CHAPTER 8

Da Nang, Vietnam

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 (map 8.1) is an important gateway city to the Central Highlands of Vietnam, the Lao People's Democratic Republic, Cambodia, Thailand, and the Republic of the Union of Myanmar. 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.

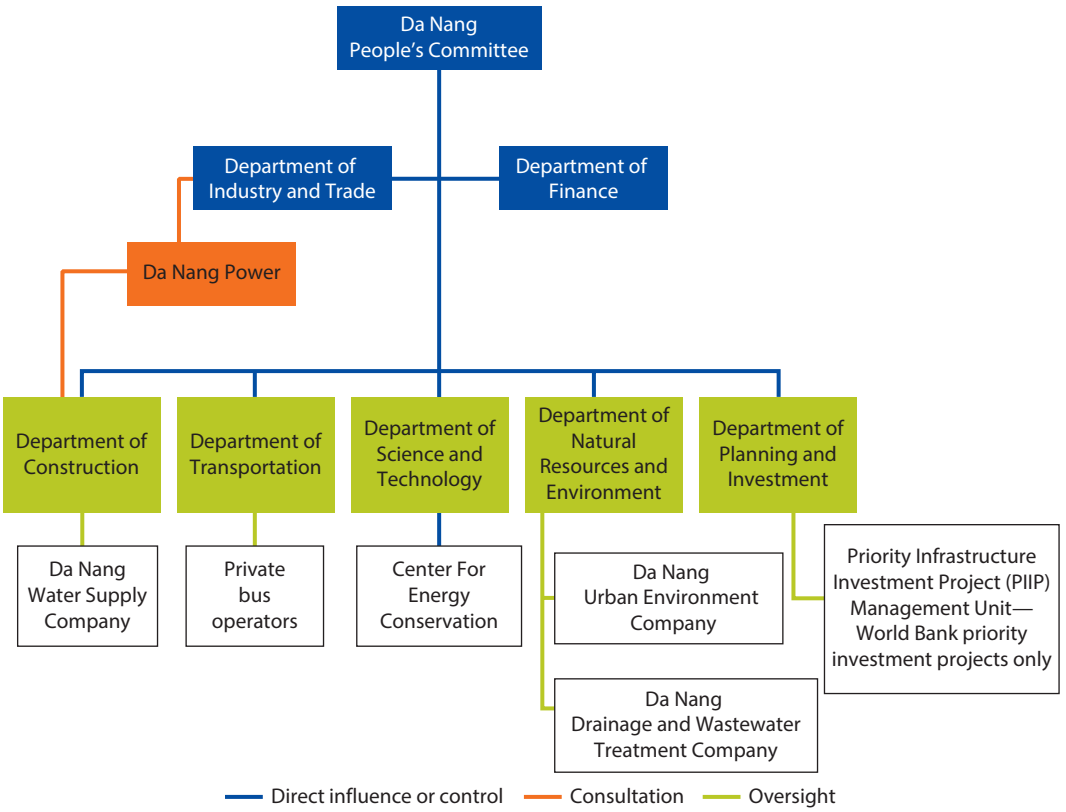
Da Nang is in a tropical monsoon zone with high temperatures and a stable climate. There are two seasons, with the wet season lasting from August through December and the dry season from January through July. Winter cold spells tend to be short and not severe. The annual average temperature is 25.9 degrees C (centigrade), 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 gross domestic product (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 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.

Map 8.1 Da Nang, Vietnam

Source: World Bank.

Figure 8.1 Da Nang Government Structure for Energy-Consuming Agencies



Source: Phase I pilot study.

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 8.1.

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
- Promotion of energy efficiency and conservation through incentives, scientific and technological development, education, and engagement of consultants by the city government
- 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

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:

- The Wastewater Management Strategy in Da Nang City with Addendum produced for the Priority Infrastructure Investment Project, 2009
- The 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
- A program for public agencies and utilities
- A school lighting program
- 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 8.1 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

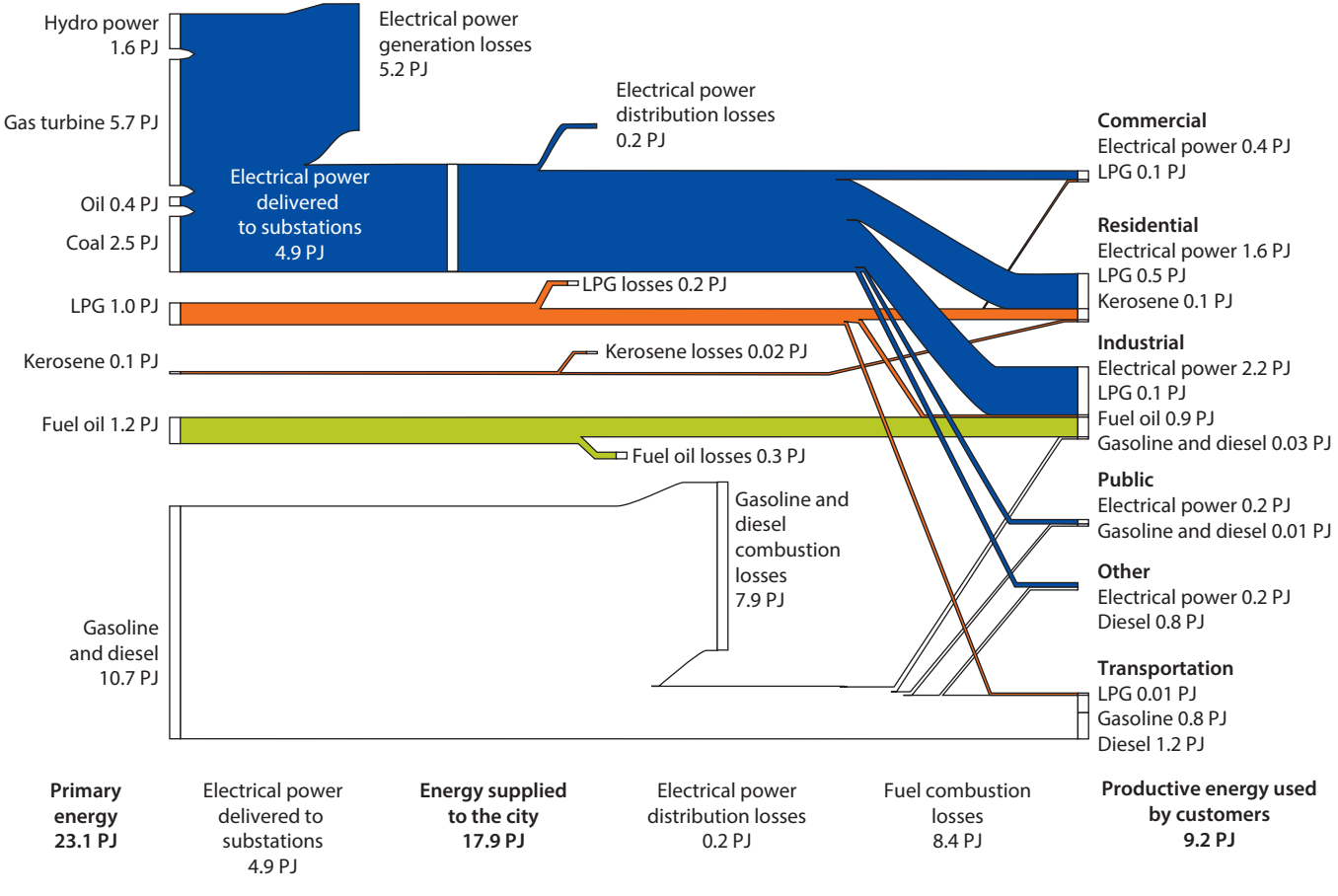
Da Nang's energy flows and profile are summarized in the Sankey diagram in figure 8.2, illustrating citywide energy supply and demand characteristics by sector. Da Nang currently has no significant energy resource base of its own (for example, indigenous coal, natural gas deposits, or hydropower facilities), 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 8.3). 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.

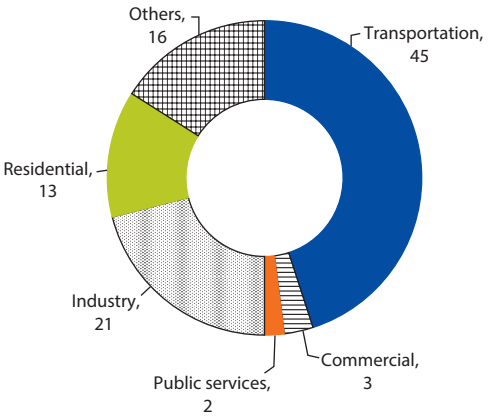
Greenhouse gas (GHG) emissions tell a similar story. A total of 1.54 million tons of carbon dioxide equivalent (CO_2e) were emitted by all sectors in Da Nang in 2010 (figure 8.4), and the city's carbon intensity (0.89 kilograms of CO_2 per unit of GDP) is more than twice the national carbon-intensity 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

Figure 8.2 Da Nang Energy Flows, 2010



Source: Phase I pilot study.
Note: LPG = liquefied petroleum gas; PJ = petajoule. "Public" includes the end-use energy of city buildings, street lighting, city vehicles, water, wastewater, and solid waste management.

Figure 8.3 Da Nang Energy Consumption by End Use
Percent



Source: Phase I pilot study.

46 percent of citywide GHG emissions. Of the total citywide CO_2 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).

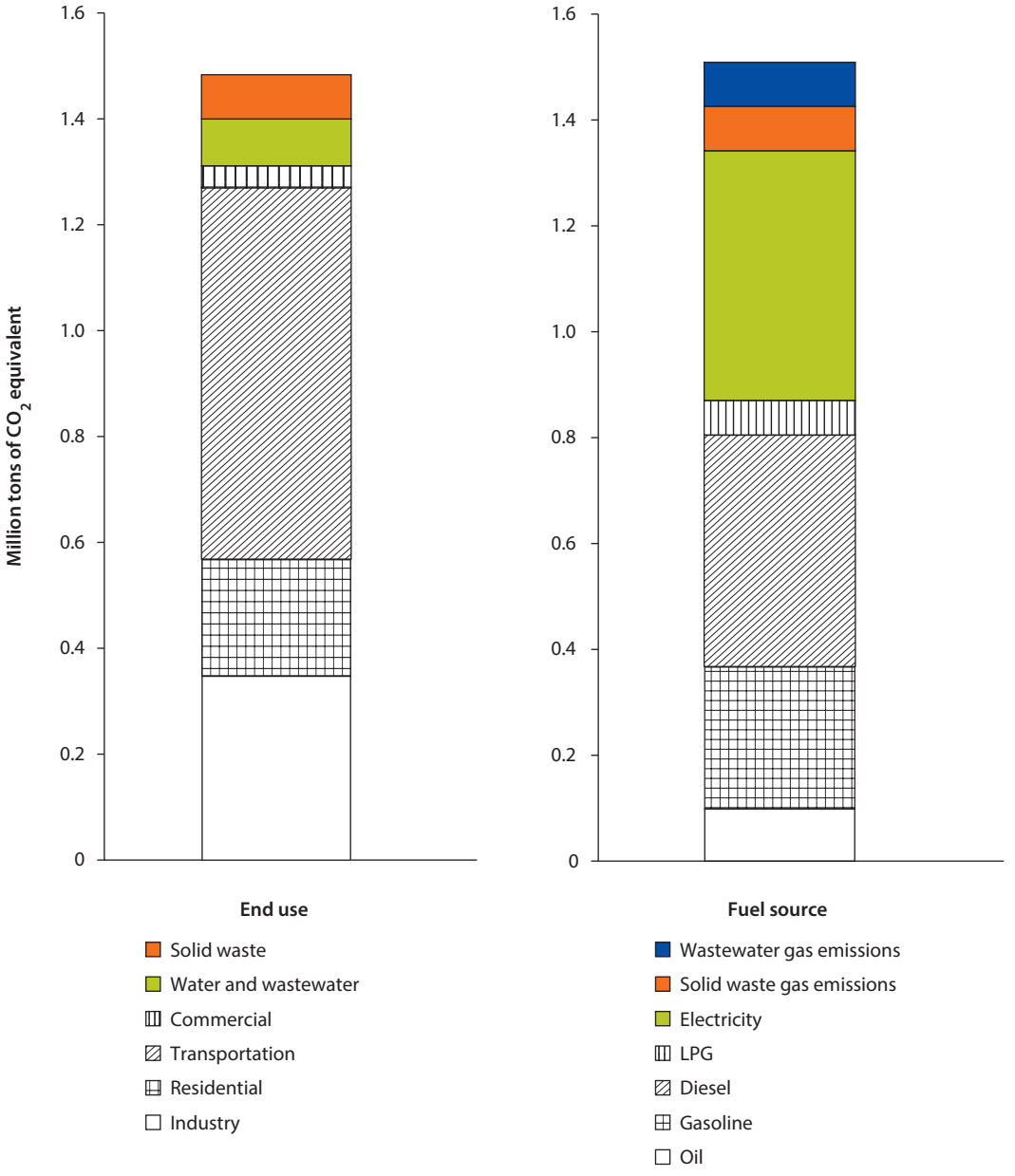
Sector Review and Prioritization

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

Figure 8.4 Da Nang GHG Emissions by End Use and Fuel Source



Source: Phase I pilot study.
Note: CO_2 = carbon dioxide; GHG = greenhouse gas; LPG = liquefied petroleum gas.

- 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
- Low levels of transmission and distribution losses

The TRACE analysis identifies priority areas in which significant energy savings are possible. Table 8.1 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.[1] 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 8.1 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.

Table 8.1 Da Nang Sector Prioritization Results

Priority ranking	*Sector*	*2010 energy spending (US$)*	*Relative energy intensity (%)*	*Level of city authority control*[a]	*Savings potential (US$)*[b]
City authority sector ranking					
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
Citywide sector ranking					
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.

a. 0 = no influence; 1 = maximum influence.

b. Based on TRACE (Tool for Rapid Assessment of City Energy) benchmarking; these figures are indicative of the quantum of savings that may be possible, but not necessarily practicable.

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.

Recommendations

The recommendations presented in this chapter 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 for 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 people 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 Sustainable Urban Energy and Emissions Planning (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 2025–30. 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, noncombustible 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_2e 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 cobenefits 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 and 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 (a) demand-reduction programs for factories, (b) end-use monitoring programs for the largest end users, (c) the use of compact fluorescent lighting, and (d) 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 (a) 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; (b) imposing green building codes or standards that encourage or require on-site renewables deployment; (c) introducing a green building rating system that rewards developers for incorporating renewables into their developments; and (d) 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 square meters [m^2]) 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 tactic, 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.

Note

1. For further details on TRACE, see chapter 3.