

The image is a composite of two nighttime city scenes. The top half shows a modern high-rise building with a distinctive arched glass facade, illuminated with blue and yellow lights. The bottom half shows a classical stone archway with a statue on top, illuminated in white, with blurred light trails from traffic in the foreground. The left side of the image has a vertical orange gradient overlay.

# *Energizing Green Cities in Southeast Asia*

THREE CITY SYNTHESIS REPORT



THE WORLD BANK



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# Foreword

Cities currently account for about two-thirds of the world's annual energy consumption and about 70 percent of the greenhouse gas (GHG) emissions. In the coming decades, urbanization and income growth in developing countries are expected to push cities' energy consumption and GHG emissions shares even higher, particularly where the majority of people remain underserved by basic infrastructure services and where city authorities are underresourced to shift current trajectories. These challenges are facing many cities and hundreds of millions of people in the East Asia and Pacific (EAP) region, which is experiencing unprecedented rates of urbanization, as the region's urban population grows almost twice as fast as the world's urban population.

This report lays out the challenges and proposes strategies for sustainable urban energy and emissions planning (SUEEP) and development. It shows that the above challenges also present a unique opportunity for EAP cities to become the global engines of green growth by choosing energy efficient solutions to their infrastructure needs and avoiding locking in energy-intensive infrastructure that has accompanied economic growth in the past.

The SUEEP studies in the three pilot cities—Cebu City (the Philippines), Da Nang (Vietnam), and Surabaya (Indonesia)—show a clear correlation between the scaling up of energy efficiency in all major infrastructure sectors and economic growth. This relationship is recognized by the municipal governments in the three pilot cities and has been incorporated into their visions of

green urban development. Achieving this vision requires institutional reforms and capacity building, including strengthening energy governance at the municipal level. Furthermore, to ensure effective implementation of their green growth plans, municipal governments will have to foster alliances and closely collaborate with a coalition of actors from the national, state, and local levels, and from civil society and the private sector, who share a commitment to advance the green economy.

The SUEEP framework presented here is designed to facilitate such collaboration and the development of capacity-building programs to strengthen energy governance and maximize energy efficiency across municipal sectors, as well as to help define actions and prioritize investments in energy efficient infrastructure. For this purpose, this report is accompanied by the *Sustainable Urban Energy and Emissions Planning Guidebook: A Guide for Cities in East Asia and Pacific*, which provides step-by-step guidance to help a city develop its own energy and emissions plan and link its aspirations to actionable initiatives to improve energy efficiency and reduce emissions.

The World Bank is committed to providing support to EAP cities for sustainable urban energy and emissions planning, and for mobilizing financing for priority investments in green infrastructure. We look forward to working hand in hand with cities to facilitate capacity building and public and private investments in programs that help them achieve their green growth objectives and a sustainable future for the generations to come.

John Roome  
Director  
Sustainable Development  
East Asia and Pacific Region  
The World Bank Group

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# *Abbreviations and Acronyms*

ADB	Asian Development Bank	IEA	International Energy Agency
AusAID	Australian Agency for International Development	ICLEI	Local Governments for Sustainability
BEEC	building energy efficiency code	IPCC	Intergovernmental Panel on Climate Change
BERDE	Building for Ecologically Responsive Design Excellence	ITS	intelligent transportation system
BRT	bus rapid transit	JICA	Japan International Cooperation Agency
C	centigrade	LED	light-emitting diode
CDM	Clean Development Mechanism	LEED	Leadership in Energy and Environmental Design
CDP	Carbon Disclosure Project	LPG	liquid petroleum gas
CFL	compact fluorescent lamp	LRT	light rail transit
CO <sub>2</sub>	carbon dioxide	M	million
CO <sub>2</sub> e	carbon dioxide equivalent	MCWD	Metro Cebu Water District
DAWACo	Da Nang Water Supply Company	PhP	Philippine peso
DONRE	Da Nang Department of Natural Resources and Environment	PJ	petajoule
EAP	East Asia and Pacific	PV	photovoltaic
ESCO	energy services company	SUEEP	Sustainable Urban Energy and Emissions Planning
ESMAP	Energy Sector Management Assistance Program	t	ton
EU	European Union	toe	ton of oil equivalent
F	Fahrenheit	TRACE	Tool for Rapid Assessment of City Energy
FIT	feed-in tariff	US	United States
GDP	gross domestic product	USAID	United States Agency for International Development
GEF	Global Environment Facility	VECo	Visayan Electric Company
GHG	greenhouse gas		
HPS	high pressure sodium		



## KEY MESSAGES

- 1. Fast-growing cities in the East Asia and Pacific (EAP) region will define the region's energy future and its greenhouse gas (GHG) footprint.** Rapid urbanization and growing standards of living offer a major opportunity to EAP cities to become the global engines of green growth by choosing modern energy efficient solutions to their infrastructure needs and by avoiding locking in the energy-intensive infrastructure of yesterday. The underlying studies in three EAP pilot cities (Cebu City [the Philippines], Da Nang [Vietnam], and Surabaya [Indonesia]) show a clear correlation between investments in energy efficient solutions in all major infrastructure sectors and economic growth—by improving energy efficiency and slowing GHG emissions, cities not only help the global environment, but also support local economic development through productivity gains, reduced pollution, and more efficient use of resources.
- 2. Mainstreaming energy efficiency on a citywide scale and introducing low-carbon policies require municipal governments to reform institutions, build capacity, and strengthen energy planning and governance.** The report reveals that a common barrier to implementing cross-sectoral urban energy efficiency and emissions mitigation programs is the absence of institutional mechanisms that support coordinated project evaluation, planning, and investment across infrastructure subsectors. However, the need for institutional reforms and capacity building is increasingly being recognized and brought to the top of urban development agendas in many EAP cities. This is clearly demonstrated in the three pilot cities, which are strongly committed to implementing their vision of green urban development. To ensure effective implementation of their green growth plans, municipal governments will have to foster alliances and collaborate closely with a coalition of actors from the national, state, and local levels, and from civil society and the private sector, which share a commitment to advance the green economy, placing it centrally within top strategic priorities for the city.
- 3. The cross-cutting nature of energy efficiency offers a unique platform for the identification and prioritization of green investments across all infrastructure subsectors as demonstrated through case studies in this report.** The Sustainable Urban Energy and Emissions Planning (SUEEP) process and methodology used in this study and outlined in the accompanying SUEEP Guidebook is designed to help city leadership formulate long-term urban green growth strategies and identify and evaluate investments in energy efficient infrastructure, thereby maximizing return on investment, relative green impact, and contributions to other social and economic development goals. The result is a high-quality pipeline of green investment projects across all key infrastructure subsectors that can be effectively communicated to local stakeholders, private investors, financing institutions, and the international donor community.

(continued)

## KEY MESSAGES, CONTINUED

- 4. Investments in green infrastructure require financing from both public and private sources in a coordinated manner.** Investments in the transportation and buildings sectors present some of the largest opportunities for scaling up energy efficiency at the city level. Financing these large investments in fast-growing EAP cities will require partnerships and coordination between public and private investors. SUEEP can help foster such public-private partnerships and mobilize green infrastructure financing by helping to prioritize and coordinate investment projects, as well as through systematic monitoring, reporting, and verification of the impact of the projects on the overall efficiency of energy use and GHG emissions at the city level.
- 5. The World Bank Group is committed to providing support to EAP cities in building capacity, creating long-term green growth plans, and attracting public and private investments in modern energy efficient infrastructure.** The Bank has accumulated global knowledge and experience in supporting institutional development and building capacity for planning and implementing green infrastructure investments in cities around the world, including successful urban development projects in the EAP region. Thus, the Bank is well positioned to assist municipal governments in building institutions, creating policies, and developing long-term green growth plans that will attract financial support and investments from both the private sector and the donor community. The SUEEP process and methodology presented in this report will serve as a starting point for transferring some of the best international practices and for providing a platform for such support and collaboration with all players in the local, national, and global arenas in achieving the green growth objectives at the city level.

## *Executive Summary*

Fast-growing cities in the East Asia and Pacific (EAP) region will define the region's energy future and its greenhouse gas (GHG) footprint. Rapid urbanization and growing standards of living offer a major opportunity to EAP cities to become the global engines of green growth by choosing energy efficient solutions to suit their infrastructure needs and by avoiding locking in energy-intensive infrastructure. The underlying studies in three EAP pilot cities show a clear correlation between investments in energy efficient solutions in all major infrastructure sectors and economic growth—by improving energy and GHG emissions efficiency, cities not only help the global environment, but they also support local economic development through productivity gains, reduced pollution, and more efficient use of resources.

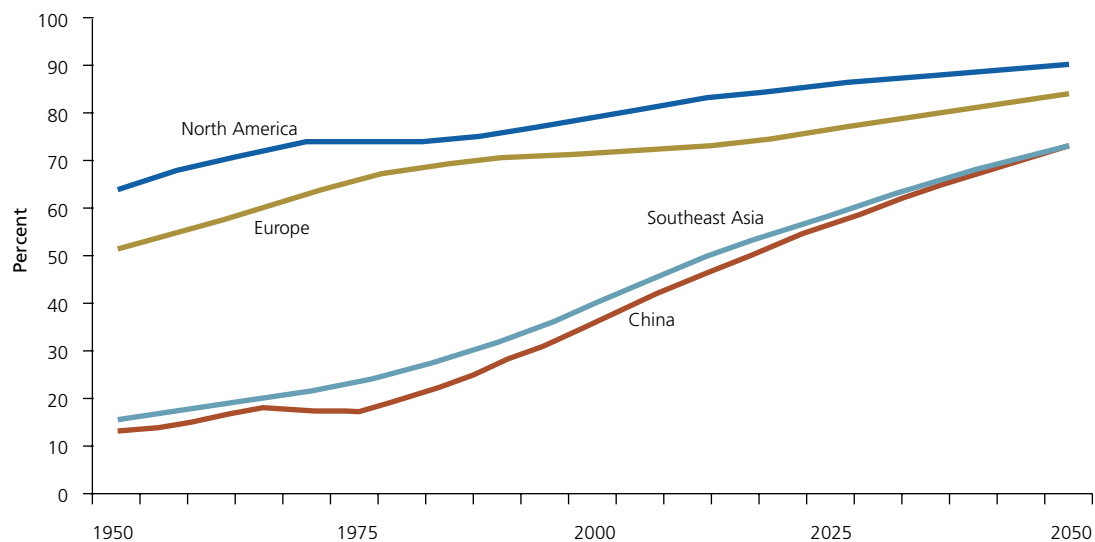
Mainstreaming energy efficiency on a citywide scale and introducing low-carbon policies requires city governments to reform institutions, build capacity, and strengthen energy planning and governance. The report reveals that a common barrier to implementing cross-sectoral urban energy efficiency and emissions mitigation programs is the absence of institutional mechanisms that support coordinated energy project evaluation, planning, and investment. However, the need for institutional reforms and capacity building is increasingly being recognized across the region, as demonstrated by the governments in the three pilot cities, Cebu City (Philippines), Da Nang (Vietnam), and Surabaya (Indonesia), which are strongly committed to implementing their visions of green urban development. To ensure effective implementation of their green growth plans, city governments will have to foster alliances and close collaboration with a coalition of actors from the national, state, and local levels, and from civil society and the private sector, which share a commitment to advance the green economy, placing it among the top strategic priorities for the city.

It is within the power of cities to develop policies and establish institutions to support citywide energy efficiency programs and green urban development. With the right institutional framework, cities can develop and implement policies supporting the next generation of urban infrastructure, which must be more efficient, smarter, and socially and environmentally sustainable. Such green infrastructure requires changing the way systems are designed and decisions are made, as well as the

application of advanced infrastructure solutions conducive to long-term energy efficient and low-carbon development paths.

The cross-cutting nature of energy efficiency offers a unique platform for the identification and prioritization of green investments in modern infrastructure across all infrastructure subsectors, as demonstrated through the case studies in this report. The Sustainable Urban Energy and Emissions Planning (SUEEP) process and methodology used in this study and outlined in the accompanying SUEEP Guidebook is designed to help city leadership formulate long-term urban green growth strategies and identify and evaluate investments in energy efficient infrastructure, thereby maximizing return on investment, relative green impact, and contributions to other social and economic development goals. The result is a high-quality pipeline of green investment projects across all key infrastructure subsectors that can be effectively communicated to local stakeholders, private investors, financing institutions, and the international donor community.

Investments in green infrastructure require financing from both public and private sources in a coordinated manner. Investments in the transportation and buildings sectors present some of the largest opportunities for scaling up energy efficiency at the city level. Financing these large investments in fast-growing EAP cities will require partnerships and coordination between public and private investors. SUEEP can help foster such public-private partnerships and mobilize green infrastructure financing by helping to prioritize and

**FIGURE 1.1. URBANIZATION RATE**

coordinate investment projects, as well as through systematic monitoring, reporting, and verification of the impact of the projects on the overall efficiency of energy use and GHG emissions at the city level.

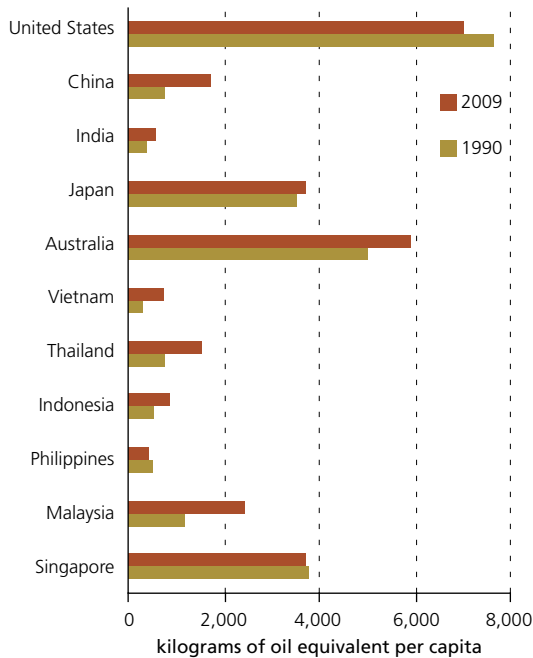
The World Bank Group is committed to providing support to EAP cities in sustainable urban energy and emissions planning, as well as to mobilize financing for priority investments in green infrastructure. The World Bank Group has accumulated global knowledge and experience in supporting institutional development and building capacity for planning and implementing green infrastructure investments in cities around the world, including successful urban development projects in the EAP region. Thus, the Bank is well positioned to assist municipal governments in building institutions, creating policies, developing long-term green growth plans that will attract financial support and investments from both the private sector and the donor community, and linking efficiency and low-carbon programs to international concessional financing and funding, as well as to the private sector investors who will play an important role in achieving green growth objectives.

### Urbanization, Economic Growth, Energy, and Emissions Trends

Cities around the world account for about 70 percent of global GDP, 67 percent of global energy consumption, and nearly 70 percent of world GHG emissions (IEA 2008). These figures are trending ever upward, and about 80 percent of global growth in urban energy use and 89 percent of growth in GHG emissions is expected to come from developing countries, and from EAP cities in particular. As rapid urbanization in EAP countries continues (see figure 1.1 for urbanization rates for Southeast Asia and China), national and city authorities will have to make decisions that will fundamentally define how cities will source and use their energy for decades to come.

Urban consumers require more energy as the economy grows and their standards of living rise. Urban growth and increased energy use are strongly linked to the economic growth required for cities to meet their diverse energy needs. In Southeast Asia, which is one of the world's least urbanized regions but whose population is expected to grow 1.75 times faster than the worldwide urban population (Yuen and Kong 2009), the rapid pace of urbanization is posing huge challenges for city governments to meet increasing energy demand in a

**FIGURE 1.2. CHANGES IN ANNUAL ENERGY CONSUMPTION PER CAPITA (1990 AND 2009)**



Source: IEA 2012.

sustainable manner. Given this, the report focuses on Southeast Asia.

Annual real GDP growth in Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam (which collectively account for close to 95 percent of GDP and 86 percent of the population for all ASEAN countries)<sup>1</sup> is projected to average 6 percent between 2011 and 2015. Income growth in urban areas is also leading to increased demand for new services, particularly those that use electricity. City sprawl, which has increasingly led to the development of areas not easily served by public transportation and has discouraged pedestrians, has resulted in an explosion of personal motor vehicles like cars and motorized two-wheelers. In addition, the lifestyles, and corresponding energy use profiles, of urban middle- and upper-income residents in the developing world increasingly mimic those of their counterparts in the developed

1. The Association of Southeast Asian Nations, or ASEAN, consists of 10 member countries: Brunei Darussalam, Cambodia, Indonesia, the Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam (OECD 2010).

world. These factors, coupled with EAP countries' low per capita energy consumption (see figure 1.2), ensure continued strong increases in urban energy demand across the region—demand that is expected to double during the next two decades.

Urbanization and economic growth in Southeast Asia have not only resulted in a continued increase in energy consumption, but also a profound shift in the energy mix. Although oil and gas will remain major sources of primary energy supply in Southeast Asia (accounting for 35 percent and 16 percent, respectively, in the ASEAN energy mix by 2030), coal is expected to have the fastest annual growth rate, 7.7 percent on average for the next 20 years in the business as usual scenario. This rate of increase would double the share of coal in the ASEAN energy mix from about 15 percent in 2007 to 30 percent by 2030. With a movement toward more carbon-intensive fuels, carbon dioxide (CO<sub>2</sub>) emissions per unit of energy consumption will increase from 0.49 tons of CO<sub>2</sub> equivalent per ton of oil equivalent (tCO<sub>2</sub>/toe) in 2007 to 0.63 tCO<sub>2</sub>/toe in 2030 in a business as usual scenario. Even in an alternative policy scenario considered by ASEAN countries to mitigate the rise of GHG emissions, the carbon intensity of energy consumption is expected to increase to 0.59 tCO<sub>2</sub>/toe by 2030. The main reason for the rapid increase in the share of coal and the carbon intensity of energy consumption is the quickly growing demand for electricity in the expanding urban areas—which are supplied by coal-fired power plants.

The region's governments and city authorities are capable of maintaining economic growth, improving environmental sustainability, and enhancing reliability of energy supply. Because energy efficiency and GHG emissions are influenced directly and permanently by urban form and density, cities' planning and infrastructure investment choices will have a substantial impact on energy and emissions trends (World Bank 2005). Furthermore, large EAP cities are increasingly vocal and influential in formulating national policies that will shape the energy future and the ways in which the cities source and use energy. Finally, cities will be the main arena for economic transformation and mainstreaming of energy efficiency policies and practices, which are the backbone of sustainable energy development in the region—a

**TABLE 1.1. SUMMARY OF STRUCTURAL AND ECONOMIC DATA FOR THE PILOT CITIES**

Parameter	Cebu City	Da Nang	Surabaya
Population (m)	0.8	0.9	2.8
City area (km <sup>2</sup> )	291	1,283	327
Population density (000's/km <sup>2</sup> )	2,748	711	8,458
GDP/cap/year (\$)	5,732	1,627	8,261
Economic structure (%)			
Services	73	56	50
Industry	19	42	32
Agriculture/other	8	2	18

Source: Authors.

sustained improvement in energy efficiency under an alternative energy scenario (ACE 2011) can provide a reduction of energy intensity of GDP from 580 toe/million US dollars in 2007 to 408 toe/million US dollars in 2030, compared with 501 toe/million US dollars under the business as usual scenario in 2030.

This alternative energy path requires a paradigm shift to new low-carbon development models and lifestyles. EAP cities need to avoid the carbon-intensive path and pursue sustainable lifestyles for their citizens by promoting novel urbanization

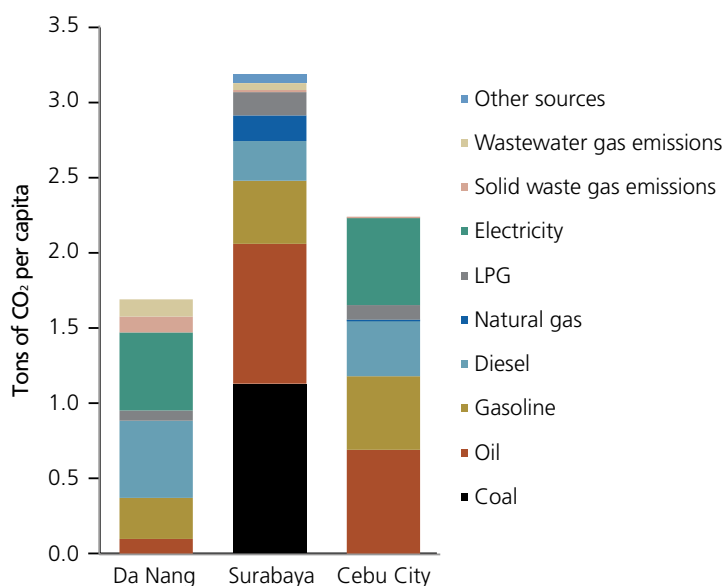
models (World Bank 2010c) focusing on compact city design, enhanced public transportation, green buildings, clean vehicles, and distributed generation. Smart urban planning—higher density, more spatially compact, and more mixed-use urban design that allows growth near city centers and transit corridors to prevent urban sprawl—can substantially reduce energy demand and CO<sub>2</sub> emissions and help cities become greener and more prosperous (World Bank 2009c). With support from AusAID, the World Bank Group initiated a regional program—East Asia and Pacific Sustainable Urban Energy and Emissions Planning (SUEEP) Program—to provide support and guidance to city governments in the EAP region to formulate such long-term urban energy strategies within cities' overall development plans.

### Understanding the Cities: Energy Use and GHG Emissions

The first phase of SUEEP was implemented in three Southeast Asian pilot cities—Cebu City, Philippines; Surabaya, Indonesia; and Da Nang, Vietnam. Pilot city key statistics are summarized in table 1.1.

The rapid population increase and rising standards of living in the three pilot cities are causing a considerable increase in city energy consumption. Da Nang is currently experiencing 11.7 percent yearly increases in energy consumption, which will lead to a doubling of energy demand in six years' time. The increases in Surabaya and Cebu City's yearly energy use are 4.9 percent and 4.3 percent, respectively, still notably high. The main drivers of the strong energy demand are the transportation sector and industry, which account for about 87 percent of energy consumption in Cebu City, about 66 percent in Da Nang, and 68 percent in Surabaya. Consequently, transportation and industrial emissions account for more than 53 percent of emissions for all pilot cities. Transportation alone is responsible for more than 40 percent of emissions in both Cebu City and Da Nang (see chapter 4 for more details).

Understanding the city energy balance and carbon footprint is the first step in formulating a long-term sustainable urban energy development strategy. The SUEEP approach uses three different city-level diagnostic tools to assess the city energy

**FIGURE 1.3. GHG EMISSIONS BY FUEL SOURCE**

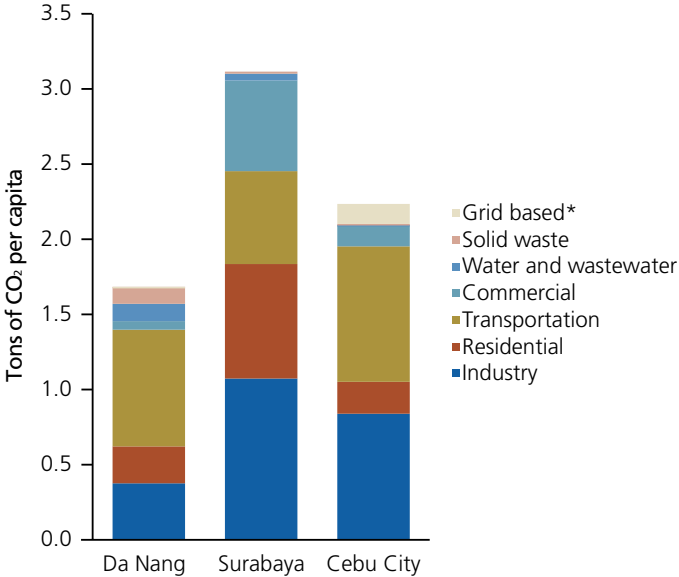
Source: Phase I pilot study.



profile. These include (i) the energy balance to analyze energy sources and uses across all sectors and categories of consumers, (ii) the GHG emissions inventory to determine the main sources of GHG emissions from energy use, and (iii) the Tool for Rapid Assessment of City Energy (TRACE) to evaluate energy efficiency opportunities in city sectors and identify priority areas for further investigation and intervention. An example of a GHG emissions inventory based on fuel source and sector for the pilot cities is shown in figures 1.3 and 1.4.

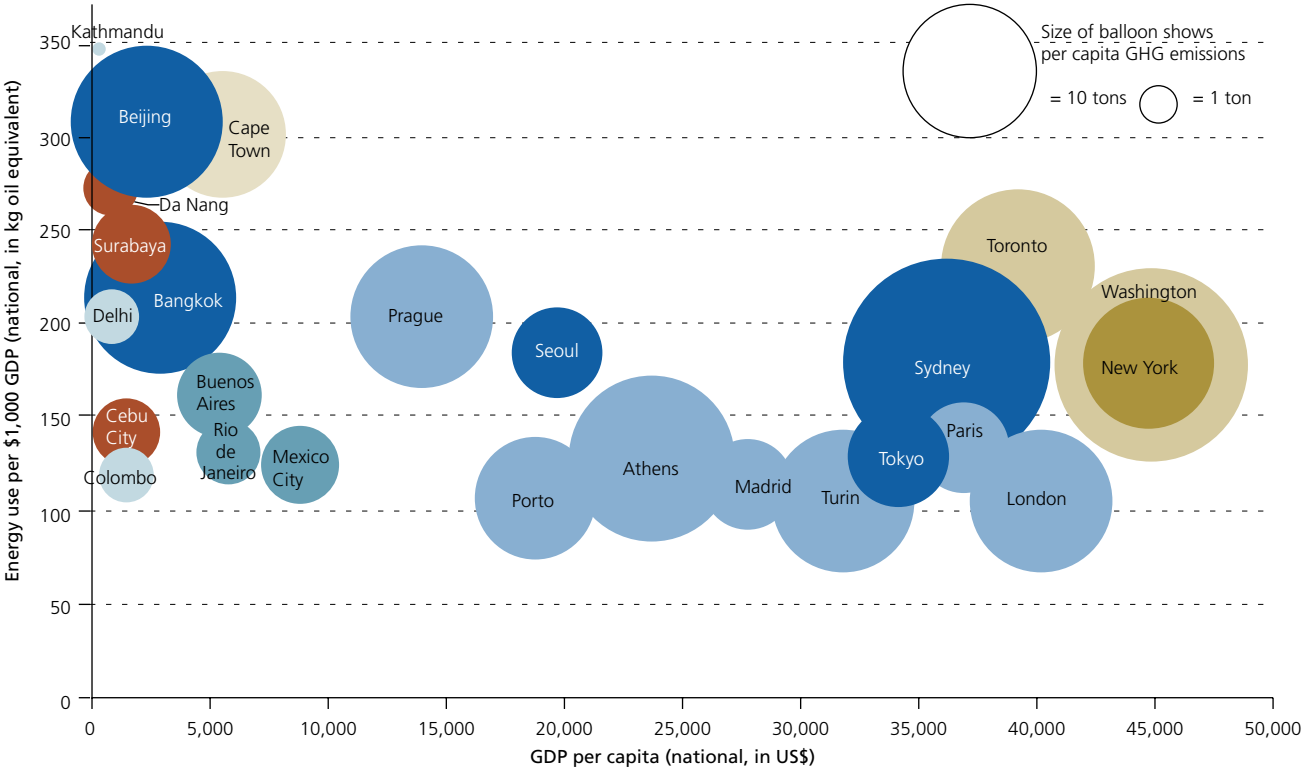
Most EAP cities, including the three pilot cities, have relatively low energy consumption and GHG emissions per capita. Figure 1.5 illustrates that the current level of energy consumption and associated GHG emissions is relatively modest in the three pilot cities when compared with many cities around the world and also suggests that countries can follow different paths in energy consumption and GHG emissions as GDP per capita increases. For example, the paths taken by Seoul and Tokyo

**FIGURE 1.4. GHG EMISSIONS BY END USE**



Source: Phase I pilot study.  
 Note: \*Grid based refers to electricity internally generated by the city. This is a separate category for Cebu City because data on end-use sector for electricity generated within the city were not available.

**FIGURE 1.5. ENERGY INTENSITY AND GDP PER CAPITA IN SELECT CITIES**



Source: Authors.

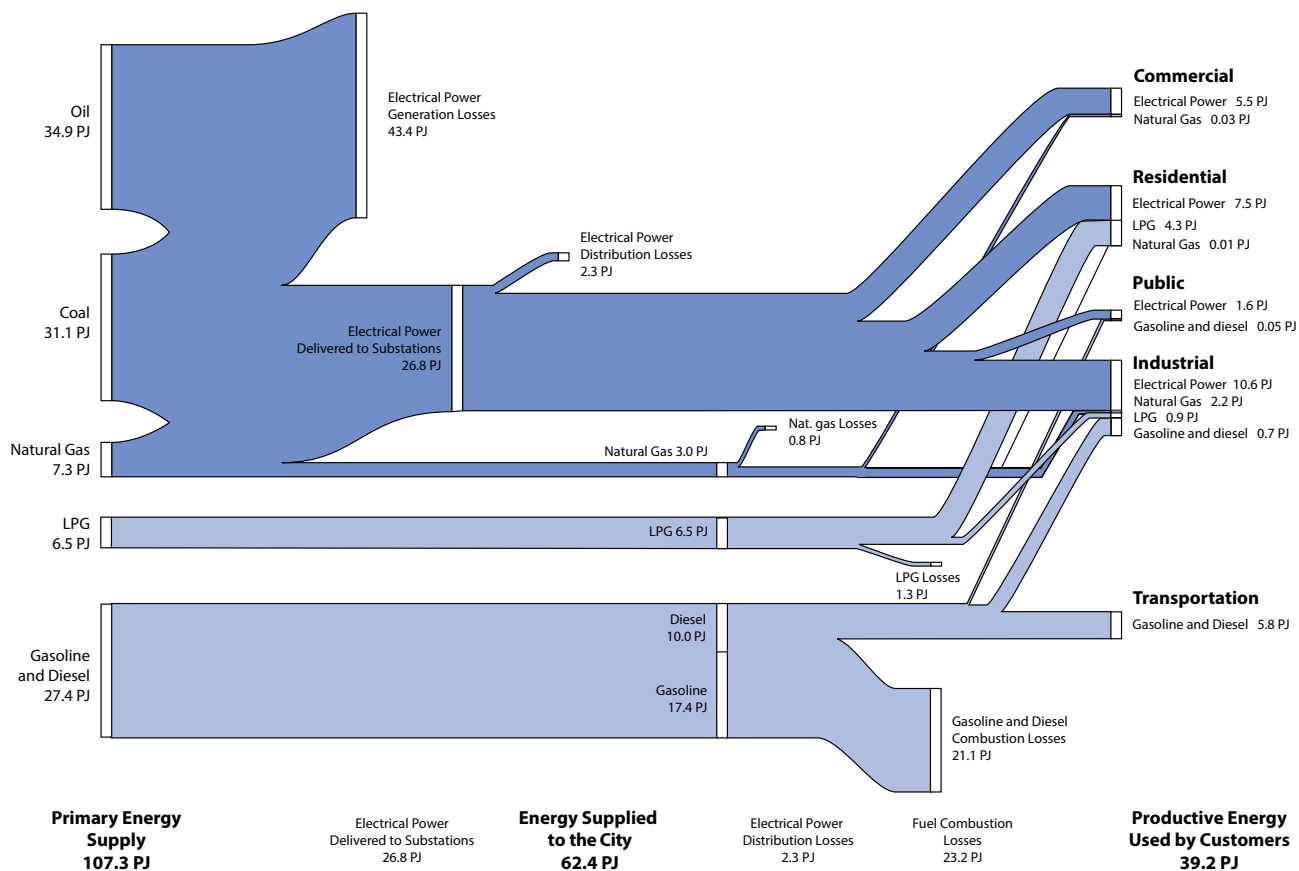
offer a greener alternative that calls for a significant reduction of energy intensity of economic activities (energy use per unit of GDP) and improvements in energy efficiency. Only Cebu City is currently at the level of energy intensity that makes such a path relatively straightforward, whereas Da Nang and Surabaya have longer paths to reduce the energy intensity of their economies.

The fuel used for electricity generation is a key determinant of the intensity of GHG emissions from energy. In Surabaya, electricity generated from coal-fired power plants is responsible for 36 percent of the city’s emissions. Cebu City and Da Nang both have significant amounts of renewable electricity generation (49 percent of electricity in Cebu City is generated by geothermal and hydro, and 30 percent of electricity in Da Nang comes from hydropower). Thus, GHG emissions

in Cebu City and Da Nang are significantly lower (per capita) and are caused mainly by diesel and gasoline fuels used for transportation and local (diesel-based) electricity generation.

All three cities source the vast majority of their electricity from the national grid. The use of distributed renewable energy production (such as solar photovoltaic) is at a very early stage in all three pilot cities. Apart from local power production, which is particularly prominent in Cebu City (11 percent of the electricity supply), most electricity is supplied by the national power grid. Therefore, the cities have limited influence over the choice of primary fuel and over the efficiency of energy conversion processes associated with the production and delivery of electricity. Furthermore, electricity tariffs and pricing policies (such as subsidies), which are key tools for demand-side promotion

**FIGURE 1.6. SURABAYA SANKEY DIAGRAM**



Source: SUEEP Pilot City Studies 2011.

Note: PJ = Petajoule. "Public" includes the end-use energy of city buildings, street lighting, city vehicles, water, wastewater, and solid waste management.

of energy efficiency, are outside city control. Thus, close collaboration between the city and national authorities is needed for developing an optimal approach to meet fast-growing urban electricity needs in a reliable, efficient, and environmentally sound manner.

Breakdowns of GHG emissions roughly match the three cities' energy use patterns but with some variation. Surabaya's energy balance (figure 1.6) illustrates the importance of fuel choice and conversion efficiencies in GHG emissions and the relative importance of energy efficiency in the industrial and buildings sectors. All three pilot cities will face challenges for achieving their economic development aspirations while managing growing energy demand and developing local generation capacity. More consistency in the cities' approaches to energy planning and

better coordination across departments would solidify the basis for improving energy efficiency and reducing GHG emissions on a citywide scale. Therefore, EAP cities will benefit from establishing strong sustainable urban energy and emissions planning approaches that take a comprehensive view of energy needs to future proof against unsustainable increases in energy consumption and GHG emissions.

There is a strong need in the pilot cities for further development of energy efficiency governance and capacity. The planning and management of energy is usually a multi-agency function, but none of the pilot cities demonstrated a cohesive approach that encouraged communication among the relevant agencies. In addition, some cities lacked any means of, or concentration on, coordination between national- and city-level initiatives.

FIGURE 1.7. COVER PAGE OF TRACE WEB-BASED TOOL

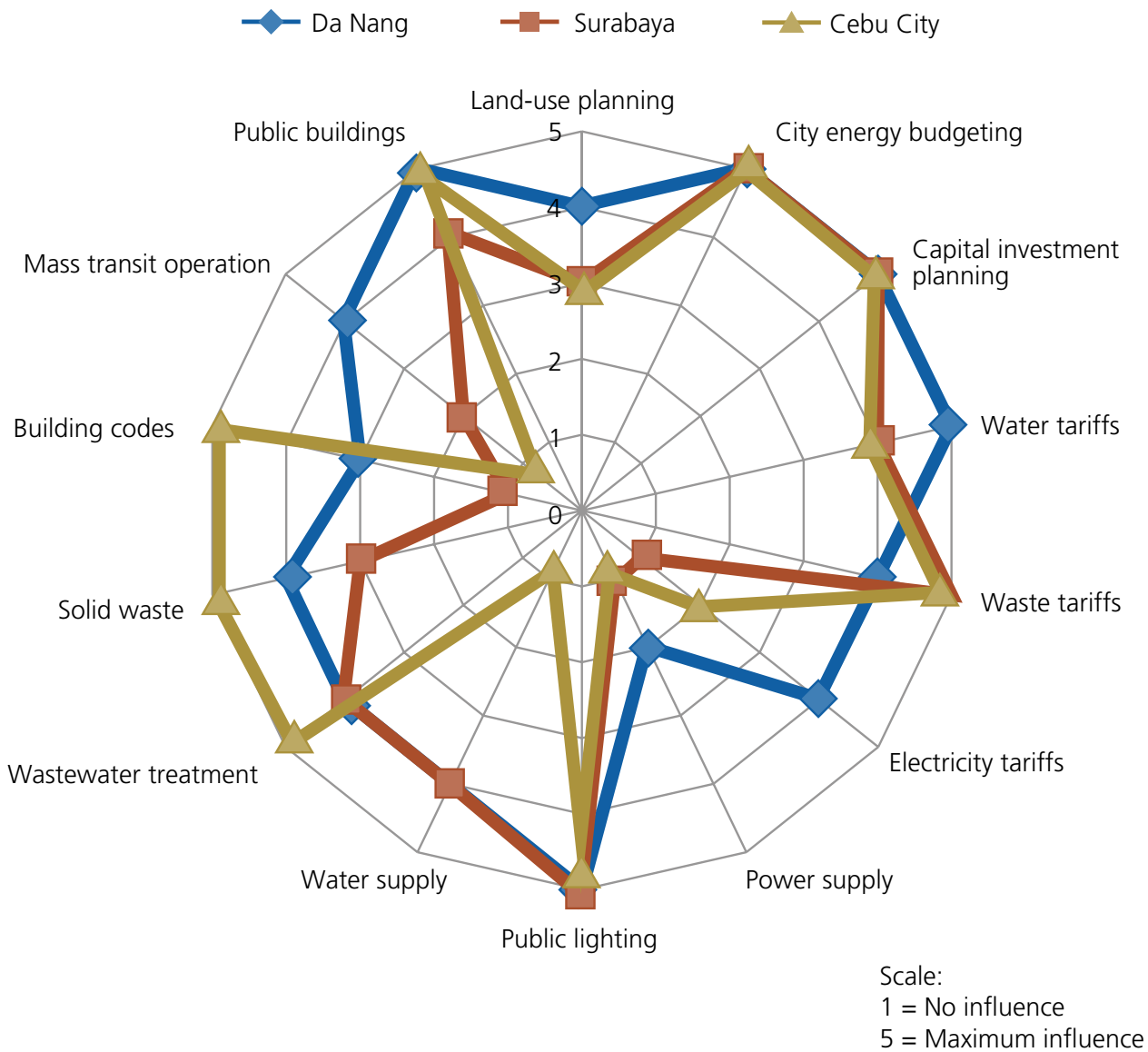


If conflicts between national and local policies, programs, and initiatives exist, cities are advised to proactively lobby the national government for action in areas that are outside of the city’s control or in which the government has promised action, but delivery is absent or ineffective in the city. The ability to influence the national government effectively requires cities to build energy governance into their institutional fabric and use it to lead and guide the planning and implementation of citywide energy efficiency programs.

The Tool for Rapid Assessment of City Energy (TRACE), developed by the World Bank Group’s Energy Sector Management Assistance Program (ESMAP),<sup>2</sup> offers a quick diagnosis of energy efficiency performance across a city’s systems and sectors. It prioritizes sectors and presents a range of potential solutions along with implementation guidance and case studies. TRACE is a software

2. For further details please visit <http://www.esmap.org/esmap/node/235>.

**FIGURE 1.8. LEVEL OF INFLUENCE OF CITY GOVERNMENTS IN VARIOUS SECTORS**



Source: Authors.

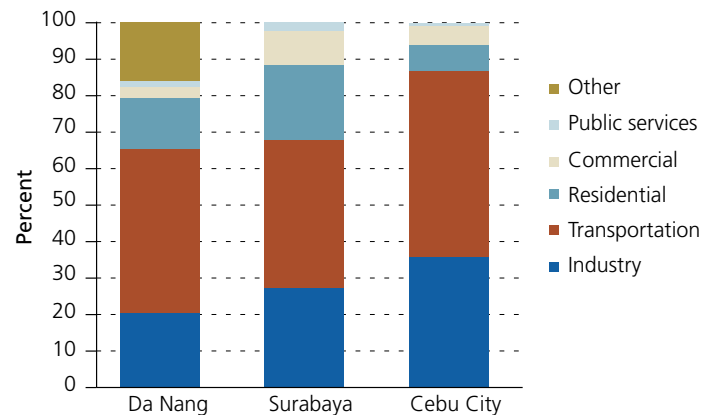
platform for assessing the energy efficiency performance of six city sectors or services: urban passenger transport, city buildings, water and wastewater, public lighting, solid waste, and power and heat. As shown in figure 1.7, TRACE consists of three principal components: an energy benchmarking tool that compares key performance indicators among peer cities, a sector prioritization process that identifies sectors with the greatest potential for energy efficiency improvements, and a “playbook” of tried and tested energy efficiency recommendations that helps in the selection of appropriate interventions. The TRACE deployment is a three-month assessment process that includes several weeks of upfront data gathering and benchmarking, sector meetings, and preparation of a final report. Based on TRACE results, city governments can identify early wins in key sectors and start developing city-wide energy and emissions strategies.

## Sector Diagnostics: Identifying Opportunities

The transportation and buildings sectors present the largest opportunities for scaling up energy efficiency at the city level. The buildings sector was found to have the most potential for success of energy efficiency measures based on city authorities’ high degree of control or influence, and the transportation sector accounted for significant energy consumption and GHG emissions (figures 1.8 and 1.9). The three pilot cities showed the potential to benefit from integrated transportation planning and the deployment of green building codes. However, public lighting has the most impact on city authorities’ budgets; therefore, energy efficiency improvements in this sector are a priority.

A comprehensive approach to integrated transportation planning is needed in all three pilot cities. The transportation sector in all pilot cities is responsible for significant energy consumption and GHG emissions and is thus a key target for action. The transportation sector is the single largest user of energy in Cebu City (51 percent), Da Nang (45 percent), and Surabaya (40 percent) and contributes significantly to GHG emissions in each of the three cities (Cebu City 40 percent, Da Nang 46 percent, and Surabaya 20 percent). Plans to implement public transportation systems in the pilot

**FIGURE 1.9. PRIMARY ENERGY CONSUMPTION BY SECTOR**



Source: Phase I pilot study

cities were generally not aligned with wider city-level planning strategies, giving rise to the potential for unforeseen challenges affecting the overall energy performance of the sector. Furthermore, trends in the three cities show a shift from non-motorized and public transportation to private vehicles. Compounding the problem of growing demand for private transportation, all three cities experience problems with the low fuel efficiency of their current vehicle fleets. Public transportation has the potential to reduce energy consumption and GHG emissions as well as to alleviate growing congestion and pollution problems, but the quality of public transportation in each of the three cities is deteriorating. High-capacity transit systems are absent in all pilot cities.

Building stock is set to double in the region during the next 20 years, and the sector’s energy consumption is projected to grow by 30 percent under a business as usual scenario (IEA 2010b). EAP cities have low building energy intensity (kWh/m<sup>2</sup>) because the existing building stock consists predominantly of smaller, low-rise buildings with basic lighting, air conditioning, and appliances. However, new buildings are responsible for a rapid increase in energy consumption in the sector because they have larger floor areas, and increased air conditioning, ventilation, lighting, appliances, and computers. Therefore, of all energy-consuming sectors, the buildings sector holds the most promise for cost efficient energy reduction. Voluntary

green building codes, which exist in all three pilot cities, reflect this opportunity. However, none of the green building codes have been implemented within city boundaries yet because most developers and financiers still perceive the associated market risks to be too high.

EAP cities are recycling waste through informal methods, but action is needed to capitalize on energy recovery and composting potential. As household income grows within the region, waste generation is expected to increase, underscoring the future need for formalized methods of waste processing. However, landfill gas capture projects appear to be difficult for the pilot cities—proposals for old landfills in two of the three pilot cities were not successfully concluded largely as a result of technical and institutional challenges. Cities need to be better equipped to take advantage of specialized procurement and funding arrangements such as public-private partnership opportunities and carbon finance.

The water and wastewater sectors face numerous challenges, including high leakage rates, lack of city-scale infrastructure, and low demand-side efficiency awareness. EAP cities can take action to improve or develop their centralized infrastructure by prioritizing energy efficient water resources, upgrading pumps, and addressing the high leakage rates that characterize the region. On the demand side, lack of awareness is a major challenge. Some EAP cities are implementing awareness campaigns, but as personal wealth and demand for resources increase, more aggressive demand-side management initiatives will be required.

Managing electricity peak load and increasing the efficiency of electricity supply are major challenges for the three pilot cities, and also provide opportunities for the application of smart grid technologies. Within the power sector, direct city-driven interventions to affect energy efficiency performance are limited to the demand side and to the provision of decentralized renewables, underscoring the need for cities to leverage their influence systematically at the national level to shape this sector. Cities can, however, successfully manage the demand side to reduce the extent of capacity expansion and can level off peak loads, mitigating the risk of rolling

blackouts. The recent advances in smart metering and grid-control technologies offer opportunities for cities to work with electricity suppliers to promote and harness demand-side energy efficiency and reduce distribution losses.

Many cities in Southeast Asia, including the three pilot cities, have the capability to increase the use of renewable energy and distributed generation. However, none of the pilot cities has a renewable energy master plan that can guide a scale-up of renewable energy production at the city level. Another way in which cities can improve efficiency of energy conversion and reduce GHG emissions is by increasing the use of natural gas and liquefied petroleum gas, including for distributed generation and other applications where it can cost-effectively replace other fuels and coal-fired grid-based power generation. However, these options are fairly limited at the moment because subsidies (at the national level) favor large power producers.

In the public lighting sector, EAP cities can take advantage of potential energy efficiency gains by replacing existing metal halide bulbs with more efficient technologies such as high pressure sodium bulbs or light-emitting diodes. In addition, optimized operation (on and off times) and maintenance regimes can further reduce energy consumption by this sector. The public lighting sector is characterized by a high level of city government influence and accounts for a considerable proportion of overall city energy expenditure. However, limited awareness of technology benefits and available financing are major barriers. All cities displayed some confusion about the benefits of energy efficient lighting technologies and concern about the capital funds required for replacement programs. Cities can address these issues through pilot studies to demonstrate improved energy performance and financial viability.

## The Role of Institutions

The institutional and policy environment is emerging, but EAP cities still lack cohesive, citywide regulatory frameworks in the energy sector. The degree of regulation and government oversight in the energy sector varies by country, but national and regional governments are always critical for



energy sector management and regulation, and the role of city government in setting energy sector policies and regulations is limited. However, this limitation does not prevent cities from planning and deciding what, where, and how urban energy infrastructure should be built. Furthermore, cities can take steps to influence national policies while continuing to influence local behavior through voluntary programs and incentives. Because city governments are intimately involved with every aspect of urban development and management and wield power and influence over urban energy demand, they have the unique ability to tie urban energy supply to demand.

Promoting sustainable urban energy development requires cities to build institutions, strengthen energy governance, and create conducive regulatory frameworks. Despite their significant regulatory powers, most cities in Southeast Asia have not effectively pursued sustainable energy planning and management practices. Several development gaps need to be bridged, including improvement of legal and fiscal frameworks, land-use planning, and development practices; leveraging of emerging technologies and innovations; and improvement of the institutional structures for effective monitoring, reporting, and management of city energy use and emissions. Filling the institutional gaps will help EAP cities to ensure that urban energy supply is reliable, efficient, and affordable, and that energy demand and emissions are efficiently managed. Cities can optimize operating costs, improve air quality, and improve quality of infrastructure services, while concurrently supporting economic development and climate change mitigation objectives. Given energy and GHG emissions' cross-sectoral nature, city governments need to evaluate options holistically. Within the urban planning framework, options must be assessed across sectors as well as across time because sustainability initiatives do not always have immediate impacts or quick roll-out strategies.

During Phase I of SUEEP, an institutional mapping exercise was undertaken in each city to establish the principal agencies and actors involved in the delivery and management of services that affect the city's energy efficiency and GHG

emissions profile. The outcome, presented in figure 1.8, shows that each pilot city generally has control of investment, budgets, and several local energy efficiency activities, as well as of certain aspects of public lighting, public buildings, and wastewater treatment and water tariffs. The main areas in which the city authorities' influence is limited relate to power supply and electricity tariffs. Significantly, in most other energy-related areas there is a mix of influence concentrated at the city level, with coordination between local agencies more likely if facilitated by the city government. This situation reinforces the need for city governments to be aware of their local circumstances so as to tailor their plans to their own needs and governance structures. The institutional mapping exercise is also useful for understanding the range of stakeholders that are involved in energy planning, delivery, and management, and serves to communicate to all parties the relevant responsibilities, ensuring that all understand why each stakeholder is involved. Furthermore, the institutional mapping exercise provides a means for understanding the interplay between agencies.

The limited number of policies enacted at the city level stems from the requirement to coordinate and institutionalize energy policies at a national level as part of the sustainable energy planning process. Implementing energy policies at the national level is more efficient and effective, and ensures consistency in application throughout the country. It is in the national government's best interests to work with individual cities on national-level policies and plans, because the efforts of city governments will be essential in the effort to achieve national energy and emissions policy goals and targets. National governments should provide clear guidance to cities on the direction they will take on sustainable development to enable cities to plan and, where possible, cooperate on issues for which national and city goals are aligned. In these areas, policies implemented by both the city and national governments can serve to reinforce each other, thus making efforts to develop the city sustainably more effective. The city government's key task would be to take the lead in energy and emissions planning and to implement and advocate for

changes that contribute to the advancement of its goals. City governments must recognize the level of influence they have in implementing policies at the city level and be fully responsible for sectors over which they have significant control (for example, street lighting, public buildings, and wastewater treatment). For sectors in which national policies affect the city, the city government should work closely and establish a strong dialogue with the national government. The city can seek support or financing for measures that are compatible with national goals and can ensure that city policies are not negatively affected by national ones. City governments should also work with national agencies and departments to coordinate activities and develop a mutual understanding of responsibilities and expectations.

A comprehensive sustainable urban energy and emissions plan should demonstrate a clear understanding of which of its components can be aided through national programs, and its leaders should engage with national agencies from the outset to determine the level of support that may be forthcoming. In discussing areas of common interest between the city and the national governments, cities can use the opportunity to secure support or financing from the national government to implement national policies. For example, in Da Nang several programs with significant energy efficiency components were implemented at the city level with coordination and cofinancing by a national agency (see appendix 3).

## Governance Mechanisms

SUEEP results in a strategic plan guided by a “vision” and a set of objectives that city authorities seek to achieve. Reliability, efficiency, and affordability of energy supply; reduction of GHG emissions; and the city’s adaptation to climate change should be strongly featured as strategic objectives in this process. An integrated strategic planning process enables providers of public services, from mass transportation to wastewater treatment, to contribute and identify opportunities that would lead to greater energy efficiency, cost savings, and reduced GHG emissions, while helping to define investment programs that respond to future demand projections.

To maintain momentum and traction after development of the plan, an institutional governance mechanism is required to formalize and govern its implementation. One of the principal institutional recommendations is for each of the pilot cities to establish a citywide energy and emissions task force to improve coordination and establish an integrated approach to energy planning and management. In all three cities, a committee or like group has already been entrusted with the governance of various aspects of energy and emissions management. Existing committees can be used by extending their mandates through broader terms of reference and enhanced powers (if necessary) to take on the role of the energy and emissions task force.

Because existing urban planning processes in the pilot cities rarely include a comprehensive citywide assessment of and plan for energy needs and systems, the pilot cities could consider proposing the plan for formal review and agreement by an executive authority to embed the energy and emissions plan into a long-term citywide strategy. By doing so, projects would no longer be at the mercy of political cycles, and the responsibility to follow through on the plan must be taken seriously. The pilot cities will have to consider the appropriateness of this route based on their respective governance structures.

Monitoring and reporting systems are crucial for providing credibility to energy and emissions management; therefore, policies need to be implemented carefully to ensure they do not increase costs unnecessarily, and that they address the needs of investors who may, at some point, become involved in financing SUEEP components. The establishment of a city-level platform for monitoring and managing energy and emissions is one of the first practical steps in implementing the vision of sustainable urban energy development, and is a prerequisite for mobilizing “green financing,” which requires verification and certification of reductions in GHG emissions.

Of the pilot cities, Da Nang had the most readily available energy data from a variety of government agencies; collection of energy data was much less routine in Cebu City and Surabaya. Even when data were available, sharing of data across departments was limited in all three cities. Sharing of

information, experiences, and knowledge will be a major opportunity for improvement of energy efficiency for all three cities. For example, analysis of trending information on population, vehicle use, traffic, economic growth, and industry would help all city agencies to make better decisions with regard to energy consumption and energy policy.

Effective monitoring and reporting systems should be structured and formalized in a way that demonstrates a high level of integrity and reliability and should cover the following:

- *Institutional arrangements*, roles and responsibilities assigned to individual agencies and personnel.
- *Boundaries*, defining what the energy and emissions inventories have included and excluded.
- *Sources of data*, including data from national agencies to city government collection arrangements and so forth. How data are collected and reported (for example, through surveys or meters), and the frequency with which data are collected, should all be defined clearly.
- *Data collation methods*, to provide transparency to the way in which raw data are processed. This is particularly important if proxy data or extrapolations have been used, or where data are incomplete.
- *Quality assurance processes*, to demonstrate that the methods, processes, and sources used have been adequately audited or reviewed to identify gaps, omissions, and potential improvements to the monitoring and reporting process.

Monitoring and reporting systems should strive for continual improvement to make them accurate, reliable, consistent, transparent, and complete.

## Next Steps

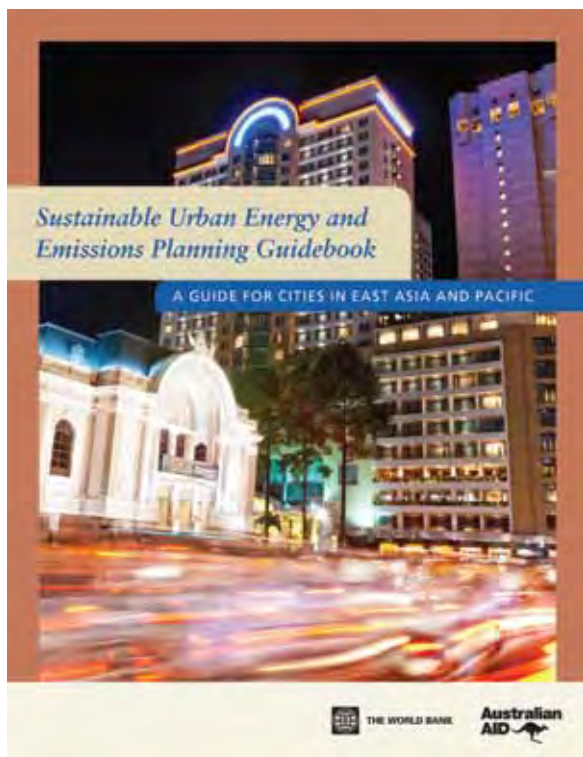
The results of the three pilot city studies demonstrated that there are significant opportunities for energy management and GHG mitigation in EAP cities, but challenges to achieving improvements remain. Lack of coordination and planning, and deficiencies in technical know-how, funding, and procurement capability all impede progress. Cities can address these challenges through improved energy governance and a robust energy efficiency and GHG planning framework.

Institution building enables cities to deploy effective energy efficiency programs by improving oversight and coordination of various energy-related initiatives across sectors. All three pilot cities had begun creating appropriate governance structures, but it did not appear that they had adopted a comprehensive approach by, for instance, actively engaging a broad range of stakeholders and legislatively formalizing the energy planning bodies. Cities need to ensure that energy governance is adequately structured to allow effective communication, coordination, and action.

The pilot cities also demonstrated a need for a SUEEP process to achieve improved energy management and GHG mitigation. The SUEEP process provides a comprehensive approach to planning to maximize energy efficiency across sectors, with the intent of helping cities to develop their own initiatives using different mechanisms. The SUEEP process also defines governance systems for implementation and for monitoring and reporting, which are important outcomes because they improve energy governance in the city and create a common platform for collaboration between the city and donors, civil society, and the private sector. The SUEEP process also provides a framework enabling city governments to prepare a pipeline of investments in energy efficient infrastructure (from mass transportation to wastewater treatment) as well as to mobilize “green financing” support. Despite the benefits of such a holistic approach, none of the pilot cities had established an integrated approach to energy planning or GHG mitigation, and the study revealed significant conflicts between various city plans, for example, transportation planning and land-use planning.

Although a comprehensive approach to planning, like the SUEEP process, is ideal, cities have different levels of capacity, resources, and priorities. Given this, city governments could engage with energy planning at three different levels. At the first level, the pilot cities could undertake a high-level, rapid assessment of its energy efficiency measures (for example, TRACE). The second level entails deeper sectoral engagements in selected areas (for example, public-private partnerships [PPPs] and sector-wide interventions). A city that is fully committed

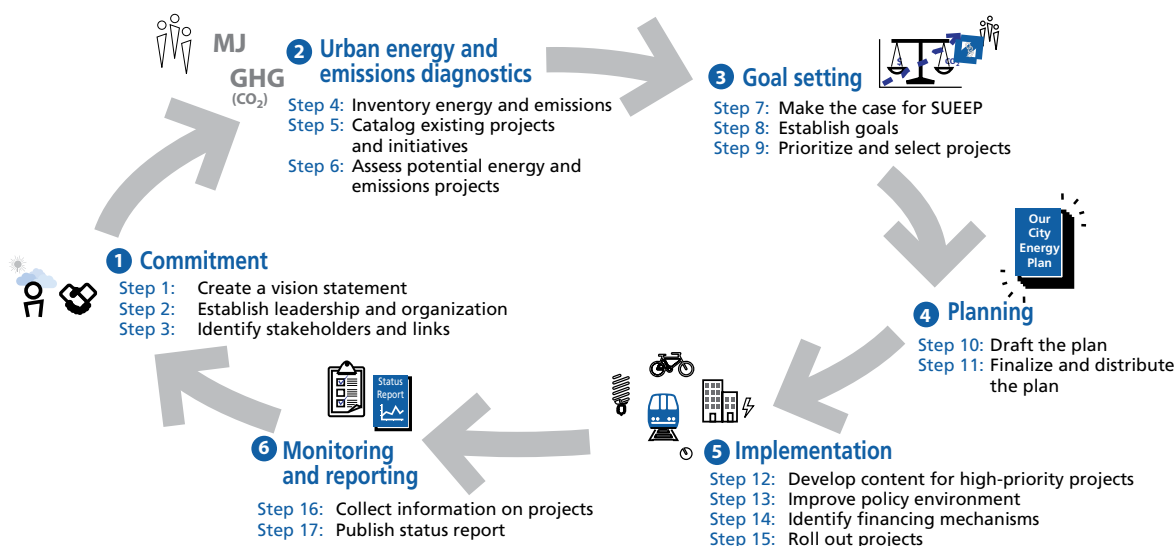
**FIGURE 1.10. COVER OF SUSTAINABLE URBAN ENERGY AND EMISSIONS PLANNING GUIDEBOOK**



to comprehensive planning could approach it from the third level—implementation of the full SUEEP guidelines.

City governments are in a unique position to achieve SUEEP goals through their own activities. Although their institutional arrangements and capacity are still works in progress, city governments perform several roles, including policy making, regulation and enforcement, and leading and facilitating across a broad range of stakeholders. A city government is the only body with this unique blend of roles and relationships, reinforced by the credibility and tenure to facilitate citywide, comprehensive, and strategic energy and emissions planning. City governments should also engage in strong dialogue with national governments, and where appropriate, align SUEEP with national and regional programs. This would attract broader support for SUEEP, which could be channeled to locally led initiatives and specific projects driven by the priorities and unique set of circumstances in each city.

**FIGURE 1.11. SUSTAINABLE URBAN ENERGY AND EMISSIONS PLANNING PROCESS**



SUEEP is a continuous process that evolves through institutional reform, capacity building, and implementation of priority investments. To develop a successful SUEEP process, cities must establish sustained city government commitment, create a baseline based on energy and emissions diagnostics, articulate a vision and goals, prioritize projects, develop an implementation plan, and regularly monitor and report on implementation progress. SUEEP has many benefits, including the following:

- identification of the principal energy and emissions issues facing the city;
- establishment of what can be achieved by the city government, as well as with the aid of other agencies, and how it can be achieved;
- integration of energy and emissions issues into wider city planning processes;
- coordination across sectors and agencies and the establishment of shared goals; and
- establishment of governance, monitoring, and reporting processes essential to future management of the issues, and that are prerequisites for third-party involvement in project and carbon finance.

Building on the three-city pilot work completed in Phase I, the project team developed a SUEEP Guidebook and Toolkit that cities can use to facilitate the development of their institutional capacity-building programs and sustainable energy and emissions plans. The Guidebook (see figure 1.10) and Toolkit are designed to give cities a starting point to begin planning for a more energy efficient development path, guiding leadership through each key step of the process, including crafting a vision statement, forming a task team, communicating with stakeholders, measuring urban energy consumption and emissions, setting green targets, preparing a sustainable urban energy and emissions plan, implementing and financing the plan, and ongoing monitoring and reporting (see figure 1.11).

The SUEEP Guidebook will be tested by the pilot cities and refined to support regionwide replication. In addition to assisting pilot cities

to develop their own SUEEP processes and create and start implementing their own sustainable urban energy and emissions plans, the next phase of the program will be the creation of a web-based platform that cities can use to measure and report energy consumption and GHG emissions, which is essential for the creation of carbon assets (such as GHG emissions reduction credits) and mobilization of carbon financing support.

Looking ahead, the attainment of long-term, sustainable urban energy and emissions development is not a goal easily defined or achieved. But the SUEEP process and its partners bring EAP cities one step closer through three critical contributions:

### *Institutional Development and Capacity Building*

The SUEEP process introduces a number of key foundation-building activities required to support long-term urban green growth strategies. The SUEEP guidelines bring clarity and international best practices to the institutional reform, policy development, and stakeholder outreach processes necessary to achieve targets. The SUEEP process also includes accounting tools cities can use to quantify their energy consumption and GHG emissions for use in target-setting, as well as for ongoing monitoring and reporting of results and implementation progress.

### *Creation of a High-Quality Pipeline of Green Investments*

Policy and institutions alone will not create green growth outcomes—investments in energy efficiency improvements and GHG mitigation activities will also play an important role. Through the SUEEP process, city leadership can evaluate investments comprehensively, based not only on their fiscal return, but also on their relative green impact and contribution to other social and economic development goals. The result is a well-defined pipeline of green investment projects that can be communicated not to just local stakeholders and financing institutions, but also to the international donor community and potential partners, including private investors.

### *Mobilization of Financing*

The international donor community's interest in supporting sustainable infrastructure for green growth in rapidly developing EAP cities is substantial. However, there have been many challenges: defining green city goals; identifying those activities that would optimally support green growth goals; ensuring local governments have the capacity and institutional structures needed to support both construction and maintenance of green investments; and

identifying means to measure success. The SUEEP process attenuates these challenges by (i) building an institutional and policy foundation for supporting green investments; (ii) setting up a quantitative system of indicators for identifying green growth targets and monitoring and reporting progress over time; and (iii) creating a long-term green growth plan and a well-defined, thoroughly evaluated pipeline of bankable investments that can be easily communicated to potential investors and financiers.



# Introduction and Background

## Urbanization, Economic Growth, and Impact on Energy and Greenhouse Gas Emissions

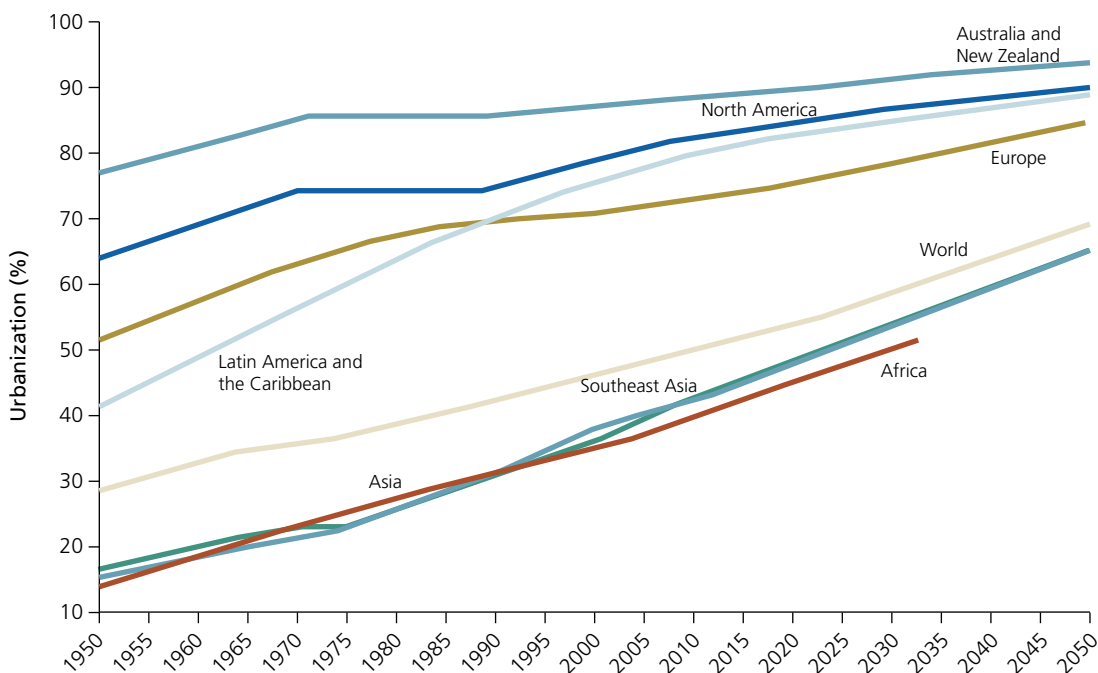
The movement of people from rural areas to cities is a prominent feature of the development process and a defining feature of the twenty-first century. The trend is likely to continue. The United Nations projects that approximately 60 percent of the world’s population will live in cities by 2030 as a consequence of the rapid urbanization in developing countries (see figure 2.1).

Cities, which account for about 70 percent of global GDP, are engines of economic growth.<sup>1</sup> Their rapid expansion is shaping energy demand and greenhouse gas (GHG) emissions. According to the International Energy Agency (IEA), cities accounted for about 67 percent of global energy requirements and 71 percent of world GHG

emissions in 2006 (IEA 2008). These figures are forecasted to grow—by 2030, cities’ share of energy demand and associated GHG emissions are projected to increase to about 73 percent and 76 percent, respectively (UN 2010). IEA further estimates that approximately 80 percent of the growth in energy use and 89 percent of the growth in GHG emissions by cities is expected to occur in developing countries, where the vast majority of people remain underserved by basic infrastructure

1. “Cities” refers to all urban areas including towns; the terms “city,” “urban,” and “municipal” are used interchangeably in this document.

**FIGURE 2.1. URBANIZATION, 1950–2050**



Source: UN 2010.

services and where city authorities are under-resourced to shift current trajectories.

Urban growth and increased energy use are fundamentally linked to the economic growth that cities need to develop sustainably. Global urban energy use patterns show an increasing trend in energy intensity, measured by energy used to produce one unit of GDP. According to IEA, global city energy use will grow by 1.9 percent per year, from approximately 7,900 million tons of oil equivalent (Mtoe) in 2006 to 12,374 Mtoe in 2030, compared with an expected overall global growth rate of 1.6 percent in energy use in the same period. Because of high levels of energy intensity in urban areas, the pattern of energy use in cities will increasingly shape global energy use.

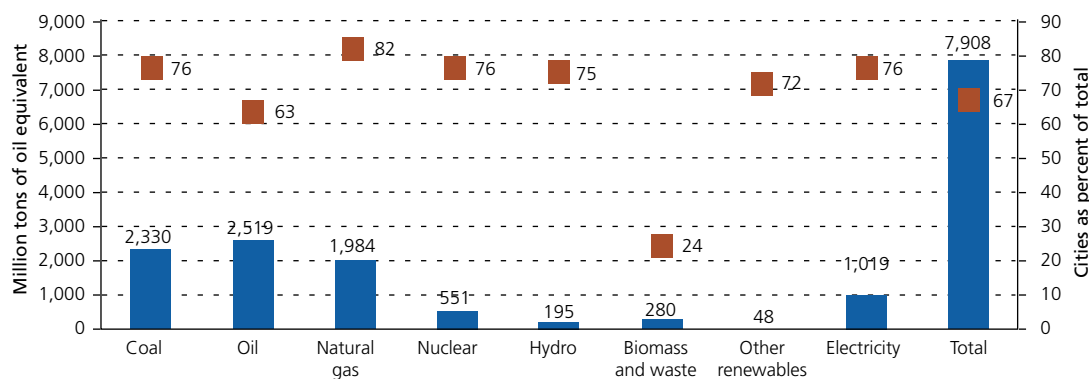
The share of natural gas (82 percent) and electricity (76 percent) consumed in cities in 2006 was disproportionate to the average consumption of all fuels (see figure 2.2), and much higher than the share of the world's population living in cities. This imbalance results from the more extensive infrastructure in cities for energy distribution and higher appliance ownership rates in developing-country cities relative to rural areas. Coal consumption in cities also accounts for 76 percent of the global total, mainly from coal-fired power generation. Figure 2.2 also illustrates that the share of oil consumed in cities (63 percent) is smaller than the average of all fuels, resulting from the higher penetration of electricity for heating and cooking

and wider use of motor vehicles for mobility of goods and people in urban areas. The share of biomass and waste consumption, at 24 percent, is much lower in cities than in rural areas. Use of renewables in cities is higher (72 percent), mainly for power generation in Organisation for Economic Co-operation and Development countries.

Given the close links between rapid urbanization, economic growth, and energy and GHG emissions growth, the way cities are planned, financed, and managed will be a determinant of sustainability outcomes and of the lives and livelihoods of city residents today and into the future, thereby placing cities at the forefront of the climate change and sustainability agenda. Therefore, policy makers have a vital role in directing the sustainable development of their cities through the identification of the main drivers of energy consumption and GHG emissions—and the implementation of policies and measures that aim to minimize the growth of these factors while enabling economic growth.

The rest of the chapter focuses on Southeast Asia. It is one of the world's least urbanized regions, but its urban population is growing rapidly—the rate of population growth is 1.75 times faster than worldwide urban population growth (Yuen and Kong 2009). This rapid urbanization rate means that Southeast Asia faces huge challenges in meeting increasing energy demand in a sustainable manner.

**FIGURE 2.2. WORLD ENERGY DEMAND IN CITIES, 2006**



Source: IEA 2008.

### *Southeast Asia: Trends in Economic Growth and Urbanization*

According to the *Southeast Asian Economic Outlook 2010*, economic indicators point toward steady economic growth in the region based on strong growth of exports, domestic consumption, and private investment, supported by improved business sentiment (OECD 2010). The average economic growth rate of the six major countries in Southeast Asia (Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam) reached 7.3 percent in 2010, compared with 1.3 percent in 2009. These six countries constituted 95 percent of total GDP and 86 percent of total population in Association of Southeast Asian Nations (ASEAN) countries in 2009.

Real annual GDP growth in the six Southeast Asian countries is projected to average 6 percent during 2011–15 (see figure 2.3). The region's steady growth will be led by above-average growth rates in Indonesia and Vietnam, supported by economic growth that is likely to rely on domestic consumption and investment.

Economic growth in Southeast Asia is inducing the migration of people seeking work, thereby resulting in an increase in urban population. Between 1950 and 2010, the urban population in the region (currently about 241 million people) grew from 15.5 percent to 41.4 percent and is expected to increase to 50 percent by 2025.

The effects of urbanization include a significant increase in an educated urban middle class that enjoys greater disposable incomes and uses

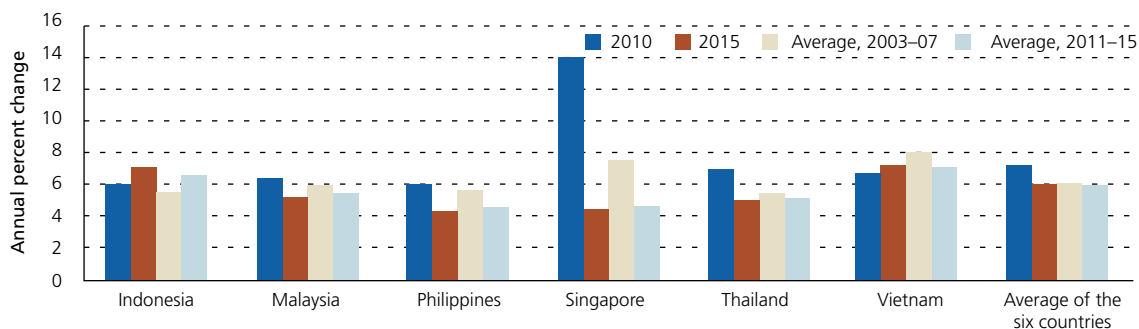
its newfound wealth to purchase goods other than basic necessities. Stability of income and employment, and increasing levels of home ownership, are also characteristics of increased urbanization. Most important, consumerism in the East Asia and Pacific (EAP) region has become a significant force in the urban economy.

#### Effects of Urbanization on Energy Demand and Energy Type

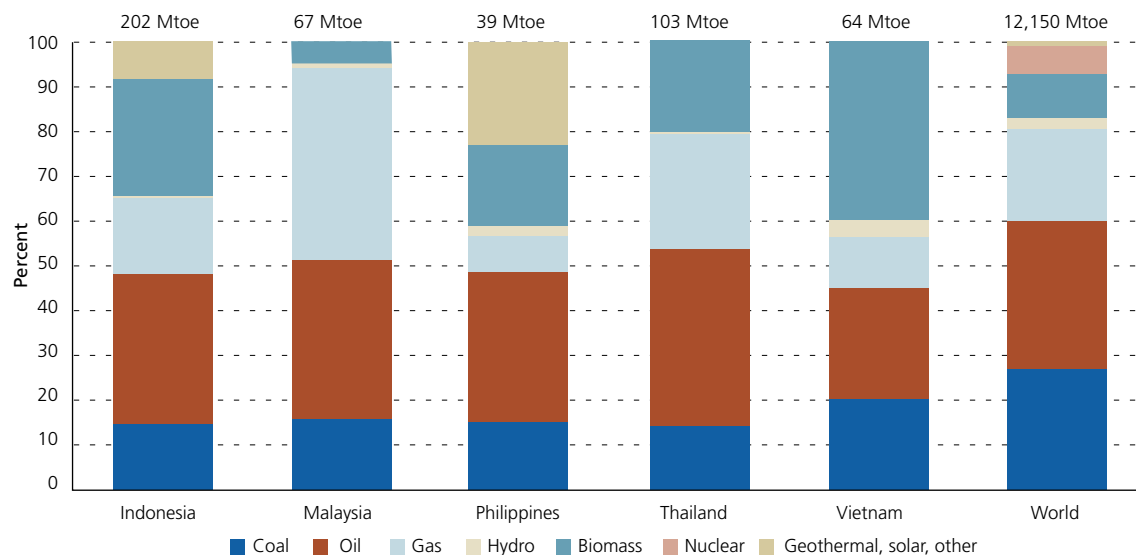
With urbanization and economic growth, energy consumers are expected to shift from carbon dioxide (CO<sub>2</sub>)-neutral energy sources (such as biomass and waste) to CO<sub>2</sub>-intensive energy sources (fossil fuels), leading to increasing GHG emissions in cities (IEA 2008). This trend is apparent in Southeast Asia. Urbanization and economic growth in Southeast Asia have not only resulted in a continued rise in the proportion of global energy consumed by cities, but have also caused profound impacts on the type of energy used. Oil and gas dominate the total primary energy supply mix of the five major economies of Southeast Asia (Indonesia, Malaysia, the Philippines, Thailand, and Vietnam), with coal accounting for a smaller portion of the energy supply mix (see figure 2.4).

Although coal accounts for a smaller portion of the energy supply mix than do oil and gas in these five economies, dependence on coal has substantially increased during the past three decades. Coal-exporting countries such as Indonesia and Vietnam have coal reserves and have significant incentives to continue increasing the share of coal in their energy mix. For coal importers—Malaysia,

**FIGURE 2.3. REAL GDP GROWTH RATES IN SOUTHEAST ASIA**



Source: OECD 2010.

**FIGURE 2.4. OIL AND GAS DOMINATE SOUTHEAST ASIA'S PRIMARY ENERGY SUPPLY MIX, 2009**

Source: IEA 2010a.

Note: Mtoe = million tons of oil equivalent.

the Philippines, and Thailand—dependence on imports to meet coal demand does not raise energy security concerns because of the relatively low share of coal in their energy mixes and the less volatile nature of coal prices (compared with oil) in the international market. For these reasons, the countries in Southeast Asia are likely to increase their use of coal significantly unless the environmental costs are internalized sufficiently to reverse this trend.

Southeast Asia's dependence on oil as an energy source has declined during the past three decades, although the extent of this decline has varied appreciably among the countries. Vietnam increased its share of oil in total primary energy consumption from 1980 to 2006, but Indonesia, Malaysia, and Thailand reduced their shares of oil to 40–50 percent from 80–90 percent in the same period.

The five countries have significantly increased their dependence on natural gas as an energy source over the past three decades. Fuel switching from coal to gas has been particularly notable in electricity generation. In the five countries, coal's share of power generation is only 21 percent, much smaller than the 57 percent share of gas, indicating that there is still considerable room for the expansion

of gas use in Southeast Asia in response to energy security and environmental concerns.

Oil and gas will remain major sources of primary energy supply in Southeast Asia (accounting for 35 percent and 16 percent, respectively, in the ASEAN energy mix by 2030), but coal is expected to have the fastest annual growth rate, at 7.7 percent in the next 20 years in the business as usual scenario. This will double the share of coal in the ASEAN energy mix from about 15 percent in 2007 to 30 percent by 2030. With a movement toward more carbon-intensive fuels, CO<sub>2</sub> emissions per unit of energy consumption will increase from 0.49 tons of CO<sub>2</sub> equivalent per ton of oil equivalent (tCO<sub>2</sub>e/toe) in 2007 to 0.63 tCO<sub>2</sub>e/toe by 2030 in a business as usual scenario. Even in an alternative policy scenario that is being considered by ASEAN countries to mitigate the rise of GHG emissions, the carbon intensity of energy consumption is expected to increase to 0.59 tCO<sub>2</sub>e/toe by 2030. The main reason for the rapid increase in the share of coal and the carbon intensity of energy consumption is the rapidly growing demand for electricity originating largely in the expanding urban areas that are supplied by coal-fired power plants.

An analysis of the energy consumption patterns in the five major economies of Southeast Asia over two different periods—1990 and 2009—brings the following observations to light:

- Total energy consumption and energy consumption per capita are still small fractions of that of developed countries (see figure 2.5).
- Vietnam has substantially reduced its energy intensity although there is much room for improvement because of its higher energy intensity levels in comparison with the EAP region (see figure 2.6).

#### Implications of Urbanization for Energy Use

Energy is intrinsic to urban settlements, embedded in the built environment; directly used to power socioeconomic activity, transport, and communications; and enabling the provision of city government services. Urbanization facilitates the transition from traditional energy sources (oil and coal) to alternative sources (gas and electricity). The urban poor rely on biofuels to meet a major portion of their energy needs, resulting in pressure on such resources.

The growth in income in urban areas is leading to greater demand for new services, particularly

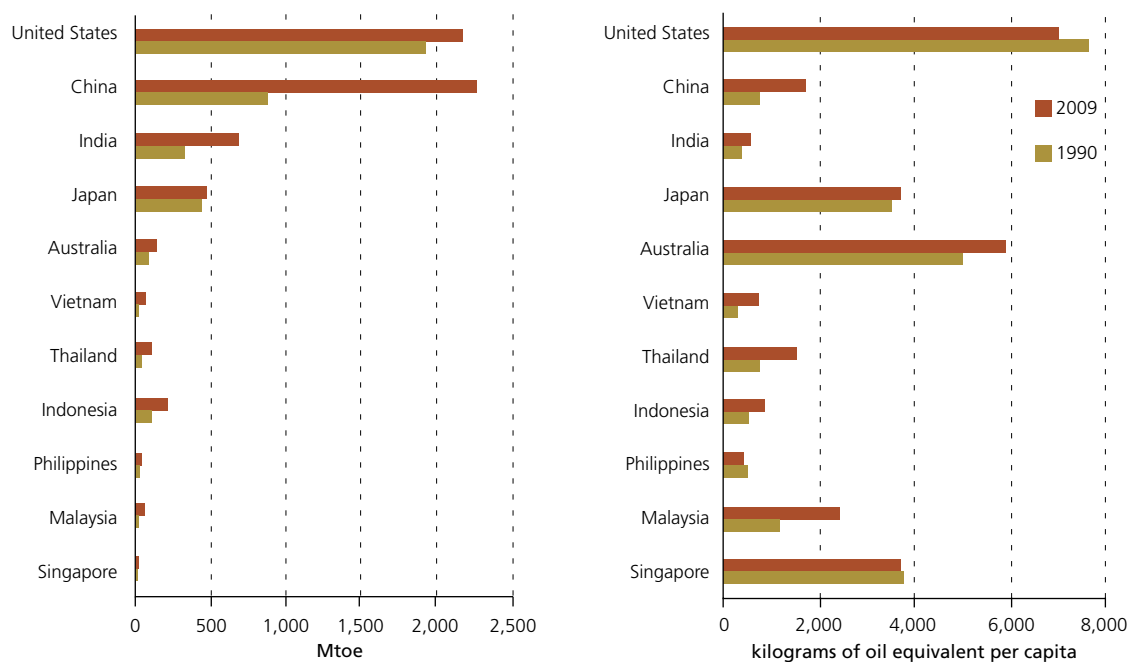
services that use electricity. City sprawl, which has increasingly led to the development of areas that are not easily served by public transportation and which discourages pedestrians, has resulted in an explosion of personal motor vehicles—cars and motorized two-wheelers. In addition, the lifestyles and corresponding energy use profiles of urban middle- and upper-income residents in the developing world progressively mimic those of their counterparts in the developed world.

Despite these trends, energy usage in Southeast Asian cities is still generally low because of the relative poverty of the majority of the population. Because energy use efficiency is influenced directly and permanently by urban form and density, cities' investment choices with regard to urban infrastructure (transportation, water, energy, and so forth) and capital will have a major impact on both energy demand and associated GHG emissions.

#### Implications of Urbanization for GHG Emissions

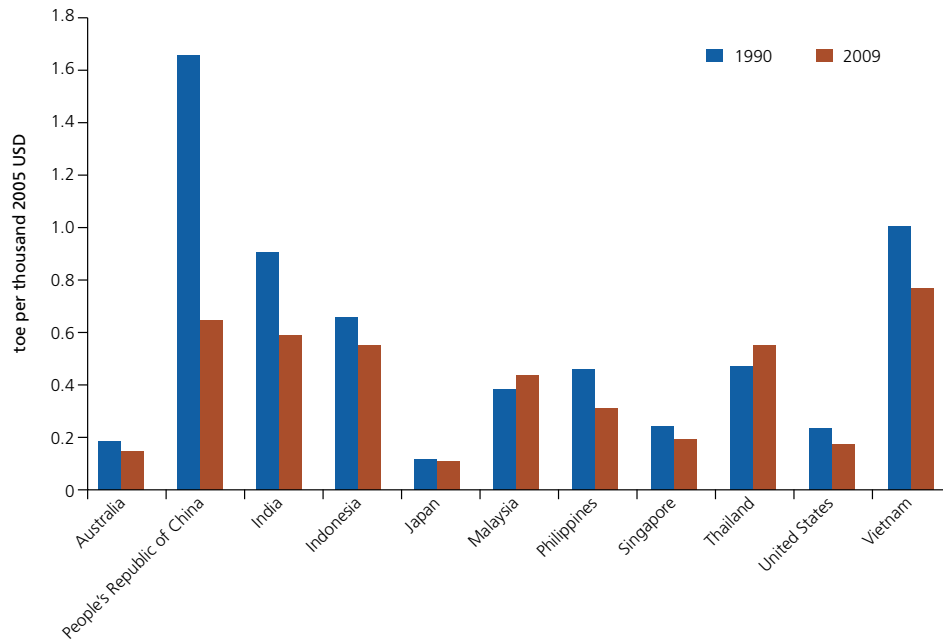
Southeast Asia contributed 5,187 million tons of CO<sub>2</sub> equivalent (MtCO<sub>2</sub>e) (12 percent) to global GHG emissions in 2000, of which 59 percent was derived from Indonesia, 6 percent from Thailand, 4 percent from the Philippines, 2 percent from

**FIGURE 2.5. CHANGES IN ANNUAL ENERGY CONSUMPTION AND ENERGY CONSUMPTION PER CAPITA**



Source: IEA 2012.

**FIGURE 2.6. CHANGES IN ANNUAL ENERGY INTENSITY**



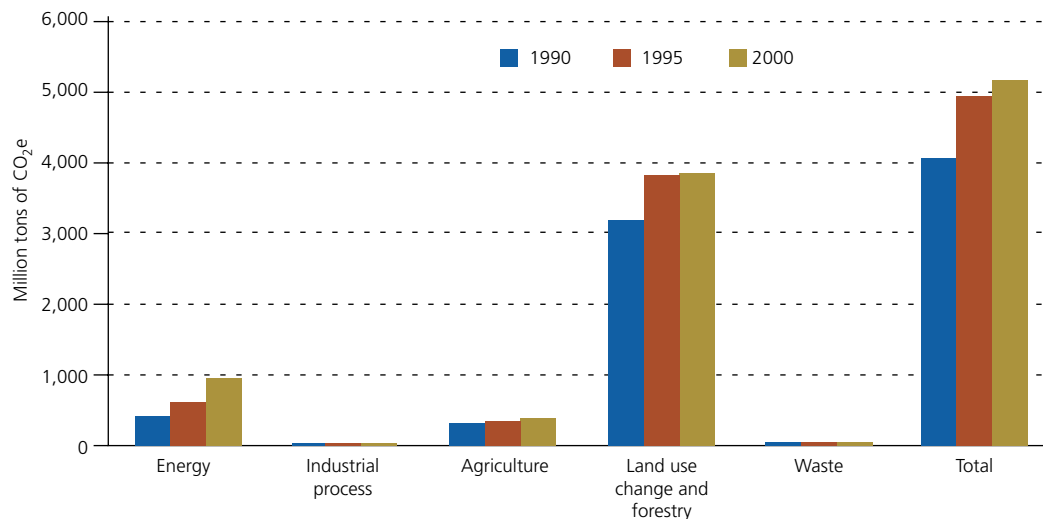
Source: World Bank 2010a.

Vietnam, and 1 percent from Singapore. The energy sector was the second largest contributor of GHG emissions in the region<sup>2</sup> (see figure 2.7).

Per capita GHG emissions in Southeast Asia are higher than the global average, but still low compared with developed countries. But CO<sub>2</sub> emissions are expected to double by 2030, which means that more action should be taken to enable Southeast Asian cities to manage energy use effectively to minimize the impact of CO<sub>2</sub> emissions.

2. The largest contributor of GHG emissions in Southeast Asia is land use change and forestry, but the largest rate of increase in GHG emissions is occurring in the energy sector.

**FIGURE 2.7. GHG EMISSIONS IN SOUTHEAST ASIA (1990–2000)**



Source: ADB 2009.



Southeast Asia has 173,251 km of coastline and high concentrations of population and economic activity in coastal areas. Climate change will expose them to increases in sea level, river flooding, and volatile weather conditions. The poor will be most affected because they live in the most vulnerable locations (low-lying flood-prone areas, marshlands, steep slopes) and lack the resources to protect themselves.

#### Increasing Concerns about Urban Environmental Sustainability

The rapidly growing cities in Southeast Asia are encountering mounting issues with environmental sustainability. They face a range of urban environmental challenges, from rapidly expanding but poorly planned cities to polluted air and water; inadequate water supply, sanitation, and energy; waste management; deficient drains; and flooding. Some of the growing concerns related to environmental sustainability include the following:

*Inadequate sewerage systems.* Piped sewer systems reach only 15 percent of the urban population of Manila (the Philippines). Domestic waste of some 192,000 tons yearly enters drains and groundwater and receives only minor treatment in unmaintained septic tanks. In Indonesia, the rate of sewerage and sanitation coverage is very low. Domestic sewerage, industrial effluents, agricultural runoff, and solid waste are polluting surface water and groundwater.

*Polluted rivers.* Rivers in Vietnam's major cities are severely polluted by untreated industrial wastewater. Lakes, streams, and canals serve as sinks for domestic sewerage and municipal and industrial wastes.

*Poor air quality.* Combustion of fossil fuels for power and transportation is causing significant deterioration in local air quality in many of the region's largest cities. The United Nations Environment Programme has ranked Jakarta, Indonesia, and Bangkok, Thailand, among the world's most polluted megacities. Poor outdoor air quality in many Southeast Asian cities has been linked to severe health impacts. Extreme levels of urban air pollution result in about 800,000 deaths per year in the world, out of which 65 percent occur in the Asia Pacific region.

*Inadequate solid waste sector.* Local governments face huge problems disposing of waste in urban areas. Common disposal methods for solid waste in Southeast Asia, such as open dumping and landfills, are becoming limited because urban local governments encounter greater and greater difficulties in finding suitable sites within city boundaries. Incineration (which has its own negative environmental impacts) is costly in the region because much of the waste consists of organic matter with a high moisture content, requiring high temperatures.

Cities can turn these environmental challenges into opportunities by promoting sustainable energy solutions across urban sectors. Good environmental stewardship in energy planning and management is essential to mitigate local, regional, and global environmental impacts that affect cities' long-term well-being. Action is required on three interconnected fronts: increasing eco-efficiency and greening of urban development; increasing inclusiveness and equity; and increasing resilience to climate change and other shocks and crises. These actions are cross-sectoral and would require fundamental changes to the current development paradigm.

#### Enhancing the Institutional and Policy Environment

In general, national and regional legislators and governments are responsible for enacting energy sector policies and regulations. The degree of regulation and government oversight in the energy sector varies by country. In many large economies, the energy sector is governed by numerous policies and regulations and is influenced by a mix of government institutions arising from concerns about energy security, market competition, social and environmental issues, and other considerations. Fuel pricing is also often subject to government intervention through taxes and subsidies. Energy sector policies and regulations used to be supplycentric, but this orientation has changed substantially since the first oil crisis in 1973. Many countries now implement regulations and standards requiring minimum energy performance in energy-consuming equipment, appliances, and building components. Governments also initiate special policies and programs to create incentives for the adoption of renewable energy and energy-efficient appliances and equipment.

The multitiered and multifaceted nature of energy sector management and regulation leads to complicated institutional interactions. Institutional and regulatory settings for urban energy planning and management in the Southeast Asian region are currently not conducive to addressing challenges and capitalizing on opportunities.

National and regional governments play critical roles in energy sector management and regulation. National and regional energy policies, legislation, and regulations influence the transparency, consistency, and predictability of modern energy supply systems in cities and address common social and environmental issues. For example, national and regional governments can establish general provisions that give cities incentives to adopt sustainable energy practices. These provisions could include renewable energy feed-in tariffs that mandate electricity utilities to purchase wind- or solar-generated electricity at set prices, and energy performance standards that set minimum energy efficiency levels for new appliances and new buildings. Conversely, national and regional regulations may hinder achievement of the sustainable energy measures of cities. For example, in most countries, the prevailing regulations on electric utilities discourage demand-side management and installation of distributed generation facilities, including renewable technologies.

The ability of the city government to set broad energy sector policies and regulations is limited. However, this should not prevent cities from planning and deciding what, where, and how urban energy infrastructure should be built. Cities can take steps to influence national policies, while seeking to influence local behavior through voluntary programs and incentives. Because city governments are intimately involved with every aspect of urban development and management and wield power and influence over urban energy demand, they have the unique ability to tie urban energy supply and demand together. Cities are among the most effective actors in pursuing sustainable energy solutions. Despite this, most cities in Southeast Asia have not vigorously pursued sustainable energy planning and management practices.

Several development gaps need to be bridged, including inadequate legal and fiscal frameworks;

lack of financing for sustainable development solutions; inadequate land-use planning and urban land development; insufficient design approaches and methodologies, technologies, and innovations; and lack of institutional structures and capacity building for effective monitoring, reporting, and management of city energy use. Solutions to bridge these gaps are discussed below.

#### **Strengthening Legal and Fiscal Frameworks**

Regulatory and fiscal measures can both be implemented to internalize environmental and social costs. Legislative measures could be introduced to change market incentives and signals and bring about changes in consumers' and producers' behavior. Examples include the requirement that public vehicles in Delhi (India) use compressed natural gas, passenger occupancy requirements for individual automobiles in downtown Jakarta, and the banning of plastic bags in Dhaka (Bangladesh).

Fiscal measures need to be introduced to reflect the true cost of providing natural resources, particularly water and energy. Costs can be more accurately reflected through measures such as progressive pricing, which actively subsidizes the poor and penalizes overuse and wastage. For example, a reasonable level of water, necessary to meet basic needs, could be provided for free or at a subsidized level, if needed, for social developmental reasons, and more intensive use or wastage could be priced at a progressive rate. Similar policies could be enacted in the provision of electricity. In the same vein, congestion pricing for automobiles entering downtown areas is a fiscal measure to internalize environmental costs. Such policies have been introduced in many Southeast Asian cities but need to be strengthened and more effectively enforced.

Penalizing the overuse and wastage of natural resources, particularly water and energy, would encourage businesses and households to conserve resources and adopt efficiency measures. Actively making urban infrastructure, particularly water, transportation, and buildings, more energy efficient would also reduce the carbon footprint of the city. Governments would have to take a long-term view on issues and implement policies that may be costly in the initial phases or may not result in short-term benefits—but have sustained benefits over the long term.

### Financing Sustainable Urban Development Solutions

How urban development is financed is crucial to the sustainability of cities. Key challenges include reforming existing city government finance systems to make them more effective, accessing new external sources of finance, and building stronger links between the formal urban development finance system and financing systems for the urban poor.

Although functions and executive authority in many countries in Southeast Asia have been devolved to a local level, fiscal authority often remains at higher levels of government, and local governments are not able to spend sizable funds on urban development without authorization from higher levels. Even in countries in which local governments may have such authority, many cities lack the capacity to make full use of their theoretical powers. Reforming the city government finance sector and building local government capacity are therefore important development strategies.

Making cities sustainable will require the infusion of funds to finance investment in urban infrastructure and services such as mass transit systems, water and sanitation systems, and the like. Although internalizing environmental costs (for example, through the implementation of a carbon tax) will increase funds available for investment in urban infrastructure, additional funds will be required, at least in the short term. New sources of finance need to be tapped to provide funding for sustainable urban development.

### Improving Land-Use Planning and Urban Development

Cities in Southeast Asia have dense cores with extended suburban areas that tend to grow along transportation corridors. New urban developments are often unplanned and haphazard—with closely intermingled industrial, residential, commercial, and agricultural land uses—and lack adequate infrastructure and services. Moreover, because development occurs along transportation corridors, large tracts of land farther away from the transportation corridor are not developed, resulting in “ribbon” or “strip” development that is environmentally unsustainable and resource intensive. Urban development often extends across several provincial and jurisdictional boundaries, posing new economic, social, and environmental

challenges that require a rethinking of urban planning, management, and governance approaches and institutions. Strengthening and extending planning laws to cover suburban areas is crucial for sustainable urban development. Examples include local laws and regulations in China, Vietnam, and Pakistan that create local intergovernmental agencies that cover both urban and suburban areas, empowering them to strengthen urban planning laws and regulations in these areas.

A major area for policy reform is urban land use. The commoditization of urban land must be balanced by the recognition that land is a public and environmental good. Planning and land-use restrictions need to be imposed to increase the social and environmental functions of land, such as the provision of housing to the urban poor and the development of urban green spaces, parks, and mass transit corridors.

### Promoting Innovation and Technologies

Cities are major consumers of energy and emitters of GHGs, but they also have the potential to create solutions to urban problems because they are centers of knowledge and of technological and process innovation. The EAP region is bursting with innovative technologies, approaches, and practices that could lead the way toward an inclusive and sustainable future.

Recent advances in smart metering and grid-control technologies offer opportunities for cities to work with electricity suppliers to promote and harness demand-side energy efficiency and reduce distribution losses. The challenge is to systematically identify, document, analyze, adapt, and scale up this technology along with other innovative solutions. To do so requires the creation of a fiscal, regulatory, and institutional environment that allows individuals, businesses, communities, and civil society organizations, and even government agencies, to find innovative solutions. It would also require research and training institutes to identify and analyze the reasons for the success of certain technologies and to assist governments in scaling up such technologies and innovations.

Introduction of new technologies, production processes, and innovative practices often means that those with access to information, knowledge, and capital benefit whereas those that do not have access are left behind. New technologies often

mean higher prices given the need to factor in costs associated with development—and the poor often lose out. Therefore, policies that minimize the impact on the poor would have to be developed and implemented. For example, the cost of grid-control technologies could be recovered from consumers other than those in non-urban slums, whose usage of electricity is at the most basic level.

#### **Strengthening Institutional Structures and Building Capacity**

To improve the resilience of Southeast Asian cities to climate change impacts, institutional strengthening and capacity building are required. Knowledge about “green growth” and climate change needs to be embedded in institutions and imparted to the people who staff them so they can make effective decisions, allocate resources efficiently to reduce escalating energy costs, and manage risk and implementation of programs. To enable this, local and global data would have to be made available, and expertise in energy sector analysis, international policy best practices, and carbon finance flows will have to be developed.

Sustainable urban energy planning and practices are elusive without realistic metrics to quantify performance (using indicators) and to measure progress (using benchmarks). Indicators and benchmarks do not merely reveal gaps; they also inspire actions to better manage services without reducing affordability or compromising the environment. Developing metrics is a crucial but difficult task because every city is unique in its energy use and levels of service. Hence, indicators need to be selected carefully to avoid distortions. A small set of key energy indicators will allow the most meaningful cross-city comparisons. An energy accounting framework should be established, supported by a structured data collection template and a baseline against which progress will be measured. This framework will help city authorities effectively carry out monitoring, reporting, and management of energy uses and carbon emissions to ensure the city remains on a low-carbon growth path.

The issue of energy use cuts across many agencies, but fostering interagency collaboration is a big challenge, particularly if the costs and benefits are distributed unevenly. The functional areas within agencies—represented by technical staff members, environmental officers, budget teams, procurement

personnel, and so forth—also bring unique biases, expertise, incentives, and constraints to efforts to improve energy efficiency. These constraints are especially apparent in cities in which infrastructure provision and services lag behind demographic growth and geographic expansion. These challenges are compounded by the cross-cutting nature of energy services, which often leads to decisions about their efficient use falling through the cracks. At the local level, some of these issues may be addressed through policies and programs, but strong mayoral leadership is often needed to insist that the parties work together.

#### ***Promoting Sustainable Urban Energy Solutions***

Sustainable urban energy—the provision of energy that meets the needs of the present without compromising the ability of future generations to meet their own needs, within a sound urban planning framework—is critical to sustainable urban development. By ensuring that urban energy supply is secure, reliable, and affordable, and that energy demand is efficiently managed, cities can optimize operating costs, improve air quality, and improve quality of infrastructure services, while concurrently supporting economic development and climate change mitigation objectives. These objectives require consideration of issues beyond those in the energy sector, to sectors that use energy to produce urban services (notably the transportation and water supply and sanitation sectors). Lifetime cost savings and local and global externalities are key considerations for city governments in prioritizing sustainable energy measures.

Given energy’s cross-sectoral nature, city governments need to evaluate options comprehensively. Within the urban planning framework, options have to be assessed across sectors as well as across time, because sustainability initiatives cannot always be rolled out quickly and do not always have immediate impacts. Effective urban land-use planning and land development provide unique opportunities to adopt “systems approaches” to addressing urban energy issues by integrating physical, socioeconomic, and environmental planning and identifying synergies and cobenefits. Land-use planning is also a sound platform for mobilizing additional and concessional financial resources because many financial

institutions are looking for opportunities to invest in “green growth” despite uncertainties about the post-Kyoto<sup>3</sup> price of carbon.

Making cities more energy efficient, increasing accessibility to renewable energy supplies, and adopting smart grids all hedge against the risks of higher energy costs if a global agreement were to be reached to reduce GHG emissions drastically. But EAP cities should not try to address all sustainable energy options simultaneously. Pursuing actions on sustainable energy, however cost effective they may be, requires public and private investment, efforts on the part of city governments and citizens, and the strong support of regional and national governments. Cities should tailor their efforts to available resources and pursue initial steps toward sustainable energy practices that generate significant and immediate local benefits.

Adopting sustainable urban energy planning in developing Southeast Asia is a challenge. In recent years, this region has been deluged with warnings, advisories, and information about climate change and energy efficiency—often at the city level. Although city government officials would like to take action, the World Bank Group has found that they often do not know where to start. They typically need technical assistance to help them take the first few steps toward achieving cross-sector efficiencies, including evaluating baseline energy consumption and supply options, identifying priority sectors for promoting sustainability, and achieving measurable improvements. These activities are the building blocks for the development of comprehensive, phased urban energy policies and investment strategies.

### *Program Objective*

With support from AusAID, the World Bank Group initiated a regional program—EAP Sustainable Urban Energy and Emissions Planning (SUEEP)—in January 2011 to provide support and guidance to city governments in the EAP region to formulate

long-term urban energy strategies, keeping in mind the cities’ overall development plans.

The establishment of SUEEP was a response to the report *Winds of Change: East Asia’s Sustainable Energy Future*, which was a joint publication of the World Bank Group and AusAID. This report concluded that, despite the challenges faced in mitigating the impact of climate change, it is possible for East Asia to develop a sustainable energy pathway, maintain economic growth, mitigate climate change, and improve energy security, provided that immediate action is taken to transform the energy sectors in cities toward much higher energy efficiency levels and the widespread use of low-carbon technologies. For this clean energy revolution to take place, major institutional and domestic policy reforms will be required.

### *Phased Approach*

SUEEP is structured in three phases; this report summarizes the outcomes of Phase I: Three City Pilots, whereby the current status of urban energy use and GHG emissions in three pilot cities in East Asia is established and a range of policy and technical measures are identified to enable the city governments to formulate long-term sustainable urban energy development strategies, which will lead to programmatic investment plans and policies.

Phase II uses the lessons learned and outputs from the three pilot city programs to develop a Guidebook and SUEEP Toolkit designed specifically for the EAP region, enabling city authorities to access the tools and resources developed by the program. The Guidebook includes a set of guidelines that cities can use to develop their own SUEEP processes, as well as identifies areas for which cities need support in implementing these strategies.

Phase III of SUEEP is planned for 2013, and will comprise development of detailed SUEEP plans and web-based tools that can be used to help cities monitor and manage energy use and GHG emissions.

### *SUEEP Phase I Approach*

Phase I involved working closely with three pilot cities in three different countries in the EAP region—Surabaya in Indonesia, Da Nang in Vietnam, and Cebu City in the Philippines, to

3. The Kyoto Protocol, which was signed in 1997, is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is the binding targets set for 37 industrial countries and the European Community for reducing GHG emissions equivalent to an average of 5 percent against 1990 levels over the five-year period 2008–12. The “post-Kyoto” period refers to the time after 2012 for which no international agreements have been made addressing the reduction of GHG emissions, which leaves the price of carbon uncertain.



- assess their current energy usage, energy expenditure, and GHG emissions;
- review existing and proposed urban plans and initiatives that affect energy usage;
- map the institutional structures relevant to policy and decision making for sustainable urban energy planning;
- provide information about international best practices that can be adopted by city governments; and
- provide a framework to allow the identification of priority sectors for energy efficiency improvements, as well as to develop a sustainable energy strategy.

### *Methodological Summary*

To achieve the objectives efficiently and consistently across the three pilot cities, a methodology was established that capitalized on the work carried out by the World Bank Group's Energy Sector Management and Assistance Program (ESMAP) in 2009–10. ESMAP developed a tool (Tool for Rapid Assessment of City Energy, or TRACE) that was used during a three-month period to quickly assess energy used by a city government, benchmark energy use against peer cities, establish priority areas, and develop interventions for improved energy efficiency across a wide range of municipal services.

Alongside the application of TRACE, an energy balance assessment was undertaken in each city to obtain a reasonable understanding of the types of fuel used, the sectors that consumed energy, and the way energy was consumed within each sector. Notably, the breakdown is limited to the sector level and all data and calculations are contained within a single, practical worksheet.

In addition, a GHG inventory was compiled using the Urban Greenhouse Gas Emissions Inventory Data Collection Tool, developed by the World Bank Group in 2011. The tool covers emissions from transport, solid waste management, water and wastewater treatment, and stationary combustion (power generation, building energy usage, industry, and so on).<sup>4</sup> The tool aims to provide a simple, user-friendly, and easily replicable approach, and emphasizes providing descriptions of data sources, years, implied boundaries, and quality of the data.

This approach was adopted to enable a swift, high-level sector analysis for prioritizing projects with significant energy savings, GHG mitigation, or low-carbon energy generation potential. A sector-based approach was chosen because it allows energy use to be mapped to institutional structures, highlighting areas with both strong governmental influence and verified significant and beneficial opportunities. Further details on methodology are provided in appendix 4.

## Report Structure

This report is structured to provide the reader with a clear understanding of Phase I of the SUEEP program, of the process undertaken in the pilot cities, and of the themes emerging from the pilot that are of interest to other cities across the EAP region. Following this background and approach chapter, the report is set out as follows:

- Chapter 3: Understanding the Cities: Energy Use and GHG Emissions, provides a brief overview of each of the pilot cities, followed by a description of the energy and GHG emissions profile of each city.
- Chapter 4: Sector Diagnosis: Identifying Opportunities, provides a review of transportation, solid waste, water and wastewater, power, public lighting, and city government buildings sectors; identifies key trends, barriers, and opportunities for energy efficiency and renewable energy in areas under city government control; and discusses how and why respective areas may be prioritized for action by city governments.
- Chapter 5: Governance, discusses the principal governance issues associated with energy planning and management at a city level.
- Chapter 6: SUEEP: The Way Forward, sets out how, given the significant body of evidence presented, city governments can establish a road map for a sustainable urban energy path in the future.
- Appendices 1–3 provide more details on the studies undertaken in the pilot cities and the recommended courses of action for enhancing energy efficiency in the various sectors.
- Appendix 4 describes the approach and methodology taken in Phase I of the program.

4. Urban forestry considerations will be included in the tool in the future.



# *Understanding the Cities: Energy Use and Greenhouse Gas Emissions*

### **City Overview**

The pilot cities were selected for the Sustainable Urban Energy and Emissions Planning (SUEEP) Program because they were representative of “second” (not capital) cities and typify cities across the East Asia and Pacific (EAP) region. Like many other cities, these three cities are experiencing the following trends:

- Increased urban migration is fueling population growth.
- Economies are growing and living standards are improving.
- The services sector, especially tourism, is a growing component of the economy although the city is still heavily reliant on manufacturing industries.

Each of these factors alone could reasonably result in an increase in urban energy consumption and greenhouse gas (GHG) emissions. Together, the impact is considerable.

#### ***Cebu City***

Cebu City is the capital of Cebu Island and the center of Metro Cebu, which includes the cities of Lapu-Lapu, Mandaue, and Talisay. Cebu City has a population of approximately 800,000, and more than 2.4 million people live in the wider Metro Cebu area. Located on the coast of Cebu Island, flanked by the Cebu Strait, and surrounded inland by mountainous terrain, the city has limited opportunities for physical expansion, maintaining its relatively compact nature. Although the city has a land area of 291 square kilometers (km<sup>2</sup>), the population density for the city is 2,748 inhabitants per km<sup>2</sup> because of the concentration of the population in a dense urban area of 23 km<sup>2</sup>.

Cebu Island occupies a strategic position in the Philippines, being centrally located and easily accessible by air and water. Cebu City is an important port city and is well connected to the EAP

region and to the Philippines capital, Manila. The city’s strategic location and seaport support local trade and services, which together employ the majority of Cebu’s labor force. Some 73 percent of the population of Cebu City work in trade or related services, such as banking, real estate, insurance, or community services. Another 19 percent are employed in industry, and 8 percent in agriculture and related services. The services sector is growing and is expected to continue to be the biggest contributor to GDP in Cebu City. The majority of establishments in the city are considered to be micro or small enterprises with an average capitalization of 1.5 million Philippine pesos or less. More than two-thirds of these business establishments are situated in the central part of the city, and collectively account for more than three-quarters of the city’s economy. Cebu City is the second-fastest growing city economy in the Philippines after Manila, and growth rates are anticipated to continue rising for the foreseeable future.

#### ***Da Nang***

Da Nang is the largest urban center in central Vietnam, with an area of 1,283 km<sup>2</sup> and a population of more than 900,000. Population density is relatively low in comparison with the other pilot cities, at just over 700 inhabitants per km<sup>2</sup>. Located at the mouth of the Han River and facing the South China Sea, Da Nang is the fourth-largest seaport in Vietnam, and forms an important gateway to the Central Highlands of Vietnam, as

well as to Cambodia, the Lao People’s Democratic Republic, Myanmar, and Thailand.

Da Nang’s economy has historically been dominated by the industrial and construction sectors. However, in 2006 services became the largest economic sector in the city as measured by gross output. Although economic growth has been concentrated in the road, rail, and seaport hubs, as well as other service-oriented industries, the tourism sector’s contribution to GDP is expected to grow. As the city’s economy moves from primary and secondary sectors toward tertiary and services sectors, changes in its energy demand can be expected to occur.

Population growth in the early twenty-first century was relatively slow (1.7 percent annually between 2000 and 2007), but Da Nang now appears to be poised for a significant increase in population, primarily because of migration from neighboring rural areas. In 2007, Da Nang’s official population was approximately 807,000, with projections that it will increase at a 3.7 percent annual rate through 2015, and at a rate of 4.9 percent per year between 2015 and 2020, resulting in a 70 percent increase in population by 2020. Counting unregistered migrants, the population may reach nearly 1.65 million people by 2020. Da Nang’s economy is also growing rapidly; between 2000 and 2007, Da Nang’s gross regional domestic product grew at 12.3 percent annually and in 2009 totaled US\$1.48 billion. Household income has also risen rapidly, increasing from 187,000 Vietnamese dong (D) per month in 1996 to 853,000 D/month in 2006. Despite the steep increase, household income levels are still less than the national average for the same period, due to the preponderance of

low-value-added production in the city and “brain drain” to other parts of the country.

### Surabaya

Surabaya is a large city with a population of about 2.8 million, which is more than three times the populations of Cebu City or Da Nang. Much of the city’s center is densely populated—population density can be as high as 8,000 persons per km<sup>2</sup> in some areas. The city occupies coastal terrain with a land area of 327 km<sup>2</sup>, and is located in the Brantas River Delta at the mouth of the Mas River, an area that confronts a high flooding hazard. Surabaya is the capital of the Indonesian province of East Java.

Surabaya is a key node in air, water, and land transportation. The city is served by Juanda International Airport and Perak Port, one of Asia’s largest and busiest seaports. Hence, Surabaya serves as an important gateway to the East Java region for both passengers and goods. Surabaya has an annual population growth rate of 0.65 percent. However, GDP grew 6.3 percent in 2008, compared with a national GDP growth rate of 6.1 percent. Surabaya’s main industries are the trade, hotel, and restaurant sectors (which together account for 36 percent of GDP) and the manufacturing sector (which accounts for 32 percent of GDP). Other significant contributors to Surabaya’s GDP are transportation and communications, construction, financial services, and the services sector.

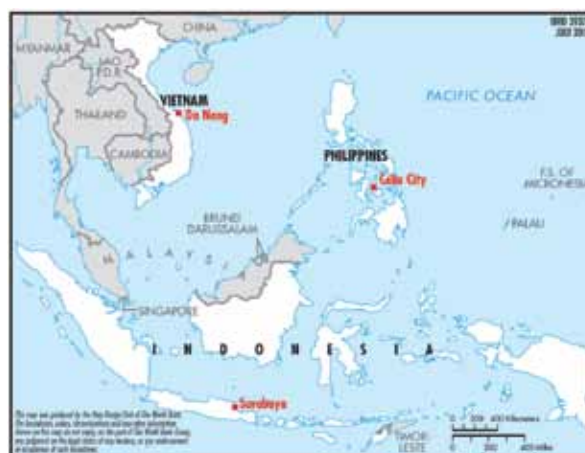
See table 3.1 for a summary of the pilot cities’ characteristics and figure 3.1 for their relative locations.

**TABLE 3.1. SUMMARY OF STRUCTURAL AND ECONOMIC DATA FOR THE PILOT CITIES**

Parameter	Cebu City	Da Nang	Surabaya
Population (m)	0.8	0.9	2.8
City area (km <sup>2</sup> )	291	1,283	327
Population density (000’s/km <sup>2</sup> )	2,748	711	8,458
GDP/cap/year (\$)	5,732	1,627	8,261
Economic structure (%)			
Services	73	56	36
Industry	19	42	32
Agriculture/other	8	2	18

Source: Authors.

**FIGURE 3.1. LOCATIONS OF THE PILOT CITIES**



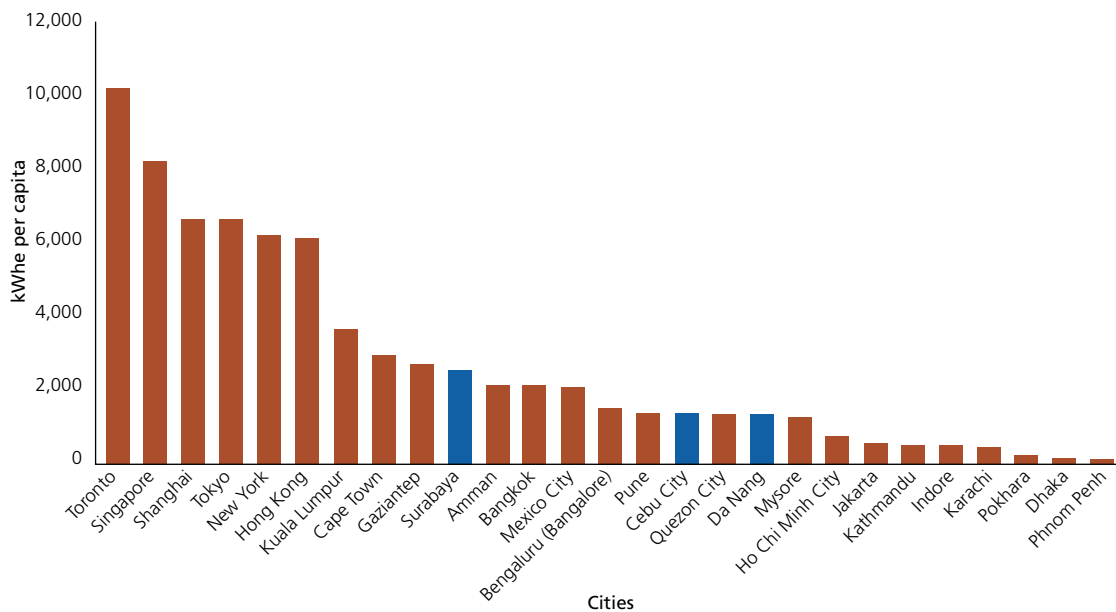
## City Energy Profile

To understand the cities' energy profiles, an energy balance assessment was undertaken in each city to obtain an overview of energy demand and supply. In addition, a number of key performance indicators were collected and benchmarked against peer cities using the Tool for Rapid Assessment of City Energy (TRACE; see chapter 2 for a further description).

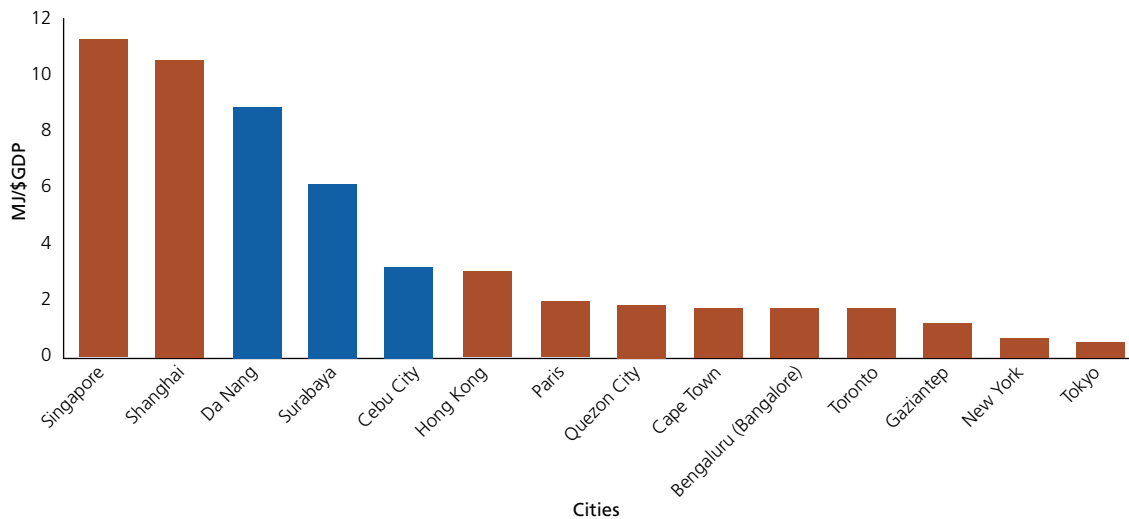
## Energy Demand

Electricity consumption per capita for the three cities is low in comparison with other Asian cities in the TRACE benchmarking tool (see figure 3.2), but energy intensity, or energy consumption per unit of GDP, is high (see figure 3.3). Given this fact, these cities will have to become more energy efficient to dampen sharp increases in energy demand as economic growth occurs.

**FIGURE 3.2. ELECTRICITY CONSUMPTION PER CAPITA BENCHMARKED AGAINST OTHER CITIES USING TRACE, 2010 (SUEEP PILOT CITIES IN BLUE)**

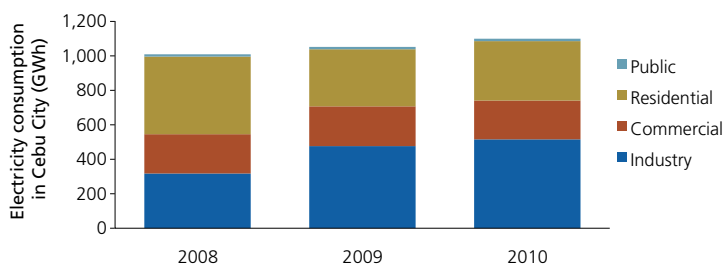


**FIGURE 3.3. PRIMARY ENERGY CONSUMPTION PER UNIT OF GDP BENCHMARKED AGAINST OTHER CITIES USING TRACE, 2010 (SUEEP PILOT CITIES IN BLUE)**



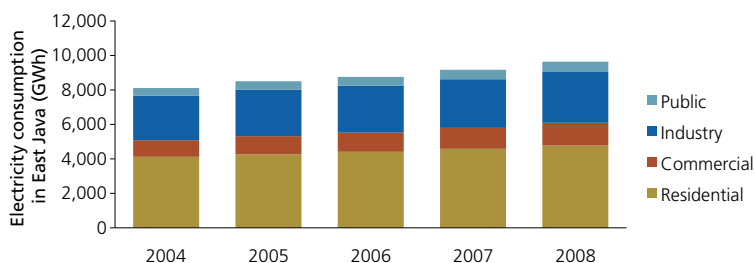
Not only is electricity demand growing year on year in the three pilot cities (see figures 3.4a–3.4c), but it is outstripping population growth, a trend playing out in other EAP cities as well. Da Nang’s annual growth in electricity demand is significantly higher than that in Cebu City and in Surabaya, as is its population growth, which will result in a doubling of energy demand in six years if demand growth continues unabated. These growth rates are likely to be replicated across much of the

**FIGURE 3.4A. ELECTRICITY CONSUMPTION IN CEBU CITY**



Source: Phase I pilot study.

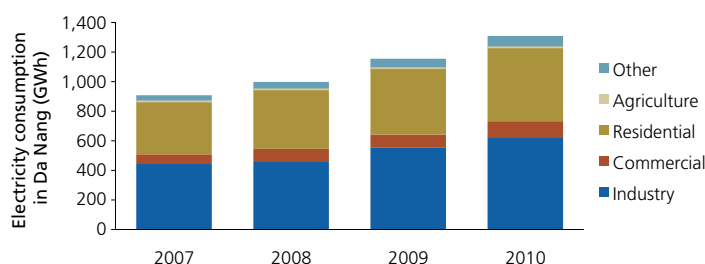
**FIGURE 3.4B. ELECTRICITY CONSUMPTION IN EAST JAVA**



Source: Phase I pilot study.

Note: Data for Surabaya was not available. Data for East Java is representative and was therefore used as a proxy for Surabaya.

**FIGURE 3.4C. ELECTRICITY CONSUMPTION IN DA NANG**



Source: Phase I pilot study.

EAP region and will present a challenge to local infrastructure, utility services providers, and city governments to supply sufficient energy to satisfy growing demand. The EAP region should therefore use this as an opportunity to integrate low-carbon generation technologies into the supply mix through long-term SUEEP.

#### Energy Demand by Sector

Energy use in different sectors in each city was analyzed, and clearly demonstrated that the two major energy-using sectors are transportation and industry (see figure 3.5).

Figure 3.5 excludes the use of solid fuel for residential cooking. As in many other studies, the energy balance data did not include these solid fuels because of the difficulties with data collection. However, cities should continue to monitor this sector given that every second household in the region still relies on solid fuel for cooking, and uses a traditional stove, which has negative impacts on health, gender equality, poverty reduction, and the local and global environment. This phenomenon affects both rural and urban areas. The use of transition and traditional fuels continues to be high in urban areas that are characterized by low incomes. In light of this, cities need to actively pursue policies that can achieve universal access to clean cooking solutions to all residents to save energy and improve quality of life.

#### Energy Supply

An energy supply profile can provide insights into a city’s reliability of energy supply, GHG emissions levels, and economic growth, which will be of value for strategic planning. The outcome of the analysis of energy supply across the pilot cities is broadly discussed below.

#### Energy Conversion Is Inherently Inefficient

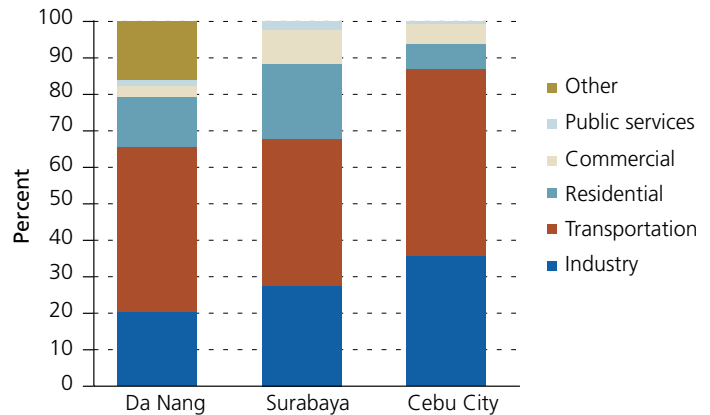
The generation of electrical energy requires the conversion of one energy source to another, a process that inherently results in losses, although the magnitude of the losses depends on the type of energy or fuel used and the technology deployed. Figure 3.6 presents the typical efficiencies associated with a range of generation technologies, from highly efficient, large hydroelectric plants to still-emerging solar technologies.

Many EAP countries rely heavily on coal and oil for electricity generation. Although newer oil- and coal-fired steam turbine power plants operate at

efficiencies between 39 and 47 percent, older power plants are significantly less efficient. Sankey diagrams, such as the example for Surabaya in figure 3.7, illustrate the efficiencies inherent in energy systems.<sup>1</sup> Surabaya exhibits conversion losses exceeding 60 percent for primary fuel energy, and about 77 percent for primary fuel energy for combustion engines (mainly for transportation) that occurs in the conversion process. In Cebu City and Da Nang, similar trends are observed. The electrical generation conversion losses are reasonably typical of the generating plants in use (although efficiencies are generally better with modern technologies). In the

1. The Sankey diagrams provide an overview of the primary fuel used upstream to supply energy within the city boundaries. The diagrams also illustrate the magnitude of final energy put to productive use across the city sectors following losses due to conversion inefficiencies. Therefore, the distribution of the total energy supplied to the individual sectors before conversion losses (labeled Energy Sold to Customers) is not apparent from the Sankey diagrams; this distribution of energy supply and consumption on a sector basis is detailed instead in the Energy Consumption figures A1.4, A2.4 and A3.4.

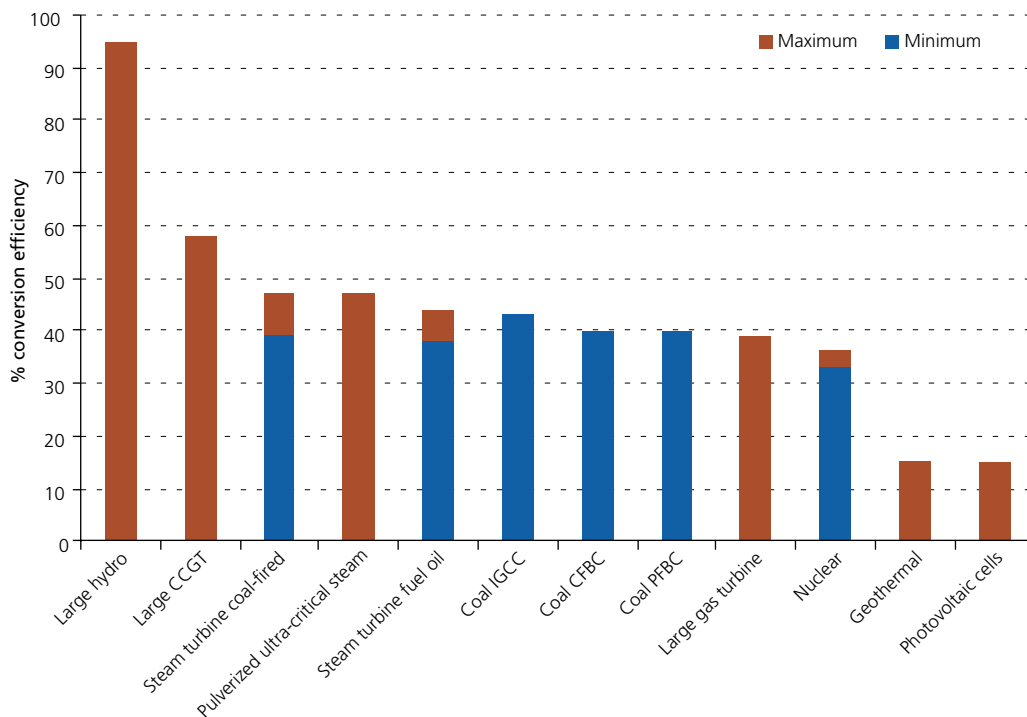
**FIGURE 3.5. PRIMARY ENERGY CONSUMPTION BY SECTOR**



Source: Phase I pilot study.

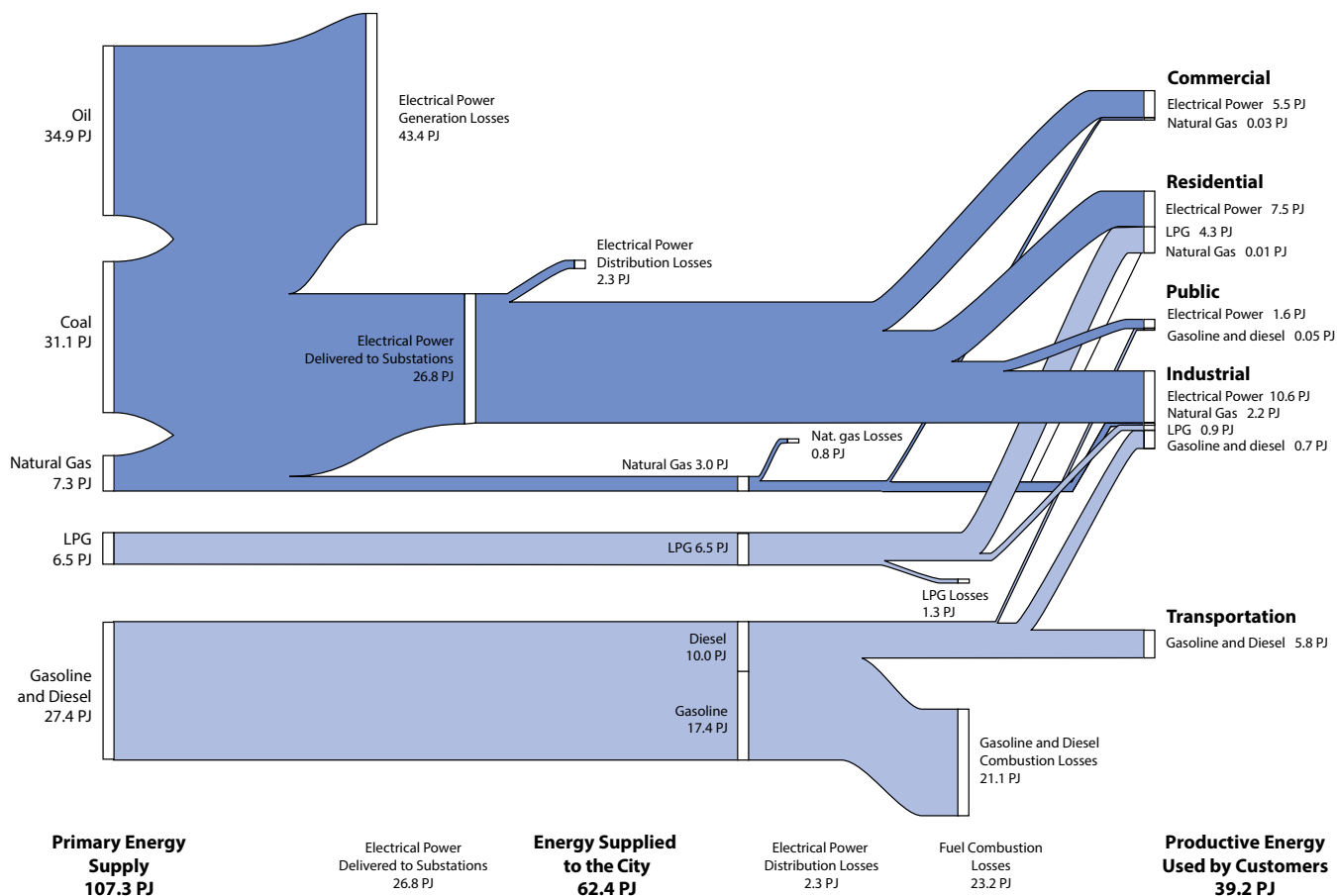
transportation sector, conversion losses are directly related to engine and transportation infrastructure efficiencies, and are thus more dependent on individual city composition and context.

**FIGURE 3.6. EFFICIENCIES IN ELECTRICITY GENERATION: PRINCIPAL TECHNOLOGIES**



Source: Eurelectric 2003.

Note: CCGT = combined cycle gas turbine; CFBC = circulating fluidized bed combustion; IGCC = integrated gasification combined cycle; PFBC = preserved fluidized bed combustion.

**FIGURE 3.7. SURABAYA SANKEY DIAGRAM**

Source: SUEEP Pilot City Studies 2011.

Note: PJ = Petajoule. "Public" includes the end-use energy of city buildings, street lighting, city vehicles, water, wastewater, and solid waste management.

### Power Generation Sources Play an Important Role in a City's GHG Emissions

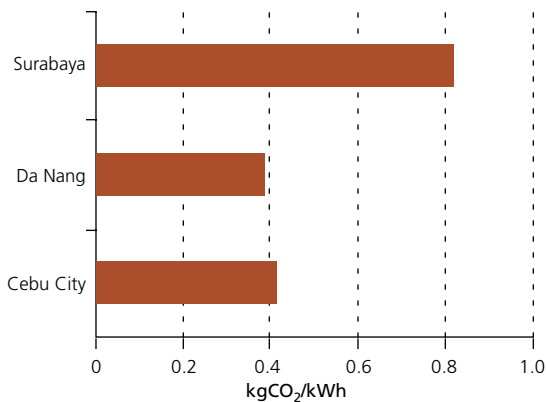
Cities must address both the choice of generating technology (if the opportunity exists), as well as the manner in which electrical energy is used when considering long-term issues of reliability of energy supply, climate change mitigation, and energy efficiency. The less efficient the generation technology used, the more important it is to address electrical end use—small efficiency gains at the point of use will have an even greater effect on primary energy inputs for electricity generation. This focus is also important because of the long-term and relatively static nature of generation infrastructure, which provides limited opportunities to alter generating efficiencies after a generation plant has been commissioned.

Electricity generation in the pilot cities is fueled by a unique mix of energy sources governed by resource availability in each country. Surabaya's electricity is generated mainly from coal and oil, whereas Da Nang uses a significant proportion of hydropower and gas, and about 49 percent of Cebu City's electricity is generated from hydro and geothermal sources. These electrical generation differences alter the cities' electricity carbon emissions factors, which in turn alter their emissions profiles. The relative carbon intensity of grid-supplied electricity in the three pilot cities is presented in figure 3.8.

Currently, none of the pilot cities generates a significant proportion of its electricity requirements within the city boundaries. They depend heavily on the national or regional electricity grids. The reliance on external sources of electricity has



**FIGURE 3.8. CARBON INTENSITY OF THE ELECTRICAL GRID**



Source: SUEEP Pilot City Studies 2011.

the potential to expose these cities to power shortages that could have major impacts because of the concentration of economic activity in urban areas.

In light of the above, improving energy efficiency and increasing decentralized energy supplies should both be key strategies for enhancing cities' reliability of energy supply. In particular, cities should prioritize the use of local low-carbon energy sources in their energy planning if such opportunities exist within the confines of the city or metropolitan area. City governments have the capacity to promote decentralized low-carbon power generation and fuel switching to lower-carbon, lower-pollution alternatives and should work with utilities to define long-term low-carbon strategies that stimulate local energy production. This effort can be achieved in concert with national and regional plans to decarbonize the grid. The point to emphasize, therefore, is that city governments should engage in strong dialogue with the national government in power generation planning and should seize opportunities at the city level that help stimulate investment and jobs, while strengthening resilience to energy shortages and lowering the carbon intensity of grid-supplied power.

### *Sustainable Solutions in the Transportation Sector*

The current trend in transportation, whereby inefficient public transportation is increasingly replaced by two-wheeled motorized vehicles and then four-wheeled vehicles as household incomes

rise, is associated with a range of environmental and economic challenges. These challenges include increased fossil fuel use, higher carbon emissions, local air pollution (and health impacts for inner-city inhabitants), and traffic congestion. This trend, if unabated, will lead to greater expenditures on imported energy, health care, and typically, transportation infrastructure to reduce congestion. By acknowledging the likelihood that the trend will continue unless addressed, city governments open up opportunities to take an alternative path.

It is apparent in the pilot cities that a substantial amount of transportation energy is lost in fuel combustion (in Surabaya, Cebu City, and Da Nang, the figures are 77 percent, 75 percent, and 75 percent, respectively). A range of opportunities exists to increase efficiencies at a city level. An integrated program of regulatory, fiscal, technological, and infrastructure-based reforms and investments can improve energy efficiency. City governments have some level of control over citywide transportation planning and management, and these powers can be used in coordination with railroad or national agencies to bring about greater efficiency in transportation energy use.

There are three types of activities cities can undertake to reduce energy consumption and mitigate GHG emissions from the transportation sector:

- reduce the carbon intensity of fuels and energy sources (to reduce tons of CO<sub>2</sub> per unit of fuel combusted);
- improve the fuel efficiency of vehicles through vehicle technology improvements and retrofits, improvements in vehicle operations efficiency, and improvements in driving conditions, such as road surface quality, congestion, and the like (to reduce units of fuel combusted per kilometer traveled); and
- reduce systemwide vehicle-kilometers traveled, through a modal shift to high-occupancy transit and nonmotorized transportation (to reduce vehicle-kilometers).

Nearly every activity that can be undertaken by a city requires one or some combination of these three approaches. For example, replacement of a traditional diesel bus system with a network of dedicated bus lanes and compressed natural gas

(CNG) hybrid buses would reflect a combination of all three of these activities, in that such a program would (i) affect the carbon content of fuel (replacement of diesel by CNG), (ii) improve the fleet fuel efficiency (through new technology, as well as improved drive cycle through use of a dedicated lane), and (iii) reduce the activity level per passenger transported (through better transportation management).

As with activities in other sectors to improve energy efficiency, these measures are evaluated with respect to their broader economic, social, and fiscal impacts on the city.

The following are specific examples of cities that have undertaken activities to reduce emissions and improve energy efficiency in urban transportation:

#### **Egypt Vehicle Scrapping and Recycling Program of Activities**

*City:* Cairo, Egypt

*Activity category:* (ii) Improve fuel efficiency

*Average annual CO<sub>2</sub> reductions (estimated by the Clean Development Mechanism):* 250,000 tons

*Description:* The average age of a taxi in Cairo is 32 years. Before the program, more than 48,000 taxis in Cairo were more than 20 years old. Through a scrapping and recycling program managed by the Ministry of Finance, taxi owners were given packages of incentives toward the purchase of new, more fuel-efficient vehicles (in most cases, about 12–15 percent more efficient) in exchange for voluntarily submitting their old vehicles for recycling. To date, more than 35,000 vehicles have been exchanged under the program.

#### **Transmilenio Bus Rapid Transit (BRT) System**

*City:* Bogota, Colombia

*Activity categories:* (i) Reduce carbon intensity of fuel; (ii) Improve fuel efficiency; (iii) Reduce vehicle activity

*Average annual CO<sub>2</sub> reductions (estimated by the Clean Development Mechanism):* 73,000 tons

*Description:* The Transmilenio BRT replaced an aging, inefficient network of micro-buses with modern articulated diesel and CNG buses operating on dedicated busways, which feature priority traffic signaling, quick-boarding stations, and frequent headways. The system reduces the carbon intensity

of fuel used in the transportation system by carrying more passenger-kilometers on CNG buses; improves fuel efficiency of the public transportation network through use of more efficient technology to move a given number of passengers, and by improving the drive cycle through use of dedicated lanes and signal priority; and reduces overall vehicle activity by inducing a modal shift from private passenger modes, such as motorcycles, to buses.

#### **New Delhi Regenerative Braking Project**

*City:* New Delhi, India

*Activity categories:* (i) Reduce carbon intensity of fuel; (ii) Improve fuel efficiency

*Average annual CO<sub>2</sub> reductions (estimated by the Clean Development Mechanism):* 41,000 tons

*Description:* Through the implementation of electrified rail and locomotives with regenerative braking capabilities, energy typically lost when braking is saved and resupplied to other vehicles. The project reduced the carbon intensity of the system through the switch to electric vehicles and improved fuel efficiency by about 30 percent by reducing losses associated with stopping and starting.

Although cities have mechanisms on hand to enhance the energy efficiency of their transportation systems, the success of their policies will also depend somewhat on national policies. For example, national subsidies for fuel will hinder the promotion of more efficient modes of transportation, as illustrated by the limited take-up of LPG and CNG in Indonesian cities despite the government's promotion of these fuel types in the transportation sector.

### **City Emissions Profile**

GHG inventories can add a useful layer of analysis to that gained from the city energy balance. The GHG inventory demonstrates the relative impact of different fuels on overall emissions, as well as the contribution of non-energy-related sectors such as agricultural production. The GHG inventories carried out for the pilot cities proved informative, highlighting trends relevant to the wider region.

Perhaps more important, cities that maintain robust systems for monitoring GHG emissions earn access to additional sources of funding

and financing for energy efficiency and emissions mitigation programs that may otherwise not be available.

When energy-related GHG emissions are analyzed according to fuel source, the differences in electrical generation in the three pilot cities become apparent. For Surabaya, use of electricity generated mainly from coal is responsible for 36 percent of the city's emissions. For Cebu City and Da Nang, which both use significant renewable electrical generation, diesel and gasoline used for transportation and local electricity generation contribute heavily to the emissions profile. This difference is due to the impact of the carbon factors of grid electricity demonstrated in figure 3.8. An inventory of GHG emissions based on fuel source and end-use sector for the pilot cities is shown in figures 3.9a and 3.9b.

Transportation and industrial emissions account for more than 53 percent of emissions for all pilot cities—sectors that are only partially controlled by the city governments. Transportation alone is responsible for more than 40 percent of emissions in both Cebu City and Da Nang. However, this does not necessarily mean that the transportation sector in Surabaya is any less carbon intensive than in Cebu City and Da Nang.

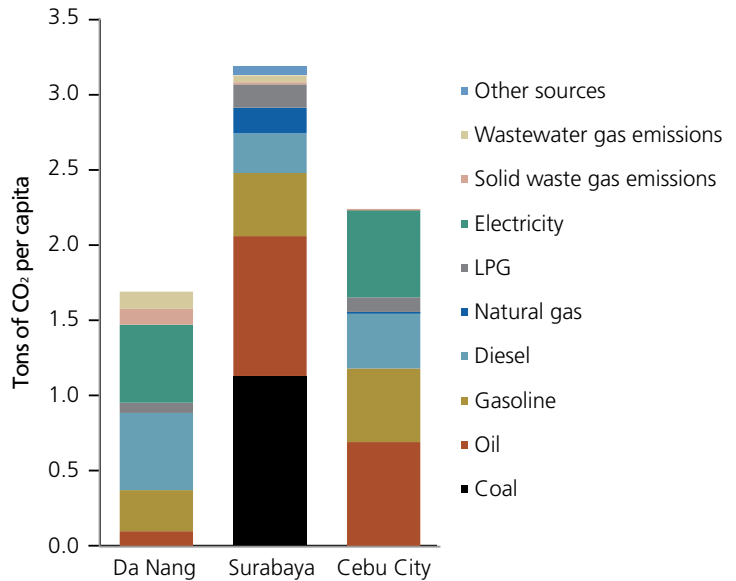
Urban GHG emissions analysis incorporates processes such as waste management and wastewater treatment. These sources should not be overlooked because they may contribute a fair portion of a city's total emissions. GHG emissions associated with solid waste management in Da Nang account for about 7 percent of the city's emissions.

### *Growing Economic Prosperity and Carbon Emissions*

A large body of evidence supports the assertion that more highly developed and richer nations have greater carbon intensities than less-developed and poorer nations. However, empirical evidence also suggests that more developed nations use energy more efficiently than do developing nations, as illustrated in figure 3.10.

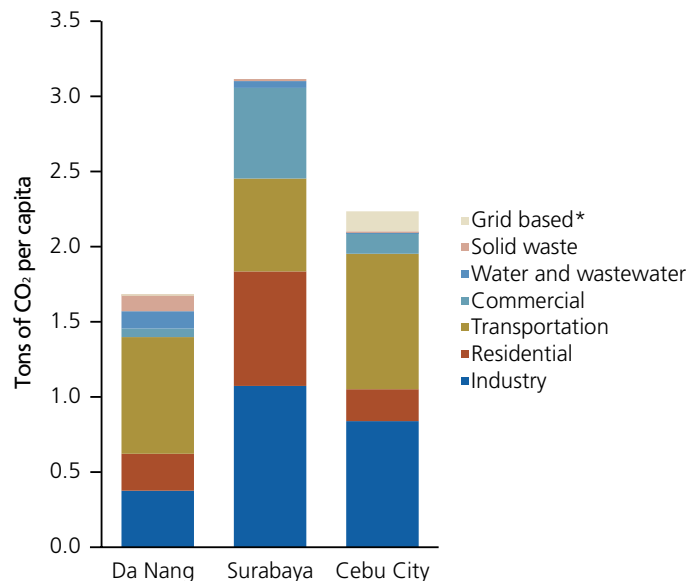
Figure 3.10 demonstrates that as per capita GDP increases, energy use per unit of GDP decreases, plateauing at about 125 kilograms of oil equivalent per US\$1,000 of GDP. Hence, there is a positive correlation between economic development

**FIGURE 3.9A. GHG EMISSIONS BY FUEL SOURCE**



Source: Phase I pilot study.

**FIGURE 3.9B. GHG EMISSIONS BY END USE**

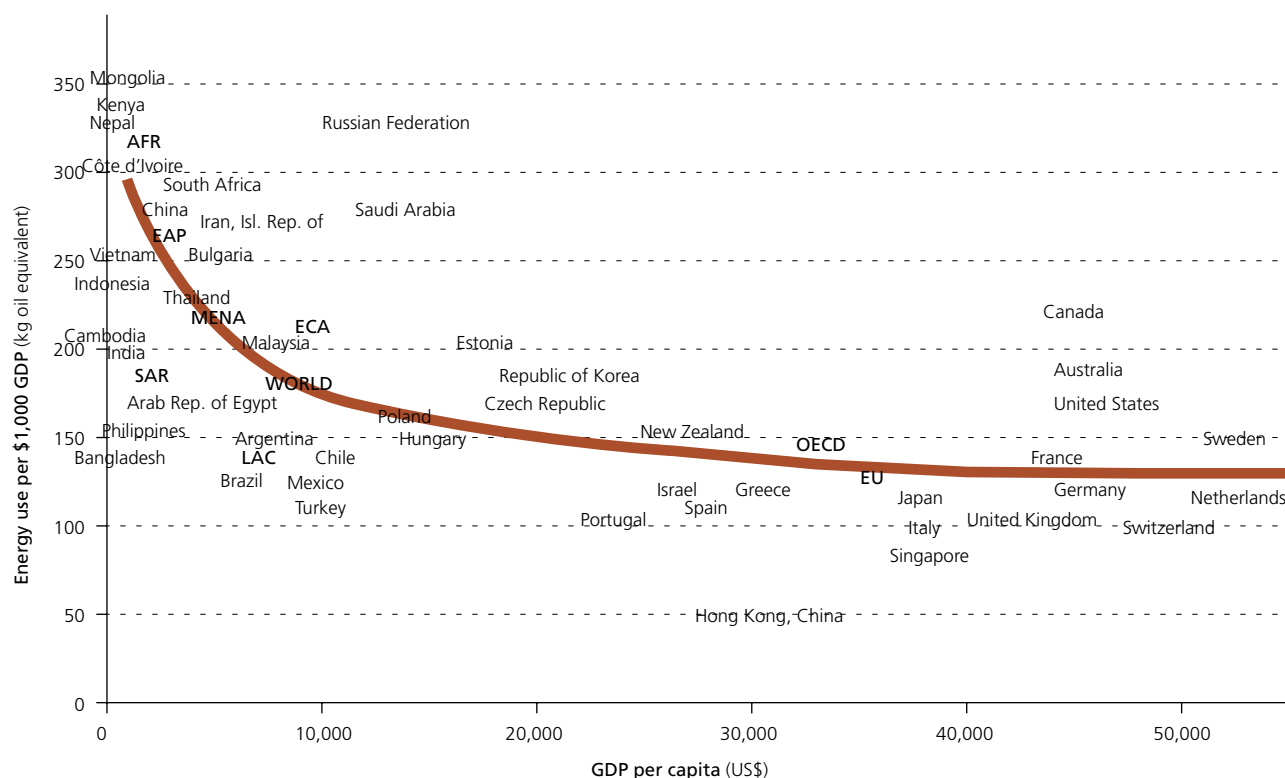


Source: Phase I pilot study.

Note: \*Grid based refers to electricity internally generated by the city. This is a separate category for Cebu City because data on end-use sector for electricity generated within the city were not available.

(approximated by increases in GDP) and the reduction of energy intensity, that is, energy efficiency improvement.

The key agents of economic development are widely accepted to be investment, employment,

**FIGURE 3.10. ENERGY EFFICIENCY AND ECONOMIC DEVELOPMENT (2008)**

Source: Authors.

Note: AFR = Africa; ECA = Eastern Europe and Central Asia; EU = European Union; LAC = Latin America and the Caribbean; MENA = Middle East and North Africa; OECD = Organisation for Economic Co-operation and Development; SAR = South Asia Region.

and productivity, all of which have a positive correlation with the improvement of energy efficiency. The empirical evidence in figure 3.10 illustrates the positive correlation in EAP cities, which are at the early or middle part of the curve linking economic growth to the energy efficiency improvement rate.

A key message for EAP cities is that energy efficiency improvements lead to

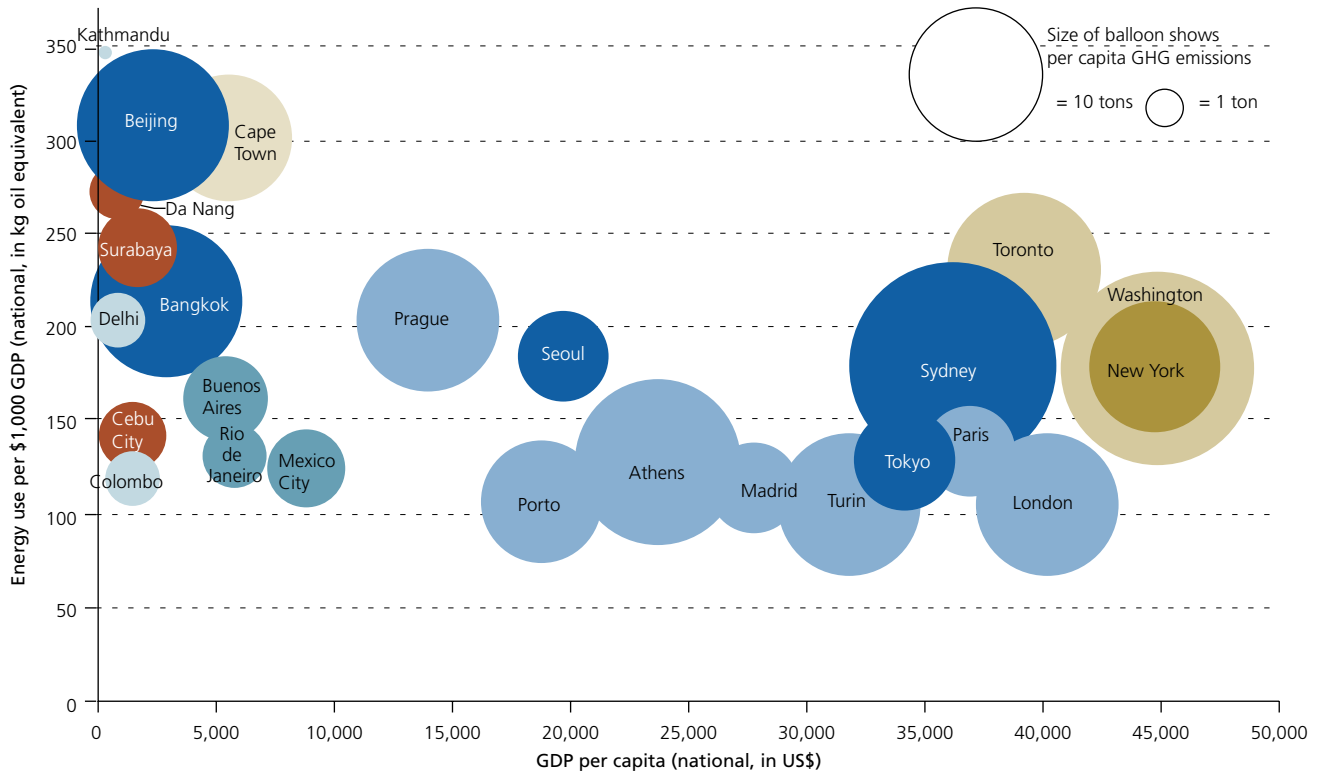
- increases in investments,
- jobs creation, and
- productivity improvements,

all of which, in turn, generate economic growth.

Thus, the case for investment in energy efficiency is clearly demonstrated. However, with respect to carbon intensity, a different story emerges. Figure 3.11 illustrates, using the same indicators as figure 3.10, the relative per capita GHG emissions in each city. The magnitude of per capita emissions is denoted by a larger balloon (see key in figure).

The figure suggests that although cities may be able to reduce energy intensity, a corresponding reduction in carbon emissions may not occur. Thus, investments in energy efficiency alone are not sufficient to keep cities on a sustainable energy path; for the most developed cities, GHG emissions per capita may plateau or even start increasing with GDP growth unless more comprehensive measures are implemented. Such measures or plans must take into consideration other causes of energy demand and emissions, for instance, land use, public transportation, distributed power generation and its mix, and so forth, which are part of a comprehensive SUEEP process. Hence, cities may quickly run out of “low hanging” energy efficiency opportunities and get stuck in the inherently highly energy-intensive infrastructure and economic models if they fail to address sustainability issues comprehensively.

**FIGURE 3.11. ENERGY INTENSITY AND GDP PER CAPITA IN SELECT CITIES**



Source: Authors. .





## Sector Diagnostics: Identifying Opportunities

City government energy expenditure across the three pilot cities accounted for 3.0–4.5 percent of annual city budgets and is expected to increase as cities grow and expand. The increase in city government energy expenditure across the pilot cities was attributed to a combination of increased energy use and increased energy unit costs. Although energy expenditure as a proportion of city budgets in the three cities appears to be small, potential exists for even that level of expenditure to be reduced.

Minimizing energy expenditures in the three cities is crucial, given the expectation of rising energy demand and the need for city governments to demonstrate good practice to wider stakeholders. The importance of the second point should not be underestimated. Many of the levers a city government can use to reduce citywide energy use (such as energy efficient building codes) will affect a wide range of stakeholders. It is therefore imperative that the city government demonstrates good housekeeping in its own affairs and, potentially, uses lessons learned to influence the activities of external organizations through mentoring or guidance.

Public lighting and city government vehicles accounted for a significant proportion of the energy budget in the three pilot cities. Wastewater treatment, waste management, and city government buildings also accounted for significant energy spending. This chapter describes the analysis undertaken across the sectors and identifies opportunities for energy efficiency improvements. Proposed projects were developed based on several factors: (i) level of potential for energy efficiency improvement, (ii) scope of control or influence of the city government, (iii) resource constraints, and (iv) compatibility of the projects with other development goals.

### Public Lighting

As cities grow and citizens expect quality of life improvements, city authorities face increasing pressures to enhance the coverage and quality of public lighting. Any program to enhance public

lighting must consider a range of factors such as cost, public safety, and the aesthetics of public space.

In the pilot cities, public lighting constitutes a considerable proportion of overall city government energy expenditure. In Cebu City, it accounts for about two-thirds of electricity expenditure (see table 4.1). Because public lighting is an activity with significant city government influence in each of the three pilots, awareness of the potential resource and financial gains to be achieved with energy efficiency measures in the sector is high.

#### Focus on Bulb Technology

Energy consumption in public lighting systems is controlled by a relatively small range of factors, including the placement of lighting poles, pole

**TABLE 4.1. PUBLIC LIGHTING PERFORMANCE FOR THREE SUEEP PILOT CITIES**

Public lighting	Cebu City	Da Nang	Surabaya
% Energy expenditure	37%	—	34%
% Electricity expenditure	67%	24%	—
Coverage (% of city roads lit)	95%	90%	79%
Energy consumption/pole (kWhe/pole)	656	416	400
Bulb technologies	—	55% sodium 18% LED 13% HPS 12% CFL 2% metal halide	95% HPS

Source: Phase I pilot study.  
Note: — = Not available.

height, angle of lighting coverage, and the efficiency of the light source. The installation of new bulbs is a costly procedure, so actions seeking short-term return on investments usually focus on optimization using appropriate light bulb technology. This approach can often reduce energy consumption significantly, reduce maintenance requirements, and increase the life span of light bulbs, the combination of which reduces the associated costs of public lighting for city authorities.

Traditional lighting technologies such as metal halide bulbs are inefficient compared with contemporary technologies. Replacement with more efficient high pressure sodium (HPS) or light-emitting diode (LED) bulbs offers potential in all pilot cities. The energy performance and extended life spans of these bulbs, and their ability to withstand fluctuating power conditions common in the region, contribute to their usefulness.

### *Improving Awareness and Support*

Although audit and replacement programs have recently been implemented in each of the three cities, significant potential remains for improvement in the selection and application of bulb technology. A common barrier to selection of appropriate bulbs and fixtures is persistent confusion about the comparative performance of the technologies on the market. Despite awareness of the availability of energy efficient technologies, such as LEDs, these bulbs are rarely deployed by the three cities. An effective means of overcoming such barriers is the implementation of pilot studies to build awareness among the involved stakeholders. Full-scale demonstration projects are usually required to validate manufacturers' promised performance and to secure necessary support from decision makers for public lighting retrofit programs. Once support is received, public lighting procurement guidelines (currently lacking in the cities) would bolster continued energy efficient operation of the public lighting sector.

Lack of upfront investment funds is often cited as a second major barrier to implementation of energy efficient public lighting. However, existing cost-effective financing models can overcome such obstacles. For example, many cities in developing economies in the region have reported success with implementation of energy performance contracting

for public lighting retrofits. Energy performance contracting is an innovative financing mechanism, normally offered by energy services companies, that uses cost savings from reduced energy consumption to repay the cost of installing energy conservation measures. These financing mechanisms allow cities to achieve energy savings without upfront capital expenses. Although such a mechanism has yet to be attempted in the three cities, it is worth pursuing actively. Future developments will likely promote financially attractive combinations of photovoltaic power sources with energy efficient technologies such as LEDs for public lighting, as is currently being investigated in Surabaya for both street lights and traffic signals.

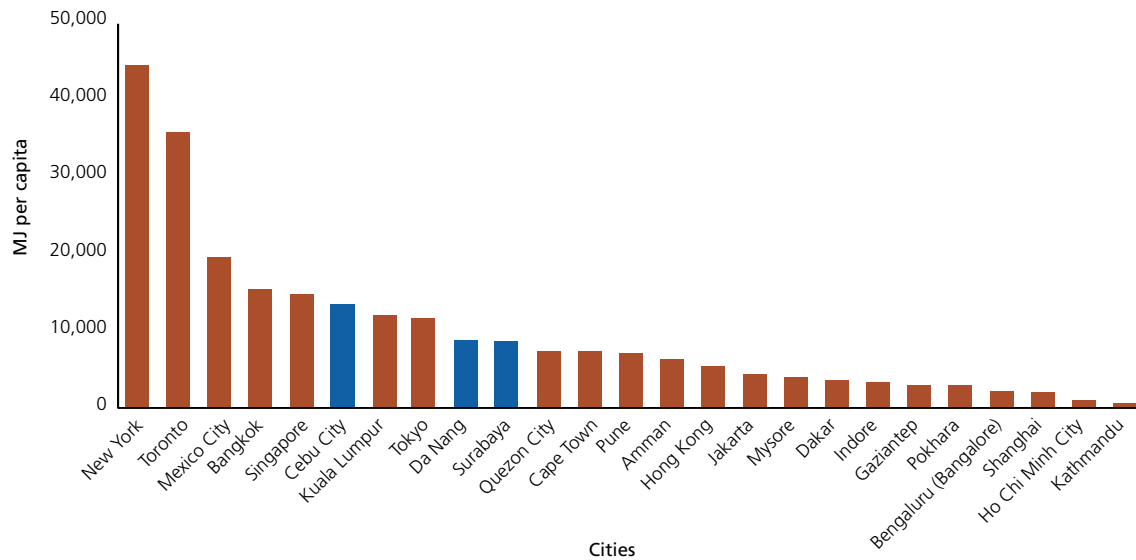
### *Implementing Strategic Timing or Dimming Programs*

Energy consumption in the public lighting sector can be further reduced by strategic timing or dimming programs tailored to the needs in specific areas, while maintaining appropriate levels of lighting for public safety. In Da Nang, the public lighting sector uses twin timing regimes that have yielded significant reductions in the sector's electricity consumption. Under this scheme, every third light in 40 of Da Nang's main streets is switched off from 6:30 pm to 11 pm, after which only every third light is kept on from 11 pm to 5 am. The second regime maintains full use of all lights in the remaining streets through the night.

## **Transportation**

The transportation sector in all pilot cities is responsible for significant energy consumption and greenhouse gas (GHG) emissions and therefore should be carefully studied. Fuel used for transportation is the single largest energy-consuming sector in Cebu City (51 percent), Da Nang (45 percent), and Surabaya (40 percent), and contributes notably to GHG emissions in each of the three cities (40 percent in Cebu City, 46 percent in Da Nang, and 20 percent in Surabaya). Across the East Asia and Pacific (EAP) region, transportation is both the largest as well as the fastest growing source of GHG emissions.

Although all three cities currently experience low energy intensity (megajoules per capita, or MJ/capita) in the transportation sector (see figure

**FIGURE 4.1. TOTAL TRANSPORTATION ENERGY PER CAPITA (SUEEP PILOT CITIES IN BLUE)**

Source: Authors, using TRACE.

4.1), the sector's energy consumption is rapidly increasing as a consequence of trends toward two-wheeled and four-wheeled motorized private transportation. This trend is representative of the sector across the region. City authorities, who are faced with the considerable challenge of influencing the type, length, and frequencies of trips that their citizens take, urgently need to intervene. A comprehensive approach is essential to address travel behavior patterns, modify urban development patterns, and take action to improve the energy efficiency of individual vehicles by increasing the distance traveled per unit of fuel and encouraging adoption of fuels that result in fewer GHG emissions.

### *Addressing Motorization*

Population expansion and economic growth are rapidly driving demand for enhanced personal mobility. Motorized two-wheeled vehicles are the predominant choice today, offering cheap and readily accessible personal mobility. But four-wheeled modes of transportation are in demand as well. Da Nang, where car ownership and monthly income are highly correlated ( $r = 0.846$ ), and where a progressive shift from public transportation to two-wheeled vehicles to four-wheeled vehicles is occurring, illustrates this trend. In addition, low elasticity in vehicle prices in the three cities means that the market offers few substitutes for private

vehicles for personal mobility. Thus, vehicle taxation alone will have only a limited direct impact on the increase in vehicles. Other regulatory and planning interventions will be necessary to decrease fuel consumption. None of the three cities currently places restrictions on the number of new vehicle registrations. Given these factors, the number of vehicles in these cities is set to increase, similar to the trend throughout Asia, where vehicle fleets are estimated to double every five to seven years.

Growing vehicle ownership increases traffic congestion, which is already apparent in some of the pilot cities during peak hours. Increased congestion increases local air pollution, GHG emissions, noise pollution, and personal fuel expenses, and also contributes to reduced health, deteriorating road safety, decreased quality of life, and loss of economic productivity for the city.

None of the three cities has yet implemented mechanisms for internalizing the externalities of personal vehicle transportation. Users of private vehicles currently do not pay the costs of congestion or pollution, and these costs are borne in equal proportion by public transportation passengers. Nonmotorized travel is becoming more difficult and decreasingly socially attractive. Walking in the three cities involves weaving across uneven pavement amid a range of obstructions, including

vendor stalls and parked cars. Despite these trends, Surabaya is putting measures in place to encourage the reemergence of pedestrian- and bicycle-friendly areas, increasingly focusing on improving accessibility and services for pedestrians and nonmotorized vehicles, including smaller pedestrianized streets and car-free days in two locations in the city.

The shift toward motorcycles and cars shapes energy performance in the transportation sector. The fuel efficiency of two-wheeled vehicles (0.01–0.02 kilometer per liter, or km/liter) is better than that of four-wheeled vehicles (0.1–0.2 km/liter). High-capacity buses are even more fuel efficient per passenger-km than two-wheeled vehicles when ridership rates are high. A shift toward clean and efficient public transportation therefore results in greater fuel efficiency. In Cebu City, public transportation ridership is high (85 percent of all trips) but the mode is inefficient (see next section). In all pilot cities, the overall fuel economy of vehicle fleets is worsened by growing numbers of idling engines.

### *Importance of Improving Fleet Performance*

The distribution of vehicle types and performance characteristics produces the difference in energy intensity illustrated by figure 4.1, which shows that Cebu City underperforms in comparison with Da Nang and Surabaya, despite its higher public transportation ridership. The disparity arises from Cebu City's highly inefficient and aging fleet of jeepneys (which have a capacity of 8 to 12 people per vehicle) with much poorer fuel economy than Surabaya's and Da Nang's predominantly two-wheeled modes of transportation.

Inefficient and aging fleets result in higher emissions levels. In response, the three cities have adopted European emissions standards (ranging from Euro II to Euro IV<sup>1</sup>). Emissions testing for older vehicles is carried out, but enforcement is fragmented and ad hoc. For example, although vehicles in Cebu City are required to be tested

when they are first registered, there is no formal repeat testing during the vehicle's life cycle and they are typically tested only after being apprehended when an officer observes smoke belching from the tailpipe. The situation is exacerbated by a lack of awareness by vehicle owners themselves of the value of regular vehicle maintenance.

Energy use in the transportation sector is currently dominated by petroleum products and the rate of consumption is growing quickly. Some vehicles, such as the angkots (minibuses) in Surabaya, run on highly polluting fuels like kerosene. Currently available vehicle engine and fuel technologies could reduce emissions substantially, and all three cities have introduced liquid petroleum gas (LPG) infrastructure for their taxi fleets.

### *Strengthening Public Transportation*

The three cities use different modes of public transportation. Cebu City's public transportation mainly comprises jeepneys, which operate on an ad hoc schedule. In Surabaya, 5,000 registered angkots run city-government-determined routes to regional bus lines served by three major bus stations and one regional train station. Da Nang has regular passenger bus service on six routes traversing the city. Despite the different modes, common threads among the three cities are the deteriorating quality of public transportation services, and a lack of clear knowledge on the role of public versus the private transportation sector and on the (dis)incentives for use of public versus private transportation.

The majority of public transportation trips are handled by the informal sector and operate inefficiently. In light of this, city authorities should initiate a modal shift that promotes lower fuel consumption per passenger-km traveled. Because buses have significantly better energy performance and emissions per passenger-km compared with private transportation, and to substantially reduce congestion, city governments should consider putting in place high-capacity public transportation networks. The three pilot cities, all of which have conducted bus rapid transit studies, are moving in the right direction. In Surabaya, plans for a mass transportation system comprising tramway and monorail systems to serve heavy traffic corridors

1. Euro II and Euro IV are European vehicle emissions standards that define acceptable levels of vehicle exhaust emissions on new vehicles sold in Europe. Euro II was passed in 1996 and regulates passenger cars and motorcycles. Euro IV was passed in 2005 and regulates all vehicles.

into the city center are being developed, and studies on integrating the rest of its public transportation network with the mass transit system have been initiated.

Although steps are being taken in the three cities to promote more efficient public transportation systems, city governments will continue to face multiple challenges. A key hurdle will be the ability to measure system performance, given the informal nature of the sector. The pilot cities have good vehicle registration data, but detailed data on modal split, passenger- and vehicle-km traveled, origin-destination, and environmental performance are largely nonexistent or, if they do exist, are of variable quality. Another challenge is attributable to the employment of a large number of citizens in the informal public transportation sector. City governments will have to include this group of stakeholders in the planning of future public transportation projects to ensure the efficient and effective operation of the formal sector.

### *Planning Integrated Development*

Similar to other Asian cities, urbanization at the edges of Cebu City, Da Nang, and Surabaya is high and increasing, exerting pressures on road space, as do the higher density areas and city centers. Accelerating urban sprawl exacerbates motorization trends, so pilot cities need to promote mixed-use urban development that reduces distances from origins to destinations to reduce motorized travel.

Table 4.2 shows that the share of nonmotorized transportation is the determining factor for total transportation energy use. In Cebu City, total transportation energy use (MJ/capita) is still substantially higher than in Da Nang and Surabaya even though it has a much higher public transportation share. This occurs because Cebu City's nonmotorized share is much lower.

Although vehicle ownership will rise with increased incomes, demand for motorized transportation can be managed by integrating land-use planning and transportation planning. A comprehensive approach will ensure that plans for mass public transportation, land use, parking policies, registration pricing, street signaling, pavement upgrades, and other measures affecting transportation systems are integrated and collectively provide

**TABLE 4.2. TRANSPORTATION SECTOR PERFORMANCE FOR THREE SUEEP PILOT CITIES**

	Cebu City	Da Nang	Surabaya
Total transportation energy use (MJ/capita)	13,394	8,668	8,481
Private transportation energy use (MJ/capita)	3.7	1.2	1.47
Public transportation energy use (MJ/passenger-km)	0.75	0.22	0.85
Nonmotorized transportation mode split (%)	5	34	40
Public transportation mode split (%)	86	1	5
% of citywide GHG emissions	40	46	20

Source: Phase I pilot study.

an effective strategy for delivering the targeted reductions in private trip lengths and frequencies. Engaging in a strong dialogue with national governments on transportation policies will also ensure that the city's plans are compatible with, or at least not in conflict with, national policies. Minimal efforts have been made so far in the three cities to effectively integrate transportation policy with land-use planning. Much scope remains for developing density, zoning, and development approaches to support pedestrian-friendly, transit-oriented transportation and urban development.

### **City Government Buildings**

Energy consumption in the buildings sector has grown along with the rapid urbanization that has increased volumes of building stock and with the behavioral changes that accompany economic growth. If prevailing practices and trends continue, global final energy consumption in buildings will grow by 30 percent between 2007 and 2030, with the increase expected to be greatest in fast-growing EAP cities, including Cebu City, Da Nang, and Surabaya. This sector has been identified by the Intergovernmental Panel on Climate Change as having the greatest potential for cost-effective reduction of GHG emissions by 2030 (IPCC 2007b).

Because the urban building stock in developing countries is expected to more than double by 2030, there is enormous potential to improve energy performance in the sector by focusing on

new construction—preventing the lock-in effect in new buildings—as compared with retrofitting existing buildings to improve energy efficiency. This is relevant for the pilot cities, given the potential for newly constructed buildings to consume higher levels of energy. City buildings in Cebu City and Da Nang currently exhibit low energy intensity (see figure 4.2) because the existing building stock comprises predominantly smaller, low-rise buildings minimally equipped with lighting, air conditioning, and appliances. However, this situation will change with the trend for new buildings to have larger floor space and increased cooling, ventilation, lighting, and plug load intensities. Thus, authorities in the three cities have ranked the buildings sector as having the highest potential for energy efficiency action following the public lighting sector.

Given that electricity is the primary energy source in buildings, two areas can be targeted to reduce energy use and emissions: (i) reducing electrical loads and (ii) reducing energy loads through building design and codes.

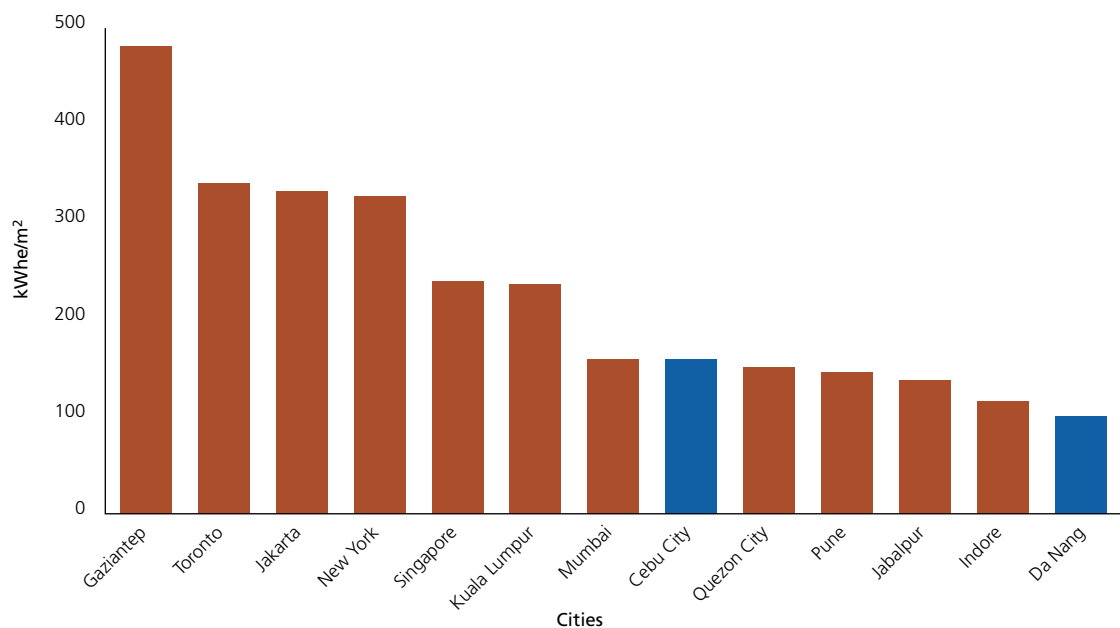
### *Reducing Electrical Loads*

Energy use in buildings is relatively low because a large proportion of hallways in city government buildings, schools, and hospitals use natural ventilation and daylight. Minimal energy is used for air conditioning and for providing hot water to supplement the black water tanks on the roofs in the pilot cities. Newer commercial buildings such as retail malls and office buildings are much larger and require central air conditioning, ventilation, and much more lighting.

As incomes grow, the size of homes and the use of electrical appliances, such as air conditioning, computers, and washing machines, also increase. In Da Nang, air conditioner ownership in homes is correlated with higher monthly incomes ( $r = 0.837$ ). This trend is likely to continue as incomes keep rising in the three cities.

Electrical load reduction can be addressed with targeted policies and programs. In the pilot cities, national-level energy efficiency standards for major appliances and equipment are broadly recognized as necessary interventions. A range of tactical and educational energy efficiency initiatives were

**FIGURE 4.2. CITY GOVERNMENT BUILDINGS ELECTRICITY CONSUMPTION (SUEEP PILOT CITIES IN BLUE, SURABAYA DATA NOT AVAILABLE)**



Source: Authors, using TRACE.



also undertaken by the city authorities, including restricted air conditioning operation times, dimming light switches, and compact fluorescent lamp replacement programs.

### *Reducing Energy Loads through Building Design and Codes*

Baseline energy loads are intrinsically related to building shape, orientation, structure, and materials, and are best addressed during the design and construction phases. Several considerable barriers impede energy efficient building design in the three cities, not least being the conflicting incentives among key stakeholders, the lack of available information and knowledge, and issues relating to the visibility of energy cost signals. The enforcement of efficiency standards through building energy efficiency codes (BEECs) may overcome these barriers and offer the greatest impact on future energy consumption in the buildings sector.

BEECs are not currently implemented in the pilot cities. Both the Philippines and Vietnam have recently introduced national green building guidelines, but these are voluntary best practices rather than mandates for minimum standards for all buildings. In Cebu City, the Building for Ecologically Responsive Design Excellence code offers an initial and valuable guideline for BEEC development. In Da Nang, the Vietnam Green Building Council's LOTUS green building rating system has drawn inspiration from other building certification programs, including Leadership in Energy and Environmental Design in the United States and Building Research Establishment Environmental Assessment Method in the United Kingdom. These codes include specifications for building design beyond energy performance, such as landscaping and noise pollution. Although the remaining work on development and implementation of appropriate BEECs for warm-climate developing countries is considerable, Da Nang's adoption of building codes is a positive step toward enhancing energy efficiency in its buildings.

BEECs in Indonesia, the Philippines, and Vietnam are not compulsory, but it would be beneficial for Cebu City, Surabaya, and Da Nang to enforce BEECs to prevent themselves from being locked in to energy inefficient buildings that would contribute substantially to their cities' carbon

emissions. To enforce BEECs successfully, cities will have to ensure the following:

- government commitment to energy efficiency,
- effectiveness of government oversight of the construction sector,
- compliance capacity of domestic and local building supply chain, and
- financing of energy efficiency measures (for example, retrofitting).

Major capacity-building is necessary in the three cities; key stakeholders need to be trained and educated, and systematic approaches for enforcement with complementary incentives need to be prepared, implemented, and regularly updated.

## Solid Waste

The solid waste sector in each of the three cities is currently characterized by relatively low waste generation rates with varying waste recycling rates (see table 4.3; for comparison with other cities, see figure 4.3). Waste generation rates are projected to increase as the economies grow and lifestyles change, and city governments are expected to manage increased waste collection and treatment needs with well-functioning collection and transport systems.

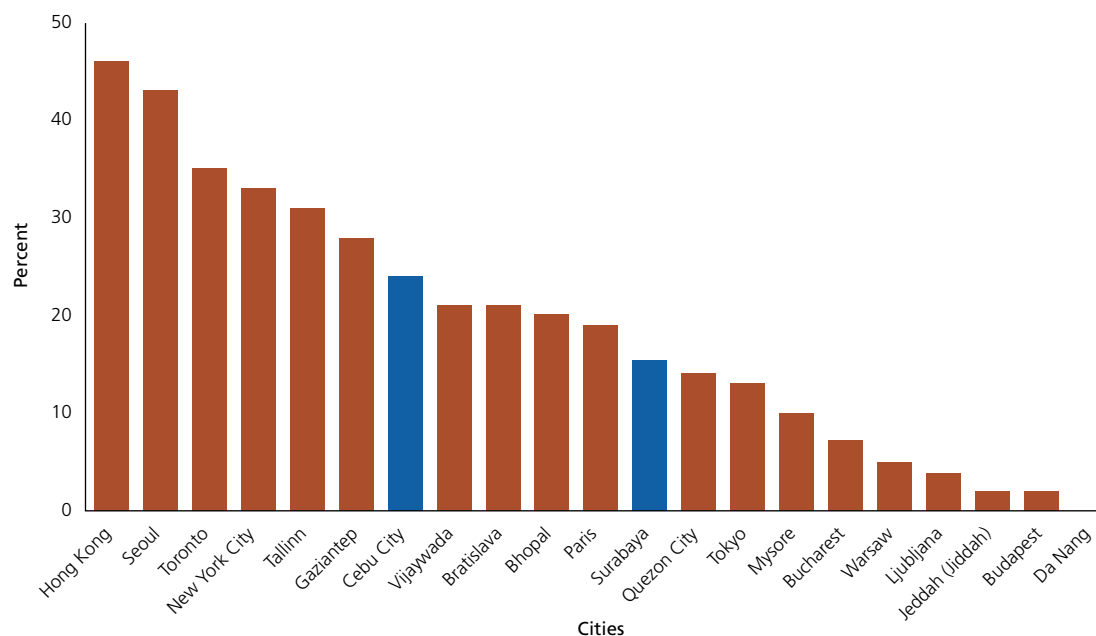
Energy efficiency improvement opportunities are available primarily in the energy embodied in the waste and its associated GHG emissions. Energy used for waste transportation is of lesser significance. In particular, potential exists in the region to scale up organic waste management activities. About 60–70 percent of city solid waste is estimated to be high-moisture organic waste. Organic waste decomposes anaerobically

**TABLE 4.3. SOLID WASTE SECTOR PERFORMANCE FOR THREE SUEEP PILOT CITIES**

	Cebu City	Da Nang	Surabaya
Waste generation (kg/capita/year)	183	248	256
Capture of solid waste (%)	80	90	70*
Solid waste recycled (%)	24	0	15
Waste that goes to landfill (%)	26	90	64
% of citywide GHG emissions	0	7	1.4

Source: Phase I pilot study.

\*Because no data were available on the proportion of solid waste captured by volume in Surabaya, a proxy using the proportion of the population served by solid waste collection was used instead.

**FIGURE 4.3. PERCENT OF SOLID WASTE RECYCLED (SUEEP PILOT CITIES IN BLUE)**

Source: Authors, using TRACE.

in landfills and releases methane gas, which is 23 times more potent than carbon dioxide as a GHG and has other potential public safety risks emanating from the decomposition process.

### *Segregating at the Source*

A primary constraint to the effective management of organic waste, which comprises the bulk of solid waste, is weak performance in source segregation. Composting and biogas projects using mixed waste inputs often fail. Hence, mandatory organics separation at the household level, as practiced in both Cebu City and Surabaya, is critical. Surabaya has a strong community-based waste self-management program based on the principles of “reduce, reuse, recycle.” The community is involved in composting organic waste and recycling or selling inorganic waste to waste collectors. A similar scheme operates in Cebu City. Da Nang has no formal recycling program, but 28 percent of households report that they remove recyclable materials from their waste before discarding. The majority of these recovered resources are given to scavengers or sold to companies that recycle and reuse the materials.

Formal waste collection systems in the pilot cities have substantial capture rates (see table 4.3),

and are organized through cooperatives, such as the daily collections at the barangay level in Cebu City. In Da Nang, bins are collected daily and a flat rate is charged for residential customers. Businesses are charged a volume-based rate. Similarly, Surabaya’s citizens are charged rates for collection that vary with distance from the main road.

### *Reducing Volume to Landfill*

Three principal treatment options can be applied to waste: landfilling, composting, and incinerating. The selection of treatment depends on a range of factors, including population size, waste volume, waste composition, availability of land, and existing policies. However, because the dense and moist waste in the region is characterized by low caloric values, incineration—which is ideal for dry waste with high caloric value—is not a suitable option, as was demonstrated in the failure of a waste incineration pilot project in Da Nang in 2003.

The most prevalent current treatment option is landfilling because it remains the cheapest and simplest means of waste disposal. However, waste is dumped indiscriminately and landfills in the three cities are poorly designed and are mostly beyond their design capacity. Waste pickers labor in all of

the cities' landfills, and informal landfill recycling has substantial volume capture. In Cebu City, it is believed that a recycling rate of 16 percent is achieved through activities of the waste pickers. Only Da Nang has a landfill with a leachate collection system. An important benefit of scaling up organic waste management is that leachate management will be easier with less organic waste going to landfills.

Landfills require large areas of land for the disposal site itself and for the buffer that usually surrounds it. With expanding city limits, increasing land value, and increasing costs, authorities will find it increasingly difficult to locate affordable land reasonably close to the city. Reducing the volume of total waste treated at landfill therefore extends the operational life of such facilities.

### *Capturing Landfill Gas*

Landfill gas emissions present potential sources of energy generation that might receive financing through the Clean Development Mechanism. Studies have been undertaken in the pilot cities to determine the potential for such projects. Thus far, Surabaya has solicited alternative bids from potential partners for landfill gas capture projects on the Benowo landfill, but no contracts have been completed. Cebu City is considering capping the Inayawan landfill, and studies are being considered to reduce emissions by 5,000 tons of CO<sub>2</sub>/year through the project. Da Nang has identified a large project at the Khanh Son landfill that would generate 1 megawatt of electrical power and reduce GHG emissions by 140,000 tons of CO<sub>2</sub>/year or nearly 5 percent of total city emissions.

### *Composting Organic Waste*

Organic waste can be recycled into compost, and if managed aerobically, would not result in the production of methane. If managed properly, aerobic decomposition would result in carbon sequestration in soil solids. Because compost improves soil fertility, there is significant potential demand from the agricultural, residential, and landscape management sectors. Increased production of compost from city organic waste benefits urban agricultural productivity and urban food security, as experienced by Cebu City, which produces 25 percent of its own food and supplies urban farmers with compost from the city's composting facilities.

In Surabaya, thousands of residential composting bins have been distributed to residents by the city government, which also operates several composting houses that are supplied with organic waste from the park maintenance program and fruit and vegetable markets. These larger schemes use static pile methods with forced aeration. Compost is reused in the city's public parks. Cebu City has small-scale composting in the barangays, as well as larger-scale facilities at the landfill.

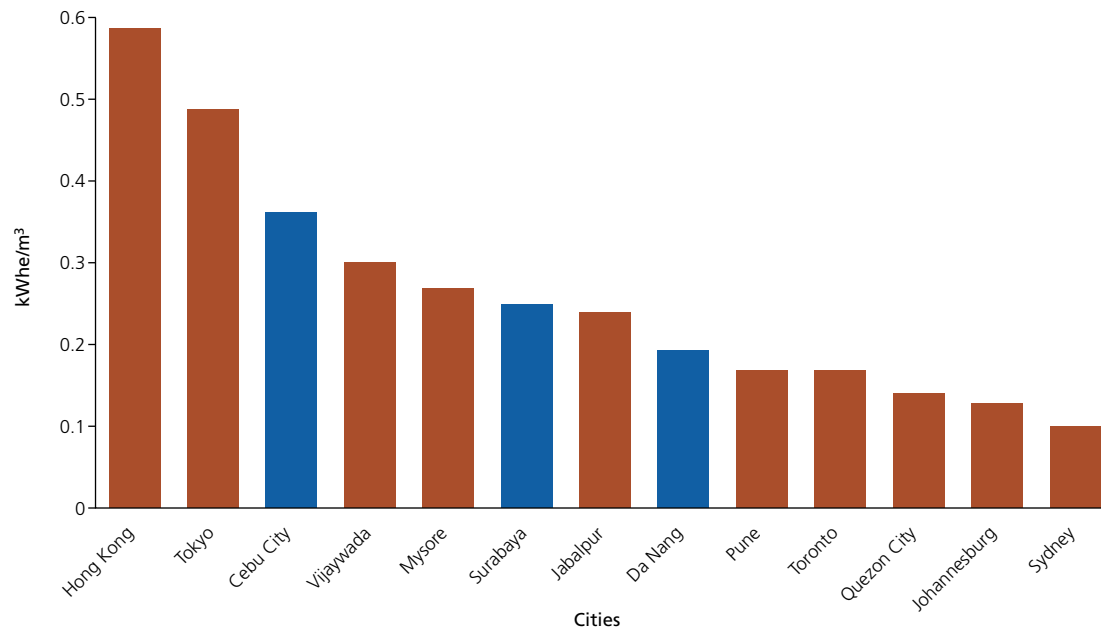
Second-generation biofuels, which are produced using nonfood sources (and therefore are not in competition with food production), are an expanding area of research and development. Of relevance to EAP coastal cities is the production of energy using fish waste. For example, Integrated Renewable Energy Solutions for Seafood Processing (Enerfish), a project developed by VTT Technical Research Centre of Finland in collaboration with the European Commission, produces biodiesel from waste generated by a fish-processing plant in Vietnam. EAP cities in coastal areas, especially those with fish-processing industries, could potentially harness such technologies, enabling them to produce local energy and reduce GHG emissions.

## **Water and Wastewater**

The primary concerns guiding city authorities in the water and wastewater sector are the need to reduce both costs and the negative impacts of treatment and distribution, while simultaneously expanding water and wastewater services to underserved populations. Many still lack access to safe drinking water and adequate sanitation facilities. In Surabaya, 70 percent of the population has access to clean drinking water; in Da Nang, the figure is 60 percent, and in Cebu City, above 50 percent. The lack of water supply, or its unreliability, can have detrimental health impacts, and result in significant social and economic costs.

Although only 2–3 percent of the world's energy consumption is used to pump and treat water for urban residents and industry, there is much scope to enhance energy efficiency in this sector. It is estimated that energy consumption in most water systems worldwide could be reduced by at least 25 percent by cost-effective efficiency actions alone.

**FIGURE 4.4. ELECTRICITY CONSUMED PER CUBIC METER OF POTABLE WATER PRODUCTION (SUEEP PILOT CITIES IN BLUE)**



Source: Authors, using TRACE.

### *Enhancing Energy Efficiency in Pumping*

The significant requirement for pumping means that sourcing water supplies from groundwater is a relatively energy-intensive process. Because Cebu City's potable water supply is sourced from groundwater, its energy intensity is higher than that of the surface water, gravity-fed systems that supply Da Nang and Surabaya (see figure 4.4). To reduce Cebu City's reliance on energy-intensive water sources, the city is considering the study of rainwater harvesting schemes in its buildings and ways to encourage the uptake of these schemes in private developments. Rainwater harvesting systems, which are not yet widely used in the region, are expected to receive much more attention in the future.

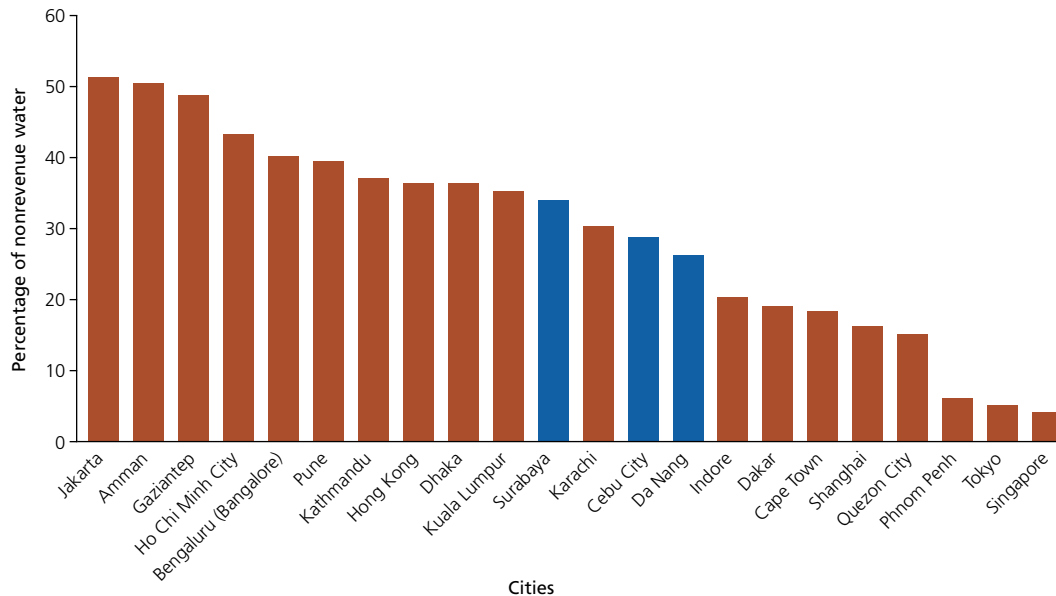
### *Improving Distribution Networks*

Improvements in distribution network performance, in particular, efficiency of pump operations throughout the network, can deliver large energy efficiency gains in the water sector. Considerable energy is used inefficiently when pump motors operate at suboptimal speeds. In addition, pumps that

consistently maintain high rates of pressure even when demand is low can result in increased leakage across the system. Remedial measures to improve pump operation can provide attractive returns on investment. Low-cost measures, such as soft starters for motors and trimming impellers, as well as higher-cost measures such as the replacement of inefficient pumps and installation of variable speed drives that adjust pressure based on the demand on the system, are available. Da Nang has installed variable-speed drive pumps, and Cebu City has partnered with an external organization to implement a wide-scale pump efficiency program. Although no pump upgrade or maintenance is currently performed in Surabaya, a program to improve network pressure will introduce additional reservoirs and in-line lift stations across the network.

Enhancing the efficiency of the distribution system can also be accomplished by minimizing leakage—the cost of every liter of water delivered to consumers is increased by every liter lost to leakage. Wider water-loss management programs focus on theft as well as leaks, and water losses should be

**FIGURE 4.5. NONREVENUE WATER AS A PERCENTAGE OF TOTAL POTABLE WATER PRODUCED (SUEEP PILOT CITIES IN BLUE)**



Source: Authors, using TRACE.

targeted to be brought to less than 10 percent. This recommended level is significantly lower than the levels of nonrevenue water experienced in the three cities' networks (see figure 4.5). Because old pipes are a primary cause of system losses, Da Nang and Cebu City have implemented audits and programs to replace them. In an effort to overcome the high initial investment cost of a leak-reduction program, the water utility company in Surabaya has considered performance-based contracting agreements to upgrade the network.

Pressure management is generally more cost effective than expensive repairs to leaks in buried pipes. This approach will likely be the preferred focus of distribution network improvement programs in the region, ahead of the replacement of existing networks.

### *Scaling Up Treatment Infrastructure*

Many cities in EAP have limited wastewater treatment infrastructure. Therefore, the impact on energy is minimal. However, more comprehensive systems are likely to be developed—thereby

increasing overall energy use levels—as a result of increasing concerns about public health threats arising from the contamination of groundwater supply by septic tank seepage and septic waste dumping. Cities can take advantage of this opportunity to learn from global best practices and leapfrog inefficient systems design.

Cebu City has no citywide wastewater infrastructure. Its wastewater is currently managed through household septic tanks. The partially treated waste stored in the septic tank is removed by private septic waste haulers and disposed of, untreated, in the landfill. A similar process takes place in Surabaya, though several private wastewater treatment companies also operate treatment facilities for large buildings, industrial sites, and campuses. Da Nang is the only pilot city with wastewater treatment plants and a sewage pipe network that handles approximately 65 percent of wastewater. The remaining wastewater is stored in septic tanks. Da Nang's energy consumption for wastewater management is relatively low compared with other cities in the wider region,

probably because the system has been designed as a “dry weather” system. During dry months, all wastewater flows through the system to treatment facilities where it is processed anaerobically. However, during the monsoon season, wastewater and rainwater are diverted directly into local waterways. This method increases pathogen levels in the receiving waters because the pumps are automatically switched off when rainfall floods the capacity of the system.

### *Capturing Sludge Gas*

In addition to treated effluent, wastewater treatment plants produce sludge composed of biomass and settled biological material. There is increasing awareness in the wastewater sectors in the three cities that sludge can be digested anaerobically or gasified to produce biogas for electricity generation. In Surabaya, smaller-scale composted sludge already contributes to soil fertilizer in city parks. A pilot project in Cebu City, aiming to treat septic tank waste using a biodigester, recently failed because of contamination of the sludge by industrial waste, which compromised the possibility of biological treatment.

### *Managing Demand*

Further energy improvements can be achieved by encouraging conservation and water-conscious behavior. Technological devices that promote water conservation, such as low-flow toilets, shower heads, and sink faucets, can be fitted in city government buildings and encouraged in private developments through outreach. In Cebu City and Da Nang, water utilities have implemented tariff structures and embarked on campaigns to educate consumers about the importance of water conservation. However, more can be done to improve customer knowledge about the importance of and means of reducing consumption at home because the initiatives are still not widespread.

## **Power**

With rapidly increasing energy demand, electric utilities in the region are challenged to establish and maintain generation and transmission capabilities and improve quality of service. All three cities are served by national electricity companies that provide subsidized power. Management of

these companies is largely out of city government control, so the number of city interventions that can affect energy efficiency performance in this sector is limited. City governments, therefore, would need to work closely with national governments on energy policies to ensure the reliability and affordability of electricity supply to their cities. Despite this, as cities in the region increasingly localize and decentralize power generation in the future, city authorities will need to build capacity to understand the complexities and critical elements of power generation, distribution, and consumption.

### *Managing Peak Loads*

The daily load curves of the three cities are characterized by high peaks of short duration. Smoother load curves would enhance the efficiency of power plant operations, allowing generators to perform within their steady optimal performance ranges and reducing the need to add new generation capacity. City authorities are in a good position to influence energy demand to enhance the overall efficiency of the power sector. Authority can be wielded in various ways, such as the imposition of building codes (discussed earlier) and flexible tariffs to encourage energy use during off-peak hours, which is practiced in Da Nang.

### *Generating Renewable Power*

Both Cebu City and Da Nang rely on electricity generated outside the city using significant renewable sources (see table 4.4). No major renewable sources of energy, however, have been deployed within any of the city limits, despite significant potential for solar-powered technologies. The potential deployment of distributed and localized generation (smart metering) is not limited to renewable technologies such as solar sources on buildings—methane gas from the solid waste and wastewater sectors could also be captured.

To successfully encourage expansion of renewable and localized generation, each of the three cities would need to produce a renewable energy strategy. Steps should include the transformation of the transmission grid to enable two-way metering for localized generation as well as the development of smart-grid technology, which offers significant potential for improving electricity distribution and



controlling demand. In addition, incentive schemes to encourage the uptake of renewable energy can be implemented. Such schemes include incentives such as feed-in tariff structures that can make renewable generation more financially attractive, given the failure of the market to account for environmental externalities. Although schemes like feed-in tariffs are usually implemented at the national level, city governments can encourage the use of renewables by favoring development that uses on-site renewables and by updating building codes to encourage the uptake of renewables in their cities.

### *Optimizing Transmission and Distribution*

As cities expand and the energy demand load increases, existing primary infrastructure, including transmission and distribution networks, experiences increased stress. Greater transmission inefficiencies and congestion occur, which, in turn, lead to reduced grid reliability and lower quality of electricity supply.

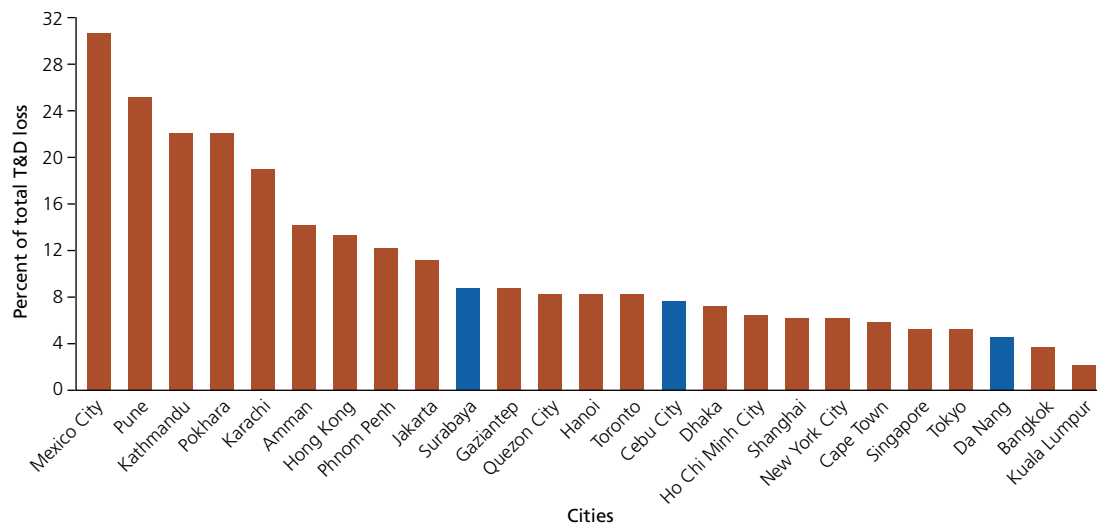
**TABLE 4.4. POWER SECTOR PERFORMANCE FOR THREE SUEEP PILOT CITIES**

	Cebu City	Da Nang	Surabaya
Transmission losses (%)	7.45	4.23	1.8
Distribution losses (%)	(combined)	(combined)	6.7
Renewable generation (% of total)	49 (geo and hydro)	30 (hydro)	0
Peak load (MW)	—	250 MW	—
% of citywide GHG emissions	26	31	69

Source: Phase I pilot study.  
Note: — Not available.

Transmission and distribution losses in the three cities are comparable (see figure 4.6). Several interventions, such as the installation of composite core conductors, high efficiency transformers, energy storage, smart controls, and localization of energy generation, can be made to reduce these losses. National energy suppliers to the three cities are aware of these engineering solutions, and have been performing ongoing maintenance on

**FIGURE 4.6. TRANSMISSION AND DISTRIBUTION PERFORMANCE (SUEEP PILOT CITIES IN BLUE)**



Source: Authors, using TRACE.

transformers and substations and making power factor corrections. In Da Nang, the power utilities are planning to ground distribution lines to minimize nontechnical losses from illegal connections, which is a persistent problem in the EAP region.

## Identifying City Government Priorities

The preceding sections of this chapter provide a review of sectoral energy use and issues across the three cities. Based on the opportunities and challenges posed, a range of potentially viable recommendations were derived for each sector that would enable emissions reductions and improvements in energy consumption efficiency. The challenge for city governments is to accurately determine which sectors and recommendations should be prioritized for action. This activity in the first phase of the Sustainable Urban Energy and Emissions Planning (SUEEP) Program was undertaken using a prioritization process that forms the second module of the Tool for Rapid Assessment of City Energy (TRACE) system. The process is summarized below.

The following factors were taken into account in prioritizing sectors for action in the pilot cities:

- *Greatest potential for improvement.* Sectors that have the most potential for improvement in energy efficiency and GHG mitigation are identified. To this end, “improvement” was defined as a function of
  - current energy expenditures on a given sector (estimated citywide expenditures) and
  - energy savings potential (based on benchmarking work conducted as a part of the study).
- *Scope of control or influence of the city government.* Although city governments may be able to implement several measures that reduce energy consumption and emissions, the impact will be limited if the sector represents a small fraction of citywide energy and emissions. The degree to which the city government can affect energy consumption and emissions in sectors such as industry, wastewater treatment, building design, or power distribution varies substantially from city to city. Thus, in the sector prioritization process, knowing the level of influence a city

ultimately has in improving energy efficiency in each sector is very important.

To prioritize specific actions and recommendations derived through the program, or additional recommendations that may be developed at a later date, the following factors should also be considered:

- *Resource constraints.* Within each sector, multiple fiscal and human resource constraints that will hinder the success of programs should be considered.
- *Compatibility with other development goals.* In addition to the improvement of energy efficiency and reduction of a city’s carbon footprint, a city government would also seek to improve the city’s environmental, social, and economic conditions. Therefore, energy efficiency and low-carbon activities that would most effectively help the city achieve these parallel objectives would be given a higher priority.
- *Timing.* Given other ongoing initiatives in the city, it is useful to identify those activities that would be the most complementary in the short, medium, and long terms.

Based on the above, a methodology was formulated to prioritize programs using the following factors:

- *Energy expenditure information:* This information can be obtained either from city government budget offices or through the conversion of energy use across the city into a monetary value.
- *Energy efficiency opportunity:* Key performance indicators from the TRACE benchmarking process that are most indicative of energy use across a particular sector or subsector were chosen. To define opportunity, the mean value of sectoral energy use of the better-performing cities in the peer group is calculated; the difference between this value and the city’s current performance provides an improvement target for the city. This is termed the “relative energy intensity” (REI) of the sector.
- *The control or influence of the city authority:* This factor ranges from minimum (national governments have full or greater control) to maximum influence (city has full budgetary and

regulatory control). Each of the seven options in the range has a range of values; therefore, the TRACE user can determine the extent of the city authority's control or influence in each sector. This final component is used as a weighting factor, with values ranging from 0.01 to 1.

The prioritization calculation is based on simple multiplication of each factor's potential for energy improvement, spending, and degree of city authority influence. Thus the calculation is as follows:

$$P = (CGSe \times REI \times C),$$

in which

$P$  = prioritization,

$CGSe$  = city government expenditure on energy,

$REI$  = relative energy intensity,

$C$  = level of city authority influence.

The prioritization table for Da Nang is illustrated in table 4.5.

Note that table 4.5 presents priorities for sectors in which the city authority has maximum influence, and for citywide issues over which the authority has limited influence. The ranking suggests that the city of Da Nang should prioritize programs as follows:

- Street lighting
- City buildings
- Solid waste
- Water treatment system.

On a citywide basis, the power supply system is a clear area of focus, as are public and private transportation.

This sector prioritization methodology relates only to energy efficiency. However, other factors that promote energy sustainability, such as increasing the share of renewable energy in the energy supply system, which will enhance the reliability of energy supply and reduce GHG emissions, can also be incorporated into the recommendations to be considered in due course without the need for further prioritization.

**TABLE 4.5. SUMMARY RESULTS OF THE TRACE PRIORITIZATION PROCESS IN DA NANG, 2011**

Priority ranking	Sector	2010 energy spending (US\$)	Relative energy intensity (%)	Level of city authority control*	Savings potential (US\$)**
<b>City authority sector ranking</b>					
1	Street lighting	1,200,000	78.2	1.00	939,141
2	City buildings	2,069,047	15.1	1.00	312,426
3	Solid waste	452,380	48.8	0.97	214,277
4	Potable water	564,349	26.4	0.96	143,163
5	Wastewater	95,000	11.1	0.96	10,133
<b>Citywide sector ranking</b>					
1	Power	54,285,714	33.8	0.38	6,973,725
2	Private vehicles	44,665,149	10.0	0.14	669,977
3	Public transportation	361,773	65.8	0.90	214,416

Source: Phase I pilot study.

\*0 = no influence; 1 = maximum influence

\*\*Based on TRACE benchmarking; these figures are indicative of the quantum of savings that may be possible, not necessarily practicable.



# Governance

### The Importance of Governance

Energy governance refers to a city government organizational framework established specifically to deal with energy-related issues. It is a key mechanism for deploying effective energy efficiency projects on a citywide level. The city's approach to energy is undertaken in an integrated manner, and the city's projects are aligned with the national government's efforts to improve energy efficiency in the city.

Improved energy governance will benefit cities through better oversight and enhanced transparency and through the coordination of various energy-related initiatives across sectors. It will also enhance the potential for innovation by giving local agencies and stakeholders the opportunity to engage and exchange ideas.

Sustainable Urban Energy and Emissions Planning (SUEEP) cuts across sectors, and touches on most areas of public service provision and private enterprise. SUEEP also has a temporal dimension, especially with planning, designing, procuring, constructing, and operating new facilities and infrastructure. In this regard, SUEEP must also guide spatial and investment plans. For instance, suppliers of electrical power and potable water, among other stakeholders, should be actively engaged in the strategic and economic development planning of cities over the long term. This not only enables them to provide inputs but also allows them to identify where capital investment will be required for new or improved utility infrastructure. As a result of these various considerations, the active and structured management of a wide variety of stakeholder relationships is necessary to ensure successful and lasting outcomes.

### Governance of Energy-Related Issues

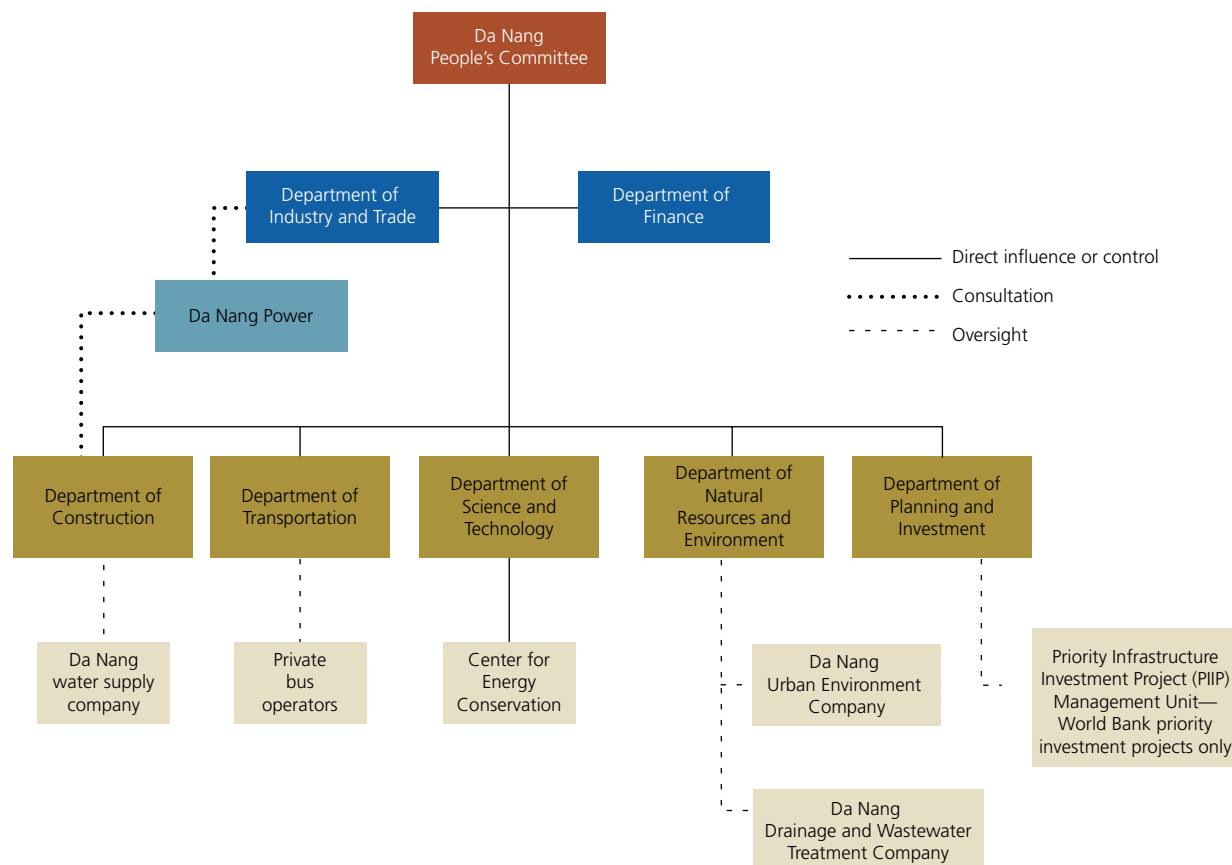
During SUEEP Phase I, an institutional mapping exercise established the principal agencies and actors involved in the delivery and management of services that directly or indirectly affect the energy and greenhouse gas (GHG) emissions profile of each pilot city. Institutional mapping is useful to understand the range of stakeholders involved in

energy planning, delivery, management, and the SUEEP process, and also serves to communicate to all parties the relevant responsibilities, ensuring that all understand why each stakeholder is involved. Institutional mapping is also a useful tool for understanding the interplay between agencies. In particular, being aware of which agency reports to whom, which agency has decision-making power, and which agency can influence the formulation and implementation of policy will be a crucial determinant of the success of SUEEP. Knowledge of such dynamics will also minimize the possibility that overlapping issues are left unaddressed, especially if more than one agency is responsible for the implementation of a policy.

Figure 5.1 illustrates the institutional arrangements in Da Nang. It shows clearly that planning and management of energy issues involved multiple agencies, underscoring the importance of cross-agency collaboration in the planning and management of sustainable urban energy and emissions issues. The institutional maps from Cebu City and Surabaya displayed a similarly complex pattern with respect to the numbers of organizations involved and the spread of control and influence over energy- and emissions-related matters. Despite this, differences in the governance structures in each of the pilot cities became evident, illustrating the need for city governments to fully understand city-specific relationships between stakeholders before embarking on an SUEEP exercise.

The degree of control or influence each city has was also mapped. The outcome, presented in figure 5.2, shows that each city generally has control of investment, budgets, and several local energy

FIGURE 5.1. OVERVIEW OF ENERGY PLANNING SYSTEM IN DA NANG



Source: Authors, Phase I pilot study.

efficiency activities, as well as public lighting, public buildings, wastewater treatment, and waste tariffs. City authorities' influence was much more limited with respect to power supply and electricity tariffs. It is significant that in most other sectors, the pilot cities had varying degrees of influence, with coordination between local agencies more likely when facilitated by the city government. Thus, city governments need to be well aware of local circumstances so as to tailor plans to their unique needs and governance structures.

### City-Level and National Energy Programs

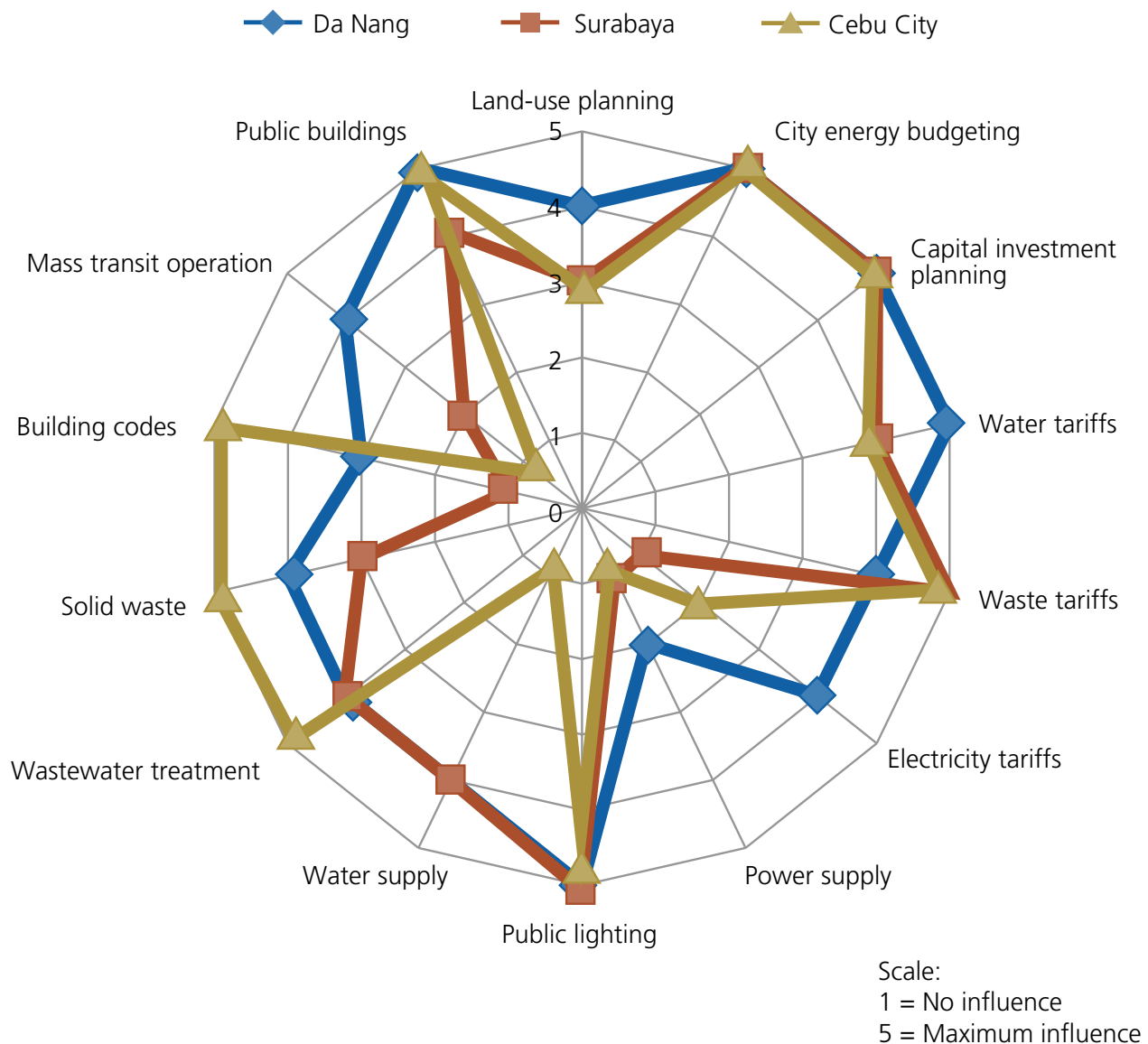
Although local governments have control or significant influence over policies at the city level, few energy policies, plans, and programs were implemented at the city level (see table 5.1). The limited number of policies enacted at the city level

stems from the requirement to coordinate and institutionalize energy policies at a national level as part of the sustainable energy planning process. Implementing energy policies on a national level is more efficient and effective, and ensures consistency in application throughout the country. Examples of such measures include vehicle standards, energy labeling, and industrial energy efficiency programs. Likewise, programs that facilitate and promote low-carbon energy generation are also usually sponsored at a national level to enable and facilitate the country's economic development. Examples of national-level programs in each of the three pilot cities are listed in table 5.2.

Given the close links between city and national energy policies, city and national governments must clearly understand the allocation of roles and responsibilities for bringing about a sustainable future. These roles are described below.



FIGURE 5.2. LEVEL OF INFLUENCE OF CITY GOVERNMENTS IN VARIOUS SECTORS



Source: Authors.

### *The City Government's Roles and Responsibilities*

Energy efficiency cuts across sectors and pertains in some way to most areas of public service provision and private enterprise. Cities often have the most direct line of public communication to residents, businesses, and industries, which means that education and incentives are most efficiently delivered through city governments. These factors, combined with the city government's intimate knowledge of city development and possession of the tools to influence or regulate sectors, mean that the

city should be responsible for planning its development comprehensively and sustainably. To do this, the city government should take the lead in energy and emissions planning and implementation, and in advocating for changes that contribute to the advancement of the city's goals. One of its responsibilities would thus be to set up an appropriate organizational structure for energy planning that includes national, regional, and local governments as well as key stakeholders in the SUEEP process.

Achieving sustainable urban energy planning objectives through market transformation

**TABLE 5.1. SUMMARY OF CURRENT PILOT CITY ENERGY ACTIVITIES**

	Surabaya	Cebu City	Da Nang
City energy team		✓	
City energy plan or program		✓	✓
Mayoral mandate for energy efficiency	✓		✓
Renewable energy research and development program			✓
Technical programs (for example, waste, buildings)		✓	✓

Source: Authors.

and integrated demand-side management will require the capability to better understand, characterize, and shape energy demand and use within urban built environments. In this regard, city

governments will need to build their capacity to (i) understand the environmental, economic, and equity impacts of the embedded energy costs and operational energy needs of urban infrastructure systems and urbanization; (ii) identify the local environmental, economic, and equity benefits of sustainable urban energy planning, especially with respect to the private sector; (iii) develop information and materials that lead to a better understanding of planning options, particularly the costs and benefits of alternative technologies, practices, and development scenarios; and (iv) develop effective decision-support tools and methods for community-based energy systems planning.

In planning its sustainable development, a city government must recognize its level of influence in implementing policies at the city level. To this end, the city government will have to be fully responsible

**TABLE 5.2. SUMMARY OF NATIONAL ENERGY EFFICIENCY POLICIES AND PROGRAMS FOR INDONESIA, THE PHILIPPINES, AND VIETNAM**

National Policies, Plans, and Programs	Indonesia	Philippines	Vietnam
Government buildings energy efficiency management program	✓	✓	✓
State-owned energy services company (ESCO)	✓		
Public-private partnership program on energy conservation	✓		
Energy benchmark and best practice guide	✓		
Building energy codes	✓	✓	✓
Energy labeling for appliances and products	✓	✓	✓
Energy efficient lighting program in the residential sector	✓	✓	
Energy awards	✓	✓	✓
Lower rates on investments in energy conservation	✓	✓	✓
Government awareness raising for energy conservation in households and industries	✓	✓	
Training and accreditation for energy managers and energy auditors	✓	✓	✓
Energy management services and energy audits		✓	
Fuel conservation and efficiency in road transport program		✓	✓
Power conservation and demand management in all commercial, residential, and industrial sectors	✓	✓	✓
System loss reduction program		✓	
Technical assistance to domestic producers on energy efficiency compliance		✓	✓
Support for industrial enterprises improving, upgrading, and optimizing technology	✓		✓

Source: Derived from Asia Pacific Energy Research Center, 2010.

for sectors over which it has significant influence (for example, street lighting, public buildings, and wastewater treatment). At the same time, city governments should determine those aspects of energy planning that can be aided by national programs and engage in a strong dialogue with national agencies from the outset of the process to determine the level of support that may be expected. In finding compatible interests between the city and national governments, cities can use the opportunity to secure support or financing from the national government to implement national policies in their cities. For example, there were programs in Da Nang that were implemented at the city level but were cofinanced by a national agency. The Department of Science and Technology, via its Center for Energy Efficiency and Conservation, coordinates the Da Nang City Project on Efficient Use of Energy and Application of Renewable Energy in accordance with the central government's energy efficiency mandates. The Center for Energy Efficiency and Conservation provides support to local businesses and government agencies on strategies to reduce energy consumption, conducts energy audits, and aids in implementation of audit findings at local businesses.

City governments should also work with national agencies and departments to coordinate activities with a clear understanding of individual responsibilities and expectations. Cities should also determine the kinds of policies and programs that must be undertaken at a national level (for example, specific aspects of energy generation and use), and those aspects of implementation for which national-level assistance is required (for example, capacity building and finance). Such feedback from city governments will be valuable to national government policy formulation, and establish a starting point for future dialogue and collaboration.

### *The National Government's Roles and Responsibilities*

Many aspects of energy consumption, such as the sources of electricity and gas supply, gasoline subsidies, household appliance energy efficiency standards, and vehicle fuel efficiency standards, are influenced by national energy policies. Given the expected increase in energy consumption with rapid urbanization in the East Asia and Pacific

region, national governments will have to take the lead in implementing policies (in the form of regulations or incentives) that will promote the efficient use of energy. However, because the efforts of city governments will usually be essential to achievement of national policy goals or targets, it will be in the national government's best interests to work closely with individual cities on national-level policies and plans and to welcome interest by city governments in furthering efforts to implement national policies on the ground. For example, national energy, transportation, and environment departments or ministries should be included in city-level SUEEP discussions.

The national government should provide clear guidance to cities on the direction it plans to take on sustainable development so that cities can plan, and where possible, cooperate in areas in which national and city goals are aligned. In these areas, policies implemented by both the city and national governments can serve to reinforce each other, thus making efforts to develop the city sustainably more effective.

## City Planning

A strategic plan is usually guided by a "vision" and a set of objectives that city authorities seek to achieve. Thus, energy, GHG emissions, and the city's adaptation to climate change should be prominently featured as strategic objectives in this process. SUEEP, which is intrinsically linked to strategic spatial, transportation, and economic development planning, will determine the future location, scale, typology, infrastructure, and utility demands for development. With a long-term planning horizon, rapidly growing cities will benefit from early consideration of these issues while determining the future form and economic focus of their cities.

An integrated strategic planning process enables providers of public services, from mass transportation to wastewater treatment, to contribute and identify opportunities that would lead to greater reliability of energy supply, energy efficiency, and reduced GHG emissions, while at a minimum helping to define investment programs targeted to projections of future demand. Integrated planning is particularly important for transportation planning. Currently, some of the pilot cities suffer traffic

congestion during peak hours and growing car use will only exacerbate this problem. The energy balance studies and emissions inventories both point to the fact that transportation-related energy use already constitutes a significant share of each city's energy and emissions burden. Encouraging nonmotorized modes of transportation along with robust public transportation will be critical to mitigating the spread of congestion and improving the quality of transportation in all cities.

In addition to transportation management, local leaders may wish to consider preparing renewable energy master plans to improve the robustness of energy supply and harness the opportunities for renewables. Even if some renewable energy technologies are currently economically unattractive, “future proofing” the city for their widespread deployment (for example, structural strength requirements for flat-roofed buildings) will be hugely beneficial when the economics of renewables become more attractive. The establishment of new green building guidelines provides a particularly potent mechanism for encouraging renewables and future proofing cities.

These types of interventions are only possible if city governments have carefully considered energy issues during strategic planning cycles, and if collaboration across agencies is practiced to enable planning and implementation on a comprehensive basis. Transparency during collaboration is necessary to obtain support and buy-in for programs.

## Governance Mechanisms

This chapter thus far has focused on the need for city authorities to adopt an integrated and strategic approach to SUEEP. To maintain momentum and gain traction after plan, program, or initiative development, subsequent steps are required to formalize and govern activities.

### *Energy and Emissions Task Force*

One of the principal institutional recommendations is for each of the three pilot cities to establish a citywide energy and emissions task force to improve coordination and establish an integrated approach to energy planning and management. In all three pilot cities, committees have already

been entrusted with the management of various aspects of energy and emissions. Where possible, existing committees can be used by extending their mandates through broader terms of reference and enhanced powers (if necessary) to take on the role of an energy and emissions task force.

Membership in the task force should not be limited to government—businesses and residential property managers, along with other members of industry and the public, can provide valuable input and offer a fresh perspective on the challenges. In addition, implementation of projects will require support from these stakeholders. The task force's roles would be threefold:

- coordinate city-government and citywide energy efficiency projects and initiatives;
- develop long-term energy plans to identify and develop supply-side opportunities (for example, distributed energy generation and low-carbon generation projects); and
- act as a liaison between various departments and external agencies, especially with regard to energy infrastructure planning.

In addition, the task force should establish the means to monitor energy-related issues over the long term, such that annual energy-use and GHG emissions performance (both city government and citywide) can be monitored.

The effectiveness of the task force will depend on several factors, in particular,

- the body to which the task force reports,
- the task force's decision-making powers, and
- the extent to which the task force can champion energy issues.

### *Formalizing Energy Plans*

In cities in which SUEEP might take place outside a formal (that is, city or national government) urban planning process, the plan may require formal review and agreement by an executive authority. For example, in some EAP cities, the support of the mayor is insufficient for a program to be implemented. In this case, the program may need to be approved by the local parliament, which will also have to approve its budget.

### *Monitoring and Reporting Systems*

Monitoring and reporting systems are crucial for providing credibility in energy and emissions management. These systems need to be implemented carefully to ensure they do not increase costs to the city unnecessarily, and to ensure that they do fulfill the needs of the donor community that may, at some point, become involved in financing energy- or emissions-related projects. The establishment of a city-level platform for monitoring and managing energy and emissions is one of the first practical steps in implementing the vision of sustainable urban energy development, and is a condition for mobilizing “green financing.”

Regular collection of energy data is a prerequisite for the success of the SUEEP process. Of the pilot cities, Da Nang had the most readily available energy data from across a variety of government agencies, whereas collection of data was much less customary in Cebu City and Surabaya. Even when data were available, the three cities were characterized by limited sharing of data across departments. Sharing of information, experiences, and knowledge will be a major area of improvement opportunity for energy efficiency for all three cities. For example, analysis of trends in population, vehicle use, traffic, economic growth, and industry data would be useful for all city agencies to make better decisions with regard to energy consumption and energy policy.

Effective monitoring systems should be structured and formalized to demonstrate a high level of integrity and reliability, and should cover

- *institutional arrangements*, roles and responsibilities assigned to individual agencies and personnel;
- *boundaries*, defining what has been included in and excluded from the energy and emissions inventories;
- *sources of data*, including data from national agencies to city government collection arrangements and others; how data are collected and reported (for example, through surveys or meters); and the frequency with which data are collected;
- *data collation methods*, provide transparency into how raw data are processed (particularly important if proxy data or extrapolations have been used, or where data are incomplete); and
- *quality assurance processes*, to demonstrate that the methods, processes, and sources used have been adequately audited or reviewed to identify gaps, omissions, and potential improvements to the monitoring and reporting process.

Monitoring and reporting systems should be continually improved for accuracy, reliability, consistency, transparency, and completeness.





# *Sustainable Urban Energy and Emissions Planning: The Way Forward*

Chapters 2 through 5 of this report present the contextual background, citywide challenges, and sectoral issues faced by the pilot cities. These were illuminated with the use of the Energy Sector Management Assistance Program's (ESMAP's) Tool for Rapid Assessment of City Energy (TRACE), which was designed to enable cities to assess how they use energy and to recommend energy efficiency initiatives to be implemented by the city government in a targeted manner. These chapters review and analyze the level of energy use and emissions in a small sample of East Asia and Pacific region countries, and identify areas in which reinforcement and capacity building may be required to enable these cities, as well as others in the region, to embed Sustainable Urban Energy and Emissions Planning (SUEEP) practices through city government leadership. However, these areas do not claim to be, and should not be, all-encompassing, given the need for cities to take into account their unique circumstances.

The SUEEP program has gone beyond the TRACE to explore ways for city governments to embark on citywide strategies to plan and manage the reduction of energy and emissions over the long term. Long-range energy planning will bring about economic growth and social benefits, such as the improvement of public health and safety, and will increase living standards. SUEEP's purpose is to provide a comprehensive approach to citywide energy planning to maximize energy efficiency across sectors. Its intent is to help cities to develop their own initiatives using different mechanisms and to define a governance system for implementation and monitoring and reporting. These outcomes will improve energy governance in the city and create a common platform for collaboration between the city and donors, civil society, and the private sector. The SUEEP process also provides a framework for city governments to plan a pipeline of investments in energy efficient infrastructure and to mobilize "green financing" support. To help cities establish and implement a road map for achieving a sustainable energy future, a SUEEP Guidebook, which recommends a set of steps based on the experiences in the pilot cities, has been prepared. It is envisaged that the Guidebook

will be refined when experiences in implementing the SUEEP process from these pilot cities, as well as others using these guidelines, are incorporated.

Although a comprehensive planning approach is recommended, cities have varying levels of resources and capacity as well as differing priorities. For example, the pilot cities experienced difficulties in sustainable energy planning across multiple sectors, so had mainly undertaken project-oriented measures aimed at addressing issues on a sectoral basis, resulting in planning that was not geared toward a systemic strategy. Based on this reality, there is flexibility in working out different levels of engagement to suit cities' circumstances. The three levels of engagement that city governments could undertake are

- a high-level, rapid assessment of energy efficiency measures in a city (for example, TRACE, the Energy Balance and Greenhouse Gas [GHG] Emissions Inventory);
- deeper sectoral engagements in selected areas (for example, public-private partnerships and sector-wide interventions); or
- implementation of the full SUEEP guidelines, subject to city governments' interest in and ownership of the process.

Feedback from the pilot cities suggests that the SUEEP process would be useful although the level of engagement may differ. Da Nang expressed interest in engaging at the most comprehensive level whereas Cebu City and Surabaya found engagement at the second level, focusing on projects in specific sectors, to be more relevant.

This chapter defines the principal requirements for a full SUEEP process based on the observations from the study of the three pilot cities and experiences of other cities. The chapter is divided into six parts that lay out the key stages in the SUEEP process:

- city government leadership and commitment to “green growth,”
- energy and emissions diagnostics,
- goal setting and project prioritization,
- planning,
- implementation, and
- monitoring and reporting of progress.

A detailed description of these stages with examples of best practices in other cities is found in the SUEEP Guidebook.

## City Government Leadership and Commitment to “Green Growth”

City governments’ multiple roles as regulator, enforcer, supplier, producer, and consumer provide great leverage in facilitating citywide, comprehensive, and strategic energy planning. As the sole body with the credibility, tenure, and strong linkages with the public and various stakeholders to put in place long-term measures to enable sustainable energy growth, city governments must exhibit commitment and leadership to enable “green growth” in their cities. Leadership is required at all levels, from the mayor’s office to legislative bodies and city government departments, given their ability to understand the local situation and connect with the public and stakeholders. It is with strong leadership and commitment that sustainable solutions will gain traction and support to facilitate economic growth and social development.

In embarking on the journey toward sustainability, city governments must first create and clearly communicate the vision the city aspires to,

and that the public and stakeholders can identify with and thus support. To work toward this vision, a city government will have to engage with stakeholders in a transparent manner, identify the agencies and organizations involved in the planning and management of energy issues, and recognize its ability to control or influence specific issues and pertinent relationships with other agencies. With a clearer view of realizable solutions, city governments can establish energy and emissions task forces (or leverage existing ones) and hand them a strong mandate to enable change. Task forces must be empowered to oversee energy and emissions issues that cut across agencies and to establish plans and programs of energy- and emissions-related activities. City governments’ roles will also include coordinating efforts with national agencies to facilitate sustainable practices. Finally, cities will be responsible for putting in place or strengthening monitoring and reporting systems to ensure that energy activities lead to the realization of the city’s vision and goals.

Thus, city governments have an extensive role in enabling sustainable growth. Critical to effective energy planning and implementation will be governance, which will determine the success (or failure) of sustainable policies. Good governance improves oversight and enhances coordination and data sharing among agencies, which will facilitate the implementation of a comprehensive solution. Missed opportunities in comprehensive urban planning arising from insufficient coordination among government agencies were evident in some EAP cities, where the Departments of Transportation, which were responsible for planning the cities’ bus rapid transit systems, worked separately from the departments that were responsible for city planning. Because of this, the EAP cities could have missed the opportunity to reap new economic and energy-saving opportunities through density planning and zoning, which arise when new bus rapid transit systems are designed as an element of city-wide planning strategies.

Institutional structures and clarity of responsibilities are also key to good governance. In Da Nang, for example, the institutional structures were modified to allow a comprehensive approach to energy governance to be taken. However,

overlaps in energy planning remained, involving a number of agencies, including the Department of Industry and Trade, Da Nang Power, the Department of Construction, the Department of Natural Resources and Environment, and the Department of Science and Technology. This meant that a segmented approach was embarked upon despite efforts to implement a cohesive strategy across agencies.

## Energy and Emissions Diagnostics

Having accurate baseline energy use and emissions data is important to enabling city governments to formulate policies in line with the SUEEP vision and overarching goals. The following are key diagnostics used to set energy and emissions targets.

- *An energy balance study.* This study maps primary and secondary energy supply and use in each city. Energy balance studies highlight the relative importance of different fuels through their contribution to the city's economy, the efficiency of different energy conversion technologies, and where energy efficiency, reliability, and conservation efforts can be targeted. Benchmarks can also be set to enable a city to assess the effectiveness of different policies.
- *A GHG emissions inventory.* An inventory establishes the principal sources of GHG emissions, which helps to identify potential policy or project initiatives that would not be chosen based on a purely energy-based analysis. Just as important, this inventory provides the emissions information that may help local government agencies or utilities obtain carbon finance funding for renewable energy or energy efficiency projects.
- *TRACE.* TRACE is a decision support tool that compares one city's energy performance with that of other cities through a custom benchmarking mechanism. Benchmarking results are used to identify priority sectors to which a city should consider targeting its energy efficiency efforts. Policy recommendations built into TRACE are linked to each sector, triggering field interviews and further data gathering by the TRACE project consultant to assess which

recommendations are most appropriate for the city context.

The application of these three processes will enable a city to establish a well-grounded overview of its current energy and emissions situation and, where data exist, build time series to provide trend and growth information.

In developing the energy balance study and GHG emissions inventory, the data- and information-gathering process must be tightly managed to ensure coordination between the various agencies that possess energy and emissions information, and to ensure that data are evidence-based rather than anecdotal. It is also important to ensure that sources of information are known and can be revisited, if necessary. For this purpose, a trained (but not necessarily large) team is needed to ensure the consistency, accuracy, and reliability of the data and information. Gaps in knowledge and information should also be accurately identified during and after data collection so that these gaps can be actively pursued as an area of future work.

## Goal Setting and Project Prioritization

### *Set Goals*

Goal setting is the process of linking the city's vision to its targets to reduce energy use and emissions through initiatives that do not compromise city development. Although the pilot cities had developed high-level visions, none had linked them to specific, measurable goals, indicating that robust connections between energy, emissions, and the city's aspirations had not yet been established.

The goal-setting process affects the SUEEP process in three principal ways:

- linking citywide goals to energy and emissions goals by pairing them with city aspirations;
- building consensus, engaging stakeholders, and securing their buy-in; and
- establishing key success factors to enable performance monitoring of the city's energy and emissions strategy.

### Linking Citywide Goals to Energy and Emissions Goals

Linking wider economic, social, and environmental city goals to energy and emissions goals clarifies the role that energy and emissions play in economic development and builds the case for SUEEP to be a key contributor to the city's sustainable growth. Connecting energy goals to the city's priorities (for example, access to energy or potable water) and to its current and projected development path, and communicating the benefits and potential impacts of energy planning beyond the energy sector, will galvanize stakeholder support and strengthen the case for adoption of SUEEP. In the pilot cities, commitment to energy efficiency and formulation of the city vision were evident, but formalized links between citywide goals and energy planning have not been established. For example, the three cities had implemented energy conservation measures that included initiatives such as lighting off-hours and air conditioning energy saving, but none had an integrated strategy covering the short, medium, and long terms. This informal approach to energy efficiency and emissions limits cities' ability to link planning over varying time scales and sectors, build lasting internal capacity and partnerships, and secure financing for major projects as part of an integrated and comprehensive plan.

### Building Consensus, Engaging Stakeholders, and Securing Their Buy-In

Early engagement with potential stakeholders helps to gain support for energy and emissions planning. Seeking widespread participation from the general public, the private sector, and public agencies helps to ensure that all potential interests are represented and that no segment of society can claim exclusion from the process. This becomes highly pertinent in the early stages of SUEEP, during development of a vision and setting of goals.

Effective buy-in from stakeholders can also be earned by demonstration of a city government's ability to manage energy issues through elements of city-government-controlled energy use. Typically, this would include activities such as the retrofitting of existing public buildings and public lighting, and pursuit of renewable energy technologies. City authorities generally have good control over these issues and can use them to galvanize support within the city

### BOX 6.1 DEVELOPING DA NANG: THE ENVIRONMENTAL CITY

In 2008, the Da Nang People's Committee, through its Department of Natural Resources and Environment, produced a plan for "Developing Da Nang: The Environmental City." This holistic environmental plan was prepared to redress the environmental damage caused by the recent urbanization and industrialization of Da Nang and covers air, water, soil, and urban environmental management over a 12-year period. The plan addresses energy use and planning via the "air environment" objective, with interventions tackling the public bus transportation network, encouraging the use of clean energy and saving energy and fuel, and developing models using renewable energy, in particular, wind and solar energy. The plan is particularly specific on governance and funding, as well as on how the plan will be monitored and reviewed.

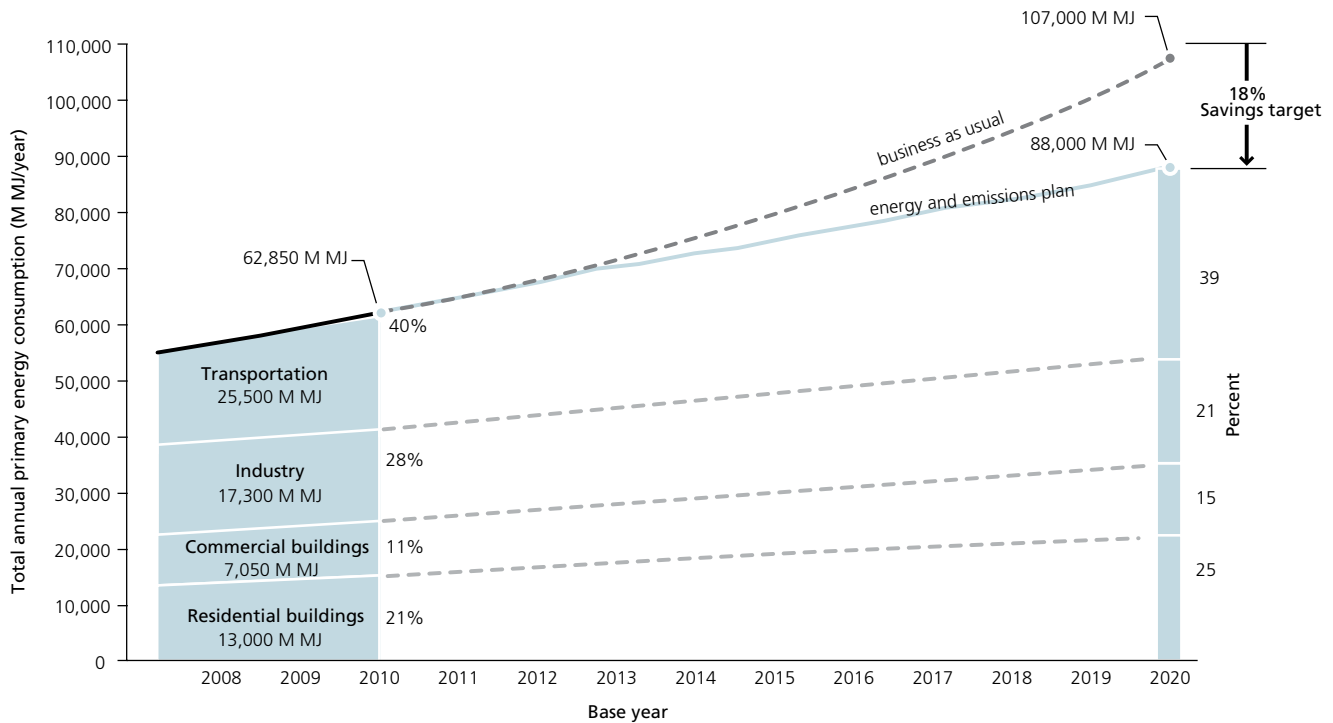
government and to show evidence of active management of energy to external stakeholder groups.

Clearly stated goals and expected outcomes engage stakeholders by formally setting out the benefits that can be expected from SUEEP (see box 6.1). Figure 6.1 shows an illustrative city's 2020 energy savings goal, indicating how the energy-growth trajectory can be "bent" over time in comparison with the business as usual scenario. More important, figure 6.1 shows clearly how individual sectors contribute to the process, starting with known trends during the first three years (2008–10). Figure 6.2 further illustrates a detailed plan by the city to achieve 25 percent energy savings against a business as usual scenario in the transportation sector through a targeted approach. Graphs such as these are powerful tools that help communicate the task at hand and the targets for each sector.

### Establishing Key Success Factors

Goal setting identifies the means by which the success of the proposals can be measured. To set goals, two requirements must be satisfied:

**FIGURE 6.1. “BENDING THE CURVE”: DEFINING A 2020 ENERGY SAVING GOAL FOR AN ILLUSTRATIVE CITY**



Note: MMJ = million megajoules.

- Quantitative indicators, either intensity (for example “X” kWh/m<sup>2</sup>) or absolute (for example “Y” tons CO<sub>2</sub>e), must be used.
- An accurate, complete, and replicable baseline must be established, from which changes will be measured.

The use of empirical and calculated evidence is vital to successfully creating and achieving goals. Using evidence-based numbers that are aggregated from several sources (that is, the sum of a number of technical interventions and application of other levers) also reduces the chances for goals to be overly influenced by political cycles or other extraneous factors.

In phased plans, the process can begin without a known baseline. However, creating the baseline would be one of the first enabling tasks, with goal setting taking place subsequently.

Ultimately, whether SUEEP succeeds or fails depends on the support and commitment of the stakeholders involved in implementing projects

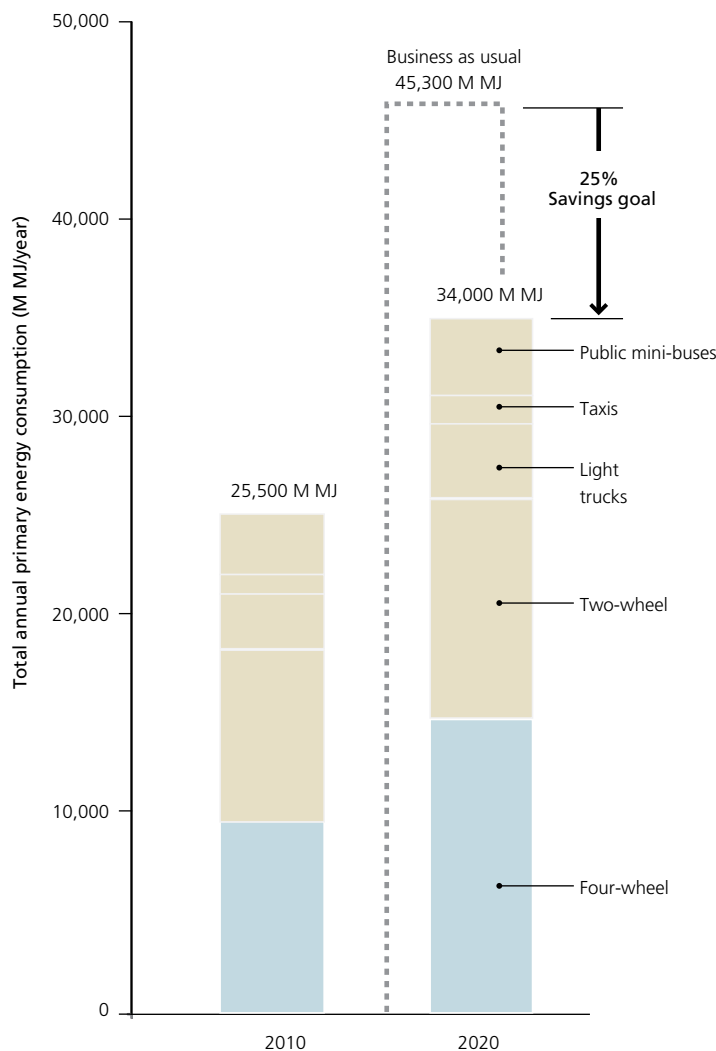
that enable the city to attain its goals. Energy goals that balance the political and technical aspects of energy use in cities provide the foundation for widespread acceptance.

In many instances, cities will be required to establish targets that address national energy or emissions goals. Ideally, cities should consider how they might work toward national goals while identifying practical measures that account for their unique conditions. For instance, a national target relating to energy consumption or efficiency in the manufacturing sector is of little relevance to a services-based city economy. Therefore, the city government must identify targets that navigate between national goals and city practicalities. National goals could be better addressed in the pilot cities.

### *Prioritize Projects*

Goal setting is not an abstract process. It should be undertaken with the full knowledge of the city’s ability to bring to fruition a variety of operational, technical, and infrastructure-related proposals that

**FIGURE 6.2. ENERGY-DEMAND REDUCTION GOALS FOR THE TRANSPORTATION SECTOR IN AN ILLUSTRATIVE CITY**



Note: MMJ = million megajoules.

collectively work to achieve a specific goal. Given the number of barriers cities will face in implementing an SUEEP process, it is important that the city's goals are aspirational, but also realistic and achievable. Therefore, a focus on priorities is essential to successful deployment of the SUEEP process. Prioritization is part of a project management approach to SUEEP and is meant to break down initiatives into manageable activities. To this end, cities will have to prioritize projects to maximize their impact using available (but usually limited) resources. Factors such as the impact on energy use and emissions, funds available, extent

### BOX 6.2 ELEMENTS OF AN SUEEP PROCESS

- Identification of key energy and emissions issues faced by the city
- Establishment of goals that can be achieved by the city government and a plan for attaining those goals (with or without the aid of other agencies or external parties)
- Integration of energy and emissions issues into wider city planning processes
- Coordination across sectors and agencies and the establishment of shared goals; in particular, engagement in a strong dialogue with the national government
- Establishment and improvement of governance, monitoring, and reporting processes essential to future management of the issues, as well as prerequisites for third-party involvement in project and carbon finance

of influence the city government has, existing institutional structures and culture of a city, as well as the relevance of the project to a city's overall sustainability and its relationship to national goals, all play a part in determining the success of a project. Therefore, prioritization of projects needs to combine common sense, quantifiable solutions aligned with the city's goals, and judgment by city leaders who understand the city's issues and politics.

## Planning

Armed with data on energy use and emissions and clarity about its goals, a city government can proceed to address its energy and emissions issues through a SUEEP process (see box 6.2) to help fulfill its vision. SUEEP enables cities to set out the case for sustainable energy, define actions they can take to improve energy and emissions performance, and garner support through the inclusion of stakeholders in the planning and implementation processes.

Despite the potential benefits that can be reaped using SUEEP, there are barriers that can hinder its implementation. These include unfamiliarity with the process; absence of formal institutional



structures and capacity; and lack of political buy-in, cross-agency collaboration, and awareness of the importance of energy planning. These barriers were evident in the pilot cities, which generally approached energy and emissions planning on a fragmented basis that limited their capability to develop a plan. Despite this, the pilot cities have taken steps in the right direction. Da Nang, Surabaya, and Cebu City had begun instituting energy governance, indicating the potential for the cities' development in the future. Da Nang City People's Committee had identified the local Department of Industry and Trade as the lead agency on energy, supported by a number of other departments and local academic institutions. Similarly, Surabaya had initiated energy planning through Bapekko, which is a department in the mayor's office responsible for overseeing long-term planning initiatives. The Philippine Department of Energy in Cebu City was responsible for a variety of energy efficiency initiatives fostered and supported by national policy, and the recently formed City of Cebu Government Committee on Energy Efficiency had been tasked with promoting energy efficiency across city government departments.

The scope of an energy and emissions plan can vary from citywide issues to internal city government energy management because of the city's plethora of energy-related functions—consumer, regulator, motivator, educator, and sometimes supplier. The approach to each of these functions should be an explicit part of the planning process to clarify the available levers for action and the potential impact of each measure, as well as the potential for conflicts of interest. For example, two key initiatives identified for Da Nang include the citywide deployment of green building codes and the development of a city procurement code for street light installations. Although the latter will positively impact energy efficiency in Da Nang, that impact is limited because street lighting represents only 2 percent of total city energy use. In contrast, the deployment of green building codes targets all potential development in the city and involves cross-sectoral stakeholders in city government and the private sector, expanding the potential impact of the intervention to all buildings in the city.

## Implementation

Successful implementation of the energy and emissions plan depends on many factors. In the pilot cities, the lack of capacity and financing were cited as the strongest impediments to the successful implementation of energy and emissions planning. In addition to these constraints, the pilot cities were faced with challenges that included the lack of personnel, low public awareness, poor communication with stakeholders, and lack of governance processes. This section discusses the most common barriers in greater detail.

### *Policy and Regulatory Environment*

Typically, sustainable energy and emissions issues are not considered in tandem with city policy development. Hence, cities may find that they face challenges related to misaligned policy (or even cases in which policies work against each other) or policy gaps that will need to be addressed when they embark upon an SUEEP process. For example, street lights in Cebu City were being upgraded, but energy efficiency was not a key consideration and carbon or other financing options had not been sought. In the transportation sector, the three pilot cities have yet to develop integrated and effective policy approaches for tackling rising congestion and private vehicle ownership despite the large contribution of the transportation sector to energy use and emissions. Regardless of these challenges, cities should persevere in formulating and implementing policies and projects on a comprehensive basis because the benefits that can be reaped are substantial.

In some instances, city governments may feel that their ability to influence or control issues is limited if national policies take precedence. For sustainability issues for which national and local governments' interests are aligned, city governments should review existing policies, projects, and initiatives to determine whether the policies can be tweaked or strengthened so that the city can build on or contribute to national policies. If so, the SUEEP process will gain national-level support.

Policies are vulnerable to political cycles and are subject to change by incoming mayoral administrations. Because energy and emissions plans require consistent application spanning a number of political cycles, codifying SUEEP policies into law could

minimize political uncertainty. EAP cities will have to review this option carefully, taking into consideration their respective governance structures.

### *Financing*

The manner in which energy and emissions projects are financed is particularly important. Financing tends to be subject to a range of factors such as knowledge and experience with financing similar projects, access to capital, perceived risk, and the need for delivery partners that possess implementation skills.

A fundamental challenge facing cities wishing to implement energy efficiency and emissions projects is achieving a return on investment acceptable to investors while mitigating perceived risks. Many such projects tend to face higher investment hurdle rates than more conventional projects because investors are not familiar with the calculation methodologies used to determine investment return, and energy efficient technology tends to be relatively new to the market. This problem is amplified in developing economies in which the level of perceived risk is heightened, especially for newer technologies in the environmental sector, thereby resulting in higher hurdle rates. Another barrier to financing is the improbability of a private financial institution accepting a return on investment lower than that provided by a government bond, as opposed to a city government that might consider investments with very low or even negative returns if the socioeconomic benefits are significant.

Still, city governments have a number of tools at their disposal to encourage investment, including

- reducing regulatory risks stemming from uncertainty about the long-term policy environment (which can be mitigated if the city is willing to make policy guarantees);
- pursuing a range of partnering options (for example, public-private partnership initiatives and partnering with energy services companies); and
- providing incentives and tax breaks (for example, by providing loan guarantees for initial seed funding of investments or fast-tracking regulatory permits).

City governments can also actively seek out alternative forms of funding that offer concessional financing for climate-positive projects. The potential to attract financing from international institutions and bilateral and multilateral agencies should be reviewed during the evaluation of potential projects that the city plans to undertake. Some financing schemes are region specific or will only fund certain types of projects or programs. For example, if an analysis of return on investment demonstrates that the proposed project cannot compete with projects in non-environmental sectors, tailored finance can be sought from investors that are experienced in environmental project risk and have obligations to direct capital into certain market segments. Socially responsible investment funds, for instance, deploy capital according to refined criteria that include environmental and social performance indicators.

Various financing mechanisms can be leveraged to support projects. They differ not so much by sector as much as they do by applicable project stage. The following sections describe the different subsidized international mechanisms applicable to different stages of development: (i) design and piloting, (ii) construction and implementation, and (iii) operations and maintenance. The common thread among them is that they are made possible through the estimation and ongoing monitoring of GHG emissions associated with specific investments.

### **Project Design and Piloting**

Significant barriers can obstruct the implementation of new energy efficiency measures, including the lack of experience or technical capacity, challenging regulatory environments, investor concerns about risks associated with untested projects, and most important, uncertainty about the potential payback. To overcome these barriers, local governments can leverage an array of international grant programs.

Grants are made available at various times by multilateral financial institutions for specific project objectives, such as GHG mitigation. Grants are often provided by international agencies, including the World Bank Group, the Asian Development Bank, and the United Nations, along with many multilateral agencies. Some large nongovernmental

organizations and research agencies may also provide funding and technical assistance for financing certain types of projects.

The most widely known program that supports project development is the Global Environment Facility (GEF), which was established to provide incremental cost financing for projects that support energy efficiency, renewable energy, new clean energy technology, and sustainable transportation projects. Its approach focuses on removing barriers to “win-win” mitigation projects by providing support for technical assistance, policy reform, capacity building, piloting, and partial risk guarantees. GEF grants through the World Bank Group average between US\$8 million and US\$10 million per project.

These grant programs can be very successful in getting new ideas and technologies off the ground and establishing greater certainty on payback periods for some initiatives, but grant funding is generally too small to support large-scale implementation of projects and policies, or to support construction of new infrastructure facilities.

#### Project Construction

After project design and piloting hurdles are overcome, a new, more robust source of financing is needed to support construction or wide-scale implementation. Financial products such as soft loans, which are becoming more common than grants, are rising to meet this need. Soft loans are also provided by international agencies and multilateral financial institutions, as well as by some larger commercial banks. These loans make funds available at reduced interest rates, and often with longer repayment times than a commercial loan. Terms can be negotiated directly between the funder and the city. Commercial banks may provide these loans only with an external guarantee or partial loan guarantee, or an external agency may provide funding to reduce the interest rate.

Another type of financing that can be used to facilitate construction is guarantees, such as the partial risk guarantee (PRG). These guarantees are particularly helpful in supporting energy efficiency projects that do not fall into traditional lending categories. PRGs protect private lenders or investors against the risk of a government (or

government-owned) entity failing to perform its obligations with respect to a private project. In the case of default resulting from the nonperformance of contractual obligations undertaken by governments or their agencies in private sector projects, PRGs ensure payment and thereby significantly reduce the risk assumed by investors. PRGs are available for projects with private participation depending on certain government contractual undertakings, such as build-operate-transfer (BOT) and concession projects, public-private partnership projects, and privatizations. PRGs are available for both greenfield and existing projects.

Combined with grants for removing initial barriers and developing pilots, these financing mechanisms can be strong incentives—but more assistance may be needed to ensure long-term sustainability during the operations and maintenance phase of GHG mitigation projects.

#### Project Operations and Maintenance

A final hurdle in supporting low-carbon investments is ensuring that sufficient funds are available for ongoing operations and maintenance, especially in the short term. Very often, green financing and funding mechanisms that support project design and implementation or construction do not provide sufficient resources for ongoing monitoring to ensure that the project is meeting expected environmental objectives—a critical step to ensuring that future investments are suitably allocated.

This is an area in which early engagement of carbon financing mechanisms, such as the Clean Development Mechanism (CDM) or the voluntary carbon markets, can improve the feasibility of GHG mitigation projects. The CDM, which can be leveraged exclusively by developing countries, is a performance-based funding mechanism, through which annual payments are made to project sponsors based on realized emissions reductions (for example, energy efficiency performance). If the potential benefits of carbon financing are recognized and pursued early in the project’s life (before commission), these mechanisms can ensure optimal and continuous project operation and maintenance. The three pilot cities have identified opportunities to leverage CDM financing across most sectors.

City governments can also actively seek alternative forms of funding. For example, tailored finance may be sought from investors experienced in environmental project risk who have obligations to direct capital into certain market segments.

### *Procurement and Implementation Supervision*

Procurement and implementation supervision are aspects of energy efficiency and emissions reductions programs that require strong technical capacity and experience, which often is not available in city governments. Technical and resource capacity may not be an issue for SUEEP initiatives that modify governance structures or for specific small-scale projects. However, successful delivery of the majority of technical and infrastructure projects requires a robust procurement process and stringent contract management, neither of which are often realistically available. For example, in Cebu City, a landfill gas capture project had been proposed on a number of occasions, but progress was limited because of a lack of institutional capacity to implement it. To preempt procurement and implementation problems, city authorities may consider a number of strategies:

- develop a favorable policy environment, for example, enact regulations enabling public-private cooperation, contract law enforcement, and so forth;
- establish a procurement policy to enable SUEEP projects;
- nurture a collaboration network to gain access to technical assistance from nongovernmental organizations;
- share resources and knowledge with neighboring cities or areas;
- develop pilot projects to increase the skill level of the city work force; and
- prioritize projects to ensure achievable workloads are maintained for city employees.

All of these strategies can enable procurement and implementation that reduces the burden on the city, thereby increasing the probability of effective project rollout.

## **Monitoring and Reporting of Progress**

EAP cities will need to establish citywide monitoring and reporting systems as well as systems specific to individual technical projects, given that performance monitoring is a requisite component of both goal setting and performance measurement. The pilot cities all have scope for improvement in this aspect of SUEEP, based on the scarcity of city-specific energy performance data. In addition, energy and emissions plans require regular review, based on measured outcomes, to realign efforts to achieve stated goals, if necessary, during the course of the plan's operation. SUEEP Phase I found that performance monitoring in the pilot cities had not been adequately implemented except in some cases as required by the national government.

### *Identification of Performance Measures*

The first requirement for performance monitoring is the selection and deployment of performance indicators. Typically, performance indicators will be either “gross” or “intensity” related. Gross indicators measure the totality of a given measure, for example, tons of carbon dioxide per year, and are useful for measuring urban issues at a city scale. Intensity indicators are more usually associated with efficiency (for example, kilowatt-hours per square meter of city buildings per year), and measure the intensity of energy use or emissions on the basis of indicative units (for example, per person, unit of area, or unit of length). Both types of indicators may be used in benchmarking performance. Table 6.1 presents the range of indicators deployed in the TRACE that enable benchmarking of city energy use against other cities; these indicators are also useful for long-term performance measurement.

### *Data Acquisition and Management*

City governments and external agencies make long-term policy and investment decisions based on data. Hence, it is imperative that city governments give appropriate consideration to the requirements of reliable data management systems and processes, as well as the risks inherent in data acquisition and management, to ensure that data are reliable, accurate, consistent, and complete.

**TABLE 6.1. CITY-SPECIFIC KPIS USED IN THE TRACE**

Citywide KPIs	
CW-1	Electricity consumption (kWhe/capita)
CW-2	Electricity consumption (kWhe/GDP)
CW-3	Primary energy consumption (MJ/capita)
CW-4	Primary energy consumption (MJ/GDP)
Transportation KPIs	
T-1	Total transportation (MJ/capita)
T-2	Public transportation (MJ/passenger-km)
T-3	Private transportation (MJ/passenger-km)
T-4	Transportation nonmotorized mode split (%)
T-5	Public transportation mode split (%)
T-6	Kilometers of high capacity transit per 1,000 people
Buildings KPIs	
B-1	Municipal buildings (kWhe/m <sup>2</sup> )
B-2	Municipal buildings heat consumption (kWth/m <sup>2</sup> )
B-3	Municipal buildings energy spend as percentage of municipal budget
Street Lighting KPIs	
SL-1	Electricity consumed per km of lit roads (kWhe/km)
SL-2	Percentage of city roads lit
SL-3	Electricity consumed per light pole (kWh/pole)
Power and Heat KPIs	
PH-1	Percentage heat loss from network
PH-2	Percentage total T & D losses
PH-3	Percentage of T & D loss due to nontechnical losses
Water and Wastewater KPIs	
WW-1	Water consumption (liter/capita/day)
WW-2	Energy density of potable water production (kWhe/m <sup>3</sup> )
WW-3	Energy density of wastewater treatment (kWhe/m <sup>3</sup> )
WW-4	Percentage of nonrevenue water
WW-5	Electricity cost for water treatment (potable and wastewater) as a percentage of the total water utility expenditures
Waste KPIs	
W-1	Waste per capita (kg/capita)
W-2	Percentage capture rate of solid waste
W-3	Percentage of solid waste recycled
W-4	Percentage of solid waste that goes to landfill

Source: TRACE model.

Note: kg = kilogram; KPI = key performance indicator; kWhe = kilowatt-hour equivalent; kWth = kilowatt-hours thermal; MJ = megajoule; T&D = transmission and distribution.

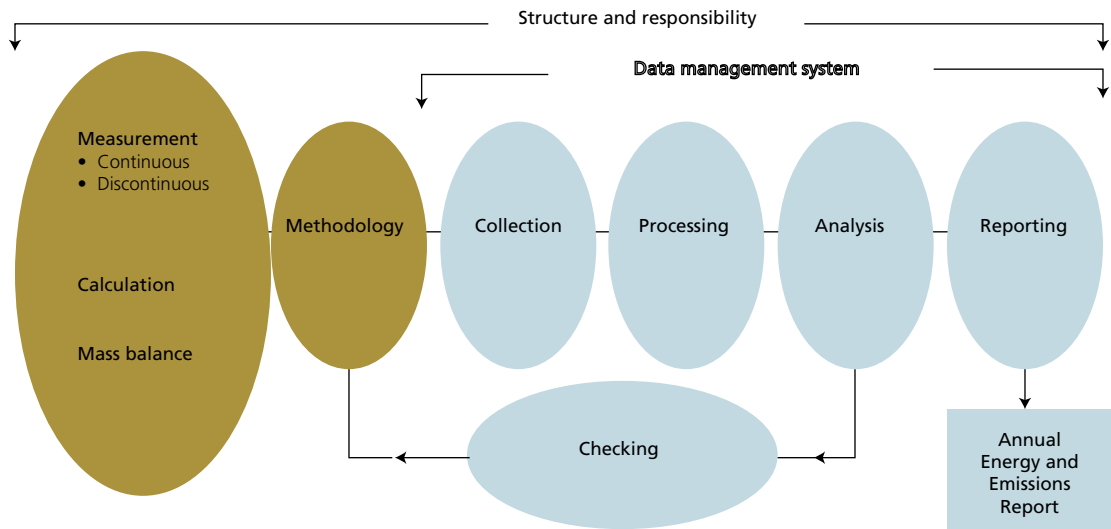
Figure 6.3 provides an overview of the principal components of a data production chain. The first two bubbles (darker shade) relate to the means of measurement and are generally defined through international standards and best practices, or by using a generic energy and emissions tool such as the SUEEP Guidebook. The remaining bubbles relate to the systemization of data acquisition and management.

Data management systems are used to establish, document, implement, and maintain an effective

process for data management. The typical characteristics of increasingly sophisticated data management systems are presented in figure 6.4.

In practice, most systems start at the informal level, and develop following a management system approach such as the International Organization for Standardization's recently released energy management systems standard (ISO 50001:2011), which specifies requirements applicable to energy use and consumption, including measurement, documentation and reporting, design, and procurement

**FIGURE 6.3. THE PRINCIPAL COMPONENTS OF A DATA PRODUCTION CHAIN**



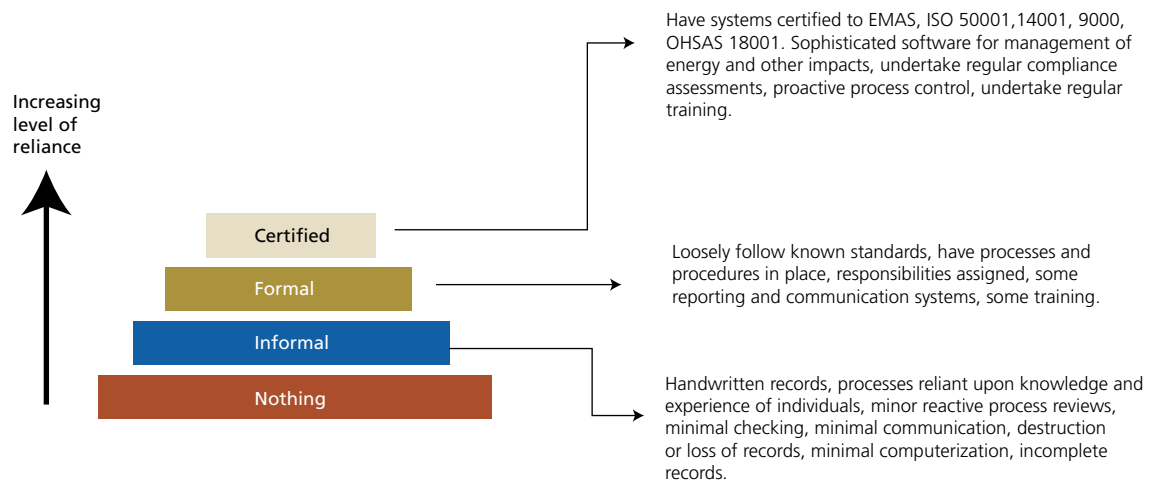
Source: Robert Carr, 2005, for British Standards Institute.

practices for equipment, systems, processes, and personnel that contribute to energy performance.

Data management systems can take many years to perfect, especially if data are only collected annually. Data management systems need to be regularly tested and reviewed to ensure that accurate, reliable, and consistent data are being reported.

In many instances, the data provider’s role is not a priority (especially if it is an external organization), which results in inaccurate and inconsistent assumptions that affect data. The review process should be designed to analyze the data production chain critically, identify gaps or inaccuracies, and deploy corrective actions to resolve these issues.

**FIGURE 6.4. TYPICAL CHARACTERISTICS OF DATA MANAGEMENT SYSTEMS**



Source: Robert Carr, 2005, for British Standards Institute.



## The Way Forward

The attainment of long-term, sustainable urban energy and emissions development is not a goal easily defined or achieved. However, the SUEEP process can facilitate cities' efforts toward a more sustainable future through the following contributions:

- **Institutional Development and Capacity Building.** SUEEP introduces a number of key foundation-building activities required to support long-term urban green growth strategies. The Guidebook brings clarity and international best practices to the institutional reform, policy development, and stakeholder outreach processes necessary to achieve targets. Also, the SUEEP process includes accounting tools cities can use to quantify their energy consumption and GHG emissions for use in target setting, as well as for ongoing monitoring and reporting of results and implementation progress.
- **Creation of a High-Quality Pipeline of Green Investments.** Policy and institutions alone will not create green growth outcomes—investments in energy efficiency improvements and GHG mitigation activities will also play an important role. Through the SUEEP process, city leadership can evaluate investments comprehensively, based not only on fiscal return, but also on relative green impact and contribution to other social and economic development goals. The result is a well-defined pipeline of green investment projects that can be communicated to local stakeholders and financing institutions, and to the international donor community and potential partners, including private investors.
- **Mobilization of Financing.** The international donor community has substantial interest in supporting sustainable infrastructure for green growth in rapidly developing EAP cities. However, there have been many challenges: defining the green city goals, identifying those activities that would optimally support green growth goals, ensuring local governments have the capacity and institutional structures needed to support both the construction and maintenance of green investments, and identifying means to measure success. The SUEEP process brings the donor and investor communities and city governments one step closer by (i) building an institutional and policy foundation for supporting green investments; (ii) setting up a system of quantitative indicators for identifying green growth targets and monitoring and reporting progress over time; and (iii) creating a long-term green growth plan and a well-defined, thoroughly evaluated pipeline of bankable investments that can be easily communicated to potential investors and financiers.



## APPENDIX 1

# Cebu City Background

Cebu City is the second biggest growth area in the Philippines after Manila. Cebu City is a midsize coastal city with a population of 799,763. Metro Cebu includes several other cities, Lapu-Lapu, Mandaue, and Talisay, which cumulatively have a population of about 2 million. Cebu City occupies mountainous terrain and has a land area of 291 square kilometers (km<sup>2</sup>). The highest point in Cebu City reaches an elevation of 900 meters. Cebu City's plateau area occupies 23 km<sup>2</sup>, about 8 percent of its total area, but is home to two-thirds of the city's population. Cebu Island occupies a strategic location, easily accessible by air and water, and is an important port. Cebu City is less than an hour away from Manila by plane and within a few hours of any city in Southeast Asia (figure A1.1). It is served by an international airport and busy seaport.

The city has a tropical climate and an average temperature of 25.6 C with an average relative humidity of 75 percent. Rainfall is at its lowest levels from February to April and gradually increases from May to July.

Cebu City has a thriving commercial seaport, and a majority of the city's labor force (73 percent) is employed in trade and other related services such as banking, real estate, insurance, and community and personal services. About 19 percent of the population is employed in industry, and 8 percent in agriculture and related services. The services sector is growing and is expected to maintain its economic dominance. Cebu City's strategic location and seaport help support trade and services. The majority of establishments in Cebu City are still considered micro or small enterprises with an average capitalization of 1.5 million Philippine

FIGURE A1.1. MAP OF CEBU CITY, PHILIPPINES

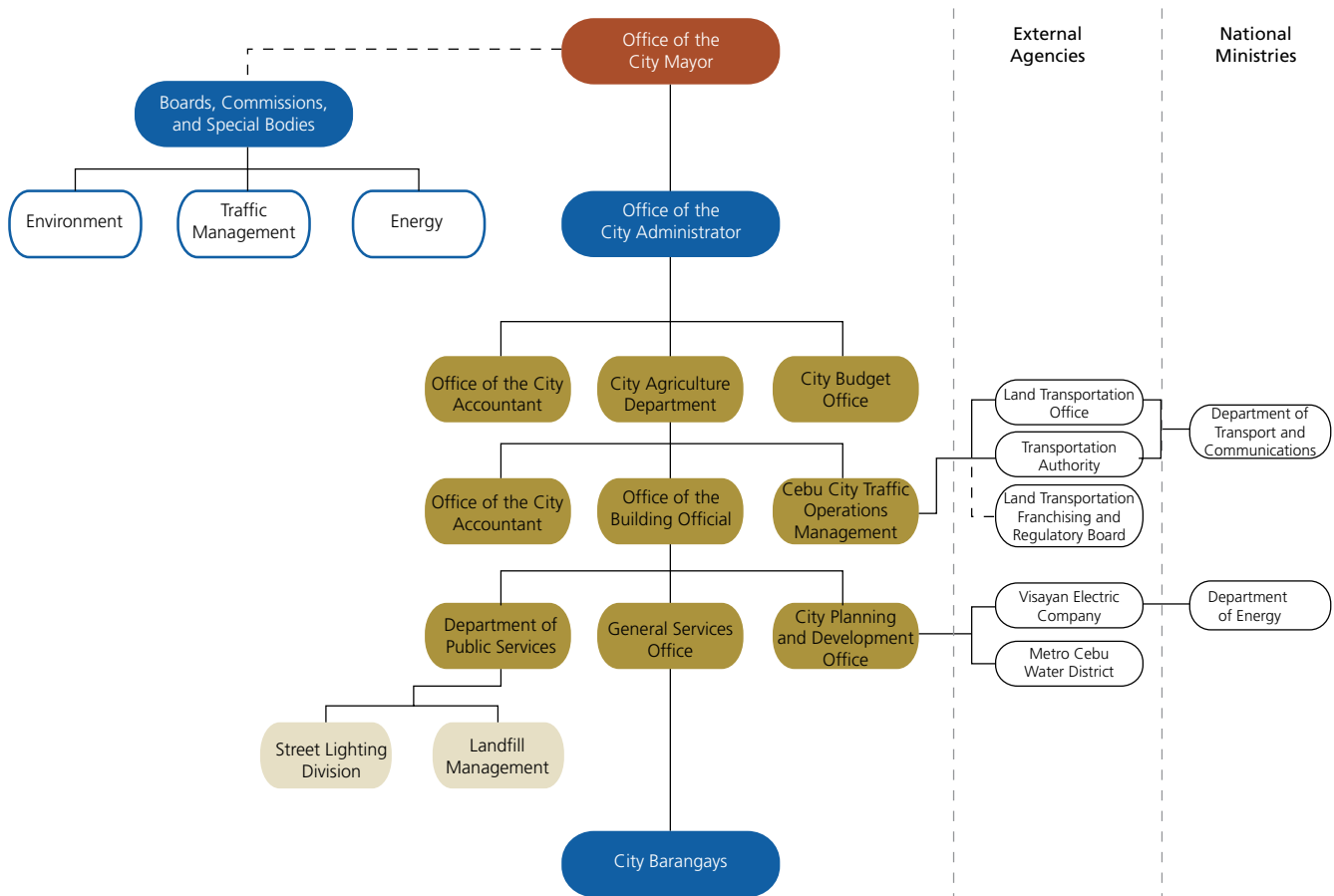


pesos (Php) (US\$34,445) or less. Some 67 percent of these business establishments are situated in the central part of the city, and collectively account for about 77 percent of the city’s economy.

The central Philippine government and Cebu City government are the focal points for policy action, but there is a strong base of grassroots action in Cebu City. Under a new local government code, which aims to devolve certain powers away from the central government, the city has the power and authority to establish an organization responsible for the efficient and effective implementation of its development plans, programs, and priorities. The main departments, committees, and external agencies responsible for the planning, development, and operation of energy-consuming sectors in Cebu City are represented in the flow chart in figure A1.2.

The city government fully controls solid waste management and its government buildings. It has partial control over transportation through traffic planning and regulation. Other agencies exercising control over the transportation sector are the Land Transportation Office and the Land Transportation Franchising and Regulatory Board, which enforce vehicle emissions and registrations, respectively. Public lighting is largely within the jurisdiction of the city, although there is a mix of responsibilities, with the national government responsible for lighting of trunk roads, and Visayan Electric Company (VECo, the electricity utility) owning all street lighting poles and responsible for installing luminaires. The city does not generate electricity, which is provided by VECO. The majority of water is supplied by Metro Cebu Water District, a public water utility, with a number of private water

**FIGURE A1.2. CEBU CITY GOVERNMENT STRUCTURE FOR ENERGY-CONSUMING AGENCIES**



companies engaged in smaller-scale potable water supply. Cebu City has no formal sewerage system, although septic tank waste (septage) is currently disposed of at the city landfill.

## National Energy Efficiency Strategy

At the national level, President Benigno Aquino III announced his intention to encourage more public-private partnerships to improve Cebu City's economy. Cebu City officials and businessmen have identified seven areas of concern: the need for more infrastructure, tourism improvement, reduction of power costs, modernization of Mactan-Cebu International Airport, realization of Panglao International Airport, implementation of a mass transit system, and building the Cebu-Bohol Bridge. The priority attached to these sectors illustrates the importance to the Philippines of energy efficiency and infrastructure projects, which are also relevant to Cebu City.

The Philippine government has initiated a number of energy efficiency programs to achieve the targeted annual savings of 23.4 million barrels of fuel oil equivalent in 10 years through the National Energy Efficiency and Conservation Program. Programs and initiatives include the following:

- The Road Transport Patrol program targets a 10 percent reduction in fuel consumption by providing consumers with information on the efficient use of fuel through proper vehicle maintenance and efficient driving through seminars and workshops and the use of all types of media.
- Voluntary agreements between government and the private sector encourage industrial economic zones in which businesses voluntarily monitor energy consumption and implement energy efficiency and conservation programs.
- An energy audit service is provided by the Philippine Department of Energy to manufacturing plants, commercial buildings, and other energy-intensive companies to help them understand their energy use patterns and identify initiatives to improve their energy performance.
- Infomercials and publications encourage energy efficiency.
- The Partnership for Energy Responsive Companies encourages industrial and commercial establishments to voluntarily monitor their energy consumption and implement energy efficiency and conservation programs.
- The Partnership for Energy Responsive Ecozones is a partnership of private sector companies formed in conjunction with the Power Patrol Project (<http://projects.wri.org/sd-pams-database/philippines/power-patrol-program>) to encourage energy efficiency and conservation in economic zones.
- Energy standards and labeling of appliances and equipment aim to improve the efficiency of appliances by requiring energy rating labeling of products.
- The Enercon program is an initiative to incorporate energy efficiency into the procurement guidelines of government agencies, bureaus, and offices.
- Energy use standards for buildings have been developed, but are not yet mandated, to give guidance on energy efficient building design.
- Initiatives for heat rate improvement in power plants will bring power plant generating units to their optimum performance levels by improving their operational capability.
- The systems loss reduction program requires energy utilities to implement measures to cut nontechnical losses.

## City-Level Energy Efficiency Strategy

The city government has enacted a number of energy efficiency initiatives:

- The Cities for Climate Protection Campaign in 1999, which is administered by Local Governments for Sustainability.
- The International Resource Cities Program, which is a technical cooperation program between Cebu City, Philippines; Larimer County, Colorado; and Fort Collins, Colorado. The program was funded by the US Agency for International Development

(USAID) and implemented by the International City/County Management Association. In March 2001, an action plan was prepared that establishes the objectives of the partnership and serves as the framework for the relationship between the communities. It also identifies how Cebu City intends to target the financial assistance from USAID.

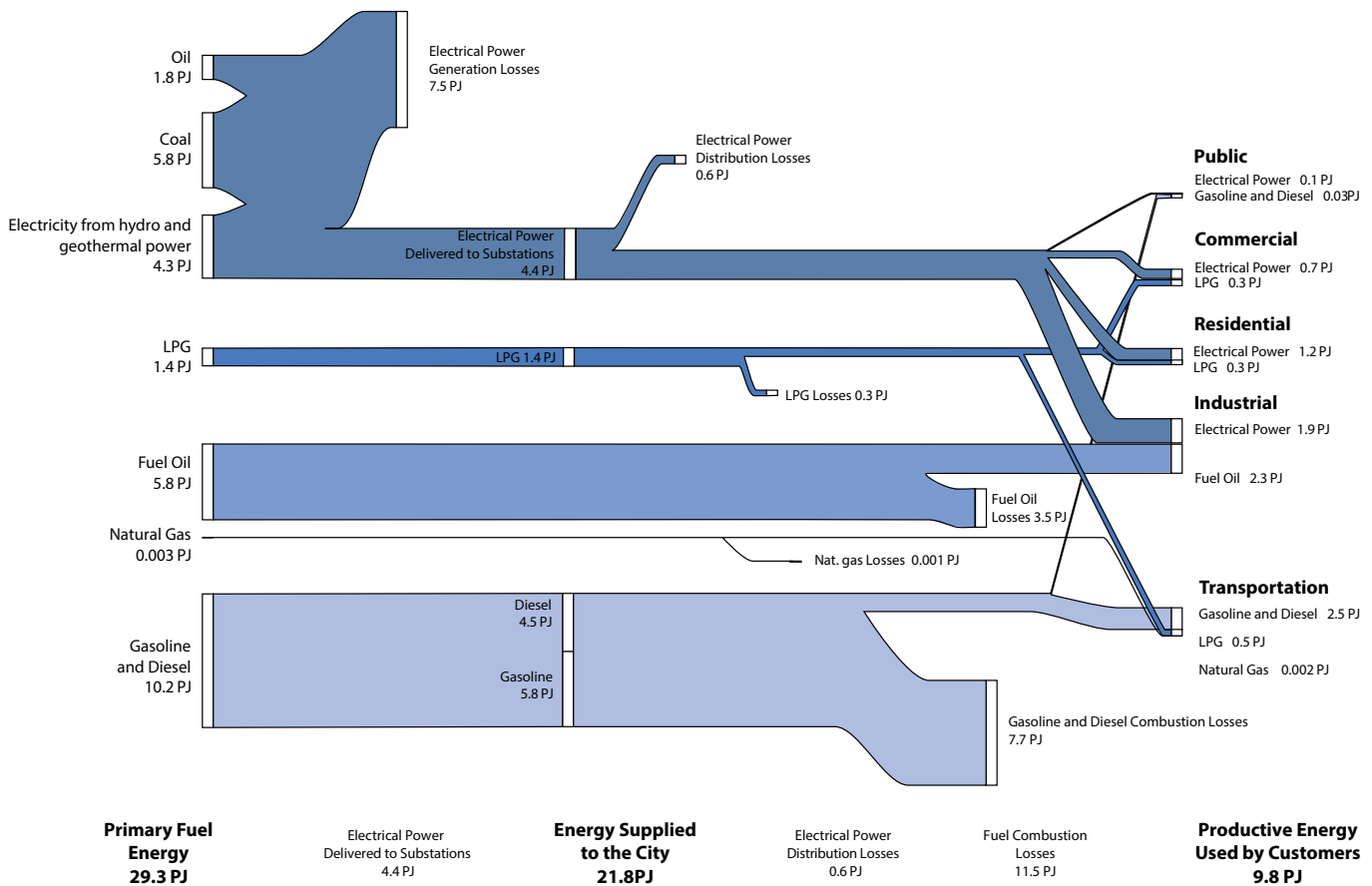
- A climate change forum initiated and conducted by the Cebu City government in 2008.
- Cebu City action plans on energy.

The city government already has a focus on energy issues covering a wide range of departments and services. Considerable progress has been made in

addressing energy consumption, and the city has proposed and engaged in a variety of energy efficiency activities, including the following:

- *building initiatives*, light fixture replacements and air conditioning operation hours policy;
- *waste sector initiatives*, barangay-level composting, “No Segregation, No Collection” policy, which requires residents to sort their trash into three containers: recyclables, organic waste, and others; and
- *efforts to encourage sustainable transportation*, for example, bicycle lane pilot areas and sidewalk repair schemes.

**FIGURE A1.3. CEBU CITY ENERGY FLOWS (2010)**



Source: SUEEP Pilot City Studies 2011.

Note: PJ = Petajoule. “Public” includes the end-use energy of city buildings, street lighting, city vehicles, water, wastewater, and solid waste management.



Building on these initiatives to develop a strategic approach to demand management will be beneficial to Cebu City's future development, contributing to the city's energy security, improving its citizens' quality of life, and attracting businesses.

## Profile of Energy Use and Carbon Emissions

An overview of Cebu City's energy supply profile provides the city government with valuable insights for strategic planning with respect to energy security and economic growth. Cebu City imports almost all of its energy; other than the 11 percent of electricity consumed that is generated within city boundaries, all energy sources (electricity, oil products, and natural gas) are imported. Although Cebu City has significant potential to harness solar power, it does not do so because no renewable power technology is installed in the city. Cebu City's energy flows and profile are summarized in a Sankey diagram (figure A1.3) to illustrate citywide energy supply and demand characteristics of its different sectors.

The total primary energy supplied to Cebu City is 21.8 billion megajoules (MJ); or 6.5 gigajoules/capita, or 6 billion kilowatt-hours (kWh);

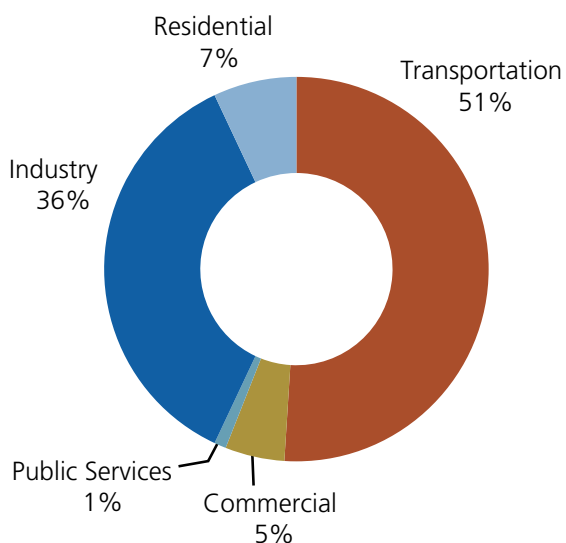
or 6 megawatt-hours/capita). Some 20.4 percent of this is in the form of electricity and 79.6 percent is in the form of petroleum products. A very small amount of natural gas is also imported into the city. The reliability of energy supply is consequently an important consideration for future energy planning. Transportation is the biggest energy user in Cebu City, consuming 51 percent of the city's primary energy and accounting for a substantial share of fuel combustion losses (see figure A1.4). Industry is the second biggest energy user in Cebu City, consuming 36 percent of energy. The residential sector accounts for 7 percent of consumption and the commercial sector 5 percent. Industrial, residential, and commercial users are the biggest consumers of electricity. The residential sector was the dominant electricity user in 2008, but saw a 26 percent decline in consumption in 2009 and only a moderate 4 percent increase in 2010. The commercial sector has held relatively steady. In contrast, industrial sector electricity use has grown explosively, with a 50 percent increase in 2009 and a more moderate 8.2 percent increase in 2010.

On the whole, citywide usage increases steadily year-on-year, with electricity demand growing 4.3 percent from 2008 to 2009 and 4.5 percent from 2009 to 2010. If Cebu City maintains this trend, electrical energy demand will double in 16 years. From a policy-making perspective, untempered electricity consumption will negatively affect energy security, economic growth, and quality of life, and should be addressed by Cebu City officials.

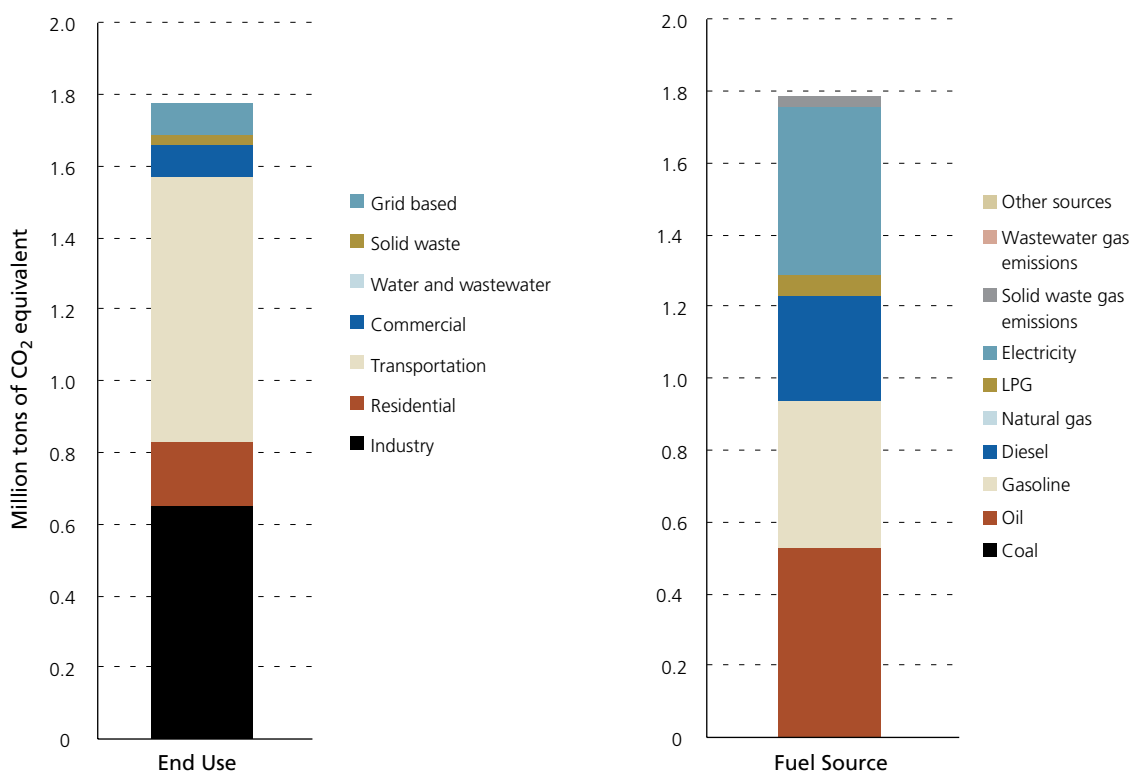
Greenhouse gas (GHG) emissions present a slightly different picture from the energy balance results. Close to 1.8 million tons of carbon dioxide equivalent (MtCO<sub>2</sub>e) were emitted by all sectors in Cebu City in 2010. Residual fuel oil and electricity are the biggest contributors by source, at 31 percent and 26 percent, respectively (figure A1.5). Both of these energy sources are used almost entirely by the industrial, commercial, and residential sectors. Gasoline and diesel, which make up 22 percent and 17 percent of emissions, respectively, are used exclusively by the transportation sector.

The transportation and industrial sectors are the largest contributors to Cebu City's emissions with 40 percent and 38 percent shares, respectively

**FIGURE A1.4. CEBU CITY ENERGY CONSUMPTION BY END USE**



Source: Phase 1 pilot study.

**FIGURE A1.5. GHG EMISSIONS BY END USE AND FUEL SOURCE**

(figure A1.5). The residential sector accounts for 9 percent of emissions and the commercial sector accounts for 6 percent.

Transportation and industry are the most significant sectors for both the energy balance and the GHG inventory results. It is worth noting, however, that transportation uses just over half of the city's energy, but its share of GHG emissions is 40 percent, whereas industry consumes 36 percent of Cebu City's energy but produces a disproportionate 38 percent of emissions. This points to the importance of fuel choice and systems efficiencies in linking energy and GHG emissions.

## Sector Review and Prioritization

Cebu City's interest in pursuing the TRACE (Tool for Rapid Assessment of City Energy) diagnostic underscores its commitment to achieving optimal energy efficiency. The analysis was carried out across six city sectors: passenger transportation,

city buildings, water and wastewater, public lighting, solid waste, and power and heat. These were, in turn, assessed against the performance of a range of peer cities through a benchmarking process. This review provided a number of significant findings that helped focus activity during the early part of the study and contributed to the definition of priority sectors for further study.

Key findings of the Cebu City diagnostics in comparison with the cities in the TRACE database follow:

- low electricity use per capita and low energy use per unit of GDP.
- high transportation energy use per capita, despite very high dependence on public transportation, arising from the dominance of inefficient jeepneys, as well as from congestion and low fuel efficiency. Many jeepneys are aging, with older, inefficient engines, and also typically carry fewer passengers than they are designed to carry. These factors, as well as the common

TABLE A1.1. CEBU CITY SECTOR PRIORITIZATION RESULTS

Priority ranking	Sector	2010 energy spending (US\$)	Relative energy intensity (%)	Level of city authority control*	Savings potential (US\$)**
<b>City authority sector ranking</b>					
1	Street lighting	2,238,761	20.0	1.00	447,752
2	City buildings	1,363,920	19.9	1.00	271,420
3	City vehicles	2,187,659	10.0	1.00	218,766
4	Solid waste	622,922	15.0	1.00	93,438
<b>Citywide sector ranking</b>					
1	Public transportation	89,696,607	10.0	0.21	1,883,629
2	Potable water	1,410,895	30.0	0.15	63,490
3	Power	Unknown	15.0	0.11	Potentially large

Source: Phase 1 pilot study.

\*0 = no influence; 1 = maximum influence.

\*\*Based on TRACE benchmarking; these figures are indicative of the savings that may be possible, not necessarily practicable.

practice of operating the vehicles for many years with occasional second-hand engine replacements, point to significant potential for improvement in the energy and operational efficiencies of this public transportation mode.

- low per capita water use but high energy density of potable water production.
- mid-range electricity consumption per kilometer of lit roads with room for improvement in public lighting.
- low but increasing electricity consumption in city buildings.
- low levels of recycling due to the absence of a formal solid waste recycling program.
- low levels of transmission and distribution losses in the electricity network.

The TRACE analysis identifies priority areas in which significant energy savings are possible. Table A1.1 indicates the amount of energy spending in each of these sectors, the relative energy intensity (the percentage of energy that can be saved in each sector, based on TRACE benchmarking), and the level of influence the city government has over these sectors. The savings potential is calculated by multiplying these three factors. The TRACE contains a playbook of 58 energy efficiency recommendations applicable across all sectors.<sup>1</sup> The recommendations themselves are not meant to be either exhaustive or normative. They simply out-

line a number of policies and investments that could help local authorities in Cebu City achieve higher energy efficiency standards.

The table shows priorities with respect both to sectors over which the city authority has maximum influence, and to citywide issues for which the authority has limited influence. The ranking suggests that the city government should prioritize street lighting, followed by city buildings and city vehicles. On a citywide basis, public transportation is clearly a focal area, followed by potable water supply.

Following the sector-by-sector analysis, each recommendation was reviewed to establish its applicability to the Cebu City context. This filtering helped focus the process on those recommendations that are both viable and practical.

## Recommendations

### *Transportation*

Transportation in Cebu City is dominated by jeepneys, with private automobiles, taxis, and motorcycles also playing increasingly important roles. A high proportion of Cebu City's taxis run on liquefied petroleum gas as a response to the incentives in place for drivers to upgrade their engines to combat urban air pollution. With regard to fuel use minimization, the city's General Services Office (GSO) implemented a biofuel project in which ethanol was used as an additive in city government automobiles. This

1. For further details on TRACE, see chapter 4.

activity is expected to result in a 15 percent reduction in fuel use in the transportation sector.

Cebu City experiences significant congestion during rush hour. Parking restrictions are in place and are regulated by zoning ordinances. However, these restrictions have not been rationalized by any strategic plan for the city. The last transportation plan was produced in 1972 and a new plan is currently being prepared. The high-profile proposal to introduce a bus rapid transit (BRT) system in combination with the city's efforts to reduce traffic congestion indicate that a comprehensive transportation plan that is aligned with overall city planning will be essential.

Nonmotorized modes of transportation such as bicycles are not common, which may be due to safety concerns associated with using crowded and often chaotic streets. In an effort to encourage sustainable transportation, a local nongovernmental organization has spearheaded the Road Revolution initiative. The Road Revolution involves closing Osmena Boulevard to vehicular traffic for a day to enable the public to enjoy entertainment activities and to experience the street's improved environment when it is occupied by pedestrians rather than automobiles, all the while reducing GHG emissions. This program has been implemented twice and received mixed reactions. Some members of the public enjoyed the initiative while some, especially businesses located on Osmena Boulevard, were negatively affected by the lack of access.

#### Public Transportation Development

The public transportation sector in Cebu is privately run and is dominated by jeepneys. The public transportation mode share is 80 percent, which is particularly high, but jeepneys tend to work inefficiently, with regard to both fuel consumption and route optimization. One of the most notable observations made by the SUEEP team was the need for an integrated planning approach to ensure that plans for BRT, land use, street signals, parking policies, vehicle registration pricing, and sidewalk policies are all adequately integrated and that there is an effective means for turning plan into practice. Integrated planning is especially important for transportation planning. Currently, traffic flow in Cebu City is congested during peak hours and growing private car use will exacerbate this

problem. Encouraging nonmotorized transportation alongside the development of robust public transportation will be critical to mitigating congestion and improving the quality of transportation. Cebu City Planning and Development and City Traffic Operations Management are responsible for ensuring that nonmotorized modes are encouraged through city planning.

Coupled with nonmotorized transportation, the promotion of public transportation should be part of an energy efficient strategy for Cebu City. A formal public transportation system has been in the works for a number of years. A BRT pre-feasibility study has been completed and further studies are under way. The city plans to improve public transportation and authorities have placed an emphasis on the need for capacity building to institutionalize transportation data gathering and management. The city could take advantage of a few carbon financing resources, such as the Clean Development Mechanism (CDM), for its BRT program.

#### Vehicle Emissions Standards Testing

Vehicle emissions standards testing infrastructure could be more effectively applied to encourage and enforce better vehicle emissions. Lower emissions will lead to better air quality and reduced energy consumption. The current testing and enforcement system is fragmented because different city and national government departments regulate (license) test centers, and enforcement is either weak or ineffective because cars can be back on the road after a few simple measures are applied to get the vehicle to pass. New testing equipment that meets standards for measuring an engine's efficiency would be required. Enforcement activities and resulting sanctions should also be revised to ensure that poorly performing vehicles are identified and removed from service. The implementation of such a measure is potentially administratively difficult because of the fragmented nature of Cebu City's existing testing system and the magnitude of enforcement required. One way to address this issue would be to establish a government-run emissions testing center as a model for private testing centers.

Inefficient two-stroke motorcycle engines are widespread in Cebu City. Fifteen two-stroke to

four-stroke engine replacement programs have been successful in a number of other cities, and this is an area in which Cebu City could make significant gains with minimal investment.

Cebu City's fleet vehicles do not follow a formal maintenance regime beyond the first few years following purchase. Initially, cars are well maintained to keep up their warranties. After the warranties expire, a city-operated vehicle maintenance center repairs faulty vehicles as necessary. The replacement parts are usually the cheapest available, leading to early failure of replacements in many cases. Life-cycle costing is not factored into parts procurement.

It is highly recommended that the GSO spearhead a city vehicle fleet efficiency program. Procurement and maintenance policies should be implemented to maximize the efficiency of the city's fleet. This includes incorporating life-cycle costing in replacement parts procurement for vehicles.

### *Solid Waste*

Residential and commercial waste is collected at the barangay<sup>2</sup> level and by city garbage trucks through the Department of Public Services. Barangay-collected waste is brought to the landfill in barangay-owned vehicles using fuel provided by the city government. Waste collection and processing in Cebu City is currently characterized by grassroots initiatives at the barangay level. Barangay Luz, in particular, has spearheaded a number of actions, including the "Kwarta sa Basura" (Money from Trash) program, which organizes a women's group to create marketable products from waste.

Composting is widespread in Cebu City and operational at the city, barangay, and household levels. At the city level, the Inayawan landfill includes composting facilities for collected compost while barangays engage in small-scale composting, which benefits the city in two ways. First, it minimizes waste sent to the landfill, and second, it responds to the high demand for compost in Cebu City, which produces 25 percent of its own food. Households use the Takakura home method of composting, which was introduced to Cebu

City in 2008 by Dr. Koji Takakura of Japan. Dr. Takakura's research team monitors the progress of composting in Cebu City as part of an ongoing project to establish a pilot area for successful home composting. All these initiatives have collectively contributed to Cebu City's recent reduction in the percentage of domestic solid waste that is disposed of at the landfill.

Disposal of hazardous and medical wastes is an ongoing challenge because no appropriate treatment facilities are available for these waste streams. Currently, they are disposed of at the landfill, exacerbating the risks posed by its current operation and ultimately, its restoration. To address this problem, the city government, through the office of Councillor Nida Cabrera, chairperson of the Committee on Environment, and in conjunction with a local nongovernmental organization and educational institutions, has initiated a household survey in the urban barangays to determine the types of household hazardous wastes that are generated and how they are disposed of.

Until the end of 2011, Cebu City had one landfill in Barangay Inayawan that accepted hazardous, septic, and noncompostable domestic solid waste. The landfill was constructed in 1998, with a design life of seven years. Dumping activities are no longer allowed in the area. Barangays located in the North District have started delivering their waste to a privately owned sanitary landfill facility in Consolacion, about 27 km from the Cebu City Hall Building. Barangays in the South District will use a transfer station that is currently being developed by the city in a private lot of nearly 8,000 square meters about 1 km from the old Inayawan landfill.

Landfill leachate at Inayawan currently remains untreated, posing further land and water contamination issues. The city has earmarked Php 11 million (US\$250,000) for funding of a facility to treat the landfill's leachate, but no action has been taken to date.

As of 2011, recycling activities were largely carried out by the approximately 300 waste pickers operating as part of a collective at Inayawan landfill. It is believed that a recycling rate of 16 percent was achieved through the activities of the waste pickers. There are plans to implement waste

2. A barangay is the smallest administrative division in a city in the Philippines, equivalent to a district or a ward.

segregation at source, and potentially to install a centralized materials recovery facility, but no conclusive actions have been taken to date.

Efforts to minimize the amount of solid waste disposed of at landfill have been highly effective. Some 60 percent of domestic solid waste is biological or compostable waste. Some of this is composted at the barangay level, and some is brought to the landfill where there are larger-scale composting and wormery facilities. This policy has been in operation since April 2011.

Although the Department of Public Works is responsible for waste infrastructure, the barangays do much of their own waste haulage and management. A separate nonprofit organization at the landfill manages waste treatment. Because of the slightly fragmented institutional arrangements for waste management in Cebu City, the SUEEP team recommends that the Department of City Planning, with the support of the mayor, identify the appropriate party to undertake waste studies or to review previous recommendations made in such studies for their relevance.

#### Landfill Gas Capture

The city is developing plans to close the Inayawan landfill, creating an opportunity to capture landfill gas and produce energy. It is recommended that a study be undertaken to investigate the feasibility of a landfill gas capture project. A successful landfill gas capture project would potentially remove up to 4,900 tCO<sub>2</sub>e annually from Cebu City's GHG emissions profile, and if used to generate electricity, could contribute to satisfying the city's electricity requirements.

#### Energy from Waste

The city has approved an allocation for waste from energy projects to be established at four sites for implementation in 2012: three at barangay material recovery facility (MRF) cluster sites in Luz, Quiot, and Talamban, and one upland site. The three MRF sites will use organic waste as feed and the upland site will use animal waste. The energy generated will be accessible to barangay residents for electrification and cooking purposes.

#### Collection Route Optimization

Following the cessation order issued by the mayor, no more dumping will occur at the Inayawan landfill. As a consequence, garbage trucks operated by the barangays and the city will deliver their waste to a private landfill located 27 km north of the city. Barangays in the north deliver their waste directly to the landfill and barangays in the south deliver waste to a transfer station 1 km away from the Inayawan landfill to reduce the distance waste must be transported by trucks originating in the south.

The SUEEP team notes that the city has already established a new route scheme for the diversion of waste from the old landfill site at Inayawan to the new Consolacion site and recommends that Cebu City continue to assess ways to optimize waste collection to minimize traffic and enhance fuel efficiency.

#### Septage Treatment

There is potential for the development of a septage waste treatment facility in Cebu City. The Spanish government funded an initiative to treat septage waste using a biodigester, but this project failed because the septage waste was often contaminated by industrial wastes before treatment, compromising the biological treatment process. Although technical knowledge in Cebu City for managing septage waste is limited, it is understood that the landfill will be closed to septage by early 2012. Thus, the need to address treatment of landfill leachate and septage is pressing. It is suggested that the city government consider the possibility of a combined septage and leachate treatment facility located at the Inayawan landfill site. A feasibility study should first be undertaken to assess the technical viability of such a proposal and how the issues with contamination of septage can be overcome.

#### Solid Waste Treatment

With the closure of the Inayawan landfill, and the pressing need to identify alternative means for the disposal of domestic solid waste, it is suggested that the city government undertake a feasibility study for development of a centralized MRF and, possibly, a new composting facility. The MRF can be staffed by former waste pickers (who are skilled in identifying waste types). Recovered materials could be bulked and shipped to local markets.



Alternatively the city government may wish to consider providing incentives for the establishment of materials reprocessing businesses colocated with the MRF, thereby creating a positive economic impact.

Because the city pays for garbage truck fuel and many of the vehicles are old and inefficient, the city would benefit from vehicle upgrades and improved procurement processes. Maintenance regimes and driver education to encourage energy efficient driving practices are also recommended to improve vehicle performance.

### *Water*

Cebu City's potable water supply is sourced from groundwater. Metro Cebu Water District (MCWD) is the principal water utility, serving 50 percent of Cebu City's population. The rest of Cebu City's water is provided by independent suppliers that sell piped potable water from private wells. There is strong competition between these private suppliers and MCWD. Although MCWD's competitors are technically subject to the same regulations as MCWD, there is reportedly minimal enforcement of regulations relating to the siting, abstraction rates, and water quality from private wells.

Groundwater resources are a relatively energy-intensive source of water supply because of the requirement for pumping, in comparison with surface water gravity-fed systems. Despite this, MCWD's water system is generally well maintained and uses energy efficient equipment, resulting in energy costs constituting about 30 percent of MCWD's operating costs.

MCWD has been the beneficiary of a number of energy efficiency projects funded by USAID. In 2006, the Alliance to Save Energy assessed MCWD's system and helped the agency to make a 0.5 kWh/m<sup>3</sup> reduction in overall energy use. MCWD is currently working with the Las Vegas Water District to improve energy efficiency by an additional 5 percent. MCWD has also taken strong action to improve leakage rates, but has run into some difficulties distinguishing its pipes from those of private suppliers, and has limited abilities to fix leaks even when they are known to exist. It is of interest that MCWD has undertaken a thorough audit of the system to identify and remedy leaks,

but losses have not been reduced significantly. The company does not have a complete understanding of the reasons behind this and is conducting further research into the issue.

MCWD has started an awareness-raising campaign to educate consumers about the importance of water conservation. However, this initiative is not yet widespread and could be more widely promoted.

### *Energy Efficient Water Resources*

Prioritizing energy efficient water sources by deploying rainwater harvesting in city buildings and providing incentives for its uptake in private developments would reduce reliance on energy-intensive groundwater and reduce the currently unsustainable water withdrawal rate.

### *Water Efficient Fixtures and Fittings*

Water efficient fixtures and fittings should be installed in government buildings and encouraged in private developments through educational measures. Types of energy and water efficient fittings applicable to both retrofit and new-build developments include

- low-flow taps and showers;
- water efficient household appliances;
- dual, very low, or siphon flush toilets;
- low-flush or waterless urinals; and
- rainwater harvesting tanks.

Water efficient fixtures and fittings help to reduce water consumption by reducing the volume of water used in each application, which also reduces the associated energy needed to treat and convey the required flows.

Efficient fittings can help to raise consumer awareness of the link between water use and energy consumption and generally leads to the consumer installing additional energy efficient products.

### *Wastewater*

Cebu City has no citywide wastewater treatment facility. Wastewater is currently managed through household, or clusters of household, septic tanks. The septage is removed by tankers and disposed of, untreated, at the landfill. For this reason, Cebu City's energy use for wastewater is technically minimal (fuel use in haulage), but in the interests

of public health, it is expected that a more comprehensive system will be developed. Wastewater management in the city will encounter significant challenges, including contamination of the groundwater supply from septic tank seepage and landfill leachate, and illegal dumping of septage waste.

Cebu City government can do little to influence the activities of the private septage haulers. Technical interventions may only be leveraged by the city government's use of the planning system, which requires citywide technological measures the city can undertake.

It is recommended that the potential for sludge reuse be investigated. Cebu City does not currently have a sustainable sludge management strategy, but CDM funding could increase the feasibility of developing a sludge reuse project. Such a project would include treating the sludge under aerobic conditions (for example, dewatering and land application), or installing a new anaerobic digester that treats wastewater or sludge (or both), from which the biogas extracted is flared or used to generate electricity, and the residual after treatment is directed to open lagoons or is treated under clearly aerobic conditions.

### *City Buildings*

The Department of Engineering and Public Works (DEPW) and Office of the Building Official (OBO) have complete control over the design of all city buildings with the exception of schools. There is no formalized refurbishment cycle for government buildings, which poses a significant challenge to achieving energy efficient performance in the existing building stock. In addition, energy efficiency is not currently a consideration in capital investment planning or life-cycle costing. This poses a barrier to the uptake of energy efficiency initiatives that require higher upfront investment but result in long-term savings.

As an initial step, the city government is using the landmark City Hall building as a pilot project for achieving energy savings in buildings. The building is being retrofitted for a centralized air conditioning system as one of the project's major efficiency measures.

VECo has provided energy-saving tips to city departments and an ad hoc energy conservation

committee was established to address energy use in the city.

Additionally, the GSO has been intensifying efforts to save energy. The GSO has begun collating data on energy use, issuing advice on energy efficiency tips, and collecting information on energy saving commitments from all departments across the city. Although this is a positive start, there is still a considerable range of opportunities to improve energy efficiency throughout the life cycle of city buildings.

Little focus has been given to energy efficiency across the city estate, although recent initiatives are starting to gain momentum. Audits of public buildings and energy efficiency calculations show that energy efficiency retrofits have good payback potential (less than three years), with continued savings thereafter over the lifetime of the project.

### *City Building Energy Efficiency Task Force*

Currently, some measures are being implemented at the barangay level to improve energy efficiency in buildings. For example, Barangay Luz has collaborated with a paint company to provide homeowners with materials to create "cool roofs" for their homes. However, these initiatives are not coordinated at a city level and are therefore difficult to track.

In light of the above, as well as the need to coordinate energy efficiency measures in the building sector, it is recommended that a city building energy efficiency task force, comprising representatives from GSO, OBO, DEPW, VECO, and the national government's Department of Energy, be set up. The task force would design, implement, and manage energy efficiency initiatives in city buildings. The establishment of a task force will put in place a formal structure for these agencies to share ideas and approaches and streamline the city's efforts to enhance energy efficiency in buildings.

A number of efforts have been made in the city buildings sector to improve energy performance, such as lighting replacement programs and the implementation of air conditioning schedules. Although the SUEEP team endorses these efforts, opportunity remains for improvement by replacing old air conditioning units and other inefficient appliances, and by improving the design and construction of building envelopes. It is recommended

that the existing efforts be continued and a city building audit and retrofit program by implemented through a city building energy efficiency task force.

It is noted that the Philippine Department of Energy supports energy efficiency through its Advisory Services for Major Industries and Commercial Buildings program. An energy audit is provided for a fee by the Department of Energy to manufacturing plants, commercial buildings, and other energy-intensive companies. A team of engineers from the department evaluates the energy utilization efficiencies of equipment, processes, and operations of these companies and recommends energy efficiency and conservation measures to attain energy savings. These advisory services may be a further avenue for the city government to pursue.

#### **Green Building Guidelines**

A consistent, citywide approach to procurement and green building guidelines is needed. Formalizing sustainability standards in the local design and construction industries is a huge challenge. The city should carefully consider adopting the Building for Ecologically Responsive Design Excellence (BERDE) code, which was recently introduced by the Philippine Green Building Council, in city building ordinances and future new build or renovation work. Both the DEPW and OBO have expressed interest in formalizing the design and construction process to encourage energy efficient green building design. The city has the power to enact ordinances for building codes, which will be advantageous should authorities wish to mandate compliance with green building codes.

If a green building code is adopted, rigorous implementation and monitoring will be big challenges for the construction industry. Typically, construction materials procurement and contractor tenders are the biggest impediments to the implementation of green building codes in industries that have not evolved to incorporate sustainability requirements. Thus, these areas will require particular attention and focus from the parties responsible for overseeing the implementation of a Cebu City green building code. Before deployment of the

BERDE system, city government personnel with knowledge of Cebu City building practices and contractor tenders will need to review the system's requirements. Identification from the outset of the aspects of the BERDE system that may not be practical for Cebu City, or components that are better applied to select developments, is imperative. It may also be appropriate to initially target high-end developments or develop a phased rollout that prioritizes some elements of BERDE above others.

The city can support its building industry by drawing on the experiences of Quezon City, including the identification of key challenges and opportunities associated with complying with such codes, and providing the resources needed to address them. It is strongly recommended that Cebu City establish contacts with the relevant agencies to capture the knowledge that Quezon City will have gained from its experience.

#### **Public Lighting**

Cebu City has good street lighting coverage, with the majority of areas being lit by low pressure sodium fixtures (mainly used in smaller streets), as well as significant numbers of fluorescent bulbs, mercury halides, and compact fluorescents. Along the coastline, high pressure sodium fixtures are used.

The city's previous efforts to upgrade street lighting encountered problems with fixture quality, which has resulted in undesirable or unacceptable lighting in some cases. General Electric, Phillips, Sylvania, and American Electric fixtures have been used in Cebu City, but it was unclear to the SUEEP team which fixtures had delivered the best performance. The city currently operates a program to upgrade low pressure sodium fixtures to metal halides along main thoroughfares, which does not take advantage of the more energy efficient technologies available.

However, the city government has put aside a budget of Php 5 million (US\$114,800) for the installation of light-emitting diode (LED) fixtures along Osmeña Boulevard in 2012, a pilot area for this project. The purpose of the project is to test the benefits of LEDs for power consumption and GHG emissions to inform decision making about a future rollout of LEDs. The city has concerns

about potential theft of the expensive LED fixtures, indicating the importance of site selection to avoid this problem.

Public lighting in Cebu City is in the remit of the Department of Public Services: Street Lighting Division. Responsibility for street lights on national roads lies with the national government, and individual barangays maintain the lights on smaller streets. The imprecise ownership and accountability for proper operation of the system has resulted in several maintenance problems. Given this, definitive responsibilities of each agency should be provided to ensure clear ownership and accountability.

#### Street Light Audit and Retrofit Program

Despite the high cost of LED luminaires when compared with other types of fixture, the low energy and maintenance costs of efficient LED lamps makes them financially and technically viable. A simple cost-benefit analysis undertaken by the SUEEP team suggests that an investment of Php 312 million (US\$7.1 million) would have a payback period of 4.95 years, and would save an additional Php 540 million (US\$12.4 million) over the 10-year lifespan of the project. This would also lead to an annual reduction in GHG emissions of 4,043 tons of CO<sub>2</sub>.

The SUEEP team notes that Cebu City had piloted the use of LED luminaires in parts of the city previously and is aware that the beam pattern of the luminaires did not meet current national street lighting standards. Although this issue could be addressed by altering the height or spacing of light poles, all of which adds cost to the program, using LED luminaires from alternative manufacturers

that meet national street lighting standards could also be considered.

The team recommends that the city trial a range of LED luminaires in pilot areas to test their efficacy as a precursor to rolling out a more comprehensive street lighting replacement program. The city can apply CDM methodology AMS-II.C, which comprises activities that encourage the adoption of energy-efficient equipment and appliances (for example, lamps, ballasts, refrigerators, motors, fans, air conditioners, pumping systems).

#### Lighting Timing Program

The current use of photosensors to determine lighting on and off times may not be optimal. Because safety is the primary purpose of public lighting, the team has avoided drawing specific conclusions about the deployment of a lighting timing program but recommends that the Department of Public Services work in conjunction with other city authorities to determine if a lighting timing program would be effective for the city.

## Conclusion

Cebu City government has recognized the need for a sound energy strategy as evidenced by its numerous excellent existing energy initiatives. The steps Cebu City has taken to improve energy use provide a sound starting point and clearly show the city's commitment to improving energy efficiency. In particular, better energy governance in government operations and on a citywide scale, better coordination between city planning and agencies, and enhanced procurement and green building codes, are all key steps Cebu City officials must initiate to work toward a genuinely coherent energy strategy and policy for the city.

# Surabaya Background

Surabaya is a large city with a population of 2,765,908 people. The city occupies coastal terrain and has a land area of 327 square kilometers (km<sup>2</sup>). The highest point in Surabaya reaches an elevation of about 30 meters. Surabaya is located in the Brantas River Delta, an area that has a high hazard of flooding.

Surabaya's population density is 8,458 inhabitants/km<sup>2</sup>. The city is highly urbanized, and the numerous industries located in the city have attracted migrants, contributing to growth of slum areas. The city's annual population growth rate is 0.65 percent, and much of the city's center is densely populated.

Surabaya is a tropical city characterized by distinct wet and dry seasons. The city enjoys plenty of sunny weather, with temperatures regularly peaking at more than 30°C (86°F). The city's wet season runs from November through May, and the dry season covers the remaining five months. Surabaya on average sees approximately 1,500 millimeters (more than 59 inches) of precipitation annually.

Surabaya is located in the northeastern corner of Java (see figure A2.1), and is a key node in various national and international air, water, and land transportation networks. Surabaya is less than two hours away from Jakarta (the country's capital) by plane and within a few hours of any city in Southeast Asia. It is served by Juanda International Airport and Perak Port, one of Asia's largest and busiest seaports. These two international nodes serve as important gateways to the province of East Java not only for passengers, but also for the transport of goods. Surabaya has a large shipyard and numerous specialized naval schools.

FIGURE A2.1. MAP OF SURABAYA, INDONESIA



As the provincial capital, Surabaya is also home to many offices and business centers and is an educational hub for Indonesian students. Surabaya's economy is also influenced by the recent growth in foreign industries and the completion of the Suramadu Bridge. Surabaya is currently building high-rise apartments, condominiums, and hotels as a way of attracting foreigners to the city.

The city has a GDP of US\$22,850 million, which grew at the rate of 6.3 percent in 2008 (compared with national GDP growth of 6.1 percent). The primary industries contributing to the city's GDP are the trade, hotel, and restaurant (together accounting for 36 percent) and manufacturing (32 percent) sectors, with smaller contributions by the transport and communication, construction, financial services, and services sectors.

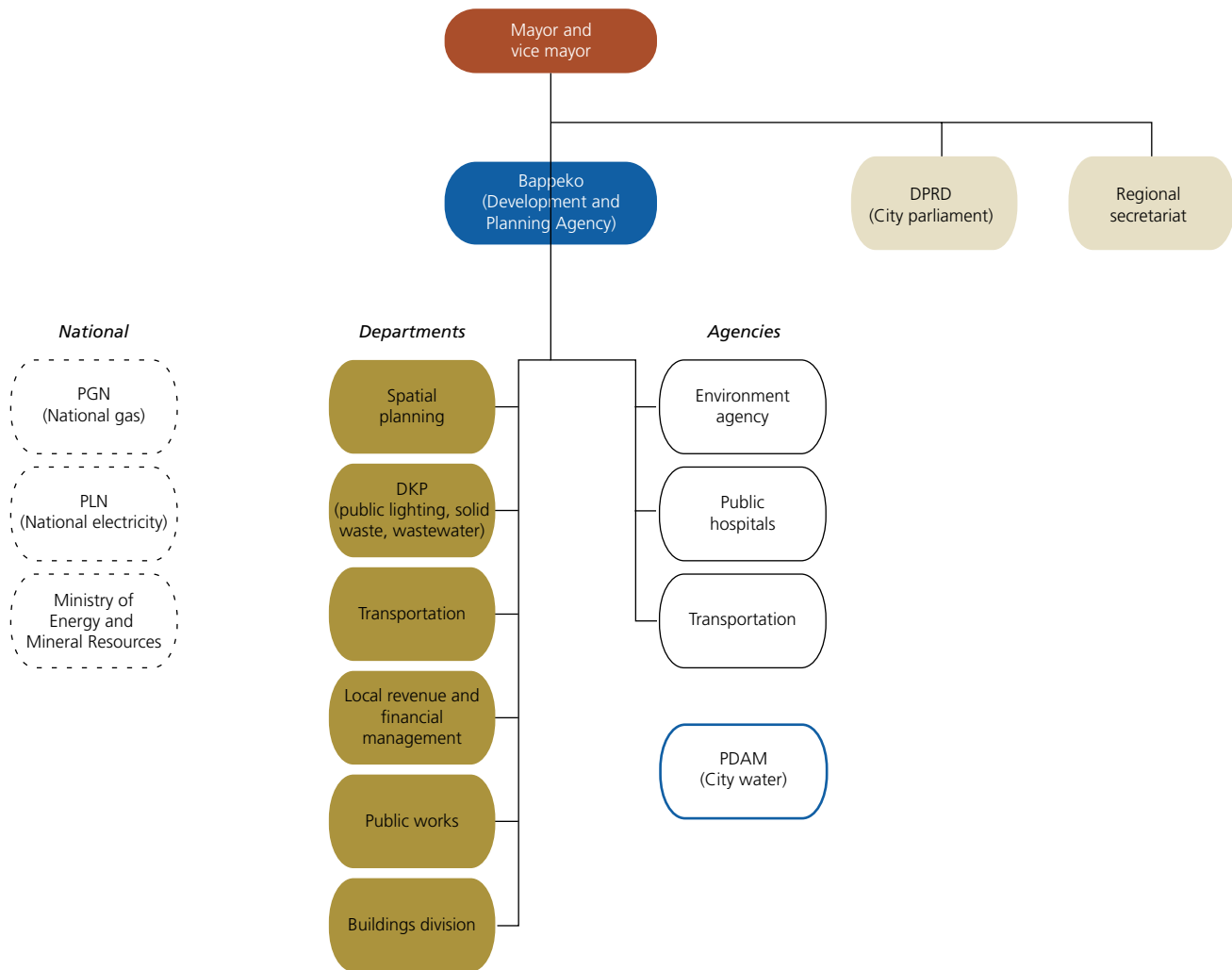
The formal sector accounts for 44.1 percent of employment. A significant factor in Surabaya's economic profile is the large contribution of the informal sector to employment (22 percent). The main employment sectors (both formal and informal) are trade, hotel, and restaurant (41.5 percent), community and personal services (21.2 percent), and industry (15 percent). Historical employment

data were only available for the manufacturing industry, which saw a decline of 2.8 percent in the 2000–07 period.

Surabaya city governance (Kota Surabaya) comprises the city government and the city’s parliamentary body. A decentralization policy implemented in Indonesia in 1998 has devolved public services provision to district and city levels; details of the structure and institutional relationships

between central and local government are articulated in Law No. 32/2004. In Surabaya, it is primarily the departments and agencies, under the guidance of the main coordinating planning body, Bappeko, that implement policy changes and actions that could affect energy supply and consumption. Figure A2.2 provides an overview of Surabaya’s institutional structure and the relationships involved in the city’s energy management.

**FIGURE A2.2. SURABAYA GOVERNMENT STRUCTURE FOR ENERGY-CONSUMING AGENCIES**



Source: Phase 1 pilot study.

Note: Bappeko = city spatial and development agency; DKP = Cleansing and Park Department; DPRD = city parliament; PDAM = Regional Drinking Water Company; PGN = state-owned gas company; PLN = state-owned electricity company.



## Energy Efficiency Initiatives

### *National Level*

At the national level, energy policies are formulated by the National Energy Council. Energy efficiency and conservation programs are implemented by the Ministry of Energy and Mineral Resources. The Indonesian government has initiated a number of energy efficiency programs, including the following:

- *National Energy Conservation Master Plan (RIKEN) (2005)*. RIKEN stipulates a target for Indonesia to decrease its energy intensity by about 1 percent per year on average. It identifies sectoral energy savings potential: 15–30 percent in industry, 25 percent in commercial buildings for electricity, and 10–30 percent in the households sector. Without this plan, energy use is projected to increase rapidly under a business as usual scenario by 41 percent in 2025.
- *National Energy Management Blueprint (PEN) (2006)*. PEN supports the RIKEN through the implementation of energy efficiency and conservation measures. It provides development road maps for various sectors that involve the implementation of supply- and demand-side management, intensification of efforts to search for and use renewable energy sources, implementation of fiscal measures such as tax allowances, development of energy infrastructure, community participation in commercial energy, and the restructuring of energy institutions.
- *National Energy Policy (2006)*. This policy stipulates national targets for an optimal energy mix in 2025: less than 20 percent from oil, more than 30 percent from gas, more than 33 percent from coal, more than 5 percent from biofuel, more than 5 percent from geothermal, and more than 5 percent from other renewables. It further stipulates a national energy elasticity target of less than 1 by 2025.
- *Presidential Decree No. 2/2008 on Energy and Water Efficiency*. This decree mandates energy conservation practices in government office buildings. Government departments and agencies and regional governments are required to implement best-practice energy-saving measures outlined in the government's guidelines and directives and

are mandated to report their monthly energy use in buildings to the National Team on Energy and Water Efficiency every six months.

- *Building energy codes*. Indonesia has four energy standards for buildings that cover the building envelope, air conditioning, lighting, and building energy auditing.
- *Fuel and electricity subsidies*. Fuel and electricity subsidies were scheduled to be phased out by 2014, mainly prompted by an increasing deficit in the state budget—electricity subsidies peaked at 83.9 trillion Indonesian rupiah (Rp) (US\$11.05 billion) in 2008 and were estimated to be Rp 65.6 trillion (US\$8.6 billion) in 2011. Currently, all categories of customers pay for electricity at rates far below market price—the average electricity tariff is about Rp 655 per kWh (US\$8.62 per kWh), whereas the market price is about Rp 1,030 per kWh (US\$13.5 per kWh). In May 2011, the government announced an increase in the base tariff of 10–15 percent to reduce the swelling subsidy. Funds formerly used for subsidies will be used to fund energy investments, including geothermal electricity generation, energy efficiency, and other low-carbon energy generation projects. These will be implemented via the Clean Technology Fund, which has amassed more than US\$4 billion since its establishment in 2008. The change in policy and approach from energy subsidy to investment in low-carbon, highly efficient technologies is a major component to the background in which energy policy decisions will be made in the future in Surabaya. Despite the government's aspirations and efforts to phase in the reduction of subsidies, the threat of faster inflation amid gains in oil prices have delayed the national government's plans, which will likely impact the timeline for the proposed phasing out of subsidies.

The primary national focus is to transition public transportation to using gas and the household sector from kerosene to liquefied petroleum gas (LPG). In June 2010, the government planned to improve fuel efficiency for private cars by imposing limits on engine capacity to no greater than 2,000 cubic centimeters. However, this plan was delayed for reconsideration. Although the national government has

long promoted LPG and compressed natural gas for transportation, uptake will continue to be limited as long as fuel and power continue to be underpriced.

**City Level**

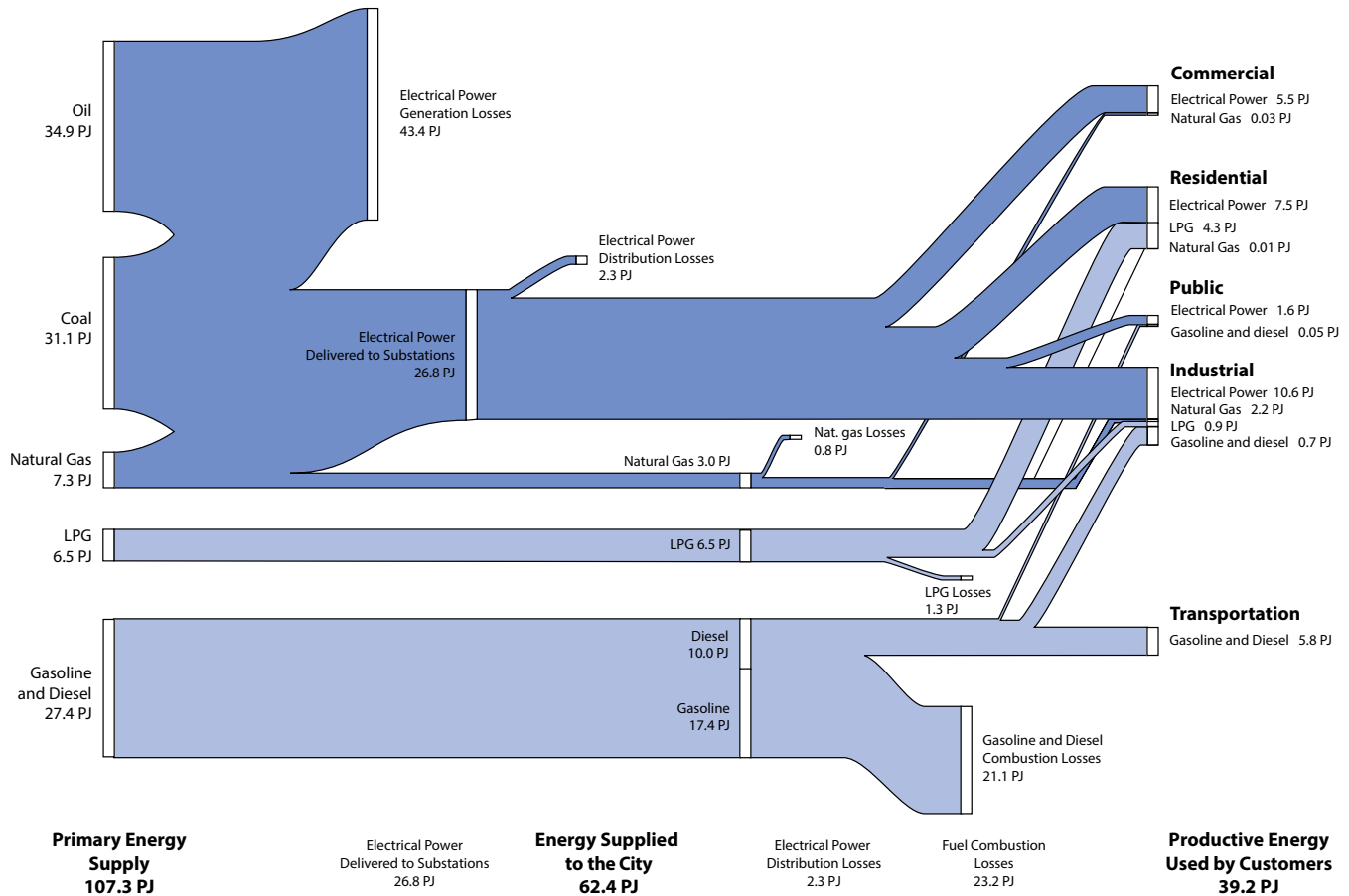
Currently, the city has neither an energy plan nor a policy directed at issues of energy efficiency. However, a number of relevant energy efficiency initiatives have been enacted by the city government, including the following:

- *Surabaya development plan 2010–2014 (RPJMD)*. This is the city’s urban development plan, which is renewed every five years. It addresses several issues, including the development of clean water networks for the city, utilities development, development of the transportation system, and spatial planning in the

city. (There is a separate Surabaya Spatial Plan 2009–2029; however, it has yet to be codified.) The development plan does not explicitly deal with issues of energy management.

- *Bus rapid transit (BRT) studies*. The city has prepared several transportation studies for the development of a BRT system in the next few years.
- *Mayor’s letter*. Following Presidential Decree No. 2/2008 on Energy and Water Efficiency, the mayor issued a letter to city departments mandating the implementation of energy efficiency measures such as energy efficient light bulbs.
- *Eco<sup>2</sup> Cities*. Surabaya is hosting a pilot World Bank Group Eco<sup>2</sup> Cities program, which will focus on strengthening its core urban planning, management, and finance capacities while investing in a catalyst waterfront redevelopment

**FIGURE A2.3. SURABAYA ENERGY FLOWS (2010)**



Source: SUEEP Pilot City Studies 2011.

Note: PJ = Petajoule. “Public” includes the end-use energy of city buildings, street lighting, city vehicles, water, wastewater, and solid waste management.

project. The waterfront redevelopment will enhance environmental and quality of life aspects of the city while increasing accessibility and social inclusiveness, and will revitalize the urban economy.

## Energy Use and Carbon Emissions Profile

Surabaya's 2010 energy flows and profile are summarized in a Sankey diagram, shown in figure A2.3, to illustrate the citywide energy supply and demand characteristics of its different sectors.

Although 62.4 billion megajoules of primary fuel energy is supplied to Surabaya, a substantial portion is lost through thermodynamic conversion processes in vehicles (about 77 percent) and in electrical power generation. Similarly, low-efficiency combustion motors in the transportation sector result in only 6.3 out of 27.4 petajoules of gasoline and diesel energy supplied to the sector being used effectively. In comparison, LPG use clearly shows its efficiency advantage because no conversion is involved until its final use. Thus, it would be beneficial both to increase the use of LPG and to locate gas-fired distributed generation closer to consumers. In particular, the industrial sector can make further efficiency gains by using heat (through cogeneration), which is otherwise wasted in coal-fired plants.

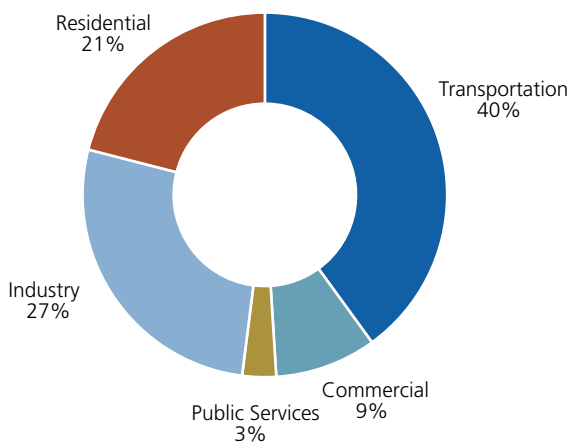
Although the transportation sector accounts for the highest proportion of Surabaya's primary energy consumption, the proportions of energy consumed in the commercial, industry, and residential sectors are also significant (see figure A2.4). In contrast, energy use is insignificant for city public services (solid waste, public lighting, water supply).

Apart from analyzing the energy end-use profile, an overview of Surabaya's energy supply profile can provide the city government with valuable insights for strategic planning with respect to issues of energy security and economic growth. A negligible amount of energy is currently generated from renewable energy sources or primary energy fuels sourced from within the city boundary, but this could be a major potential source of energy production (through thermal solar) for residential, industrial, and hotel uses.

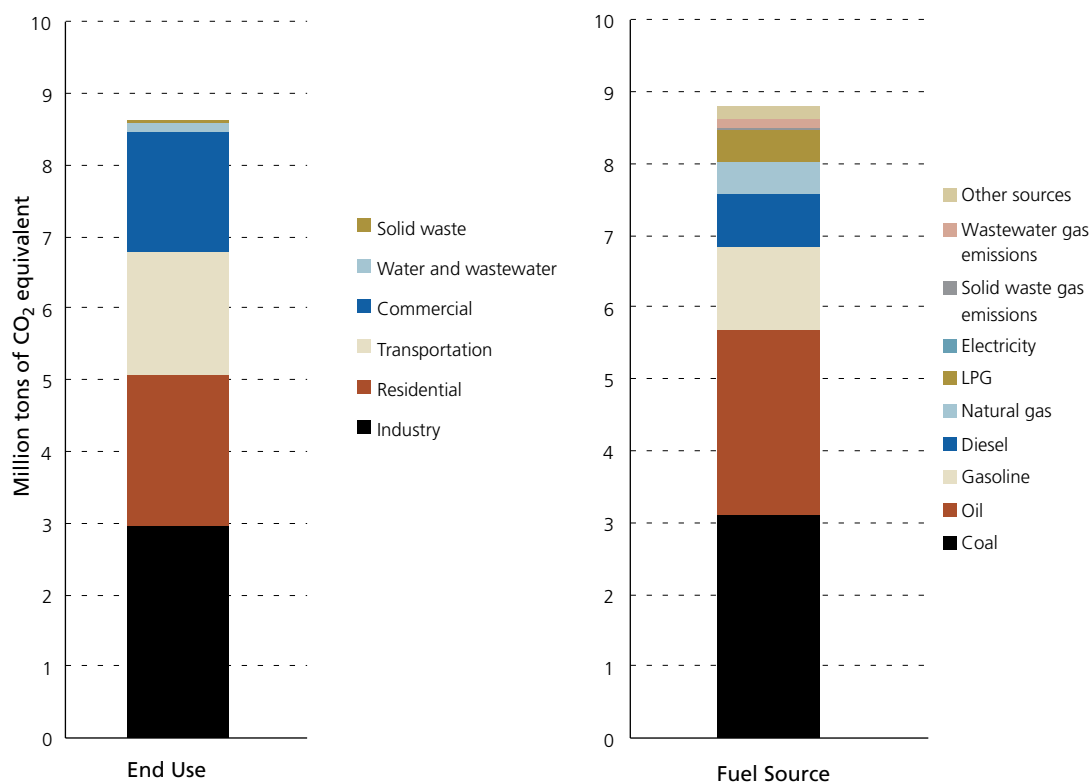
Of the energy supplied to the city, 58 percent is in the form of petroleum products. The majority (68 percent) of the petroleum products consumed in Surabaya is used in the transportation sector; another 18 percent of the city's petroleum use occurs in the industrial sector. The remaining 42 percent of energy imported is electricity. Currently, only 2 percent of energy supplied to Surabaya is generated within the city boundaries. For electricity generation both within and outside its city boundaries, Surabaya relies on oil, natural gas, and coal.

Greenhouse gases (GHG) totaling 8.6 million tons of carbon dioxide (CO<sub>2</sub>) equivalent were emitted by all end-use sectors in Surabaya in 2010 (see figure A2.5). Industrial energy use represents 35 percent of GHG emissions. Commercial and residential energy use represents 43 percent of GHG emissions. Transportation fuel results in 20 percent of the city's GHG emissions, with the remaining emissions emanating from methane released from the city's wastewater treatment operations and local landfills. On a fuels basis, coal is the dominant contributor to GHG emissions in Surabaya (36 percent) and oil the second largest contributor (29 percent). Gasoline, diesel, LPG, and natural gas collectively account for another 31 percent of emissions from fuel use.

**FIGURE A2.4. SURABAYA ENERGY CONSUMPTION BY END USE**



Source: Phase I pilot study.

**FIGURE A2.5. GHG EMISSIONS BY END USE AND FUEL SOURCE**

Source: Phase I pilot study.

## Sector Review and Prioritization

Surabaya's interest in pursuing the Tool for Rapid Assessment of City Energy (TRACE) underscores its commitment to achieving optimal energy efficiency. The analysis was carried out across six city sectors: passenger transportation, city buildings, water and wastewater, public lighting, solid waste, and power and heat. These were, in turn, assessed against the performance of a range of peer cities through a benchmarking process. This review provided a number of significant findings that helped to focus activities during the early part of the study and contributed to the definition of priority sectors for further analysis.

Key findings of the Surabaya diagnostics in comparison with the cities in the TRACE database are the following:

- high electricity use per capita and high energy use per unit of GDP;
- relatively low energy consumed by transportation due to the low level of automobile use and high usage of relatively fuel-efficient motorcycles;
- low use of public transportation coupled with growing private vehicle ownership and widespread use of private motor scooters, resulting in relatively low operating energy intensity for mobility;
- high per capita water consumption and relatively high water losses from the distribution system, but midrange energy density for potable water production;
- low electricity consumption per light pole but room for improvement in public lighting;
- low energy consumption in city buildings but electricity use is on the rise;

**TABLE A2.1. SURABAYA SECTOR PRIORITIZATION RESULTS**

Priority ranking	Sector	2010 energy spending (US\$)	Relative energy intensity (%)	Level of city authority control*	Savings potential**
<b>City authority sector ranking</b>					
1	Street lighting	6,089,000	20	1.00	1,217,000
2	City buildings	2,237,000	10	0.95	212,515
3	Public vehicles	1,617,840	10	0.05	6,235
<b>Citywide sector ranking</b>					
1	Potable water	6,528,000	36	0.96	2,256,000
2	Public transportation	68,889,000	5	0.38	1,309,000
3	Power	Unknown	12	0.05	Potentially large
4	Solid waste	1,306,000	15.	0.75	146,000

Source: Phase 1 pilot study.

\*0 = no influence; 1 = maximum influence.

\*\*Based on TRACE benchmarking; these figures are indicative of the savings that may be possible, not necessarily practicable.

- low level of recycling and high amount of solid waste that goes into one landfill; and
- low levels of transmission and distribution losses in the electricity network.

The TRACE analysis identified priority areas for which significant energy savings are possible. Table A2.1 indicates the energy spending in each of these sectors, the relative energy intensity (the percentage of energy that can be saved in each sector, based on the TRACE benchmarking), and the level of influence the city has over these sectors. The savings potential is calculated by multiplying the three factors. The TRACE contains a playbook of 58 energy efficiency recommendations applicable across all sectors analyzed.<sup>1</sup> The recommendations are not meant to be either exhaustive or normative. The recommendations only outline a number of policies and investments that could help local authorities achieve higher energy efficiency standards. Following the sector-by-sector analysis, each recommendation was reviewed to establish its applicability to Surabaya. This filtering process helped concentrate the process on those recommendations that are both viable and practical.

Table A2.1 shows priorities with respect both to sectors over which the city authority has maximum

influence, and to citywide issues over which the authority has limited influence.

The rankings suggest that the city government should prioritize street lighting, followed by city buildings, and then public vehicles. On a citywide basis, potable water supply is clearly deserving of attention, followed by public transportation, power, and solid waste.

## Recommendations

The recommendations to improve the city's energy efficiency concentrate on areas over which the city has direct influence and are, for the most part, derived from TRACE. Many of the recommendations are targeted at reducing energy use to lower the city's energy expenditure. The recommendations will help city officials identify how the initiatives can be implemented in Surabaya. The recommendations are embedded in TRACE and their details can be made available. The recommendations are expected to be refined by the city and the SUEEP team as further analysis and discussions occur. Although the energy balance and GHG emissions inventory provide an overview of the energy and emissions profile of Surabaya, additional analysis beyond the public sector is required to develop a sustainable urban energy and emissions plan that includes sectors outside the direct influence of the city government.

1. For further details on TRACE, see chapter 4.

### *Transportation*

More than 1.3 million motorcycles and motor scooters dominate private vehicle transportation in Surabaya as they do in many cities in Southeast Asia. The other important modes of transportation in Surabaya are private automobiles, taxis, and angkot buses. Surabaya currently experiences a high-volume rush hour, during which traffic flow is severely impeded.

Although motor scooters in Surabaya are predominantly new and fuel efficient, a shift toward private cars—influenced by higher wages and increasing standards of living, as well as the lack of restrictions on new vehicle registration (although progressive taxes apply to second, third, and fourth vehicles)—is driving up fuel usage. Fuel usage is rising despite the fact that new vehicles tend to be smaller and more fuel efficient than cars in other developed cities.

No high-capacity public transit system serves Surabaya aside from regional commuter trains that run only three or four times each morning and account for a very small share of mode split, estimated at less than 1 percent. Angkot minibuses, another mode of public transportation in Surabaya, generally have older and inefficient engines, and typically use kerosene fuel that may be blended with gasoline, which can damage the engine and is highly polluting. Despite the low usage of public transportation in the city, transportation energy intensity per capita remains fairly low because of the widespread use of fuel-efficient motor scooters.

These factors point to significant potential for improvement in the energy and operational efficiencies of the public transportation system. Furthermore, the lack of access to nonmotorized modes as well as safety concerns regarding the use of crowded streets have made nonmotorized modes of transportation such as bicycling unattractive. Bicycle lanes could potentially be established on a few main thoroughfares wide enough to accommodate them, though the vast majority of streets in Surabaya are too narrow to safely make room for bicycle lanes.

With respect to Surabaya's city operations, its fleet vehicles are maintained at a single facility so projects to improve maintenance and energy

efficiency could be easily implemented at this location. The city government is responsible for more than 500 vehicles that support the following services: garbage collection and transfer, official vehicles, street sweeping, and street light maintenance.

### **Public Transportation Development**

The traffic congestion in Surabaya, which is exacerbated by growth in private vehicle ownership, has led city officials to enhance planning efforts to increase public transportation networks. Irregular public transportation schedules and a declining perception of the attractiveness of road-based transit have been identified as the main challenges. Therefore, the city is focusing its planning efforts on the implementation of multimodal transportation systems based on a light rail transit line, the development of an Intelligent Transportation System, and park-and-ride facilities. Campaigns to increase public awareness include programs such as car-free days and license plate restrictions. A recent increase in the use of bicycles has also prompted plans for the development of bicycle and pedestrian path networks.

One of the most notable observations was the need for an integrated planning approach to ensure that plans for public transportation systems, land use, street signals, parking policies, vehicle registration pricing, and sidewalk policies are adequately integrated and that there is an effective means for turning plan into practice. Integrated planning is especially important for transportation planning. Encouraging nonmotorized modes alongside the development of robust public transportation will be critical to mitigating congestion and improving the quality of transportation in Surabaya.

Coupled with nonmotorized transportation, the promotion of public transit should be part of an energy efficient strategy for Surabaya. Various proposals for enhancing the public transportation system have been in development for a number of years. A bus rapid transit (BRT) pre-feasibility study was completed with the support of Japan International Cooperation Agency (JICA), and the World Bank Group is involved in helping Surabaya conduct more detailed studies. Because of the complexity involved in the development of public transportation and the level of documentation available



for the proposed BRT, this report will not go into detail on this issue. Surabaya is also developing plans for a mass transportation system comprising tramway and monorail systems to serve heavy traffic corridors into the city center, and is initiating studies to integrate the rest of its public transportation network with this system.

#### Vehicle Emissions Standards

Surabaya's transportation system is dominated by motorcycles and cars, which are currently fairly new and fuel efficient. However, vehicle emissions standards testing could be more effectively applied to encourage and enforce better vehicle emissions, which will be important as vehicles begin to age. This, in turn, will lead to better air quality and reduced energy consumption. The current system of testing and enforcement of vehicle emissions is fragmented because different city and national government departments regulate (license) test centers, and enforcement is either weak or ineffective because cars can be back on the road after a few simple measures are applied to get the vehicle to pass. New testing equipment that meets standards for measuring an engine's efficiency would be required. Enforcement activities and resulting sanctions should also be revised to ensure that poorly performing vehicles are identified and removed from service. The implementation of such a measure is potentially difficult because of the fragmented nature of Surabaya's existing testing system and the magnitude of enforcement required.

It is highly recommended that the Bappeko lead a city vehicle fleet efficiency program. Procurement and maintenance policies should be implemented to maximize the efficiency of the city's fleet.

In response to the limited transportation data available to support the Department of Transportation's decision making for energy efficiency issues, a data collection program is also recommended. A variety of informal and inexpensive data collection systems are now becoming available with software applications that collect data from cell phones or city vehicles and do not rely on manual counts to collect transportation data.

Finally, the establishment of a Surabaya regional transportation planning authority is highly recommended to study all types of regional transportation

issues and to allocate funds to the lowest-cost solutions for the most pressing problems.

#### *Solid Waste*

Surabaya has one landfill, which accepts hazardous, septic, and noncompostable waste. The landfill is fairly new and has capacity for approximately 10 years, with expansion sites nearby. Residential waste is collected by the kampungs<sup>2</sup> and brought to transfer stations. DKP (Dinas Kebersihan dan Pertamanan, or Cleansing and Park Department) waste transfer trucks take waste from the transfer stations to the landfill.

Sludge from wastewater treatment is collected from private wastewater treatment companies and processed by DKP. Composted sludge is used as soil fertilizer for city parks.

Landfill leachate currently remains untreated, posing contamination and disposal issues. Surabaya produces nearly 707,000 tons of domestic solid waste annually, giving rise to approximately 37,800 tons of CO<sub>2</sub>e from landfill gas emissions.

Programs have started in four of the transfer stations to extract compostable waste to be turned into soil for use as fertilizer in parks throughout the city. Kampungs are also engaged in small-scale composting with thousands of residential-scale composting bins distributed to households. Surabaya has reviewed numerous energy-from-waste proposals for the landfill, and proposals for a number of different technologies by a variety of bidders are being evaluated; however, no projects have yet been implemented. The landfill in Surabaya is currently set up to capture methane gas, but the gas is not being used as a resource.

#### Vehicle Maintenance Program and Vehicle Operations Program

The first easy win for energy efficiency in the waste sector is a vehicle maintenance program for the collection and transfer vehicles under control of the city government. These vehicles, if tuned up and operated with the correct tire pressure and with clean fuel, could run at least 10 percent more efficiently.

2. Kampungs are the local neighborhood level of city governance.

An effective vehicle operations program would improve the efficiency of routes for the trucks by running them through less-congested areas and making the routes shorter and more direct.

#### Composting Program

The existing composting programs should be expanded and be run at all of the waste transfer facilities, not just the four sites where composting is already happening.

#### Landfill Gas Capture Program

Finally, the proposal for a landfill gas capture program should be executed. The program would provide quick and easy energy and reduce GHG emissions at a very low cost to the city.

### Water

The regional drinking water company (PDAM) produces and distributes Surabaya's drinking water and manages the treatment and distribution infrastructure. PDAM is owned and operated by the city government. About 70 percent of the population has access to clean drinking water. Domestic wastewater is mostly treated with septic tanks and absorption technology. Industrial wastewater is often discharged directly into the Surabaya River without treatment. However, a small number of companies install and manage their own facilities to treat their wastewater discharge. The Surabaya River is a primary source for the city's drinking water, so coordination and action on upstream industrial sites is particularly necessary.

Raw water is gravity fed to the two potable water treatment facilities by the Surabaya River; thus, the energy intensity of potable water is fairly low because no energy is required for transmission pumping or groundwater pumping. Because the water consumption rate in Surabaya is relatively high at 290 liters/person/day, reflecting both actual consumption and loss, water leakage reduction programs and water conservation will be effective.

Surabaya has no citywide wastewater infrastructure and wastewater is currently managed through household, or clusters of household, septic tanks. Seventeen private wastewater treatment companies run treatment facilities for large buildings or campuses. For this reason, Surabaya's energy use for wastewater is very low. However, in the interest of public health, it is expected that a more comprehensive system will eventually be developed.

Surabaya has a large number of storm water ejector pumps in the canals to move water through and out to the sea during rain events. Although many of these facilities are quite old and use large, inefficient pumps, the limited time that these pumps are operated each year means that total energy savings potential is unlikely to be significant.

The city is facing significant challenges in wastewater management, including the contamination of water supply from septic tank seepage, contaminated landfill leachate, and the lack of treatment of wastewater sludge. However, the Surabaya city government has the opportunity to overcome these issues because it owns PDAM (as is common in Indonesia). The large leakage rates and the low water pressure in the east and north sectors of the network also provide opportunities to greatly reduce nonrevenue water losses.

#### Pump Replacement Program

Considering the age of Surabaya's water network and water treatment facilities, a pump replacement program is strongly recommended for Surabaya.

#### Leak Reduction Program

The city should implement a leak reduction program and hire a long-term partner to deliver a performance-based contract.

#### Water Awareness Program

A public water awareness program would also be a productive complement to the water use reduction efforts in Surabaya.

### Power

Surabaya is primarily an importer of electricity, with only one 57 megawatt power plant in Perak (in northern Surabaya), which is fueled by natural gas. PLN Distribution East Java is the state-owned enterprise that provides electricity to meet Surabaya's needs. Hence, although Surabaya can make recommendations and ask for improvements to the electrical network, the city government cannot make direct decisions or even allocate funding for improvements in this sector.

With respect to transmission and distribution, Surabaya has relatively low losses (1.8 percent for transmission and 6.7 percent for distribution). PLN has implemented energy efficiency programs and performs ongoing maintenance on transformers in substations and seems to have a good program for

addressing transmission and distribution losses. Because the PLN network is performing relatively well, any improvements would be incremental.

JICA recently provided technical assistance to PLN for the study of “smart metering” in Jakarta. This concept would be beneficial to Surabaya as well.

#### **Distributed Generation Program**

In light of the city government’s limited influence in the power generation sector, the SUEEP team recommends that a distributed generation program, which would use the capacity of the natural gas network and the nearby natural gas fields to generate low-cost, local electricity within the city, be developed. A distributed generation program would produce additional benefits, such as the use of waste heat for hot water heating, generation of chilled water with waste heat, and reductions of distribution losses in the electrical grid.

#### **Public Lighting**

Public lighting in Surabaya is in the remit of the Cleansing and Parks Department (DKP). Responsibility for street lights on most city streets is under DKP, whereas small roads in residential areas are maintained by the kampung or by the local developer. Surabaya has good street lighting coverage at 79 percent, but its implementation of a program to achieve 100 percent coverage does not suggest that it is a top priority. The SUEEP team noted that the program did not appear to have significant funding.

Surabaya has 40,000 street lights, 95 percent of which use high pressure sodium lamps, which is good practice today, although not the most energy efficient lamp on the market. The lighting levels do not meet international standards, hence electricity consumed per km of road lit is low. A bulb replacement program to ensure all street lights use high pressure sodium lamps was nearly complete.

Only 12 maintenance vehicles were identified for street lighting repair and lamp replacement for the entire city. The team of people assigned to maintenance was also quite small for a city of close to 3 million people. Construction costs for new street lamps can be high, and fitting new wiring and poles into already crowded streets filled with old existing pipes and wires can be difficult.

Despite the above, there is scope for improving public lighting in Surabaya (see below).

#### **Public Lighting Assessment Program**

The first recommendation for public lighting is to improve data collection processes and data availability through a public lighting assessment program so that future programs and funding allocations can be adequately informed with accurate data.

#### **Lighting Timing and Dimming Program**

There is an opportunity to create a lighting timing and dimming program that would test and install new technologies for new street light installations and replacement lamps.

#### **Public Lighting Research and Development Program**

Because DKP does not have the capacity or funding to test new technologies, the most important recommendation in this sector is the public lighting research and development program, which could accept demonstration poles and lamps from manufacturers and measure their performance and test their lighting output to satisfy decision makers that new low-energy technologies can perform satisfactorily.

#### **City Buildings**

The city buildings category covers all buildings owned by the city, including government offices, city schools, and city hospitals. The city building stock is generally characterized by the use of natural daylight, fans and natural ventilation, compact fluorescent lighting fittings, and limited meeting rooms and offices augmented by air conditioning on a timed basis. Hallways, lobbies, and open-plan offices are generally open air and naturally ventilated. Very few buildings in Surabaya have central air conditioning, and the SUEEP team did not identify any city buildings with chillers or central ventilation. These are excellent examples of sustainable design—on the sea coast, where natural ventilation is quite good, not every facility should be fully enclosed with sealed windows and air conditioning. The city buildings in Surabaya consume very little energy, and the opportunities to further enhance energy efficiency seem to be very limited.

No new construction projects were under way for city buildings during the time of the SUEEP mission, and no new building construction projects

were identified. Only minor renovation projects were under way to improve city buildings.

No green building codes or ordinances were identified, nor were any building energy code revisions. National-level green building guidelines have not been set up in Indonesia.

Surabaya's city buildings are low energy users, so maintaining this low consumption while increasing the quality of buildings and services will be a challenge. For example, the SUEEP team's walk-throughs of the hospitals in Surabaya showed that the old hospital was open to the air in all hallways and had minimal air conditioning and lighting, whereas the new hospital was fully air conditioned and overlit through all lobbies, hallways, and spaces. This trend presents both a challenge and an opportunity.

Each department has control over the buildings it uses. There is no central facilities management group within the Surabaya government. Neither is there a formalized refurbishment cycle for government buildings, which poses a significant challenge for achieving energy efficient performance in the existing building stock. In addition, energy-efficiency-oriented capital investment planning and life-cycle costing are not used, hindering the uptake of those energy efficiency initiatives that require higher upfront investment but yield long-term savings.

Any new city building design and construction projects would be good opportunities for the city to show leadership in energy efficient building design practices. The city has the power to pass ordinances for building codes, which will be advantageous for any agency that wishes to mandate compliance with green building codes. The current mayor has been a vocal proponent of energy efficiency and it has been through her leadership that the existing energy efficiency projects have been implemented.

Because of the low energy use by city buildings in Surabaya, only two recommendations are put forward for this sector.

#### Computer Power Save Program

First, based on the walk-throughs of more than a dozen city buildings, the computer power save program was deemed to have the most potential because of the large number of desktop computers in evidence.

#### Energy Efficient Building Code

Second, because of the growing stock of higher-quality and higher-energy-using buildings, the SUEEP team recommends development of an energy efficient building code to appropriately address the construction industry in Surabaya and mitigate the trend of increasing energy consumption in new buildings. The city government can use future new building projects to demonstrate the techniques and benefits of energy efficient buildings.

## Conclusion

Robust energy planning and management will help shape Surabaya's future. Without a formal energy and emissions strategy, Surabaya's economy and quality of life will not reach their full potential. A comprehensive and strategic approach to energy now will pay dividends by future proofing the city's infrastructure against increases in energy use, a growing population, and the pitfalls of energy-intensive development that have hindered so many other cities.

Surabaya's government has recognized the need for a sound energy and emissions strategy through the many existing excellent energy initiatives reviewed above.

In the future, energy governance should be prioritized by the city government because it will help strengthen the city's internal energy management practices as well as engage other key stakeholders who have not played a significant role in the city's energy planning efforts to date. Better governance practices include not just enhanced oversight and data tracking, but also improved procurement practices and a willingness to "lead by example" by showcasing best practices for the benefit of local businesses and households.



## APPENDIX 3

# Da Nang Background

Da Nang is a major harbor city and the largest urban center in central Vietnam. The city is spread over 1,283 square kilometers, with 911,890 people and a population density of 711 inhabitants per square kilometer. With the fourth largest seaport in the country, Da Nang is an important gateway city to the Central Highlands of Vietnam, the Lao People's Democratic Republic, Cambodia, Thailand, and Myanmar (figure A3.1). After relatively slow population growth (1.7 percent annually) between 2000 and 2007, Da Nang appears poised for a significant increase in the next 10 years, primarily due to migration from rural areas. By 2020, Da Nang hopes to become one of the country's major urban centers with a population of about 1.65 million.

Da Nang is in a tropical monsoon zone with high temperatures and a stable climate. There are two seasons, with the wet season lasting from August through December and the dry season from January through July. Winter cold spells tend to be short and not severe. The annual average temperature is 25.9°C, with average humidity of 83.4 percent. On average, the city receives 2.5 millimeters of rainfall per year, and enjoys 2,156 hours of sunshine annually.

Da Nang has recorded remarkable changes in economic development. Its GDP growth rate has been higher than the country's average rate. Between 2000 and 2007, Da Nang's regional GDP grew 12.3 percent annually, totaling US\$1.48 billion in 2009. The production of industrial, agricultural, and aquatic products has increased, as has export value. Promising growth in tourism, commerce, and services has also occurred. Da Nang's economy has historically been dominated by the industry and construction sectors, but this is slowly changing. In 2006, the services sector became the largest economic sector in the city as

FIGURE A3.1. MAP OF DA NANG, VIETNAM



measured by gross output. This shift is in keeping with local policy targets, which seek to develop the city as a rail, road, and seaport hub, in addition to other services-oriented industries (financing, banking, insurance, telecommunications, and consulting). The tourism sector is also expected to grow, as the city strives to become a major national tourist sector that capitalizes on the city’s beaches and proximity to the old capital, Hue; Hoi An Ancient Town; and the ruins at My Son.

Da Nang became a centrally governed city in 1997. The central Vietnamese government and Da Nang City People’s Committee are the focal points for policy making, but a strong base of local entities is involved in energy planning matters and energy systems operations in Da Nang. The main departments, committees, and external agencies responsible for the planning, development, and operation of energy-consuming sectors are represented in the city government structure as shown in figure A3.2.

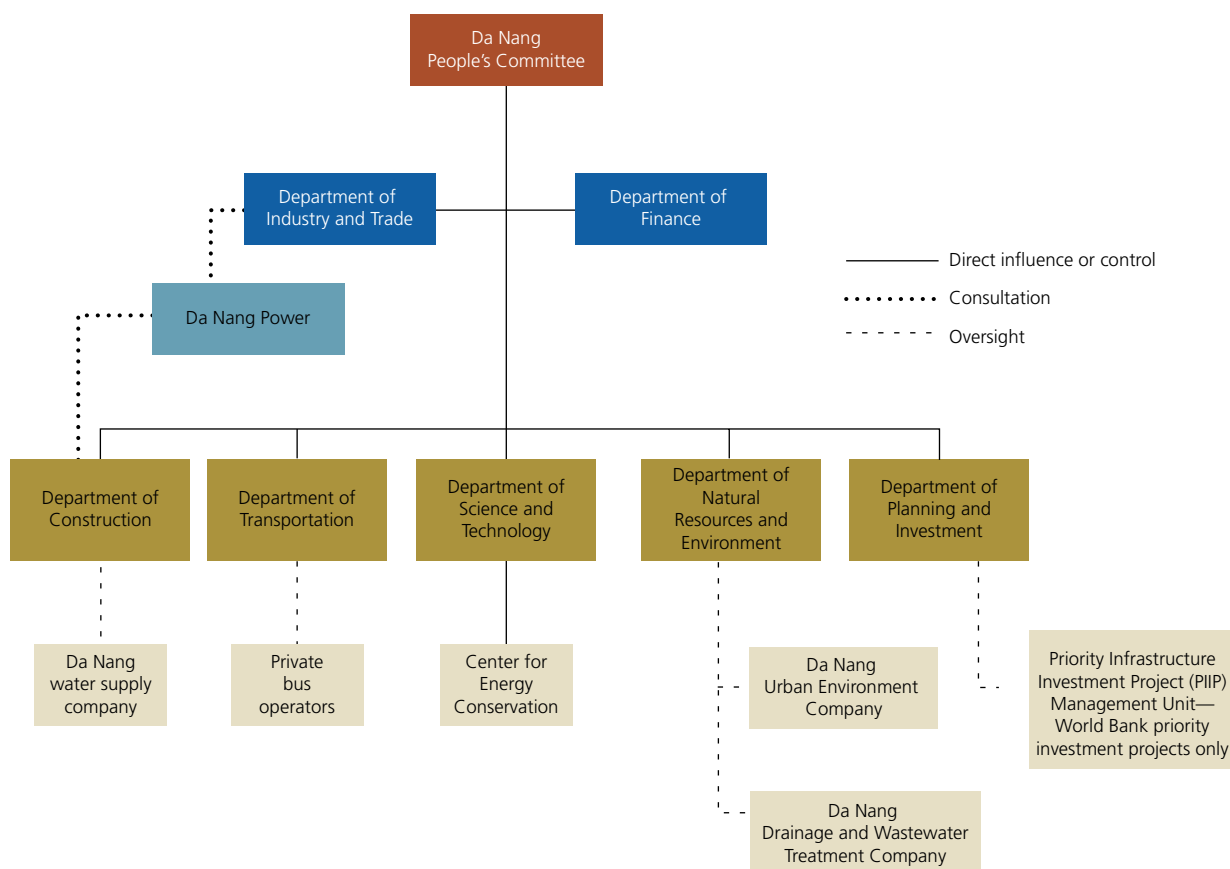
## Energy Efficiency Initiatives

### National Level

The Vietnamese government has acknowledged that increasing energy efficiency is a national priority. The National Energy Efficiency Program (2006–15), which is run by the Department of Industry and Trade, comprises a set of activities to encourage, promote, and propagate energy efficiency and conservation to the public. Elements of the program include the following:

- a targeted reduction in national energy usage of 3–5 percent between 2006 and 2010, and of 5–8 percent between 2011 and 2015;
- coverage across sectors including organizations, households, and individuals using energy;
- prescription of energy efficiency and conservation measures, for example, product labeling to encourage energy efficiency technology and phasing out of inefficient equipment;

**FIGURE A3.2. DA NANG GOVERNMENT STRUCTURE FOR ENERGY-CONSUMING AGENCIES**



Source: Phase I pilot study.

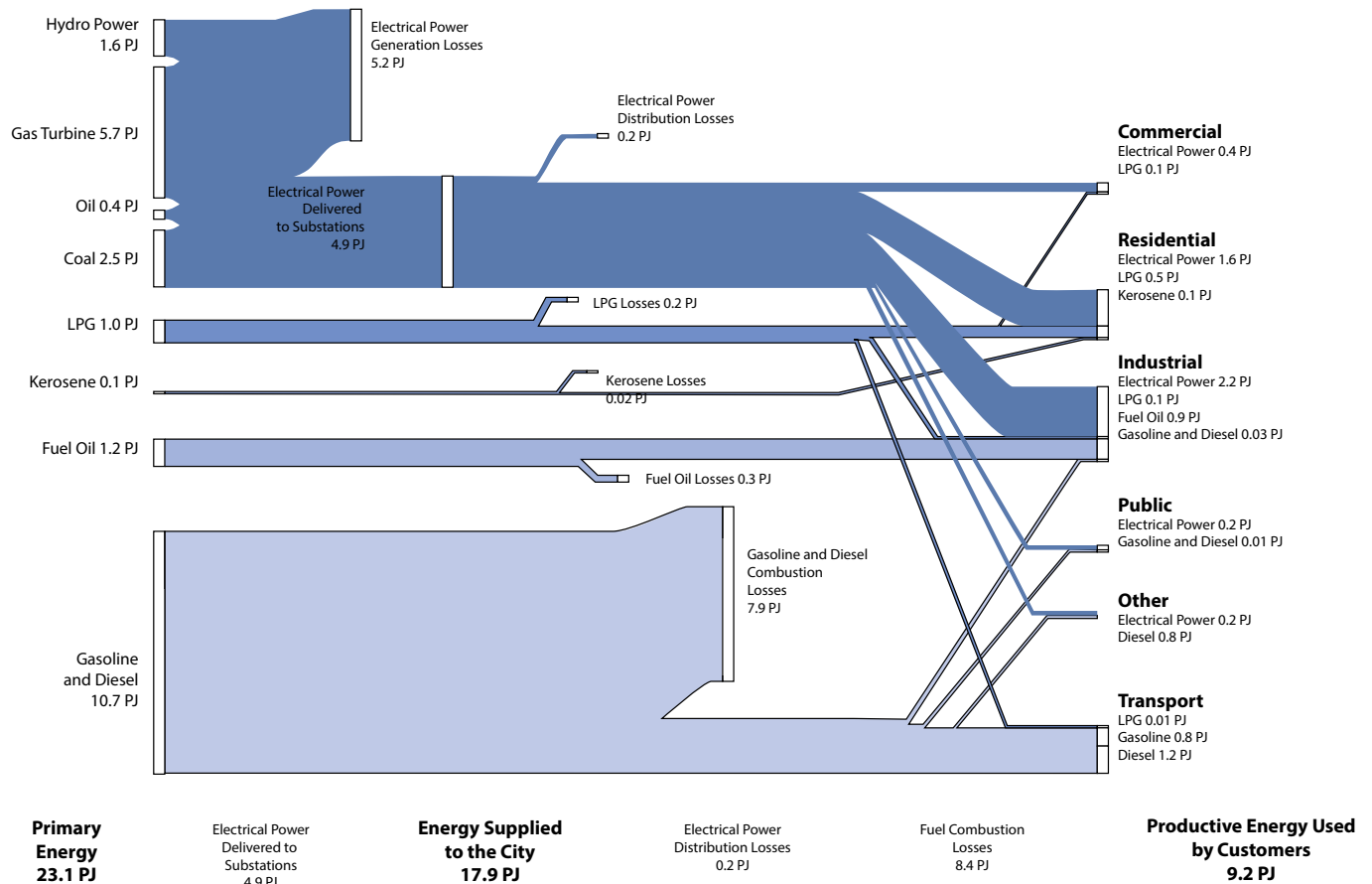


- promotion of energy efficiency and conservation through incentives, scientific and technological development, education, and engagement of consultants by the city government; and
- engagement of consultancy support for energy efficiency measures in enterprises and buildings in Da Nang in 2010, for example, provision of training to companies on energy auditing.
- a study on Wastewater Management Strategy in Da Nang City with Addendum produced for the Priority Infrastructure Investment Project, 2009;
- a study on Integrated Development Strategy for Da Nang City and Its Neighboring Area;
- a city energy efficiency and conservation program covering six energy efficiency projects to be cofinanced by the National Target Program on Energy Efficiency and Conservation, the city budget, private investors, and other sources;
- a city priority infrastructure investment project;
- the Da Nang Master Plan for Water Supply Systems for 2020, which lays out the city water supply company’s strategy for expanding Da Nang’s current potable water system;
- a program for public lighting;

**City Level**

The City People’s Committee Decision on “Promulgation of the Plan for Developing Da Nang – The Environmental City” lays the foundation for city planning in the context of sustainability and encourages resource efficiency. In addition, a number of relevant energy efficiency initiatives and studies have already been enacted by the local Da Nang city government, including the following:

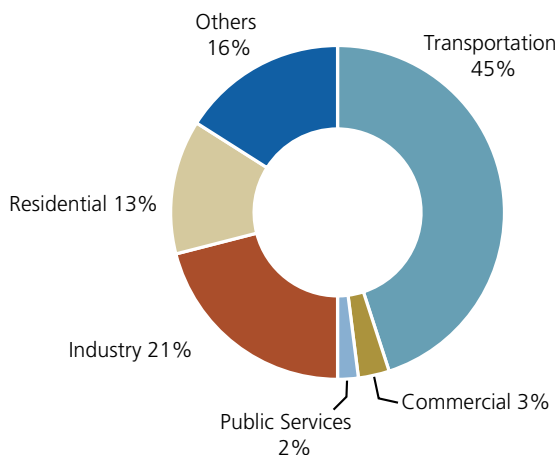
**FIGURE A3.3. DA NANG ENERGY FLOWS (2010)**



Source: SUEEP Pilot City Studies 2011.

Note: PJ = Petajoule. “Public” includes the end-use energy of city buildings, street lighting, city vehicles, water, wastewater, and solid waste management.

**FIGURE A3.4. DA NANG ENERGY CONSUMPTION BY END USE**



Source: Phase 1 pilot study.

- a program for public agencies and utilities;
- a school lighting program; and
- Renewable Energy Research and Development and Renewable Energy Application in the city.

Da Nang has already deployed and assigned different agencies, districts, and enterprises to employ and follow the Government Guidelines on the National Target Program on Energy Efficiency. The city has also set targets for public agencies to save energy in office buildings, and encouraged energy conservation through lighting turn-off times and air conditioning use guidelines. The city has also considered such initiatives as using nanotechnologies for lighting on bridges and solar energy for traffic signal lighting. Figure A3.2 provides an overview of Da Nang's institutional structure and the relationships involved in the city's energy management.

### Energy Use and Carbon Emissions Profile of Da Nang

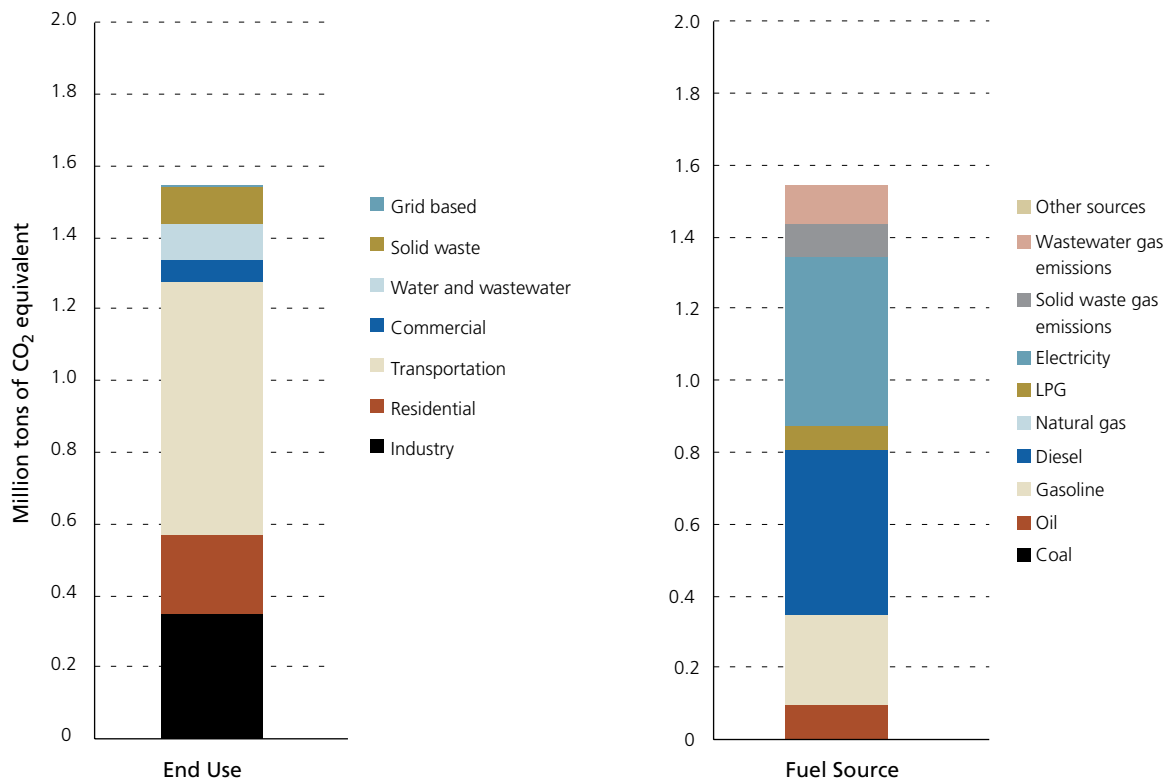
Da Nang's energy flows and profile are summarized in the Sankey diagram in figure A3.3, illustrating citywide energy supply and demand characteristics by sector. Da Nang currently has no significant energy resource base of its own (for example, indigenous coal, natural gas deposits, or hydropower facilities), so virtually 100 percent of the city's energy supply is imported. The city

does enjoy significant solar energy potential and may be able to benefit from local wind resources, but because no renewable power technology is installed in Da Nang, no power is harvested from these resources.

Two sectors (transportation and industry) dominate energy use and emissions, and energy demand is increasing rapidly, with electricity demand alone likely to double between 2011 and 2015. In 2010, the city used roughly 17.9 petajoules of energy in various forms. Transportation was responsible for 45 percent of the city's energy use, followed by 21 percent by the industrial sector. The residential sector consumes 13 percent of the city's energy (figure A3.4). Commercial uses (3 percent) and public services (that is, the government sector, at 2 percent) lag far behind these other sectors. Some 16 percent of energy is consumed in other sectors.

Of the energy imported, 73 percent is in the form of petroleum products, out of which 61 percent is used in the transportation sector. This 61 percent comprises mainly diesel fuel and gasoline, in equal shares. Some 11 percent of the city's petroleum use is attributable to the industrial sector, of which 83 percent is fuel oil, which presumably is used to create process heat in boilers. Electricity accounts for 27 percent of energy imported into the city. In the residential sector, electricity is the primary form of energy used, although a sizable percentage of liquid petroleum gas is used for cooking and hot water. Current peak electricity demand in Da Nang is approximately 250 megawatts, which is a significant increase from 2007, when peak demand totaled just 176 megawatts. Electricity usage in Da Nang steadily increased between 2007 and 2010 (an increase of 44 percent in that period), and is expected to double in six years. The industrial and residential sectors dominate electricity use. Although the commercial sector accounts for a small share of electricity consumption, it has seen the most rapid growth from 2007 to 2010, with demand increasing 44 percent. Industrial demand has kept pace with the overall increase, at 41 percent for that time period, whereas residential demand has grown at a slightly slower pace of 39 percent.

Greenhouse gas (GHG) emissions tell a similar story. A total of 1.54 million tons of carbon dioxide equivalent (CO<sub>2</sub>e) were emitted by all sectors

**FIGURE A3.5. GHG EMISSIONS BY END USE AND FUEL SOURCE**

in Da Nang in 2010 (figure A3.5), and the city's carbon intensity (0.89 kilograms of CO<sub>2</sub> per unit of GDP) is more than twice the national carbon-intensity estimate for Vietnam. Da Nang's carbon intensity is quite high even in comparison with other developing or highly industrial countries. Transportation fuels are responsible for 46 percent of citywide GHG emissions. Of the total citywide CO<sub>2</sub> emissions that originate from the transportation sector, two-thirds are derived from the use of diesel fuel vehicles. Gasoline use (primarily from local motorbikes) accounts for roughly 16 percent of total citywide emissions. The industrial sector is the second largest contributor to GHG emissions in Da Nang. The city's wastewater treatment and water supply operations account for 6.8 percent of the city's emissions, and the solid waste system accounts for 6.7 percent, adding another 13.5 percent to the total. The residential sector is responsible for roughly 14.6 percent of total emissions,

far outpacing the commercial sector's share of the emissions load (3.4 percent).

## Sector Review and Prioritization

Da Nang's interest in pursuing the Tool for Rapid Assessment of City Energy (TRACE) underscores its commitment to achieving optimal energy efficiency. The analysis was carried out across six city sectors: passenger transportation, city buildings, water and wastewater, public lighting, solid waste, and power. These were, in turn, assessed against the performance of a range of peer cities through a benchmarking process. This review provided a number of significant findings contributing to the definition of priority sectors.

Key findings of the Da Nang diagnostics in comparison with other cities in the TRACE database are the following:

- low electricity use per capita but high level of energy use per unit of GDP;
- relatively low energy use in transportation due to a low level of automobile use and high usage of relatively fuel-efficient motorcycles;
- very low use of public transportation coupled with growing ownership and use of private motor vehicles, which is increasing energy intensity for the transportation sector;
- low per capita water consumption and relatively high water losses from the distribution system;
- midrange energy density of potable water production;
- low electricity consumption per light pole (although there is room for improvement in public lighting);
- low but rising energy consumption in city buildings;
- very low level of recycling due to the absence of a formal recycling solid waste program; and
- low levels of transmission and distribution losses.

The TRACE analysis identifies priority areas in which significant energy savings are possible. Table A3.1 indicates the amount of energy spending in each of these sectors, the relative energy intensity (the percentage of energy that can be saved in each sector, based on the TRACE benchmarking), and the level of influence the city government has over

these sectors. The savings potential is calculated by multiplying the three factors. The outcome of the TRACE analysis is a playbook of 58 energy efficiency recommendations applicable across all the analyzed sectors.<sup>1</sup> The recommendations are not meant to be exhaustive or normative. They simply outline a number of policies and investments that could help local authorities in Da Nang achieve higher energy efficiency standards.

Table A3.1 shows priorities with respect both to sectors over which the city authority has maximum influence, and to citywide issues over which the authority has limited influence. The ranking suggests that Da Nang city government should prioritize street lighting, followed by city buildings, solid waste, and the water treatment system. In relation to the buildings sector, the results demonstrate a wide range of opportunity for all residential and commercial buildings in Da Nang although the TRACE analysis in the buildings sector focused on city buildings.

On a citywide basis, the power supply system is a clear area of focus, followed by both private and public transportation. Incorporating this information into a sector-by-sector analysis filters and narrows the recommendations to ensure that they are both viable and practical for Da Nang.

1. For further details on TRACE, see chapter 4.

**TABLE A3.1. DA NANG SECTOR PRIORITIZATION RESULTS**

Priority ranking	Sector	2010 energy spending (US\$)	Relative energy intensity (%)	Level of city authority control*	Savings potential (US\$)**
<b>City authority sector ranking</b>					
1	Street lighting	1,200,000	78.2	1.00	939,141
2	City buildings	2,069,047	15.1	1.00	312,426
3	Solid waste	452,380	48.8	0.97	214,277
4	Potable water	564,349	26.4	0.96	143,163
5	Wastewater	95,000	11.1	0.96	10,133
<b>Citywide sector ranking</b>					
1	Power	54,285,714	33.8	0.38	6,973,725
2	Private vehicles	44,665,149	10.0	0.14	669,977
3	Public transportation	361,773	65.8	0.90	214,416

Source: Phase 1 pilot study.

\*0 = no influence; 1 = maximum influence.

\*\*Based on TRACE benchmarking; these figures are indicative of the quantum of savings that may be possible, not necessarily practicable.

## Recommendations

The recommendations presented in this appendix focus on areas over which the city has direct influence and are, for the most part, derived from the TRACE. The recommendations were shared with the Da Nang City People's Committee and relevant agencies. It is expected that the recommendations will be further refined by the city and study team as further analysis and discussions are completed. Although the energy balance and GHG data discussed earlier are good indicators of the energy and emissions profile of Da Nang, additional analysis beyond the public sector is required to develop a sustainable urban energy and emissions plan that includes sectors outside the direct control of the city.

### Transportation

Although TRACE identified private vehicles and public transportation, as the second and third priorities, respectively, on a citywide scale for immediate energy savings potential, the transportation sector has the highest potential of guiding future city growth in a sustainable manner. Public infrastructure investments are one of the main tools local authorities can use to encourage compact development (for example, development around transit hubs), encourage alternative modes of transportation (walking, biking, public transportation), and decrease local energy inputs (transportation is one of the most energy-intensive sectors). Da Nang has to be proactive in its thinking and must strategically use infrastructure to guide city growth from the current 0.9 million to the estimated 1.65 million in 2020. In its planning, it should move away from a static model, and focus on a dynamic model to accommodate the quickly changing characteristics of the city. To this end, integrated planning is especially important for transportation.

#### Public Transportation Development

Public transportation results in lower operating energy intensity and lower emissions per capita than private cars, and has the potential to provide a more efficient transportation network. A reduction in the number of private vehicles in circulation can lower emissions and improve air quality. Bus rapid transit (BRT) has attracted a great deal of attention in cities around the world in recent years

because of its ability to move large volumes of riders at a cost much lower than light and heavy rail systems. Da Nang would like to see a BRT system deployed in one or more parts of the city by 2016.

One of the SUEEP team's most notable observations in the city is the need for an integrated land-use and transportation planning approach to ensure that plans for BRT, land use, street signals, parking policies, vehicle registration pricing, and sidewalk policies are coordinated and that there is an effective means for turning plan into practice. For example, Da Nang's central business district does not have a pedestrian-friendly environment—most sidewalks serve as motorbike parking lots or spots for food vendors to set up their operations. Similarly, encouraging the use of regular and electric bicycles alongside the development of a robust public transportation system will help to ease traffic flow in Da Nang, given increasing use of private cars. For such benefits to materialize, the Da Nang City Department of Transportation and City Vehicle Registration and Control Office would need to work together, through city planning, to encourage the use of public transportation and nonmotorized modes of transportation.

#### Bicycle Use

Although it bucks the current local trend to abandon bicycles and take up motorized transportation, the lowest energy and carbon mobility path the city can pursue is to promote high rates of walking and cycling around the city. Such a strategy requires careful attention to the way in which new real estate development or neighborhood redevelopment takes place around the city to ensure a mixture of land uses that promotes relatively short travel distances between where people work, live, shop, attend school, relax, and so on. Da Nang's current land-use master plan emphasizes a mixture of land uses for development and redevelopment, thus facilitating low-energy, low-carbon mobility in those areas. Close coordination will be needed between the Departments of Natural Resources and Environment, Construction, and Transportation to ensure the development of high density, mixed-use areas, with space appropriately allocated for pedestrians and bicycles on local roadways and sidewalks. One alternative is dedicated pedestrian malls or other areas in which motorized vehicles

are banned or restricted. Sufficient space for bicycle parking must also be provided, in locations that do not impede pedestrian traffic. Consideration must also be given to effectively linking bike use with public transportation, by creating large bike parking areas near bus stops.

#### Electric Bicycles

Motorbikes already have achieved strong market penetration in Da Nang (and Vietnam as a whole), so it may be difficult to shift large numbers of users “backward” to nonmotorized bicycles. This is particularly true for motorbike users traveling long distances between home, work, school or university, and shopping. Therefore, the city may wish to consider policies and programs aimed at alternative-powered motorbikes such as electrified bicycles. This technology, which is extremely popular in China, could result in a shift away from gasoline to different forms of electric power generation. Large solar charging stations could be set up in different locations around the city to provide low- or no-cost battery charging. Battery-swap businesses could also be established around the city to allow riders to replace the batteries on their bikes quickly and continue on with their trips, rather than waiting for the battery to fully recharge. Electric bike owners could also recharge their batteries at home.

#### Land-Use Planning

People will generally walk a limited distance to a bus stop; anything farther is considered inconvenient, which will lead people to turn to alternative forms of transportation such as cars or motorbikes. To ensure high levels of bus ridership, it is important to increase the density of land development within this acceptable walk zone, thus increasing the likelihood of large numbers of bus users. To the extent possible, routes should be designated, and land use in appropriate areas along the routes “upzoned,” as soon as possible to allow for denser development. Taking this step well in advance of the deployment of the BRT system would allow a landowner to assess whether to increase the size of the building or sell it to other developers interested in some type of speculative development. Advance planning and zoning can help to ensure that by the time a BRT system is launched, residential

and business density along the route will have increased to levels likely to support high ridership.

#### Parking Policies

BRT is predicated on riders walking to and from the system to another destination. To support a BRT system, Da Nang should begin to reclaim the sidewalks around the city so they become more usable by pedestrians. Establishing designated motorbike parking areas and strictly enforcing their use will help accomplish this objective. Da Nang could also take a cue from other cities, where food vendors must apply for permission to occupy public sidewalks to ensure they are not located in areas that would obstruct pedestrians.

#### Car-Minimization Strategies

The city should continue its program of car-minimization strategies. Limits on street parking, high vehicle registration fees, promotion of car-sharing programs, congestion pricing, and other strategies that discourage private vehicle use in certain areas or at certain times of the day or week can help make private vehicle use a less attractive option in Da Nang, potentially leading to higher rates of public transportation and BRT use.

#### Bus System Design

Many elements of bus system design must be considered during the implementation planning process to encourage ridership. These include issues associated with ticket pricing and the availability of free transfers from one bus route to another. The city must also work with new BRT system operators to ensure high levels of rider comfort, longer operating hours, and an increase in the frequency of bus service along designated routes. All of these issues have been cited by the public as reasons for their limited use or overall dissatisfaction with the city’s current bus system.

#### *Solid Waste*

Residential, commercial, and industrial solid waste collection and management services in Da Nang are operated by Hanoi Urban Environment Company (URENCO), a state-owned enterprise. Waste collection is a massive endeavor for a city of this scale. The landfill in Da Nang is not currently set up to capture methane gas (thus missing an opportunity to make use of this resource), and



is expected to reach capacity by 2025 to 2030. The capacity problem is further exacerbated by low fees for residential waste collection, which provide no incentive for waste reduction. The following areas are identified for action by the city government or URENCO officials.

#### Waste Combustion for Power Generation

Approximately 64 percent of Da Nang's waste is kitchen waste, which means it has a high moisture content that is unsuitable for most mass-burn type facilities, even those with energy recovery in mind. Some 28 percent of the waste stream is composed of highly combustible materials, while the remaining 8 percent is composed of inert, non-combustible materials. Both of the latter categories include materials that should be prioritized for recycling. High-moisture-content material can result in incomplete combustion, reducing the burn temperature and resulting power output. To the extent that nonrecyclable waste materials can be presorted into wet and dry streams, a more suitable mix of dry combustible materials may result.

#### Landfill Gas Capture

Da Nang has proposed a Clean Development Mechanism (CDM) project aimed at generating electricity from methane captured at the landfill at Khanh Son. A successful landfill gas capture project would remove 140,000 tons of CO<sub>2</sub>e per year from Da Nang's GHG emissions profile, and if used to generate electricity, contribute to satisfying the city's electricity requirements. The initial analysis suggests the potential for 1 megawatt of power generation at the landfill given current methane gas levels. The Da Nang People's Committee could request information on anticipated gas availability levels over time from this facility. Most landfills experience peak gas availability 5–10 years after the facility is closed and capped; gas levels then decline until the quantity of gas that can be recovered is too low to support power generation or the quality of gas deteriorates and begins to degrade the power generation equipment.

#### Truck Procurement Guidelines

URENCO hopes to upgrade its waste collection fleet in the next several years because most of its vehicles are 5–10 years old. No information was

available on the current fuel efficiency of the fleet, but before any new vehicle purchases are made, Da Nang should work with URENCO to analyze waste collection vehicles available in the marketplace and then establish minimum fuel economy requirements for any vehicles purchased. Da Nang may wish to require that any purchases be subject to a life-cycle analysis that compares the upfront purchase cost, fuel purchases over the life of the vehicle, and maintenance expenditures to determine which vehicles are most appropriate or meet any desired cost-effectiveness threshold conditions.

#### Progressive Tariff Structure

Da Nang's current waste collection tariff structure is volume based for business customers, but residential customers pay a flat fee. In other sectors, such as water, fees are structured to discourage excess consumption; in the case of waste, residential fees should be similarly structured to discourage excess waste generation. The Da Nang People's Committee should thus explore alternative rate structures when rates are next up for review in 2013. Should the city want to promote source separation of different materials to facilitate recycling, it could set rates to provide incentives for this practice. For example, the rate for clean organic waste could be very low (or even free), while rates for nonorganic, nonrecyclable materials could be much higher, encouraging households to reduce waste generation. Of course, in such systems, the city must take steps to ensure that households do not illegally dump waste materials to avoid payment.

#### Water

In Da Nang, water losses from the system were approximately 25 percent in 2011, a decline from 2007 when losses were 40 percent. Da Nang Water Supply Company (DAWACo) indicated that old pipes are a primary cause of system losses and noted they are working to replace these pipes over time. DAWACo has also installed (and would like to install more) variable speed drive pumps, which adjust the pressure in relation to demand on the system. Pumps that consistently maintain high pressure when demand is low can result in leakage across the system.

### Active Leak Detection and Pressure Management System

Despite continuous improvements in the system, DAWACo has reported 25 percent physical water loss in the system, and the water that does eventually get to consumers requires energy-intensive pumping. An active leak detection and pressure management program could address both of these issues at once. Because the Da Nang water network falls under the authority of the Metro Da Nang Water District, technical interventions can only be leveraged by the city government's use of the planning system, for example, making land available for water reservoirs and distribution infrastructure to improve the network's pressure and energy performance.

DAWACo also mentioned that it would like to install Supervisory Control and Data Acquisition technology throughout its system to improve its real-time monitoring capability over the entire distribution network, but this is costly and would likely not be pursued without outside assistance from an international development aid organization.

Da Nang was the first city in Vietnam to have a wastewater management strategy. Currently, fewer than 20 percent of all residences are connected to the DAWACo system. The Da Nang Department of Construction established the policy that allows some buildings to have their own septic systems and requires others to connect to the citywide wastewater treatment system. Connected households pay for service according to a progressive rate schedule, whereby rates increase as usage of wastewater treatment services increases. This system provides an incentive to households to reduce wastewater levels, but may discourage connection to the system. Therefore, a progressive water tariff may be more effective at reducing wastewater although the rates charged are still quite modest.

From a more technical perspective, the current design of the wastewater treatment network does not allow for the capture and combustion of methane gas generated during the anaerobic phase of processing. If new facilities are constructed or any existing facilities are expanded, Da Nang may wish to encourage the inclusion of some type of electric power production technology that combusts the methane gas generated onsite.

In addition to developing a sludge beneficial reuse program, several actions could positively influence energy consumption levels across the DAWACo system:

#### Increasing Connections

Increasing the number of buildings connected to the DAWACo wastewater treatment system would be important. Amending local policies and building codes to require any new development projects to connect to the system would reduce the amount of energy used per unit of wastewater treated. Increasing the volume of material in the system would provide important co-benefits by improving the biological oxygen demand concentrations at the treatment facilities, helping them to operate more efficiently and subsequently improving the quality of water released to local waterways.

#### Demand-Side Measures

It is further recommended that Da Nang require water-harvesting or low-flow devices to be used in new construction projects. Cities are increasingly incorporating demand-side measures into their building codes, aiming to reduce the amount of material entering the wastewater treatment system from new construction projects. It does not appear as if Da Nang has any requirements for the use of low-flow toilets, showerheads, or other fixtures that reduce water flow, and thus, wastewater discharge levels. The cost impact of such measures is quite small, but they provide long-term cost savings for households on both their water and wastewater bills. Systemwide benefits—particularly reducing water demand in the supply network—would also occur.

#### Power

Da Nang Power has been charged with the implementation of the central government's Directive 171 requiring a 10 percent savings in overall electricity use, with a 1 percent savings from major industrial users. Da Nang Power has reportedly implemented several measures to meet the government targets, including (i) demand-reduction programs for factories, (ii) end-use monitoring programs for the largest end users, (iii) the use of compact fluorescent lighting, and (iv) imposition of restrictions on when air conditioning units and building lighting systems can be used. In addition,

a tariff structure that encourages energy use during off-peak hours has been established to reduce peak demand, and efforts have been put into more effective metering of the manufacturing sector. Although Da Nang Power already enjoys very low levels (4.2 percent) of transmission and distribution losses, the company plans to ground distribution lines, which will reduce nontechnical losses to an absolute minimum, in addition to improving safety and reliability.

Distribution and supply-side management are outside the remit of this study, so the SUEEP team's recommendations focus on the diversification of the city's power supply, particularly through local deployment of renewables. Demand management is primarily tackled through the buildings sector, and therefore is not explored in detail in this section. Da Nang Power and city leadership both highlighted the need for a master plan to enhance the reliability of electricity supply as well as a renewables master plan; this acknowledgment of the need for a renewables master plan is a very important development. In many cases, local officials do not have the clout to enact prorenewables policies similar to those put into place at the national level, such as feed-in tariffs, but Da Nang government officials have a number of opportunities for leveraging their authority, including (i) propagating buildings codes that include structural requirements to enable renewables retrofits, such as requirements that buildings be constructed to physically support the weight of renewables installations; (ii) imposing green building codes or standards that encourage or require on-site renewables deployment; (iii) introducing a green building rating system that rewards developers for incorporating renewables into their developments; and (iv) embarking on pilot projects to demonstrate that renewables can be successful in practice.

The new Da Nang Wholesale Fish Market is an example of how the imposition of building codes can encourage the use of renewables. The fish market is a potential host of an on-site photovoltaic system to supply energy for ice making, water treatment, and lighting. The building is attractive for this purpose because of its large size (approximately 7,000 m<sup>2</sup>) and unobstructed roof design. If the highest efficiency monocrystalline or

polycrystalline photovoltaic cells are installed on the fish market's roof, the SUEEP team's preliminary calculations indicate that all of the facility's energy needs could be met by the power generated over the greatest part of the year, with the exception of the monsoon months of September to November. It is unclear, however, whether the roof could support the weight of such a large installation, and thus it is more likely that lighter (but less efficient) thin film photovoltaics would be used. In this case, a significant portion, but not all, of the market's power requirements could be satisfied.

### *Public Lighting*

Da Nang has relatively low electricity consumption per light pole in comparison with other cities in the TRACE benchmark database, probably because the city uses low-energy fixtures, and various dimming regimes have been implemented throughout the city. There is still room for improvement in the public lighting sector, including the mass roll out of light-emitting diodes (LEDs) and development of procurement codes with more stringent energy efficiency requirements. It is also important to consider the speed at which Da Nang is growing and its citizens' quality of life is improving. Lighting preferences could change in the future, putting more demand on the system to provide higher levels of lighting in more areas. Da Nang can prepare for this shift by continuing its excellent efficiency programs and pushing them even further.

Da Nang Bridge and Road Management Company (under the Department of Transportation) has already begun extensive measures to reduce energy consumption in public lighting, including installing LED traffic signals, replacing many of the existing mercury street lights with high pressure sodium luminaires, and replacing decorative halides with compact fluorescents. The agency is also piloting two lighting regimes to optimize street lighting and save energy. Forty of Da Nang's main streets operate under Regime 1, in which every third light is kept off from 6:30 pm to 11:00 pm, and every third light is kept on (with the other two off) from 11:00 pm to 5:00 am. Regime 2 is used for all other streets and all lights are on during night hours. These measures have reduced

the electricity power requirement for public lighting by 28 percent across the city, according to city officials.

The Da Nang Public Lighting Operations and Management Company's goal is to reduce electricity power consumption by 40–50 percent for main streets. The city must continue its existing audit and retrofit program for public lighting. The city might like to reconsider the use of metal halides because these bulbs have high maintenance requirements, shorter life spans, and higher electricity demand than high pressure sodium bulbs or LEDs. It is noted that Da Nang is conducting a pilot test for the installation of LEDs on Tran Hung Dao Street and in Son Tra district, which will enable city officials to test their impact, technology, and aesthetics before the final decision is made.

### *City Buildings*

Energy consumption in Da Nang's city buildings is relatively low, most likely due to the limited funds available for energy expenditures. However, electricity use in city buildings is on the rise. A number of efforts in the city buildings sector have been undertaken to improve energy performance, such as lighting replacement programs and the implementation of air conditioning schedules. However, replacing old air conditioning units and other inefficient appliances, and improving the design and construction of building envelopes, provide additional opportunities for energy performance improvement. It is recommended that existing efforts be continued and a retrofit program be implemented through a city buildings energy efficiency task force.

#### **City Building Audit and Retrofit Program**

To set a good example for other buildings in the city, local authorities should develop an audit and retrofit program for all the buildings the city owns. Such programs can help reduce energy bills and the carbon footprint of the city, and they offer a good knowledge basis for upgrading and updating city building codes.

The Da Nang city government could also benefit from the work of the Vietnam Green Building Council, which was launched in 2008 with the

goal of promoting green building around the country. Work has begun on LOTUS, a Vietnam-specific green building rating system that drew inspiration from other building certification programs, including Leadership in Energy and Environmental Design in the United States, Building Research Establishment Environmental Assessment Method in the United Kingdom, and Green Star in Australia. Developed with voluntary contributions from experts in and outside Vietnam, a first set of guidelines for nonresidential facilities was released in late 2010. Six buildings have applied for certification thus far. There are nine categories in which points can be awarded for a project: energy, water, materials use, ecology, waste and pollution, health and well-being, adaptation and mitigation, community, and management.

Given the population and income growth anticipated in Da Nang over the next several decades, it is important that the Da Nang People's Committee begin work to address building-related energy consumption, both in city government buildings and in other buildings around the city. This is one of the few areas for which the city does not yet appear to have a comprehensive strategy, or to have conducted significant research on different policy or technology options. Taking action now can help the city lock in a lower energy use trajectory than will otherwise occur. There are several opportunities the city may wish to consider, discussed below.

#### **Lead by Example**

The Da Nang People's Committee is reportedly planning to build a tall office tower that would bring together into a single building the local government departments currently dispersed across the city. By constructing a model green building that achieves LOTUS or other preeminent building performance standards, the People's Committee would send a powerful message to others of the importance of this type of design and its viability in Da Nang's economic climate and climatic zone. Work on such a high-profile project could provide training opportunities for businesses and individuals in the city, helping to jumpstart the creation of a local green building marketplace. When the Vietnam Green Building Council completes the

LOTUS guidelines, the People's Committee should consider pursuing LOTUS Existing Buildings Operations and Maintenance certification for any government buildings that remain after completion of the new office tower.

#### Voluntary or Mandatory Green Building Guidelines

The Department of Construction encourages investors to install energy efficient equipment and appliances when it issues construction licenses. A more aggressive approach could be used in advancing energy efficiency in the buildings sector. The fact that the LOTUS system now exists means the Department of Construction (DOC), the local agency with primary responsibility for enforcing compliance with all building codes, has a new tool in its green building education arsenal. The guidelines should prove very helpful in educating project developers and building operators about the full range of steps they can take to create a greener building. However, DOC's capacity to proffer its recommendations to enhance energy efficiency of building projects is limited, which has resulted in an uneven distribution of green features across Da Nang. The city may need to adopt a more aggressive tact, requiring compliance with LOTUS (or other guidelines) as a condition of construction permit approval. The city could even consider imposing local building codes that are more stringent than national codes.

Da Nang need not impose these conditions on all buildings. In many cities, similar requirements are applied only to buildings exceeding a certain size. The bigger buildings play an iconic role and also tend to use the greatest amounts of energy. Targeting them can have an important effect in reducing local energy demand, improving local environmental quality, and creating new markets for green building products and services.

The city might also consider imposing such requirements sectorally, such as on the hospitality sector. Because Da Nang hopes to expand the local tourism industry dramatically, and because hotels and resorts tend to use relatively more energy to provide numerous amenities and to ensure the comfort of their international clientele, focusing

on the greening of that sector could have sizable and long-lasting benefits for the city. By partnering with the hospitality sector on these issues, the city could even turn this initiative into a marketing virtue, eventually allowing the city to promote itself as having the greenest hotels and resorts in Southeast Asia.

Sectoral strategies may require some tailoring of the LOTUS system or other best practice guidance to address the city's unique climate and waterfront location. This tailoring could be done directly by local government experts in Da Nang, in collaboration with the Vietnam Green Building Council. Alternatively, it could become a civil society initiative involving local university and business experts from around Da Nang, along with other technology, design, and engineering experts from Vietnam or the Southeast Asia region.

#### Operational Efficiencies

The city building energy efficiency task force should be responsible for implementing and overseeing the appropriate energy efficiency initiatives in city buildings. The Da Nang Community Relations Department and DOC are well-placed to take on responsibility for energy efficiency in building design and refurbishment. The buildings sector recommendations sheets in the TRACE provide further detail on implementation of individual measures.

#### Computer Power Save Program

Although several good measures have been initiated in local government buildings, old computer workstations abound. These old computers use high levels of energy compared with newer models. Therefore, a computer power save program is deemed to be an effective recommendation for reducing energy consumption in city buildings.

Da Nang city government has already undertaken an impressive amount of work on energy matters, serving as a foundation for future efforts. This work has likely slowed the rate of energy demand growth; however, the anticipated population changes in the next 10–20 years require that much more action be taken. Utility stakeholders in the water, waste, and power sectors have done an excellent job at identifying opportunities for energy



efficiency improvements, in addition to exploring ways to potentially capture energy from different renewable sources. These efforts clearly show the considerable talent the city can bring to bear on future energy policy and planning initiatives.

## Conclusion

In the future, energy governance should be prioritized because it will help strengthen the city's internal energy management practices as well as engage other key stakeholders who have not played a significant role in the city's energy planning efforts to date. Better governance practices include not just enhanced oversight and data tracking, but also improved procurement practices, and a willingness to "lead by example" by

showcasing best practice strategies for the benefit of local businesses and households. Therefore, it is important that Da Nang establish a citywide energy task force to improve coordination and establish a streamlined approach to energy. In keeping with Da Nang's current policy structure, this task force should operate under the auspices of the Department of Industry and Trade. The citywide task force should not limit its focus to government operations, nor should its membership be restricted to government officials. Business and real estate professionals, along with other members of industry, can provide valuable input and offer a fresh perspective on the energy challenges and opportunities facing Da Nang.



# *Approach and Methodology*

The Sustainable Urban Energy and Emissions Planning (SUEEP) project team applied new techniques for the data collection and analysis that were used to identify and inform priority energy system interventions in each city. This report presents the findings of the project, which was structured in three phases:

- four weeks of preliminary data gathering by a local consultant,
- a two-week mission to each city involving international consultants from Happold Consulting, and
- a six-week follow-up period for final data gathering and report writing.

A discussion of the methodological frameworks applied during each mission and the resulting outputs follows.

### **Energy Balance Study**

The energy balance study maps primary and secondary energy supply and use in each city. Energy balance studies highlight the relative importance of different fuel supplies through their contribution to the city's economy; demonstrate the efficiency of different energy conversion technologies; establish benchmarks that allow a city to assess the effectiveness of different policies; and potentially highlight the sectors to which energy efficiency, security, and conservation efforts can be targeted by clearly showing how energy is used in a city. Energy balance studies are further used as a check on the completeness of the available data, as a high level check on data accuracy, and as a starting point for construction of various indicators of energy consumption and energy efficiency.

In 2011, the World Bank developed an energy balance assessment technique that breaks down information by the type of fuel source, the sector consuming the energy, and the way energy is consumed within that sector. Notably, the breakdown is limited to the sector level and all data and calculations are contained within a single, practical worksheet. Data for the energy balance studies were compiled from published data, local electric utility companies, and officials from different government departments in each city.

In most cases, data were collected before and during the two-week mission. The energy balance study contributes to the compilation of background information for the Tool for Rapid Assessment of City Energy (TRACE), although the TRACE model also requires specialized data that go beyond that collected in a traditional energy balance study.

### **Greenhouse Gas (GHG) Emissions Inventory**

The GHG emissions inventory establishes the principal sources of GHG emissions and may identify policy or program initiatives not highlighted by a purely energy-based analysis. The GHG emissions inventory may result in, for example, a heightened focus on renewable power or steps to reduce fugitive landfill gas emissions. This analysis provides the basis for emissions information that may help local government agencies or utilities obtain carbon finance funding for different renewable or energy efficiency projects.

The GHG inventories were compiled using the Urban Greenhouse Gas Emissions Inventory Data Collection Tool, developed by the World Bank in

2011. The tool covers emissions from transportation, solid waste management, water and wastewater treatment, and stationary combustion (power generation, building energy usage, industry, and the like). (Urban forestry considerations may be included in the tool in the future.) The tool aims to provide a simple, user-friendly, and easily replicable approach, and places significant emphasis on providing descriptions of data sources, years, implied boundaries, and quality of the data.

## Analysis Using the TRACE

The TRACE is the project component that most directly links local energy use data with the identification of policy alternatives city authorities may use to reduce energy use. Developed by Happold Consulting for the World Bank's ESMAP team in 2010, the TRACE was specifically designed for application at the city government level, and was piloted in Quezon City, the Philippines, and in Gaziantep, Turkey.

The TRACE is a decision-support diagnostic that compares one city's energy performance with that of other cities through a custom benchmarking system. Benchmarking results are used to identify priority sectors to which a city should target its energy efficiency efforts. Policy recommendations built into the TRACE are linked to each sector, triggering field interviews and further data gathering by the TRACE project consultant to assess which recommendations are most appropriate for the local city context. In some cases, the city may have already implemented or begun work on these policy options, whereas in other cases local political, policy, or market circumstances make a recommendation unviable. Ultimately, the TRACE model is designed to produce tailored, actionable recommendations that will guide or support local policy efforts and ideally be of interest to development banks and other project funders.

The energy balance and GHG emissions components of the study were carried out using frameworks created by the World Bank to quickly assess these two issues, with emphasis on city government services provision and citywide energy-consuming or GHG-creating activities. The application

of more detailed, international standards would have required further data gathering and analysis, and was not considered necessary to provide the macro-level insights afforded by the methodological frameworks used.

## Data Validity

Data used in the study were provided by local sources, either city government office records or other agencies such as utility companies. The accuracy, reliability, and completeness of the data were examined, and queried where necessary, but were not verified by the consultant team because of the rapid nature of the study. Happold Consulting does not, therefore, assure or guarantee these aspects of the study, or acknowledge any liability arising from their future reliance or use by others.

## Mission Activities

The major activities undertaken during the pre-mission and mission phases of the project included the following:

- training of local consultants on the logic and techniques used in the TRACE;
- World Bank-initiated contact between the consultancy team and pilot city governments and other key local utilities (water, electricity) to introduce the project, establish high-level project engagement and support for the release of relevant data, and obtain agreement to follow the proposed mission schedule;
- initial data collection by local consultants through a literature review and telephone and in-person contact with relevant agency and utility staff;
- data review and data input into the TRACE by the consulting firm;
- meetings between the mission team and pilot city government and utility officials;
- final presentation on TRACE findings to pilot city government officials;
- TRACE training for relevant pilot city government officials; and
- follow-up data collection and preparation of a final report.

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