Climate-Informed Decisions

The Capital Investment Plan as a Mechanism for Lowering Carbon Emissions

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Abstract

Global trajectories for reducing carbon emissions depend on the local adoption of alternatives to conventional energy sources, technologies, and urban development. Yet, decisions on which type of capital investments to make, made by local governments as part of the normal budget cycle, typically do not incorporate climate considerations. Furthermore, current academic and professional literature specific to climate change draws attention to decision-making tools that would require access to technical expertise, data, and financial support that may not be practical for cities in low- and middle-income countries. Arguably, the methodologies most able to effect this transformation will be those that are convenient and affordable to administer, and that

offer straight-forward low carbon alternatives to traditional forms of infrastructure investment. Current methodologies for capital investment planning that do not take climate change into consideration can result in prioritization of investments that diverge from a low carbon path and a potential missed opportunity to reap financial benefits from efficiency gains. This paper concludes that relatively minor alterations to common procedures can reveal the trade-offs and local benefits of low carbon alternatives in the capital investment planning process. This paper was written as an input to the preparation of the Climate-Informed Capital Investment Planning Guidebook, a how-to guide for local government staff, which will be published in 2015.

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1 Introduction

Half of the world's 7.1 billion people live in cities today. By 2050, 6.2 billion people, or two-thirds of the world's population, are expected to be urban dwellers. Cities hold the majority of the world's economic wealth and infrastructure assets, are home to some of the most highly educated populations, and are hotbeds for innovation (World Bank, 2010a, 1). Cities and their ancillary service organizations in local government, such as utilities, are therefore uniquely situated to be catalysts for change (Corfee-Morlot et al., 2009, 2).

Despite the benefits cities provide, they are also major contributors to climate change. An estimated 36 to 48 percent of global greenhouse gas emissions result from activities occurring within cities (Marcotullio et al., 2013). These emissions come from a variety of sources, such as energy supply, transportation, buildings, and industry (World Bank, 2013b, 1). Local governments and their complements, such as local utilities or other special purpose organizations, retain responsibility for planning, financing, and managing most infrastructure sectors in the modern urban economy. Government-owned infrastructure, in the form of office buildings, municipal power plants, waste water treatment plants, buses, street lights, and so on, are major sources of emissions for urban areas.

Cities are small enough to engage strategies that address climate change in a manner that is location specific and relevant to their communities. At the same time, collectively they are big enough economically to have a voice on the global stage. The 50 largest cities in the world have a combined GDP of \$9.6 trillion; an amount larger than every country's GDP except the United States (World Bank, 2010a, 1). As cities utilize the majority of the world's energy, decisions made on a local level will have global ramifications. Estimates suggest that if local governments were to select a low carbon path for the five sectors with highest levels of GHG emissions (i.e., residential and commercial buildings, passenger and freight transport and waste), greenhouse gas emissions on a global scale could be reduced by roughly 47 percent by 2050 (potential of avoided emissions of core sectors by 2050, figure 4 Bloomberg, et al., 2014).

Infrastructure decisions made by local governments have path dependent implications for local and regional development patterns. In other words, the economic system "reorganizes itself" around infrastructure (Hallegatte et al., 2012, 2). For example, the decision to build a road into an otherwise remote area can promote facility-induced development. A few, or perhaps just one such investment can implicitly adjust market conditions to encourage development along an entire corridor, and may result in undesired externalities such as urban sprawl (Beimborn and Kennedy, 1995, 17). Studies of changes in urban form over centuries indicate that once established, a roadway or any other infrastructure is unlikely to be converted to another use. The implications for development patterns can be profound: areas where particular kinds of infrastructure investments are made, such as transportation arterials or water and sewer mains, are the places most likely to grow first (Kelly, 1993, 3).

Every year, hundreds of thousands of decisions on infrastructure investments in urban areas are made across the globe. Most local governments in developed countries – and a growing portion of local governments in developing countries – make these decisions as part of a formal capital investment planning process. Capital investment plans, sometimes referred to as capital improvement plans or

programs, are policy tools that local governments use to prioritize, forecast, and budget for investments in major capital projects and acquisitions. These major projects can include buildings, such as schools and hospitals, energy generation and distribution systems, water treatment facilities, etc. Capital investment plans are the critical juncture in local governance at which development plans are coupled with funding, and where line departments and agencies must demonstrate the merit of their proposed projects to the local leadership in order to move them from plan to reality. As such, the capital investment planning process presents an opportunity to significantly alter the nature of infrastructure investments in cities.

This paper presents a methodology for capital investment planning that illuminates the local benefits and trade-offs between carbon reduction and cost of infrastructure choices for local decision-makers. The methodology aims to illustrate the degree to which planned investments, made individually and collectively, lock the community into future carbon emissions. Organized as minor modifications to commonly used procedures, the methodology is designed to appeal to the pragmatics of local decision-making, irrespective of a city's geographic location or pace of development. For local governments that do not yet have a formal capital investment planning process in place, it presents an opportunity to establish one that already integrates climate considerations. It is up to each local government to determine how much emphasis (weight) they wish to put on climate considerations; the methodology is climate-informed rather than ensuring to deliver low carbon outcomes.

This paper begins with a brief outline of the current practical and academic expectations for local capital investment planning in an era of climate change. It then analyzes the relevance of current municipal approaches to the challenges created by climate mitigation, noting how capital investment planning processes that do not take climate change into consideration can result in investments that diverge from a low carbon path. This is followed by a suggested set of modifications to facilitate the identification and prioritization of infrastructure choices that meet local objectives and lower the cost, energy demand, and carbon output of development. The result is a procedural model that measures the difference, or "wedge," in projected emissions between conventional and carbon-minimizing infrastructure choices.

2 Local Investment in an Era of Climate Change

The gap between the demand and the current level of investments in infrastructure – ports, power plants, pipelines, hospitals, highways, water, sewer, and telecommunications – is estimated to be \$1 trillion annually through 2020 (World Economic Forum, 2014, 40). Population growth, unprecedented rates of migration from rural to urban areas, and pre-existing unmet demand for the essential services that define urbanization are factors that drive estimates of infrastructure need considerably above the current rate of public and private spending. Furthermore, it is estimated that a transition to more environmentally clean infrastructure "would raise this estimate by an additional \$200-\$300 million yearly" (World Economic Forum, 2014, 40). Marginal carbon abatement curves, popularized by McKinsey and Co., suggest that several forms of environmentally beneficial infrastructure can provide positive returns on investment. A few forms – alternative settings for environmental controls in buildings, or alternative building codes for new structures, for instance – may even be possible with little or no up-front capital costs (McKinsey & Co., 2009, 16). Still, the extent and urgency of decarbonization

necessary to stabilize global temperatures requires capital investments in both new and retrofitted assets, with more environmental intent than historically observed (World Bank, 2010a, 11). Regardless of marginal abatement curves, inertia and lock-in to infrastructure investments with lower capital costs and excessive emissions can be expected to continue as long as conventional rationales for prioritizing investments predominate (Vogt-Schlib et al., 2011, 14-15).

Climate change is just one of many challenges faced by local governments. Scarcity of funds, competing interests in government investment, demands for economic growth and employment, the pitfalls of political self-interest, public responses to inequities in fees and taxes, shortages of technical expertise, and lack of access to financing are just a few potential challenges. In the context of rapid urbanization, demands and desires for capital projects outstrip the capacity of the local government to fund them. For this reason, as well as the long-range nature of infrastructure projects and their tendency to lock-in a specific development path, it is necessary for local governments to make transparent, well-defined choices about what projects to implement, when to implement them, and how to pay for them. These issues are brought to the forefront during the annual (or biannual) budgeting process. While many forms of public rule-making can be useful to combating climate change on a local level, much of the opportunity for local governments to act depends on their willingness and ability to prioritize climate-smart investments within their budgeting process.

3 Finding a Low Carbon Path

Currently a number of cities are actively supporting investments in low-carbon infrastructure. However, many local governments have not yet incorporated climate issues in their planning processes or do not have access to the right tools to understand what needs to be considered. Capital investment planning processes have the potential to steer cities to take a low-carbon path. The adaptable nature of the multi-criteria analysis as a decision-making tool could present an opportunity for cities to mainstream climate mitigation considerations into their existing planning processes and build on current efforts.

Long-range planning: City-scale approaches

Master plans, be they citywide or sectoral, are one means by which governments could encourage investment in infrastructure projects that can help mitigate, versus contribute to, climate change. Stating in these long-range plans that climate change is an important issue encourages government officials to take climate change into account when making decisions, and may reduce barriers to information between departments. However, these master plans, and even climate action plans, do not always translate into action (Millard-Ball, 2012, 4-5). This is likely because when it comes time for decisions to be made, short-term financial considerations are given sway over broader long-term goals. Moreover, many climate action plans are developed as special initiatives in isolation from general infrastructure planning and budgeting processes of the local government. Climate change is occurring, but people generally perceive its dangers in the distance, 20 years or more down the road (Hulme and Turnpenny, 2004, 105). As the capital investment plan is the document where master plan elements can be translated into actual infrastructure projects, incorporating climate criteria into the capital investment planning process can ensure that these long-range goals are realized (Elmer, 2014, 137).

Major project planning

Low carbon infrastructure investments often bring efficiencies in operations and maintenance that are only achievable with a commitment of capital. Technical guidance on capital investment planning encourages the incorporation of forecasted operation and maintenance costs of proposed projects, through the use of lifecycle cost analysis (Kaganova, 2011; Marlowe 2009; Elmer 2014).

Local governments in developing countries rarely take operating and maintenance costs into account when evaluating proposed capital projects. Historically, they have been more likely to do so when the projects are very large in scale. The city of Bangkok, Thailand, for instance, realized this potential and decided to power their newly constructed international airport in the early 2000s with a cogeneration and district energy network of natural gas and steam power. This cogeneration system came at a greater upfront cost than a natural gas system, which is more traditional in Thailand. The decision was therefore based on the premise that the cogeneration system would decrease energy consumption within the airport, while at the same time increasing the reliability of the system and reducing costs in the long run. Based on engineering calculations, the designers estimated that the airport would require 66 MW of electricity to run smoothly. They therefore designed the cogeneration system to produce 50 MW of electricity, all of the airport's electricity needs minus air conditioning. To provide air conditioning, they designed a system to recover the waste energy – low-pressure steam – and cycle it through “vapor absorption machines” to cool the entire airport (Mohanty, 2011, 9). While this is a great example of achieving carbon reductions and cost savings, the decision was project-specific rather than based on a comparison with other projects competing for the same scarce resources.

Signaling the local benefits of low-carbon investment

The potential savings from low carbon investments can be significant, but difficult for local governments to foresee if plans and procedures do not adequately signal the local benefits of low-carbon alternatives. Local government investments, in turn, signal the potential returns from these investments to participants in the private market for development.

State and local governments in the US, for instance, are responsible for more than 16 billion square feet of building space, and the total annual energy cost of these facilities is estimated to be between \$10 billion and \$19 billion. Investments in efficient operations and maintenance of building systems could save 35-50% of these energy costs (i.e., heating, ventilation, and air conditioning as well as lighting improvements), with payback periods of less than four years. However, with energy costs comprising about 10% of operating budgets, government officials may not consider the need to invest upfront capital in alternative HVAC and lighting systems to be as urgent as other demands (USEPA, 2009, 9).

If longer time horizons were included in capital investment plan decision-making the reduction in operating costs over time that come with low carbon decisions would become more apparent and allow decision makers to see their economic value. Payback periods on investments in clean energy systems, such as wind and solar, vary with site conditions and fluctuate with the capital cost of these technologies, but they are generally longer than current capital investment planning horizons. In windy locations in the UK, large, free-standing wind turbines have been estimated to have a four to eight year

payback period, but building-mounted types may take 20 years or more. For solar photovoltaic, estimates are between five and ten years. Wind turbines require periodic maintenance, although solar operating and maintenance costs are negligible (Carbon Trust, 2012, 8 and 44).

Local government dedication of capital to low carbon assets may appear to impact a small portion of a city's carbon footprint, but local governments "lead by example," signaling market opportunities through their analyses and investments (USEPA, 2014, 62). In the US, 58% of green energy purchases have been made by government, yet the capital assets of government and private industry are similar enough to benefit from the same types of carbon reducing improvements (USEPA, 2009, 62). The financial projections of capital, operating, and maintenance costs estimated by governments in the capital investment planning process signal to the community the economic returns possible from various low carbon investments. Businesses may perceive a payback period of more than two or three years to be too long to justify energy saving capital investments, and overcoming this hurdle involves demonstrating how the government achieved returns for the same types of investments. Local government plans that lack the time horizon and metrics necessary to convey the business case for low carbon investment miss this opportunity (Koh et al., 2011, 2050).

Measuring carbon to reduce carbon

Greenhouse gas inventories originated from the need to determine whether or not – and to what extent – anthropogenic emissions contribute to observed patterns of rising global temperature. Having unequivocally served that purpose, greenhouse gas inventories have since become one of several steps governments, commercial entities, and communities may take in order to reverse the causal trend of rising temperature from rising emissions. Emissions are measured today – or in reference to a meaningful point in history, such as the 1990 numbers cited in the Kyoto Protocol – to form a baseline from which local governments and nation-states can then measure change over time. If local governments can associate changes in emissions over time with specific policy and investment actions, they can begin to manage greenhouse gas emissions.

City networks such as Local Governments for Sustainability (ICLEI) and C40 Cities Climate Leadership Group (C40) are promoting the creation of greenhouse gas emission inventories at the local level. Additionally, many mayors have already signed climate agreements to reduce their city's carbon footprint based on the merits of climate change science, or to promote the "green" image of their city for branding purposes. Regardless of the catalyzing rationale, the technical information created through these inventories can prove useful to local governments in addressing climate change. Inventories create opportunities to set targets for greenhouse gas reductions, and then help local governments track their progress toward these goals. Capital investment plans are developed at a critical juncture, when determining which investments will be made in infrastructure goods and services, all of which raise implications for carbon emissions. Just as greenhouse gas inventories back-cast carbon emissions, capital investment plans present opportunities to forecast the carbon emissions anticipated from proposed projects.

4 The Capital Investment Plan

Capital investment plans are policy tools used by local governments to forecast and budget capital projects and acquisitions over a given timeframe (Marlowe et al., 2009, 27). Capital investment plans are integral to capital and operating budgets, asset management, long-term plans for development (e.g., comprehensive or master plans), and financial management of cities (Bowyer, 1993, 1-2; Kelly, 1993, 9-10; Neuman and Whittington, 2000, 59-60; Dowall and Whittington, 2003 108; Kaganova, 2011, 6; Marlowe et al., 2009, 11-13 and 28-29; Farvacque-Vitkovic and Kopanyi, 2014, 230 and 281). When executed properly, the capital investment plan acts as a strategic management tool that supports the vision of the community (Kaganova, 2011, 4; Marlowe et al., 2009, 33).

A local government's budget is typically made up of two parts, the operating budget and the capital budget. The operating budget usually includes revenues from tax and rent collections, and expenses relating to salaries, office supplies, and minor maintenance and repairs (Farvacque-Vitkovic and Kopanyi, 2014, 97). In contrast, the capital budget includes investments in the acquisition or construction of new assets that have an economic life longer than one year and a value above a specified threshold (Kaganova, 2011, 3). The threshold is set to avoid confusion over minor and major expenditures for the repair and maintenance of assets. Projects included in the capital budget often consist of new construction of buildings and infrastructure, major repairs, rehabilitation, retrofits, replacement of assets, major equipment, and vehicles and machinery. Plan-making activities and projects that anticipate alternative forms of procurement, such as public-private partnerships, are included as well. Capital investments are by definition more costly than operating expenses, and hinge on higher-stakes decisions with long-term impacts. Their planning often involves collecting and consolidating revenue from multiple sources, the use of debt instruments, and a commitment to expenditures into the future. In developing countries particularly, the central and regional governments often choose to circumvent the local capital investment planning process and invest in capital projects that are not coordinated with local capital budgets, but have major implications on these (Kaganova, 2011, 16). The methodology proposed here applies to capital investments that are under the jurisdiction of local governments.

Capital budgets are guided and supported through the development of a capital investment plan. Simply stated, the capital investment plan is a plan for allocating resources to project-specific expenditures in current and future years. Completed capital investment plans allow governments to prioritize the funding and timing of their most urgent projects, while planning for the future implementation of others. Projects prioritized for the current capital investment plans are added to next year's budget, and others are scheduled for future budgets based on their need and the availability of funding. By adopting a longer outlook than the current budget year, capital investment plans give local governments time to arrange financing, determine project design, hire contractors, and purchase land for future projects (Marlowe et al., 2009, 28-29). A typical capital investment plan covers the current budget year and an additional five years, and is updated by budgeting officials on an annual or biennial basis. The frequency of updates depends on the calendar for adoption of the local government budget (Marlowe et al., 2009, 30; Farvacque-Vitkovic and Kopanyi, 2014, 230).

The Public Purpose of Capital Investment Plans

Capital investment planning is meant to help allocate scarce resources toward physical investments that serve a public purpose. Today's literature on the subject of capital investment planning is cross-disciplinary, spanning political science, economics, sociology, and applied fields such as urban planning, engineering, public finance, public administration, and environmental and natural resource economics. Capital investment plans can assist local governments in simultaneously accomplishing several objectives. These include:

- Implementation of plans such as master, comprehensive, and development Plans (Kaganova, 2011, 8; Berke, 2006, 60; Kelly, 1993, 5; Bowyer, 1993, 4; Farvacque-Vitkovic and Kopanyi, 2014, 309; Elmer, 2013, 88);
- Involvement of the public in resource allocation decisions in a meaningful way (Kaganova, 2011, 22-23, Marlowe et al., 2009, 42; Rubin, 1996, 115);
- Serving public preferences in a balanced way (Lucy, 1988, 229; Beatley, 1988, 211-212);
- Spending cost-effectively, within prudent fiscal limits and administrative capacities (Marlowe et al., 2009, 7-11); and
- Making the process of decision-making and the outcome transparent (Rubin, 1996, 115; Kaganova, 2011, 5, 29 and 43).

Another possible objective of capital investment planning is to maintain or establish a local government's standing in the bond market. Formally approved by local governing bodies, capital investment plans become statements of commitment to finance and otherwise support the development of specific assets. Many large infrastructure projects are debt-financed through bonds, loans, or other financial instruments. Capital investment plans signal to intermediaries in financial markets how the government intends to pay for its projects. Financial entities such as credit rating agencies observe and monitor local governments for the extent to which they keep these commitments. Well-designed, implemented capital investment plans can assist local governments in obtaining better bond ratings and lower interest rates on debt. Thus, the creation of a well-designed capital investment plan can increase a municipality's capacity to fill the gap in infrastructure investment (Marlowe et al., 2009, 29).

Historically, the methods used by government for capital investment planning have generated mixed results. These procedures and the investments that resulted have not been equally effective at supporting human settlements over the long run, nor have they been equal in their advancement of economies or distribution of wealth, to economic effect (Diamond, 2005; Acemoglu and Robinson, 2012). The abovementioned objectives have gained widespread appeal through the perceived success of plans and procedures adopted in today's advanced urban economies. These objectives are increasingly viewed as expectations for the capital investment planning methodologies adopted by local governments in developing countries.

5 Capital Investment Planning Methodologies

While there are numerous possible ways for local government to structure capital investment decision-making, opinions in research and practice have supported cost-benefit analysis and, more recently, turned to multi-criteria analysis.

Cost-benefit analysis

Cost-benefit analysis has been recommended for evaluating public expenditures in the United States since at least the 1930s, and is widely understood to be instrumental in preparing infrastructure projects for financial investment from international donors and private investors. However, local governments have not adopted the practice with the frequency one might expect. As late as 1987, a survey of US municipal finance officers found that only 40% of cities used cost-benefit analysis as the primary method of project evaluation, and 33% did not use any quantitative evaluation technique (Kee et al., 1987, 17-18). In Europe as well as the US, economists and spatial planners explained the situation by noting that the evaluation of infrastructure projects requires the consideration of multiple conflicting objectives which, despite the introduction of shadow pricing to cost-benefit methods, did not appear to be addressed or reconciled to the satisfaction of local decision-makers (Nijkamp et al., 1990, vii).

Multi-criteria analysis

From the 1980s onward, analysis with multiple criteria grew in popularity (see Roy, 1972, and Cochrane and Zeleny, 1973). The “goals-achievement matrix” was developed as a methodology that sought to “allocate benefits (i.e. movement toward achieving a goal) to groups within society by looking at the different mixes of goal satisfaction and full achievement within each strategy” (Shefer et al., 1990, 149). Similarly, an evaluative framework based on the French ‘multi criteria decision aid’ became popular (e.g., the ELECTRE-techniques, see Roy 1996; Wang 2009, 265). Summarizing the reasons for the rise of multi-criteria evaluation techniques in public planning and administration, economists Nijkamp and Rietveld, and spatial planner Voogd (1990, 2) list:

- The possibility of including intangible and incommensurable effects in the conventional cost-benefit methodology;
- The conflicting nature of modern planning problems, so that – instead of a single decision-maker – various (multi-level) formal and informal decision agencies influence or determine a final choice;
- The shift from conventional “one-shot” decision-making to institutional and procedural decision-making, where many political aspects play a major role; and
- The desire in modern public decision analysis not to end up with a single and “forced” solution dictated by a researcher but with a spectrum of feasible solutions from which a choice can be made.

Multi-criteria analysis as a public, participatory budgeting process

Methodologies using multi-criteria analysis range in complexity from assessments that can be performed by any person with basic algebra skills to complex modeling. The choice of approach involves trading-off technological complexity for transparency, and therefore the ability of the public to hold decision-makers accountable in the use of public funds. One could argue that the selection of a methodology that appears as a “black box” would defeat the purpose of collective decision-making in a

political environment, in the public interest (Shefer et al., 1990, 117). Although subjective assessment can be a source of criticism, it is to be expected that different stakeholder groups would prioritize outcomes differently, and methodologies that enable the exploration of the consequences of those differences can be beneficial (Scrieciu et al., 2014). For example, public participants – as well as governmental officials – can be given a set of points to freely allocate across projects in an expression of the perceived relative performance of each project against each criterion. Project scores, whether the result of technical forecasts or the opinions of participants, can then be aggregated to produce a preference rank-ordering of projects. The successful use of multi-criteria methods in capital investment planning depends on a well-defined set of criteria, a simple scoring system, and robust information (Miller, 1989, 86-93).

The strategies described above have been used successfully by a number of cities in developed countries, and are recommended for cities around the world (Matzer, 1989, 121-131; Kaganova 2011). For example, a decision-making strategy for the allocation of capital expenditures that embraces the expression of multiple-subjective preferences has proven quite effective in Brazil. Known as participatory budgeting, the process was developed in Porto Alegre in the late 1980s, in response to the widespread need to provide basic services such as water connections to a significant portion of the population (World Bank, 2003). The process “aims to involve citizens in the decision-making process of public budgeting,” and is therefore pro-poor. “By creating a channel for citizens to give voice to their priorities, [the process] can be instrumental in making the allocation of public resources more inclusive and equitable” (World Bank, 2013d). More than 240 municipalities in Brazil have since begun to utilize these practices, and impacts can be seen in tangible improvements to the circumstances of low-income residents, such as increased access to schools, public housing units, and water and sewer connections (World Bank, 2003, 3).

Multi-criteria analysis as a vehicle to address sustainable development and climate change mitigation

In a recent article, De Brucker et al. (2013, 122) explore how “stakeholder-oriented multi-criteria analysis can adequately address a variety of sustainable development dilemmas in decision-making.” They express the challenges of evaluating for sustainable development that low carbon frameworks face:

First, project evaluation by definition entails making choices, whereby not all projects considered contribute equally to sustainable development. Large-scale project evaluations nearly always involve trade-offs among multiple objectives, such as narrow-scope economic goals, broader social objectives and environmental considerations. Second, in complex cases, specific subsets of objectives typically reflect the interests of stakeholder groups, such as project developers, consumers, and third parties affected by the project. These interests must ultimately be aligned to guarantee effective project implementation. Third, in most cases the selection of specific projects typically has distributional consequences, with different stakeholder groups affected in an idiosyncratic way, and becoming ‘winners’ or ‘losers’, i.e., enjoying net benefits or incurring net costs as a result of project implementation. Often this also implies an excessive weight given

to narrow-scope economic considerations, at the expense of the social and environmental elements (De Bruker et al., 2013, 122).

They conclude that the use of multi-criteria analysis allows for the movement from the expression of ‘individual’ to ‘collective preferences.’ The transition creates an opportunity for resolving complex, multi-objective decisions (De Bruker et al., 2013, 130). Addressing climate change at the local level is a prime example of a challenge requiring such complex, multi-objective decisions.

6 A Procedural Model of Capital Investment Planning

There are many ways to proceed in the use of multi-criteria analysis for capital investment planning, but what existing methodologies have in common is the sequential approach to decision-making defined below (Kaganova, 2011, 30; Marlowe et al., 2009, 41-32; CDIA, 2010; Bowyer, 1988):

1. Prepare the organization and schedule applicable to the task of capital investment planning, including policies (e.g., identified personnel with proper authority for tasks) and budgetary decisions (e.g., the allocation of funds).
2. Establish fiscal policies to be applied in the development of the capital investment plan.
3. Establish the criteria to be used in evaluating proposals for capital investment.
4. Assign weight to each criterion.
5. Identify the objectives to be served by capital investments.
6. Generate proposals describing the capital investments to be evaluated.
7. Evaluate, with subjective and/or objective (standardized) scores, each proposal against each pre-determined criterion.
8. Aggregate the scores given to each proposal for each criterion (e.g., average score), apply the weights given to each criterion to produce a single score for each proposal (e.g., weighted average score), and rank proposals in order of indicated preference (e.g., high to low weighted average score).
9. Arrange proposed investments, with preference to rank order, into one or more draft capital investment plans within the limits accorded by fiscal policies, human resources, and current/forecasted available funds over time (including commitments to prior approved capital investments).
10. Select and formally adopt (by ordinance or resolution) a capital investment plan.

The process creates opportunities for the expression of preferences on multiple dimensions, though limited to the evaluation of a given set of proposals for investment. In local government, proposals are often generated by managers or technical staff responsible for various sectors of public infrastructure (e.g., energy, electricity, transportation, water, and/or wastewater), and particular lines of public service (e.g., education, justice, police, fire). The other steps, including the final decision of which projects to fund, are often the purview of elected officials or personnel appointed for this purpose such as budget and finance officers. It is important to distinguish between the project scale (i.e., how do we make this proposed facility greener?) and the portfolio scale (i.e., looking at an array of projects, how do we select which ones to prioritize?). The process and criterion described above apply to the latter – the portfolio

of projects that have been put forth for inclusion in the capital investment plan by technical departments.

As designed, the process may allow local government officials and any other participants to reconcile competing demands for capital investment in observance of the preferences exhibited and weighed in criteria. This assumes, however, that participants do not skew weights and scores in pursuit of ulterior motives. Table 1 illustrates how changes in weights can affect project rankings through the application of three weighting schemes and the resulting project rankings. This is the type of content elicited in step 8 of the process (see above). The section on the far left shows the average of (hypothetical) scores participants gave to each of the three projects indicating their perception (using subjective scores or objective data) of the extent to which each project would meet each of the ten criteria for evaluation. The weights assigned to each criterion are multipliers. The sections to the right show how the overall scores and thus ranking of projects is sensitive to the weight given to each criterion. These projects would be ranked in a capital investment plan from highest to lowest total score. Note how rankings differ with changes in weighting schemes: if weighting scheme A were applied, project 2 would be first in rank, while scheme B would give project 1 top marks.

Table 1: Three Project Scores Ranked According to Three Schemes for Weighting Criteria

Criteria for Project Prioritization	Project 1	Project 2	Project 3	Weight A	Project 1	Project 2	Project 3	Weight B	Project 1	Project 2	Project 3	Weight C	Project 1	Project 2	Project 3
	averaged score	averaged score	averaged score		averaged score x weight A	averaged score x weight A	averaged score x weight A		averaged score x weight B	averaged score x weight B	averaged score x weight B		averaged score x weight C	averaged score x weight C	averaged score x weight C
Criterion 1	9	9	9	3	27	27	27	10	90	90	90	10	90	90	90
Criterion 2	10	10	10	5	50	50	50	20	200	200	200	6	60	60	60
Criterion 3	6	10	6	5	30	50	30	13	78	130	78	12	72	120	72
Criterion 4	0	3	9	7	0	21	63	10	0	30	90	15	0	45	135
Criterion 5	9	5	6	7	63	35	42	15	135	75	90	5	45	25	30
Criterion 6	7	7	5	10	70	70	50	7	49	49	35	10	70	70	50
Criterion 7	7	8	4	10	70	80	40	7	49	56	28	10	70	80	40
Criterion 8	9	5	2	13	117	65	26	5	45	25	10	7	63	35	14
Criterion 9	6	2	4	20	120	40	80	10	60	20	40	10	60	20	40
Criterion 10	3	9	4	20	60	180	80	3	9	27	12	15	45	135	60
Total	38	36	44		607	618	488		715	702	673		575	680	591

Carefully prepared criteria can sharpen distinctions among projects, narrow the range of disagreement, provide a basis for discussion, and, hopefully, make the entire process more transparent (Kaganova, 2011, 33). A remarkable degree of transparency is possible through the publication of participant scores, investment proposals, evaluations, and results at each step of the process. Making this information available to the public can enhance the opportunity for the public to hold decision-makers accountable. As Valerie Belton and Theodor Stewart note in their synthesis of multi-criteria decision analysis, “subjectivity is inherent in all decision-making, in particular the choice of criteria on which to base the decision, and the relative ‘weight’ given to those criteria. Multi-criteria analysis does not dispel that subjectivity; it simply seeks to make the need for subjective judgments explicit and process by which they are taken into account transparent” (2002, 3).

The nature of the capital investments in the resulting plan depends on the capital investments proposed, the fiscal policies exercised in the process, the criteria and measures applied to evaluate the proposals, and the regulatory framework in which the local government operates. The efficiency of the process as a plan-making activity, depends on the arrangement of the abovementioned elements, and

the experience of the participants as the process unfolds (i.e., the relative success of the procedure in addressing the public's general lack of information and understanding about capital budgeting and the ways in which such decisions made by local government affect their livelihood and well-being). It also depends on the number of criteria and demands for data they generate, and the multiple uses of documentation produced for the process.

7 Modifications to the Capital Investment Planning Process

While local governments have adopted particular conventions when using multi-criteria analysis for capital investment planning, there is reason to believe that simple adjustments to the process can assist local governments in discerning the degree to which proposed infrastructure projects place the city on a low carbon path of development, or may be modified to do so. Specifically, we suggest that capital investment plans and planning:

- Include “climate-smart” criteria;
- Generate low carbon alternatives to conventional projects;
- Expand the time horizon of the capital investment plan to 15+ years; and
- Forecast carbon emissions from proposed investments.

“Climate-Smart” criteria

Climate mitigation goals may be fashioned into criteria for evaluating proposed investments. In general, criteria should be clearly linked to identified values or goals, understandable, measureable, non-redundant, independent, appropriately comprehensive, appropriately simple, and operational (Belton and Stewart, 2002, 55-58).

If the goal is a low carbon future, one could create criteria that speak directly to the goal of reducing carbon emissions – on an annual basis, for the lifecycle of facilities, and used in the production of materials and construction for the facilities. However, there are several pathways to reducing carbon emissions in infrastructure and, because each approach entails trade-offs, those who evaluate project proposals may appreciate knowing which approaches are being proposed. In particular, there are four common approaches, which may be used together or separately to strategically reduce the carbon emissions of any given project:

- Reductions in scale or increases in density of the physical structure;
- Reducing the carbon-intensity of the fuel sources generated by or served to the structure;
- Designing or installing energy efficient or carbon sink technologies; and
- Designing to reduce the embedded carbon in materials and processes used in construction.

Together, these approaches would comprehensively address the goal of reducing carbon, and do so in a manner that explains to evaluators how the project would still manage to serve its intended objectives. Further, climate-specific criteria can be applied together with criteria to evaluate the costs of proposed projects. In combination, proposals would be evaluated for cost-effectiveness. Similarly, revenue can be

made part of the evaluation, as could energy security, community health, or any other desired benefit from climate mitigation. Criteria appropriate to costs include:

“Project exhibits strategic and prudent use of available funds for:

1. Capital costs,
2. Operations, maintenance, repair, and rehabilitation, and/or
3. Lifecycle costs.”

It is also important to note that most infrastructure investments are expected to address needs other than climate change, such as public health and safety, equitable access to public services, the rehabilitation of existing assets, and economic growth. Any local government attempting to incorporate climate change into their capital investment planning process will need to place climate-specific criteria alongside other locally determined criteria for evaluating proposed investments. The goal is not to prioritize low-carbon projects over other important community investments; rather, the goal is to prioritize low-carbon alternatives of important community investments. The integration of low-carbon criteria with the variety of existing criteria for evaluating projects (e.g., public health and safety, economic growth) allows carbon emissions to become one additional measured area of performance for proposed capital projects.

In the application of weights to criteria, decision-makers express preferences for each criterion and the outcomes they imply. Considering the extent to which opinions can differ regarding the relative importance of criteria, the weighting process should include a diverse and, in the best case, representative set of participants for concerns and preferences of the community. To bring long-term value and awareness of environmental considerations such as climate change to bear, decision-making should include parties with concern for sustainability, the conservation of natural resources, and the integrity of ecosystem services.

There are many techniques that can be used to determine weights: rating, ranking, percent of base point, paired comparisons, and distribution of points, are just a few. A distribution of points is perhaps the easiest to execute and most easily understandable for the variety of stakeholders that may participate in the capital investment planning process. As noted above, in this technique a budget of points is allotted to each participant, who then distributes the points across the criteria based on their subjective assessment of relative importance. A participant may score more than one criterion the same, or assign zero points to one or more criterion, as long as the total points distributed are the same as the total points allotted. When 100 points are allotted, this suggests implicitly that the participants are to indicate the importance of each criterion proportionately. The mean of the points allotted from all participants is usually the figure used to weight each criterion.

The outcome of the process will only result in lower carbon emissions if the criteria specific to climate change are allotted an influential proportion of weight. Table 2 illustrates this point with a hypothetical evaluation of eight projects using a combination of climate-smart and other criteria. It highlights how the relative proportion of weight given to climate-smart criteria can affect the ranking of projects in a capital investment plan. Before weights are applied, each project would be assessed against each

criterion. The scores shown on the left are the sum of scores each project received when evaluated against ‘typical municipal’ and ‘climate-smart’ criteria, along with the total score received. The section to the right shows the project scores and resulting rank order of projects after they have been multiplied by the weights.

Table 2: Sensitivity of Project Score and Rank to the Weight Distributed to Two Groups of Criteria

Hypothetical Projects	Scores before Weights are Applied				Score and Rank Order of Projects as the Weight of Climate-Smart and Local Criteria are Redistributed																				
Name	Local Criteria	Climate-Smart Criteria	Total	Climate-Smart	0% Rank	10% Rank	20% Rank	30% Rank	40% Rank	50% Rank	60% Rank	70% Rank	80% Rank	90% Rank	100% Rank										
				Local	100%																				
Water Distribution System	73.3	39.6	112.9	812	1	810	1	808	1	806	1	804	1	802	1	800	1	799	2	797	2	795	2	793	4
Wind Power Installation	64.0	43.0	107.0	717	2	730	2	743	2	756	2	769	2	782	2	795	2	808	1	821	1	834	1	847	1
Hospital	59.0	36.7	95.7	659	3	664	3	669	3	674	3	679	3	684	3	689	4	694	5	698	5	703	5	708	5
Wastewater Treatment Plant	56.0	19.9	75.9	617	4	600	4	583	4	567	5	550	8	534	8	517	8	500	8	484	8	467	8	451	8
Landfill	45.0	33.5	78.5	517	5	528	6	540	6	551	6	563	6	574	6	585	6	597	6	608	6	620	6	631	6
Solar Energy Grid	46.3	33.4	79.7	515	6	526	7	537	7	547	7	558	7	568	7	579	7	590	7	600	7	611	7	622	7
Government Building	43.7	41.4	85.1	510	7	540	5	571	5	601	4	632	4	662	4	692	3	723	3	753	3	784	4	814	3
Street Lights	34.7	40.3	75.0	399	8	442	8	486	8	530	8	574	5	617	5	661	5	705	4	749	4	793	3	836	2

Note how the rank order of projects changes as the weight of climate-smart criteria increases (from left to right). The first column suggests the rankings that would result if only typical municipal criteria were considered in decision-making, while the final column shows rankings possible if only climate-smart criteria were considered. The water distribution system is at the top of the rankings according to typical criteria, and continues to fare well as climate-smart criteria are given greater weight. If only climate-smart criteria were applied, however, the top ranked projects would be the wind power installation and the conversion of street lights from incandescent to more energy-conserving LEDs. Note that climate-smart criteria include the evaluation of projects for cost-effectiveness. The solar energy grid (concentrated solar facility and electrical distribution system), as a relatively costly investment, would have received a much higher ranking on the right half of the table if criteria for cost-effectiveness were not part of the climate-smart group of criteria.

This hypothetical evaluation illustrates how criteria may be grouped and given proportional weight in the evaluation of projects, and shows how the weighting of climate-smart criteria can influence the rank order of projects and, by extension, the chances that any given project will be funded in a capital investment plan.

Generating low carbon alternatives to conventional projects

The decarbonizing potential of any capital investment plan is only as great as the set of projects proposed by local government departments. Technical staff must lead the process of identifying “climate-smart” alternatives to conventional projects. When this approach is adopted together with capital investment planning criteria that incentivize low carbon options at the portfolio level, the local government can catalyze a virtuous cycle of low carbon investment, because departments that submit low carbon projects would be more likely to secure funding in the budget. The green low-income housing sector in the US provides an interesting example of such a virtuous cycle (Box 1).

Box 1: “Climate Smart” Criteria for Affordable Housing in the United States

The federal low-income housing tax credit (LIHTC) program was established in 1986 to serve as an incentive for private investment in affordable rental housing. Although it is a federal program, state housing finance agencies guide the annual distribution of LIHTC through published documents called Qualified Allocation Plans (QAP). These QAPs define how applications for LIHTC money will be evaluated – and developers seeking this money must earn high marks against these criteria in order to compete for these funds. Since 2005, the number of green criteria – those related to smart growth, energy efficiency, resource conservation, and health protection—have steadily increased. In 2012, Connecticut and Maryland became the first states to achieve perfect scores on Global Green’s annual ranking of QAPs. Moreover, for the first time, the proportion of “A” states was greater than every other grade category. This is in stark contrast to the 2005 results in which no states received an “A” and seven states received an “F”.

The impact of including green criteria in QAPs is significant. According the Department of Housing and Urban Development, LIHTC units account for over one-third of all multifamily rental housing constructed each year. In 2010 and 2011, LIHTC units accounted for over half of all new multifamily rental units.

Sources:

Global Green USA. “2013 QAP Analysis: Green Building Criteria in Low-Income Housing Tax Credit Programs.” (November 2013).

Fuhry, Lauren and Walker Wells. “Green Goes Mainstream in Low-Income Housing.” *Planning Magazine* Volume 79, Number 9 (2013): 31-35.

www.huduser.com “Characteristics of LIHTC Projects, 1995 -2012”. Accessed November 11, 2014.

As suggested by the “climate-smart” criteria offered above, there are several approaches available to design projects that meet performance goals along with reduced carbon emissions:

- Reductions in scale or increases in density of the physical structure;
- Reducing the carbon-intensity of the fuel sources generated by or served to the structure;
- Designing or installing energy efficient or carbon sink technologies; and
- Designing to reduce the embedded carbon in materials and processes used in construction.

In this section, we offer a brief explanation of how these approaches may be implemented to produce low carbon alternatives to conventional infrastructure projects.

The scale of an individual project, both in physical size and density, is an essential driver of energy use and greenhouse gas emissions. With buildings, for instance, an extensive literature documents the relationships between energy consumption, area of interior space, area of the exterior walls, and numerous other endogenous and exogenous variables that are predictive for carbon emissions. Density influences wall space, and can be changed through either reductions in scale or increases in scale. Though planners debate this subject, all measures generally treat density as a function of the scale of the structure divided by the scale of the parcel it occupies (altered, for instance, by floor area ratios). Efficiencies in the use of space can have the effect of reducing energy demand by reducing the cubic meters of heated and cooled space needed to perform the same amount of work. Scaled up, efficiencies reduce demand for development.

Projects proposed in capital investment plans are intended to serve a programmatic purpose, which can also be expressed in quantified units. Performing the same programmatic function in a facility that is reduced in physical size will reduce the energy needed to power that facility and provide that function. Increases in density allow further energy reductions per programmatic unit. Conversely, proposed projects may be bigger than necessary, utilizing more energy during a lifetime of operations and maintenance, as well as greater capital costs (Jowitt et al., 2011, 92). ‘Right sizing’ buildings and other common urban infrastructure investments such as roads can also help to reduce embodied carbon—carbon emitted into the atmosphere during the production of the construction materials themselves. Although there will be some major infrastructure projects, such as the electrical transmission system for a city, that cannot be downsized, the scale of a project is often one helpful dimension to consider.

One of the most effective ways to reduce carbon emissions is to switch to less carbon-intensive fuels (IPCC Working Group III, 2014, 41). According to the most recent report by the IPCC, over 25% of global emissions come from the energy supply utilized—more than any other sector (IPCC Working Group III, 2014, 14). This is because most of the world’s infrastructure is powered by fossil fuels such as coal, oil, and natural gas. In 2010, these three types of fuel provided 80% of the world’s energy (U.S. Energy Information Administration, 2013). Every kWh of energy switched to renewable sources such as wind, solar, and hydroelectric power eliminates the direct emissions associated with energy supply. Also, switching between fossil fuels can provide emission reductions. For instance, natural gas generates less CO₂ per kWh than oil or coal (U.S. Energy Information Administration, 2011). This reduction will not be nearly as great as switching to renewable sources, but a reduction in emissions will occur nonetheless. All approaches matter – emission reductions can be achieved through investments in localized renewable energy generation (e.g., distributed solar or wind), in the local movement toward increased proportions of renewable sources, and in the movement of centralized generation to lower carbon sources.

To incorporate energy saving (or carbon sink) technologies into proposals would require the designers of buildings and other infrastructure assets to collaborate for this purpose, perhaps consulting different references (e.g., product specifications) and vendors than they may be accustomed to, and familiarizing themselves with the features, specifications, and tolerances of alternative materials and products. The process of design would be similar to that undertaken for a conventional facility, but the phasing of participation and the parameters governing the approach to the design would be different. For example, passive design strategies are critical to reducing energy loading in buildings and infrastructure. Passive design is a way to utilize the natural resources available at the site to reduce required inputs. By considering site characteristics, the design team can maximize the use of existing features in the natural environment (as opposed to manufactured, energy intensive features) to provide desired operating parameters and uses for the facility (Grondzik et al., 2009, 287). One example of a passive design strategy, for instance, is the incorporation of daylight and solar radiation through the installation of insulated windows to reduce electricity needs. Technologies that take advantage of passive design strategies, such as cross ventilation for a building and geothermal heat for power generation can dramatically cut a project’s greenhouse gas emissions. There are hundreds of such technologies.

The designers of facilities are also key participants in decisions about the scope, materials, and procedures to be used in construction, and thus the amount of carbon embedded in the materials and emitted as a result of construction. The rehabilitation, retrofit, and recycling of existing infrastructure and materials takes advantage of the fact that carbon was already emitted during the production process of existing concrete, steel, brick, and wood. As with the pursuit of lower carbon emissions in the operation of facilities, designing for lower carbon embedded or emitted during construction necessitates a shift in the process, references, and expertise utilized.

Expanding the time horizon of the capital investment plan

The purpose of extending the timeframe is to allow the capital investment plan to reflect, more directly, the goals expressed in long-range plans, and to create the expectation of exhibiting, in the capital investment plan, the savings to operations and maintenance that are made possible through low-carbon investments. The intention is for plans to result in a set of proposals plausibly financed in current and immediate future budget years, with a more coherent picture of their fiscal impact and ties to other planned future commitments.

Forecasting carbon from projects proposed in the capital investment plan

Local governments that forecast the aggregated carbon anticipated from proposed infrastructure projects in their capital investment plan will be taking a critical step toward recognizing, and thus potentially avoiding, unnecessary contributions to global warming.

Measuring carbon in the capital investment planning process will also allow for the direct transfer of information from a local government's greenhouse gas inventory to its capital investment plan, and vice versa. Quantifying a city's emissions allows the government to identify which sectors contribute most to overall GHG emissions and thereby strategize how best to reduce those emissions. The capital investment plan is the most opportune place to apply inventory information, if it is to be put to use in reducing emissions.

The emissions accounting for infrastructure assets in local government's greenhouse gas inventory can be used as a "conventional" baseline scenario, against which to measure reduction potential from the climate-informed capital investment planning process. Establishing a conventional project to compare against mitigation alternatives is extremely important for quantifying greenhouse gas reductions (World Resource Institute, 2005, 50). Having an inventory can also ease the effort of forecasting future emissions from proposed projects. However, given the availability of numerous tools and calculators for estimating emissions from buildings and other various types of infrastructure, it may be fairly easy for local governments and special purpose organizations to forecast measures of emissions for proposed projects, even if they do not yet have a greenhouse gas inventory.

One common emissions accounting protocol, Local Government Operations Protocol, developed in a partnership between The Climate Registry, ICLEI, and others, requires a local government to determine the emissions from its infrastructure assets in one of two ways. Local governments with continuous emission monitoring systems can use those systems to directly monitor emissions produced in the exhaust stream of the asset. Local governments without this technology can estimate emissions by

multiplying activity data from a given project, by its emission factor, the quantity of greenhouse gases produced per unit of energy (CCAR et al., 2010, 40). This can be done using a formula such as the one below (CCAR et al., 2010, 42).

$$CO_2 \text{ emissions (MTCO}_2\text{)} = \text{electricity use (MWh)} \times \text{emission factor (MTCO}_2\text{/MWh)}$$

The CURB (Climate Action for Urban Sustainability) tool enables local governments to analyze the impacts of different interventions designed to reduce local GHG emissions, improve air quality, and cut local energy demand. The software-based tool, developed by the World Bank in collaboration with the C40 Cities Climate Leadership Group and AECOM, allows local governments with emissions inventories to forecast how their city's emissions will change over time; compare their energy and emissions performance to peer cities; explore which actions can help the municipality achieve its reduction targets in a cost effective manner; and access other information germane to the development of a climate action plan.

Existing tools, however, may not contain parameters amenable to a particular proposed project. The Climate Registry's protocol stipulates that, in the absence of data for a given piece of infrastructure, energy use should be estimated based on another infrastructure asset of similar size and use (CCAR et al., 2010, 44). For example, if a municipality has energy data from an existing hospital, that data can be used to estimate the probable energy use of a new hospital, given that it is of similar size and energy requirements. If no such data exists, there are tools that give rough estimates of energy use for different types of building uses per location (e.g., IFC's EDGE tool). Again, multiplying energy data by the appropriate emission factor yields the greenhouse gas output of the asset. This information can be fed directly into the capital investment plan.

Even if a tool or calculator does not already exist, the specifications of the technologies incorporated in the design of the projects may be used to generate rough forecasts of emissions from future investments. Estimates can also be generated by comparing the energy-related features (i.e., energy generated and/or consumed) of common infrastructure technologies to one another (e.g., steam compared to combined combustion and steam natural gas turbines, fluorescent compared to LED streetlights). Though greenhouse gases occur in several forms, it is common to discuss the emissions of gases in terms of the equivalent measure of carbon dioxide they would create (CO₂e, or "carbon"). If the emissions are in a form of gas other than carbon (i.e., methane gas), a ratio can also be applied to convert the form of emission to carbon equivalent. The information necessary to generate these rough forecasts would include the type of project, scale of project, sources fuel and technology used to generate energy, and technologies incorporated in the project that consume or conserve energy. Thus, if proposals for investments could describe the features of the project relevant to energy generation and consumption, this information could be used to estimate future emissions, in carbon equivalent, from the operation of the facility.

If emissions for any given infrastructure project are already estimated in the capital investment plan prior to the beginning of operations, that information can then be incorporated into the local government's next greenhouse gas inventory. Before this can happen, actual energy use should be

monitored and reported to ensure that the estimates used were correct. Continuous emission monitoring systems could be used as well to determine if local conditions have had an impact on the emission factors estimated in the investment plan. Once it is confirmed that emissions are consistent with those predicted in the capital investment plan, the information can be incorporated into the inventory. If the actual emissions differ from those predicted, that information can be used to improve the emission factors and/or energy use estimates for future capital projects.

8 A “Climate-Informed” Procedural Model

To incorporate the four “climate-smart” criteria and approaches described above into the typical capital investment planning process, would result in the following modified steps, highlighted in bold and italic text:

1. Prepare the organization and schedule.
2. Establish fiscal policies to be applied in the development of the capital investment plan.
3. ***Integrate “climate-smart” criteria into the universe of criteria to be used in evaluating proposals for capital investment.***
4. Assign weight to each criterion, ***ensuring that sufficient weight is devoted to “climate-smart” criteria.***
5. Identify the objectives to be served by capital investments.
6. ***Identify, through pre-design, a conventional project and low carbon alternatives to meet each policy objective.***
7. ***Select preferred alternatives to meet each policy objective.***
8. Generate proposals describing the capital investments to be evaluated.
9. Evaluate, with subjective and/or objective (standardized) scores, each proposal against each pre-determined criterion (objective scores for “climate-smart” criteria could include measures of carbon and cost).
10. Aggregate the scores given to each project for each criterion (e.g., average score), apply the weights given to each criterion to produce a single score for each project (e.g., weighted average score), and rank projects in order of indicated preference (e.g., high to low weighted average score).
11. Arrange proposed investments, with preference to rank order, into one or more draft capital investment plans within the limits accorded by fiscal policies, human resources, and current/forecasted available funds over time (including commitments to prior approved capital investments).
12. Select and formally adopt (by ordinance or resolution) a capital investment plan.

Measuring the “Wedge”

By evaluating the carbon output of each proposed infrastructure project in its conventional and alternative forms, this modified, “climate-informed” capital investment planning methodology would allow decision-makers to see exactly what emissions reductions they are achieving. They can use this information to check their choices of alternatives at step 7, and to check to see whether the prioritized

proposals, in step 10, or funded projects in steps 11 and 12, will have the desired effect on carbon emissions. The difference between the emissions that would have resulted from conventional investment choices, and the emissions that would result from the actual investments selected for financing in the capital investment plan, is the “wedge” of emissions that were avoided.

The wedge is one of several calculations that can be generated through the inputs provided in the process. The data can illustrate to local government officials the potential impacts of their infrastructure choices over the span of the capital investment plan. The same data can be used to show the total amount of carbon emissions anticipated for the designed life of all proposed investments, conventional and “climate-smart.” These results should be illuminating. They will allow decision-makers to see *ex ante* the roles their local investments, in various sectors, would play in the global problem of climate change, to realize their options, and to take action to reverse this trend. Moreover, the data could be used to calculate the cost-savings wedge of the investments, which could be a compelling rationale for climate-informed decision-making across a broad spectrum of stakeholders. In all cases, there is a need for coordination between those who prepare, evaluate and monitor the carbon inventories and those whose responsibility include capital investment planning.

While all cities will need to reduce carbon emissions in order to avoid the consequences of climate change, measuring the wedge will prove especially useful for local governments that have self-imposed or mandated reduction targets. In the United States alone, over 200 municipalities have set greenhouse gas reduction targets, and nations and local governments around the world are doing the same (ICLEI, 2010, 35). Successfully meeting a reduction target means that the local government must analyze current and future emissions and come up with strategies to reduce them. ICLEI lists the identification and prioritization of emissions reducing actions as two important parts of the process for climate action planning (ICLEI, 2005, 9). The “climate-informed” methodology for capital investment planning detailed here allows local governments to do exactly this, and the wedge is the tangible product of that process.

9 Scaling Up, with Low Thresholds for Empowerment

Global trajectories for reducing carbon emissions depend on the local adoption of alternatives to conventional energy sources, technologies, and urban development. Yet, decisions on which type of capital investments to make, made by local governments as part of the normal budget cycle, typically do not incorporate climate-smart considerations. Furthermore, current academic and professional literature specific to climate change draws attention to decision-making tools that would require access to technical expertise, data, and financial support that may not be practical for local governments in developing countries. Arguably, the methodologies most able to effect this transformation will be those that are convenient and affordable to administer, and that offer straight-forward low carbon alternatives to traditional forms of infrastructure investment. Current methodologies for capital investment planning that do not take climate change into consideration can result in prioritization of investments that diverge from a low carbon path.

In many developing countries, capital investment plans tend to be wish lists, and there is often a disconnect between the identified projects and the availability of financial resources. Moreover, the

process of formulating the plans is not as structured and transparent as what is advocated by experts. As part of decentralization agendas, many countries are now requiring local governments to establish capital investment planning processes as a tool for good urban governance and management. This is a window of opportunity. Although the methodology described in this paper could be most readily used by cities in developed countries that have established budgeting processes and sophisticated data systems, the basic approach (i.e., inserting climate considerations into local decision-making processes) could be applied to cities with a range of capacities, even those that do not currently have a structured capital investment planning process in place. The *Climate-Informed Capital Investment Planning Guidebook*, forthcoming in 2015, provides step-by-step guidance to local government staff on how to adapt the methodology to their specific context and institutional arrangements.

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