Tools for Regulators in a Changing Climate: Proposed Standards, State Policies, and Case Studies from the Western Grid

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ABSTRACT

With climate change a present reality, governments are confronting the need to adapt their regulatory planning processes to withstand new and uncertain climate risks. This Article provides three new resources to support this essential work. First, it develops a new standard for assessing the quality of climate adaptation decisionmaking, focusing on defining the problem, quantifying adaptation benefits, and evaluating equitable distribution of risk. Second, it reviews California's climate adaptation policy development efforts between 1988 and 2018—from the state's early efforts to study the problem, to later attempts at statewide strategic planning, until more recent work to integrate adaptation into existing regulatory processes—and applies the new assessment standard to illuminate many of the challenges that California has confronted. Third, the Article presents four case studies from California's electric power regulatory sector—electric grid reliability planning processes, wildfire risk mapping, coastal generator siting, and rate case risk costing—to demonstrate the difficulties inherent in incorporating climate-relevant data into complex technical proceedings in a transparent and consistent fashion. A hope exists that lawmakers, policymakers, planners, and regulators can learn from California's three decades of hard work on the climate adaptation problem, build on California's successes, avoid California's mistakes, and, ultimately, develop more resilient and transparent regulatory adaptation strategies.

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INTRODUCTION: ADAPTATION, CALIFORNIA, AND THE GRID

"Climate change," or "anthropogenic climate change," is the result of humanity's release into Earth's atmosphere of gases such as carbon dioxide and methane that absorb and re-emit thermal-wavelength radiation (collectively, "greenhouse gases," or "GHGs") in levels sufficient to change those gases' atmospheric concentrations and, thus, Earth's global average surface temperatures, relative to pre-industrial levels, with resulting unpredictable changes to earth's atmospheric processes. This phenomenon was first predicted in 1896.[1] It has been the subject of worldwide scientific investigation for the last several decades,[2] and it is generally accepted by the research community that, lacking a strategic response, anthropogenic climate change threatens to materially disrupt many human systems.[3]

"Adaptation" describes one primary strategy for responding to climate change.[4] Adaptation approaches assume that climate change will occur, and

1. Svante Arrhenius, *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground*, 41 LONDON, EDINBURGH, & DUBLIN PHIL. MAG. & J. OF SCI. 237–76 (1896).

2. *See* G.A. Res. 45/53, U.N. GAOR, 43d. Sess., U.N. Doc. A/RES/43/53 at 133 (Dec. 6, 1988) (requesting investigation by an Intergovernmental Panel on Climate Change ("IPCC")), and subsequent research timeline, https://perma.cc/H9CU-C9L3.

3. *See*, *e.g.*, WORKING GROUP II CONTRIBUTION TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014 – IMPACTS, ADAPTATION, AND VULNERABILITY: SUMMARY FOR POLICYMAKERS 6, 32 (2014).

4. *See* Philipp Schmidt-Thomé, *Climate Change Adaptation*, OXFORD RES. ENCYCLOPEDIA OF CLIMATE SCI. (2017) (surveying definitions), https://perma.cc/TG7G-PRLE.

typically involve either proactive planning to adjust human systems to those changes, or reactive adjustment of human systems following climate-related failures.[5] At the present time, adaptation strategies are relatively underdeveloped, as compared to programs designed to reduce GHG emissions.[6] However, it is becoming increasingly apparent that this will have to change in the coming decades.

Given the slow progress of worldwide emissions reduction efforts, the world's climate *is* changing. This, in turn, is stressing built systems (and vice versa), often with catastrophic results. In California, for example, the 2017 and 2018 wildfire seasons, the most destructive in the state's history, involved interactions between downed electrical equipment, heat-induced (and thus climate change-induced) wind storms,[7] and drought-stressed (and thus climate change-stressed) vegetation,[8] as mediated (possibly poorly) by state- and utility-scale grid management policies and practices.[9] Natural disasters in other parts of the country, including New York City's Hurricane Sandy and Houston's Hurricane Harvey, have demonstrated the vulnerability of coastal built environments to increasing storm flooding, again associated with climate change.[10] In order to weather the coming storms, regulatory processes that govern built infrastructure systems will need to integrate climate change impacts into their decisionmaking.

To assist in the development of climate-sensitive regulatory planning processes, this Article seeks to construct three new resources: (1) a set of standards by which to evaluate efforts to incorporate climate adaptation into policymaking and regulatory decisionmaking; (2) a critical assessment of one state's efforts to develop climate adaptation policy and guidance; and (3) four case studies that

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5. The other two primary strategies are mitigation (reducing GHG emissions) and geoengineering (direct interventions into earth systems). *See Annex II: Glossary*, *in* CLIMATE CHANGE 2014: SYNTHESIS REPORT – CONTRIBUTION OF WORKING GROUPS I, II AND III TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 123, 125 (2014).

6. *See*, *e.g.*, J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 363 (2010) (recognizing the "adaptation gap" phenomenon).

7. *See* Yufang Jin et al., *Identification of Two Distinct Fire Regimes in Southern California: Implications for Economic Impact and Future Change*, 10 ENVTL. RES. LETT. 094005 (2015) (contribution of climate change to Santa Ana wind-driven fires); John T. Abatzoglou & A. Park Williams, *Impact of Anthropogenic Climate Change on Wildfire Across Western U.S. Forests*, 113 PROC. OF THE NAT'L ACAD. OF SCI. 11,770–75 (2016).

8. CALIFORNIA WILDFIRE STRIKE FORCE, WILDFIRES AND CLIMATE CHANGE: CALIFORNIA'S ENERGY FUTURE 1 (Apr. 12, 2019).

9. *See California North Bay Fire Cases*, Jud. Council Coord. Proc. No. 4955 (Cal. Super. Ct. San Francisco) (consolidating claims alleging PG&E's liability for California wildfires). Climate change also may have contributed to the storm that threatened the integrity of California's Oroville Dam. Daniel L. Swain et al., *Increasing Precipitation Volatility in Twenty-First-Century California*, 8 NATURE CLIMATE CHANGE 427, 427 (2018).

10. James Bradbury & C. Forbes Tompkins, *New Report Connects 2012 Extreme Weather Events to Human-Caused Climate Change*, WORLD RES. INST. BLOG (Sept. 6, 2013), https://perma.cc/S6GE-HC5C; Henry Fountain, Scientists Link Hurricane Harvey's Record Rainfall to Climate Change, N.Y. TIMES (Dec. 13, 2017), https://perma.cc/V9XF-8NPR.

examine whether and to what extent climate change has been integrated into ongoing regulatory proceedings. These three resources correspond to this Article's three Parts.

Part I examines the five Assessment Reports prepared by the Intergovernmental Panel on Climate Change ("IPCC") between 1990 and 2014. This Article draws from them a set of principles by which climate adaptation regulatory decisionmaking may be assessed. These principles are organized according to frameworks used by policy analysts, focusing on criteria assessing effectiveness, efficiency, equity, and feasibility—i.e., will a proposed solution work, what will it cost, will it be fair, and can it be done? The IPCC Assessment Reports provide a rich series of suggestions for approaching these questions within the context of climate change adaptation.

Part II examines climate adaptation policymaking within the state of California between 1988 and 2018. California is the most populous U.S. state, and, as of this writing, the sixth largest economy in the world; it has a long history as a leader in environmental regulatory development and expertise; and it has been working on climate adaptation policy for thirty years. Furthermore, as a sub-national jurisdiction, California is responsible for providing policy development and guidance down to the local level. And yet its size and regulatory capacities have also made its climate regulatory programs state-of-the-art on the world stage. Even so, California has struggled to develop a workable climate change adaptation policy framework.

Finally, Part III examines four regulatory processes in California's electric power sector into which climate adaptation considerations could have been injected. The electric grid involves complex and multi-scalar decisionmaking processes requiring coordination and cooperation among multiple agencies, governing a single built system relied upon by a huge population. Transmission grid reliability, wildfire management, power plant siting, and recent attempts at risk management regulation are all considered. Each proceeding handled the question of climate change differently, and together they demonstrate that there is not yet any coherent strategy for regulatory integration, although that may be changing.

Ultimately, this review demonstrates the enormous challenges that lie ahead as long-term planning and regulatory processes contend with the loss of "stationarity"—the assumption that the world will remain the same. Parts I, II, and III, together, demonstrate that climate adaptation policy development has often failed to address necessary questions, and that even very sophisticated regulatory processes are struggling to incorporate climate information. The hope is that, as policymakers and lawmakers confront the challenges posed by the physical reality of climate change, California's efforts can serve to show what has and has not worked to date.

I. A STANDARD OF REVIEW

Climate adaptation is a nascent regulatory field and there are no generally accepted standards for assessing the qualities of any given effort. This Part

proposes a "standard of review" adapted from the policy analysis disciplines and develops the general standard by reference to the relevant discussions and findings of the synthesis reports published between 1990 and 2014 by the IPCC. In brief, this Part argues that climate adaptation decisionmaking is susceptible to multi-criteria decision analysis tools—particularly investigations into effectiveness, costs and benefits, equity, and feasibility. The analysis collects and arranges the decision criteria developed in the IPCC reports within that framework to propose standards for assessing regulatory decisionmaking on this topic.

To begin developing a standard for assessment, this Part proceeds from the position that climate adaptation regulatory policy is a problem of decisionmaking under uncertainty. Climate change's inherent uncertainty is one of the key attributes that makes it a "super wicked" problem for regulators to address.[11] Even where general trends may be increasingly subject to accurate prediction, infrastructure and social planners require a much greater degree of spatial accuracy than is currently possible. In deciding whether to build a dam, it matters a great deal whether climate change will greatly increase, or greatly decrease, precipitation in a given watershed—knowledge that precipitation will almost certainly change in an unknown direction is insufficient. Considering how to adapt to climate change, therefore, is a process that requires public decisionmakers to take action with insufficient information. It is, then, a classic tough problem of policy analysis, susceptible to policy-oriented decision analysis frameworks.

One such framework is "multi-criteria decision analysis." This is a "generic term for a collection of systematic approaches developed specifically to support the systematic evaluation of alternatives in terms of multiple and often conflicting objectives."[12] Given any question about what should be done, this decision analysis framework says that it is possible to examine alternatives according to a range of criteria, including especially *effectiveness*, *economic impact*, *equity*, and *feasibility*.[13] Comparing evidence of past decision frameworks to an idealized multi-criteria analytical approach allows an assessment of the quality of past decisionmaking.

A. STANDARDS IN THE IPCC ASSESSMENT REPORTS

Between 1990 and 2014 five worldwide literature reviews were published that contained, among many other things, a developing documentation of best

11. Richard J. Lazarus, *Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future*, 94 CORNELL L. REV. 1153 (2009).

12. Mika Karttunen et al., *Structuring Problems for Multi-Criteria Decision Analysis in Practice: A Literature Review of Method Combinations*, 263 EUR. J. OF OPERATIONAL RES. 1-17, 1 (2017), and works cited.

13. *See generally* Michael E. Kraft & Scott R. Furlong, *Assessing Policy Alternatives*, *in* PUBLIC POLICY: POLITICS, ANALYSIS, AND ALTERNATIVES (4th ed. 2012); Eugene Bardach, *Selecting the Criteria*, *in* A PRACTICAL GUIDE FOR POLICY ANALYSIS, THE EIGHTFOLD PATH TO MORE EFFECTIVE PROBLEM SOLVING (4th ed. 2012).

practices for climate change adaptation policy development. The IPCC published its First Assessment Report ("AR1") in 1990; Second Assessment Report ("AR2") in 1995; Third Assessment Report ("AR3") in 2001; Fourth Assessment Report ("AR4") in 2007; and Fifth Assessment Report ("AR5") in 2014. In each, the IPCC summarized the state of worldwide research on climate change, its impacts, and potential responses. This section gathers and arranges the recommendations of the various Assessment Reports within the criteria categories, effectiveness, efficiency, equity, and feasibility, to further develop standards for reviewing and assessing climate change adaptation policy and regulatory decisionmaking. These analyses, taken together, support the formation of an evaluative rubric against which climate change adaptation decisionmaking may be assessed.

1. The IPCC First Assessment Report (1990)

AR1 was completed in 1990, in three parts, corresponding to the IPCC's three "working groups." AR1 Working Group I ("WG1") explained the climate science consensus,[14] AR1 Working Group II ("WG2") assessed the impacts of climate change,[15] and AR1 Working Group III ("WG3") discussed potential response strategies.[16] AR1 WG3 was split into topical subgroups, which did not all discuss adaptation. However, Chapters 5 and 6, on coastal zone management and resource use and management, respectively, included substantial climate adaptation discussions.

The authors of AR1 WG3 Report Chapter 5 (Coastal Zone Management) (the "CZM Chapter")[17] approached the adaptation problem as one of options categorization and analysis. They identified among themselves the range of CZM adaptation alternatives that had been discussed up to that point and reduced them into three analytical categories: retreat, accommodation, and protection.[18] In plain language, these three approaches were to abandon coastal development, put it on stilts, or build walls around it. The authors then suggested universal evaluative criteria for choosing between these options. In assessing how to handle any given coastal area, they suggested that decisionmakers ought to consider what the land is being used for, the importance of those activities along all possible values (environmental, social, economic, etc.), the financial and political ability to respond, the cost of various options, the effectiveness of those options, their cost-effectiveness, how well the option performs under uncertainty, and "equity,"

14. IPCC WG1, CLIMATE CHANGE—THE IPCC SCIENTIFIC ASSESSMENT (1990) [hereinafter AR1 WG1 REPORT], https://perma.cc/D785-GZ4B.

15. IPCC WG2, CLIMATE CHANGE—THE IPCC IMPACTS ASSESSMENT (1990) [hereinafter AR1 WG2 REPORT], https://perma.cc/B67M-APFB.

16. IPCC WG3, CLIMATE CHANGE—THE IPCC RESPONSE STRATEGIES (1990) [hereinafter AR1 WG3 REPORT], https://perma.cc/Y6NM-PHUB.

17. J. Dronkers et al., *Coastal Zone Management*, *in* AR1 WG3 REPORT, *supra* note 16, 129–59.

18. *Id*. at 146–49.

which was undefined.[19] The authors also noted that "[s]uccessful coastal management programmes [will] require public education to gain broad-based support, and public participation to ensure equal representation of interests."[20]

Although the CZM Chapter authors did not draw attention to this aspect of their approach, they did not pre-select the "correct" adaptation alternative. Rather, they attempted to collect all known options for addressing a single significant climate change impact (sea level rise) to simplify further analysis.[21] They did not become caught in the traps of endless impact assessment, uncertainty paralysis, or impossible attempts to combine the costs of carbon reduction and adaptation. Rather, they tackled the questions following impact assessment, acknowledged uncertainty without trying to resolve it, and moved on to building a platform for public discussion of the pros and cons of various responses if the impacts come. This approach is remarkable for its rarity.

AR1 WG3 Report Chapter 6 (Resource Use and Management),[22] in contrast, offered a different taxonomy, within which was hidden telling conclusions about competing values—a much more typical presentation. The resource management authors categorized adaptation options into those that provided additional information ("Category A"), those that are "economically justifiable" under present circumstances ("Category B"), and those that are costly and should only be considered once Category A options have reduced uncertainty ("Category C").[23] As with contemporaneous work in California,[24] this taxonomy was built on the unquestioned and possibly mistaken assumption that additional data will reduce uncertainty to improve future decisionmaking. It also selected, without debate or examination, present-day economic valuation as the primary decision criterion for immediate action.

Chapters 5 and 6 also each took a stand on how to deal with uncertainty. The CZM Chapter stated, without further discussion, that adaptation options should be judged based on their "performance under uncertainty."[25] The Resource Use Chapter approach provided two additional, related criteria: whether an option is "flexible," meaning adjustable in light of new knowledge and successful in all

19. *Id*. at 158 tbl. 5.6 ("Criteria for Allocation of Resources"), including, *inter alia*, "The importance of the coastal area in terms of: urgency of risk; proportion of national land area; population affected; environmental importance; economic importance; social and cultural importance; and regional importance;" "the cost of the option;" "the effectiveness of the option;" etc.

20. *Id*. at 146.

21. "The responses required to protect human life and property fall broadly into three categories: retreat, accommodation, and protection." *Id*. at 135.

22. R. Pentland et al., *Resource Use and Management*, *in* AR1 WG3 REPORT, *supra* note 16, at 161–205.

23. *Id*. at 168–70. "Economically justifiable" is defined as including "ensuring cost-effectiveness and economic efficiency, and consideration of opportunity costs—aspects that are likely to be met if it provides other non-climate-related benefits, [and] consider[ing] the broad range of social and environmental factors." *Id*. at 168.

24. *See* Section II.A, *infra*.

25. AR1 WG3 REPORT, *supra* note 16, at 158.

possible future situations, and whether it is "timely,"[26] meaning neither too early nor too late. However, neither criterion was discussed in detail.

2. The IPCC Second Assessment Report (1995)

Unlike AR1, which separated impact and response between WG2 and WG3, AR2's WG2 took on impact, mitigation, and adaptation in combination, while AR2 WG3 summarized the growing literature on climate change's socioeconomic implications. AR2 represented a significant step forward in adaptation policy development by collecting, for the first time in one place, many of the technical concepts that would be useful for future adaptation policy development.

a. AR2 WG2 Report: Impacts and Responses

The goal of the AR2 WG2 Report[27] was to assess the current state of knowledge on the potential impacts of climate change, and then to "review[] available information on the technical and economic feasibility of a range of potential adaptation and mitigation strategies."[28] To make the task manageable, the report relied upon—and in the process, mainstreamed—three key analytical concepts: 1) sensitivity (how sensitive is a system to climate change?), 2) adaptive capacity (how capable of change is the system?), and 3) vulnerability (given this information, how susceptible is the system to harm?).[29] However, these concepts presented serious definitional and measurement challenges, and they did not serve as strict organizing foundations for most of the rest of the report.

Instead, the AR2 WG2 Report's adaptation analysis was incorporated into individual chapters that each examined climate impacts on various resources, and assessed, to varying degrees, humanity's response options. The chapters on rangelands, coastal zones, industry and energy, human settlement, agriculture, and water resources each followed this pattern and included some discussion of adaptation (other chapters addressed only impact assessment, or only impacts and mitigation options).[30] Each chapter took a different approach. For example, a short section in the rangelands chapter noted that pastoral societies may need to respond and recommended adaptive intervention into food species reliance.[31] The industry and energy chapter discussed, among other things, the possibilities

26. *Id*. at 168.

27. AR2 WG2, Climate Change 1995—Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analysis (1995) [hereinafter AR2 WG2 REPORT], https://perma.cc/X7Q2-QTUP.

28. *Id*. at ix.

29. *Id*. at ix, 4–5, 23–25.

30. *See id*. chs. 2 ("Rangelands in a Changing Climate: Impacts, Adaptations, and Mitigation"), 9 ("Coastal Zones and Small Islands"), 11 ("Industry, Energy, and Transportation: Impacts and Adaptation"), 12 ("Human Settlements in a Changing Climate: Impacts and Adaptation"), 13 ("Agriculture in a Changing Climate: Impacts and Adaptation"), and 14 ("Water Resources Management").

31. *Id*. at 47–48.

for voluntary adaptation; the challenges to adaptation posed by long-lived assets; the need for good information in adaptation planning; the challenges posed by short-term planning horizons; the alleged need for an integrated approach to assessment of impacts, mitigation, and adaptation; the potential need for adaptation in construction industries and transportation infrastructure planning, adaptation capacity to gradual and sudden changes; and ultimately concluded that the literature on adaptation in industry was "weak."[32] Many of the other discussions were more brief.[33]

As in the AR1, the most cogent adaptation analysis was the CZM assessment.[34] The CZM authors summarized the results of vulnerabilities assessments and concluded that despite some success, "vulnerability assessment has been less successful in assessing the range of response options to deal with the problems of climate change."[35] The chapter then returned to AR1's three-category framework for analysis. The CZM authors also produced the first significant discussion of so-called "barriers" to adaptation. They began by proposing that the solution to adaptation was to build capacity for integrated coastal zone management, by which they meant a strategy for integrating all possible considerations into some unified decision framework.[36] They emphasized the need for good leadership, supportive institutions, technical capacity, and management instruments.[37] At the national scale, they provided another list of important evaluative criteria for feasibility of implementation: available technological, human, and financial resources; social and political acceptability; and legality. With this review, the CZM authors demonstrated that beyond vulnerability assessment, it is possible to attempt to collect and organize alternatives, analyze the costs and benefits of each along uniform criteria, survey what has been adopted and what has not (and why), discuss feasibility in a conceptually rigorous manner, and assess needs for future analyses along these lines.

b. AR2 WG3 Report: Analytical Concept Development

The AR2 WG3 Report [38] took a very different approach: to summarize and synthesize the state of socioeconomic literature on climate change. In doing so, it produced a significant and important set of analytical lenses through which to

32. *Id.* at 369–70, 379, 382, 391, 394.

33. *Id.* at 416–21 (identifying adaptation options in numerous sectors while concluding that there is no good way to evaluate them); 452–55 (in the context of agriculture, discussing adaptive capacity); and 481 (in the context of water resource management, stating that no real developments have occurred since AR1, and urging adherence to the principles stated there).

34. *See* Luitzen Bijlsma et al., *Coastal Zones and Small Islands*, in AR2 WG2 REPORT, *supra* note 27, at 289–324; *see esp. id.* at 311–17 (discussing adaptation).

35. *Id.* at 311.

36. *Id.* at 315.

37. *Id.*

38. AR2 WG3, CLIMATE CHANGE 1995—ECONOMIC AND SOCIAL DIMENSIONS OF CLIMATE CHANGE (1995) [hereinafter AR2 WG3 REPORT], https://perma.cc/6REF-WEC9.

consider adaptation. The challenge came in applying these concepts to adaptation options, where the authors demurred: "possible trade-offs between implementation of mitigation and adaptation measures are important to consider in future research."[39] That said, the AR2 WG3 Report flagged many issues that may serve to inform adaptation assessment.

First, Chapter 2[40] discussed decision analysis, a broadly descriptive term for the collection of quantitative tools (e.g., expected utility theory, probabilities, optimization) for decisionmaking under uncertainty. Given dispersed decisionmaking, inconsistent and unquantifiable utilities, and unknown probabilities, the authors concluded that "decision analysis cannot serve as the primary basis for international climate change decision making," though it "suffers fewer problems when used by individual countries to identify optimal national policies."[41] It also noted that given the likely failure to identify universally acceptable optimal solutions, final decisions likely will require "negotiation and compromise,"[42] with all of the game theory implications that this implies. As an alternative decision framework, the authors suggested sequential decisionmaking approaches similar to AR1 WG3's "flexibility" criterion, involving learning from incremental action, while preserving options to the extent possible.[43]

Second, Chapters 3 and 4[44] provided concrete suggestions for incorporating equity into adaptation. Chapter 3 surveyed the lack of equity analysis in prior international climate contexts, and suggested guiding principles, along the lines of polluter-pays, for the international context.[45] The authors pointed out that at the sub-national level, ethical principles often are incorporated into liability rules, which typically should form a part of an ethical analysis of the topic. In addition, they offered concrete suggestions for furthering equity analysis: cost studies should begin to ascribe cost to bearing risk, and policymakers should support development of climate impact insurance.[46] Chapter 4 was entirely devoted to the special case of intergenerational equity, and the role that the discount rate has on

39. *Id*. at 12.

40. K.J. Arrow et al., *Decision-Making Frameworks for Addressing Climate Change*, *in* AR2 WG3 REPORT, *supra* note 38, at 53–77.

41. *Id*. at 57; and *see esp*. 62–65 (§ 2.3.2, on decision analysis and climate change).

42. *Id*. at 57.

43. *Id*. at 68, quoting Alexander Shlyakhter et al., *Integrated Risk Analysis of Global Climate Change*, 30:8 CHEMOSPHERE 1585–1618 (1995).

44. T. Banuri et al, *Equity and Social Considerations*, and K.J. Arrow et al, *Intertemporal Equity, Discounting, and Economic Efficiency*, *in* AR2 WG3 REPORT, *supra* note 38, at 78–124, 125–44.

45. *Id*. at 101 ("[there is a] need to develop general rules of international law regarding liability and compensation. However, in the absence of new rules of liability, the traditional '"fault-based" rules of responsibility of international law could provide a basis for vulnerable, generally poorer, states adversely affected by climate change to receive compensation from richer states whose past and present emissions of greenhouse gases have caused environmental harm. The issue of historical emissions could be of direct relevance here, as climate impacts are a function of atmospheric concentrations, which depend strongly on cumulative emissions.").

46. *Id*. at 102.

net present valuation of alternatives across long periods of time. It concluded that there is no consensus between two competing viewpoints: those that seek to minimize impact on future generations, and those that seek to maximize resources available to future generations.[47]

Chapter 17[48] focused on insurance and banking and introduced risk analysis concepts to a degree far beyond all other discussions to that date. The insurance industry was reported to be aware of increasing trends in extreme events, disaster intensity, and the resulting financial losses of climate-driven weather events.[49] As of AR2, the industry was already adopting its own adaptation strategies: the traditional methods of restricting coverage, transferring risk, controlling losses (e.g., requiring better resiliency standards to insure), and adjusting premiums to reflect new risks.[50] They were also considering novel approaches such as building disaster reserves, taking an active role in educating stakeholders about risk, and working with government and international bodies to support development practices that reduce risk.[51] Banks were tightening lending requirements based on climate risk.[52] These strategies are at the heart of the special challenges that uncertainty poses to adaptation planning: the financial services sector must function within high degrees of risk, and the control strategies it adopts may be relevant elsewhere.

AR2 WG3's primary adaptation output was intended to be Chapter 7, but that work paid little attention to adaptation.[53] It concluded: "There are no comprehensive surveys of the various adaptation options and their costs, probably because adaptation covers such a broad range of potential action and also because of the large uncertainties surrounding these options."[54] There was a brief discussion of "what to adapt to" and "how to adapt," but the chapter ended by stating only that an "integrating approach" is needed.[55] Similarly, Chapter 11's brief discussion concluded that "[a]ny adaptation policies should be designed in concert with mitigation policies."[56]

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47. *Id*. at 140–41. AR2 WG3 REPORT Chapter 5 discussed how cost-benefit analysis can be applied to climate problems. Unfortunately, its analysis was limited to mitigation only, and did not address the special valuation problems of adaptation in detail. *Id*. at 162, 164. Chapter 6, concerned with damage valuation, discussed the difficulties of valuing adaptation in integrated assessment models. *Id*. at 184, 187–88.

48. Andrew F. Dlugolecki et al., *Financial Services, in* AR2 WG3 REPORT, *supra* note 38.

49. *Id*. at 545–47.

50. *Id*. at 548–51.

51. *Id*.

52. *Id*. at 553.

53. C.J. Jepma et al., *A Generic Assessment of Response Options*, *in* AR2 WG3 REPORT, *supra* note 38, at 236–48.

54. *Id*. at 249.

55. *Id*. at 253.

56. B B.S. Fisher et al., *An Economic Assessment of Policy Instruments for Combatting Climate Change*, in AR2 WG3 REPORT, *supra* note 38, at 399–439, 411–12.

3. The IPCC Third Assessment Report (2001)

Between AR2 (1995) and AR3 (2001), the nations of the world adopted the Kyoto Protocol[57] and agreed, in principle, to a worldwide greenhouse gas emissions mitigation strategy. In the meantime, AR3's authors made significant progress towards understanding climate adaptation policy analysis. During AR2, WG2 handled impacts and responses together, while WG3 discussed socioeconomic aspects of analysis. For AR3, mitigation and adaptation were finally separated—AR3 WG2 handled vulnerability and adaptation while WG3 handled mitigation. Even so, most of WG2's work for AR3 focused on impact evaluation and vulnerability assessment, and only a very small amount of work was devoted to the special problems of adaptation. Regarding adaptation specifically, the AR3 WG2 Report[58] included, once again, a combination of sectoral analyses and synthesis reports.

a. AR3 WG2 Report Chapter 18: Climate Adaptation as Policy Analysis

AR3 WG2 Report Chapter 18[59] contained the first treatment of climate adaptation as a generalizable policy problem; AR1 WG2 Report Chapter 5 had treated it as a policy problem in the context of coastal zone management only. AR3 WG2 Report Chapter 18 discussed the nature of the problem, the processes by which policy options could be identified, and the evaluative criteria that could be applied. In general, it supported evaluating adaptation measures using a mixture of cost-benefit, cost-effectiveness, risk-benefit, and multi-criteria methods, and it summarized the confused state of cost estimates.[60]

Chapter 18 also sought to categorize the kinds of criteria that agencies had been applying to guide adaptation strategy and planning: favor actions that increase robustness of infrastructure designs, increase flexibility (e.g. adjusting more often or reducing planned operating lives), reduce other system stresses (and so provide room for adaptation), identify and reverse maladaptation, and improve public awareness and preparedness.[61] In general, the authors supported an iterative management approach involving information collection, planning, and design incorporating policy criteria and development objectives, implementation, monitoring, and evaluation.[62]

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57. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, U.N. Doc FCCC/CP/1997/7/Add.1, 37 I.L.M. 22 (1998).

58. AR3 WG2, Climate Change 2001–Impacts, Adaptation, and Vulnerability (2001), [hereinafter AR3 WG2 REPORT], https://perma.cc/E89M-CHQT.

59. Barry Smit et al., *Adaptation to Climate Change in the Context of Sustainable Development and Equity*, *in* AR3 WG2 REPORT, *supra* note 58, at 877–912.

60. *Id*. at 884–85.

61. *Id*. at 891.

62. *Id*. at 892 (citing Klein et al., *Coastal adaptation to climate change: Can the IPCC Technical Guidelines be applied?*, 4(304) MITIGATION & ADAPTATION STRATEGIES FOR GLOB. CHANGE 239–52 (1999)).

b. AR3 WG2 Report Chapter 2: Decision Frameworks and the Poor State of the Art

AR3 WG2 Report Chapter 2[63] contained a five-page discussion of climate adaptation "decision analytic frameworks"—specifically decision analysis, cost-benefit analysis, cost-effectiveness analysis, and the "policy exercise" approach, that were available to guide adaptation decisionmaking under uncertainty. It stated:

> The proper mode to conduct analyses to support adaptation decisions . . . is sequential decisionmaking under uncertainty and considering future learning. The principal task is to identify adaptation strategies that will take regions or sectors to the best possible position for revising those strategies at later dates in light of new information about expected patterns of regional climate change, socioeconomic development, and changes in climate-sensitive sectors. Consequently, applications of all [decision analysis frameworks] in adaptation studies should be formulated in the sequential decisionmaking mode.[64]

It also defended using cost-benefit analysis. While cost-benefit analysis criticisms were "largely valid . . . it is still better to get at least the measurable components right and complement them with a combination of judgments on hard-to-measure items and sensitivity tests to assess their implications than to abandon the whole method because it does not get everything perfect."[65] It added that cost-effectiveness analysis could also be useful, provided that all parties could define the public good that is the policy output—after which it could be possible to determine an optimal strategy to achieve it. It also noted:

> [WG2] has reviewed a huge volume of climate impact assessment studies conducted to date. Most of these studies investigate possible implications of climate change for a single economic sector or environmental component. An increasing, yet still small, fraction of these studies lists options to alleviate impacts, but few take even the next step of exploring direct and indirect costs of those adaptation options. Even fewer studies provide comprehensive assessments of direct and indirect benefits.[66]

In other words, WG2 conceived of adaptation policy development on a spectrum, from studies that stopped at impact assessment to comprehensive assessments of the costs and benefits of alternatives. Much of the work done to that date had been of the former type.

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63. Q.K. Ahmad et al., *Methods and Tools*, *in* AR3 WG2 REPORT, *supra* note 58, at 105–43.
64. *Id*. at 134.
65. *Id*. at 135.
66. *Id*. at 136.

4. The IPCC Fourth Assessment Report (2007)

Between 2001 and 2007 the United States declined to ratify the Kyoto Protocol, and global GHG emissions increased steadily. Meanwhile, the AR4 WG2 Report[67] represented a quiet turning point in adaptation analysis. Prior to 2007, the IPCC assessment reports had largely not treated adaptation as a policy problem, except to the extent described above. Starting in 2007, adaptation was treated mostly as a policy problem, with much effort pointed toward studying decisionmaking challenges in this context.

The AR4 WG2 Report Chapter 2[68] reviewed developments in assessment methodology between 2001 and 2007. It explained that a need for policy-relevant information had driven exploration of new assessment methods, particularly incorporation of risk assessment and management methods into decisionmaking. "A major aim of [new] assessment approaches is to manage, rather than overcome, uncertainty. . . . Another important trend has been the move from research-driven agendas to assessments tailored towards decision-making, where decision-makers and stakeholders either participate in or drive the assessment."[69] Regarding adaptation assessment, WG2 highlighted "the difficulty of establishing a general methodology for adaptation assessment due to the great diversity of analytical methods employed."[70] From scenario-based impact assessments incorporating adaptation as an input, the state of practice had moved through multi-criteria analysis into development of indicators of adaptive capacity, organizational studies, technology assessments, and risk assessment.[71]

There was still very little progress developing the tools needed to perform multi-criteria policy analysis. Later in the report, WG2 concluded with high confidence that "comprehensive estimates of adaptation costs and benefits are currently lacking," with only a "small methodological literature on the assessment of costs and benefits in the context of climate change adaptation," and with very high confidence that "there are substantial limits and barriers to adaptation."[72] "The literature on adaptation costs and benefits remained quite limited and fragmented in terms of sectoral and regional coverage."[73]

AR4 also used a "barriers" framework to attempt to assess the status of adaptation initiatives. Seeking to create a worldwide classification system, it posited five major categories of adaptation barriers: (1) ecological/physical, (2) technological,

67. AR4 WG2, CLIMATE CHANGE 2007 – IMPACTS, ADAPTATION, AND VULNERABILITY (2007) [hereinafter AR4 WG2 REPORT], https://perma.cc/85AS-U7AY.

68. Timothy R. Carter et al., *New Assessment Methods and the Characterization of Future Conditions*, *in* AR4 WG2 REPORT, *supra* note 67, at 133–171.

69. *Id*. at 136.

70. *Id*. at 138.

71. *Id*. at 137.

72. AR4 WG2 REPORT, *supra* note 67, at 719.

73. *Id*. at 724.

(3) cognitive/psychological, (4) financial, and (5) social/cultural. WG2 also recognized that adaptive capacity was not turning out to be a particularly useful analytical tool for understanding barriers to adaptation:

> Further evidence from Europe and other parts of the globe suggests that high adaptive capacity may not automatically translate into successful adaptations to climate change. Research on adaptation to changing flood risk in Norway, for example, has shown that high adaptive capacity is countered by weak incentives for proactive flood management. Despite increased attention to potential adaptation options, *there is less understanding of their feasibility, costs, effectiveness, and the likely extent of their actual implementation*.[74]

In summary, by 2007 the world recognized that adaptation was a fundamentally different kind of decision problem than was mitigation and had begun to develop generalized theories for why adaptation was difficult, coalescing around a barriers framework with the realization that adaptive capacity, the previously prevailing paradigm, was largely not useful.

5. The IPCC Fifth Assessment Report (2014)

The AR5 WG2 Report[75] continued to track efforts to develop adaptation decisionmaking processes. Chapter 14[76] presented a new generalized taxonomy for adaptation options: "structural/physical" options (engineered systems, new technologies, ecological management, public services), "social" options (educational programs, informational programs, and preparatory/accommodation programs), and "institutional" options (financial incentives, legal standards, and public planning efforts).[77] This taxonomy was not intended to be comprehensive, and the authors noted that many options might cross-categorize.

Regarding the selection between options, the authors noted that a "variety of systematic techniques have been developed for selecting options," but that they "do not account for a range of critical factors such as leadership, institutions, resources, and barriers."[78] The authors recognized that cost-benefit analysis requires "valuation of non-market costs and benefits, which can be impractical."[79] Ultimately, they noted that current practice had emphasized no-regrets, low-regrets, and win-win options, and that multi-criteria analysis was used sporadically.[80]

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74. *Id*. at 733 (citations omitted, emphasis added).

75. AR5 WG2, CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY (2014) [hereinafter AR5 WG2 REPORT], https://perma.cc/JZ4Z-L7PN.

76. Ian R. Noble et al., *Adaptation Needs and Options*, *in* AR5 WG2 REPORT, *supra* note 75, at 833–868.

77. *Id*. at 844–50.

78. *Id*. at 849.

79. *Id*.

80. *Id*. at 836, 849.

The report also collected the decision criteria that had been used to date, beginning with the three most familiar: "effective in reducing vulnerability and increasing resilience," "efficient (increase benefits and reduce costs)," and "equitable, especially to vulnerable groups."[81] Further criteria included that the options be integrated into broader social programs, built with stakeholder participation, consistent with prevailing social norms and traditions, the result of legitimate processes, environmentally and socially sustainable, flexible, appropriately scoped, likely to avoid maladaptation, robust, consistent with available resources, able to consider transformative change, and coherent and synergistic with other strategies.[82]

The report also stated that stakeholders "have found it difficult to clearly define and identify precisely what constitutes adaptation, how to track its implementation and effectiveness, and how to distinguish it from effective development," in part because there are "no common reference metrics."[83] The authors discussed the challenges in measuring vulnerability, resiliency, and adaptive capacity, and they proposed measurements by which metrics themselves could be judged: valid (unambiguous, well founded, well defined, accurate, precise, quality checked, transparent, honest, with a known purpose), providing value (easy to understand, relevant, responsive, actionable, disaggregatable, participatory, and with high information content), available, homogenous, periodically collected, consistent over time, and spatially comprehensive.[84] Ultimately, the authors concluded that for years "the climate change community [had been] far from adopting common standards, paradigms, or analytic language. This still appears to be true, making the search for commonly accepted metrics, even within well-specified contexts, a challenging task."[85]

Finally, AR5 WG2 Chapter 17[86] provided information relevant to economic efficiency analysis. It explained that policy analysis had moved from traditional cost-benefit analysis "to include consideration of non-monetary and non-market measures, risks, inequities and behavioral biases, and barriers and limits and consideration of ancillary benefits and costs."[87] The report concluded that monetizing benefits was sometimes impossible, and therefore that "any analysis [should] be multi-metric, with part in monetary terms and other parts not, and some in precise quantitative terms and others not."[88] It recommended real option analysis to capture costs and benefits together with the cost of delaying a decision, but

81. *Id*. at 850.
82. *Id*.
83. *Id*. at 853.
84. *Id*. at 855.
85. *Id*. at 857.
86. Muyeye Chambwera et al., *Economics of Adaptation*, *in* AR5 WG2 REPORT, *supra* note 75, at 945–77.
87. *Id*. at 948.
88. *Id*. at 951.

concluded that "[m]ulti-metric decision making provides a broader framework."[89] As of this writing, this was the last word on adaptation at the IPCC.

B. AN IDEALIZED FRAMEWORK FOR ASSESSMENT

The IPCC Assessment Reports provide a rich variety of assessment criteria by which to examine climate change adaptation policy and regulation, although they are dispersed across dozens of chapters in five very large reports. Arranged by reference to the basic framework of multi-criteria policy analysis—examining effectiveness, efficiency, equity, and feasibility—the reports' disparate discussions may be drawn together into a nuanced and descriptive set of considerations.

- *Idealized effectiveness analysis*. Any analysis of climate adaptation policy should struggle to "define the problem," i.e., to craft a definition of what is wrong that is measurably remediable. Proposals for action should also explain exactly what the proposed outcome is supposed to be and how to measure it, hopefully in a manner that is consistent with the problem statement. If it is not possible to conduct cost-effectiveness comparisons (cost-per-unit-outcome) between alternative proposals, decisionmakers probably need to do further work.
- *Idealized economic impact analysis*. Any analysis of climate adaptation policy should grapple with how to define the benefit side of adaptation options. This is particularly the case where actions are being compared against up-front costs to decide whether to proceed. Given that climate adaptation is a decades-long process, it is also important that economic analysis clearly discloses the underlying decisions made about present value of future expenses (i.e., the discount rate) and understands the implications of different choices.
- *Idealized equity analysis*. Any analysis of climate adaptation policy should include some attempt to assess the outcomes of various proposals for inequitable impacts. Beyond traditional concepts of process and outcome equity, the pervasive uncertainty in climate adaptation analysis suggests that risk equity also must be addressed—possibly by attributing a cost value to risk-bearing.
- *Idealized feasibility analysis*. Any analysis of climate adaptation policy should interrogate assumptions and conclusions about what is and is not possible, in order to ensure that alternatives are not prematurely discarded. It should also confront institutional limitations that may pose barriers to action—for example, a lack of leadership, institutional constraints, budget, and other exogenous factors.
- *Idealized process legitimacy*. The processes that investigate these questions should involve all relevant stakeholders and should be transparent and accessible.

89. *Id.* at 957. Scenario analysis, meanwhile, was proposed to study worst-case possibilities and be evaluated according to maxi-min and mini-max regret criteria, or robustness. *Id.*

Ideally, climate adaptation policy decisions would demonstrate a clear understanding of these decision processes.

II. ASSESSING CALIFORNIA'S CLIMATE ADAPTATION POLICY DEVELOPMENT—1988 TO 2018

Informed by the framework developed in Part I, this Part recounts and assesses climate adaptation policy development in the state of California over the last three decades. It examines each step along the way for potentially problematic underlying assumptions, missed opportunities, and inconsistent or incoherent approaches, and it demonstrates that California has struggled to develop a climate adaptation policy that permits sufficient regulatory consideration of climate change adaptation. The Part proceeds chronologically: Section A describes climate adaptation policy development in California from 1988 to 2005, when the work was approached primarily as a research question; Section B describes the period from 2005 to 2015, when the state shifted to a strategic planning framework but struggled to develop workable guidance; and Section C covers 2015 to 2018, following a statewide mandate to integrate climate change adaptation considerations into regulatory decisionmaking processes.

A. 1988 TO 2005: PUBLIC RESEARCH ORIGINS

California's climate adaptation policy development process began in 1988, with the state's first climate law. Through the 1990s, the state established a world-class climate change research program, but this program struggled to move beyond impact assessment to tackle the hard questions of climate adaptation. By 2005, the state had developed significant climate expertise in the legislative and executive branches of government and the technical research sector, but it had not yet resolved the question of how to respond if mitigation efforts were insufficient.

1. The First Legislative Directive: A.B. 4420 (1988)

In 1988, the California legislature enacted Assembly Bill ("A.B.") 4420,[90] the state's first law to address climate change. The one-page bill recognized the potential for climate change to impact the state's resources and operations and directed the California Energy Commission ("CEC"),[91] in consultation with the

90. Cal. Assemb. B. ("A.B.") 4420 (1988) (Sher) ("An act relating to the State Energy Resources Conservation and Development Commission"), 1988 Cal. Stat. 5336. For an informative survey of Assemblyman Sher's legislative contributions between 1988 and 2005, *see* W.M. Hanemann, *How California Came to Pass A.B. 32, the Global Warming Solutions Act of 2006*, DEPT. OF AG. & RES. ECON., UCB CUDARE WORKING PAPERS (U.C. BERKELEY) (2007).

91. California created the California Energy Commission ("CEC") following the 1973 energy crisis caused by the Organization of Arab Petroleum Exporting Countries' U.S. oil export embargo. The Warren-Alquist State Energy Resources Conservation and Development Act, 1974 Cal. Stat. 500, § 2,

University of California, the California Air Resources Board ("CARB"),[92] the California Department of Water Resources, and the California Department of Food and Agriculture, to submit a report to the legislature and governor on how climate change could impact California, and to provide "recommendations for avoiding, reducing, and addressing" those impacts.[93]

The law's language did not include the word "adaptation," and subsequent history suggests that mitigation, rather than adaptation, was the Legislature's primary interest. But it did require the CEC to report on the state's options for "addressing" the impacts of climate change, and one option is to adapt.

2. The First CEC Reports (1989 & 1991)

Following A.B. 4420, the CEC produced two reports: an interim report ("CEC 1989")[94] and a final report ("CEC 1991").[95] The final report examined response options but was primarily devoted to mitigation policy. Adaptation was relegated to a brief final chapter that compiled lists of potential policy interventions suggested for further analysis by California state agencies.

The clearest message was that the state's development of climate adaptation policy was initially stymied by the uncertainty of adaptation, resulting in recommendations for further study to reduce uncertainty rather than accepting uncertainty as a given.[96] That is, California state government agencies could not immediately say what California's climate adaptation policy goals should be, what evaluative criteria should be used to judge alternatives, or what data would be needed to support analysis along those criteria.

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created the State Energy Resources Conservation and Development Commission (the CEC's full official name) and tasked it with a wide variety of energy policy development, technical forecasting and assessment, resource conservation, and alternative energy research duties. *Id.* (enacting Cal. Pub. Res. Code Div. 15, §§ 25000 *et seq.*). The Legislature also required the CEC to certify construction of all large power plants in the state—the agency's most public-facing regulatory function. *Id.* Between 1973 and 1988, the CEC's research portfolio had been expanded several times. *See* 1976 Cal. Stat. 1635 (large-scale renewables demonstrations); 1977 Cal. Stat. 3476 (passive thermal systems); 1978 Cal. Stat. 3331 (wind energy research program); 1978 Cal. Stat. 4543, § 2 (passive solar design competition); 1980 Cal. Stat. ch. 905, § 2 (agricultural solar design competition); and 1984 Cal. Stat. 4057, § 16 (biannual trends reporting).

92. California created the California Air Resources Board ("CARB") in 1967 to promote unified action on the problem of air pollution. 1967 Cal. Stat. 3679, § 5 (the Mulford-Carrell Air Resources Act) (codified at Cal. Health & Safety Code Div. 26, §§ 39000 *et seq.*). By 1988, CARB's authority had been expanded, particularly via 1975 Cal. Stat. 1975, ch. 957 (significantly expanding Div. 26, including, *inter alia*, creating an air pollution research program that reported to the legislature).

93. A.B. 4420 § 2.

94. CEC, P500-89-004, THE IMPACTS OF GLOBAL WARMING IN CALIFORNIA (1989) [hereinafter CEC 1989].

95. CEC, P500-91-007, GLOBAL CLIMATE CHANGE: POTENTIAL IMPACTS AND POLICY RECOMMENDATIONS [hereinafter CEC 1991] (published in two volumes, but the two volumes contain identical information, with the first being an executive summary version of the second; citations here are to the Volume II version).

96. *Id.* at 6–1.

This, however, did not stop the CEC from choosing decision rules. The report concluded that "adaptation policies should be designed so they can be introduced incrementally as change occurs. Premature adaptation measures may incur unnecessary costs, while large engineering projects may over-commit or under-commit society in terms of the appropriate response level."[97] This statement hides value judgments, including, among others, that taking costly actions that in hindsight were not necessary wastes money and acting without good information increases the likelihood of such outcomes. That is, the only evaluative criterion offered by the CEC was present cost. Without any proposal for measuring or comparing benefits, the state's first climate policy was, necessarily, inaction.

In discussing its data collection program, the CEC made a further assumption: although it had just said that it did not know how it could be done, the CEC was sure that the goal of any future policy development would be to "compare the economic costs of adaptation policies with mitigation policies."[98] The idea was that a climate change response strategy could be formulated as some optimal combination of mitigation and adaptation actions. However, such an optimization assumes that mitigation and adaptation can be compared, an assumption that fails to account for several very difficult aspects of problem definition and measurements of effectiveness. Mitigation can be expressed in terms of unit cost (for example, dollars per megaton CO_2 reduction), but adaptation may be unitless and unmonetizable. Furthermore, mitigation strategies are capable of economic benefit-side valuation (e.g., avoided social cost of carbon), while adaptation strategies often are not, or rely on valuations that are so general or wide-ranging as to be essentially meaningless.

Thus, as of CEC 1991 (and AR1), California recognized uncertainty as a major problem for adaptation policy development but had not considered best practices for decisionmaking under uncertainty. There was no attempt to establish how to define or measure adaptation values, or promote public input into these questions. Rather, the strategy was to collect technical data, in the hope that it would reduce uncertainty and somehow improve decisionmaking, which was imagined as a process comparing two potentially incomparable sets of options.

3. The First PIER Research (1996 to 2003)

The CEC's next major climate report did not discuss climate change adaptation at all,[99] and the AR2 adaptation analyses passed without official comment in the state. Nonetheless, the intervening years saw a significant expansion of the state's climate policy development capacity in the form of a world-class climate research

97. *Id.*
98. *Id.*
99. CEC, P500-98-00IV1, 1997 GLOBAL CLIMATE CHANGE: GREENHOUSE GAS EMISSIONS REDUCTION STRATEGIES FOR CALIFORNIA (1998), https://perma.cc/F6EA-4CMF.

program. Following California's electric deregulatory initiative,[100] regulators predicted that the state's electric utilities would no longer be motivated to fund prosocial electric system research.[101] Consequently, the California legislature provided for a Public Interest Energy Research ("PIER") electricity rate surcharge to produce funds for electric system research under deregulation.[102] Under the CEC, the PIER program became a primary conduit for climate research funding in California.

In 1998, the CEC issued its First General Solicitation for PIER funds, which included an environmental research program.[103] The Electric Power Research Institute ("EPRI"), a nonprofit funded and operated by U.S. electric utilities to pool research efforts, was awarded $28.4 million to study climate change in California.[104] EPRI's work ran for five years and resulted in dozens of publications.[105] Ultimately, however—and although an analysis had been part of its original plan—EPRI equivocated on the question of how to approach climate adaptation. It ended its CEC-funded research work with an impact assessment, concluding that its work would probably be useful for future examinations of adaptation alternatives. As stated succinctly in the report's executive summary: "The results of the studies can be useful for examining adaptation needs, but no

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100. *E.g.*, Severin Borenstein and James Bushnell, *Electricity Restructuring: Deregulation or Reregulation?* 23 REGULATION 46 (2000); CHRISTOPHER WEARE, THE CALIFORNIA ELECTRICITY CRISIS: CAUSES AND POLICY OPTIONS (2003); Benjamin F. Hobbs & Shmuel S. Oren, *Three Waves of U.S. Reforms: Following the Path of Wholesale Electricity Market Restructuring*, 17:1 IEEE POWER & ENERGY MAG. 73 (2019).

101. *See* CPUC, D. 95-12-063 ("Opinion"), at 145–62 (Dec. 20, 1995), ftp://ftp2.cpuc.ca.gov/LegacyCPUCDecisionsAndResolutions/Decisions/Decisions_D9507001_to_D9905055/D9512063_19951220_R9404031.pdf; D. 96-03-22 ("Interim Opinion"), at 26–28 (Mar. 14, 1996), ftp://ftp2.cpuc.ca.gov/LegacyCPUCDecisionsAndResolutions/Decisions/Decisions_D9507001_to_D9905055/D9603022_19960313_R9404031.pdf; WORKING GROUP REPORT ON PUBLIC INTEREST RESEARCH, DEVELOPMENT & DEMONSTRATION ACTIVITIES, P500-96-010 (Sept. 6, 1996).

102. A.B. 1890, 1996 Cal. Stat. 4488 (electric utility deregulation), as amended by S.B. 90, 1997 Cal. Stat. 6495 (creating PIER); S.B. 1194, 2000 Cal. Stat. 7719 (addressing research funding); S.B. 1038, 2002 Cal. Stat. 2912 (five-year investment plan and selection criteria); S.B. 71, 2005 Cal. Stat. 1775, 1778–79 (requiring planning and reporting), S.B. 1250, 2006 Cal. Stat. 3724, 3733–34 (extending program for five years); and A.B. 2267, 2008 Cal. Stat. 3861 (expressing priority for economic benefit). PIER ended when the legislature failed to pass an extension bill in 2011 and was replaced by a similar program at the CPUC. CPUC, Order Instituting Rulemaking, R.11-10-003, at 4 (Oct. 13, 2011), https://perma.cc/TR4T-CF75 (initiating rulemaking to replace PIER); CPUC, D 11-12-035 (Dec. 21, 2011), https://perma.cc/VT2K-AZF3 (establishing a new funded program for renewable energy research); CPUC, D 12-05-037 (May 31, 2012), https://perma.cc/K5YJ-AAM9 (same).

103. *See* CAL. ENERGY COMM'N, QUARTERLY REPORT CONCERNING THE PUBLIC INTEREST ENERGY RESEARCH PROGRAM 4 (Apr. 8, 1998), https://perma.cc/UUK3-6EDQ.

104. CAL. ENERGY COMM'N, 1998 ANNUAL REPORT CONCERNING THE PUBLIC INTEREST ENERGY RESEARCH PROGRAM 49–50 (P500-99-004, 1999), https://perma.cc/5NF2-EHUM.

105. Elec. Power Res. Inst., *Summary of Benefits from Commission Funding of EPRI's Collaborative Climate Research Program 1998-2002*, *att'd as* App'x XVI *to* GLOBAL CLIMATE CHANGE AND CALIFORNIA: POTENTIAL IMPLICATIONS FOR ECOSYSTEMS, HEALTH, AND THE ECONOMY (Aug. 2003), https://perma.cc/28MR-66P5.

specific study on adaptation was done for this assessment."[106]

This is the earliest example of what would become another very important hallmark of California's climate change adaptation policy development: expending all available resources on assessment to the detriment of everything else. Efforts at adaptation analysis are frequently bogged down in impact assessment, with little left—invariably in the last pages or paragraphs—for the translation of those assessed impacts into policy proposals, let alone an analysis of those proposals or even an analysis framework. The (possibly quixotic) desire for more certainty attracted recurring investigation into the same questions, and the very different questions raised by adaptation policy—identification and evaluation of alternatives that involve changes to currently-prevailing conceptions of, for example, intra- and intergenerational equity, societal allocation of risk, timely decision-making lacking sufficient information, and land use and property rights, as well as the legal and political feasibility of implementing such alternatives—go unexamined. EPRI's work would not be the last example of this phenomenon.

As of 2001, then, California's climate adaptation policy was what it had been in 1988: to try to generate useful information, and, otherwise, to wait and see.

4. The CEC's Climate Change Research Plan (2001 to 2005)

With its first PIER studies ongoing, the CEC moved to solicit further climate policy research.[107] The agency commissioned research roadmaps,[108] including, as relevant here, an adaptation roadmap.[109] However, the proposal combined adaptation and mitigation research under the broader efforts of integrated assessment modeling. As such, the roadmap's focus was on economic equilibrium models and the difficulties of incorporating adaptation policies into these models. Consequently, the roadmap identified, in a general way, the need for improved theory and practice to support incorporating impact assessment and adaptation analysis into large-scale policy options models, but—again—did not take the opportunity to confront the more fundamental challenges posed by adaptation.[110]

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106. ELEC. POWER RES. INST., GLOBAL CLIMATE CHANGE AND CALIFORNIA: POTENTIAL IMPLICATIONS FOR ECOSYSTEMS, HEALTH, AND THE ECONOMY 21 (Aug. 2003). As it turns out, this was not exactly true. The research plan supported EPRI's larger climate research initiative, a part of which was an adaptation conference that resulted in an academic publication on adaptation. The book was SMITH ET AL., CLIMATE CHANGE, ADAPTIVE CAPACITY AND DEVELOPMENT (2003). The book was strongly influenced by the concepts developed in the IPCC assessments and was not specific to California.

107. *See* CAL. ENERGY COMM'N, PIER FIVE-YEAR INVESTMENT PLAN, 2002-2006, (P600-01-004a, 2001), https://perma.cc/C8LV-XNWR.

108. CAL. ENERGY COMM'N, 500-03-025FS, CLIMATE CHANGE RESEARCH, DEVELOPMENT, AND DEMONSTRATION PLAN (2003), https://perma.cc/6D8U-TY2U.

109. ALAN SANSTAD, P500-03-025FAVI, THE ECONOMICS OF CLIMATE CHANGE MITIGATION AND ADAPTATION IN CAL., https://perma.cc/6SAR-5B4L, *att'd as* Attachment VI *to* Guido Franco, et al., Climate Change Research, Development, and Demonstration Plan, P500-03- 025FS (Apr. 2003), https://perma.cc/AT7E-L8P2.

110. *See*, *e.g.*, Karen Fisher-Vanden et al. *Modeling Climate Change Feedbacks and Adaptation Responses: Recent Approaches and Shortcomings*, 117 CLIMATIC CHANGE 481, 481–95 (2013); Juan-

Notwithstanding the lack of progress in adaptation specifically, beginning in 2003 the CEC oversaw a major expansion in climate research. In June 2003, the CEC created the California Climate Change Center, an online repository for California's climate research. In 2004, the CEC also began hosting an annual conference on climate change research. Under the auspices of the Climate Research Center and the CEC's PIER program, publication levels soared. Six papers were published in 2004. Forty papers were published in 2005. Thereafter, the state produced an average of about thirty studies per year, spiking to 62 in 2009, and 73 in 2012, as grant cycles ended. The work was world-class in many respects and remains an impressive achievement. But in the context of climate adaptation policy development, it produced little.[111]

5. Assessment: 1988 to 2005

California's experience between 1988 and 2005 revealed the following potential barriers to climate adaptation policy development:

- *Uncertainty paralysis*—treating future uncertainty as an impediment to analysis, rather than as an analytical input (e.g., CEC 1991)—and *endless investigation*—focusing only on trying to resolve uncertainty through accumulation of additional data, regardless of its information value, without recognizing that certainty may never be achieved (e.g., CEC 1991). This approach is most like that proposed in AR1 WG3's Resources Chapter (where uncertainty was treated as a problem to be attacked by "Category A" interventions, and costly "Category C" options were to be delayed until Category A's success), and may be distinguished from, for example, the act-learn-act sequential decisionmaking advocated in AR3 WG2 Report Chapter 2 and later reports.
- *Premature combination*—attempting to compare mitigation and adaptation without first ensuring that they are defined in comparable fashion (e.g., CEC 1991). This is similar to the IPCC's early approaches, which did not separate mitigation and adaptation until 2001's AR3, and distinguishable from later frameworks that focus on adaptation alternatives alone.
- *Assessment burnout*. In efforts nominally devoted to adaptation, committing most or all resources to assessment, leaving no time or energy for addressing questions unique to climate adaptation policy analysis (e.g., EPRI 2003). Again, this had analogues in the IPCC's early approaches, including AR3's primary focus on vulnerability assessment in combination with a short analysis of adaptation.

Carlos Ciscar & Paul Dowling, *Integrated Assessment of Climate Impacts and Adaptation in the Energy Sector*, 46 ENERGY ECON. 531, 531–38 (2014).

111. *See Research*, CAL-ADAPT, https://perma.cc/J7TW-UHW5 (last visited Oct. 24, 2019).

California's efforts did not treat adaptation as a policy problem conducive to multi-criteria analysis and consequently did not make major inroads into questions regarding the effectiveness, efficiency, equity, or feasibility of competing adaptation options. As discussed below, the trends are recognizable in part because they continued to manifest.

B. 2005 TO 2015: STRATEGIC PLANS AND FRAGMENTATION

Beginning in 2005, California began dual processes of issuing high-level, broad, agenda-setting directives and developing strategies and plans consistent with those directives. For climate adaptation, however, these proved insufficient to meet the demand for coordination, and over the course of the next decade, state-level planning processes were barely able to keep up with the proliferation of adaptation work at local and regional scales. During this period, the Governor's Office took the lead. This began with Executive Order S-03-05 (2005) and continued with Executive Order S-13-08 (2008), which transformed the state's adaptation outlook to one of strategic planning. However, the implementation of this planning was delegated without much direction. State agencies, coordinated by the California Natural Resources Agency ("CNRA"),[112] were tasked with completing sectoral climate change impact assessments, which expanded into collections of recommendations but not a coherent statewide climate adaptation policy. Meanwhile, local and regional efforts to incorporate adaptation into their planning processes multiplied, and state agencies responded with guidance.

1. Executive Order S-03-05 (June 2005)

On June 1, 2005, Governor Schwarzenegger issued Executive Order ("E.O.") S-03-05.[113] It is best known for setting California's greenhouse gas emission reduction targets, which led to the California Legislature's enactment of A.B. 32 the next year.[114] A.B. 32 authorized CARB to create and implement regulations to meet the state's GHG emissions targets,[115] CARB created a cap-and-trade system for statewide GHG emissions, and the state has since invested a great deal of time, money, and thought into mitigating climate change impacts by improving its GHG profile. Thus, 2005 marked the beginning of California's world leadership in carbon control policy implementation. This is relevant here, however,

112. The CNRA, created in 1961, is a cabinet-level organization to which most of the state's natural resources administrations report. Cal. Govt. Code § 12805 (West 2019). The CEC is under CNRA, as is CAL FIRE and over a dozen other organizations.

113. Cal. Exec. Order No. S-03-05 (Schwarzenegger, June 1, 2005) ("E.O. S-03-05").

114. A.B. 32, 2006 Cal. Stat. ch. 488 ("California Global Warming Solutions Act of 2006") (adding Div. 25.5 to the Cal. Health & Safety Code).

115. *Id.* at pt. 3 (codified Cal. Health & Safety Code § 38550).

primarily to the extent that mitigation policy overshadowed and largely displaced adaptation policy development.

With much less fanfare, E.O. S-03-05 also attempted to consolidate the mechanisms by which California state government would prepare for the inevitable impacts of a changing climate. The E.O. instructed the California Environmental Protection Agency ("CalEPA")[116] to coordinate and report on the state's climate adaptation plans: "[CalEPA] shall also report to the Governor and the State Legislature by January 2006 and biannually thereafter on the impacts to California of global warming, including impacts to water supply, public health, agriculture, the coastline, and forestry, and shall prepare and report on mitigation and adaptation plans to combat these impacts."[117]

Some of the problems with the E.O.'s framing should be evident from the discussion above: it foregrounded impact assessment (ensuring that the majority of CalEPA's work would be devoted to that task, potentially to the detriment of adaptation policy) and immediately combined "mitigation and adaptation plans" into a single category, with the concomitant potential for taxonomic confusion. It also obscured a hard truth: there were no agreed-upon standards by which adaptation planning could be carried out and no plan for locating leadership responsibility to create them. E.O. S-03-05 neither directed CalEPA to develop such standards nor provided any explicit guidance on how to define success, how to measure cost, what fair solutions would look like, or what kind of solutions had any political support. Instead, it left this to CalEPA to intuit, in a manner that did not make it clear that this was now entirely CalEPA's responsibility. Because this is the first top-level government action on the topic after A.B. 4420 in 1988, and because it came from the Governor's office (which has a great deal of policymaking capacity and influence), E.O. S-03-05 therefore represents the earliest positive example of another hallmark of California's climate adaptation policy development: failure of leadership to define policy.

2. The Climate Action Team Report (April 2006)

In response to E.O. S-03-05, CalEPA formed the Climate Action Team ("CAT"), formally populated by leaders of state agencies with regulatory portfolios impacted by climate change, functionally operating as a loose inter-agency coordinating body with research staffing.[118] In its first year, the CAT split its work into two areas: development of market-based options for mitigating

116. CalEPA was created in 1991 following years of debate over and inaction on creating a consolidated environmental regulatory agency in California. CALEPA, THE HISTORY OF THE CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY 19 (2016), https://perma.cc/H8D3-LCCA. It currently hosts a variety of program-level organizations, including CARB, and the state's pesticide, recycling, toxics, health hazards, and water resources control agencies.

117. E.O. S-03-05, ¶ 6.

118. CAL. CLIMATE ACTION TEAM ("CAT"), 2006 FINAL CLIMATE ACTION TEAM REPORT TO THE GOVERNOR AND LEGISLATURE 19 (Apr. 3, 2006), https://perma.cc/54J9-8DFX.

emissions and scenario analysis to evaluate climate change impacts and adaptation planning.[119] Notably, neither of these things were "adaptation plans" as contemplated (however vaguely) by E.O. S-03-05.

The CAT's first annual report focused on impact assessment and mitigation and did not make any headway on adaptation. It discussed in general terms the high level of uncertainty facing adaptation decisionmakers and spoke of adaptation challenges in terms of the need for better information on which to build plans.[120] The CAT's scenario analysis work was important and groundbreaking, and one of its team members wrote a useful paper on climate adaptation barriers around this time,[121] but the CAT's work did not result in a workable statewide adaptation policy development model. The subsequent years, 2006 to 2008, were extremely important for mitigation policy development. Thus, the CAT shifted its focus to supporting CARB's creation of the A.B. 32 Scoping Plan.[122] No further adaptation policy development occurred until late 2008.

3. Executive Order S-13-08 (November 2008)

In November 2008, Governor Schwarzenegger issued E.O. S-13-08.[123] The first six sections followed a familiar pattern: state agencies were to consolidate efforts to predict climate change in the state, assess the impacts to state resources that climate change could have, and assess the vulnerability of state social and physical systems to those impacts. But the new E.O. also ordered something new:

> By June 30, 2009, [the CNRA], through the [CAT], shall coordinate with local, regional, state and federal public and private entities to develop a state Climate Adaptation Strategy. The strategy will summarize the best known science on climate change impacts to California (led by CEC's PIER program), assess California's vulnerability to the identified impacts and then outline solutions that can be implemented within and across state agencies to promote resiliency.[124]

This was the first explicit instruction from a California government authority directing the identification of policy alternatives for climate adaptation—an assessment and presentation of "solutions that can be implemented." The new E.O. also included the first authoritative expression of an explicit criterion for

119. *Id.*

120. *Id.* at 37–39.

121. AMY LYND LUERS & SUSANNE C. MOSER, CEC-500-2005-198-SF, PREPARING FOR THE IMPACTS OF CLIMATE CHANGE IN CAL.: ADVANCING THE DEBATE ON ADAPTATION (2005) [hereinafter Luers & Moser], https://perma.cc/9VH2-DXEZ.

122. CAT, CAT SUBGROUP REPORTS SUPPORTING AB 32 SCOPING PLAN (Dec. 2008) (agriculture, cement, energy, forestry, green building, waste management, water, and state transportation sectors, with no discussions of adaptation), https://perma.cc/7LCK-HNP2.

123. Cal. Exec. Order No. S-13-08 (Schwarzenegger, Nov. 14, 2005) [hereinafter E.O. S-13-08].

124. *Id.* ¶ 7.

selecting among such alternatives: "resiliency." The prevailing, research-oriented, integrated assessment paradigm had been quietly abandoned.

However, the new E.O.'s structure was still far from ideal. From an effectiveness perspective, it did not define its desired outcome: resiliency. It should have been clear at that point that resiliency was not (and still is not) a clearly defined concept, and that delegated agencies would struggle without further instruction regarding what it was supposed to mean, or a formal structure for reaching some consensus on that question.[125] Had it been crafted with effectiveness in mind, the E.O. might also have taken some position on metrics—meaning how resiliency, however defined, should be measured for purposes of, for example, cost-effectiveness analysis. As it was, there was no uniform basis by which to measure progress or success or to define what constituted a potential "solution," and so no way to assess how effective (or cost-effective) any given proposal might be.

From an economic impact perspective, the E.O. also did not define how to measure costs and benefits, rendering uniform cost-benefit analysis impossible. This was particularly problematic given current events at the time: California was in the depths of a budgetary crisis during the height of what would be called the Great Recession.[126] Without attention paid to the unmonetizable (or long-term) upsides of climate adaptation investment, very few available solutions would be likely to appear economically rational on planning horizons typically employed by state agencies.

This was probably exacerbated by the second, less obvious criterion: that the chosen solutions "can be implemented within and across state agencies." One possible reading of this language—one that ultimately prevailed—is that proposed solutions must be feasible under current governance conditions. Thus, long-term investment strategies, and all options that cost a great deal of money or involved changes in prevailing governance structures, were rejected before their other merits and demerits could be evaluated. What was left was present cost, meaning immediately available funding, amounting to very little.

Finally, the agency-led drafting strategy—a single state agency would take the lead on drafting sectoral plans—ensured that plans for how to deal with the physical transformation of the entire state would not receive public input or be impacted by political considerations beyond those most salient to the agency authors. This lack of process equity and procedural legitimacy evidenced a general lack of consideration for the equity and public input implications of climate adaptation at this time. The result was the Climate Change Adaptation Strategy.

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125. For a contemporary introduction to this topic, see Carl Folke, *Resilience: The Emergence of a Perspective for Social-Ecological Systems Analyses*, 16 GLOB. ENVTL. CHANGE 253 (2006).

126. *See generally*, Ashok Bardhan & Richard Walker, *Cal. Shrugged: Fountainhead of the Great Recession*, 4 CAMBRIDGE J. OF REGIONS, ECON. & SOC'Y 303 (2011).

4. The California Climate Adaptation Strategy (December 2009)

The CNRA's response to E.O. S-13-08 highlighted the difficulties of translating an order to develop a strategic plan through multiple bureaucracies into a single strategic, policy, or planning statement. Rather than providing a consistent vision for the future, identifying alternative actions that could be taken to achieve that vision, and picking the alternatives most consistent with previously stated, clearly defined core values (all of which are typical elements of strategic planning with analogues in multi-criteria policy analysis), the participating agencies instead produced a list of possibly feasible near-term actions, vaguely specified. This may have been useful for those involved, but it did not result in a persistent statewide framework to guide climate adaptation policy development.

The Climate Change Adaptation Strategy ("the CCAS")[127] was developed in the same manner as CEC's 1991 report: by surveying state agency subject matter experts for adaptation desiderata and attempting to organize these into a logical structure. The result was less a strategic planning statement than a lengthy to-do list. The document devoted almost no space to climate adaptation's hard questions. By this time, these hard questions were public knowledge, as they had been discussed in depth in AR3. The CCAS did not even mention them.

Regarding effectiveness, having not defined its desired outcomes, the document was unable to suggest a meaningful approach to determining whether any given alternative would have some desired effect on resiliency or any other metric. Regarding feasibility and economic impact analysis (efficiency), as public officials working at the height of a state budget crisis, the authors defaulted to the message implied by the E.O.: the CCAS would "[g]ive priority to adaptation strategies that initiate, foster, and enhance *existing efforts* that improve economic and social well-being, public safety and security, public health, environmental justice, species and habitat protection, and ecological function;" and "[w]hen possible, give priority to adaptation strategies that modify and enhance *existing policies* rather than solutions that require new funding and new staffing."[128] In other words, the CCAS chose to pursue, at best, the so-called "no regrets" alternatives—those that are justifiable and feasible under current conditions. Even this characterization may be generous, however, as the CCAS criteria foreclosed the possibility of any additional spending, even where it may have been justified under a no-regrets framework, and failed to discuss how to quantify or monetize the benefits of adaptation decisions beyond their up-front costs. The report did this even while recognizing the need to "[f]ormalize criteria for prioritizing identified adaptation strategies."[129]

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127. CNRA, 2009 CALIFORNIA CLIMATE ADAPTATION STRATEGY: A REPORT TO THE GOVERNOR OF THE STATE OF CAL. IN RESPONSE TO EXECUTIVE ORDER S-13-2008 (Dec. 2009) [hereinafter CCAS], https://perma.cc/K2H4-2Q96.

128. *Id*. at 5 (emphasis added).

129. *Id*. at 13.

The bulk of the CCAS was a sector-by-sector discussion of "impacts, risks, and strategies," with each section led by the state agency with primary sectoral oversight authority.[130] Each sectoral impact assessment ended with a nested list of proposed actions, divided into general "strategy" categories and labeled as near-term or long-term.[131] There was no evidence of effort to identify the goals that the proposals were designed to achieve; no discussion of the range of alternatives that could also have been considered before the chosen strategies would be adopted; no attempt to agree upon criteria by which alternatives could be evaluated; and no attempt to apply such criteria to confirm that the proposed strategies actually would be effective at achieving these goals, to assess the cost and cost per unit outcome of each strategy, or to grapple with equity. Rather, the solutions appear to be what each agency (apparently) believed were financially and politically feasible.

No doubt, many of the suggestions in the CCAS were good. For example, consistent with the long-recognized need to inject climate adaptation into planning processes, the CCAS supported revising the California Environmental Quality Act[132] to require discussion of potential impacts from climate change, although it did not suggest how the analysis should be done or how to deal with uncertainty. The criticism here is toward the process that resulted in only including these proposals (not the full range of other proposals) in the document, without the alternatives selection process being explained, explicit, or carefully reviewed.

Beyond the individual agency contributions, the CCAS did present several statewide strategies that have been influential in developing further policy. First, the CCAS recommended a California Climate Vulnerability Assessment, which it hoped would "allow policy-makers the ability to develop a more systematic approach to funding risk reduction efforts."[133] This reflected the growing consensus that the primary expression of equity analysis would be via vulnerability assessment. This was consistent with international practice at this time (vulnerability had been the foundation of the United Nations Framework Convention on Climate Change equity approach), although by 2009 it had become apparent that vulnerability itself was a difficult standard to employ.[134] By directing the majority of the state's climate adaptation resources toward vulnerability assessment, the CCAS created the risk of endless investigation to more carefully define a fundamentally vague metric, particularly in the event of allocation conflict where vulnerability will be used to decide whether groups received money.

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130. For example, the forestry section was written by CAL FIRE staff. *See id*. at 1, 4 (chapters "led by" competent agencies).

131. *Id*. at 40–44, 57–64, 73–78, 86–91, 100–06, 116–21, 130–34.

132. Cal. Pub. Res. Code §§ 21000 *et seq*.

133. CCAS, *supra* note 127, at 28.

134. For a contemporary discussion of the vulnerability concept, *see* Stephen H. Schneider et al., *Assessing Key Vulnerabilities and the Risk from Climate Change*, *in* AR4 WG2 REPORT, *supra* note 67, at 779–810.

Next, the CCAS recommended continued investment in CalAdapt, a statewide climate vulnerability data mapping system that would "allow[] local communities to develop their own climate adaptation strategies based on this information."[135] Although this also sought to address equity, the difficulty with the CalAdapt program was, and continues to be, that to provide information that is useful, it is necessary to know what the goals are. CalAdapt's purpose of letting local communities "develop their own . . . strategies" replaced statewide policy leadership with a website.

The leadership failure problem, then, was again at the core of the CCAS—and appears to have been obliquely recognized by the authors, who highlighted the need for a unified effort to set policy and admitted that they had not done so themselves. To address the lack of clear answers to many of the questions that a strategic plan is typically supposed to answer, the CCAS recommended creating a Climate Adaptation Advisory Panel to continue developing a strategic vision.[136] The results were the CCAAP/PCIP.

5. The CCAAP/PCIP Strategy (November 2010)

By 2009, the lead agency on climate adaptation had shifted several times. Between 1988 and 2005, the CEC took the reins with a research focus. In 2005, the governor's office took over leadership and imposed a more strategic focus while making several attempts to consolidate and unify adaptation policymaking. The CAT did not achieve this goal, and with E.O. S-13-08, the torch passed to CNRA. CNRA, however, recommended creating an advisory panel to oversee and develop a strategic vision. For a brief period, that job was given to a policy firm.

In early 2009, the Pacific Council on International Policy ("PCIP") organized a Task Force on Adaptation to Climate Change.[137] Following the publication of the CCAS, Governor Schwarzenegger named the PCIP's Task Force to serve as the Climate Adaptation Advisory Panel. The panel's work resulted in a single report, remarkable for its policy-oriented approach.[138]

PCIP's report set out a new vision: "to encourage that all major planning and development decisions throughout the State be made within a coherent,

135. CCAS, *supra* note 127, at 28.

136. *Id*. at 7, 22, 26, 146–47.

137. *See Pacific Council Task Force to Advise State on Climate Adaptation*, BUSINESS WIRE (Dec. 8, 2009) (the description of the Task Force's work at that time is consistent with the layout of their final report), https://perma.cc/SN9X-V5H7. It is not clear to what extent CNRA's recommendation for an advisory panel was made with the intent that the PCIP Task Force serve in that role, or to which the PCIP's creation of the Task Force was with the purpose of taking on more official advisory responsibilities.

138. PAC. COUNCIL ON INTL. POL'Y, PREPARING FOR THE EFFECTS OF CLIMATE CHANGE – A STRATEGY FOR CALIFORNIA: A REPORT BY THE CALIFORNIA ADAPTATION ADVISORY PANEL OF THE STATE OF CAL. (2010), https://perma.cc/BRN2-7SR8. After the report came out, the PCIP moved on to other things.

comprehensive framework to guide adaptation," based on values, including that the approaches be "science and analysis-based, collaboratively developed, and financially viable," and providing a "long-term approach to adaptation to guide decision-making at all levels."[139] PCIP was concerned with legitimacy through stakeholder participation, public engagement, and comment,[140] and it recognized the importance of clearly delegated decisionmaking authority.[141] This was the first time that these ideas had been discussed in state-level climate adaptation policy documents.

The PCIP report also reflected an understanding of the policy analysis and development process. For example, the PCIP recommended anticipatory data gathering and the creation of a central repository under unitary authority as an element of its problem identification strategy.[142] Prior data gathering proposals had been framed in terms of needing additional data because uncertainty was a problem; in contrast, the PCIP proposed limited, rational anticipatory data gathering because it recognized that certain data would be useful to help define the problems that needed to be solved.[143] This data gathering would not simply result in more data gathering, it would result in problem definitions which, in turn, would help agencies identify alternative solutions.[144]

Likewise, with respect to assessment, the PCIP recommended the creation of "a credible, authoritative, and scientific professional entity to assess climate risks to the built and natural environments throughout the state,"[145] which would develop and maintain protocols for state and local entities to follow when conducting climate risk assessments, risk characterization, and adaptation alternatives identification evaluation. The PCIP, it seems, recognized that it was not such an entity, even though it had been given a similar job.

Regarding integration into planning processes, PCIP recommended incorporating climate change analysis into "all long-term general planning and public and private sector development proposals,"[146] with a focus on integrating the many regional and local planning initiatives that were then beginning to proliferate. Again, this proposal can be contrasted to the CCAS's strategy, which referred local agencies to public resources made available on CalAdapt. The suggestion to integrate climate adaptation into planning was made in combination with the suggestion that some authority centrally guide the process.

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139. *Id*. at 1.

140. *Id*. at 2.

141. *Id*. ("Lead agencies are needed at every level of government to reconcile competing interests, forge compromises, expedite decisions on adaptation, and overcome barriers to action.").

142. *Id*. at 4–5.

143. *See id*.

144. *See id*.

145. *Id*. at 5.

146. PAC. COUNCIL ON INTL. POL'Y, *supra* note 138, at 8.

And finally, regarding funding, the report recommended "that the state launch a feasibility study to explore mechanisms to fund adaptation and encourage resilient actions,"[147] particularly to build funds for large-scale public works and to revise private property insurance standards to incentivize resiliency. These ideas were available in the IPCC assessment reports and can be contrasted to the CCAS's limitations to current spending and existing programs.

The PCIP did not attempt to answer the many criteria-level questions that policy development would have to resolve. Instead, it made recommendations that would create the conditions of possibility for such resolutions. It had its drawbacks—it was short, provided few references, and did not fully explain the basis of some of its assumptions and perspectives. But when compared against policy analytical ideals, it exceeded all other efforts. It was entirely ignored.

6. The Adaptation Planning Guide (Sept. 2012) and Other Guidance (2010 to 2015)

During the next five years, the demand for unified climate adaptation guidance only grew. California government is not just a state-level affair. Local and regional organizations pursue independent objectives and interface with state bodies in a complex project of federalist co-governance. The years between 2010 and 2015 saw a number of guidance documents issued by state agencies to support local planning efforts.[148] None of these was prepared under a unified framework for assessing alternatives.

The most significant guidance effort during this period was the Adaptation Planning Guide ("APG") by the Governor's Office of Planning and Research ("OPR").[149] The APG was significant in part because it developed the OPR's adaptation policymaking capacity, but also because it demonstrated the degree to which local and regional organizations had stepped into the breach left by the state government. It was primarily descriptive, rather than prescriptive, providing suggestions based on what other jurisdictions in the state had already done. Rather than suggest that cities draft a climate change plan, the APG provided a link to the City of Chula Vista's. Rather than suggest outreach programs, the APG provided a link to an example by the San Francisco Bay Conservation and

147. *Id.* at 10.

148. See, e.g., CAL. DEP'T OF FISH & GAME, UNITY, INTEGRATION, AND ACTION: DFG'S VISION FOR CONFRONTING CLIMATE CHANGE IN CALIFORNIA (2011), https://perma.cc/KR2Q-Q9VD; CAL. DEP'T OF WATER RES. & U.S. ENVTL. PROT. AGENCY, Climate Change Handbook for Regional Water Planning (2011), https://perma.cc/THE9-A9QV; COASTAL & OCEAN WORKING GRP. OF THE CAL. CLIMATE ACTION TEAM & CAL. OCEAN PROT. COUNCIL, STATE OF CALIFORNIA SEA-LEVEL RISE GUIDANCE: MARCH 2013 UPDATE, https://perma.cc/2DB6-8UMP; CAL. DEP'T OF PUB. HEALTH, CLIMATE ACTION FOR HEALTH: INTEGRATING HEALTH INTO CLIMATE ACTION PLANNING (2012), https://perma.cc/E3PK-C77X; PUB. HEALTH WORKING GRP. OF THE CAL. CLIMATE ACTION TEAM, PREPARING FOR EXTREME HEAT IN CALIFORNIA: GUIDANCE AND RECOMMENDATIONS (2013), https://perma.cc/WGB9-F896.

149. CAL. GOV.'S OFF. OF PLANNING & RESEARCH, CALIFORNIA ADAPTATION PLANNING GUIDE (2012) [hereinafter APG].

Development Commission. The APG, then, performed a useful function but did not provide a great deal of leadership. Instead, responsibility devolved downward, with efforts duplicated across local authorities. This continued for several more years.

7. The Little Hoover Commission Report (July 2014)

California maintains an independent government review commission called the Milton Marks "Little Hoover" Commission on California State Government Organization and Economy (the "LHC").[150] In early 2013, the LHC decided to study climate adaptation for the first time. It conducted three public hearings and seventy expert interviews and convened an advisory Commission that published its report the following July.[151]

The LHC's primary findings were consistent with the above analysis. There was a documented lack of state-level leadership, processes largely conducted without public input, and failure to produce information that was usable or useful to those who needed it. The LHC Report documented criticisms of the recently-completed CCAS in particular: it was not developed with input outside of the state agencies that wrote it, and it was entirely non-binding and thus "likely to go largely unread and unheeded."[152] The LHC also criticized the CAT as insular and out of touch.[153] It commented more favorably on the many agency initiatives to incorporate climate adaptation into their processes and the proliferation of regional and local planning initiatives, particularly among the large metropolitan areas, but it recognized that these were proceeding without coordination and with a potentially large duplication of efforts.[154] The Commission summarized its findings:

> While state and local governments study what might happen on the ground in California as a result of climate change, other fundamental questions also call for attention: How will the state most effectively govern during possible sustained periods of trial, disruption or emergency? What governing and administrative structures will best provide comprehensive regional or statewide solutions and minimize poorly-considered and wasteful community-by-community fixes? How might elected officials best budget today's tax dollars

150. The unusual name is a reference to the 1947 and 1953 "Hoover Commissions" on federal government organization, both chaired by then-former President Hoover. Milton Marks was a California legislator. *Milton Marks; Career S.F. Legislator*, L.A. TIMES (Dec. 5, 1998), https://perma.cc/9BMG-BL6P.

151. CAL. LITTLE HOOVER COMM'N, GOVERNING CALIFORNIA THROUGH CLIMATE CHANGE (July 2014), https://perma.cc/QTW4-BVFU.

152. *Id.* at 17.

153. *Id.* at 19 ("The [LHC] heard more criticisms from outsiders in local government and the private sector that the Climate Action Team process, too, tends to be insular with state officials talking mostly with their peers in other state agencies. The Climate Action Team, like the official adaptation strategy process, could benefit from obtaining more perspective outside the state government purview.").

154. *Id.* at 19–20.

> to prepare the state for tomorrow's uncertainty? What kind of land use decisions are most appropriate when long-held assumptions of predictable, stable geography in which to live, work and build permanent buildings are no longer relevant? The Commission's study process portrayed a state still seeking the answers. There is not much of a game plan beyond a growing stack of studies and plans.[155]

The LHC was particularly concerned that this situation did not compare favorably to California's successful actions on emissions mitigation policy development, which could rely on clear effectiveness metrics. In the LHC's words: "No one has proposed reducing California acreage burned by wildfires to 1990 levels by 2020. There is no global target to make coastal development withstand six feet of sea level rise by 2100."[156] Lacking centralized standards, local and regional entities were left "scrambling" for their own answers.[157]

In its discussion of governance challenges, the LHC identified several common problems that, in its judgment, were impeding progress. First, it noted that decisionmakers "lack common adaptation standards," as evidenced for example by the construction of the new Bay Bridge without accounting for sea level rise, while development on Treasure Island (through which the Bay Bridge transits) has been planned to withstand 55 inches of sea level rise. "Such inconsistency, multiplied countless times across the state, reveals potential for disarray if different layers of government continue to make land use and infrastructure decisions in the absence of a larger governing framework for climate change adaptation."[158] The LHC also noted that current governance systems were built on the same limited heuristics that make climate change difficult for individuals to grapple with: current processes assume "stationarity" (being able to rely on the world being the way it always has been); the inability to sacrifice in the present for the benefit of the future; and the inability to measure progress on long timescales.[159] These unique challenges, combined with everyday institutional barriers (lack of funding, lack of knowledge, jurisdictional conflict, etc.) had stymied all progress.

To address these challenges, the LHC took the very unusual (and politically challenging) step of proposing a new state authority.[160] The LHC imagined the agency as a unified authority to help other agencies decide which data to use and how to integrate climate into their disparate planning processes. It would, in other

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155. *Id*. at iv.

156. *Id*. at 44.

157. *Id*. at vi ("Such questions in the absence of mutually-agreed upon solutions and risk assessment protocols from the state have sent regions scrambling to assemble their own understanding of local impacts and possible solutions.").

158. *Id*. at 41.

159. *Id*. at 42–43.

160. *Id*. at 46–66. The LHC was very clear that it did not see this organization as a policymaking body (devoting a short section titled "Not a Policymaking Body" to allaying fears of state overtake of local land use control). *Id*. at 57.

words, help local authorities ensure that they were using the best available information and risk assessment tools and practices. "Over the long run, the standards [developed by this authority], updated as needed to reflect emerging climate conditions, would gradually, thoroughly embed themselves into state and local planning and development processes."[161] What the LHC's proposal failed to address, however, was that it is not possible simply to provide tools and information without some prior decision regarding the manner in which those tools and information can be, or should be, used.

Overall, the LHC report was a perceptive and useful description of the dysfunctional state of climate adaptation policy development in California as of 2014. Its proposals, influenced by experts in policy development and governance, were designed to garner support and move the state's efforts forward. They were, however, purely advisory, and the inertia of existing processes would exert more influence.

8. Safeguarding California (July 2014)

In 2009, E.O. S-13-08 had ordered the CNRA to take the lead on climate adaptation policy development. CNRA had responded by collecting together policy proposals, sourced entirely from California state government agency specialists. By 2013, CNRA had determined that it should update the CCAS. This resulted in a series of public meetings between July 2013 and January 2014. Once again, CNRA oversaw sector-specific and cross-sectoral working groups to handle the work. The result was "Safeguarding California."[162]

Safeguarding California remains California's "official" climate adaptation policy statement. It was quickly amended with a series of sectoral implementation plans and was recently updated, as discussed below. The 2014 document recommended that the state "[e]stablish a mandate . . . for all state agencies to consider climate risks in their policies, planning efforts, and investments."[163] This recommendation was weakened by the fact that the plan did not take any position on how agencies were supposed to consider climate risks. Rather, it proposed that some authority promulgate "guidelines for state agencies to follow as they incorporate climate considerations" into their planning processes.[164] It recommended that any guidance "develop metrics and indicators to track progress on efforts to reduce climate risk."[165]

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161. *Id.* at 57.

162. CNRA, SAFEGUARDING CALIFORNIA: REDUCING CLIMATE RISK: AN UPDATE TO THE 2009 CALIFORNIA CLIMATE ADAPTATION STRATEGY (July 2014), http://resources.ca.gov/docs/climate/Final_Safeguarding_CA_Plan_July_31_2014.pdf [hereinafter SAFEGUARDING CALIFORNIA].

163. *Id.* at 10.

164. *Id.* at 11.

165. *Id.* at 13.

As had previous state efforts, Safeguarding California recommended that the state "[p]rovide data, tools, and guidance to support efforts to reduce climate risks."[166] But the real problem had not been a lack of information—it was that there was far too much information, and not enough effort to make it useful. So, for example, Safeguarding California recommended numerous additional vulnerability assessments,[167] but without a clear purpose. Similarly, it promoted maintaining and expanding environmental monitoring systems.[168] However, there was no effort to determine in each case whether additional data would actually change outcomes if it were collected, or otherwise be useful. Overall, the 2014 iteration of Safeguarding California did little to overcome any of the barriers that had slowed California's climate adaptation policy development to that point.

9. Assessment: 2005 to 2015

The state's climate adaptation policy between 2005 and 2015 was to encourage development of sector-specific (e.g., agricultural, energy) and jurisdiction-specific (e.g., local, regional transportation sector, etc.) action plans, without strong centralized coordination. The state government's role was confined to coordinating intermittent lists of items being discussed, and, sporadically, tracking progress on proposed actions. The state collected the lists and made efforts to extract cross-sectoral proposals from the collections, which were, typically, ignored. The state's stated policy was to produce plans—but nothing it did, upon scrutiny, looked like planning. The state received recommendations from two independent review authorities—PCIP and the LHC—but these could not immediately overcome the inertia of work set in motion by E.O. S-03-05 and E.O. S-13-08. The preceding history revealed the following significant barriers to climate adaptation policy development in California:

- *Leadership failure*. Entities with the authority to set statewide policy resulting from a difficult but necessary value-balancing process—particularly the Governor's office and Legislature—did not do so, and instead delegated policy development work to subsidiary organizations that were not capable of doing so (E.O. S-03-05, CCAS, E.O. S-13-08, legislative silence).
- *Undefined criteria*. Decisionmakers failed to rigorously consider the decision criteria they were using to develop policy. After another decade of work, it was not clear even what adaptation meant in various contexts, or how to measure it. Prevailing decisionmaking defaults pushed alternative selection toward low- or no-cost options regardless of effectiveness or need (E.O. S-13-08).

166. *Id*. at 259.
167. *Id*. at 183–85.
168. *Id*. at 185–86.

- *Lack of public participation*. Policy development was conducted by executive agencies not capable of embodying the full range of stakeholder interests and viewpoints (CCAS, as discussed in LHC Report; Safeguarding California).
- *Laundry listing*. Instructed to develop statewide strategic plans, individual agencies listed what they were doing, or wanted to do, and efforts were made *ex ante* to structure these recommendations into some sort of apparent strategy. (CCAS, Safeguarding California).
- *Information overload*. While a great deal of effort had gone into producing information, much less was undertaken to ensure the information provided was useful (CCAS, CalAdapt, APG and other guidance).
- *Duplicating work*. Resources were wasted by entities that felt the need to develop plans but had no guidance on how to do so. State authorities struggled to develop guidance but faced challenges owing to the leadership vacuum (APG and other guidance).
- *Mistrust regarding land-use control*. Proposals for statewide standard-setting authorities were not implemented. It is possible that one reason for this (apparently present behind the LHC report) was that climate adaptation policy includes land use control, and local authorities do not wish to cede traditional powers to state decisionmakers.
- *Limited heuristics*. As recognized by the LHC, climate change adaptation tests the limits of human decisionmaking capacity. To the extent that there is a signal of long-term danger, it is lost among crises of more near-term concern.
- *Everyday barriers*. Also as recognized by the LHC, climate change adaptation suffers from the same challenges that plague most public administration. Lack of funding, a lack of expertise, jurisdictional disputes, and other quotidian management issues combine with the challenges discussed above.
- *The false choice*. Although never discussed above, another notable aspect of the above history is the lack of participation by civil society. Had environmentally-oriented non-governmental organizations wished to make climate adaptation a priority, it is likely that state climate adaptation policy development would have gone very differently. However, the perception among environmental policy leaders had been that focusing on adaptation would undercut mitigation efforts. Thus, there was a lack of concerted effort by non-governmental advocacy organizations to focus the government on these problems.[169]

Fundamentally, as examined by both the PPIC and LHC Reports, the state had failed to examine climate change adaptation as a policy problem. Lacking the political coordination to define a clear vision or measurable goals, the state could make no progress on developing *effective* strategies for achieving those goals. Without a serious effort to quantify and monetize risks of inaction and the (financial or non-financial) benefits of action, and often considering only immediate

169. *See* LUERS & MOSER, *supra* note 121, at 1–3.

costs, the state could make no progress on developing *efficient* approaches, particularly as examined over a long term. Having not been empowered with a broad mandate to resolve problems, *feasibility* became understood primarily in terms of present cost in a constrained budgetary environment and resulted in a total lack of action. Ultimately, then, the state could do nothing to address the increasingly serious *equity* implications of climate change.

As of 2015, then, California still did not really have a climate adaptation policy. It would next turn its attention to integrating climate adaptation into the state's many decision processes.

C. 2015 TO 2018: STEPS TOWARD INTEGRATION

The years 2015 to 2018 saw a spike in interest in climate adaptation policy development in California. These efforts were hindered, however, by the shortcomings described above. The primary development was an effort to begin to integrate climate adaptation into all state decisionmaking processes. This has remained difficult, however, as there is a difference between ordering that integration occur and deciding how it should occur. The Legislature has addressed this need in limited circumstances, and state planning documents seem, slowly, to be trending toward better models. But it remains to be seen if these efforts will succeed.

1. Executive Order B-30-15 (April 2015): Mandating Integration

On April 29, 2015, Governor Brown issued E.O. B-30-15.[170] The new order was directly influenced by the suggestions in both Safeguarding California and the LHC Report, although there were significant differences between what was suggested and what was done.

First, E.O. B-30-15 required all state agencies to "take climate change into account in their planning and investment decisions and employ full life-cycle cost accounting to evaluate and compare infrastructure investments and alternatives."[171] In other words, following the growing consensus that this must occur, the Governor issued a mandate that would, from this point forward, require state planning processes to incorporate climate change considerations.

Second, the new E.O. moved forward with the LHC Report's suggestion that some authority take the lead on helping state agencies comply with the first requirement. The authority was kept within the Governor's office, at OPR, which was required to establish a "technical, advisory group to help state agencies incorporate climate change impacts into planning and investment decisions."[172] The E.O. specified that these decisions were to be guided by four principles: priority

170. Cal. Exec. Order No. B-30-15 (Brown, Apr. 29, 2015) ("E.O. B-30-15").
171. *Id.* § 6.
172. *Id.* § 9.

is given to actions that "both build climate preparedness and reduce greenhouse gas emissions;" are "flexible and adaptive . . . to prepare for uncertain climate impacts;" "protect the state's most vulnerable populations;" and prioritize "natural infrastructure solutions."[173]

As with prior directives, the new order continued to defer the problem of deciding which standards are supposed to govern, with OPR now in charge of establishing another advisory committee, and agencies required to incorporate adaptation into their processes without being told how that should be done. However, the E.O.'s additional criteria do finally recognize, though not completely address, several key policy analytical issues. By stating that state action should "protect the state's most vulnerable populations,"[174] the state explicitly recognized the potential equity implications of climate adaptation planning, although not in the context of unequal costs of risk-bearing. By prioritizing actions that serve both mitigation and adaptation purposes, the order highlights the need for economic efficiency where possible, while recognizing that these cannot always be combined. By highlighting flexibility, the state has, for the first time, stated a preference for an approach that could entail a more formally iterative, act-learn-act process that incorporates risk and uncertainty ranges, although again this is not specified. All of these are positive developments, but success will depend on how these instructions are implemented.

2. California Senate EQC Hearings (Feb. to Nov. 2015)

From February to October 2015, the California Senate Environmental Quality Committee ("EQC") conducted a series of hearings on the status of the state's climate adaptation governance. These hearings were conducted simultaneously with the Legislature's consideration of several bills, discussed in the following sections. Although presented *in seriatim* here, the bills and hearings developed simultaneously and in tandem.[175]

The Senate background documentation described the highly fragmented state of adaptation planning, noting trends in climate adaptation plans, the LHC Report's conclusion that there was a "need for a more unified approach to adaptation on the part of state government," and the largely advisory nature of most guidance. The hearings began from the idea that "aggressive adaptation and resiliency building policies must be holistically incorporated into the state's overarching climate strategy to create a more comprehensive approach to addressing climate change." The EQC hearings coincided with the introduction and passage of three bills: S.B. 246 (centralizing adaptation policy in the OPR); A.B. 1482

173. *Id.* § 7.

174. *Id.*

175. *Cal. Sen. EQC, Climate Change Impacts and Adaptation Efforts in California* (Nov. 2015), https://senv.senate.ca.gov/sites/senv.senate.ca.gov/files/Climate%20Change%20Adaptation_California%20State%20Senate_2015.pdf.

(mandating rolling reviews), and S.B. 379 (integrating adaptation into local planning), each discussed below. [176]

3. S.B. 246 (Oct. 8, 2015): OPR Coordination

S.B. 246 (2015)[177] attempted to address the fragmentation problem that had been a hallmark of California's adaptation policy development, a need identified by the LHC report and Senate EQC hearings. Its author intended to consolidate state climate adaptation planning efforts under a single coordinating authority via what the bill called the Integrated Climate Adaptation and Resiliency Program ("ICARP"). The original bill sought to locate this authority in the still-extant, if largely dormant, Climate Action Team. Later amendments, consistent with the decision that had just been made in E.O. B-30-15, switched these responsibilities to OPR.[178] In its final form, S.B. 246 required the OPR to "coordinate regional and local efforts with state climate adaptation strategies to adapt to the impacts of climate change with, to the extent feasible, an emphasis on climate equity considerations across sectors and regions and strategies that benefit both greenhouse gas emissions reductions and adaptation efforts."[179] The OPR would develop "tools and guidance" for local and regional use and promote coordination between state agencies and local and regional authorities.

Beyond this general mission, OPR's immediate tasks were to create and maintain an online clearinghouse for climate adaptation information, to assist CalEPA to update the APG, and to work with a new advisory council on adaptation.[180] As of this writing, OPR had organized the ICARP Technical Advisory Council ("TAC"), which began conducting regular meetings in March 2017.[181] The TAC's statement of vision and principles contains a number of familiar elements: vulnerability as a resource allocation rule (a footnote states that the workgroup is working to define vulnerability, indicating again that this work requires a lot of additional effort), promoting resilience, promoting actions that reduce GHG emissions and build resilience simultaneously, stating equity as a criterion (implemented primarily via participation), prioritizing green infrastructure solutions, employing adaptive and flexible governance, and avoiding maladaptation.

176. Prior to E.O. B-30-15, the only further Legislative statement was A.B. 2516, 2014 Cal. Stat. Ch. 522, https://perma.cc/9WNP-5AUP. This bill created the California Planning for Sea Level Rise Database, managed by the CNRA and populated with contributions from various state agencies. This resulted in a biannual review by the OPR and final compilation of a single spreadsheet, posted online at https://perma.cc/BC4J-25HD. It was only authorized through 2018, and the resulting spreadsheet does not appear to be very useful.

177. S.B. 246, 2015 Cal. Stat. Ch. 606, https://perma.cc/TDQ9-RFH7.

178. See comparison of bills as introduced and chaptered, https://perma.cc/3RMQ-6V8L.

179. S.B. 246 (2015), § 1, codified Cal. Pub. Res. Code § 71354.

180. *Id*., codified Cal. Pub. Res. Code § 71360.

181. *See Technical Advisory Council*, CAL. GOVERNOR'S OFFICE OF PLANNING & RESEARCH, https://perma.cc/X9WJ-LESU (last visited Nov. 4, 2019).

OPR has also made progress on the online clearinghouse.[182]

4. A.B. 1482 (Oct. 8, 2015): Rolling Reviews

A.B. 1482 (2015)[183] codified and amended parts of E.O. B-30-15. It required the CNRA to update Safeguarding California every three years beginning in January 2017.[184] It also codified the plan's existing structure: sectoral vulnerability assessment and identification of "priority actions needed to reduce risks in those sectors."[185] The CNRA would be required to report to the legislature each year regarding progress on implementing actions identified in the plan.[186] Meanwhile, the Strategic Growth Council received direction in its award of Sustainable Communities development funds, including particularly reviewing the Five-Year Infrastructure Plan and the State Environmental Goals and Policy Report.[187]

The bill also put forth a number of "objectives" that state agencies were required to incorporate ("where applicable and feasible") into their attempts to "address the vulnerabilities identified in the plan:" facilitate public education; maintain a scientific data repository; use the plan to inform planning decisions and state investments; promote natural-feature adaptation alternatives; encourage regional adaptation planning; promote drought resiliency; develop urban greening projects; protect species habitat; and promote healthy soils, transportation planning, emergency management, safe energy, health threat response capacity, disadvantaged communities, and cultural resources.[188] It is not yet clear how all of these requirements will be integrated into all of the relevant planning processes.

5. S.B. 379 (Oct. 8, 2015): Local Adaptation Plans

S.B. 379 (2015)[189] required the integration of climate adaptation and resiliency principles into the safety element of municipal comprehensive plans. The new requirements include a climate vulnerability assessment; a set of adaptation and resilience goals, policies, and objectives; and a set of implementation measures designed to carry out those goals.[190] Again, it is not yet clear exactly how well these new plans are progressing.

182. *See* RESILIENTCA.ORG, https://perma.cc/H8VB-9UNS (last visited Nov. 4, 2019).
183. A.B. 1482, 2015 Cal. Stat. Ch. 603, https://perma.cc/5L7A-R3CN.
184. *Id.* § 2 (codified at Cal. Pub. Res. Code § 71153).
185. *Id.* (codified at Cal. Pub. Res. Code § 71153).
186. *Id.* (codified at Cal. Pub. Res. Code § 71153(2)(c)).
187. *Id.* (codified at Cal. Pub. Res. Code § 75125).
188. *Id.* (codified at Cal. Pub. Res. Code § 71154).
189. S.B. 379, 2015 Cal. Stat. 2015 Ch. 608, https://perma.cc/VT7L-R33Q.
190. *Id.* § 1 (codified at Cal. Govt. Code § 65302(g)(4)).

6. A.B. 2800 (Sept. 24, 2016): the CSIWG

A.B. 2800 (2016)[191] recognized that climate change impacts must be accounted for in the engineering and design processes for major infrastructure in California. It requires all state agencies to "take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining and investing in state infrastructure."[192] The law also created a Climate-Safe Infrastructure Working Group ("CSIWG"), which would examine how to integrate scientific data into state infrastructure. It would, among other things, assess the informational and institutional barriers to integrating projected climate change impacts into infrastructure design, identify critical information needed for engineers responsible for infrastructure design and construction, and make recommendations to the legislature. The CSIWG began meeting in January 2018[193] and published a report in September of that year.[194]

7. A.B. 398 (July 7, 2017): Cap-and-Trade Funds

Finally, although not specifically a climate adaptation bill, A.B. 398 (2017)[195] added "climate adaptation and resiliency" projects to the list of works eligible to receive funds generated by the state's cap-and-trade program, which the bill also extended. To the extent that funding has been a barrier to implementation of climate adaptation policy, this may provide resources.

8. Assessment: 2015 to 2018

Starting in 2015, the "lead agency" on climate adaptation appears to have shifted once again, from CNRA (still responsible for coordinating Safeguarding California) to the Governor's OPR, with significant contributions by way of binding directives from the California Legislature. Both the Governor's Office and the Legislature have prioritized climate adaptation and have provided a series of new directives about priorities.

The primary outstanding problem appears to be a lack of specificity regarding the resolution of the many policy-analytical problems that the state must still, eventually, confront if it is to truly make progress on climate change adaptation. As currently framed, these problems will most likely become expressed as a series of decisions about *how* to integrate climate change into decisionmaking.

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191. A.B. 2800, 2016 Cal. Stat. Ch. 580, https://perma.cc/AU4W-ZLUR.

192. *Id.* § 2 (codified at Cal. Pub. Res. Code § 71155).

193. *See* CAL. NAT. RES. AGENCY, PAYING IT FORWARD: THE PATH TOWARD CLIMATE-SAFE INFRASTRUCTURE IN CALIFORNIA, https://perma.cc/XBE7-US5M.

194. CSIWG, PAYING IT FORWARD: THE PATH TOWARD CLIMATE-SAFE INFRASTRUCTURE IN CALIFORNIA – A REPORT OF THE CLIMATE-SAFE INFRASTRUCTURE WORKING GROUP TO THE CALIFORNIA STATE LEGISLATURE AND THE STRATEGIC GROWTH COUNCIL (2018), http://resources.ca.gov/docs/climate/ab2800/AB2800_Climate-SafeInfrastructure_FinalWithAppendices.pdf.

195. A.B. 398, 2017 Cal. Stat. Ch. 135, https://perma.cc/MA5M-3PLU.

There is still a great deal of room for interpretation, wasted effort, and avoidance of the hard questions, which risks maintaining a fragmented and internally inconsistent statewide regulatory patchwork until further guidance is provided. It is likely that this will have to be confronted sector-by-sector, and even process-by-process, for the time being.

Whether officially or not, California appears to be committed to this bottom-up policy development strategy. The state leaves it to agency experts and technical workgroups to recognize that planning for climate adaptation requires metrics for measuring success (effectiveness), choices about present versus future costs (efficiency), risk allocation (equity), and, potentially, significant shifts in control over land use (feasibility), among many other difficult and politically controversial matters. With little policy guidance, each organization responsible for protecting the health and safety of the people of California will be required to confront the difficult task of deciding how best to integrate climate change into their existing decisionmaking structures and authorities.

The question then becomes: can they do it?

III. ASSESSING CALIFORNIA'S REGULATORY INTEGRATION—EXAMPLES FROM THE ELECTRIC POWER SECTOR

This Part examines whether and to what extent four Californian electric regulatory processes have integrated climate change adaptation considerations and incorporated climate-relevant data. Each analysis is based on a review of complete regulatory dockets to determine the data sources and methods used by decisionmakers. The reviews were limited to publicly available records to simultaneously assess the extent to which the public and other outside stakeholders could have contributed.

Prior to the case studies, Section A briefly returns to the documents discussed in Parts I and II, but with a focus entirely on the electricity sector. From A.B. 4420, in 1988, to IPCC's AR5 and beyond, researchers and policymakers have recognized that the electric grid will need to adapt to climate change. The review confirms that these specific studies have been no more successful at answering how this ought to be done than the more general planning efforts.

Sections B through E cover the four regulatory case studies. Section B explores the long-term electric grid reliability planning process—the effort to model future electricity supply, demand, and transmission in order to ensure that the future grid will be able to function without widespread blackouts or massively spiking electricity costs. This process involves numerous planning authorities—from standards developed by the National Electric Reliability Corporation ("NERC"), to regional studies conducted according to those standards by the Western Electricity Coordinating Council's ("WECC"), to the statewide study conducted by the California Independent System Operator (the "CAISO"), using data inputs from the CEC and the California Public Utilities Commission ("CPUC").

Variations in temperature and precipitation trends are especially relevant to this planning work.

Section C examines a fire threat mapping proceeding conducted by the CPUC, using inputs from the California Department of Forestry and Fire Protection ("CAL FIRE"). The goal of this work is to produce a single map that electric utilities are able to use to plan their vegetation management activities (stricter standards in areas with higher fire risks). Variation in temperatures, wind speeds, precipitation, and vegetation cover are all relevant to this proceeding.

Section D reviews two recent thermal generator siting reviews conducted by the CEC and CPUC in coordination with the California Coastal Commission ("CCC"). The reviews are conducted prior to the construction or relicensing of large thermal generators,[196] and the two facilities reviewed were each proposed to be built on the coast (a plentiful source of cooling water), where long-term variations in mean sea level are particularly relevant.

Section E covers a recent effort at the CPUC to introduce risk assessment into its general rate cases.[197] Specifically, it reviews the initial effort by one of California's largest electric utilities—Pacific Gas & Electric ("PG&E")—to create a model that would adjust financial risks faced by the company after incorporating changing climatic variables.

Section F discusses the implication of the case studies taken together.

A. ELECTRIC POWER SECTOR POLICY DEVELOPMENT

Many of the research and planning documents discussed in Part II included energy-sectoral discussions. With the overall narrative traced, it is useful to retrace it briefly with a focus on the electric power system. Following this overview, the analysis will move toward the energy elements of plans developed after 2015, and then into the active regulatory processes that must integrate climate change responses.

1. Reviewing 1988 to 2015, Focusing on the Electricity Sector

Between 1988 and 2005, most electric sector climate adaptation policy development focused on understanding and assessing the potential impacts of climate change to the grid. In California, A.B. 4420 instructed the CEC to examine climate change's potential impacts on "energy supply and demand," and to provide recommendations for avoiding, reducing, and addressing those impacts;[198] the

196. "Thermal generation" is industry terminology for electricity production facilities that use heat to produce steam, which drives turbines that produce electricity. The most common fuel source for thermal generation is natural gas, although coal is common elsewhere, and technically nuclear power is also thermal.

197. A "rate case" is an industry term for the proceeding that determines how much a utility can charge the customers in its service territory (its rates).

198. A.B. 4420, *supra* note 90, at §§ 1, 2.

CEC analyzed climate change's potential to impact hydroelectric supply[199] and recommended incorporating climate change into energy resource planning, promoting renewable electricity generation, promoting high-efficiency gas electricity generation, and promoting efficiency measures to reduce electricity demand.[200] Abroad, the first three IPCC assessment reports summarized the state of knowledge regarding the impact that climate change would have on electric power systems.[201]

California's PIER program also produced several relevant studies, including an impact assessment for California's electric power system;[202] a method for evaluating high-elevation hydropower output under varying climate scenarios;[203] an examination of current climate projections and likelihood of an increase in extreme heat days in California;[204] further analyses of hydropower predictions;[205] an electricity demand assessment;[206] and a review of price incentive programs to reduce electricity demand.[207] The CCAS included an electric-sector specific

199. CEC 1989, *supra* note 94, at 40–48.

200. CEC 1991, *supra* note 95, at x.

201. AR1 WG3 Report, *supra* note 16, at 5-11 and 5-17; AR2 WG3 Report, *supra* note 38, at 376–78, 382, 383, and 390–93; AR3 WG2 Report, *supra* note 58, at 381–416.

202. GUIDO FRANCO & ALAN SANSTAD, CEC-500-2005-201-SF, Climate Change and Electricity Demand in California (2005), https://perma.cc/MNK2-PCXT. This identified several prior studies on the same topic: JOEL B. SMITH & DENNIS TIRPAK (EDS.), EPA-230-05-89-050, THE POTENTIAL EFFECTS OF GLOBAL CLIMATE CHANGE ON THE UNITED STATES. REPORT TO CONGRESS, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, OFFICE OF POLICY, PLANNING AND EVALUATION, OFFICE OF RESEARCH AND DEVELOPMENT (Dec. 1989); Lester W. Baxter & Kevin Calandri, *Global warming and electricity demand: A study of California*, 20 ENERGY POL'Y 233–44 (1992); Robert Mendelsohn, *The Impact of Climate Change on Energy Expenditures in California*, *att'd as* App'x XI *to* WILSON ET AL., CEC-500-03-058CF, GLOBAL CLIMATE CHANGE AND CALIFORNIA: POTENTIAL IMPLICATIONS FOR ECOSYSTEMS, HEALTH, AND THE ECONOMY (Aug. 2003). Franco & Sanstad's work was later published as Guido Franco & Alan Sanstad, Climate Change and Electricity Demand in California, 87 CLIMATIC CHANGE S139–51 (2008), https://perma.cc/X6WG-ZF9P.

203. SEBASTIAN VICUñA ET AL., CEC-500-2005199-SF, CLIMATE CHANGE IMPACTS ON HIGH ELEVATION HYDROPOWER GENERATION IN CALIFORNIA'S SIERRA NEVADA: A CASE STUDY IN THE UPPER AMERICAN RIVER (Mar. 2006), https://perma.cc/H8HW-JGFW.

204. NORMAN MILLER ET AL., CEC-500-2007-023, Climate CHANGE, EXTREME HEAT, AND ELECTRICITY DEMAND IN CALIFORNIA (2007), https://perma.cc/4MYB-Z7BU.

205. DENNIS LETTENMEIER ET AL., CEC-500-2007-104, EVALUATION OF ALTERNATIVE MODELS AND METHODS FOR PREDICTION OF HYDROPOWER RESOURCES IN CALIFORNIA AND THE PACIFIC NORTHWEST (2007), https://perma.cc/4PNZ-MGNB; SEBASTIAN VICUNA ET AL., CEC-500-2009-019-F, CLIMATE CHANGE IMPACTS ON THE OPERATION OF TWO HIGH-ELEVATION HYDROPOWER SYSTEMS IN CALIFORNIA (2009), https://perma.cc/UYE2-EC8T. *See also* GUEGAN ET AL., CEC-500-2012-020, CLIMATE CHANGE EFFECTS ON THE HIGH-ELEVATION HYDROPOWER SYSTEM WITH CONSIDERATION OF WARMING IMPACTS ON ELECTRICITY DEMAND AND PRICING (2012), https://perma.cc/42SG-MB4M.

206. ANIN AROONRUENGSAWAT & MAXIMILIAN AUFHAMMER, CEC-500-2009-018-D, IMPACTS OF CLIMATE CHANGE ON RESIDENTIAL ELECTRICITY CONSUMPTION: EVIDENCE FROM BILLING DATA (2009), https://perma.cc/X35A-YSWC; *see also* MAXIMILIAN AUFFHAMMER & ANIN AROONRUENGSAWAT, CEC-500-2012-021, HOTSPOTS OF CLIMATE DRIVEN INCREASES IN RESIDENTIAL ELECTRICITY DEMAND: A SIMULATION EXERCISE BASED ON HOUSEHOLD LEVEL BILLING DATA FOR CALIFORNIA (2012), https://perma.cc/MA3F-YXHQ.

207. LARRY DALE ET AL., CEC-500-2009-032-F, PRICE IMPACT ON THE DEMAND FOR WATER AND ENERGY IN CALIFORNIA RESIDENCES (2009).

planning element (with the CEC the sole energy agency represented),[208] as did Safeguarding California.[209] AR5 WG2 briefly discussed the growing recognition that the electric power sector may require comprehensive adaptation planning, but "[w]ith mitigation concerns dominating the literature and urban energy policy discussions, there is less focus on adaptation issues."[210]

Again, therefore, the conclusion must be that the challenging questions raised by climate change adaptation, including matters of problem definition, effectiveness measurement, cost and benefit calculation, and equity, were not addressed with respect to the electric power sector any more than they had been generally.

2. Federal Policy Development (2015 to 2016)

There is little to say about U.S. federal government climate adaptation policy development. In 2013, President Obama issued Executive Order 13653,[211] and federal agencies, including the U.S. Department of Energy, developed their own strategies and practices, primarily in the form of guidance. In the electricity sector, this resulted in a national vulnerability assessment first circulated in July 2015, largely duplicative of what California had already contributed.[212] Like California's 2012 APG, this assessment included proposed "resilience solutions" for the electric grid. The U.S. Department of Energy also piloted a partnership with energy utilities, including several in California that resulted in utility-specific vulnerability assessments. However, after the November 2016 election, the new administration rescinded E.O. 13653[213] and these programs have not continued.

3. Safeguarding California Action Implementation Plan: Energy (2016)

Shortly after California's E.O. B-30-15 mandated sectoral plans for Safeguarding California, the CEC and CPUC arranged a joint workshop with the primary California electric utilities (four investor-owned and one municipally-owned entity). The workshop was held on July 27, 2015, and included presentations from the U.S. Department of Energy, the CEC, OPR, and California's large investor-owned utilities, but not the CPUC or the CAISO (the two organizations primarily responsible for regulating and operating California's electric grid). Following the workshop, the CEC, with one participant from the CPUC and several participants from the California Department of General Services (given their

208. CCAS, *supra* note 127, ch. X, pp. 122–134.
209. SAFEGUARDING CALIFORNIA, *supra* note 162, at 104–27.
210. AR5 WG2 Report, *supra* note 75, at chs. 8 and 10.
211. Exec. Order No. 13,653, 78 Fed. Reg. 66,819 (Nov. 6, 2013).
212. *See* U.S. DEPT. OF ENERGY, Climate Change and the U.S. Energy Sector: Regional Vulnerabilities and Resilience Solutions (2015), https://perma.cc/SUJ2-4Y2J.
213. Exec. Order No. 13,783, 82 Fed. Reg. 16,093 (Mar. 31, 2017).

knowledge of building energy efficiency), drafted the state's Energy Sector Implementation Action Plan.[214]

This new plan highlighted initiatives that had been undertaken for other reasons, reframed as adaptation actions.[215] It included a lengthy discussion of renewables integration and descriptions of numerous existing energy efficiency and demand-side management programs, each of which was not primarily developed as a resiliency program, although they may provide resiliency co-benefits. As the document itself said: the actions discussed were "more related to developing new information via research projects and less oriented towards the substantial investments that implementation of adaptation measures will require,"[216] while "future adaptation studies for the energy sector will include consideration of costs" and specifically compare "the cost of doing nothing with the cost of different adaptation measures."[217]

The last several pages were devoted to "next steps": to create a CPUC-CEC work group to "design, implement, and monitor the actions listed below;" to complete vulnerability assessments for each electric utility service territory; to "[c]ollaborate with research needs and efforts with the [CEC] Commissions to ensure that research produces actionable science and investment and operational parameters;" and to "[e]ncourage cooperation and collaboration among all utilities and the various regional climate resilience collaboratives."[218] On the last pages, the document discussed the need for agreement on the definition of metrics—for example, cooling degree days—but no discussion of how that could be done.[219]

4. Safeguarding California Plan: 2018 Update (January 2018)

In January 2018, responsible agencies published an update to Safeguarding California ("2018 Update").[220] Unlike previous iterations, this version included a vision: that climate adaptation would be integrated as standard practice, with the vulnerable protected, natural systems functioning, and built systems continuing to provide essential services. The plan also provided "overarching principles" (also finding expression in legislation and elsewhere), including to consider climate change in all levels of government, to involve vulnerable communities in decisionmaking, and to identify funding sources for climate adaptation and disaster response.

The 2018 Update's energy element was written primarily by CEC research staff, with unspecified contributions from the CPUC and the Department of General

214. CNRA, *Energy Sector Plan*, *in* SAFEGUARDING CALIFORNIA: IMPLEMENTATION ACTION PLANS 68–90 (2016).

215. *See id*. at 73–87.

216. *Id*. at 87.

217. *Id*.

218. *Id*. at 88.

219. Id. at 241–45.

220. CNRA, SAFEGUARDING CALIFORNIA PLAN: 2018 UPDATE (2018), https://perma.cc/ZNH5-VRAF.

Services. It provided six sector-specific goals: (1) continue to support climate research; (2) use common climate scenarios in all energy planning; (3) incorporate climate adaptation into energy planning; (4) support local adaptation efforts; (5) improve CalAdapt; and (6) increase resiliency in vulnerable communities.

5. 2017 IEPR Adaptation Chapter (March 2018)

Finally, as part of its regulatory functions (discussed in greater detail below), the CEC drafted a biennial Integrated Energy Policy Report ("IEPR"). The 2017 IEPR (published March 2018) included, for the first time, an entire chapter on climate adaptation and electric grid resiliency.[221] As with other recent reports, this one included a great deal of summary and review of past events. It also devoted space to the CEC's ongoing efforts to develop load projections that account for climate change (see discussion below). In its recommendations, the IEPR noted that the electric utilities had reported that the most important developments were ongoing in the RAMP proceedings (also discussed below) and made a series of recommendations pointed toward ensuring that this information was available.

6. Conclusions: California Electric Sector Adaptation Policy

The materials discussed above do not address the most significant regulatory processes related to grid infrastructure and most in need of climate adaptation planning, several of which are examined below. It is also notable that the agencies that manage and operate the grid (and regulate the grid's operators), particularly the CAISO and the CPUC, were rarely involved in the state's climate adaptation policy development for the electric power sector.

Instead, most of the pertinent decisions have occurred in technical forums that are only slightly more readily accessible to the public than have been the state's policy processes, the subject of the four case studies below.

B. CASE 1: CLIMATE RISK IN ELECTRIC GRID RELIABILITY PLANNING PROCESSES

Electric service reliability means keeping the lights on, and the applicable standards have changed a great deal in the last fifteen years. After 50 million people lost electric power during the Northeast blackout in August 2003,[222] Congress included grid reliability planning mandates in the Energy Policy Act of 2005.[223] The law required a single entity to promulgate national bulk electric system

221. CEC, *Chapter 10: Climate Adaptation and Resiliency*, *in* 2017 INTEGRATED ENERGY POLICY REPORT (2018).

222. *See* U.S.-CANADA POWER SYSTEM OUTAGE TASK FORCE 2004, FINAL REPORT ON THE AUGUST 14, 2003 BLACKOUT IN THE UNITED STATES AND CANADA: CAUSES AND RECOMMENDATIONS 1 (2004), https://perma.cc/M4BM-7MTZ.

223. Pub. L. 109–58 (Aug. 8, 2005).

reliability standards, which thereafter would be mandatory nationwide.[224] The National Electric Reliability Corporation ("NERC") undertook to develop these standards. The Federal Energy Regulatory Commission approved NERC's first proposed nationwide reliability standards in 2007,[225] and the standards continue to be followed and updated.[226]

NERC reliability standard implementation flows downwards. Below NERC, Regional Reliability Councils conduct regional reliability planning.[227] The California service territory is within the Western Electricity Coordinating Council ("WECC") region.[228] Beneath the regional organizations, independent transmission operators, among them the CAISO, are responsible for conducting long-term transmission planning to support system reliability.[229] Beneath the transmission planners, state regulators implement state-level transmission planning and approval processes[230] and regulate the local electric utilities—which conduct their own reliability planning as well. Typically, each of these entities also participates in the procedures of the entities above them in the hierarchy, but not below. For example, California's large privately-owned utilities participate in or contribute to CPUC, CAISO, WECC, and NERC processes, but NERC does not participate in CPUC proceedings. Multiple decision processes may therefore incorporate climate considerations. It makes sense to start at NERC and work downwards.

1. NERC Standard Development Process

NERC promulgates reliability standards for a broad range of bulk electric power system operations and planning processes—from moment-to-moment frequency management, to years-long system resource planning activities. Among these, NERC's transmission planning standard, TPL-001-4,[231] is the primary nexus for climate-relevant data.

In simplified summary, electric grid reliability planning requires forecasts of three things: load (the amount of electric demand, spread across space),

224. 16 U.S.C. § 824o.

225. *Mandatory Reliability Standards for the Bulk-Power System*, Order No. 693, FERC Stats. & Regs. ¶ 31,242 at 1433–49, *order on reh'g*, Order No. 693-A, 120 FERC ¶ 61,053 (2007).

226. *See Standards*, N. Am. Elec. Reliability Corp., https://perma.cc/7256-VP9S (last visited Oct. 21, 2019).

227. *See Regional Standards Development*, N. Am. Elec. Reliability Corp., https://perma.cc/4DJG-SHEF (last visited Oct. 21, 2019).

228. *See Standards*, W. Elec. Coordinating Council, https://perma.cc/689Y-DTCR (last visited Oct. 21, 2019).

229. *See Transmission Planning Process*, CAISO, https://perma.cc/E9SJ-NFV2 (last visited Oct. 21, 2019).

230. *See, e.g.*, *Integrated Resource Plan and Long Term Procurement Plan*, Cal. Pub. Util. Comm'n, https://perma.cc/ZNM5-6GTB (last visited Oct. 21, 2019).

231. NERC, Standard TPL-001-4: Transmission System Planning Performance Requirements, Version 4 (adopted Oct. 17, 2013), https://perma.cc/TYA6-4KPM.

generation (the amount of available electric supply, also spread across space), and transmission (the physical capacity of the links between load and generation points, passing through space). System reliability planning is a function of ensuring adequate generating and transmission capacity to serve load under all reasonably foreseeable operating conditions. Grid planners have limited control over electric demand and only a bit more over generator availability. Centralized grid planning, then, must make (very) educated guesses about how much electric demand will exist, where, and how much generating capacity will exist, where, in the future. They then build the grid that allows future generating resources to transmit electricity to future load. All of the forecasts underlying this process involve climate-relevant data. Transmission planning standards, then, require a unification of many other forecasting processes, each of which may itself integrate climate-relevant data.

TPL-001-4 requires transmission planning coordinators to maintain models of the electric power system representing existing transmission facilities, planned generating facilities, and load forecasts. These conditions are used to generate modeling scenarios, which stress the system in various ways—typically by determining system conditions under peak load (e.g., what is happening on the hottest day of the year), and then applying contingencies to determine sensitivities. The most important of these contingencies involves removal of a major system element (e.g., a large power plant), followed by automatic system readjustment, followed by the loss of a second important element (e.g., a major transmission line). If the system collapses (a major blackout), planners propose corrective actions that would have avoided that outcome. The NERC standard also includes an extreme events testing scenario, developed to examine events such as pipeline explosions or a plane crash into a transmission corridor with multiple lines present, but also including "wide area events . . . based on System topology," such as wildfires, loss of cooling water, and severe weather (e.g., a hurricane).[232] The standards define the data and modeling rules that planners must use.

NERC is not blind to the changing climate conditions into which its standards must function. However, to date NERC has not made climate change risk assessment a priority. NERC's Reliability Issues Steering Committee ("RISC") conducts regular reviews of the reliability standards to ensure that they incorporate realistic threat assessment.[233] Recently, those processes have identified the high-priority risks to be cyberattack, poor risk management culture in responsible entities, and insufficient real-time monitoring capacity—concerns that, when "risk" is the focus, are likely to always take precedence over climate risk. Until recently, climate change was categorized as a low-priority risk that affirmatively would not be subject to additional standard development. In 2013, this changed when a

232. *Id.* at 11.

233. *See Reliability Issues Steering Committee*, N. Am. Elec. Reliability Corp., https://perma.cc/W77C-HXRU (last visited Oct. 21, 2019).

fifth high-risk category was created from a conglomeration of many previously low-priority risks involving the changing physical and regulatory environment within which reliability must occur—changes that include not only new technologies and regulatory structures, but also climate change.[234] However, this premature combination of technological, regulatory, and climate risk into a unified category may make it more difficult to develop best practices around climate alone.

The situation has not changed much since 2013. In February 2018, NERC RISC published an update that tracked development of its risk categorization processes. Regarding extreme weather, it concluded that there was *less* risk than previously estimated:

> The RISC believed the impact is better characterized as "decreasing" from last year's report because although there have been more severe weather events, the grid has responded well. Severe weather or other natural events (e.g., hurricanes, tornadoes, protracted extreme temperatures, geomagnetic disturbances (GMDs), flooding, earthquakes, forest fires, extreme icing, etc.) are some of the leading causes of outages, and the industry must remain vigilant in improving preparation and coordination in order to minimize the effect of such events.[235]

That is, NERC's reliability risk steering committee concluded that extreme weather grid risks were in fact decreasing and did not appear to consider the stress on the bulk system imposed by changing temperature and precipitation, whether alone or in combination with the changing resource mix that is also stressing the grid, to be a serious problem. The RISC proposed that in the five-year timeframe, NERC should begin to assess analytic data about grid operation under severe weather conditions. In the ten-year timeframe, the RISC recommended incorporating information from whatever extreme weather events had occurred by that date.[236]

As a policy development question then, it appears that NERC is aware of the climate adaptation problem but believes that it is not urgent compared to other risks, and in any event will be folded into existing processes. NERC does not appear to have taken a strong position on the type of weather data that must be incorporated into load forecasting models or the kind of disaster risk frequency assumptions that should drive, for example, wildfire risk assessment, and it may be underestimating the risks posed by climate change to grid reliability. This certainly seems to be the case in California, where, as explained below, regional entities are stepping in to address the gap NERC has left.

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234. NERC RISC, ERO PRIORITIES: RISC UPDATES AND RECOMMENDATIONS 10 (2013), https://perma.cc/U5ZM-DJEC.

235. NERC RISC, ERO RELIABILITY RISK PRIORITIES: RISC RECOMMENDATIONS TO THE NERC BOARD OF TRUSTEES 13 (2018), https://perma.cc/PT8J-YM4M.

236. *See id*. at 25.

2. WECC Reliability Planning Process

WECC is the electric grid reliability planning coordinator for the Western United States, responsible for regional modeling and risk assessment under NERC's standards. WECC recognizes that the Western grid is uniquely exposed to climate variability and weather extremes.[237] Recently, WECC developed its first reliability modeling scenario specifically designed to incorporate climate change data. The Energy-Water-Climate Change Scenario ("EWCC") was formulated to assess: "What are the most significant system impacts in the Western Interconnection that could result from changes to the climate and to what extent do those impacts on the electrical grid present risks to electric system reliability?"[238] The scenario is predicated upon a 3° F increase in global average surface temperature by 2034 and incorporates impact data based on professional judgment about what such a warming would entail for grid-relevant modeling parameters. A consultant developed the specific parameters, recommending a modeling case that included a 10% increase over baseline Pacific Northwest peak summer load; a 3% increase over baseline California peak summer load; a 5% summer capacity derate for steam turbines (due to warmer cooling water); a 15% reduction in Pacific Northwest hydropower output; a 20% reduction in Arizona hydropower output; and a 50% reduction in California hydropower output, however with no changes in gas turbine efficiency or solar PV performance (possible due to ambient air heating) and no changes to transmission efficiencies.[239]

Whether or not this is a reasonable scenario for climate-based stress-testing, it is important to recognize that the EWCC is only one scenario. It treats climate change as a single potential future event, rather than as a certainty that will manifest along a broad range of possibilities. EWCC can tell a great deal about what will happen under the specific stated conditions, but it cannot resolve the fundamental planning uncertainty: what should we do if the model shows us that the grid collapses under this scenario? Should we spend money to avoid the impact? How much? Answers depend on impossible determinations regarding the likelihood of the scenario itself, as compared to others, which the scenario does not—and currently cannot—begin to address.

3. CAISO Transmission Planning Process

NERC develops standards and WECC ensures that the Western Interconnect remains stable, but primary transmission planning responsibility devolves to smaller entities—whoever owns and manages the transmission grid in regional

237. *See* WECC, 2016 STATE OF THE INTERCONNECTION iv (2016), https://perma.cc/8HGK-AKUM.

238. WECC Scenario Planning Steering Group, ENERGY-WATER-CLIMATE CHANGE SCENARIO REPORT 13 (2015), https://perma.cc/U43J-PUS7.

239. Kahrl et al., CLIMATE CHANGE IMPACTS ON THE WESTERN INTERCONNECTION: RECOMMENDATIONS FOR WECC'S ENERGY-WATER CLIMATE CHANGE SCENARIO 15, 18, 20, 22, 24 (2015), https://perma.cc/4MRU-ATS7.

service territories. In California, this entity is the CAISO, an independent nonprofit organization that conducts statewide transmission planning and operates both the energy markets and physical transmission system that keeps electricity flowing from generators to consumers across California. As part of its duties, the CAISO conducts an annual Transmission Planning Process ("TPP"). The TPP develops the state's base case for transmission planning purposes, against which specialized scenarios may be compared to provide additional insight into potential needs.

According to the CAISO's 2018-2019 TPP study plan (finalized in March 2018),[240] the CAISO incorporates reliability studies conducted according to TPL-001-4, with these studies performed for various grid levels, including utility bulk transmission systems and local distribution areas (e.g., all Northern California transmission lines, Greater Bay Area transmission and distribution, etc.). Specifically, its planning processes are based on:

> [t]he 1-in-10 weather year, mid demand baseline case with low [Additional Achievable Energy Efficiency (AAEE) and Additional Achievable Photovoltaic (AAPV)] savings load forecasts will be used in PG&E, SCE, SDG&E, and VEA local area studies including the studies for the local capacity requirement (LCR) areas. The 1-in-5 weather year, mid demand baseline with mid AAEE and AAPV savings load forecast will be used for system studies.[241]

That is, large utility service territory transmission systems must be built assuming low load reduction due to energy efficiency and solar power integration ("low AAEE and AAPV"), and peak demand adjusted for past temperatures in a "1-in-10 weather year" (more discussion below), while the state's high-voltage, "backbone" transmission system must be built to survive peak demand in a "1-in-5 weather year" assuming mid-level efficiency load reductions and mid-level solar power rollout ("mid AAEE and AAPV"). "The assessment will utilize the 2017 California Energy Demand Revised Forecast 2018-2028 adopted by the California Energy Commission (CEC) on February 21, 2018," with loads spread across the utility service territories according to methodologies developed by the utilities.[242] This densely-packed paragraph is the most complete description of the data used to build the CAISO's 2018 TPP. It describes multiple components that must each, in turn, be evaluated for the inclusion and treatment of climate-relevant data.

4. The CAISO's Demand Assumptions: CEC CED (February 2018)

As just explained, the CAISO TPP will rely upon load assumptions developed in the CEC's California Energy Demand ("CED") 2018 forecast.[243] This forecast

240. CAISO, 2018-2019 TRANSMISSION PLANNING PROCESS UNIFIED PLANNING ASSUMPTIONS AND STUDY PLAN (2018), https://perma.cc/ULF2-393F.

241. *Id*. at 12.

242. *Id*.

243. CEC, DRAFT STAFF REPORT: CALIFORNIA ENERGY DEMAND 2018-2030 REVISED FORECAST (2018), https://perma.cc/PQ8C-6KD3.

does incorporate information about climate change. This was done by choosing climate change scenario forecasts that seemed, in staff judgment, to be reasonable:

> To estimate the potential of future climate change to impact electricity and natural gas consumption and peak demand, [CEC Energy Assessment Division] staff *used temperature scenarios developed by the Scripps Institution of Oceanography through a set of global climate change models*, where results are downscaled to 50-square-mile grids in California. *Multiple scenarios were generated by Scripps, and staff from the Energy Commission's Research and Development Division chose a "likely" and a more aggressive scenario for use in the CED 2017 Revised mid and high cases, respectively*. The low demand case assumes no additional impacts from climate change.[244]

Combining this information with the CAISO's TPP plan description, it is possible to conclude that the TPP models will incorporate the Scripps-developed climate change scenario that CEC staff determined was "likely" in both the statewide and utility service territory reliability assessments, both of which use the "mid demand baseline." However, CEC's public report did not explain the "weather year" concept referenced by CED 2018, and did not disclose which Scripps climate scenarios, exactly, CEC used, or why the CEC determined that a "likely" scenario is the appropriate choice for grid reliability testing. These questions are examined in Subsection 6, *infra*. It must be emphasized that the information just provided is the totality of what was publicly available without the review of the administrative record in Subsection 6, *infra*.

5. The CAISO's Generator Assumptions: CPUC Default Scenario (February 2018)

As explained above, the CAISO TPP will model generators based on the CPUC's Default Scenario developed in the Integrated Resource Planning ("IRP") proceeding, CPUC Rulemaking (R.) 16-02-007. IRP is the process by which the CPUC ensures that, as California transforms its electric power system to achieve state GHG emissions targets, it does so in a financially responsible manner.[245] It involves running RESOLVE, a capacity expansion model, to determine the economically optimal mix of resources to achieve GHG reduction targets while not threatening electric service reliability.

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244. *Id*. at 41 (emphases added).

245. *See* S.B. 350 (2015) (De León) (An act to add Section 44258.5 to the Health and Safety Code, etc.), 2015 Cal. Stat. Ch. 547, https://perma.cc/H8KH-Z7XV; S.B. 338 (2017) (Skinner) (An act to amend Sections 454.52 and 9621 of the Public Utilities Code, relating to energy), 2017 Cal. Stat. 2017 Ch. 389, https://perma.cc/H8KH-Z7XV.

According to the IRP proceeding's unified assumptions,[246] the IRP default generator forecasts will assume achievement of the state's 50% renewable portfolio standard and incorporate available demand response and energy storage resources.[247] However, it does not appear that the generator models will incorporate climate change impacts on the state's hydropower resources. Rather, it assumes that existing hydroelectric capacity will remain online during the planning period, which, as already discussed, is unlikely.[248] Thus, it incorporates projections of hydropower availability that do not change between now and 2030. The model imagines that in 2030, large hydro will continue to make up 7.9% of the state's generation capacity, and 9% of the state's energy production.[249] This is not consistent with the WECC EWCC climate change scenario that would test the system with California hydropower reduced by 50% in 2034. It also does not include information necessary to adjust nameplate capacity due to thermal efficiency losses.

6. Investigating Public Disclosure: What Climate Dataset Is CAISO Using?

The CAISO and the CEC explained that the CEC's demand forecast incorporated climate scenario data from the Scripps Institute. However, no published report disclosed which Scripps climate scenarios were chosen by CEC staff for use in the mid- and high-demand scenarios, nor what assumptions are baked into the various "weather years" used. This required investigating the state's regulatory dockets.

a. 2017 IEPR Hearings

In order to determine which climate-relevant data had been used in the CEC's forecasts (and simultaneously to evaluate the level of public discussion of this information), all documents in CEC Docket 17-IEPR-03 (the 2017 IEPR load forecasting docket) were downloaded, combined, made text-searchable (where not already so formatted) and searched (2,147 pages) for the words "Scripps," and "weather year." As explained below, the Scripps data were only mentioned twice, during the testimony of a single person: a staff member in the CEC's Energy Assessments Division responsible for coordinating the CEC's technical forecasting work. These brief disclosures, however, were insufficient to determine which information, exactly, was used.

As a preliminary matter, the CEC hearings included a brief discussion that illuminated the "weather year" concept.[250] CEC staff explained that the "weather

246. CPUC, Decision (D.) 18-02-018 (Feb. 8, 2018), https://perma.cc/DSZ6-QNUD (Decision Setting Requirements for Load Serving Entities Filing Integrated Resource Plans).

247. *Id*. at 31–34.

248. *Id*. at 34, 86–87.

249. *Id*. at 86, 87.

250. *See* CEC, Transcript of February 22, 2017 IEPR Commissioner Workshop on Data Inputs and Assumptions for IEPR Modeling and Forecasting Activities, CEC Docket 17-IEPR-03 (TN# 216424), at 20–25, https://perma.cc/2A25-LH3J.

year" is a metric for determining peak load and described a statistical process that resulted in distributed estimates of peak load depending on weather. However, staff explained that the projections were based on the past 15 years of weather data, and therefore do not appear to include adjustments for future climate change. That means the only climate change adjustments to CEC's load forecast (and by extension the TPP) will be made using scenario data from Scripps. The question remains: which?

In 2017, the only two references to the Scripps data in the entire IEPR docket appeared during CEC staff testimony to the Commission during two hearings on IEPR technical development. During an early presentation, CEC staff discussed the assumptions used in the demand forecast and noted in passing that climate forecasts had been used.[251] In a later hearing, they explained: "We weren't able to get the newest [climate] scenarios in time for this Preliminary Forecast. So what we're using for this, for now, is what we used in 2015 as a placeholder. But for the Revised Forecast, we'll be incorporating the newest temperature scenarios."[252]

These two passing references during two slideshow presentations from CEC staff to one CEC Commissioner constituted the total public discussion of the incorporation of climate data into the forecasts that will be used to plan for California's long-term electric power grid reliability in 2018.[253]

b. 2015 IEPR Hearings

In one of those references, CEC staff mentioned "[data] we used in 2015." To assess whether more information was made available in an earlier proceeding, all documents in CEC Docket 15-IEPR-03 (the 2015 IEPR load forecasting proceeding) were downloaded, combined, made text-searchable (where not already so formatted) and searched (3,241 pages) for the word "Scripps." This revealed that there had been some additional discussion of the process in prior years:

> [CEC STAFF]: Climate change impacts, we get temperature scenarios produced for us by the Scripps Institute of Oceanography and they provide

251. *Id.* at 129–130; *see also* Presentation: IEPR 2017-02-22 Workshop: Timeline, Forecast Structure, and Remaining Inputs and Assumptions for 2017 IEPR Demand Forecast, CEC Docket 17-IEPR-03 (TN# 216141), at 9, https://perma.cc/V6KN-648S.

252. Transcript of August 3, 2017 IEPR Lead Commissioner Workshop on the 2017 CA Energy Demand Preliminary Electricity Demand Forecast, CEC Docket 17-IEPR-03 (TN# 220936), at 18–19, https://perma.cc/K3M5-AHQR; Presentation: IEPR 2017-08-03 Workshop: California Energy Demand 2018-2028 Preliminary Electricity and Natural Gas Baseline Forecast: CEC Docket 17-IEPR-03 (TN# 220503), at 16, https://perma.cc/KXB2-9HW2.

253. A search of all of the materials on the CEC's Demand Analysis Working Group (DAWG) (Google search: site:dawg.info "climate change" and site:dawg.info "climate change & scripps") showed that while climate change was often mentioned in passing, the CEC's work on the Scripps data does not ever appear to have been discussed here either.

> multiple scenarios, 12 to 15. And *we typically choose one of the higher scenarios, in terms of temperature change*, to use in the high demand case. And in the mid demand case *we pick a scenario from Scripps right around in the middle*.[254]

That is, the choice of scenario was the result of a conversation between CEC staff and the scenario developers at Scripps, resulting in the incorporation of two scenarios—"most likely" and "high" climate change scenario—the details of which were never discussed in the public record. Commissioners and staff did discuss challenges that were cropping up in their modeling selection approach, in a discussion that provides additional insight into their process:

> [CEC STAFF]: . . . we have typically just taken the scenarios and said, "Okay, here's one roughly in the middle temperature wise. Here's one towards the end. This will be our high, this will be our mid." But you end up sometimes with what we have in this case with a larger increase in minimum temperatures and something in the Mid Case. So what I'm planning to do is to talk to Scripps about developing a distribution, so we can have something more consistent in our scenarios. . . . [255]

This discussion implies that the CEC technical team had internal discussions regarding the implications of their climate scenario data, but that these were left to staff to work out, without input or oversight from either the Commission or the public. It became an issue once in 2015, when incorporating the scenarios yielded an unexpected result (lower demand in a hotter scenario), at which point it was noted that the process the CEC staff have been developing has some inherent limitations.

Overall, therefore, it was not possible to determine from the public record exactly what climate data was used in the CEC's demand forecast, or how it was incorporated.

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254. Transcript of the Feb. 26, 2015 IEPR Workshop on Electricity and Natural Gas Model Inputs, CEC Docket 15-IEPR-03 (TN# 204949), at 42–43 (emphasis added), https://perma.cc/527W-DSZZ; *see also* Transcript of May 21, 2015 IEPR Commissioner Workshop on Preliminary Natural Gas Outlook, CEC Docket 15-IEPR-03 (TN# 204977), at 29, https://perma.cc/8L64-K5YE ("We incorporate potential climate change on natural gas demand by employing scenarios, temperature scenarios provided to us from the Scripps Institute of Oceanography. And we convert those temperature scenarios into changes in heating degree days, which affect natural gas demand."); Transcript of the July 7, 2015 IEPR Commissioner Workshop on the 2015 California Energy Demand Preliminary Electricity Forecast, CEC Docket 17-IEPR-03, (TN# 205689), at 31–32, https://perma.cc/N7VJ-UPER ("[W]hat we asked Scripps to do was provide us, among all the different scenarios that they've run, a case, a scenario that's roughly in the middle in terms of temperature increase, and then one that's more at the high end, for our high demand case. . . . we match our weather stations . . . to the appropriate 50-square-mile grid. And from that we get projections of increases in maximum temperatures and, also, changes in heating and cooling degree days.").

255. *See* CEC Transcript of February 22, 2017, *supra* note 250, at 33–37.

7. Grid Reliability Planning: Conclusions

To summarize the findings in this section:

- NERC has not integrated climate change into its reliability standards. The problem is recognized but is not a priority.
- Over the last several years, WECC has engaged a consultant to create a "most likely" climate scenario for sensitivity analysis. WECC does not otherwise model climate change.
- CAISO uses CEC demand forecasts that integrate data on changing temperatures, but the TPP does not account for climate change in its generator or transmission model data.

The CAISO TPP's incomplete incorporation of climate change into its grid models means that California's current grid reliability planning process probably overestimates grid reliability in the face of a changing climate. Compounding this, the opportunity for public review and comment on any of these matters is extremely low. The above review suggests that technical experts analyzing climate risks speak primarily to each other and explain their work in only summary fashion to decisionmakers, who contribute their own expertise but also tend to accept what their staff conclude regarding the many technical choices that must be made. Third parties often do not participate at all and lack the resources and expertise to review and advise on the modeling process. Consequently, little pressure is exerted on those in charge of these processes to provide more detailed justifications or explanations of their work. Without increased opportunities for public participation and oversight, it is likely that no such pressure will be felt unless and until a disaster has already occurred.

C. CASE 2: WILDFIRE RISK MAPPING AROUND POWER LINES

Climate change contributes to increased wildfire risk. Changing precipitation and temperature patterns contribute to increased flammable biomass concentration. The electric grid interacts with this risk in both directions: grid malfunctions that create sparks are likely to start fires, those fires are increasingly likely to be much more ferocious, and increasingly ferocious wildfires, regardless of the ignition point, are likely to impact the electric grid.

Electric utility fire risk management in California is guided by a unified map. Following a serious wildfire in October 2007 that impacted the electric grid, the CPUC initiated R. 08-11-005 (later R. 15-05-006) and began developing a statewide fire risk map usable by the electric utilities to guide their vegetation management activities. The first "Fire Map" was developed to identify high-risk areas based on "fire weather" calculations. Then, according to frameworks set down in

a series of CPUC decisions,[256] the electric utilities, working together with CPUC and CAL FIRE, incorporated additional data into a final statewide Fire Risk Map against which electric utility infrastructure could be compared. The new map's risk zones are made enforceable through revisions to CPUC General Order 95,[257] which creates new construction and vegetation management requirements in high fire-risk zones.

The map is built from the following data sources: Tier 1 High Hazard Zones ("HHZ") on the U.S. Forest Service-CAL FIRE Joint Tree Mortality Task Force map of HHZs; cells on the CPUC's Fire Map 1 with a Utility Fire-Threat Index value that is equal to or greater than 800; cells on CAL FIRE's Fire Resource and Assessment Program ("FRAP") map of fire threats classified as High, Very High, or Extreme; historic fire perimeter data (all causes) in CAL FIRE's FRAP database; and communities at risk from wildfire ("CARs") in areas classified as "Very High" on CAL FIRE's map of Fire Hazard Severity Zones ("FHSZs"). Essentially, the CPUC map is a compilation of spatial data that shows high and severe fire risk areas, against which the electric utilities are supposed to overlay maps of their grid infrastructure.

It is possible to review how each of these data sources treats climate change. The HHZ tree mortality maps were created by combining information on dead trees and fire threat zones.[258] To determine dead trees, CAL FIRE has been conducting statewide aerial and on-the-ground tree mortality surveys. To determine fire threat, CAL FIRE combines information on likelihood of fire occurrence and expected fire behavior under severe weather conditions.[259] Current CAL FIRE guidance specifies "using historical fire rotation for a forest type and region" in on-the-ground fire risk assessment. In other words, the HHZ maps are based on data for current flammable biomass and historic fire risk. They do not incorporate forecast data, meaning they do not account for future climate change.

Fire Map 2 also incorporates areas scoring above 800 on CPUC's Fire Map 1. This earlier map was developed by the CPUC in 2016.[260] "Fire Map 1 depicts areas of California where there is an elevated hazard for the ignition and rapid spread of power-line fires due to strong winds, abundant dry vegetation, and other environmental conditions."[261] The maps were built on weather data from 2004 to 2013 to calculate number of fire weather days, potential wind speeds, and then-

256. *See, e.g.*, CPUC D. 17-01-009 (Jan. 20, 2017), https://perma.cc/2LJY-UTBX; D. 17-06-024, at 2 (June 30, 2017), https://perma.cc/9TP2-AVW8; D. 17-12-024, at 2 (Dec. 21, 2017), https://perma.cc/L7Y7-97F2.

257. CPUC, General Order 95: Rules for Overhead Electric Line Construction, at I-8, VIII-9 (rev. Dec. 2017), https://perma.cc/8FEM-TQ2G.

258. *See* CAL FIRE, Description of CAL FIRE's High Hazard Zone Determination Pursuant to Governor Brown's October 30, 2015 Proclamation of a State of Emergency (2015).

259. *See Rapid Assessment of Fire Threat v. 2*, CAL FIRE (Rev. June 20, 2017).

260. CPUC D. 16-05-036, at 2 (May 26, 2016), https://perma.cc/T446-TA7X.

261. *Id.* at 2.

current vegetation conditions.[262] There was no effort made to adjust these values for possible future climate change. Fire Map 2 also incorporates CAL FIRE's Fire Threat Map.[263] This map, in turn, was developed on CAL FIRE scoring of Fuel Rank and Fire Rotation.[264] The Fuel Rank map, in turn, is based on Surface Fuels data.[265] The Surface Fuels mapping methodology explains that this is built on current vegetation states, i.e., not incorporating climate predictions.[266] Fire Rotation, meanwhile, also uses historical data to rank fire frequency.[267] Finally, Fire Map 2 incorporates the mapping data from CAL FIRE's Fire Hazard Severity Zones project.[268] These maps assess not the risk of fire, but the risk that if a fire occurs, it will cause a great deal of damage. Like CAL FIRE's Fire Threat Map, the FHSZ are designed based on current, not projected, conditions.[269] This is also true of the communities at risk dataset, which is built using the same data.[270]

The monumental task of mapping the areas in California exposed to wildfire risk has just begun to impose requirements in existing risk zones and has not yet made any progress mapping risks that are likely to develop as the result of climate change. This is particularly concerning where, as discussed above, the CAISO TPP is not performing wildfire impact reliability testing. Catastrophic wildfire impacts, therefore, are likely to continue to be a major and increasing threat to the grid. This appears to remain an item of discussion and concern (e.g., at the 2018 Fire Safety and Utility En Banc held by the CPUC),[271] but no progress has been made on incorporating climate change into the fire risk maps on which utility wildfire management is based. In one respect the CPUC's Fire Map 2 proceedings surpass the grid reliability proceedings discussed above: it is relatively easy to determine and assess what data are being used. This is largely thanks to CAL

262. *Id*. at 7–10.

263. D. 17-06-024, at A-4 (June 30, 2017), https://perma.cc/9TP2-AVW8.

264. *Fire Threat Map*, CAL FIRE, https://web.archive.org/web/20161223141558/https://frap.fire.ca.gov/data/frapgismaps/pdfs/fthreat_map.pdf. The explanation of the map's data sources is printed on the map, which points to a defunct web link.

265. *Fuel Rank: Potential Fire Behavior*, CAL FIRE, Map ID: FRNK_MAP, https://web.archive.org/web/20171218235814/https://frap.fire.ca.gov/data/frapgismaps/pdfs/frnk_map.pdf. The Fuel Rank map methodology is described at https://web.archive.org/web/20161230071057/http://frap.cdf.ca.gov/data/fire_data/fuel_rank/index.

266. The Surface Fuels Mapping Methodology was described online. *Surface Fuels Maps and Data*, CAL FIRE, https://perma.cc/L52A-V8KR.

267. CAL FIRE, TRENDS IN WILDLAND FIRE 12–19 (Oct. 2003), https://web.archive.org/web/20181221233526/https://frap.fire.ca.gov/data/assessment2003/Chapter3_Quality/wildfiretrends_2.pdf.

268. *See Fire Hazard Severity Zone R-Mapping Project*, CAL FIRE, https://perma.cc/W9Y3-695Q.

269. Dave Sapsis, *Fire Hazard Severity Zoning Draft Map Review and Validation*, https://web.archive.org/web/20161220203250/http://frap.fire.ca.gov/projects/hazard/Fire_Hazard_Zoning_workshop_1_8.ppt (explaining the fire hazard severity zoning model methodology).

270. *See Fire Hazard Severity Zone R-Mapping Project, supra* note 268.

271. Agenda, CPUC Fire Safety and Utility Infrastructure En Banc (Jan. 31, 2018), https://perma.cc/P6GJ-Z4FChttps://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Safety/Fire Safety and Utility Infrastructure En Banc Agenda FINAL 1.31.2018.pdf.

FIRE's careful online documentation, but also a product of having data sources printed directly on the final map.

Certainly, however, there is room for improvement. The Fire Map proceedings pose significant hurdles to public participation: a stakeholder would need to be able to navigate not only the CPUC decisionmaking process that resulted in the Fire Map, but also the numerous decisionmaking processes that resulted in CAL FIRE's maps and the expert working group processes that were actually involved in translating the CAL FIRE materials to CPUC purposes.

D. CASE 3: SEA LEVEL RISE IN LARGE THERMAL GENERATION SITING

Construction and expansion of electric power system infrastructure typically requires review and approval by multiple government agencies, all of which have their own standards, procedures, and requisite data inputs. Climate change poses new risks to this infrastructure—including risks in coastal areas and flood zones threatened by sea level rise and changing storm and precipitation patterns. Although numerous planning and permitting processes exist, this review focuses on the specialized requirements for construction of large thermal generating stations, i.e., power plants with nameplate capacities above 50 megawatts that burn coal or natural gas. Such plants must be reviewed and approved by both CEC and CPUC.[272] None of these regulations specifically requires climate change adaptation to be incorporated, and therefore it is necessary to examine the proceedings themselves to see how this has been accomplished.

CEC Power Plant Site Certifications are docketed online. To support this review, docketed files for four pending large thermal generating station applications were downloaded, combined, made text-searchable (where not already so formatted) and searched for climate-relevant keywords including "sea level rise" and "flooding."[273] The preliminary review revealed that two of the four currently pending station applications proposed siting on or directly adjacent to the Pacific Coast, and are therefore potentially susceptible to impacts from sea level rise.

The Redondo Beach Energy Project ("RBEP") was proposed to replace the current natural gas-fired electric generating station at Redondo Beach, on the coast south of Los Angeles. Its coastal location prompted officials to examine whether sea level rise would threaten the station. In July 2014, CEC staff

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272. The CEC reviews applications pursuant to 20 C.C.R. Chapter 5 (Power Plant Site Certification). CPUC reviews under CPUC General Order 131-D, Rules Relating to the Planning and Construction of Electric Generation, Transmission/Power/Distribution Line Facilities and Substations Located in California (1994), at 2-4, https://perma.cc/CUZ8-BJ8U.

273. The four files reviewed were: Mission Rock Energy Center, 2015-AFC-02 (~7,000 pages), https://perma.cc/CE49-VAD9; Puente Power Project, 2015-AFC-01 (~34,000 pages), https://perma.cc/5EBC-R2WG; S Stanton Energy Reliability Center, 2016-AFC-01 (~5,000 pages), https://perma.cc/49HJ-JMKS; and Redondo Beach Energy Project, 12-AFC-03 (~9,000 pages), https://perma.cc/CKB6-W9A3.

completed a preliminary analysis of the RBEP application.[274] The staff analysis concluded that the site faced about 17 inches of sea level rise by 2050 and that this sea level rise would not change storm surge risks at the site.[275] Overall, CEC staff concluded that sea level rise impacts would not be significant enough to warrant denying the application.[276] However, CEC staff did not have the final word. The California Coastal Commission ("CCC") is required to contribute to reviews of coastal power plant applications made to the CEC.[277] A year after the CEC staff analysis, CCC came to the opposite conclusion. Explaining that California had recently adopted new statewide guidance on sea level rise,[278] the CCC determined that the site could actually see between 32 and 38 inches of sea level rise over the plant's operating lifetime (2060)—much more than the 17 inches by 2050 used as the baseline in the CEC staff analysis.[279] The CCC expressed concern that later in the plant's lifetime, rising seas, combined with storm surge or tsunami, could overtop the site's perimeter and seriously damage the site, potentially contributing to a serious public safety problem.[280] The CCC recommended assessing alternative sites, or, in the event that the CEC disagreed, investing in more protection that the applicant had originally proposed.[281] In other words, as of about 2014, the CEC and the CCC had differing views as to which were the appropriate sea level rise data and projections to use in siting power plants. The CEC appears to have used information and assumptions that understated the risks of sea level rise, and the CCC urged the CEC to update its practices. The CCC advocated using the analytical methods in the then-new state guidance. As of this writing, the RBEP application is suspended indefinitely.[282]

The Puente Power Project included the first analysis of sea level rise submitted by a CEC thermal siting review applicant under the state's 2013 sea level rise guidance. The proposed plant was to be sited at 14 feet elevation, directly next to the Pacific Ocean. The project's consultant argued that sea level rise at this location, and potential storm surge, would be less than 14 feet and therefore did not

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274. CEC, REDONDO BEACH ENERGY PROJECT - PRELIMINARY STAFF ASSESSMENT (CEC-700-2014-003-PSA), CEC Docket 12-AFC-03 (July 2014) (TN# 202833), https://perma.cc/Y9G7-8EU9.

275. *Id*. at 5.2–26.

276. *Id*. 5.2–27 ("Energy Commission staff concludes that the potential adverse cumulative impacts to project facilities from geologic hazards during its design life are less than significant.").

277. Cal. Pub. Res. Code § 30413(d).

278. CAL. OCEAN PROT. COUNCIL, STATE OF CALIFORNIA SEA-LEVEL RISE GUIDANCE DOCUMENT (2013). This was based on NAT'L ACAD. OF SCIS., SEA-LEVEL RISE FOR THE COASTS OF CALIFORNIA, OREGON, AND WASHINGTON: PAST, PRESENT, AND FUTURE (2012), https://perma.cc/5A23-CUA5, https://perma.cc/T5MJ-7XS8.

279. Cal. Coastal Comm'n, California Coastal Commission 30413(d) Report—Final Approved Report, CEC Docket 12-AFC-03 (2016) (TN# 205306), at 32 n. 18, https://efiling.energy.ca.gov/GetDocument.aspx?tn=205306&DocumentContentId=6548.

280. *Id*. at 33.

281. *Id*. at 2.

282. CEC, Order Suspending Proceedings, CEC Docket 12-AFC-03(2018) (TN# 206771), at 2, https://perma.cc/8PXM-HB8F.

pose a risk.[283] The issue was subsequently a major point of contention in the public proceedings. In June 2016, the CEC staff presented its analysis, ultimately concluding that sea level rise could contribute to some flood risk at the site.[284] Again, the CCC conducted a review as well, recommending that the CEC move the project away from the coast because updated projections showed that flood risk was much higher than the applicant had projected.[285] The question of sea level rise subsequently became one of the key contested issues in the proceedings related to this proposal. The CEC ultimately denied the application for other reasons.[286]

Although the CPUC reviews electric generating facilities applications, its reviews are limited to necessity within the structure of grid reliability and capacity analysis. In this regard, climate adaptation is considered only to the extent that it is raised as a potential reliability or capacity constraint. The CPUC conducts its review in part under California Public Utilities Code § 451, which provides for CPUC review of all electric utility facilities to ensure that the grid continues to be operated in a safe and reliable matter. As it happens, exactly this argument was made at the CPUC against the Puente project.[287] The CPUC concluded that, despite protests to the contrary, E.O. B-30-15 did not require it to wait until the CEC's review was finished and that, at least on the evidence presented to the CPUC at that time, "[b]ased on a review of all of the expert testimony, we find that, during the term of the contract and the expected life of the plant, the risk of coastal flooding has not been shown to compromise the reliability of the proposed project."[288] CPUC went on to approve the Puente project, although it later reopened the case for other reasons.

Unlike temperature and precipitation data relevant to other processes, California has a centralized system for integrating sea level rise into its decision-making processes, in the form of its sea level rise guidance.[289] The public is aware of these risks and has ample opportunity to submit protests in well-established regulatory proceedings. In addition, the CCC has authority to inject its independent analysis into these processes and has done so to identify risks from sea level

283. AECOM, Technical Memorandum—Sea Level Rise Analysis: Prepared in Support of Application for Certification, Puente Power Project, attached as Appendix N-2 to Application, Docket No. 15-AFC-01 (TN# 204220-14), at 58–88, https://perma.cc/6FP6-NPP7.

284. CEC, CEC Docket 15-AFC-01 (2016) (TN# 211885-1), at 4.10–58 to 4.10–60.

285. CCC, California Coastal Commission 30413(d) Report – Final Approved Report, CEC Docket 15-AFC-01 (2016) (TN# 213667), at 37, https://perma.cc/TA5T-T6CB.

286. CEC, Order Terminating Proceeding, CEC Docket 15-AFC-01 (2018) (TN# 226068), at 2, https://perma.cc/DVX2-WF5X.

287. CPUC D. 16-05-050 (Decision Approving, in Part, Results of Southern California Edison Company Local Capacity Requirements Request for Offers for Moorpark Sub-Area Pursuant to Decision 13-02-015) (June 1, 2016), at 13, https://perma.cc/DT8X-4UFC.

288. *Id*. at 12.

289. Although this section has discussed proceedings using the 2013 version of the guidance, it has since been updated. CAL. NAT. RES. AGENCY & CAL. OCEAN PROT. COUNCIL, STATE OF CALIFORNIA SEA LEVEL RISE GUIDANCE: 2018 UPDATE 3 (2018), https://perma.cc/UKC7-PP3Z.

rise that other agency staff had not completely identified. Overall, there appears to be a developing consensus regarding the data to be used and, generally, the extent to which uncertainties in the data need to be addressed. Sea level rise is, today, delaying and even potentially preventing the construction of coastal power plants in California. It remains to be seen whether project proposals will begin to account for this by moving inland, adjusting designs, or incorporating shoreline armoring and other protective elements.

E. CASE 4: CLIMATE RISK IN AN ELECTRIC RATE CASE

Marking a significant break from past practice, the CPUC recently required regulated utilities to justify expenditures in part based on a unified risk assessment methodology. Risk assessment is supposed to guide utility decisionmaking on what to spend, where, and when. The CPUC's determinations on these risk assessments will govern how much money the utilities can recover from electric utility ratepayers. This is a unique and problematic risk assessment application: unique because it has not been done before, problematic because it makes utility revenues dependent on potentially inscrutable risk modeling. These processes are relevant to this Article because, among the many risk models now being proposed and deployed by the utilities, at least one utility—PG&E—developed a climate risk model. This model, in turn, was used to justify various PG&E expenditures. As explained below, these models do integrate climate change data—but in questionable ways.

1. Background: From San Bruno to RAMP

On September 9, 2010, a gas distribution pipeline in a residential neighborhood within PG&E's service territory ruptured and exploded. The resulting fire killed eight people and injured many more. For the purposes of this Article, the disaster is important because it led to several regulatory reforms regarding utility risk assessment, resulting in processes now relevant to climate change risk assessment in the electricity sector.

At the time of the San Bruno explosion, PG&E had a risk assessment program for its natural gas system. Briefly, PG&E maintained a Risk Management Program, described via Risk Management Procedure ("RMP") documents. Immediately following the San Bruno explosion, pre-existing federal accident response and investigation processes began. The U.S. Department of Transportation's National Transportation Safety Board ("NTSB") investigated the explosion's causes for two years, as documented in the final Pipeline Accident Report.[290] The NTSB found fault in PG&E's pipeline integrity management practices, as well as the oversight

290. NAT'L TRANSP. SAFETY BD., NTSB/PAR-11/01 PB2011-91650, PACIFIC GAS AND ELECTRIC COMPANY NATURAL GAS TRANSMISSION PIPELINE RUPTURE AND FIRE: SAN BRUNO, CALIFORNIA SEPTEMBER 9, 2010 – ACCIDENT REPORT (2011), https://perma.cc/9BDF-6286.

of those practices by the CPUC, and the oversight of the CPUC's program by the federal Pipeline and Hazardous Materials Safety Administration ("PHMSA").[291]

At all levels of regulatory oversight, PG&E's risk assessment program had been deemed sufficient to protect public health and safety. The system failed to identify the threat at San Bruno, and, more importantly, the underlying causes of that threat. In retrospect, there were flaws both in the design of the assessment tools, and PG&E's execution of the tasks that those tools required to function properly. From data collection and management to threat identification and risk assessment, the existence of a risk management tool was not enough to avoid loss of life.

After San Bruno, the CPUC initiated several investigations that would continue for the next several years. Meanwhile, the California state legislature reacted by passing S.B. 705, which provided a single, clear policy directive:

> It is the policy of the state that the [CPUC] and each gas corporation place safety of the public and gas corporation employees as the top priority. The [CPUC] shall take all reasonable and appropriate actions necessary to carry out the safety priority policy of this paragraph consistent with the principle of just and reasonable cost-based rates.

The CPUC later interpreted this to also apply to electric utilities,[292] meaning that from that point forward, all electric utility ratemaking would be conducted with safety as its number one priority. In practice, this meant that utility ratemaking would be required to incorporate risk assessment going forward.[293]

The CPUC did this by adjusting its rate case plan. Pursuant to its core utility regulatory authority, the CPUC conducts General Rate Case ("GRC") proceedings to

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291. *Id*. at xii.

292. This interpretation was codified in S.B. 900 (2014) (Hill) (An act to amend Section 321.1 of, and to add Section 750 to, the Public Utilities Code, relating to public utilities), 2014 Cal. Stat. 2014 Ch. 552, https://perma.cc/T96R-RF9R.

293. In fact, it began immediately. On March 5, 2012, CPUC Executive Director Paul Clanon sent a letter to PG&E regarding the utility's upcoming 2014 rate case application. It instructed PG&E to "perform and provide a risk assessment of its entire system, both gas and electric, and a comparison to industry best practices." The letter contemplated PG&E's submission of information regarding its risk management and planning policies and practices, and required PG&E to fund studies, performed by consultants hired by the CPUC's Safety and Enforcement Division (SED). Letter from Paul Clanon, Executive Director, CPUC to Tom Bottorff, Senior Vice President of Regulatory Affairs, Pacific Gas & Electric Company (Mar. 5, 2012). PG&E subsequently filed its 2014 rate case application (A.12-11-009, filed Nov. 15, 2012), SED hired its consultants, and the consultants duly issued their reports. *See* A.12-11-009 Administrative Law Judge's Ruling Making Available Reports Published by Safety and Enforcement Division (May 17, 2013), at 1, https://perma.cc/U9VC-YXPU; Administrative Law Judge's Ruling Making Available Financial Audit Report on Gas Distribution System (May 31, 2013), at 2, https://perma.cc/X2E5-3G9R; One consultant focused on PG&E's gas system. Cycla Corporation, Evaluation of PG&E's 2014 Gas Distribution GRC Filing (May 16, 2013), at iii, https://perma.cc/VWV9-ECYL. The other focused on its electric system. Liberty Consulting Group, Study of Risk Assessment and PG&E's GRC (May 6, 2013). The third report is not relevant here, https://perma.cc/35NN-AWFS.

determine electric utility revenue requirements and electric consumer rate schedules. The GRC process is governed by a schedule, the Rate Case Plan ("RCP"), that is updated from time to time to account for new regulatory processes.[294] Pursuant to the RCP, electric utilities file GRC applications seeking to ensure revenues sufficient to cover operating costs and to generate a return on capital investment. As relevant to this discussion, utility costs include maintenance and risk management, and capital expenditures include system components sufficient to protect public safety. Prior to 2010, the methodologies employed by utilities to evaluate risk were not uniform, and no effort was contemplated to make them so. This changed in CPUC Rulemaking 13-11-006, titled *Rulemaking to Develop a Risk-Based Decision-Making Framework to Evaluate Safety and Reliability Improvements and Revise the General Rate Case Plan for Energy Utilities*.

After some examination, the CPUC adopted a staff proposal that created a framework for risk assessment in rate cases.[295] The general idea was that in rate case proceedings where utilities request funding for safety-related activities, the utilities were required to file (1) Safety Model Assessment Proceeding ("S-MAP") applications, which would be consolidated, and (2) Risk Assessment and Mitigation Phase ("RAMP") filings in which each utility would "describe how it plans to assess its risks, and to mitigate and minimize such risks." RAMP filings were required to contain: (1) "[the] utility's prioritization of the risks it believes it is facing and a description of the methodology used to determine such risks," (2) "[a] description of the controls currently in place, as well as the 'baseline' costs associated with the current controls," (3) "[the] utility's prioritization of risk mitigation alternatives, in light of estimated mitigation costs in relation to risk mitigation benefits," (4) "[the] utility's risk mitigation plan, including an explanation of how the plan takes into account: Utility financial constraints, Execution Feasibility; Affordability Impacts; Any other constraints identified by the utility," and (5) "[for] comparison purposes, at least two other alternative mitigation plans the utility considered and an explanation of why the utility views these plans as inferior to the proposal plan."[296]

Finally, it is important to note that the Commission declined to include reliability in its safety assessment processes, except to the extent that it is necessary for the consideration of safety.[297] The Commission declined because: (1) electric utilities are already required to provide reliable service (PUC § 451), (2) S.B. 705

294. The current RCP format was laid out in D.89-01-040 (Jan. 27, 1989), at 1. Minor changes have been made since (e.g., D.92-08-033, D.07-07-004, Appx. A, https://perma.cc/6TG5-FDVH).

295. CPUC, Administrative Law Judge's Ruling Regarding Refined Straw Proposal, R. 13-11-006 (Apr. 17, 2014), at 1, https://perma.cc/XW75-K9KA; CPUC, D. 14-12-025 (Decision Incorporating a Risk-Based Decision-making Framework into the Rate Case Plan and Modifying Appendix A of Decision 07-07-004), R. 13-11-006 (Dec. 9, 2014), https://perma.cc/95X4-DB24.

296. D. 4-12-025 at 32.

297. *Id*. at 19–20 ("Some of the parties raised the issue that the S-MAP and RAMP process should also make reliability, along with safety, a top priority of the Commission and the energy utilities.").

"only refers to making safety a top priority," and (3) "[the] energy utilities have tariff provisions in place that limit liability under certain circumstances. To open up the S-MAP to ensure reliability could affect those liability limitations, which in turn could significantly expand the intended scope of the S-MAP process and S.B. 705."[298] "We recognize, however, that reliability-related issues can affect safety. In such situations, those reliability issues should be included in the assessment of safety."[299]

2. PG&E's RAMP Filings

PG&E submitted its RAMP filing in late 2017.[300] The document was supported by a series of workpapers that were filed with the CPUC, but which are not currently available on the CPUC's online public docket. Since the risk model can only be understood with the assistance of the workpapers, and because the workpapers should have been made public by the CPUC, this analysis focuses on them even though they were not currently publicly available.[301]

PG&E's RAMP acted to support funding requests across all aspects of PG&E's business. The model is too complex to cover completely here, but understanding its basic mechanisms is helpful because, ultimately, one element of the risk model also seeks to address climate change-related planning expenditures.

The PG&E RAMP model is a collection of twenty-two separate risk models. It was built using the "@RISK Add in," a third-party Excel add-in for running Monte Carlo simulations. Each of the models requires inputs for exposure, frequency, consequence severity, and mitigation:

- *Exposure* parameters include miles of pipeline and other elements that can fail or otherwise create negative consequences.
- *Frequency* data are expressions of failure rate, expressed as event counts per period.
- *Consequence severity* data capture the damage likely to be caused by any particular failure state. There are six categories of consequence data:
  - injury and fatality rate for a failure (the "safety" parameter) (as counts),
  - remediation and clean-up costs (the "environmental" parameter) (as dollars),
  - grid outage time (the "reliability" parameter) (as customer-outage minutes),
  - investment required to bring system into compliance once failure occurs (the "compliance" parameter) (as dollars),

298. *Id.* at 20.

299. *Id.*

300. PG&E, 2017 Risk Assessment and Mitigation Phase Report of Pacific Gas and Electric Company, I. 7-11-003 (Nov. 30, 2017), https://perma.cc/EDZ9-96XV.

301. The workpapers were received from PG&E upon request.

    - percentage change in brand favorability (the "trust" parameter) (as a percentage),
    - total financial impact of event (the "financial" parameter) (as dollars).
- *Mitigation* data account for risk reduction from any specified mitigation action.

These data are subjected to a variety of statistical calculations to compute a Multi-Attribute Risk Score ("MARS") for every potential failure state. The MARS score, and the impact on MARS score of particular mitigation proposals, is the model's primary output.

Most of the risk models in the PG&E RAMP are "asset" models, which stop at this point. However, the Climate Resilience risk model is a "cross-cutting" model, meaning that it combines outputs from numerous other risk models into a higher-order model. Specifically, the Climate Resilience risk model performs additional calculations on the outputs from eleven other models: Distribution Overhead Conductor Primary (model 9), Transmission Overhead Conductor (model 10), Storage – Wells (model 8), Maintaining System Capacity (model 2), Compression & Processing Facility (model 6), Measurement & Control Facility (model 3), Transmission Pipeline (model 1), Hydro Dam Failure (model 13), Motor Vehicle Safety (model 16), Employee Safety (model 15), and Contractor Safety (model 14).

In order to model the impact of climate change on these risk categories, PG&E developed multipliers for each of six climate-change "risk drivers": drought, wildfire, major storm event days, sea level rise, heat waves, and subsidence. The multiplier was based on the estimated contribution of each risk driver to each grid risk, as follows:

- Storm event days: a linear extrapolation of a 30% increase by 2050.
- Sea level rise: based on the NAS data as interpreted by the CCC
- Subsidence: projected changes in drought months per year multiplied by maximum historic subsidence.
- Heatwaves: maximum daily temperatures based on California consensus for scenario modeling.
- Wildfire: acres burned in PG&E service territory based on historic data and future projections of areal increase.
- Drought: number of months of drought per year.

These projections were turned into multipliers that applied to the eleven risk categories, which then, combined, produced new, aggregate consequence scores. That is, the model attempts to quantify the impact of, say, heatwaves, on PG&E's motor vehicle safety program, expressed as a number of injuries per year. The eleven risk models, times the six risk drivers, divided by additional calculations to ensure against double-counting, equal the Climate Resilience risk model outputs.

Thus, the Climate Resilience risk model provided an estimate of the number of likely additional injuries and fatalities (three and several hundred per year, respectively), because of climate change's impacts on the grid. It also produced a figure of $47 million per year in additional environmental cleanup costs, 105 million additional customer outage minutes per year, $33 million per year in compliance costs, an 8.64% trust impact, and $384 million per year financial impact.

Again, the purpose of the model is to support a rate case. As such, the model ends with a series of expenditure proposals that will require CPUC review and approval. Although the exact numbers depend on a variety of alternatives, the general outlines of the funding request are, roughly, between 2020 and 2022:

- $100,000 per year to research climate impacts on PG&E's grid,
- $40,000 per year to identify and prioritize assets that need to be replaced, hardened, etc.,
- $30,000 per year to run the existing "Better Together Resilient Communities" grant program,
- $40,000 per year to create a "climate resilience screening tool,"
- $100,000 per year to develop resilience metrics for use in tracking progress,
- $100,000 per year to train PG&E staff on climate change adaptation issues,
- $100,000 to $200,000 per year on a series of "deep dives" into improving the major storm event days, drought, and subsidence calculations used in the Climate Resilience risk model (with others to follow in future years).

As an effort to incorporate climate change projections into utility planning process, PG&E's RAMP filing is a step forward. The method is well documented, and best available information on various climate impacts has been incorporated into all of the other risk assessment frameworks that will guide PG&E's decision-making. Although the model is very complex and involves statistical applications that require special expertise to evaluate, it is available for public scrutiny, and a process exists, in the CPUC's investigation, to see that evaluation done.

However, PG&E's RAMP filing creates more questions than answers. Every step in the chain of calculations makes potentially unjustifiable assumptions. Every input requires scrutiny for its appropriateness and accuracy, and every output requires examination for its tendency to support what are, ultimately, the exercise's entire purpose: to justify a utility rate case.

While it is beyond the scope of this paper to conduct a thorough inspection of every aspect of the model, there do appear to be reasons for serious concern. First, the climate resilience model is built primarily on PG&E staff estimates. The model inputs are repeatedly described as being built on "guidance from SMEs," i.e., "subject matter experts" and "RAMP stand-alone risk owners." There are not currently any methods to validate the judgment of these unnamed individuals.

Second, it appears that the complex risk methodology is not, in fact, driving the line-item expenses that form the basis of the rate case. These expenses are, rather, pre-determined based on existing spending levels and past practices and would not be adjusted regardless of the model's outputs. This raises the question of what purpose, exactly, the model serves.

Third, it is not clear that the methodology truly captures climate risk in any meaningful way. Again, the outputs of the climate resilience model include the number of people likely to be injured by climate change's impact on the grid. This bizarre metric is based on so many assumptions and calculations as to be essentially meaningless and does not in any way reflect the risk of, for example, a major fire caused by a downed power line, or a statewide blackout during a heatwave.

In summary, PG&E has endeavored to build a model of climate change risk from the ground up, moving from information about possible failure states to incorporating changes in failure state occurrence based on climate risks, expressing the risk of climate change as a change in negative outcomes from failure states, and proposing expenditures justified by those increased negative outcomes. The problem with the model is that any break in the chain calls into question the entire effort, and, as it stands, most of the links look weak.

CONCLUSION

Part I of this Article developed an idealized framework for assessing climate adaptation policy assessment and Parts II and III examined how California's policy development and regulatory integration efforts fare against these standards. Part II concluded that significant barriers, including especially a lack of leadership and a failure to define evaluative criteria, have prevented successful climate adaptation policy development in California. Where these processes have involved the electric power sector, they have largely failed to incorporate input from key regulators and other stakeholders. The case studies in Part III showed that California regulatory entities are just beginning to grapple with the difficult task of translating broad climate adaptation integration goals into specific regulatory proceedings and decisionmaking processes.

If any pattern emerges, it is that the proceedings with the greatest public involvement—the facilities siting reviews—had the most nuanced discussion of climate risks and were informed to a greater degree about the costs of risk bearing being allocated by the decisions (equity) and the definition and measurement of failure states (effectiveness). The nascent efforts to understand the cost implications of climate adaptation (efficiency) in the general rate case were not promising. Risk management tools, from fire mapping to complex reliability planning processes, are not yet accounting for the ongoing loss of stationarity. Equity considerations—particularly liability regimes and public discourse regarding acceptable risk thresholds—are essentially nonexistent.

This Article is agnostic about what, exactly, must be done to prepare human systems for climate change.[302] Rather, its animating conviction lies in process. Regulators are aware that much work remains to be done. Every proceeding and policy process reviewed above is subject to iterative review and improvement. Most significantly, the CPUC recently initiated a climate adaptation proceeding that, if managed well, could begin to address some of the integration challenges discussed above. What appears to be missing is the constant pressure from participants with a *primary* interest in climate adaptation. Civil society has provided organizations committed to participating in government proceedings that have environmental impacts, human health impacts, and ratepayer cost impacts. But these groups represent *current* interests, and *current* perspectives. There is very little support for the interest of future generations, to insist on the construction of an infrastructure system, and a governance system, that can withstand a changing climate. Although this has not emerged after three decades of work in California, it may soon.

The loss of stationarity confronts policymakers and regulators with their responsibility to the future, and the fundamental uncertainty that that future brings. Only the future will tell if today's decisions have protected tomorrow's interests. With only the past to guide us, it may seem unlikely that this will occur. But if climate change teaches us anything, it is that past trends do not necessarily dictate future outcomes.

302. For a recent set of high-quality recommendations for the electric power system, *see* Anna M. Brockway & Laurel N. Dunn, *Weathering Adaptation: Grid Infrastructure Planning in a Changing Climate*, pre-print available online at https://arxiv.org/abs/1912.02920.