horizons for already leased federal fossil fuel resources underscore how unwarranted any additional leasing is, and in turn how unreasonable new leasing is. Comparing these production horizons to dates at which carbon budgets would be exceeded if current emission levels continue:

- Federal crude oil already leased will continue producing for 34 years beyond the 1.5°C threshold and 19 years beyond the 2°C threshold;
- Federal natural gas already leased will continue producing 23 years beyond the 1.5°C threshold and 8 years beyond the 2°C threshold;
- Federal coal already leased will continue producing 20 years beyond the 1.5°C threshold and 5 years beyond the 2°C threshold.[58]

Simply put, the timeframe to avoid catastrophic climate change is short, and the management of our federal minerals is dangerously out of step with this reality. As noted above, the BLM has failed to consider any of this new information in its leasing decisions, and the agency has not taken a hard look at this information in any relevant analysis.

Choosing not to lease oil and gas parcels could be a very significant part of U.S. efforts to address climate change. If new leasing ceases and existing non-producing leases are not renewed, 12% of oil production could be avoided in 2025 and 65% could be avoided by 2040 while 6% of natural gas production could be avoided in 2025 and 59% could be avoided by 2040.[59] This avoided production would significantly reduce future U.S. emissions. Cessation of new and renewed leases for federal fossil fuel extraction could reduce CO_2 emissions by about 100 Mt per year by 2030.

The 100 Mt CO_2 emissions savings that could result from no leasing in 2030 compares favorably with EPA standards for light- and medium-vehicles that are expected to yield 200 Mt in CO2 savings in 2030, and with standards for heavy-duty vehicles that are expected to yield 70 Mt in CO2 savings in the same year. The 100 Mt CO_2 emissions reduction from leasing restrictions would be greater than either the emission reductions that the EPA expects to achieve through its existing regulation of oil and gas industry emissions or reductions the BLM expects to achieve from its proposed methane waste standards on oil and gas operations on federal land. Clearly, cessation of new and renewed leases could make an important contribution to U.S. climate change mitigation efforts.[60]

Here, BLM has failed to consider the impacts of climate change despite implications that selling new leases could have on national policy, and despite clear guidance requiring the agency to consider such impacts and describing how to undertake such consideration.

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[57] McGlade at 188 (attached as Exhibit 23).
[58] Mulvaney (2016) at 5 (attached as Exhibit 21).
[59] Peter Erickson and Michael Lazarus, *How Would Phasing Out U.S. Federal Leases for Fossil Fuel Extraction Affect CO2 Emissions and 2°C Goals?,* Stockholm Environmental Institute (2016) at 16, *available at* https://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2016-02-US-fossilfuel-leases.pdf (last accessed 11/13/16) (attached as Exhibit 30).
[60] Erickson (2016) at 27 (attached as Exhibit 30).

Requested Remedy: BLM must defer the sale of new oil and gas leases until the agency has undertaken a thorough hard look at potential climate impacts associated with its management of oil and gas. That analysis must consider national policies and recent science that BLM has never considered and that the agency has failed to internalize to date.

Conclusion: BLM has failed to take a hard look at the potential impacts of selling the proposed parcels. The agency has not undertaken the required site-specific analysis of individual parcels, and the agency has not considered the potential climate impacts of selling more oil and gas leases. BLM should consider remedies discussed above for the various problems plaguing this process. Until the problems discussed here are resolved, the agency should defer the sale of any new parcels.

Thank you,

Peter Hart, Staff Attorney
Wilderness Workshop
PO Box 1442
Carbondale, CO 81623
www.wildernessworkshop.org
970.963.3977
peter@wildernessworkshop.org

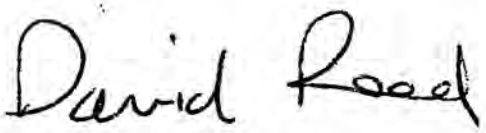
Juli Slivka, Planning Specialist
The Wilderness Society
1660 Wynkoop St. Ste. 850
Denver, CO 80202
www.wilderness.org
(303) 650-1179
juli_slivka@tws.org

Laura King, Staff Attorney
Western Environmental Law Center
103 Reeder's Alley
Helena, MT 59601

(406) 204-4852 (tel.)
king@westernlaw.org
www.westernlaw.org

Luke Schafer, West Slope Advocacy Director
Conservation Colorado
529 Yampa Ave□Craig, CO 81625
luke@conservationco.org
970-824-5241
www.conservationco.org

Matthew Sandler, Staff Attorney
Rocky Mountain Wild
1536 Wynkoop St., Suite 900
Denver, CO 80202
Phone: 303-579-5162
matt@rockymountainwild.org
www.rockymountainwild.org



Dave Reed, Executive Director
Western Colorado Congress
134 Nth 6th St
Grand Junction, CO
(970) 256-7650
dave@wccongress.org
www.wc**congress**.org

Jimbo Buickerood, Lands and Forest Protection Program Manager
San Juan Citizens Alliance
1309 East Third Avenue #5
PO Box 2461
Durango, CO 81302
970.259.3583 Ext. 2
jimbo@sanjuancitizens.org
sanjuancitizens.org

Exhibit 1

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
WASHINGTON, D.C. 20503

August 1, 2016

MEMORANDUM FOR HEADS OF FEDERAL DEPARTMENTS AND AGENCIES

FROM: CHRISTINA GOLDFUSS
COUNCIL ON ENVIRONMENTAL QUALITY

SUBJECT: Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews

I. INTRODUCTION

The Council on Environmental Quality (CEQ) issues this guidance to assist Federal agencies in their consideration of the effects of greenhouse gas (GHG) emissions[1] and climate change when evaluating proposed Federal actions in accordance with the National Environmental Policy Act (NEPA) and the CEQ Regulations Implementing the Procedural Provisions of NEPA (CEQ Regulations).[2] This guidance will facilitate compliance with existing NEPA requirements, thereby improving the efficiency and consistency of reviews of proposed Federal actions for agencies, decision makers, project proponents, and the public.[3] The guidance provides Federal agencies a common

[1] For purposes of this guidance, CEQ defines GHGs in accordance with Section 19(m) of Exec. Order No. 13693, Planning for Federal Sustainability in the Next Decade, 80 Fed. Reg. 15869, 15882 (Mar. 25, 2015) (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride, and sulfur hexafluoride). Also for purposes of this guidance, "emissions" includes release of stored GHGs as a result of land management activities affecting terrestrial GHG pools such as, but not limited to, carbon stocks in forests and soils, as well as actions that affect the future changes in carbon stocks. The common unit of measurement for GHGs is metric tons of CO_2 equivalent (mt CO_2-e).

[2] *See* 42 U.S.C. 4321 et seq.; 40 CFR Parts 1500–1508.

[3] This guidance is not a rule or regulation, and the recommendations it contains may not apply to a particular situation based upon the individual facts and circumstances. This guidance does not change or substitute for any law, regulation, or other legally binding

approach for assessing their proposed actions, while recognizing each agency's unique circumstances and authorities.[4]

Climate change is a fundamental environmental issue, and its effects fall squarely within NEPA's purview.[5] Climate change is a particularly complex challenge given its global nature and the inherent interrelationships among its sources, causation, mechanisms of action, and impacts. Analyzing a proposed action's GHG emissions and the effects of climate change relevant to a proposed action—particularly how climate change may change an action's environmental effects—can provide useful information to decision makers and the public.

CEQ is issuing the guidance to provide for greater clarity and more consistency in how agencies address climate change in the environmental impact assessment process. This guidance uses longstanding NEPA principles because such an analysis should be similar to the analysis of other environmental impacts under NEPA. The guidance is intended to assist agencies in disclosing and considering the reasonably foreseeable effects of proposed actions that are relevant to their decision-making processes. It confirms that agencies should provide the public and decision makers with explanations of the basis for agency determinations.

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requirement, and is not legally enforceable. The use of non-mandatory language such as "guidance," "recommend," "may," "should," and "can," is intended to describe CEQ policies and recommendations. The use of mandatory terminology such as "must" and "required" is intended to describe controlling requirements under the terms of NEPA and the CEQ regulations, but this document does not affect legally binding requirements.

[4] This guidance also addresses recommendations offered by a number of stakeholders. *See* President's State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience, *Recommendations to the President* (November 2014), p. 20 (recommendation 2.7), *available at* www.whitehouse.gov/sites/default/files/docs/task_force_report_0.pdf; U.S. Government Accountability Office, *Future Federal Adaptation Efforts Could Better Support Local Infrastructure Decision Makers*, (Apr. 2013), *available at* http://www.gao.gov/assets/660/653741.pdf. Public comments on drafts of this guidance document are available at http://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/comments.

[5] NEPA recognizes "the profound impact of man's activity on the interrelations of all components of the natural environment." (42 U.S.C. 4331(a)). It was enacted to, *inter alia*, "promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man." (42 U.S.C. 4321).

Focused and effective consideration of climate change in NEPA reviews[6] will allow agencies to improve the quality of their decisions. Identifying important interactions between a changing climate and the environmental impacts from a proposed action can help Federal agencies and other decision makers identify practicable opportunities to reduce GHG emissions, improve environmental outcomes, and contribute to safeguarding communities and their infrastructure against the effects of extreme weather events and other climate-related impacts.

Agencies implement NEPA through one of three levels of NEPA analysis: a Categorical Exclusion (CE); an Environmental Assessment (EA); or an Environmental Impact Statement (EIS). This guidance is intended to help Federal agencies ensure their analysis of potential GHG emissions and effects of climate change in an EA or EIS is commensurate with the extent of the effects of the proposed action.[7] Agencies have discretion in how they tailor their individual NEPA reviews to accommodate the approach outlined in this guidance, consistent with the CEQ Regulations and their respective implementing procedures and policies.[8] CEQ does not expect that implementation of this guidance will require agencies to develop new NEPA implementing procedures. However, CEQ recommends that agencies review their NEPA procedures and propose any updates they deem necessary or appropriate to facilitate their consideration of GHG emissions and climate change.[9] CEQ will review agency

[6] The term "NEPA review" is used to include the analysis, process, and documentation required under NEPA. While this document focuses on NEPA reviews, agencies are encouraged to analyze GHG emissions and climate-resilient design issues early in the planning and development of proposed actions and projects under their substantive authorities.

[7] *See* 40 CFR 1502.2(b) (Impacts shall be discussed in proportion to their significance); 40 CFR 1502.15 (Data and analyses in a statement shall be commensurate with the importance of the impact…).

[8] *See* 40 CFR 1502.24 (Methodology and scientific accuracy).

[9] *See* 40 CFR 1507.3. Agency NEPA implementing procedures can be, but are not required to be, in the form of regulation. Section 1507.3 encourages agencies to publish explanatory guidance, and agencies also should consider whether any updates to explanatory guidance are necessary. Agencies should review their policies and implementing procedures and revise them as necessary to ensure full compliance with NEPA.

proposals for revising their NEPA procedures, including any revision of CEs, in light of this guidance.

As discussed in this guidance, when addressing climate change agencies should consider: (1) The potential effects of a proposed action on climate change as indicated by assessing GHG emissions (e.g., to include, where applicable, carbon sequestration);[10] and, (2) The effects of climate change on a proposed action and its environmental impacts.

This guidance explains the application of NEPA principles and practices to the analysis of GHG emissions and climate change, and

- Recommends that agencies quantify a proposed agency action's projected direct and indirect GHG emissions, taking into account available data and GHG quantification tools that are suitable for the proposed agency action;
- Recommends that agencies use projected GHG emissions (to include, where applicable, carbon sequestration implications associated with the proposed agency action) as a proxy for assessing potential climate change effects when preparing a NEPA analysis for a proposed agency action;
- Recommends that where agencies do not quantify a proposed agency action's projected GHG emissions because tools, methodologies, or data inputs are not reasonably available to support calculations for a quantitative analysis, agencies include a qualitative analysis in the NEPA document and explain the basis for determining that quantification is not reasonably available;

[10] Carbon sequestration is the long-term carbon storage in plants, soils, geologic formations, and oceans.

- Discusses methods to appropriately analyze reasonably foreseeable direct, indirect, and cumulative GHG emissions and climate effects;
- Guides the consideration of reasonable alternatives and recommends agencies consider the short- and long-term effects and benefits in the alternatives and mitigation analysis;
- Advises agencies to use available information when assessing the potential future state of the affected environment in a NEPA analysis, instead of undertaking new research, and provides examples of existing sources of scientific information;
- Counsels agencies to use the information developed during the NEPA review to consider alternatives that would make the actions and affected communities more resilient to the effects of a changing climate;
- Outlines special considerations for agencies analyzing biogenic carbon dioxide sources and carbon stocks associated with land and resource management actions under NEPA;
- Recommends that agencies select the appropriate level of NEPA review to assess the broad-scale effects of GHG emissions and climate change, either to inform programmatic (e.g., landscape-scale) decisions, or at both the programmatic and tiered project- or site-specific level, and to set forth a reasoned explanation for the agency's approach; and
- Counsels agencies that the "rule of reason" inherent in NEPA and the CEQ Regulations allows agencies to determine, based on their expertise and

experience, how to consider an environmental effect and prepare an analysis based on the available information.

II. BACKGROUND

A. NEPA

NEPA is designed to promote consideration of potential effects on the human environment[11] that would result from proposed Federal agency actions, and to provide the public and decision makers with useful information regarding reasonable alternatives[12] and mitigation measures to improve the environmental outcomes of Federal agency actions. NEPA ensures that the environmental effects of proposed actions are taken into account before decisions are made and informs the public of significant environmental effects of proposed Federal agency actions, promoting transparency and accountability concerning Federal actions that may significantly affect the quality of the human environment. NEPA reviews should identify measures to avoid, minimize, or mitigate adverse effects of Federal agency actions. Better analysis and decisions are the ultimate goal of the NEPA process.[13]

Inherent in NEPA and the CEQ Regulations is a "rule of reason" that allows agencies to determine, based on their expertise and experience, how to consider an environmental effect and prepare an analysis based on the available information. The usefulness of that information to the decision-making process and the public, and the

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[11] 40 CFR 1508.14 ("'Human environment' shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment.").
[12] 40 CFR 1508.25(b) ("Alternatives, which include: (1) No action alternative. (2) Other reasonable courses of actions. (3) Mitigation measures (not in the proposed action).").
[13] 40 CFR 1500.1(c) ("Ultimately, of course, it is not better documents but better decisions that count. NEPA's purpose is not to generate paperwork—even excellent paperwork—but to foster excellent action. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment.").

extent of the anticipated environmental consequences are important factors to consider when applying that "rule of reason."

B. Climate Change

Climate change science continues to expand and refine our understanding of the impacts of anthropogenic GHG emissions. CEQ's first Annual Report in 1970 referenced climate change, indicating that "[m]an may be changing his weather."[14] At that time, the mean level of atmospheric carbon dioxide (CO_2) had been measured as increasing to 325 parts per million (ppm) from an average of 280 ppm pre-Industrial levels.[15] Since 1970, the concentration of atmospheric carbon dioxide has increased to approximately 400 ppm (2015 globally averaged value).[16] Since the publication of CEQ's first Annual Report, it has been determined that human activities have caused the carbon dioxide content of the atmosphere of our planet to increase to its highest level in at least 800,000 years.[17]

It is now well established that rising global atmospheric GHG emission concentrations are significantly affecting the Earth's climate. These conclusions are built upon a scientific record that has been created with substantial contributions from the

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[14] *See* CEQ, *Environmental Quality The First Annual Report*, p. 93 (August 1970); *available at* https://ceq.doe.gov/ceq_reports/annual_environmental_quality_reports.html.

[15] *See* USGCRP, *Climate Change Impacts in the United States The Third National Climate Assessment* (Jerry M. Melillo, Terese (T.C.) Richmond, & Gary W. Yohe eds., 2014) [hereinafter "Third National Climate Assessment"], *Appendix 3 Climate Science Supplement*, p. 739; EPA, April 2015: *Inventory of U.S. Greenhouse Emissions and Sinks 1990-2013, available at* https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2015-Main-Text.pdf. *See also* Hartmann, D.L., A.M.G. Klein Tank, M. Rusticucci, et al., *2013 Observations Atmosphere and Surface. In Climate Change 2013 The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K., et al. (eds)]. Cambridge University Press: Cambridge, United Kingdom and New York, NY, USA. *Available at* http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter02_Final.pdf.

[16] *See* Ed Dlugokencky & Pieter Tans, National Oceanic and Atmospheric Administration/Earth System Research Laboratory, http://www.esrl.noaa.gov/gmd/ccgg/trends/global.html.

[17] *See* http://earthobservatory.nasa.gov/Features/CarbonCycle; University of California Riverside, National Aeronautics and Space Administration (NASA), and Riverside Unified School District, *Down to Earth Climate Change*, http://globalclimate.ucr.edu/resources.html; USGCRP, *Third National Climate Assessment, Appendix 3 Climate Science Supplement*, p. 736 ("Although climate changes in the past have been caused by natural factors, human activities are now the dominant agents of change. Human activities are affecting climate through increasing atmospheric levels of heat-trapping gases and other substances, including particles.").

United States Global Change Research Program (USGCRP), which informs the United States' response to global climate change through coordinated Federal programs of research, education, communication, and decision support.[18] Studies have projected the effects of increasing GHGs on many resources normally discussed in the NEPA process, including water availability, ocean acidity, sea-level rise, ecosystem functions, energy production, agriculture and food security, air quality and human health.[19]

Based primarily on the scientific assessments of the USGCRP, the National Research Council, and the Intergovernmental Panel on Climate Change, in 2009 the Environmental Protection Agency (EPA) issued a finding that the changes in our climate caused by elevated concentrations of greenhouse gases in the atmosphere are reasonably anticipated to endanger the public health and public welfare of current and future generations.[20] In 2015, EPA acknowledged more recent scientific assessments that "highlight the urgency of addressing the rising concentration of CO_2 in the atmosphere," finding that certain groups are especially vulnerable to climate-related effects.[21] Broadly

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[18] *See* Global Change Research Act of 1990, Pub. L. 101–606, Sec. 103 (November 16, 1990). For additional information on the United States Global Change Research Program [hereinafter "USGCRP"], visit http://www.globalchange.gov. The USGCRP, formerly the Climate Change Science Program, coordinates and integrates the activities of 13 Federal agencies that conduct research on changes in the global environment and their implications for society. The USGCRP began as a Presidential initiative in 1989 and was codified in the Global Change Research Act of 1990 (Public Law 101–606). USGCRP-participating agencies are the Departments of Agriculture, Commerce, Defense, Energy, Interior, Health and Human Services, State, and Transportation; the U.S. Agency for International Development, the Environmental Protection Agency, NASA, the National Science Foundation, and the Smithsonian Institution.

[19] *See* USGCRP, *Third National Climate Assessment, available at* http://nca2014.globalchange.gov/system/files_force/downloads/low/NCA3_Climate_Change_Impacts_in_the_United%20States_LowRes.pdf?download=1; IPCC, *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* (R.K. Pachauri, & L.A. Meyer eds., 2014), *available at* https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf; *see also* http://www.globalchange.gov; 40 CFR 1508.8 (effects include ecological, aesthetic, historic, cultural, economic, social, and health effects); USGCRP, *The Impacts of Climate Change on Human Health in the United States A Scientific Assessment, available at* https://health2016.globalchange.gov/.

[20] *See generally Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act*, 74 Fed. Reg. 66496 (Dec. 15, 2009). (For example, at 66497-98: "[t]he evidence concerning how human-induced climate change may alter extreme weather events also clearly supports a finding of endangerment, given the serious adverse impacts that can result from such events and the increase in risk, even if small, of the occurrence and intensity of events such as hurricanes and floods. Additionally, public health is expected to be adversely affected by an increase in the severity of coastal storm events due to rising sea levels").

[21] *See* EPA, *Final Rule for Carbon Pollution Emission Guidelines for Existing Stationary Sources Electric Utility Generating Units*, 80 Fed. Reg. 64661, 64677 (Oct. 23, 2015) ("Certain groups, including children, the elderly, and the poor, are most vulnerable to climate-related effects. Recent studies also find that certain communities, including low-income communities and some communities of color ... are disproportionately affected by certain climate change related impacts—including heat waves, degraded air quality, and

stated, the effects of climate change observed to date and projected to occur in the future include more frequent and intense heat waves, longer fire seasons and more severe wildfires, degraded air quality, more heavy downpours and flooding, increased drought, greater sea-level rise, more intense storms, harm to water resources, harm to agriculture, ocean acidification, and harm to wildlife and ecosystems.[22]

III. CONSIDERING THE EFFECTS OF GHG EMISSIONS AND CLIMATE CHANGE

This guidance is applicable to all Federal actions subject to NEPA, including site-specific actions, certain funding of site-specific projects, rulemaking actions, permitting decisions, and land and resource management decisions.[23] This guidance does not – and cannot – expand the range of Federal agency actions that are subject to NEPA. Consistent with NEPA, Federal agencies should consider the extent to which a proposed action and its reasonable alternatives would contribute to climate change, through GHG emissions, and take into account the ways in which a changing climate may impact the proposed action and any alternative actions, change the action's environmental effects over the lifetime of those effects, and alter the overall environmental implications of such actions.

This guidance is intended to assist agencies in disclosing and considering the effects of GHG emissions and climate change along with the other reasonably foreseeable environmental effects of their proposed actions. This guidance does not establish any

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extreme weather events—which are associated with increased deaths, illnesses, and economic challenges. Studies also find that climate change poses particular threats to the health, well-being, and ways of life of indigenous peoples in the U.S.").

[22] *See* http://www.globalchange.gov/climate-change/impacts-society and Third National Climate Assessment, Chapters 3-15 (Sectors) and Chapters 16-25 (Regions), *available at* http://nca2014.globalchange.gov/downloads.

[23] *See* 40 CFR 1508.18.

particular quantity of GHG emissions as "significantly" affecting the quality of the human environment or give greater consideration to the effects of GHG emissions and climate change over other effects on the human environment.

A. GHG Emissions as a Proxy for the Climate Change Impacts of a Proposed Action

In light of the global scope of the impacts of GHG emissions, and the incremental contribution of each single action to global concentrations, CEQ recommends agencies use the projected GHG emissions associated with proposed actions as a proxy for assessing proposed actions' potential effects on climate change in NEPA analysis.[24] This approach, together with providing a qualitative summary discussion of the impacts of GHG emissions based on authoritative reports such as the USGCRP's National Climate Assessments and the Impacts of Climate Change on Human Health in the United States, a Scientific Assessment of the USGCRP, allows an agency to present the environmental and public health impacts of a proposed action in clear terms and with sufficient information to make a reasoned choice between no action and other alternatives and appropriate mitigation measures, and to ensure the professional and scientific integrity of the NEPA review.[25]

Climate change results from the incremental addition of GHG emissions from millions of individual sources,[26] which collectively have a large impact on a global scale.

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[24] *See* 40 CFR 1502.16, 1508.9.

[25] *See* 40 CFR 1500.1, 1502.24 (requiring agencies to use high quality information and ensure the professional and scientific integrity of the discussions and analyses in environmental impact statements).

[26] Some sources emit GHGs in quantities that are orders of magnitude greater than others. *See* EPA, *Greenhouse Gas Reporting Program 2014 Reported Data*, Figure 2: Direct GHG Emissions Reported by Sector (2014), *available at* https://www.epa.gov/ghgreporting/ghgrp-2014-reported-data (amounts of GHG emissions by sector); *Final Rule for Carbon Pollution Emission Guidelines for Existing Stationary Sources Electric Utility Generating Units*, 80 Fed. Reg. 64661, 64663, 64689 (Oct. 23, 2015) (regulation of GHG emissions from fossil fuel-fired electricity generating power plants); *Oil and Natural Gas Sector Emission Standards for New, Reconstructed, and Modified Sources*, 81 Fed. Reg. 34824, 35830 (June 3, 2016 (regulation of GHG emissions from oil and gas sector).

CEQ recognizes that the totality of climate change impacts is not attributable to any single action, but are exacerbated by a series of actions including actions taken pursuant to decisions of the Federal Government. Therefore, a statement that emissions from a proposed Federal action represent only a small fraction of global emissions is essentially a statement about the nature of the climate change challenge, and is not an appropriate basis for deciding whether or to what extent to consider climate change impacts under NEPA. Moreover, these comparisons are also not an appropriate method for characterizing the potential impacts associated with a proposed action and its alternatives and mitigations because this approach does not reveal anything beyond the nature of the climate change challenge itself: the fact that diverse individual sources of emissions each make a relatively small addition to global atmospheric GHG concentrations that collectively have a large impact. When considering GHG emissions and their significance, agencies should use appropriate tools and methodologies for quantifying GHG emissions and comparing GHG quantities across alternative scenarios. Agencies should not limit themselves to calculating a proposed action's emissions as a percentage of sector, nationwide, or global emissions in deciding whether or to what extent to consider climate change impacts under NEPA.

1. GHG Emissions Quantification and Relevant Tools

This guidance recommends that agencies quantify a proposed agency action's projected direct and indirect GHG emissions. Agencies should be guided by the principle that the extent of the analysis should be commensurate with the quantity of projected GHG emissions and take into account available data and GHG quantification tools that

are suitable for and commensurate with the proposed agency action.[27] The rule of reason and the concept of proportionality caution against providing an in-depth analysis of emissions regardless of the insignificance of the quantity of GHG emissions that would be caused by the proposed agency action.

Quantification tools are widely available, and are already in broad use in the Federal and private sectors, by state and local governments, and globally.[28] Such quantification tools and methodologies have been developed to assist institutions, organizations, agencies, and companies with different levels of technical sophistication, data availability, and GHG source profiles. When data inputs are reasonably available to support calculations, agencies should conduct GHG analysis and disclose quantitative estimates of GHG emissions in their NEPA reviews. These tools can provide estimates of GHG emissions, including emissions from fossil fuel combustion and estimates of GHG emissions and carbon sequestration for many of the sources and sinks potentially affected by proposed resource management actions.[29] When considering which tool(s) to employ, it is important to consider the proposed action's temporal scale, and the availability of input data.[30] Examples of the kinds of methodologies agencies might consider using are presented in CEQ's 2012 Guidance for Accounting and Reporting GHG Emissions for a wide variety of activities associated with Federal agency operations.[31] When an agency determines that quantifying GHG emissions would not be

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[27] *See* 40 CFR 1500.1(b) ("Most important, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail."), 40 CFR 1502.2(b) (Impacts shall be discussed in proportion to their significance); 40 CFR 1502.15 (Data and analyses in a statement shall be commensurate with the importance of the impact...).

[28] *See* https://ceq.doe.gov/current_developments/GHG-accounting-tools.html.

[29] For example, USDA's COMET-Farm tool can be used to assess the carbon sequestration of existing agricultural activities along with the reduction in carbon sequestration (emissions) of project-level activities, http://cometfarm.nrel.colostate.edu/. Examples of other tools are available at https://ceq.doe.gov/current_developments/GHG-accounting-tools.html.

[30] *See* 40 CFR 1502.22.

[31] *See* https://www.whitehouse.gov/sites/default/files/microsites/ceq/revised_federal_greenhouse_gas_accounting_and_reporting_guidance_

warranted because tools, methodologies, or data inputs are not reasonably available, the agency should provide a qualitative analysis and its rationale for determining that the quantitative analysis is not warranted. A qualitative analysis can rely on sector-specific descriptions of the GHG emissions of the category of Federal agency action that is the subject of the NEPA analysis.

When updating their NEPA procedures[32] and guidance, agencies should coordinate with CEQ to identify 1) the actions that normally warrant quantification of their GHG emissions, and consideration of the relative GHG emissions associated with alternative actions and 2) agency actions that normally do not warrant such quantification because tools, methodologies, or data inputs are not reasonably available. The determination of the potential significance of a proposed action remains subject to agency practice for the consideration of context and intensity, as set forth in the CEQ Regulations.[33]

2. The Scope of the Proposed Action

In order to assess effects, agencies should take account of the proposed action – including "connected" actions[34] – subject to reasonable limits based on feasibility and practicality. Activities that have a reasonably close causal relationship to the Federal action, such as those that may occur as a predicate for a proposed agency action or as a consequence of a proposed agency action, should be accounted for in the NEPA analysis.

060412.pdf. Federal agencies' Strategic Sustainability Performance Plans reflecting their annual GHG inventories and reports under Executive Order 13514 are available at https://www.performance.gov/node/3406/view?view=public#supporting-info.

[32] *See* 40 CFR 1507.3.

[33] 40 CFR 1508.27 ("'Significantly' as used in NEPA requires considerations of both context and intensity: (a) Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. . . . (b) Intensity. This refers to the severity of impact.").

[34] 40 CFR 1508.25(a) (Actions are connected if they: (i) Automatically trigger other actions which may require environmental impact statements; (ii) Cannot or will not proceed unless other actions are taken previously or simultaneously, or; (iii) Are interdependent parts of a larger action and depend on the larger action for their justification.).

For example, NEPA reviews for proposed resource extraction and development projects typically include the reasonably foreseeable effects of various phases in the process, such as clearing land for the project, building access roads, extraction, transport, refining, processing, using the resource, disassembly, disposal, and reclamation. Depending on the relationship between any of the phases, as well as the authority under which they may be carried out, agencies should use the analytical scope that best informs their decision making.

The agency should focus on significant potential effects and conduct an analysis that is proportionate to the environmental consequences of the proposed action.[35] Agencies can rely on basic NEPA principles to determine and explain the reasonable parameters of their analyses in order to disclose the reasonably foreseeable effects that may result from their proposed actions.[36]

3. Alternatives

Considering alternatives, including alternatives that mitigate GHG emissions, is fundamental to the NEPA process and accords with NEPA Sections 102(2)(C) and 102(2)(E).[37] The CEQ regulations emphasize that the alternatives analysis is the heart of the EIS under NEPA Section 102(2)(C).[38] NEPA Section 102(2)(E) provides an independent requirement for the consideration of alternatives in environmental documents.[39] NEPA calls upon agencies to use the NEPA process to "identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment."[40] The requirement to

[35] *See* 40 CFR 1501.7(a)(3), 1502.2(b), and 1502.15.
[36] *See* 40 CFR 1502.16.
[37] 42 U.S.C. 4332(2)(C), 4332(2)(E); 40 CFR 1502.14, 1508.9(b).
[38] 40 CFR 1502.14.
[39] *See* 40 CFR 1500.2, 1508.9(b).
[40] 40 CFR 1500.2(e).

consider alternatives ensures that agencies account for approaches with no, or less, adverse environmental effects for a particular resource.

Consideration of alternatives also provides each agency decision maker the information needed to examine other possible approaches to a particular proposed action (including the no action alternative) that could alter the environmental impact or the balance of factors considered in making the decision. Agency decisions are aided when there are reasonable alternatives that allow for comparing GHG emissions and carbon sequestration potential, trade-offs with other environmental values, and the risk from – and resilience to – climate change inherent in a proposed action and its design.

Agencies must consider a range of reasonable alternatives consistent with the level of NEPA review (e.g., EA or EIS) and the purpose and need for the proposed action, as well as reasonable mitigation measures if not already included in the proposed action or alternatives.[41] Accordingly, a comparison of these alternatives based on GHG emissions and any potential mitigation measures can be useful to advance a reasoned choice among alternatives and mitigation actions. When conducting the analysis, an agency should compare the anticipated levels of GHG emissions from each alternative – including the no-action alternative – and mitigation actions to provide information to the public and enable the decision maker to make an informed choice.

Agencies should consider reasonable alternatives and mitigation measures to reduce action-related GHG emissions or increase carbon sequestration in the same fashion as they consider alternatives and mitigation measures for any other environmental effects. NEPA, the CEQ Regulations, and this guidance do not require the decision

[41] *See* 42 U.S.C. 4332(2)(C), 4332(2)(E), and 40 CFR 1502.14(f), 1508.9(b). The purpose and need for action usually reflects both the extent of the agency's statutory authority and its policies.

maker to select the alternative with the lowest net level of emissions. Rather, they allow for the careful consideration of emissions and mitigation measures along with all the other factors considered in making a final decision.

4. Direct and Indirect Effects

If the direct and indirect GHG emissions can be quantified based on available information, including reasonable projections and assumptions, agencies should consider and disclose the reasonably foreseeable direct and indirect emissions when analyzing the direct and indirect effects of the proposed action.[42] Agencies should disclose the information and any assumptions used in the analysis and explain any uncertainties.

To compare a project's estimated direct and indirect emissions with GHG emissions from the no-action alternative, agencies should draw on existing, timely, objective, and authoritative analyses, such as those by the Energy Information Administration, the Federal Energy Management Program, or Office of Fossil Energy of the Department of Energy.[43] In the absence of such analyses, agencies should use other available information. When such analyses or information for quantification is unavailable, or the complexity of comparing emissions from various sources would make quantification overly speculative, then the agency should quantify emissions to the extent that this information is available and explain the extent to which quantified emissions information is unavailable while providing a qualitative analysis of those emissions. As

[42] For example, where the proposed action involves fossil fuel extraction, direct emissions typically include GHGs emitted during the process of exploring for or extracting the fossil fuel. The indirect effects of such an action that are reasonably foreseeable at the time would vary with the circumstances of the proposed action. For actions such as a Federal lease sale of coal for energy production, the impacts associated with the end-use of the fossil fuel being extracted would be the reasonably foreseeable combustion of that coal.
[43] For a current example, see Office of Fossil Energy, Nat'l Energy Tech. Lab., U.S. Dep't of Energy, *Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States*, Pub. No. DOE/NETL-2014/1649 (2014), *available at* http://energy.gov/sites/prod/files/2014/05/f16/Life%20Cycle%20GHG%20Perspective%20Report.pdf.

with any NEPA analysis, the level of effort should be proportionate to the scale of the emissions relevant to the NEPA review.

5. Cumulative Effects

"Cumulative impact" is defined in the CEQ Regulations as the "impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions."[44] All GHG emissions contribute to cumulative climate change impacts. However, for most Federal agency actions CEQ does not expect that an EIS would be required based *solely* on the global significance of cumulative impacts of GHG emissions, as it would not be consistent with the rule of reason to require the preparation of an EIS for every Federal action that may cause GHG emissions regardless of the magnitude of those emissions.

Based on the agency identification and analysis of the direct and indirect effects of its proposed action, NEPA requires an agency to consider the cumulative impacts of its proposed action and reasonable alternatives.[45] As noted above, for the purposes of NEPA, the analysis of the effects of GHG emissions is essentially a cumulative effects analysis that is subsumed within the general analysis and discussion of climate change impacts. Therefore, direct and indirect effects analysis for GHG emissions will adequately address the cumulative impacts for climate change from the proposed action and its alternatives and a separate cumulative effects analysis for GHG emissions is not needed.

6. Short- and Long-Term Effects

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[44] 40 CFR 1508.7.

[45] *See* 40 CFR 1502.16, 1508.7, 1508.8. *See also* CEQ Memorandum to Heads of Federal Agencies, *Guidance on the Consideration of Past Actions in Cumulative Effects Analysis*, June 24, 2005, *available at* https//ceq.doe.gov/nepa/regs/Guidance_on_CE.pdf.

When considering effects, agencies should take into account both the short- and long-term adverse and beneficial effects using a temporal scope that is grounded in the concept of reasonable foreseeability. Some proposed actions will have to consider effects at different stages to ensure the direct effects and reasonably foreseeable indirect effects are appropriately assessed; for example, the effects of construction are different from the effects of the operations and maintenance of a facility.

Biogenic GHG emissions and carbon stocks from some land or resource management activities, such as a prescribed burn of a forest or grassland conducted to limit loss of ecosystem function through wildfires or insect infestations, may result in short-term GHG emissions and loss of stored carbon, while in the longer term a restored, healthy ecosystem may provide long-term carbon sequestration. Therefore, the short- and long-term effects should be described in comparison to the no action alternative in the NEPA review.

7. Mitigation

Mitigation is an important component of the NEPA process that Federal agencies can use to avoid, minimize, and compensate for the adverse environmental effects associated with their actions. Mitigation, by definition, includes avoiding impacts, minimizing impacts by limiting them, rectifying the impact, reducing or eliminating the impacts over time, or compensating for them.[46] Consequently, agencies should consider reasonable mitigation measures and alternatives as provided for under existing CEQ Regulations and take into account relevant agency statutory authorities and policies. The NEPA process is also intended to provide useful advice and information to State, local

[46] *See* 40 CFR 1508.20, 1508.25 (Alternatives include mitigation measures not included in the proposed action).

and tribal governments and private parties so that the agencies can better coordinate with other agencies and organizations regarding the means to mitigate effects of their actions.[47] The NEPA process considers the effects of mitigation commitments made by project proponents or others and mitigation required under other relevant permitting and environmental review regimes.[48]

As Federal agencies evaluate potential mitigation of GHG emissions and the interaction of a proposed action with climate change, the agencies should also carefully evaluate the quality of that mitigation to ensure it is additional, verifiable, durable, enforceable, and will be implemented.[49] Agencies should consider the potential for mitigation measures to reduce or mitigate GHG emissions and climate change effects when those measures are reasonable and consistent with achieving the purpose and need for the proposed action. Such mitigation measures could include enhanced energy efficiency, lower GHG-emitting technology, carbon capture, carbon sequestration (e.g., forest, agricultural soils, and coastal habitat restoration), sustainable land management practices, and capturing or beneficially using GHG emissions such as methane.

Finally, the CEQ Regulations and guidance recognize the value of monitoring to ensure that mitigation is carried out as provided in a record of decision or finding of no significant impact.[50] The agency's final decision on the proposed action should identify those mitigation measures that the agency commits to take, recommends, or requires

[47] NEPA directs Federal agencies to make "advice and information useful in restoring, maintaining, and enhancing the quality of the environment" available to States, Tribes, counties, cities, institutions and individuals. NEPA Sec. 102(2)(G).
[48] *See* CEQ Memorandum to Heads of Federal Agencies, *Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact*, 76 FR 3843 (Jan. 21, 2011) *available at* https://ceq.doe.gov/current_developments/docs/Mitigation_and_Monitoring_Guidance_14Jan2011.pdf.
[49] *See* Presidential Memorandum: *Mitigating Impacts on Natural Resources from Development and Encouraging Related Private Investment* (https://www.whitehouse.gov/the-press-office/2015/11/03/mitigating-impacts-natural-resources-development-and-encouraging-related) defining "durability" and addressing additionality.
[50] *See* 40 CFR 1505.2(c), 1505.3. *See also* CEQ Memorandum to Heads of Federal Agencies, *Appropriate Use of Mitigation and Monitoring and Clarifying the Appropriate Use of Mitigated Findings of No Significant Impact*, 76 FR 3843 (Jan. 21, 2011) *available at* https://ceq.doe.gov/current_developments/docs/Mitigation_and_Monitoring_Guidance_14Jan2011.pdf.

others to take. Monitoring is particularly appropriate to confirm the effectiveness of mitigation when that mitigation is adopted to reduce the impacts of a proposed action on affected resources already increasingly vulnerable due to climate change.

B. CONSIDERING THE EFFECTS OF CLIMATE CHANGE ON A PROPOSED ACTION AND ITS ENVIRONMENTAL IMPACTS

According to the USGCRP and others, GHGs already in the atmosphere will continue altering the climate system into the future, even with current or future emissions control efforts.[51] Therefore, a NEPA review should consider an action in the context of the future state of the environment. In addition, climate change adaptation and resilience — defined as adjustments to natural or human systems in response to actual or expected climate changes — are important considerations for agencies contemplating and planning actions with effects that will occur both at the time of implementation and into the future.[52]

1. Affected Environment

An agency should identify the affected environment to provide a basis for comparing the current and the future state of the environment as affected by the proposed action or its reasonable alternatives.[53] The current and projected future state of the environment without the proposed action (i.e., the no action alternative) represents the reasonably foreseeable affected environment, and this should be described based on

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[51] *See* Third National Climate Assessment, *Appendix 3 Climate Science Supplement* 753-754, *available at* http://s3.amazonaws.com/nca2014/low/NCA3_Full_Report_Appendix_3_Climate_Science_Supplement_LowRes.pdf?download=1.

[52] *See* Third National Climate Assessment, Chapter 28, "Adaptation" and Chapter 26, "Decision Support: Connecting Science, Risk Perception, and Decisions," *available at* http://www.globalchange.gov/nca3-downloads-materials; see also, Exec. Order No. 13653, 78 Fed. Reg. 66817 (Nov. 6, 2013) and Exec. Order No.13693, *Planning for Federal Sustainability in the Next Decade*, 80 Fed. Reg. 15869 (Mach 25, 2015) (defining "climate-resilient design").

[53] *See* 40 CFR 1502.15 (providing that environmental impact statements shall succinctly describe the environmental impacts on the area(s) to be affected or created by the alternatives under consideration).

authoritative climate change reports,[54] which often project at least two possible future scenarios.[55] The temporal bounds for the state of the environment are determined by the projected initiation of implementation and the expected life of the proposed action and its effects.[56] Agencies should remain aware of the evolving body of scientific information as more refined estimates of the impacts of climate change, both globally and at a localized level, become available.[57]

2. Impacts

The analysis of climate change impacts should focus on those aspects of the human environment that are impacted by both the proposed action and climate change. Climate change can make a resource, ecosystem, human community, or structure more susceptible to many types of impacts and lessen its resilience to other environmental impacts apart from climate change. This increase in vulnerability can exacerbate the effects of the proposed action. For example, a proposed action may require water from a stream that has diminishing quantities of available water because of decreased snow pack in the mountains, or add heat to a water body that is already warming due to increasing atmospheric temperatures. Such considerations are squarely within the scope of NEPA and can inform decisions on whether to proceed with, and how to design, the proposed action to eliminate or mitigate impacts exacerbated by climate change. They can also

[54] *See, e.g.*, Third National Climate Assessment (Regional impacts chapters) *available at* http://www.globalchange.gov/nca3-downloads-materials.
[55] *See, e.g.*, Third National Climate Assessment (Regional impacts chapters, considering a low future global emissions scenario, and a high emissions scenario) *available at* http://www.globalchange.gov/nca3-downloads-materials.
[56] CEQ, *Considering Cumulative Effects Under the National Environmental Policy Act* (1997), https://ceq.doe.gov/publications/cumulative_effects.html. Agencies should also consider their work under Exec. Order No. 13653, *Preparing the United States for the Impacts of Climate Change*, 78 Fed. Reg. 66817 (Nov. 6, 2013), that considers how capital investments will be affected by a changing climate over time.
[57] *See, e.g.*, http://nca2014.globalchange.gov/report/regions/coasts.

inform possible adaptation measures to address the impacts of climate change, ultimately enabling the selection of smarter, more resilient actions.

3. Available Assessments and Scenarios

In accordance with NEPA's rule of reason and standards for obtaining information regarding reasonably foreseeable effects on the human environment, agencies need not undertake new research or analysis of potential climate change impacts in the proposed action area, but may instead summarize and incorporate by reference the relevant scientific literature.[58] For example, agencies may summarize and incorporate by reference the relevant chapters of the most recent national climate assessments or reports from the USGCRP.[59] Particularly relevant to some proposed actions are the most current reports on climate change impacts on water resources, ecosystems, agriculture and forestry, health, coastlines, and ocean and arctic regions in the United States.[60] Agencies may recognize that scenarios or climate modeling information (including seasonal, inter-annual, long-term, and regional-scale projections) are widely used, but when relying on a single study or projection, agencies should consider their limitations and discuss them.[61]

4. Opportunities for Resilience and Adaptation

As called for under NEPA, the CEQ Regulations, and CEQ guidance, the NEPA review process should be integrated with agency planning at the earliest possible time that would allow for a meaningful analysis.[62] Information developed during early

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[58] *See* 40 CFR 1502.21 (material may be incorporated by reference if it is reasonably available for inspection by potentially interested persons during public review and comment).
[59] *See* http://www.globalchange.gov/browse/reports.
[60] *See* Third National Climate Assessment, *Our Changing Climate, available at* http://nca2014.globalchange.gov/report. Agencies should consider the latest final assessments and reports when they are updated.
[61] *See* 40 CFR 1502.22. Agencies can consult www.data.gov/climate/portals for model data archives, visualization tools, and downscaling results.
[62] *See* 42 U.S.C. 4332 ("agencies of the Federal Government shall ... utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making"); 40 CFR 1501.2 ("Agencies shall integrate the NEPA process with other planning at the earliest possible time..."); *See also* CEQ Memorandum

planning processes that precede a NEPA review may be incorporated into the NEPA review. Decades of NEPA practice have shown that integrating environmental considerations with the planning process provides useful information that program and project planners can consider in the design of the proposed action, alternatives, and potential mitigation measures. For instance, agencies should take into account increased risks associated with development in floodplains, avoiding such development wherever there is a practicable alternative, as required by Executive Order 11988 and Executive Order 13690.[63] In addition, agencies should take into account their ongoing efforts to incorporate environmental justice principles into their programs, policies, and activities, including the environmental justice strategies required by Executive Order 12898, as amended, and consider whether the effects of climate change in association with the effects of the proposed action may result in a disproportionate effect on minority and low income communities.[64] Agencies also may consider co-benefits of the proposed action, alternatives, and potential mitigation measures for human health, economic and social stability, ecosystem services, or other benefit that increases climate change preparedness or resilience. Individual agency adaptation plans and interagency adaptation strategies, such as agency Climate Adaptation Plans, the National Fish, Wildlife and Plants Climate Adaptation Strategy, and the National Action Plan: Priorities for Managing Freshwater

for Heads of Federal Departments and Agencies, *Improving the Process for Preparing Efficient and Timely Environmental Reviews under the National Environmental Policy Act*, 77 Fed. Reg. 14473 (Mar. 12, 2012), *available at* https://ceq.doe.gov/current_developments/docs/Improving_NEPA_Efficiencies_06Mar2012.pdf.

[63] *See* Exec. Order No. 11988, "Floodplain Management," 42 Fed. Reg. 26951 (May 24, 1977), *available at* http://www.archives.gov/federal-register/codification/executive-order/11988.html; Exec. Order No. 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*, 80 Fed. Reg. 6425 (Jan. 30, 2015), *available at* https://www.gpo.gov/fdsys/pkg/FR-2015-02-04/pdf/2015-02379.pdf.

[64] *See* Exec. Order No. 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*, 59 Fed. Reg. 7629 (Feb. 16, 1994), *available at* https://ceq.doe.gov/nepa/regs/eos/ii-5.pdf; CEQ, *Environmental Justice Guidance Under the National Environmental Policy Act* (Dec. 1997), *available at* http://ceq.doe.gov/nepa/regs/ej/justice.pdf.

Resources in a Changing Climate, provide other good examples of the type of relevant and useful information that can be considered.[65]

Climate change effects on the environment and on the proposed project should be considered in the analysis of a project considered vulnerable to the effects of climate change such as increasing sea level, drought, high intensity precipitation events, increased fire risk, or ecological change. In such cases, a NEPA review will provide relevant information that agencies can use to consider in the initial project design, as well as alternatives with preferable overall environmental outcomes and improved resilience to climate impacts. For example, an agency considering a proposed long-term development of transportation infrastructure on a coastal barrier island should take into account climate change effects on the environment and, as applicable, consequences of rebuilding where sea level rise and more intense storms will shorten the projected life of the project and change its effects on the environment.[66] Given the length of time involved in present sea level projections, such considerations typically will not be relevant to short-term actions with short-term effects.

In addition, the particular impacts of climate change on vulnerable communities may be considered in the design of the action or the selection among alternatives to

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[65] *See* http://sustainability.performance.gov for agency sustainability plans, which contain agency adaptation plans. *See also* http://www.wildlifeadaptationstrategy.gov; http://www.whitehouse.gov/sites/default/files/microsites/ceq/2011_national_action_plan.pdf; and https://www.epa.gov/greeningepa/climate-change-adaptation-plans

[66] *See* U.S. Department of Transportation, Gulf Coast Study, Phase 2, *Assessing Transportation Vulnerability to Climate Change Synthesis of Lessons Learned and Methods Applied*, FHWA-HEP-15-007 (Oct. 2014) (focusing on the Mobile, Alabama region), *available at* http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study/phase2_task6/fhwahep15007.pdf; U.S. Climate Change Science Program, Synthesis and Assessment Product 4.7, Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I (Mar. 2008) (focusing on a regional scale in the central Gulf Coast), *available at* https://downloads.globalchange.gov/sap/sap4-7/sap4-7-final-all.pdf. Information about the Gulf Coast Study is *available at* *http://www.fhwa.dot.gov/environment/climate_change/adaptation/ongoing_and_current_research/gulf_coast_study*. *See also* Third National Climate Assessment, Chapter 28, "Adaptation," at 675 (noting that Federal agencies in particular can facilitate climate adaptation by "ensuring the establishment of federal policies that allow for "flexible" adaptation efforts and take steps to avoid unintended consequences"), *available at* http://nca2014.globalchange.gov/report/response-strategies/adaptation#intro-section-2.

assess the impact, and potential for disproportionate impacts, on those communities.[67] For example, chemical facilities located near the coastline could have increased risk of spills or leakages due to sea level rise or increased storm surges, putting local communities and environmental resources at greater risk. Increased resilience could minimize such potential future effects. Finally, considering climate change preparedness and resilience can help ensure that agencies evaluate the potential for generating additional GHGs if a project has to be replaced, repaired, or modified, and minimize the risk of expending additional time and funds in the future.

C. Special Considerations for Biogenic Sources of Carbon

With regard to biogenic GHG emissions from land management actions – such as prescribed burning, timber stand improvements, fuel load reductions, scheduled harvesting, and livestock grazing – it is important to recognize that these land management actions involve GHG emissions and carbon sequestration that operate within the global carbon and nitrogen cycle, which may be affected by those actions. Similarly, some water management practices have GHG emission consequences (e.g., reservoir management practices can reduce methane releases, wetlands management practices can enhance carbon sequestration, and water conservation can improve energy efficiency).

Notably, it is possible that the net effect of ecosystem restoration actions resulting in short-term biogenic emissions may lead to long-term reductions of atmospheric GHG concentrations through increases in carbon stocks or reduced risks of future emissions. In the land and resource management context, how a proposed action affects a net carbon sink or source will depend on multiple factors such as the climatic region, the distribution

[67] For an example, *see* https://www.blm.gov/epl-front-office/projects/nepa/5251/42462/45213/NPR-A_FINAL_ROD_2-21-13.pdf.

of carbon across carbon pools in the project area, and the ongoing activities and trends. In addressing biogenic GHG emissions, resource management agencies should include a comparison of estimated net GHG emissions and carbon stock changes that are projected to occur with and without implementation of proposed land or resource management actions.[68] This analysis should take into account the GHG emissions, carbon sequestration potential, and the changes in carbon stocks that are relevant to decision making in light of the proposed actions and timeframes under consideration.

One example of agencies dealing with biogenic emissions and carbon sequestration arises when agencies consider proposed vegetation management practices that affect the risk of wildfire, insect and disease outbreak, or other disturbance. The public and the decision maker may benefit from consideration of the influence of a vegetation management action that affects the risk of wildfire on net GHG emissions and carbon stock changes. NEPA reviews should consider whether to include a comparison of net GHG emissions and carbon stock changes that are anticipated to occur, with and without implementation of the proposed vegetation management practice, to provide information that is useful to the decision maker and the public to distinguish between alternatives. The analysis would take into account the estimated GHG emissions (biogenic and fossil), carbon sequestration potential, and the net change in carbon stocks relevant in light of the proposed actions and timeframes under consideration. In such cases the agency should describe the basis for estimates used to project the probability or likelihood of occurrence or changes in the effects or severity of wildfire. Where such

[68] One example of a tool for such calculations is the Carbon On Line Estimator (COLE), which uses data based on USDA Forest Service Forest Inventory & Analysis and Resource Planning Assessment data and other ecological data. COLE began as a collaboration between the National Council for Air and Stream Improvement, Inc. (NCASI) and USDA Forest Service, Northern Research Station. It currently is maintained by NCASI. It is available at http://www.fs.usda.gov/ccrc/tools/cole.

tools, methodologies, or data are not yet available, the agency should provide a qualitative analysis and its rationale for determining that the quantitative analysis is not warranted. As with any other analysis, the rule of reason and proportionality should be applied to determine the extent of the analysis.

CEQ acknowledges that Federal land and resource management agencies are developing agency-specific principles and guidance for considering biological carbon in management and planning decisions.[69] Such guidance is expected to address the importance of considering biogenic carbon fluxes and storage within the context of other management objectives and ecosystem service goals, and integrating carbon considerations as part of a balanced and comprehensive program of sustainable management, climate change mitigation, and climate change adaptation.

IV. TRADITIONAL NEPA TOOLS AND PRACTICES

A. Scoping and Framing the NEPA Review

To effectuate integrated decision making, avoid duplication, and focus the NEPA review, the CEQ Regulations provide for scoping.[70] In scoping, the agency determines the issues that the NEPA review will address and identifies the impacts related to the proposed action that the analyses will consider.[71] An agency can use the scoping process to help it determine whether analysis is relevant and, if so, the extent of analysis

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[69] *See* Council on Climate Change Preparedness and Resilience, *Priority Agenda Enhancing the Climate Resilience of America's Natural Resources*, at 52 (Oct. 2014), *available at* http://www.whitehouse.gov/sites/default/files/docs/enhancing_climate_resilience_of_americas_natural_resources.pdf.

[70] *See* 40 CFR 1501.7 ("There shall be an early and open process for determining the scope of issues to be addressed and for identifying the significant issues related to a proposed action. This process shall be termed scoping."); *see also* CEQ Memorandum for Heads of Federal Departments and Agencies, *Improving the Process for Preparing Efficient and Timely Environmental Reviews under the National Environmental Policy Act*, March 6, 2012, *available at* https://ceq.doe.gov/current_developments/docs/Improving_NEPA_Efficiencies_06Mar2012.pdf (the CEQ Regulations explicitly require scoping for preparing an EIS, however, agencies can also take advantage of scoping whenever preparing an EA).

[71] *See* 40 CFR 1500.4(b), 1500.4(g), 1501.7.

appropriate for a proposed action.[72] When scoping for the climate change issues associated with the proposed agency action, the nature, location, timeframe, and type of the proposed action and the extent of its effects will help determine the degree to which to consider climate projections, including whether climate change considerations warrant emphasis, detailed analysis, and disclosure.

Consistent with this guidance, agencies may develop their own agency-specific practices and guidance for framing the NEPA review. Grounded on the principles of proportionality and the rule of reason, such aids can help an agency determine the extent to which an analysis of GHG emissions and climate change impacts should be explored in the decision-making process and will assist in the analysis of the no action and proposed alternatives and mitigation.[73] The agency should explain such a framing process and its application to the proposed action to the decision makers and the public during the NEPA review and in the EA or EIS document.

B. Frame of Reference

When discussing GHG emissions, as for all environmental impacts, it can be helpful to provide the decision maker and the public with a recognizable frame of reference for comparing alternatives and mitigation measures. Agencies should discuss relevant approved federal, regional, state, tribal, or local plans, policies, or laws for GHG emission reductions or climate adaptation to make clear whether a proposed project's

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[72] *See* 40 CFR 1501.7 (The agency preparing the NEPA analysis must use the scoping process to, among other things, determine the scope and identify the significant issues to be analyzed in depth) and CEQ, *Memorandum for General Counsels, NEPA Liaisons, and Participants in Scoping*, April 30, 1981, *available at* https://ceq.doe.gov/nepa/regs/scope/scoping.htm.

[73] *See, e.g.*, Matthew P. Thompson, Bruce G. Marcot, Frank R. Thompson, III, Steven McNulty, Larry A. Fisher, Michael C. Runge, David Cleaves, and Monica Tomosy, *The Science of Decisionmaking Applications for Sustainable Forest and Grassland Management in the National Forest System* (2013), *available at* http://www.fs.fed.us/rm/pubs_other/rmrs_2013_thompson_m004.pdf; U.S. Forest Service Comparative Risk Assessment Framework And Tools, *available at* www.fs.fed.us/psw/topics/fire_science/craft/craft; and Julien Martin, Michael C. Runge, James D. Nichols, Bruce C. Lubow, and William L. Kendall, *Structured decision making as a conceptual framework to identify thresholds for conservation and management* (2009), Ecological Applications 19:1079–1090, *available at* http://www.esajournals.org/doi/abs/10.1890/08-0255.1.

GHG emissions are consistent with such plans or laws.[74] For example, the Bureau of Land Management has discussed how agency actions in California, especially joint projects with the State, may or may not facilitate California reaching its emission reduction goals under the State's Assembly Bill 32 (Global Warming Solutions Act).[75] This approach helps frame the policy context for the agency decision based on its NEPA review.

C. Incorporation by Reference

Incorporation by reference is of great value in considering GHG emissions or where an agency is considering the implications of climate change for the proposed action and its environmental effects. Agencies should identify situations where prior studies or NEPA analyses are likely to cover emissions or adaptation issues, in whole or in part. When larger scale analyses have considered climate change impacts and GHG emissions, calculating GHG emissions and carbon stocks for a specific action may provide only limited information beyond the information already collected and considered in the larger scale analyses. The NEPA reviews for a specific action can incorporate by reference earlier programmatic studies or information such as management plans, inventories, assessments, and research that consider potential changes in carbon stocks, as well as any relevant programmatic NEPA reviews.[76]

Accordingly, agencies should use the scoping process to consider whether they should incorporate by reference GHG analyses from other programmatic studies, action

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[74] *See* 40 CFR 1502.16(c), 1506.2(d) (where an inconsistency exists, agencies should describe the extent to which the agency will reconcile its proposed action with the plan or law). *See also* Exec. Order No. 13693, 80 Fed. Reg. 15869 (Mar. 25, 2015) (establishing GHG emission and related goals for agency facilities and operations. Scope 1, 2, and 3 emissions are typically separate and distinct from analyses and information used in an EA or EIS.).

[75] *See, e.g.*, U.S. Bureau of Land Management, Desert Renewable Energy Conservation Plan Proposed Land Use Plan Amendment and Final Environmental Impact Statement, Vol. I, § I.3.3.2, at 12, *available at* http://drecp.org/finaldrecp/.

[76] *See* 40 CFR 1502.5, 1502.21.

specific NEPA reviews, or programmatic NEPA reviews to avoid duplication of effort. Furthermore, agencies should engage other agencies and stakeholders with expertise or an interest in related actions to participate in the scoping process to identify relevant GHG and adaptation analyses from other actions or programmatic NEPA documents.

D. Using Available Information

Agencies should make decisions using current scientific information and methodologies. CEQ does not expect agencies to fund and conduct original climate change research to support their NEPA analyses or for agencies to require project proponents to do so. Agencies should exercise their discretion to select and use the tools, methodologies, and scientific and research information that are of high quality and available to assess the impacts.[77]

Agencies should be aware of the ongoing efforts to address the impacts of climate change on human health and vulnerable communities.[78] Certain groups, including children, the elderly, and the poor, are more vulnerable to climate-related health effects, and may face barriers to engaging on issues that disproportionately affect them. CEQ recommends that agencies periodically engage their environmental justice experts, and the Federal Interagency Working Group on Environmental Justice, [79] to identify approaches to avoid or minimize impacts that may have disproportionately high and

[77] *See* 40 CFR 1502.24 (requiring agencies to ensure the professional and scientific integrity of the discussions and analyses in environmental impact statements).
[78] USGCRP, *The Impacts of Climate Change on Human Health in the United States A Scientific Assessment* (Apr. 2016), *available at* https://health2016.globalchange.gov/downloads.
[79] For more information on the Federal Interagency Working Group on Environmental Justice co-chaired by EPA and CEQ, *see* http://www.epa.gov/environmentaljustice/interagency/index.html.

adverse human health or environmental effects on minority and low-income populations.[80]

E. Programmatic or Broad-Based Studies and NEPA Reviews

Agency decisions can address different geographic scales that can range from the programmatic or landscape level to the site- or project-specific level. Agencies sometimes conduct analyses or studies that are not NEPA reviews at the national level or other broad scale level (e.g., landscape, regional, or watershed) to assess the status of one or more resources or to determine trends in changing environmental conditions.[81] In the context of long-range energy, transportation, and resource management strategies an agency may decide that it would be useful and efficient to provide an aggregate analysis of GHG emissions or climate change effects in a programmatic analysis and then incorporate by reference that analysis into future NEPA reviews.

A tiered, analytical decision-making approach using a programmatic NEPA review is used for many types of Federal actions[82] and can be particularly relevant to addressing proposed land, aquatic, and other resource management plans. Under such an approach, an agency conducts a broad-scale programmatic NEPA analysis for decisions such as establishing or revising USDA Forest Service land management plans, Bureau of Land Management resource management plans, or Natural Resources Conservation Service conservation programs. Subsequent NEPA analyses for proposed site-specific

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[80] *President's Memorandum for the Heads of All Departments and Agencies, Executive Order on Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* (Feb. 11, 1994), *available at* https://ceq.doe.gov/nepa/regs/eos/ii-5.pdf; CEQ, *Environmental Justice Guidance Under the National Environmental Policy Act*, *available at* https://ceq.doe.gov/nepa/regs/ej/justice.pdf.

[81] Such a programmatic study is distinct from a programmatic NEPA review which is appropriate when the action under consideration is itself subject to NEPA requirements. *See* CEQ, *Memorandum for Heads of Federal Departments and Agencies, Effective Use of Programmatic NEPA Reviews*, Dec. 18, 2014, § I(A), p. 9, *available at* https://www.whitehouse.gov/sites/default/files/docs/effective_use_of_programmatic_nepa_reviews_final_dec2014_searchable.pdf (discussing non-NEPA types of programmatic analyses such as data collection, assessments, and research, which previous NEPA guidance described as joint inventories or planning studies).

[82] *See* 40 CFR 1502.20, 1508.28. A programmatic NEPA review may be appropriate when a decision is being made that is subject to NEPA, such as establishing formal plans, programs, and policies, and when considering a suite of similar projects.

decisions – such as proposed actions that implement land, aquatic, and other resource management plans – may be tiered from the broader programmatic analysis, drawing upon its basic framework analysis to avoid repeating analytical efforts for each tiered decision. Examples of project- or site-specific actions that may benefit from being able to tier to a programmatic NEPA review include: constructing transmission lines; conducting prescribed burns; approving grazing leases; granting rights-of-way; issuing leases for oil and gas drilling; authorizing construction of wind, solar or geothermal projects; and approving hard rock mineral extraction.

A programmatic NEPA review may also serve as an efficient mechanism in which to assess Federal agency efforts to adopt broad-scale sustainable practices for energy efficiency, GHG emissions avoidance and emissions reduction measures, petroleum product use reduction, and renewable energy use, as well as other sustainability practices.[83] While broad department- or agency-wide goals may be of a far larger scale than a particular program, policy, or proposed action, an analysis that informs how a particular action affects that broader goal can be of value.

F. Monetizing Costs and Benefits

NEPA does not require monetizing costs and benefits. Furthermore, the weighing of the merits and drawbacks of the various alternatives need not be displayed using a monetary cost-benefit analysis and should not be when there are important qualitative considerations.[84] When an agency determines that a monetized assessment of the impacts of greenhouse gas emissions or a monetary cost-benefit analysis is appropriate and

[83] *See* Exec. Order No. 13693, 80 Fed. Reg. 15869 (Mar. 25, 2015).
[84] *See* 40 CFR 1502.23.

relevant to the choice among different alternatives being considered, such analysis may be incorporated by reference[85] or appended to the NEPA document as an aid in evaluating the environmental consequences.[86] For example, a rulemaking could have useful information for the NEPA review in an associated regulatory impact analysis which could be incorporated by reference.[87] When using a monetary cost-benefit analysis, just as with tools to quantify emissions, the agency should disclose the assumptions, alternative inputs, and levels of uncertainty associated with such analysis. Finally, if an agency chooses to monetize some but not all impacts of an action, the agency providing this additional information should explain its rationale for doing so.[88]

V. CONCLUSION AND EFFECTIVE DATE

Agencies should apply this guidance to all new proposed agency actions when a NEPA review is initiated. Agencies should exercise judgment when considering whether to apply this guidance to the extent practicable to an on-going NEPA process. CEQ does not expect agencies to apply this guidance to concluded NEPA reviews and actions for

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[85] *See* 40 CFR 1502.21 (material may be cited if it is reasonably available for inspection by potentially interested persons within the time allowed for public review and comment).

[86] When conducting a cost-benefit analysis, determining an appropriate method for preparing a cost-benefit analysis is a decision left to the agency's discretion, taking into account established practices for cost-benefit analysis with strong theoretical underpinnings (for example, see OMB Circular A-4 and references therein). For example, the Federal social cost of carbon (SCC) estimates the marginal damages associated with an increase in carbon dioxide emissions in a given year. Developed through an interagency process committed to ensuring that the SCC estimates reflect the best available science and methodologies and used to assess the social benefits of reducing carbon dioxide emissions across alternatives in rulemakings, it provides a harmonized, interagency metric that can give decision makers and the public useful information for their NEPA review. For current Federal estimates, *see* Interagency Working Group on Social Cost of Carbon, United States Government, *Technical Support Document Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (revised July 2015), *available at* https://www.whitehouse.gov/omb/oira/social-cost-of-carbon.

[87] For example, the regulatory impact analysis was used as a source of information and aligned with the NEPA review for Corporate Average Fuel Economy (CAFÉ) standards, *see* National Highway Traffic Safety Administration, Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2017-2025, Final Environmental Impact Statement, Docket No. NHTSA-2011-0056 (July 2012), § 5.3.2, *available at* http://www.nhtsa.gov/Laws+&+Regulations/CAFE+-+Fuel+Economy/Environmental+Impact+Statement+for+CAFE+Standards,+2017-2025.

[88] For example, the information may be responsive to public comments or useful to the decision maker in further distinguishing between alternatives and mitigation measures. In all cases, the agency should ensure that its consideration of the information and other factors relevant to its decision is consistent with applicable statutory or other authorities, including requirements for the use of cost-benefit analysis.

which a final EIS or EA has been issued. Agencies should consider applying this guidance to projects in the EIS or EA preparation stage if this would inform the consideration of differences between alternatives or address comments raised through the public comment process with sufficient scientific basis that suggest the environmental analysis would be incomplete without application of the guidance, and the additional time and resources needed would be proportionate to the value of the information included.

# # #

Exhibit 2

Climate Change 2014
Synthesis Report
Summary for Policymakers

Introduction

This Synthesis Report is based on the reports of the three Working Groups of the Intergovernmental Panel on Climate Change (IPCC), including relevant Special Reports. It provides an integrated view of climate change as the final part of the IPCC's Fifth Assessment Report (AR5).

This summary follows the structure of the longer report which addresses the following topics: Observed changes and their causes; Future climate change, risks and impacts; Future pathways for adaptation, mitigation and sustainable development; Adaptation and mitigation.

In the Synthesis Report, the certainty in key assessment findings is communicated as in the Working Group Reports and Special Reports. It is based on the author teams' evaluations of underlying scientific understanding and is expressed as a qualitative level of confidence (from *very low* to *very high*) and, when possible, probabilistically with a quantified likelihood (from *exceptionally unlikely* to *virtually certain*)[1]. Where appropriate, findings are also formulated as statements of fact without using uncertainty qualifiers.

This report includes information relevant to Article 2 of the United Nations Framework Convention on Climate Change (UNFCCC).

SPM 1. Observed Changes and their Causes

Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems. *{1}*

SPM 1.1 Observed changes in the climate system

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen. *{1.1}*

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. The period from 1983 to 2012 was *likely* the warmest 30-year period of the last 1400 years in the Northern Hemisphere, where such assessment is possible (*medium confidence*). The globally averaged combined land and ocean surface temperature data as calculated by a linear trend show a warming of 0.85 [0.65 to 1.06] °C[2] over the period 1880 to 2012, when multiple independently produced datasets exist (Figure SPM.1a). *{1.1.1, Figure 1.1}*

In addition to robust multi-decadal warming, the globally averaged surface temperature exhibits substantial decadal and interannual variability (Figure SPM.1a). Due to this natural variability, trends based on short records are very sensitive to the beginning and end dates and do not in general reflect long-term climate trends. As one example, the rate of warming over

[1] Each finding is grounded in an evaluation of underlying evidence and agreement. In many cases, a synthesis of evidence and agreement supports an assignment of confidence. The summary terms for evidence are: limited, medium or robust. For agreement, they are low, medium or high. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and typeset in italics, e.g., *medium confidence*. The following terms have been used to indicate the assessed likelihood of an outcome or a result: virtually certain 99–100% probability, very likely 90–100%, likely 66–100%, about as likely as not 33–66%, unlikely 0–33%, very unlikely 0–10%, exceptionally unlikely 0–1%. Additional terms (extremely likely 95–100%, more likely than not >50–100%, more unlikely than likely 0–<50%, extremely unlikely 0–5%) may also be used when appropriate. Assessed likelihood is typeset in italics, e.g., *very likely*. See for more details: Mastrandrea, M.D., C.B. Field, T.F. Stocker, O. Edenhofer, K.L. Ebi, D.J. Frame, H. Held, E. Kriegler, K.J. Mach, P.R. Matschoss, G.-K. Plattner, G.W. Yohe and F.W. Zwiers, 2010: Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties, Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland, 4 pp.

[2] Ranges in square brackets or following '±' are expected to have a 90% likelihood of including the value that is being estimated, unless otherwise stated.

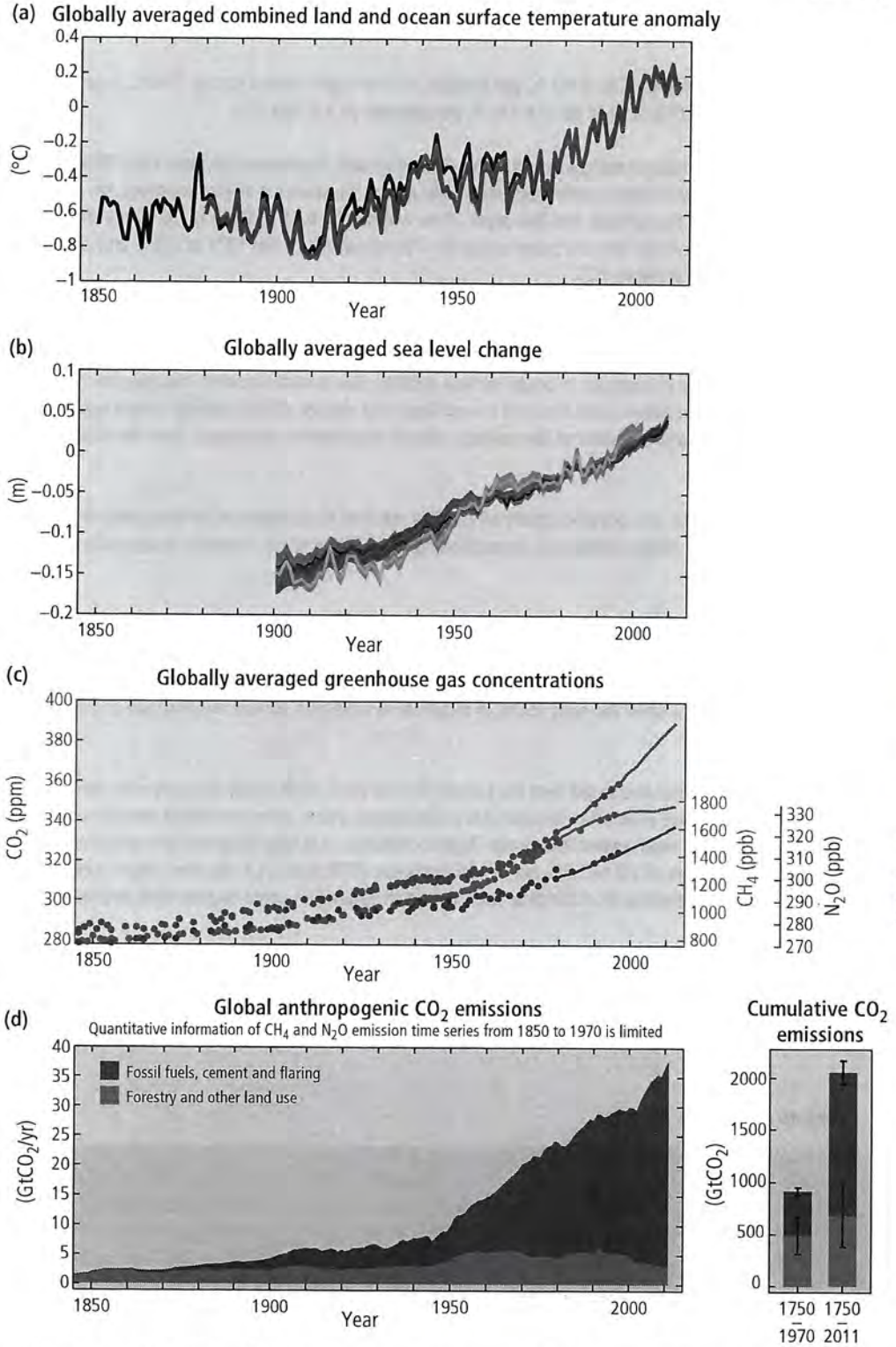

Figure SPM.1 | The complex relationship between the observations (panels a, b, c, yellow background) and the emissions (panel d, light blue background) is addressed in Section 1.2 and Topic 1. Observations and other indicators of a changing global climate system. Observations: **(a)** Annually and globally averaged combined land and ocean surface temperature anomalies relative to the average over the period 1986 to 2005. Colours indicate different data sets. **(b)** Annually and globally averaged sea level change relative to the average over the period 1986 to 2005 in the longest-running dataset. Colours indicate different data sets. All datasets are aligned to have the same value in 1993, the first year of satellite altimetry data (red). Where assessed, uncertainties are indicated by coloured shading. **(c)** Atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2, green), methane (CH_4, orange) and nitrous oxide (N_2O, red) determined from ice core data (dots) and from direct atmospheric measurements (lines). Indicators: **(d)** Global anthropogenic CO_2 emissions from forestry and other land use as well as from burning of fossil fuel, cement production and flaring. Cumulative emissions of CO_2 from these sources and their uncertainties are shown as bars and whiskers, respectively, on the right hand side. The global effects of the accumulation of CH_4 and N_2O emissions are shown in panel c. Greenhouse gas emission data from 1970 to 2010 are shown in Figure SPM.2. *(Figures 1.1, 1.3, 1.5)*

the past 15 years (1998–2012; 0.05 [–0.05 to 0.15] °C per decade), which begins with a strong El Niño, is smaller than the rate calculated since 1951 (1951–2012; 0.12 [0.08 to 0.14] °C per decade). *{1.1.1, Box 1.1}*

Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (*high confidence*), with only about 1% stored in the atmosphere. On a global scale, the ocean warming is largest near the surface, and the upper 75 m warmed by 0.11 [0.09 to 0.13] °C per decade over the period 1971 to 2010. It is *virtually certain* that the upper ocean (0–700 m) warmed from 1971 to 2010, and it *likely* warmed between the 1870s and 1971. *{1.1.2, Figure 1.2}*

Averaged over the mid-latitude land areas of the Northern Hemisphere, precipitation has increased since 1901 (*medium confidence* before and *high confidence* after 1951). For other latitudes, area-averaged long-term positive or negative trends have *low confidence*. Observations of changes in ocean surface salinity also provide indirect evidence for changes in the global water cycle over the ocean (*medium confidence*). It is *very likely* that regions of high salinity, where evaporation dominates, have become more saline, while regions of low salinity, where precipitation dominates, have become fresher since the 1950s. *{1.1.1, 1.1.2}*

Since the beginning of the industrial era, oceanic uptake of CO_2 has resulted in acidification of the ocean; the pH of ocean surface water has decreased by 0.1 (*high confidence*), corresponding to a 26% increase in acidity, measured as hydrogen ion concentration. *{1.1.2}*

Over the period 1992 to 2011, the Greenland and Antarctic ice sheets have been losing mass (*high confidence*), *likely* at a larger rate over 2002 to 2011. Glaciers have continued to shrink almost worldwide (*high confidence*). Northern Hemisphere spring snow cover has continued to decrease in extent (*high confidence*). There is *high confidence* that permafrost temperatures have increased in most regions since the early 1980s in response to increased surface temperature and changing snow cover. *{1.1.3}*

The annual mean Arctic sea-ice extent decreased over the period 1979 to 2012, with a rate that was *very likely* in the range 3.5 to 4.1% per decade. Arctic sea-ice extent has decreased in every season and in every successive decade since 1979, with the most rapid decrease in decadal mean extent in summer (*high confidence*). It is *very likely* that the annual mean Antarctic sea-ice extent increased in the range of 1.2 to 1.8% per decade between 1979 and 2012. However, there is *high confidence* that there are strong regional differences in Antarctica, with extent increasing in some regions and decreasing in others. *{1.1.3, Figure 1.1}*

Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] m (Figure SPM.1b). The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia (*high confidence*). *{1.1.4, Figure 1.1}*

SPM 1.2 Causes of climate change

Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by economic and population growth, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are *extremely likely* to have been the dominant cause of the observed warming since the mid-20th century. *{1.2, 1.3.1}*

Anthropogenic greenhouse gas (GHG) emissions since the pre-industrial era have driven large increases in the atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) (Figure SPM.1c). Between 1750 and 2011, cumulative anthropogenic CO_2 emissions to the atmosphere were 2040 ± 310 $GtCO_2$. About 40% of these emissions have remained in the atmosphere (880 ± 35 $GtCO_2$); the rest was removed from the atmosphere and stored on land (in plants and soils) and in the ocean. The ocean has absorbed about 30% of the emitted anthropogenic CO_2, causing ocean acidification. About half of the anthropogenic CO_2 emissions between 1750 and 2011 have occurred in the last 40 years (*high confidence*) (Figure SPM.1d). *{1.2.1, 1.2.2}*

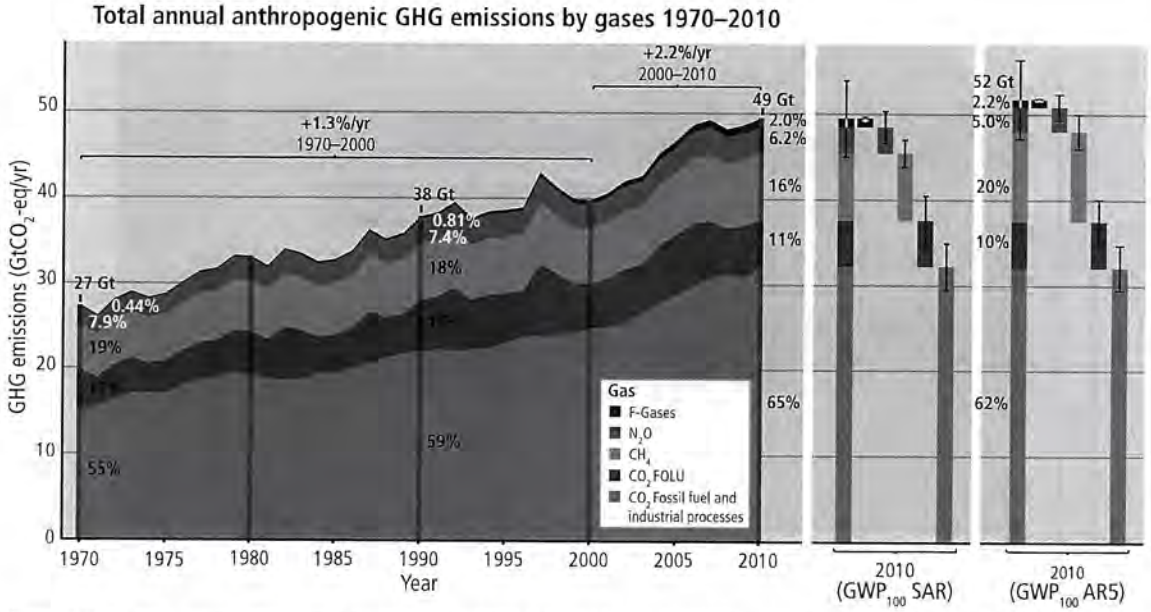

Figure SPM.2 | Total annual anthropogenic greenhouse gas (GHG) emissions (gigatonne of CO_2-equivalent per year, $GtCO_2$-eq/yr) for the period 1970 to 2010 by gases: CO_2 from fossil fuel combustion and industrial processes; CO_2 from Forestry and Other Land Use (FOLU); methane (CH_4); nitrous oxide (N_2O); fluorinated gases covered under the Kyoto Protocol (F-gases). Right hand side shows 2010 emissions, using alternatively CO_2-equivalent emission weightings based on IPCC Second Assessment Report (SAR) and AR5 values. Unless otherwise stated, CO_2-equivalent emissions in this report include the basket of Kyoto gases (CO_2, CH_4, N_2O as well as F-gases) calculated based on 100-year Global Warming Potential (GWP_{100}) values from the SAR (see Glossary). Using the most recent GWP_{100} values from the AR5 (right-hand bars) would result in higher total annual GHG emissions (52 $GtCO_2$-eq/yr) from an increased contribution of methane, but does not change the long-term trend significantly. *{Figure 1.6, Box 3.2}*

Total anthropogenic GHG emissions have continued to increase over 1970 to 2010 with larger absolute increases between 2000 and 2010, despite a growing number of climate change mitigation policies. Anthropogenic GHG emissions in 2010 have reached 49 ± 4.5 $GtCO_2$-eq/yr [3]. Emissions of CO_2 from fossil fuel combustion and industrial processes contributed about 78% of the total GHG emissions increase from 1970 to 2010, with a similar percentage contribution for the increase during the period 2000 to 2010 (*high confidence*) (Figure SPM.2). Globally, economic and population growth continued to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion. The contribution of population growth between 2000 and 2010 remained roughly identical to the previous three decades, while the contribution of economic growth has risen sharply. Increased use of coal has reversed the long-standing trend of gradual decarbonization (i.e., reducing the carbon intensity of energy) of the world's energy supply (*high confidence*). *{1.2.2}*

The evidence for human influence on the climate system has grown since the IPCC Fourth Assessment Report (AR4). It is *extremely likely* that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the anthropogenic increase in GHG concentrations and other anthropogenic forcings together. The best estimate of the human-induced contribution to warming is similar to the observed warming over this period (Figure SPM.3). Anthropogenic forcings have *likely* made a substantial contribution to surface temperature increases since the mid-20th century over every continental region except Antarctica[4]. Anthropogenic influences have *likely* affected the global water cycle since 1960 and contributed to the retreat of glaciers since the 1960s and to the increased surface melting of the Greenland ice sheet since 1993. Anthropogenic influences have *very likely* contributed to Arctic sea-ice loss since 1979 and have *very likely* made a substantial contribution to increases in global upper ocean heat content (0–700 m) and to global mean sea level rise observed since the 1970s. *{1.3, Figure 1.10}*

[3] Greenhouse gas emissions are quantified as CO_2-equivalent ($GtCO_2$-eq) emissions using weightings based on the 100-year Global Warming Potentials, using IPCC Second Assessment Report values unless otherwise stated. *{Box 3.2}*

[4] For Antarctica, large observational uncertainties result in *low confidence* that anthropogenic forcings have contributed to the observed warming averaged over available stations.

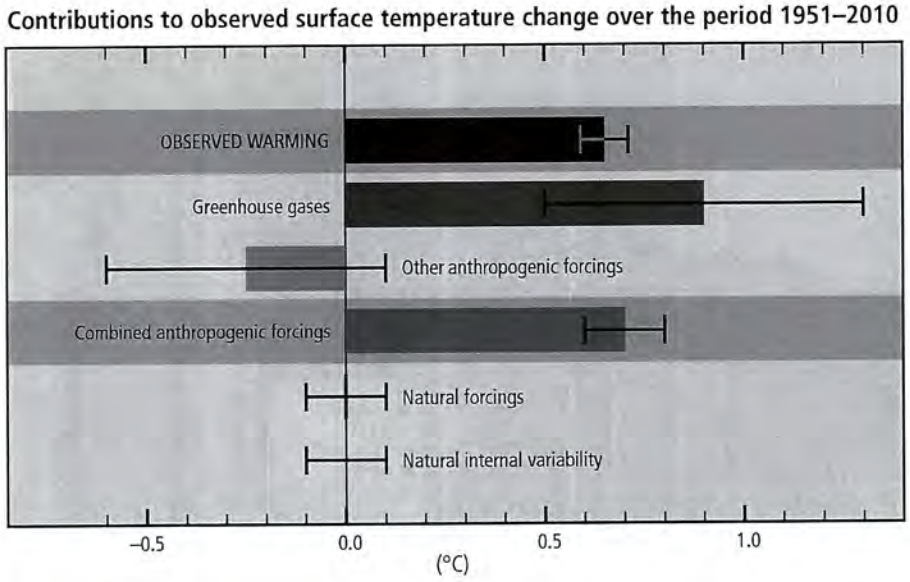

Figure SPM.3 | Assessed *likely* ranges (whiskers) and their mid-points (bars) for warming trends over the 1951–2010 period from well-mixed greenhouse gases, other anthropogenic forcings (including the cooling effect of aerosols and the effect of land use change), combined anthropogenic forcings, natural forcings and natural internal climate variability (which is the element of climate variability that arises spontaneously within the climate system even in the absence of forcings). The observed surface temperature change is shown in black, with the 5 to 95% uncertainty range due to observational uncertainty. The attributed warming ranges (colours) are based on observations combined with climate model simulations, in order to estimate the contribution of an individual external forcing to the observed warming. The contribution from the combined anthropogenic forcings can be estimated with less uncertainty than the contributions from greenhouse gases and from other anthropogenic forcings separately. This is because these two contributions partially compensate, resulting in a combined signal that is better constrained by observations. *{Figure 1.9}*

SPM 1.3 Impacts of climate change

In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate. *{1.3.2}*

Evidence of observed climate change impacts is strongest and most comprehensive for natural systems. In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality (*medium confidence*). Many terrestrial, freshwater and marine species have shifted their geographic ranges, seasonal activities, migration patterns, abundances and species interactions in response to ongoing climate change (*high confidence*). Some impacts on human systems have also been attributed to climate change, with a major or minor contribution of climate change distinguishable from other influences (Figure SPM.4). Assessment of many studies covering a wide range of regions and crops shows that negative impacts of climate change on crop yields have been more common than positive impacts (*high confidence*). Some impacts of ocean acidification on marine organisms have been attributed to human influence (*medium confidence*). *{1.3.2}*

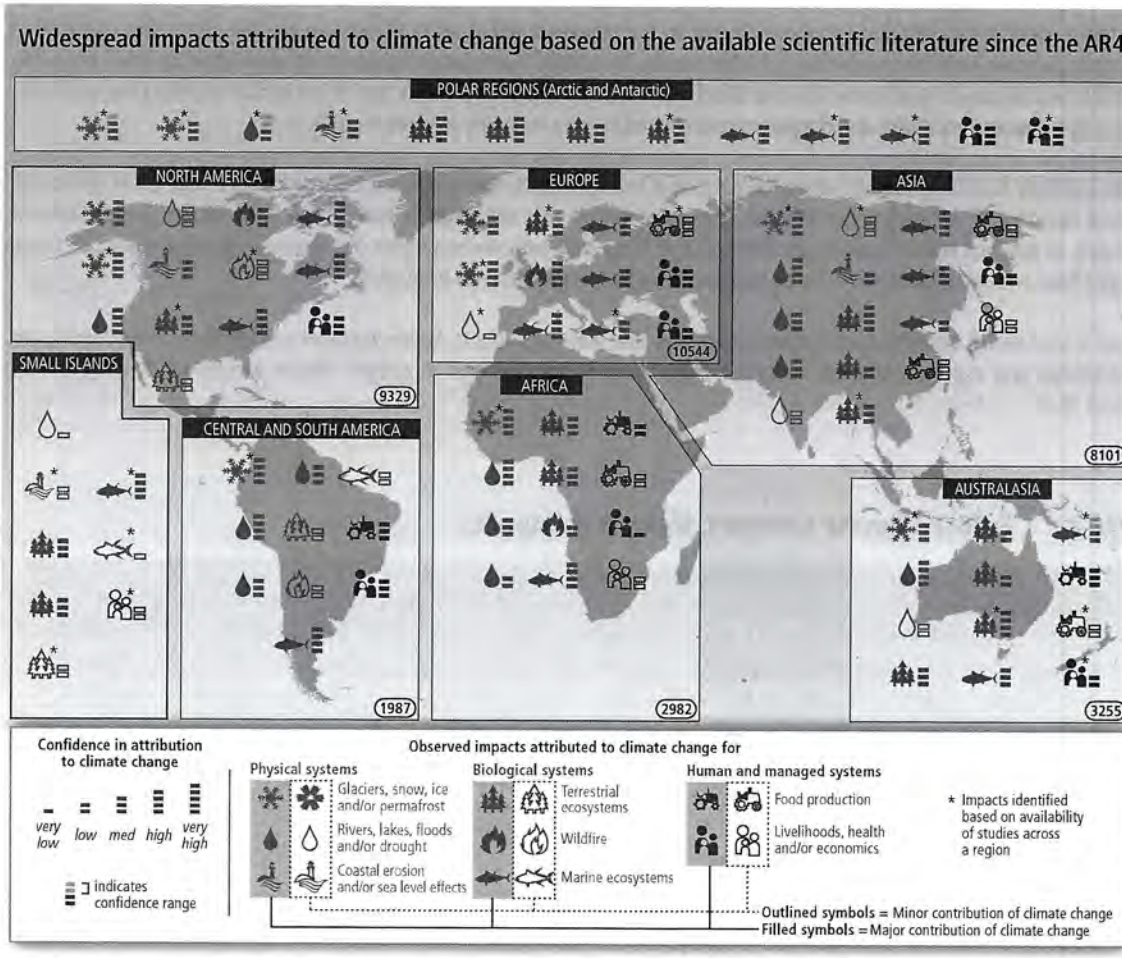

Figure SPM.4 | Based on the available scientific literature since the IPCC Fourth Assessment Report (AR4), there are substantially more impacts in recent decades now attributed to climate change. Attribution requires defined scientific evidence on the role of climate change. Absence from the map of additional impacts attributed to climate change does not imply that such impacts have not occurred. The publications supporting attributed impacts reflect a growing knowledge base, but publications are still limited for many regions, systems and processes, highlighting gaps in data and studies. Symbols indicate categories of attributed impacts, the relative contribution of climate change (major or minor) to the observed impact and confidence in attribution. Each symbol refers to one or more entries in WGII Table SPM.A1, grouping related regional-scale impacts. Numbers in ovals indicate regional totals of climate change publications from 2001 to 2010, based on the Scopus bibliographic database for publications in English with individual countries mentioned in title, abstract or key words (as of July 2011). These numbers provide an overall measure of the available scientific literature on climate change across regions; they do not indicate the number of publications supporting attribution of climate change impacts in each region. Studies for polar regions and small islands are grouped with neighbouring continental regions. The inclusion of publications for assessment of attribution followed IPCC scientific evidence criteria defined in WGII Chapter 18. Publications considered in the attribution analyses come from a broader range of literature assessed in the WGII AR5. See WGII Table SPM.A1 for descriptions of the attributed impacts. *{Figure 1.11}*

SPM 1.4 Extreme events

Changes in many extreme weather and climate events have been observed since about 1950. Some of these changes have been linked to human influences, including a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions. *{1.4}*

It is *very likely* that the number of cold days and nights has decreased and the number of warm days and nights has increased on the global scale. It is *likely* that the frequency of heat waves has increased in large parts of Europe, Asia and Australia. It is

very likely that human influence has contributed to the observed global scale changes in the frequency and intensity of daily temperature extremes since the mid-20th century. It is *likely* that human influence has more than doubled the probability of occurrence of heat waves in some locations. There is *medium confidence* that the observed warming has increased heat-related human mortality and decreased cold-related human mortality in some regions. *{1.4}*

There are *likely* more land regions where the number of heavy precipitation events has increased than where it has decreased. Recent detection of increasing trends in extreme precipitation and discharge in some catchments implies greater risks of flooding at regional scale (*medium confidence*). It is *likely* that extreme sea levels (for example, as experienced in storm surges) have increased since 1970, being mainly a result of rising mean sea level. *{1.4}*

Impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones and wildfires, reveal significant vulnerability and exposure of some ecosystems and many human systems to current climate variability (*very high confidence*). *{1.4}*

SPM 2. Future Climate Changes, Risks and Impacts

Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks. *{2}*

SPM 2.1 Key drivers of future climate

Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. Projections of greenhouse gas emissions vary over a wide range, depending on both socio-economic development and climate policy. *{2.1}*

Anthropogenic GHG emissions are mainly driven by population size, economic activity, lifestyle, energy use, land use patterns, technology and climate policy. The Representative Concentration Pathways (RCPs), which are used for making projections based on these factors, describe four different 21st century pathways of GHG emissions and atmospheric concentrations, air pollutant emissions and land use. The RCPs include a stringent mitigation scenario (RCP2.6), two intermediate scenarios (RCP4.5 and RCP6.0) and one scenario with very high GHG emissions (RCP8.5). Scenarios without additional efforts to constrain emissions ('baseline scenarios') lead to pathways ranging between RCP6.0 and RCP8.5 (Figure SPM.5a). RCP2.6 is representative of a scenario that aims to keep global warming *likely* below 2°C above pre-industrial temperatures. The RCPs are consistent with the wide range of scenarios in the literature as assessed by WGIII[5]. *{2.1, Box 2.2, 4.3}*

Multiple lines of evidence indicate a strong, consistent, almost linear relationship between cumulative CO_2 emissions and projected global temperature change to the year 2100 in both the RCPs and the wider set of mitigation scenarios analysed in WGIII (Figure SPM.5b). Any given level of warming is associated with a range of cumulative CO_2 emissions[6], and therefore, e.g., higher emissions in earlier decades imply lower emissions later. *{2.2.5, Table 2.2}*

[5] Roughly 300 baseline scenarios and 900 mitigation scenarios are categorized by CO_2-equivalent concentration (CO_2-eq) by 2100. The CO_2-eq includes the forcing due to all GHGs (including halogenated gases and tropospheric ozone), aerosols and albedo change.

[6] Quantification of this range of CO_2 emissions requires taking into account non-CO_2 drivers.

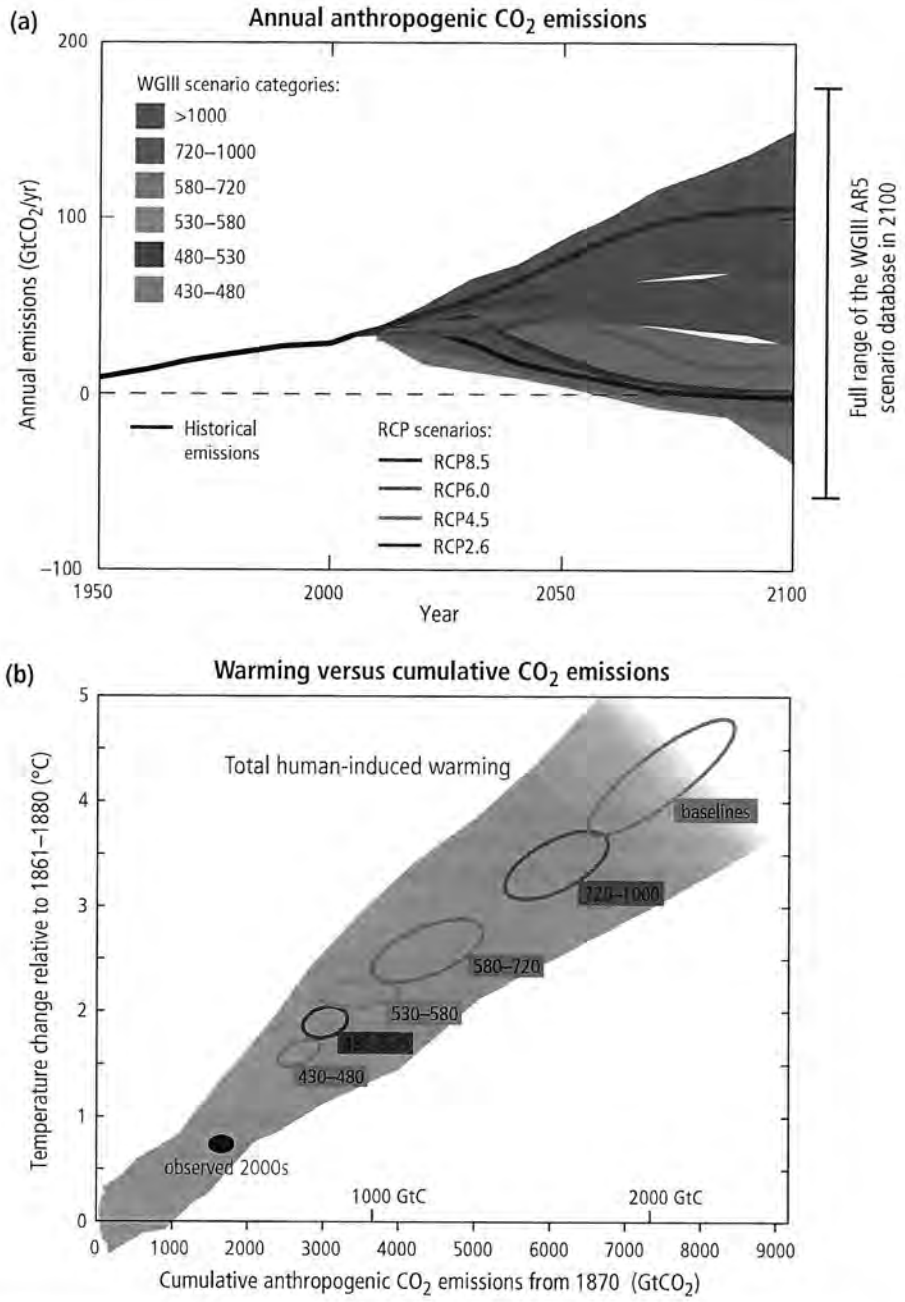

Figure SPM.5 | **(a)** Emissions of carbon dioxide (CO_2) alone in the Representative Concentration Pathways (RCPs) (lines) and the associated scenario categories used in WGIII (coloured areas show 5 to 95% range). The WGIII scenario categories summarize the wide range of emission scenarios published in the scientific literature and are defined on the basis of CO_2-eq concentration levels (in ppm) in 2100. The time series of other greenhouse gas emissions are shown in Box 2.2, Figure 1. **(b)** Global mean surface temperature increase at the time global CO_2 emissions reach a given net cumulative total, plotted as a function of that total, from various lines of evidence. Coloured plume shows the spread of past and future projections from a hierarchy of climate-carbon cycle models driven by historical emissions and the four RCPs over all times out to 2100, and fades with the decreasing number of available models. Ellipses show total anthropogenic warming in 2100 versus cumulative CO_2 emissions from 1870 to 2100 from a simple climate model (median climate response) under the scenario categories used in WGIII. The width of the ellipses in terms of temperature is caused by the impact of different scenarios for non-CO_2 climate drivers. The filled black ellipse shows observed emissions to 2005 and observed temperatures in the decade 2000–2009 with associated uncertainties. *(Box 2.2, Figure 1; Figure 2.3)*

Multi-model results show that limiting total human-induced warming to less than 2°C relative to the period 1861–1880 with a probability of >66%[7] would require cumulative CO_2 emissions from all anthropogenic sources since 1870 to remain below about 2900 $GtCO_2$ (with a range of 2550 to 3150 $GtCO_2$ depending on non-CO_2 drivers). About 1900 $GtCO_2$[8] had already been emitted by 2011. For additional context see Table 2.2. *{2.2.5}*

SPM 2.2 Projected changes in the climate system

Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. 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 level to rise. *{2.2}*

The projected changes in Section SPM 2.2 are for 2081–2100 relative to 1986–2005, unless otherwise indicated.

Future climate will depend on committed warming caused by past anthropogenic emissions, as well as future anthropogenic emissions and natural climate variability. The global mean surface temperature change for the period 2016–2035 relative to 1986–2005 is similar for the four RCPs and will *likely* be in the range 0.3°C to 0.7°C (*medium confidence*). This assumes that there will be no major volcanic eruptions or changes in some natural sources (e.g., CH_4 and N_2O), or unexpected changes in total solar irradiance. By mid-21st century, the magnitude of the projected climate change is substantially affected by the choice of emissions scenario. *{2.2.1, Table 2.1}*

Relative to 1850–1900, global surface temperature change for the end of the 21st century (2081–2100) is projected to *likely* exceed 1.5°C for RCP4.5, RCP6.0 and RCP8.5 (*high confidence*). Warming is *likely* to exceed 2°C for RCP6.0 and RCP8.5 (*high confidence*), *more likely than not* to exceed 2°C for RCP4.5 (*medium confidence*), but *unlikely* to exceed 2°C for RCP2.6 (*medium confidence*). *{2.2.1}*

The increase of global mean surface temperature by the end of the 21st century (2081–2100) relative to 1986–2005 is *likely* to be 0.3°C to 1.7°C under RCP2.6, 1.1°C to 2.6°C under RCP4.5, 1.4°C to 3.1°C under RCP6.0 and 2.6°C to 4.8°C under RCP8.5[9]. The Arctic region will continue to warm more rapidly than the global mean (Figure SPM.6a, Figure SPM.7a). *{2.2.1, Figure 2.1, Figure 2.2, Table 2.1}*

It is *virtually certain* that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales, as global mean surface temperature increases. It is *very likely* that heat waves will occur with a higher frequency and longer duration. Occasional cold winter extremes will continue to occur. *{2.2.1}*

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[7] Corresponding figures for limiting warming to 2°C with a probability of >50% and >33% are 3000 $GtCO_2$ (range of 2900 to 3200 $GtCO_2$) and 3300 $GtCO_2$ (range of 2950 to 3800 $GtCO_2$) respectively. Higher or lower temperature limits would imply larger or lower cumulative emissions respectively.

[8] This corresponds to about two thirds of the 2900 $GtCO_2$ that would limit warming to less than 2°C with a probability of >66%; to about 63% of the total amount of 3000 $GtCO_2$ that would limit warming to less than 2°C with a probability of >50%; and to about 58% of the total amount of 3300 $GtCO_2$ that would limit warming to less than 2°C with a probability of >33%.

[9] The period 1986–2005 is approximately 0.61 [0.55 to 0.67] °C warmer than 1850–1900. *{2.2.1}*

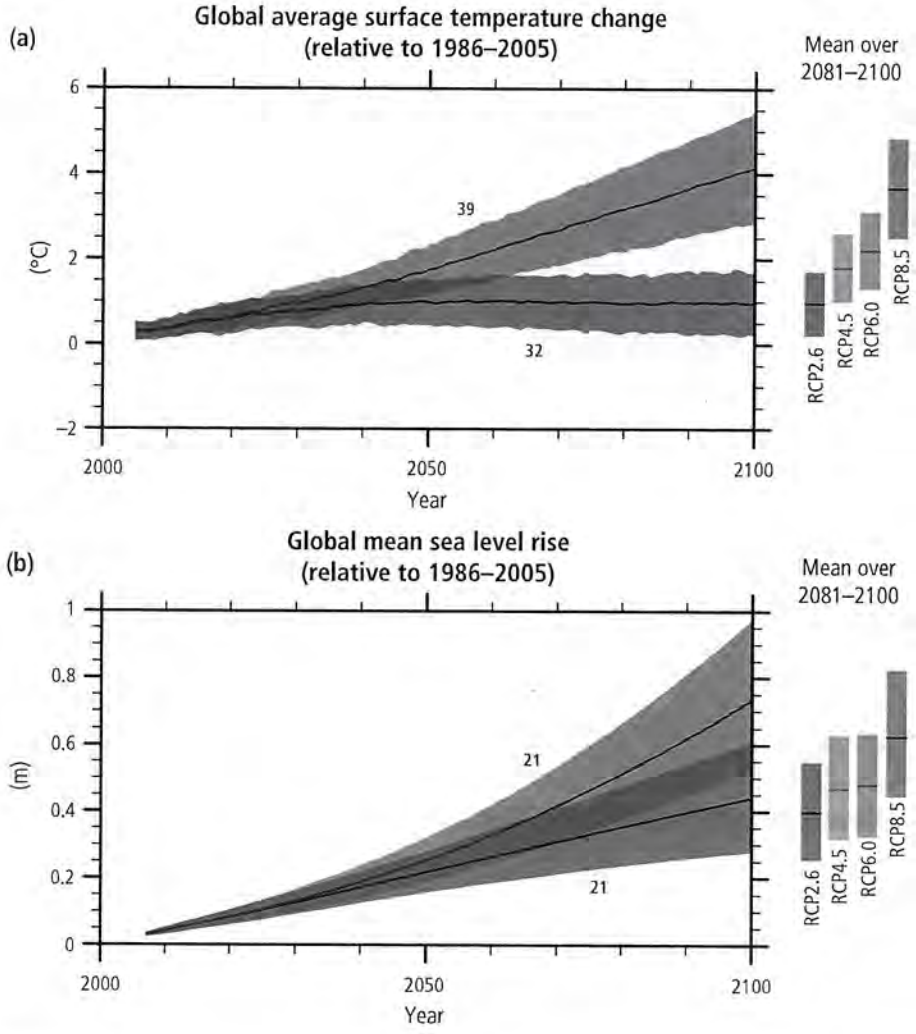

Figure SPM.6 | Global average surface temperature change **(a)** and global mean sea level rise[10] **(b)** from 2006 to 2100 as determined by multi-model simulations. All changes are relative to 1986–2005. Time series of projections and a measure of uncertainty (shading) are shown for scenarios RCP2.6 (blue) and RCP8.5 (red). The mean and associated uncertainties averaged over 2081–2100 are given for all RCP scenarios as coloured vertical bars at the right hand side of each panel. The number of Coupled Model Intercomparison Project Phase 5 (CMIP5) models used to calculate the multi-model mean is indicated. *{2.2, Figure 2.1}*

Changes in precipitation will not be uniform. The high latitudes and the equatorial Pacific are *likely* to experience an increase in annual mean precipitation under the RCP8.5 scenario. In many mid-latitude and subtropical dry regions, mean precipitation will *likely* decrease, while in many mid-latitude wet regions, mean precipitation will *likely* increase under the RCP8.5 scenario (Figure SPM.7b). Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions will *very likely* become more intense and more frequent. *{2.2.2, Figure 2.2}*

The global ocean will continue to warm during the 21st century, with the strongest warming projected for the surface in tropical and Northern Hemisphere subtropical regions (Figure SPM.7a). *{2.2.3, Figure 2.2}*

[10] Based on current understanding (from observations, physical understanding and modelling), only the collapse of marine-based sectors of the Antarctic ice sheet, if initiated, could cause global mean sea level to rise substantially above the *likely* range during the 21st century. There is *medium confidence* that this additional contribution would not exceed several tenths of a meter of sea level rise during the 21st century.

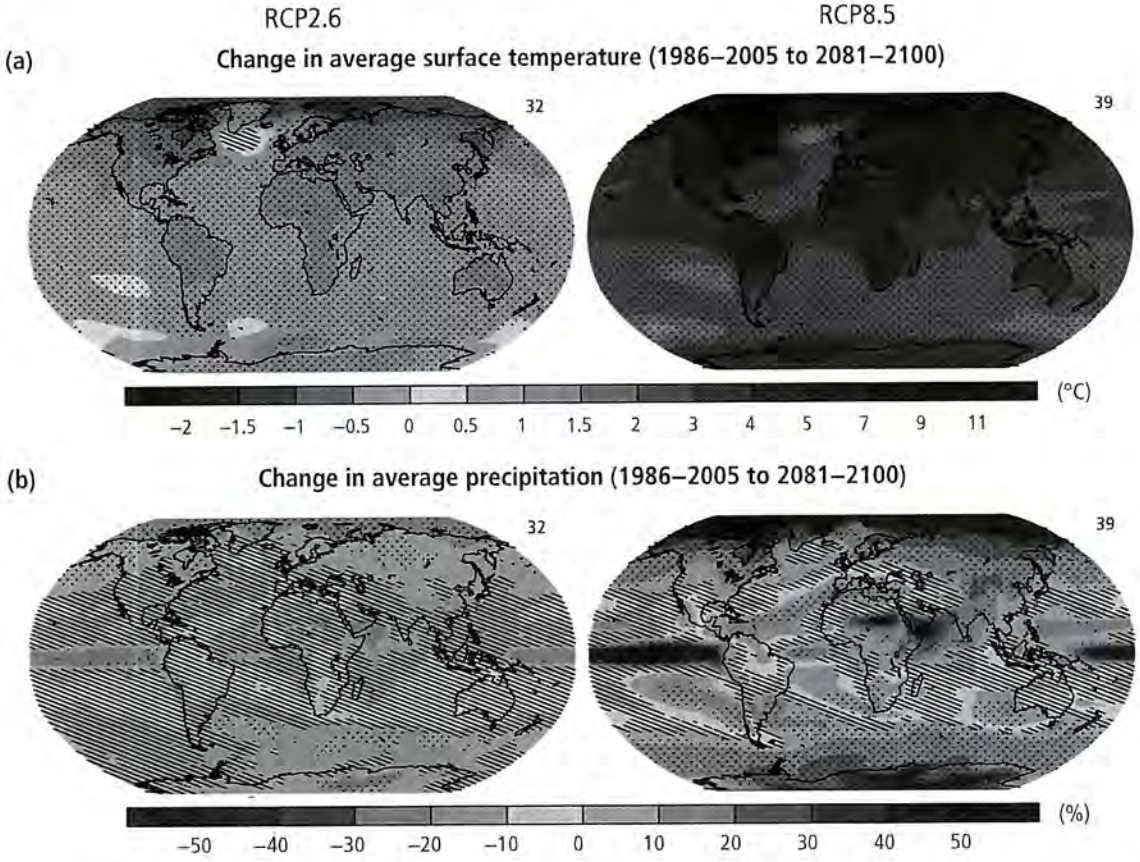

Figure SPM.7 | Change in average surface temperature **(a)** and change in average precipitation **(b)** based on multi-model mean projections for 2081–2100 relative to 1986–2005 under the RCP2.6 (left) and RCP8.5 (right) scenarios. The number of models used to calculate the multi-model mean is indicated in the upper right corner of each panel. Stippling (i.e., dots) shows regions where the projected change is large compared to natural internal variability and where at least 90% of models agree on the sign of change. Hatching (i.e., diagonal lines) shows regions where the projected change is less than one standard deviation of the natural internal variability. *{2.2, Figure 2.2}*

Earth System Models project a global increase in ocean acidification for all RCP scenarios by the end of the 21st century, with a slow recovery after mid-century under RCP2.6. The decrease in surface ocean pH is in the range of 0.06 to 0.07 (15 to 17% increase in acidity) for RCP2.6, 0.14 to 0.15 (38 to 41%) for RCP4.5, 0.20 to 0.21 (58 to 62%) for RCP6.0 and 0.30 to 0.32 (100 to 109%) for RCP8.5. *{2.2.4, Figure 2.1}*

Year-round reductions in Arctic sea ice are projected for all RCP scenarios. A nearly ice-free[11] Arctic Ocean in the summer sea-ice minimum in September before mid-century is *likely* for RCP8.5[12] (*medium confidence*). *{2.2.3, Figure 2.1}*

It is *virtually certain* that near-surface permafrost extent at high northern latitudes will be reduced as global mean surface temperature increases, with the area of permafrost near the surface (upper 3.5 m) projected to decrease by 37% (RCP2.6) to 81% (RCP8.5) for the multi-model average (*medium confidence*). *{2.2.3}*

The global glacier volume, excluding glaciers on the periphery of Antarctica (and excluding the Greenland and Antarctic ice sheets), is projected to decrease by 15 to 55% for RCP2.6 and by 35 to 85% for RCP8.5 (*medium confidence*). *{2.2.3}*

[11] When sea-ice extent is less than one million km² for at least five consecutive years.

[12] Based on an assessment of the subset of models that most closely reproduce the climatological mean state and 1979–2012 trend of the Arctic sea-ice extent.

There has been significant improvement in understanding and projection of sea level change since the AR4. Global mean sea level rise will continue during the 21st century, *very likely* at a faster rate than observed from 1971 to 2010. For the period 2081–2100 relative to 1986–2005, the rise will *likely* be in the ranges of 0.26 to 0.55 m for RCP2.6, and of 0.45 to 0.82 m for RCP8.5 (*medium confidence*)[10] (Figure SPM.6b). Sea level rise will not be uniform across regions. By the end of the 21st century, it is *very likely* that sea level will rise in more than about 95% of the ocean area. About 70% of the coastlines worldwide are projected to experience a sea level change within ±20% of the global mean. *{2.2.3}*

SPM 2.3 Future risks and impacts caused by a changing climate

Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development. *{2.3}*

Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems, including their ability to adapt. Rising rates and magnitudes of warming and other changes in the climate system, accompanied by ocean acidification, increase the risk of severe, pervasive and in some cases irreversible detrimental impacts. Some risks are particularly relevant for individual regions (Figure SPM.8), while others are global. The overall risks of future climate change impacts can be reduced by limiting the rate and magnitude of climate change, including ocean acidification. The precise levels of climate change sufficient to trigger abrupt and irreversible change remain uncertain, but the risk associated with crossing such thresholds increases with rising temperature (*medium confidence*). For risk assessment, it is important to evaluate the widest possible range of impacts, including low-probability outcomes with large consequences. *{1.5, 2.3, 2.4, 3.3, Box Introduction.1, Box 2.3, Box 2.4}*

A large fraction of species faces increased extinction risk due to climate change during and beyond the 21st century, especially as climate change interacts with other stressors (*high confidence*). Most plant species cannot naturally shift their geographical ranges sufficiently fast to keep up with current and high projected rates of climate change in most landscapes; most small mammals and freshwater molluscs will not be able to keep up at the rates projected under RCP4.5 and above in flat landscapes in this century (*high confidence*). Future risk is indicated to be high by the observation that natural global climate change at rates lower than current anthropogenic climate change caused significant ecosystem shifts and species extinctions during the past millions of years. Marine organisms will face progressively lower oxygen levels and high rates and magnitudes of ocean acidification (*high confidence*), with associated risks exacerbated by rising ocean temperature extremes (*medium confidence*). Coral reefs and polar ecosystems are highly vulnerable. Coastal systems and low-lying areas are at risk from sea level rise, which will continue for centuries even if the global mean temperature is stabilized (*high confidence*). *{2.3, 2.4, Figure 2.5}*

Climate change is projected to undermine food security (Figure SPM.9). Due to projected climate change by the mid-21st century and beyond, global marine species redistribution and marine biodiversity reduction in sensitive regions will challenge the sustained provision of fisheries productivity and other ecosystem services (*high confidence*). For wheat, rice and maize in tropical and temperate regions, climate change without adaptation is projected to negatively impact production for local temperature increases of 2°C or more above late 20th century levels, although individual locations may benefit (*medium confidence*). Global temperature increases of ~4°C or more[13] above late 20th century levels, combined with increasing food demand, would pose large risks to food security globally (*high confidence*). Climate change is projected to reduce renewable surface water and groundwater resources in most dry subtropical regions (*robust evidence, high agreement*), intensifying competition for water among sectors (*limited evidence, medium agreement*). *{2.3.1, 2.3.2}*

[13] Projected warming averaged over land is larger than global average warming for all RCP scenarios for the period 2081–2100 relative to 1986–2005. For regional projections, see Figure SPM.7. *{2.2}*

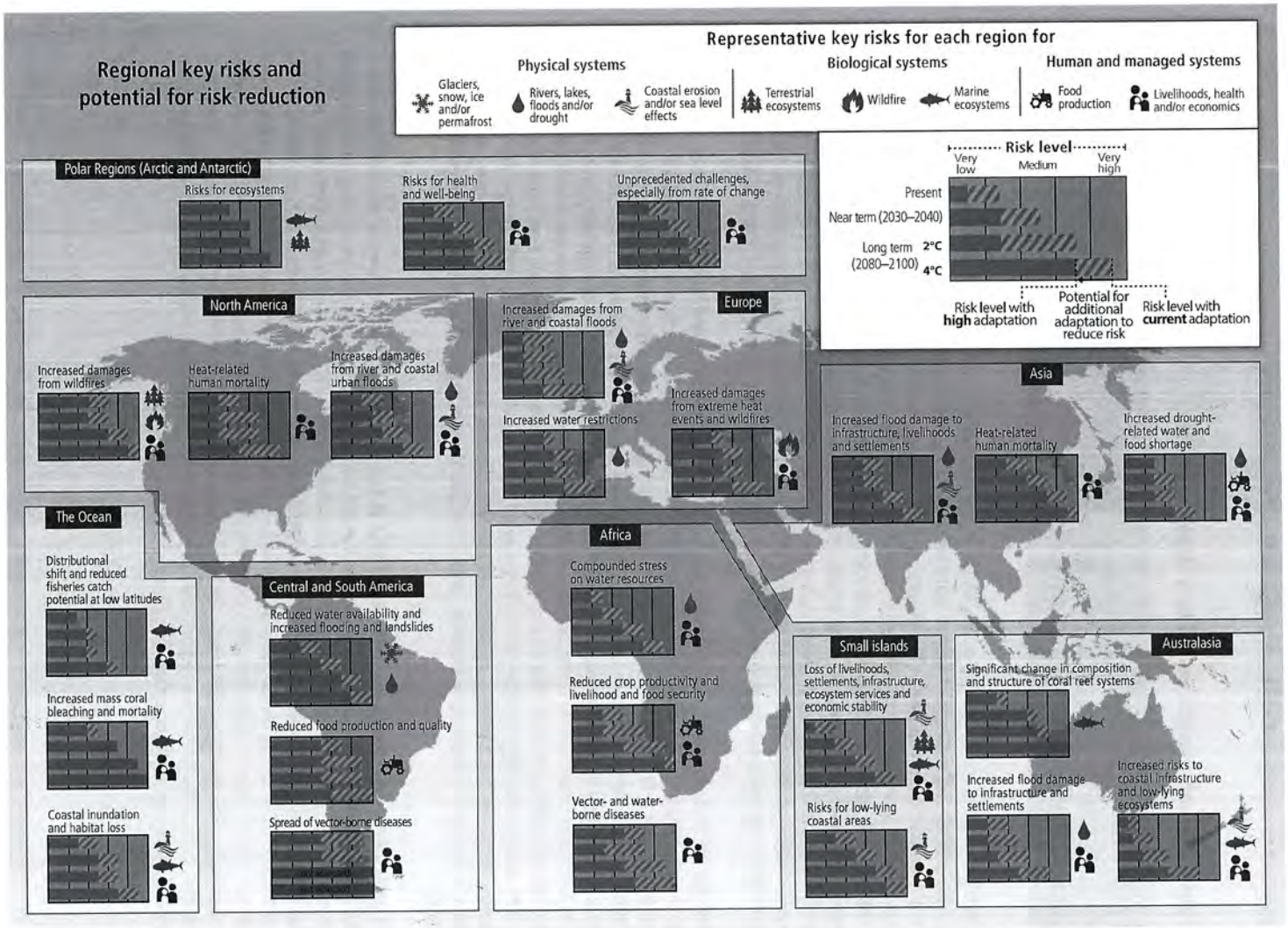

Figure SPM.8 | Representative key risks[14] for each region, including the potential for risk reduction through adaptation and mitigation, as well as limits to adaptation. Each key risk is assessed as very low, low, medium, high or very high. Risk levels are presented for three time frames: present, near term (here, for 2030–2040) and long term (here, for 2080–2100). In the near term, projected levels of global mean temperature increase do not diverge substantially across different emission scenarios. For the long term, risk levels are presented for two possible futures (2°C and 4°C global mean temperature increase above pre-industrial levels). For each timeframe, risk levels are indicated for a continuation of current adaptation and assuming high levels of current or future adaptation. Risk levels are not necessarily comparable, especially across regions. *{Figure 2.4}*

[14] Identification of key risks was based on expert judgment using the following specific criteria: large magnitude, high probability or irreversibility of impacts; timing of impacts; persistent vulnerability or exposure contributing to risks; or limited potential to reduce risks through adaptation or mitigation.

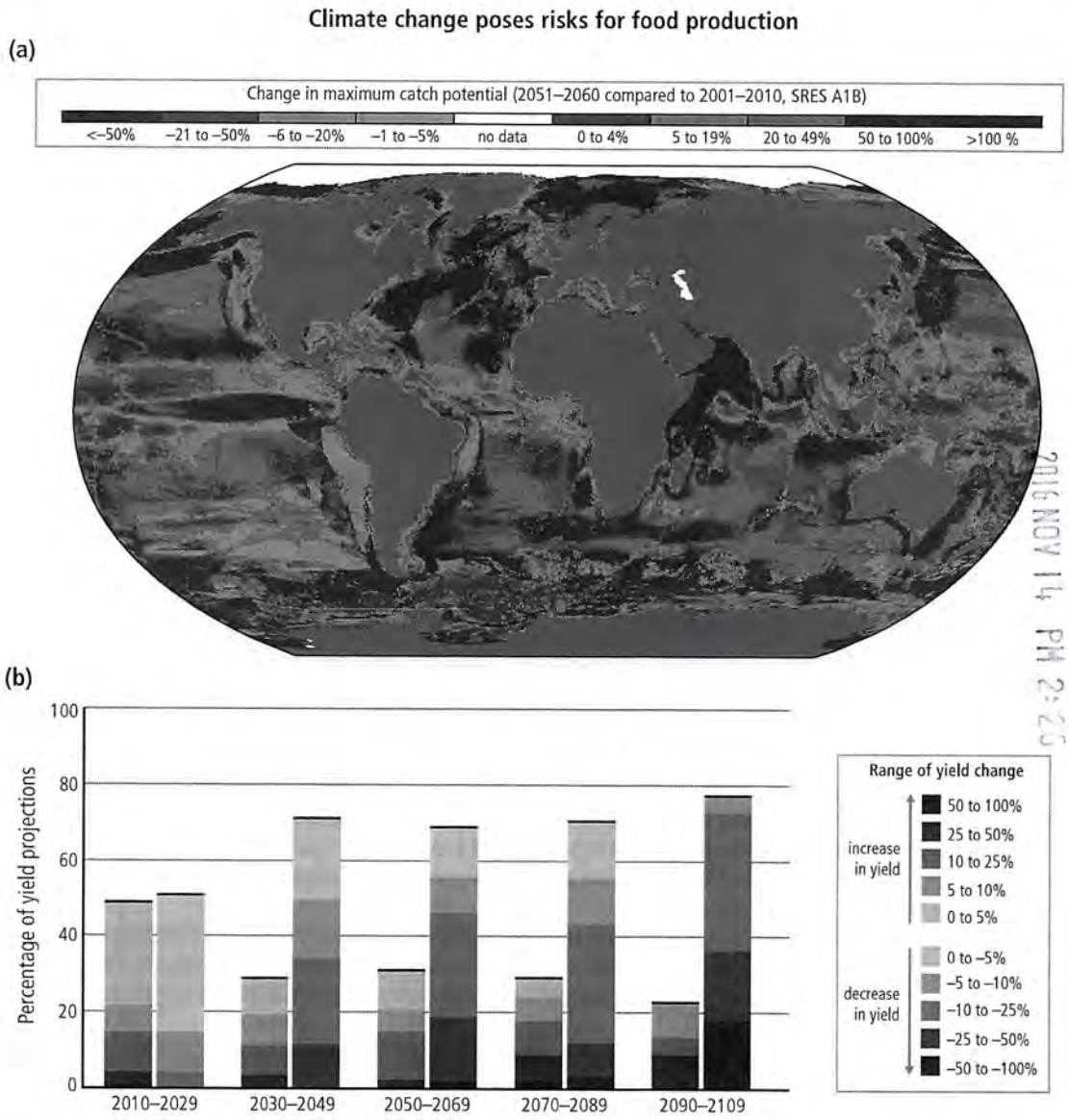

Figure SPM.9 | **(a)** Projected global redistribution of maximum catch potential of ~1000 exploited marine fish and invertebrate species. Projections compare the 10-year averages 2001–2010 and 2051–2060 using ocean conditions based on a single climate model under a moderate to high warming scenario, without analysis of potential impacts of overfishing or ocean acidification. **(b)** Summary of projected changes in crop yields (mostly wheat, maize, rice and soy), due to climate change over the 21st century. Data for each timeframe sum to 100%, indicating the percentage of projections showing yield increases versus decreases. The figure includes projections (based on 1090 data points) for different emission scenarios, for tropical and temperate regions and for adaptation and no-adaptation cases combined. Changes in crop yields are relative to late 20th century levels. *{Figure 2.6a, Figure 2.7}*

Until mid-century, projected climate change will impact human health mainly by exacerbating health problems that already exist (*very high confidence*). Throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions and especially in developing countries with low income, as compared to a baseline without climate change (*high confidence*). By 2100 for RCP8.5, the combination of high temperature and humidity in some areas for parts of the year is expected to compromise common human activities, including growing food and working outdoors (*high confidence*). *{2.3.2}*

In urban areas climate change is projected to increase risks for people, assets, economies and ecosystems, including risks from heat stress, storms and extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, water scarcity, sea level rise and storm surges (*very high confidence*). These risks are amplified for those lacking essential infrastructure and services or living in exposed areas. *{2.3.2}*

Rural areas are expected to experience major impacts on water availability and supply, food security, infrastructure and agricultural incomes, including shifts in the production areas of food and non-food crops around the world (*high confidence*). *{2.3.2}*

Aggregate economic losses accelerate with increasing temperature (*limited evidence, high agreement*), but global economic impacts from climate change are currently difficult to estimate. From a poverty perspective, climate change impacts are projected to slow down economic growth, make poverty reduction more difficult, further erode food security and prolong existing and create new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger (*medium confidence*). International dimensions such as trade and relations among states are also important for understanding the risks of climate change at regional scales. *{2.3.2}*

Climate change is projected to increase displacement of people (*medium evidence, high agreement*). Populations that lack the resources for planned migration experience higher exposure to extreme weather events, particularly in developing countries with low income. Climate change can indirectly increase risks of violent conflicts by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (*medium confidence*). *{2.3.2}*

SPM 2.4 Climate change beyond 2100, irreversibility and abrupt changes

Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gases are stopped. The risks of abrupt or irreversible changes increase as the magnitude of the warming increases. *{2.4}*

Warming will continue beyond 2100 under all RCP scenarios except RCP2.6. Surface temperatures will remain approximately constant at elevated levels for many centuries after a complete cessation of net anthropogenic CO_2 emissions. A large fraction of anthropogenic climate change resulting from CO_2 emissions is irreversible on a multi-century to millennial timescale, except in the case of a large net removal of CO_2 from the atmosphere over a sustained period. *{2.4, Figure 2.8}*

Stabilization of global average surface temperature does not imply stabilization for all aspects of the climate system. Shifting biomes, soil carbon, ice sheets, ocean temperatures and associated sea level rise all have their own intrinsic long timescales which will result in changes lasting hundreds to thousands of years after global surface temperature is stabilized. *{2.1, 2.4}*

There is *high confidence* that ocean acidification will increase for centuries if CO_2 emissions continue, and will strongly affect marine ecosystems. *{2.4}*

It is *virtually certain* that global mean sea level rise will continue for many centuries beyond 2100, with the amount of rise dependent on future emissions. The threshold for the loss of the Greenland ice sheet over a millennium or more, and an associated sea level rise of up to 7 m, is greater than about 1°C (*low confidence*) but less than about 4°C (*medium confidence*) of global warming with respect to pre-industrial temperatures. Abrupt and irreversible ice loss from the Antarctic ice sheet is possible, but current evidence and understanding is insufficient to make a quantitative assessment. *{2.4}*

Magnitudes and rates of climate change associated with medium- to high-emission scenarios pose an increased risk of abrupt and irreversible regional-scale change in the composition, structure and function of marine, terrestrial and freshwater ecosystems, including wetlands (*medium confidence*). A reduction in permafrost extent is *virtually certain* with continued rise in global temperatures. *{2.4}*

SPM 3. Future Pathways for Adaptation, Mitigation and Sustainable Development

Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term and contribute to climate-resilient pathways for sustainable development. *{3.2, 3.3, 3.4}*

SPM 3.1 Foundations of decision-making about climate change

Effective decision-making to limit climate change and its effects can be informed by a wide range of analytical approaches for evaluating expected risks and benefits, recognizing the importance of governance, ethical dimensions, equity, value judgments, economic assessments and diverse perceptions and responses to risk and uncertainty. *{3.1}*

Sustainable development and equity provide a basis for assessing climate policies. Limiting the effects of climate change is necessary to achieve sustainable development and equity, including poverty eradication. Countries' past and future contributions to the accumulation of GHGs in the atmosphere are different, and countries also face varying challenges and circumstances and have different capacities to address mitigation and adaptation. Mitigation and adaptation raise issues of equity, justice and fairness. Many of those most vulnerable to climate change have contributed and contribute little to GHG emissions. Delaying mitigation shifts burdens from the present to the future, and insufficient adaptation responses to emerging impacts are already eroding the basis for sustainable development. Comprehensive strategies in response to climate change that are consistent with sustainable development take into account the co-benefits, adverse side effects and risks that may arise from both adaptation and mitigation options. *{3.1, 3.5, Box 3.4}*

The design of climate policy is influenced by how individuals and organizations perceive risks and uncertainties and take them into account. Methods of valuation from economic, social and ethical analysis are available to assist decision-making. These methods can take account of a wide range of possible impacts, including low-probability outcomes with large consequences. But they cannot identify a single best balance between mitigation, adaptation and residual climate impacts. *{3.1}*

Climate change has the characteristics of a collective action problem at the global scale, because most GHGs accumulate over time and mix globally, and emissions by any agent (e.g., individual, community, company, country) affect other agents. Effective mitigation will not be achieved if individual agents advance their own interests independently. Cooperative responses, including international cooperation, are therefore required to effectively mitigate GHG emissions and address other climate change issues. The effectiveness of adaptation can be enhanced through complementary actions across levels, including international cooperation. The evidence suggests that outcomes seen as equitable can lead to more effective cooperation. *{3.1}*

SPM 3.2 Climate change risks reduced by mitigation and adaptation

Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread and irreversible impacts globally (*high confidence*). Mitigation involves some level of co-benefits and of risks due to adverse side effects, but these risks do not involve the same possibility of severe, widespread and irreversible impacts as risks from climate change, increasing the benefits from near-term mitigation efforts. *{3.2, 3.4}*

Mitigation and adaptation are complementary approaches for reducing risks of climate change impacts over different timescales (*high confidence*). Mitigation, in the near term and through the century, can substantially reduce climate change

impacts in the latter decades of the 21st century and beyond. Benefits from adaptation can already be realized in addressing current risks, and can be realized in the future for addressing emerging risks. *{3.2, 4.5}*

Five Reasons For Concern (RFCs) aggregate climate change risks and illustrate the implications of warming and of adaptation limits for people, economies and ecosystems across sectors and regions. The five RFCs are associated with: (1) Unique and threatened systems, (2) Extreme weather events, (3) Distribution of impacts, (4) Global aggregate impacts, and (5) Large-scale singular events. In this report, the RFCs provide information relevant to Article 2 of UNFCCC. *{Box 2.4}*

Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread and irreversible impacts globally (*high confidence*) (Figure SPM.10). In most scenarios without additional mitigation efforts (those with 2100 atmospheric concentrations

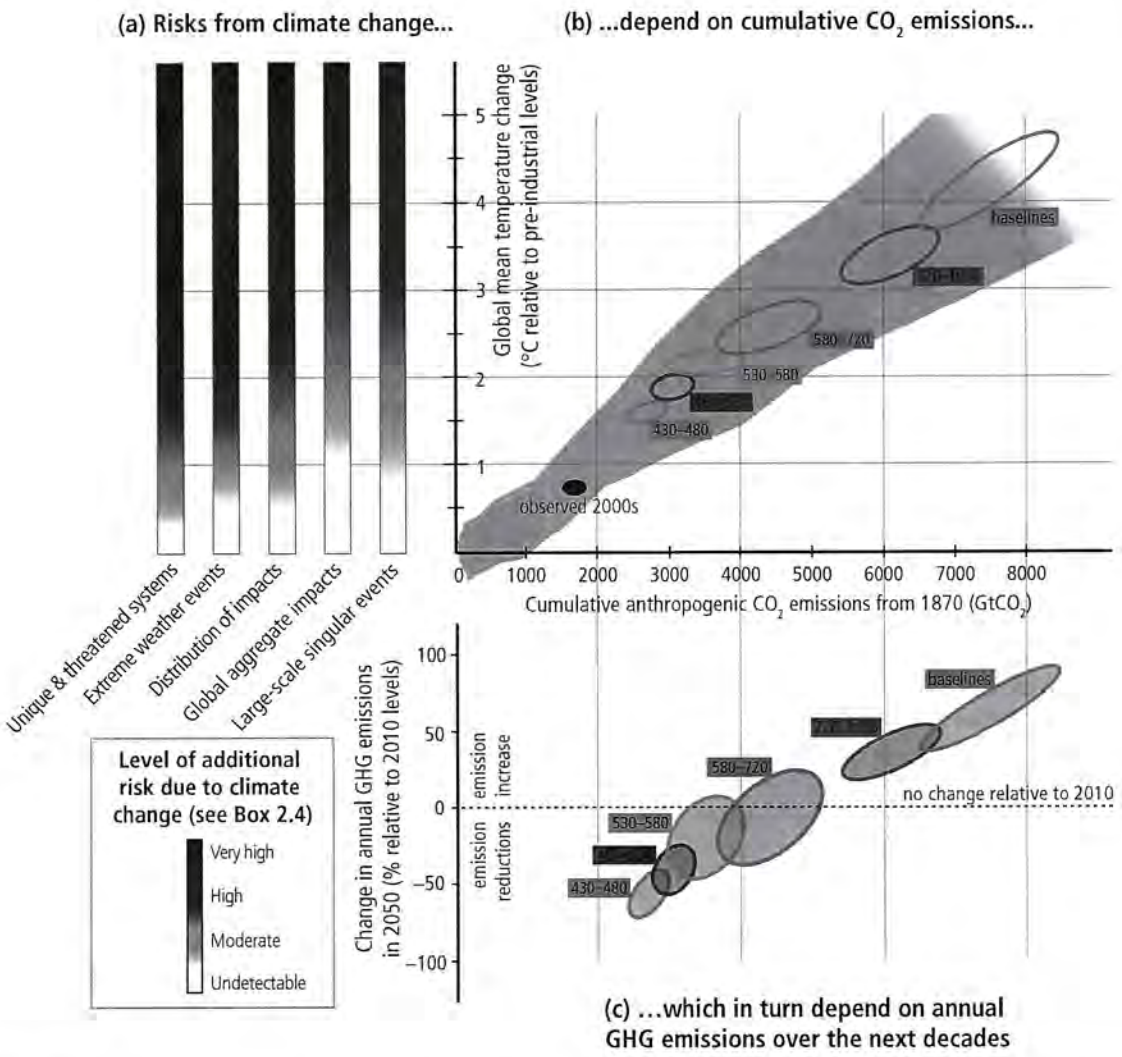

Figure SPM.10 | The relationship between risks from climate change, temperature change, cumulative carbon dioxide (CO_2) emissions and changes in annual greenhouse gas (GHG) emissions by 2050. Limiting risks across Reasons For Concern **(a)** would imply a limit for cumulative emissions of CO_2 **(b)** which would constrain annual GHG emissions over the next few decades **(c)**. **Panel a** reproduces the five Reasons For Concern *(Box 2.4)*. **Panel b** links temperature changes to cumulative CO_2 emissions (in $GtCO_2$) from 1870. They are based on Coupled Model Intercomparison Project Phase 5 (CMIP5) simulations (pink plume) and on a simple climate model (median climate response in 2100), for the baselines and five mitigation scenario categories (six ellipses). Details are provided in Figure SPM.5. **Panel c** shows the relationship between the cumulative CO_2 emissions (in $GtCO_2$) of the scenario categories and their associated change in annual GHG emissions by 2050, expressed in percentage change (in percent $GtCO_2$-eq per year) relative to 2010. The ellipses correspond to the same scenario categories as in Panel b, and are built with a similar method (see details in Figure SPM.5). *(Figure 3.1)*

>1000 ppm CO_2-eq), warming is *more likely than not* to exceed 4°C above pre-industrial levels by 2100 (Table SPM.1). The risks associated with temperatures at or above 4°C include substantial species extinction, global and regional food insecurity, consequential constraints on common human activities and limited potential for adaptation in some cases (*high confidence*). Some risks of climate change, such as risks to unique and threatened systems and risks associated with extreme weather events, are moderate to high at temperatures 1°C to 2°C above pre-industrial levels. *{2.3, Figure 2.5, 3.2, 3.4, Box 2.4, Table SPM.1}*

Substantial cuts in GHG emissions over the next few decades can substantially reduce risks of climate change by limiting warming in the second half of the 21st century and beyond. Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. Limiting risks across RFCs would imply a limit for cumulative emissions of CO_2. Such a limit would require that global net emissions of CO_2 eventually decrease to zero and would constrain annual emissions over the next few decades (Figure SPM.10) (*high confidence*). But some risks from climate damages are unavoidable, even with mitigation and adaptation. *{2.2.5, 3.2, 3.4}*

Mitigation involves some level of co-benefits and risks, but these risks do not involve the same possibility of severe, widespread and irreversible impacts as risks from climate change. Inertia in the economic and climate system and the possibility of irreversible impacts from climate change increase the benefits from near-term mitigation efforts (*high confidence*). Delays in additional mitigation or constraints on technological options increase the longer-term mitigation costs to hold climate change risks at a given level (Table SPM.2). *{3.2, 3.4}*

SPM 3.3 Characteristics of adaptation pathways

Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater magnitudes and rates of climate change. Taking a longer-term perspective, in the context of sustainable development, increases the likelihood that more immediate adaptation actions will also enhance future options and preparedness. *{3.3}*

Adaptation can contribute to the well-being of populations, the security of assets and the maintenance of ecosystem goods, functions and services now and in the future. Adaptation is place- and context-specific (*high confidence*). A first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability (*high confidence*). Integration of adaptation into planning, including policy design, and decision-making can promote synergies with development and disaster risk reduction. Building adaptive capacity is crucial for effective selection and implementation of adaptation options (*robust evidence, high agreement*). *{3.3}*

Adaptation planning and implementation can be enhanced through complementary actions across levels, from individuals to governments (*high confidence*). National governments can coordinate adaptation efforts of local and sub-national governments, for example by protecting vulnerable groups, by supporting economic diversification and by providing information, policy and legal frameworks and financial support (*robust evidence, high agreement*). Local government and the private sector are increasingly recognized as critical to progress in adaptation, given their roles in scaling up adaptation of communities, households and civil society and in managing risk information and financing (*medium evidence, high agreement*). *{3.3}*

Adaptation planning and implementation at all levels of governance are contingent on societal values, objectives and risk perceptions (*high confidence*). Recognition of diverse interests, circumstances, social-cultural contexts and expectations can benefit decision-making processes. Indigenous, local and traditional knowledge systems and practices, including indigenous peoples' holistic view of community and environment, are a major resource for adapting to climate change, but these have not been used consistently in existing adaptation efforts. Integrating such forms of knowledge with existing practices increases the effectiveness of adaptation. *{3.3}*

Constraints can interact to impede adaptation planning and implementation (*high confidence*). Common constraints on implementation arise from the following: limited financial and human resources; limited integration or coordination of governance; uncertainties about projected impacts; different perceptions of risks; competing values; absence of key adaptation leaders and advocates; and limited tools to monitor adaptation effectiveness. Another constraint includes insufficient research, monitoring, and observation and the finance to maintain them. *{3.3}*

Greater rates and magnitude of climate change increase the likelihood of exceeding adaptation limits (*high confidence*). Limits to adaptation emerge from the interaction among climate change and biophysical and/or socio-economic constraints. Further, poor planning or implementation, overemphasizing short-term outcomes or failing to sufficiently anticipate consequences can result in maladaptation, increasing the vulnerability or exposure of the target group in the future or the vulnerability of other people, places or sectors (*medium evidence, high agreement*). Underestimating the complexity of adaptation as a social process can create unrealistic expectations about achieving intended adaptation outcomes. *{3.3}*

Significant co-benefits, synergies and trade-offs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions (*very high confidence*). Increasing efforts to mitigate and adapt to climate change imply an increasing complexity of interactions, particularly at the intersections among water, energy, land use and biodiversity, but tools to understand and manage these interactions remain limited. Examples of actions with co-benefits include (i) improved energy efficiency and cleaner energy sources, leading to reduced emissions of health-damaging, climate-altering air pollutants; (ii) reduced energy and water consumption in urban areas through greening cities and recycling water; (iii) sustainable agriculture and forestry; and (iv) protection of ecosystems for carbon storage and other ecosystem services. *{3.3}*

Transformations in economic, social, technological and political decisions and actions can enhance adaptation and promote sustainable development (*high confidence*). At the national level, transformation is considered most effective when it reflects a country's own visions and approaches to achieving sustainable development in accordance with its national circumstances and priorities. Restricting adaptation responses to incremental changes to existing systems and structures, without considering transformational change, may increase costs and losses and miss opportunities. Planning and implementation of transformational adaptation could reflect strengthened, altered or aligned paradigms and may place new and increased demands on governance structures to reconcile different goals and visions for the future and to address possible equity and ethical implications. Adaptation pathways are enhanced by iterative learning, deliberative processes and innovation. *{3.3}*

SPM 3.4 Characteristics of mitigation pathways

There are multiple mitigation pathways that are *likely* to limit warming to below 2°C relative to pre-industrial levels. These pathways would require substantial emissions reductions over the next few decades and near zero emissions of CO_2 and other long-lived greenhouse gases by the end of the century. Implementing such reductions poses substantial technological, economic, social and institutional challenges, which increase with delays in additional mitigation and if key technologies are not available. Limiting warming to lower or higher levels involves similar challenges but on different timescales. *{3.4}*

Without additional efforts to reduce GHG emissions beyond those in place today, global emissions growth is expected to persist, driven by growth in global population and economic activities. Global mean surface temperature increases in 2100 in baseline scenarios—those without additional mitigation—range from 3.7°C to 4.8°C above the average for 1850–1900 for a median climate response. They range from 2.5°C to 7.8°C when including climate uncertainty (5th to 95th percentile range) (*high confidence*). *{3.4}*

Emissions scenarios leading to CO_2-equivalent concentrations in 2100 of about 450 ppm or lower are *likely* to maintain warming below 2°C over the 21st century relative to pre-industrial levels[15]. These scenarios are characterized by 40 to 70% global anthropogenic GHG emissions reductions by 2050 compared to 2010[16], and emissions levels near zero or below in 2100. Mitigation scenarios reaching concentration levels of about 500 ppm CO_2-eq by 2100 are *more likely than not* to limit temperature change to less than 2°C, unless they temporarily overshoot concentration levels of roughly 530 ppm CO_2-eq

[15] For comparison, the CO_2-eq concentration in 2011 is estimated to be 430 ppm (uncertainty range 340 to 520 ppm)

[16] This range differs from the range provided for a similar concentration category in the AR4 (50 to 85% lower than 2000 for CO_2 only). Reasons for this difference include that this report has assessed a substantially larger number of scenarios than in the AR4 and looks at all GHGs. In addition, a large proportion of the new scenarios include Carbon Dioxide Removal (CDR) technologies (see below). Other factors include the use of 2100 concentration levels instead of stabilization levels and the shift in reference year from 2000 to 2010.

before 2100, in which case they are *about as likely as not* to achieve that goal. In these 500 ppm CO_2-eq scenarios, global 2050 emissions levels are 25 to 55% lower than in 2010. Scenarios with higher emissions in 2050 are characterized by a greater reliance on Carbon Dioxide Removal (CDR) technologies beyond mid-century (and vice versa). Trajectories that are *likely* to limit warming to 3°C relative to pre-industrial levels reduce emissions less rapidly than those limiting warming to 2°C. A limited number of studies provide scenarios that are *more likely than not* to limit warming to 1.5°C by 2100; these scenarios are characterized by concentrations below 430 ppm CO_2-eq by 2100 and 2050 emission reduction between 70% and 95% below 2010. For a comprehensive overview of the characteristics of emissions scenarios, their CO_2-equivalent concentrations and their likelihood to keep warming to below a range of temperature levels, see Figure SPM.11 and Table SPM.1. *{3.4}*

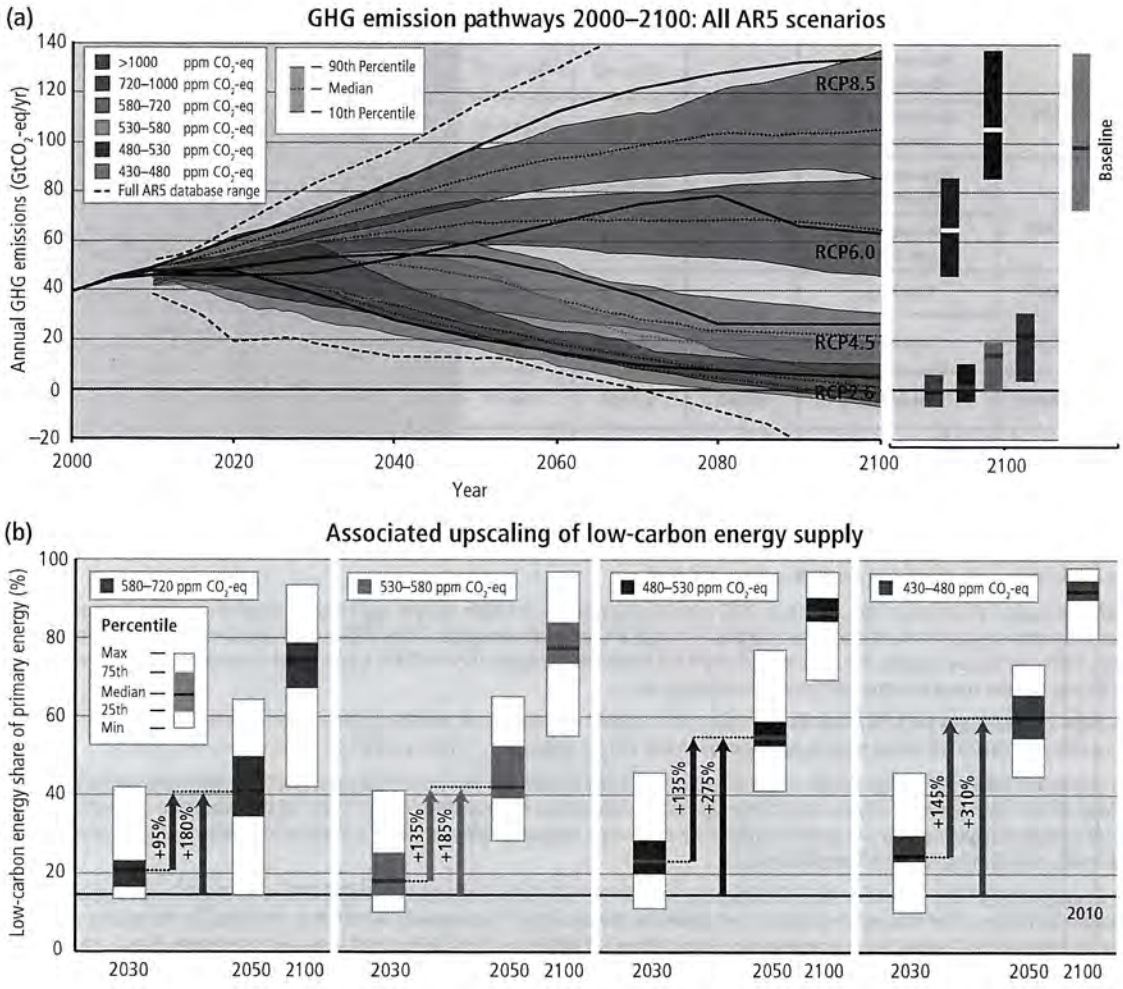

Figure SPM.11 | Global greenhouse gas emissions (gigatonne of CO_2-equivalent per year, $GtCO_2$-eq/yr) in baseline and mitigation scenarios for different long-term concentration levels **(a)** and associated upscaling requirements of low-carbon energy (% of primary energy) for 2030, 2050 and 2100 compared to 2010 levels in mitigation scenarios **(b)**. *{Figure 3.2}*

Table SPM.1 | Key characteristics of the scenarios collected and assessed for WGIII AR5. For all parameters the 10th to 90th percentile of the scenarios is shown [a]. *[Table 3.1]*

CO_2-eq Concentrations in 2100 (ppm CO_2-eq) [f] Category label (conc. range)	Subcategories	Relative position of the RCPs [d]	Change in CO_2-eq emissions compared to 2010 (in %) [c]		Likelihood of staying below a specific temperature level over the 21st century (relative to 1850–1900) [d,e]			
			2050	2100	1.5°C	2°C	3°C	4°C
<430	Only a limited number of individual model studies have explored levels below 430 ppm CO_2-eq [i]							
450 (430 to 480)	Total range [a,g]	RCP2.6	−72 to −41	−118 to −78	*More unlikely than likely*	*Likely*	*Likely*	*Likely*
500 (480 to 530)	No overshoot of 530 ppm CO_2-eq		−57 to −42	−107 to −73	*Unlikely*	*More likely than not*		
	Overshoot of 530 ppm CO_2-eq		−55 to −25	−114 to −90		*About as likely as not*		
550 (530 to 580)	No overshoot of 580 ppm CO_2-eq		−47 to −19	−81 to −59		*More unlikely than likely* [i]		
	Overshoot of 580 ppm CO_2-eq		−16 to 7	−183 to −86				
(580 to 650)	Total range	RCP4.5	−38 to 24	−134 to −50				
(650 to 720)	Total range		−11 to 17	−54 to −21		*Unlikely*	*More likely than not*	
(720 to 1000) [b]	Total range	RCP6.0	18 to 54	−7 to 72	*Unlikely* [h]		*More unlikely than likely*	
>1000 [b]	Total range	RCP8.5	52 to 95	74 to 178		*Unlikely*	*Unlikely*	*More unlikely than likely*

Notes:

[a] The 'total range' for the 430 to 480 ppm CO_2-eq concentrations scenarios corresponds to the range of the 10th to 90th percentile of the subcategory of these scenarios shown in Table 6.3 of the Working Group III Report.

[b] Baseline scenarios fall into the >1000 and 720 to 1000 ppm CO_2-eq categories. The latter category also includes mitigation scenarios. The baseline scenarios in the latter category reach a temperature change of 2.5°C to 5.8°C above the average for 1850–1900 in 2100. Together with the baseline scenarios in the >1000 ppm CO_2-eq category, this leads to an overall 2100 temperature range of 2.5°C to 7.8°C (range based on median climate response: 3.7°C to 4.8°C) for baseline scenarios across both concentration categories.

[c] The global 2010 emissions are 31% above the 1990 emissions (consistent with the historic greenhouse gas emission estimates presented in this report). CO_2-eq emissions include the basket of Kyoto gases (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) as well as fluorinated gases).

[d] The assessment here involves a large number of scenarios published in the scientific literature and is thus not limited to the Representative Concentration Pathways (RCPs). To evaluate the CO_2-eq concentration and climate implications of these scenarios, the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) was used in a probabilistic mode. For a comparison between MAGICC model results and the outcomes of the models used in WGI, see WGI 12.4.1.2, 12.4.8 and WGIII 6.3.2.6.

[e] The assessment in this table is based on the probabilities calculated for the full ensemble of scenarios in WGIII AR5 using MAGICC and the assessment in WGI of the uncertainty of the temperature projections not covered by climate models. The statements are therefore consistent with the statements in WGI, which are based on the Coupled Model Intercomparison Project Phase 5 (CMIP5) runs of the RCPs and the assessed uncertainties. Hence, the likelihood statements reflect different lines of evidence from both WGs. This WGI method was also applied for scenarios with intermediate concentration levels where no CMIP5 runs are available. The likelihood statements are indicative only *[WGIII 6.3]* and follow broadly the terms used by the WGI SPM for temperature projections: likely 66–100%, more likely than not >50–100%, about as likely as not 33–66%, and unlikely 0–33%. In addition the term more unlikely than likely 0–<50% is used.

[f] The CO_2-equivalent concentration (see Glossary) is calculated on the basis of the total forcing from a simple carbon cycle/climate model, MAGICC. The CO_2-equivalent concentration in 2011 is estimated to be 430 ppm (uncertainty range 340 to 520 ppm). This is based on the assessment of total anthropogenic radiative forcing for 2011 relative to 1750 in WGI, i.e., 2.3 W/m², uncertainty range 1.1 to 3.3 W/m².

[g] The vast majority of scenarios in this category overshoot the category boundary of 480 ppm CO_2-eq concentration.

[h] For scenarios in this category, no CMIP5 run or MAGICC realization stays below the respective temperature level. Still, an *unlikely* assignment is given to reflect uncertainties that may not be reflected by the current climate models.

[i] Scenarios in the 580 to 650 ppm CO_2-eq category include both overshoot scenarios and scenarios that do not exceed the concentration level at the high end of the category (e.g., RCP4.5). The latter type of scenarios, in general, have an assessed probability of *more unlikely than likely* to stay below the 2°C temperature level, while the former are mostly assessed to have an *unlikely* probability of staying below this level.

[j] In these scenarios, global CO_2-eq emissions in 2050 are between 70 to 95% below 2010 emissions, and they are between 110 to 120% below 2010 emissions in 2100.

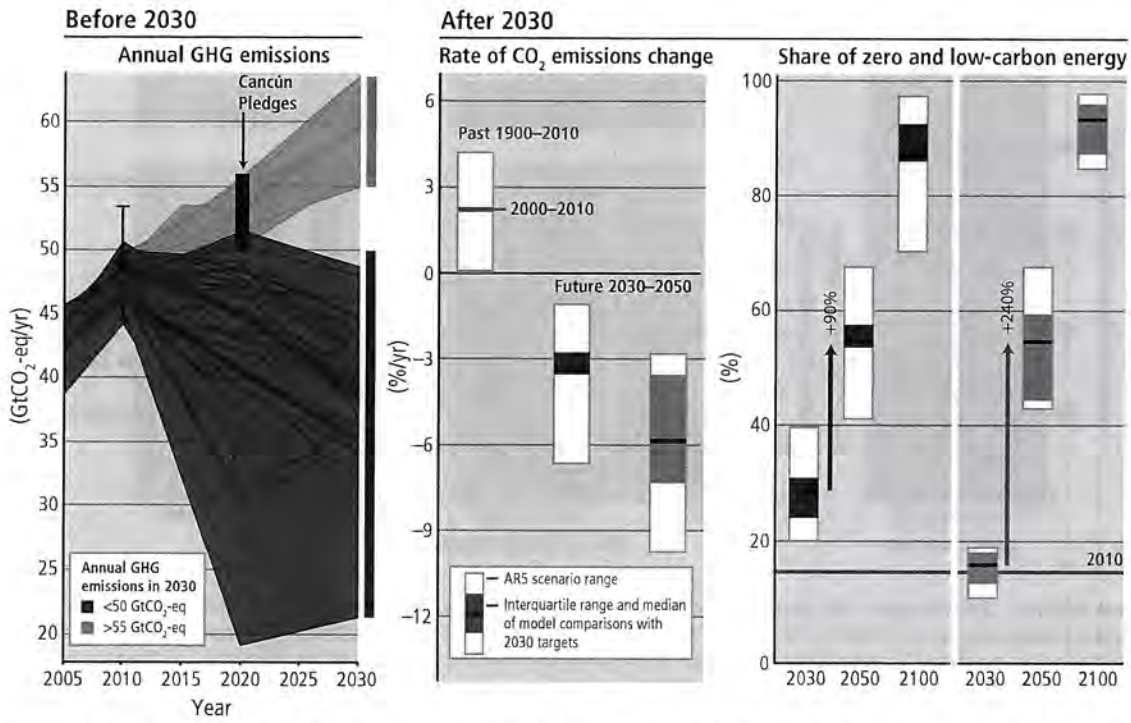

Figure SPM.12 | The implications of different 2030 greenhouse gas (GHG) emissions levels for the rate of carbon dioxide (CO_2) emissions reductions and low-carbon energy upscaling in mitigation scenarios that are at least *about as likely as not* to keep warming throughout the 21st century below 2°C relative to pre-industrial levels (2100 CO_2-equivalent concentrations of 430 to 530 ppm). The scenarios are grouped according to different emissions levels by 2030 (coloured in different shades of green). The left panel shows the pathways of GHG emissions (gigatonne of CO_2-equivalent per year, $GtCO_2$-eq/yr) leading to these 2030 levels. The black dot with whiskers gives historic GHG emission levels and associated uncertainties in 2010 as reported in Figure SPM.2. The black bar shows the estimated uncertainty range of GHG emissions implied by the Cancún Pledges. The middle panel denotes the average annual CO_2 emissions reduction rates for the period 2030–2050. It compares the median and interquartile range across scenarios from recent inter-model comparisons with explicit 2030 interim goals to the range of scenarios in the Scenario Database for WGIII AR5. Annual rates of historical emissions change (sustained over a period of 20 years) and the average annual CO_2 emission change between 2000 and 2010 are shown as well. The arrows in the right panel show the magnitude of zero and low-carbon energy supply upscaling from 2030 to 2050 subject to different 2030 GHG emissions levels. Zero- and low-carbon energy supply includes renewables, nuclear energy and fossil energy with carbon dioxide capture and storage (CCS) or bioenergy with CCS (BECCS). [Note: Only scenarios that apply the full, unconstrained mitigation technology portfolio of the underlying models (default technology assumption) are shown. Scenarios with large net negative global emissions (>20 $GtCO_2$-eq/yr), scenarios with exogenous carbon price assumptions and scenarios with 2010 emissions significantly outside the historical range are excluded.] *{Figure 3.3}*

Mitigation scenarios reaching about 450 ppm CO_2-eq in 2100 (consistent with a *likely* chance to keep warming below 2°C relative to pre-industrial levels) typically involve temporary overshoot[17] of atmospheric concentrations, as do many scenarios reaching about 500 ppm CO_2-eq to about 550 ppm CO_2-eq in 2100 (Table SPM.1). Depending on the level of overshoot, overshoot scenarios typically rely on the availability and widespread deployment of bioenergy with carbon dioxide capture and storage (BECCS) and afforestation in the second half of the century. The availability and scale of these and other CDR technologies and methods are uncertain and CDR technologies are, to varying degrees, associated with challenges and risks[18]. CDR is also prevalent in many scenarios without overshoot to compensate for residual emissions from sectors where mitigation is more expensive (*high confidence*). *{3.4, Box 3.3}*

Reducing emissions of non-CO_2 agents can be an important element of mitigation strategies. All current GHG emissions and other forcing agents affect the rate and magnitude of climate change over the next few decades, although long-term warming is mainly driven by CO_2 emissions. Emissions of non-CO_2 forcers are often expressed as 'CO_2-equivalent emissions', but the choice of metric to calculate these emissions, and the implications for the emphasis and timing of abatement of the various climate forcers, depends on application and policy context and contains value judgments. *{3.4, Box 3.2}*

[17] In concentration 'overshoot' scenarios, concentrations peak during the century and then decline.

[18] CDR methods have biogeochemical and technological limitations to their potential on the global scale. There is insufficient knowledge to quantify how much CO_2 emissions could be partially offset by CDR on a century timescale. CDR methods may carry side effects and long-term consequences on a global scale.

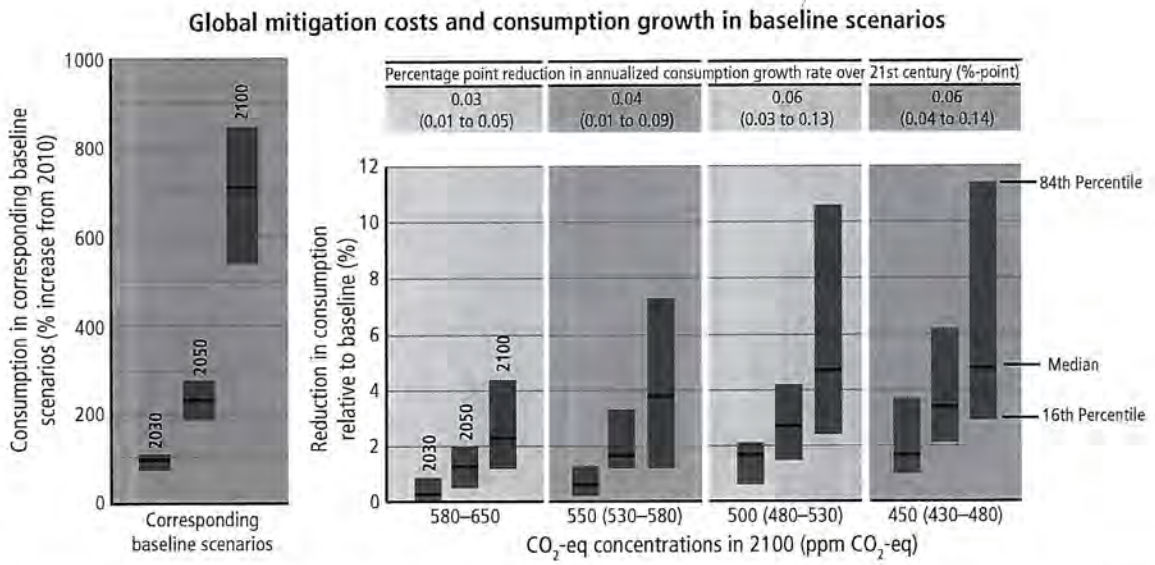

Figure SPM.13 | Global mitigation costs in cost-effective scenarios at different atmospheric concentrations levels in 2100. Cost-effective scenarios assume immediate mitigation in all countries and a single global carbon price, and impose no additional limitations on technology relative to the models' default technology assumptions. Consumption losses are shown relative to a baseline development without climate policy (left panel). The table at the top shows percentage points of annualized consumption growth reductions relative to consumption growth in the baseline of 1.6 to 3% per year (e.g., if the reduction is 0.06 percentage points per year due to mitigation, and baseline growth is 2.0% per year, then the growth rate with mitigation would be 1.94% per year). Cost estimates shown in this table do not consider the benefits of reduced climate change or co-benefits and adverse side effects of mitigation. Estimates at the high end of these cost ranges are from models that are relatively inflexible to achieve the deep emissions reductions required in the long run to meet these goals and/or include assumptions about market imperfections that would raise costs. *{Figure 3.4}*

Delaying additional mitigation to 2030 will substantially increase the challenges associated with limiting warming over the 21st century to below 2°C relative to pre-industrial levels. It will require substantially higher rates of emissions reductions from 2030 to 2050; a much more rapid scale-up of low-carbon energy over this period; a larger reliance on CDR in the long term; and higher transitional and long-term economic impacts. Estimated global emissions levels in 2020 based on the Cancún Pledges are not consistent with cost-effective mitigation trajectories that are at least *about as likely as not* to limit warming to below 2°C relative to pre-industrial levels, but they do not preclude the option to meet this goal (*high confidence*) (Figure SPM.12, Table SPM.2). *{3.4}*

Estimates of the aggregate economic costs of mitigation vary widely depending on methodologies and assumptions, but increase with the stringency of mitigation. Scenarios in which all countries of the world begin mitigation immediately, in which there is a single global carbon price, and in which all key technologies are available have been used as a cost-effective benchmark for estimating macro-economic mitigation costs (Figure SPM.13). Under these assumptions mitigation scenarios that are *likely* to limit warming to below 2°C through the 21st century relative to pre-industrial levels entail losses in global consumption—not including benefits of reduced climate change as well as co-benefits and adverse side effects of mitigation—of 1 to 4% (median: 1.7%) in 2030, 2 to 6% (median: 3.4%) in 2050 and 3 to 11% (median: 4.8%) in 2100 relative to consumption in baseline scenarios that grows anywhere from 300% to more than 900% over the century (Figure SPM.13). These numbers correspond to an annualized reduction of consumption growth by 0.04 to 0.14 (median: 0.06) percentage points over the century relative to annualized consumption growth in the baseline that is between 1.6 and 3% per year (*high confidence*). *{3.4}*

In the absence or under limited availability of mitigation technologies (such as bioenergy, CCS and their combination BECCS, nuclear, wind/solar), mitigation costs can increase substantially depending on the technology considered. Delaying additional mitigation increases mitigation costs in the medium to long term. Many models could not limit *likely* warming to below 2°C over the 21st century relative to pre-industrial levels if additional mitigation is considerably delayed. Many models could not limit *likely* warming to below 2°C if bioenergy, CCS and their combination (BECCS) are limited (*high confidence*) (Table SPM.2). *{3.4}*

Table SPM.2 | Increase in global mitigation costs due to either limited availability of specific technologies or delays in additional mitigation [a] relative to cost-effective scenarios [b]. The increase in costs is given for the median estimate and the 16th to 84th percentile range of the scenarios (in parentheses) [c]. In addition, the sample size of each scenario set is provided in the coloured symbols. The colours of the symbols indicate the fraction of models from systematic model comparison exercises that could successfully reach the targeted concentration level. *(Table 3.2)*

Mitigation cost increases in scenarios with limited availability of technologies [d] *[% increase in total discounted [e] mitigation costs (2015–2100) relative to default technology assumptions]*					**Mitigation cost increases due to delayed additional mitigation until 2030** *[% increase in mitigation costs relative to immediate mitigation]*	
2100 concentrations (ppm CO_2-eq)	no CCS	nuclear phase out	limited solar/wind	limited bioenergy	medium term costs (2030–2050)	long term costs (2050–2100)
450 (430 to 480)	138% (29 to 297%) 4	7% (4 to 18%) 8	6% (2 to 29%) 8	64% (44 to 78%) 8	44% (2 to 78%) 29	37% (16 to 82%) 29
500 (480 to 530)	not available (n.a.)	n.a.	n.a.	n.a.		
550 (530 to 580)	39% (18 to 78%) 11	13% (2 to 23%) 10	8% (5 to 15%) 10	18% (4 to 66%) 12	15% (3 to 32%)	16% (5 to 24%)
580 to 650	n.a.	n.a.	n.a.	n.a.		

Symbol legend—fraction of models successful in producing scenarios (numbers indicate the number of successful models)

- : all models successful
- : between 80 and 100% of models successful
- : between 50 and 80% of models successful
- : less than 50% of models successful

Notes:

[a] Delayed mitigation scenarios are associated with greenhouse gas emission of more than 55 $GtCO_2$-eq in 2030, and the increase in mitigation costs is measured relative to cost-effective mitigation scenarios for the same long-term concentration level.

[b] Cost-effective scenarios assume immediate mitigation in all countries and a single global carbon price, and impose no additional limitations on technology relative to the models' default technology assumptions.

[c] The range is determined by the central scenarios encompassing the 16th to 84th percentile range of the scenario set. Only scenarios with a time horizon until 2100 are included. Some models that are included in the cost ranges for concentration levels above 530 ppm CO_2-eq in 2100 could not produce associated scenarios for concentration levels below 530 ppm CO_2-eq in 2100 with assumptions about limited availability of technologies and/or delayed additional mitigation.

[d] No CCS: carbon dioxide capture and storage is not included in these scenarios. Nuclear phase out: no addition of nuclear power plants beyond those under construction, and operation of existing plants until the end of their lifetime. Limited Solar/Wind: a maximum of 20% global electricity generation from solar and wind power in any year of these scenarios. Limited Bioenergy: a maximum of 100 EJ/yr modern bioenergy supply globally (modern bioenergy used for heat, power, combinations and industry was around 18 EJ/yr in 2008). EJ = Exajoule = 10^{18} Joule.

[e] Percentage increase of net present value of consumption losses in percent of baseline consumption (for scenarios from general equilibrium models) and abatement costs in percent of baseline gross domestic product (GDP, for scenarios from partial equilibrium models) for the period 2015–2100, discounted at 5% per year.

Mitigation scenarios reaching about 450 or 500 ppm CO_2-eq 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. *{4.4.2.2}*

Mitigation policy could devalue fossil fuel assets and reduce revenues for fossil fuel exporters, but differences between regions and fuels exist (*high confidence*). Most mitigation scenarios are associated with reduced revenues from coal and oil trade for major exporters (*high confidence*). The availability of CCS would reduce the adverse effects of mitigation on the value of fossil fuel assets (*medium confidence*). *{4.4.2.2}*

Solar Radiation Management (SRM) involves large-scale methods that seek to reduce the amount of absorbed solar energy in the climate system. SRM is untested and is not included in any of the mitigation scenarios. If it were deployed, SRM would

entail numerous uncertainties, side effects, risks and shortcomings and has particular governance and ethical implications. SRM would not reduce ocean acidification. If it were terminated, there is *high confidence* that surface temperatures would rise very rapidly impacting ecosystems susceptible to rapid rates of change. *{Box 3.3}*

SPM 4. Adaptation and Mitigation

Many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link adaptation and mitigation with other societal objectives. *{4}*

SPM 4.1 Common enabling factors and constraints for adaptation and mitigation responses

Adaptation and mitigation responses are underpinned by common enabling factors. These include effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods and behavioural and lifestyle choices. *{4.1}*

Inertia in many aspects of the socio-economic system constrains adaptation and mitigation options (*medium evidence, high agreement*). Innovation and investments in environmentally sound infrastructure and technologies can reduce GHG emissions and enhance resilience to climate change (*very high confidence*). *{4.1}*

Vulnerability to climate change, GHG emissions and the capacity for adaptation and mitigation are strongly influenced by livelihoods, lifestyles, behaviour and culture (*medium evidence, medium agreement*). Also, the social acceptability and/or effectiveness of climate policies are influenced by the extent to which they incentivize or depend on regionally appropriate changes in lifestyles or behaviours. *{4.1}*

For many regions and sectors, enhanced capacities to mitigate and adapt are part of the foundation essential for managing climate change risks (*high confidence*). Improving institutions as well as coordination and cooperation in governance can help overcome regional constraints associated with mitigation, adaptation and disaster risk reduction (*very high confidence*). *{4.1}*

SPM 4.2 Response options for adaptation

Adaptation options exist in all sectors, but their context for implementation and potential to reduce climate-related risks differs across sectors and regions. Some adaptation responses involve significant co-benefits, synergies and trade-offs. Increasing climate change will increase challenges for many adaptation options. *{4.2}*

Adaptation experience is accumulating across regions in the public and private sectors and within communities. There is increasing recognition of the value of social (including local and indigenous), institutional, and ecosystem-based measures and of the extent of constraints to adaptation. Adaptation is becoming embedded in some planning processes, with more limited implementation of responses (*high confidence*). *{1.6, 4.2, 4.4.2.1}*

The need for adaptation along with associated challenges is expected to increase with climate change (*very high confidence*). Adaptation options exist in all sectors and regions, with diverse potential and approaches depending on their context in vulnerability reduction, disaster risk management or proactive adaptation planning (Table SPM.3). Effective strategies and actions consider the potential for co-benefits and opportunities within wider strategic goals and development plans. *{4.2}*

Table SPM.3 | Approaches for managing the risks of climate change through adaptation. These approaches should be considered overlapping rather than discrete, and they are often pursued simultaneously. Examples are presented in no specific order and can be relevant to more than one category. *[Table 4.2]*

Overlapping Approaches	Category	Examples
Vulnerability & Exposure Reduction through development, planning & practices including many low-regrets measures; Adaptation including incremental & transformational adjustments; Transformation	Human development	Improved access to education, nutrition, health facilities, energy, safe housing & settlement structures, & social support structures; Reduced gender inequality & marginalization in other forms.
	Poverty alleviation	Improved access to & control of local resources; Land tenure; Disaster risk reduction; Social safety nets & social protection; Insurance schemes.
	Livelihood security	Income, asset & livelihood diversification; Improved infrastructure; Access to technology & decision-making fora; Increased decision-making power; Changed cropping, livestock & aquaculture practices; Reliance on social networks.
	Disaster risk management	Early warning systems; Hazard & vulnerability mapping; Diversifying water resources; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements.
	Ecosystem management	Maintaining wetlands & urban green spaces; Coastal afforestation; Watershed & reservoir management; Reduction of other stressors on ecosystems & of habitat fragmentation; Maintenance of genetic diversity; Manipulation of disturbance regimes; Community-based natural resource management.
	Spatial or land-use planning	Provisioning of adequate housing, infrastructure & services; Managing development in flood prone & other high risk areas; Urban planning & upgrading programs; Land zoning laws; Easements; Protected areas.
	Structural/physical	***Engineered & built-environment options***: Sea walls & coastal protection structures; Flood levees; Water storage; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements; Floating houses; Power plant & electricity grid adjustments.
		Technological options: New crop & animal varieties; Indigenous, traditional & local knowledge, technologies & methods; Efficient irrigation; Water-saving technologies; Desalinisation; Conservation agriculture; Food storage & preservation facilities; Hazard & vulnerability mapping & monitoring; Early warning systems; Building insulation; Mechanical & passive cooling; Technology development, transfer & diffusion.
		Ecosystem-based options: Ecological restoration; Soil conservation; Afforestation & reforestation; Mangrove conservation & replanting; Green infrastructure (e.g., shade trees, green roofs); Controlling overfishing; Fisheries co-management; Assisted species migration & dispersal; Ecological corridors; Seed banks, gene banks & other *ex situ* conservation; Community-based natural resource management.
		Services: Social safety nets & social protection; Food banks & distribution of food surplus; Municipal services including water & sanitation; Vaccination programs; Essential public health services; Enhanced emergency medical services.
	Institutional	***Economic options***: Financial incentives; Insurance; Catastrophe bonds; Payments for ecosystem services; Pricing water to encourage universal provision and careful use; Microfinance; Disaster contingency funds; Cash transfers; Public-private partnerships.
		Laws & regulations: Land zoning laws; Building standards & practices; Easements; Water regulations & agreements; Laws to support disaster risk reduction; Laws to encourage insurance purchasing; Defined property rights & land tenure security; Protected areas; Fishing quotas; Patent pools & technology transfer.
		National & government policies & programs: National & regional adaptation plans including mainstreaming; Sub-national & local adaptation plans; Economic diversification; Urban upgrading programs; Municipal water management programs; Disaster planning & preparedness; Integrated water resource management; Integrated coastal zone management; Ecosystem-based management; Community-based adaptation.
	Social	***Educational options***: Awareness raising & integrating into education; Gender equity in education; Extension services; Sharing indigenous, traditional & local knowledge; Participatory action research & social learning; Knowledge-sharing & learning platforms.
		Informational options: Hazard & vulnerability mapping; Early warning & response systems; Systematic monitoring & remote sensing; Climate services; Use of indigenous climate observations; Participatory scenario development; Integrated assessments.
		Behavioural options: Household preparation & evacuation planning; Migration; Soil & water conservation; Storm drain clearance; Livelihood diversification; Changed cropping, livestock & aquaculture practices; Reliance on social networks.
	Spheres of change	***Practical***: Social & technical innovations, behavioural shifts, or institutional & managerial changes that produce substantial shifts in outcomes.
		Political: Political, social, cultural & ecological decisions & actions consistent with reducing vulnerability & risk & supporting adaptation, mitigation & sustainable development.
		Personal: Individual & collective assumptions, beliefs, values & worldviews influencing climate-change responses.

SPM 4.3 Response options for mitigation

Mitigation options are available in every major sector. Mitigation can be more cost-effective if using an integrated approach that combines measures to reduce energy use and the greenhouse gas intensity of end-use sectors, decarbonize energy supply, reduce net emissions and enhance carbon sinks in land-based sectors. *{4.3}*

Well-designed systemic and cross-sectoral mitigation strategies are more cost-effective in cutting emissions than a focus on individual technologies and sectors, with efforts in one sector affecting the need for mitigation in others (*medium confidence*). Mitigation measures intersect with other societal goals, creating the possibility of co-benefits or adverse side effects. These intersections, if well-managed, can strengthen the basis for undertaking climate action. *{4.3}*

Emissions ranges for baseline scenarios and mitigation scenarios that limit CO_2-equivalent concentrations to low levels (about 450 ppm CO_2-eq, *likely* to limit warming to 2°C above pre-industrial levels) are shown for different sectors and gases in Figure SPM.14. Key measures to achieve such mitigation goals include decarbonizing (i.e., reducing the carbon intensity of) electricity generation (*medium evidence, high agreement*) as well as efficiency enhancements and behavioural changes, in order to reduce energy demand compared to baseline scenarios without compromising development (*robust evidence, high agreement*). In scenarios reaching 450 ppm CO_2-eq concentrations by 2100, global CO_2 emissions from the energy supply sector are projected to decline over the next decade and are characterized by reductions of 90% or more below 2010 levels between 2040 and 2070. In the majority of low-concentration stabilization scenarios (about 450 to about 500 ppm CO_2-eq, at least *about as likely as not* to limit warming to 2°C above pre-industrial levels), the share of low-carbon electricity supply (comprising renewable energy (RE), nuclear and carbon dioxide capture and storage (CCS) including bioenergy with carbon dioxide capture and storage (BECCS)) increases from the current share of approximately 30% to more than 80% by 2050, and fossil fuel power generation without CCS is phased out almost entirely by 2100. *{4.3}*

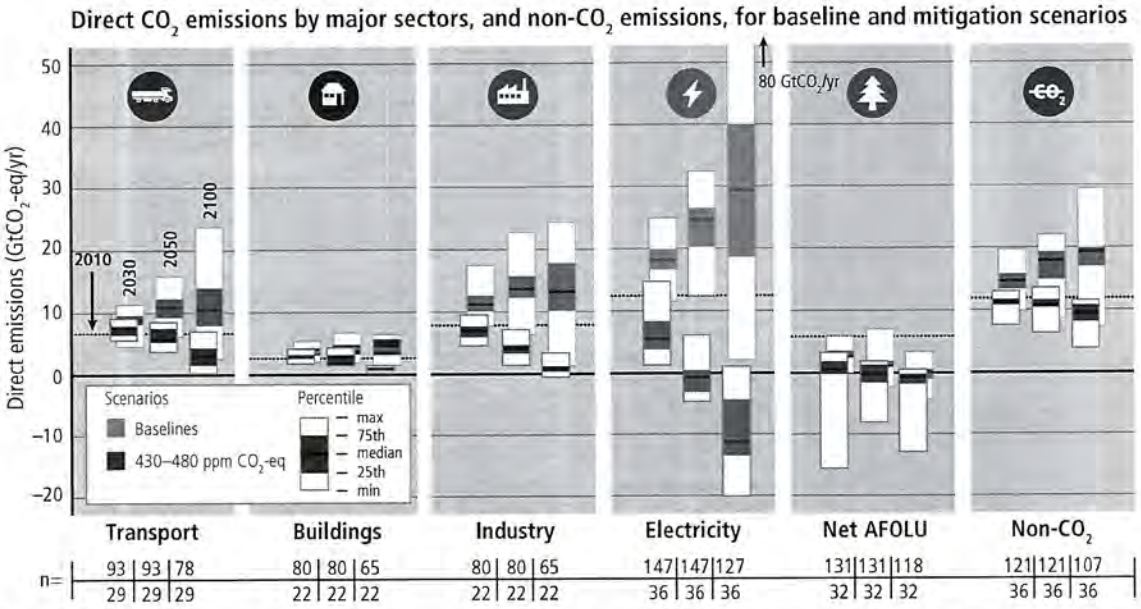

Figure SPM.14 | Carbon dioxide (CO_2) emissions by sector and total non-CO_2 greenhouse gases (Kyoto gases) across sectors in baseline (faded bars) and mitigation scenarios (solid colour bars) that reach about 450 (430 to 480) ppm CO_2-eq concentrations in 2100 (*likely* to limit warming to 2°C above pre-industrial levels). Mitigation in the end-use sectors leads also to indirect emissions reductions in the upstream energy supply sector. Direct emissions of the end-use sectors thus do not include the emission reduction potential at the supply-side due to, for example, reduced electricity demand. The numbers at the bottom of the graphs refer to the number of scenarios included in the range (upper row: baseline scenarios; lower row: mitigation scenarios), which differs across sectors and time due to different sectoral resolution and time horizon of models. Emissions ranges for mitigation scenarios include the full portfolio of mitigation options; many models cannot reach 450 ppm CO_2-eq concentration by 2100 in the absence of carbon dioxide capture and storage (CCS). Negative emissions in the electricity sector are due to the application of bioenergy with carbon dioxide capture and storage (BECCS). 'Net' agriculture, forestry and other land use (AFOLU) emissions consider afforestation, reforestation as well as deforestation activities. *{4.3, Figure 4.1}*

Near-term reductions in energy demand are an important element of cost-effective mitigation strategies, provide more flexibility for reducing carbon intensity in the energy supply sector, hedge against related supply-side risks, avoid lock-in to carbon-intensive infrastructures, and are associated with important co-benefits. The most cost-effective mitigation options in forestry are afforestation, sustainable forest management and reducing deforestation, with large differences in their relative importance across regions; and in agriculture, cropland management, grazing land management and restoration of organic soils (*medium evidence, high agreement*). *{4.3, Figures 4.1, 4.2, Table 4.3}*

Behaviour, lifestyle and culture have a considerable influence on energy use and associated emissions, with high mitigation potential in some sectors, in particular when complementing technological and structural change (*medium evidence, medium agreement*). Emissions can be substantially lowered through changes in consumption patterns, adoption of energy savings measures, dietary change and reduction in food wastes. *{4.1, 4.3}*

SPM 4.4 Policy approaches for adaptation and mitigation, technology and finance

Effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and sub-national. Policies across all scales supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation. *{4.4}*

International cooperation is critical for effective mitigation, even though mitigation can also have local co-benefits. Adaptation focuses primarily on local to national scale outcomes, but its effectiveness can be enhanced through coordination across governance scales, including international cooperation: *{3.1, 4.4.1}*

- The United Nations Framework Convention on Climate Change (UNFCCC) is the main multilateral forum focused on addressing climate change, with nearly universal participation. Other institutions organized at different levels of governance have resulted in diversifying international climate change cooperation. *{4.4.1}*

- The Kyoto Protocol offers lessons towards achieving the ultimate objective of the UNFCCC, particularly with respect to participation, implementation, flexibility mechanisms and environmental effectiveness (*medium evidence, low agreement*). *{4.4.1}*

- Policy linkages among regional, national and sub-national climate policies offer potential climate change mitigation benefits (*medium evidence, medium agreement*). Potential advantages include lower mitigation costs, decreased emission leakage and increased market liquidity. *{4.4.1}*

- International cooperation for supporting adaptation planning and implementation has received less attention historically than mitigation but is increasing and has assisted in the creation of adaptation strategies, plans and actions at the national, sub-national and local level (*high confidence*). *{4.4.1}*

There has been a considerable increase in national and sub-national plans and strategies on both adaptation and mitigation since the AR4, with an increased focus on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side effects (*high confidence*): *{4.4.2.1, 4.4.2.2}*

- National governments play key roles in adaptation planning and implementation (*robust evidence, high agreement*) through coordinating actions and providing frameworks and support. While local government and the private sector have different functions, which vary regionally, they are increasingly recognized as critical to progress in adaptation, given their roles in scaling up adaptation of communities, households and civil society and in managing risk information and financing (*medium evidence, high agreement*). *{4.4.2.1}*

- Institutional dimensions of adaptation governance, including the integration of adaptation into planning and decision-making, play a key role in promoting the transition from planning to implementation of adaptation (*robust evidence,*

high agreement). Examples of institutional approaches to adaptation involving multiple actors include economic options (e.g., insurance, public-private partnerships), laws and regulations (e.g., land-zoning laws) and national and government policies and programmes (e.g., economic diversification). *{4.2, 4.4.2.1, Table SPM.3}*

- In principle, mechanisms that set a carbon price, including cap and trade systems and carbon taxes, can achieve mitigation in a cost-effective way but have been implemented with diverse effects due in part to national circumstances as well as policy design. The short-run effects of cap and trade systems have been limited as a result of loose caps or caps that have not proved to be constraining (*limited evidence, medium agreement*). In some countries, tax-based policies specifically aimed at reducing GHG emissions—alongside technology and other policies—have helped to weaken the link between GHG emissions and GDP (*high confidence*). In addition, in a large group of countries, fuel taxes (although not necessarily designed for the purpose of mitigation) have had effects that are akin to sectoral carbon taxes. *{4.4.2.2}*

- Regulatory approaches and information measures are widely used and are often environmentally effective (*medium evidence, medium agreement*). Examples of regulatory approaches include energy efficiency standards; examples of information programmes include labelling programmes that can help consumers make better-informed decisions. *{4.4.2.2}*

- Sector-specific mitigation policies have been more widely used than economy-wide policies (*medium evidence, high agreement*). Sector-specific policies may be better suited to address sector-specific barriers or market failures and may be bundled in packages of complementary policies. Although theoretically more cost-effective, administrative and political barriers may make economy-wide policies harder to implement. Interactions between or among mitigation policies may be synergistic or may have no additive effect on reducing emissions. *{4.4.2.2}*

- Economic instruments in the form of subsidies may be applied across sectors, and include a variety of policy designs, such as tax rebates or exemptions, grants, loans and credit lines. An increasing number and variety of renewable energy (RE) policies including subsidies—motivated by many factors—have driven escalated growth of RE technologies in recent years. At the same time, reducing subsidies for GHG-related activities in various sectors can achieve emission reductions, depending on the social and economic context (*high confidence*). *{4.4.2.2}*

Co-benefits and adverse side effects of mitigation could affect achievement of other objectives such as those related to human health, food security, biodiversity, local environmental quality, energy access, livelihoods and equitable sustainable development. The potential for co-benefits for energy end-use measures outweighs the potential for adverse side effects whereas the evidence suggests this may not be the case for all energy supply and agriculture, forestry and other land use (AFOLU) measures. Some mitigation policies raise the prices for some energy services and could hamper the ability of societies to expand access to modern energy services to underserved populations (*low confidence*). These potential adverse side effects on energy access can be avoided with the adoption of complementary policies such as income tax rebates or other benefit transfer mechanisms (*medium confidence*). Whether or not side effects materialize, and to what extent side effects materialize, will be case- and site-specific, and depend on local circumstances and the scale, scope and pace of implementation. Many co-benefits and adverse side effects have not been well-quantified. *{4.3, 4.4.2.2, Box 3.4}*

Technology policy (development, diffusion and transfer) complements other mitigation policies across all scales, from international to sub-national; many adaptation efforts also critically rely on diffusion and transfer of technologies and management practices (*high confidence*). Policies exist to address market failures in R&D, but the effective use of technologies can also depend on capacities to adopt technologies appropriate to local circumstances. *{4.4.3}*

Substantial reductions in emissions would require large changes in investment patterns (*high confidence*). For mitigation scenarios that stabilize concentrations (without overshoot) in the range of 430 to 530 ppm CO_2-eq by 2100[19], annual investments in low carbon electricity supply and energy efficiency in key sectors (transport, industry and buildings) are projected in the scenarios to rise by several hundred billion dollars per year before 2030. Within appropriate enabling environments, the private sector, along with the public sector, can play important roles in financing mitigation and adaptation (*medium evidence, high agreement*). *{4.4.4}*

[19] This range comprises scenarios that reach 430 to 480 ppm CO_2-eq by 2100 (*likely* to limit warming to 2°C above pre-industrial levels) and scenarios that reach 480 to 530 ppm CO_2-eq by 2100 (without overshoot: *more likely than* not to limit warming to 2°C above pre-industrial levels).

Financial resources for adaptation have become available more slowly than for mitigation in both developed and developing countries. Limited evidence indicates that there is a gap between global adaptation needs and the funds available for adaptation (*medium confidence*). There is a need for better assessment of global adaptation costs, funding and investment. Potential synergies between international finance for disaster risk management and adaptation have not yet been fully realized (*high confidence*). *{4.4.4}*

SPM 4.5 Trade-offs, synergies and interactions with sustainable development

Climate change is a threat to sustainable development. Nonetheless, there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses (*high confidence*). Successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond (*medium confidence*). *{3.5, 4.5}*

Climate change exacerbates other threats to social and natural systems, placing additional burdens particularly on the poor (*high confidence*). Aligning climate policy with sustainable development requires attention to both adaptation and mitigation (*high confidence*). Delaying global mitigation actions may reduce options for climate-resilient pathways and adaptation in the future. Opportunities to take advantage of positive synergies between adaptation and mitigation may decrease with time, particularly if limits to adaptation are exceeded. Increasing efforts to mitigate and adapt to climate change imply an increasing complexity of interactions, encompassing connections among human health, water, energy, land use and biodiversity (*medium evidence, high agreement*). *{3.1, 3.5, 4.5}*

Strategies and actions can be pursued now which will move towards climate-resilient pathways for sustainable development, while at the same time helping to improve livelihoods, social and economic well-being and effective environmental management. In some cases, economic diversification can be an important element of such strategies. The effectiveness of integrated responses can be enhanced by relevant tools, suitable governance structures and adequate institutional and human capacity (*medium confidence*). Integrated responses are especially relevant to energy planning and implementation; interactions among water, food, energy and biological carbon sequestration; and urban planning, which provides substantial opportunities for enhanced resilience, reduced emissions and more sustainable development (*medium confidence*). *{3.5, 4.4, 4.5}*

Exhibit 3

The White House

Office of the Press Secretary

For Immediate Release November 11, 2014

U.S.-China Joint Announcement on Climate Change

Beijing, China, 12 November 2014

1. The United States of America and the People's Republic of China have a critical role to play in combating global climate change, one of the greatest threats facing humanity. The seriousness of the challenge calls upon the two sides to work constructively together for the common good.

2. To this end, President Barack Obama and President Xi Jinping reaffirmed the importance of strengthening bilateral cooperation on climate change and will work together, and with other countries, to adopt a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties at the United Nations Climate Conference in Paris in 2015. They are committed to reaching an ambitious 2015 agreement that reflects the principle of common but differentiated responsibilities and respective capabilities, in light of different national circumstances.

3. Today, the Presidents of the United States and China announced their respective post-2020 actions on climate change, recognizing that these actions are part of the longer range effort to transition to low-carbon economies, mindful of the global temperature goal of 2℃. The United States intends to achieve an economy-wide target of reducing its emissions by 26%-28% below its 2005 level in 2025 and to make best efforts to reduce its emissions by 28%. China intends to achieve the peaking of CO2 emissions around 2030 and to make best efforts to peak early and intends to increase the share of non-fossil fuels in primary energy consumption to around 20% by 2030. Both sides intend to continue to work to increase ambition over time.

4. The United States and China hope that by announcing these targets now, they can inject momentum into the global climate negotiations and inspire other countries to join in coming forward with ambitious actions as soon as possible, preferably by the first quarter of 2015. The two Presidents resolved to work closely together over the next year to address major impediments to reaching a successful global climate agreement in Paris.

5. The global scientific community has made clear that human activity is already changing the world's climate system. Accelerating climate change has caused serious impacts. Higher temperatures and extreme weather events are damaging food production, rising sea levels and more damaging storms are putting our coastal cities increasingly at risk and the impacts of climate change are already harming economies around the world, including those of the United States and China. These developments urgently require enhanced actions to tackle the challenge.

6. At the same time, economic evidence makes increasingly clear that smart action on climate change now can drive innovation, strengthen economic growth and bring broad benefits – from sustainable development to increased energy security, improved public health and a better quality of life. Tackling climate change will also strengthen national and international security.

7. Technological innovation is essential for reducing the cost of current mitigation technologies, leading to the invention and dissemination of new zero and low-carbon technologies and enhancing the capacity of countries to reduce their emissions. The United States and China are two of the world's largest investors in clean energy and already have a robust program of energy technology cooperation. The two sides have among other things:

- established the U.S.-China Climate Change Working Group (CCWG), under which they have launched action initiatives on vehicles, smart grids, carbon capture, utilization and storage, energy efficiency, greenhouse gas data management, forests and industrial boilers;
- agreed to work together towards the global phase down of hydrofluorocarbons (HFCs), very potent greenhouse gases;

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- created the U.S.-China Clean Energy Research Center, which facilitates collaborative work in carbon capture and storage technologies, energy efficiency in buildings, and clean vehicles; and
- agreed on a joint peer review of inefficient fossil fuel subsidies under the G-20.

8. The two sides intend to continue strengthening their policy dialogue and practical cooperation, including cooperation on advanced coal technologies, nuclear energy, shale gas and renewable energy, which will help optimize the energy mix and reduce emissions, including from coal, in both countries. To further support achieving their ambitious climate goals, today the two sides announced additional measures to strengthen and expand their cooperation, using the existing vehicles, in particular the U.S.-China Climate Change Working Group, the U.S.-China Clean Energy Research Center and the U.S.-China Strategic and Economic Dialogue. These include:

- **Expanding Joint Clean Energy Research and Development:** A renewed commitment to the U.S.-China Clean Energy Research Center, including continued funding for three existing tracks on building efficiency, clean vehicles and advanced coal technology and launching a new track on the energy-water nexus;
- **Advancing Major Carbon Capture, Utilization and Storage Demonstrations:** Establishment of a major new carbon storage project based in China through an international public-private consortium led by the United States and China to intensively study and monitor carbon storage using industrial CO2 and also work together on a new Enhanced Water Recovery (EWR) pilot project to produce fresh water from CO2 injection into deep saline aquifers;
- **Enhancing Cooperation on HFCs:** Building on the historic Sunnylands agreement between President Obama and President Xi regarding HFCs, highly potent greenhouse gases, the two sides will enhance bilateral cooperation to begin phasing-down the use of high global warming potential HFCs and work together in a multilateral context as agreed by the two Presidents at their meeting in St. Petersburg on 6 September 2013;
- **Launching a Climate-Smart/Low-Carbon Cities Initiative:** In response to growing urbanization and increasingly significant greenhouse gas emissions from cities and recognizing the potential for local leaders to undertake significant climate action, the United States and China will establish a new initiative on Climate-Smart/Low-Carbon Cities under the CCWG. As a first step, the United States and China will convene a Climate-Smart/ Low-Carbon Cities Summit where leading cities from both countries will share best practices, set new goals and celebrate city-level leadership in reducing carbon emissions and building resilience;
- **Promoting Trade in Green Goods:** Encouraging bilateral trade in sustainable environmental goods and clean energy technologies, including through a U.S. trade mission led by Secretaries Moniz and Pritzker in April 2015 that will focus on smart low-carbon cities and smart low-carbon growth technologies; and
- **Demonstrating Clean Energy on the Ground:** Additional pilot programs, feasibility studies and other collaborative projects in the areas of building efficiency, boiler efficiency, solar energy and smart grids.

Exhibit 4

CLIMATE ACTION PLAN
STRATEGY TO REDUCE METHANE EMISSIONS

MARCH 2014

CLIMATE ACTION PLAN - STRATEGY TO REDUCE METHANE EMISSIONS

EXECUTIVE SUMMARY

Reducing methane emissions is a powerful way to take action on climate change; and putting methane to use can support local economies with a source of clean energy that generates revenue, spurs investment, improves safety, and leads to cleaner air. That is why in his Climate Action Plan, President Obama directed the Administration to develop a comprehensive, interagency strategy to cut methane emissions.

This document lays out that strategy – summarizing the sources of methane and trends in emissions; setting forth a plan to reduce both domestic and international methane emissions through incentive-based programs and the Administration's existing authorities; and, outlining the Administration's efforts to improve measurement of these emissions. This strategy also highlights examples of technologies and industry-led best practices that are already helping to cut methane emissions.

Today, methane accounts for nearly 9 percent of domestic greenhouse gas emissions. And although U.S. methane emissions have decreased by 11 percent since 1990, they are projected to increase through 2030 if additional action is not taken. As a key element of the Climate Action Plan, this strategy outlines new actions to reduce methane emissions. These actions will improve public health and safety while providing more energy to power our communities, farms, factories, and power plants. These steps will also make an important contribution to meeting the Administration goal of reducing U.S. greenhouse gas emissions in the range of 17 percent below 2005 levels by 2020. While the elements of the strategy will be further fleshed out in the coming months, Administration estimates show that steps along these lines could deliver greenhouse gas emissions reductions up to 90 million metric tons in 2020.

Through partnerships with industry, both at home and abroad, we have already demonstrated the technology and best practices to deliver substantial reductions in methane emissions. These cost-effective steps can deliver multiple benefits:

- *Economic Benefits:* Methane is the primary component of natural gas, so the recovery of methane that would otherwise be emitted can be productively used for power generation, heating or manufacturing. In addition, projects to reduce methane emissions can put people to work and spur investment in local economies.

- *Climate Change Benefits:* Every ton of methane in the atmosphere has a global warming effect that is more than 20 times greater than a ton of carbon dioxide. Thus, methane reductions yield important climate benefits, particularly in the near term.

- *Public Health:* Actions to reduce methane also improve the quality of the air we breathe. Methane is a contributor to ground level ozone, so cutting methane emissions reduces smog, which is associated with higher rates of asthma attacks. Moreover, methane is often co-emitted with volatile organic compounds, some of which are hazardous air

pollutants, and many measures can cost-effectively reduce both pollutants.

- *Safety:* Improved safety and reduced methane emissions go hand-in-hand, as in our natural gas transmission and distributions systems and coal mining industries.

Reducing Methane Emissions

The Administration is pursuing a targeted strategy that builds on progress to date and takes steps to further cut methane emissions from a number of key sources:

- **Landfills**: In the summer of 2014, the Environmental Protection Agency (EPA) will propose updated standards to reduce methane from new landfills and take public comment on whether to update standards for existing landfills. Through the Landfill Methane Outreach Program, EPA will further reduce methane emissions through voluntary programs – partnering with industry, state, and local leaders, many of whom are putting the methane waste to use powering their communities.

- **Coal Mines:** In April of 2014, the Interior Department's Bureau of Land Management (BLM) will release an Advanced Notice of Proposed Rulemaking (ANPRM) to gather public input on the development of a program for the capture and sale, or disposal, of waste mine methane on lands leased by the Federal government. In addition, EPA will continue to partner with industry through its voluntary program to reduce institutional, technical, regulatory, and financial barriers to beneficial methane recovery and use at coal mines.

- **Agriculture:** In June, in partnership with the dairy industry, the US Department of Agriculture (USDA), EPA and the Department of Energy (DOE) will jointly release a "Biogas Roadmap" outlining voluntary strategies to accelerate adoption of methane digesters and other cost-effective technologies to reduce U.S. dairy sector greenhouse gas emissions by 25 percent by 2020. USDA and EPA will also continue to support biodigester technology deployment by providing financial and technical assistance through voluntary programs.

- **Oil and Gas:** Building on the success of voluntary programs and targeted regulations in reducing methane emissions from the oil and gas sector, the Administration will take new actions to encourage additional cost-effective reductions. Key steps include:

    - In the spring of 2014, EPA will assess several potentially significant sources of methane and other emissions from the oil and gas sector. EPA will solicit input from independent experts through a series of technical white papers, and in the fall of 2014, EPA will determine how best to pursue further methane reductions from these sources. If EPA decides to develop additional regulations, it will complete those regulations by the end of 2016. Through the Natural Gas STAR program, EPA will work with the industry to expand voluntary efforts to reduce methane emissions.

- Later this year, the BLM will propose updated standards to reduce venting and flaring from oil and gas production on public lands.

- As part of the Quadrennial Energy Review, and through DOE-convened roundtables, the Administration will identify "downstream" methane reduction opportunities.

Beyond these actions to reduce domestic methane emissions, the United States is also helping partners around the world to reduce methane emissions, including through the Climate and Clean Air Coalition and the Global Methane Initiative.

Improving Methane Measurement

Methane emissions come from diverse sources and sectors of the economy, unevenly dispersed across the landscape. These characteristics complicate measurement and attribution and lead to significant uncertainties in estimates of current and projected methane emissions. Better data collection and measurement will improve our understanding of methane sources and trends, and enable more effective management of opportunities to reduce methane emissions. Key steps under the strategy to improve data quality include:

- Developing new measurement technologies, including lower-cost emissions sensing equipment.

- Addressing areas of higher uncertainty in bottom-up inventories through additional data collection, direct emission measurements, and research and analysis.

- Enhancing top-down modeling and monitoring based on direct measurement of atmospheric concentrations.

I. SOURCES AND TRENDS IN METHANE EMISSIONS

Methane has a global warming potential more than 20 times greater than that of carbon dioxide, per metric ton; on this basis, emissions of methane from human-related sources were equivalent to approximately 560 million metric tons of carbon dioxide pollution in 2012 – making up nearly 9 percent of all the greenhouse gases emitted as a result of human activity in the United States[1]. Since 1990, methane emissions in the United States have decreased by 11 percent, even as many activities that can produce methane have increased. However, methane emissions are projected to increase to a level equivalent to over 620 million tons of carbon dioxide pollution in 2030 absent additional action to reduce emissions. The main sources of human-related methane emissions are agriculture (36 percent), natural gas systems (23 percent), landfills (18 percent), coal mining (10 percent), petroleum systems (6 percent), and wastewater treatment (2 percent) [2].

II. REDUCING METHANE EMISSIONS

On June 25, 2013, the President issued a broad-based Climate Action Plan to cut the pollution that causes climate change and damages public health. The plan has three key pillars: cutting domestic greenhouse gas emissions, preparing the United States for the impacts of climate change, and continuing American leadership in international efforts to combat global climate change.

Low-cost technologies and best practices to recover methane and cut pollution are already widely available and used in key sectors. In addition to taking on climate change, reducing methane emissions has many other benefits. Recovered methane provides a local source of clean energy that can generate revenue and spur economic development. Reducing methane emissions can also improve safety and reduce local air pollution and odors. For example, landfill gas can be captured with collection systems and used for electricity generation or to provide fuel to a nearby factory. Methane recovered from coal mine degasification systems can be sold to natural gas pipelines or used on site for process heat. Methane generated from livestock manure can be captured through the use of biodigesters and used to generate electricity, avoiding fuel costs or providing a source of additional revenue. Methane that is vented or leaked from oil and natural gas production or processing facilities can be recovered through upgraded equipment and management practices that improve the company's bottom line.

This section outlines cost-effective opportunities to reduce methane emissions in four key sectors of our economy. It highlights new Administration actions to encourage voluntary emissions reductions and to set new standards where appropriate. The section also features key public-private sector initiatives that are cutting methane emissions or improving our understanding about specific sources of emissions. Finally, this section describes key U.S. efforts in helping

[1] Estimates of methane's potency as a greenhouse gas in this document use 100-year global warming potential values from the Second Assessment Report of the Intergovernmental Panel on Climate Change, as required by international reporting standards.

[2] These estimates are based on the Draft *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012*, EPA, February 2014. The draft 2014 GHG Inventory (calculating emissions from 1990 through 2012) includes several updates to the methane numbers. As a result of the recalculations, in the draft 2014 Inventory, the total methane emissions estimate decreased by about 4 percent from the previous estimate.

international partners to reduce their methane emissions.

Reducing Emissions from Landfills

Municipal solid waste landfills are the third-largest source of human-related methane emissions in the United States, accounting for approximately 18 percent of methane emissions in 2012, equivalent to approximately 100 million metric tons of carbon dioxide pollution. Instead of allowing landfill gas to escape into the air, there is an opportunity to capture this gas and use it as a source of clean energy. In fact, standards and programs already in place have reduced landfill emission considerably, while creating jobs and improving public health. The Administration is committed to further reducing landfill emissions and tapping this important energy resource:

- **Updating Common Sense Rules to Reduce Landfill Emissions**: EPA will release a proposed update to its current standards for new municipal solid waste landfills in the summer of 2014, including assessing opportunities for further minimizing emissions when landfills are built or modified. Since there may be an even bigger opportunity for reducing methane emissions at existing landfills, EPA will also issue an Advanced Notice of Proposed Rulemaking (ANPRM) by June 2014 to engage industry and stakeholders on a range of approaches for cutting methane-rich landfill gases currently being emitted by existing facilities.

Case Study: Blue Ridge Renewable Energy Plant in Pennsylvania

In a true private-public partnership, landfill gas supplier IESI Blue Ridge Landfill, power purchaser Borough of Chambersburg and project developer PPL Renewable Energy (PPLRE) worked closely together to bring this 6.4-megawatt landfill gas electricity project online after only seven months of construction. In addition to designing, constructing, owning, and operating the LFG electricity plant at the landfill, PPLRE designed, permitted, and built the dedicated, 4-mile Express Generator Feeder from the plant to the Borough's Cree substation. Coming full circle, waste that Borough residents and businesses deposited in the landfill now supplies about 15 percent of its 11,000 customers' electric needs, plus the Borough was able to decrease the price of electricity those customers pay. In addition, the project generates 50,000 renewable energy credits annually toward meeting the state renewable energy goal.

- **Enhancing Landfill Gas-to-Energy Projects**: EPA will continue to work with municipalities and landfill owners to advance cost-effective voluntary energy recovery projects at landfills through the Landfill Methane Outreach Program.

- **Reducing Landfill Waste:** Through the U.S. Food Waste Challenge, the USDA and EPA are challenging producers, processors, manufacturers, retailers, communities, and other government agencies to help reduce, recover, or recycle food waste. Less waste in our landfills, means less methane emissions, a win-win.

Capturing Methane Emissions from Coal Mining

In 2012, 10 percent of human-related methane emissions came from the coal mining sector, equivalent to 56 million tons of carbon dioxide pollution. When recovered safely, coal mine methane can be a valuable, clean-burning source of energy. One of the most important co-benefits to reducing methane emissions at coal mines is increasing mine safety since uncontrolled methane emissions can cause fires and explosions. To further reduce coal mine

methane emissions, the Department of Interior's BLM and the Environmental Protection Agency will take actions in two key areas:

- **Establishing a Program to Reduce Waste Coal Mine Emissions on Public Lands**: The BLM will release an Advanced Notice of Proposed Rulemaking (ANPRM) in April 2014, to solicit public input on the development of a program for the capture, sale, or disposal of waste mine methane from Federal coal leases and Federal leases for other solid minerals. The ANPRM will seek public input on preferred technology options for methane capture, whether the BLM should promote partnerships to capture or destroy waste mine methane, and how the agency could encourage cost-effective capture of methane from coal mines.

- **Overcoming Barriers to Reducing Coal Mining Emissions:** Since the Coalbed Methane Outreach Program's launch in 1994, the coal mining industry has nearly doubled its total methane recovery and use. Currently, over 20 mines have installed methane degasification systems. The EPA will continue to work with industry through this voluntary program to encourage recovery and beneficial use of methane by helping to overcome institutional, technical, regulatory, and financial barriers. The EPA will also continue to coordinate with the Department of Labor's Mine Safety and Health Administration to ensure that implementation of methane recovery projects at coal mines is consistent with all applicable safety standards and with the BLM's efforts to facilitate coalbed methane capture and use on Federal lands.

Reducing Emissions from Agriculture

Thirty six percent of human-related methane emissions come from the agricultural sector in the United States, equivalent to over 200 million tons of carbon pollution. This strategy addresses emissions from agriculture exclusively through voluntary actions, not through regulations. The most important voluntary opportunities are through manure management with anaerobic digestion and biogas utilization. Biogas systems are proven and effective technology to process organic waste and generate renewable energy. They can reduce the risk of potential air and water quality issues while providing additional revenue for the operation. Yet, there are still relatively few digesters in operation on farms across America. To encourage adoption of this technology, the Administration is committed to promoting additional, cost-effective actions to reduce methane emissions through voluntary partnerships and programs, including:

- **Developing a Biogas Roadmap**: This June, in partnership with the dairy industry, USDA, EPA and DOE will jointly release a Biogas Roadmap outlining voluntary strategies to accelerate the adoption of biogas systems and other cost-effective technologies to reduce greenhouse gas emissions. This work will support the U.S. dairy industry goal to reduce greenhouse gas emissions by 25 percent by the year 2020 for the entire value chain.

- **Enhancing Biogas System Deployment**: USDA will continue to support biogas system deployment by providing financial and technical assistance through the Natural Resources Conservation Service's Environmental Quality Incentive Program and Rural Development's Rural Energy for America Program, Bioenergy Program for Advanced Biofuels, and Biorefinery Assistance Program. The Natural Resources Conservation Service Conservation's Innovation Grants program is already catalyzing reductions in methane emissions through projects on rice cultivation and manure management. Through the AgSTAR program, EPA and USDA will continue working together to overcome barriers to expanding the use of agricultural biogas systems, and provide a forum for industry and other stakeholders to access information.

The Dairy Innovation Center "Dairy Power" Project

The Innovation Center for U.S. Dairy's "Dairy Power™ "project is focused on realizing the significant potential of anaerobic digester systems that can produce clean energy and value-added products, generate revenue for dairy producers and create jobs. The Dairy Power project report findings show a $3 billion market potential through the products and co-products developed by mature digester systems that process manure and commercial food waste, with additional value for potential nutrient trading markets, and renewable energy and low-carbon energy production incentives.

Reducing Methane Emissions from the Oil and Natural Gas Sectors

In 2012, 28 percent of methane emissions were attributed to the oil and natural gas sectors. Methane equivalent to 127 million tons of carbon dioxide pollution was emitted from production, processing, transmission, storage, and distribution of natural gas. Methane equivalent to 32 million tons of carbon dioxide pollution was emitted from production and refining, of oil. Within the natural gas industry, approximately 31 percent of this methane came from production sources, 15 percent from processing, 34 percent from the transmission and storage, and 20 percent from distribution. As our use of natural gas in manufacturing, transportation, and power generation increases – creating jobs, reducing costs, cutting carbon pollution, and reducing dependence on foreign oil in our nation – we must continue to build on progress in reducing methane emissions from this vital sector of our economy.

There are cost-effective technologies and best management practices to capture methane from venting and leaks across the entire oil and natural gas value chain. These range from equipment upgrades or replacements, to process or operational changes. Building on progress to date, the Administration will undertake new steps, including:

- **Working with States:** States are the primary regulators of many aspects of oil and gas production activities and the distribution of natural gas. DOE and EPA will continue to provide technical assistance in support of effective state policy actions to reduce emissions, and to encourage broader adoption of proven mitigation strategies.

- **Building on Common-Sense Federal Standards**: Since 2012, the EPA has taken a series of steps to address air pollution from the oil and gas sector. On April 17, 2012, the EPA issued final regulations to reduce the emissions of volatile organic compounds (VOCs), some of which are hazardous air pollutants, establishing, among other things, the first Federal air pollution standards for natural gas wells that are hydraulically

fractured, along with requirements for other sources, such as compressors, that were not previously regulated at the Federal level. Although these regulations targeted VOCs, they also reduced methane emissions substantially. EPA estimates that when fully implemented in 2015, the 2012 rules will decrease methane equivalent to 33 million tons of carbon pollution per year. Going forward, the EPA will deploy a carefully selected combination of policy tools to maximize cost-effective methane and VOC reductions from the oil and gas sector.

During the spring of 2014, the EPA will release a series of white papers on several potentially significant sources of methane in the oil and gas sector and solicit input from independent experts. The papers will focus on technical issues, covering emissions and control technologies that target both VOC and methane —with particular focus on oil and co-producing wells, liquids unloading, leaks, pneumatic devices and compressors. The agency will use these technical documents to solidify its understanding of these potentially significant sources of methane. This robust technical understanding will allow the agency to fully evaluate the range of policy mechanisms that will cost-effectively cut methane waste and emissions. The EPA will make peer reviewer comments available this summer. This fall, the EPA will determine what if any regulatory authorities, including setting standards under section 111 of the Clean Air Act or issuing Control Techniques Guidelines under section 182 of the Act, the agency will apply to emissions from these sources. If the agency determines to follow a regulatory course of action, it will undertake a schedule that will ensure that both rulemaking and any ensuing regulatory requirements for the states are completed by the end of 2016.

- **Enhanced Partnerships and Stakeholder Engagement:** The Administration will work collaboratively with key stakeholders to reduce methane emissions from natural gas systems.

  - In coordination with the Executive Office of the President and other Federal agencies, Secretary of Energy Ernest Moniz hosted a roundtable discussion on March 19, 2014 with leaders from industry, state governments, academic researchers, non-governmental organizations, and labor. DOE will sponsor additional roundtable discussions with stakeholders, with the primary objective of accelerating the adoption of best practices for reducing methane emissions from natural gas systems. Through these DOE roundtables the Administration also aims to:
    - Promote a common understanding of methane emissions from natural gas systems and related abatement opportunities.
    - Develop strategies for cost-effectively reducing methane emissions from processing, transmission and storage and distribution segments of the supply chain.
    - Catalyze greater action and engagement by policymakers at all levels of government, and encourage industry to embrace a common vision, including through participation in existing voluntary programs.
  - EPA will take steps to bolster its voluntary Natural Gas STAR Program, which has already identified over 50 cost-effective technologies and practices that reduce or

avoid methane emissions, by eliciting more robust industry commitments while enhancing transparency and accountability. In the spring of 2014, EPA will begin to engage the industry, states, and other key stakeholders on ways to enhance this program, and will formally launch the new partnership by the end of 2014.

- **Minimizing Venting and Flaring on Public Lands:** DOI's Office of Inspector General and the U.S. Government Accountability Office have both criticized BLM's outdated requirements governing venting and flaring for wasting Federal gas resources and associated royalties to the American taxpayer. To reduce the loss of natural gas through the venting or flaring of methane produced from Federal and Indian oil and gas leases, the BLM will develop a draft rule, known informally as Onshore Order 9, and anticipates releasing this proposed rule later this year. To aid in the development of the rule, DOI has begun outreach to tribes, industry and other stakeholders.

Reducing Downstream Emissions

Safety is a top priority for natural gas distribution companies and state regulators. Thirty-eight states have some form of accelerated infrastructure replacement cost recovery program in place. Many companies are working with their state regulators to accelerate the modernization, replacement and expansion of the nation's natural gas pipeline system. These efforts to enhance safety also put people to work and reduce methane emissions. Several cooperative efforts are also underway. A group of 13 American Gas Association members are working with the Environmental Defense Fund on a project to improve measurement of methane emissions from natural gas distribution systems. In addition, the Natural Gas Downstream Initiative, a group of natural gas utilities, is collaborating to address key technical and regulatory factors affecting methane emission reduction opportunities from natural gas distribution systems. Through the initiative, partners are working to identify and encourage programs that accelerate investments in infrastructure and promote outstanding operations, including modernizing their systems and utilizing next generation technologies. The initiative is focused on opportunities that can substantially reduce methane emissions and support safe, reliable and cost-effective service. Current partners include Consolidated Edison Company of New York, National Grid, Pacific Gas & Electric Company, Public Service Electric and Gas Company, and Xcel Energy.

- **Identifying Policy Recommendations for Reducing Emissions from Energy Infrastructure**: The first installment of the Quadrennial Energy Review (QER), to be released in January of 2015, will recommend actions that industry, and Federal and state governments can take to improve the performance of our energy transmission, storage and distributions systems. Building on the DOE roundtables, the QER will evaluate methane emissions abatement opportunities from the processing, transmission, storage and distribution segments of the natural gas supply chain. To help identify the most cost-effective mitigation options, DOE's Office of Energy Policy and Systems Analysis will work with the National Labs and EPA to evaluate technology cost estimates developed by NGOs and industry, and combine analysis with associated emissions data, recently updated by EPA.

- **Supporting Development of New Technologies to Reduce Emissions:** DOE will support the development of new technologies to enable more cost-effective emission reductions through several programs:

- In December 2013, the DOE made up to $8 billion in loan guarantee authority available for a wide array of advanced fossil energy projects under its Section 1703 loan guarantee program. Innovative technologies to reduce methane emissions from the coal mining and oil and gas sectors is one specific focus of this initiative, which will include regular solicitations for new loan applications.

- The 2015 Budget proposes a new $4.7 million DOE program to speed development of technologies for leak detection and monitoring, pipeline leak repair without having to evacuate gas from the pipelines, smart pipeline sensors, and compressor controls. The program will be aimed at accelerating the commercialization of advanced pipeline inspection technologies. For example smart sensors could be distributed within the pipeline network and provide real-time continuous tracking of gas volumes and pipeline internal conditions.

- **Continuing to Prioritize Pipeline Safety**: The Pipeline and Hazardous Materials Safety Administration (PHMSA) will continue monitoring natural gas pipeline systems for safety, including requiring pipeline operators to take steps to eliminate leaks and prevent accidental releases of methane. Through this effort PHMSA has conducted a survey to evaluate each states progress to replace old, high-risk cast iron pipelines in their systems with new technologies that reduce leakage and accidental releases of methane over time.

U.S. Leadership in Reducing Global Methane Emissions

Methane accounts for approximately 15 percent of global annual greenhouse gas emissions. The United States is the recognized global leader in helping partners around the world to reduce methane emissions, including through the following two key actions:

- **Spearheading Key Initiatives in the Climate and Clean Air Coalition:** As a founding partner of the Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants (CCAC) – which now includes nearly 40 country partners and key actors like the World Bank, UN Environment Programme, and World Health Assembly – the United States is helping to spearhead initiatives to across key sectors:

  - The CCAC Municipal Solid Waste Initiative is currently working with 26 cities in Africa, Asia and Latin America to develop sustainable municipal solid waste practices to reduce methane emissions from landfills and improve air quality, public health, and the environment. To scale-up and replicate these efforts, the initiative is helping to build the capacity of national governments; has created a global city network that promotes peer-to-peer learning and sharing of best practices; and is developing innovative, sustainable financing solutions.

  - The recently-launched CCAC Agriculture Initiative will promote improved manure management and rice cultivation practices through new global knowledge platforms, regional centers providing targeted assistance, and support to national and local early adopters of policies and technologies to catalyze large-scale practice change. This effort will not only reduce methane emissions and local pollution from the agriculture sector, it will also increase food security and productivity.

- The United States is working with international and corporate partners to launch the CCAC Oil and Gas Methane Partnership in 2014 with an initial group of oil and gas companies agreeing to systematically survey, report, and reduce methane emissions across a range of their participating operations. Participating companies will deploy proven and cost-effective technologies and practices across the largest sources of methane emissions in the oil and gas sector.

- Leveraging U.S. Technical Expertise through the Global Methane Initiative: Through the Global Methane Initiative (GMI), the United States leverages U.S. technical expertise to help partners around the world substantially reduce their methane emissions in five key sectors: agriculture; coal mines; municipal solid waste; oil and gas systems; and municipal wastewater. GMI is a public-private initiative with 43 partner countries, including all of the top 10 leading methane emitters, and over 1,000 members of the Project Network, including private sector, nongovernmental organizations, and multilateral organizations such as the World Bank, the Asian Development Bank, and the Inter-American Development Bank. GMI advances cost-effective, near-term methane recovery and use as a clean energy source, with a proven track record of helping to reduce methane emissions of over 220 million metric tons carbon dioxide since 2004, and identifying additional potential reductions that can be achieved cost-effectively. GMI has also developed a suite of tools and resources to help overcome barriers to methane capture and recovery and has built institutional capacity in Partner countries to ensure the long-term success of these efforts. These projects reduce greenhouse gas emissions in the near term and provide important environmental, safety, and economic co-benefits. The EPA is the lead agency from the U.S. Government and coordinates with the Department of State, Department of Energy, Department of Agriculture, USAID, and the Trade and Development Agency.

NGO-Industry Cooperative Research Initiative

In 2012, Environmental Defense Fund kicked off a series of studies — collaborating with more than 90 academic, research and industry partners — to better understand how much and from where methane is lost from the natural gas system today.

This project is investigating emissions from five key areas that make up the natural gas supply chain: production, gathering lines and processing facilities, long-distance pipelines and storage, local distribution and commercial trucks and refueling stations. The initiative includes 16 independent projects, all expected to be completed by the end of 2014.

III. IMPROVING MEASUREMENT OF METHANE SOURCES AND EMISSIONS

Our current understanding of methane sources and trends supports the steps to reduce emissions outlined in this strategy. At the same time, sharpening our ability to measure emissions will enable more targeted efforts in the future. For this reason, in addition to identifying technologies and best practices for reducing emissions, the Climate Action Plan also calls for an assessment of current methane emissions data. Unlike carbon dioxide, where emissions are easily estimated from well-tracked energy statistics, many sources of methane are more diffuse, not systematically tracked by statistics agencies, and thus considerably more uncertain.