Asia-Pacific
Economic Cooperation

Policy Review for APEC
Low Carbon Model Town Phase 4
Final Report
San Borja, Lima, Peru

January 2016

Report for the APEC Energy Working Group

TABLE OF CONTENTS

PREFACE

The APEC Low-Carbon Model Town (LCMT) project seeks to promote low-carbon technologies in city planning in order to manage rapidly growing energy consumption and greenhouse gas emissions in urban areas of the APEC region.

The key objectives of the project are:

1) To develop 'The Concept of the Low-Carbon Town in the APEC Region', which is a guidebook on the principles and implementation of low-carbon design;

2) To assist in implementing concepts in selected towns by providing feasibility studies and policy reviews of these planned urban development projects; and

3) To share best practices and real-world experiences of low-carbon design with planners and policymakers throughout the APEC

This report presents the findings of Policy Review for San Borja, Lima, Peru.

The reviewed economy and the Review Team share the accountability for the policy review. A team of eleven experts conducted the Policy Review in San Borja, Lima, Peru (see Appendix A). They visited San Borja from 18 to 21 January 2015.

During the visit, the Review Team held comprehensive discussions with representatives and experts from San Borja's Municipality and other Peruvian government agencies (see Appendix B). The Review Team wishes to thank all the presenters and others that spent time with the team for discussions. We give special thanks to the team of the San Borja's Municipality who organised the event.

EXECUTIVE SUMMARY

San Borja is a rapidly growing district in Lima and, as such, there is an imperative for it to address carbon emissions in parallel with its development. The city is in the process of developing local low carbon targets whilst aiming to improve the quality of life for its residents. Its low carbon town plan addresses the building sector, energy planning, transportation, urban function planning, and environmental planning. Critically, the city has a capability to both address important metrics - such as, the cost effectiveness of actions to mitigate emissions associated with this growth - alongside the individual and collective leadership that inspires sustainability change.

To assist the city develop its plans, and become a model for other towns, San Borja is the site of a two part APEC peer-review led by the Asia Pacific Energy Research Centre (APERC). Part 1 of the review contains background information on San Borja and provides context to Part 2, – which is produced by the review team. The findings and 50 recommendations for implementation in this policy review are grouped by topic: legal framework, urban planning, low carbon buildings, energy management, energy efficiency, transport and environmental planning.

. Implementing these recommendations requires considering multiple perspectives:

- Is the action cost effective? E.g. a simple analysis of the unit cost of carbon emissions mitigation.
- Is the action visible and engaging? E.g. to what extent will the action educate residents and visitors about the importance of sustainability.
- Does the action generate political and community support? E.g. does strong leadership exist to promote the action?
- Will community, businesses and other stakeholders engage to promote these changes?

There are quantifiable issues, such as costs and timing, and also less tangible considerations such as leadership and stakeholder enthusiasm and support.

The recommendations are graded by priority for implementation, 'immediate action', 'action in 2-3 years', and 'action in the longer term' so that policymakers have a base to determine the timeframes for each recommendation when drawing on the experts' review. An 'integrated framework' explains the rationale for the prioritisation. The Municipality is well placed to understand issues such as leadership and support and along with using an integrated framework San Borja can become a leading Low Carbon Town (LCT) and implement the short-term recommendations. The immediate action recommendations are the higher priority, as they are both cost effective and likely to generate strong community support. Residents and visitors can embrace the low-carbon concept from the beginning and receive early benefits when travelling along the pathway to a low-carbon future.

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

RECOMMENDATIONS

OVERARCHING

Recommendations for immediate action★★★

Rec. 1: Promote the residents of San Borja's and the citizens of Lima Province's awareness of the LCMT.

Rec. 2: Use the San Borja LCMT Project as a case study of Peru's firm commitment to low carbon APEC activities.

Rec. 3: Prioritise the recommendations in this report by cost effectiveness, leadership, community support, impact and emissions reduction.

Recommendations for action in the next 2-3 years★★

Rec. 4: . Retrofit the Municipality Building into a low carbon building for both educational and awareness-raising purposes.

Rec. 5: All levels of government should carry out an integral evaluation of the transformational opportunities, considering the shift in community attitudes and paradigm alongside the greenhouse and cost considerations.

LEGAL AND INSTITUTIONAL FRAMEWORK

Recommendations for immediate action ★★★

Rec. 6: Revise the San Borja Low Carbon Plan (LCP) 2021 as the Feasibility Study suggests possible further reductions of GHG.

Rec. 7: Set an aspirational target in the 'Low Carbon Plan (LCP) 2021' that goes beyond the existing (and/or revised) target.

Rec. 8: Maintain strong leadership in sustainability and efficient institutions in order to realise LCP 2021.

Rec. 9: Establish a 'LCT-Community Planning Council' as soon as possible.

URBAN PLANNING

Recommendations for immediate action★★★

Rec. 10: Develop a strategic design guide, through community consultation, that spells out the expectations for a better-designed and sustainable environment.

Rec. 11: Develop an apartment/multifamily housing design guide with the aim of promoting good design of apartment/multifamily housing.

Recommendations for action in the next 2-3 years★★

Rec. 12: Increase street tree planting in the horizontal space between the building edge and the street through developing street tree strategy, guidance and regulations.

Rec. 13: Support good quality apartment and street design low carbon town initiatives with Mayoral Awards.

Recommendations for action in the longer term★

Rec. 14: Develop a set of Crime Prevention through Environmental Design (CPTED) guidelines to help reduce crime and the fear of crime.

LOW CARBON BUILDING

Recommendations for immediate action★★★

Rec. 15: Coordinate with relevant Peruvian and Regional Agencies regarding the promotion of low carbon buildings.

Rec. 16: Establish a San Borja Green Building Task Force under the 'LCT-Community Planning Council'.

Recommendations for action in the next 2-3 years ★★

Rec. 17: Develop a San Borja-centric sourcebook for green buildings suited to Lima's climate conditions.

Rec. 18: Establish a Comprehensive Capability Program.

Recommendations for action in the longer term ★

Rec. 19: Work with the Ministry of Housing, Construction and Sanitation to establish a Mandatory Building Code for Lima.

Rec. 20: Develop or adopt a voluntary green building rating certification system.

Rec. 21: Establish a Comprehensive Incentives Scheme.

ENERGY MANAGEMENT

Recommendations for immediate action★★★

Rec. 22: Establish an Energy Master Plan that adopts Low Carbon Measures (LCMs), including developing and deploying renewable energy sources and Community Energy Management System (CEMS).

Rec. 23: Improve data and information collection in the energy sector and developing governance structure for energy management in the Municipality.

Rec. 24: Plan effective financial measures.

Recommendations for action in the next 2-3 years★★

Rec. 25: Introduce and implement Demand Response (DR) Programs with an incentive system in cooperation with electric power companies.

Rec. 26: Introduce the concept of Energy Service Company (ESCO) to implement DR Programs effectively.

Recommendations for action in the longer term ★

Rec. 27: Review electricity pricing system to distribute economic resources efficiently at the central government level.

Rec. 28: Consider micro-grid as a long-term low carbon measure.

ENERGY EFFICIENCY

Recommendations for immediate action★★★

Rec. 29: Create an Energy Efficiency (EE) agency responsible for the energy efficiency program.

Rec. 30: Create an Office of Utilities responsible for the water, electricity and gas sectors and coordinate their work with the EE agency.

Rec. 31: Develop and implement a San Borja Master Plan for Energy Efficiency.

Recommendations for action in the next 2-3 years★★

Rec. 32: Require all businesses and organisations in San Borja to create their own energy efficiency program with annual targets, which is reported to the agency.

Rec. 33: Support ESCO companies to create an economic environment for utilities to provide energy efficiency services to the people and businesses.

Rec. 34: Ensure appropriate amendments to the municipal management law and amendments to the Budget Code allowing private ESCO companies to enter into long-term contracts for the provision of energy services.

Recommendations for action in the longer term★

Rec. 35: Establish a funding mechanism to support EE programs and initiatives.

Rec. 36: Create a scheme of municipal guarantees for private sector applying for the commercial loans to support energy efficiency projects and encourage collaboration across industries for pulling projects together.

Rec. 37: Create a scheme of competition for local subsidies.

Rec. 38: Create incentives for commercial companies to develop in-house or industrial continuous professional development (CPD) training programs on EE and RES development for the employees.

Rec. 39: Create municipal education programs for residents to encourage responsible energy consumption; incorporate energy efficiency subjects in education materials in primary, secondary schools and higher education.

Rec. 40: Create rebates and incentives for residents to install solar and utilise efficient equipment

TRANSPORT

Recommendations for immediate action★★★

Rec. 41: Consider providing a Municipality operated 'ring-road' bus every 10-15 minutes in both directions.

Rec. 42: Give support to the users of privately owned bicycles, while maintaining the 'San Borja en bici' program.

Recommendations for action in the next 2-3 years★★

Rec. 43: Improve residents' understandings and awareness of low-carbon mobility systems through educational programs and road signs.

Recommendations for action in the longer term★

Rec. 44: Assess how mobility can best be provided to residents in the future given that new low-carbon transport technologies are developing fast, such as the use of IT to plan journeys, and the advent of electric vehicles.

ENVIRONMENTAL PLANNING

Recommendations for immediate action★★★

Rec. 45: Reduce water usage and increase the diversity of uses within the park network.

Rec. 46: Make sustainability easy.

Recommendations for action in the next 2-3 years★★

Rec. 47: a) The government needs to expand the waste recycling program and b) introduce a system of solid recyclable waste separation by households. This program should be a part of the San Borja EE and renewable energy generation program.

Rec. 48: Introduce a municipal legislation aimed at substantially reducing landfill

Recommendations for action in the longer term★

Rec. 49: Create incentives for the private sector to take on the responsibility of waste segregation waste repurposing and waste-to-energy processing.

Rec. 50: Create rebates and incentives for the businesses to launch public private partnership projects in the field of renewable energy sources generation.

PART I: BACKGROUND INFORMATION

The San Borja Municipal Government and the Feasibility Study undertaken by Hitachi Consulting in 2014 have contributed the background information contained in this report. This information provides some context to the Policy Review Team's recommendations.

OVERVIEW OF LIMA

LIMA CITY

The city of Lima is located along the Peruvian coastline and within the bounds of the the Chillón, Rímac and Lurín rivers. The region of Lima covers 2 811 km^2, with an urban area that extends around 60 km from north to south and around 30 km from west to east (Hitachi Consulting, 2014). The city centre is located 15 km inland at the shore of the Rímac River, a vital resource for the city, since it carries what will become drinking water for its inhabitants and fuels the hydroelectric dams that provide electricity to the area.

Area and population.

Lima City has a population of 9 585 636 for the metropolitan area and a population density of 3 410 inhabitants per square kilometres as of 2013, 29% of Peru's population lives in the capital (Inei, 2013). The Metro area is composed of 49 districts and by gender Lima's population can be divided in to 49% men and 51% women. The 49 districts in Metropolitan Lima are divided into five areas: Cono Norte (North Lima), Lima Este (East Lima), Constitutional Province of Callao, Lima Centro (Central Lima), and Lima Sur (South Lima). The largest areas are Lima Norte with 2 475 432 people and Lima Este with 2 619 814 people, including the largest single district San Juan de Lurigancho, which surpasses de 1 million people in population.

The National Institute of Statistics categorises Lima as a 'young city', based on the age distribution by mid-2014, when the age distribution was as follows: 24% between 0 and 14 years old; 27% between 15 and 29; 22% between 30 and 44; 15% between 45 and 59; and 11% above 60. Lima receives a high level of immigration mainly from the Andes region. For example, during 2013 almost 3.5 million people migrated from the following regions: Junin, Ancash and Ayacucho (Inei, 2013).

Land use

Currently, Lima City land uses can be broken down into 55% residential land use, 9% agricultural land use, 8% commerce land use, 6% industrial land use and 22% under other categories such as military use, services, transport (Protransporte, 2015).

INFRASTRUCTURE

Transport System

a. Roads: The three of the major highways originate in Lima are as follow:
   - The Northern Pan-American Highway: Extends for more than more than 1 330 km from Ecuador to the northern districts of the city, crossing the major cities in the northern coast of Peru;
   - The Central Highway: Connects the eastern districts of Lima with many cities in central Peru, crossing the Andes at 4818 metres above sea level. The highway is about 860 km from Lima to Pucallpa city near Brazil.
   - The Southern Panamerican Highway: Connects the southern districts of Lima to cities south coast cities. The highway is about 1 450 kilometres from Lima to the border with Chile.

Lima's large number of migrants (around 3.5 million people as of 2013) generate demand for interprovincial trips. Accordingly, it has two main bus terminals which serve the northern districts and are a point of connection between the main cities in Peru. There are also many informal bus terminals used by unauthorised transport buses called 'Piratas'.[1]

b. Sea: Lima city is close to the port of Callao, which is Peru's main port. The port is mainly a freight port and has limited leisure cruise arrivals. In the south of Lima, the district of Lurin has a small port, which receives oil tankers due for the local refinery.
c. Air: The Jorge Chávez International Airport, located in Callao, is the economy's largest airport. During 2013 the traffic was around 14 million passengers and moved around 321 thousand tonnes (Corpac, 2013). Additionally, Lima has five other airports: Las Palmas (military base), Collique Airport, and runways in Santa María del Mar, San Bartolo and Chilca.
d. Rail: Lima is the departure point for the Peruvian railroad system that connects the capital with the Central Andean region. The Ferrocarril Central Andino runs from Lima through the departments of Junín, Huancavelica, Pasco, and Huánuco. Major cities along this line include Huancayo, La Oroya, Huancavelica, and Cerro de Pasco (FCP, 2015). The rail system in Peru is based on freight transport and the passenger transport is almost inexistent.

Electricity Supply

Lima receives its electricity supply through the National Interconnected Electrical System. Energy supply composed of thermal (72%) and hydro (28%) (Minem, 2014). In 2012, Peru's electrificiation rate was 91%.

ECONOMIC DEVELOPMENT

Lima is the economic and industrial centre of Peru, contributing to 45% of Peru's GDP. It accounts for around 60% of Peru's industrial production and has 35% of the labour force. The unemployment rate in the metropolitan area was 5.7% in 2013 (Inei, 2012).

The port of Callao is the main fishing and commerce port in the economy, moved 30 million metric tons of freight during 2013. The main export goods are minerals, coffee, oil, cotton, sugar and coffee.

NATURAL CONDITIONS

Climate

Lima has a subtropical and desert climate with rare light rains between June and October. Despite being in a desert, Lima has relatively high humidity with an average of 86%, due its proximity to the coast. Lima's unique coastal and mountain borders means it only has two marked seasons, summer and winter. During the summer season (December to March), the average temperature range between 18°C and 26°C. The rest of the year average temperatures range between 16°C and 22°C. Precipitation occurs in the form of a persistent morning drizzle events, called 'garúa'. The summer rains, are infrequent and occurs in the form of isolated light showers during the evening or summer nights.

[1] Piratas alludes to the unauthorised nature of the service; it is cheap and without a fixed schedule.

Topography

Lima consists of two main regions, the coast and the mountains. The city of Lima is located in the desert plains, framed by hills and small valleys formed by the Rimac, Chillon and Lurin rivers.

Hydrography

Lima has relatively high levels humidity with very low rainfall. The major source of water is the Rimac River, which crosses through Lima, 160 km from the Andes to the Pacific Ocean.

The Chillon and Lurin rivers also cross Lima, however are used for irrigating small farms.

ENVIRONMENTAL STATE

Water quality

The Rimac River is Lima's main water source, yet it is also used for industrial, sewage and oil related waste. In Peru 88% of water is used for forestry, 1% for industry, 10% for human consumption and 1.5% for mining (Inei, 2013). In Lima around 87% of the population has access to drinking water compared with 75% elsewhere in the economy.

Air quality

The sources of air pollution in Lima are industrial activity and vehicle emissions. In 2011 the air pollution in Lima surpassed the international standard by 126% (WHO, 2014).

Soil quality

Peru is susceptible to soil erosion, where the coast is susceptible to wind erosion and the Mountain region is affected by water erosion. Erosion also occurs in the High Selva when vegetation is cleared and in Low Selva where land is farmed and cleared by burning (Alegre et. al, 1990).

FUTURE DEVELOPMENT ISSUES

By 2020 Lima will a 'Mega City' with more than 10 million inhabitants. This will require more than 600 000 new houses with access to drinking water, sewage and electricity. By 2010 transport is expected to exceed the new Metro Line's capacity totalling more than 600 000 passenger per day.

THE MUNICIPALITY OF SAN BORJA

The district of San Borja was established in 1983, covering 10 km^2 and situated 170 m above sea level (Hitachi Consulting, 2014). The district is located in the 'Centre Area' of Lima[2]. Seven districts border it: La Victoria and San Luis to the north, Santiago de Surco and Ate Vitarte to the west. Surquillo and Santiago de Surco to the

[2]Lima Metropolitan area is divided in 5 different geographic areas: Northern Lima, Centre Lima, Southern Lima, Eastern Lima and Callao.

South, and San Isidro to the west. San Borja is the 23rd largest municipality in terms of population, and is within the top five municipalities in terms of educational levels and affluence.

SOCIO-ECONOMIC INFORMATION

Population

In 2011, San Borja´s population was 111 808, comprising approximately 36 000 households and a projected population of 120 000 inhabitants by 2021. The majority of the population is between 20 and 50 years (52%) and is made of 55% female and 45% male. Figure 1.1 shows the projected population by 2015.

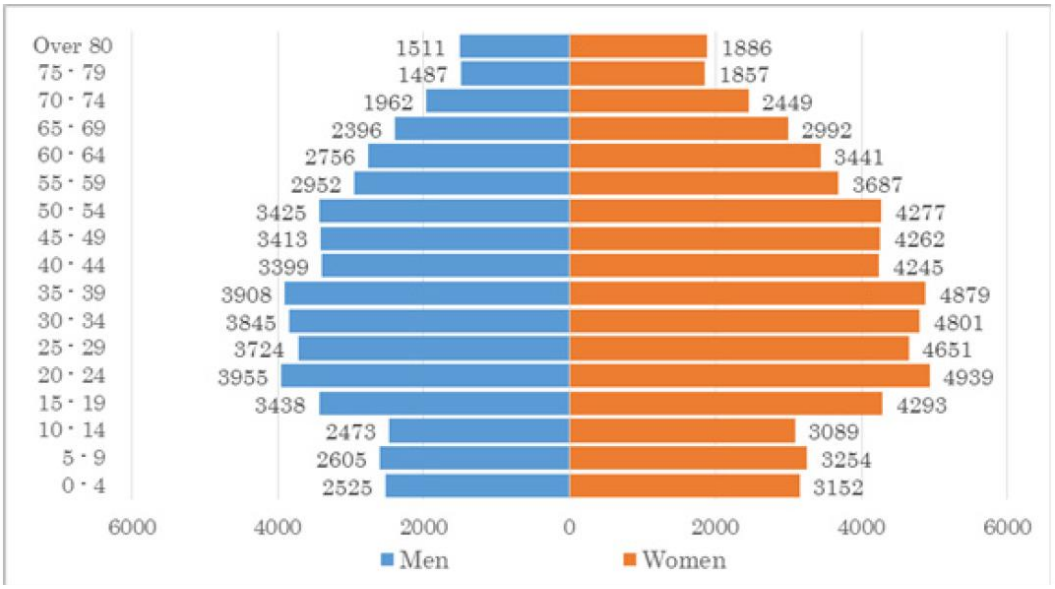


Figure 1.1: Age pyramid - San Borja.

Source: Hitachi Consulting, 2014.

Electricity Supply

Luz del Sur (LdS) supplies San Borja's electricity supple. It is a private electricity distribution company that serves more than 800 thousand customers in the south-east area of Lima. The company EE.UU. Sempra International, a subsidiary of Sempra Energy, owns almost 80% of LdS, with the remaining shares held by institutional investors and the general public.

Land Uses

San Borja is primarily a residential district (80% of land use) with small commercial areas along the avenues San Luis, Aviación, Guardía Civil, Javier Prado and San Borja Norte, which are metropolitan avenues. The district is primarily residential, with commercial and residential uses separated by zoning requirements. As can be observed in Figure 1.2, San Borja has identified the different areas in commercial (red), residential (yellow) parks (green) and institutional areas (gray).

Figure 1.2: San Borja Zoning.

Source: Hitachi Consulting, 2014.

Economic development and industries

San Borja is primarily a residential district with small commercial areas along the avenues San Luis, Aviación, Guardía Civil, Javier Prado and San Borja Norte, which are metropolitan avenues. In these areas there is limited mixed use development that includes housing, employment, commercial, and access to public transit.

In the particular case of the district of San Borja, 95% of the population has income and upper middle class, and more than 97% of the population with the ability to work is employed, which indicates that its population has a greater purchasing power than the average of Lima and Peru.

Key drivers for energy use and economic development.

Table 1.1: San Borja Economic Indicators

San Borja Stratification	Monthly per capita income (current: USD 2009)	Population	Homes	Percentage (%)
High	590.01 +	59 696	17 670	58.97
Middle high	313.01 -590.00	36 638	9 904	36.19
Middle	191.01-313.00	48 32	1 179	4.77
Middle low	132.01-191.00	64	18	0.06
Low	132 -	0	0	0

Total	**-**	**101 230**	**28 771**	**100**

Source:National Institute of Statistics, 2009.

Industries

San Borja is a residential district with limited commercial areas and industry is almost nonexistent.

Transport

Important arterial roads intersect San Borja that connect the city of Lima from south to north and from east to west. The Lima Metro Train is a metropolitan electric train system, which crosses San Borja through Aviación Avenue, and is one of the most important mass transport systems in Lima.

In 2012, residents in San Borja averaged 168,849 trips per day, traveling on average 337,697 miles per day, and can be breakdown as follow:

Table 1.2: Modes of Transport in San Borja

Mode	Percentage (%)
Mini Bus	36
Car	23
Bus	20
Walk	7.5
Taxi	5.1
Train	1.4
Bicycle	1

Source: Hitachi Consulting, 2014.

FUTURE DEVELOPMENT PLAN FOR SAN BORJA

San Borja is looking to promote harmonious development in the city and its environment through its Concerted Development Plan. Regarding low carbon development, this Plan aims to:

- Promote harmonious development of the city and its environment;
- Develop an Environmental Management System and Solid Waste water treatment for irrigation;
- Implement programs that improve public spaces, through enhancing urban development centres and the landscape designs of parks, gardens integrators axes;

- Develop tree planting programs to minimise the generation of dust and gas fireplaces vehicles and shopping centres; and
- Determine each program's viability.

Socio Economic Plan for Lima City with vision to 2025

The Municipality of Lima (ML) proposed the Concerted Regional Developed Plan for 2012-2025. This plan presents the principles that define how Lima and its citizens will face the future as a modern city fully integrated with its environment and promoting human development (ML, 2012). Under this Plan Lima aims to become a city recognised for integrating cultural heritage and environment, productivity and entrepreneurship and high quality tourism.

San Borja, will be impacted positively by this Plan as the district is recognised as a cultural centre, where the National Theatre, the National Library and the National Museum are located. Increased tourism is anticipated as the transport sector reforms, improving accessibility to and from the district. The district also anticipates increased investment in the tourism sector as well, mainly in hotels and restaurants.

By 2025, the Peruvian economy is expected to reach a GDP per capita of USD 10 482 and a population of 33.7 million people. At the same time, San Borja district projects to get 126 260 inhabitants and a GDP per capita around USD 18 150.

LOW CARBON POLICIES

Ministry of Environment: The National Strategy for the Climate Change

The National Strategy on Climate Change (ENCC) is part of the Peruvian Government's commitment to reduce the effects of climate change (Minam, 2014). This strategy looks to integrate cross-sectorial strategies in compliance with the international commitments made by the economy under the United Nations Framework Convention on Climate Change (UNFCCC).

Peru is considered vulnerable to climate change because it presents seven of the nine indicators identified by the UNFCCC. These are:

- Low coastal areas;
- Arid and semi-arid areas;
- Exposure to floods, drought and desertification;
- Fragile mountain eco-systems;
- Areas with high levels of air pollution;
- Economies dependent on the use and production of fossil fuels; and
- Disaster-prone areas (Minam, 2014)

In 2011, the Environmental Action Plan (EAP) was approved and is the main long term planning instrument for low carbon planning. The EAP's main goals are to reduce deforestation to 54 million hectares on forests and reducing GHG to 47%. (Minam, 2013)

The ENCC considers Local Governments as key actors to developing policies and programs to reduce the effects of climate change. The EAP looks to reinforce the capacity of local governments to identify and promote actions and plans to reduce the effects of climate change.

Lima´s Strategic Plan.

One of the pillars of the Concerted Developed Plan for Lima is ensure the integrated management, protection, conservation and restoration of natural and urban ecosystems. It promotes urban growth that mitigates and adapts to climate change. Accordingly the City has proposed the following strategic goals to be achieved by 2025:

- 100% of solid waste disposed safely in planned infrastructure;
- Provide the 43 districts of Lima with systems for collecting solid waste;
- Protect productive green areas 100% (12 680 hectares).
- Construct 4m^2 of green areas per inhabitant, where WHO proposes 8m^2 per inhabitant and Lima currently has 2.4 m^2 per inhabitant;
- Protect 3 000 hectares in the valleys of the Chillon, Rimac and Lurin rivers and maintained as agricultural parks, garden houses, public spaces, and areas for recreation and tourism; and
- Maintain 100% of metropolitan parks with treated water (approximately 9 600 hectares).

This policy refers to the development of ecosystems, established by the Convention on Biological Diversity. It proposes integrated management of land, water and living resources to promote a sustainable and equitable manner, the conservation and use of those resources. It aims to achieve a balance between conservation, sustainable use and fair and equitable sharing of the benefits these resources provide.

San Borja's Low Carbon Plan (LCP) 2021.

The San Borja LCP 2021 sets six action areas with targets for reducing emissions within the following areas: residential sector, commercial sector, transport sector, solid waste, institutional, and urban forestry. Table 1.3 summarises the areas and the strategic actions considered under the LCP.

Table 1.3: San Borja Low Carbon Plan 2021

Action Areas	Strategic Actions
Residential Sector	• Increase natural gas use in residential buildings. • Promote energy efficiency in households.
Commercial Sector	• Increase natural gas use in commercial buildings. • Promote energy efficiency in commercial buildings.
Institutional Sector (San Borja Municipal Operations)	• Promote energy efficiency in municipal buildings. • Replace municipal vehicles with LPG CNG vehicles.
Transport Sector	• Increase the number of NMT trips, specifically through bicycle use. • Increase average occupancy rate in private cars. • Improve the average traffic speed through intelligent

	traffic lights and traffic controls. • Reduce the number of trips in smaller vehicles by increasing the number of bus and van trips. • Increase efficiency of freight transport through circulations plans, routes and schedules for cargo transport in the district.
Urban Forestry	• Plant 50 000 new trees to achieve a tree density of 23% of the total area of the district.
Solid Waste	• Ensure proper treatment and disposal of waste from municipal organic waste. • Improve segregation and collection and recycling of municipal solid waste.

Source: Hitachi Consulting, 2014.

The LCP describes San Borja's 15% GHG reductions targets, the 2012 GHG baseline, reduction strategies. The targets within each of the six sectors are summarised in Figure 1.4.

Figure 1.4: San Borja Low Carbon Plan 2021, Targets and GHG baseline.

Source: Hitachi Consulting, 2014.

San Borja Feasibility Study

The main goal of Low Carbon Model Town Project (LCMT) Phase 4, Feasibility Study for San Borja, Lima Province, Peru (the Feasibility Study) was to provide advice on designing a low carbon development plan for a residential area. The scope of the study was as follows:

- Creating of a Low Carbon Development strategy for San Borja including defining a GHG emissions baseline, defining GHG reductions and environmental targets, providing a guideline for categories of low carbon town design challenges and selecting GHG reduction measures for each design category;
- Analysing the GHG reductions and costs for the selected design measures; and
- Developing a methodology and action plan for implementing the proposed GHG reduction measures.

The expected results in the Feasibility Study under the BAU scenario and the Low Carbon Plan (LCP) presented by the Municipality of San Borja are summarised in Table 1.4:

Table 1.4: BAU and LCP 2021 results.

Sector	Original 2012 Baseline	2021 (BAU)	2021 (LCP)	$MtCO_2e$ Reduction	Percentage Reduction 2012 (%)
Residential	29 425.0	33 330	26 062	3363	11.43
Commercial	38 070.5	46 574	37 749	320.80	0.84
Transportation	34 415.4	40 249	29109	5 305.70	15.42
Solid Waste	7 453.0	8 907	1 648	5 804.10	77.88
Institutional	4 340.0	4 746	1958	2 381.68	54.88
Urban Forest	0	0	(550)	550.00	0.005
TOTAL	**113 703.9**	**133 08.60**	**95978.62**	**17 725.29**	**15.60**

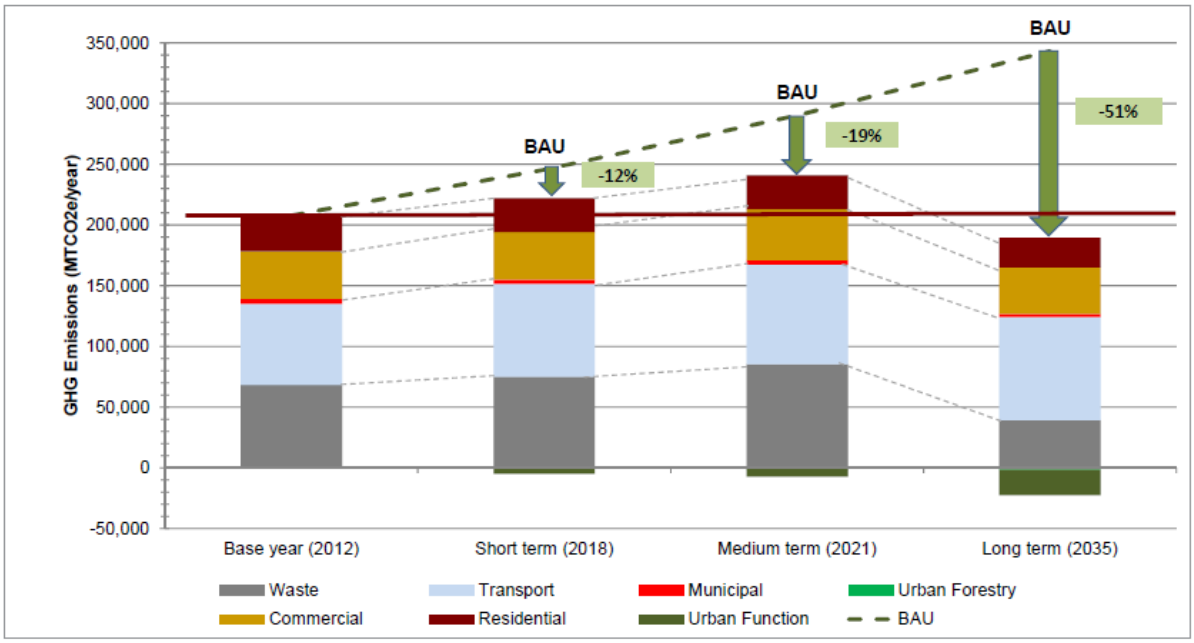
Source: Hitachi Consulting, 2014.

The BAU scenario assumes that no additional low carbon measures are introduced in the district. On the other hand, the results under the LCP considers the results under the application of policies and measures under the San Borja´s LCP.

The results of the application of the measures and policies of the LCP represents a reduction in 15% in total CO_2 emissions by the 2021, with highest reductions from solid waste and institutional sectors.

In comparison with the proposed reductions targets and based on the San Borja 2021 Plan, the GHG expected reductions are 20% reduction compared to BAU scenario emissions by 2021 and 52% reduction compared to BAU scenario emissions in 2035.

Figure 1.5: Projected emissions reductions by sector compared with BAU.



Source: Hitachi Consulting, 2014.

According to the Feasibility Study, the following defines the GHG scope and the options for San Borja to reduce carbon emissions (Hitachi Consulting, 2014):

- **Scope 1:** All direct emissions from sources within San Borja's geopolitical boundaries.
- **Scope 2:** Indirect emissions that occur outside the community boundary because of consumption/ use of grid-supplied electricity, heating and/or cooling, (i.e. purchased electricity or heating and/ or cooling), or generation of solid waste and wastewater within the district's boundary (i.e., waste treatment services operating outside the boundary).
- **Scope 3:** All other indirect emissions that occur outside the boundary because of activities within San Borja's geopolitical boundary, as well as trans-boundary emissions due to the exchange/use/ consumption of goods and services.
- **Scope exclusions:** Under the previous definitions, the following policies are not under control of the Municipality of San Borja:
    - The Metropolitano BRT system
    - The MetroLima rail system
    - Electricity generation and use
    - Solid waste disposal
    - Waste water treatment
    - Freight and commercial cargo transport
    - Transboundary commuters
    - Exchange of goods and services

According to the Feasibility Study 'San Borja has the direct capacity to reduce its Scope 1 emissions through its decisions about how to operate and manage all District-owned buildings, motor vehicles and equipment, lands, and other assets. San Borja also has the authority to address Scopes 2 and 3 emissions through its

procurement decisions, negotiations with vendors, and public policy decisions'. Using its influence over these three scopes San Borja may reach the goals on CO_2 reduction by 2035.

Table 1.5: San Borja GHG Baseline and Inventory by Scope

Emitted Scope	All GHGs Emitted	Avoided GHGs	Sequestered GHGs	Net Emissions	Percentage Contribution (%)
Scope 1	3 232	0	(139)	3092	1
Scope 2	101857	(9 126)	0	92731	45
Scope 3	117 025	(5 044)	0	111981	54
Total	**222 114**	**(14170)**	**(139)**	**207 805**	**100**

Source: Hitachi Consulting, 2014.

The Feasibility Study concludes by looking at the sustainable benefits to San Borja brought by the measures, based on the implementation capability that San Borja has as a local authority. Noting that implementing these measures will require technology transfer as well as technical and financial support from other economies and institutions with experience and background in low carbon development.

PART II: POLICY REVIEW TEAM REPORT

This part of the report presents the Policy Review Team's conclusions and recommendations for low-carbon town development in San Borja, Lima, Peru.

The Feasibility Study focused on the San Borja Municipality, however the findings and recommendations could have wider application to other municipalities in Lima for developing low carbon policies and programs.

The Policy Review Team evaluated the recommendations using an 'integrated framework' to help determine the priority recommendations.

1. LEGAL AND INSTITUTIONAL FRAMEWORKS

FINDINGS

The APEC LCMT Phase 4 Policy Review Team visited San Borja, Lima, Peru in January 2015. The United Nations Framework on Climate Change 20th Conference of the Parties (UNFCCC COP 20) was also held there in December 2014.The Peruvian participants, - the Central Government in particular-, was conscious of the forthcoming APEC Peru Year in 2016, when Peru will host APEC Leaders Summit and Ministerial Meetings including the Energy Minister meeting. The San Borja LCT Project seems to be the catalyst for transforming Peru into a low carbon society for these years where Peru has and will receive international focus.

The Low Carbon Model Town Project (LCMT) Phase 4, Feasibility Study for San Borja, Lima Province, Peru, as submitted to the Asia-Pacific Economic Cooperation Forum, identifies over 50 billion tonnes (carbon dioxide equivalent) of potential greenhouse gas reductions. These reductions are from actions that address multiple areas including:

- Residential, commercial and municipal:
  - Low carbon building design
  - Renewable Energy
  - Community Energy Management System (CMES)
  - Area Energy Planning
  - Waste
- Transport;
- Urban planning and policy changes facilitating low carbon initiatives;
- Walking, cycling and public transport use instead of private cars;
  - Avoiding waste, recycling, waste stream re-use
  - Accessibility encouraging adoption of sustainable choices
  - Lowering the urban heat island impact
  - The likelihood of alternate travel, consumption and energy use choices.

The Policy Review Team found that it is important to maintain the awareness of people of low carbon living not only in San Borja but also in greater Lima City and Peru as a whole. This will also sustain and strengthen legal and institutional frameworks for the San Borja LCT project.

To this end the Policy Review Team recommends that actions are considered in an integrated fashion. Carbon abatement potential and cost are important considerations. Similarly, the city's leadership, especially the Mayor's, passion and advocacy for changes are of great importance. Visibility and enjoyment, awareness, community and business support are also significant factors. Ultimately, the LCMT succeeds when the people of the city regard sustainability and low carbon practice as a norm.

Accordingly the Policy Review Team suggests the city evaluates action using an 'integrated framework'. An 'integral approach' starts from recognising human motivation (internal - what I and we care about) alongside objective measurement (external). Explicitly considering paradigms, personal motivation, world-views and

cultural norms can lead to strong outcomes.[3]Matrix 1.1 summarises these factors represented by four quadrants:

Matrix 1.1: Integral framework for low carbon considerations matrix.

Matrixes 1.2 and 1.3 apply the above matrix using translated quotes from Mayor Marco Alvarez Vargas, Sr. Elmer Linares during the Peer Review to San Borja.

[3] A '*cultural norm*' could be viewed as the most prevalent things that people value. E.g. family, clean city, health, ethics. The *norm* is the centre of gravity of the collective individual perspectives/community desires.

	Internal	External
Individual	• "Love it when our people become their own engine" • "Main transformation is to change people's attitude - get them to commit" • I like to spend time in the park, among the trees, listening to the waterfalls – peaceful fun Thoughts, emotions, memories, states of mind, perceptions	• Citizen participation • Money talks • There's a bike and a safe path near me • I can recycle • It's easy and economically sensible to put in solar hot water on my house. • I spend time in the park Material body, physical object, what we can see or touch, time
Collective	• "Not fighting for our world we're fighting for our children's worlds" • Break a paradigm - automobile drivers are not ready to respect the bike riders • Attitudes! "Have to change the business model paradigm on transport and construction" • People need to understand the value of trees Shared values, meanings, language, relationships, cultural influence	• "To grow we have to provide sustainability" • Increasing density pressures green areas • 140 bikes, 7000 users, equivalent of 32 circumnavigations around the world • "The streets become safe so that they are their own bicycle way" Systems, networks, San Borja government(s), environment

Matrix 1.2: Integral framework considerations using quotes from the Peer Review

Source: Policy Review to San Borja, 2015.

In Matrix 1.2, the quote 'love it when our people become their own engine' was from the English translation of Mayor Vargas' Monday 19 January speech. It is shown in the upper-left quadrant as one of the primary influences is the passion and emotion expressed for motivating change. Such leadership - plus other individuals who may share similar perceptions - is a significant factor in the success of any change initiative; 'Money talks' is shown in the upper-right quadrant. It was part of the discussion during question time on the Monday. It reflects the important considerations that individuals will quantify, particularly decision makers in the San Borja government, in deciding on supporting various sustainability practices; In the lower-right, 'to grow we have to provide sustainability' is a reflection of the physical infrastructure required for a sustainability shift. This includes structures like bike paths, recycling options, markets for recycled products, water purification and tree planting.; The lower-left quadrant's quote, 'break a paradigm', was a common quote in speeches and the question and answer session during the review team's visit. This represents a shift in cultures, a community shift of values, a step change in collective attitudes.

Matrix 1.3: Integral factors examples and drivers for sustainability

Source: Policy Review to San Borja, 2015.

These integral factors are considered at the end of each recommendation subsection and provide a short discussion on the priority of the recommendations

As referred to in Part I, even before the Feasibility Study, San Borja's Municipality had already established a 'Low Carbon Plan (LCP) 2021' with the goal of reducing total greenhouse gas (GHG) emissions by 15% by 2021 from its 2012 baseline levels. The Feasibility Study found that a 15% reduction target is achievable and further reductions are possible with additional low carbon measures.

Under the existing institutional framework, the Feasibility Study recommended that San Borja establish 'a LCT-Community Planning Council' that involves the district, province, and Peruvian governments, residents, key neighbouring municipalities and other relevant stakeholders. For local governments, such as San Borja

Municipality Government, its legal jurisdiction is developing local planning and the local economy, in accordance with regional and central government policies. Though the Organic Law of Municipalities (DL 27972) has helped to facilitate and promote direct and private investment within local governments, the autonomy of municipalities is limited by their financial and regulatory dependence on the central and metropolitan government. Funding for low carbon development comes primarily from property taxes, licenses, and local government fees.

Despite this, San Borja is different compared with many other municipalities in Lima City and Peru as a whole, as it shows greater sustainability leadership than most other municipalities.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Overarching Recommendations for San Borja to become an LCMT

Rec. 1. Promote the residents of San Borja's and the citizens of Lima Province's awareness of the LCMT. ★★★

Along with APEC LCMT Phase 4 Project, experiences and memories of hosting the UNFCCC COP 20 in December 2014 will serve to reinforce the awareness of LCMT and low carbon development among San Borja residents and Lima citizens. This will help to maintain the longevity of the project and ensure that action is done with community engagement.

Rec. 2. Use the San Borja LCMT Project as a case study of Peru's firm commitment to APEC activities. ★★★

Peru will host APEC Leaders Summit and Ministers Meetings including Energy Minister Meeting in 2016, and so the Peruvian Government can and use the San Borja LCMT Project as a case study of Peru's firm commitment to APEC activities. This will highlight Peru's commitment to low carbon development in the future.

Rec. 3. Prioritise the recommendations in this report by cost effectiveness, leadership, community support, impact and emissions reduction.★★★

An integral map assists in prioritising actions across some of the many areas discussed in this report including renewable energy certificates, solar hot water, energy data collection improvement, separating waste into individual bins, a private sector mandate for bike stations and showers, building standards, city planning, a significant expansion of bike.

Rec. 4. Retrofit the Municipality Building into a low carbon building for both educational and awareness-raising purposes. ★★

The Municipality Building is centrally located in San Borja, with many residents and local government workers passing in and out of the building daily. Turning the building into an education and awareness-raising low carbon building for the community would help to demonstrate low carbon development in action.

For example, the Municipality Building could:

- Install solar water heating system visible from the road;
- Provide 10% of electricity from on-site solar PV system with meter in hall for public to view outputs; and
- Provide electric bikes for staff use and recharging facility onsite.

Rec. 5. All levels of governments should carry out an integral evaluation of the transformational opportunities, considering the shift in community attitudes and paradigm alongside the greenhouse and cost considerations. ★★

Matrix 1.1: Overarching recommendations under an integrated framework

Overarching Recommendations	Integral upper left quadrant - Psychology	Integral upper right quadrant - Behaviours	Integral lower right quadrant - Systems	Integral lower left quadrant - Cultures
1★★★ and 2★★★ Community awareness and government commitment	Mayor and other staff already passionately communicate and promote current low carbon actions.	Low cost actions.	LCMT APEC project shows how actions work together as a system.	Prominence and profile support generating strong community acceptance/ culture shift.
3★★★ Evaluate sustainably actions	Incorporates values into prioritising these LCMT recommendations.	Cost and abatement potential considered.	System wide influences and outcomes considered.	Explicitly considers the importance of paradigm and culture shifts.
4★★★ Retrofit the Municipality Building		Some cost (municipal building).	Demonstration building sets standards for city.	City employee culture prioritises low carbon actions.
5★★ All-levels of Government 'integral evaluation'	Builds ability to work in the complexity associated with sustainability change.	Involves planning and capacity building activities.	Decisions based on whole of system understanding.	Culture that can manage sustainability change – i.e. complex adaptive uncertain change.

Legal and Institutional Framework

Rec. 6. Revise the San Borja 'Low Carbon Plan (LCP) 2021' as the Feasibility Study suggests the possibility of further reduction of GHG. ★★★

San Borja should upgrade its LCT plan with a higher GHG reduction target than the 15% in the existing LCP 2021. The higher target could be 19% as found in the findings from the Feasibility Study.

Rec. 7. Set an aspirational target in the 'Low Carbon Plan (LCP) 2021' that goes beyond the existing (and/or revised) target). ★★★

An aspirational target is a secondary set of targets above the expected outcomes. These aspirational targets are set at levels higher than the 19% and 51% reductions highlighted in the Feasibility Study. Aspirational targets help to change paradigms and encourage the city to look for the transformational opportunities. These targets also help local communities understand and manage local priorities against global best practices. Moreover, San Borja's Municipality should compare the local and global considerations against outcomes, measurable and culture shifts, to prioritise the most important recommendations. These ranked priorities, as assessed by San Borja, when put together become a pathway to sustainability change.

Rec. 8. Maintain strong leadership in sustainability and efficient institutions in order to realise LCP 2021. ★★★

The San Borja's Municipality demonstrates strong leadership and efficient institutions regarding LCT planning. However, in order to ensure the longevity of these institutional characteristics, the San Borja local government should put in place succession planning for sustainability roles and set dates for the LCP 2021's revision. This includes educating the next generation of low carbon leaders.

Rec. 9. Establish 'a LCT-Community Planning Council' as soon as possible. ★★★

'A LCT-Community Planning Council' will be necessary for San Borja to not only realise its Low Carbon Town (LCT) projects but also disseminate the idea of LCT to neighbouring municipalities, City of Lima and Peru as a whole.

APEC LCMT project is not self-contained to the case study towns, instead it aims at establishing LCTs in the APEC region as the case study town for modelling LCT for each APEC economy.

In particular, this should involve the provincial government and key neighbouring municipalities as the activities in San Borja, which emit GHG are closely intertwined with those of City of Lima and neighbouring municipalities.

Matrix 1.2: Legal and institutional framework recommendations under an integrated framework

Legal and Institutional Framework	Integral upper left quadrant - Psychology	Integral upper right quadrant - Behaviours	Integral lower right quadrant - Systems	Integral lower left quadrant - Cultures
6 ★★★ and 7 ★★★ Revise Plan and Target			Sets appropriate/ aspirational targets.	
8 ★★★ Strong Leadership	Recognises articulate and passionate effective low carbon leadership.			A culture that values new and emerging leadership.
9 ★★★ LCT Community Planning Council	Leverages the benefits from inspirational leaders in San Borja.	Showcases individual effective low carbon actions across Lima districts.	Up-scales the benefits of the city's programs.	Strengthens the sustainability culture and learning.

2. URBAN PLANNING

FINDINGS

San Borja's Municipality in Lima is 9.6 hectares of relatively flat land covered by well-connected primary and secondary streets with closely packed residential accommodation and an extensive network of avenue parks and pocket parks. A majority of primary streets have a large middle green space densely planted with trees both exotic eucalyptus and indigenous Peru species. There is uniformity in the design of the middle green

space with cut grass and regular grid planting. This space is primarily for passive recreation space due to the tree planting and limited overall width. The recent addition of the bici pathways has added an active use to these spaces.

The street edges next to building footpath have a range of tree types planted sporadically. The local residents primarily planted primarily these trees and not the San Borja Municipality. There is no defined avenue tree planting at the street edge or matching planting with the middle green space. Residents feel that they own the these street trees as they have planted them, irrigated them and can therefore chop them down when they are no longer required.

The residents of San Borja predominately live in apartment buildings (53%) or houses (47%) (Hitachi Consulting, 2014). The houses are densely packed together with a hundred percent connection between side boundaries. San Borja's revised zoning ordinances permit increased residential and commercial density with higher height limits. This is noticeable with a number of apartment or multi-family buildings that are new or under construction within San Borja.

The height of the apartment buildings (between 5 and 8 levels) relate well to proportion of the streets. Contact and interaction between the apartments from balconies and the street below is possible. However, the street frontage at the ground floor (first level) in the majority of cases consists of a blank wall with no entrances except into a car garage. This means there is no permeability on the street or active edges at the ground (first) floor level. The interesting and valuable experiences that generally make it safer for pedestrians and reinforce a sense of community are therefore not present at this level.

The solid walls that reduce permeability and active edges at street level occur around houses as well as apartment/multifamily buildings. These walls are often topped with further security measures such as electric wires or spikes.

There is a fear of insecurity that is affecting the design of houses and buildings at the street level minimising an active street edge. In some cases, it is also causing the removal of street trees next to the residential dwellings, as residents do not want people climbing up the trees into their houses. The removal of trees is also occurring with the construction of new apartments resulting in less shade, increasing the cities heat island effect, and making it less pleasant and safe for pedestrians on the footpath.

Residential dwellings do have open railings but edge car parking on the street frontage often dominates these residents. The whole edge of the street frontage becomes a point of exit and entry for the car onto the street making the footpath less inviting and often unsafe for pedestrians. The high solid walls, with only garage entrances or the street frontages dominated by car parking, combined with the removal of trees, create a hostile pedestrian street environment. This reduces pedestrian activity, leads to increase vehicle usage and an increased fear of crime.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 10. Develop a strategic design guide, through community consultation that spells out the expectations for a better-designed and sustainable environment.★★★

By setting clear urban design and planning expectations with a focus on distinctive buildings and spaces San Borja and its community will be able to refine its present planning regime in respect to low carbon towns.

For example, Hamilton City Council in New Zealand created a strategic design guide calling it Vista Design Guide (2007). It considered six elements of design quality, sense of place, access, public space, lifestyle and sustainable environment. It is available online at: http://www.hamilton.govt.nz/our-services/planningguidanceandresourceconsents/urban-design-advisory-panel/Documents/Vista%20Design%20Guide%20-%20VISTA.PDF.

Note: in reviewing this recommendation the San Borja Municipality acknowledged that a design guide could be developed through the Municipality's existing workshops on planning proposals for the district. Any design guide would need to be passed as a municipal regulation to be enforceable.

Rec. 11. Improve quality of life through design by developing an apartment/multifamily housing design guide with the aim of promoting good design of apartment/multifamily housing. ★★★

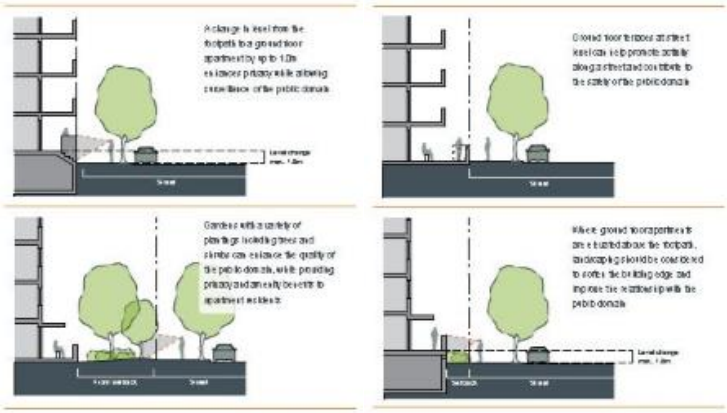
The design guide should speak to developers, designers, planners, council staff and future occupants of these accommodations to arise the standards of apartment/multifamily housing.

Examples of apartment design guides include:

- North Shore City Council, New Zealand in conjunction with other councils and organisations developed a Good Solutions Guide for Apartments in 2007. This has now been incorporated into the Auckland Design Manual a web-based resource on best practice design advice. It is available online at: http://www.urbanismplus.com/wp-content/uploads/2011/07/2001-Good-solutions-guide-medium-density-housing.pdf.
- The Planning and Environment Department of New South Wales, Australia has recently brought out a proposal to update its Residential Flat Design Pattern Book (2011) with a new version Improving apartment design and affordability–State Environmental Planning Policy No 65 (2014) . See Figure 2.1. It is available online at: http://patternbook.planning.nsw.gov.au/.

Some areas worth developing in a San Borja apartment design guide would be creating active edges to enhance the interaction between the apartments and the pedestrian footpath. Active edges can influence the real or perceived safety and security of residents, promote opportunities of social interaction and identify the apartment development with view from the street.

Figure 2.1: Diagrams of various scenarios of the interface with the street edge



Source: the NSW Apartment Design Guide, 2014.

The apartment design guidelines should consider maximum car parking requirements or exemptions for car parking. Minimum car parking standards first emerged in Los Angeles in the 1950s to respond to growing vehicle congestion with no relationship to the type of dwelling, alternative transport modes and closeness to shops, work and other social infrastructure. In New Zealand, Auckland Council's economic analysis of car parking maximums, created by MRCagney Pty Ltd (2013), shows traffic congestion reduction for drivers and improvements in amenity for pedestrians. Figure 2.2 shows the use of car parking maximums could allow different configurations and positions within a building for car parking.

Figure 2.2: Position of car parking on different levels and in different positions allows a more diverse street front

Source: the NSW Apartment Design Guide, 2014.

Rec. 12. Increase street tree planting in the space between the building edge and the street through developing street tree strategy, guidance and regulations. ★★

Increased street trees aims to provide continuous shade along pedestrian footpaths throughout San Borja to encourage walking throughout the municipality and reduce the heat island effect within the street.

The street tree strategy/guidance/regulation should develop a clear vision for future street tree planting and maintenance. Street trees constitute an important element in the heritage and landscape of most cities. The vision of creating world famous 'Great Avenue Streets' of San Borja with trees on the street edge and trees within the green spaces is possible. Having a target of, for example, x number of street trees by a certain date similar to the Mayor of London's Street Tree Initiative would

focus the amount of planting. Ultimately, it should be part of a broader Streetscape Strategy similar to Kapiti Coast District Council's 2008 Streetscape Strategy and Guideline. Available online at: http://www.kapiticoast.govt.nz/Documents/Downloads/Strategies/Streetscape-Strategy-and-Guidelines.pdf.

Plans for street trees needs to be deliberate in order to ensure that they are designed, planted and maintained in a manner that develops the shade throughout the municipality. The community needs to be part of the design process so that trees are in streets where the residents want them to increase the success rate of tree survival.

Street trees should be part of any street infrastructure upgrade or green space improvement to provide deep soil zones where trees can grow unimpeded by underground or overhead infrastructure. Alternatively, the Municipality should provide alternative planting structures.

San Borja needs to plan for street tree planting in streets proposed for new apartment/multifamily housing. With a plan, new apartments/multifamily buildings would be required to provide or pay for street tree planting on the street edge as part of their approval process. The street trees then become part of the overall design of the project.

This recommendation would require amendments to Municipal Ordinance No. 491, which contains a loophole that excludes unused spaces, such as footpaths, with a width of less than 15 metres from requiring greenspace development.

A street tree strategy should consider:

- The sense of place and identity that will be created;
- The size, density and position of the trees in relationship to the effect on adjacent properties, traffic visibility and personal safety;
- The space and site suitability available of the tree to thrive;
- Public support for planting in the street;
- Providing sufficient distance from utility services including street lights, water, sewage and storm water pipes and overhead or underground power, phone and gas;
- Pedestrian and traffic visibility and activity in the street, including kerbside collection trucks, road sweepers etc;
- The ongoing tree maintenance; and
- An approved list of street trees that increases biodiversity with less reliance on a monoculture of Eucalyptus and use of more Peruvian indigenous trees.

Rec. 13. Support good quality apartment and street design low carbon town initiatives with Mayoral Awards. ★★

Award projects that demonstrate low carbon excellence on in architecture, design and place making. The awards would be part of an education process and provide a way of promoting excellent initiatives within San Borja. The Municipality currently has plans to encourage builders to incorporate low carbon design through rewards.

Rec. 14. Develop a set of 'Crime Prevention Through Environmental Design' (CPTED) guidelines to help reduce crime and the fear of crime. ★★

Although San Borja is one of the safer districts of Lima, CPTED guidelines, applied to new and existing buildings and public open spaces to use design, can reduce the incidence and fear of crime. The aim is

to improve the pedestrian environment, increase pedestrian movement and ultimately reduce the number of car journeys in San Borja.

In 2005, New Zealand's Ministry of Justice, with a number a large number of stakeholders, developed a set of seven qualities for safer places. The CPTED approach to design emphasises natural strategies wherever possible to integrate behavioural concepts into how people use spaces and how physical resources are used.

There are four key overlapping and essential circular CPTED principles:

- **Improve surveillance**- have an active street edge of buildings fronting on to the street surveillance. Residents can see what is going on when there are active street edges.
- **Access management** –attract people to some places and restrict them from others.
- **Territorial reinforcement**- set clear boundaries that encourage 'community' ownership and maintenance of the space.
- **Quality environments**- ensure good quality environments that are well-maintained places attracting people and supporting surveillance.

By increasing its green space usage with its bici pathways, San Borja has increased its activity and surveillance of these spaces. By using CPTED methods, greater surveillance on the footpaths through active edges and greater shade the pedestrian environment is improved and ultimately number of journeys by a car reduced in San Borja.

A flow on benefit from this recommendation, include reduced Municipality spending on security in their annual budget, which is currently a significant component.

Matrix 2.1: Urban planning recommendations under an integrated framework

Urban planning recommendations	Integral upper left quadrant - Psychology	Integral upper right quadrant - Behaviours	Integral lower right quadrant - Systems	Integral lower left quadrant - Cultures
10★★★ Strategic design guide		Lowers cost of other carbon initiatives but some time needed to develop this action.	Whole city system creating competitive advantage.	Develops low carbon community paradigm through engagement and understanding of planning.
11 ★★★Improve quality of life through design	Increases amenity and desirability of buildings.	Consultation and planning required along with care in design.		Low carbon = community quality of life.
12 ★★ Street tree strategy	Creates environments people wish to be in and spend time in (aesthetically and climate pleasing).	Established program with good supply of trees.	Planning can further scale up the effectiveness of planting.	Visible reminder of a low carbon culture shift/values.
13 ★★ Mayoral awards	Showcases city leadership and mayor's vision.	Great design rewarded.	Encourages competition across the city.	
14 ★★ Crime Prevention through Environmental Design guidelines	Creates environments people wish to be in and spend time in (feel safe).	Action on one site only may have limited impact.	Outcomes from this action are long term.	Overall culture change is strong once broad adoption achieved.

3. LOW CARBON BUILDINGS

FINDINGS

The Municipality of San Borja's work to promote sustainability in its jurisdiction is progressive and impressive compared to many towns and cities located within APEC member economies.

The Municipality presently implements mandatory building regulations. However, mandatory regulations with particular focus on the design, construction and operation of low-carbon buildings for the residential, commercial and industrial sectors are not present. In particular, an economy-wide building energy code and other relevant codes are lacking in Peru. These codes should:

- mandate energy efficiency and conservation;
- provide guidance on the use of renewal energy sources;
- govern issuance of renewable energy certificates;
- provide standards on net metering;
- provides guidance on energy performance contracting; and
- mandate the use of building energy management systems is lacking in Peru.

Prevailing economy-wide and local building regulations focus primarily on safety and quality of buildings.

Currently, no level of government in Peru has a clear policy formally adopting the LEED green building rating system or any other green building standard or rating scheme. The use of LEED is still in the early stages and is largely ad hoc, in that sense voluntarily implementing green buildings is promoted by San Borja. Private sector interest in developing low carbon buildings is supported largely with the use of private green building rating systems such as LEED (USGBC, 2015).

According to San Borja officials, the Municipality has legislated an ordinance to promote green buildings for both new and existing buildings by providing density bonuses for green buildings. This measure is voluntary. However, developers noted that recognition of LEED's marketing value for the commercial sector remains main driver for its use. The residential sector perceives green buildings as an added cost and local information regarding green building benefits for the residential sector do not exist.

Around a hundred buildings in Peru are registered with Green Building Certification Institute (GBCI)[4]for LEED certification and buildings receiving full certification are still very low (USGBC, 2015). Recently, in San Borja, only four buildings received LEED Certification despite the density bonus incentive offered by the jurisdiction. A contributing factor to the property sector's low and slow acceptance of LEED may be attributed to the apparent incompatibility of LEED with current local building and environmental regulations and the perceived additional costs associated with green building certification.

San Borja is in the process of developing its own green building certification program. In addition, San Borja expressed its interest in seeking expertise, experience and insight of existing green building standards developers to support local green building tool development. At the same time, local officials are currently

[4] 'GBCI is the only group to administer project certifications and professional credentials and certificates within the framework of the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building Rating Systems.' For more information visit 'GBCI: Green Building Certification Institute,' n.d., http://www.gbci.org/

reviewing existing green building certification schemes and are considering its potential for applicability and appropriateness for adoption.

In general, procuring green materials is challenging. Building developers recognise the need for certified green materials to support current green building initiatives. Most green materials are imported and are perceived to be more expensive. Local green building materials is present in the local market; however, most developers find it challenging to find them. Green materials testing are not mandatory and certified green materials are highly perceived to be expensive. Similarly, services of competent building commissioning agents are very difficult to procure. Building commissioning agents are very much needed for evaluation and validation of performance of design, technologies and strategies. Developers often attribute the additional costs of green building on their reliance on foreign commissioning agents. In Peru and in most, if not all localities, including San Borja, building commissioning is not a requirement.

Most of the current efforts in reducing carbon emissions in buildings focus on active systems. There is a need to promote passive strategies. San Borja has embarked on a massive tree planting project as part of its passive cooling strategy. In particular, the tree planting project intends to reduce heat island effect and to provide shade in the community and improve walkability. However, considerable care is necessary when selecting tree species. Species currently selected may be requiring more water than local endemic species.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 15. Coordinate with relevant Peruvian and Regional Agencies about promoting low carbon buildings. ★★★

Policy issues and concerns such as the establishment of an economy-wide Building Energy Code and other relevant Codes that facilitates the reduction of carbon emissions are beyond the jurisdiction of San Borja. In particular, net metering and issuance of renewable energy certificates essential in stimulating the renewable energy market and in pursuing San Borja's low carbon town agenda is under purview of the Peruvian Government.

Establishment of bicycle parking or at a minimum bicycle racks at various strategic points will make the use of bicycles more compelling and meaningful in San Borja. Unfortunately, transport related policy issues such as bicycle parking at bus and train stops is a regional concern and is largely the responsibility of Metropolitan Lima.

It is highly recommended that San Borja proactively coordinate with the relevant Peruvian and Regional Agencies to address these issues. Experience regarding the introduction of local low carbon policy in San Borja may be shared with the above-mentioned agencies to positively influence their low carbon policy development agenda.

Rec. 16. Establish a San Borja Green Building Task Force under the 'LCT-Community Planning Council'. ★★★

Establish a San Borja Green Building Task Force that may serve as a coordination and consultative body among and between representatives of the private property sector and the Municipality of San Borja. In general, this task force can be the central source of collective expertise and insight on green property

issues present in San Borja. It should report to the 'LCT-Community Planning Council as referred to in section 1.

Specifically, this body may provide policy advice on the use of relevant standards, incentives and other pertinent recommendations that may help the Municipality develop a robust policy on promoting low carbon buildings. Further, through this body, San Borja can leverage other business-related experience on sustainable development.

Rec. 17. Develop a San Borja-centric sourcebook for green buildings. ★★

Although green building information may be available online, reliable data and information relevant to the San Borja market is lacking. Information regarding applicable standard[5],green materials and technology, building performance, costs and benefits of green building, and comparative analysis of conventional buildings vis-à-vis green buildings are needed to stimulate uptake of green building in San Borja. In addition, green building design strategies for building professionals should also be included. Preferably, the sourcebook should be available online.[6]

Rec. 18. Establish a Comprehensive Capability Program. ★★

A robust capability building program, for both the private and public sector is highly recommended. The foundation of a successful implementation of new policies requires well-informed building professionals and government personnel. Training programs can be forums to gather feedback from stakeholders as part of a continuous improvement. Such feedback allows government to fine tune relevant policies to achieve environmental targets.

Rec. 19. Work with the Ministry of Housing, Construction and Sanitation to establish a Mandatory Building Code for Lima. ★

The Municipality, and other municipalities should work with the Ministry of Housing, Construction and Sanitation to establish a mandatory policy on developing and implementing a Green Building Code, as it has regulatory power to enforce and establish a Green Building Code This Code should cover the design, construction and operation of buildings and focus particularly on local climatic conditions, culture and architecture. Key targets for performance should be set in the Code, which may include, maximum allowable consumption of energy and water; maximum allowable embodied energy on key building materials such as cement and steel; and minimum targets for use of on-site renewable energy. This code should zone districts and require different standards, depending on the capacity of that area to apply green building code standards. The Municipality should ensure that it is consistent with the design guidelines recommendations raised in section 2.

Other suggested and recommended policy directives for the proposed Green Building Code may include:

- **Mandate the services of commissioning agents for green building projects**. It will create a market for this service and would lower the cost of procuring said services. Commissioning agents are essential in validating the performance of green building projects in places like San Borja. In addition, their services are essential to performance contracting. Third party assessment is necessary when a performance contracting industry is being created. Commissioning agents

[5] Building and environmental standards both mandatory and voluntary currently used in Peru

[6]Visit this site as an example. ;EcoSpecifier,' n.d., http://www.ecospecifier.co.za/.

fully complements the work of San Borja in ensuring that it achieves its target for low carbon buildings.

- **Promote the use of Building Energy Management Systems (BEMS)** for both new and existing buildings. BEMS complements San Borja's goal of achieving sustainability in the municipality. BEMS allow building owners to monitor, control, evaluate and report energy use, which allows building owners make informed choices in managing energy use in buildings. Further, it complements mandatory disclosure requirements for energy use of San Borja decides to adopt a measure regarding this.
- **Promote use of passive systems over active systems.** There is an existing notion that low-carbon buildings are expensive, as it requires the mobilisation of cutting edge technologies. Efficient chillers, renewable energy technologies, LED lighting, articulated glare control and the like are very good technologies that allow reduction of energy use. It must be noted however that appropriate, traditional and indigenous technologies that are passive may also be utilised to achieve low carbon buildings. Peru enjoys a climate condition that supports thermal comfort. It is very much possible to achieve optimum levels of thermal comfort through passive strategies. Review traditional architectural strategies with particular focus on the building envelope. For example:
    - Ensure that operable windows are facing North with light shelves installed to reflect natural light into the building while reducing glare;
    - Avoid orienting building with longitudinal side facing North to reduce heat gain;
    - Install a brise soleil to reduce heat gain by deflecting sunlight; and
    - Hot days are easily addressed by promoting the 'stack effect' in buildings, which circulates air within the building by providing a window opening at opposite ends of the building and installing an operable transom at doorways.

Most passive technologies are traditional, low cost, appropriate and widely available, moreover, this Code should be complemented with a robust conformity assessment scheme and consultation to ensure proper implementation. Furthermore, this should fully complement existing building codes at-play in San Borja.

Rec. 20. Develop or adopt a voluntary green building rating certification system. ★

It is highly recommended that San Borja establish a voluntary policy regarding the use of a Green Building Rating Certification System (GBRCS) and provide incentives for high levels of environmental performance beyond mandatory building and environmental codes.

The use of a GBRCS allows property developers benchmark their projects against established and specific set of parameters or credits. These credits are holistic and address various negative environmental impacts.[7] Most, if not all GBRCS, promote adopting low-carbon building designs and strategies. Moreover, industry experts with full consultation with a wide multi-stakeholder base usually, more often than not, establish GBRCS.

When GBRCS is voluntary, it enhances private sector engagement. It facilitates industry-led and market-driven reduction of negative environmental impacts often associated with the property sector

[7] Specifically law, air and water pollution, carbon emissions, greenhouse gases and waste.

through friendly competition. Commonly, it is in countries with a large uptake of certified green buildings that companies continuously strive to pursue higher levels of building performance, in particular low carbon emissions to increase competitiveness.

It is highly recommended that San Borja's Municipality promote the use of a green building rating systems (GBRS) certification. GBRCS promotes a holistic approach to building design, construction and operation. Addressing negative environmental impacts such as land, air, water pollution, and climate change that are often associated with buildings are usually within frameworks of most GBRCS.

San Borja should decide whether to adopt an existing GBRS such as LEED,CASBEE[8] or BERDE,[9] or develop its own green building rating system. Moving forward, San Borja has to recognise the value of having a single nascent green building rating system.

Different GBRCS measure environmental performance differently. In the future, San Borja may find it difficult to monitor and evaluate the environmental performance of the building sector if several green building rating systems are used.

Adopting an existing scheme will enable San Borja to save time, money and effort associated with research and development of GBRCS. Because a conflict with existing building and environmental codes in Peru can exist, it is necessary to comprehensively review several GBRCS prior to adoption. In addition, should San Borja decide to pursue adoption of an existing scheme, local legislation may be needed to support its use.

Development of a local GBRCS for San Borja enables the Municipality to address specific environmental metrics that matter to the jurisdiction. Moreover, developing a San Borja-centric GBRCS ensures that it is appropriately aligned with local contexts that may include business and professional practice, codes and standards, and industry norms with local priorities. Finally, if San Borja adopts this path, a robust capability-building program for both government and industry is necessary to ensure efficient implementation.

Rec. 21. Establish a Comprehensive Incentives Scheme. ★

The current effort of providing density bonuses to certified green buildings is compelling financially to developers. In addition to this, if resources allow, San Borja may want to introduce tax breaks such as income tax holidays and real estate tax discounts. Capital grants and subsidies for renewal energy and energy efficiency technologies, subsidised loans and other forms of fiscal incentives are highly recommended. Moreover, San Borja may also want to introduce non-fiscal incentives to further promote uptake of green building. This may include expedited permitting for green building developers, and promotional activities for green building projects (Koeppel and Urge-Vorsatz, 2007).

Matrix 3.1: Low carbon buildings recommendations under an integrated framework

Low carbon buildings recommendations	Integral upper left quadrant - Psychology	Integral upper right quadrant - Behaviours	Integral lower right quadrant - Systems	Integral lower left quadrant - Cultures

[8]CASBEE is a tool for assessing and rating the environmental performance of buildings and built environment. For more information see Japan GreenBuild Council (JaGBC) and Japan Sustainable Building Consortium (JSBC), CASBEE: Comprehensive Assessment System for the Built Environment Efficiency, n.d., http://www.ibec.or.jp/CASBEE/english/.

[9] BERDE is developed by the Philippine Green Building Council (PHILGBC), and is used to measure, verify, and monitor the environmental performance of buildings that exceeds existing mandatory regulations and standards. http://berdeonline.org/development/.

15 ★★★ Coordinate between all levels of government			Enhances cross sector cooperation.	Regulatory and business cultures understand differences and coordinate across cultural perspective.
16 ★★★ San Borja Green Building Task Force		Helps to ensure optimal standards.	Whole of Lima common approach supports San Borja actions.	
17 ★★ San Borja green buildings source book		Lowers barriers for green building design.	Appropriate design for local climate conditions.	
18 ★★ Comprehensive Capability Program			A talent pool of skilled green professionals.	City culture of green innovation associated with buildings.
19 ★ Mandatory San Borja Green Building Code	Green building is often counterintuitive for some – people may believe everything is more expensive, in reality this is a mistaken view.	Standards, baselines and requirements to ensure performance.	Prioritises and emphasises lower cost change across all buildings (e.g. passive systems).	
20 ★ Voluntary green building rating certification system	Encourages leadership and excellence.	Base for strong performance and credibility of claims.		
21 ★ Comprehensive Incentives Scheme	Incentivises developers to build green.	Incentives encourage 'public good' outcomes overcoming perverse cost barriers.		

4. ENERGY MANAGEMENT

FINDINGS

In San Borja the primary energy source is electricity and it accounts for over 70% of energy use. Peru has one universal energy grid with interconnected transmission lines and in San Borja the power transmission line is publicly owned and the electricity is distributed by the private company on a very low tariff of $0.1046 per kWh for the residential sector, and $0.0146 for the commercial sector.

Due to future infrastructure development stemming from population growth and expansion of the Lima metropolitan area, electricity demand in Peru is likely to increase between 2012 and 2016 and there may be a short-term deficit before new supply capacity is fully online in Peru (BBVA, 2012). The Municipality needs to introduce various measures in the electric power sector in order to reduce GHG emissions from the residential. San Borja's Municipality does not have a Demand Response Program to improve energy efficiency and to save energy. The electricity price in Peru is very low and regulated by the central government (approximately USD 0.10 per kWh). For this reason, customers are not concerned with energy costs. Therefore, it is very difficult to attract customers to participate in a Demand Response Program.

San Borja's Municipality does not have an Energy Master Plan for developing and deploying renewable energy sources as well as introducing a CEMS. For the establishment of effective energy plan, the energy data collection and analysis is most important. San Borja's energy data collection is undertaken only every four years by investigation.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 22. Establish Energy Master Plan that adopts Low Carbon Measures (LCMs), including developing and deploying renewable energy sources and Community Energy Management System (CEMS). ★★★

In order to achieve the goals of LCP 2021, San Borja's Municipality has to establish a plan of supply to meet future energy demand with a minimum of GHG emissions. The Municipality should do this by:

- Forecasting a long-term energy demand by sources and by sectors based on exact consumption data at current level;
- Selecting technically affordable energy supply options to satisfy future energy demand; and
- Establishing energy supply and demand-side management plan based on the cost-effectiveness to minimise GHG emissions.

Rec. 23. Improve data and information collection in the energy sector and developing governance structure for energy management in the Municipality. ★★★

San Borja Municipality presently collects data on residential energy consumption every four years. Gathering exact data and its analysis are crucial pillars to make and implement policy measures effectively. Accordingly, data updates at shorter intervals of time is necessary to figure out the change of behaviour and build up the effective and efficient policy capability. Reducing the data collection period will help to catch residents' behaviour change rapidly.

Creating an energy department in Municipal Government will improve data quality and help with developing more practical policy measures. In addition, public officers, who are specialise in the energy sector, can manage energy data effectively and implement energy policy efficiently.

Rec. 24. Plan effective financial measures. ★★★

In order to implement Low Carbon Plan 2021 established by San Borja's Municipality, financial support from not only Lima City Government but Peruvian Central Government is required.

Rec. 25. Introduce and implement a Demand Response (DR) Program with an incentive system in cooperation with electric power companies. ★★

As electricity demand in San Borja increases due to economic growth, DR Programs will be important. DR Program will contribute to reduce energy consumption especially during peak hours and periods.

These programs can run in conjunction with those proposed in Section 5 and could include:

- Promoting energy efficient equipment deployment, including labelling scheme and Minimum Energy Performance Standards (MEPS).

- Developing a financial incentive scheme to support replacement of old and inefficient energy appliances and equipment.
- Improving public awareness on energy efficiency by focusing on training and building competitive industry and business.

Example: Jointly, California and energy companies implemented an Energy Demand Response Program. This program aims to reduce the energy demand during times of peak demand. Pacific Gas and Electric Company is one of the energy providers in California, and has special programs for small businesses, one of them is the Smart AC Program, focused on air conditioning systems during the summer. To be enrolled in this program the small businesses need to implement a smart device to regulate the use of the energy flowing to the AC system. This is important considering that San Borja is a commercial and residential district with a high income level and it is expected that the demand for AC systems in the country will increase around 10%

Box 4.1: Example of Demand Response Program from the USA

Sources: PGE, 2015 and MEM, 2015.

Rec. 26. Introduce the concept of Energy Service Company (ESCO) to implement DR Programs effectively. ★★

ESCOs are commercial or non-profit businesses that provide a broad range of energy solutions, including energy saving project design, energy savings project implementation, retrofitting, energy conservation, energy infrastructure outsourcing, power generation, energy supply, and risk management. San Borja's Municipality should consider introducing ESCOs in cooperation with the Central Government because of the limits of the local government's regulatory power.

Example: The Chilean Association of ESCO (ANESCO) companies was created in 2013. ANESCO looks to promote the development of ESCO's as a main actor under the new energy policy. In that sense, the ANESCO has promoted the Development Bureau, with representatives of The Chilean Energy Efficiency Agency, the Centre for Renewables Energies, Inter-American Development Bank, German Cooperation

Box 4.2: Example of ESCOs in Chile

Source: ANESCO, 2015.

Rec. 27. Review electricity pricing system to distribute economic resources efficiently at the central government level. ★

While the price of electricity is low, consumers will not attempt to reduce power consumption. Therefore, the tariff system reflecting real energy consumption, such as Time-of-Use Pricing (TOU), Real-time Pricing (RTP), should be considered to effectively operate Community Energy Management System (CEMS). The Peruvian Government should look into considering a reform of the electricity tariff system regarding economic resource allocation throughout the economy.

Rec. 28. Consider micro-grid as a long-term low carbon measure. ★

Micro-grid is not yet commercialised and huge amount of investment is required to construct it. San Borja's Municipality should maintain interest in and conduct research on the introduction of a micro-grid as a long-term method to satisfy energy demand in the future.

Example: The rural community of Huatacondo in Chile has a small smart grid that provides energy for the town. As it is describe by the project website 'the smart micro-grid includes 150 kW diesel generator, 22 kW tracking solar PV system, a 3 kW wind turbine, a 170 kWh battery, and an energy management system. The energy management system provides online set-points for generation units while minimising operating

Box 4.3: Example of microgrids in Chile

Source: Microgrids, 2015.

Matrix 4.1: Energy management recommendations under an integrated framework

Energy management recommendations	Integral upper left quadrant - Psychology	Integral upper right quadrant - Behaviours	Integral lower right quadrant - Systems	Integral lower left quadrant - Cultures
22 ★★★ Energy Master Plan that adopts Low Carbon Measures (LCMs),			Whole of city prioritisation of EE.	
23 ★★★ Improve data, information collection and energy governance in the Municipality.		Ensures evidence base exists for strong effective policy.	Base data for good whole of city decision making.	
24 ★★★ Plan effective financial measures.			A priority for all world governments and international institutions (not just Peru).	
25 ★★ Demand Response (DR) Program with an incentive system.		Helps to remove perverse pricing signals.	Can assist to lower barriers to electricity pricing reform.	Assists a culture shift to understand the value of power and sources of it.
26 ★★ Introduce the concept of Energy Service Company (ESCO).		Skilled assistance available and affordable.		
27 ★ Review electricity pricing system.	Strong leadership advocacy required from many individuals across all sectors.		Fast change can be driven through economy wide price signals.	Whole of city/economy expectations and political imperatives need to be considered.

28 ★ Consider micro-grid as a long-term low carbon measure.	People and businesses often have great desire and motivation around energy independence and self-sufficiency.	Distributed and localised generation rapidly becoming economically attractive.	Disruptive innovation can change the whole system quickly.	

5. ENERGY EFFICIENCY AND RENEWABLES

FINDINGS

San Borja's Municipality is committed to implementing a full-scale program to achieve Low Carbon Town status, which includes a genuine concern and ambition to increase energy efficiency in all areas of San Borja's life, including modernising utility networks. A greater focus on energy efficiency is one of the main solutions to the energy challenges facing San Borja, as well as a way of boosting its economic development and competitiveness in Lima. The Municipality of San Borja recognises the need to facilitate emerging projects that will lead to increased energy efficiency across sectors, including public, residential and commercial buildings, transport and launch appropriate education and awareness raising programs. The Municipality wants to convince local businesses that energy efficiency will not only benefit them by saving money on energy but also put them ahead of the curve as San Borja's Municipality seeks to limit the impacts of industry on the environment. The Municipality has a similar position to the development of renewable energy sources, including waste-to-energy processing and higher level of solid waste recycling wherever possible.

The Municipality of San Borja is trying to develop various financing schemes to implement energy efficiency and renewable energy resources development projects and is keen to support public private partnership collaboration. It has the right to adjust local regulations for creating certain market incentives and by doing this can encourage the launch of new commercial projects while staying in line with the state government laws. San Borja does not receive any subsidies from the Peruvian Government and from the City of Lima. However, San Borja is considering providing subsidies to local companies. In some cases, the government supports projects by providing special permissions or contributes financial help of up to 10% from the total project cost.

The Municipality recognises it is necessary to develop technical capacity building and training programs for professionals in the field of energy efficiency and renewable. Awareness rising campaigns on energy efficiency among adult residents to encourage responsible consumption of resources and products and among children to raise a future responsible citizen from an early age take place already.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 29. Create an Energy Efficiency (EE) agency or centre responsible for energy efficiency and renewable energy programs. ★★★

San Borja's Municipality should create an Energy Efficiency (EE) agency or centre responsible for energy efficiency, and coordinate financing energy efficiency projects in all sectors and developing renewable energy resources similar to the General Directorate of Energy Efficiency (GDEE).

Alternatively, San Borja could establish a Working Group on Energy Efficiency that would coordinate and oversee EE activities.

The Centre could also work as an Energy Service Company, as referred to in Section 4, and assist implementing environmentally friendly energy solutions. The Centre should develop its model Energy Performance Contracting experience to demonstrate it to other companies, using energy saving measures as important tools toward preventing fiscal deficits. The Centre should support the Municipality to prepare tenders for energy performance contracting including carrying out initial diagnoses, tender procedures, evaluation and negotiation, and verification. It should also develop technical and economic details of the projects, and conclude contracts with the municipal entities.

The Centre should develop the most suitable model together with the commercial company-partner by conducting a sample energy audit in some selected municipal pilot sites to assess savings potential. For example, the audit can evaluate to what extent improving distribution losses efficiency will result in potential reductions in resource consumption. The Centre can then extrapolate, compare with agreed benchmark data, develop short-, medium- and long-term targets, and prioritise sectors based on economic benefits, savings potential and ease of implementation.

The findings will reveal typical energy saving activities, which would be possible to replicate for various types of buildings in San Borja. The Centre can then compile the findings into a report as a working reference document. The report will also list major challenges of developing energy audits in San Borja, such as, the lack of trained energy saving specialists at the Municipality or at single company levels, insufficient regulatory and methodological support or insufficient numbers of energy audit specialists.

The most probable barriers to ESCO development in San Borja are the:

- Lack of planning/organisation/management/control mechanisms required for the ESCO market;
- Lack of data and information for consumers;
- Limited understanding of the provision of energy services; and
- Lack of incentives for the private sector to take on the responsibility and commercial risks and launch an ESCO project.

The report should also contain a list of ESCO tasks, among them:

- Developing viable monitoring technologies;
- Establishing an energy consumption and analytical accounting system that applies modern information technologies in the utility organisation, ensuring maximum reliability of data transfers; and
- Developing opportunities for attracting large investments.

The pilot projects should help identify correct and realistic targets setting leading to an improved use of municipal resources and providing data for the annual municipal budget planning. The list of assessment indicators to ensure that public sector facilities are used efficiently may consist of the following indicators and groups of indicators:

- Unit cost of utility services supply per $1m^2$;
- Consumption volume of water and energy resources in the given entity

- Unit cost of energy resource consumption per 1 m^2;
- Unit cost of water consumption per one utility services customer in the given entity;
- Unit costs for the implementation of measures to improve efficiency of utility resources consumption per 1 m^2;
- Classify implementation target level of basic management decisions leading to the efficient use of utility resources in:
  - public sector facilities;
  - commercial sector facilities;
  - industrial sector facilities; and
  - The residential sector.

Rec. 30. San Borja should create an Office of Utilities to be responsible for the water, electricity and gas sectors and coordinate their work with the EE agency. ★★★

To maintain high progress in energy efficiency improvements San Borja should announce a 'Go Energy Efficiency' campaign that uses aggressive policies to realise energy efficiency potential in San Borja. The Energy Efficiency Centre (see Recommendation 29)should be a Public-Private Partnership project and report to the Municipality or a dedicated department like the Office of EE within the municipality. The Centre's business areas will include:

- consulting on all aspects of efficient energy use;
- international know-how transfer; and
- contracting.

The Municipality should also create an Office of Utilities, which works closely with the EE Centre and carries out responsibilities for:

- Developing and monitoring the implementation of the 'Municipal Perspective Energy Plan';
- Defining a unified technical policy in gas, electricity and water sector in order to reduce maintenance costs and apply compatible or the same type of equipment;
- Developing standards and regulations for services in utilities supply sector and the municipal procedure for their control and monitoring;
- Developing and implementing the program of metering equipment installation;
- Implementing activities under the program of energy conservation; and
- Identifying and tracking of limits on energy consumption in the public sector and organising for energy conservation activities in these areas.

Forming a stable long-term municipal energy plan involves:

- Forecasting economic development of the city, including long-term balance of power electricity and water supplies;
- Developing long-term spatial balances for individual resources (heat for industries, gas, liquid and solid fuel electricity, water, etc.;

- Reviewing real level of losses in the water and electricity networks;
- Defining basic set of technical solutions within a unified technical policy of municipality
- Setting targets, standards of reliability and efficiency of the owned by the municipality infrastructure and problems for enterprises of heat, water and gas supply;
- Developing promising industrial and investment program in industrial heat, water, electricity and gas;
- Introducing new schemes for charging (billing) and developing operating rules and billing of energy service companies to facilitate the growth of ESCO sector.

Rec. 31. Develop and implement a San Borja Master Plan for Energy Efficiency. Set up a process for annual reviews of the energy efficiency targets in the Master Plan and involve all sectors as part of the plan to increase targets over time, create a scheme of incentives, such as, proposing appropriate subsidies. ★★★

San Borja's Municipality should develop a strategic long-term municipal Energy Efficiency (EE) improvement program/ Master Plan that includes:

- a list of target indicators in the field of EE improvements;
- a list of EE measures and deadlines for implementing these measures including appropriate funding from the private sector without relying on the municipal budget resources.

The Master Plan should provide clarifications regarding calculation of these target indicators, include groups of target indicators used for preparing municipal programs, and give examples of EE indicator calculations. There could be two approaches for the developing municipal EE programs.

The first method deals with the developing basic principles while allowing flexibility in detailed implementation. The second method involves prescriptive EE measures and activities. The prescriptive approach requires a more detailed data and selection criteria to effectively implement and monitor the program. For example, calculating a target for EE indicators for each facility and for the program involves collecting information about facilities (projects) for the Municipal Information Energy Saving data collection system and EE Improvement System; and establishing the municipal system for monitoring target EE parameters that takes into account requirements with regard to data transfer to the main data collection system.

However, the prescriptive approach has its drawbacks, particularly the lack of complete information on energy resources and water consumption. Major operational subjects for the EE program could include:

- Data collection and processing, and the typical data constraints;
- Establishing baseline EE indicators;
- Setting EE targets;
- Energy audits;
- Analytical tools identifying EE actions and conduct their economic and financial analysis;
- Integration of energy efficiency and savings in long-term planning;
- Monitoring systems; and

- EE statistics and information systems.

While evaluating the effectiveness of municipal organisations and agencies it is necessary to assess the effective use of municipal resources for their managed assets, as well as for residential and industrial sectors in San Borja. The discussion with main stakeholders around an effective San Borja energy efficiency improvement program should include:

- Energy management and monitoring in public buildings and subsequently in residential and commercial sectors;
- Financing of energy efficiency activities;
- Remaining barriers and issues; and
- Public procurement of energy distribution and EE services involving ESCO business and energy saving performance contracts: potential models suitable for San Borja and issues.

Reducing energy costs creates fiscal space for socioeconomic investments in the municipality. However, realising these gains in the public sector requires overcoming many barriers, including incentives, financing, budgeting, and procurement. There are advantages of using energy savings performance contracts (ESPCs) in the public sector for implementing energy efficiency projects. If possible, various locations and industry specific ESCO and ESPC models should be offered, along with approaches to promoting ESPCs in the public sector, and alternative financing mechanisms to support ESPCs. The Municipality should work in close contact and even better together with the private sector (potential ESCO businesses) to reveal and summarise specific barriers to ESPCs in San Borja, understand where energy saving could be made on each step of ESCO contract implementation and develop options to address them and incentives for the ESCO business sector growth. Ideally, this cooperation should lead to a menu of several ESPCs contracts.

Rec. 32. Enforce all businesses and organisations in San Borja to create their own energy efficiency program with annual targets, which are reported agency/centre. ★★

The Municipality should require all commercial and non-commercial entities in San Borja to increase energy efficiency and reach certain levels of savings of utility resources, including:

- Decreasing specific energy consumption per square metre; and
- Installing a target number of metering equipment and developing a target plan for works.

Rec. 33. Support ESCO companies to create an economic environment for utilities to provide energy efficiency services to the people and businesses.★★

San Borja's Municipality can meet several methodological problems related to evaluating the cost-effectiveness of energy efficiency investments and availability of additional effects (ancillary benefits). Capital investments will lead to not only energy efficiency improvements, but also address other problems. For example, improve energy supply reliability through the replacement of worn-out energy equipment, and energy efficiency improvements may be a side effect. If this is the case, capital investments in energy efficiency can be regarded as incremental costs, if more efficient equipment is more expensive; reduction of distribution losses and of production costs in the fuel and energy sector is one of additional side-effects of end use energy efficiency improvements; many energy efficiency projects generate savings of several energy resources and water. Therefore, capital investments can be part to overall energy efficiency effect, and account for water savings in the cost savings.

It will help if all organisations in the Municipality submit their energy plan to form a collective 'Perspective Municipal Energy Plan in the approved form, for example, every four years.

Improving the budget planning system can lead to energy efficiency and resource savings increases though:

- Introducing the practice of inviting professional (including private) organisations (energy service companies/ ESCO) to ensure the maintenance of buildings on the basis of performance contracts;
- Introducing a system when appropriate changes in the municipal Budget Code and other municipal regulations create an opportunity to carry out improvements in the San Borja utility network by the private ESCO companies. Agree on the energy service contracts with a payback within a specified period of time from savings generated on utility bills;
- Putting in place procedures allowing public organisations and commercial ESCO companies to enter into contracts for a period of several years, within which the accounting and agreed distribution of the budgetary savings takes place on a sustainable basis.
- Introducing contracting ESCO companies for the delivery of services to public sector organisations of comfort services provision or maintenance of power supply systems, water and gas supply systems, or services related to the property maintenance, subject to guarantee savings under such contract in comparison with the traditional methods of utility bills payments;
- Ensure strict cost reduction under such contracts, compared with the expenses of the public organisations for utilities and all direct and indirect costs for the property maintenance of the budget organisations; and
- Forwarding resulting savings from the public sector to increase wages of the public organisations employees, for example

Rec. 34. Ensure appropriate amendments to the municipal management law and amendments to the Budget Code allowing private ESCO companies to enter into long-term contracts for the provision of energy services. ★★

To summarise, such services include:

- Contracting out to provide comfort services;
- Contracting out utilities networks' engineering and technical maintenance services provision, including energy, water and gas; and
- Contracting out general property maintenance.

Under conditions of any of such contracts, public organisations do not pay utility bills. The ESCOs provide these payments in the framework of its agreement with the resource supplier.

It is necessary to make the contractors interested and incentivised in long-term sustainable income, rather than making quick earnings. When they perform a refurbishment or network modernisation project, they should also sign a maintenance contract for several years with incentives for continuous improvement and innovation and damages if the job is done on a poor standard.ESCOs must understand the asset, business strategy, and client's requirements, how the property is fit for purpose now and going forward, available cash flow and capital, pressures, legislation, regulation,

demand and many more variables. Understanding the asset is important - there are many claims from big and small organisations that they can solve the large non-domestic asset efficiency problem - the client must be convinced that the ESCO has addressed the issue in a holistic way and therefore effectively. ESCOs should review the estate, business needs, aspirations, capital availability, cash flow (op-ex and cap-ex), new and existing working practices, introduction of IT and a number of other areas before starting major refurbishment programs with incentives for continuous improvement.

Rec. 35. Establish funding mechanism to support EE programs and initiatives. ★

Be creative in finding ways for new public-private partnership (PPP) projects initiation. For example, instead of exercising the currently existing practice where the Municipality contributes to about 10% of project cost, provide with smaller amounts to initiate feasibility study subsidies for the businesses willing to implement energy efficiency or renewables development projects. Encourage businesses to make a pool of projects linked to each other and apply together for international banks funding.

Rec. 36. Create a scheme of municipal guarantees for private sector applying for the commercial loans to support energy efficiency projects and encourage collaboration across industries for pulling projects together.★

Rec. 37. Create a scheme of competition for local subsidies. ★

Rec. 38. Create incentives for commercial companies to develop in-house or industrial continuous professional development (CPD) training programs on EE and RES development for the employees. ★

The programs should provide effective training related to technical, financial and economic fields and inform about the benefits of EE increase and facilitate launch of new projects in energy efficiency and development of renewables.

Rec. 39. Create municipal education programs for residents to encourage responsible energy consumption; incorporate energy efficiency subjects in education materials in primary, secondary schools and higher education. ★

San Borja's Municipality should contribute financially to energy efficiency education programs, which could be titled 'Energy Efficient San Borja'.

San Borja needs a broad, collaborative and holistic approach that includes both the local government and all other stakeholders to run an effective energy efficiency education program for San Borja residents and increase their interest in the renewable energy generation. A San Borja 'Go Energy Efficiency' campaign financed as a public-private partnership project and local companies' sponsorships or with an international grant should include a continuous education program that lasts several years and applies to all s of population and all sectors. Behaviour change should be a priority. Where savings are significant, they should be publicised to the community.

Education program should explain that additional energy efficiency often comes at no cost, or at a very low incremental capital cost. It should include:

- Analysing new buildings under construction in San Borja and show to what extend erection of more efficient buildings imply any additional costs or do not; it is possible that higher costs are determined by other factors, such as the number of floors, building geometry and orientation, the costs of materials, labour costs, etc.;

- Making new refrigerators and many other appliances available in the San Borja retail market, so there are no additional costs for higher energy efficiency and additional energy efficiency is a 'free lunch' for motivated customers: promote this message;
- Installing automatic process control systems, which allows manufacturing production to increase with a simultaneous reduction of energy consumption: promote this message;
- Investing in efficient lighting costs electricity saving versus residential electricity price in case utility tariffs go up;
- Educating that energy efficiency improvement projects can generate significant positive environmental effects and lead to GHG emission reductions; and
- Introducing a waste recycling education program in schools.

Rec. 40. Create rebates and incentives for residents to install solar and utilise efficient equipment. ★

San Borja's Municipality suffers from a worn electricity network and the transmission losses associated with it. It could invite a private company into a partnership and run a PPP pilot project to apply local generation (installing PV on several municipal buildings rooftops and accumulate energy in storage batteries) and feedback into grid. Distances in such micro- grid are small; the associated losses also get lower. An intelligent analytics system is required to monitor the energy footprint of local communities. Installation should be gradual throughout the whole municipality starting with the pilot projects. An analytics system coupled with a micro-grid can help to understand consumption pattern and build an energy efficient system in the district of municipal buildings and later in the area of residential houses. There is a wide residential area of wealthy housing in San Borja. Some house owners might be convinced by the Municipality to take part (by putting financial contribution) in a similar multi-houses pilot project to demonstrate the financial benefits of saving costs on tariff payments. If the pilot is successful it could then spread renewable energy resources throughout the community. Additionally, if there is a clear financial benefit, then installing new underground power transmission lines dedicated for the micro-grids could be done by the private companies.

Matrix 5.1: Energy management recommendations under an integrated framework

Energy efficiency and renewable recommendations	Integral upper left quadrant - Psychology	Integral upper right quadrant - Behaviours	Integral lower right quadrant - Systems	Integral lower left quadrant - Cultures
29 ★★★ and 30 ★★★ Create an Energy Efficiency (EE) agency and an Office of Utilities.		Coordination can reduce waste and duplication.	Overview of whole of city.	
31 ★★★ San Borja Master Plan for Energy Efficiency.		Ensures evidence base exists for strong effective policy.	Base data for good whole of city decision making.	
32 ★★ Businesses and organisations create energy efficiency program.		Business benefit through EE profits; appropriate support to implement change can be accessed.	Establishes a competitive advantage for whole of city.	
33 ★★ and 34 ★★ Support ESCO		Skilled assistance available and	Supports and attracts innovative businesses.	

companies and long-term ESCO contracts.		affordable.		
35 ★, 36 ★ and 37 ★ Create and support EE programs, through the competition for local subsidies		Business benefit through EE profits; appropriate support to implement change can be accessed.	Establishes a competitive advantage for whole of city.	
38 ★ training programs on EE and RES.		Training matches employee and business needs.		
39 ★ EE education.	Residents often have great desire and motivation around sustainability.	Overcomes barriers to action with education.		Can be highly effective for supporting a broad culture shift valuing low carbon living.
40 ★ Rebates and incentives to install solar and utilise efficient equipment.			A priority for all world governments and international institutions (not just Peru).	

6. TRANSPORT

FINDINGS

Gasoline and diesel prices remain relatively cheap. So in San Borja, as in most other cities, light duty vehicles (cars and vans) continue to dominate the number of passenger and freight delivery journeys. Peak traffic loads occur regularly, particularly at key places where traffic congestion regularly occurs. Emissions of greenhouse gases (GHGs) from vehicles are responsible for around one third of total GHG emissions from the municipality.

In San Borja, non-motorised 'active travel' (where cycling and walking modes are chosen for a journey to a specific destination such as to work, school, or the shops) can be ideal due to local conditions with virtually no rainfall, little wind and flat terrain. The green spaces that have been constructed within the municipality to give it ambience, also encourage cycling and walking for leisure activities and exercise.

The public bus 'Combi' and taxi services (Figure 6.1) are privately owned and can only be better regulated and managed if the Municipality works in close association with Lima City authorities.

Figure 6.1: Combi buses used throughout Lima City

Source: Policy Review to San Borja, 2015.

The Metropolitan BRT links to Lima's CBD (and also goes further north to Rimac or south to Surco). Itis relatively fast and cheap (~USD 4 return fare compared with taking a car costing around USD 20-25 for the same trip plus any parking charges). However, connections to the nearest station by bus, taxi, car, cycle or walking are not well organised and hence a deterrent to using the BRT by local residents (Figure 6.2).

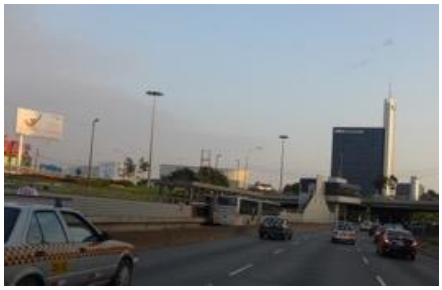



Figure 6.2: The Metropolitan BRT bus and stations on one of Lima's main arterial roads.

Source: Policy Review to San Borja, 2015.

Similarly, the MetroLima light rail transit has good potential but is limited due to the number and locations of destinations until the network is further expanded.

Moving freight into and out of the municipality and distributing goods to shops and businesses occurs mainly by road transport. Some retailers of fast-food products use tricycles to move around and find customers which is commendable and provides a useful service to residents. In suburbs where safety can be an issue, police and security personnel using cycles to patrol local neighbourhoods is an excellent concept (Figure 6.3).

Figure 6.3 Ice cream vendor's tricycle and San Borja police officer on patrol.


Source: Policy Review to San Borja, 2015.

The 'San Borja en bici' initiative (Figure 6.4) is highly commendable and demonstrates leadership throughout Peru. It aims to provide greater short trip mobility for residents who sign up to use the cycles for no charge. The scheme is in the process of further development with an aim to extend the opening hours from the present 7am to 7pm and to link it with neighbouring communities in order to expand the cycling network. Visitors are not actively encouraged to borrow the cycles at present and it requires prior notification. However, this would enable them to explore the district and could be encouraged by having some cycles for informal short-term rental activities.

Figure 6.4: 'San Borja en bici' logo and cycle stand.

Source: Policy Review to San Borja, 2015.

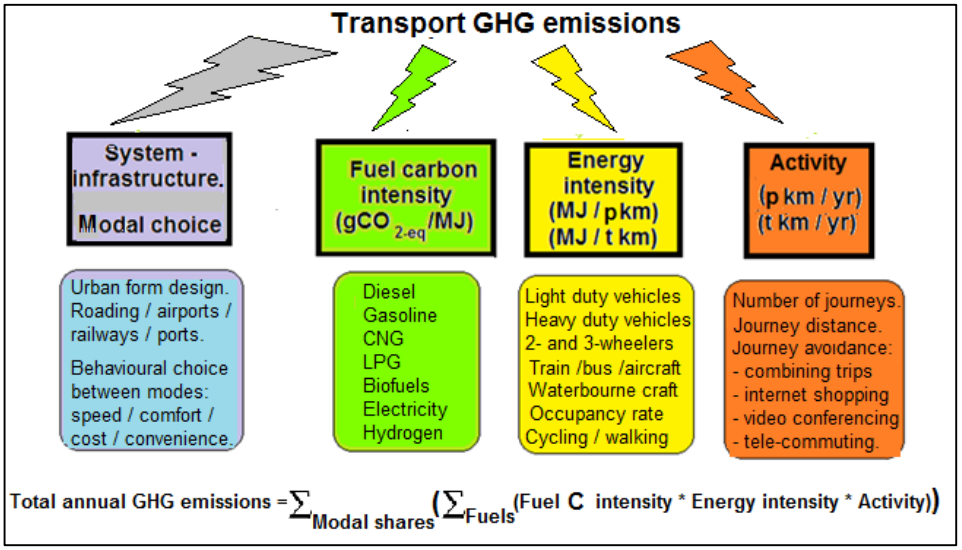
Demand for passenger transport and freight movement will grow everywhere in the world. Therefore, having a vision for what this growing demand might look like in 2030 and beyond is imperative when developing a transport plan today. Urban planning and investing transport infrastructure now will lock-in transport modes of choice for the next few decades.

An efficient passenger transport system involves moving people expediently between residential suburbs and their work places, between hotels and tourist attractions, to neighbouring suburbs and the Lima City Centre, and around the local communities, as well as having well-designed logistics for the movements of goods and materials between ports, manufacturers and consumers.

San Borja can achieve transport GHG emissions reductions in several ways (Figure 6.5) including the following.

- Infrastructure development and urban planning to encourage shorter journeys; cycling and walking; the use of low-carbon mass transit systems, including dedicated bus lanes; bus rapid transit (BRT) and light rail; and avoiding traffic congestion in various ways such as introducing congestion charges; time-of-road-use charges; provision of public transit etc.;
- Encouraging a shift to lower carbon transport modes, including the non-motorised, 'active travel' options of walking and cycling, and, where feasible, changing freight movements from road to rail or to coastal shipping;
- Using lower carbon-intensity fuels (gCO_2/MJ) such as biofuels, hydrogen and electricity, but this is only effective when these energy carriers are produced from low-carbon sources;
- Selecting and operating vehicles and engines with relatively low energy intensity (MJ/passenger km or MJ/tonne-km) as achieved by design and material improvements by the manufacturers;
- Eco-driving to gain improved fuel consumption for a vehicle journey (and lowering I/100km); and
- Reducing the number and length of journeys (total p-km/yr and t-km/yr).

Figure 6.5: GHG emissions reductions from the transport sector through adopting policies and actions relating to system infrastructure investment, modal choice, fuel selection, vehicle and engine design, and influencing



journey activities.

Source: Sims, R. E. H., et al., 2014.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 41. Consider providing a Municipality operated 'ring-road' bus every 10-15 minutes in both directions. ★★★

Without regulations in place for private buses, improving the local bus service is difficult, if not impossible. Liaising with the City of Lima to encourage improved regulations such as imposing bus licenses and operating rules is unlikely to be possible or to be meet with success.

Encouraging people to move away from using cars to lower-carbon modes of travel will require improving the balance between cost, convenience, comfort, speed and safety. In this regard, linking bus routes and timetables better with the BRT and MetroLima light rail routes, including coordinating arrival and departure times to ease connections for passengers, would be a good step forward. Such an integration of modes would also enable passengers to benefit from the purchase of a single ticket per journey regardless of mode of travel – or even an all-day ticket pass. Passengers would also benefit if bus stops electronically provide real-time GPS data for projecting and communicating bus arrival times at each bus stop. However, such changes would demand full co-operation of the bus companies and this is not possible to achieve for the Municipality.

San Borja's Municipality could explore operating its own buses for the benefit of residents. Analysis could focus on operating a bus service around an inner 'ring-road' route (Figure 6.6) running on suitable urban roads, in walking distance for many residents to access, and linking with key destinations such as shopping centres, light-rail stations and schools. The 'ring-road' could extend further to cross into the cultural area of the district depending on potential demand and ease of crossing the main highway.

Figure 6.6: An indicative route for a Municipality owned and operated community bus service within San Borja district to link a majority of dwellings with key destinations such as shops, schools and light-rail stations.

Note, possible links or diversions to the cultural area to the north are not shown but would need to be considered.

Due to the nature of many of the urban roads,small mini-buses could be more suitable than standard 40-50 seat buses. Ideally they would be scheduled to arrive at a stop every 10-15 minutes to encourage their use and avoid the need for a fixed timetable. Whether the service would be provided free, or relatively low fares charged, would need a cost-benefit analysis to be undertaken. The number of buses needed would depend on the demand and could also vary during the day to match peak travel demands. As demand grows, more buses could be added.

Given that Peru generates around 60% of electricity from renewable energy sources, the use of electric buses for this service should also be considered. Examples exist in other cities such as Seoul, South Korea, where free electric buses are available for selected journeys such as from the city centre to the top of Namsung Park. The typical range of an electric bus is currently between re-charging is around 120-150 km, although this is increasing with improved batteries and the potential for induction charging whilst at a bus stop.

Example: In Adelaide, Australia, the 'Tindo' solar electric bus has been operating for several years on a circular route around the city centre and covers around 150 km per day. The bus depot recharges the Tindo at night from the electricity grid, but this is offset during the day with the equivalent amount of power being produced from solar PV panels on the roof of the bus depot and exported to the grid. Therefore, it can genuinely claim to be a zero-carbon transport mode, (even though the Australian electricity grid is only around 13% renewable electricity with the balance mainly from coal-fired power plants).

Example 6.1: Adelaide, Australia's solar electric bus.

Source: Tindo, 2013.

Example: Malaysia, under the National Electric Mobility Blueprint, also promotes the use of electric vehicles (EV) through 55 electric buses and an EV sharing program for public transport, 30 EV chargers and infrastructure roadmaps and 400 E-Scooters courier and food delivery services such as KFC and Pizza Hut. It aims to have 2000 electric buses for city public transport, bus rapid transport and last mile connection for the Mass Rapid Transport by 2020.

Example 6.2: Malaysia promoting electric buses.

Source: GTM, 2015.

Although there are several manufacturers of electric buses around the world that could supply vehicles to San Borja's Municipality, only a few manufacturers offer 14 to 25 seaters (Alibaba, 2015).

A locally operated bus service in San Borja, should ideally integrate with cycles through cycle racks attached to the buses or having secure cycle parks at each bus stop to enable convenient mixed mode journeys for local residents. Where a bus stop location is close to a 'San Borja en bici' station, cycle parks would still be needed for private cyclists (Figure 6.7).

Figure 6.7: Example of the cycle racks on buses in Canberra, Australia, and cycle parking areas for privately owned bikes.

Source: Transport ACT, 2015.

Rec. 42. Give support to privately owned bicycle users, while maintaining the 'San Borja en bici' program. ★★★

The cycle paths provided throughout San Borja are a credit to the Municipality and are reasonably well used, both by users of the 'San Borja en bici' scheme as well as by cyclists using their own bicycles.

Improving the separation of cyclists and cars in places, can be achieved either by greater use of the black and yellow poles used in some parts or by introducing judder strips of small rubber discs glued to the road surface that warn the car driver when s/he is too close by making a loud noise when the car tyres ride over them (right hand photo, Figure 6.8). The two-way cycle track shown below (left photo Figure 6.8) is an obvious place where they would be effective, the cyclists heading away from the camera being in a precarious position so close to the fast moving cars, buses and trucks with only a painted yellow line as the barrier.

There are also places on the existing cycle track where greater priorities for cyclists would make it safer and more pleasant for riders. For example, in several places around the cycling route, a two-way cycle track suddenly turns into a one-way track leaving cyclists travelling against the traffic flow with nowhere safe to go. In such places cyclists sharing the pavement with walkers and runners could be considered since there is often room for both (right photo, Figure 6.8).

Figure 6.8: Examples of differentiated bicycle lanes


Source: Policy Review to San Borja, 2015.

Greater priority for cyclists at many intersections is another way to improve safe bicycle use. To make a major modal shift from cars to cycles successfully entails making it more difficult and costly, in both time and money, for car drivers and faster, cheaper and more convenient for the cyclists. Managing traffic flows with higher priority for cyclists as well as pedestrians encourages the shift (Figure 6.9).

Figure 6.9: Examples of prioritising bicycles at intersections, including priority traffic lights and intersection demarcations, and turning lanes.


Source: Policy Review to San Borja, 2015.

Plans to construct new cycle ways along Aviacion Avenue need careful consideration. With the light rail structure in the centre of the road, it is not be practical given the number of intersections and the difficulty of providing crossing for cyclists. Perhaps pedestrian footpaths would work better along this green strip. Major re-planning of the current road layout will be necessary so opportunities exist to provide numerous cycle parks next to the light rail stations, and to include possible electric vehicle recharging points – at least for electric scooters if not for electric cars.

The Policy Review Team observed few facilities for securely parking cycles outside of shops and public buildings or at bus stops and rail stations. There are a few parking places available, such as outside of the San Borja's Municipality offices and close to the salsa dancing arena, but consideration should be given to building more (Figure 6.10).

Figure 6.10: Examples of secure bicycle parking facilities.


Source: Policy Review to San Borja, 2015.

In the medium-term, San Borja's Municipality should consider extending the operation hours that of the 'San Borja en bici', as it is currently restricted between 7am and 7pm when the staff are at the hire stations. However, this would probably involve partially automating the hire system, as is common elsewhere in the world, and also the need to add lights to some cycles for night-timeuse[10].

San Borja's Municipality should also support local cycle dealers and retail shops to encourage more cycle purchases and use. It was somewhat ironic to see several 'San Borja en bici' cycle stations advertising new cars, including high fuel consuming SUVs, which seemed to defeat the purpose of aiming for a low-carbon transport future (Figure 6.11).

[10] Cycles lights are improving all the time – for example see http://www.springwise.com/device-adds-100-smart-features-bike/ but for hire bikes they would need to be secured to avoid getting stolen.

Figure 6.11: Examples of existing advertising of SUVs at the San Borja en bici rental areas (left and centre), and proposed new advertising (right).

Source: Policy Review to San Borja, 2015.

Rec. 43. Improve understandings and awareness of low-carbon mobility systems by residents through educational programs and road signs. ★★

Educating all road users is necessary when cars, trucks, cycles and pedestrians all use the same road. Schools could be encouraged to teach cycling and traffic skills, possibly having a number of small cycles for the children to learn to ride in the school playgrounds. Where safe to do so, schools could also support cycling to school by the children as well as walking.

Finally it is strongly recommended that a large number of reminder signs should be placed at key locations along the roads within the San Borja'sMunicipality (Figure 6.12).

Figure 6.12: Example road signs reminding users to share the road.

Rec. 44. Assess mobility improvements for residents in the future given that new low-carbon technologies are developing rapidly, such as the use of IT to plan journeys, and the advent of electric vehicles. ★

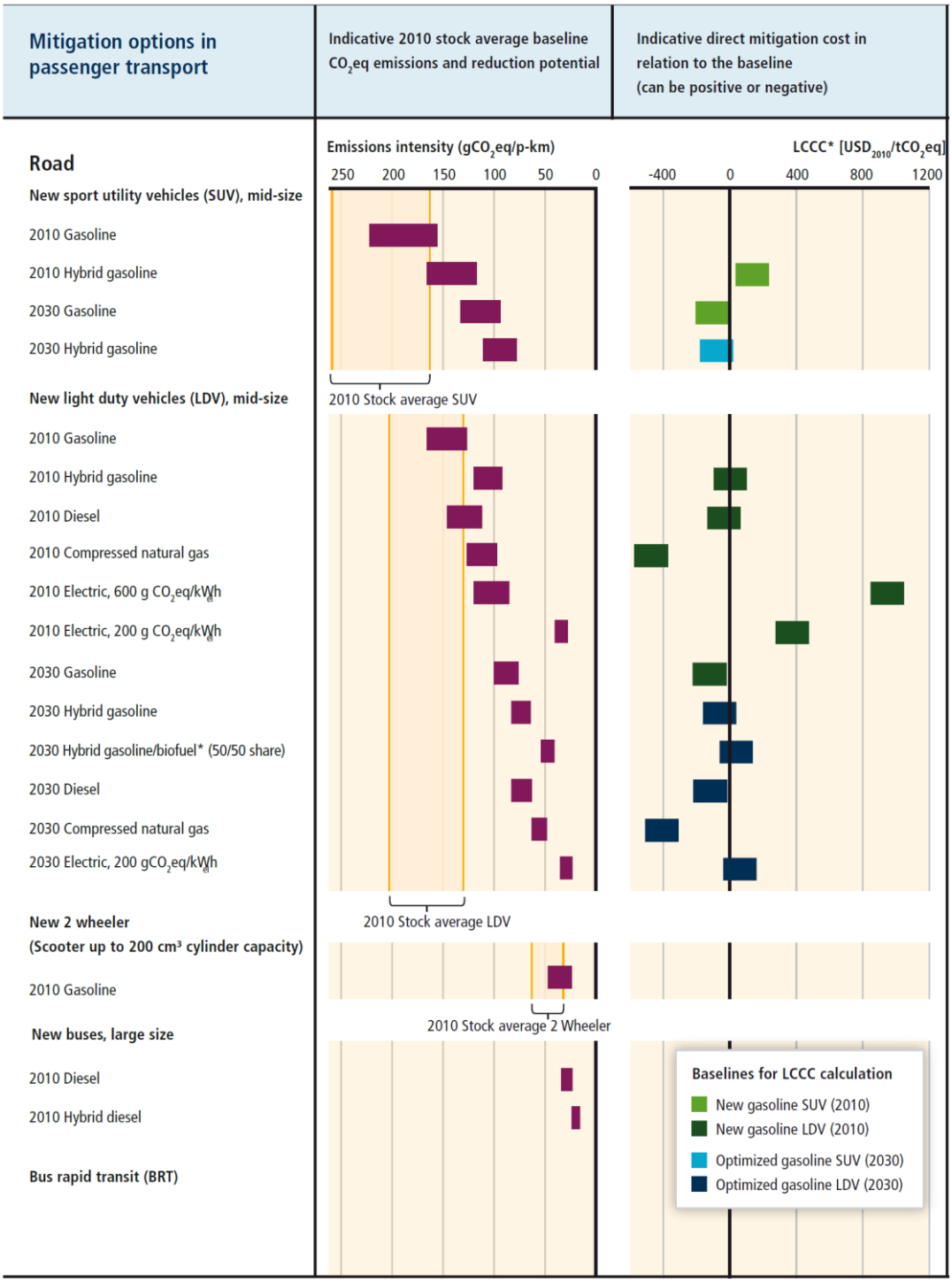
Vehicle technology is advancing rapidly and electric cars, electric motorbikes and pedal-assist cycles are becoming common. Improved battery designs have aided this trend. Given the relatively low GHG emission factor for Peru due to the high share of renewable electricity in the generation mix (Brander et.al, 2011), the deployment of more electric vehicles will provide low-carbon transport. These include electric cars, including plug-in hybrids, motorbikes, cycles, including the front wheel driven 'Yike bike' that also folds up for carrying on a bus (www.yikebike.com), and pedal-assist electric cycles, including covered designs.

The trend towards electric vehicles could be encouraged in San Borja by providing public recharging points for vehicles. These have been made available in many cities over the past decade, such as Wellington, London and Berlin where community car ownership is common), often at no cost for the electricity and with free parking available.

Recent analysis by the IPCC (Sims, et al., 2014) assessed the GHG emissions for road, marine and aviation transport from the average existing vehicle fleet, a new vehicle design as sold in 2010, and future expectations for vehicle developments by 2030; selected examples of electric vehicles as shown in Figure 6.13. For conventional light duty vehicle vehicles and SUVs (sports utility vehicles) fuelled by gasoline or diesel as commonly used in San Borja, the GHG emissions per passenger kilometre are relatively high compared with travel by buses, two wheeler motorbikes and trains (not shown). Electric cars are currently an expensive option to reduce carbon emissions but their purchase costs continue to decline whilst performance efficiency increases. So certainly by 2030, and probably well before, where the electricity emission factor is around 200g CO2/ MWh generated as in Peru, electric vehicles will become a viable low-carbon option.

There is evidence that many cities have now passed the 'peak car' stage and vehicle kilometres travelled each year by light duty vehicles are starting to decline (Green and Naughton, 2014). Hence the aim for San Borja, and indeed for Lima City, should be to follow this trend and encourage citizens to move out of their conventional cars (and discourage the use of taxis) to other transport modes wherever feasible. If everyone simply moved from gasoline cars to electric cars, the GHG emissions would reduce but the traffic congestion problems would show no improvement. So improving the speed, cost, convenience and comfort of public transport systems is also essential as well as investing in infrastructure to support more active travel and improve safety.

Figure 6.13: Selected CO_2 mitigation potential for various road transport modes with baselines of stock average vehicle fleets compared with new vehicle designs in 2010 and projected vehicle designs in 2030 based on available data.



Source: Sims R E H et al., 2014.

Matrix 6.1: Transport recommendations under an integrated framework

Transport recommendations	Integral upper left quadrant - Psychology	Integral upper right quadrant - Behaviours	Integral lower right quadrant - Systems	Integral lower left quadrant - Cultures
41 ★★★ Municipality local bus system.		Addresses difficulties and barriers for individuals.	Visible and useful for many in San Borja.	Supports a paradigm shift from private car use.

42 ★★★ Promote the use of owned private bicycles and 'San Borja en bici' program.	Passionate leadership is strongly supportive of bicycles.		Visible infrastructure creating safe effective transport options.	Helps establish cycling as a cultural 'norm'.
43 ★★ Improve understandings and awareness of low-carbon mobility systems.		Lowers barriers to change and reduces personal risks.	Visible evidence of priority placed on alternative transport.	Helps establish cycling as a cultural 'norm'.
44 ★ Assess mobility improvements for residents in the future.		Makes public transport use easier for many people.		Helps to establish an overall cultural expectation for transport systems of the future.

7. ENVIRONMENTAL PLANNING

FINDINGS

San Borja has a strong commitment to improving the quality of life of its citizens through implementing environmental planning policies. The Municipality's policies focus on: solid waste management, water reuse and supply management and urban greening. The solid waste management and sustainability plans are a shared obligation between authorities and citizens. The collection of waste by the Municipality has not affected the beauty of the city as the solid waste receptacles are largely underground (see Figure 7.1). As shown in Figure 7.1, the majority of the bin is underground hidden from view, a magnetic crane then lifts the whole bin and the waste releases from the bottom into the garbage truck.The Municipality of San Borja is expecting to increase solid waste from 26 000 metric tons in 2014 to 28 000 metric tons in 2021, in that sense they are considering the acquisition of new underground containers to reach the future demands.

Figure 7.1: San Borja solid waste bins.

Source: Policy Review to San Borja, 2015.

The water reuse plan focuses on public parks irrigation, reducing irrigation in parks, urban forests and urban greenery. There are two new water treatment facilitates that use treated water for public irrigation.In urban greening, San Borja's Municipality is introducing the use of native species as well as Australian eucalypti. The

Municipality has an agreement with the Army Headquarters to use part of its installations as a nursery to mature saplings for the district.

RECOMMENDATIONS

★★★ Recommendation for immediate action; ★★ Recommendation for action in next 2-3 years; ★ Recommendation for action in the longer term.

Rec. 45. Reduce water usage and increase the diversity of uses within the park network.★★★

San Borja residents enjoy and use the park network. However, the Municipality should consider sustainable water practices and water efficient landscapes as its current irrigation techniques are very water intensive. These lower water intensive parks should also include greater diversity of facilities and range of planting and different surfaces to increase park usage. Different types of passive and active recreation could be included into the parks as well as different planting and structural elements.

The parks network could include experimental gardens (small botanic garden) of plants that are appropriate in San Borja for different uses e.g. roof gardens, fruit trees, street trees, green walls etc. In this way, the San Borja residents can see what is possible and what will grow in the area. In New Zealand, Auckland Council's has a Parks Hub on the Auckland Design Manual website that could provide a number of ideas and guidance on park design within San Borja.

In addition, San Borja should consider working with the universities to promote the design of parks and public open space; as an example would be for San Borja to help promote the first landscape architecture course in Peru Universities.

Rec. 46. Make sustainability easy.★★★

Wherever there is an existing or new street bin, a recycling option should be available. This helps to both promote when considering the cost of putting recycling in everywhere – no street bin without a second recycling option.

Rec. 47. a) The government needs to expand the waste recycling program and b) introduce a system of solid recyclable waste separation by households. This program should be a part of the San Borja energy efficiency and renewable energy generation program.★★

Currently only 29% of households separate their waste into combustible/landfill waste, paper waste, plastic waste and aluminium waste. The 'Segregation at the Source' program is a voluntary program, where registrants have to deliver their separated recyclables to a collection point/truck. By introducing a waste separation household and accompanying bins for each household, the Municipality will have a better source of waste for a waste to energy program and be able to recycle waste into other products. This could even extend to composting at industrial composting facilities for residential and commercial organic waste. The program could be voluntary or mandatory depending on its structure and enforcement mechanisms.

The Policy Review Team visited a plastics to fabrics and materials recycling plant neighbouring San Borja. If San Borja separated its plastics then it could distribute them to the plant, which is only a short distance away. Any program would need to be accompanied with an educational program and

appropriate infrastructure and bins. It could start in the schools, where the students teach their parents.

Example: In Singapore, the government set targets for recycling, to reach 44% in 2002, 60% by 2012 and 70% by 2030. In 2014 Singapore was recycling 60% of its waste. 38% is disposed at an incineration waste-to-energy plant and only 2% is disposed at landfill. Singapore provides recycling bags and bins for residents to use at the homes or complexes, and the recyclables are collected fortnightly. Although it is a voluntary program, as all residents are educated on how to use it and are provided with the necessary equipment, 60% of people use it. The program is divided into home, school and work streams and the equipment and education methods are tailored to each stream. It employs the commonly used 'Reduce, Reuse, Recycle'

Box 7.1: Example of waste recycling program in Singapore

Source: NEA, 2015.

Rec. 48. Introduce a municipal legislation aimed at substantially reducing landfill.★★

Reducing waste generation is a shared responsibility between municipal government and San Borja stakeholders (residents, businesses, enterprises and other organisations). This legislation needs to assign rights and duties in the community to reduce waste generation and at the same time create incentives to reduce, reuse and dispose of waste. On the other hand and as a complement, this law need to promote the use of products and services that reduce waste generation.

Rec. 49. Create incentives for the private sector to take on the responsibility of waste segregation, waste repurposing, and waste-to-energy processing.★

As San Borja's Municipality does not want to manage dedicated transfer stations for waste, the municipal legislation should include incentives for the private sector to take on the responsibility of waste segregation, waste repurposing, and waste-to-energy processing, applying PPP mechanisms to attract financing to implement projects related to the processing of solid waste. If possible, the Municipality should introduce modified tariffs and conditions for trading processed products, which would provide preferences for operators. The disproportion between the profitability of waste collection (about 30% on average) and waste sorting (1-12%) should be addressed in the legislation. In many ways, this explains the small number of PPP projects in the field of recycling.

Rec. 50. Create rebates and incentives for the businesses to launch public private partnership projects in the field of renewable energy sources generation.★

If created, the San Borja Energy Efficiency Centre referred to in Section 5, could think about the optimal models of public private partnership (PPP) for waste management. Concession schemes could be beneficial for private investment in solid waste treatment as well as what types of state or municipal guarantees or tariff system, which might ensure return on investment for processing municipal solid waste. The Municipality should consider including all sides of integrated waste management, including collection, transport, treatment and disposal.

The Municipality has an advantage of knowing the exact volume of waste produced annually and its growth projection based on the existing method of waste collection in San Borja. This is helpful if the

government wants to set up a waste-to-energy production facility and seeks an investment for it, as investors will want to know about the potential production.

Example: Following on from Box 7.1, in Singapore, the government contracts out its waste collection on 7 year contracts through a transparent contract tender and bidding process. The infrastructure includes waste-to-energy plants, and contracted waste collectors must use those facilities and pay the relevant fees and waybills. Depending on the type of contract, they are licensed to handle a certain type of waste, and the recycling or waste-to-energy method changes depending on the type. Waste collectors must be licensed

Box 7.2: Example of private waste to renewable energy collection system in Singapore

Source: NEA, 2015.

Matrix 7.1: Environmental planning recommendations under an integrated framework

Environmental planning recommendations	Integral upper left quadrant - Psychology	Integral upper right quadrant - Behaviours	Integral lower right quadrant - Systems	Integral lower left quadrant - Cultures
45 ★★★ Reduce and optimise water usage.		Cost benefits.		Grows community care and engagement with San Borja's parks.
46 ★★★ Make sustainability easy.	Demonstrates leadership and care for residents wellbeing.	Lowers barriers to change.	Visible city wide initiatives can support other less obvious measures (such as power and energy efficiency).	Helps establish sustainability and low carbon cultural 'norms'.
47 ★★Creation of a waste recycling program and promote solid recyclable waste separation by households.	Waste and recycling strongly associated with valuing the environment.	Effective solutions required to encourage mass public participation.		Recycling can very quickly become a cultural norm.
48 ★★Introduce a municipal legislation aimed at substantially reducing landfill.		Cost effective policy when carefully designed.	Policy to support whole of system change.	
49 ★ Promote waste segregation, waste repurposing, and waste-to-energy processing by privates		Careful community consultation is required to avoid poor decision making and inappropriate development.	Rigorously apply a waste hierarchy which prioritises the avoidance of waste over downcycling (e.g. reuse over waste to energy).	
50 ★ Promote public private partnership in renewable energy sources generation.		Strong incentives and careful design ensure equity and access for all.	Outside investment may support the development of appropriate city wide solutions.	

APPENDIX A: MEMBERS OF THE LCMT POLICY REVIEW TEAM

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APPENDIX C: REFERENCES

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