8 Funding Infrastructure: Trends, Needs, Challenges and Tools

Introduction

In Chapter 2, we described the status of state infrastructure and in many cases were able to capture in fiscal terms the size of the backlog that currently exists, even without consideration of climate change or the needs for new infrastructure given demographic trends, technological changes and the desire to maintain California as an attractive and vibrant economy. The multi-billion-dollar need across infrastructure sectors for deferred maintenance, ongoing operation and maintenance (O&M) and new investment is not a unique California story, however, but one that is a shared challenge across the nation[2,257-264].

Figure 8.1: Over the past two decades, progress on infrastructure planning and investment has been made, but there is widespread consensus that spending has been insufficient. (Photo: State Capitol workers; John Chacon, DWR, used with permission)

For decades, California lawmakers and infrastructure experts have recognized the importance of state infrastructure for its economy and the health and well-being of its residents (Appendix 12). As recently as June 2018, in recognition of the nationwide Infrastructure Week, California Senate Concurrent Resolution 136[1] noted, among other things, that:

- "Decades of underfunding and deferred maintenance have pushed infrastructure across the state to the brink of crisis, with preventable failures occurring in some communities that impose financial costs to the public and government;
- ...California risks compromising its competitive advantage by failing to adequately invest in its infrastructure;
- ...California's failure to invest in infrastructure systems is more than a drag on the economy, it can be harmful to health and safety, even though most tragedies resulting from infrastructure failures are preventable with adequate investment;
- ...Every dollar invested in infrastructure generates in excess of $2 in economic output and jobs; and
- ... now, therefore, be it resolved, that despite fiscal challenges, it is important for the Legislature to dedicate sufficient resources to transportation, infrastructure and green investments in our community" (Figure 8.1).

This call to action to make the necessary investments in the future comes amidst and despite the fact that over the course of every legislative session, tens of bills are introduced into the Legislature, and over the past two decades, incremental progress on infrastructure planning and financing has indeed been made. And yet, there is widespread consensus – from the ASCE to members of

[1] The full text of SCR136: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SCR136.

the Climate-Safe Infrastructure Working Group (CSIWG), from not-for-profits advocating for greater infrastructure investment to lawmakers across both houses of the California Legislature, and across party lines – that investment in infrastructure, and thus in the future of the state is insufficient.

Recent Trends in Infrastructure Spending in the US and in California

Federal Infrastructure Spending Trends

To frame California infrastructure spending trends, it is helpful to place them into the larger context of federal trends, which were analyzed within the last few years as the national debate over infrastructure spending heated up. These national trends are also important given the significant influx of federal dollars, particularly for transportation infrastructure.

Federal non-defense infrastructure investment rose sharply after World War II, particularly during and following the Eisenhower Administration, and has been increasing overall in gross terms. But when depreciation of the capital is taken into account, infrastructure investment has actually followed a declining trend (in constant/inflation-adjusted dollars) through 2015, the infusion of federal investment in the late 2000's notwithstanding[258,259]. This decline is particularly evident when tracing the federal investment as a share of Gross Domestic Product (GDP) or as a share of federal spending overall[258]. Most of federal infrastructure spending is in the transportation sector (particularly highways), followed by aviation, mass transit and rail and water resources[258,261].

At the same time, State and local expenditures on infrastructure has always been significantly larger than the federal share and gross investment has grown faster than federal spending: over the past two decades, State and local governments have spent 7-9 times more on infrastructure than the federal government[261]. State and local investment took a sizable hit, however, during the Great Recession of the late 2000's and is recovering since, although trends for any particular type of infrastructure did not all follow the same pattern.[2]

Over the same period (1956-2015), private sector investment in infrastructure (particularly in the electricity sector, and to a lesser extent in water, transportation and communication) has increased, with the strongest increase seen since the mid-2000's, particularly in the power sector[258].

California's Infrastructure Spending Trends

In 2011, the California Legislative Analyst's Office (LAO) produced an analysis of infrastructure investment trends over the preceding ten years[262]. No comparable update has been produced since. However, the Five-Year Infrastructure Plans – by law to be prepared annually as part of the Governor's budget[3] – as well as independent analyses, provide some insights on recent trends in infrastructure spending across the state.

California's gross infrastructure investment trends – to the extent they have been studied longitudinally – appear to be quite similar to the national trends summarized above (data for 1957-2002[263,265]; data for 1998-2010[262]). After an early peak in infrastructure investment during the P. Brown Administration, and a steep decline in the 1970's and 1980's, infrastructure spending recovered to 1960's levels in the last decade of the 20th century and continued to increase into the early 2000's[263]. The proportion of spending on different infrastructure sector changed profoundly over these decades, with, for example, a much greater proportion spent on transportation early on, and a much bigger proportion spent on schools in more recent decades[263].

Over the past two decades, State and local governments have spent 7-9 times more on infrastructure than the federal government.

Drivers of infrastructure spending included the need to maintain existing infrastructure, build new infrastructure to accommodate growth, comply with State and/or federal mandates and fulfill new priorities and voter initiatives[262]. During the decade from 2000 to 2010, California spent $102 billion on infrastructure[262]. From 2011-18, new general bond issuance was limited to $24.1 billion. An additional $36 billion of general obligation and lease revenue bonds that voters had authorized have not yet been issued to avoid increasing the debt burden, as California works to pay down pre-existing bond obligations[266].

Bond funding cannot be used for regular maintenance. Thus, the growing share of bond-financed infrastructure investment obscures the fact that departments must draw on the General Fund to fund O&M. With every new investment that demand is increasing. At the same time, there is a persistent amount of deferred maintenance. Figure 8.2 illustrates – with an example from the

[2] For more detail on particular infrastructure sectors, see: see: http://www.governing.com/gov-data/state-local-government-construction-spending.html.

[3] While the law requires these plans to be prepared annually, this has not always been the case.

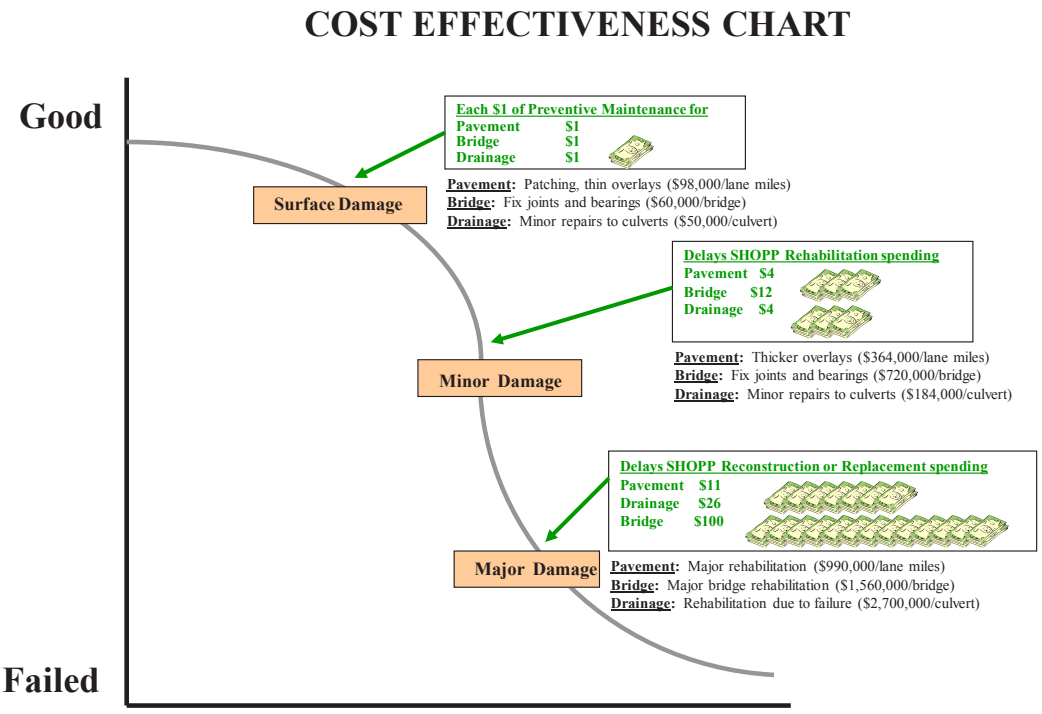


Figure 8.2 The cost-effectiveness of timely maintenance: Earlier maintenance keeps infrastructure in better condition and costs less than deferring maintenance to a later date. (Source: Caltrans 2015[267], p.8; used with permission)

transportation sector – what the fiscal implications of deferred maintenance are: the longer infrastructure is not maintained, in a state of good repair, the more expensive the repair ultimately gets.

As recently as 2018, California's LAO stated, "The State does not have a comprehensive inventory of the condition of its existing infrastructure. However, according to the administration's 2016-17 estimate, the state has $77 billion in deferred maintenance, most of which is in the transportation area"[6]. "In 2015-16 and 2016-17, the State provided almost $1 billion for deferred maintenance, mostly from the General Fund (non-Proposition 98)"[6].[4] The 2018 Five-Year Infrastructure Plan identified statewide deferred maintenance needs amounting to a slightly improved backlog of currently $67.3 billion[6], p.132 and $383 million was actually allocated in the 2018-19 budget, an increase over previous years.

Estimates of future infrastructure funding needs vary widely by source, by year and for different time periods and infrastructure categories and it is unclear whether they include or exclude deferred maintenance. There is also no indication in any of these estimates that infrastructure spending needs account for climate change (Box 8.1).

Box 8.1: Selected Estimates of Infrastructure Funding Needs

- 2007 First California Strategic Growth Plan[268]:
  $500 billion over 20 years
- 2015 California Forward[269]:
  $853 billion over 10 years for transportation, water and K-12 school construction
- 2016 Five-Year Infrastructure Plan[270]:
  $55 billion over 5 years
- 2017 ASCE infrastructure investment need estimates for California[7]:
  $78.75 billion ($44.5 billion for drinking water; $26.2 billion for wastewater; $3.2 billion for schools; and $4.85 billion for State parks)[5];
- 2018 Five-Year Infrastructure Plan[266]:
  $61.3 billion over 5 years (93% for transportation)

[4] On Proposition 98, see: http://lao.ca.gov/2005/prop_98_primer/prop_98_primer_020805.htm.

[5] No estimates for other types of infrastructure and no timeframe given.

With the generally improved fiscal situation of the State as seen, for example, in its strong revenues and establishment of a State rainy-day fund, and recently approved bills and propositions providing additional funding for infrastructure (see Chapter 1), the State is in a better situation at this time than probably at any time over the past 20 years with regard to infrastructure funding. Between the widely recognized need for infrastructure investment and the (greater) ability to do so, California is in a strong position to have meaningful conversations about how to invest in its future and ensure that this investment seriously considers climate change.

The State is in a strong position to have meaningful conversations about how to invest in its climate-safe future.

Structural Challenges to State Infrastructure Financing: The Pre-Existing Condition

To fully appreciate the added financial challenges posed by climate change, it helps to take a look at the ways in which California funds infrastructure at present. In general, "spending on infrastructure can be categorized as either capital spending or operation and maintenance spending. Capital spending consists of purchasing and modernizing new structures – [such as] roads and sewer systems - and equipment. Operation and maintenance include the cost of maintenance and upkeep as well as administration of public infrastructure – such as air traffic controllers. Associated education and research and development devoted to infrastructure is also included in this category of expenditure"[258], pp. 10-11. Taylor[262], p.6 counts local assistance by the State as an additional budget item related to infrastructure spending, and notes that infrastructure planning and design is included by some State agencies in their O&M budgets, but not by others.

The sources of money for these categories of infrastructure spending come – generally speaking – from two key sources: (1) so-called pay-as-you-go funding, which draws on the General Fund and fees collected in Special Funds; and (2) borrowed funding, which uses financial vehicles such as General Obligation (GO) bonds, Lease-Revenue or Traditional Revenue bonds (Figure 8.3). During the first decade of the 21st century, 35% of infrastructure spending came from pay-as you go funding and 65% came from bonds[262].

Hanak and Reed[265], in their 2009 report on needed financial reforms in the ways California funds its infrastructure, note the following key structural challenges (reiterated by other analysts, including the J. Brown administration itself):

- An overreliance on GO bonds, which require only a simple majority to pass but which increase the debt burden and debt service expenditures (the capital and interest of GO bonds are paid back over several decades from the General Fund);
- A relatively high debt service burden can lead to downgrading of credit ratings and thus increase the cost of debt and/or demand cuts to other budget items paid for from the General Fund – the situation witnessed in the early 2000's.[6]
- Since the passage of Proposition 13 in 1978, local governments require a 2/3 (super) majority to increase taxes, i.e., to increase the revenue sources required to pay for local infrastructure investment. This has dramatically altered the funding situation of local governments. State bonds, by contrast, require only a simple majority to pass and thus are increasingly called upon to pay for infrastructure investment. (Since 2000 and the passage of Proposition 39, local school bonds require only a 55% voter approval rate and are thus easier to get passed);
- Traditionally, the State has made insufficient use of generating revenue for infrastructure through user fees, which do not require voter approval. This is an option to improve funding streams in the water and transportation sectors in particular, and to increase efficiencies through demand management such as water pricing, gas tax increases, local development impact fees etc.; and
- Public-private partnerships (P3) with private equity sharing is still limited, obscuring opportunities for private sector investment in public infrastructure.

Figure 8.3: Bonds are often used for upfront capital outlays, but bond money cannot be used for operation and maintenance. (Photo: American Canyon High School; Wikimedia Commons, licensed under the Creative Commons license 3.0)

[6] See also: http://www.dof.ca.gov/Reports/Budget/documents/CompletedDebtsandLiabilitiesat2018-18GB(Website).pdf

Nearly a decade later, the 2018 Five-Year Infrastructure Plan still mirrors these observations, although some aspects have been improved in the intervening years, while others remain challenging for California to this day[266]. It adds to the understanding of the current infrastructure finance situation by illuminating some of the infrastructure financing tools traditionally used in and by the State and pointing to the fiscal implications:

> "Budget challenges in the early 2000's resulted in a greater reliance on debt financing, rather than pay-as-you-go spending. From 1974 to 1999, California voters authorized $38.4 billion of general obligation bonds. From 2000 to 2010, voters expanded the types of programs funded by bonds and authorized approximately $111.9 billion of general obligation bonds."(p.129)

> "The [J. Brown] Administration has greatly tempered the use of debt, supporting $24.1 billion of new general obligation bonds from 2011 to 2018 - including $8 billion on the ballot for Natural Resources and Housing in 2018 - and strengthening oversight of bond spending for educational facility bonds enacted through initiative. Of all previously approved infrastructure bonds, debt obligations of $73.4 billion in general obligation bonds and $9.3 billion in lease revenue bonds remain outstanding. Additionally, there are $36 billion of general obligation and lease revenue bonds ($31.3 billion and $4.7 billion, respectively) that are authorized but not yet issued, which represents a significant decrease from the 2011 reported total of $48 billion. The bonds will be issued when projects are approved and ready for construction."(p. 129)

> "When the State borrows to pay for infrastructure, roughly one out of every two dollars spent on infrastructure investments pays interest costs, rather than construction costs. The amount of funds required to service the debt had increased steadily over past years, but that growth has slowed during this Administration. Annual expenditures on debt service grew from $2.9 billion in 2000-01 to $6.4 billion in 2010-11 - an average annual growth of 9.2%. Since that time, debt service grew more slowly to $7.3 billion in 2017-18 - an average annual growth rate of only 1.7%."(pp. 129-130)

As a result of recent efforts by the J. Brown Administration and the Legislature to work toward a balanced State budget, California's debt situation (measured, for example, as a ratio to personal income or as debt/capita) has significantly improved compared to the height of its debt crisis in 2011 but is still higher than the national average[266].

When the State borrows to pay for infrastructure, roughly one out of every two dollars spent on infrastructure investments pays interest costs, rather than construction costs.

Figure 8.4 When the State borrows to pay for infrastructure, roughly one out of every two dollars spent on infrastructure investments pays interest costs, rather than construction costs. (Photo: three bridges; Justin Dolske, flickr, licensed under Creative Commons license 2.0)

Recent Developments

In addition to efforts in reducing debt and ensuring the more efficient use of government funds, as well as a generally stronger economy, several other steps have been taken to ease some of the challenges noted in the Public Policy Institute of California's report calling for financial reform[265]. Maybe most notably, SB 628 (Beale), passed in 2014, and effective as of January 1, 2015, enables local governments to form Enhanced Infrastructure Finance Districts (EIFDs) – a special governance district empowered to collect tax increments (i.e., the additional taxes generated from the new development within the bounds of the EIFD) to finance infrastructure development. Voter approval is not required to form an EIFD, but a 55% majority is required to pass bonds[271-273]. While oriented toward local governments, this new financing tool is likely to ease local financing capabilities, indirectly reducing pressure on State funds to support local infrastructure projects.

Even more recently, Assembly Resolution ACA-21 (Mayes, Obernolte, an active bill, remaining in progress[7]) proposes to amend the State constitution by establishing a California Infrastructure Investment Fund. It would create a permanent fund in the State Treasury and require the Controller, beginning in the 2019–20 fiscal year, to transfer from the General Fund to the California Infrastructure Investment Fund in each fiscal year an amount equal to up to 2.5% of the estimated General Fund revenues for that fiscal year. The measure would require, for the 2019–20 fiscal year and each fiscal year thereafter, the amounts in the fund to be allocated, upon appropriation by the Legislature, for specified infrastructure investments, including the funding of deferred maintenance projects.[8]

Lack of Vision, Prioritization and Coordinated Strategy

While the fate of ACA-21 is yet to be determined, long-standing observers of state infrastructure investment argue that more than additional funds are needed to move California toward modern, climate-safe and sustainable infrastructure. For example, the Little Hoover Commission, in its 2010 Building California report[2], warned – as the state was barely emerging out of years of fiscal deficits and the late 2000's Great Recession – that the state needed to profoundly reconsider its infrastructure investment thinking and approaches.

It bemoaned that the State seemed to lack a compelling vision and coordinated strategy to guide its infrastructure investment decisions. Since 1999, the legislature had mandated that an annual Five-Year Infrastructure Plan be submitted alongside the Governor's budget, summarizing state infrastructure needs compiled by department staff in collaboration with the Department of Finance (DOF). It was mandated to be considered by the legislature during its deliberations and budget decisions.[11]

> "If California is to emerge from the recession more economically competitive, State leaders must develop an infrastructure strategic plan that prioritizes the state's most pressing needs and identifies new ways to pay for the billions of dollars of infrastructure the state will need. This plan must integrate the state's existing strategy for reducing greenhouse gas emissions and improving sustainable development. A smart infrastructure strategy can help the State meet its environmental goals as well as foster a healthy economy. Likewise, the transformation envisioned by AB 32[9] and SB 375[10] only can be achieved with a growing economy, one supported by strategic infrastructure investments." (para. 2, Letter to Governor and Legislature)

Twenty years after passage of the Infrastructure Planning Act, however, the Little Hoover Commission remarked,

> "What governmentwide planning exists – collated in the administration's annual Five-Year Infrastructure Plan – is segmented by department without a view to overarching goals or a ranking of projects by relative need or the value they would deliver economically or environmentally. Though the plan is delivered to the Legislature, lawmakers have yet to engage the administration in a discussion about which projects are most important or how California can use existing state assets more efficiently." (para. 4, Letter to Governor and Legislature)

Discussions during the CSIWG meetings made clear that this situation has barely improved since. Little significance was given to the Five-Year Infrastructure Plan, as it lacks coordination across agencies and an integrated vision that would allow for prioritization. Moreover, while the

[7] See: http://leginfo.legislature.ca.gov/faces/billStatusClient.xhtml?bill_id=201720180ACA21.

[8] The CSIWG provides information on this pending legislation to provide the full context of activity at the State level. It states no opinion on whether or not this legislation should be approved.

[9] All past Five-Year Infrastructure Plans and other reports related to infrastructure financing are available from the California Department of Finance at: http://www.dof.ca.gov/Programs/Capital_Outlay/.

[10] See: http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf.

[11] See: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200720080SB375.

Figure 8.5 A recently updated comprehensive study undertaken by the National Institute for Building Safety (NIBS) in collaboration with the Federal Emergency Management Agency (FEMA) and other partners illustrates that pre-disaster investment in hazard mitigation pays manifold. For every dollar invested, the nation saves $6 (avoided damages and other benefits) (Source: FEMA, based on NIBS 2017[275])

J. Brown Administration set forth funding priorities, and mentioned that Executive Order B-15 – which demands that State agencies account for climate change in long-term investment decisions – is being implemented, the statement about implementation is vague and the priorities list does not reflect any overt consideration of climate change.

And while California's credit rating has improved steadily in recent years as a result of the improvements in its fiscal situation[12], making State borrowing more affordable, the debt burden of the State – as shown above – is still significant. Given tax rules in the state, voters would need to be convinced that higher taxation is needed to increase revenues for infrastructure rather than borrow more money (which they have tended to approve at a greater rate than bonds have been issued) (Figure 8.5). Previous studies suggest the public has only limited understanding of how bonds affect State finances[263,265], but the comparatively high success rate of fiscal measures in the June 2018 election suggests it is not impossible to make a convincing case for why Californians should invest in their own communities, economy, education, quality of life and their future[274].

The State lacks a compelling vision and coordinated strategy to guide its infrastructure investment decisions.

[12] See: https://www.treasurer.ca.gov/ratings/current.asp.

Recommendation 7

Because improving resilience is not a zero-sum activity, adding resilience in one area cannot be balanced by relaxing resilience requirements somewhere else. Adding requirements for resilience will come at a cost, so unfunded mandates are not feasible. The true costs over the full life-cycle of infrastructure projects should be assessed broadly, and the State should make efforts to help policy-makers and the public better understand the necessity of bearing these costs. Educational, promotional and other outreach should be conducted to generate support for the expenditures.

A concrete way forward with implementing this recommendation is for the Strategic Growth Council and other State agencies to launch serious engagement (persistent and creative education and outreach) efforts to help Californians more fully understand why investment in climate-safe infrastructure is necessary, why the Climate-Safe Path for All is the safest and – in light of observed climate trends and already-experienced catastrophic impacts – likely a highly cost-effective way forward (Figure 8.6). This will help make the case for continued financial reforms that remove some of the structural obstacles to a more reliable and affordable approach to infrastructure financing (see Stakeholder Engagement discussion in Chapter 9).

Figure 8.6 The State must engage elected officials at all levels and the public to help them better understand the necessity for paying for resilience and generate the necessary support. (Photo: In the streets of Oakland; Thomas Hawk, flickr, licensed under the Creative Commons License 2.0)

The Added Challenges of Infrastructure Financing in the Face of Climate Change

Greater Damages and New Costs to Infrastructure Due to Unmitigated Climate Change

First, it is important to understand how climate change can cause greater damages and higher costs to infrastructure if the impacts of climate change and related extreme events are not prevented or mitigated. Possible cost increases from unmitigated climate change fall into several categories:

Increased damages to existing infrastructure and related increases in the costs for operation, maintenance and repair.

- Gradually increasing stresses may depreciate infrastructure more rapidly than previously estimated, requiring more frequent maintenance, repair or earlier-than-expected replacement (such as higher temperatures affecting the need for road resurfacing);
- Gradually increasing stresses may also increase operating costs (such as extreme heat requiring more air conditioning in state buildings);
- Due to more frequent and/or more intense climate-related extreme events, wear-and tear will increase, resulting in shorter expected lifespans of infrastructure or require more frequent repairs (such as the need to replace culverts more frequently);
- More intense or concurrent extreme events may lead to premature failure of infrastructure (such as the scour from concurrent coastal and inland flooding, as occurred in Hurricane Katrina[276]);
- As climate change increases the occurrence of extreme events – in California and beyond – there is empirical evidence that the cost of materials and of labor increases due to the higher demand for both in post-disaster times. If infrastructure were built back to pre-disaster conditions, and thus insufficiently prepared for the next (and possibly worse) extreme event, replacement needs/costs would incur more frequently;

Increased costs of new infrastructure and retrofits.

- Higher material and labor costs also affect new infrastructure. Labor shortages during such times may add to potential cost overruns. The CSIWG deliberations revealed how the disasters in 2017 and 2018 resulted in such cost increases to current projects in California (particularly in the Building sector). Thus, estimates made today of the cost of new infrastructure without considering the spill-over effects of increasingly frequent climate-driven disasters may well be too low;
- To the extent new construction takes climate change into account, upfront costs for infrastructure may be higher than construction without doing so (e.g., by laying the foundation now for adaptive design), but over multiple decades may be significantly more cost-effective than overestimating or underestimating what kind of infrastructure is ultimately needed over the course of its lifetime;[13]

Increased indirect losses from failing infrastructure.

- Whenever infrastructure fails, there are significant indirect damages to life and safety of communities and to the economy, as the lack of functional infrastructure can severely disrupt and delay the return to full economic activity[277,278];
- Given that infrastructure funding comes from all levels of government and the private sector, lack of funding from local and federal levels or failure of the private sector to take climate change into account can increase the economic vulnerability of the state, for example by more frequent demands on disaster recovery funds, supply-chain disruptions or slowed local recovery and hence diminished economic returns to the State treasury;

Increased R&D costs but also opportunities for significant return on investment (ROI)

- Earlier sections pointed to significant needs for investment in the relevant science, tools and platforms to make actionable climate science available to engineers and architects. This type of investment requires sustained support;
- Because adaptive design is still in its early stages of development, there is a need for increased investment in applied engineering science; and
- Investment in Research and Development (R&D), however, is likely to pay off as the need for such knowledge is global and rapidly growing, providing a significant opportunity to generate a return on investment over time. Put differently, failing to invest in this area may be a significant lost opportunity.

[13] There is no example – anywhere in California or in the United States – of ever having structurally "over-protected" against a natural disaster such as floods, wildfires, storms, earthquakes and so on. There are examples of having taken sufficient precautionary measures and, sadly, many examples of having not protected ourselves enough, either because we did not believe certain extremes would be possible to occur or because we believed ourselves safe, ignored best hazard management practices or stopped short of making adequate investments in our safety (the disasters of the 21st century alone suffice to underscore this point).

A selective literature review conducted as part of a study for the Fourth Assessment revealed that the state has no comprehensive or reliable estimates of what climate change impacts and adaptation would cost at the state or local level[279](Figure 8.7). A range of factors make such estimates difficult, but significant opportunities for filling knowledge gaps and improving on existing partial assessments are possible. This is why we suggested earlier – as a concrete step forward to realizing the Climate-Safe Path for All – to invest more heavily in research that assesses the economics of climate change impacts and of different infrastructure adaptation options, as well as seriously evaluates different financing vehicles to support building adaptive infrastructure.

There are as yet no comprehensive or reliable estimates of what climate change impacts and adaptation would cost at the state or local level

Figure 8.7: A study conducted for the California's Fourth Climate Assessment revealed that the state has no comprehensive or reliable estimates of what climate change impacts and adaptation would cost at the state and local level, yet that is where most of the costs will be borne. (Photo: Stakeholder workshop on adaptation finance challenges in Los Angeles; Robert Kay, used with permission)

Distribution of Damages and Costs

At present, the (mostly) increased damages and costs listed above are not adequately known, nor accounted for in the finance systems at any level of the public or private sectors. One reason for it is that it is not easy to determine how, when, where and to whom these costs and damages accrue. Geography, changing climate patterns and past patterns of infrastructure investment (or, as the case may be, dis- and underinvestment), however, guarantee that they will accrue unevenly. Moreover, it is not easy to determine what a fair distribution of the added economic burden should be. Questions of responsibility, liability and capability are a long-standing feature of greenhouse gas mitigation policy debates and are now also emerging in public debate around adaptation. We expect them to become more pronounced in the future.

Credit rating agencies, such as Standards & Poor's and Moody's, recently announced that they will take climate change into account in assessing the credit worthiness of local government entities[280,281]. As rating agencies move to assessing climate risks, and these risks show up in the interest rates and insurance costs paid by localities, the benefits from climate-safe infrastructure can be monetized upfront. Over time, all financing becomes climate financing. However, this places a strong onus on local governments to get serious about addressing the growing risk from climate change. Given the significant constraints local governments face, however, in funding adaptation[279], not to speak of major infrastructure upgrades, given the tax-limited nature of California local governments and the growing burden on local budgets from pension obligations, it is not to be taken for granted that local governments can face this challenge without significant help from higher levels of government. It is particularly unlikely that low-income communities will have the necessary fiscal capacity to do so. Thus, in addition to the increased outlay to make state infrastructure climate-safe, the demands on State budgets may grow as local governments require additional help.

At the same time, federal willingness to invest in infrastructure is unclear at present. While the Trump Administration has promised greater infrastructure investment and streamlining of the infrastructure permitting process[282], the source of funding is far from clear[283]. A greater involvement of the private sector is expected, but there is no clarity or any standardized procedure for how to draw in private financing. Further, because the federal Administration has reversed most positions, guidance and priorities related to climate change, it is not clear to what extent expenditure of federal infrastructure funding coming into the state can explicitly account for climate change. State-federal consistency requirements, however, may allow the State to put those dollars to good use, i.e., toward climate-safe infrastructure investment, if it raises the bar through design guidance and sets strong regulatory requirements.

Against the backdrop of historical patterns and complexities in infrastructure funding, taking climate change into account from a fiscal perspective is thus everything but straightforward. In a fiscally constrained and uneven environment, with little clarity on the relative roles of private and public sectors, many questions arise. These include:

- How will climate-safe infrastructure projects be funded (i.e., what is the source of revenue) and/or financed (i.e., how can additional money be borrowed) and what is the proper deal structure?
- How will costs be distributed across different infrastructure owners and different levels of government?
- What role can or should the private sector play?
- What improvements are needed to allow for effective P3s?
- What can or should finance seekers do to attract investment funds?
- What do investors need to come to view infrastructure as a viable place to invest?
- How should the cost-benefit analysis be calculated?
- How will social equity in the access to and distribution of funds be ensured?

A follow-on activity to the work of the CSIWG should explore them in detail.

Accounting for Climate Change in Infrastructure Financing

Many analysts and practitioners call for the development of new financial tools (see review in Moser et al. 2018[279]) to generate new funds for adaptation, including for forward-looking, climate-safe infrastructure investment. Some, however, recognize that the financial tools alone will not suffice[225,279,284]. Instead, an integrated financing system needs to be built instead, and this report follows this advice, with Chapters 5-9 constituting the elements of such a system.

There is important precedent for developing complex financing systems in many areas of public responsibility. In climate adaptation there are now many financing experiments and development of innovative financing instruments underway, but they do not yet constitute a "system."

A more fully developed "system" would have standardized complex transactions so they can be predictably executed on a routine basis (Figure 8.8). It would entail (1) strong data and analytics to support economic assessments and financial transactions, including an assessment of the performance of climate-safe infrastructure (see Chapter 5); (2) a pipeline of well-developed projects ready for investment (see Chapter 6); (3) clear governance processes and structures that allow moneys from various sources to be received, integrated and applied toward properly designed climate-safe infrastructure (see Chapter 7); (4) a range of readily available and proven financing tools (this chapter); and (5) a variety of efforts that enable appropriate implementation (see Chapter 9). Figure 4.8 in Chapter 4 illustrated these five components as well as the need to integrate them across scales of governance.

Below, we highlight more specific needs to realize the finance-related needs. The CSIWG considers progress on each essential to actually get climate-safe infrastructure built on the ground.

Data and Analytics in Support of Climate-Safe Infrastructure Finance

Chapter 4 provided an overview of what data is already available and what more is needed to assist engineers and architects in the planning and design of climate-safe infrastructure. In addition, however, there are several non-climate science information needs that are essential to make the economic case for adaptation investment.

Figure 8.8 An integrated system of skills, capacities and mechanisms is needed to analyze, design, plan, govern, finance and implement infrastructure projects. (Photo: San Francisco Main Public Library; Thomas Hawk, flickr, licensed under Creative Commons license 2.0)

An assessment of the economic feasibility of a project is commonly the first step in the infrastructure development cycle but assessing costs and benefits in the face of both climate and societal uncertainties is not trivial. What is commonly lacking are:

- **Appropriate benefit cost analysis tools** deployed in robust decision-making in the face of deep uncertainty, risk management and adaptation pathways contexts, applied over the entire life-cycle of a project, along with the necessary capacity of many analysts to use these tools appropriately (see also Chapter 6);
- **Adequate data on costs** of non-traditional designs as well as well-established methodologies for assessing costs over the entire life-cycle of an infrastructure project, not only its upfront costs;
- **Adequate data on benefits** to the project owner and to society, including trusted methodologies for assessing difficult-to-monetize benefits such as ecological or cultural values; from an investor's perspective, this also requires performance data on the environmental, social and governance (ESG) factors that would satisfy green and/or climate bond requirements; and, last but not least,
- **Defensible metrics of "success" of adaptive infrastructure projects**, which would give infrastructure owners and investors/lenders the confidence that the chosen adaptation pathway is viable and well-considered, and progress toward climate safety is being made.

At the moment, none of these approaches are standardized, and for some types of projects, such as nature-based infrastructure, they are only in development. This lack of established approaches and metrics of success makes it difficult for investors to assess with confidence whether a project is a good investment or not.

The lack of established approaches and metrics of success makes it difficult for investors to assess with confidence whether a project is a good investment or not.

[14] This might be a possible opportunity for collaboration with the Sustained National Climate Assessment (see Box 5.3).

A number of practical steps forward can help implement the overarching recommendation on developing the funding and public support for investment in a climate-safe future:

1. The State should include economic analyses of the costs and benefits of climate-safe infrastructure as an explicit focus in the next update of the Climate Change Strategic Research Plan to develop better estimates of the fiscal challenges and opportunities;
2. With available and improved methodologies in hand, State agencies should carefully evaluate expected costs and benefits of current and proposed policy approaches to infrastructure planning and design, including via interdependencies with other agencies and policies. They should also publicly and transparently disclose those costs, benefits, interdependencies and related climate-risks. This evaluation should include consideration of factors such as:
    - Timing (life-cycle);
    - Equity (who bears the costs and who enjoys the benefits);
    - Appropriate cost-benefit tests (such as participant costs, total resource costs, and full accounting of externalities); and
    - Second-order effects (such as the impacts of adopting one policy on the success of another).
3. The State should find ways to compile and critically assess economic valuation methodologies, particularly of difficult-to-assess costs and benefits, that are available in the literature[14] and update outdated State economic valuation practices, so that the environmental and social benefits can be more effectively integrated into feasibility studies; and
4. The Technical Advisory Council of the State's Integrated Climate Adaptation and Resiliency Program's (ICARP) has begun investigating indicators and metrics of adaptation success. This is also subject to ongoing research in the research community[285]. The TAC or a subset of the TAC, in cooperation with relevant State agency staff, external researchers, stakeholders representing social equity interests and financial experts should develop a suite of metrics that are meaningful to all parties – funding seekers and funding providers.

Pipeline of Investment-Ready Projects

As discussed above and in Chapter 6, California does not currently have an integrated vision and clearly prioritized strategy of how to modernize its infrastructure. Each agency puts forward its own set of projects and budget priorities get made in a non-transparent fashion. The legislature has its own priorities and does not appear to follow the Five-Year Infrastructure Plans. Voter initiatives reflect popular demand (or at least popular support) but again, do not constitute an integrated strategy.

Private-sector investment is sometimes seen as an additional option to supplement State or federal funds. With private-sector funding, however, traditional models to deliver enough return-on-investment to motivate investors could be undermined by climate change variability, resulting in potentially increased costs or shifts in how project liability is shared between the State and the private investor.

P3 authorizing legislation does not exist for every infrastructure sector in California (it is available for highways, the high-speed rail and courthouses)[1] and is thus still relatively rare compared to the use of such approaches in other countries. In the few instances in which California State agencies have engaged in P3s to date, the public-private partnership was hampered by lack of project selection criteria, lack of clarity whether the P3 was actually the best procurement approach, limited oversight from the State's Public Infrastructure Advisory Commission (PIAC), and uneven expertise in procurement[286].[15] Many consider P3s to be complex arrangements that require considerable expertise to carry out appropriately[223,287]. As we will discuss in Chapter 9, workforce development for procurement staff on how to re-orient toward climate-safe infrastructure investment is a critical aspect of realizing climate-safe infrastructure.

These complexities notwithstanding, P3s are commonly invoked as potential vehicles to attract more funding to infrastructure, particularly in light of the need for growing investment due to climate change. This potential should only be realized, however, if rules and accountability mechanisms have been clarified, and if there is a series of projects lined up (see Chapter 6), ready for investment and in final costs to the taxpayer are sufficiently prudent as compared to traditional government financing.

[15] The California legislative authority (Section 143 of the Streets and Highways Code) for P3 projects expired on January 1, 2017. See additional information on P3s used by DOT at: http://www.dot.ca.gov/hq/innovfinance/public-private-partnerships/PPP_main.html.

Dedicated Climate Funds vs. Climate Accountability in All Infrastructure Finance

Proposition 68[16] (a ballot measure deciding the fate of SB 5, De Léon[17]) was approved in the June 2018 election. It approved the issuance of general obligation bonds for parks, natural resources protection, ocean and coastal protection, water quality and supply, including groundwater management, flood protection, climate preparedness/adaptation and resiliency projects[266]. While Prop. 68 is one of several bond measures and $4 billion dollars is indeed significant, it has many intended purposes, climate adaptation being one, and it only begins to make a down-payment on the estimated funding needs for infrastructure cited above. How much of the $4 billion will actually be spent on adaptation – and on state infrastructure specifically – remains to be seen.

Another bill is currently making its way through the Assembly (AB 733, Berman)[18], which would explicitly allow EIFDs to be used for local climate change adaptation projects. While it is awaiting action from a concurrent Senate bill in the next legislative session and it focuses on local rather than state infrastructure funding mechanisms, Prop. 68 and AB 733 are examples of how voters and the legislature try to improve the availability of funding for climate-safe infrastructure through dedicated funding sources.[19]

The alternative – or rather, additional – approach particularly promoted in this report is to ensure that all new or retrofitted infrastructure accounts for climate change, which requires changes in standards, codes, guidelines and planning processes (see Chapter 7). If such changes are made, all available funding mechanisms – not just a limited dedicated source – provide a pool of resources to make the state's infrastructure climate safe.

The two complementary approaches point to the different demands of effective governance systems required to put climate-safe infrastructure financing in place. In the case of dedicated funds, infrastructure project owners may claim adaptation benefits but accountability mechanisms would need to be established. EIFDs might constitute critically important governance structures for projects that cross jurisdictional lines (as is often the case with infrastructure projects). Moreover the 55% voter approval

[16] See: https://ballotpedia.org/California_Proposition_68,_Parks,_Environment,_and_Water_Bond_(June_2018).
[17] See: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB5.
[18] See: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB733.
[19] Here again, the CSIWG only provides information on pending legislation to provide the full context of activity at the state level. It does not state an opinion on whether or not this legislation should be approved.

of bonds issued through EIFDs makes it easier to obtain financing compared to taxation requiring a super majority. Yet, as with dedicated funds, what is being built with those funds does not have to follow strict codes or standards unless they are established by the State.

Innovative Climate-Safe Financing Tools

Another set of governance issues relates to the design of financing instruments that reduce the barrier of upfront costs versus O&M costs over the course of the project's entire life cycle. An example from the building sector illustrates the point: arguably, climate adaptation strategies can be more easily incorporated into new construction as the building is being planned and designed. Existing facilities pose a greater challenge on many fronts. Major retrofits to an existing facility are a significant investment in time and resources that will need to provide clear value to the building owner.

Upfront capital, in particular, is limited, in the public sector. To avoid the need for upfront funding in energy retrofits, building owners often enter into arrangements with energy service companies (ESCOs), whereby the ESCO provides an energy savings guarantee and the building owner secures a loan from a lender based on the guaranteed savings provided. From the owner's perspective, the savings from the retrofits will offset the loan payments. From a lender's perspective, the savings guarantee provided by the ESCO gives the lender confidence that the project will generate a positive cash flow.

Climate adaptation strategies could conceivably be integrated in existing buildings, in a similar fashion. Either as part of an energy retrofit or as a stand-alone effort, financing options to offset the initial costs would relieve a key barrier to implementation. However, unlike energy retrofits, climate adaptation strategies may not result in immediate short-term financial benefits such as utility bill reductions. Therefore, financing products may need to be structured to recognize the longer-term benefits such as reducing risks from extreme climate events like wildfires, flooding, high heat and so on.

Similar ideas have led to the creation of "resilience bonds"[224]. Resilience bonds combine the benefits of catastrophe insurance (also called "cat bonds" – namely, to have insurance coverage for the unlikely case of a catastrophic event)- with the benefits of investing in resilience which aims at reducing losses - namely, to reduce catastrophe insurance premiums and the risk to the principal (i.e., the cat bond holder). Resilience bonds put a price on the risk reduction that would be achieved from a resilience project, turn it into a rebate on the catastrophe insurance policy, and return that rebate as financing to the resilience project.

Resilience bonds were created as one way to ensure that the financial value created by public investments in resilience is returned to the public sector. While still in the pilot phase, interest in resilience bonds is rapidly growing in part due to the growing climate risks and expected losses, partly due to the requirement for many infrastructure projects to carry insurance and partly due to the pressure to find financing for upgrades/retrofits or new infrastructure projects. Resilience bonds can fill project funding gaps for upfront costs, funding future project phases, cover O&M costs or buy additional insurance; they can help meet insurance obligations; and they enhance project design integrity.

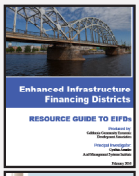
A number of other innovative finance instruments have been developed or are being proposed (e.g., project cost overrun insurance[288, 289]; green bonds[290,291]; climate bonds; environmental performance bonds[292,293]; and social impact investment[294,295]). For many, however, these novel instruments are still too risky because they are unproven, certification and/or accountability is lacking, or existing governance structures present obstacles. Thus, to realize the full potential of these innovative finance instruments, these governance structures and components need to be reworked, revised or invented and users must become familiar and skilled in using them. For example, finances are often handled within departmental budgets but benefits of multi-faceted infrastructure projects may accrue to other sectors. Thus, to enable those benefits to be counted against the costs incurred, financial accounting must be able to "bust" governance silos (see the discussion at the end of Chapter 7).

Over the course of the Climate-Safe Infrastructure webinar series, three webinars were dedicated to infrastructure finance. Those webinars were some of the best attended. Similarly, the Third California Adaptation Forum has a stronger-than-ever focus on funding and financing. These observations suggest the growing interest and need for infrastructure designers, planners, consultants and not-for-profits to learn more about adaptation finance, particularly for large infrastructure projects (Box 8.2).

To advance innovative financing for state climate-safe infrastructure projects, additional concrete follow-up steps would include:

1. Building greater in-house technical know-how on innovative financing mechanisms; and
2. Working closely with financial advisers from the private and public sectors, including philanthropy, to explore and implement innovative funding mechanisms.

Box 2.2 Selected Resources on Funding and Finance Relevant to Climate Adaptation and Infrastructure



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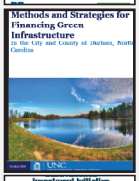

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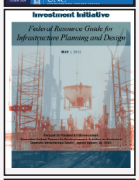

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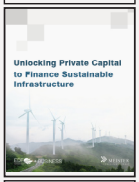

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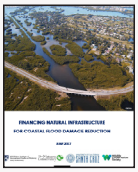

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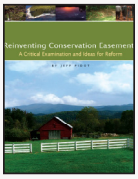

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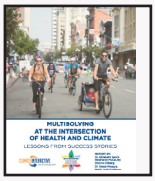

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Conclusions

In this chapter, we have reviewed infrastructure funding trends, challenges and the needs and opportunities to put in place finance systems that can make further progress on improving infrastructure finance in the state, and address the growing cost of infrastructure in the face of climate change. This review illustrates that California has long grappled with infrastructure funding, has made incremental progress, and, in fact, is probably in a better position today than at any time in the past 20 years to make more strategic moves and investments in a climate-safe future. Our report makes clear that integration of forward-looking climate science is not only a necessary ingredient in the planning and design stage of infrastructure but is also needed as an integral part of a comprehensive system required to finance climate-safe infrastructure. Climate data, demographic, land use and economic data, a variety of metrics of the environmental, social and governance performance of traditional and innovative funding mechanisms and additional metrics to measure adequate progress and success of adaptive infrastructure projects are required to secure the necessary funding (Figure 8.9).

Metrics to measure adequate progress and success of adaptive infrastructure projects are required to secure the necessary funding.

In Chapter 10, we will turn to additional conditions that will help or hinder the implementation of the Climate-Safe Path for All.

Figure 8.9 Metrics of the environmental, social and governance performance of infrastructure and related funding mechanisms are needed to attract funding and to evaluate progress and effectiveness over time. (Photo: Full moon over wetlands; Alice Cahill, flickr, licensed under Creative Commons license 2.0)