9 Implementation:
Steps Toward Realizing the Climate-Safe Path

At the End of the Day…

The final component of the framework to action introduced in Chapter 4 – which aims to chart the way to implementing the Climate-Safe Path for All proposed in this report – is to focus on a number of implementation challenges after all other pieces – data, projects, governance and finance – are in place. While an overall vision – and policy to give it prominence – were seen as critical, one phrase was used maybe more times than any other over the course of the Climate-Safe Infrastructure Working Group's (CSIWG) process – by members, expert panels and invited webinar speakers: and that is, "at the end of the day." This phrase reflected the urgency and impatience felt by many to get on with making climate-safe infrastructure a reality yet pointed to common "last mile" challenges of getting such infrastructure actually built on the ground. Such challenges include:

- Having sufficient well-trained staff who know how to do it;
- Having mechanisms for coordination to move the Climate-Safe Path vision forward across administrations, across government silos and beyond government; and
- Having incentives, means and know-how on how to turn State-level policy into meaningful action at local and project levels.

In this chapter then, we address key implementation challenges that were raised over the course of the CSIWG's work and recommend ways to address them.

Training, Capacity Building and Other Workforce Issues

Over the course of the CSIWG's work, a reoccurring theme was the need to have the skilled workforce to actually get climate-safe infrastructure appropriately designed, built, operated and maintained. This is far from a new theme in infrastructure discussions, neither in the state[187,296,297], nor across the nation[188,189, 192,193,223]. But with regard to the central concern of this report, namely how to account for climate change in infrastructure engineering, the workforce issues take on a unique flavor.

Figure 9.1 California needs a skilled workforce to actually get climate-safe infrastructure appropriately designed, built, operated and maintained. (Photo: Solar installer lays a photovoltaic module; Department of Energy)

The CSIWG encountered the following 11 specific training and skills gaps and needs during its deliberations:

- **Climate skepticism:** CSIWG members reported regularly encountering and/or working with colleagues who do not know about the degree of scientific consensus on climate change or who overtly share the skepticism about predominantly human-caused climate change that can still be found in some parts of the American public[298] (Chapter 5).
- **Lack of understanding of climate science:** Among some in the workforce, this skepticism of climate change is rooted in a lack of deep familiarity or comfort with climate science – something that is still not regularly included in engineers' and architects' education[299]. Similar discomfort and lack of climate science understanding can be found among procurement staff, investors and financing experts, elected officials and planners who are now asked to prepare for climate change or account for it in their area of expertise. Some, even if they generally accept the scientific fact of climate change, do not feel solidly enough anchored in the science to defend it with skeptical audiences. Doing so would make them vulnerable to looking professionally incompetent (Chapter 5).
- **Lack of familiarity with sophisticated risk and uncertainty assessment tools and approaches to decision-making under deep uncertainty**: There is a similar situation arising from the lack of training in risk and uncertainty assessment methodologies, and how to make decisions in the face of uncertainty, all of which go beyond the traditional compendium in their professional trainings (Chapter 6).
- **Lack of familiarity with sophisticated economic analysis methodologies:** Traditional benefit-cost assessment methodologies, narrowly focused on easily quantifiable project costs and outcomes are well established, but they are inadequate for the systemic, silo-busting, integrative approach promoted throughout this report (Chapter 8).
- **Lack of knowledge of and disconnect from the adaptation literature and field:** Most engineers and architects are professionally anchored within their fields, disciplines and professional societies, which still have very small overlap with multiple decades of adaptation science and an emerging, but still small field of adaptation professionals[300]. Concepts like adaptive management, adaptation pathways, building adaptive capacity and so on are only slowly being integrated into the thinking of those who build our infrastructure.
- **Lack of familiarity with many available tools and platforms:** The webinar series and literature review unearthed a number of tools and platforms. While some had heard of some of these tools and platforms, most were unfamiliar – even among the experts on the CSIWG. Meanwhile, there is an overwhelming number of tools with little guidance as to which of them are most useful for what purposes. Platforms and processes for scientists to engage regularly and on an ongoing basis with engineers and architects are rare, and none were found that focus on exchange around climate change *per se* (Chapter 5).

Figure 9.2: Workforce development must reach into all segments of California society, and particularly open doors to minority, women and otherwise previously disadvantaged workers. (Photo: Workers erecting a telephone pole; Russ Allison Loar, flickr, licensed under Creative Commons license 2.0)

- **Lack of comfort with performance standards:** Engineers and architects are most familiar and comfortable with targeted structural design standards and technical specifications. As the tried and true standards of their respective fields, they give clear instructions on how to build and come with the trust of having been approved by standard-setting bodies through a consensus-based process. Performance standards, by contrast, entail far more flexibility and creativity, but also professional uncertainty, as to how to achieve desired outcomes (Chapter 7).
- **Lack of familiarity with adaptive design approaches and techniques:** Adaptive design is only an emerging paradigm and only few examples exist yet on how to build in ways that allow infrastructure to be built in stages and in modular ways over time. Practices are not yet well established and guidance is limited, leaving practicing engineers and architects with little know-how to go on (Chapter 7).

- **Resistance to integrative and systems thinking that crosses silos:** Broadening out from individual assets or structures to infrastructure systems embedded in social, ecological and economic environments, where there is a demand to account for costs and benefits across sectors and where disciplines, interest groups and jurisdictions need to come together to agree on a shared vision, engineers and architects are asked to step out of the comfort zone of traditional ways of doing things. Some welcome this opportunity, while other feel ill-prepared to do so effectively. Numerous institutional and educational barriers hinder effective collaboration.
- **Lack of skill in effective stakeholder engagement and communication:** From the start of this project, CSIWG members emphasized the need to effectively communicate climate change and to engage stakeholder communities. They asked for resources to improve these practices, as these skills, too, are not yet widely taught in their professional training. This is as true for climate scientists as it is for architects and engineers (see also webinars series) (Chapter 6).
- **Lack of cultural competency in working with diverse stakeholders to address long-standing legacies of social exclusion and inequity:** Finally, where infrastructure planners and designers need to address historical legacies of underinvestment in low-income communities and communities of color, there is inadequate skill and experience in practices of inclusive and transparent forms of visioning, deliberation and decision-making. Limited appreciation for the legacies of systemic racism, the need to (re)build trust and address immediate concerns such as health, economic opportunity and safety alongside infrastructure rehabilitation or expansion, all too often lead to contentious or unsatisfying interactions.

Many of these gaps in knowledge, skill and professional training were a stumbling block during the development of the State's *Sustainability Roadmap*, where The Governor's Office of Planning and Research (OPR) staff requested, for the first time, that climate risks be taken into account (L. Bedsworth presentation to the CSIWG 2018). Against the backdrop of the already well-recognized workforce challenges facing California (and the nation), it is essential that workforce development include a concerted effort to ensure that the existing and future workforce is prepared to deal with rapidly changing technologies, industry changes and climate change. "People readiness" thus must include "climate readiness." Importantly, as California engineers and architects become comfortable and proficient in the issue areas listed above, the state's infrastructure will benefit irrespective of the emissions pathway on which humanity finds itself.

"People readiness" must include "climate readiness."

Recommendation 8

The Strategic Growth Council should coordinate with the Government Operations Agency, the Labor and Workforce Development Agency, and other relevant agencies to develop a work plan on how to address the training and professional development gaps of its infrastructure-related workforce as identified in this report, and begin to implement that work plan as soon as feasible. Because the Strategic Growth Council does not currently have the staff capacity and funding to implement this task, it would require adequate funding to do so.

Workforce development of the magnitude and scope required is not a short-term program, and it cannot be accomplished through State agencies' efforts alone. Workforce development, as is already widely understood, requires partnerships with professional societies, universities, philanthropy, labor unions and the private sector[299,301]. It should not be narrowly disciplinary[302] and embrace the challenges over the entire course of the infrastructure lifespan. Workforce development efforts that are climate-cognizant must recognize that with an increasing number of disasters, the labor shortage can become acute quickly. Workforce development should clearly have a dedicated focus on benefiting youth, women, minorities and low-income populations already in need of well-paying jobs[303]. It does not begin only after high school but must reach back into K-12 for adequate STEM education and developing a pipeline of engaged and interested young women and men who have the breadth of skills needed to build the California of the future. Education, maybe like no other investment, is a form of "paying it forward" – as this report suggests.

According to a National Academy of Engineering 3-year project on engineering education on climate change[299], two challenges however persist in the education of engineers (and architects):

- Climate change remains largely absent in engineering curricula (except renewables engineering); and
- Few, if any materials, fully engage the integration of climate, society and engineering.

Through collaboration with professional societies and universities, professional training and education curricula and related materials must be developed as well as mechanisms through which practicing engineers and architects can obtain the necessary skills and competencies (Box 9.1).

A focus on engineers and architects, however, will not suffice to effectively and efficiently address the workforce issues. Societal decisions about climate change will involve a wide range of experts, decision-makers in various sectors and different publics. Climate scientists are not usually trained in effective engagement, human concerns, ecology and governance issues, hindering their ability to communicate fluently with practitioners. Likewise, social scientists are not usually trained in engagement with publics or with physical/natural/engineering scientists. None (engineers, architects, scientists and practitioners) are sufficiently trained in matters of finance and law that have emerged as crucial over the course of the CSIWG's exploration.

Box 9.1: Hard Engineering Skills and Professional Skills Required to Implement the Climate-Safe Path for All

"Hard" engineering skills:

- The ability to **apply knowledge of mathematics, science, and engineering, including a solid footing in climate science and climate impacts science**;
- The ability to **design and conduct experiments**, as well as to **analyze and interpret data**;
- The **ability to design a system, component, or process** to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
- The **ability to identify, formulate, and solve engineering problem**s; and
- The **ability to use the techniques, skills, and modern engineering tools** necessary for engineering practice.

"Professional" skills:

- The ability to **communicate** and connect across boundaries effectively;
- The ability to **function on multi- and transdisciplinary teams**;
- An understanding of **professional and ethical responsibility**;
- **Cultural competency** in working with diverse stakeholders;
- The propensity and skill in **systemic, integrative thinking**;
- The broad education necessary to understand the **impact of engineering solutions in a global, economic, environmental, and societal context**;
- A recognition of the need for, and an ability to engage in life-long learning; and
- A **knowledge of contemporary issues**.

Source: Adapted from[304-306]

The CSIWG clearly recognizes the magnitude of the infrastructure workforce challenge in California. It also recognizes that the State has taken the first step already by recognizing what is at stake due to climate change. As concrete next steps in operationalizing the recommendation to foster a "climate-ready workforce," the Strategic Growth Council and other State agencies should:

- Engage with professional societies, state-based engineering schools and universities, the American Society of Adaptation Professionals, private sector engineering and architecture firms and others deemed relevant in the development of the recommended workplan. As we suggest in the next section, a coordinating body at the state level could lead this effort;
- Incentivize – through the State's existing research programs – a rapid and substantial expansion of end-to-end, multidisciplinary climate change research, education and application programs;
- Set expectations through professional standards, qualification and continuing education requirements etc. of state engineers and architects as well as those receiving State funding; and
- Expand and institutionalize the State's internal decision support capabilities, including a professional development pipeline of well-trained professionals by requiring staff to engage in ongoing professional development in the areas found to be most in need of advancement.

Statewide Coordination at the Highest Level

In Chapters 6, 7 and 8, we repeatedly highlighted the need to coordinate across government silos in order to design better integrated projects, align policies and goals, appropriately assess multi-sector costs and benefits and develop adequate finance mechanisms. These are complex, often novel and thus unfamiliar tasks that are no one's explicit task. Mission agencies, while often responsible for a broad portfolio of issues, have agency-specific, not cross-agency coordinating missions. In 2010, the Little Hoover Commission, as pointed out earlier, criticized the lack of an integrated statewide infrastructure strategy and little has changed since. While the State now has the Integrated Climate Adaptation and Resilience Program (ICARP) to support integration of adaptation across State agencies and coordinate better with local government entities (and a Technical Advisory Council to support that effort), ICARP is not solely focused on climate-safe infrastructure, and simply tasking it with adding that on, may overwhelm existing capacity or sideline coordination around the Climate-Safe Path for All and climate-safe infrastructure issues to being one of many equal priorities.

Meanwhile, this report makes a number of recommendations and suggests many concrete follow-up steps to operationalize them with no single entity providing coordination or oversight, or even just a mechanism to deepen the work begun over the short period in which the CSIWG completed its tasks. Without some entity singularly focused on the implementation of the recommendations offered in this report, there is legitimate concern that the Climate-Safe Path for All will go nowhere.

Without some entity focused on the implementation of the recommendations in this report, the Climate-Safe Path for All will go nowhere.

Recommendation 9

The State should establish a Standing CSIWG to devise and implement a process for coordinating and prioritizing Climate-Safe Path-related resilience policies and actions at the highest level. This panel would provide a needed forum for agencies to coordinate their policies, take advantage of synergies, address potential conflicts and learn from one another. As AB 2800 is slated to sunset in 2020, the work of a standing CSIWG would require an extension of AB 2800 and adequate financial support to conduct its business.

The Foundations Are Already in Place

Over the last decade and a half, the State of California has led the nation in climate change mitigation, with key strategies initiated in 2006 with Governor Arnold Schwarzenegger signing EO S-3-05[1], which, in part, eventually was codified as AB 32[2] – the *Global Warming Solutions Act*. Recognizing the need to put as much attention on adapting to climate change, the State has since also strengthened its focus on preparedness. From these initial actions, the State has recognized the importance of ensuring climate-safe infrastructure – though it did not bear that name until AB 2800.

In 2009, the State released its first Climate Adaptation Strategy (CAS)[307]. This was intended to be a companion to the bold mitigation efforts of AB 32 several years before. The CAS laid the foundation for much of the work the State has done since, including two updates (in 2014 and 2018). The plan was renamed the *Safeguarding California Plan*. Annual implementation reports to the Legislature on the status of actions identified in *Safeguarding California* are required by statute (AB 1482)[3].

These strategies and related efforts were precursors to AB 2800 and the discussions of the CSIWG. The initial CAS recommendations in 2009 mandated that State agencies begin planning for climate change and initiated thinking about infrastructure adaptation. The most relevant subset of these recommendations stated:

- **Recommendation 4:** All State agencies responsible for the management and regulation of public health, infrastructure or habitat subject to significant climate change should prepare as appropriate agency-specific adaptation plans, guidance or criteria by September 2010;
- **Recommendation 6:** The California Emergency Management Agency (CalEMA) will collaborate with CNRA, the [Climate Action Team] CAT, the Energy Commission, and the [Clean Air Action Plan] CAAP to assess California's vulnerability to climate change, identify impacts to State assets and promote climate adaptation/mitigation awareness through the Hazard Mitigation Web Portal and My Hazards Website as well as other appropriate sites; and
- **Recommendation 10:** State fire-fighting agencies should begin immediately to include climate change impact information into fire program planning to inform future planning efforts.

The State has also developed an *Adaptation Planning Guide* (APG), first published in 2012[308], and is currently slated to be updated. The APG presents the basis for climate change adaptation planning and introduces a step-by-step process for local and regional climate vulnerability assessment and adaptation strategy development. It is intended as a resource primarily for local governments and provides specific guidance on infrastructure:

- Incorporate consideration of climate change impacts as part of infrastructure planning and operations;
- Assess climate change impacts on community infrastructure;
- Facilitate access to local, decentralized renewable energy; and
- Use low-impact development (LID) stormwater practices in areas where storm sewers may be impaired by high water due to sea-level rise or flood waters.

Finally, Governor Brown's 2015 EO B-30-15[4] mandated for how the State should plan infrastructure under a changing climate. The EO is specific in places, preceding some of the suggestions reiterated in this report:

- State agencies shall 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;
- State agencies' planning and investment shall be guided by the following principles:
  - Priority should be given to actions that both build climate preparedness and reduce greenhouse gas emissions;
  - Where possible, flexible and adaptive approaches should be taken to prepare for uncertain climate impacts;
  - Actions should protect the state's most vulnerable populations; and
  - Natural infrastructure solutions should be prioritized.
- The State's Five-Year Infrastructure Plan will take current and future climate change impacts into account in all infrastructure projects; and
- [State agencies shall] update the APG, to identify how climate change will affect California infrastructure and industry and what actions the State can take to reduce the risks posed by climate change.

[1] For more information, see: https://cetesb.sp.gov.br/proclima/wp-content/uploads/sites/36/2014/08/governor_state_california.pdf.
[2] For more information see: https://www.arb.ca.gov/cc/ab32/ab32.htm.
[3] For more information, see: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1482.
[4] For more information, see: https://www.gov.ca.gov/2015/04/29/news18938/.

Pursuant that EO, a Technical Advisory Group – comprised of 50 members – met from March 2016 to January 2017 to develop a guidebook for State agencies, entitled *Planning and Investing for a Resilient California*[230]. The *Guidebook* provides five resilient decision-making principles, which align well with the CSIWG's recommendations and implementation suggestions:

1. Prioritize actions that promote integrated climate action;
2. Prioritize actions that promote equity and foster community resilience;
3. Coordinate with local and regional agencies;
4. Prioritize actions that utilize natural and green infrastructure solutions and enhance and protect natural resources; and
5. Base all planning and investment decisions on the best-available science.

This report and its specific recommendations on more detailed science, easily accessible tools and platforms for interaction, training and workforce development, engagement, financing and so on are intended to build directly on this State guidance and inform and enable its implementation in concrete ways. As experience both in California and elsewhere shows, without ongoing interaction with those who are expected to use information and tools or implement guidance, action can be stymied.

In addition, several State agencies – largely in response to the original CAS – are providing internal guidance for their own (agency-specific) operations and decisions and external guidance to the entities and communities that manage resources the State agencies oversee.[5] Since 2011, the California Coastal Commission (CCC), the Coastal Conservancy, the Department of Water Resources (DWR) and the Ocean Protection Council (OPC) have worked jointly to help identify the most up-to-date sea-level rise (SLR) projections and develop guidance to communities on how to use forward-looking climate information in their coastal planning and decision-making, notably through the updating of local coastal programs. The first *OPC Sea-Level Rise Policy Guidance* was developed in 2011, updated in 2014, and again recently updated in 2018[49]. The CCC has a longstanding concern about sea-level rise (since 1989), issued previous guidance on how to account for SLR in Local Coastal Programs and released an update in 2015[309]. The CCC is currently updating its guidance based on the 2018 *OPC SLR Policy Guidance* update.[6]

[5] As an example, DWR developed such agency-specific guidance documents: *The Climate Change Handbook for Regional Water Planning* (2011) and how to use climate change information in the Water Storage Investment Program (2016a and 2016b, see also Appendix 13).
[6] For more information, see: https://www.coastal.ca.gov/climate/climatechange.html.

This brief review of past and ongoing State efforts on adaptation make clear that the deliberations of the CSIWG are not new conversations. Many of the state engineers and architects, as well as the social and physical climate scientists on the Working Group, have incrementally advanced their respective agency's missions for many years. The Climate-Safe Path for All is intended to ambitiously push efforts even further and to provide an integrative vision and frame that unites the state's mitigation and adaptation efforts.

The Role of a Standing CSIWG

The Climate-Safe Path for All is thus not a new or extra process that communities or State agencies must understand and subsequently align with other State policies. It is not another series of meetings that are to be added to already overcommitted schedules. It should certainly not be another unfunded mandate. Rather, the Climate-Safe Path for All is intended to serve as the vision for connecting all of the State's disparate, but ultimately interconnected, climate adaptation and mitigation actions on infrastructure and related systems. It also prominently integrates the importance of social equity across these efforts and gives it a central and coherent place.

Figure 9.3: The role of a future Standing Climate-Safe Infrastructure Working Group would be to coordinate infrastructure-related efforts across State agencies, provide a central point of contact and forum for learning and exchange, and provide leadership in implementing the recommendations of this report (Photo: Joseph Wraithwall, used with permission)

As a concrete next step, the current CSIWG recommends the formation of a standing CSWIG panel to ensure that this vision is carried forward, that integration happens, and that the many challenges unearthed during this CSIWG's efforts are being addressed. The standing CSIWG would have the following roles:

- **Coordination:** The standing CSIWG would provide a central coordinating mechanism. The group would be comprised of State agency representatives who would devise and implement a process for coordinating and prioritizing potential resilience policies at the highest level. This panel would have no authority other than to require agencies to address conflicts and coordinate their policies.
- **Central point of contact for infrastructure:** In addition, the standing CSIWG should be considered a central point of contact whereby other existing planning and coordinating efforts (such as ICARP and its Technical Advisory Council, the Strategic Growth Council's Infrastructure Workgroup, the Climate Change Strategic Research Plan, future California Adaptation Forums (CAF) and so on) have a go-to place for infrastructure issues.
- **Forum to advance climate-safe infrastructure questions:** The panel should also function as a forum for exchange to foster internal learning and to solicit input – as needed – from outside subject matter experts and stakeholders, particularly in areas where State agencies' in-house capacity is more limited (social equity, financial tools etc.). It could coordinate engagement efforts to ensure fair and equitable social inclusion. As such, it could be responsible for ensuring – as we emphasized in earlier chapters – that climate-safe infrastructure is being planned *with* communities, not *for* communities.
- **Leadership in incorporating forward-looking information in engineering standards:** With this initial work and the proposed development of a California Manual of Practice (CA-MOP), there is an important opportunity for the future CSIWG to encourage and drive the integration of climate resiliency measures into the code-setting processes in California. Their deliberations and products can also serve as a national and international model as other communities, states and nations struggle with the same challenges.

Recommendation 10

The State Budget should provide full funding to State agencies to make deliberate efforts in reducing or eliminating the barriers that hinder or slow down adoption of State-level climate-safe infrastructure policy into practice. Key focus areas include the translation of Climate-Safe Path policy into practice manuals and contracting language, providing incentives to account for climate change in infrastructure projects, identifying metrics of success for monitoring and evaluation and developing a best-practices compendium.

Linking State Policy and Guidance to Project-Level Action

Ultimately, the best policy statements and guidance documents need a path to implementation if they are to make it off the shelves of agency bookcases. The CSIWG sought to make its recommendations actionable by providing concrete next steps to operationalize them. "At the end of the day", however, CSIWG members thought it was critical to ensure that high-level policies would become integrated into project-level action. This included discussions on the best way to incentivize climate-safe infrastructure development, translate policies to individual contractors and develop success metrics.

It is critical to ensure that high-level policies become integrated into project-level action.

Translation from State Policy to Local Decision-Makers to Individual Contractors

In general, infrastructure design at the scale at which AB 2800 is concerned, is driven by international standard-setting organizations, large federal entities such as the Army Corps of Engineers, the Bureau of Reclamation and the Federal Highway Administration (FHWA), and professional organizations such as the American Society of Civil Engineers (ASCE). But states always have the option of going above and beyond international and national standards and practices. By doing so, states often become the initiators and drivers of higher standards everywhere.

As California and other governments stand at the threshold of a new era, in which climate change is taken into account in infrastructure design, the State inevitably must hold the tension between leading and following. So, while some State agencies await clarity from standard-setting organizations, others move beyond existing guidance and develop their own manuals of practice, codes and/or guidelines to drive climate-cognizant design for their respective agencies. Caltrans, while also adhering to standards from the American Association of State Highways and Transportation Officials (AASHTO) and FHWA, also develops Design Manuals that run the gamut from design to construction to maintenance. As another example, the California Building Standards Commission oversees and updates Title 24 to guide building codes every three years. However, for the many reasons described throughout this report, standards, codes and guidelines used in California are not yet where they should be in incorporating forward-looking climate information. On the policy precedent recalled above, the State now has the opportunity to make the Climate-Safe Path for All statewide policy which must be translated to on-the-ground contractors.

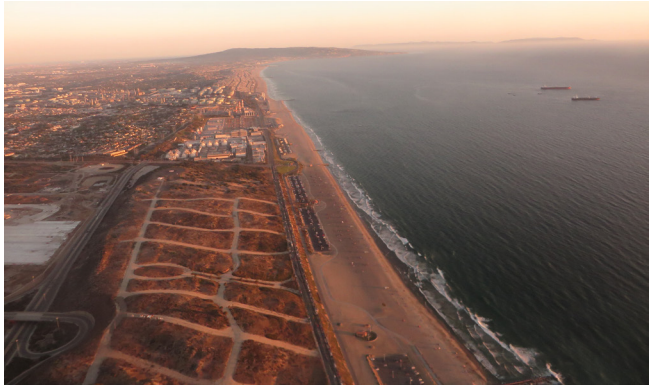

Figure 9.4: A California-specific MMOP should address all infrastructure types and the unique hazards they face across the state. (Photo: Different types of development along the El Segundo shoreline; Ken Lund, Wikimedia Commons, licensed under Creative Commons license 2.0)

There are two steps the State can take to move forward.

Developing a California Manual of Practice. The first is the previously recommended development of a California-focused infrastructure design Manual of Practice (Cal-MOP) for each infrastructure type and for all relevant climatic hazards. Advanced tools and methods introduced in Chapter 6 should be integrated into this step-by-step guide. With input, coordination and assistance from the recommended standing CSIWG, state architects and engineers, along with relevant external subject matter experts, and inclusive and effective stakeholder engagement (per Recommendations 4 and 5), this technical working group should develop infrastructure-specific guidance that incorporates the best available climate-information and the many innovative strategies outlined in Chapter 6 (e.g., systems thinking, climate screening, risk management, adaptive design for a range of plausible futures). This type of focused but coordinated attention to each infrastructure type will allow for a unified approach across the State and provide necessary impetus for moving forward.

Advancing Procurement Approaches. With a state engineer and architect-developed Cal-MOP for each infrastructure category, the second step then becomes more straightforward, i.e., the translation of State-level policy and guidance to on-the-ground contractors. The two most common procurement methods (in addition to the increasingly considered public-private partnerships (P3s) discussed in Chapter 8) that are used to get to project delivery are: Design-Bid-Build or Design-Build[310] (Figure 9,4). Design-Bid-Build is the more common of these approaches for project development and implementation. According to the Legislative Analysts Office[310], "The main difference between these approaches is which project phases – such as design, construction, maintenance, and funding – are performed under a single contract and which ones are performed separately. For example, under the design-bid-build approach, the State typically contracts with one firm to design an infrastructure project and a separate firm to build it. In contrast, under the design-build approach, the State typically contracts with one firm to design and build the infrastructure project." The latter shifts the responsibility of project delivery to the contractor. As described, "design-build, with its single point responsibility carries the clearest contractual remedies for the clients [in case of faults leading to liability claims] because the design-build contractor will be responsible for all of the work on the project, regardless of the nature of the fault"[311].

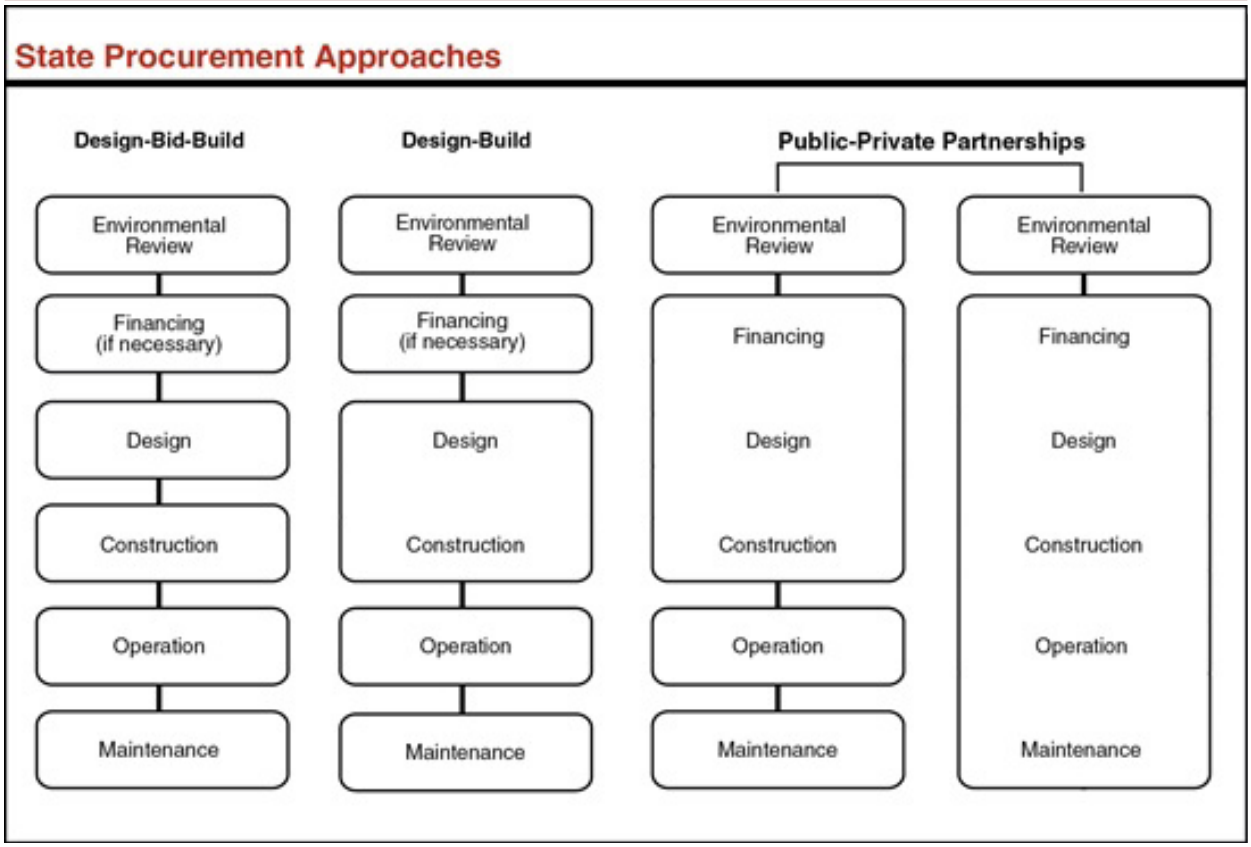

Figure 9.4 California's basic procurement approaches differ in how many contractors are involved from project initiation to construction and operation and maintenance. (Source: Legislative Analyst's Office 2018[310], used with permission)

There are various pros and cons to either of the three procurement approaches, although it was beyond the scope of the CSIWG to examine in detail the advantages and disadvantages of each vis-à-vis planning, designing and building climate-safe infrastructure. This should be undertaken by a future working group made up of relevant experts and interest groups. There are likely to be benefits and drawbacks to using one or the other for certain types of projects.

Infrastructure owners need help turning overall policy guidance into contractual language and clear statements of work.

Regardless of the procurement method chosen, infrastructure owners need help turning overall policy guidance into contractual language and clear statements of work. The Cal-MOP will help, but the CSIWG recommends several important follow-on steps from its work:

- Once procurement approaches have been thoroughly assessed by a future working group for their advantages and disadvantages for differing types of climate-safe infrastructure projects, guidance should be developed for infrastructure owners for writing different types of bids;
- Effectively assessing and managing bids, design proposals and contracts requires adequate training of staff in infrastructure agencies. Thus, the workforce development plan proposed above should explicitly include modules for evaluating design proposals; and
- The standing CSIWG or a designated working group should engage with legal and financial experts as well as engineering and climate change experts to develop model contract language and other support to assist with linking policy to project-level contracts.

To align the procurement and contracting process with the overall intent of the Climate-Safe Path for All, however, it is not enough to work only on integrating climate concerns. The social equity component needs to be carried down to the procurement and project level as well. A recent report on inclusive procurement[197], p.5 noted,

> "State and local governments are the most important venues for advancing inclusive procurement and contracting policies in the infrastructure sector. Federal infrastructure investments are blended with local public funds, and a great deal of infrastructure investment is exclusively derived from State and local revenue."

The State of California generally follows a "race-neutral" procurement approach, which has helped women and minorities but has not overtly supported them[197]. Deliberate efforts are needed to ensure minority-owned, women-owned and disadvantaged business entities (MWDBEs) have access to and are able to bid on climate-safe infrastructure projects. This would be in line with the centrality given to social equity in this report.

According to Fairchild and Rose, "There is [however] no "one-size-fits-all" inclusion policy. The policy levers, revenue streams, business motives, historical precedents, and strategies to strengthen inclusive procurement differ for transportation, water, energy, public housing, health, educational institutions, and other sectors"[197],p.5. They note the following challenges:

- Disconnect between inclusive procurement policies and their realization in practice, including lack of enforcement;
- Lack of readiness on the supply side and lack of awareness and competency on the demand side of procurement;
- Public-sector practitioners operate in silos with a wide range of disparate approaches and policies, creating inefficiencies, duplication, burdensome procurement processes and suboptimal outcomes;
- Lack of tools and processes for proactively monitoring the compliance and enforcement of inclusion policies, and lack of resources and capacity to find them;
- Large-scale infrastructure projects are using sophisticated project delivery methods to address risk and capital needs, increasing the size and time horizon of projects; and, thus, diminishing opportunities for MWDBEs to effectively participate in bids;
- Lack of technical assistance for MWDBEs to help them effectively participate in larger projects;
- The movement in the construction industry toward "green", modular approaches is shifting work toward a supply chain involving pre-fabrication; historically, however, there are few MDWBEs in the prefabrication supply chain, further excluding them from contracts;
- An aging MDWBE workforce and lack of succession planning among MDWBEs (see above); and
- The legacy of discrimination.

The CSIWG thus recommend a number of best practices and steps (Box 9.2). The CSIWG recommends as a practical follow-up step to its work, that the standing CSIWG or a designated working group systematically examine the hurdles and opportunities for improved inclusive procurement practices as it transitions to building more climate-safe infrastructure and develop the inclusive procurement practices toolbox (Recommendation 3) called for in Fairchild and Rose[197] (Box 9.2).

Box 9.2: Best Practices for Inclusive Procurement

- Strengthen the community constituency for and advocacy efforts around MWDBEs;
- Increase the capacity of local and state elected officials and agency staff to implement legal (race-averse and race-conscious) and effective inclusive procurement policies;
- Develop inclusive procurement policy toolkits by sector;
- Proactively engage the private sector;
- Use triggers in tax credits and Community Reinvestment Act requirements to build regional capital pools that can provide lines of credit and bonding capacity to help grow participating MWDBEs; and
- Strengthen accountability mechanisms to ensure policy goals are met, including assigning 1% of project costs to support capacity building of MWDBEs.

Source: Fairchild and Rose[197]

Incentives

If the development of a Cal-MOP provides the technical guidance required to design and implement a climate-safe infrastructure project, and improved procurement approaches help with the legal and financial translation of such projects, incentives – financial or otherwise – provide the inducements to break from traditional and well-trodden paths and try the innovative approaches. Eventually, such incentives will help spread the new practices and foster the paradigm shift necessary to move infrastructure design into this new climate-changed era. As the State works to update its own codes and standards to incorporate forward-looking climate science, incentives can encourage design above minimum standards, providing a bridge between the infrastructure work that needs to happen today to deal with decades of deferred maintenance, with the engineering standard and code updates that will take some time to develop.

Financial incentives. Financial incentives are the most likely to gain immediate attention, and while State agencies do not have "extra" funds, there is considerable funding available already for infrastructure projects in the immediate and near future through bonds. Embedding climate change language in Request for Proposals (RFP) and establishing transparent proposal selection criteria that favor projects that are consistent with the Climate-Safe Path for All proposed here are ways to make use of available funds toward climate-safe infrastructure. State regulation and oversight of different infrastructure sectors and activities is already used to incentivize preferred actions by the entities overseen (e.g., incentives for energy efficiency measures, incentives for consideration of climate change in disaster preparedness plans). Similar mechanisms could be used to foster climate-safe

Non-financial incentives. There are non-financial incentives that should also be considered and may be more feasible more quickly. They would not require added expenditures from agency budgets and they all have to do with speed and time (which, in fact, translates into money).

- **Expedited permitting.** The most promising incentive identified by the CSIWG is the concept of expedited permitting for infrastructure projects that meet climate-safe infrastructure goals and are resilient. This can be achieved at the local and state level. It can also help to address permitting bottlenecks between State and federal agencies. For instance, if a State-funded project encroaches into federal jurisdiction, federal rules and regulations can impede project progress. Moreover, combining an expedited permitting process with the use of a rating system (e.g., LEED or Envision, see Chapter 7) can further incentivize and encourage climate-safe-designs and practices. There are, of course, limitations to rating systems. Notably, they are generally not mandatory and cannot be enforced and meeting rating systems require financial outlays, leading to further potential exacerbation of inequities. These challenges notwithstanding, rating systems and voluntary standards have been demonstrated to continuously raise the floor of mandatory building standards (see Chapter 7; see also Sullen 2018 webinar and Georgiakoulis 2018 webinar).
- **Pre-disaster planning and code changes.** The unprecedented natural disasters in 2017-18 created the need to rebuild damaged and impacted infrastructure throughout California – from removing mudflow debris from freeways, to rebuilding public structures burned down during the wildfires that ravaged the state. Fires in 2018 appear to continue this trend. Generally speaking, however, recovery

Figure 9.6 In a crisis, expedited permitting is crucial, but rebuilding with climate change in mind must become part and parcel of permitting and waiver guidance. (Photo: Bonds Flat Road near the Don Pedro Dam spillway, February 23, 2017; Dale Kolke, DWR, used with permission)

funding for public assets require building back to exact pre-disaster specifications unless prevailing codes allow for "building back better."[7] Thus, washed out culverts would need to be built to the old-size requirements; burnt buildings would be rebuilt without sprinkler systems; a wood utility pole gone up in flames would be replaced with another wood utility pole, rather than a steel pole that may be more resistant to future fire, unless codes had been established well before the disaster to require otherwise. Inquiries with State agency staff yielded no known examples, except possibly L.A.'s cool-roof ordinance. Systematic tracking of state and local adaptation actions such as climate-cognizant code changes would help the State know whether adaptation plans are being translated into binding code and thus whether infrastructure will be built back better after a disaster. This would have the added benefit of providing case studies and examples throughout the state for peer-to-peer exchange.[8] The significant resources available post-disaster cannot be used toward adaptation to climate change nor the transition toward climate-safe infrastructure without pre-disaster code changes and may in fact be squandered on projects that – based on the best available scientific understanding and even best available engineering knowledge – must be considered maladaptive.

The significant resources available post-disaster cannot be used toward adaptation to climate change nor the transition toward climate-safe infrastructure without pre-disaster code changes.

- **Clarification of policies on waivers.** In crisis situations such as after disasters or for projects under time pressure, infrastructure builders often seek waivers to allow for more rapid (re)building and recovery. This is understandable, as it is in everyone's interest to help communities get back on their feet quickly after major events. These waivers, however, may have negative consequences. These can range from impacts to the environment such as insufficient accounting of toxins inadvertently released in an attempt to quickly clean up debris, to impacts to people such as disregarding environmental justice concerns in an effort to get critical services back online. However, if managed and incentivized properly, waivers could be used to advance climate-safe principles. For instance, following an event:
  - infrastructure managers could receive waivers that expedite permitting if they meet the most climate-safe voluntary standards or rating systems;
  - they would not receive waivers if they do not use climate-safe infrastructure principles.

  Because waivers set precedent, granting them should be considered systematically prior to the urgent time when they are sought. For example, clarifying liability issues (see Chapter 7), developing waiver guidance to regulators (e.g., if x is replaced, replace it with a climate-safe asset, i.e., attach an infrastructure requirement to getting exemptions), developing statewide maps which rank the future likelihood of climate extremes under different emissions scenarios, particularly the high-emissions scenario, and not granting waivers in regions expected to experience such extremes frequently or making waivers contingent on good pre-disaster infrastructure management are just some of the ways in which granting waivers can be done in a
- **Improving the permitting process.** The State should examine common patterns as to where or when waivers and exemptions are sought. Many waiver requests are about speed. Such a systematic exploration may reveal patterns and identify priorities for where the permitting process can be streamlined, so that they are not needed or less frequently.
- **Pre-certification of contractors.** Pre-disaster, infrastructure managers should develop lists of pre-certified contractors (with an eye to inclusive practices) and put permitting structures in place to allow for the opportunity to "build back better." These certified contractors can also be used to update hazard mitigation plans. These pre-disaster plans (at the state and local level) should be developed in concert with CalOES to ensure that they would comply with State and federal funding requirement mandates.

[7] With respect to public infrastructure specifically, FEMA's Public Assistance (PA) funding program provides federal assistance to government organizations (and certain private nonprofit (PNPs) organizations) following a Presidential disaster declaration. PA funds can be used for repair, replacement or restoration of disaster-damaged publicly-owned facilities including roads and bridges, water control facilities, buildings and equipment, utilities, parks, recreational and other infrastructure. FEMA covers no less than 75% of the costs and CalOES covers 75% of the remaining 25% non-federal share. FEMA provides PA funding to restore facilities on the basis of pre-disaster design and function and conformity with current applicable codes, specifications and standards.

[8] AB 2516 (Gordon, Sea-level rise planning database) established one way to track sea-level rise related adaptation measures. This approach might constitute a model for ongoing monitoring, but any statewide, cross-sector monitoring system should build on lessons learned from this pioneering effort. (For more information, see: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB2516 and the link to the database through the adaptation clearinghouse).

Develop and Monitor Metrics for Success/ Performance

A repeated theme throughout the work of the CSIWG was the question of measuring success. What is the level of performance the State should aim for? What are meaningful metrics to investors that would attract them to invest in climate-safe infrastructure projects? How can State agencies show progress along the Climate-Safe Path for All, both for internal planning, budgeting, prioritization and design purposes, and for external communication to Californians, who are asked to pay for and bear the impact of infrastructure renewal.

As noted by one of the AB 2800 webinar series presenters: "Measurement is a fraction of the cost of restoration or mitigation and saves money over time by defining best practices for a changing world." Metrics for success, and the monitoring protocols necessary for measuring these metrics, are critical at every stage of the infrastructure life cycle – from design, to planning, to construction, to maintenance and to decommissioning. Evaluation at every stage should be considered. While the issue of monitoring and evaluation (M&E) is widely discussed in the adaptation literature and is increasingly recognized in California (e.g., in discussions of the Technical Advisory Group of the ICARP), more attention – through applied research and changed practices – is required to advance the conversation.

The CSIWG thus believes that developing metrics for success and performance will play an important role in achieving many of the objectives and recommendations within this report and are thus a critical next step for the State to take. There are at least five fundamental reasons (based on[194]) why a concerted effort in establishing effective M&E mechanisms would aid the State in implementing the Climate-Safe Path for All. They include:

- **Enabling deliberate planning and decision-making.** Setting clear goals (e.g., performance standards or desirable outcomes related to the Climate-Safe Path for All) and aligning planning, design approaches and needs to those outcomes enables internal consistency. It also provides external consistency by providing transparency of goals, allowing other infrastructure or resource managers to better understand how their infrastructure fits in the larger system and ensures that State policy goals are not at odds.
- **Providing a mechanism for accountability and evidence of good governance.** When the CSIWG discussed what they found important in developing or participating in any State process that leads to climate-safe infrastructure, accountability and linkage to definable goals was identified as the most important. Recommendation 9 calls for the establishment of a standing CSIWG to provide coordination among the various components of State government that will need to work in concert to achieve climate-safe infrastructure. This group could play a central role in coordinating an agency-cross-cutting effort in developing metrics. While accountability would need to be anchored in rules, professional standards of care and liability policies, achievement of these metrics offer important opportunities for communication with the public and could serve as a clear mechanism for the State legislature to track progress toward State goals.

Developing metrics for success and performance will play an important role in achieving many of the objectives and recommendations within this report and are thus a critical next step for the State to take.

- **Supporting adaptive design, management and performance-based standards.** As described in the ASCE MOP[253] – and expected in a California-specific MOP – adaptive design requires identifying the triggers or thresholds at which the next set of adaptive measures gets implemented (see Chapter 4 and Figure 4.2). Both climate patterns and the infrastructure itself must therefore be monitored to determine when/if those triggers or thresholds are expected to being crossed to ensure readiness for the next phases of adaptive design implementation. Moreover, determining whether or not an asset meets the metrics pre-identified will support learning and adaptive management. Adaptive management assumes that learning is critical. With critical infrastructure there is little room for catastrophic mistakes, but combining multiple strategies (Chapter 4, Box 4.2) and implementing equitable safe-to-fail design options (Chapter 6) can help ensure that there is room for flexibility and deliberate learning, and that those lessons are taken seriously as adaptation progresses.

- **Justifying adaptation expenditures.** Whether true or not in the final accounting, there is a perception that climate-safe infrastructure will cost more – at least at the outset if adaptive design principles are implemented. Full life-cycle analysis as recommended in this report will help make the case, however, that building climate-safe infrastructure is not only economically smart but has many other benefits. This must be shown – with measurable metrics – to State policy-makers, to investors and to the public. Providing clear accounting of the different expenditures and how they are achieving the pre-defined metrics for success will be critical for effective demonstration of the success of innovative strategies that perhaps run counter to more traditional methods and cost-benefit accounting.
- **Supporting communication, public engagement and, ultimately, public support**. Public infrastructure is in place to serve the public good; moreover, it is publicly funded. Climate-safe infrastructure is there first and foremost to protect the people of California and support their well-being and lives. Accountability to this ultimate goal must be paramount. In a socially-inclusive process, in which infrastructure is developed with a common vision shared by diverse stakeholders, illustrating progress and success is critical to demonstrate that state infrastructure is both meeting the needs of constituents as well as a wise use of financial resources. Public support is arguably the most important tool in engineers and architects' toolbox. It is only with public support and demand that climate-safe infrastructure will be prioritized and will be able to receive the ongoing financial commitment required to safeguard climate-safe infrastructure into the future.

Develop Compendium of Best Practices

Finally, measuring progress and success will provide the evidence basis on which we can argue that certain practices are better or "best practices." We conclude this chapter with a call for developing such a compendium because of what is at stake for practicing engineers and architects.

Engineers and architects enjoy an immense level of public trust. We drive over the bridges they build, not even thinking about whether they will hold. We live and work in buildings trusting they will withstand the vagaries of nature. This trust can't be squandered as we move into a more volatile future.

Like all individuals, engineers and architects rely on each other to do high-quality work, and in this rapidly changing climate, there is simply no way to replace the trust that comes from sharing experiences and learning from peers. As the field moves together to build more climate-safe infrastructure, having a compendium of best practices, vetted by practicing engineers, will provide an invaluable resource that practitioners can turn to for support, inspiration and on-the-ground guidance. The California Adaptation Clearinghouse (www.CAresilience.org) could be one important point of access to such a compendium as it already contains case studies and resources for other aspects of adaptation planning. This has the dual benefit of pulling engineers and architects into the budding adaptation community and for the thinking embedded in the best practices compendium to reach a broader audience. It also links directly to the Cal-Adapt platform available for sharing climate science. Rather than creating an entirely new compendium or clearinghouse that runs in parallel to these already existing State efforts, resources should be directed to incorporating climate-safe engineering practices for California at these central sites.

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Recognizing that engineers may not yet be familiar with these sites, however, a multi-pronged outreach approach should be used to bring engineers to the compendium and the compendium to engineers. In other words, it is critical to link to wherever they already go for the information and best practices they need. State agencies should partner with professional societies, existing platforms (see Table 5.3 in Chapter 5) in promoting the available resources. They should also reference them as key resources to contractors and partner entities in RFPs and statements of work. Such compendiums should be – in the spirit of adaptive design – be living documents that are regularly updated. Projects employing them could become case studies from which others can learn and be included in the Adaptation Clearinghouse.

In this way, peer-to-peer learning from trusted sources, combined with a continually updated scientific data basis, performance-based standards, and evidence-based evaluation of what is working, will – in time – change the way we think, and what we do.