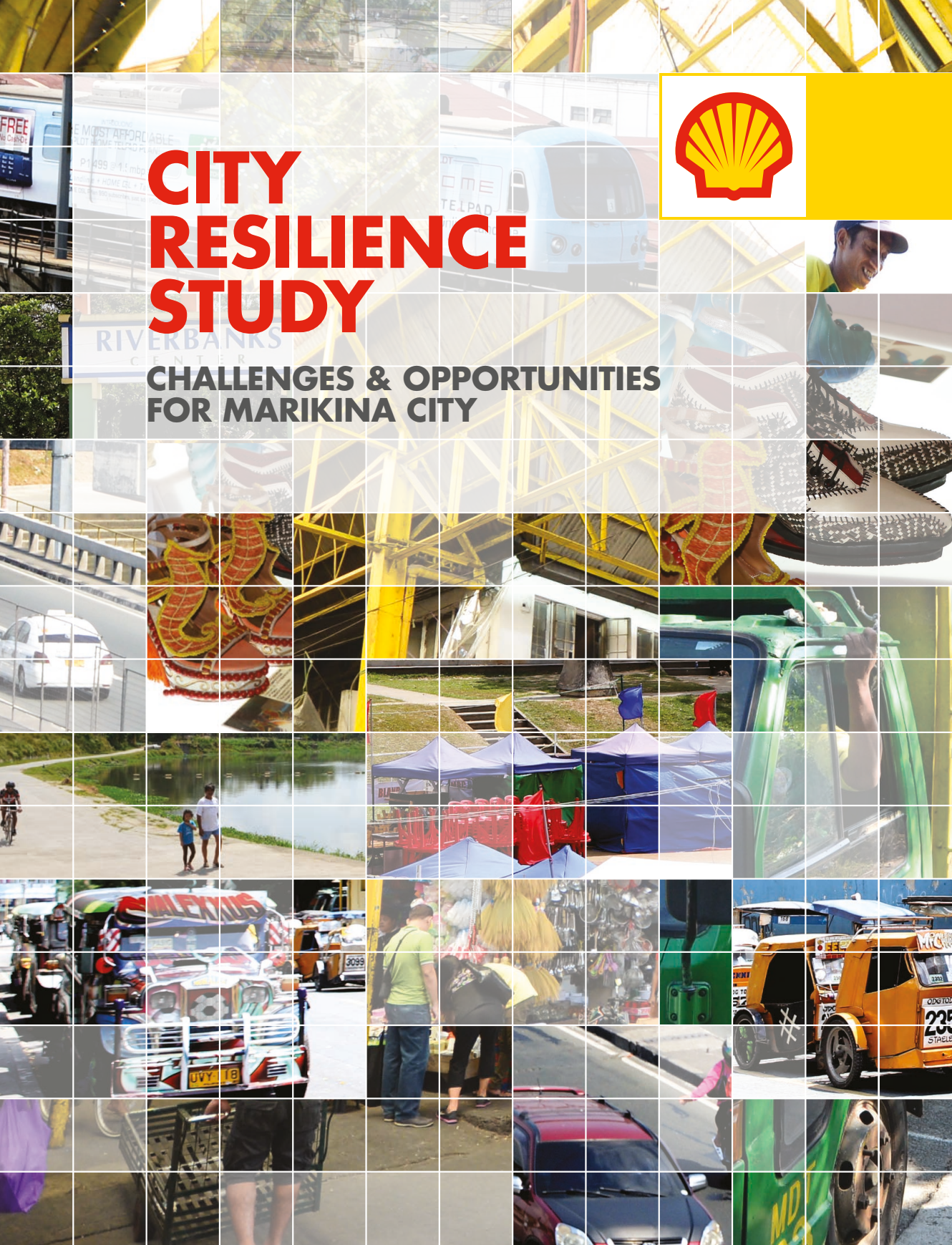
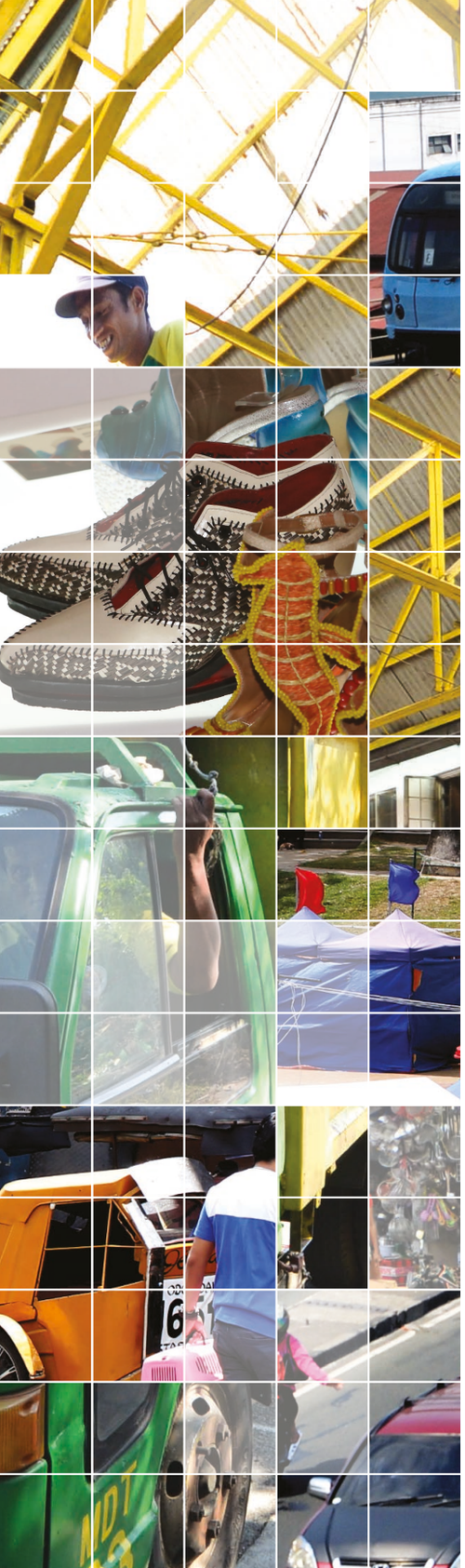


CITY RESILIENCE STUDY

CHALLENGES & OPPORTUNITIES FOR MARIKINA CITY



CONTENTS

APPROACH & LIST OF PARTNERS

This study is co-created together with Marikina City. The approach to this study has been to engage and collaborate, with the objective of understanding the challenges the city faces as a result of urbanisation.

To understand how Marikina City sees the future, a diverse set of facilitated meetings was held with key stakeholders in the city such as mayor Del Reyes De Guzman, representatives of the Metropolitan Manila Development Authority (MMDA), the European Chamber of Commerce of the Philippines (ECCP), the League of Cities of the Philippines (LCP) and various NGOs such as Clean Air Asia. This study would not have been possible without the input of several private parties including Wärtsilä Corporation, Meralco, Royal Dahlman and One Renewable Energy Inc.

WE ARE GRATEFUL TO ALL OUR PARTNERS IN THIS STUDY, ESPECIALLY:

PARTNER	FUNCTION/AFFILIATION
Del Reyes De Guzman	Mayor, Marikina City
Francis N. Tolentino	Chairman, MMDA
Third Espero	Program Officer for Special Projects, LCP
Willie Reyes	Executive Assistant of the Mayor of Marikina City
Veronica Hitsosis	Head, Policy and Legislation Unit, LCP
Jasmin Runez	Events Manager, ECCP
Gerry Constantino	Vice President for Operations, ECCP
Nonoy Alba	Business Consultancy and Research Manager, ECCP
Alvin Mejia	Clean Air Asia
Chee Anne Roño	Clean Air Asia
Mark Tacderas	Clean Air Asia
Rey Montoya	Shell Retail Dealer, Marikina City
Josefina Faulan	Head, Policy and Legislation Unit, MMDA
Dr Chris Diaz	Assistant Professor, School of Urban and Regional Planning, University of the Philippines

PREFACE
MAYOR DEL R. DE GUZMAN

On behalf of my constituents, I would like to express my gratitude for the honour of having Marikina as the subject of this City Study. It has been a pleasure to collaborate with Shell, and its partners – the League of Cities of the Philippines, the European Chamber of Commerce of the Philippines, the Metro Manila Development Authority, Clean Air Asia, and others – in pursuit of this project.

Filipinos are known around the world for their sense of patriotism – doing what is right and good for the country. It is no wonder that the Philippines is replete with non-governmental associations and private companies who go out of their comfort zone to help contribute to community and nation building. Our city is fortunate to experience such meaningful partnerships.

As you will learn from this report, Marikina City is confronted with myriad challenges attendant to urbanisation, but, nevertheless, we are cognisant of the many opportunities that our city can explore and pursue.

"WITH THE HELP OF SHELL AND ITS PARTNERS, WE ARE ABLE TO FINE TUNE OUR PLANS FOR THE FUTURE OF OUR CITY."

We understand that there is much to do in advancing our city's sustainable development. This will be the subject of more detailed studies involving more companies and stakeholders, so that we can better understand and plan our future.

Mabuhay ang Marikina!

DEL R. DE GUZMAN
Mayor, Marikina City

PREFACE
SHELL COUNTRY CHAIR ED CHUA

From the moment Shell first opened its doors in the Philippines in 1914, we have always done all we can to help empower Filipinos everywhere. Our drive for innovation and contribution to nation-building has constantly guided us in our first 100 years and will remain with us as we look towards the next century in our company's history.

" THE WORK IN THIS REPORT REFLECTS THE SIGNIFICANCE SHELL PLACES ON WORKING WITH LOCAL COMMUNITIES TO HELP TACKLE THEIR CHALLENGES, PARTICULARLY IN FAST-GROWING CITIES LIKE MARIKINA."

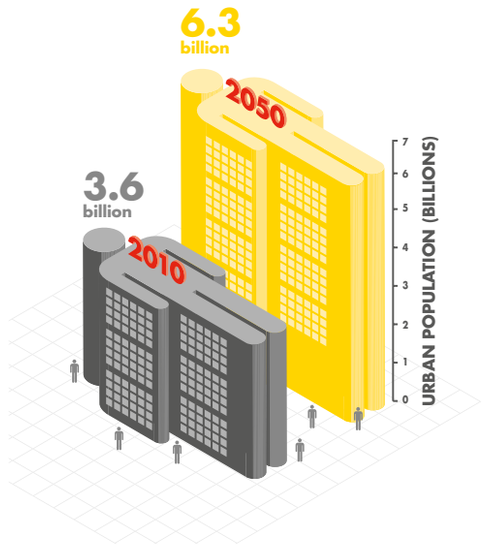
It has been an honour to work with Mayor Del Guzman and his team in developing this study, which was a genuinely interactive and collaborative approach to identifying key resilience issues and ways to tackle them.

We also appreciate the strong engagement and support we have received from a wide range of local stakeholders including the Metro Manila Development Authority and the European Chambers of Commerce throughout this work.

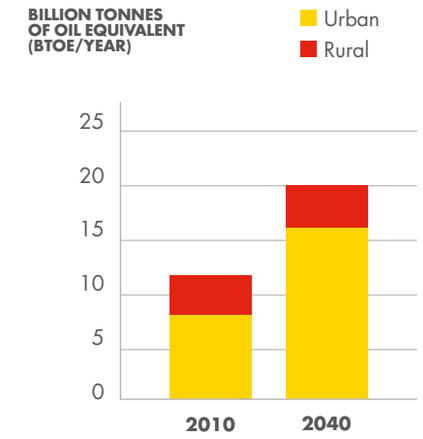
The issues and ideas in this report are very much a joint effort and we have learnt much from the achievements and aspirations of the people of Marikina. We hope that this study provides a modest contribution to the considerations of Mayor Del Guzman as he works to ensure a positive and sustainable future for his city. ■

ED CHUA
Shell Philippines Country Chair

GLOBAL URBAN POPULATION GROWTH

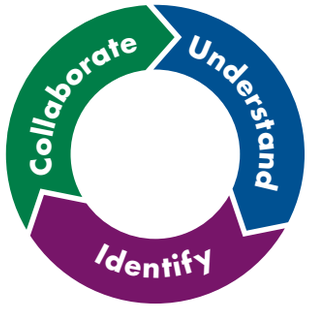


WORLD ENERGY CONSUMPTION



WHERE WILL THESE EXTRA 2.7 BILLION PEOPLE COME FROM?

THE THREE STEP CO-CREATION PROCESS USED IN THIS STUDY



Step 1 – Understand
The first set of workshops, aimed at understanding the type of the city: demographics, population.

Step 2 – Identify
The second set of engagements, aimed at identifying key constraints and concerns, as well as aspirations of the city.

Step 3 – Collaborate
Collaborating using both global expertise and local knowledge, a set of options is created that can help the city to tackle the challenges it faces.

INTRODUCTION TO CITY RESILIENCE STUDY

"THE 21ST CENTURY IS THE ERA OF CITIES"

Rapid urbanisation is one of the most significant dynamics affecting the world. Today, about half of the world's seven billion inhabitants live in cities. This will rise to approximately 75% by 2050 as the urban population grows from 7 to 9 billion. Shell estimates that by 2040, almost 80% of global energy will be consumed in cities. Urbanisation is also a key dynamic for the future of Asia, as almost 50% of urbanisation is occurring there. Asia will continue to be the global economic powerhouse in the decades to come.

Cities are places of opportunities and challenges. They are the engines of economic growth as well as being cultural, historical hubs and centres of social mobility. City growth is also accompanied by increased demand for natural resources, such as energy, water and food. As a result there will be greater pressures on current infrastructure and supply systems as well as increased societal and political challenges. To be a resilient, liveable and prosperous city of the future, municipal services will need to be planned carefully using resources in an efficient and sustainable way. Urban design and planning will be essential to our future well-being. However, what that might look like is very different for every city. It depends on the current state of the city, its history and its different challenges and aspirations.

In recent years, Shell has explored urbanisation with a number of partners to understand the implications and opportunities for the inhabitants and governments of cities. Our first insights were published in the 'New Lenses on Future Cities'*. To further deepen our understanding of the patterns of urban growth and develop our thinking into potential options for sustainable development Shell has been working with a number of major cities to understand their challenges and opportunities and collaborate in helping to identify potential solutions.

Marikina City, as part of Metro Manila, is one the first of the cities we have worked with and this selection reflects Shell's long history and commitment to the Philippines. We appreciate the commitment of the Mayor Del Guzman of Marikina City, the Metro Manila Development Authority (MMDA), the League of Cities of the Philippines (LCP), and the European Chamber of Commerce of the Philippines (ECCP) and various NGOs such as Clean Air Asia who agreed to work with Shell on this project.

The study has been co-created with these and other stakeholders using a three-step process explained on the previous page to Understand, Identify and Collaborate. This report reflects the output from our collaborative work and aims to give the city authorities a set of options to improve the resilience, liveability and economic potential of the city. The report could not have been written without keeping the city's vision and values in mind: "A City of *distinction* where *leaders* are made, citizens are *godly*, performance is *competitive*, work is done at *its best*, nurtured in a *healthy environment*". We hope that this report provides positive ideas that will help the Marikina City authorities as they plan and navigate the future development of their city. To develop these ideas further more detailed analysis and study would be necessary to assess their economic, technical and commercial feasibility. ■

*You can find the 'New Lenses on Future Cities' at **www.shell.com/scenarios**

INTRODUCTION TO MARIKINA CITY BY THE MAYOR'S OFFICE

Marikina City has long been considered a model city and has become a hub for study tours (lakbay-aral), with a steady stream of delegations from other LGUs visiting to see for themselves and learn how it does things.

Mayor Del R. de Guzman, its 20th Local Chief Executive, is an advocate of pro-people policies and reforms, reflected in his electoral platform *"Tunay na Kaunlaran, Tao Naman"*. Programmes and projects that address key concerns under his *7K Vision: – karunungan* (education) *kapayapaan at kaayusan* (peace and order), *kalusugan* (health), *kabuhayan* (livelihood), *katiyakan sa pabahay* (housing) and *kapaligiran* (environment) – are vigorously pursued.

The city has fully recovered from the Ondoy tragedy but the perennial threat of flooding remains. As such, the city puts a premium on adequate disaster-preparedness and continuing resilience to the detrimental effects of climate change. Since nature cannot be controlled, people might as well be more adaptive to its whims.

A collaborative effort was initiated between and among adjacent cities and municipalities similarly situated and exposed to the same hazards along the Marikina-Pasig River System including those from the Marikina Valley Fault System, thus forming the Alliance of Seven. This has paved the way for the sharing of good practices in reducing and mitigating the impact of climate change and disaster risks. One of the more prominent activities of the Alliance of Seven is continuing tree planting at the Marikina watershed where the DENR designated to the city a huge tract of land for that purpose. From the original 20 hectares previously allotted, another 200 hectares were added. With the support of partners, the planting of saplings of hardwood species, Robusta coffee and seedlings of various varieties of trees in the area is being carried out in several waves. As envisioned, a total of more or less 100,000 trees will have to be planted, and so the entire effort is still a work in progress.

These collaborative efforts have been significantly expanded into a Metro Manila-Rizal LGU Network comprising 13 cities and municipalities with areas of engagement on early warning systems, communication network and response resource mobilisation.

In anticipation of what might happen should the "Big One" occur, the city is on its toes pursuing enhanced earthquake-preparedness. An updated Comprehensive Land Use Plan (CLUP) which is disaster risk reduction management-climate change adaptation (DRRM-CCA) responsive is now in effect. Protocols for a Rapid Earthquake Damage Assessment (REDAS) to estimate earthquake impact and efforts to develop and simulate hazard maps in relation to the Marikina Valley Fault System traversing their jurisdiction have been undertaken. It is quite providential that geo-hazard maps are now available in scales that are more detailed. Even as strict adherence to the provision of the Building Code is observed, as a pre-emptive measure, the city is conducting a sustained infrastructure audit of public buildings

as well as private ones in consultation with the Philippine Institute of Civil Engineers and the Association of Structural Engineers of the Philippines. In time, scanners will be acquired to more accurately detect structural defects requiring retrofitting of buildings and other infrastructures

In sum, the city has always been proactive in enhancing capabilities to address the challenges posed by two major natural hazards – river flooding and the long-overdue movement of the Marikina Valley Fault System that could trigger a 7.2 (or higher) magnitude earthquake, to ensure a safer and a more disaster-resilient Marikina.

With the goal of creating a more dynamic, liveable and prosperous city, access to clean, renewable and sustainable energy sources such as solar power is at the top of the city's development agenda. Anticipating a fast-growing demand for energy arising from the pressures of urbanisation, the city is determined to likewise achieve power-resiliency. This is a challenge that will require partnering with entities with a similar frame of mind and the technological capability to help bring this goal to fruition.

The city has made available a new and updated *Marikina Citizens' Charter*. This compact publication is a sleek and handy guide containing a wide array of information such as vital facts about our city, its history, achievements, governance agenda, development goals, range of services offered as well as pertinent steps and procedures that are useful in transacting business with city authorities, departments, agencies and instrumentalities. This is yet another proof of commitment towards transparency, accountability and disclosure of relevant information to constituents. Through this publication, the people's fundamental right to know and be informed of the basic workings of the city government is well served.

Now in his second term, Mayor Del R. de Guzman has pledged unwavering commitment to continually serve the people in a most meaningful and responsive way. ■

MARIKINA CITY CHARACTERISTICS

Marikina City is one of the 16 cities that make up Metro Manila, the National Capital Region (NCR) of the Philippines.

Metro Manila is the seat of government and the most populous region and metropolitan area of the country. The NCR has a large population (ca. 11.85 million in the 2010 census) which has approximately doubled in size since 1980 and is now the fifth most populous urban area in the world.[1,2] It has a growing GDP/capita (5.5%, last 5 year average), and according to Forbes it is the #4 densest Megacity in the world (ca.15,000 people/km^2).[3,4]

MAP OF METRO MANILA

Although the areas of the NCR have different challenges and aspirations for the future, there are some similarities. They compete for commercial investment and growth. Urbanisation and a rising population create pressure on employment, energy supply and transportation systems, which is reflected in the perceptions of the city's inhabitants (Table 1). Furthermore, all cities in Metro Manila are exposed to risks of natural events such as earthquakes, typhoons and flooding.

Marikina City is often referred to as "A Little Singapore". It is a vibrant community where the citizens have a strong pride in their community and concern for the welfare of all.[5] Marikina City is one of the smaller and less densely populated cities of Metro Manila. It covers ca. 25 km^2, and has approximately 450,000 inhabitants and 98,000 households, while in recent years its population growth has been limited (ca. 1%).[6] In 2012 it had an average income per capita of ₱1,000, which is below that of its neighbours Pasig City and Quezon City, and places it in the lower 20% of income per capita among cities in Metro Manila.[6] However, these income levels have been increasing in recent decades.[6]

Marikina is a suburban city and is a dormitory for some of its larger neighbours. Most of the land use is for residential housing, though this percentage has dropped in recent years (51% in 1981 to 37% in 2014).[6] In terms of economy, Marikina City is known as the 'Shoe capital of the Philippines', producing approximately 70% of the shoes made in the country.[7] The industry faces increased competition from countries such China. In 2005, imported shoes from China made up 80% of local supply.[7] Today, the city administration is taking steps to support the re-emergence of the

industry and create new jobs in the sector. Other key manufacturing industries include tobacco and defence equipment. There is also an increasing number of commercial activities in the city, such as cafes and restaurants that attract visitors from around the region. The Manila Light Rail Transit system Line 2 connects Marikina City with neighbouring Quezon City and other cities in Metro Manila and many inhabitants commute daily to jobs and schools in these areas.

Marikina City faces strong environmental pressures. It is highly vulnerable to flooding from the Marikina River as it sits in a low-lying basin surrounded by elevated areas and has earthquake risk from the West Volley Fault which runs through the west of the city. Recent surveys have indicated concerns from the populations of cities to the east of Metro Manila about their resilience to flooding risk (Table 2).[8] The negative perceptions built around the city's challenges may be constraining its ability to compete effectively for growth and investment against other Metro Manila cities.

Despite these challenges Marikina City has recognisable strengths in being well managed and a model of good governance in the metro area. It is regarded as well organised, e.g. excellent waste separation and collection, river bank rehabilitation, a green space plan etc. It also has a proactive environmental agenda that includes a network of 52 kilometres of bike lanes and on 'eco-savers' recycling programme for elementary school children. Marikina City's burgeoning restaurant industry is an increasingly attractive destination for Metro Manila residents and tourists. In 2013, Marikina City was ranked as one of the ten most competitive cities in the country and in the list of three most competitive cities in terms of economic dynamism, which is measured by business registration figures, employment and financial institutions.[9] ■

TABLE 1 – According to the inhabitants of Marikina City (part of East Metro Manila), the city is less resilient to urbanisation and growing population.[8]

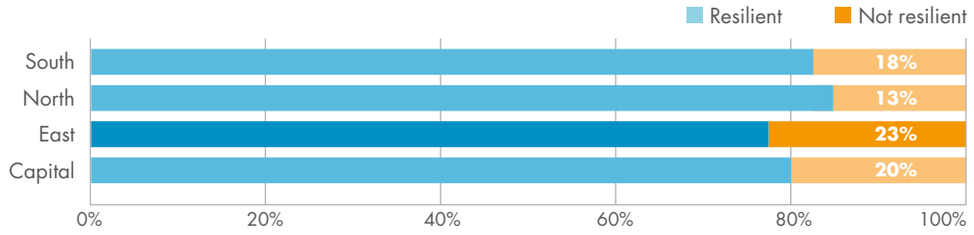
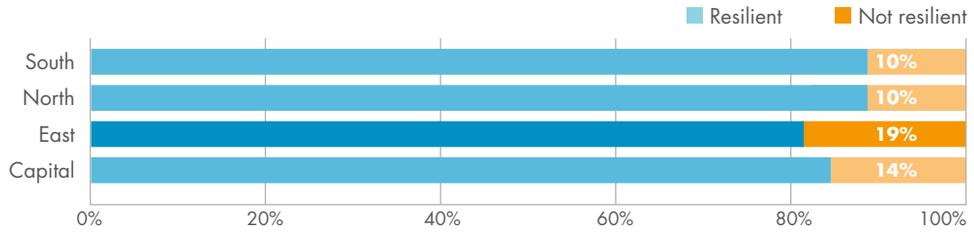


TABLE 2 – According to the inhabitants of Marikina City (part of East Metro Manila), the city is less resilient to extreme weather events.[8]



CHALLENGES

During the study, five fundamental challenges were highlighted by stakeholders. These bottlenecks are affecting the city's aspirations for growth and investment and impact the potential prosperity, liveability and resilience of the city.

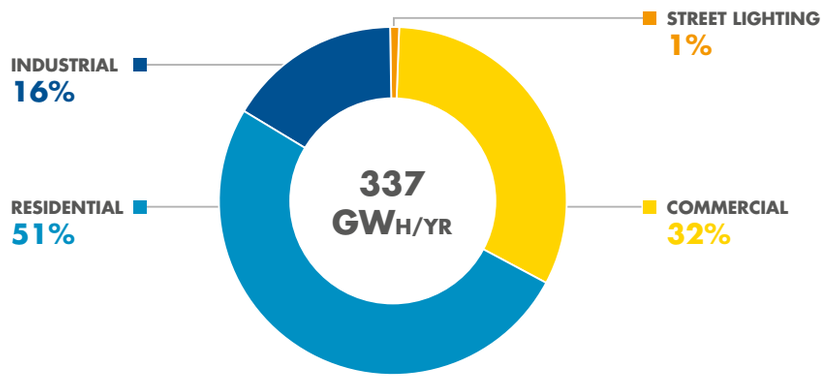
1 AFFORDABLE AND DEPENDABLE ELECTRICITY

One of the global challenges of urbanisation is the development and planning of electricity generation, transmission and distribution infrastructure. In this study, key stakeholders highlighted the supply of affordable and dependable electricity as one of the major challenges for the growth of Marikina City. There is public awareness of the urgency of this challenge, and power supply is front page news in the Philippines. For example, the daily power capacity is published in a national newspaper to make people aware about the (limited) amount of power available that day.[10] The perception of challenges to electricity supply in Metro Manila is strong enough to impact residents and businesses.

In terms of the energy demand in Marikina City, it is a largely residential city, with an average household electricity consumption of 1,868 kWh/yr, which is high compared to the Philippines average of 1,150 kWh/yr, and small compared to a global overage of 3,336 kWh/yr,[11,12] Commercial activities such as manufacturing and restaurants also contribute to demand. However, there is little heavy industry. The total electricity demand of Marikina City is the 330 GWh/yr (Table 3).

The supply of power to Marikina City is part of the electricity grid of Luzon, the Philippines' biggest island. So the challenge that Marikina City is facing is driven by challenges the country as whole is facing.

TABLE 3 – Electricity demand in Marikina City (2013).[11]



THE MAIN THREE DRIVERS ARE:

1. THE POWER SUPPLY CAPACITY IN THE PHILIPPINES IS RESTRICTED UNTIL 2030

Growing population and economic welfare are increasing electricity demand now and in the future. For example, the federal government is aiming to increase the percentage of the population that has access to electricity from 70% to 90% in the upcoming 5 years, and there is a push for electrification in transport. In 2030, the expected demand will have risen by 70% compared to today. This includes ambitions to make fuel and electricity usage 10% more efficient. There is a growing concern about the resource adequacy, and the national power supply capacity for Luzon Island alone needs to increase by a significant 8,100 MW until 2030 to cope with increased demand.[13]

Over the short term, the Philippines need to improve the system reliability to keep up with economic and population growth. Recently, the Department of Energy (DOE) gave warnings about possible brownouts in the upcoming summer (2015) months due to delays in the start-up of several power plants.[14]

2. HIGH ELECTRICITY PRICES IN THE PHILIPPINES

Another concern is that the electricity price in the Philippines is ranked among the highest in the world: #9 (Table 4).[15] Filipinos pay some of the highest electricity prices in Southeast Asia. The high prices have been cited by the U.S. Energy Information Administration as creating a risk to foreign investment.[16] Reasons for this high price include:

- Past policy choices such as limited electricity subsidies.
- The Philippines is an archipelago with 100 million people spread over 7,107 islands. The electricity infrastructure is likely to be more costly compared to other continental countries.
- The country is exposed to environmental pressures (e.g. tropical storms and typhoons) which can make it difficult and expensive to maintain dependable and affordable infrastructure.

3. DEMAND FOR SOLUTIONS DURING AND AFTER NATURAL EVENTS

There are moments when the power supply will need to be cut off for safely reasons, as the country is regularly exposed to significant environmental pressures such as flooding due to tropical storms and typhoons. During a flood in September 2014, Metro Manila suffered a 48-hour brownout.[17] To cope with these events, the power grid needs to be resilient, meaning that it is able to:

- isolate and minimise the area where the power supply is cut off;
- restore the power supply as quickly as possible; and
- have back-up power solutions in case events occur near power generating facilities.

TABLE 4 – Average electricity price

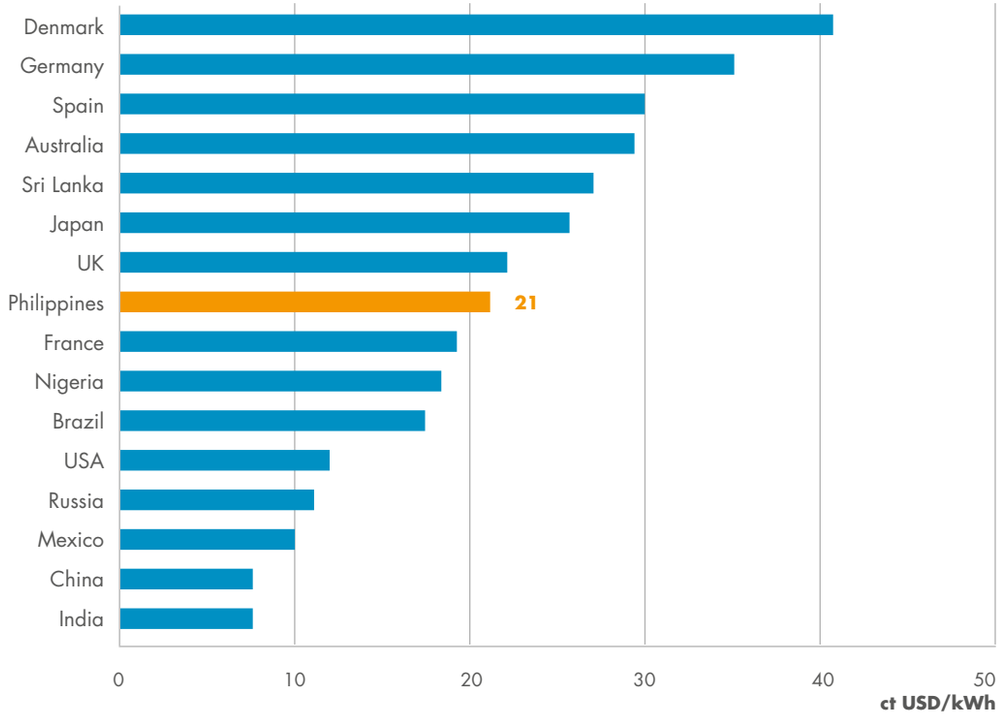
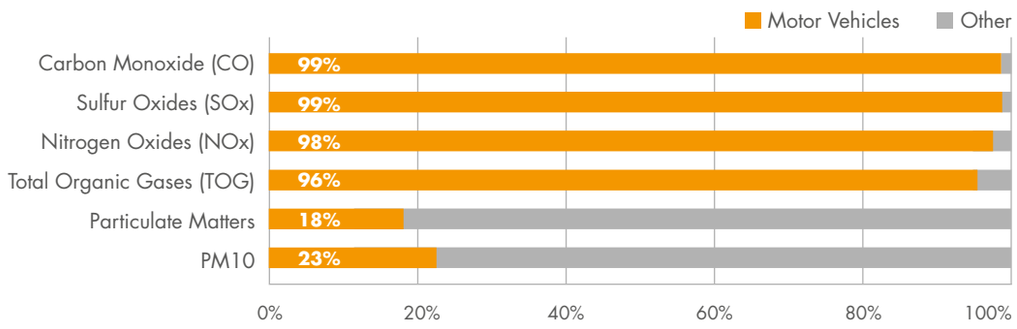


TABLE 5 – Motor vehicle emissions compared to other emissions sources in Metro Manila.[19]



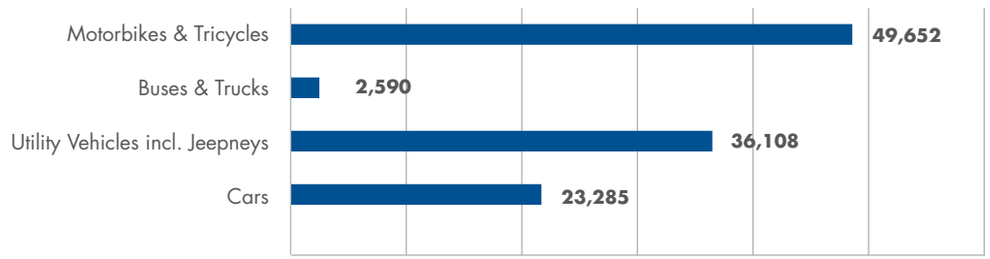
2 ROAD AND PUBLIC TRANSPORT INFRASTRUCTURE

One of the key infrastructure bottlenecks is the transportation system. Traffic congestion across Metro Manila has long been recognised as an escalating problem that (1) creates an increasing economic burden (reported at ₱1.5 trillion over the past 11 years due to lost productivity, and >₱4.5 billion in losses from fuel consumption),[18] and (2) decreases the quality of life for Metro Manila citizens due to increased pollution and loss of time. One can differentiate between Marikina City (intra-city) transport and Metro Manila (inter-city) transport issues. Inter-city issues highlighted by stakeholders are obedience of traffic rules, congestion caused by commuting and air quality. The intra-city issues are directly related to urban planning, such as small roads, limited/unregulated street parking, limited loading bays and limitations on land use.

Metro Manila employs various rail, road and water transport systems to accommodate the needs of ~12 million inhabitants. The limited public transport is offered by privately owned jeepneys and buses. Furthermore, the metropolis has only three Light Rail Transit (LRT) lines that connect the various cities and which struggle to keep up with demand. This creates a reliance on private transport, including 1.38 million registered motor vehicles, which results in major and persistent congestion throughout the day.[19] Transportation is also one of the main contributors of air quality problems in the city, accounting for 99% of the carbon monoxide and sulphur oxide emissions (Table 5).

Compared to other cities across Metro Manila, Marikina itself is not as congested. There is a large number of motorbikes and tricycles (Table 6). Marikina City is a "Bedroom Community", which means that most of its residents commute to other cities to get to work, and currently waste hours in traffic. The population of Metro Manila as a whole is approximately 12 million at night and 15 million during the daytime, an increase of 25%.[20] However, the indications are that Marikina's population decreases by 25% during the daytime. There are approximately 500,000 trips to Metro Manila daily from the Marikina Valley area.[21] The principal challenge for Marikina City is to enhance the transport infrastructure that links it to the rest of Metro Manila. It also needs to enhance the accessibility of the river bank and restaurant areas for visitors.

TABLE 6 – Vehicles registered in Marikina City (2013).[11]



3 WASTE MANAGEMENT

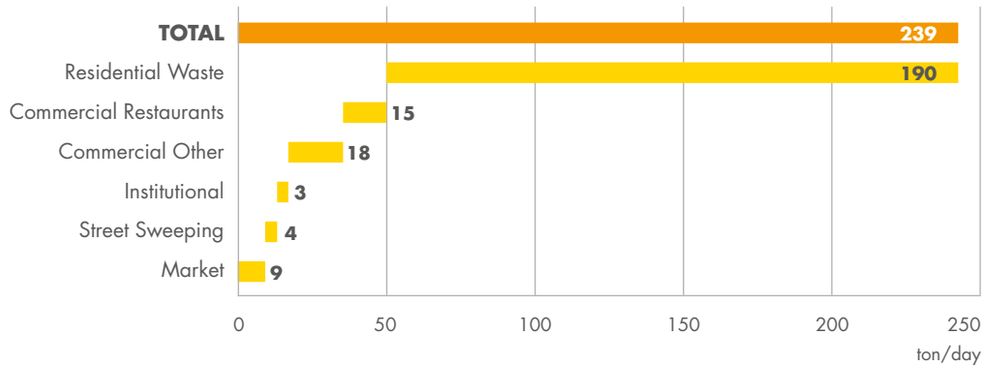
The people of Marikina City have an excellent level of personal responsibility towards waste collection and separation. Marikina City has a separated (biodegradable and non-biodegradable) waste collection service within its barangays. The biodegradable fraction is taken to disposal site (landfill), such as Payatas Dumpsite ("Second Smokey Mountain") and Catmon.[22,23] The non-biodegradable fraction is taken to a recycling station where workers sort and extract materials utilising a mechanised conveyor system. The recyclable materials are then transferred to private recyclers for eventual further processing and reuse.[23]

Marikina City residents are proud to have the best practice in waste management compared to cities across the metropolis. Unfortunately, good waste management is not apparent throughout the Metro Manila area. People do not always show responsibility towards waste collection and treatment. Research by the Asian Development Bank indicates that: "As long as the mounds of garbage are removed, it is a problem out of sight and out of mind."[23] Of the 6,700 tons of waste generated per day, only 720 tons per day is recycled or composted. The rest is hauled to landfill sites. However, it is the least efficient way of dealing waste, for reasons which include:

- It discards all potential resources.
- It is one of the least environmentally friendly methods because of the high methane and CO_2 emissions.
- It poses serious health risks, for example due to toxic leachate to groundwater.

Also, illegal dumping is a serious problem; 1,500 tons of waste per day is daily illegally dumped on private land, in rivers, and in creeks in Metro Manila.[23] Waste ends up in the sewage system and the Marikina and Pasig River systems, blocking water spillways and increasing the damage in Marikina City caused by heavy rain and flooding. Excess pollution (including silting) in the Marikina River has reduced its utility for both water transport (e.g. ferries, barges) and recreation (e.g. recreation, fishing).[24,25] Access to disposal sites is becoming an issue throughout Metro Manila due to the limited supply of new sites and increasing cost.

TABLE 7 – Waste generation in Marikina City.[11]



4 FLOOD MANAGEMENT

Marikina City is exposed to regular flooding of the Marikina River System, which runs throughout the city. The current infrastructure (pumping stations, spillways) is unable to cope with these conditions, exacerbated by the polluted and silted-up Marikina-Pasig Rivers, clogged city drainage systems and equally poor infrastructure along neighbouring cities up and down river.

The cost of flooding in Metro Manila can range from 109 million USD to 2.5 billion USD per year.[26] During tropical storm Trami (2013), the water in the Marikino River rose 19 metres, affecting 2 million inhabitants and costing the adjacent cities $2.4 million in direct damages.[27] Marikina City was badly impacted by Typhoon Ondoy (2013). Almost the entire city was submerged in water.[28] Marikina City can experience flood events up to three times a year.

Flooding has a number of consequences. There are risks to the safety of the population and damage to property. The city's transport systems are disrupted, stopping commuters going to work. Also, the power supply to the city may be cut, causing business and commercial enterprises to lose productive time. In the event of a strong typhoon, evacuation of large parts of the city may be required and there is a significant risk to the population.

This exposure has a negative impact on the reputation of the city, inhibiting its ability to attract investment (industry, commercial, residential) and limiting its potential for growth.

The water system infrastructure, including the drainage and control system, is governed by regional and federal authorities. Flood management engineering and controls require co-ordination across several city districts and fall under the authority of the Philippines Department of Public Works and Highways (DPWH). Subsequent maintenance and operations are under the authority of the MMDA. The interfaces between these bodies need to be managed carefully to ensure the efficient management of the overall system.

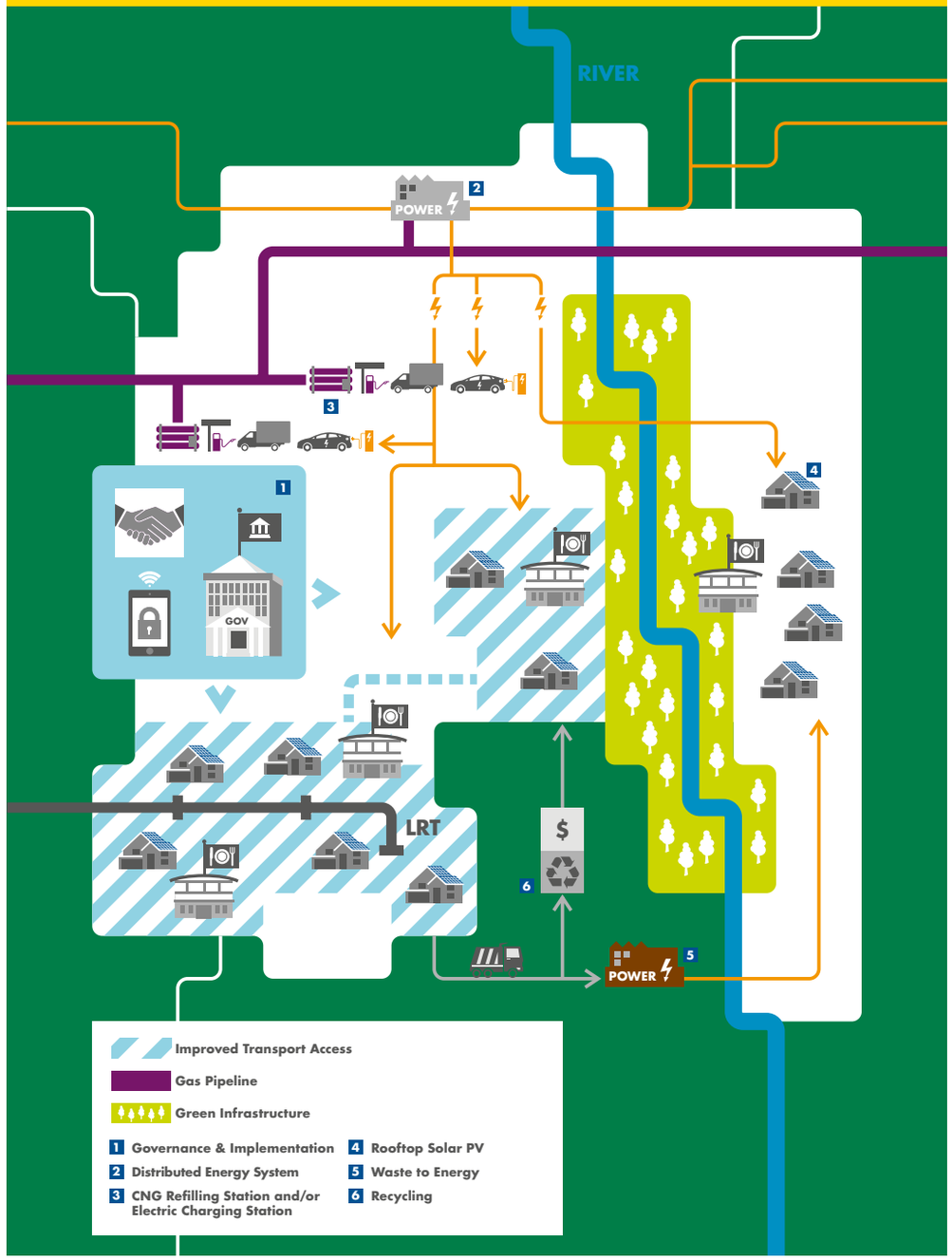
WASTE IN THE RIVER NEAR MANILA CAPITAL

5 GOVERNANCE AND CO-ORDINATION OF IMPLEMENTATION

Marikina City has considerable strengths in its strong and transparent governance and it has implemented positive changes to the city such as waste recycling efforts and the rehabilitation of the river banks. Challenges for future development include:

- The ability to co-ordinate and implement projects and services across city boundaries. All the infrastructure challenges described here require effort and co-ordination with adjacent cities and a range of public bodies, whether it is flood control or waste management.
- The pace of implementation of major projects and the ability to collaborate with the private sector to drive delivery.
- Availability of funding and financing for projects and improvement works.
- Ensuring strong consultation with the local population on proposed improvements.
- Reinvigorating investment to further develop Marikina as a city to visit, to work in and to live in.

AN INTEGRATED SOLUTION TACKLES MULTIPLE CHALLENGES



This is a stylised image of a city that shows how the various solutions can be integrated. It is not intended to specifically resemble the geography of Marikina or any other city.

OPPORTUNITIES

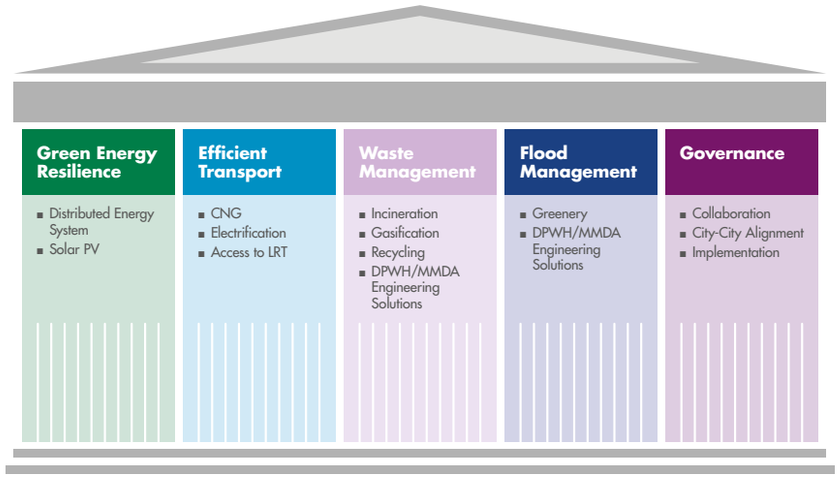
Given the five challenges highlighted during the study, we have identified a range of solutions and assessed them against six key criteria:

- Does the option enhance the resilience of the city infrastructure against environmental pressures?
- Does the option tackle more than one bottleneck?
- Can the option be implemented within 10 years?
- Is the option within the city's own authority to implement?
- Does the option enhance the economy and create jobs?
- Is the option cost-effective?

The five challenges are interconnected and one solution can form an integrated solution to tackle multiple problems. For example, the waste-to-energy option is a solution for waste management (challenge #3) as well as creating affordable and dependable electricity (challenge #1).

Integrated solutions enhance the resilience of the city. For a city, resilience is the capacity of its infrastructure to resist disturbance, be reliable, and respond and recover in a timely and adequate manner.

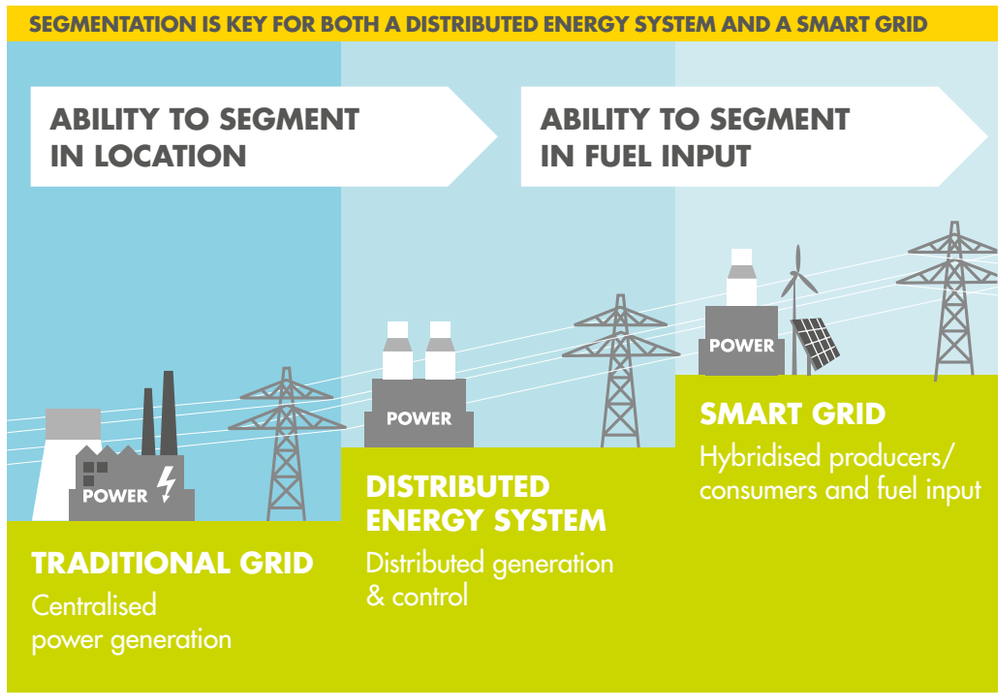
EVERY CHALLENGE CAN BE TACKLED WITH DIFFERENT SOLUTIONS



OPPORTUNITY 1
GREEN ENERGY RESILIENCE

In order to provide a more resilient energy system that can cope with the environmental challenges faced by Marikina City, improve the economic opportunities for businesses and inhabitants in the city and contribute towards the wider stability of the electricity grid in Metro Manila, we have looked at three main options:

- A Distributed Energy System providing decentralised electricity generation within the city
- Rooftop solar PV as an addition and complement to the Distributed Energy System, which together form a SMART grid.
- Waste-to-Energy, which is discussed in Opportunity #3 as a waste management solution, can also improve energy resilience.



ELECTRICITY DISTRIBUTED ENERGY SYSTEM

Historically, economies of scale have dictated a preference for centralised power generation in most places in the world, including the Philippines. It has been necessary to build a large power plant to get high fuel efficiency. Therefore the current electricity infrastructure is set up with large centralised power generation and control outside local boundaries. To supply electricity into the city, there is a network of high voltage transmission and low voltage distribution lines.

Though this arrangement is efficient, it has resilience weaknesses, with little redundancy in the system so that if an individually significant part of the network is taken out of action (e.g. a power station or main transmission line) it can cause power failures in a wide-ranging area and be expensive and difficult to recover from. In a city such as Metro Manila which regularly faces extreme weather events and environmental stresses this is a regular problem.

One answer to this challenge is the installation of a decentralised gas-fired Distributed Energy System. The traditional grid operates as one unit, while the decentralised grid operates as a collection of (semi-)independent modular systems, each with their own control. Due to the partitioning of the power generation, the generation facilities of a Distributed Energy System do supply a smaller amount of electricity compared to the traditional grid but may still provide a meaningful MW load. The major benefits of this approach are:

- It is more resilient to disruption (e.g. from natural causes) because the modular system has some redundancy, which allows a limited amount of modules to switch off/on according to the location of any source of disruption. Moreover, it has inherent back-up connections to other modules, which enhances recovery. Therefore the modularity of both control and power generation is key for a more responsive system.
- The modular setup allows the city to plan smaller-scale investments instead of planning more complex and expensive infrastructure projects. Decisions about large-scale infrastructure projects have to be taken while future developments are uncertain. As these projects are implemented over long periods of time, there are many factors that can change in the meantime: increased demand, technological advances and economic fluctuations. A Distributed Energy System gives the city more dynamic flexibility and the ability to build capacity incrementally. The city can also replicate the facilities in other districts/ regions as appropriate.
- In times of peak demand it can help power companies to balance load and increase capacity ("peak shaving ability").
- The costs for small-scale power generation units have reduced substantially in recent years, and these options are increasingly cost-competitive and complementary with centralised generation options.[29]
- A Distributed Energy System can also have a "SMART" dimension, with information technology managing demand peaks intelligently and switching between different fuels such as gas and renewables.

The benefits of a Distributed Energy System have been demonstrated when Hurricane Sandy hit the east coast of the U.S. in October 2012. The resulting power disturbance affected 8.5 million people, and kept more than 1.3 million in the dark for a week. However, the gas-fired Distributed Energy System system at Long Island was able to generate power for over 15 days, providing power to the North Shore Health System Facility and 400 other homes and allowing for a 24-hour emergency operation. Today, 20 States in the U.S. are planning Distributed Energy Systems for their power supply.[30]

A key part of the solution is that the power systems utilise natural gas as the fuel source (as opposed to coal). A gas-fired power plant produces less than 1/10th of the SO_x, NO_x and particulate matters per kWh compared to coal-fired plants. Moreover, natural gas-fired plants produce around half the greenhouse gas emissions per kWh compared to burning coal.

Continued use of coal in power plants is exacerbating the air quality issues that the Philippines is already grappling with. Based on World Bank studies on China, it is estimated that the health cost of air pollution in emerging Asian countries amounts to between 1% to 4% of its GDP.[31]

Utilising natural gas as the backbone fuel in power generation also helps achieve the full benefits of integrating other low-polluting alternative energy systems such as rooftop solar PV, wind, and transport electrification and CNG. President Benigno Aquino III has recognized the benefit of natural gas in his speech in January 2014 with reference to the typhoon in the Visayas, "The situation calls on us to reassess the sources of power and their effects on the environment. In the coming years, we will make a concerted effort to use more efficient forms of energy generation, and natural gas will play a starring role in this."

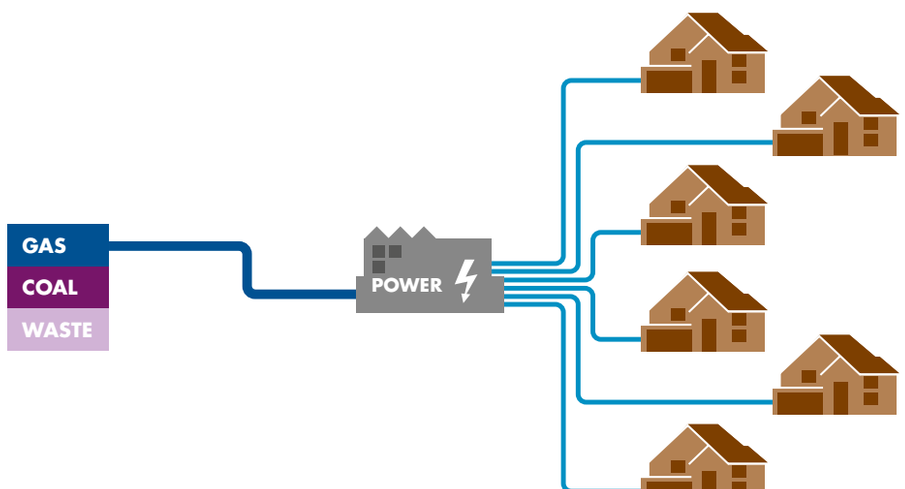
Gas can best be supplied to Marikina in various ways. The first option is as pipeline gas via the planned BATMAN II gas pipeline system. The other possibility is to transport LNG either by truck or by barge along the Marikina River and to store the gas near the power station site.

Marikina City's power demand can be supplied by a total of 50 MW power generation facilities that run at 80% of the capacity. The type of generating equipment that could be applicable in Marikina City includes:

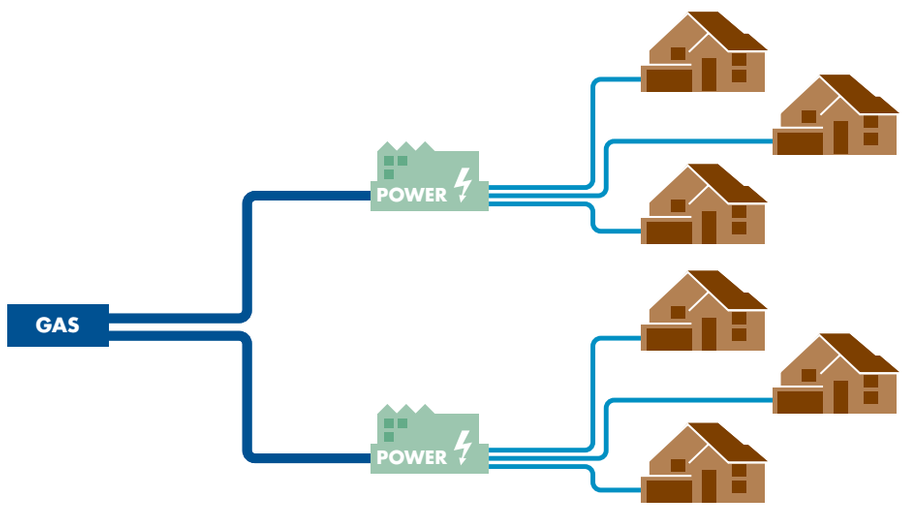
PRIME TECHNOLOGY	PROS	CONS
1. Reciprocating engines (RE)	■ Higher flexibility ■ Fast ramp up/down (10 min) ■ Highest fuel efficiency (~45%) ■ Regular maintenance could be done by local crew ■ Can accept larger range of fuel composition "fuel flexibility"	■ More emissions compared to turbines, incl. ppm level methane slip ■ Lower power density (higher footprint) ■ Higher noise levels ■ More frequent maintenance ■ Highest down time
2. Aero-derivative turbines	■ High fuel efficiency (~35%) ■ Lower emissions compared to RE ■ Lowest down time ■ On-site maintenance time is limited because the core of engine is substituted	■ Specialist needed for maintenance ■ Maintenance costs will be relatively higher
3. Industrial turbines	■ Option to boost efficiency by integrating a steam cycle. However, ramp up/down is decreased dramatically (hours)	■ Lower fuel efficiency (~30%) ■ Specialist needed for maintenance ■ Slow ramp up/down (40 min)

Given resilience requirements, any power generation equipment should be able to provide electricity quickly to recover from periods of environmental pressure and in times of peak demand (i.e. "black start" and "peak shaving ability"). Therefore, looking at the options above, reciprocating gas-fuelled engines may be the most effective option for the city given their high level of flexibility and fuel efficiency. A Distributed Energy System of this nature could also be configured with renewable generation capacity such as solar PV to jointly be part of the existing electricity grid via SMART technology integration.

TRADITIONAL GRID: CENTRALISED POWER GENERATION AND CONTROL OF SUPPLY TO ALL END-USERS



GAS-FIRED DISTRIBUTED ENERGY SYSTEM, CLUSTERED DECENTRALISED POWER GENERATION AND CONTROL, SUPPLYING CLUSTERS OF END-USERS



An additional advantage in using reciprocating engines is that they can be designed to burn a variety of gaseous and liquid fuels without incurring increased maintenance or reducing downtime. For example, a multi-fuel power plant instantaneously switches to a backup fuel oil and maintains load without incurring any maintenance penalty. This greatly adds to the system's overall versatility in being able to use other fuels as a backup option if required.

It should be noted that the economic and commercial viability of this option in Marikina City does require a more detailed cost/benefit analysis of all elements of the fuel and infrastructure supply chain, electricity distribution impact study, as well as an environmental and community impact assessment.

The great benefit to Marikina City from hosting its own distributed power system is the ability for the city to provide reliable, clean and green electricity at all times, including at times of environmental pressure (e.g. during floods or storms). The system could also be used to provide additional electricity to the Metro Manila grid during peak demand periods, helping to reduce the frequency and impact of brownout events. Power outages close schools, shut down business and impede emergency services, ultimately costing millions of pesos in lost productivity, and disrupting the lives of the city's inhabitants. For Marikina City, having the ability to guarantee power grid resilience not only becomes a key defence against natural disaster but also provides a critical resource to increase business and investor confidence in the infrastructure of the city.

HOW DOES THE DISTRIBUTED ENERGY SYSTEM OPTION SCORE AGAINST OUR ASSESSMENT CRITERIA?

Does it enhance the resilience of the city infrastructure against environmental pressures?
Yes, strong resilience enhancement.

Does it tackle more than one bottleneck?
Yes, it can increase energy resilience and reliability and increase the competitiveness of the city. Power reliability ensures that other infrastructure can continue to run, e.g. water pumping stations, traffic lights, LRT etc.

Can it be implemented within 10 years?
Yes, subject to finance, funding and regulatory approval.

Is the option within the city's own authority to implement?
It would need strong collaboration between city authorities and private sector.

Does it enhance the economy and create jobs?
Yes, increased power reliability can make the city a more attractive place to invest and set up businesses.

Is it cost-effective?
It could be cost-effective but a more detailed commercial and economic assessment needs to be undertaken.

(ROOFTOP) SOLAR PV

A key part of developing new energy solutions for Marikina City is to review options to introduce alternative energy systems (e.g. wind, solar). The relatively small size of Marikina City, high urban density and limited amounts of open land, suggest that options such as wind power and large-scale solar farms are not feasible. There is, however, potential scope for rooftop solar to be installed on suitable buildings. Solar PV power supply is increasingly cost-competitive to fossil-fuel power systems. Integrating alternative energy supply as part of a city's overall power mix is important to residents, with solar energy regarded as one of the most preferred future energy sources. 9 out of 10 Filipinos believe it is key to reducing CO_2 emissions.[32]

The Philippines is ideally suited for solar power, with high solar irradiation, supporting photovoltaic energy generation for up to 7 hours per day. The Philippine's solar industry continues to strengthen, mostly driven by local entrepreneurial companies, also partnered with international companies. Key to this growth has been supportive policy structures implemented by the government. These include:

- the Renewable Energy Act of 2008 (Republic Act No 9513) to promote the development, utilisation and commercialisation of renewable energy resources;
- the introduction of feed-in tariffs ($0.13 kWh, ₱3.50 kWh) for ground-mounted and rooftop systems;
- the net metering rules to facilitate sale of excess generated energy back into the local grid; and
- a government aspiration to continue to develop a renewable portfolio.

Taken together, with ever-reducing manufacturing costs, advances in solar cell technology and the introduction of creative business solutions, the future of solar-based power systems is fast becoming an important part of securing the Philippines, energy future.

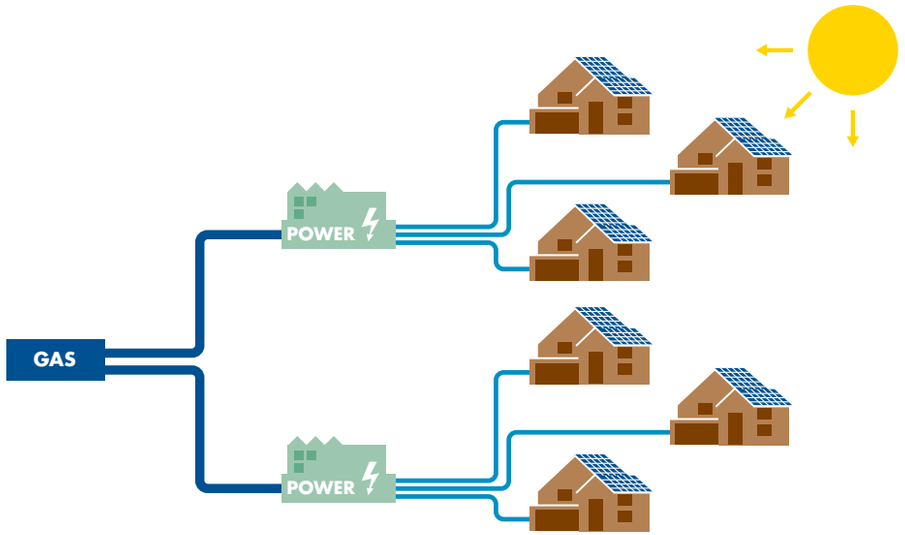
In 2013, the European Chamber of Commerce of the Philippines estimated the potential market for rooftop solar PV projects at $450 million yearly, based on 50,000 households with average solar panel installation of 2 kW each. Solar energy solutions not only deliver opportunities to save money but also reduce CO_2 release from conventional power stations systems (especially coal-fired power generation) and mitigate the effects of climate change.

The commercial viability of this option depends on several factors, including installation scale and costs, energy consumption patterns, and the development of viable business models that deliver a competitive rate of commercial return relative to the necessary up-front investment costs. At current costs and energy pricing, a typical rooftop solar system could pay for itself within 5–7 years. Furthermore, utilisation of solar energy can result in CO_2 savings equivalent to 1.2–1.7 metric tons per annum per kW installed against coal-generated electricity (or 120< tonnes/yr for a 100 kW system).

Due to the likely correlation between solar power generation and air-conditioning demand in Manila, PV systems may also help to reduce the net peak load on the power distribution system. For Marikina City, rooftop solar installation could be most easily considered on buildings that the city/government has potential access to (e.g. schools, hospitals, city administration). These buildings have the added benefit of most electricity consumption between the hours 8am to 5pm, which is the optimal time for solar electricity generation. A preliminary assessment suggests that in excess of 10,000 m^2 of roof space of this type may be available. This could support a 1.0–1.5 MW PV system (about 5,000–5,800 PV cells). In excess of an additional 20,000 m^2 rooftop space (up to 2 MW) could be available across non-government buildings (e.g. industry, commercial), but this requires building access to be negotiated with owners and may thus be more complex. Ultimately, city-wide rooftop solar electricity generation capability is insufficient to meet the total power demand requirements of Marikina City, but does offer a significant complement to the existing grid. A city-wide rooftop solar system could also be integrated with a fully distributed Distributed Energy System that maximises and complements the efficiency of an integrated SMART system by using information technology to dynamically manage demand and supply.

Making the system "SMART" is key to improving the efficiency of electricity demand and supply, ultimately leading to more reliable power availability and an overall reduction in charges to consumers. Achieving a smart grid requires building in new technical infrastructure, and the application of digital processing and communications technology to the power grid. This will enable sophisticated data collection and integration of systems which manage consumption patterns, direct local power production and control the integration of the local grid with existing utility systems.

SMART GRID: AN INTEGRATED SOLUTION OF A DISTRIBUTED ENERGY SYSTEM WITH SOLAR PV



HOW DOES THE SOLAR PV OPTION SCORE AGAINST OUR ASSESSMENT CRITERIA?

Does it enhance the resilience of the city infrastructure against environmental pressures?
Yes, it improves energy resilience and the rooftop location of the solar cells may make the solution less vulnerable to flooding.

Does it tackle more than one bottleneck?
Yes, improved energy resilience increases the competitiveness of the city and renewable energy reduces pollution and CO_2 emissions.

Can it be implemented within 10 years?
Yes, initial installation of solar PV is relatively straightforward.

Is the option within the city's own authority to implement?
Yes, as it relates to properties within the city, starting with municipal buildings.

Does it enhance the economy and create jobs?
Yes, greater power reliability improves the economic potential and attractiveness of the location as a place to run a business.

Is it cost-effective?
Can be cost-effective depending on alternative fuel prices. Initial indications positive though more detailed commercial and economic assessment would need to be done.

TRANSPORT

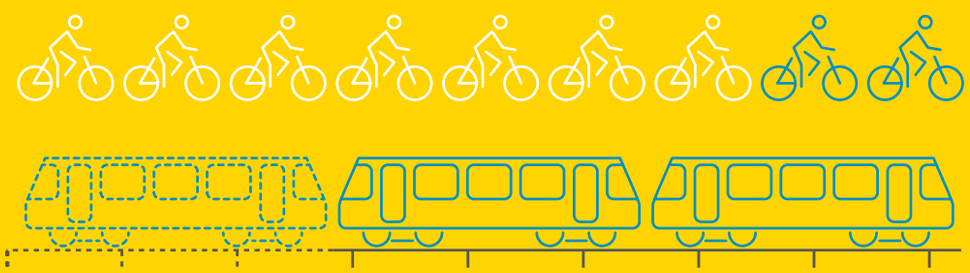
1 CLEANER TRANSPORT FUELS

CNG

ELECTRIC

ELECTRIC TRICYCLES

2 ENHANCED LRT ACCESS



3 CONGESTION REDUCTION INCENTIVES

OPPORTUNITY 2
EFFICIENT TRANSPORT

In order to tackle the challenges of congestion and pollution that come from inefficient transport systems in Metro Manila we looked at options for the introduction of different, cleaner fuels into the vehicle fleet in Marikina City and the improvement of public transport access.

Several studies and trials have been undertaken across Metro Manila to implement cleaner transport fuels such as Compressed Natural Gas (CNG) and/or electrification and there has already been the development of the Manila LRT. These solutions can attract investment, create jobs and leverage local skill, while improving the liveability of the city and impact on the environment. There is also a set of congestion reduction options which could be considered which have a lower capital cost e.g. road charging, tolling and strict enforcement of traffic rules.

CLEANER TRANSPORT FUELS: CNG

CNG could provide a cleaner transportation fuel into the city's energy mix, with significantly lower emissions compared to conventional diesel vehicles (Table 8). Dedicated CNG vehicles offer Marikina City an opportunity to improve air quality and liveability of the city. Besides the environmental benefits, vehicles converted to CNG are more cost-effective than those running on traditional fuels. The cost of CNG can be as little as a third of the price of a gallon of gasoline. The benefits of CNG have been identified earlier by several city and federal bodies, including the Department of Energy, which commenced the creation of a master plan in the form of the Natural Gas Vehicle Program for Public Transport (NGVPPT) in 2003. In the master plan, the commercial, environmental and health benefits of CNG are clearly established.

TABLE 8 – Emission benefit of replacing diesel with CNG vehicles.[34]

FUEL	CO	NOx	PM
Diesel	2.4 g/km	21 g/km	0.38 g/km
CNG	0.4 g/km	89 g/km	0.12 g/km
% Reduction	**-84**	**-58**	**-97**

To power a vehicle with CNG, the vehicle owner has three options:

PRIME TECHNOLOGY	PROS	CONS
1. Purchasing a dedicated OEM CNG vehicle	■ Original equipment manufacturer (OEM) guarantee on vehicle quality ■ No integration trouble with existing vehicle	■ Higher purchase price compared to gasoline and diesel e.g. in India 6,000–12,000 USD[33] ■ Redundancy of existing vehicles
2. "Re-powering": replacing diesel/gasoline engines with OEM CNG engines	■ Suitable for large existing fleets of transport e.g. trucks, buses	■ Technically challenging ■ More expensive compared to retro-fitting
3. Retrofit: converting current existing diesel/gasoline engines to CNG engines	■ Suitable for cars, tricycles and other small vehicles ■ Technically easy to implement – could be done by local shops in a couple of hours ■ Most affordable options for vehicle owner ■ Retrofitting gives the vehicle dual-fuel capability	■ Generally, infeasible in heavy-duty vehicles like trucks (high maintenance, low efficiency and higher emissions) ■ To install a CNG conversion kit into a gasoline-powered vehicle sacrifices a part of the car trunk or cargo space

All the options above indicate an upfront capital investment from the vehicle owners. However, vehicle owners can recoup their investment (switch over costs) over a period of time through lower input fuel costs.

In order to encourage consumers to switch over to CNG, it is also imperative to ensure adequate supply. A key requirement for this is the presence of CNG distribution infrastructure such as refuelling facilities. The necessary refuelling facilities will be determined by the operating characteristics of the vehicles (fleet size, vehicle type, trip lengths, fuel economy etc.). The CNG refuelling infrastructure consists of a mother station and a number of daughter stations. The mother station is supplied by a continuous supply of natural gas from a pipeline or a large storage facility. The daughter stations can be supplied by the mother station via a pipeline, or via trailer truck delivery. According to a study published by Pacific Northwest National Laboratory for the U.S. Department of Energy, the cost (incl. installation) of a mother station is $2 million; smaller fuelling units average around $10,000. The costs for refuelling infrastructure (as with most transport fuels) is embedded in the fuel pricing. With considerable economies of scale, CNG would still be affordable.

In the situation that there is a gas-fired Distributed Energy System, Marikina City has the opportunity to leverage the available gas supplied to the city for power generation for CNG provision, potentially at lower cost than if the supply infrastructure was being provided purely for transport fuel purposes.

CLEANER TRANSPORT FUELS: ELECTRIFICATION OF ROAD TRANSPORT

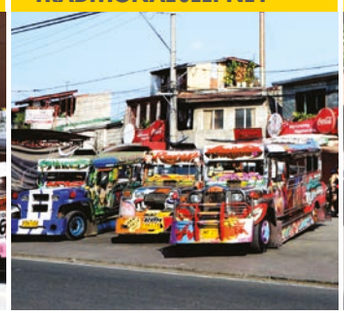
Within the last decade, electrified mobility has been given increasing priority in the U.S., Japan, China, Korea and the EU, and is part of the long-term strategic vision of many of the world's cities. Mass production of electric and hybrid vehicles is under way, and they are becoming increasingly competitive in terms of costs (purchase and running) and utility (range and speed) with conventional combustion vehicles as advances are made in battery technologies, infrastructure investment and scale production. The advantages of increased electrified road transport include energy savings, improved air quality (reduction in greenhouse gases and air pollution) and a reduction in noise pollution. All of these could have positive impacts in improving public health, economic growth and reducing the impact of climate change, if the electricity was generated from low carbon resources (Table 9).

If Marikina City hosted a Distributed Energy System power system inside the city limits, it could give encouragement to exploit potential electrification of road transport. Increased reliability of the supply of electrical power inside Marikina City would provide confidence to investors (1) to install necessary electrical charging stations across the city and (2) to purchase electric vehicles for personal use and as part of business fleets (e.g. jeepneys, tricycles, buses). It is important to note that the benefit in reducing air pollution is dependent on the primary source of fuel used in generating electricity. Electricity generated from coal-fired power stations offers little to no overall reduction in CO_2 emissions compared to conventional combustion engines. However, alternatives such as gas or solar (as proposed under Opportunity #1) would provide an electricity source with significant reductions in CO_2 emissions, enabling the full benefits of electrification of road transport to be captured.

Metro Manila is already piloting electric tricycles (Asian Development Bank plans to deliver 100,000 tricycles by 2016) and battery-powered jeepneys (financial district, Makati), but at present there are very few privately owned electric cars. Manila Electric Company (Meralco) has announced plans to install vehicle power station at Mandaluyong as a pilot test. Acceptance and market penetration of electric vehicles can only succeed if adequate infrastructure (e.g. high-power charging stations) is developed in parallel. The energy resilience proposal made in this study provides more reliable electricity, which encourages the electrification of transport in the city.

TRADITIONAL TRICYCLES

TRADITIONAL JEEPNEY



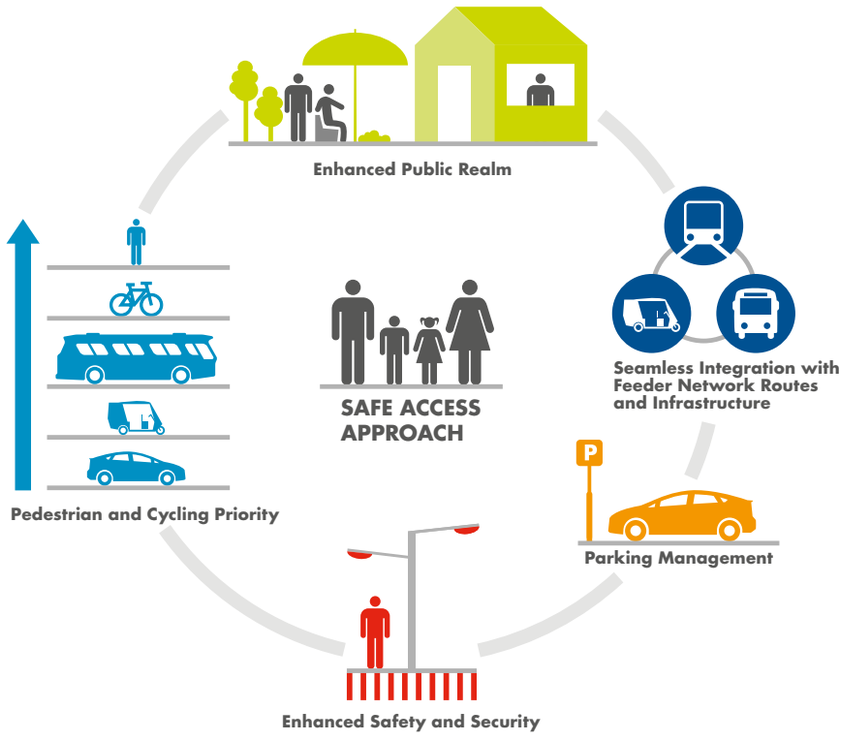
ELECTRIC JEEPNEY

TABLE 9 – Comparison of well-to-wheel CO_2 emissions for conventional gasoline internal combustion engine (ICE) vehicles, biofuels ICE vehicles and electric vehicles (EV) in relation to the electricity mix.

	CO_2 eq. in g/km		
FUEL	**WELL TO TANK (BATTERIES)**	**TANK (BATTERIES) TO WHEELS**	**TOTAL EMISSIONS**
Conventional ICE Car	23	120	143
Biofuels ICE Car	17–28	97–135	114–163
Battery Electric Vehicle 27% Nuclear 20% Renewable 53% Fossil Fuel	67–84	0	67–84
Battery Electric Vehicle 100% Coal	126–155	0	126–155
Battery Electric Vehicle 50% Wind 50% Photovoltaic	0–4	0	0–4

THE LRT 2 LINE CURRENTLY HAS ONE STATION IN MARIKINA CITY. TWO ADDITIONAL STATIONS ARE APPROVED.[35]

EMBARQ MODEL FOR SAFE ACCESS APPROACH.[36]



LRT LINE 2 ACCESS ENHANCEMENT PLANNING

Feedback from Marikina City stakeholders as part of this study indicates a strong desire for improved intercity transport to:

- facilitate residents moving to and from areas of employment;
- improve the delivery of goods and services; and
- increase ease of access across Marikina City itself.

Intercity transportation between Marikina and other cities across Metro Manila is being partly addressed by the "Metro Manila Master Plan", which aims to expand the current LRT line to reduce traffic congestion and reduce emissions by displacing the use of private vehicles. This plan is part of a federal programme. However, there is an opportunity to improve the ease of access to LRT stations within the city, enhancing the desirability of Marikina City as a place to live, work and visit.

Facilitating access to new LRT stations is just as important as planning the location of the LRT stations and this is an area that can be controlled by Marikina City. An accessible LRT station can be connected to several other transport options like buses, pedestrian walkways, bike lanes etc. to ensure a smooth flow of passengers moving in and out, and to connect the LRT to key areas in the city
such as restaurants, shopping, employment and recreation.

In discussion with the city administration and the University of the Philippines School of Urban & Regional Planning (Dr Cris Diaz), a proposal has been made to prepare a "safe access enhancement plan" between LRT Line 2 and key areas across Marikina City. Enhancing access to LRT Line 2 stations is expected to encourage greater utilisation of the LRT service.

For Marikina City, this involves assessing options to improve safe access systems (e.g. roads, cycleways, footpaths, parking facilities, green spaces and efficient public transport including jeepneys, tricycles and buses) in the "last mile" around the LRT 2 Santolan Station, and connecting routes from the station to key areas of the city. Key areas where connection routes to the LRT station could improve include access through to the burgeoning Marikina City restaurant district (which attracts visitors from across Metro Manila), commercial and industrial areas that offer employment opportunities and the Marikina River embankment, which once improved (see Green Infrastructure option), would offer attractive open spaces for recreation.

The LRT 2 Access Enhancement Planning proposal is currently being reviewed by the Marikina City administration.

LOWER COST CONGESTION REDUCTION OPTIONS

Efforts to reduce congestion in Metro Manila and Marikina can also be helped by the use of a range of lower-cost mechanisms to incentivise reductions in car use. Manila already implements the Unified Vehicular Volume Reduction Program (UVVRP), which restricts the types of vehicle that can use major public roads based on the final digit of the vehicle's licence plate. In addition, there are other solutions from cities around the world that could be considered:

- STRICT ENFORCEMENT OF TRAFFIC RULES
  This can be the cheapest option to implement to reduce congestion on busy roads. Simply ensuring that vehicles are not illegally parked and that signals at junctions are observed can significantly increase the availability of existing road capacity and improve the flow of traffic while also reducing accidents.
- CONGESTION/ROAD CHARGING
  Singapore has an Electronic Road Pricing (ERP) scheme for major roads in the city. It charges road users a variable price based on traffic speeds and timing of journeys (e.g. travelling during peak hours on busy roads is more expensive than on other routes at other times). It has been estimated that the ERP has reduced congestion on major expressways during operational hours by around 15%. However, congestion charges can be unpopular, as their calculation can be viewed as unreliable and a cost burden to drivers, particularly at times of high fuel prices.

OPPORTUNITY 2 **EFFICIENT TRANSPORT**

- TOLLING
  Road tolling is an established mechanism for restricting usage of road space and funding the building of infrastructure. Tolls are often associated with Public-Private Partnership models for the construction and operation of these assets. They have been implemented in many places in the Philippines (e.g. North Luzon expressway, Metro Manila Skyway) and in cities across the world (e.g. Delhi, Jakarta).

  Though they are successful in encouraging the building of new road capacity at lower capital cost to the public purse, they have a mixed record in reducing congestion, largely due to the partial nature of their coverage of the road network, which can result in drivers re-routing onto smaller "free" roads. Tolls collected at booths at the end of the road or bridge can also create congestion at the points that drivers stop to pay.

HOW DO THE IDENTIFIED TRANSPORT OPTIONS SCORE AGAINST OUR ASSESSMENT CRITERIA?

Do they enhance the resilience of the city infrastructure against environmental pressures?
Yes, by reducing pollution and emission levels.

Do they tackle more than one bottleneck?
Yes, more efficient fuels reduce pollution and new infrastructure investment increases the competitiveness of the city by making it easier to move around.

Can they be implemented within 10 years?
Yes, though some require significant investment.

Are the options within the city's own authority to implement?
Some local investment in refuelling infrastructure and improvements around LRT stations are in the city's control but would need strong collaboration between city authorities and private sector.

Do they enhance the economy and create jobs?
Yes, investment in new infrastructure and reduction of congestion and pollution can make the city a more attractive place to invest and set up businesses.

Are they cost-effective?
Costs of congestion are significant, so improvements can be cost-effective. Fuel switching can be cost-effective but is dependant on pricing points for existing fuels.

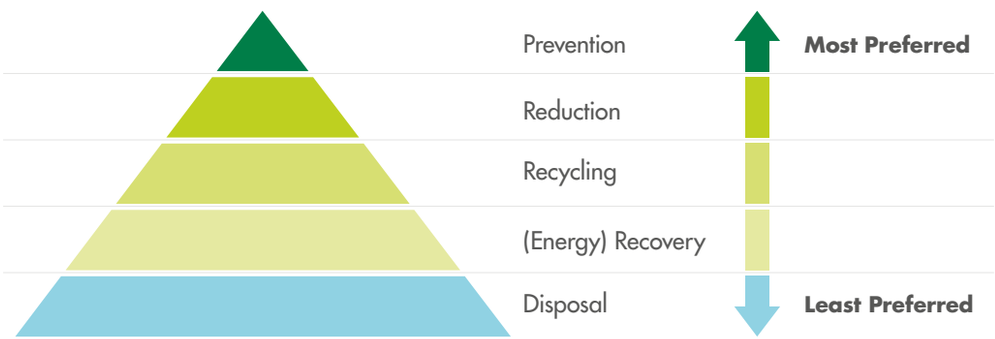
OPPORTUNITY 3 **WASTE MANAGEMENT**

Waste con be a valuable resource (via recycling or as fuel). However, it is not always easy to realise this potential because the ability to optimise waste management can be constrained by local physical (e.g. environment) and governance issues (e.g. policies, regulatory frameworks, financing, education etc.).

This makes the associated challenges complex. In this section, a selected number of opportunities are highlighted, but this does not offer a comprehensive solution to all the challenges.

One way of looking at waste is by using the "waste hierarchy", which is the cornerstone of most waste minimisation strategies: it aims to extract the maximum practical benefits from products and to generate the minimum amount of waste. Given that Marikina City has a track record of best practice in waste collection and separation (as described in Chapter 3), we have focused our attention on the potential for recycling and energy recovery.

THE WASTE HIERARCHY.[37]



OPPORTUNITY 3 **WASTE MANAGEMENT**

RECYCLING

Materials such paper, plastics, glass and metals are recyclable. To be recovered, these materials need to be separated and collected. In the past decade recycling rates around the world have dramatically increased – in many cases recycling well over 50% of all waste produced.[29] In Metro Manila there seems to be market demand for certain recyclable materials, however, this is not matched by the available supply.[23] For example, one of the paper factories in Metro Manila is willing to buy all the paper available for recycling. However, the current supply can only account for 10% of its needs.[23]

Marikina City collects waste in a separated manner (biodegradable and non-biodegradable). The non-biodegradable fraction is taken to a recycling station to be sorted. The recyclable materials are then sold for further processing and reuse. This is an excellent example of how recycling can monetise waste. Further options to encourage recycling in Marikina and across Metro Manila are:

- Expand the "Eco Savers" programme throughout Metro Manila. Eco Savers aims to improve the recycling rate in Marikina City up to 20%. The programme educates children in schools and enables them to install waste segregation at the household level. The separated waste is exchanged for Eco Points for the children. In the first 3 years, 238 tonnes of waste was recycled instead of being taken to landfill.
- Municipalities can start by showing good behaviour in their own facilities. This includes:
  - discouraging the use of non-recyclable products and materials by employees and contractors;
  - buying recycled products, such as office paper made from recycled paper; and
  - requiring composting of food waste and plant material generated at government facilities.
- Marikina City has good examples of Barangay-based material recovery facilities. These could be expanded, while underground and/or side-walk containers could be installed to encourage greater recycling rates.

ENERGY RECOVERY

Even if high levels of recycling are achieved, there will always remain a fraction of waste that has to be disposed of safely and economically. Much of this non-recycled waste is currently sent to landfill sites throughout Metro Manila. Landfill is a sub-optimal way to dispose of waste. Sites lack capacity to deal with the demands of an expanding city, they are dangerous places for those who work there (formally and informally), can be breeding grounds for disease, and are highly polluting to the environment. Another way of dealing with waste is to use it as fuel to produce power, e.g. waste-to-energy. This option works for hazardous waste that should not end up in landfill, such as medical and toxic waste.

There are three routes for waste-to-energy:

- Via (co-)incineration: burning waste (potentially with gas, coal or biomass) and using the generated heat to produce steam or electricity:
  - MASS-BURN INCINERATORS are fed with untreated waste after basic removal of organic matter, glass, metals, batteries etc. (which can be recycled);
  - REFUSE-DERIVED FUEL (RDF) incineration, where waste is processed into a uniform "fuel". RDF feed stream usually consists of plastics and biodegradable waste – products that are combustible with the potential to deliver energy.
- Via gasification: various technologies are available to produce methane from waste and then burn the methane.

In the Netherlands it is common practice to burn unrecyclable waste as a fuel to generate power and heat. For example, the incinerator near Amsterdam (ca. 750,000 people) supplied the city with an average of 64 MW in 2014 using both RDF and bio-gasification technologies.[38] A similar-sized plant would be enough to supply Marikina City with all the power it needs. In Asia, similar-sized systems exist in Singapore, Japan, South Korea and Taiwan. However, most of them are mass-burn incinerators.[39]

The economic feasibility of this option is strongly related to the price of landfill sites. Most incinerators earn a big portion of their revenue from the price paid for waste at the gate, not from the generation and supply of power. So, as the costs for landfill get higher across Metro Manila, a waste-to-energy system becomes a competitive and affordable option for Marikina City. However, in considering this option it has to be recognised that incinerators can be highly controversial due to health and environmental concerns. Currently, there are also legislative barriers (Clean Air Act 1999) that prohibit such schemes in Metro Manila, though amendments to these rules are being considered which may make some projects viable.

HOW DO THE IDENTIFIED WASTE MANAGEMENT OPTIONS SCORE AGAINST OUR ASSESSMENT CRITERIA?

Do they enhance the resilience of the city infrastructure against environmental pressures?
Yes, by reducing emission levels and pollution in comparison to landfill.

Do they tackle more than one bottleneck?
Yes, alternatives to disposal reduce the amount of waste that gets into water spillways and the sewage system. Waste-to-energy can supply dependable and affordable power to the city.

Can they be implemented within 10 years?
Yes, the technology is available.

Are the options within the city's own authority to implement?
Recycling efforts are clearly within the control of the city. The city would need strong collaboration with the local population to ensure proper waste collection and separation.

Do they enhance the economy and create jobs?
Yes, part of the waste-to-energy infrastructure is the pre-treatment of waste, which requires labour (i.e. creates jobs) and attracts new knowledge into the city.

Are they cost-effective?
As Marikina grows, the costs of landfill will only increase, making waste-to-energy a more affordable option.

OPPORTUNITY 4
FLOOD MANAGEMENT – GREEN INFRASTRUCTURE

Periodic flooding impacts much of the Marikina-Pasig river system across east Metro Manila. Consequently, several detailed studies and recommendations on developing/improving flood management and structural infrastructure have been completed (e.g. World Bank, JICA sponsored studies) and integrated into a detailed "Flood Management Master Plan for Metro Manila and Surrounding Area" currently being implemented by the DPWH.

Recommendations include upstream spillway construction/improvement, improved pumping stations, waste removal from drainage systems, reforestation and watershed management and flood information and early warning systems. Since then, various parts of the river have been dredged, as part of a ₱50 million project tendered via the MMDA. It will, however, still take some time before full completion.

Though the implementation of the flood management master plan is the key to reducing flood risk in Marikina City, resilience can also be improved through cost-effective incorporation of "Green infrastructure" into the flood management landscape for Marikina City. This is a set of natural solutions to help solve urban and climatic challenges particularly focused on using natural features and materials to reduce flood risk.

Opportunities to do this in Marikina City include restoration and enhancement of river banks, levee systems and spillways and the development of open green recreation spaces that can assist in absorbing heavy rains and tropical storms. Further developing these areas with upgraded evacuation routes and increased bikeway networks (already in development) will enhance their utility. Linking improved access to these "active" green spaces to Marikina City's restaurant districts and the LRT Line 2 systems (see Efficient Transport section) will create a unique area in Marikina City that will attract residents, visitors and tourists. Rooftop and vertical gardening, and planting of trees on walkways and roadways could also be considered.

There is some cost associated with maintenance of these green spaces, but it is significantly less than the cost of heavily engineered solutions. Results in other locations (figure opposite) have shown that, when implemented correctly, high-performing green spaces provide real economic, ecological and social benefits.

EXAMPLES OF GREEN INFRASTRUCTURE

WETLANDS FOR SUSTAINABLE WATER MANAGEMENT

ASSET RESILIENCE TO COASTAL EROSION

MARIKINA RIVER BANK REHABILITATION

HOW DO THE IDENTIFIED FLOOD CONTROL OPTIONS SCORE AGAINST OUR ASSESSMENT CRITERIA?

Do they enhance the resilience of the city infrastructure against environmental pressures?
Yes, strong resilience enhancement.

Do they tackle more than one bottleneck?
Yes, increasing flooding resilience reduces the risk of power outages and damage to property.

Can they be implemented within 10 years?
Yes, and they can be implemented relatively quickly.

Are the options within the city's own authority to implement?
Yes, as they relate to land use within the city.

Do they enhance the economy and create jobs?
Yes, they improve the attractiveness of the city and therefore economic potential.

Are they cost-effective?
Green infrastructure solutions can be significantly cheaper than heavily engineered flood control solutions.

OPPORTUNITY 5
GOVERNANCE AND IMPLEMENTATION

Marikina City has been in the forefront of making positive changes to the infrastructure of the city over recent decades and is also seen as a leader in effective and transparent governance in the Metro Manila area. Marikina City works collaboratively with the MMDA, which plans, monitors and co-ordinates metropolitan-wide transport, waste management and flood control projects and services.

The Philippines also has a rich NGO and private sector that supports positive changes for cities such as Marikina City. Shell in the Philippines has been a pioneer in the space of Corporate Social Responsibility, being a founding member of Philippines Business For Social Progress in 1970 and the Pilipinas Shell Foundation Inc. (PSFI) in 1983 – one of the first corporate foundations in the country. For the past four decades, Shell, through the PSFI and its partner NGOs, has been supporting the efforts of government in improving the quality of life of Filipinos, covering the areas of education, health and the environment, among others.

However, there are still challenges that remain in encouraging and managing development in Marikina City and across the Metro Manila area. Options for improvement that could be considered include:

- **Public-Private Partnerships to design, build, finance and operate key infrastructure assets** e.g. for toll roads and bridges, street lighting, public housing development. These can be financed through federal government-backed infrastructure funds or state-backed pension fund investment. National government investment guarantees can also help to reduce project costs. These mechanisms can also help to bring in private sector expertise to implement and manage projects.
- **Smart data solutions can make city management more effective**. For example:
  - **City control rooms** such as the Center of Operations (COR) in Rio de Janeiro, Brazil, which monitors the daily activity of the city using multiple data inputs and allows it to manage potential crisis situations including traffic, major events and natural disasters.
  - **Smart ticketing** e.g. OV chipkaart in Netherlands, which allows all public transport journeys in the country to be paid for on one smart card.
  - **Smart metering** of utilities to allow time of day tariffs and load balancing.
- **Localised funding streams and tax retention** can help to plan, finance and build infrastructure e.g. municipal bonds, tax incremental finance (where the predicted tax revenue increase created by infrastructure investment can be used as a revenue stream to finance that investment e.g. the London, UK Metro extension to Battersea). Private developers can also be asked to contribute to building elements of public infrastructure as a condition of planning approval.
- **Local consultation and collaboration to build trust and create solutions**. Crowdsourcing solutions using digital tools and making city data publicly available online, as has happened in Helsinki, Finland. Neighbourhood forums and partnership agreements can also help to build public engagement in plans for the city.
- **Consider new forums for collaboration across city agencies and authorities** on common Metro Manila issues, building on examples such as the Metropolitan Manila Disaster Coordinating Council (MMDCC). Bodies such as the League of Cities and League of Municipalities can take a positive role in these efforts.
- **Master planning and collaboration**, e.g. Singapore's Master Plans (most recent plan published in 2014, first published in 1958), which have created a strong vision and pipeline of future investment across several decades. These plans can be developed through international collaboration such as the work done with the Japan International Cooperation Agency on the Transport Infrastructure Development Roadmap for Mega Manila to help ease congestion in the metropolis and to attract more investment. Plans such as these require collaboration and a strong mandate coming from local and national authorities to drive implementation, spanning several electoral tenures.

HOW DO THE IDENTIFIED GOVERNANCE OPTIONS SCORE AGAINST OUR ASSESSMENT CRITERIA?

Do they enhance the resilience of the city infrastructure against environmental pressures?
Yes, strong resilience enhancement through encouragement of collaboration and investment.

Do they tackle more than one bottleneck?
Yes, they can encourage infrastructure investment and effective management across a range of sectors in a more co-ordinated manner.

Can they be implemented within 10 years?
Yes, better investment and management will have a positive impact on the local economy.

Are the options within the city's own authority to implement?
Collaboration across municipal and national boundaries is required.

Do they enhance the economy and create jobs?
Yes, investment in new infrastructure and reduction of congestion and pollution can make the city a more attractive place to invest and set up businesses.

Are they cost-effective?
Some options are low-cost, and new financing mechanisms can be efficient ways to encourage new investment.

CONCLUSIONS & NEXT STEPS

This study provides a series of focused solutions to key challenges facing Marikina City's vision to become a green, resilient, sustainable city that is attractive to business, commercial and residents. These solutions are the result of discussion and feedback from many people associated with living, working in, administering and guiding Marikina City. As such, these solutions belong to Marikina City. Individually, each solution has potential. However, the real value to Marikina is in their integrated implementation.

THE OPPORTUNITY TO:

A. put in place a resilient, green clean power Distributed Energy System that complements the existing grid;

B. further develop the potential natural attractiveness of the Marikina River using green infrastructure systems that complement the flood management engineering solutions under construction;

C. develop efficient transport systems that could leverage new Distributed Energy System infrastructure (e.g. conversion of jeepneys, tricycles and buses to CNG and/or electricity) and build smart usable transport networks across the city; and

D. build on and further develop the excellent management and governance systems that Marikina City is already respected for.

A visualisation of these potential solutions is shown on page 20.

Taken together these options can help Marikina City attain its aspired vision. However, we suggest the results in this report are just the beginning. The proposed solutions are achievable, but much needs to be done to further assess detailed engineering feasibility, commercial viability (investor funding, project economics), local and federal regulatory support, and environmental fit and to ensure complete understanding of community support.

"WE HOPE THAT THE RESULTS OF THIS STUDY WILL HELP TO BUILD THE ROADMAP FOR MARIKINA CITY'S VISION."

FOR FURTHER INFORMATION, CONTACT:

- **Glynn Ellis** | Exploration/Energy Advisor | g.ellis@shell.com
- **Suiee Suarez** | Global Campaign Manager "Future of Energy" | ronald.suarez@shell.com
- **John Russell** | Project Manager, CITIES team | john.russell@shell.com
- **Lydia Boktor** | CITIES Analyst | lydia.l.boktor@shell.com

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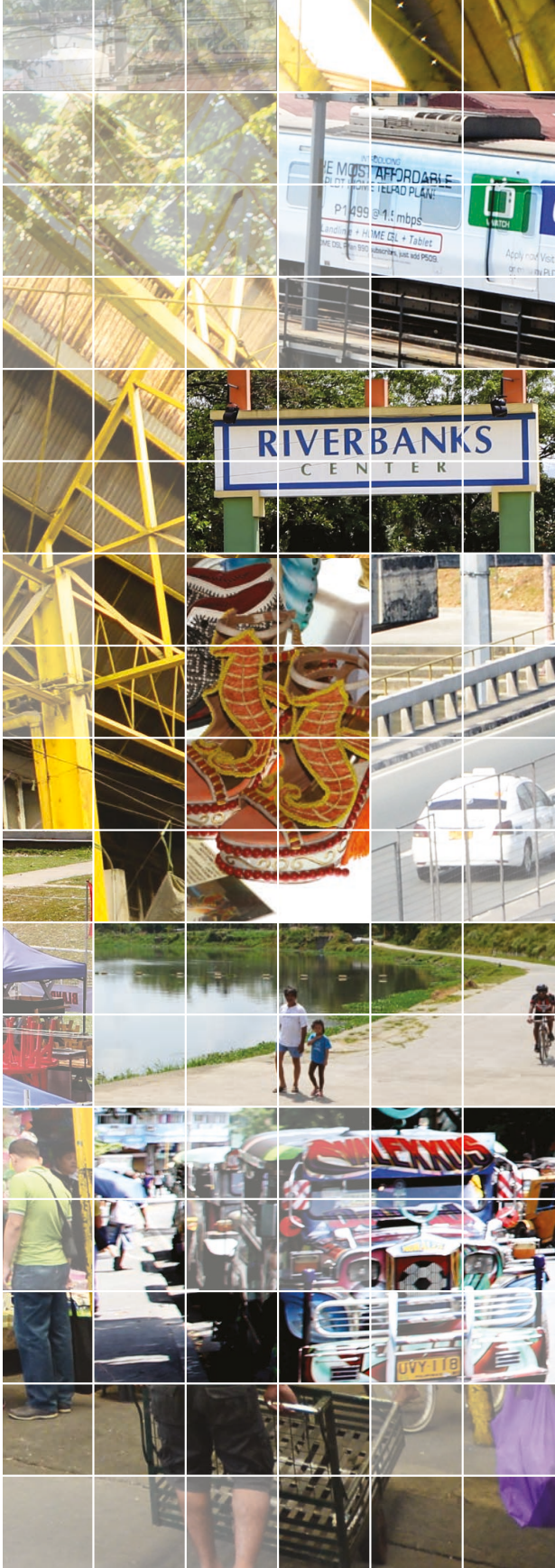

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