COLUMBIA LAW SCHOOL
SABIN CENTER FOR CLIMATE CHANGE LAW

April 13, 2018

The Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE, Room 1A
Washington, DC 20426

VIA ELECTRONIC SUBMISSION

Re: Grid Resilience in Regional Transmission Organizations and Independent System Operators (Docket No. AD18-7-000)

Dear Secretary Bose,

The Sabin Center for Climate Change Law submits these comments in response to the Federal Energy Regulatory Commission ("FERC")'s request for input on the resilience of the bulk power system ("BPS") in areas overseen by regional transmission organizations and independent system operators ("RTO/ISOs"). For the reasons discussed below, we consider that RTO/ISOs' efforts to address resilience have given insufficient weight to the impacts of climate change, which have the potential to disrupt operation of the BPS. We urge FERC to work with RTO/ISOs to ensure they adequately assess and plan for such disruptions. To achieve this goal, we recommend FERC convene a technical conference to discuss issues relating to climate change resilience in the BPS, and take appropriate measures thereafter.

I. Climate Change Poses a Major Threat to BPS Resilience

The impacts of climate change – including higher average and peak temperatures, altered precipitation patterns, and more frequent and intense storms – will adversely affect the generation and transmission segments of the BPS. A range of possible effects are discussed in the attached Sabin Center working paper, titled "Climate Change Impacts on the Bulk Power System: Assessing Vulnerabilities and Planning for Resilience."[1]

[1] JUSTIN GUNDLACH & ROMANY WEBB, CLIMATE CHANGE IMPACTS ON THE BULK POWER SYSTEM: ASSESSING VULNERABILITIES AND PLANNING FOR RESILIENCE (2018), https://perma.cc/G9H8-Y2FW.

The attached working paper compiles numerous government and independent studies detailing how the impacts of climate change will affect generating and transmission facilities. As just one example, the studies indicate that the higher temperatures associated with climate change may force generating facilities to curtail output or shutdown,[2] while also reducing the carrying capacity of transmission lines and leading to increased line losses.[3] These disruptions will occur alongside increases in electricity load and load peaks, which will further strain transmission and generating facilities.[4]

Temperature-related disruptions to generation and transmission facilities are likely to be experienced in all RTO/ISO regions in the future. Each region will likely also experience disruptions due to more intense extreme weather events and other climate change-induced phenomena including:

- more frequent and severe droughts, which are expected to occur in parts of the American West and Southwest, and will affect operation of the BPS in regions overseen by the California ISO ("CAISO"), Midcontinent ISO ("MISO"), and Southwest Power Pool ("SPP");[5]

- more heavy rainfall events, which could occur nationwide, but will be a particular problem in regions overseen by the New York ISO ("NYISO") and ISO-New England ("ISO-NE");[6]

- sea level rise and coastal flooding, which will affect all ISO regions, except that overseen by SPP; and[7]

- increased wildfire risks, which will be a particular problem in the CAISO region.[8]

These and other phenomena may occur simultaneously and thus have compounding effects on generation and transmission facilities.[9] Unless appropriately managed, those effects could severely disrupt operation of the BPS, impairing its ability to deliver reliable electricity services at just and reasonable rates.

[2] *Id*. at 7-8.
[3] *Id*. at 11.
[4] *Id*. at 13.
[5] *Id*. at 9.
[6] *Id*. at 9-10, 12-13.
[7] *Id*. at 10.
[8] *Id*. at 11-12.
[9] Id. at 6-7.

II. RTO/ISOs Are Not Currently Planning for the Effects of Climate Change

Despite the potentially significant and widespread adverse effects of climate change, its implications for BPS resilience have been largely ignored by RTO/ISOs. No RTO/ISO discussed the resilience implications of climate change in its submission to FERC's grid resilience proceeding and the topic has received scant attention in other forums (e.g., before the North American Electric Reliability Corporation). While some attention has been devoted to extreme weather events, the consideration thereof has generally been piecemeal, with RTO/ISOs focusing on specific events (or types of events) and overlooking broader trends. RTO/ISOs have, for example, tended to overlook the potential for climate change to increase the frequency and severity of individual events and the likelihood of multiple events occurring simultaneously.

One – but by no means the only – example of this can be found in CAISO's submission to the grid resilience proceeding. The submission rightly identifies extreme weather events as a threat to BPS resilience, with CAISO noting that its region often experiences droughts that "can significantly affect the power system."[10] CAISO acknowledged that "[d]roughts are not uncommon" in the region and often "last for a year or several years."[11] It did not, however, consider the likelihood of even longer-lasting and more severe droughts occurring in the future due to climate change.[12] Nor did it recognize that future droughts will occur alongside other climate change-induced phenomenon, which will have compounding effects on the power system.[13]

CAISO is not alone in failing to plan for the impacts of climate change.[14] To our knowledge, no RTO/ISO has undertaken a comprehensive assessment to determine how climate change will affect generation and transmission facilities in their region, nor explored options for managing any adverse effects.[15] This leaves RTO/ISOs ill-equipped to deal with climate change-related generation and transmission disruptions and thus threatens the resilience of the BPS.

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[10] Comments of the California Independent System Operator Corporation in Response to the Commission's Request for Comments About System Resiliency and Threats to Resilience 11 (Mar. 9, 2018).
[11] *Id.*
[12] M.F. Wehner et al., *Droughts, Floods, and Wildfires, in* CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT 231, 240 (D.J. Wuebbles et al. eds., 2017), https://perma.cc/TD85-T3H8 (finding that "chronic, long-duration hydrological drought is increasingly possible by the end of this century").
[13] For example, severe droughts disrupting hydroelectric and other generation will increasingly occur alongside heat waves that further stress generating facilities, while also leading to increased load. *See* Gundlach & Webb, *supra* note 1, at 6-7.
[14] Extreme weather events were discussed in similar terms in the submissions of other RTO/ISOs. All RTO/ISOs focused on past experience with extreme weather events and only one – PJM – recognized that "the frequency and magnitude of these events is decidedly on the rise." Neither PJM, nor any other RTO/ISO, discussed the likelihood of this trend continuing and events becoming more frequent and severe due to climate change. Nor did any discuss the potential for multiple climate-induced events to occur simultaneously. *See* Comments and Responses of PJM Interconnection, L.L.C. 29 (Mar. 9, 2018).
[15] *For a discussion of this issue, see* Gundlach & Webb, *supra* note 1, at 15-16.

To ensure the long-term resilience of the BPS, RTO/ISOs must plan for the impacts of climate change. Such planning is technically feasible, and may be performed using existing publicly-available tools and datasets, examples of which are provided in the attached working paper.[16] Using those and other resources, several electric industry participants, including some distribution system operators, have already begun planning for the impacts of climate change.[17] One example is Consolidated Edison Company of New York, Inc. which, in the aftermath of Superstorm Sandy in 2012, agreed to conduct a thorough assessment of its system's vulnerability to climate change.[18] In its order endorsing the assessment, the New York Public Service Commission ("NYPSC") noted that "Sandy drove home the urgency not only of emergency preparedness, but of advance planning for the impacts . . . of extreme weather," which will be "exacerbated by a changing climate."[19] Recognizing that planning is essential to ensure that the electric system is "resistant to climate change" and thus "reduce outage and storm costs to consumers,"[20] the NYPSC indicated that all utilities should "consult the most current data to evaluate the climate impacts anticipated in their regions . . . and integrate those considerations into their system planning." RTO/ISOs should do the same.[21]

To plan effectively for climate change, RTO/ISOs will need to alter their processes, including by expanding planning horizons. In their submissions to the grid resilience proceeding, most RTO/ISOs reported planning over a ten-year time horizon,[22] which is inconsistent with

[16] *Id*. at 19-21. *For further information on available tools and datasets, see* JESSICA WENTZ, ASSESSING THE IMPACTS OF CLIMATE CHANGE ON THE BUILT ENVIRONMENT UNDER NEPA AND STATE EIA LAWS: A SURVEY OF CURRENT PRACTICES AND RECOMMENDATIONS FOR MODEL PROTOCOLS 15–26 (2015), https://perma.cc/M6MQ-S2UB.

[17] *See e.g.*, TENNESSEE VALLEY AUTHORITY, CLIMATE CHANGE ADAPTATION PLAN—2016 UPDATE (June 2016), https://perma.cc/AQ82-M736; CRYSTAL RAYMOND, SEATTLE CITY LIGHT CLIMATE CHANGE VULNERABILITY ASSESSMENT AND ADAPTATION PLAN (2015), https://perma.cc/GBT2-2UV8

[18] *See* Joint Proposal of Consolidated Edison Company of New York, Inc. et al. to the New York Public Service Commission 50-52 (Dec. 31, 2013).

[19] State of New York Public Service Commission, Order Approving Electric, Gas and Steam Rate Plans in Accordance with Joint Proposal 62 (Feb. 21, 2014).

[20] *Id*. at 24.

[21] *Id*. at 72.

[22] Comments of the California Independent System Operator Corporation in Response to the Commission's Request for Comments About System Resiliency and Threats to Resilience 14 (Mar. 9, 2018) (indicating that "CAISO identifies and plans for contingencies and other potential reliability problems over a 10-year horizon"); Response of the Midcontinent Independent System Operator, Inc. 34 (Mar. 9, 2018) (stating that MISO plans over "near, intermediate and longer term horizons – typically 2, 5, and 10 years forward"); Response of ISO New England Inc. 59 (Mar. 9, 2018) (stating that "[t]he horizon for transmission planning studies in New England is ten years"); Response of the New York Independent System Operator, Inc. 20 (reporting that NYISO develops reliability plans "over a forward-looking ten-year planning horizon"); Comments and Responses of PJM Interconnection, L.L.C. 36 (Mar. 9, 2018) (expressing the view that "resilience assessments should be conduct annually with a five year planning horizon"). Based on submissions to FERC, it appears that only two RTO/ISOs developed longer-range plans. One is the Electric Reliability Council of Texas (ERCOT), which reported planning ten to fifteen years into the future. *See* Joint Comments of the Electric Reliability Council of Texas and the Public Utilities Commission of Texas 9 (Mar. 9, 2018) (indicating that ERCOT "conducting a long-term system assessment (LTSA) focusing on possible developments 10 to 15 years in the future"). The other is the Southwest Power Pool which develops ten-

recommended best practice for the development of climate change resilience plans.[23] As further elaborated in the attached working paper, those plans should assess the impacts of climate change over the full useful life of generation and transmission facilities (i.e., often forty years or more), based on forward-looking projections. Those projections should be used in conjunction with historic data (e.g., on past extreme weather events), which offers limited insight on future conditions in the age of climate change, but is currently relied upon by some RTO/ISOs.[24]

III. FERC Should Take Steps to Improve Climate Change Resilience Planning

Given the above, as part of the grid resilience proceeding, FERC should explore options for improving climate change resilience planning by RTO/ISOs. Action in this area falls squarely within FERC's mandate under the Federal Power Act to ensure the BPS operates in a manner that yields reliable electricity services at just and reasonable rates.[25] As recognized in the Act, operation of the BPS should avoid "instability, uncontrolled separation, or cascading failure . . . as a result of a sudden disturbance,"[26] which may be triggered by the impacts of climate change.[27] To minimize any instability due to climate-related disturbances, RTO/ISOs must identify and plan for the impacts of climate change.[28] Such planning is also necessary to ensure that RTO/ISO-operated markets account for the risks posed by climate change and thus provide appropriate incentives for investment in new facilities capable reliably delivering electricity.[29]

We recommend that, as a first step, FERC convene a technical conference to discuss issues relating to climate change resilience in the BPS. Such a conference would provide an invaluable opportunity for FERC, RTO/ISOs, and other stakeholders to explore the resilience challenges posed by climate change and how best to plan for those challenges. Following the conference, FERC could initiate a rulemaking or other proceeding to address deficiencies in climate change resilience planning, including (if appropriate) identifying recommended or required standards therefor.

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and twenty-year plans. *See* Southwest Power Pool, Integrated Transmission Planning, https://perma.cc/F4TQ-NLDJ (last visited Apr. 4, 2018).

[23] *See* Gundlach & Webb, *supra* note 1, at 21-22.

[24] *See, e.g.*, Responses of the Midcontinent Independent System Operator Inc. 17 (Mar. 9, 2018) (indicating that MISO considers "[p]revious experiences with . . . extreme weather events . . . to better understand the risk likelihood"). *See also* Comments and Responses of PJM Interconnection, L.L.C. 36 (Mar. 9, 2018) (noting that, in assessing the BPS's ability to withstand "high-impact, low-frequency" events, PJM selects events "based on [weather-related] threats previously experienced in the PJM Region . . . such as the 2014 Polar Vortex and Hurricane Sandy in 2012").

[25] 16 U.S.C. §§ 824d & 824o.

[26] *Id.* § 824o(a)(4).

[27] *See supra* part I.

[28] *See supra* part II.

[29] Webb & Gundlach, *supra* note 1, at 14-15.

Sincerely,

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Attachments (2):

(1) Justin Gundlach and Romany Webb, *Climate Change Impacts on the Bulk Power System: Assessing Vulnerabilities and Planning for Resilience*, Sabin Center Working Paper (2018)

(2) Jessica Wentz, *Assessing the Impacts of Climate Change on the Built Environment Under NEPA and State EIA Laws: A Survey of Current Practices and Recommendations for Model Protocols*, Sabin Center Working Paper (2015)

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CLIMATE CHANGE IMPACTS ON THE BULK POWER SYSTEM:

Assessing Vulnerabilities and Planning for Resilience

By Justin Gundlach and Romany Webb

February 2018

The Sabin Center for Climate Change Law develops legal techniques to fight climate change, trains law students and lawyers in their use, and provides the legal profession and the public with up-to-date resources on key topics in climate law and regulation. It works closely with the scientists at Columbia University's Earth Institute and with a wide range of governmental, non-governmental and academic organizations.

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EXECUTIVE SUMMARY

As the scale, speed, and implications of climate change come into focus, stakeholders in the electricity sector are finding it increasingly difficult to turn a blind eye. However, many have opted to attend to climate impacts in a piecemeal fashion, often merely responding to particular extreme events—or types of extreme events, such as coastal storms or floods—and failing to consider the larger phenomenon. This is true of the bulk power system (BPS) in regions overseen by Independent System Operators and Regional Transmission Organizations (collectively, ISO/RTOs), none of which have comprehensively assessed their systems' vulnerabilities to climate change. Lacking such assessments, ISO/RTOs cannot plan for the impacts of climate change, and thereby ensure the continued reliability and resilience of the BPS.

The higher temperatures, more intense storms, and other weather extremes associated with climate change pose numerous threats to the BPS. These threats are summarized in a table in the appendix to this paper. As shown there, the impacts of climate change could force generating facilities to curtail output or shutdown, and lead to widespread transmission outages. These disruptions will be accompanied by other climate-driven phenomenon, including increases in electricity load and the height of load peaks, which will further strain facilities.

While the nature and extent of generation and transmission impairments will vary across the U.S.—due to differences in the nature and extent of climatic changes seen—no region will go unscathed. It is, therefore, vital that all ISO/RTOs begin planning now for a future in which climate change will feature. Otherwise, in the future, the BPS may be unable to deliver reliable electricity services at just and reasonable rates as required by the Federal Power Act.

This paper offers ISO/RTOs advice on how to plan for climate change and identifies resources and processes they could employ in the planning process. The regional variation in climate change impacts, as well as differences in generation and transmission resources, prevent formulation of a "one-size fits-all" approach to planning across ISO/RTO regions. Nevertheless, there are a number of general principles which we recommend all ISO/RTOs follow, namely:

- A detailed climate change vulnerability assessment should be undertaken to determine how the components and operations of each ISO/RTO's system will be affected by increasing

temperatures, changing precipitation patterns, more intense storms, droughts, and other climate-driven weather extremes.

  - Vulnerability assessments should be based on downscaled projections of future climate change in the ISO/RTOs' respective operating regions. Many projections are available in existing datasets, including those developed by NASA and the U.S. Geological Survey. Gaps in available datasets (if any) should be noted and, if possible, filled by sponsoring supplemental research.

  - Vulnerability assessments should consider multiple projections that reflect a range of possible climate change scenarios, including a "worst case" (i.e., assuming continued high greenhouse gas emissions lead to large temperature increases and rates of sea level rise).

  - The timeframe for each vulnerability assessment should reflect the anticipated useful life of existing facilities or facilities scheduled for construction in the relevant ISO/RTO's region.

  - Vulnerability assessments should be periodically reviewed and updated as new information becomes available.

- Building on the vulnerability assessment, a plan should be developed for how to adapt and thereby prevent or manage the system disruptions that could threaten BPS reliability and resilience.

CONTENTS

1. INTRODUCTION

The resilience of the bulk power system (BPS) to various types of disruption has been the subject of much discussion in recent months. It was a key focus of the "Grid Reliability and Resiliency Pricing" proceeding before the Federal Energy Regulatory Commission (FERC),[1] the agency responsible for overseeing six Independent System Operators and Regional Transmission Organizations (collectively, ISO/RTOs) that manage much of the BPS.[2] The proceeding, which FERC opened on October 2, 2017 in response to a request from the Secretary of Energy, considered the need for ISO/RTO-level reforms to support so-called "resilience resources" that have a ninety-day fuel supply on-site. Concluding that a legal basis for such reforms was missing, FERC terminated the proceeding on January 8, 2018. FERC noted, however, that resilience "warrants further attention" and therefore opened another proceeding "to explore resilience issues in the RTOs/ISOs" (resilience proceeding).[3]

For the purposes of the resilience proceeding, FERC proposes to define "resilience" as "[t]he ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event."[4] Notably, resilience is distinct from reliability. In the short term, reliability is defined as the frequency and duration of outages due to "high frequency, low impact" events experienced in a given service territory[5] and, in the long-term, as the adequacy of energy supply vis-à-vis load in

[1] *Grid Resiliency Pricing Rule*, 82 Fed. Reg. 46,940 (Oct. 10, 2017).

[2] FERC, *Regional Transmission Organizations (RTO)/Independent System Operators (ISO)*, https://perma.cc/EVQ6-TZFJ (updated Dec. 21, 2017). FERC does not regulate the Electric Reliability Council of Texas. See FERC, *ERCOT*, https://perma.cc/84GU-5W2P (updated Nov. 17, 2017).

[3] Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures, 162 FERC ¶ 61,012, P 10 (2018). It is possible, though not certain, that the current phase of the proceeding will result in FERC calling for a full technical conference to address one or more sources of risk to BPS resilience.

[4] *Id.* at P 13 (citing the National Infrastructure Advisory Council's 2009 Critical Infrastructure Resilience Final Report and Recommendations at 8).

[5] Examples of short-term reliability metrics include: System Average Interruption Frequency Index (SAIFI), which captures the ratio of sustained outages over a year to the number of customers served (including both affected and unaffected customers); System Average Interruption Duration Index (SAIDI), is similar, and is often expressed as "consumer minutes" or "hours" to convey the average annual outage duration per consumer in a given service territory; and Consumer Average Interruption Frequency Index (CAIFI), which

that territory.[6] Resilience, by contrast, is concerned with preparation for, responses to, and recovery from less predictable "high impact, low frequency events."[7]

The order convening the resilience proceeding noted that FERC has already examined and addressed several types of risks to BPS reliability, both directly and via the North American Electric Reliability Corporation (NERC)'s development of reliability standards.[8] According to FERC, "[w]hile none of the Commission's efforts . . . were specifically targeted at 'resilience' by name, they were directed at elements of resilience, in that they sought to ensure the uninterrupted supply of electricity in the face of fuel disruptions" or other risks.[9] Risks addressed in a systematic fashion include "fuel assurance," "fuel supply issues during periods of system stress" (including due to extreme weather events), and "cybersecurity and physical security threats, as well as geomagnetic disturbances."[10] Missing from this list are risks arising from the effects of climate

captures the ratio of sustained outages over a year to the number of customers affected by those outages. NATIONAL ACADEMY OF SCIENCES, ENHANCING THE RESILIENCE OF THE NATION'S ELECTRICITY SYSTEM 13 (Apr. 2017).

[6] NORTH AMERICAN ELECTRICITY RELIABILITY CORPORATION (NERC), 2016 LONG-TERM RELIABILITY ASSESSMENT (2016) ("NERC's primary objective with the [Long-Term Reliability Assessment] is to assess resource and transmission adequacy across the NERC footprint, and to assess emerging issues that have an impact on BPS reliability over the next ten years.").

[7] Mathaios Panteli & Pierluigi Mancarella, *The Grid: Stronger, Bigger, Smarter?*, IEEE POWER ENERGY MAG., May/June 2015, at 58 (describing key parameters of resilience in electricity systems).

[8] Section 215 of the Federal Power Act, which became law in 2005, invites FERC to certify as the Electricity Reliability Organization (ERO) an entity able "to develop and enforce . . . reliability standards that provide for an adequate level of reliability of the bulk-power system" in an objective and procedurally sound manner. *See* Federal Power Act § 215(c)(1), *codified at* 16 U.S.C. § 824o; Energy Policy Act of 2005, Pub. L. 109–58, § 1211(a), 119 Stat. 941 (Aug. 8, 2005). FERC certified the North American Electric Reliability Council (NERC) as the ERO in 2006 (since 2007, the "C" has stood for "Corporation"). *See* 116 FERC ¶ 61,062 (2006). NERC's standards have been legally enforceable since 2007. *See* Mandatory Reliability Standards for the Bulk Power System, Order No. 693, 72 Fed. Reg. 16,416 (April 4, 2007), FERC Stats. & Regs. ¶ 31,242 (2007), *order on reh'g*, Order No. 693-A, 120 FERC ¶ 61,053 (2007).

[9] *Id.* at 7.

[10] *Id.* at 5–7. The Order cites the following past orders to illustrate and support these points: Centralized Capacity Markets in Regional Transmission Organizations and Independent System Operators, 149 FERC ¶ 61,145 (2014) (order addressing technical conferences on, among other things, the 2014 Polar Vortex); ISO New England Inc. and New England Power Pool, 147 FERC ¶ 61,172 (2014), *reh'g denied*, 153 FERC ¶ 61,223 (2015), *appeal pending sub nom.*, New England Power Generators Ass'n v. FERC, No. 16-1023 (D.C. Cir. filed Jan. 19, 2016); PJM Interconnection, L.L.C., 151 FERC ¶ 61,208 (2015), *reh'g denied*, 155 FERC ¶ 61,157 (2016), *aff'd sub nom.*, Advanced Energy Mgmt. All. v. FERC, 860 F.3d 656 (D.C. Cir. 2017); Physical Security Reliability Standard, Order No. 802, 149 FERC ¶ 61,140 (2014); Revised Critical Infrastructure Protection Reliability Standards, Order No. 822, 154 FERC ¶ 61,037 (2016), *reh'g denied*, Order No. 822-A, 156 FERC ¶

change. To the extent that FERC, NERC, or individual ISO/RTOs have examined such risks, that examination has been piecemeal, and has at no point taken into account downscaled climate projections[11] for the coming years and decades.

This paper argues that such an approach is inadequate to ensure the long-term resilience of the BPS to climate change. That inadequacy is legal as well as practical. The Federal Power Act (FPA) requires FERC to ensure the BPS operates in a manner that yields reliable electricity services at rates that are just, reasonable, and not unduly discriminatory or preferential.[12] To meet that requirement, FERC relies on market mechanisms, reasoning that they "provide correct incentives for [participants] to . . . make efficient investments in facilities and equipment."[13] However, FERC has recognized that, for markets to provide "correct" investment incentives, they must account for differences in the risk profiles of BPS facilities.[14] At present, because neither FERC nor the ISO/RTOs have conducted a comprehensive assessment of climate risks to BPS facilities, it is unclear whether those risks are duly unaccounted for.

While various facility owners have identified climate change as a source of material physical risk to their operations,[15] no one has sought to map such risks systematically at the ISO/RTO level. This paper argues that such mapping is an essential first step toward ensuring that, as the climate changes, the BPS continues to deliver reliable electricity services at just and reasonable rates. The rest of the paper proceeds in three sections. Section 2 briefly describes key

61,052 (2016); Revised Critical Infrastructure Protection Reliability Standards, Order No. 829, 156 FERC ¶ 61,050 (2016); Cyber Systems in Control Centers, Notice of Inquiry, FERC Stats. & Regs. ¶ 35,557 (2016); Revised Critical Infrastructure Protection Reliability Standards CIP-003-7 – Cyber Security – Security Management Controls, Notice of Proposed Rulemaking, 161 FERC ¶ 61,047 (2017); Reliability Standard for Transmission System Planned Performance for Geomagnetic Disturbance Events, Order No. 830, 156 FERC ¶ 61,215 (2016).

[11] Downscaled projections identify likely future changes in climate-driven extreme weather and other phenomenon at local scales.

[12] 16 U.S.C. §§ 824d(a)-(b) & 824o.

[13] Price Formation in Energy and Ancillary Services Markets Operated by Regional Transmission Organizations and Independent System Operators; Notice Inviting Post-Technical Workshop Comments, 80 Fed. Reg. 3,580 (Jan. 23, 2015).

[14] *See generally* P.J.M Interconnection, L.L.C., 151 FERC ¶ 61,208 (2015), *order on reh'g*, 155 FERC ¶ 61,157 (2016).

[15] *See e.g.*, NextEra Energy, Inc., Florida Power & Light Co., Annual Report (Form 10-K) 26 (Feb. 23, 2017); Consolidated Edison Company of New York, Inc., Annual Report (Form 10-K) 32 (Dec. 31, 2016); American Electric Power Company, Inc., Annual Report (Form 10-K) 41–42 (Dec. 31, 2016).

risks climate change poses for the BPS. Section 3 identifies processes and resources that can be employed to assess the BPS's vulnerability to climate change and plan for climate resilience. Section 4 contains recommendations for conducting vulnerability assessments and developing resilience plans.

2. CLIMATE CHANGE AND THE BULK POWER SYSTEM

Since the start of the 19th century, annual average temperatures in the contiguous U.S. have increased by up to 1.8°F (1.0°C), with two-thirds of this increase occurring in the last two decades.[16] Those decades also saw a marked rise in the frequency and intensity of heat waves[17] and other extremes, including droughts, floods, and storms,[18] as well as climate-related environmental changes such as sea level rise.[19] Conditions are expected to worsen in coming years as temperatures continue to increase, leading to significant and widespread adverse impacts, including on the BPS and the systems, communities, and individuals that rely on it.

Numerous sources—including reports of national laboratories,[20] federal agencies,[21] state agencies,[22] privately-sponsored researchers,[23] and international organizations,[24] corporate filings

[16] R.S. Vose et al., *Temperature Changes in the United States*, *in* CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT 185, 186 (D.J. Wuebbles et al. eds., 2017), https://perma.cc/TD85-T3H8.
[17] *Id*. at 191-192.
[18] M.F. Wehner et al., *Droughts, Floods, and Wildfires, in* CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT 231, 231 (D.J. Wuebbles et al. eds., 2017), https://perma.cc/TD85-T3H8.
[19] W.V. Sweet et al., *Sea Level Rise*, *in* CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT 333, 333 (D.J. Wuebbles et al. eds., 2017), https://perma.cc/TD85-T3H8.
[20] *See e.g.*, BENJAMIN L. PRESTON ET AL., RESILIENCE OF THE U.S. ELECTRICITY SYSTEM: A MULTI-HAZARD PERSPECTIVE (2016), https://perma.cc/9G93-P824.
[21] *See e.g.*, U.S. DEPT. OF ENERGY, CLIMATE CHANGE & THE ELECTRICITY SECTOR: GUIDE FOR CLIMATE CHANGE RESILIENCE PLANNING (2016), https://perma.cc/4WHR-EDFJ [hereinafter 2016 DOE Report]; U.S. DEPT. OF ENERGY, U.S. ENERGY SECTOR VULNERABILITIES TO CLIMATE CHANGE & EXTREME WEATHER (2013), https://perma.cc/9N8H-VM6S [hereinafter 2013 DOE Report]; ELECTRIC POWER RESEARCH INSTITUTE, POTENTIAL IMPACT OF CLIMATE CHANGE ON NATURAL RESOURCES IN THE TENNESSEE VALLEY AUTHORITY REGION (Nov. 2009), https://perma.cc/6YXR-QPBG.
[22] *See e.g.*, JAYANT SATHAYE ET AL., ESTIMATING RISK TO CALIFORNIA ENERGY INFRASTRUCTURE FROM PROJECTED CLIMATE CHANGE (2012), https://perma.cc/2ANF-S8ZV.
[23] *See e.g.*, EDWARD VINE, PUBLIC POLICY INSTITUTE OF CALIFORNIA, ADAPTATION OF CALIFORNIA'S ELECTRICITY SECTOR TO CLIMATE CHANGE (2008), https://perma.cc/5N2N-667Q.
[24] *See e.g.*, INTERNATIONAL ENERGY AGENCY, MAKING THE ENERGY SECTOR MORE RESILIENT TO CLIMATE CHANGE (2015), https://perma.cc/5WSM-J45P.

with the U.S. Securities and Exchange Commission,[25] and utilities' climate change vulnerability assessments and adaptation plans,[26] have identified the effects of climate change as sources of material physical risk for the generation and transmission segments of the BPS. The nature and extent of risks to generation and transmission will vary across regions because, though the global climate is generally growing warmer and stormier, regional climates will experience these and other phenomenon to varying degrees,[27] and also because different regions rely on different types of generation and differently situated transmission facilities. However, according to a 2015 Department of Energy (DOE) report, which mapped climate impacts on different parts of the U.S. energy sector, no region will go unscathed (see Figure 1).[28] Thus, ISO/RTOs in all regions should be planning for the effects of higher temperatures, heat waves, and more intense storms, which will be felt nationwide, as well as for regional effects, such as sea level rise along the coasts, wildfires in the West, drought in the Southwest and California, and more frequent and intense precipitation in the Northeast.[29]

[25] *See e.g.,* the 10-Ks listed *supra*, in note 15.
[26] TENNESSEE VALLEY AUTHORITY, CLIMATE CHANGE ADAPTATION PLAN—2016 UPDATE (June 2016), https://perma.cc/AQ82-M736; CRYSTAL RAYMOND, SEATTLE CITY LIGHT CLIMATE CHANGE VULNERABILITY ASSESSMENT AND ADAPTATION PLAN (2015), https://perma.cc/GBT2-2UV8.
[27] *See generally* CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 370–618 (J.M. Melillo et al., eds., U.S. Global Change Research Program 2014) [hereinafter 3rd NCA].
[28] U.S. DEP'T OF ENERGY, CLIMATE CHANGE AND THE U.S. ENERGY SECTOR: REGIONAL VULNERABILITIES AND RESILIENCE SOLUTIONS (2015), https://perma.cc/3WQC-5JYV.
[29] These effects are described thoroughly in chapters 16 to 25 of the 3rd NCA, *supra* note 27.

Figure 1: DOE Map of Climate Impacts on the U.S. Energy Sector [30]

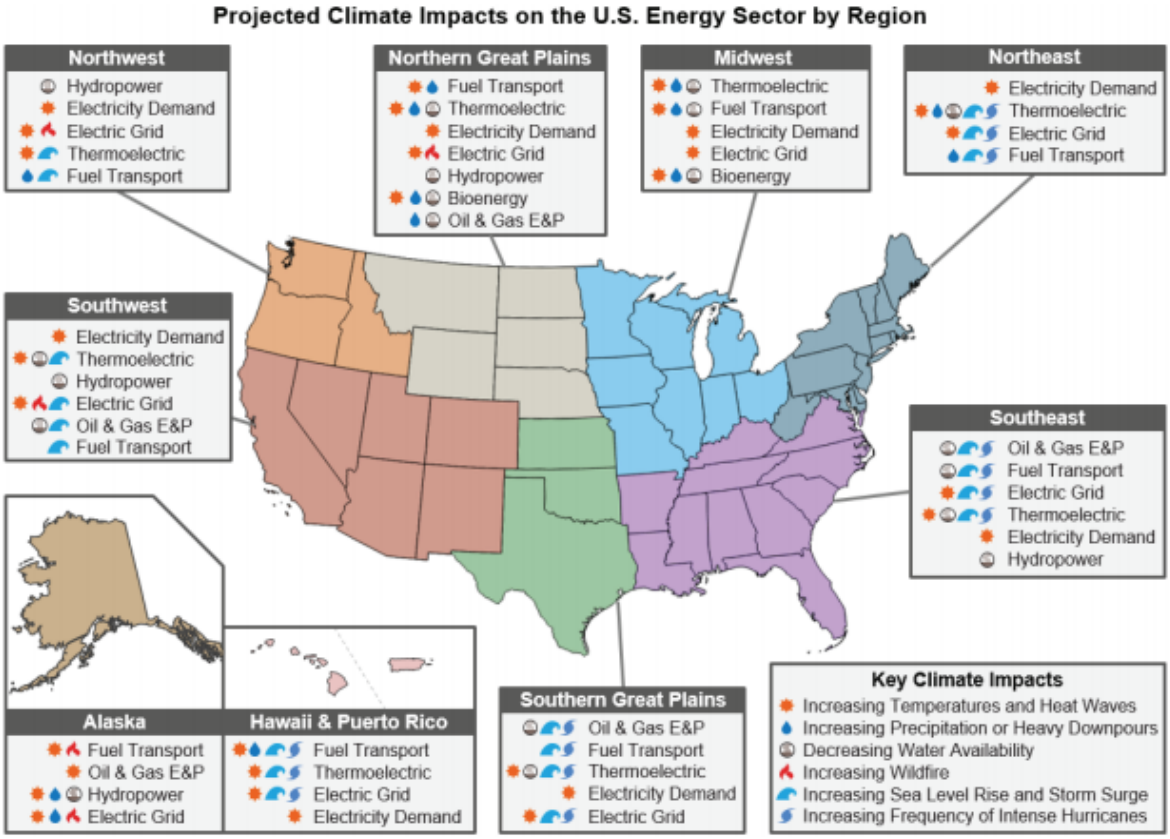

Figure ES-1. Potential climate change impacts on the U.S. energy infrastructure vary by region. Energy subsectors considered most vulnerable to projected climate impacts are listed first for each region.[1]

[1] "Thermoelectric" generally refers to power plants that use a steam turbine to generate electricity. Examples of thermoelectric power plant fuel sources include coal, natural gas, oil, nuclear, biomass, geothermal, and concentrated solar power. "Oil & Gas E&P" refers to upstream oil and gas operations, primarily exploration and production (E&P). "Fuel Transport" refers to movements of energy resources by rail, truck, marine vessel, and pipeline, and it includes associated facilities such as ports, pumping stations, terminals, and storage facilities. Hurricane impacts in Hawaii refer to a projected increase in the frequency of all hurricanes striking the islands, not just intense hurricanes; see Chapter 10 for specific projections. The order of subsector vulnerabilities shown in the figure is based on judgments by the report authors as well as experts from government agencies, national laboratories, and private sector energy companies.

A table summarizing the likely effects of various climatic changes on electricity generation and transmission facilities in each ISO/RTO region is included as Appendix A to this paper. Additional information regarding the effects is provided in this section. While the section discusses each climatic change separately, many will occur in parallel, and thus have compounding effects. Parts of the northeastern U.S., for instance, will simultaneously experience higher temperatures and sea level rise, both of which will adversely affect generation. Similarly, in the West, transmission will be simultaneously affected by higher temperatures and more extreme wildfires. In both areas, interdependencies between generation and transmission facilities and, more

[30] U.S. Dep't of Energy, *supra* note 28, at i.

generally, between the bulk and retail electricity systems may lead to further compounding of effects.[31]

2.1 Climate Change Impacts on Generating Facilities

Climate change will have profound impacts on electricity generation in the U.S., disrupting operations at many facilities, and forcing some to curtail output or entirely shutdown. The likely extent of these and other impacts, under various climate change scenarios, has been explored in a number of studies, the key findings of which are summarized below.

Increasing air temperatures: The Fourth National Climate Assessment, published in November 2017, forecasts that annual average temperatures in the contiguous U.S. will rise by at least 2.5°F (1.4°C) between 2021 and 2050.[32] Rising temperatures lower the efficiency of thermoelectric generating facilities, including nuclear and fossil fuel plants equipped with steam turbines, for at least three reasons. At higher temperatures:

1. the air mass of the turbine for a given volume intake is lower (i.e., as warmer air is less dense) ;
2. the pressure ratio within the turbine is lower, which reduces mass flow; and
3. the specific volume of air is higher, resulting in more power being consumed by the turbine during compression.[33]

The degree of efficiency reductions will depend on, among other things, the design of the generating facility and the fuel used. As an example, most natural gas facilities are designed to operate at 59°F (15°C), and may experience efficiency reductions of up to 1% for each 1.8°F (1°C) increase in temperatures above that level.[34] While this may sound small, when extended regionally, the impact on generator efficiency would be significant, particularly during heat waves. Research

[31] *See supra* subpart 2.3.
[32] Vose et al., *supra* note 16, at 195.
[33] Sathaye et al., *supra* note 22, at 12.
[34] *Id*. at 13 (citing previous studies finding that, for each 1.0oC increase in temperatures above 15°C, the capacity of combined-cycle gas power plants may fall by 0.3-0.5% (if equipped with wet cooling) or up to 0.7% (if equipped with dry cooling) and indicating that, as "simple-cycle gas units . . . have been shown to be more sensitive to ambient temperature relative to combined-cycle units," the capacity of those units is assumed to "decrease by 1.0 percent per degree Celsius above 15°C"). *See also* 2013 DOE Report, *supra* note 21, at 10 (noting that "the power output of natural gas-fired combustion turbines . . . is estimated to decrease by approximately 0.6%-0.7% for a 1.8°F (1°C) increase in air temperature," while "[f]or combined cycle plants, output can decrease by approximately 0.3%-0.5%").

undertaken by the Lawrence Berkeley National Laboratory (LBNL), focusing on gas-fired generation in California, indicates that electricity losses on hot days could reach 10.3 gigawatts (GW) by 2100 or 23.4% of total current gas-fired capacity.[35] Electricity load on hot days is also projected to increase,[36] and with it the height of peak load, leading to an expected shortfall in peak generating capacity of over 35%.[37]

Increasing water temperatures: Generation shortfalls can also occur due to high water temperatures. Thermoelectric power plants generally require low-temperature water for cooling, using it to condense steam that has passed over the turbine, and thereby create a vacuum to draw more steam in.[38] Increased water temperatures reduce the effectiveness of this process, leading to turbine backpressure which lowers plant output.[39] Some nuclear plants, for example, could see declines in electricity output of 0.5% for each 1.8°F (1°C) increase in water temperatures.[40] In cases where water temperatures exceed technical specifications, plants may be forced to curtail output by larger amounts or entirely shutdown. This occurred in Connecticut in 2012, when the Millstone nuclear plant shut down after a heat wave caused cooling water temperatures to rise above the maximum allowed under its permit from the Nuclear Regulatory Commission.[41] Also in 2012, a heat wave in Illinois affected operations at several nuclear and coal plants, causing them to exceed

[35] Sathaye et al., *supra* note 22, at 18. This represents a 6.2 percent increase in the maximum peak capacity loss compared to the period from 1961 to 1990. *Id*.

[36] *Id*. at 35 (indicating that, in California, "per-capita peak loads are projected to increase between 10 percent and 20 percent at the end of the century due to the effects of climate change on summer weekday afternoon temperatures").

[37] *Id*. at 38.

[38] Some thermoelectric generating plants are equipped with "dry cooling" systems which use ambient air to cool the steam and condense it back to water. *See* STEVE FLEISCHLI & BECKY HAYAT, POWER PLANT COOLING AND ASSOCIATED IMPACTS: THE NEED TO MODERNIZE U.S. POWER PLANTS & PROTECT OUR WATER RESOURCES & AQUATIC ECOSYSTEMS 3 (2014), https://perma.cc/DUF4-4H9Z.

[39] 2013 DOE Report, *supra* note 21, at 10 (indicating that "[i]ncreases in . . . cooling water temperatures will increase steam condensate temperatures and turbine backpressure, reducing power generation efficiency").

[40] Ahmet Durmayaz & Oguz Salim Sogut, *Influence of Cooling Water Temperature on the Efficiency of a Pressurized-Water Reactor Nuclear Power Plant*, 30 INTL. J. OF ENERGY RESEARCH 799 (2006).

[41] Matthew L. Wald, *Heat Shuts Down a Coastal Reactor*, N.Y. TIMES (Aug. 13, 2012), https://perma.cc/XE3C-8AH7 (reporting that the shutdown occurred after water temperatures in Long Island Sound reached 76.7°F. Under Millstone nuclear plant's operating permit, the cooling water it extracts can be no warmer than 75°F).

thermal limits[42] for cooling water discharges.[43]

Declining water availability: Many thermoelectric and other generating facilities, particularly in the West and South, will also be affected by droughts, which may become more frequent and severe due to climate change.[44] This will reduce the availability of cooling water for thermoelectric generating facilities, potentially forcing them to curtail or shut down operations. According to a recent DOE study, under extreme drought conditions on par with those experienced during the U.S. "dust bowl" of the 1930s, thermoelectric generation in the Southwest could decline by up to 20%.[45] The study also predicted declines of almost 60% in the region's hydroelectric generation under extreme drought conditions.[46] California has already experienced double-digit reductions in hydroelectric generating capacity, for example, in 2014, when persistent drought caused it to fall to just 58% of the ten-year average.[47]

Changing precipitation patterns: Hydroelectric and some thermal generating facilities will also be affected by other changes in precipitation, including shifts to more precipitation falling as rain rather than snow.[48] This will increase runoff during winter months, overloading hydroelectric reservoir capacity, and leading to the loss of energy normally available later in the year.[49] Similar losses may also occur as a result of earlier and more rapid thawing of the snowpack due to higher temperatures.[50] In both cases, stream flows throughout the year will be lower, reducing the

[42] Thermal limits have been established for cooling water discharged back into the environment (i.e., following use) to protect aquatic ecosystems. *See* R. SKAGGS ET AL., CLIMATE AND ENERGY-WATER-LAND SYSTEM INTERACTIONS 2.14-2.15 (2012), https://perma.cc/969B-RAUS.
[43] Matthew L. Wald, *So, How Hot Was It?* N.Y. TIMES (Jul. 17. 2012), https://perma.cc/TNK3-CMAP.
[44] D.J. Wuebbles et al., *Executive Summary, in* CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT 10, 11 (D.J. Wuebbles et al. eds., 2017), https://perma.cc/TD85-T3H8.
[45] ARGONNE NATIONAL LABORATORY, IMPACTS OF LONG-TERM DROUGHT ON POWER SYSTEMS IN SOUTH WEST 10, 37 (2012), https://perma.cc/7EKU-2Z3C (defining the "southwest" region to encompass Arizona, California, Colorado, New Mexico, Nevada, Texas, and Utah).
[46] *Id*.
[47] Preston et al., *supra* note 20, at 13.
[48] Wuebbles et al., *supra* note 44, at 22 (projecting "shifts to more precipitation falling as rain than snow in the cold season in many parts of the central and eastern United States").
[49] Preston et al., *supra* note 20, at 13.
[50] *Id*. *See also* Wuebbles et al., *supra* note 44, at 21 (indicating that "[t]here has been a trend toward earlier snowmelt" and noting that this trend is expected to continue).

efficiency of hydroelectric generating facilities by reducing the pressure that drives their turbines.[51] Intense deluges, like the one that accompanied Hurricane Harvey in 2017, have also saturated coal piles, preventing their use as an energy source.[52]

Storms and flooding: All electricity generating facilities, regardless of type or location, will be impacted by future storms which are expected to become more intense due to climate change.[53] More intense rainstorms will contribute to inland flooding which can prevent the operation of generating facilities, as seen in Nebraska in mid-2011, when floodwaters surrounded the Fort Calhoun nuclear plant and prevented it returning to service after an earlier routine shutdown.[54] Similar issues have also occurred at coastal facilities due to hurricanes and associated storm surge—e.g., in New York during Hurricane Sandy[55]—with this situation expected to worsen in the future due to rising sea levels. Research by the National Laboratories suggests that, by 2050, sea level rise could increase the number of generating facilities exposed to inundation from storm surge during a weak (category 1) hurricane by 40%.[56] Many facilities could also be inundated by sunny-day or "nuisance" flooding caused solely by sea level rise—a recent DOE study of just four coastal cities (Houston, Los Angeles, New York, and Miami) identified up to 315 energy facilities that could be affected by 2100.[57]

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[51] 2013 DOE Report, *supra* note 21, at 26. *See also* U.S. Dept. of Energy & U.S. Dept. of Homeland Security, Dams & Energy Sectors Interdependency Study 24 (2011), https://perma.cc/9PB7-QFHR (indicating that "[f]or every foot of elevation lost in Lake Mead, Hoover Dam produces 5.7 MW less power").

[52] *Harvey's rain caused coal-to-gas switching: NRG Energy*, PLATTS, Sept. 27, 2017.

[53] *See e.g.*, Wuebbles et al., *supra* note 44, at 21 (noting that "[t]he frequency and intensity of heavy precipitation events in the United States are projected to continue to increase over the 21st century").

[54] The Fort Calhoun plant was shut-down prior to the flooding for refueling. The plant's return to service was delayed for several months due to persistent flood waters. *See* A.G. Sulzberger & Matthew L. Wald, *Flooding Brings Worries Over Two Nuclear Plants*, N.Y. TIMES, Jun. 20, 2011, http://www.nytimes.com/2011/06/21/us/21flood.html.

[55] Steven Mufson, *3 Nuclear Power Reactors Shut Down During Hurricane Sandy*, WASH. POST, Oct. 30, 2012, https://perma.cc/BTX9-FDLF (noting that "[t]hree nuclear power reactors were shut down because of electricity issues during Hurricane Sandy, while a fourth plant, Oyster Creek in New Jersey, remains in "alert" mode because of high water levels in its water intake structure").

[56] JAMES BRADBURY ET AL., CLIMATE CHANGE & ENERGY INFRASTRUCTURE EXPOSURE TO STORM SURGE & SEA-LEVEL RISE 11 (2015), https://perma.cc/3WKY-CVY9.

[57] U.S. DEPT. OF ENERGY, EFFECT OF SEA LEVEL RISE ON ENERGY INFRASTRUCTURE IN FOUR MAJOR METROPOLITAN AREAS 13 (2014), https://perma.cc/D23E-768D (predicting that, in Houston, 16 energy facilities could be inundated by 2050 and 67 by 2100. In Los Angeles, 11 facilities could be inundated by 2050

2.2 Climate Change Impacts on Transmission Facilities

Climate change will also have impacts on electricity transmission facilities and operations, though uncertainty remains as to the precise nature and extent of those impacts. The current state of knowledge, based on research to date, is summarized below.[58]

Increasing air temperatures: Higher ambient air temperatures, particularly when accompanied by higher humidity, increase transmission line resistance, which lowers the line's carrying capacity and increases the fraction of electricity lost rather than transmitted.[59] The impacts are likely to be particularly severe during future summer heat waves, when already high temperatures rise by large amounts over short periods.[60] NREL estimates that the 9°F (5°C) increase in summer temperatures expected in parts of California by 2100 could reduce transmission capacity by 7% to 8%.[61] Increasing temperatures will also reduce the useful life of some transmission equipment,[62] and cause lines to expand and sag, potentially resulting in them coming into more frequent contact with trees.[63] Furthermore, higher night-time temperatures (which have risen faster than day-time temperatures) will reduce or eliminate opportunities for transmission lines and equipment to cool.[64]

More frequent wildfires: Transmission facilities are also affected by wildfires which, due to

and 29 by 2100. In Miami, one facility could be inundated by 2050, and 49 by 2100. In New York, 17 facilities could be inundated by 2050 and 170 by 2100.)

[58] The authors are aware of conferences led by the Electric Power Research Institute (EPRI) and of EPRI-authored research focused on this subject area. *See, e.g.*, EPRI, How the Transmission Resiliency Research Fits Together (Dec. 2015); EPRI, Proceedings of EPRI/NATF 2014 Resiliency Summit (Dec. 2014); EPRI, Proceedings of the Industry Summit on Transmission System Resiliency to Severe Natural Events (June 2013). However, the results of such efforts sit behind very high paywalls and so are not publicly available. They also seem not to have prompted the sort of assessments we call for in this paper, nor to have put to rest the need for such assessments.

[59] Sathaye et al., *supra* note 22, at 25. See also Preston et al., *supra* note [20], at 16.

[60] Studies suggest that the impact of smaller temperature increases, occurring gradually over time, are likely to prove easier to manage. *See e.g.*, EDWARD VINE, ADAPTATION OF CALIFORNIA'S ELECTRICITY SECTOR TO CLIMATE CHANGE 10 (2008), https://perma.cc/JV3M-LMJF.

[61] Sathaye et al., *supra* note 22, at 27.

[62] 2016 DOE Report, *supra* note 21, at 10.

[63] 2013 DOE Report, *supra* note 21, at 13.

[64] *Id.* at 12.

higher temperatures and drought conditions, are expected to become more frequent and intense.[65] Wildfires can damage or destroy wooden transmission poles, and the associated soot and smoke can affect the operation of lines, causing leakage currents[66] and arcing.[67] Grid operation can also be affected by certain firefighting practices, including the use of fire retardants that foul lines.[68] While grid operators have traditionally been able to manage these impacts due to the redundancy built into the transmission system, management is likely to become increasingly difficult as more frequent, longer, and more severe wildfires threaten more facilities.[69] This will be a particular problem in California, where almost all transmission facilities are expected to face increased wildfire risk by 2100, in some cases by 45% annually.[70]

Storms and flooding: Storm-related transmission disruptions could also increase in the future as extreme weather events become more frequent and severe due to climate change.[71] Transmission facilities in some areas—e.g., the Midwest and Northeast—could be affected by more intense winter storms that cause ice to accumulate on lines and equipment, and thereby cause mechanical problems.[72] Transmission lines may also be damaged by trees felled by accumulated ice or uprooted during hurricanes.[73] Hurricane-related flooding is another problem, as seen in Texas in 2017, when floodwaters from Hurricane Harvey inundated a number of transmission substations, leading to outages.[74] In total, Harvey-related flooding and winds caused widespread high-voltage

[65] Wehner et al., *supra* note 18, at 249 (finding that "[t]he incidence of large forest fires in the western United States and Alaska has increased since the early 1980s . . . and is projected to further increase in those regions").
[66] Leakage currents may occur where particulate matter in soot accumulates on insulators. *See* Sathaye et al., *supra* note 22, at 40 (noting that "the insulators that attach the lines to the towers can accumulate soot, creating a conductive path and causing leakage currents").
[67] Arcing may occur where ionized air in smoke acts as a conductor. *See Id*. (finding that "[i]onized air in smoke can act as a conductor, causing arcing; either between lines, or between lines and the ground").
[68] *Id*.
[69] *Id*.
[70] *Id*. at 42 –45.
[71] J.P. Kossin et al., *Extreme Storms, in* CLIMATE SCIENCE SPECIAL REPORT: FOURTH NATIONAL CLIMATE ASSESSMENT 257, 257 (D.J. Wuebbles et al. eds., 2017), https://perma.cc/TD85-T3H8.
[72] Hyde M. Merrill & James W. Feltes, *Transmission Icing: A Physical Risk with a Physical Hedge*, POWER ENGINEERING SOCIETY GENERAL MEETING 1 (2006). *See also* Preston et al., *supra* note [20], at 16.
[73] *Id*. at 10 & 16.
[74] Kenny Mercado, CenterPoint Energy's Response to Hurricane Harvey, Presentation to ERCOT Board of Directors (Oct. 17, 2017), https://perma.cc/5KCJ-V2VK.

transmission outages, including on six 345 kilovolt (kV) lines and more than 200 69 to 138 kV lines.[75]

2.3 Interrelated Impacts on Facilities and Load

The sections above identify various ways in which higher temperatures and other climatic changes could disrupt the operation of generation and transmission facilities. These disruptions would occur alongside higher peaks in electricity load—potentially high enough to strain transmission and generation facilities' capacities.[76] PJM experienced an instance of this in 1999, when a heat wave caused load to exceed projections by 10% and several transmission problems followed, including transformer failures and—as a result of an increase in imported energy—a depression in voltage.[77]

These strains create a pincer effect: higher load peaks amid higher temperatures increase the likelihood of bumping into technical and operational limits on the supply side, at the same time as higher temperatures also tighten those limits by reducing the efficiency and capacities of transmission and generation facilities.[78] Therefore, to usefully capture the full range of scenarios that BPS facilities can expect to face, ISO/RTOs must consider potentially synergistic combinations of coincident changes in operationally important factors. The California Energy Commission,[79] for one, seeks to do this by identifying what it calls "climate parameters" and incorporating those parameters into relevant design specifications and planning criteria.[80]

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[75] U.S. Energy Information Administration, *Hurricane Harvey Caused Electric System Outages & Affected Wind Generation in Texas*, TODAY IN ENERGY (Sep. 13, 2017), https://perma.cc/P7T3-QXMN.

[76] EPRI, Temperature Impacts on Electricity Demand for Cooling in New York State; 2017 Technical Update 3-2 l – 3-5 (Sept. 2017); Matthew Bartos et al., *Impacts of rising air temperatures on electric transmission ampacity and peak electricity load in the United States*, 11 ENVTL. RES. LETTERS 114008, 1 (Nov. 2016).

[77] EPRI, JOINT TECHNICAL SUMMIT ON RELIABILITY IMPACTS OF EXTREME WEATHER AND CLIMATE CHANGE 3-1 – 3-5 (2008), https://perma.cc/6FNY-8WYN.

[78] JAMES MCCALL ET AL., NAT'L RENEWABLE ENERGY LAB'Y, WATER-RELATED POWER PLANT CURTAILMENTS: AN OVERVIEW OF INCIDENTS AND CONTRIBUTING FACTORS (2016), https://perma.cc/9TXQ-VH9G (reporting 43 curtailments due to higher water temperatures).

[79] The California Energy Commission, formerly the Energy Resources Conservation and Development Commission, is the state's energy policy and planning agency, not to be confused with the California Public Utility Commission.

[80] Guido Franco, Cal. Energy Comm'n, Climate Parameters for the Energy System, 2017 IEPR Joint Agency Workshop: Climate Adaptation and Resilience for the Energy System, Sacramento, Aug. 29, 2017, https://perma.cc/JNK8-JQKB.

3. PLANNING FOR THE IMPACTS OF CLIMATE CHANGE

Given the potential for higher temperatures, more intense storms, and other climate-driven phenomenon to disrupt operation of the BPS, FERC and ISO/RTOs' resilience planning efforts must recognize and account for the present and foreseeable future effects of climate change. Ignoring rather than assessing those effects would invite a circumstance in which the BPS may be unable to deliver reliable electricity services at just and reasonable rates as required by the FPA. To explain, under the FPA, FERC must ensure that rates for the interstate[81] transmission and wholesale sale[82] of electricity are just and reasonable and not unduly discriminatory or preferential, and that the BPS operates reliably.[83] To that end, ISO/RTOs under FERC's jurisdiction operate markets, which are intended to encourage the development of plentiful electricity supplies at low prices.[84] Both ISO/RTOs and FERC have recognized that, to achieve these goals, markets must be designed so as to incentivize investment in new facilities capable of reliably delivering electricity.

This was the motivation behind recent reforms to the capacity market operated by PJM Interconnection, L.L.C. (PJM).[85] PJM argued, and FERC accepted, that its pre-existing capacity market design failed to ensure the delivery of electricity during extreme weather and other emergencies.[86] To address this issue, PJM proposed market changes, which would have the effect of increasing the compensation paid to facilities that reliably delivered electricity during emergencies.[87] In approving the proposal, FERC emphasized that it would "incentivize existing reliable resources to stay in the market, while facilitating the entry of new reliable resources to displace less reliable ones."[88]

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[81] For the purposes of the FPA, the transmission and sale of electricity is "interstate" whenever electric energy moves from the buyer to the seller via an interstate transmission grid, such as the eastern or western interconnect. *See* Fed. Power Comm'n v. Florida Power & Light Co. 404 U.S. 452 (1972).

[82] Under the FPA, "sales at wholesale are defined to mean sales to any person for resale. *See* 16 U.S.C. § 824(d).

[83] 16 U.S.C. §§ 824d(a)-(b) & 824o.

[84] FERC, *Electricity Markets: National Overview* (last updated Apr. 13, 2017), https://perma.cc/PJX9-2A8X . *See also* FERC v. Electric Power Supply Association 136 S. Ct. 760 (2015).

[85] PJM operates the BPS in Delaware, Maryland, New Jersey, Pennsylvania, Virginia, the District of Columbia, and parts of Illinois, Michigan, North Carolina, Ohio, Tennessee, and West Virginia

[86] P.J.M Interconnection, L.L.C., 151 FERC ¶ 61,208 (2015), *order on reh'g*, 155 FERC ¶ 61,157 (2016).

[87] *Id*.

[88] *Id*.

FERC's reasoning in the PJM case suggests that, to provide appropriate incentives for investment, markets must account for differences in the risk profiles of BPS facilities.[89] This can only occur if there is a thorough mapping of risks which, to our knowledge, has not yet occurred in the context of climate change. While a number of BPS facility owners have identified climate change as a source of material physical risk to their operations,[90] there has been no comprehensive assessment of such risks at the ISO/RTO level.[91] Rather, to the extent that any assessments have occurred, they have generally been partial and piecemeal.

A prime example is ISO-New England[92] (ISO-NE)'s 2017 Regional System Plan, which identifies resource and transmission facilities needed to maintain BPS reliability over the next ten years.[93] The plan assumes, for the purposes of projecting peak loads, that summer temperatures will increase as they have done in the recent past, but does *not* consider the implications of summer heat for transmission facility efficiency or lifespan.[94] Thus, even though ISO-NE is assuming that increasing levels of summer heat will drive load and load peaks higher, as the Department of Homeland Security observed in 2016, it "is not addressing climate change in its planning activities to determine the grid enhancement requirements necessary to meet future demand given projected temperature increases."[95] ISO-NE's planning is often based on historic trends which, given the existence of climate change, are not a good proxy for future conditions. In particular, ISO-NE's annual Capacity, Energy, Loads and Transmission Report, which forecasts key details like expected transmission and large transformer losses and peak loads, looks to "historical demand" and "weather data," among other factors, but not climate projections.[96]

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155 FERC ¶ 61,157 (2016).

[90] See 10-Ks listed in note 15, *supra*.

[91] *See* note 58, *supra*.

[92] ISO-NE operates the BPS in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

[93] ISO-NE, 2017 REGIONAL SYSTEM PLAN (2017), https://perma.cc/4YSP-UWW5.

[94] *Id*. at 19 & 41.

[95] U.S. DEP'T OF HOMELAND SECURITY (DHS), CASCO BAY REGIONAL CLIMATE CHANGE RESILIENCY ASSESSMENT 40 (2016), https://perma.cc/8JL9-RWXJ.

[96] The "2017-2026 Forecast Report of Capacity, Energy, Loads, and Transmission" is a source of assumptions for use in electric planning and operations reliability studies. *See* ISO-NE, 2017 CELT REPORT: 2017-2026 FORECAST REPORT OF CAPACITY, ENERGY, LOADS AND TRANSMISSION (2017), https://perma.cc/Y3LV-F8D8. Its "energy and peak load forecasts integrate state historical demand, economic and weather data, and the

We do not mean to single out ISO-NE here. It is by no means alone in its failure to comprehensively assess the impacts of climate change on the BPS using downscaled climate projections. ISO/RTOs typically leave such considerations to the states in which they operate or the owners of facilities they oversee. By and large, however, those entities have not considered or addressed the likely effects of future climate change on the BPS or its component parts. To illustrate what this might mean, consider an example from the distribution segment of the grid: testimony given before the New York Public Service Commission during the post-Sandy rate case in 2013 revealed that Consolidated Edison[97] had specified design parameters for its equipment that would be incompatible with the summer temperatures expected to occur during the useful life of that equipment.[98] Climate vulnerability assessments of existing or planned segments of the BPS could detect this sort of incompatibility—and failure to conduct such assessments is likely to leave them present, but obscured from the analysis of risks to and constraints on BPS performance.

3.1 Approach to Planning

As discussed in section 2 above, the impacts of climate change on the BPS will vary by region, as will the solutions available to ensure the system is climate resilient. Given this regional variation, there can be no "one-size fits-all" approach to planning, though a number of general principles have been identified to guide the process. DOE, for example, has outlined eight key steps for climate change resilience planning in the electricity sector (see Figure 2).[99] Most of the steps relate to the conduct of a vulnerability assessment which aims to identify where and under what conditions facilities may be affected by rising temperatures, more intense storms, and other

impacts of utility-sponsored conservation and peak-load management programs." *See* ISO-NE, *CELT Reports*, https://perma.cc/3PRT-RQJH (accessed Feb. 1, 2018).

[97] Consolidated Edison is a distribution utility operating in New York City and Westchester County in New York.

[98] Report of Klaus H. Jacob on behalf of the New York State Office of the Attorney General, In re Con Edison Major Rate Proceedings, Case Nos. 13-E-0030 et al., 10 tbl.2 (May 31, 2013) (listing expected departure from 1971-2000 baseline in 2020s, 2050s, and 2080s for, inter alia, ambient temperature); *see also* Consolidated Edison Company of New York, Inc., Storm Hardening and Resiliency Collaborative Report 81 tbl.12 (Dec. 2013) (listing design standards under review for likely revision, including "temperature variable" and "heat waves").

[99] 2016 DOE Report, *supra* note 21.

climate-driven weather changes.[100] Based on the results of the vulnerability assessment, a resilience plan can be developed, identifying actions that should be taken to mitigate critical vulnerabilities, either by reducing the probability of damage or disruption to facilities (e.g., through relocation or hardening) or the consequences of any damage or disruption (e.g., by enhancing recoverability).

It is important that any planning effort take a long-term view and consider climate-related risks over the expected useful life of transmission and generation facilities. Currently however, stakeholders in the BPS planning process tend to employ ten to fifteen-year time horizons when evaluating risks to reliability (and resilience),[101] whereas generation and transmission facilities tend to have useful lives of twenty-five to forty years or more.[102] Thus, as DOE's Quadrennial Energy Review notes, "[p]lanning for decarbonization and climate resilience reaches beyond typical planning horizons for grid operators."[103]

While taking a longer view is essential to adequately assess how the impacts of climate change could constrain and disrupt BPS operations, simply expanding planning horizons would add complexity and uncertainty to the plans developed by ISO/RTOs[104]—to a potentially unworkable degree. Changes in technology, regulation, consumer demand, and other important factors cannot be foreseen several decades in advance, yet the likelihood of such changes also cannot be ignored because they could significantly affect the grounds for ISO/RTOs' initial

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[100] *Id*. at iii.

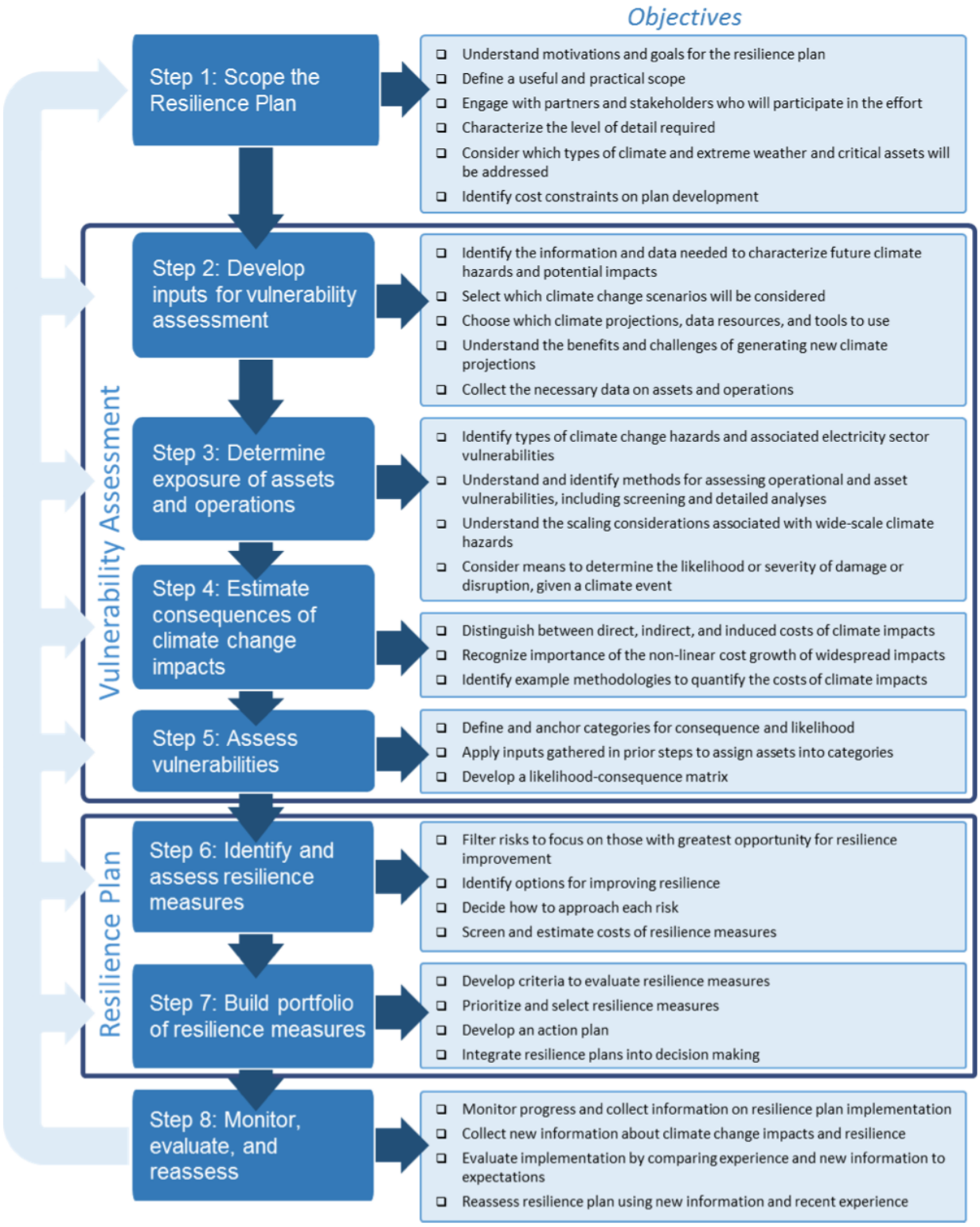
[101] *See e.g.*, PJM, 2017 PJM Baseline Reliability Assessment for the 2017–2032 Period (Jan. 2018) (using 15-year planning horizon).

[102] *See e.g.*, NERC, *Reliability Assessments*, https://perma.cc/XFC8-F6LP (accessed Feb. 5, 2018) ("Long-Term Reliability Assessments annually assess the adequacy of the Bulk Electric System in the United States and Canada over a 10-year period. The reports project electricity supply and demand, evaluate transmission system adequacy, and discuss key issues and trends that could affect reliability."); U.S. Energy Information Administration, *Nuclear Regulatory Commission resumes license renewals for nuclear power plants*, TODAY IN ENERGY (Oct. 29, 2014), https://perma.cc/D7HG-V2Q9 (reporting approvals of 20-year extensions on 40-year operating licenses for 74 nuclear reactors); Edison Electric Institute, Transmission Projects: At A Glance (Dec. 2016), https://perma.cc/433Q-WQL7 (". . . transmission assets are built to be in use for several decades . . . ."); Electric Power Research Institute, Plant Support Engineering: Common Medium-Voltage Cable Specification for Nuclear Power Plants, at vi (Oct. 2009) ("The existing fleet's medium-voltage cable population has an average age of roughly 30 years.").

[103] Quadrennial Energy Review (Second Installment): Transforming the Nation's Electricity System 4-7 (Jan. 2017).

[104] 2016 DOE Report, *supra* note 21, at 86.

Figure 2: DOE's Recommended Approach to Resilience Planning in the Electricity Sector[105]



[105] *Id.* at 3.

planning decisions. And, of course, they could also alter aspects of the BPS's vulnerability to climate change and the options available to enhance its climate resilience. What to do? The approach taken by California's Pacific Gas and Electric (PG&E),[106] a distribution utility, to assessing climate-related risk and resilience is instructive here.[107] As part of its periodic Risk Assessment Mitigation Phase (RAMP) effort PG&E has identified climate-driven hazards, potential impacts of those hazards, and resilience measures that can mitigate or avoid them. But unlike other types of risk which it assesses in just one timeframe, PG&E considers two time frames—2022 and 2050—when assessing risks arising from climate-driven hazards.[108] This approach serves to highlight looming risks and likely constraints without forcing PG&E to speculate unduly about the future. Furthermore, because PG&E's RAMP efforts are periodic, it will revisit its assessment of vulnerabilities and resilience options, updating them as appropriate.[109]

3.2 Existing Tools and Resources

As the foregoing discussion makes clear, significant information will be required to conduct vulnerability assessments and prepare resilience plans, including localized climate change projections. Such projections may be found in existing publicly available tools, datasets, and reports developed by governmental, academic, and other independent bodies.[110] Examples include:

- NASA downscaled datasets;[111]
- U.S. Geological Survey (USGS) National Climate Change and Wildlife Science Center downscaled datasets;[112]

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[106] PG&E provides retail electricity services in the northern two-thirds of California, from Bakersfield to almost the Oregon border.

[107] PG&E, 2017 RISK ASSESSMENT AND MITIGATION PHASE 22-i – 22-20 (2017); PG&E, CLIMATE CHANGE VULNERABILITY ASSESSMENT AND RESILIENCE STRATEGIES (2016), https://perma.cc/5LXQ-83U7.

[108] *Id.* at 22-3.

[109] 2016 DOE Report, *supra* note 21, at 86–89 (calling for adaptive approach involving periodic review and update).

[110] Among the hundreds of datasets accessible via Data.gov, dozens capture information on climate-related topics like precipitation, solar radiation, and temperature. *See* Data.gov, https://www.data.gov/climate/ (accessed Feb. 16, 2018). For a collection and description of tools and data useful for this and related purposes, see JESSICA WENTZ, ASSESSING THE IMPACTS OF CLIMATE CHANGE ON THE BUILT ENVIRONMENT UNDER NEPA AND STATE EIA LAWS: A SURVEY OF CURRENT PRACTICES AND RECOMMENDATIONS FOR MODEL PROTOCOLS 15–26 (2015), https://perma.cc/M6MQ-S2UB.

[111] National Aeronautics and Space Administration, NASA Earth Exchange (NEX) Downscaled Climate Projections (NEX-DCP30).

- ClimateNA (short for North America) dataset.[113]
- New York City Panel on Climate Change data and reports;[114] and
- Cal-Adapt's data, tools, and other resources;[115]

These resources draw on the climate models used by the Intergovernmental Panel on Climate Change, an international body which periodically assesses global climate trends,[116] and the U.S. Global Change Research Program, which prepares national climate assessments.[117] ISO/RTOs may find it useful to review those bodies' reports, which provide the most authoritative projections of national and regional climate change trends.

Given uncertainty regarding the pace and magnitude of climate change—which will depend on future emissions levels and any mitigation action taken—ISO/RTOs planning should take into account multiple projections covering a range of scenarios (e.g., "high emissions," "medium emissions," and "low emissions").[118] Plans should not be based solely on historic data, particularly records of past storms and other extreme events, which are unlikely to reflect the intensity of future events.

This encouragement to consult climate projections would be incomplete if it did not also warn against reliance on data that are incomplete and/or ignore the future. The Flood Insurance

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[112] U.S. Geological Survey, New Statistically Downscaled Climate Data Available for the Conterminous U.S., http://bit.ly/2abfdNu (accessed Feb. 8, 2018); *see also* Adrienne Wootten et al., U.S. Geological Survey, Downscaled Climate Projections for the Southeast United States: Evaluation and Use for Ecological Applications, Open-File Report 2014–1190 (2014), https://perma.cc/7UYP-AF9R.

[113] Tongli Wang et al., *Locally Downscaled and Spatially Customizable Climate Data for Historical and Future Periods for North America*, PLoS ONE (June 2016) (describing ClimateNA software package, useful for deriving downscaled climate data for North American locations).

[114] *Building the Knowledge Base for Climate Resiliency: New York City Panel on Climate Change 2015 Report*, 1336 Ann. N.Y. Acad. Scis. 1–150 (2015).

[115] *See* http://cal-adapt.org/ (accessed Feb. 8, 2018), Cal-Adapt is the product of a collaboration among state agencies, universities, and private companies based in California. Susan Wilhelm, Cal. Energy Comm'n, Unveiling Cal-Adapt 2.0: Facilitating Energy Sector Resilience and Providing Foundational Scenarios for California's Fourth Climate Change Assessment, IEPR Workshop on Adaptation and Resilience for the Energy System, Sacramento, California, Aug. 29, 2017, https://perma.cc/27TJ-H2J7.

[116] *See* Intergovernmental Panel on Climate Change, https://perma.cc/Y2S6-2GDA (accessed Feb. 9, 2018).

[117] *See* U.S. Global Change Research Program, *Climate Science Special Report*, https://perma.cc/2XL4-SBDN (accessed Feb. 9, 2018).

[118] Consistent with this recommendation, PG&E's Climate Resilience RAMP considers two emissions scenarios. PG&E, *supra* note 107, at 22-3.

Rate Maps (FIRMs) developed by the Federal Emergency Management Authority (FEMA) for use in the National Flood Insurance Program (NFIP) usefully illustrate this danger. To begin, FIRMs are strictly backward looking, even though the risks they purport to depict are highly sensitive to several climate-driven impacts. FIRMs also suffer from several other problematic limitations, resulting from their design parameters and the funding and administration of mapping efforts.[119] Currently, for instance, the maps do not reflect flood risks arising from the rapid accumulation of precipitation, such as occurred in Houston during Hurricane Harvey. The Technical Mapping Advisory Council (TMAC), established to review and suggest improvements to the maps, has issued a host of recommendations to FEMA,[120] most of which have gone largely unheeded.[121] A 2017 Inspector General's report highlighted several programmatic deficiencies as well, such as the slow rate of updating and poor application of quality control measures.[122] Thus BPS planning decisions should not rely exclusively on FEMA flood maps to determine flood risk in the near or long-term.

4. RECOMMENDATIONS

To ensure that the BPS continues to deliver reliable electricity services at just and reasonable rates, FERC and ISO/RTOs must plan for the impacts of climate change. Recommendations to guide the planning process are set out below.

- A detailed climate change vulnerability assessment should be undertaken to determine how the components and operations of each ISO/RTO's system will be affected by increasing

[119] For an overview of the key issues, see Michael Keller et al., *Outdated and Unreliable: FEMA's Faulty Flood Maps Put Homeowners at Risk*, Bloomberg, Oct. 6, 2017, https://perma.cc/QWN8-PNRL. Notably, mapping efforts were an incidental feature of the NFIP until 2012, when new legislation incorporated them into the independently authorized and funded National Flood Mapping Program. *See* Biggert-Waters Flood Insurance Reform Act of 2012, Pub. L. No. 112-132, 126 Stat. 365 (May 31, 2012), *codified at* 42 U.S.C. § 4101b.

[120] *See* TMAC, National Flood Mapping Program Review (June 2016), http://bit.ly/2sclUaH; TMAC, Future Conditions Risk Assessment and Modeling (Dec. 2015), http://bit.ly/2fJY7Vq.

[121] *See* Comment letter from Sabin Center for Climate Change Law to FEMA, re National Flood Insurance Program Draft Nationwide Programmatic, June 1, 2017, at 7–10, https://perma.cc/3AGQ-Q7SF.

[122] DHS OFFICE OF THE INSPECTOR GENERAL, FEMA NEEDS TO IMPROVE MANAGEMENT OF ITS FLOOD MAPPING PROGRAMS (2017), http://bit.ly/2nNoLkV.

temperatures, changing precipitation patterns, more intense storms, droughts, and other climate-driven weather extremes expected in their respective regions.

  - Vulnerability assessments should be based on downscaled projections of future climate change in their respective operating regions. Many projections are available in existing datasets, including those developed by NASA and the USGS.
  - Where even downscaled projections fail to provide data for key variables (e.g., humidity (wet-bulb temperature) or temperatures at particular times of day) the entity conducting the assessment should, at minimum, acknowledge the lack of complete information, and, if possible, seek to supplement available data sets.
  - Multiple projections reflecting a range of possible climate change scenarios, including a "worst case" (i.e., assuming continued high greenhouse gas emissions lead to large temperature increases and rapid rates of sea level rise), should be considered in the vulnerability assessment.
  - The timeframe for the vulnerability assessment should reflect the anticipated useful life of existing facilities or facilities scheduled for construction in the relevant ISO/RTO's region.
  - The vulnerability assessment should be periodically reviewed and updated as new information becomes available.

- Based on the vulnerability assessment, a resilience plan should be developed, outlining measures that can be taken to prevent or manage system disruptions.

5. CONCLUSION

FERC and NERC's ongoing efforts to address risks to electric reliability aim to, among other things, "identif[y] long-term emerging issues and trends that do not necessarily pose an immediate threat to reliability but will influence future [BPS] planning, development and system

analysis."[123] The resilience of the BPS to climate-driven impacts—and to other impacts amid climate-related constraints—falls cleanly within this mandate. The implications of climate change for the BPS should inform efforts by ISO/RTOs, FERC, and NERC to ensure its resilience to all manner of disruptions.

[123] NERC, *Reliability Assessment and Performance Analysis*, https://perma.cc/TMZ9-BXCL (accessed Feb. 1, 2018).

APPENDIX A

Potential Impacts of Climate Change on the Generation and Transmission Segments of the BPS

Climate Change Phenomenon		Potential BPS Impacts		ISO/RTO Regions Impacted
		Generation	Transmission	
Temperature	Rising air temperatures	↑ electricity load and the height of peak load ↓ thermoelectric and solar photovoltaic generating efficiency and capacity Shifts in timing of hydroelectric generation (e.g., due to earlier snow melt)	↓ transmission line carrying capacity ↑ transmission line losses ↑ transmission outages (e.g., due to sagging lines contacting trees)	All
	More frequent and severe heat waves			
	Higher water temperatures	↓ thermoelectric generating efficiency and capacity ↑ thermoelectric generating facility curtailment and shutdown (e.g., due to temperature of cooling water exceeding technical specifications)	N/A	All
Precipitation	Lower annual precipitation	↓ thermoelectric and hydroelectric generating capacity ↑ thermoelectric generating facility curtailment and shutdown (e.g., due to water levels falling below water intake structures) ↑ hydroelectric generating facility curtailment and shutdown (e.g., due to insufficient water flows) Shifts in timing of hydroelectric generation (e.g., from summer to winter)	N/A	California ISO, Mid-continent-ISO, Southwest Power Pool (SPP)
	More frequent and severe droughts			

Climate Change Phenomenon		Potential BPS Impacts		ISO/RTO Regions Impacted
		Generation	**Transmission**	
	Shift from snow- to rain-fall	↓ hydroelectric generating capacity (e.g., due to lower annual water storage) ↑ hydroelectric generating facility curtailment and shutdown (e.g., due to insufficient water flows) Shifts in timing of hydroelectric generation (e.g., from summer to winter)	N/A	All
	More heavy rainfall events	↑ generation facility curtailment and shutdown (e.g., due to flooding)	↑ transmission outages (e.g., due to trees falling on lines)	All
Storms	More frequent and severe storms	↑ thermoelectric generating facility shutdown (e.g., due to flooding) ↑ hydroelectric facility shutdown (e.g., due to dam damage)	↑ transmission outages (e.g., due to trees falling on lines)	All
Coastal impacts	Sea level rise	↑ generating facility shutdown (e.g., due to flooding)	↑ transmission outages (e.g., due to flooding)	All except SPP
	Increased storm surge			
Wildfire	Increased wildfire risk	↑ generating facility shutdown (e.g., due to fire damage)	↑ transmission outages (e.g., due to destruction or fouling of lines)	California ISO

COLUMBIA LAW SCHOOL

SABIN CENTER FOR CLIMATE CHANGE LAW

Assessing the Impacts of Climate Change on the Built Environment under NEPA and State EIA Laws:

A Survey of Current Practices and Recommendations for Model Protocols

By Jessica Wentz

August 2015

The Sabin Center for Climate Change Law develops legal techniques to fight climate change, trains law students and lawyers in their use, and provides the legal profession and the public with up-to-date resources on key topics in climate law and regulation. It works closely with the scientists at Columbia University's Earth Institute and with a wide range of governmental, non-governmental and academic organizations.

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The June 18, 2015 Workshop that was convened to discuss a draft of this report and the model protocols was generously supported by the David Sive Memorial Fund.

EXECUTIVE SUMMARY

Climate change and its effects on temperature, precipitation, storm patterns, sea level rise, and other environmental processes have important implications for the construction, maintenance, and operation of buildings and infrastructure. The risks posed by climate change in this context are three-fold. Climate-related phenomena such as flooding and heat waves can directly impair the performance and longevity of buildings and infrastructure. These phenomena can also alter the nature and magnitude of environmental impacts associated with a particular project, such as surface runoff and releases of hazardous substances. Finally, climate change can increase the vulnerability of the surrounding environment (human and natural) to the environmental impacts of a project.

One way to prepare for these impacts is to incorporate climate change projections into the Environmental Impact Assessment (EIA) of proposed development and infrastructure projects. Through EIA, decision-makers can assess the potential impacts of climate change on a proposed project and the surrounding environment before the project is implemented, thus allowing the decision-maker to modify design features, develop alternatives, or adopt other measures to mitigate climate-related risks. The publication of EIA documents also provides a collaborative mechanism through which agencies and other stakeholders can learn about the risks of climate change and make recommendations on adaptation and resilience measures that will most effectively mitigate those risks.

The U.S. Council on Environmental Quality (CEQ) has promulgated draft guidance which directs federal agencies to account for the impacts of climate change on proposed projects and the affected environment when conducting environmental reviews under the National Environmental Policy Act (NEPA). CEQ notes that such an analysis falls squarely within the realm of the impact assessment required by NEPA. A variety of states and foreign jurisdictions have issued similar directives, either in draft or final form, to ensure that project proponents account for climate risks when conducting project-level EIA. Some of these directives also require project applicants to propose risk mitigation measures to improve the resilience of projects and address any significant environmental impacts that can be traced back to climate-related phenomena.

Federal agencies in the U.S. have begun to incorporate climate-related considerations into their NEPA review processes, and have taken the first steps towards addressing the impacts of climate change on proposed federal projects. However, the scope and depth of this analysis vary substantially across different agencies and projects, and it is still very rare for an agency to conduct an in-depth assessment of how climate change may impact a project and its surrounding environment. This also appears to be the case for state EIA documents, although an in-depth review of state practice is beyond the scope of this paper.

More specific guidelines or protocols would help to promote consistency in agency practice and ensure that agencies are adequately accounting for the impacts of climate change when conducting environmental reviews. The Sabin Center for Climate Change Law has therefore developed a set of model protocols for assessing the impacts of climate change on the built environment under NEPA and similar laws.

This paper summarizes the legal and empirical research that underpinned the development of these protocols. Specifically:

- Section 1 describes the observed and anticipated impacts of climate change on the built environment and presents the rationale for incorporating climate risk assessments into project-level EIA.
- Section 2 outlines the legal requirements of NEPA and explains why the consideration of climate impacts falls squarely within the realm of the environmental analysis conducted by federal agencies under NEPA. Section 2 also briefly identifies other state, local, and foreign EIA laws which require consideration of climate change impacts on proposed projects.
- Section 3 reviews the existing guidelines for integrating climate impact and vulnerability assessments into EIA documents, including guidelines developed by governmental as well as non-governmental actors.
- Section 4 describes the results of a survey of how federal EISs currently address the impacts of climate change on projects subject to NEPA review. Our key findings are that federal agencies have begun to assess these impacts, but the scope and depth of this analysis vary substantially across different agencies and projects, and it is still very rare for an agency to

conduct an in-depth assessment of how climate change may impact a project and its surrounding environment.

- Section 5 summarizes the outcomes of a stakeholder workshop convened by the Sabin Center on June 18, 2015 to discuss this project with government employees, EIA consultants, and other interested parties. This section highlights some of the general comments that we received on the scope and substance of the model protocols, as well as several case studies on how climate change adaptation and resilience considerations factored into environmental reviews conducted by workshop participants.
- Section 6 contains the model protocols for assessing the impact of climate change on the built environment under NEPA and similar statutes. These protocols have been revised to reflect input from the June 18 stakeholder workshop.

This paper is also accompanied by three appendices:

- Appendix A provides a list of informational resources that can be used to conduct project-specific climate impact assessments, organized into two categories: (i) data resources, such as models, visualization tools, and impact assessments; and (ii) decision-support tools to facilitate the evaluation of risks and selection of adaptation measures.
- Appendix B contains excerpts of climate impact analysis in federal EISs.
- Appendix C contains the full list of EISs that we reviewed in our survey of federal EISs prepared between 2012 and 2014, and identifies which topics related to climate change impacts and adaptation were covered in each EIS.

CONTENTS

INTRODUCTION

Climate change and its effects on temperature, precipitation, storm patterns, sea level rise, and other environmental processes have important implications for the construction, maintenance, and operation of buildings and infrastructure. Recognizing this, the Obama Administration has issued several executive orders directing federal agencies prepare for the impacts of climate change on federal operations and facilities.[1] The Council on Environmental Quality (CEQ) has also issued draft guidance directing federal agencies to account for these impacts when conducting environmental reviews under the National Environmental Policy Act (NEPA).[2]

The Environmental Impact Assessment (EIA) process provides a useful framework for addressing the risks of climate change in the context of specific projects.[3] Through EIA, decision-makers can assess the potential impacts of climate change on a proposed project and the surrounding environment before the project is implemented, thus allowing the decision-maker to modify design features, develop alternatives, or adopt other measures to mitigate climate-related risks. The publication of EIA documents also provides a collaborative mechanism through which agencies and other stakeholders can learn about the impacts of climate change and make recommendations on appropriate adaptation and resilience measures.

Federal agencies have begun to incorporate climate-related considerations into their NEPA review processes, and have taken the first steps towards addressing the impacts of climate change

[1] Executive Order 13693: Planning for Federal Sustainability in the Next Decade (2015); Executive Order 13690: Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input (2015); Executive Order 13677: Climate-Resilient International Development (2014); Executive Order 13653: Preparing the United States for the Impacts of Climate Change (2013); The President's Climate Action Plan (2013); Executive Order 13547: Stewardship of the Ocean, Our Coasts, and the Great Lakes (2010).

[2] CEQ, Revised Draft Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews, 79 Fed. Reg. 77,802 (Dec. 24, 2014).

[3] Many commentators have endorsed the utilization of EIA to assess the impacts of climate change on proposed projects. *See, e.g.*, Teresa Parejo Navajas, *Reverse Environmental Assessment Analysis for the Adaptation of Projects, Plans, and Programs to the Effects of Climate Change in the EU: Evaluation of the Proposal for an EIA Directive*, Columbia Public Law Research Paper No. 14-445 (2015); Sean Capstick et al., *Incorporating Climate Change Impacts into Environmental Assessments,* IAIA14 Conference Proceedings, 34th Annual Conference of the International Association for Impact Assessment, 8-11 April 2014, Viña del mar, Chile; Michael B. Gerrard, *Reverse Environmental Impact Analysis: Effect of Climate Change on Projects*, 247(45) NEW YORK LAW JOURNAL (March 8, 2012); S. Agrawala et al., *Incorporating Climate Change Impacts and Adaptation in Environmental Impact Assessments: Opportunities and Challenges*, OECD Environmental Working Paper No. 24 (OECD 2010); European Commission, *White Paper on Adaptation to Climate Change: Towards a European Framework for Action* 13 (2009); Inter-American Development Bank, *Disaster Risk Management Policy Guidelines* (2008); CARICOM, *Guide to the Integration of Climate Change Adaptation into the Environmental Impact Assessment (EIA) Process* (2004); CBD & CARICOM, *Sourcebook on the Integration of Natural Hazards into the Environmental Impact Assessment (EIA) Process* (2004).

on proposed federal projects. However, the scope and depth of this analysis vary substantially across different agencies and projects, and it is still very rare for an agency to conduct an in-depth assessment of how climate change may impact a project and its surrounding environment.

CEQ's latest draft guidance directs agencies to consider this issue during NEPA reviews by incorporating climate change projections into their assessments of baseline environmental conditions and environmental impacts from proposed actions. However, the draft guidance does not contain detailed instructions on how agencies should conduct this analysis. More specific guidelines or protocols would help to promote consistency in agency practice and ensure that federal agencies are adequately accounting for the impacts of climate change when conducting these assessments.

To fill this gap, the Sabin Center for Climate Change Law has developed a set of model protocols for assessing the impacts of climate change on the built environment under NEPA and state EIA laws. This paper summarizes the empirical and legal research underpinning this project. The model protocols are presented in Section 6.

1. CLIMATE CHANGE AND THE BUILT ENVIRONMENT

Climate change will have far-reaching impacts on buildings and infrastructure. The risks posed by climate change in this context are three-fold. Climate-related phenomena such as flooding and heat waves can directly impair the performance and longevity of buildings and infrastructure. These phenomena can also alter the nature and magnitude of environmental impacts associated with a particular project, such as surface runoff and releases of hazardous substances. Finally, climate change can increase the vulnerability of the surrounding environment (human and natural) to the environmental impacts of a project.

1.1 Overview of Climate Change Impacts on Buildings and Infrastructure

The Third National Climate Assessment, published by the U.S. Global Change Research Program (USGCRP) in 2014, describes the observed and predicted impacts of climate change on different sectors of the U.S. economy. Table 1.0 summarizes some of the key findings from that report as they relate to buildings and physical infrastructure (see next page).

Table 1.0 – Climate Change Impacts on the Built Environment (USGCRP 2014)

Sector	Applicable Impacts	Key Findings
Water Management	• Increased temperatures (averages and extremes) • Increased precipitation (and flooding, erosion) • Decreased precipitation, (and snowmelt, stream flow) • Increased storm frequency, intensity, variability • Sea level rise	Water supply (quality and quantity): • Changes in precipitation and runoff, combined with changes in consumption and withdrawal, have reduced surface and groundwater supplies in many areas. These trends are expected to continue. • Increased temperatures influence water demand and usage patterns. The Southwest, Great Plains, and Southeast are particularly vulnerable to changes in water supply and demand. • Precipitation changes (increases and decreases) can adversely impact water quality by decreasing supply or increasing run-off. Impacts on water management structures: • Increased precipitation, rising sea levels, flooding and saltwater intrusion can adversely affect wastewater facilities and stormwater management systems (especially along coastlines, low-lying areas).
Energy supply and use	• Increased temperatures • Increased precipitation • Decreased precipitation • Increased storm frequency, intensity, variability • Sea level rise	Direct impacts on infrastructure: • Extreme temperature and weather events are affecting energy production and delivery facilities, causing supply disruptions and affecting other infrastructure that depends on energy supply. Impacts expected to increase. • Sea level rise, extreme storm surge events, and high tides will affect coastal facilities and infrastructure. Water requirements: • Possible reduction in water supply (see above). Electricity demand: • Higher summer temperatures will increase electricity use, causing higher peak loads, while warmer winters will decrease energy demands for heating. Net electricity use is projected to increase.
Transportation systems	• Increased temperatures • Increased precipitation • Increased storm frequency, intensity, variability • Sea level rise	• Impacts from sea level rise and storm surge, extreme weather events, higher temperatures and heat waves, precipitation changes, Arctic warming, and other climatic conditions are already affecting the reliability and capacity of the U.S. transportation system. • Storms and increased precipitation will cause additional flooding, erosion, landslides, and damage. • Temperature variability and increased average and extreme temperatures will have adverse impacts on roads and rail tracks. • Sea level rise and storm surge pose a threat to coastal infrastructure, including airports, ports and harbors, roads, rail lines, tunnels, and bridges.
Urban and Suburban Development	• Increased temperatures • Increased precipitation • Decreased precipitation • Increased storm frequency, intensity, variability • Sea level rise	• Heavy rainfall, flooding, rising sea levels, heat waves, and more severe wildfires pose risks to urban and suburban infrastructure . • Coastal areas are particularly vulnerable. • Climate-related disruptions of services in one infrastructure system almost always result in disruptions in other infrastructure systems. • Climate vulnerability and adaptive capacity of urban residents and communities are influenced by social inequalities.

As highlighted in many of these findings, climate change is *already* affecting much of our nation's infrastructure. USGCRP summarizes the observed impacts:

> Sea level rise, storm surge, and heavy downpours, in combination with the pattern of continued development in coastal areas, are increasing damage to U.S. infrastructure including roads, buildings, and industrial facilities, and are also increasing risks to ports and coastal military installations. Flooding along rivers, lakes, and in cities following heavy downpours, prolonged rains, and rapid melting of snowpack is exceeding the limits of flood protection infrastructure designed for historical conditions. Extreme heat is damaging transportation infrastructure such as roads, rail lines, and airport runways.[4]

Based on current greenhouse gas (GHG) emissions trajectories, it is extremely likely that the scope and severity of these impacts will increase in the coming decades.

1.2 The Rationale for Project-Level Analysis of Climate Impacts

Some concerns have been raised about the feasibility of integrating climate change projections into EIA at the project level, given the inherent uncertainty about these projections and the difficulty of downscaling climate models for regional and local impact assessments. But agencies and EIA consultants frequently confront uncertainty during environmental reviews, and there are methodologies that can be employed to conduct meaningful assessments in the context of significant uncertainty.[5] Efforts are also being made to provide downscaled climate data and models that can be easily applied to regional and local impact analysis.[6]

In 2010, the Organization for Economic Cooperation and Development (OECD) published an international EIA survey which found that there is "ample scope for employing EIA procedures as a vehicle for enhancing the resilience of projects to the impacts of climate change."[7] The report also found that the project level was "particularly critical for the consideration of climate risks and for incorporating suitable adaptation measures" owing to the long duration of infrastructure projects and the fact that these projects can affect the vulnerability of natural and human systems,

[4] U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 13 (2014).

[5] For example, the NEPA regulations instruct federal agencies on how to address incomplete or unavailable information about the environmental impacts of proposed projects. 40 C.F.R. § 1502.22.

[6] See *Appendix A: Informational Resources* for an overview of different data and modeling resources that already exist to aid the assessment of climate impacts on projects and the surrounding environment.

[7] OECD (2010), *supra* note 3, at 3.

leading to maladaptation.[8] The U.S. Government Accountability Office (GAO) reached a similar conclusion in a 2015 report, which highlighted the economic risks of climate change and concluded that better vulnerability assessments, planning processes, and physical preparation would be needed to reduce the federal government's fiscal exposure to these risks.[9]

Opponents of incorporating climate change into project-level EIA have also argued that NEPA and similar laws only require (or permit) the assessment of a project's impact on the environment, and not the impact of the environment on the project.[10] The counterpoint to this argument is that the environmental impacts of a project are a consequence of both project design and the environmental conditions in which the project is located (e.g., rain falls on a paved surface and creates runoff). An accurate impact assessment thus requires an accurate characterization of the baseline environment. To the extent that climate change may influence that baseline, it should factor into the environmental review process.

This means that decision-makers should account for the impacts of climate change when describing the natural resources, ecosystems, and communities that will be affected by a project.[11] Decision-makers should also assess the impacts of climate change on the project itself and whether these impacts may exacerbate any environmental consequences or generate new risks. For example, if sea level rise or extreme inland precipitation cause or worsen flooding at a hazardous waste management facility, a chemical storage facility, or a nuclear power plant, dangerous materials could be released into the environment. Similarly, rising groundwater levels would have implications for the design of landfills and underground storage facilities, as additional measures may be required to prevent water contamination. It would also be necessary to account for increases in average and extreme precipitation events when designing storm water and drainage

[8] *Id.* at 8.

[9] GAO, *Limiting the Federal Government's Fiscal Exposure by better Managing Climate Change* Risks (2015), *available at* http://www.gao.gov/highrisk/limiting_federal_government_fiscal_exposure/why_did_study. *See also* RISKY BUSINESS: THE ECONOMIC RISKS OF CLIMATE CHANGE IN THE UNITED STATES (2014), *available at* http://riskybusiness.org/.

[10] The California Court of Appeal endorsed this viewpoint in Ballona Wetlands Land Trust et al. v. City of Los Angeles, 201 Cal.App.4th 455 (2011). For a more detailed discussion of this decision and other California case law, see Section 2.4.

[11] *See* Jones & Stokes Climate Focus Group, *Addressing Global Warming in CEQA and NEPA Documents in the Post AB 32 Regulatory Environment* 15 (2007): "Consider a project that would create a new industrial plant that discharges wastewater into a nearby lake. To determine the possible impacts of the discharge on the water body, one has to characterize the baseline future condition of the lake for the dates that the plant will be in operation. If climate change may potentially change the depth of the lake within the foreseeable future, one could consider the most conservative lake depth for baseline analysis."

systems. As discussed in the following section ("Legal Context"), such considerations fit squarely within the scope of analysis required by NEPA and other EIA laws.

There are multiple benefits to be realized from incorporating an assessment of climate change impacts into project-level EIA. The main goal, noted above, would be to facilitate the successful "climate proofing" of projects and to avoid maladaptation to climate change. Such efforts can reduce the risk of adverse environmental consequences and reduce the government's fiscal exposure in the long term. In addition, OECD notes that EIA is a "well consolidated and publicly accepted process in many countries and in bilateral and multilateral development co-operation agencies."[12] Based on these benefits, OECD states that it is probably "more efficient and effective to broaden the scope of existing EIA modalities to include climate change and adaptation considerations, as opposed to establishing and implementing parallel procedures for screening projects for climate change risks."[13]

2. LEGAL CONTEXT

The National Environmental Policy Act (NEPA) requires federal agencies to review the environmental impacts of major proposed actions and prepare an Environmental Impact Statement (EIS) for any action that has a significant effect on the environment.[14] These statements must describe the affected environment and any direct, indirect, and cumulative impacts accruing from the action and reasonable alternatives.[15] The agency conducting this analysis must make a draft EIS available for public comment and respond to these comments in the final EIS.[16] The dual purpose of these requirements is to ensure that agencies take a "hard look" at the potential consequences of their activities and disclose this information to the public—the ultimate goal being to promote better informed decision-making.[17]

Many states have enacted laws with similar requirements, which are sometimes referred to as "little NEPAs." New York, for example, introduced its State Environmental Quality Review Act

[12] OECD (2010), *supra* note 3, at 9.

[13] *Id.*

[14] National Environmental Policy Act of 1969 (NEPA) § 102, 42 U.S.C. § 4332.

[15] NEPA § 102(2)(C) , 42 U.S.C. § 4332(2)(C); 40 C.F.R. §§ 1502.14-1502.16.

[16] 40 C.F.R. §§ 1502.9, 1503.1, 1503.4, 1506.6.

[17] Baltimore Gas & Electric Co. v. Natural Resources Defense Council, Inc., 462 U.S. 87, 97-98 (1983).

(SEQRA) in 1975.[18] The European Union and various foreign jurisdictions have also enacted laws that are modeled after NEPA. Section 2.4 highlights some of the existing EIA laws that require consideration of climate change impacts (either as a result of statutory amendments or interpretations by agencies and courts). Although an in-depth analysis of these laws is beyond the scope of this paper, the model protocols presented in Section 6 could be utilized for environmental reviews conducted under many different EIA regimes.

2.1 The National Environmental Policy Act of 1969

As noted in CEQ's draft guidance, considerations relating to the impact of climate change on a proposed action and its affected environment are:

> …squarely within the realm of NEPA, informing decisions on whether to proceed with and how to design the proposed action so as to minimize impacts on the environment, as well as informing possible adaptation measures to address these impacts, ultimately enabling the selection of smarter, more resilient actions.[19]

The justification for requiring such analysis can be traced back several different statutory and regulatory provisions.

First, NEPA declares a continuing federal policy "to use all practicable means and measures… to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans."[20] In accordance with this policy, NEPA directs all federal agencies to conduct their programs in a manner which will "assure all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings" and "attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable or intended consequences," among other things.[21] To accomplish these objectives, it is necessary for agencies to consider whether climate change may compromise the productivity of their activities or exacerbate any environmental and public health threats associated with those activities.

[18] SEQRA, N.Y. ENVTL. CONSERVATION LAW (ECL) art. 8.

[19] 2014 Draft Guidance, *supra* note 2, 79 Fed. Reg. at 77,828-29.

[20] NEPA, 42 U.S.C. § 4331(a).

[21] NEPA, 42 U.S.C. § 4331(b)(2) and (3).

Second, when preparing an EIS under NEPA, agencies must describe the affected environment[22] and assess the environmental impacts of the project and reasonable alternatives (including a "no action" alternative).[23] As noted above, climate change can increase the risk of certain impacts, such as spillage from a hazardous waste containment facility. Climate change can also impact baseline environmental conditions, which would influence the agency's analysis of the affected environment and the "no action" alternative. It is therefore necessary for an agency to account for climate change in order to conduct an accurate impact assessment.

Third, the EIS must describe the purpose of and need for the project,[24] the "relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity" and "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."[25] If climate change significantly reduces the useful life of a project subject to NEPA or requires extensive repairs (as with a flooded airport, transit system, or housing project), the benefits of the project may be much different than those anticipated in an EIS that was prepared without consideration of these issues. The project may be significantly less productive than otherwise anticipated and additional resources may be needed to maintain its operation. Thus, sound impact analysis requires consideration of the future conditions in which the facility will operate.

Fourth and finally, NEPA requires all federal agencies to "recognize the worldwide and long-range character of environmental problems."[26] The analysis of global climate change and its effect on agency actions clearly fits within the purview of this mandate.

2.2 Draft Guidance on NEPA and Climate Change

In December 2014, CEQ published "Revised Draft Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews."[27] The draft guidance clarifies that agencies have an existing legal obligation to

[22] 40 C.F.R. § 1502.15.

[23] 42 U.S.C. § 4332(2)(C)(i)-(iii); 40 C.F.R. §§ 1502.14, 1502.16

[24] 40 C.F.R. § 1502.13.

[25] 42 U.S.C. § 4332(2)(C)(iv) and (v).

[26] 42 U.S.C. § 4332(2)(F).

[27] CEQ (2014), *supra* note 2, 79 Fed. Reg. at 77,802.

consider "the ways in which a changing climate over the life of the proposed project may alter the overall environmental implications of such actions."[28] Such impacts may include "more frequent and intense heat waves, 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, and harm to wildlife and ecosystems."[29]

The draft guidance instructs agencies to consider how climate change may alter the affected environment, the environmental impacts of the proposed action, and the environmental impacts of alternatives to the proposed action. For example, agencies should consider the extent to which climate change may "increase the vulnerability of a resource, ecosystem, human community" within the affected environment of the project, both to establish baseline conditions and to determine if these resources will be more susceptible to impacts or risks posed by the project.[30] The timeframe for this analysis should reflect the anticipated duration of the action and its impacts.[31]

The guidance highlights several examples of situations where an agency should assess the implications of climate change for a proposed action, including:

- Future projections of rainfall, snow pack, and watershed hydrology should be assessed when reviewing a proposal that requires water withdrawals from a stream or river.
- Future projections of sea level rise, storm patterns, and storm surge should be assessed when reviewing a proposal for a coastal infrastructure project.

By conducting this analysis, agencies can select alternatives that are more resilient to the effects of a changing climate, and thus "avoid the environmental and, as applicable, economic consequences of rebuilding should potential climate change impacts such as sea level rise and more intense storms shorten the projected life of the project."[32]

2.3 Managing Uncertainty: Insight from the Regulations

The regulations implementing NEPA do not specifically address climate change, but they do discuss how agencies should manage uncertainty during EIS reviews. Specifically, Section

[28] *Id.* at 77,825.

[29] *Id.*

[30] *Id.*

[31] *Id.* at 77,828.

[32] *Id.* at 77,829.

1502.22 instructs agencies to include the following elements in an EIS when the agency cannot obtain information that is relevant to its analysis of significant environmental impacts from a proposed action:

1. A statement that such information is incomplete or unavailable;
2. A statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment;
3. A summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment; and
4. The agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community.[33]

Federal agencies can use this framework to discuss climate change impacts that are highly uncertain but nonetheless have implications for the environmental consequences of the project.

2.4 State, Local, and Foreign Laws

Several jurisdictions have promulgated laws, policies, or agency guidance requiring the consideration of climate change effects on actions subject to environmental review. Table 2.0 provides an overview of the applicable requirements and directives under state, local, and foreign laws (see next page). Massachusetts is the only U.S. jurisdiction that has expressly amended its EIA statute to require consideration of climate change effects. However, New York State, New York City, Washington State, and King County, WA, have all issued policies or guidance documents calling for the consideration of climate change effects and adaptation considerations (at least for some agencies and some projects).

Of the five foreign jurisdictions on the list, the European Union, Kiribati, and Vanuatu have all expressly amended their EIA laws to require an analysis of climate change effects.[34] Canada and Fiji have also published guidance directing project applicants to conduct such analysis without formally amending their EIA statutes or regulations.

[33] 40 C.F.R. § 1502.22.

[34] Several European jurisdictions have introduced policies or guidance to implement the EU Directive on Climate Change and EIA, but they are not listed in Table 2.0 because they fall within the scope of the legal requirements outlined in the EU directive. The relevant guidance documents are listed in Section 3: Existing Guidance and Assessment Tools.

Table 2.0 – Legal Requirements to Consider Climate Change Impacts in EIA

Jurisdiction	Law	Policy / Guidance	Content
UNITED STATES			
Massachusetts	Massachusetts Environmental Policy Act (MEPA) (2009 Amendments)	*Draft MEPA Climate Change Adaptation and Resiliency Policy* (2014)[35]	MEPA was amended in 2009 with the following language: "In considering and issuing permits, licenses, and other administrative approvals and decisions, the respective agency, department, board, commission or authority shall also consider reasonably foreseeable climate change impacts, including additional greenhouse gas emissions, and effects, such as predicted sea level rise."[36]
New York	State Environmental Quality Review Act (SEQRA)	*Commissioner's Policy – Climate Change and DEC Action* (2010)[37]	A 2010 policy document directs the NY State Department of Environmental Conservation (DEC) staff to "identify potential adverse impacts from climate change" on all DEC programs, "incorporate climate change adaptation strategies into applicable DEC programs, actions and activities" and to "use the best available scientific information of environmental conditions resulting from the impacts of climate change."[38]
New York City, NY	City Environmental Quality Review Act (CEQR)	*CEQR Technical Manual* (2014)[39]	The CEQR Technical Manual states: "…depending on a project's sensitivity, location, and useful life, it may be appropriate to provide a qualitative discussion of the potential effects of climate change on a proposed project in environmental review. Such a discussion should focus on early integration of climate change considerations into the project and may include proposals to increase climate resilience and adaptive management strategies to allow for uncertainties in environmental conditions resulting from climate change."[40]
Washington	State Environmental Policy Act (SEPA)	WSDOT, *Guidance for NEPA and SEPA Project-Level Climate Change Evaluations* (2014)[41]	A 2014 guidance document published by the Washington State Department of Transportation (WSDOT) outlines an analytical process and provides template language for assessing the impacts of climate change on all WSDOT projects subject to NEPA and SEPA.[42]

[35] Commonwealth of Massachusetts, *Draft MEPA Climate Change Adaptation and Resiliency Policy* (2014).

[36] MASS. GEN. LAWS ch. 30, § 61, *amended* by Massachusetts Global Warming Solutions Act (GWSA), Ch. 298 of the Acts of 2008, § 7. *See also* MASS. CODE REGS. § 11.12(5)(a).

[37] New York State Department of Environmental Conservation (DEC), *Commissioner's Policy – Climate Change and DEC Action* (2010), *available at* http://www.dec.ny.gov/regulations/65034.html.

[38] *Id.* New York State also adopted the Community Risk and Resiliency Act in 2014, which does not specifically amend SEQRA, but does require the assessment of climate change impacts and risks for certain projects. Similarly, the draft regulations for the Waterfront Revitalization Program will require consideration of sea level rise and coastal impacts.

[39] NYC MAYOR'S OFFICE OF ENVIRONMENTAL COORDINATION (MOEC), CITY ENVIRONMENTAL QUALITY REVIEW (CEQR) TECHNICAL MANUAL (March 2014).

[40] MOEC, *Greenhouse Gas Emissions and Climate Change,* Ch. 18 in CEQR TECHNICAL MANUAL 18-7 (2014).

[41] WSDOT, *Guidance for NEPA and SEPA Project-Level Climate Change Evaluations* (2014), *available at* http://www.wsdot.wa.gov/NR/rdonlyres/BDF7C3DA-4F27-4CD5-8D02-6813027A928B/0/WSDOT_ClimateGuidance.pdf.

[42] *Id.*

King County, WA	Executive Order PUT 7-10-1 (2007)	*Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments* (2007)[43]	King County, WA promulgated an executive order which acknowledges "serious local impacts of global climate change" and requires that "climate impacts, including but not limited to those pertaining to greenhouse gases, be appropriately identified and evaluated when [King County] departments are acting as the lead in reviewing the environmental impacts of private or public proposals pursuant to the State Environmental Policy Act."[44]
FOREIGN JURISDICTIONS			
Canada	Canadian Environmental Assessment Act (CEAA)	*Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (2003)[45]	The Canadian Environmental Assessment Agency published a general guidance document in 2003, which directs project applicants to conduct a preliminary scoping for climate change impacts and vulnerability, and to conduct a more thorough assessment of such impacts where appropriate.
Nova Scotia, Canada	Nova Scotia Environment Act	*Guide to Considering Climate Change in Environmental Assessments in Nova Scotia* (2011)[46]	In 2011, Nova Scotia adopted regional guidance on how climate change considerations should be incorporated into EIA conducted by provincial authorities. This guidance complements a planning document, *Guide to Considering Climate Change in Project Development in Nova Scotia*.[47]
European Union	Directive 2014/52/EU (2014)	*EC Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment* (2013)[48]	EIA should address "the risk of major accidents and/or disasters which are relevant to the project concerned, including those caused by climate change, in accordance with scientific knowledge" and "the vulnerability of the project to climate change."[49]
Fiji	Environmental Management Act of 2005	*Environment Impact Assessment (EIA) Guidelines* (2008)[50]	Fiji's EIA guidelines require project applicants to consider the vulnerability of a project to natural disasters, taking into account the future impacts of climate change and sea-level rise.[51] Applicants should also identify any species in that may be vulnerable to climate change impacts.[52]

[43] The Climate Impacts Group, King County, Washington, & ICLEI, *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments* (2007), *available at* http://www.cses.washington.edu/db/pdf/snoveretalgb574.pdf.

[44] King County, WA, Executive Order: Evaluation of Climate Change Impacts through the State Environmental Policy Act, PUT 7-10-1 (AEO) (2007).

[45] Canadian Environmental Assessment Agency, *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (2003).

[46] Nova Scotia Environment, *Guide to Considering Climate Change in Environmental Assessments in Nova Scotia* (2011).

[47] Nova Scotia Environment, *Guide to Considering Climate Change in Project Development in Nova Scotia* (2011).

[48] European Commission, *Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment* (2013).

[49] EIA Directive 2014/52/EU (2014), Annex III, §1(f); Annex IV, §5(f).

[50] Fiji Department of Environment, *Environment Impact Assessment (EIA) Guidelines* (2008).

[51] *Id.* at 75.

[52] Id. at 70.

Kiribati	Environment Act §33(1)(d)	*Adaptation Handbook: Undertaking Risk Treatment for Coastal Climate Change Risks in the Republic of Kiribati* (2009)[53]	EIA must include "a description of how climate change and climate variability may impact on the activity."[54]
Vanuatu	Environmental Management and Conservation Act (EMCA) (2010 Amendment)	CARICOM, *Guide to the Integration of Climate Change Adaptation into the Environmental Impact Assessment (EIA) Process* (2004)[55]	In 2010, Vanuatu amended the EIA provisions in the EMCA, changing the definition of "significant environmental impact" to include "the degree to which the adaptation to, and mitigation of climate change is affected."[56]

A variety of foreign jurisdictions have also signaled their intention to integrate climate considerations within EIA processes in policies and planning documents, but these statements fall short of a legally binding requirement. For example, the Spanish National Climate Change Adaptation Plan (2006) proposes the development of guidelines and regulations to incorporate climate change impacts into the EIA process, with a special focus on projects in the water sector.[57] The Spanish Ministry of Environment also considers EIA to be an entry point for integrating adaptation considerations into development projects.[58] Other countries which have signaled their intent to incorporate these considerations into EIA processes include Samoa,[59] the Solomon Islands,[60] the Cook Islands,[61] Dominica,[62] St. Lucia,[63] and Bangladesh.[64]

[53] C. Elrick & R. Kay, *Adaptation Handbook: Undertaking Risk Treatment for Coastal Climate Change Risks in the Republic of Kiribati*, prepared for Kiribati Adaptation Project Phase II (KAP II), Government of Kiribati (2009), *available at* http://www.coastalmanagement.com/wp-content/uploads/2013/08/adaptation-handbook_kap-ii-component-1.3.2_low_res.pdf.

[54] World Bank, *Reducing the Risk of Disasters and Climate Variability in the Pacific Islands – Republic of Kiribati Country Assessment* (2009).

[55] CARICOM, *Guide to the Integration of Climate Change Adaptation into the Environmental Impact Assessment (EIA) Process* (2004), *available at* http://dms.caribbeanclimate.bz/M-Files/openfile.aspx?objtype=0&docid=2358.

[56] Environmental Management and Conservation (Amendment) Act of 2010, Section 3 (amending Environmental Management and Conservation Act of 2002, Section 2).

[57] Oficina Española de Cambio Climático, Plan Nacional de Adaptación al Cambio Climático (2006).

[58] Oficina Española de Cambio Climático, Plan Nacional de Adaptación al Cambio Climático: Segundo Programa de Trabajo (2009).

[59] Government of Samoa, *First National Communication to the UNFCCC* (1999); *National Adaptation Programme of Actions: Samoa* (2005).

[60] Government of Solomon Islands, *Solomon Islands: National Adaptation Programme of Actions* (2008).

[61] Government of Cook Islands, *Initial National Communication under the United Nations Framework Convention on Climate Change* (2000).

Notably, California is not among the jurisdictions listed in Table 2.0. This is because there has been some controversy as to whether the California Environmental Quality Act (CEQA) requires an evaluation of how climate change will impact a project and its affected environment. In 2007, state lawmakers enacted Senate Bill (SB) 97, which called for an amendment of the CEQA guidelines to provide for analysis of "mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions."[65] The revised CEQA guidelines, adopted via a regulatory amendment in 2010, specified that Environmental Impact Reports (EIRs) prepared under CEQA should "evaluate any potentially significant impacts of locating development in other areas susceptible to hazardous conditions (e.g., floodplains, coastlines, wildfire risk areas) as identified in authoritative hazard maps, risks assessments or in land use plans addressing such hazards areas."[66] According to the Governor's Office of Planning and Research this means that "lead agencies must analyze potentially significant impacts associated with placing projects in hazardous locations, including locations potentially affected by climate change."[67]

However, in *Ballona Wetlands Land Trust v. City of Los Angeles* (2011), the California Court of Appeal, Second District, held that this component of the CEQA guidelines was invalid because "the purpose of an EIR is to identify the significant effects of a project on the environment, not the significant effects of the environment on the project."[68] According to the Court, "identifying the effects on the project and its users of locating the project in a particular environmental setting is neither consistent with CEQA's legislative purpose nor required by the CEQA statutes."[69] Thus, the Court held that the EIR for a real estate development was not required to discuss the impact of sea level rise on the project.

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[62] Government of the Commonwealth of Dominica, *Initial National Communication of the Commonwealth of Dominica under the United Nations Framework Convention on Climate Change* (2001).

[63] Government of Saint Lucia, *Saint Lucia's Initial National Communication Climate Change* (2001).

[64] Government of the People's Republic of Bangladesh, *National Water Management Plan Project; Guidelines for Environmental Assessment of Water Management (Flood Control, Drainage and Irrigation) Projects* (2005).

[65] Cal. S.B. 97(2007), § 1 (2007), *amending* CAL. PUB. RES. CODE. § 21083.05.

[66] CAL. CODE REGS. Tit. 14, § 15126.2.

[67] OPR, *CEQA and Climate Change*, http://www.opr.ca.gov/s_ceqaandclimatechange.php.

[68] Ballona Wetlands Land Trust et al. v. City of Los Angeles, 201 Cal.App.4th 455, 473 (2011).

[69] *Id.* at 474.

Despite this decision, California agencies still consider climate risks when conducting environmental reviews under CEQA.[70] There have also been at least two court decisions holding that consideration of sea level rise does fall within the scope of CEQA considerations, at least to the extent that it has implications for the environmental consequences of a project. In *Sierra Club v. City of Oxnard*, a California Superior Court issued a trial order which required a local government to evaluate the impacts of sea level rise on a proposed mixed-use development project.[71] In *No Wetlands Landfill Expansion v. County of Marin*, the California Appellate Court affirmed a decision holding that an EIR had properly considered sea level rise in an EIR for a proposed landfill expansion, even though the landfill was located miles from the ocean, because sea level rise may impact the level of waterways adjacent to the ocean.[72] Both cases held that *Ballona Wetlands* was not controlling because it did not address whether an EIR should address sea level rise to the extent that it may alter the affected environment or the environmental impacts of the project.[73] The decision in *Sierra Club v. City of Oxnard* also questioned the rule in *Ballona Wetlands* (that EIRs need not evaluate the significant effects of the environment on the project), noting that land use compatibility is an "integral part of EIR analysis" and a "two-way street" which requires consideration of whether a project is located in an area subject to hazards such as sea level rise.[74]

3. EXISTING GUIDELINES AND ASSESSMENT TOOLS

There are a variety of existing guidelines and assessment tools that describe how agencies and project applicants should assess the impacts of climate change on a project and its affected environment. These resources were consulted prior to drafting the model protocols set forth in

[70] This finding is based on our review of federal EISs located in California, which were prepared in accordance with both NEPA and CEQA, and which routinely reviewed sea level rise and other climate change impacts on projects, as well as an independent review of approximately 20 EIRs prepared under CEQA.

[71] Sierra Club v. City of Oxnard, 2012 WL 7659201 (Cal.Super.) (Trial Order).

[72] No Wetlands Landfill Expansion v. County of Marin, 204 Cal. App. 4th 573 (2012), *aff'd in part and rev'd in part*, 2014 WL 7036032 (Cal. Ct. App. Dec. 12, 2014).

[73] *See* No Wetlands Landfill, 204 Cal. App. at FN 9 ("But *Ballona Wetlands* is distinguishable because, although the EIR may not specifically say so, future sea rise here presumably would not only impact the project but would also impact the environment by contaminating waterways"); Sierra Club, 2012 WL 7659201 at 47 (noting that the project at issue may have significant adverse consequences on the proper inland *migration* of wetlands and related biota in light of sea level rise, and this analysis involves "the significant effects of the NSP on the environment").

[74] Sierra Club, 2012 WL 7659201 at 47.

Section 6. They include official guidance documents issued by government agencies, as well as technical guides published by intergovernmental and nongovernmental organizations. Notably, many of these documents were published in the absence of any express amendment to EIA laws, based on an understanding that the consideration of how climate change will impact a project and its surrounding environment already fall within the scope of existing EIA requirements.

This section reviews the existing guidance documents and assessment tools, organized by source: (i) U.S. federal agencies, (ii) U.S. state and local jurisdictions, (iii) foreign jurisdictions, and (iv) intergovernmental and nongovernmental actors, including development banks and foreign aid agencies.[75] The documents listed in this section were specifically developed for EIA purposes or contain provisions which are directly relevant to the EIA process. As such, they do not reflect the full range of planning guidelines for climate change adaptation.

3.1 Federal Agencies

Executive Order 13,653 directed all federal agencies to prepare for the impacts of climate change on their operations and facilities.[76] In fulfillment of this order, federal agencies have begun to assess their vulnerability to climate change and develop agency-wide adaptation plans. Many of these climate impact and vulnerability assessments contain data that is relevant to project-level EIA, and are thus listed in Appendix A: Informational Resources.

Although federal agencies have published numerous policy and planning documents on climate change adaptation and resilience, only a few agencies have published guidance on how these considerations should be incorporated into environmental reviews conducted under NEPA. Nor have these agencies begun to routinely account for such considerations in EISs. The Department of Transportation (DOT), for example, has published a Climate Adaptation Plan and a variety of other planning documents,[77] but it does not typically discuss the effects of climate change on proposed transportation projects in NEPA reviews.[78]

[75] These documents are also available on the Sabin Center website, http://web.law.columbia.edu/climate-change/resources/nepa-and-state-nepa-eis-resource-center/eia-guidelines-assessing-climate-risk.

[76] Executive Order 13653: Preparing the United States for the Impacts of Climate Change (2013).

[77] *See* DOT, *Adaptation Planning*, http://climate.dot.gov/impacts-adaptations/planning.html.

[78] For additional details, see the discussion of our Federal EIS survey in Section 4.

Table 3.1 lists the relevant guidance documents and assessment tools that have been published by federal agencies. These include several guidance documents that specifically discuss how agencies should assess climate change effects in NEPA reviews, as well as a selection of other resources that could be used in the EIA context (e.g., guidelines on how to conduct climate change vulnerability assessments).

Table 3.1 - U.S. Federal Agency Guidance and Assessment Frameworks

Agency	Guidance / Framework	Content
Council on Environmental Quality (CEQ)	*Revised Draft Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews* (2014)[79]	CEQ's guidance instructs agencies to consider climate-related impacts when assessing (i) the affected environment, (ii) the environmental impacts of the proposed action, and (iii) the environmental impacts of alternatives to the proposed action.
Department of Defense (DOD)	*Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs* (2009)[80]	DOD published guidance for incorporating the direct and indirect physical effects of projected future sea-level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects.
Department of Transportation (DOT)	*Highways in the Coastal Environment: Assessing Extreme Events* (2014)[81]	This engineering circular provides technical guidance and methods for assessing the vulnerability of coastal transportation facilities to extreme events and climate change, focusing on sea level rise, storm surge, and waves.
	Strategic Issues Facing Transportation, Volume 2: Climate Change, Extreme Weather Events, and the Highway System: Practitioner's Guide and Research Report (2014)[82]	This report outlines strategic adaptation considerations, taking into account the likely impacts of climate change through 2050 in the planning, design, construction, operation, and maintenance of infrastructure assets in the United States (and through 2100 for sea-level rise).
	Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2, Task 3.1, Screening for Vulnerability (2014)[83]	This study outlines a screening approach that helps identify which assets could be considered more likely to be vulnerable to future climate conditions.

[79] CEQ (2014), *supra* note 2.

[80] DOD, *Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs*, Engineering Circular No. 1165-2-211 (2009).

[81] DOT, *Highways in the Coastal Environment: Assessing Extreme Events*, Hydraulic Engineering Circular No. 25, Vol. 2 (2014).

[82] DOT,: *Strategic Issues Facing Transportation, Volume 2: Climate Change, Extreme Weather Events, and the Highway System: Practitioner's Guide and Research Report*, National Cooperative Highway Research Program (NCHRP) Report 750 (2014).

[83] DOT, *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: The Gulf Coast Study, Phase 2, Task 3.1, Screening for Vulnerability*, in ENGINEERING ASSESSMENTS OF CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES, FWHA-HEP-15-004 (2014).

Department of Transportation (DOT), cont'd	*Impacts of Climate Change and Variability on Transportation Systems and Infrastructure, The Gulf Coast Study, Phase 2, Task 3.2* (2014)[84]	This study discusses a series of engineering assessments on specific transportation facilities in Mobile that evaluated whether those facilities might be vulnerable to projected changes in climate, and what specific adaptation measures could be effective in mitigating those vulnerabilities. It includes a description of the climate impact assessment process used, as well as findings that may apply more generally to engineering design practices, operations and maintenance practices, and other lessons learned.
	Federal Highway Administration, *Climate Change & Extreme Weather Vulnerability Assessment Framework* (2012)[85]	The Federal Highway Administration's (FHWA's) Climate Change and Extreme Weather Vulnerability Assessment Framework is a guide for transportation agencies interested in assessing their vulnerability to climate change and extreme weather events. It gives an overview of key steps in conducting vulnerability assessments and uses in-practice examples to demonstrate a variety of ways to gather and process information.
	A Framework for Considering Climate Change in Transportation and Land Use Scenario Planning: Lessons Learned from an Interagency Pilot Project on Cape Cod: Final Report (2011)[86]	The Interagency Transportation, Land Use, and Climate Change Pilot Project utilized a scenario planning process to develop a multi-agency transportation- and land use-focused development strategy for Cape Cod, Massachusetts, with the intention of achieving a reduction in future greenhouse gas emissions and considering the potential impacts of sea-level rise on the region. The outcome document is intended to inform the region's long-range transportation planning and other related efforts, as well as the planning efforts of local, state, and federal agencies.
Environmental Protection Agency (EPA)	*EIA Technical Review Guideline: Non-Metal and Metal Mining Volume 1* (2011)[87]	This is a general guidance document for EIA of mining facilities. It instructs engineers to consider the impacts of global climate change, including projections of increased extreme weather events, e.g., in the design of tailings management systems. But it does not contain extensive guidance on how to conduct such assessments.
General Services Association (GSA)	*Sustainable Facilities Tool: Climate Adaptation*[88]	As part of its Sustainable Facilities tool, GSA has introduced a "climate change risk workshop process" that combines best practices from the federal adaptation community to help users identify climate risks and develop strategies to secure vulnerable real property investments and supply chains. It prescribes a multi-step

[84] *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure, The Gulf Coast Study, Phase 2, Task 3.2*, in ENGINEERING ASSESSMENTS OF CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES, FWHA-HEP-15-004 (2014).

[85] FHWA, *Climate Change & Extreme Weather Vulnerability Assessment Framework* (2012).

[86] DOT, *A Framework for Considering Climate Change in Transportation and Land Use Scenario Planning: Lessons Learned from an Interagency Pilot Project on Cape Cod: Final Report* (2011).

[87] EPA, *EIA Technical Review Guideline: Non-Metal and Metal Mining Volume 1* (2011).

[88] GSA, *Sustainable Facilities Tool: Climate Adaptation*, https://sftool.gov/plan/430/climate-adaptation.

		process for conducting vulnerability assessments and implementing adaptation measures. The tool is intended to help assess the vulnerability of specific assets and infrastructure to climate change; it does not provide instruction on how to assess environmental impacts of a project in light of climate change.
National Oceanic and Atmospheric Administration (NOAA)	*Adapting to Climate Change: A Planning Guide for State Coastal Managers* (2010)[89]	The purpose of this guide is to help U.S. state and territorial (state) coastal managers develop and implement adaptation plans to reduce the impacts and consequences of climate change and climate variability (climate change) in their purview. It focuses primarily on providing support for broader planning processes, but does contain some relevant guidelines for assessing physical vulnerability to climate change and implementing adaptation measures.
US Agency for International Development (USAID)	*Adapting to Climate Variability and Change: A Guidance Manual for Development Planning* (2007)[90]	This guidance manual takes a broad perspective on adaptation planning, but it does outline an approach for project-level vulnerability risk assessment and the selection of adaptation options. See page 11 for a useful diagram of the approach.
U.S. Army Corps of Engineers (USACE)	*How to Incorporate SLR in Civil Works Programs* (2011)[91]	This USACE circular provides guidance for incorporating the direct and indirect physical effects of projected future sea-level change across the project life cycle in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects.
U.S. Forest Service (USFS)	*Climate Change Considerations in Project Level NEPA Analysis* (2009)[92]	This USFS guide primarily concerns land use actions and climate change mitigation, but includes relevant information for assessing climate change impacts on baseline environmental conditions and implications for the vulnerability of the affected environment. Recommends that EIS preparers consider measures to enhance adaptive capacity in alternatives analysis.

3.2 State and Local Governments

Several states, including California, New York, Massachusetts, and Washington have developed guidelines for assessing the impacts of climate change on projects undergoing EIA. The legal basis for these guidelines is discussed in Section 4.2. A handful of localities (New York, NY,

[89] NOAA, Office of Ocean and Coastal Resource Management, *Adapting to Climate Change: A Planning Guide for State Coastal Managers* (2010).

[90] USAID, *Adapting to Climate Variability and Change: A Guidance Manual for Development Planning* (2007).

[91] USACE, *How to Incorporate SLR in Civil Works Programs,* USACE Circular No. 2265-2-212 (2011).

[92] USFS, *Climate Change Considerations in Project Level NEPA Analysis* (2009).

San Francisco, CA, and King County, WA) have also generated their own guidelines for such assessments. Table 4.2 lists these documents.

Table 3.2. State and Local Government Guidance and Assessment Frameworks

Jurisdiction	Guidance / Framework	Content
California	*Sea Level Rise Policy Guidance* (2015)[93]	This guidance document outlines a process for addressing sea level rise in local coastal programs and coastal development permits.
	California Department of Water Resources, *Climate Change Handbook for Regional Water Planning* (2011)[94]	Developed cooperatively by the CA Department of Water Resources (DWR), the U.S. Environmental Protection Agency, Resources Legacy Fund, and the U.S. Army Corps of Engineers, the Climate Change Handbook for Regional Water Planning provides a framework for considering climate change in water management planning. Key decision considerations, resources, tools, and decision options are presented that will guide resource managers and planners as they develop means of adapting their programs to a changing climate.
	California Department of Transportation, *Guidance on Incorporating Sea Level Rise: For use in the planning and development of project initiation documents* (2011)[95]	This document is similar to sea-level rise guidance document noted above, but with specific focus on integrating sea level rise considerations into transportation projects.
San Francisco, CA	*Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco: Assessing Vulnerability, Risk, and Adaptation* (2014)[96]	This guidance provides a framework for considering sea level rise within the capital planning processes for the City and County of San Francisco, CA. The guidance includes information on: • official estimates of sea level rise • sea level rise scenario selection • sea level rise inundation mapping • vulnerability and risk assessment • adaptation planning • permitting and regulatory considerations It also includes examples of how the guidance would be applied with respect to different types of projects.
Massachusetts	*Draft MEPA Climate Change Adaptation and Resiliency Policy* (2014)[97]	The draft MEPA policy provides guidance on how proponents should assess the impacts of climate change in EIRs. It identifies three key types of impacts that should be evaluated: • Sea level rise, coastal flooding and storm surge

[93] CA Coastal Commission, *Sea-Level Rise Policy Guidance* (2013).

[94] CA Department of Water Resources, *Climate Change Handbook for Regional Water Planning* (2011).

[95] CA Department of Transportation, *Guidance on Incorporating Sea Level Rise: For use in the planning and development of project initiation documents* (2011), *available at* http://www.dot.ca.gov/ser/downloads/sealevel/guide_incorp_slr.pdf.

[96] Sea Level Rise Committee of SF Adapt for the San Francisco Capital Planning Committee, *Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco: Assessing Vulnerability, Risk, and Adaptation* (2014).

[97] Commonwealth of Massachusetts, *Draft MEPA Climate Change Adaptation and Resiliency Policy* (2014).

		• Impacts associated with changes in precipitation • Impacts associated with changes in temperature It requires preparation of a "climate impact assessment" to "evaluate how a project may be impacted by climate change related events and how the project itself may contribute to, or reduce, climate change impacts. Required elements include: 1. Detailed description of the site and proposed project 2. Evaluation of how climate change may impact the project site and proposed infrastructure 3. Evaluation of mitigation alternative and measures to identify commitments The guidance also provides guidance on how to address uncertainty, risk analysis and adaptive capacity.
New York	*Commissioner's Policy: Climate Change and DEC Action* (2010)[98]	This policy document directs the NY State Department of Environmental Conservation (DEC) staff to "identify potential adverse impacts from climate change" on all DEC programs, "incorporate climate change adaptation strategies into applicable DEC programs, actions and activities" and to "use the best available scientific information of environmental conditions resulting from the impacts of climate change."
New York City, NY	*CEQR Technical Manual* (2014)[99]	The CEQR technical manual does not provide detailed guidance, but it does include limited instruction on how and when agencies should consider climate change effects in CEQR reviews. E.g., the manual notes that the analysis "should focus on early integration of climate change considerations into the project and may include proposals to increase climate resilience and adaptive management strategies to allow for uncertainties… resulting from climate change."
Washington	WSDOT, *Guidance for NEPA and SEPA Project-Level Climate Change Evaluations* (2014)[100]	The Washington State Department of Transportation (WSDOT) guidance specifies an analytical process and template language for assessing the impacts of climate change on all WSDOT projects subject to NEPA and SEPA.
King County, WA	King County, Climate Impacts Group, and ICLEI, *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments* (2007)[101]	This guidebook provides step-by-step guidance on how state and local decision-makers can prepare for the impacts of climate change within their jurisdiction. It does not specifically discuss integrating climate risk into EIA, but it does provide some guidance on vulnerability and risk assessments for physical infrastructure.

[98] NYS Department of Environmental Conservation, *Commissioner's Policy: Climate Change and DEC Action* (2010).

[99] NYC Mayor's Office of Environmental Coordination, *Greenhouse Gas Emissions and Climate Change*, Ch. 18 in CEQR TECHNICAL MANUAL 18-7 (2014).

[100] WSDOT, *Guidance for NEPA and SEPA Project-Level Climate Change Evaluations* (2014).

[101] King County, Climate Impacts Group, and ICLEI, *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments* (2007).

3.3 Foreign Jurisdictions

The European Commission, Canada, Kiribati, the Netherlands, New Zealand, and the United Kingdom have promulgated guidance on climate risk assessment in EIA. These guidance documents are typically more detailed than the federal and state resources identified above, but not as detailed as the intergovernmental and nongovernmental resources discussed in the following section. European Commission guidelines are included in this section because they are attached to a legally binding directive and are implemented at the national level by member states.

Table 3.3. Guidance and Assessment Frameworks from Other Jurisdictions

Jurisdiction	Guidance / Framework	Content
European Commission	European Commission (EC), *Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment* (2013)[102]	The EC guidance outlines overarching principles as well as pragmatic considerations for addressing climate change (mitigation and adaptation) as well as biodiversity in EIA. Provides a list of key questions for identifying climate change adaptation issues, and lists the considerations that should factor into the assessment of how climate change will impact the environmental baseline, the vulnerability of built infrastructure, and adaptation opportunities.
	Guidelines for Project Managers: Making Vulnerable Investments Climate Resilient (2012)[103]	These guidelines form part of the overall EU effort to mainstream climate change adaptation, following on from the White Paper on Adapting to Climate Change published by the Commission in 2009. They are designed to provide support to developers of physical assets and infrastructure. They provide information on the steps that can be undertaken to integrate climate resilience within a familiar project lifecycle appraisal practiced by project developers.
Canada	Canadian Environmental Assessment Agency, *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (2003) [104]	Canada's general guidance document provides instruction on how to evaluate climate impacts and project vulnerability during environmental reviews conducted under the Canadian Environmental Assessment Act. It includes the following: • Methods that can be used to obtain and evaluate information concerning the impacts of climate change on a project • Key sources of information that practitioners can use to address climate change considerations in project

[102] European Commission (EC), *Guidance on Integrating Climate Change and Biodiversity into Strategic Environmental Assessment* (2013).

[103] This is a report submitted to the European Commission (EC), as opposed to a formal guideline promulgated by the EC. As such, these guidelines are not binding on member states. Climate Risk Management Ltd., *Guidelines for Project Managers: Making Vulnerable Investments Climate Resilient*, report prepared for the European Commission (2012).

[104] Canadian Environmental Assessment Agency, *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (2003).

		environmental assessments • Methodology to encourage consistent consideration of climate change in the environmental assessment process across federal, provincial and territorial jurisdictions The guidance indicates that, where the risks associated with climate change are associated with the private sector only, the project proponent can choose to absorb this risk. However, if the risks could potentially impact the project, they must be accounted for (and possibly mitigated) in the EIS. It also outlines a five step process for EIA: 1 – Preliminary scope for impacts considerations 2 – Identify impacts for more detailed assessment 3 – Assess impacts and risks 4 – Develop impact management plans 5 – Monitoring, follow-up and adaptive management
British Columbia, Canada	*Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use* (2011)[105]	This document provides guidelines for the design of sea dikes to protect low lying lands that are exposed to coastal flood hazards arising from their exposure to the sea and to expected sea level rise due to climate change.
Nova Scotia, Canada	*Guide to Considering Climate Change in Environmental Assessments in Nova Scotia* (2011)[106]	This guide describes how climate change considerations should be incorporated into EIA processes and components of EIA documents, including: (1) project description, (2) existing environment, (3) issue scoping, (4) identification of valued environmental components, (5) impact assessment, (6) identification of significant impacts, (7) effects of the environment on the project, (8) mitigation and monitoring. Recommends including an adaptation plan for projects that are identified as medium or high risk for climate change impacts.
Kiribati	*Adaptation Handbook: Undertaking Risk Treatment for Coastal Climate Change Risks in the Republic of Kiribati* (2009)[107]	This handbook outlines a step-by-step procedure for reviewing climate-related risks (primarily coastal risks) and selecting risk mitigation measures.
Netherlands	*The NCEA's Recommendations on Climate Change in Environmental Assessment* (2009)[108]	This paper describes the NCEA's approach to assessing climate change adaptation during the EIA process. Notes that the assessment depends on circumstantial factors, including the local climatological impacts in the long and short term; the nature of the area in which the adaptation must take place; an estimate of the risks; how the additional short-term costs relate

[105] BC Ministry of Environment, *Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use* (2011).

[106] Nova Scotia Environment, *Guide to Considering Climate Change in Environmental Assessments in Nova Scotia* (2011). For a 2003 version of this guide, see ClimAdapt, *Practitioner's Guide: Incorporating Climate Change into the Environmental Impact Assessment Process* (2003).

[107] C. Elrick & R. Kay, *Adaptation Handbook: Undertaking Risk Treatment for Coastal Climate Change Risks in the Republic of Kiribati*, Prepared for the Kiribati Adaptation Project Phase II (KAP II), Government of Kiribati (2009).

[108] Netherlands Commission for Environmental Assessment (NCEA), *The NCEA's Recommendations on Climate Change in Environmental Assessment* (2009).

		to the costs avoided in the longer term (i.e. costs that increase as a result of management and maintenance, costs of later compulsory modifications, and costs incurred because there is now no room for other functions, such as water storage). If adaptation is deemed to be a factor of significance, the NCEA requires information to be given on how the initiative can best respond to the impacts of climate change: how the risk of damage can be limited, and at the same time how the quality of life, the spatial quality and the safety can be maintained or enhanced. They also require information to be given about whether the project might hamper necessary adaptation measures in the future, for example by taking up space and thereby making it no longer possible to store water.
New Zealand	*Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand* (2008)[109]	This Guidance Manual is designed to help local governments identify and quantify opportunities and hazards that climate change poses for their functions, responsibilities and infrastructure. It provides projections of future climate change in New Zealand, identifies potential effects on local government functions and services, outlines methods for assessing the likely magnitude of such effects and explains how this information can be applied to assess the risk associated with various climate change impacts. It also provides guidance on incorporating climate risk assessment into local government regulatory, assessment and planning processes.
United Kingdom	*Strategic Environmental Assessment and Climate Change: Guidance for Practitioners* (2011)[110]	This guidance provides general recommendations on how climate change issues can be considered in strategic environmental assessments (SEA) in England and Wales. It presents information on the causes and impacts of climate change and how they can be described and evaluated in SEA. It also describes how adaptation and mitigation measures can be developed through SEA.
	Greater London Authority (GLA), *Adapting to Climate Change: A Checklist for Development. London: London Climate Change Partnership* (2005)[111]	The overall aims of the document are to assist developers and their design teams to future- proof developments at the design stage, to incorporate resilience to climate change impacts within existing communities, and to help planners scrutinizing planning applications. The resulting checklist provides a useful framework for reviewing climate change impacts on urban ventilation and cooling, urban drainage and flood risk, water resources, and outdoor spaces.

[109] New Zealand Ministry for the Environment, *Climate Change Effects and Impacts Assessment: A Guidance Manual for Local Government in New Zealand* (2008).

[110] UK Environment Agency, *Strategic Environmental Assessment and Climate Change: Guidance for Practitioners* (2011).

[111] Greater London Authority (GLA), *Adapting to Climate Change: A Checklist for Development. London: London Climate Change Partnership* (2005).

3.4 Intergovernmental and Nongovernmental Organizations

A variety of different intergovernmental and nongovernmental organizations have issued voluntary guidelines and protocols to support the assessment of climate risks in the context of EIA and development planning. These resources vary substantially in terms of scope and technical detail. The IEMA Principles on Climate Change Adaptation and EIA (2010) are particularly useful for the purpose of developing legal protocols for climate risk assessment, as they provide clear direction without overly constraining the discretion of agencies and project proponents that will conduct such assessments.

Table 3.4. Intergovernmental and Nongovernmental Guidance and Assessment Frameworks

Organization	Title	Content
Caribbean Community and Common Market (CARICOM)	*Guide to the Integration of Climate Change Adaptation into the Environmental Impact Assessment (EIA) Process* (2004)[112]	This guide prescribes a six step process for addressing climate change effects in EIA in Caribbean countries: 1 – Define project and alternatives 2 – Conduct preliminary vulnerability assessment 3 – Conduct initial screening for climate change impacts and risks 4 – Scoping: identify key issues and information needs 5 – Assessment and evaluation 6 – Develop an environmental management plan
Engineers Canada, Public Infrastructure Engineering Vulnerability Committee (PIEVC)	*PIEVC Engineering Protocol for Infrastructure Vulnerability Assessment and Adaptation to a Changing Climate* (2011)[113]	This is a very detailed technical protocol for assessing the vulnerability of new and existing infrastructure to the impacts of climate change. It provides information on: • Data gathering and sufficiency (including a list of climate data resources, focused on Canada) • Risk assessments • Engineering analysis The protocol is focused on technical rather than legal considerations.
European Spatial Planning (ESPACE)	Climate Change Impacts and Spatial Planning Decision Support Guidance (2008)[114]	Concentrating on climate change adaptation, this guidance document presents a series of tools which can be used to assist planners in carrying out their own high level climate change risk assessment on development options. The guidance contains several tools to help spatial planners consider potential climate change impacts when evaluating different planning options.

[112] CARICOM, *Guide to the Integration of Climate Change Adaptation into the Environmental Impact Assessment (EIA) Process* (2004).

[113] Engineers Canada, *PIEVC Engineering Protocol for Infrastructure Vulnerability Assessment and Adaptation to a Changing Climate* (2011).

[114] ESPACE, Climate Change Impacts and Spatial Planning Decision Support Guidance (2008).

Institute of Environmental Management & Assessment (IEMA)	*Principles on Climate Change Adaptation & EIA* (2010)[115]	These principles establish a framework for integrating climate change considerations into EIA through the application of 20 principles. These principles are prescriptive but not overly technical. For example: ***Principle 11 (Significance)*** **-** Where the EIA identifies impacts likely to be generated as a consequence of predicted changes in the climate their significance should be evaluated based on a combination of: • Scenarios: an impact's likelihood under a range of climate scenarios; • Vulnerability: a receptor's vulnerability to existing climatic variations; and • Resilience: a receptor's ability to absorb such disturbance and continue to function. Where the EIA identifies that the likely consequences of climate change pose significant risk to a project's ability to effectively function in the future, the assessment should aim to ensure the costs of not adapting are properly considered in the design process.
International Association for Impact Assessment	*Climate Change in Impact Assessment: International Best Practice Principles* (2012)[116]	These best practice principles are intended to help practitioners integrate climate change considerations into both project-level and strategy-level impact assessments. The protocols deal with both mitigation and adaptation. The protocols deal with screening and scoping for climate impacts, refining project baselines, conducting vulnerability assessments, identifying adaptation objectives and measures to implement those objectives, using the best available science, discussing uncertainty, and follow-up assessments / adaptive management.
Organization for Economic Cooperation and Development (OECD)	*Incorporating Climate Change Impacts and Adaptation in Environmental Impact Assessments: Opportunities and Challenges* (2010)[117]	This report identifies key considerations for EIA of climate risks and adaptation options and outlines a rationale for assessing such risks in the EIA context. It does not, however, contain specific guidelines on how to conduct that assessment.
	Strategic Environmental Assessment and Adaptation to Climate Change (2008).[118]	This is one in a series of Advisory Notes that supplement the OECD/DAC Good Practice Guidance on Strategic Environmental Assessment (SEA) (OECD/DAC 2006). The Guidance provides a broad framework, steps and principles of SEA application across the full range of policies, plans and programmes. This Advisory note supplements that analysis with additional recommendations on addressing climate change adaptation through SEA.

[115] *IEMA Principles on Climate Change Adaptation & EIA* (2010).

[116] P. Byer et al., *Climate Change in Impact Assessment: International Best Practice Principles*, Special Publication Series No. 8 (International Association for Impact Assessment 2012).

[117] OECD, *Incorporating Climate Change Impacts and Adaptation in Environmental Impact Assessments: Opportunities and Challenges* (2010).

[118] OECD, *Advisory Note: Strategic Environmental Assessment and Adaptation to Climate Change* (2008).

4. SURVEY OF FEDERAL PRACTICE UNDER NEPA

This section describes the results of several studies examining how federal EISs assessed the impacts of climate change on proposed. These surveys show that it has become increasingly common for federal agencies to address these issues. However, in the absence of final guidance from CEQ, many EISs still fail to account for the impacts of climate change on the project and its affected environment. In those EISs that do consider such impacts, the scope and depth of the analysis varies substantially, and it is still very rare for an agency to conduct an in-depth assessment of how climate change may affect a project and its surrounding environment.

4.1 Sabin Center Study of Federal EISs, 2009-2011

The Sabin Center conducted two previous studies of how federal EISs engaged with issues related to climate change. In July 2012, the Center published "Consideration of Climate Change in Federal EISs, 2009 – 2011," which tracked the analysis of climate change in 227 EISs prepared between January 1, 2009 and December 31, 2011. [119] One of the analytical areas covered in that paper was the impact climate change on the project.[120] 102 of the 227 EISs (44%) included some discussion of how climate change would impact the project or its surrounding environment. The key findings from that report were summarized as follows:

> While greenhouse gas emissions from projects are frequently addressed in EISs, the effects of climate change on the proposed projects are considered far less often. Preparing agencies face considerable scientific uncertainty about the severity and exact nature of climate change impacts at the regional level, and projections are even more difficult at the local level. Infrastructure project EISs often briefly analyze the impacts of climate change on the region or locality in which the project is located without addressing the direct impacts of climate change on the project itself. Climate impacts in the project region are often discussed in order to consider their effect on a resource which the project might also impact. For example, an EIS for a project which adversely impacts surrounding wetlands may also address climate change impacts on the wetland and consider the cumulative effect of both climate and project impacts on the wetland.

[119] Patrick Woolsey, *Consideration of Climate Change in Federal EISs, 2009-2011* (Center for Climate Change Law 2012).

[120] As noted in the paper, "[t]his category includes the effects of rising sea levels and water tables, increased flooding, extreme weather events, greater temperature variations, water shortages, reduced snowpack and other occurrences that require adaptation." *Id.* at 6.

> The degree to which impacts of climate change on a project are included correlates more with project type and location than with the preparing agency. The potential effects of climate change on a project are most likely to be considered for coastal or water-related projects (irrigation and reservoirs, ports, bridges, waterfront development), military projects and land management or forestry EISs. Most commonly, impacts such as sea level rise and flooding are included for projects in coastal locations and water supply projects. Many types of coastal infrastructure are vulnerable to sea level rise and increased storm intensity, including ports, coastal nuclear reactors and military facilities. Projects in marine or coastal settings are likely to consider the effects of sea level rise and increased storm intensity, as well as impacts on marine habitats from rising sea temperatures. However, these impacts are often considered not in relation to the project itself, but rather to its surrounding environment.
>
> In EISs which do not involve coastal sites or water projects, analysis of the impact of climate change on a project is often limited to a brief discussion of climate impacts on wildlife species or vegetation as a secondary or compounding impact. Projects in desert areas, such as solar energy projects or transmission lines, are also likely to discuss the impacts of climate change and temperature increase on the surrounding ecosystem, although impact analyses are often limited to their effect on the environment rather than on the project.[121]

In March 2013, the Center published a more targeted study on the analysis of climate change-related water impacts in federal EISs prepared between January and September of 2012."[122] This study examined how federal EISs addressed issues relating to water usage, water shortage and drought, sea level rise and water tables, and flooding. The study found that there was considerable variation in the treatment of these issues across different projects and agencies. Unsurprisingly, projects with more significant water usage impacts tended to include a more extensive discussion of water-related issues in the EIS—but this discussion did not necessarily include any analysis of how climate change may impact future water supply. The one context where climate change did frequently factor into the analysis was when sea level was assessed for coastal infrastructure projects—however, the quality of the discussion varied considerably, and some coastal projects did not even discuss sea level rise.[123]

[121] *Id.* at 15-16.

[122] Cathy Li, *Discussion of Climate Change-Related Water Impacts in Federal Environmental Impact Statements (EISs), January-September 2012* (Center for Climate Change Law 2013).

[123] *Id.* at 9.

4.2 Defenders of Wildlife Study of Federal EISs, 2011-2012

In 2013, Defenders of Wildlife published its own study on the assessment of climate change impacts in environmental impact statements.[124] Defenders of Wildlife analyzed 154 Final EISs released between July 2011 and April 2012 to determine how well these documents incorporated the climate adaptation elements of the 2010 draft guidance. Their study included EISs in a range of categories including land and resource management actions as well as projects involving the construction of buildings and infrastructure.

They formulated ten questions based on the various elements discussed in the guidance, intending to score the EISs on how well they answered these questions.[125] However, they discovered that only 10% of the EISs included enough information to even apply the questions.[126] As discussed below, we reached a similar conclusion during our review of federal EISs prepared between 2012 and 2014, and therefore relied on five broader questions for our general evaluation of the EISs. The key findings from the Defenders of Wildlife study were as follows:

- 26 of the EISs (17%) included limited consideration of climate impacts to the project and affected environment.[127]
- Eight (5%) demonstrated a recognition of potential climate change impacts, but considered them only with respect to the outcome of the project itself, while ignoring climate change impacts on the resources affected by the project.
- 38 EISs (25%) contained a discussion of climate change which only considered the project's GHG emissions footprint, with no mention of the potential impacts to either the project or affected resources, let alone consideration of adaptation measures for those impacts.

[124] Defenders of Wildlife, *Reasonably Foreseeable Futures: Climate Change, Adaptation and NEPA* (2013).

[125] The questions included: (1) does the EIS include relevant and recent information? (2) Does the EIS include downscaled modeling? (3) Are projections made using appropriate timescales? (4) Does the EIS discuss the impact of climate change on the reasonably foreseeable future condition of affected resources under No Action? (5) Does the EIS discuss the impact of climate change on the reasonably foreseeable future condition of affected resources under the various alternatives? (6) Does the EIS discuss the impact of climate change on the success or outcome of the proposed action? (7) Does the EIS identify and work through climate related uncertainties? (8)_ Does the project include a monitoring program adequate to detect effects of climate change? (9) Does the agency discuss the impact of climate change on vulnerable human communities? (10) Does the mitigation section of the EIS discuss ways to mitigate the project's impacts to reduce climate change effects? *Id.* at 8-9.

[126] *Id.* at 3.

[127] The discrepancy between this figure and the results of the 2009-2012 Sabin Center survey may be explained by two factors: (1) the Defenders of Wildlife survey relied on a smaller EIS sample; (2) the Sabin Center survey examined whether the EISs contained some discussion of how climate change would impact the project *or* the affected environment, whereas the Defenders of Wildlife survey examined whether EISs considered the impact of climate change on the project *and* the affected environment.

- Nearly one-third contained a brief mention of climate change but failed to incorporate any meaningful analysis of climate change mitigation or adaptation considerations.
- 19 (12%) did not mention climate change anywhere in the document.[128]

Defenders of Wildlife concluded that, in the absence of final CEQ guidance, most EISs did not contain an adequate discussion of climate change impacts and adaptation considerations. [129]

4.3 Sabin Center Study of Federal EISs, 2012-2014

The Sabin Center conducted a follow-up study of over 300 federal EISs prepared between July 2012 and December 2014 to determine if climate change has become a more prevalent consideration in these documents. The scope of that study is broader than the scope of this paper: it covers *all* categories of EISs, including land management actions, and a variety of topics relating to both mitigation and adaptation.

For the purposes of this paper, we selected 117 projects that involve public infrastructure and construction, and applied a more targeted set of questions to those projects:

(1) Does the EIS contain *any* discussion of how climate change will impact the project or its surrounding environment?

(2) Does the EIS discuss how climate change will impact the quantity or quality of *water resources* to be used or affected by the project?

(3) Does the EIS examine how climate change will impact the *affected environment* of the project, taking into account the various environmental and human resources in the area?[130]

(4) Does the EIS examine the impacts of climate change on the *project itself* and any implications that this may have for the resilience of the project or the environmental consequences of the project?

(5) Did the analysis of climate change impacts influence the agency's final decision in any way, e.g., by causing the agency to: (i) conclude that an otherwise insignificant impact was significant, (ii) modify design features, or (iii) implement additional mitigation measures?

The results of this survey are summarized in Table 4.0 (see next page), and discussed in further detail below.

[128] Defenders of Wildlife (2013), *supra* note 124, at 3.

[129] *Id.*

[130] EISs that merely acknowledged that an impact such as sea level rise may occur in the project area without discussing how it would affect one or more aspects of the local environment were not included under this category. Similarly, EISs that *only* discussed impacts on water supply (without discussing impacts on aquatic ecosystems or species) were not included since this issue was captured in the second category.

Table 4.0 - Consideration of Climate Change Impacts in Federal EISs Involving Physical Infrastructure, July 2012 – December 2014

EIS Category	Total EISs	Q1		Q2		Q3		Q4		Q5	
		#	%	#	%	#	%	#	%	#	%
Low-Carbon Electric Generation	13	12	92%	11	85%	11	85%	3	23%	1	7%
Electric Transmission	8	4	50%	2	25%	4	50%	1	12.5%	1	12%
Energy Development and Mining	26	23	88%	14	54%	22	85%	8	31%	4	15%
Transportation	40	10	25%	0	0%	4	10%	4	10%	1	2%
Public Works	18	16	88%	13	72%	9	50%	12	67%	9	50%
Buildings and Real Estate	12	7	58%	6	50%	4	33%	4	33%	2	16%
Total (all categories)	**117**	**72**	**61%**	**46**	**39%**	**54**	**46%**	**32**	**27%**	**18**	**15%**

Key Findings **-** The percentage of EISs that discuss the impacts of climate change has grown, but the scope of the analysis varies quite substantially between project categories. There were also considerable differences between EISs within any given category. Moreover, although it has become increasingly common for agencies to acknowledge the impacts of climate change on a project or the surrounding environment, it is still quite rare for agencies to actually incorporate this into final decisions about project design, selection of alternatives, or mitigation measures—only 15% of the EISs indicated that climate change considerations had factored into these final decisions about how to go forward with the project.

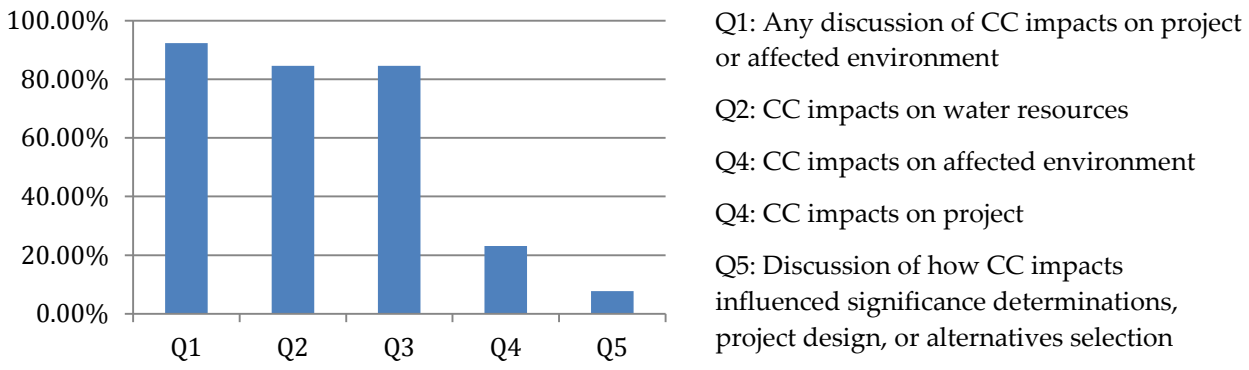
The chief justification for ignoring the impacts of climate change on a project and the surrounding environment was that the project would not generate a significant level of GHG emissions.[131] In some EISs, it also appeared that there was confusion about the difference between evaluating the contribution of a project to climate change and evaluating the impacts of climate change on the project. For example, in response to an EPA request to "evaluate climate change effects on" a proposed dam modification, USACE responded: "The proposed project's impact on

[131] *See, e.g.,* U.S. Department of Energy, Final Champlain Hudson Power Express EIS 5-188 – 5-189 (2014) ("At present, there is no methodology that would allow DOE to estimate the specific impacts (if any) this increment of climate change would produce near the proposed CHPE Project or elsewhere").

greenhouse gas emissions on climate change was evaluated in the DEIS. It is located in section 3.5 - Air Quality, in the DEIS."[132]

Low-Carbon Electric Generation – The low-carbon electric generation category included hydroelectric, solar, wind, nuclear, and carbon capture and sequestration facilities. 92% (12/13) of the EISs for electric generation projects contained some discussion of how climate change would affect the project or surrounding environment, and 85% (11/13) included a discussion of how climate change would affect water resources required for the project. However, only three of the EISs in this category actually analyzed *how* those impacts may influence the construction or operation of the facilities, and only one EIS provided for modified design features to address those impacts. Specifically, the EIS for the Blythe Solar Project in Palm Springs, CA noted the impacts that climate change may have on water supply in the context of both the proposed action and alternatives, and identified mitigation measures that could be implemented if there was reduced recharge to the underlying groundwater basin.[133] Interestingly, many of the EISs for renewal of Nuclear Plants contained a detailed description of climate impacts on the surrounding environment (e.g., water resources), but did not discuss the subsequent implications for power plant performance or environmental consequences such as runoff and spill risk.

Figure 4.1 – Climate Impact Assessment in Low Carbon Electric Generation Projects

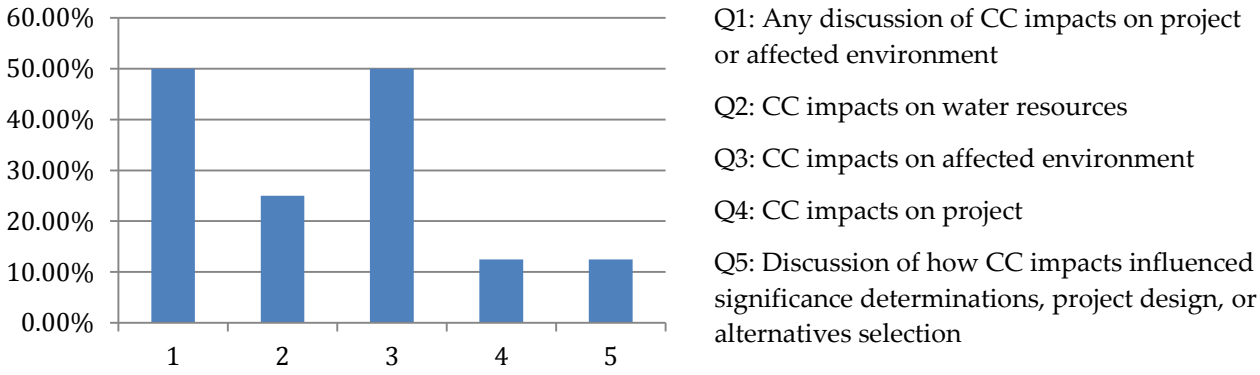


[132] U.S. Army Corps of Engineers, Isabella Lake Dam Safety Modification Project, To Remediate Seismic, Seepage, and Hydrologic Deficiencies in the Main Dam, Spillway and Auxiliary Dam FEIS A-17 (2012).

[133] U.S. Department of the Interior, Bureau of Land Management, Modified Blythe Solar Power Project, Proposed Amendment to Right-of-Way Grant FEIS 4.3-8 (2014).

Electric Transmission – Half (4/8) of the EISs for electric transmission projects contained some discussion of how climate change would impact the project or its surrounding environment, but this discussion tended to be quite limited. For example, one EIS merely included a paragraph about the global impacts of climate change and then briefly mentioned that climate change may impact one of the species located in the project area.[134] Another EIS included a very detailed description of the impacts of climate change in the state where the project was located (Arizona), but did not address any corresponding implications for the construction, operation or maintenance of the transmission line, or for the environmental resources that may be impacted by the project.[135]

Figure 4.2 – Climate Impact Assessment in Electric Transmission Projects



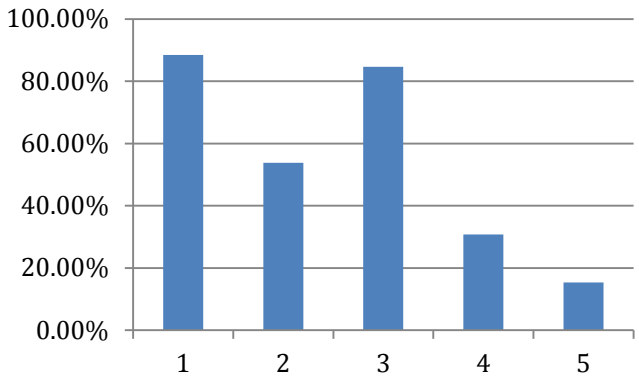
Energy Development and Mining – This category included coal, oil and gas development; mining projects; and associated infrastructure (e.g., tailings facilities, pipelines, and liquefaction projects). 88% (23/26) of the projects reviewed contained some discussion of climate change impacts, 85% (22/26) provided a summary of climate impacts on the affected environment, and 54% (14/26) evaluated impacts on water resources required for the project. The quality of the discussion varied substantially, perhaps due to the diversity of projects within this category. Some EISs, like those prepared for Keystone XL, the Rosemont Copper Mine, and the Tarmac King Road Limestone Mine, contained an extremely detailed analysis of how climate change could impact both the project and the surrounding environment. The Tarmac King Limestone Mine also

[134] U.S. Department of Agriculture, Antelope Valley Station to Neset Transmission FEIS 3-41, 4-32 (2014).

[135] U.S. Department of the Interior, Bureau of Land Management, APS Sun Valley to Morgan 500/230kV Transmission Line FEIS 3-12, 3-16 (2013).

included a mitigation plan with specific measures to address the impacts of climate change on the surrounding environment – e.g., "the [mitigation plan] will provide potential replacement habitat for salt marsh and coastal hydric hammock in the event of continued climate change and sea level rise."[136] In contrast, the EIS for an expansion of the Greens Creek Mine Tailings Disposal Facility Expansion, *located on a small island off the coast of Alaska,* briefly mentioned climate impacts but concluded that it was unnecessary to analyze these in the context of the project.[137]

Figure 4.3 – Climate Impact Assessment in Energy Development and Mining Projects



Transportation – Surprisingly, only 25% of EISs prepared for transportation projects considered *any* climate-related impacts. Issues such as increased average and extreme temperatures and increased precipitation were largely ignored for this category. The EISs for transportation projects located in coastal areas typically acknowledged the potential for sea level rise, but only one project was specifically designed to withstand future sea level rise (the San Francisco Ferry Terminal Expansion Project, which was a joint EIS/EIR prepared under both NEPA and CEQA).[138] The other EISs that identified climate impacts either concluded that these would not interfere with the operation and maintenance of the infrastructure or simply ignored these in final determinations about project design and alternatives selection. One noteworthy example is the EIS for the replacement of the Harbor Bridge and certain sections of US Highway 181 in Corpus

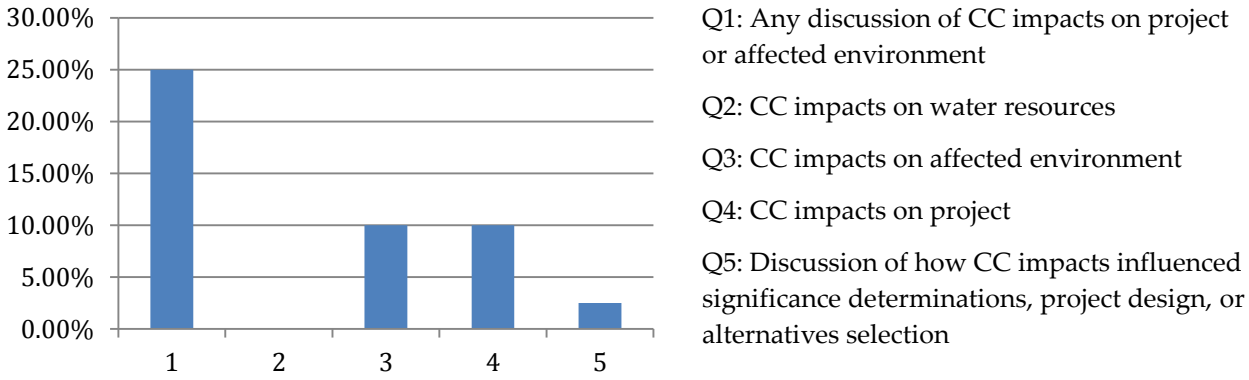
[136] U.S. Army Corps of Engineers, Tarmac King Road Limestone Mine FEIS, Appendix G: Mitigation Plan 2 (2013).

[137] U.S. Forest Service, Greens Creek Mine Tailings Disposal Facility Expansion FEIS 3-201, 3-301 - 3-302 (2013).

[138] San Francisco Bay Area Water Emergency Transportation Authority and the U.S. Department of Transportation Federal Transit Administration, Downtown San Francisco Ferry Terminal Expansion Project, Final EIS and Record of Decision/Environmental Impact Report (2014).

Christi, Texas (a coastal town). That EIS contained several general statements acknowledging projections of sea level rise in the area, but did not analyze the structural impact of sea level rise on the proposed project or alternatives.[139]

Figure 4.4 – Climate Impact Assessment in Transportation Projects



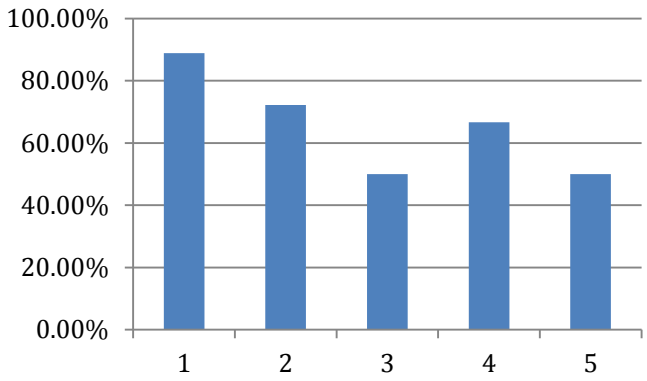
Public Works – The EISs in this category included water management, storm management, navigation, and landscape restoration projects, most of which were implemented by the U.S. Army Corps of Engineers (USACE). 89% (16/18) of the projects in this category mentioned the impacts of climate change on the project, and 73% (13/18) discussed the impact of climate change on water resources required for the project, but only 50% (9/18) provided additional details on how these impacts may affect the surrounding environment. Interestingly, this was the only category where more of the EISs (67%, 12/18) discussed the impact of climate change *on the project itself* as opposed to the impacts of climate change on the surrounding environment. Because many of these projects dealt with water management, changes in rainfall patterns were discussed more than any other impacts. Sea level rise also factored into the analysis of coastal projects.

Whereas climate change rarely factored into the final decision-making process in other EIS categories, 50% (9/18) of the EISs reviewed in this category indicated that consideration of climate change impacts had influenced the final design of the project. Overall, the EISs in this category contained the most comprehensive and analytical assessment of climate change impacts and their

[139] Federal Highway Administration, Texas Division, and the Texas Department of Transportation, Corpus Christi District, US 181 Harbor Bridge Project: From Beach Avenue to Morgan Avenue at the Crosstown Expressway Final EIS / Section 4(f) Evaluation 3-97, 3-99, 3-101 (2014).

implications for project operation. One noteworthy example is the Arkansas Valley Conduit in Colorado, which considered the impact of climate change on the operation of the project (and water resources required of the project), as well as the impact of climate change on *every* aspect of the affected environment.[140] This was one of two projects in the category that was implemented by the Bureau of Reclamation; the rest were implemented by USACE.

Figure 4.5 – Climate Impact Assessment in Public Works Projects



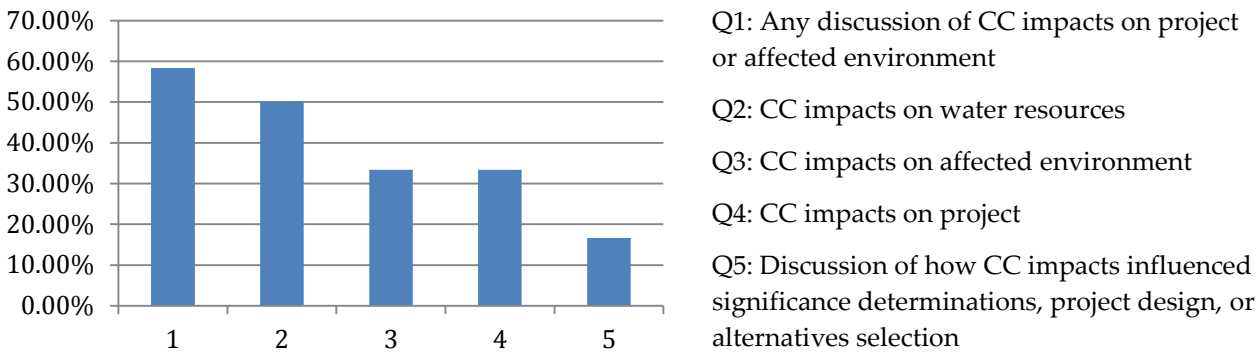
Buildings and Real Estate – This category included land use planning actions and private sector construction projects requiring a federal permit. 58% (7/12) of the EISs mentioned the impacts of climate change on the project or surrounding environment. 50% (6/12) described the impacts of climate change on water resources required for the project, and 33% (4/12) provided additional details on how these impacts would affect the surrounding environment. The quality of the analysis varied substantially. Two of the projects contained an in-depth analysis of climate impacts as well as modified design features to account for those impacts. The first, the Halletts Point Rezoning Project, fell within the land covered by New York City's new regulations requiring consideration of climate impacts and sea level rise for new development as well as SEQRA and CEQR. It included a detailed discussion of flood risk and sea level rise for a waterfront development project.[141] The second, the Cloverdale Rancheria Casino Project, assessed the significance of climate impacts with respect to each alternative and discussed how mitigation

[140] Bureau of Reclamation, Arkansas Valley Conduit Long-Term Excess Capacity Master Contract FEIS -5 - 4-9; 4-11; 4-36; 4-37; 4-44; 4-76 - 5-77; 4-84; 4-100 - 4-101; 4-109 - 4-110; 4-138 - 4-139; 4-150; 4-161; 4-163; 4-170 (2013).

[141] New York City Department of City Planning and the U.S. Department of Housing and Urban Development (HUD), Halletts Point Rezoning FEIS 17-9 – 17-14 (2013).

measures would address any potentially significant impacts.[142] Both of these EISs are discussed in greater detail below.

Figure 4.6 – Climate Impact Assessment in Building and Real Estate Projects



4.3.1. Trends and Best Practices in Federal EISs, 2012-2014

The EISs that discussed climate change impacts were analyzed to identify trends and best practices. For the purposes of this analysis, we considered eight of the ten questions originally put forth by Defenders of Wildlife in their survey of federal EISs:

(1) Does the EIS include relevant and recent information?

(2) Does the EIS include downscaled modeling?

(3) Are projections made using appropriate timescales?

(4) Does the EIS discuss the impact of climate change on the reasonably foreseeable future condition of affected resources under No Action?

(5) Does the EIS discuss the impact of climate change on the reasonably foreseeable future condition of affected resources under the various alternatives?

(6) Does the EIS discuss the impact of climate change on the success or outcome of the proposed action?

(7) Does the EIS identify and work through climate related uncertainties?

(8) Does the project include a monitoring program adequate to detect effects of climate change?

Several of these questions involve subjective determinations (e.g., as to the relevancy of data, what constitutes a "downscaled" impact model, and the appropriateness of timescales), and thus it was

[142] U.S. Department of the Interior, Bureau of Indian Affairs, Cloverdale Rancheria of Pomo Indians' Proposed 65-Acre Fee-to-Trust Acquisition and Resort Casino Project FEIS (2013) at 4.4-8, 4.4-14, 4.4-19, 4.4-25, 4.4-31.

not possible to conduct a quantitative analysis using this rubric. Rather, we focused on a qualitative examination of how EISs in our sample selection addressed these issues.

1. Quality of Data **-** The EISs typically relied on the most recent data available from the Intergovernmental Panel on Climate Change (IPCC), the U.S. Global Change Research Program (USGCRP), the National Oceanic and Atmospheric Administration (NOAA), and other federal agencies. The EISs also used data from academic articles and other climate assessments to evaluate regional and local climate impacts, where such resources were available. These data were most frequently used to develop multiple scenarios for assessing climate impacts. However, the EISs did not always explain *how* they were using this data in their analysis, nor did they disclose all of the underlying assumptions and uncertainties associated with the data.

2. Geographic scale of analysis **-** The EISs relied on regional climate projections for their analysis, since this was the most local scale at which credible data was available.

3. Timeframe for Analysis **–** The EISs used the projected duration of the project as the timeframe for analyzing climate impacts. These typically fell within 50-100 years. Several EISs distinguished between short- mid- and long-term impacts, but they generally did not attempt to specify precisely what impacts would fall within a given period due to the inherent uncertainty of this analysis.

4. Impact of Climate Change on Baseline Environmental Conditions and the No Action Alternative **–** There was significant variation in terms of: (i) whether impacts on baseline environmental conditions were considered, (ii) how these impacts were considered, and (iii) where this analysis was located in the EIS. Some EISs discussed climate change in the description of the affected environment, and others discussed this only in the context of cumulative impacts or in a separate section that dealt with climate change. There were a few exemplary EISs that integrated climate impact considerations into the discussion of various affected resources (e.g., ground water, surface water, biological diversity, etc.)—this analysis was typically more informative than EISs that only discussed climate change in a separate section. Even within individual EISs, there was a lack of consistency in terms of where and how climate impacts were addressed—for example, an EIS may list certain climate impacts in the context of one aspect of the affected environment, and ignore climate impacts in the context of other affected resources.

5. Impact of Climate Change on Preferred and Other Alternatives – As noted in Table 4.0, only 27% of the EISs actually discussed the impact of climate change on the proposed project. There were only a handful of exemplary EISs (several of which are highlighted below) that actually discussed impacts on other alternatives, and whether those alternatives might be more resilient to t hose impacts. In the vast majority of EISs, climate change impacts had no bearing on the initial identification of alternatives or the final decision on which alternative to implement.

6. Impact of Climate Change on the Outcome or Success of the Proposed Action – This issue was discussed in some EISs, but the analysis tended to be quite brief. The EISs that confronted this issue at all would typically acknowledge that climate change may affect project performance or environmental outcomes but then conclude that these effects were too speculative for further analysis. Several EISs did examine the issue further, but ultimately concluded that climate change would not alter the significance of environmental impacts or the performance of the project. For example, many of the coastal infrastructure projects concluded that sea level rise would not affect the project because critical structures and equipment would be located at a sufficient height to withstand future sea level rise.

7. Uncertainty – Almost all of the EISs mentioned uncertainty, but the extent to which they "worked through" that uncertainty varied substantially. The EISs with the most detailed analysis used scenario modeling to address uncertainties, which typically corresponded with different global climate models and emissions scenarios. The Keystone XL EIS took a precautionary approach justified their conclusions about project impacts and design features by referring to worst case scenarios of climate change.[143]

8. Monitoring – Aside from several coastal projects that included monitoring for coastal storms, there were no EISs that included a specific monitoring program for climate change effects.

Based on this analysis, we identified several EISs which contained a particularly in-depth analysis of climate change impacts. These are summarized in Table 4.4 (see next page). Language from these EISs is also excerpted in Appendix C: Excerpts of Climate Change Risk Assessments in Federal EISs.

[143] U.S. Department of State, Keystone XL Project, Final Supplemental EIS (2014).

Table 4.4 – Federal EISs with Detailed Assessment of Climate Change Impacts

EIS	Project Description	Discussion of Climate Change Impacts
Arkansas Valley Conduit FEIS (2013)	Water supply pipeline in the Arkansas River Basin, consisting of over 200 miles of buried pipeline, a water treatment facility, and other related facilities. Lead agency: U.S. Bureau of Reclamation EIA Law: NEPA	This EIS considered the impact of climate change on the operation of the project and alternatives, as well as the impact of climate change on each aspect of the affected environment. [144] The EIS contained a particularly detailed analysis of how climate change may impact water yield in the Colorado river basin. This analysis was used to evaluate the proposed action as well as the no action alternative and one other proposed alternative.[145]
Cloverdale Rancheria Casino FEIS (2014)	Development of resort casino in Cloverdale, CA (64.52 acres). Lead federal agency: United States Bureau of Indian Affairs (BIA) EIA Laws: NEPA, CEQA	This EIS addressed how climate change would impact significance determinations for the preferred alternative and all of the other alternatives discussed in the EIS, and identified mitigation measures as needed to address any potentially significant impacts. This analysis focused on the impact of climate change on water resources required for the project, flooding, and storm events. Although the impact of climate change on temperatures was briefly noted, it did not factor into the comparison of alternatives.[146]
Halletts Point Rezoning FEIS (2013)	Mixed-used development along the East River in Astoria, Queens, New York (9.66 acres). Lead federal agency: Housing and Urban Development (HUD) EIA Laws: NEPA, SEQRA, and CEQR.	This EIS contained a relatively detailed discussion of how sea level rise and flooding may impact the proposed waterfront development and possible risk mitigation measures. However, the project proponent elected not to adopt certain risk mitigation measures, such as situating the project at an elevation that would be sufficient to prevent flooding in the context of anticipated sea level rise to 2050 and 2100.[147] Chapter 10 (natural resources) integrated climate change considerations into the general discussion of how the project will impact the surrounding environment. This discussion primarily focused on sea level rise and flooding impacts, which were considered in the discussion of the project's impacts as well as the no action alternative. The EIS noted that "true floodplain boundaries may exist further inland than currently mapped as a result of projected rises in sea level caused by global climate change, but overall, floodplains as well as groundwater within the project site are expected to remain largely unchanged." Chapter 17 (GHG Emissions) discussed the resilience of the

[144] Bureau of Reclamation, Arkansas Valley Conduit Long-Term Excess Capacity Master Contract FEIS 4-5 - 4-12; 4-36; 4-37; 4-44; 4-76 - 5-77; 4-84; 4-100 - 4-101; 4-109 - 4-110; 4-138 - 4-139; 4-150; 4-161; 4-163; 4-170 (2013).

[145] *Id.* at 4-9 – 4-12.

[146] U.S. Department of the Interior, Bureau of Indian Affairs, Cloverdale Rancheria of Pomo Indians' Proposed 65-Acre Fee-to-Trust Acquisition and Resort Casino Project FEIS (2013).

[147] New York City Department of City Planning and the U.S. Department of Housing and Urban Development (HUD), Halletts Point Rezoning FEIS (2013).

		proposed project to climate change, focusing on coastal impacts and flooding. The EIS noted that proposed project was situated only 3 feet above the 100-year flood levels, which is still above the projected sea level rise estimate of 1-2 feet by mid-century, but "may be within the range of end-of-century 100-year flood levels." It specified that proposed buildings would be flood-proofed and would utilize flood barriers on an as-needed basis. In addition, it stated that the elevation of buildings would be increased if FEMA updated flood maps before project construction began. Finally, the EIS stated that: "to the extent practicable and feasible, the proposed project would elevate emergency generators, fuel pumps, and water, electricity, and gas distribution well above future flood levels and flood-protect those utility connections and fuel tanks that are required to be at lower elevations."
Keystone XL Project, Final Supplemental EIS (2014)	875-mile pipeline project that would extend from Morgan, Montana, to Steele City, Nebraska. Lead federal agency: U.S. Department of State EIA Law: NEPA	Chapter 4 contained a section dedicated to evaluating climate changes impacts on the construction and operation of the proposed project. The EIS identified three emissions scenarios—a high (A2) scenario, a medium (A1B) scenario, and a low (B1) scenario. The EIS preparers decided to take a "precautionary approach by using the worst-case projections (A2 scenario) to ensure potential impacts and outcomes [of climate change] are not underestimated."[148] The EIS then reviewed anticipated climate impacts under a worst case scenario for the two climate regions where the pipeline would be located (the Dry Temperature climate region and the Prairie climate region). The specific data underlying the climate impact projections presented in in Appendix V, Literature Review. The EIS included climate projections that matched the anticipated operational life of the project (50 years, 20-15-2065) as well as projections from 2070-2099, to account for the possibility that the pipeline would be in operation longer than anticipated. Climate impacts were reviewed in two categories: (1) the direct impacts of changing temperatures and precipitation on the pipeline, and (2) the impact of climate change on the affected environment, including soils, water resources (surface and ground), wetlands, terrestrial vegetation, fisheries, wildlife and threatened and endangered species, land use, socioeconomics, cultural resources, air quality and noise, and potential releases.
Suncreek Specific Plan FEIS (2012)	Mixed-use development and supporting infrastructure improvements in Rancho Cordova, California (1,265 acres). Lead federal agency:	This EIS contained a detailed assessment of multiple climate impacts, including: increased average temperatures; changes in the timing, amount, and form (rain versus snow) of precipitation; changes in the timing and amount of runoff; reduced water supply; deterioration of water quality; elevated sea level; and agricultural changes. For each impact, the EIS discussed: (i) the status of current

[148] U.S. Department of State, Keystone XL Final Supplemental EIS (2014) at 4.14 - 4.19.

	USACE EIA Laws: NEPA, CEQA.	scientific information and adapt about past trends; (ii) projected future changes and the accuracy and variability of modeling results, including identification of results presumed too speculative for conclusive analysis; and (iii) potential for the environmental effects of climate change to affect the proposed project alternative, based on both the certainty or uncertainty of modeling results and the physical nature of the effect. The EIS also noted that climate change may also impact energy supply but did not analyze this issue, explaining that these impacts were too speculative to assess how they might influence the proposed project. The EIS relied on multiple global warming scenarios based on different global climate models and emissions scenarios. Relied on state-level (California) projections when these were available, and compared these to global projections.[149]
Tarmac King Road Limestone Mine FEIS (2013)	Proposed mining approximately 3,900 acres of a 4,800-acre area about 80 miles north of Tampa. Lead agency: U.S Army Corps of Engineers EIA Laws: NEPA	This EIS contains a detailed description of how sea level rise may impact the project area based on four different sea level rise scenarios (baseline, low, intermediate, high). This analysis is accompanied by maps of predicted sea-level rise conditions on available topographic data with the project site superimposed.[150] The EIS also included a mitigation plan (Appendix G) with specific measures to address the impacts of climate change on the surrounding environment – e.g., "the [mitigation plan] will provide potential replacement habitat for salt marsh and coastal hydric hammock in the event of continued climate change and sea level rise."[151]

5. WORKSHOP OUTCOMES AND CASE STUDIES

On June 18, 2015, The Sabin Center for Climate Change Law hosted a workshop at Columbia Law School: "Protocols for Integrating Climate Risk Analysis into Environmental Impact Assessment Procedures." The workshop provided an opportunity for numerous stakeholders[152] to comment on an initial draft of the protocols presented in Section 6 of this paper,[153] and to discuss various opportunities and challenges associated with the consideration of climate change impacts

[149] U.S. Army Corps of Engineers and Sacramento District, Suncreek Specific Plan FEIS (2013).

[150] U.S. Army Corps of Engineers, Tarmac King Road Limestone Mine FEIS 3-52 – 3-57 (2013).

[151] Tarmac King Road Limestone Mine FEIS, Appendix G: Mitigation Plan 2 (2013).

[152] The stakeholders who were present at the June 18 workshop included representatives from the Council on Environmental Quality and other federal agencies, state agencies, EIA consulting groups, environmental organizations, and academic institutions.

[153] The protocols were subsequently revised based on input from the workshop stakeholders.

during the environmental assessment process. Some of the specific topics that were covered at the workshop included:

- What are the existing tools and informational resources that can be used to project and analyze impacts such as sea level rise and increased temperatures?
- To what extent are agencies and EIS preparers already assessing the impacts of climate change during environmental reviews?
- How should agencies conduct this analysis and how would this translate to the development of protocols or guidelines?
- What is the best method for incorporating such protocols into the environmental review process under NEPA and state equivalents?

The general consensus among participants was that agencies and project proponents are beginning to address climate impacts in their environmental reviews, but that there is a great deal of uncertainty as to exactly how such impacts can be evaluated in a manner that will be useful for decision-makers and ensure that project proponents are satisfying any legal obligations under NEPA and state equivalents. As such, the stakeholders were generally in favor of the development of more detailed protocols that could be used as a supplement to the CEQ guidance as well as any guidelines or directives issued at the state level.

Although some participants expressed concerns about the additional time and cost of addressing climate impacts in environmental reviews, most felt that this analysis could be structured in a way such that it would facilitate better decision-making without imposing an undue burden on the project proponent. Some of the participants did note that the difficulty of obtaining relevant data on climate change impacts could pose a barrier to effectively conducting this analysis. Thus, they recommended that one priority for federal and/or state policy-makers should be to compile the most current projections of on-the-ground climate change impacts, conduct vulnerability assessments, and make information readily available to government agencies and the public.

Several participants also presented case studies of projects where climate change vulnerability assessments and resilience measures were incorporated into the environmental review of the project. These cases are presented below.

5.1 Massachusetts

The Massachusetts Environmental Policy Act (MEPA) was amended in 2009 to require the consideration of GHG emissions and climate change impacts in environmental assessments. The state also published a *Draft MEPA Climate Change Adaptation and Resiliency Policy* in 2014, which identifies some of the key impacts that should be evaluated in MEPA reviews and calls for the preparation of a "climate impact assessment" to "evaluate how a project may be impacted by climate change related events and how the project itself may contribute to, or reduce, climate change impacts."[154]

Since 2012, the Massachusetts Environmental Policy Act Office has conducted environmental reviews of approximately 50 projects that address climate change adaptation and resiliency issues.[155] One example is the Redevelopment of the Government Center Garage project in downtown Boston.[156] The project involved redeveloping an old garage structure with transit-oriented, mixed-used phased development.

As part of the environmental review process for this project, the design team considered the potential impacts of climate change (predicted sea level rise, increased frequency and intensity of precipitation events, and extreme heat events) on the project and associated transportation infrastructure.[157] Based on this analysis, the design team concluded that the impacts of sea level rise would need to be considered for all project components (building elements), except one component which would be situated above even the highest scenario of sea level rise.[158] The analysis also revealed that the project could be impacted by more intense rainfall events, heat waves, and droughts.

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[154] Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, *Draft MEPA Climate Change Adaptation and Resiliency Policy* 5 (2014), *available at* http://www.lawandenvironment.com/wp-content/uploads/sites/5/2014/11/MEPA-Climate-Adaptation-and-Resiliency-Policy-November-2014-DRAFT-.pdf.

[155] Deirdre Buckley, MEPA Director, Massachusetts Executive Office of Energy and Environmental Affairs (EEA), Presentation at Columbia Law School Workshop: Protocols for Integrating Climate Risk Analysis into Environmental Impact Assessment (EIA) Procedures (June 18, 2015).

[156] Final Environmental Impact Report, Redevelopment of the Government Center Garage, EEA No. 15134 (2014), *available at* http://www.hyminvestments.com/images/GCG_FEIR_FINAL-09152014.pdf.

[157] FEIS Redevelopment of the Government Center Garage at 2-22.

[158] FEIS at 2-22.

The design team used the results of the analysis to identify potential design elements to mitigate the effects of climate change during the early stages of planning and design. The following resiliency measures were noted in the final EIR for the project: [159]

Sea Level Rise and Flood Risk

- Placing critical electrical and telecommunications equipment above the first floor, thus providing resiliency during flood events
- Stormwater harvesting to reduce the amount of stormwater run-off and supplement on-site irrigation and water needs for air conditioning
- Modified elevator locations and elevations
- Placing air intake and exhaust areas at least one level above ground-floor
- Modified ventilation system design
- Installing hard flooring materials on all first floors
- Flood protection for emergency generators and fuel supplies
- Measures to reduce flood risk at the subway station and bus station that would service the development project, including: the incorporation of flood-hardening measures, additional surface drainage elements that could direct stormwater away from the transit facilities, increasing the proposed grade to mitigate potential sudden rainfall events

Rising Temperatures

- Designing residential units for improved natural ventilation (i.e., operable windows)
- Altered HVAC design [160]
- Green roof to help mitigate extreme heat waves and reduce stormwater runoff

5.2 Washington

The Washington State Department of Transportation (WSDOT) published *Guidance for NEPA and SEPA Project-Level Climate Change Evaluations* in 2014. [161] This guidance document outlines an analytical process for considering climate change impacts and provides template language for conducting this assessment in the context of NEPA and SEPA reviews for WSDOT projects. Washington State agencies and research institutions have also conducted numerous

[159] FEIS at 2-23 – 2-24.

[160] FIES at 2-23.

[161] WSDOT, *Guidance for NEPA and SEPA Project-Level Climate Change Evaluations* (2014).

climate impact and vulnerability studies to better understand the manner in which climate change may impact the state's natural resources and built infrastructure, including transportation infrastructure.[162] A representative from WSDOT noted that these studies have facilitated meaningful assessment of climate change impacts for site-specific transportation projects.

The WSDOT representative also shared several examples of transportation projects where climate change adaptation and resiliency considerations factored into the design of the project and/or mitigation measures to address the project's environmental impacts.

One example was the State Route (SR) 520 Pontoon Construction Project which involved the building a new pontoon construction facility and subsequent construction of the pontoons needed to replace a floating bridge. For this project, WSDOT relied on sea level rise projections during the site selection and design of a wetland mitigation site.[163] The pontoon construction facility was also designed to "withstand the potential effects of long-term climate change."[164] Specifically, the facility incorporated features to protect the site from wave action during large storm events and to protect the surrounding harbor from potential contamination with waters from inside the facility during large storm events. The project developers also used native vegetation, driftwood, and other natural materials to protect and stabilize the shoreline and minimize erosion. Finally, the selected site was "graded to allow stormwater to run off the site more easily and protect the site against rises in sea level and from waves during a large storm."[165]

Another example was the Alaskan Way Viaduct (SR 99). The purpose of this project was to replace a viaduct that ran along the shoreline of Elliot Bay in downtown Seattle. The FEIS for the project discussed current research on projected sea level rise and other climate impacts over the

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[162] *See, e.g.*, John MacArthur et al., Washington State Department of Transportation, *Climate Change Impact Assessment for Surface Transportation in the Pacific Northwest and Alaska* (January 2012), *available at* http://www.wsdot.wa.gov/research/reports/fullreports/772.1.pdf; Washington State Department of Transportation, *Climate Impacts Vulnerability Assessment* (November 2011), *available at* http://www.wsdot.wa.gov/NR/rdonlyres/B290651B-24FD-40EC-BEC3-EE5097ED0618/0/WSDOTClimateImpactsVulnerabilityAssessmentforFHWA_120711.pdf; Climate Impacts Group, *The Washington Climate Change Impacts Assessment*, Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle, Washington (M. McGuire Elsner et al. eds., 2009), *available at* http://www.cses.washington.edu/db/pdf/wacciareport681.pdf;

[163] WSDOT and FHWA, *Draft Wetland and Aquatic Resources Mitigation Report – Grass Creek Mitigation Site, Pontoon Construction Project, SR 520 Bridge Replacement and HOV Program* 6-42 (December 2010), *available at* http://co.grays-harbor.wa.us/info/pub_svcs/PontoonProj/JARPA/JARPAAppendices/ApxG/Apx_G_101213.pdf.

[164] WSDOT and FHWA, *Final Environmental Impact Statement, SR 520 Bridge Replacement and HOV Program, SR 520 Pontoon Construction Project*, 3.6-11 (December 2010).

[165] *Id.*

100-year design life of the facility. In addition, the FEIS indicated that climate considerations would be incorporated into the final design of the project:

> To ensure that our facilities can function as intended for their planned 50-, 70-, or 100-year lifespan, they should be designed to perform under the variable conditions expected as a result of climate change. The standard design for this project has incorporated features that will provide greater resilience and function with the potential effects brought on by climate change. For example, drainage culverts may need to be resized to accommodate more intense rainfall events or increased flows due to more rapid glacial thawing.[166]

However, the FEIS did not confirm exactly which design features were selected to account for climate change. Rather, it appeared to leave open the possibility of further modifications to design features during the construction phase.

The FEIS for the Columbia River Crossing project provided a third example of how WSDOT incorporated climate impact considerations into its environmental review process. The purpose of this project was to replace the existing Interstate-5 crossing over the Columbia River. The project team relied on research conducted by University of Washington's Climate Impacts Group (CIG) to assess future conditions in the project location. The available data indicated that:

- Warmer winter temperatures in the Columbia River Basin would result in lowered snowpack and higher winter base flows. Lower base flows were expected in the spring and summer months, and an increased likelihood of more intense storms could increase the chance of flooding.
- Average annual precipitation was likely to stay within the range of 20th century variability.
- Sea level rise in the Pacific Northwest would vary with regional rates of uplift, but would be similar to the global average increase of 1.3 feet by 2100.
- Climate change could negatively impact salmon and trout populations in the Columbia River Basin, but climate change-induced impacts were anticipated to be less severe than other human activities that destroy or degrade freshwater habitat.[167]

Each of these projected changes was addressed in the cumulative impacts section of the FEIS to better understand how the project would affect protected species, water quality, and navigation.

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[166] Washington State Department of Transportation, Federal Highway Administration and City of Seattle, Alaskan Way Viaduct Replacement Project Final Environmental Impact Statement and Section 4(f) Evaluation (July 2011), *available at* http://www.wsdot.wa.gov/Projects/Viaduct/Library/Environmental.

[167] Oregon Department of Transportation, Washington State Department of Transportation, U.S. Department of Transportation, Final Environmental Impact Statement, Columbia River Crossing 3-446 (September 2011), *available at* http://library.state.or.us/repository/2011/201109191128141/.

The FEIS also incorporated measures to address the cumulative impact of the project and climate change on species, water quality, and navigation. These measures were included as part of an overarching Columbia River Crossing Sustainability Strategy. The measures specifically relating to climate change included:

- Eco-system based climate change adaptation: locating new and modified transportation and utility project components in a manner which would avoid fragmentation and degradation of significant floodplain hydrology.
- Stormwater management: restoring existing unused impervious paved areas to natural, permeable, and vegetated conditions to the maximum extent possible, and including treatment devices such as bioretention ponds, soil-amended bio-filtration swales, bioslopes, and constructed treatment wetlands in the stormwater management design.
- Bridge design: Designing the bridge to accommodate projected climate change-induced rise in the Columbia River's high water levels.[168]

The Columbia River Crossing project did not ultimately go forward as planned due to inadequate funding, but the FEIS still provides insight into how climate impacts can be incorporated into environmental reviews of major bridge projects.

5.3 New York

New York State has not adopted official laws or statewide guidance on the consideration of climate change impacts in environmental reviews under SEQRA. However, the Commissioner of the State Department of Environmental Conservation (DEC) published a 2010 policy directing all DEC staff to "identify potential adverse impacts from climate change" on all DEC programs, "incorporate climate change adaptation strategies into applicable DEC programs, actions and activities" and to "use the best available scientific information of environmental conditions resulting from the impacts of climate change." [169]

One of the case studies presented at the workshop was the Rockaway Delivery Lateral Project, a proposed natural gas pipeline and associated infrastructure connecting an offshore pipeline to an onshore delivery point in Queens County, New York. The Federal Energy Regulatory Commission (FERC) was the lead agency on this project. FERC received a comment

[168] *Id.* at 3-446 – 3-447.

[169] New York State Department of Environmental Conservation (DEC), *Commissioner's Policy – Climate Change and DEC Action* (2010), *available at* http://www.dec.ny.gov/regulations/65034.html.

from EPA regarding the potential for flooding to occur at the metering and regulating facility for the pipeline and how flood risk could be exacerbated by a potential increase in the frequency and intensity of Category 3 to 5 storms due to climate change and sea level rise.[170] The agency reviewed the Post-Sandy Advisory Base Flood Elevation map published by the Federal Emergency Management Authority (FEMA) and recent literature on likely sea level rise in NYC by 2100. Based on this information, the facility was designed to ensure that the lowest floor elevation and all equipment and wiring would be above the 100-year floodplain until 2085 (based on the highest sea level rise projected by the IPCC at that time).[171] The project proponent (Transco) also agreed to monitor future hurricanes and shut down the facility in advance of any potential flooding.[172]

The FEIS for the Memorial Sloan Kettering Cancer Center / CUNY-Hunter College Science and Health Professions Building provides another example of how climate change adaptation considerations factored into the environmental review process. Recognizing that most of the project would be located within the current 100-year floodplain, and that flooding may worsen as a result of sea level rise and other coastal impacts, the project developers incorporated many flood protection features into this project. Most of these features consisted of locating critical infrastructure on upper floors or otherwise above anticipated future flood levels.[173]

6. MODEL PROTOCOLS

These model protocols were developed as a complement to CEQ's guidance for considering climate change effects under NEPA, but they could also be adapted for use in environmental reviews conducted under state EIA laws.[174] They are based on the legal and empirical research presented in this paper, and have been revised to reflect input from the Stakeholder Workshop discussed in Section 5.

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[170] Federal Energy Regulatory Commission, Final Environmental Impact Statement, Rockaway Delivery Lateral and Northeast Connector Projects (Docket Nos. CP13-36-000 and CP13-132-000) 4-4 (February 18, 2014).

[171] *Id.* at 4-5.

[172] *Id.* at 4-7.

[173] NYC Office of the Deputy Mayor for Economic Development et al., Memorial Sloan Kettering Cancer Center – CUNY/Hunter College Science and Health Professions Building FEIS 11-17 – 11-19 (2013).

[174] NEPA terminology is used throughout the protocols. Many states use different terminology for the same concepts.

Model Protocols for Assessing the Impacts of Climate Change on the Built Environment under NEPA and State EIA Laws

Overarching Principles

1. **Agencies should evaluate and disclose the impacts of climate change when conducting environmental reviews in accordance with NEPA and its state equivalents. These impacts should be considered in the approval of a categorical exclusion (CE), the preparation of an environmental assessment (EA), and the scoping and preparation of an environmental impact statement (EIS).**

2. **Agencies should assess the impacts of climate change in the following contexts:**

    a. **Future baseline:** Whether climate change may influence the future baseline conditions which would exist in the absence of the proposed action (the no action alternative).

    b. **Project description:** Whether the project may be vulnerable to the impacts of climate change, taking into account the location of the project, the project's expected useful life, and the resilience of design features, construction materials, operational processes, and decommissioning processes.

    c. **Purpose and need for project:** Whether climate change may influence the need for the proposed project or the ability of the project to fulfill its intended purpose.

    d. **Affected environment and resources:** Whether climate change may increase the vulnerability of the affected environment and any natural and human resources that are impacted by the project.

    e. **Implications for the environmental consequences of the project:** Whether the impacts of climate change may exacerbate the environmental consequences of the project or generate new consequences which would not have otherwise occurred.

3. **Due to the uncertainty of the pace and magnitude of climate change, agencies should take a precautionary approach when assessing and disclosing the potential impacts of climate change: they should evaluate impacts by using multiple scenarios, including the most severe climate change projections developed by the IPCC and other authoritative bodies. The probabilities of each of the scenarios should be disclosed if they can be estimated.**

4. **The timeframe for this analysis should reflect the anticipated duration of the project, taking into account the operational lifetime as well as any decommissioning activities.**

5. **The scope and depth of this analysis should be proportional to the magnitude of the risk posed by climate change and the correlated vulnerability of the action and its affected environment to the impacts of climate change.**

6. **The analysis of climate change impacts should inform the selection of design features, alternatives, site location, mitigation measures, and other aspects of the final decision undertaken by the agency.**

Categorical Exclusions

1. **When reviewing existing or approving new categorical exclusion (CE) lists, agencies should consider whether any existing CEs should be removed or modified as a result of climate-related considerations.** Specifically, agencies should consider whether the category of actions may individually or cumulatively have a significant effect on the human environment, taking into account the impacts of climate change on those actions and the environmental settings in which they are typically located.

2. **Before approving a CE for a particular action, agencies should consider whether the impacts of climate change on the project and its affected environment constitute "unusual circumstances" which will require the agency to conduct additional environmental studies to determine whether the CE classification is proper.** Specifically, agencies should consider whether otherwise insignificant impacts may become significant due to the impacts of climate change on the project and its affected environment.

Environmental Assessments

1. **When preparing an environmental assessment (EA), agencies should:**

   a. **Identify the potential impacts of climate change on the project and its affected environment.** To identify all relevant impacts, agencies should consider using a checklist like that provided in *Attachment A: Checklist for Identifying Climate Change Impacts* (see page 57).

   b. **Evaluate whether any of these impacts will influence the agency's significance determination (e.g., by altering the context or intensity of a particular impact).** For example, an agency could conclude that an otherwise insignificant risk of spills or contamination from a hazardous waste facility located on a coastline will be significant in light of sea level rise and increased storm intensity, or that an otherwise insignificant impact on water resources will be significant in light of decreased stream flow caused by precipitation and snowpack changes.

2. **Agencies should also consider whether the impacts of climate change will have implications for:**

    a. The purpose and need of the proposed project,

    b. The selection of alternatives, and

    c. The implementation of any mitigation measures that the agency has relied upon to justify a Finding of No Significant Impact (FONSI).

Environmental Impact Statements (EISs)

Step 1: Identifying Climate Change Impacts during the Scoping Process

1. **The potential impacts of climate change on the project and its affected environment should be identified and disclosed to the public during the scoping phase of an EIS.** This will enable agencies to receive public input on climate-related impacts that warrant evaluation in the EIS *before* the publication of the draft EIS. To simplify the process, agencies should consider using a checklist like that provided in *Attachment A: Checklist for Identifying Climate Change Impacts* (see page 57).

2. **During the scoping process, agencies should also solicit information from relevant stakeholders regarding any climate-related considerations and local data or knowledge that is relevant for the purpose of assessing the impact of climate change on the project and its affected environment.** Relevant stakeholders may include:

    a. Other government agencies who are directly involved in the project;

    b. Tribal, state and local authorities in the area where the project will be sited;

    c. Any tribal, state or local agency or non-governmental entity with specific expertise on climate change impacts in the area where the project will be sited; and

    d. Members of the affected public.

3. **When deciding how many resources to dedicate to the scoping and subsequent assessment of climate change impacts, agencies should pay special attention to actions that are particularly sensitive to climate change due to the nature of the action or the geographic location where it will occur.** To identify highly sensitive projects, agencies should consider:

    a. Geographic location

i. Coastal projects;

ii. Projects in arid climates and regions subject to heat wave and/or drought; and

iii. Projects in areas that are frequently exposed to storms or flooding.

b. Nature of the project

i. Projects that require substantial water resources, e.g., electricity generation facilities or water supply facilities;

ii. Projects that are particularly susceptible to increased temperatures, e.g., electric transmission and distribution systems, residential buildings, hospitals, nursing homes, and prisons;

iii. Projects that have particular risks which may be further compounded by climate impacts, e.g., wastewater treatment facilities and hazardous and nuclear waste facilities; and

iv. Critical facilities, such as hospitals and electric infrastructure.

Step 2: Evaluating the Impacts of Climate Change

After identifying the potential impacts of climate change on the project and its affected environment, agencies should evaluate and disclose those impacts in accordance with the following framework.

1. **Evaluate the impacts of climate change on the affected environment of the proposed action.**

   a. **Identify sources of information and uncertainty:** Identify scientific studies and planning documents that contain information about the impacts of climate change within the project area and the corresponding vulnerability of the local environment. Identify any major information gaps or areas of uncertainty.

   b. **Summary of climate change impacts:** Disclose any existing information about the likelihood and severity of climate change impacts in the affected environment over the duration of the project, and integrate this information into the description of the environmental baseline (no action alternative). When making this disclosure, agencies may incorporate by reference any scientific studies and planning documents, as long as the materials are reasonably available for inspection by potentially interested persons in accordance with 40 CFR § 1502.21.

c. **Vulnerability and/or resilience of affected environment:** Disclose any existing information about the extent to which specific components of the affected environment are vulnerable and/or resilient to the impacts of climate change. The environmental components that should be reviewed include:

   i. Natural systems that are affected by the project;

   ii. Human systems that are affected by the project; and

   iii. Key resources required for project and systems impacted by project (e.g., water resources).

d. **Address uncertainty by:**

   i. Describing impacts under a range of different scenarios, including any worst case scenarios published by the IPCC and USGCRP;

   ii. Considering past extremes as an indicator of future trends; and

   iii. Complying with the regulatory guidelines for dealing with "incomplete or unavailable information" in NEPA reviews (40 CFR § 1502.22).

e. **Clearly state all underlying assumptions and sources of data used**.

2. **Describe how the proposed action will be affected by the impacts of climate change.**

   a. **Identify project-specific impacts:** Identify any climate change impacts that will directly affect the physical or operational elements of the proposed project.

   b. **Assess project resilience:** Determine whether any of the project-specific impacts may have an adverse effect on the project (e.g., by impairing longevity and/or productivity) and assess the resilience of the project with respect to those effects.

   c. **Project need and resources:** Determine whether any of the project-specific impacts will modify the need for the project or the resources that must be committed to the project.

   d. **Identify adaptation options:** Identify design features or operational changes which could be used to improve the resilience of the project to any adverse effects identified in this analysis.

3. **Determine whether the impacts described in step 1 or 2 will have implications for the environmental consequences of the proposed project.**

   a. **Implications for project impacts:** Evaluate whether climate change may alter the nature or magnitude of environmental impacts of the action or generate new impacts that would not have otherwise occurred.

b. **Implications for susceptibility of resources to project impacts:** Evaluate whether any of the environmental systems or resources that are affected by climate change will be more susceptible (or resilient) to the adverse environmental consequences of the project as a result of climate change.

4. **Conduct a similar assessment for all reasonable alternatives to the project.**

   a. **Environmental baseline:** The no-action alternative should simply reflect the baseline environmental analysis conducted in Step #1

   b. **Comparison of alternatives:** For other alternatives, the agency should identify where the analysis re: climate change impacts is the same as that conducted for the preferred alternative, and should discuss any climate change impacts that may differ across alternatives.

5. **Identify resilience/adaptation measures when impacts are deemed significant or risks are deemed unacceptable.** Such measures may include the selection of a more resilient alternative, modifications to the preferred alternative, or the implementation of actions to mitigate adverse environmental impacts that are exacerbated by climate change.

   a. **Modified design elements:** Consider opportunities to incorporate adaptation and resilience into the design of the project, the operational plan for the project, and any environmental management plans or mitigation measures that are implemented as part of the project.

   b. **Siting decisions:** Consider whether the project could be sited in an alternate location to address concerns about the impacts of climate change and the implications of those impacts for the environmental consequences of the project.

   c. **Adaptation measures with co-benefits**: Consider adopting adaptation and resilience measures that have environmental and/or economic co-benefits (e.g., building insulation that improves energy efficiency).

   d. **Addressing uncertainty:** To address uncertainty about future impacts, the agency should consider: (i) whether to expressly incorporate monitoring and risk management procedures into the final project or action, and (ii) whether to include provisions for incremental adaptation measures that can be implemented in the event that certain impacts do occur (e.g., operational changes)

Step 3: Justifying the Final Decision

1. **In making its final decision, the agency should describe how the agency's analysis of climate change impacts on the action and the affected environment has influenced:**
   a. The selection of design features, operational practices, etc.;
   b. The choice between the preferred alternative and other reasonable alternatives (including the no action alternative); and
   c. The selection of measures to mitigate any adverse environmental impacts that are exacerbated or caused by climate change.
2. **Monitoring for incremental adaptation measures:** If an agency decides to mitigate climate-related risks through a system of incremental adaptation measures (i.e., measures which are conditioned on the occurrence of specific climate impacts), the agency should also include adequate monitoring and evaluation mechanisms to accompany these measures.

Step 4: Communicating Results to the Public

1. **Clear communication of both analysis and decisional outcomes:** The agency's assessment of climate change impacts and the manner in which this assessment has influenced the agency's final decision should be clearly communicated to the public in both the draft and final EIS.
2. **Summary for public review:** To better inform the public about the analysis conducted on climate change impacts and risks, agencies should consider summarizing this information in a table like that provided in *Attachment B: Table Summarizing Climate Change Impacts and Response Measures* (see page 58).

Attachment A

Checklist for Identifying Climate Change Impacts

Climate-related phenomena		Possible impact on project or affected environment?
Temperature and Humidity	Increased average temperatures	
	Increased peak temperatures (heat waves)	
	Freeze-thaw damage (e.g., melting permafrost)	
	Cold spells	
	Increased humidity	
Precipitation	Increased average precipitation in project area	
	Decreased average precipitation in project area	
	Increase in extreme precipitation events in project area	
	Drought	
	Increased precipitation in upstream area, modifying flow quality or quantity of water resources in affected env't	
	Decreased precipitation upstream, modifying flow quality or quantity of water resources in affected env't	
	Change in the type of precipitation in project area or upstream (e.g., rainfall instead of snow)	
Storms	Increased storm severity	
	Increased storm frequency	
	Increased uncertainty associated with storm patterns	
Inland Flooding	Inland flooding, erosion, and other on-the-ground impacts from altered precipitation and storms	
Coastal impacts	Sea level rise	
	Higher storm surge	
	Coastal inundation, erosion, subsidence	
	Saltwater intrusion	
Air Quality	Reduced local air quality	
Wildfire	Greater wildfire risk due to heat and/or drought impacts	
Biodiversity	Increased vulnerability of species and habitats	
	Invasive species	
Public Health	Threats to public health	
Other Impacts	Humidity	

Attachment B

Table Summarizing Climate Change Impacts and Response Measures

Impact	Likelihood	Severity	Risk to affected env't.	Risk to project	Implications for envtl. impacts	Response and mitigation

Likelihood *– The likelihood that a particular impact will occur within the project area (e.g., certain, almost certain, likely, possible, unlikely, rare, or N/A).*

Severity *– The magnitude of the impact (e.g., minor, moderate, significant, severe).*

Risk to affected environment *– The extent to which the impact poses a risk to environmental systems and resources within the affected environment (this could be assigned a ranking – e.g., low, medium, high – or a qualitative description could be provided in the appropriate box).*

Risk to project *– The extent to which the impact poses a risk to the physical or operational aspects of the project (ranking or qualitative description).*

Implications for environmental impacts – *Whether the climate-related impact will have implications for the environmental consequences of the project.*

Response and mitigation *- Summary of how the agency intends to respond to and mitigate any risks to the affected environment and project or implications for the environmental impact of the project (e.g., through modified design features, selection of alternatives, or adoption of measures to mitigate an environmental impact).*

CONCLUSION

Based on our review of federal EISs published between 2012 and 2014, it appears that the incorporation of climate change considerations into EIA has become increasingly common in the past few years. The fact that some of these EISs contain a robust discussion of climate change impacts which informed final design decisions demonstrates that it is possible for agencies to assess these impacts and draw meaningful conclusions, even in the context of extreme uncertainty about climate change. There is also evidence that climate change is being mainstreamed into local decision-making and city planning processes.[175] This reinforces our conclusion that it is technically feasible to account for climate change when making decisions about public infrastructure and building projects.

Standardized protocols like those proposed in Section 6 would help to ensure that agencies and other project proponents apply a rigorous and consistent assessment methodology when evaluating climate change impacts. This would improve decision-making in the context of specific projects while providing a broader and more detailed universe of information on climate change impacts and assessment opportunities that can be used to inform future decision-making.

[175] Urban Climate Change Governance Survey, http://www.urbanclimatesurvey.com/.

Document Content(s)