REPORT

SHAPING THE CITIES OF TOMORROW:

Renewable Energies and Sustainable Urban Ecosystems

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IESE Business School
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PPP for CITIES
Specialist Centre on PPP in Smart and Sustainable Cities

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Hugo Ferradans, Miquel Rodriguez, Albert Tapia, Albert Banal-Estañol y Joan Enric Ricart

With the support of Iberdrola

PPP FOR CITIES

The Specialist Center on PPPs in Smart and Sustainable Cities (PPP for Cities) is a research, innovation and advisory center whose purpose is to provide government agencies around the world with support in the organization, management and development of collaborative projects between the public and private sectors, in the field of smart cities.

It is also a platform for partnerships between companies and agencies at a global level where they can thoroughly explore the dynamics of public-private partnerships, create guides on best practices and standards, and design solutions to the problems faced by cities.

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

This report aims to provide a general outlook on the impact that the use of smart solutions is having on the consumption and production of energy in cities. The report has been structured around three areas: sustainable neighborhoods, sustainable electric urban transport and energy access by citizens. For each of these areas, a broad set of individual cases has been analyzed. For each case, we present the main purpose and provide some details about the implementation and the key characteristics (factors of success, agents involved, technologies used, outcomes and impacts), which enables us to produce a list of good practices and lessons learned for each area.

The common characteristic of all the cases is the use of smart solutions, some of which foster the use of renewable energy and others that enable a more efficient use of energy. In the area of sustainable neighborhoods, ten cases show how clean and renewable energy consumption can be increased in cities. Examples of how smart solutions allow a better use of energy in cities are the implementation of a circular use of energy, and an improved use of clean energy and demand management. In the area of sustainable electric urban transport, a combination of ten cases exemplifying new trends in urban mobility show how the use of car-sharing systems or a strong public electric transport network can improve traffic flows and be more efficient in energy consumption. A strategic implementation of transport policy is also shown to be a step forward towards more sustainable mobility. Finally, the nine cases related to energy access show how the use of smart solutions and renewable energy can be crucial in satisfying the basic needs of citizens.

The current section summarizes the good practices and lessons learned in each area of study, highlighting the common characteristics identified across the cases analyzed. From these characteristics, changes in behavior patterns in the energy sector can be suggested. Some of these changes, as it will be observed, may generate an opportunity to mitigate climate change in cities. Therefore, replicating and scaling up the cases analyzed in this report can have a positive impact on the global challenge of climate change. For this reason, this section also includes a series of recommendations to public officers who are willing to implement smart solutions related to the improvement of sustainable urban ecosystems.

Table 1 below lists, and provides some details for, each of the 29 cases.

Table 1. Detailed list of cases studied

SUSTAINABLE NEIGHBOURHOODS				
Project	**City**	**Country**	**Summary of project**	**Subtype**
Malaga Smart City	Málaga	Spain	Development of Smart Grid technologies to foster energy efficiency and cut GHG emissions.	Smart Grids and Energy Distribution
Energy Smart Community Project	Ithaca, NY	USA	Improvement of electric distribution service integrating renewable sources.	Smart Grids and Energy Distribution
Fernando de Noronha Smart City	Fernando de Noronha	Brazil	Development of sustainable area through smart grids, renewable energy generation, smart metering, etc.	Smart Grids and Energy Distribution; Behavioural change
Sao Luiz do Paraitinga: "Cidade Inteligente"	Sao Luiz de Paraitinga	Brazil	Advanced Metering Infrastructure, distributed generation, interaction with consumer, Evs, smart street lighting, etc.	Smart Grids and Energy Distribution; Behavioural change
Hammarby Sjostad	Stockholm	Sweden	Smart neighbourhood: co-generation, renewable energies, smart metering, etc.	Behavioural change & Production
Villa 31	Buenos Aires	Argentina	Giving access to energy to Villa 31, a slum in Buenos Aires characterized by poor infrastructure and limited connectivity. The project includes green buildings, energy efficient services, and efficient connection to grid.	Slum electrification
City of Puerto Princesa	Puerto Princesa	Philippines	Sustainable neighbourhood: renewable energy sources, efficient housing.	Production & circular use of energy
Dezhou Solar City	Denzhou	China	Sustainable neighbourhood: integration of solar energy systems into new buildings. Strategy includes incentives to business through policies on land-usage, tax-return, and financing.	Production & circular use of energy
Taipei Smart City	Taipei	Taiwan	Smart waste management, and grids; efficient and sustainable buildings; green transport.	Production & circular use of energy
Clichy Batignolles	Paris	France	Smart neighbourhood: sustainable buildings, self-sufficiency from renewable energy, efficient and green waste and water management.	Production & circular use of energy

Table 1. Detailed list of cases studied (cont.)

SUSTAINABLE TRANSPORT				
Project	**City**	**Country**	**Summary of project**	**Subtype**
Charge & Drive	Oslo	Norway	Charging stations around the city of Oslo.	Charging stations
Cambio	Cologne	Germany	Electric carsharing system in Cologne.	Carsharing
Car2Go	Madrid	Spain	Electric carsharing system in Madrid.	Carsharing
Autolib	Paris	France	Electric carsharing system in Paris. As opposed to other carsharing projects, Autolib is a standard PPP.	Carsharing
Metrocable	Medellín	Colombia	Fully electric funicular system that gives services to citizens in slums, and that has helped to activate the economic activity in the area surrounding the funicular.	Public transport; Other infrastructures
Electric BRT system	Curitiba	Brazil	Electric BRT system in Curitiba.	Public transport; BRT
Metrorrey	Monterrey	Mexico	Metro fuelled by bioenergy.	Public transport; Metro
BlueTram	Paris	France	Bus/Tram system in which the bus/tram is fully electric and it charges everytime it arrives to a but stop while passengers are getting on and off.	Public transport; Bus/Tram
Amsterdam electric	Amsterdam	Netherlands	Long-term strategy for the development of a successful electric and sustainable transport system.	Integrated strategy
BMW iCharge Forward	San Francisco	USA	Vehicle-grid optimization and integration of renewable energy sources.	Behavioural change

ENERGY ACCESS				
Project	**City**	**Country**	**Summary of project**	**Subtype**
Microgrids by SteamCo	Rural areas in Kenya	Kenya	Solar-powered microgrids in rural areas of Kenya that do not have access to general grids.	Rural electrification
Ilumexico	Rural Mexico	Mexico	Affordable solar lighting systems in rural parts of Mexico.	Rural electrification
Ahmedabad slum electrification project	Ahmedabad	India	Ensuring energy access in slums by giving dwellers fluorescent bulbs and meters, as well as installing internal wiring and easing requirements for energy connection, among others.	Slum electrification
Energy access in Paraisopolis	São Paulo	Brazil	Create an efficient energy grid in Paraisopolis, Sao Paulo, by upgrading distribution network, providing metering and consumer registradion, as well as providing safe and energy-efficient appliances to slum-dwellers.	Slum electrification
Solar lighting in schools	Koraput	India	Solar lighting to support education in tribal residential schools of India.	Education
Soular backpack	Rural areas in Kenya	Kenya	Solar-powered backpacks for children.	Education
Project Optimize	Rural areas of Tunisia	Tunisia	Innovative health supply chain solutions through renewable energy for the supply of vaccines in rural Tunisia.	Healthcare
Renewable Energy Desalination Pilot Program	Abu Dhabi	UAE	Development of energy-efficient, cost-competitive desalination technologies through Renewable Energy.	Food supply and water
Alianza Shire	Refugee camps	Ethiopia	Giving access to energy to refugee camps.	Refugee and conflict areas

COMMON CHARACTERISTICS OF ALL THE CASES

Some characteristics are present in the cases of all three areas: sustainable neighborhoods, sustainable transport and access to energy. These characteristics can help explain the changes observed in the energy sector.

CHARACTERISTIC 1. COMPLEX ECOSYSTEMS

Possibly, the main characteristic common to all the cases analyzed is the fact that a wide range of stakeholders is involved in the implementation of the smart solutions. Energy companies, public authorities and citizens are always present, but the cases also often include companies from other industrial sectors, depending on the characteristics of the sector where the smart solution is implemented. Other partners, such as research centers, also appear in some cases. That said, a specific partnership is put in place for each case, with a different leader or promoter. In some cases the public sector is leading, while, in others, the project is led by the energy company or the other industrial partner. Citizens, although present in all the cases, do not lead the projects.

CHARACTERISTIC 2. USE OF INNOVATIVE TECHNOLOGY

The partnerships between several industrial companies, together with other partners such as research centers, offer the opportunity to enhance the use of innovative technologies in relation to the provision or storage of energy. Together with these new processes, the use of information and communication technologies (ICTs) and the digitalization process is present among almost all the projects. Although this is necessary for the provision of smart solutions, it also improves the capacity for user-centric behavior. The success of the smart solutions depends less on new technologies and more on appropriate technologies.

CHARACTERISTIC 3. SMART CITIZENS

Although citizens are not promoting or leading the partnerships, a common characteristic in all cases is that citizens are active stakeholders. This means that the smart solutions analyzed have a user-centric approach, where people play an active role in the energy supply system. As described in the previous characteristic, the implementation of ICT allows citizens to become active consumers.

CHARACTERISTIC 4. SMART PAYMENTS

Also, thanks to the use of innovative technologies, most cases include innovative systems of financing through what can be called smart payment systems. This characteristic is common in smart solutions, due to the intensive use of ICT and the relationship that smart solutions have with the sharing economy, where the fact that users pay for consumption drives behavioral changes in terms of the source of energy used. But besides the use of ICT, smart payments also allow the use of different methods of payment and adapt the payment methods to the socioeconomic environment of the population. This is a very interesting characteristic of the energy access cases, which are implemented in areas that have difficulties establishing regular payments for services.

CHARACTERISTIC 5. NEW ROLES FOR THE ENERGY COMPANIES

Not only citizens but also other stakeholders become more active than they are in more traditional activities. This is the case of energy companies, which, both in the sustainable neighborhoods and sustainable transport cases, become key actors, as they have the knowledge to develop some solutions. Energy companies are also taking on a new role, as they are financing the implementation of smart solutions and act as active industrial partners in the deployment of smart solutions, especially in the mobility cases.

CHARACTERISTIC 6. INCREASE IN DIVERSITY OF THE ENERGY MIX THANKS TO SMART GRIDS

A final characteristic observed in many cases is the increase in the diversity of the energy mix. In some cases, energy dependent on fossil fuels is combined with renewable and clean energy. In the rest, the sole energy used is renewable and clean. This diversification increases the share of clean and renewable energy and, therefore, reduces the share of energy based on fossil fuels. The diversification of the energy mix can also allow for cost savings and energy efficiency. This happens when the mixed energy matrix is developed in accordance with the available sources. The increase in the diversity of the energy mix is possible thanks to the implementation of smart grids that improve the capacity to connect different sources of energy more efficiently.

CHANGES OBSERVED

The smart solutions implemented in the different cases provide an opportunity for a change in behavior of all the actors in the energy sector in cities. We now provide an overview.

CHANGE 1.
TRANSFORMATION OF PASSIVE CONSUMERS INTO ACTIVE CONSUMERS

As seen in the description of the common characteristics, the cases analyzed show how customers can become active players because the smart solutions allow for a user-centric approach. The ability of final users to decide the energy mix of their consumption and payment has several consequences. First, it allows for an opportunity to reduce the use of fossil fuels in the energy sector and enhances the use of renewable energy. This, in turn, reduces air pollution and mitigates climate change.

CHANGE 2.
POTENTIAL NEGATIVE INDIRECT IMPACT ON TRADITIONAL BUSINESS

Smart solutions are an innovative process that solves existing problems. These challenges were already addressed in some way. The presence of smart solutions might have an indirect negative impact on third parties that were offering these services, especially in the transport or tourism sectors. The disruption of the market caused by smart solutions has to be considered by public authorities. They will need to study how to minimize the impact on the traditional economic sectors.

CHANGE 3.
REVISITING THE ROLES OF THE PUBLIC SECTOR

The distribution of competences among public authorities will determine which administration has to be responsible for the regulation of the use of smart solutions. Besides this role, smart solutions are changing the role of the public sector in the smart solution sector. Despite the existence of new disruptive businesses, the public sector can be a promoter of smart solutions: sometimes from an active point of view, when it pays for them, at other times from a passive point of view, when it facilitates them. Local, regional and national authorities can all be prescribers of smart solutions.

As a promoter of smart solutions, the public sector can affect the kind of energy that will be produced and consumed. This is not new. The public sector has incentivized, in recent decades and especially after the oil crisis in the 1970s, the production of power from alternative sources to fossil fuels. But now, with smart solutions and the responsibility to mitigate climate change, their role to promote renewable energy has increased. The energy sector has a long tradition of regulation. Nevertheless, this regulation might need to be reviewed in the near future to consider the new kinds of self-production of energy, the new potential micro-distributors of energy, and the new kinds of usage and storage of energy that smart solutions promote. Regulation might need to be reviewed and take into account the new business models that appear as a result of the introduction of the smart solutions.

CHANGE 4.
NEW BUSINESS MODELS FOR THE ENERGY SECTOR

Smart solutions are pushing energy companies to review their business models. The disruption of the smart business models might be transposed to the business models of energy companies, and this might have consequences. Questions that may need to be answered are: Who will the customer be? Will the citizens still be the final consumers or will it be the smart solution company? Will it be a mix of both? Besides perhaps being a customer, what will the relationship be between smart solution companies and energy companies? Will the latter get into the smart sector, or will it be on the other side? Will there be mergers between energy and smart solution companies?

RECOMMENDATIONS TO POLICY OFFICERS

Besides the conclusions regarding the energy sector, other general lessons can be learned. One is the need for multilateral partnerships with a wide variety of combinations, moving away from company-customer or public-private partnerships (PPPs) to a public-private-citizen partnership or to a PPP with multiple numbers of firms and administrative levels, developing a new version of PPPs. Another lesson learned is that without ICTs, these solutions cannot reach their full potential, as ICTs will help to improve the use and management of the solutions and will give customers the capacity to decide and improve their consumption choices.

The cases surveyed in the report have a positive impact on mitigating climate change, especially in urban areas, as they improve the share of clean and renewable energy in the energy mix and reduce the share of energy arising from fossil fuels. Therefore, the replication of these cases should be positive. This is why this section ends with a set of recommendations to policy officers who are willing to promote solutions that stimulate more sustainable urban ecosystems thanks to the use of cleaner sources of energy.

RECOMMENDATION 1. PROMOTE INNOVATIVE PARTNERSHIPS AND SMART BUSINESS MODELS

The mix of partners has been observed as a common characteristic in most of the cases analyzed. This helps to implement innovative solutions that need the combination of knowledge and technology, normally spread across different industrial sectors and research centers. Citizens, as explained previously, are at the center of the solutions, and therefore also have to be considered as partners. Finally, public authorities, although they might not have a contractual relationship within the solution, should also be present in the partnership, as there are externalities related to these solutions that might need to be promoted (the positive ones) or reduced (the negative ones).

Therefore, policy officers should promote the creation of innovative partnerships that are able to implement and replicate similar solutions as the ones analyzed in this report. Innovative partnerships can come under the umbrella of public procurement, where there is room to explore new processes—such as innovative public purchasing or an improvement of current PPPs. Public authorities might also need to explore other kinds of agreements and collaborations with other partners that facilitate the implementation of smart solutions.

Specifically, the recommendations to promote innovative partnerships are:

- **Reinforce the structures of governance of contracts,** with the permanent presence of public authorities, citizens and external experts.
- **Explore innovative payment methods,** such as advertisement income, capturing land value surplus from infrastructure construction, or adapting the payment methods to the socioeconomic reality of the communities.
- **Allow flexibility inside contracts,** giving the opportunity to adapt to non-expected changes or the inclusion of new innovative solutions.
- **Improve public purchasing,** especially when there is a high innovative component in the services required.
- **Explore the relationship between the public and private sector beyond contracts,** as the former can be a promoter of smart solutions that the latter can implement in a matured market but may need a lever of support to start.

RECOMMENDATION 2. ENCOURAGE SMART CITIZENS AND IMPROVE CITIZENS' AWARENESS

Citizens are at the center of the solutions explored. The user-centric approach, one of the main characteristics of all the cases, can be a tool to reduce air pollution and climate change. Therefore, encouraging smart citizens, and raising citizens' awareness about climate change and the use of cleaner sources of energy, has to be a priority for public officers. By increasing awareness, the will among the population to develop similar solutions to the ones surveyed in this report will increase.

The recommendations related to improving citizens' awareness are:

- **Step up the implementation of open data** that will increase the capacity to collect and manage information related to the solutions.
- **Guarantee the extension of open data to the private sector,** especially to companies implementing user-centric solutions and companies managing public services.

- **Maintain public campaigns** to raise citizens' awareness about climate change and the use of cleaner energy.

- **Review tax and public policies a**nd offer discounts to citizens using devices and solutions that improve the use of clean and renewable energy.

RECOMMENDATION 3.
PROMOTE THE USE OF EFFICIENT ENERGY NETWORKS

The implementation of advanced metering, distributed generation, IT and automation guarantees a better energy provision, reduces costs and allows the interface between energy production and supply and customers. This system also ensures the continuity of energy provision through different energy sources and tackles the intermittency of renewables. The move towards a cleaner energy system needs to ensure that electricity distribution is efficient and stable. Therefore, the promotion of efficient energy networks has to be a priority for public authorities.

The recommendations related to promoting the use of efficient energy networks are:

- **Promote the use of circular economy models,** especially to improve sustainable neighborhoods that can be self-sufficient in terms of energy. To do that, public authorities need to review local waste and energy management systems.

- **Study the possibility of implementing a tax-friendly policy** regarding the production of clean and renewable energy, as it can be a way to improve its future consumption.

- **Facilitate the implementation of smart grids** by helping to integrate renewables into existing grids and installing monitoring systems that identify problems and foster constant upgrade of the grid.

- **Invest in R&D projects** led by research centers in cooperation with private partners that focus on improving the production and distribution of clean and renewable energy.

- **Support the implementation of pilot schemes** where new solutions can be tested, monitored, evaluated and improved before being launched to the market.

RECOMMENDATION 4.
CREATE SMART CITIES AND DEVELOP AN INTEGRATED STRATEGY THAT COORDINATES DIFFERENT PUBLIC INSTITUTIONS

The solutions identified are complex. First, there is a wide range of industrial partners that come from different industry sectors and with different business models. Second, the use of a user-centric model impacts existing businesses and traditional business models. Third, different public institutions, from regulatory agencies to local authorities, are implicated. Smart solutions may also affect different departments of the same institution that are not traditionally related.

The recommendations related to the role of the public sector regarding the implementation of smart solutions or, in other words, the creation of smart cities, are:

- **Break silos inside the same public organization,** where departments such as Transport, IT or Energy need to work together to support the implementation of smart solutions.

- **Have a holistic overview while designing public policies.** All cases are a result of the capacity to interconnect different partners that have complementary skills. Public policies need to create integrated strategies that work together in the same direction.

- **Implement transversal leadership.** The previous recommendations can only succeed if there is clear leadership among the different public authorities that prioritizes the implementation of solutions that improve more sustainable urban ecosystems. This leadership is key to guaranteeing that the cooperation between departments and the integration of policies is maintained throughout the implementation of the solutions.

These recommendations are envisaged for public officers from administrations that will implement solutions that can change the patterns of energy consumption and the use of cleaner energy. In the full report, the cases are analyzed individually, one by one. We also collect the lessons learned at the end of each case, as well as at the end of each area of study. We hope that this executive summary, as well as the complete document, can be a useful tool for the implementation of solutions that allow cities to use more sustainable energy and help the energy transition that mitigates climate change.

STRUCTURE OF THE DOCUMENT

This document will be structured as follows.

Section 1 will briefly put this document in context, explaining the importance of public-private partnerships (PPPs) and public-private collaboration in the urban context and the need to reach the United Nations Sustainable Development Goals (UNSDGs).

Section 2 will set out the methodology for the choice of projects and cities. As mentioned previously, each city is different and thus the scope and projects to integrate renewables and electricity will change when considering high- vs. low-income or highly populated vs. low-populated cities.

Section 3 will set out the trends, case studies and good practices related to sustainable neighborhoods. It will focus on projects related to energy demand management and the sustainable production of energy.

Section 4 will focus on projects related to creating sustainable electric urban transport. It will focus mainly on introducing electric vehicles (EVs) in cities and on creating innovative projects related to electric public transportation networks, such as bus, metro and tram systems.

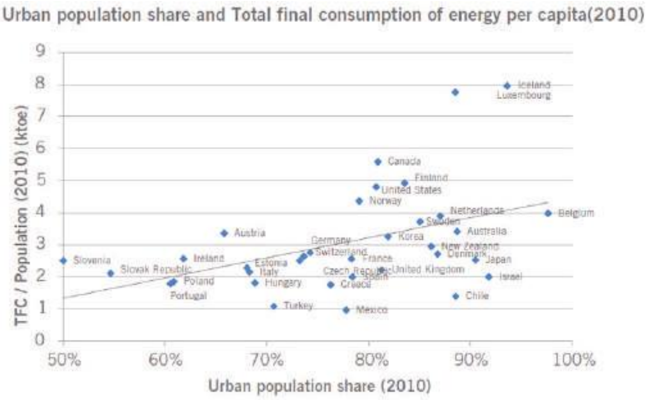
Section 5 will set out cases related to ensuring energy access by citizens of both high- and low-density population areas. Finally, **Section 6** will summarize the good practices acquired and will comment on the role of both the public and private sectors in creating sustainable energy systems.

INTRODUCTION – ENERGY AND THE URBAN FUTURE

Urbanization is a relatively recent phenomenon. Around the year 1800, less than 3% of the world's population lived in urban areas[1].New job opportunities, better health care and education, and a lack of resources in rural areas led to large-scale migration from rural to urban areas of people looking for a better future–a trend that is still present today and is expected to continue in the years to come. According to the United Nations (UN) data, cities are growing, in total by more than 60 million people each year—a figure which is similar to the entire population of the UK or France[2]. The latest UN projections from *World Urbanization Trends* estimate that the overall urban population is expected to rise from 54% in 2014 to more than 66% by 2050[3].

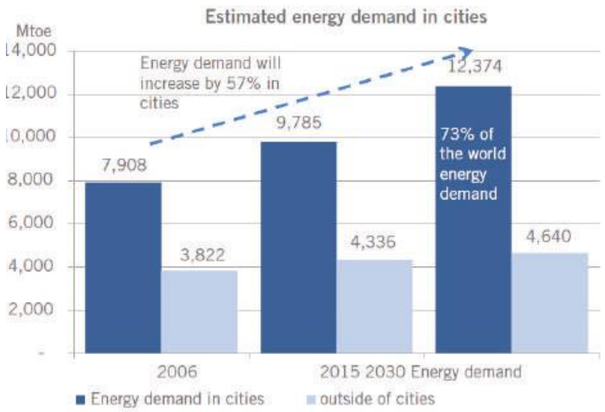
These trends put an enormous pressure on the supply and management of energy in urban areas. As more and more people move to cities, overall consumption of energy will increase (see Figure 1), causing increasing levels of pollution and greenhouse gas (GHG) emissions. According to the International Energy Agency (IEA), more than 70% of global energy demand will come from cities by 2030 (see Figure 2), representing more than 80% of the share of future pollution and GHG emissions. This will ultimately have an impact on global warming, increasing the world's temperature and fueling the worst consequences of climate change, as the increase in average global temperatures is caused primarily by raises in GHG emissions from transport and the energy supply[4]. If such emissions are not stopped or reduced, the negative effects can increase. As the IEA also reports, air pollution and low air-quality will be problems that are going to have a deep impact on citizens' health. Currently, around 6.5 million premature deaths each year can be attributed to air pollution—much higher than the number of deaths from HIV/AIDS, tuberculosis and injuries combined. It can be said that pollution in cities is a major health problem.

Figure 2. Energy demand: rural vs. urban areas (2006-2030)



Source: Prepared by the authors based on the data from UN (2014), IEA (2015).

Figure 1. Energy demand: rural vs. urban areas (2006-2030)



Source: Data from IEA (2008).

Meanwhile, it is undeniable that energy is crucial for the development of prosperous societies. Energy allows people to move from one place to another, to keep warm during winter, to light buildings at night, to access knowledge sources such as the Internet and, ultimately, to foster economic development. Energy access is crucial for a city and a country to grow, innovate and supply its population with food, water and sanitation. This means that governments and local authorities are at a crossroads between providing greater access to energy to their citizens, and having to reduce pollution and mitigate the negative externalities of energy production and consumption.

Urbanization can be not only the cause but also the solution for the challenge posed by climate change and air pollution. Cities may allow local governments to leverage the high density of people in urban areas. Supplying public services can be easier for local governments in areas with a high concentration of people, making use of economies of scale and agglomeration. Cities can foster the development of sustainable areas faster. Indeed, it is estimated that the world's 724 largest cities could

[1] United Nations, Urban Millennium – Urbanization facts and figures. Available at: http://www.un.org/ga/Istanbul+5/booklet4.pdf

[2] http://www.un.org/esa/population/publications/wup2007/2007WUP Highlights_web.pd

[3] https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.Pdf

[4] https://www.iea.org/publications/freepublications/publication/

reduce GHG emissions by up to 1.5 billion tons of CO_2 annually by 2030,[5] mainly by changing urban transport systems and by improving buildings' energy efficiency.

For these reasons, this document will focus on a number of urban case studies that are paving the way to a more sustainable future. By reviewing 29 case studies, we will identify new trends and good practices applied in cities all over the world. These cases illustrate how the energy system is being re-conceptualized in the cities of the 21st century. Specifically, we will center on projects related to renewable energies and an efficient use of energy that are having a significant impact on the United Nations Sustainable Development Goals (UNSDGs).

Scope and objectives of this document:

- The objective of this document is to identify and explain a number of good practices and trends in energy business models for both the private and public sector.
- To reach this objective, we will review 30 case studies related to renewable energies and efficient consumption and production of electricity that will help build sustainable urban areas in the coming decades and that will help achieve the United Nations Sustainable Development Goals (UNSDGs).

These case studies suggest three main areas of action: (1) sustainable urban models, (2) sustainable and electric transport systems, and (3) increasing energy access.

Building sustainable and energy-efficient neighborhoods will be key for the great urbanization that the 21st century will experience. Building smart grids and encouraging a circular use of energy can change the landscape of cities and encourage not only the cleaner production and supply of energy but also a more sustainable way of consuming it.

Since transport accounts for more than 27% of global energy demand,[6] it is also crucial that cities establish a transport system that is non-polluting and sustainable in the long term. Electric, shared and public mobility may play a key role in fueling the construction of a transport system that helps reduce both energy consumption and GHG emissions within urban areas.

However, as mentioned earlier, societies cannot prosper if they do not have energy access. We shall also show that renewable electricity can be an opportunity to bring sustainable energy to those who lack basic energy provision. The cities of tomorrow will not be sustainable if citizens do not have energy access and thus an appropriate level of education, health care and economic activity.

The conclusions of this analysis are clear. Renewable energy, combined with the efficient production and use of energy, the use of new information and communication technologies (ICTs) and new business models related to electricity, can power the future growth of cities in a sustainable way. Notwithstanding, both the private and public sector should be cautious when implementing projects. While the potential for renewables and electricity is high, it varies greatly depending on each city's characteristics. Population density, growth prospects and demand profiles shape the opportunities to introduce renewables and innovative energy systems. Accordingly, deployment strategies must be tailored to the technology options and policy frameworks of each city.

Moreover, collaboration between all stakeholders in cities will be key to implementing successful projects related to renewable energy and electricity. The private sector can be a great source of innovation and financing, as well as a source of knowledge and know-how when building city strategies, but behavioral change from citizens will also be crucial to ensure a more sustainable use of energy. Thus, local authorities will have to organize and create a strategy that takes into account all the stakeholders in order to put forward successful projects.

[5] See Floater et al., 2014 (forthcoming). Cities and the New Climate Economy.

[6] IEA, 2012

THE IMPORTANCE OF UNSDGs AND PUBLIC-PRIVATE PARTNERSHIPS

The UNSDGs form the specific goals that humanity, governments and the private sector should ultimately strive for. The UNSDGs are a number of targets that not only cities, but also regional, national and international levels of government, have to achieve in order to make the lives of the population better and provide a more sustainable world economic and political order. They cover a broad range of social issues, like poverty, hunger, health, education, climate change, gender equality and social justice, among others.

The UNSDGs serve as a basis to analyze and evaluate policies and specific projects. By setting out a number of goals, both the public and the private sector can understand which specific lines of policy might be needed, or in which areas of policy their projects are helping towards building a more sustainable future. For these reasons, this document will set out which UNSDGs are being fulfilled by each project, allowing us to see to what extent projects related to sustainable energies and the efficient use and production of electricity can help towards the building of a better future.

IESE's PPP for Cities is a research center that aims to create knowledge on effective public-private collaboration at the urban level. As mentioned previously in the introduction, the inevitable urban future is creating a number of pressing challenges, and thus putting pressure on research institutions and both public and private actors to think about innovative solutions to overcome them. However, we also believe that the increasing importance of cities over the next decades presents an opportunity for local and regional governments. Indeed, cities allow governments and private actors to supply public services more efficiently due to the high density and concentration of people, benefiting from network and agglomeration effects. Also, cities give local authorities the opportunity to take advantage of the high number of firms, innovation and creativity characteristic of urban areas. In this way, it is the view of IESE PPP for Cities that overcoming the challenges of the 21st century and reaching the UNSDGs goes hand in hand with building sustainable urban areas—something that we will try to help contribute to with this document, in partnership with Iberdrola.

Areas of action for renewables and electricity in cities:

1. Sustainable urban models
2. Sustainable and electric transport systems
3. Energy access

Moreover we argue, as the Specialist Center on PPPs in Smart and Sustainable Cities at IESE Business School, that cooperation between all stakeholders in urban areas is key to achieving the UNSDGs. For this, local authorities will have to create a clear strategy that integrates every actor in urban economies, both when defining the strategy and when implementing specific action plans, as well as make use of new technological innovations. Furthermore, we believe that the mere definition of collaboration in cities between public and private agents is undergoing deep changes, and thus both academia and the local authorities will need to explore the possibilities that new economic dynamics are bringing to overcome the challenges of the 21st century. Indeed, over the past decades, the concept of PPPs has been centered on the development of complex infrastructure projects that lasted for several decades. However, modern economies ask for a more flexible and wider definition that integrates other forms of collaboration based on the modern technologies, as well as a broader notion of PPPs with new formats, new objectives and new actors at play. All of these ideas will be developed throughout this document, with each project linked to both the specific UNSDGs that it contributes to and the way in which public-private collaborations materialize in that specific project.

METHODOLOGY

We now provide an overview of the methodology used in this report. The PPP for Cities carried out research to find several cases that could be considered interesting for the purpose of the project. The PPP for Cities also created a specific advisory board formed by experts in fields such as PPPs, smart cities, energy or climate change (see the list of members in Figure 3). The advisory board met online in July 2017 and during the first semester of 2018. During the advisory board meeting, the experts gave their assessments regarding the first list of cases selected and suggested broadening the scope of the study to try to include social projects whose implementation had been made possible by the use of smart solutions, and also to take into account the impact of these projects on the UNSDGs. After the advisory board meeting, the research team at PPP for Cities widened the selection of cases to include the experts' suggestions.

Once the list of cases was redefined, the study team contacted the person responsible for each case and sent them a spreadsheet requesting specific information. When possible, conference calls or interviews were carried out with the project leader. With this information, the PPP for Cities produced brief, specific case studies for each project and used the information, along with sources such as research papers or official reports, to detect good practices and lessons learned for each case and to provide some general conclusions.

The cases were selected with the objective of studying a balanced sample from different regions of the world and a variety of countries. This resulted in the selection of 29 cases, distributed between three fields of research: urban models, transport and energy access.

Figure 3. Members of the project advisory board

Advisor Board of the Project: Shapping the Cities of Tomorrow

1. **Ivonne Higuero.** Forests, Land and Housing Division Director UNECE. United Smart Cities. UNECE
   Fields of expertise: Smart Cities
2. **Neil Pinto.** CEO PPA Energy.
   Fields of expertise: Energy
3. **Ana Alcantud.** Consulting Director at Anteverti Consultant Firm.
   Fileds of expertise: Smart Cities
4. **Pilar Conesa.** CEO Anteverti Consultant firm & Curator SCEWC.
   Fields of expertise: Smart Cities
5. **Julia Lopez.** European Regional Director at C40 Cities Climate Leadership Group
   Fields of expertise: Environment
6. **David Baxter.** International Development and PPP Specialist and Facilitator. Former Executive Director IP3.
   Fields of expertise: PPP
7. **Pedro Neves.** CEO Global Solutions.
   Fields of expertise: PPP

Guest members:

Francisco Laverón. Iberdrola Direction of Energy Policies Head of Energy Policy. Chairman Area.
Fields of expertise: Energy

Beatriz Crisostomo. Iberdrola Head of Innovation Management
Fields of expertise: Innovation, Energy.

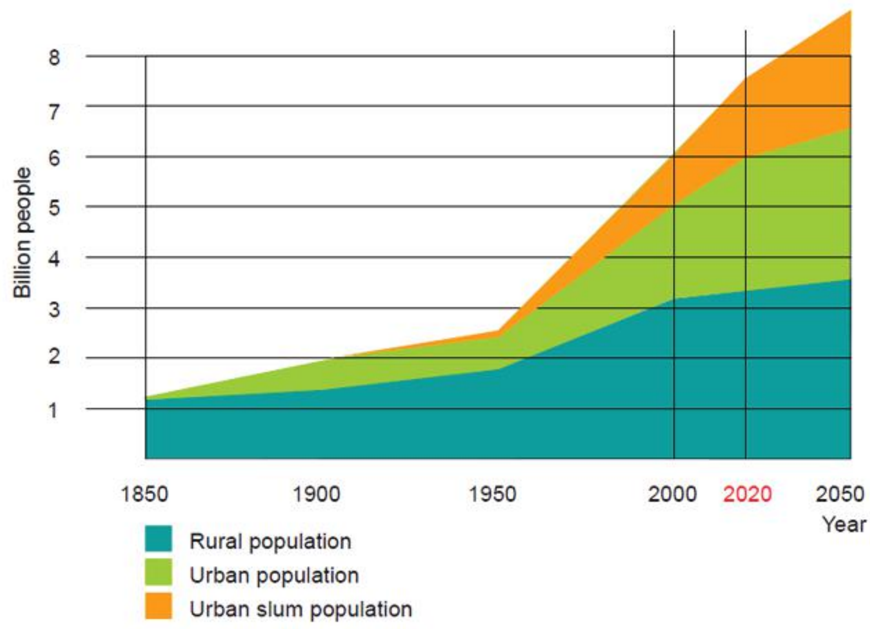
Maria Isabel Gomez. Iberdrola Senior Analyst Energy Policy and Climate Change Directorate.
Fields of expertise: Energy, Environment.

SUSTAINABLE URBAN MODELS

Cities are the primary engines of economic development and growth. Cities create wealth, enable economic activity and offer great life opportunities for their inhabitants. Roughly three-quarters of global economic activity is concentrated in urban areas. As the urban population grows even further (see Figure 4), so will the urban share of global GDP and investment.[7]

This is of special concern, as cities account for 70% of CO_2 emissions and the prospect of increasing urbanization raises the concern about the sustainability of such a process. According to the IEA, if we keep the current energy system trends (a 6ºC increase in temperatures), there will be a 70% increase in urban energy demand by 2050, as compared to 2013 levels (see Figure 5). In parallel, carbon emissions from energy use will increase by 50%.

Figure 4. Distribution of the World's Population (1850-2050)



Source: UN-HABITAT, Global Urban Observatory.

Besides being the main center of human economic activity, cities are also home to 54% of the world's population.[8] Increasing urbanization requires new and innovative development plans.[9] Development plans must balance the provision of services and infrastructure, the policies to reduce poverty and the sustainability of such measures in terms of resources. In cities, the three dimensions of sustainable development, as set out by the Brundtland Commission, are intrinsically related: the social dimension to promote quality of life and tackle marginalization, the economic dimension to develop productive activity, and the environmental dimension to foster development without compromising resources for the next generations.[10]

Despite the high consumption levels, cities offer the best opportunities to steer the global energy systems towards greater sustainability. For instance, the scenario of a 2ºC increase in temperatures by 2050 corresponds to just a 20% increase in energy demand compared to 2013. This can be achieved through the deployment of clean energy technologies, efficient energy use and the support of behavioral changes among citizens, among other possible initiatives.[11] In this way, neighborhoods emerge as a favorable dimension where sustainable systems and flows of resources can be integrated. The high density of neighborhoods, which means a strict relationship between economic, social, environmental and physical factors, can be an important element in accomplishing sustainability goals.[12] Cities, and consequently the neighborhoods that form them, need to

[7] https://sustainabledevelopment.un.org/content/documents/2569130918-SDSN-Why-the-World-Needs-an-Urban-SDG.pdf

[8] https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.Pdf

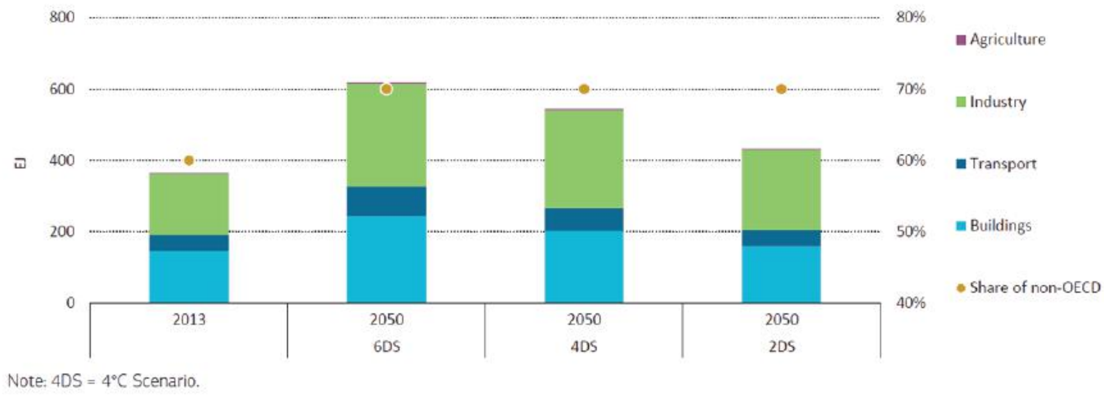
[9] http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/507480/IPOL-ITRE_ET(2014)507480_EN.pdf

[10] WCED (The World Commission on Environment and Development; 1987): Our common future. Oxford

[11] https://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives2016_ExecutiveSummary_EnglishVersion.pdf

[12] Barton et al., 2003: 207; Wheeler, 2004: 190

Figure 5. Urban primary energy demand 2013-2050 (scenarios)



Source: IEA,2016.

learn how to grow sustainably, leveraging agglomeration and network effects, as well as new developments in ICTs. Both private and public actors will have to collaborate to create a holistic strategy to tackle the challenges ahead.

New Frontiers in Energy Efficiency: Integrating ICTs in the Development of Sustainable Neighborhoods

In the past, efforts to mitigate climate change have focused on the construction of low-to-zero energy consumption buildings and large-scale facilities (solar and wind) in remote locations, or have been implemented in an uncoordinated manner. While they have promoted energy efficiency in buildings, these efforts have not included transportation and infrastructure systems (energy, water and waste) in the development plans, except for large renewables in remote locations that relied on long power lines.[13] Moreover, some cities have lagged behind in terms of including innovations in ICTs in their strategies; something that, if developed properly, is crucial for the creation of more efficient energy systems.

Indeed, the spread of information and communication technologies and global interconnectedness has great potential to accelerate human progress, to develop knowledge in societies, and to innovate and find new ways of delivering better services to citizens while curbing emissions. As the Ericsson Mobility Report expounds, ICT solutions could help to reduce GHG emissions by up to 15 % by 2030, amounting to around 10 gigatons of CO_2–more than the current carbon footprint of the European Union and United States combined. ICTs and new technologies, such as data processing, data mining and machine-learning, can automate processes that were extremely costly and time-consuming, while also enhancing machine-to-human interactions, sensing and control, and, more broadly, delivering synergies in the distribution and production of energy. In this way, the environmental dimension of sustainable development goes hand in hand with the use of new ICTs, such as energy grids, metering, pollution control and monitoring, and the renovation of buildings to integrate interconnected systems that encourage cost-containment and efficiency.

In the rest of this section, we present cases that serve as an example of good practices for projects related to distribution and production of energy. Although different, all projects are similar in nature: they leverage the expertise of both the public and private sector, foster collaboration, take advantage of new ICTs and make use of new business models.

We have divided this section into two main parts: (i) Demand-side management of energy innovations, which includes smart grid technologies and technologies for changes in customers' behavior; and (ii) Circular use of energy and clean energy for sustainable urban development plans, with the aim of fostering resilient, compact and economically productive cities.

[13] Fraker, H., 2013. The Hidden Potential of Sustainable Neighborhoods: Lessons from Low-Carbon Communities.

1. Demand Management

Greater availability of information about energy demand allows for better energy provision and consumption. In terms of provision and distribution, the development of smart grids fosters an efficient system (investment and operation) and provides information about energy use to customers. Through the availability of information, customers can better manage their own consumption.

Demand management can be seen as an important tool for energy efficiency, understood as using less energy to provide the same product or service. The IEA in its *World Energy Investment* report estimates that global investment in energy efficiency was US$221 billion in 2015, two thirds greater than the investment in conventional power generation.[14]

Through energy efficiency, the IEA estimates that 1.5 billion tons of carbon dioxide (CO_2) were avoided in 2015. As awareness of these benefits–and of their economic and social value–grows, they will become more important as drivers of further efficiency improvements.

In this section, we provide good practices regarding two key elements of energy efficiency: the employment of technologies in power grids, and sustainable consumption behavior.

Smart grid characteristics:

- Automation, communication and monitoring;
- Self-healing and adaptation;
- Use of digital meters, telemetering and telemanagement;
- Interaction for proactive and informed consumers;
- Possibility of differentiated and dynamic tariffs;
- Optimal operation for the best use of resources and equipment;
- Decentralized management;
- Integration of systems and services;
- Safety from physical and cyberattacks;
- Integration and control of both centralized and distributed generation;
- Controlled multidirectional energy flow.

Smart Grids and Distribution

Renewing electricity networks, meeting growing electricity demand, integrating renewable sources of energy and enabling a dynamic energy market are challenges of growing concern in cities worldwide. More efficient and more resilient power grids seek to supply these needs.

Smart grid projects have emerged as a successful model to tackle these challenges in a sustainable way. The intensive use of technologies allows a more user-centric approach that substitutes the current model of a vertically integrated scheme with only centralized generation, distributed consumption and limited interconnection capabilities between the control areas.

Through an electricity distribution network that interfaces with distributed energy resources and end users, smart grids can automatically monitor energy flows using smart meters, digital computing power and interconnected communication networks. In addition, they can adjust flows according to changes in energy supply and consumer demand.

Smart grids increase the efficiency of the system, minimizing costs and environmental impacts, while maximizing reliability, resilience and stability of the system. For developing countries, this is a crucial component, given the high costs and the low quality of the existing infrastructure. In addition, smart grids are an important tool for promoting mixed power matrices from different energy sources, including the integration of renewable energy, as these sources rely on climate and environmental variables that are volatile by nature.

While looking to modernize their power grids, cities face the need for significant investments and planning to develop advanced technologies. In order to achieve this, PPP represents a very attractive channel for designing, implementing and operating smart grids.

Below, we present some cases in which smart grids are an essential element of a smart city project or the starting point for future smart city initiatives. All the cases present ambitious plans to develop power grid technologies, most of them being pilot projects for future replication in other areas.

One of the most ambitious and pioneering projects of energy efficiency and sustainability through the implementation of smart grids technologies is the Smartcity Málaga project, launched in 2009. Under the EU energy efficiency plan, this project became a world-renowned benchmark, as it has achieved energy savings of 25%, and a 20% reduction in CO_2 emissions.

[14] World Energy Investment 2016 – Can be found here: http://www.iea.org/eemr16/ and also summary here: https://www.iea.org/media/publications/wei/WEI2016FactSheet.pdf

Case Study 1: Smartcity Málaga

Source: https://www.google.com/maps

	Case Study 1
City	Málaga, Spain
Population	1,628,973
Wealth	High
Type of project	Sustainable neighborhoods
Subtype	Smart grids and distribution

What Is It About?

Modernization of the existing electricity grid by implementing new smart meters and integrating renewable energy sources into the grid.

Summary

Under the EU energy plan to foster energy efficiency and cut GHG emissions, in 2008 the city of Málaga implemented a living lab for smart grid technologies through PPP. It was designed, built and operated by a consortium contributing to the modernization and optimization of the existing electricity grid, the use of new smart meters and the integrated use of renewable energy sources into the smart grid.

This project is one of the Europe's largest eco-efficient initiatives for smart cities. Through smart grid technologies that include renewable energy sources, Málaga was able to rationalize energy consumption and cut CO_2 emissions via new technologies. According to the Smartcity Málaga white paper published by Endesa in 2014, the first phase of the project has achieved energy savings of 25% and a 20% reduction in CO_2 emissions.

Factors of Success

- Implementation of an exemplary distribution grid that includes a heterogeneous mixture of generation and consumption;
- Intelligent connection: Plug It Smart;
- Validation and practical implementation of the conclusions from a project to create new technologies (DENISE);
- Integration of renewable generation and storage at the medium and low voltage level, and application of supervision and control techniques for the optimal use of natural resources;
- Construction of a central plant from which the distribution grid is monitored and the consumer portal is managed;
- Key performance indicator (KPI) monitoring system of the new technologies;
- Active demand-side management: customers have access to their electricity demand—including real-time changes—and a comparison of their consumption with those of similar users, along with personal advice for reducing consumption.

Agents Involved

- City of Málaga;
- Consortium led by ENDESA: 11 companies and 14 research institutions;
- Startups: encouraged to take advantage of the Smartcity Málaga infrastructure to create solutions for citizens and reward public contribution.

Case Study 1: Smartcity Málaga (cont.)

Energy and Environment Technologies

- Air quality and water management control through sensors and smart meters;
- Automation of the grid and deployment of communication infrastructure for real-time monitoring;
- Cogeneration plants fuelled by biogas;
- Street lighting: use of LED lamps, with some areas powered by solar energy and wind;
- 200 EVs (Zem2All Initiative);
- Technology for charging EVs;
- Research on vehicle-to-grid (V2G) technology, which uses vehicle batteries to balance fluctuations in renewable power generation.

Outcomes

This living lab successfully implemented a distribution grid that incorporates a heterogeneous mix of generation and consumption with the inclusion of renewables. In addition, monitoring the distribution grid and implementing a consumer portal have also strengthened the effectiveness and reliability of the system. As a result, there is an overall increase in the efficiency of the distribution system and of energy consumption. The main impacts were:

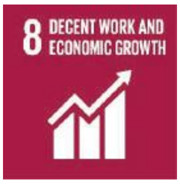
- Annual consumption savings of 20% in terms of CO_2
- Increase in the use of renewable energy of around 5%
- Energy efficiency improvements of approximately 25%
- 42% of participants in the project achieved a reduction in energy consumption of more than 10%.

Impact (Good Practices, Lessons Learned)

- The implementation of new technologies and an integrated system of monitoring that keeps them updated;
- Partners from distinct disciplines facilitate the concentration of know-how and experience, resulting in benefits for the project with the development of new technologies to rationalize energy consumption:
  - Large companies (users and technology providers) facilitate the definition and achievement of the objectives;
  - R&D centers are sources of specialized knowledge;
  - Small and medium-sized businesses are specialists in methods and tools;
  - Service providers contribute their practical experience in meeting real-world requirements;
  - Startups provide innovative solutions.
- Reduction of GHG emissions through energy efficiency improvement, based on:
  - Efficiency of the distribution system, which leads to a reduction in energy demand due to the high availability and capacity of the cogeneration plant, a flattening of the demand curve and a reduction in technical losses at all voltage levels;
  - Efficiency in energy consumption, which includes all the local actions developed: a reduction in the consumption of public lighting, a reduction in consumption by customers with a high contract demand (SMEs and the residential sector), an increase in the use of renewable energy resources through storage systems and the use of EVs with V2G technology, and greater efficiency of the data processing systems used in the project.

Case Study 1: Smartcity Málaga (cont.)

- Impact in terms of SDGs

7. Affordable and Clean Energy	8. Decent Work and Economic Growth	9. Industry Innovation and Infrastructure	11. Sustainable Cities and Communities	13. Climate Action
				
HIGH IMPACT	**MODERATE IMPACT**	**HIGH IMPACT**	**HIGH IMPACT**	**HIGH IMPACT**

Feasibility and Replicability

- The Smartcity Málaga project is considered a living lab for future smart grid technology worldwide. Its model has already been replicated in some cities around the world, such as Barcelona, Buzios, Santiago and El Hierro;
- It is enhanced by the involvement of a wide range of companies that can implement their know-how and technologies in other cities.

Movement Towards Digital Energy Utilities

Renewables, distributed energy resources and smart grids demand new capabilities and are triggering new business models and regulatory frameworks in the power energy industry.[15] At first, private energy companies might see this revolution as a threat to their business models and as a trend that can cause increasing competition and, thus, revenue losses. Nevertheless, if able to transform the sector properly, the digital revolution can provide opportunities for incumbent private companies that will generate increasing revenues in some business areas and encourage efficiency in others, such as customer relationship management. Moreover, with regard to the public sector, governments and regulatory bodies worldwide are stimulating the adoption of smarter measuring systems and more environmentally sustainable systems of generation and consumption, as they have been found to substantially improve the provision of energy to citizens.

McKinsey proposes three dimensions in which energy utilities may focus attention on the digital revolution: productivity and efficiency, customer experience and new frontiers.[16] It estimates that digital optimization (for instance, smart meters and smart grids) can boost profitability by 20% to 30 %–something of importance to both the private and public sector. Meanwhile, by digitizing the customer experience, utilities can simultaneously improve satisfaction and lower costs.

The Energy Smart Community project of the New York State Electric and Gas Corporation, a subsidiary of the energy company AVANGRID, exemplifies this new approach. It includes new technologies, such as advanced metering systems, as part of a modern and ambitious plan to integrate infrastructure, process and people in a distributed systems platform (DSP) provider. Unlike the Smartcity Málaga project, this pilot project is an initiative of AVANGRID, which has chosen the city of Ithaca to host this platform of initiatives and technologies under the framework of the State of New York's energy strategy Reforming the Energy Vision. This project aims to integrate all the actors of the energy system, enable markets by connecting both consumers and producers, and give new services to customers, becoming a world-class example of the implementation of the latest technologies in a neighborhood.

[15] http://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-digital-utility-new-opportunities-and-challenges

[16] Ibidem

Case Study 2: Energy Smart Community Project

Source: https://www.google.com/maps

	Case Study 2
City	Ithaca, United States
Population	30,756
Wealth	High
Type of project	Sustainable neighborhoods
Subtype	Smart grids and distribution

What Is It About?

A digital platform for both customers and energy producers and distributors to improve the electric distribution service, the use of renewable sources, and give more information to customers on their energy consumption and potential solutions. The proposals include, among others, a digital platform application that gives customers the ability to choose between different pricing solutions, as well as informing them about local service providers that offer energy efficiency solutions. The project also includes the implementation of an advanced smart metering system in the community, which, besides giving customers smart meters, also provides consumers with rechargeable batteries so that smart meters automatically charge their batteries with cheaper energy to use at a later time.

Summary

In 2014 The New York Public Service Commission launched the energy strategy Reforming the Energy Vision (REV) for the State of New York, with the aim of improving the electric distribution service, developing new energy products and services, introducing more distributed and renewable resources and helping customers to make more informed energy choices.

In this context, Iberdrola USA Networks (AVANGRID) has developed the Energy Smart Community project in the city of Ithaca to serve as a platform for initiatives and technologies that will test these REV concepts. AVANGRID expects to gradually add new services and redesign its way of doing business around New York State. The project was approved in June 2016 by AVANGRID. Ithaca was chosen because of its energy and sustainability plans, including its engagement to reduce GHG emissions by 80% by 2050, in accordance with the Paris Agreement.

The platform developed under this pilot project will be designed not only to operate the new grid efficiently, but also to incorporate integrated system planning and market enablement that will provide information to the market and customers. Some program elements will be designed, implemented and managed by the company, with the significant involvement of community or market partners. It includes foundational investments in technologies and systems: advanced metering that provides sensors to operate the grid efficiently and data for customers' forecasting and planning, and it enables temporal-based pricing for customer and market enablement in order to create time-based products and services.

The primary objectives of the project include:

- Test and prove the functionality of foundational platform technologies;
- Develop new capabilities and processes that support the evolution of the DSP;
- Create and test new rate designs that support system efficiency;
- Identify new methods of creating value for customers;

Case Study 2: Energy Smart Community Project (cont.)

- Identify new methods of engaging with the market;
- Create an environment of collaboration;
- Support and inform a clean energy policy.

Factors of Success

- The use of technologies, especially advanced metering infrastructure (AMI), for integrating the distribution system and all the agents involved;
- Online access to information is crucial: it supports distributed energy resources (DER) developers and local government planners in the development of energy plans and processes; it allows customers' management of energy consumption, such as through time-varying rates (TVRs), which provide the opportunity to capture bill savings by eliminating energy consumption or shifting it to less expensive periods; and it gives the opportunity to have a detailed view of system conditions and load patterns, which favors setting targets for improving the use of renewable energy.

Agents Involved

- New York State Electric & Gas Corporation, AVANGRID;
- Tompkins County, City of Ithaca, Town of Ithaca and New York State;
- Cornell University and Atkinson Center for a Sustainable Future.

Energy and Environment Technologies

- Advanced Metering Infrastructure (AMI): integrated set of technologies that collect interval energy usage data through smart meters, validate and store the data in a database, provide customers access to their own meter data through a web portal, and provide behind-the-meter monitoring and control capabilities;
- Distribution automation (DA): integrated application of technologies that enables the automated or centralized control of power quality, reliability and flow conditions on circuits;
- Telecommunications: set of technologies that enable telecommunication between network and devices and company systems. It is the base for grid operation applications (AMI and automation);
- Advanced distribution management systems (ADMS): set of systems that help manage and control the network, optimize network performance, respond to outages and support the integration of DER;
- System analysis and planning tools: customized tools that utilize data compiled by systems and databases, and perform complex analyses to support all three core DSP functions.

Outcomes

This platform, approved in 2016, will develop new capabilities and processes to support the evolution of the DSP, prove the functionality of foundational platform technologies, identify new methods for creating value for customers and for engaging with the market, implement new rate designs that support system efficiency and inform a clean energy policy. Approximately 12,400 homes and businesses will benefit from smart meters, energy managers and innovative pricing solutions.

Case Study 2: Energy Smart Community Project (cont.)

Impact (Good Practices, Lessons Learned)

This is a well-designed model of future energy systems based on the digital domain. Establishing an effective interface between customers, the market and the company allows an updated user-centric system. Moreover, market enablement fosters innovation of the system through an online energy platform and marketplace for access to energy service offerings. It develops opportunities for market partners to gain access to new markets, to retail customers and to the data needed to effectively engage those that most benefit from energy services.

- Development of a platform that integrates infrastructure, process and people (DSP provider): it contributes to the operation of a more dynamic and diverse grid, customers' control of their energy profile and access to new energy products and services;
- Program measures of success;
- Grid operations: real-time network and DER performance data to coordinate and control grid resources, ensure the stability of the network, and maintain the quality of power delivered to residential and business customers;
- Customer average interruption duration index (CAIDI);
  - Market enablement: online energy platform and marketplace for access to energy service offerings and to develop opportunities for market partners to gain access to new markets, to retail customers and to the data needed to effectively engage those that most benefit from energy services.
- Impact in terms of SDGs

7. Affordable and Clean Energy

High Impact

9. Industry Innovation and Infrastructure

High Impact

11. Sustainable Cities and Communities

High Impact

13. Climate Action

High Impact

Smart Grids and Developing Countries

Since 1990, more than 1.7 billion people have gained access to electricity for the first time.17 However, there are still frequent blackouts and brownouts that leave many developing countries with more than 20 hours of power outages each month.18 Indeed, while advanced countries have well-developed modern grids, many others have grids that do not operate consistently over a 24-hour period, and still others have no electricity infrastructure at all. Developing countries and emerging economies are often categorized by high growth in electricity demand, high commercial and technical losses in a context of rapid economic growth and development, dense urban populations and dispersed rural populations. These aspects present both significant challenges and opportunities.

Smart grids can play an important role in the deployment of new electricity infrastructure in developing countries and emerging economies by enabling more efficient operation and lower costs. Small remote systems (not connected to a centralized electricity infrastructure and initially employed as a cost-effective approach to rural electrification) could later be connected easily to a national or regional infrastructure. In this way, smart grids could enable transition from simple, one-off approaches to electrification (e.g., battery-based or solar photovoltaic (PV)-based household electrification) to community grids that can then connect to national and regional grids.

Improving energy efficiency provision and distribution through smart grids is an approach that is being adopted by some developing countries. For instance, Brazil is expected to invest US$36 billion19 in its smart grid and has announced a goal to replace the nation's 63 million energy readers with smart readers by 2023.

In Brazil's context, the cases of Fernando de Noronha and São Luiz do Paraitinga, besides being part of the UNESCO World Heritage list, provide good practices and serve as great examples to overcome the limited Brazilian Electric System. This system is characterized by large hydraulic plants that are far away from consumer centers. Guided by the need for new technologies and innovation in the electric sector, the Brazilian National Agency of Electric Energy launched a R&D program addressed to companies involved in the distribution, transmission and generation of energy. It requires that these companies invest 0.5% of their net operational revenues in R&D. As a result, a series of pilot projects were developed with the potential of replicability. Fernando de Noronha and São Luiz do Paraitinga projects are some of the pilot projects funded by the Brazilian Electric Energy Agency's—Agência Nacional de Energia Elétrica (ANEEL)—R&D program.

In both Brazilian cases, the pilot projects are developed by concessionaires of energy in their respective areas. Funding comes from the net revenues of the companies, as requested by ANEEL's program, which pushes private companies to implement projects for increasing energy efficiency in Brazilian cities.

[17] World Bank: http://www.worldbank.org/en/news/press-release/2013/05/28/first-set-of-global-data-on-energy-access-renewable-energy-and-energy-efficiency-released

[18] http://www.theatlantic.com/sponsored/siemens-2014/how-smart-grids-could-transform-the-developing-world/171/

[19] Ibidem

Case Study 3: *Redes Elétricas Inteligentes*

Source: https://www.google.com/maps

	Case Study 3
City	Fernando de Noronha, Brazil
Population	2,930
Wealth	Low
Type of project	Sustainable neighborhoods
Subtype	Smart grids and distribution; behavioral change

What Is It About?

Implementation of 816 smart meters, improvement of telecommunication technologies using fiber-optic, IT, automation and distributed microgeneration. The project will allow better energy provision, as well as data collection and processing for the evaluation of the project and potential new initiatives.

Summary

The island of Fernando de Noronha is the place chosen by CELPE, the Energy Company of Pernambuco from the group Neoenergia, to implement the project of smart grids, Redes Eléctricas Inteligentes (Smart Electrical Networks), which started in 2012. It is part of the R&D project for smart grids, funded and supervised by ANEEL.

Previously, the island has also received a project under the Energy Efficiency Program regulated by ANEEL. It consisted of two solar plants implemented in the years of 2014 and 2015, with the aim of reducing oil consumption by 10%. The Noronha I solar plant was installed in 2014 on the property of Aeronautica, which is responsible for operations and maintenance after the first year of working, while the Noronha II solar plant was installed in an area owned by the government of the state of Pernambuco. After the implementation, Noronha II became the property of the government of the state of Pernambuco and the energy is used in public buildings. The first plant has had technical support from the United States Agency for International Development (USAID), and the German Corporation for International Cooperation (GIZ) has contributed to both projects.

The project aims to develop and implement smart grids in the island, through the use of modern technologies for metering (816 smart meters), telecommunication using fiber-optic, IT, automation and distributed microgeneration. In addition, it also seeks to evaluate the viability of the project in terms of sustainability, quality of electric energy, provision of electric vehicles and application of differentiated tariffs.

This project has received investments of 18 million reals from ANEEL's program of R&D. CELPE has built the infrastructure and operates the service, under a contract with the government of the state of Pernambuco and the administration of Fernando de Noronha.

Factors of Success

- Management of energy consumption by the energy distributor and the customer;
- Control system to manage the different alternative energy sources of the island.

Case Study 3: Redes Elétricas Inteligentes (cont.)

Agents Involved

- Administration of Fernando de Noronha;
- The government of the state of Pernambuco;
- CELPE (Pernambuco Energy Company, part of the group Neoenergia);
- Pernambuco's secretariats: Science, Technology and Innovation; Environment and Sustainability and Economic Development;
- ANEEL (National Electric Energy Agency);
- Research institutions: Universidade de Pernambuco (UPE), Universidade Federal de Pernambuco (UFPE), Centro de Pesquisa e Desenvolvimento em Telecomunicações (CPqD) and National Renewable Energy Laboratory;
- Other private companies providing technologies.

Energy and Environment Technologies

- Smart metering:
- 816 smart meters;
- Characteristics: open protocol communication, metering system with interoperability with multiproviders, energetic balance, remote management of energy lines and identification of the lack of energy;
- Online consumer portal;
- Telecommunication technologies, using fiber-optic;
- Automation of the distribution;
- Distributed generation for solar and wind energy sources;
- Storage system linked to microgeneration;
- EV and PV charging station that accumulates energy in batteries;
- Street lighting: remote management system, LED lamps.

Outcomes

It aims to provide an energy saving of 10% in the island through energy efficiency provision and more sustainable energy use by customers.

Case Study 3: Redes Elétricas Inteligentes (cont.)

Impact (Good Practices, Lessons Learned)

This pilot project shows the importance of partnerships for the development and implementation of technologies, which foster the Brazilian incipient market of ICTs for the energy sector. The control system to manage the different energy sources of the island and the stimulus to use distributed microgeneration contribute to the diversification of the energy matrix. The project also seeks to evaluate its own viability in terms of sustainability, quality of electric energy, provision of EVs and application of differentiated tariffs.

- Customers can manage energy consumption through an online portal: monthly consumption portal, daily control of consumption;
- Stimulus to use distributed microgeneration, which contributes to the diversification of the energy matrix of the island (still dependent on the coal power station of Tubarao) through the installation of solar panels in residential and public buildings.
- Impact in terms of SDGs

7. Affordable and Clean Energy	9. Industry Innovation and Infrastructure	10. Reduced Inequalities	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action

High Impact	**High Impact**	**Moderate Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- This pilot project, which is part of the Brazilian national program, can easily be replicated throughout the country due to the characteristics of the Brazilian electric sector and geography;
- Given the incipient market of smart grids in the country, partnerships between producers, energy concessionaries, ICTs and universities are crucial for the development of new technologies and solutions;
- In terms of feasibility, in addition to the funds from the R&D program, it is essential to set up multiple partnerships for the development and implementation of technologies for smart grids.

Case Study 4: Cidade Inteligente

Source: https://www.google.com/maps

	Case Study 4
City	São Luiz do Paraitinga, Brazil
Population	10,404
Wealth	Low
Type of project	Sustainable neighborhoods
Subtype	Smart grids and distribution; behavioral change

What Is It About?

A pilot project that implements smart grids for energy savings. Its results will support a future large-scale commercial deployment project.

Summary

under the funding of the Brazilian National Energy Agency (ANEEL) R&D program for smart grids. The agency states that 0.5% of energy distributors' revenues must be invested in R&D projects. It is being deployed in the city of São Luiz do Paraitinga, in São Paulo state, by the energy company Elektro, a member of the Neoenergia group. It aims to test smart grid technologies for energy savings applied in the Brazilian scenario. The project is focused on items related to energy distribution and the integration of the city's population with the new technologies. The project started in 2013 and, at this point, academic research is being completed. It is expected to develop technical, economic and regulatory methodology and guidelines to support a future large-scale commercial deployment in the Elektro supply area, based on the results obtained from the implementation of the pilot project.

The goal of developing this reference model for innovative solutions for automation and operation of the power grid, for distributed generation, smart metering and for the inclusion of EVs includes some specific objectives:

- Evaluate existing technologies and case studies (smart grid/smart city) in the national and international markets;
- Design an integrated and interoperable smart grid architecture involving consumers and specialized systems, such as power distribution, computer, telecommunications and others;
- Evaluate the legal and regulatory restrictions to the services and systems to be offered by Elektro;
- Conduct technical-economic feasibility studies of technologies, architectures and services;
- Create proof of scenarios for solutions, regarding automation and operation of the low-voltage and medium-voltage networks; distributed generation in low-voltage points through solar and wind energy; creation of the AMI involving radio frequency (RF) mesh and power line carrier (PLC) technologies; connection of EVs to the grid and charging stations; and shared telecommunication and IT infrastructure;
- Development of marketing procedures, operation, control and protection of smart cities.

Case Study 4: Cidade Inteligente (cont.)

The second goal is to raise the awareness of the population regarding smart city technologies and energy efficiency. This was achieved by the following actions:

- Partnership with the Secretary of Education to promote energy efficiency measures in the schools of São Luiz do Paraitinga through initiatives such as science fairs and writing contests.
- Creation of a smart house—open to the public—with a meter museum, lectures on how to save energy, electronic totem with access to the project's website and the virtual agency, etc;
- Creation of the Android app Passeio Inteligente (Smart Stroll) that allows people to take a virtual tour around the city and learn about the different technologies implemented;
- Supply of electric bicycles for people who understand the advantages of EVs;
- Renewal of public lighting using new LED lamps.

The third goal is to develop knowledge about smart grids in the country. To achieve this goal, Elektro signed partnerships with three major Brazilian universities.

Factors of Success

- Development of knowledge in smart grid technologies through partnership with Brazilian universities. It has provided Elektro with insights as how to implement these technologies in their concession area;
- Installation of the infrastructure for the communication of smart meters with the Elektro system;
- Training of personnel to carry out the previous tasks, generating knowledge value;
- Monitoring the communication network;
- Raising the population's awareness regarding the new technologies and more efficient energy consumption, contributing to more sustainable attitudes among citizens.

Agents Involved

- Elektro, Neoenergia group;
- ANEEL;
- Private companies: Energia Pura (PV panels), BeeLEDS, Ecil, Elucid, FITec, Golden, Metrowatt, MFAP, Nansen, TAG, Tembici, V2COM, ZIV;
- Universities: PUC-Rio, UNESP (Ilha Solteira campus), USP (São Carlos campus);
- Local government of São Luiz do Paraitinga.

Energy and Environment Technologies

- EVs and bicycles: loading stations;
- Smart meters, inverters, telecommunications and IT infrastructure;
- PV panels, LED lighting;
- Interaction with customers: mobile app, website (virtual agency).

Case Study 4: Cidade Inteligente (cont.)

Outcomes

Higher integration of the population to the new technologies being implemented, with better energy planning and consumption. The outcomes of the project are still being evaluated.

Impact (Good Practices, Lessons Learned)

The joint strategy of new technologies implemented and customers' access to information fosters energy efficiency in terms of provision and consumption. In a context in which sustainable consumption is still incipient, initiatives to raise people's awareness about the importance and the means for consuming energy in a sustainable way were crucial. In addition, the involvement of diverse private companies, research institutions and universities stimulates knowledge production for the design of new technologies for the Brazilian energy context and can serve as a pilot project to foster a bigger and more comprehensive project.

- Raise customer awareness about the new technologies implemented for effective promotion of sustainable energy use;
- Joint strategy of new technologies implemented and customers' access to information to foster energy efficiency in terms of provision and consumption;
- Stimulus of knowledge production to foster innovative technologies in the Brazilian energy sector.
- Impact in terms of SDGs

7. Affordable and Clean Energy	9. Industry Innovation and Infrastructure	10. Reduced Inequalities	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action
7 AFFORDABLE AND CLEAN ENERGY	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	10 REDUCED INEQUALITIES	11 SUSTAINABLE CITIES AND COMMUNITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION
High Impact	**High Impact**	**Moderate Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- This pilot project can easily be replicated throughout the country, given the characteristics of the Brazilian electric sector and the geographic and demographic characteristics of the country;
- Given the incipient market of smart grids in the country, partnerships between producers, energy concessionaries, ICTs and universities are crucial for the development of new technologies and solutions.

Behavioral Change

The introduction of new technologies in the electricity network is changing the customers' relationship with the system and, consequently, their consumption behavior. It is an example of the information market places concept, in which cities provide a real-world testing ground for new ideas and technologies, and users are transformed from passive recipients of ideas, services and solutions to active generators and creators of their smart city. This concept is applied, for instance, in the case of the Energy Smart Community project in Ithaca described earlier.

Providing information access and the possibility to plan and manage energy consumption combines energy efficiency with rationalization of consumption. The use of digital platforms, such as online portals, smartphone apps and new customer-centered services, provides, not only customers' access to information, but it also allows companies to analyze customers' behaviors. It can enhance service quality, lower costs, and preserve and deepen customer relationships.

BMW's i ChargeForward project focuses on customers' relationships to boost the use of EVs. In a first phase, the company provided customers with a smartphone application to manage their own vehicle charging times, helping to optimize the electric grid through demand response, with incentives to reduce usage during periods of high-peak demand. This technology allows increased grid reliability, lower costs and lower impact on the environment. This is a project developed under the funding of the California Energy Commission. BMW set up a partnership with the California-based utility provider PG&E due to its support for new smart grid technologies and its willingness to explore advanced forms of smart charging.

In terms of sustainable neighborhoods, a central component is a community that has been able to learn, adapt and innovate.[20] In this sense, the provision of real-time information about consumption can change people's behavior towards a more sustainable lifestyle. This is the case where communities have a robust, sustainable agenda and in places in which sustainable consumption is still being presented and encouraged among people.

For the first case, the smart system in the neighborhood of Hammarby Sjöstad in Stockholm complements an ambitious model of sustainability. Beyond cogeneration of energy and the integrated energy, water and waste management system, it also provides inhabitants with a display in their kitchen that shows, in real time, the use of heating, electricity and water. In addition, independent power producers allow people to play an active role in energy supply, thereby helping to reduce reliance on the central network system. Under this integrated system, inhabitants can have direct control over both energy consumption and production. Such a system is favored by existing sustainable behavior among citizens.

In other contexts, sustainable consumption is still a flourishing movement. Raising citizens' awareness about the importance of energy efficiency and more sustainable energy consumption is one of the goals of the pilot project Cidade Inteligente in São Luiz do Paraitinga, Brazil. This objective promotes the implementation of smart grid technologies through the access of consumption information available in an online portal, the virtual agency. There, people can control, plan and manage their daily energy use. Through a joint strategy of new technologies and customers' access to information, it is possible to foster energy efficiency in terms of provision and consumption.

[20] Coe, A., Paquet, G., Roy, J., 2001. E-governance and smart communities: a social learning challenge. Journal on Social Science Computer Review 19 (1).

Case Study 5: Hammarby Sjöstad

Source: https://www.google.com/maps

	Case Study 5
City	Stockholm, Sweden
Population	789,024
Wealth	High
Type of project	Sustainable neighborhoods
Subtype	Circular use of energy and clean energy; behavioral change

What Is It About?

The creation of a sustainable neighborhood in a former industrial district, where a number of solutions were implemented in order to reduce fossil fuel energy use. These solutions include the implementation of solar cells, hydropower technologies and cogeneration to provide both energy and heat to homes at the same time.

Summary

In the beginning of the 1990s, there was a strong demand for housing in Stockholm. In that period, the industrial regional of Hammarby Sjöstad was seen as attractive for residential purposes because of its proximity to the city center. After being selected to become an urban district, the city of Stockholm set the goal to create an international model of sustainable development. The program includes targets for decontamination, use of brownfield land, provision of public transport options to discourage car use, energy consumption, and recycling of water and waste. The Hammarby Sjöstad project was partially supported by a national subsidy program that aimed to encourage municipalities to become part of an ecologically sustainable society, while providing project-related jobs in municipalities (Bylund, 2003). The financial investment of the project consists of €0.5 billion from the public sector and €3 billion from the private sector.

The Hammarby model aimed to be twice as sustainable as the Swedish average, with three comprehensive objectives:

1. Fossil-fuel-free city district by 2030;
2. CO_2 emissions cut to 1.5 tons per person per year (CO_2 equivalent) by 2020;
3. Adapt the area to the expected effects of climate change.

This model has an ecocycle that addresses energy, waste, water and sewage for housing, offices and other commercial structures. Core environmental and infrastructure plans for this area have been developed jointly by three city agencies: the Stockholm Water Company, the energy company Fortum and the Stockholm Waste Management Administration. Project management was carried out by representatives of departments overseeing planning, roads and real estate, water and sewage, and waste and energy. The model is an attempt to turn a linear urban metabolism, which consumes inflowing resources and discards outflowing wastes, into a cyclical system that optimizes the use of resources and minimizes waste.

Case Study 5: Hammarby Sjöstad (cont.)

Factors of Success

- Integrated planning with an eco-focus, in which the residential environment is based on sustainable resource usage;
- Environmental Lead Program (ELP) tool to assess and monitor environmental performance in the development project. It defines relevant activities from an environmental perspective and quantifies the environmental loads originating from these activities, such as emissions, soil pollutants, waste and the use of water and nonrenewable energy sources. This tool allows decision-makers to understand environmental issues early in project planning;
- Coordination among key stakeholders (planning authorities, architects, consulting engineers and developers): Stockholm's various departments have been integrated into a single fabric, led by a project manager and an environmental officer whose responsibilities have included guiding and influencing all stakeholders, public as well as private, to realize the environmental objectives of the project (Johansson and Svane, 2002).

Agents Involved

- Local government of Stockholm;
- Swedish national government;
- Stockholm Water Company;
- Energy company Fortum;
- Stockholm waste management administration;
- Private actors: 33 developers and 29 architectural firms;
- Environmental Information Center.

Energy and Environment Technologies

- Solar cells, hydropower and biofuel technology;
- Bioenergy and incineration of local waste to produce both locally generated heat and cogenerated electricity;
- Large-scale local wastewater and stormwater harvest and filtration;
- Smart system: interface between customers and energy provider;
- High-tech waste sorting and waste transportation system.

Outcomes

This model is moving towards a fossil-fuel-free city district by 2030, by successfully implemented integrated planning—from the production and management of resources to the best design of buildings.

Case Study 5: Hammarby Sjöstad (cont.)

Impact (Good Practices, Lessons Learned)

One of the key elements for the success of this model is the integrated planning and management through systematic collaboration among stakeholders, who include 33 developers and 29 architectural firms. In order to achieve this, Stockholm's various departments have been integrated into a single fabric led by a project manager and an environmental officer whose responsibilities have included guiding and influencing all stakeholders, public as well as private, to realize the environmental objectives of the project.

- Integrated planning and management through systematic stakeholder collaboration led to greater life-cycle benefits: the project involved 33 developers and 29 architectural firms in total;

- Development and implementation of the closed-loop system: integrated water, waste and energy management for sustainable solutions.

- Impact in terms of SDGs

7. Affordable and Clean Energy	9. Industry Innovation and Infrastructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action
High Impact	High Impact	High Impact	High Impact	High Impact

Feasibility and Replicability

- The ELP is replicable in different contexts, just needing to be adapted to specificities regarding dimensions, level of development, institutional context and specific targets;

- A specific agent who is responsible for the coordination of key stakeholders and potential interested parties makes the replicability of the model possible.

2. Circular Use of Energy and Clean Energy

Circular economy principles consist of a regenerative system in which resource input and waste are minimized by slowing, closing and narrowing material and energy loops. The idea is to substitute the linear system (extraction, manufacture, use and disposal) by closing the life cycle of goods, services, waste, materials, water and energy.[21] A key feature of this model is the re-thinking progress in terms of designing and implementing new models of production and consumption, in which redundant consumer goods are viewed as inputs rather than waste.

This circular model moves the sustainable goals from efficiency to effectiveness. While efficiency relies on a one-way linear model, an eco-effective model proposes the transformation of products and their material flows to form a supportive relationship with ecological systems and future economic growth. The goal is not to minimize the cradle-to-grave flow of materials, but to generate cyclical metabolisms that enable materials to maintain their status as resources and accumulate intelligence over time (upcycling). This inherently generates a synergistic relationship between ecological and economic systems.[22]

In terms of energy, it means, among other measures, integrated systems involving waste, water and energy management; increased use of renewable and clean energy sources and a systemic approach from energy generation to energy consumption.

This model is usually thought of as appropriate for high-income countries, as a response to their over-consumption of energy and resources. However, for low- and medium-income countries, this model can be an alternative growth model that fits reduction of poverty through economic growth and the protection of the environment. Below, we present cases of both high-income and low- and medium-income countries that have adopted circular economy strategies.

Low- and Medium-Income Countries

Urbanization is changing the landscape of cities worldwide. Urban sprawl, which promotes the occupation of larger areas of land, has created other urban problems, including car dependency, low density and energy inefficiencies. This is a special concern for low-income countries whose urbanization rate between 1995 and 2015 was 3.68%, compared to 0.88% in high-income countries.[23] Developing countries need a sustainable development plan in which social and economic development are integrated into environmentally sustainable measures.

This is the case of Villa 31, an urban slum in Buenos Aires with 43,000 inhabitants. It is characterized by poor infrastructure and housing, limited connectivity and lack of quality in basic service provision. One of the consequences is the high electricity consumption per household, which is paid for by the municipality. With the aim to upgrade this informal settlement, the municipality of Buenos Aires launched the *Plan de Acción Integral 2016-2019* (Comprehensive Action Plan 2016-2019) for Barrio 31, in technical and financial cooperation with the World Bank. In terms of energy, the project aims to harness the energy efficiency potential to help ensure energy security, reliability and affordability, as well as capture energy efficiency's multiple benefits, such as climate change mitigation.

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[21] http://economiacircular.org/EN/?page_id=62

[22] https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram/efficiency-vs-effectiveness

[23] UN Habitat 2016 Report: Urbanization and Development.

Case Study 6: Villa 31

Source: https://www.google.com/maps

	Case Study 6
City	Buenos Aires, Argentina
Population	2,891,000
Wealth	Medium
Type of project	Sustainable neighborhoods
Subtype	Circular use of energy and clean energy

What Is It About?

Villa 31 is a neighborhood in the city of Buenos Aires where housing conditions and the access to basic services like energy were lacking. In terms of energy, the project involves the improvement of the electricity network, with the inclusion of renewable sources and the end of informal electric networks through the creation of a smart energy grid, in addition to the implementation of LED lamps in public lighting and new housing based on energy efficiency standards

Summary

The city of Buenos Aires experiences high housing deficit levels and it is estimated that 17% of the population lives in informal settlements. In this context, the city launched the Metropolitan Buenos Aires Urban Transformation project that seeks to improve housing conditions and access to selected basic services and infrastructure in selected disadvantaged neighborhoods, which include Villa 31.

Villa 31 is an urban slum in Buenos Aires with 43,000 inhabitants. It is characterized by poor infrastructure and housing, limited connectivity and lack of quality in basic service provisions. One of the consequences is the high electricity consumption per household, which is paid for by the municipality.

The urban renewal of Barrio 31 is a top priority for the city of Buenos Aires' administration, which wants to transform Villa 31 into a neighborhood (Barrio 31), improving people's living conditions and ensuring long-lasting social and urban integration. In December 2009, the city parliament approved a law aimed at upgrading this settlement, and the previous and current governments have made it a key commitment to develop a comprehensive plan to integrate Barrio 31 with the rest of the city. The administration constituted the Secretariat for Social and Urban Integration (SECISYU) to design and lead the implementation of the city's Plan de Acción Integral 2016-2019 for Barrio 31. It is estimated to cost US$194.57 million, of which US$159.5 million will come from International Bank for Reconstruction and Development (IBRD) financing. The loans are extended to the municipality of Buenos Aires (Ciudad Autónoma Buenos Aires) and to the province of Buenos Aires (PBA).

The main areas of the project are:

- Access to improved water sources;
- Access to improved sanitation;
- Access to all-season roads, within a 500-meter range;
- Access to regular solid waste collection under the project;
- Access to electricity under the project via household connections.

Case Study 6: Villa 31 (cont.)

In terms of energy, the city aims to integrate energy efficiency into the plan, with the assistance of the World Bank Energy Sector Management Assistance Program. Its costs are estimated to be US$15.25 million. The project aims to harness the energy efficiency potential to help ensure energy security, reliability and affordability, as well as capture energy efficiency's multiple benefits, such as climate change mitigation. Less than 20% of households have a formal connection to electricity, but 79% have access to energy by means of a neighbor's connection, from a lamppost or through other informal means. Additionally, the neighborhood-level distribution networks are overloaded, causing frequent interruption of services.

The improvement of the electricity network and public lighting (including the use of LEDs) is expected to generate energy efficiency improvement and reduce transmission and distribution losses. In addition, bank-executed technical funds have been secured from the Energy Sector Management Assistance Program's (ESMAP) Efficient and Sustainable Buildings Program (P161183) to support the integration of energy efficiency into the design of the works. It is estimated that 12% of the investment will have mitigation co-benefits due to improvements in energy efficiency in new housing, which will incorporate energy efficiency standards, and in electricity infrastructure and public lighting.

As most informal settlements have irregular connections to water, sanitation and electricity, and pay no fees, it is important to gradually introduce cost recovery through tariffs, taxes and other fees, to ensure the sustainability of investments. The respective utilities (including AySA, EDENOR and EDESUR) will take over the operations and maintenance of the water, sewage and electricity infrastructure once the works are completed in the streets that will be formally recorded in the city's cadastre.

Factors of Success

- Integrated public service provision (including energy access) under a broad urban development plan that aims to integrate Villa 31 inhabitants in society;
- Citizens' engagement through active participation of the municipality in the project.

Agents Involved

- City of Buenos Aires, province of Buenos Aires;
- Utilities: AySA, EDENOR and EDESUR;
- World Bank;
- Private companies.

Energy and Environment Technologies

- Modernization of insulation, heating and cooling systems;
- Energy efficient services (e.g., street lighting) for lower operation costs.

Outcomes

It seeks to transform Villa 31, an informal settlement, into a neighborhood, Barrio 31, improving people's living conditions and ensuring long-lasting social and urban integration, while increasing energy efficiency.

Case Study 6: Villa 31 (cont.)

Impact (Good Practices, Lessons Learned)

This model integrates strong social engagement to ensure the sustainability of urban infrastructure investments; for instance, those regarding the formalization of irregular electricity networks.

- Integration of disadvantaged settlements into the wider urban fabric benefits the neighborhood itself and its surroundings;
- Strong social engagement ensures the sustainability of urban infrastructure investments;
- Strong political commitment and government capacity is key to success;
- In-situ revitalization of disadvantaged neighborhoods;
- Incorporating measures to mitigate possible gentrification.
- Impact in terms of SDGs

7. Affordable and Clean Energy	9. Industry Innovation and Infrastructure	10. Reduced Inequalities	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action
High Impact	**High Impact**	**Moderate Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- This ambitious plan is a replicable model of cooperation with an international organization (the World Bank) that provides financial and technical support. These resources are often limiting factors for the implementation of urban development plans in low- and middle-income countries.

Another case that addresses the problems from the increasing urban population is the city of Puerto Princesa in the Philippines. The growing urbanization led to congestion in the city's bay area, threatening the people's quality of life and coastal reserve areas. The city has a series of initiatives that seek to solve social problems in an environmentally sustainable way. For instance, a biofuel plant to supply public transportation energy demands: the biodigester will promote the decomposition of the city's biowaste, feeding methane to a gas turbine that will power zero-emission eJeepneys and eTrikes, creating a complete green circle. Another example is housing projects that have been designed to reduce energy demand through increased natural light, improved ventilation, the cooling effect of the roofing material and strategically planting at least one fruit tree per household.

Case Study 7: Puerto Princesa

Source: https://www.google.com/maps

	Case Study 7
City	Puerto Princesa, Philippines
Population	222,673
Wealth	Low
Type of project	Sustainable neighborhoods
Subtype	Circular use of energy and clean energy

What Is It About?

The implementation of an integrated system of renewable energy power plants, EV charging stations, electric modes of transport, such as buses and tricycles, and other building improvements, such as the installation of a rainwater catchment facility that reduces the demand for water pumping.

Summary

The city of Puerto Princesa is a leader in sustainable policies and is widely acknowledged as the cleanest and greenest amongst local Philippine governments. The rising urban population of Puerto Princesa has led to congestion in the city's bay area, threatening people's quality of life and coastal reserve areas.

The city is part of the Climate-Friendly Cities (CFC) initiative, coordinated by the Institute for Climate and Sustainable Cities (iCSC), a non-government organization (NGO), based in the Philippines, working on sustainable energy solutions and fair climate policy. It aims to contribute to climate change mitigation and, at the same time, promote climate-resilient communities through the integration of sustainable waste management, energy generation and sustainable transport programs. In close partnership with the Dutch DOEN Foundation, the program aims to use energy from organic waste from wet markets, business establishments and households of partner cities to power a sustainable public transport system composed of eJeepneys and other electric public utility vehicles. The project consists of three components:

- Fleet of eJeepneys, each with a capacity of 12 passengers: it was introduced in 2009, in partnership with iCSC and with funding from the DOEN foundation. Political cooperation played a major role in the institutionalization of the EVs as public transport;
- Depot serves as charging station; and
- Power plant designed by iCSC, consisting of a generator, an anaerobic digester or biodigester, and a gas engine. It provides up to 1 MW of power to fuel the city's growing electric public transport fleet and other public energy needs. It is estimated to cost US$2-4 million. Based on a build-operate-transfer scheme, the biodigester will promote the decomposition of the city's biowaste, feeding methane to a gas turbine that will power zero-emission eJeepneys and eTrikes, creating a complete green circle.

Among different initiatives and projects in the city, we highlight:

- Technical partnership with Optimal Power Solutions (2010) to address the city's power shortage (5 MW-10 MW) and substitute diesel for renewable energy.

Case Study 7: Puerto Princesa (cont.)

- Sabang Renewable Energy Corporation's (SREC) project (Sabang project) in Barangay Cabayugan, designed by experts from WEnergy Global Pte Ltd and the city government's Planning Department. The design of this hybrid power infrastructure was determined by the area's conditions in order to protect the catchment area of the Puerto Princesa Underground River. It also serves as an example to encourage local architecture and renewable energy generation. SREC, being aware of the induced urbanization in Barangay Cabayugan after its electrification, has also prepared an Image Quality Plan for Sabang to provide concepts and guidelines for sustainable development (green growth) of the area, with a focus on use of space in the forest, aesthetics and architecture. The aim is to prevent electrification leading to negative impacts on Puerto Princesa. A bank loan will provide 75% of the fund, and the remaining amount will be shared between Delta P, with a 60% investment, and Singapore-based We Energy Global, which has a 40% stake in the project. The project will be managed by SREC, which is covered by an agreement with the Palawan Electric Cooperative that authorizes the corporation to supply electricity to the whole barangay for 15 years. The agreement also provides a subsequent five-year extension period.

Factors of Success

- Close cooperation between the city government and the iCSC NGO. This partnership leverages potential international and private partnerships for the projects being developed, in accordance with the local reality.

Agents Involved

- Local government of Puerto Princesa;
- iCSC (NGO);
- Private energy companies;
- Optimal Power Solutions;
- Building companies.

Energy and Environment Technologies

- For energy supply: solar PVs, proprietary inverter control technology, battery storage and diesel engines configured for 24-hour continuous power supply;
- Housing projects: installation of a rainwater catchment facility that reduces the demand for water pumping, prohibiting the use of wood for roofs and interior frames, and an appropriate disposal system for non-recyclables and non-biodegradables;
- eJeepneys and etrikes;
- Biodigestor: decomposition of the city's biowaste, feeding methane to a gas turbine that will power zero-emission eJeepneys and etrikes, creating a complete green circle;
- Hybrid power infrastructure (Sabang project): solar PV power plant of 1.4 MW, a battery pack of 1.7 MWh, 1 MW of diesel generators and a 15-kilometers smart grid to supply 24/7 power to about 650 small and large off-takers.

Outcomes

These initiatives seek to provide energy services and infrastructure to solve social problems, while adopting measures in an environmentally sustainable way.

Case Study 7: Puerto Princesa (cont.)

Impact (Good Practices, Lessons Learned)

Close cooperation between the city government and the iCSC NGOare key to the success of the initiatives. This partnership leverages potential international and private partnerships in terms of funding and expertise for the projects being developed, in accordance with the local reality.

- The engagement of the local government in partnership with the Institute for Climate and Sustainable Cities (iCSC) NGO is crucial. It guarantees the support of Puerto Princesa citizens, as well as funding and expertise through partnerships;
- iCSC has a deep knowledge of the reality of the region, as well as the potential in terms of energy, which favors the development of clean energy initiatives.
- Impact in terms of SDGs.

6. Clean water and Sanitation	7. Affordable and Clean Energy	9. Industry Innovation and Infrastructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action

High Impact	**High Impact**	**Moderate Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- This model of partnerships can be easily replicated.

A specific initiative in terms of fostering the use of clean energy is China's Solar City project in the city of Dezhou. This is a case in which public authorities have the role of incubators and multipliers of renewable energy clusters in the city.

The close collaboration between the public and private sector is also the case in the Taipei Smart City project, through an online platform coordinated by local government offices. In 2016, Taipei City Government Department of Information Technology (DOIT) established the Taipei Smart City Project Management Office (PMO). Under a PPP scheme, DOIT and PMO work together to collect and determine the needs of the government and its citizens through an online platform. In addition, they support the implementation of these solutions. Since its implementation, more than 60 cases of matchmaking have already been conducted successfully, more industry resources were introduced in support of the central government's policies, and better smart services were provided for citizens.

Case Study 8: Dezhou Solar City

Source: https://www.google.com/maps

	Case Study 8
City	Dezhou, China
Population	5,586,000
Wealth	Medium
Type of project	Sustainable neighborhoods
Subtype	Circular use of energy and clean energy

What Is It About?

Transformation of the municipality of Dezhou into a Solar City, where solar energy systems are integrated into new buildings.

Summary

In 1997, the municipality of Dezhou produced a Development Plan for the Dezhou Economic Development Zone to centralize solar technology research and development, manufacturing, education and capacity building. In order to achieve this, the local government attracted direct investments through a series of policies and reforms.

SolarCity's commitment to developing renewable energy was strengthened by China's central government legislation and policies. Dezhou now boasts over 120 solar energy enterprises, which generate an annual turnover of US$3.46 billion.

In August 2015, the local government launched a program to transform Dezhou into China's Solar City. The strategy includes incentives to business through policies on land-usage, tax-return and financing; integration of solar energy systems into new buildings and a PV demonstration project.

The government of Dezhou played an important role as incubator and multiplier for the renewable energy industry cluster of the city. It has boosted the innovation system of the city, reduced the consumption of coal and the labor market with an estimated creation of 18,500 jobs.

This is not a traditional PPP, but a public-private cooperation to foster the industry of renewables. As a consequence, it allows the development of new technologies with lower costs and higher accessibility for customers

Case Study 8: Dezhou Solar City (cont.)

Factors of Success

- Local government role as incubator and multiplier of the renewable energy cluster. It includes supportive policies on land-usage, tax-return and financing:
    - These new policies allowed land prices to be negotiated on a case–by-case basis, promoting favorable prices that depended on when the business would move into the zone, the industry sector and the business size;
    - Foreign companies, export-oriented companies and high-tech companies received a two-year tax waiver, followed by a three-year tax reduction. In addition, during the following three years, if the company remained in the high-tech sector, it would receive a 50% tax rebate;
    - Dezhou local government also lowered the entrance barriers for new solar energy ventures by allowing enterprises with a capital reserve of less than US$157,480 (RMB 1 million) to qualify for two-year installments. Low-interest loans and financing channels were provided to enterprises with patented technologies.
- The promotion of renewable energy is included in a broader strategy to boost local demand for renewables and to promote an attractive environment for investment in this sector;
- Large investments in R&D.

- Local government of Dezhou;
- Private energy companies.

Energy and Environment Technologies

- High-efficiency solar thermal vacuum tubes;
- Solar thermal power generation;
- Solar central air conditioning;
- 5555 PV Demonstration project: it installed or replaced conventional lights with solar lights at 50 traffic junctions, five main roads and five residential districts, including the provision of street and landscape lighting in five scenic areas.
- Integrated solar systems for the building sector in accordance with the Million Roof project, which required low- to mid-level buildings (less than 12 levels) to install solar thermal rooftop facilities and high-level buildings to install wall-mounted or centralized solar thermal equipment.

Outcomes

It has successfully developed the solar energy industry in the city, boosting the innovation system, reducing consumption of coal and stimulating labor market with 18,500 new jobs.

Case Study 8: Dezhou Solar City (cont.)

Impact (Good practices, Lessons Learned)

Dezhou's model shows that public and private investments to develop a mature technology innovation system through R&D are key to stimulating local demand for solar panels, as this provides products at lower costs.

- Local government fiscal expenditure stimulates private sector funding: approximately every dollar invested by the government corresponds to an increase of US$78 in private investment;
- High public and private investments to develop a mature technology innovation system were crucial to boost the local demand. The project includes excellent capacities in engineering, research and commercialization.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry Innovation and Infrastructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action
7 AFFORDABLE AND CLEAN ENERGY	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	11 SUSTAINABLE CITIES AND COMMUNITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION
High Impact	**High Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- Supportive policies for the renewable energy industry can boost microgeneration of energy, through the reduction in costs of solar energy technologies;
- Local governments can play an important role as incubators and multipliers of renewable energy clusters, ensuring an attractive environment for private companies to develop and implement new technologies.

Case Study 9: Taipei Smart City

Source: https://www.google.com/maps

	Case Study 9
City	Taipei, Taiwan
Population	2,705,000
Wealth	High
Type of project	Sustainable neighborhoods
Subtype	Circular use of energy and clean energy

What Is It About?

A matchmaking platform among citizens, the public sector and the private sector to put forward successful energy projects.

Summary

In the past, collaborations between the public sector and partners in the industry and academia were often limited by regulations that placed strict rules upon the role played by the former. In light of this, DOIT established the Taipei Smart City PMO in 2016. Through the PPP scheme, DOIT and PMO worked together to collect and determine the needs of the government and its citizens. They also worked on introducing the innovative and creative resources from the private sector, strengthening the capabilities of city agencies to meet citizens' expectations, and making the city government more willing to accept innovation and changes. In addition to supporting numerous internal projects, DOIT and PMO came up with appropriate app utilization scenarios and devised workable solutions, tailor-made for Taipei, based on brainstorming exercises and meetings among city agencies, industries and academia partners.

Since its establishment a year ago, the platform has successfully conducted more than 60 cases of matchmaking, introduced industry resources in support of the central government's policies and provided better smart services for citizens. To foster public participation, the Taipei Smart City website offers the functions of publishing information regarding smart city projects and research; encouraging exchange among government, start-ups and residents; boosting the information flow among international cities; and marketing Taipei's smart city implementation experience to the world. Taipei has been transformed into a living lab through the efforts of PPP.

Factors of Success

- Matchmaking platform to connect the government and the private sector through the collaborative work of DOIT and PMO. PMO does the first screening of the proposal, taking into account the needs of citizens and integrating it into a scenario. PMO then discusses the possibility and outcome of the scenario with Taipei City Government Bureau, and comes out with a suitable solution that could actually be trialed in Taipei;

- Through the cooperation of DOIT and PMO (intersectoral cooperation), it is possible to match other bureaus (horizontal cooperation) with domestic or international smart service providers (intersectoral cooperation) to build suitable solutions and smart applications for Taipei citizens and regions (spatial cooperation).

Case Study 9: Taipei Smart City (cont.)

Agents Involved

- Local government of Taipei;
- DOIT;
- Taipei Smart City PMO;
- Taipei Computer Association;
- Institute for Information Industry;
- Commerce Development Research Institute;
- Private companies and startups.

Energy and Environment Technologies

- LoRa Taipei IoT Experimental Platform: virtual network platform to research and develop LoRa technology. It was created by DOIT, PMO and Gemtek;
- Taipei IoT Innovation Lab: it provides the necessary Internet, hardware, software and equipment to create an experimental space for new innovation teams to use for free, hoping it will nurture future industry elites. It was set up by Dell, Gemtek, Asia Pacific Telecom and SigFox;
- Website of Taipei Smart City: integration platform to release domestic and international smart city related research information, Taipei city empirical cases and event announcements. Additionally, the website specially designed project proposal and citizen demand sections to provide a communication channel for citizens' needs, pending problems and operator service information.

Impact (Good Practices, Lessons Learned)

- Creation of a government smart city professional think tank through the cooperation between DOIT and PMO: it provides smart city related policies and professional advice for bureaus of Taipei city government and it acts as the communication bridge between companies and all bureaus;
- Successful engagement of the private sector for creativity and resource integration through a platform where companies and startups can demonstrate their new ideas and service solutions;
- Promotion of smart city concepts and experiences domestically and internationally as a means to reinforce innovation.
- Impact in terms of SDGs.

11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action	17. Partnerships for the goals
			
High Impact	**High Impact**	**High Impact**	**High Impact**

High-Income Countries

According to UN-Habitat,24 the urban agenda must promote cities and human settlements that are environmentally sustainable, resilient, socially inclusive and economically productive. In order to achieve this, it set five interrelated principles: adequate space for streets and an efficient street network; high density; mixed land-use; social mix; and limited land-use specialization.

Such models can already be seen in some cities, mainly in high-income economies. The cases of Clichy-Batignolles and Hammarby Sjöstad in Paris and Stockholm, respectively, represent benchmarks in terms of compact, integrated and connected models of sustainable development. In their urban plan, the promotion of high-density urban growth is a key element, with an optimized use of land, provision of interconnected means of transport and the fostering of walkable neighborhoods. Moreover, circular economy principles are guidelines for the remodeling of energy, waste and water systems, and building design.

Both are brownfield projects for residential purposes, through the initiative of the city's council. In the case of Hammarby Sjöstad, the initiative came from a strong demand for housing in Stockholm; the industrial region of Hammarby was seen as attractive. Under the local investment program of the Swedish government, the city adopted a project with the aim of becoming an international model of sustainable development. Similarly, in 2002, the municipality of Paris launched the Éco-Quartier project in the district of Clichy-Batignolles with the aim of transforming an area traditionally occupied by logistic activities and heavy transport infrastructures into a mixed sustainable neighborhood (offices, housing, businesses and facilities), including sustainable buildings, self-production of renewable energy, efficient waste and water management, and green areas. Both have set targets in terms of reduction of energy consumption and emission of GHGs that are more ambitious than the average targets in their countries. So, the public company Paris Batignolles Aménagement, concessionaire of the project, set specific tools to engage property developers in sharing the project's ambitions regarding environmental requirements.

[24] http://habitat3.org/wp-content/uploads/NUA-English-With-Index-1.pdf

Case Study 10: Clichy-Batignolles Éco-Quartier

Source: https://www.google.com/maps

	Case Study 10
City	Paris, France
Population	2,229,621
Wealth	High
Type of project	Sustainable neighborhoods
Subtype	Circular use of energy and clean energy

What Is It About?

Transformation of a former logistics area into a sustainable neighborhood, with self-production of renewable energy, efficient waste and water management, green areas, etc.

Summary

The city of Paris is a benchmark in terms of urban regeneration. One example of this is the Éco-Quartier project, launched by the municipality of Paris in the district of Clichy-Batignolles. It aims to transform an area traditionally occupied by logistic activities and heavy transport infrastructures into a mixed sustainable neighborhood (offices, housing, businesses and facilities), including sustainable buildings, self-production of renewable energy, efficient waste and water management, and green areas. The project is expected to attract 7,500 inhabitants and 12,700 jobs.

This is a globally renowned and awarded project led by the public company Paris Batignolles Aménagement to promote a sustainable neighborhood, the Éco-Quartier,. Operationally, the project realization is organized into five sectors: energy; biodiversity, water and the climate; setting; mobility and transport; and project management. It is expected to be finished by 2020.

This project, in terms of energy, is a benchmark for integrating building design and economy of energy. Moreover, it seeks self-sufficiency in energy consumption for heating and domestic hot water via geothermal energy and PV panels installed in the new buildings. Its main objectives are:

- Limitation of energy consumption of the buildings to Paris regulation limits: 50 kWh/m2 per year. This can be done through compacting the buildings'areas of exposure to the external environment, double orientation and solar protection, and isolation from the external environment;
- A heating system based on geothermal energy in all of the buildings (at least 85% of the heating system based on renewable energy), estimated to save 4,000 tons of CO_2;
- Installation of 35,000 m2 of PV panels that have the capacity to produce 3,500 MWh/year, corresponding to 40% of the electric consumption in the neighborhood.

To meet the energy targets, the Co-Responsibility in District Energy Efficiency and Sustainability (CORDEES) project was launched in April 2017 to create a new energy ecosystem. It combines three main solutions in an integrated approach.

Firstly, it establishes an Urban Energy New Deal (UEND) that will define, on a collective basis, the energy commitments and the contractual/financial/regulatory conditions necessary for its successful implementation. Secondly, the Community Energy Management Platform, a monitoring platform that is both interoperable and multi-user, will be deployed. Energy data from buildings (electricity and heat) and public facilities (EV stations, street lighting and automated waste collection) will be analyzed and consolidated in real time.

Case Study 10: Clichy-Batignolles Éco-Quartier (cont.)

Thirdly, new services will be tested to empower stakeholders and target groups to achieve energy efficiency goals. An Urban Sustainability Trustee Facilitator (USTF) will provide technical recommendations, ensure stakeholder cooperation and end-user empowerment, and coordinate the creation and implementation of services.

Factors of Success

- Specific management tools to engage property developers in sharing the project's ambitions regarding environmental requirements:
  - Compliance with the environmental and sustainable development specifications is a binding obligation for those who purchase serviced plots in Clichy-Batignolles;
  - Financial guarantee equal to 4% of the sale price is placed in escrow and returned only when compliance with the specifications has been verified;
  - Data and methodological tools regarding grey energy (consumed during a material's life cycle) and performances of each material, incorporation of PV panels in the architecture, etc.;
  - Specialized engineering and design firms are commissioned to assist contracting authorities in designing projects to meet environmental requirements.

Agents Involved

- Municipality of Paris;
- Paris Batignolles Aménagement (public company);
- François Grether, Jacqueline Osty and bureau d'études techniques OGI (urban plan);
- SYTCOM (metropolitan agency for recycling);
- 20 property developers and architectural firms.

Energy and Environment Technologies

- Geothermal plants integrated with the heating system in all buildings;
- PV panels;
- Building design based on compacting the areas of exposure to external environment, double orientation and solar protection, and isolation from the external environment;
- Smart grids.

Case Study 10: Clichy-Batignolles Éco-Quartier (cont.)

Outcomes

The new building design and the energy systems being implemented are expected to provide a reduction in energy consumption, as well as in GHG emissions.

Impact (Good Practices, Lessons Learned)

- Public administration's role in engaging the private sector in complying with environmental targets and promoting innovative solutions: specific regulations, Effinergie + label, habitat and environment certification, profile A option performance, etc.;
- Development of an ambitious brownfield project with high environmental targets through partnerships with key stakeholders (private sectors and citizens);
- UEND: commitment chain for the rational energy management.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry Innovation and Infrastructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action
High Impact	**High Impact**	**High Impact**	**High Impact**	**High Impact**

3. Good Practices and Lessons Learned

The cases described in the previous sections suggest a number of good practices that can be useful for the public and private sectors to build sustainable neighborhoods and promote energy efficiency.

Many of the cases seek to engage a wide range of stakeholders: energy companies and consumers, as well as business developers. For instance, our first four projects—Case 1 (Málaga), Case 2 (Ithaca), Case 3 (Fernando de Noronha) and Case 4 (São Luiz do Paraitinga)—developed smart grids that facilitate the connection and operation of generators of all sizes and technologies, on the production side, and include the installation of smart meters that allow customers to monitor and change their energy use, on the consumer side. These projects allowed for a more efficient energy consumption and distribution that provides a more reliable energy grid. Case 9 (Taipei) developed a platform that matches citizens' and the government's needs with business sector proposals, thus fostering innovative solutions and partnerships for implementation. It is also important to encourage the private sector to come up with innovative solutions for energy access and consumption. Case 8 (Dezhou) fostered the development and production of accessible (low-cost) solar panels for Dezhou citizens, which in turn fostered economic development in the city.

However, more importantly, the cases sought to involve energy users as much as energy product developers and providers, leading to a user-centric approach that complements the old model of centralized generation and distributed consumption of energy. Case 5 (Stockholm) allowed people to play an active role in energy supply, thereby helping to reduce use of the central network system. Case 6 (Buenos Aires) integrated strong social engagement to ensure the sustainability of the infrastructure investments: those regarding the formalization of irregular electricity networks. As part of Case 10 (Paris), new services will be tested out to empower stakeholders and target groups to achieve energy efficiency goals.

A first step to engage stakeholders in most of the cases is to find ways to collect and manage (often real-time) information. Case 2 (Ithaca) included an integrated set of technologies that collect interval energy usage data through smart meters, validate and store the data in a database, and provide customers with access to their own meter data through a web portal. Case 5 (Stockolm) included the provision of a display in customers' kitchens that shows the use of heating, electricity and water in real time. Case 10 (Paris) included a monitoring platform with energy data from buildings (electricity and heat) and public facilities (EV stations, street lighting and automated waste collection), analyzed and consolidated in real time.

In addition to providing information, many cases tried to obtain responsiveness from market participants. Smart apps that make citizens aware of their consumption patterns can have a deep effect on the level of consumption and the distribution of consumption throughout the day. As an example, Case 4 (São Luiz do Paraitinga) created an online portal for their citizens to monitor their level of energy consumption, fostering a reduction of around 10% in their absolute level of energy use, as well as a smoothing of their energy consumption throughout the day.

Several academic articles and policy reports have recommended the use of normative comparative feedback, in which the consumption of a household is reported in comparison to the consumption of other similar groups of households.[25] In the smart grid of Case 1 (Málaga), customers have access to their electricity demand and a comparison of their consumption to that of similar users. This is one of the examples in which a widespread behavioral bias among individuals is exploited to achieve a good purpose.

While some projects benefit from an already existent sustainable behavior among citizens, e.g., in Case 5 (Stockholm), others need to raise citizens' awareness about the importance of energy efficiency and a more sustainable energy consumption, e.g., Case 4 (São Luiz do Paraitinga). Indeed, in a context in which sustainable consumption is still incipient, initiatives to raise people's awareness about the importance and the means for consuming energy in a sustainable way are crucial.

Many projects made use of new ICTs Digitalization in the energy sector can foster sustainable behavior of customers through the access to information about consumption. Case 3 (Fernando de Noronha) aimed to foster the Brazilian incipient market of ICTs for the energy sector. Case 5 (Stockholm) included the deployment of residential devices that provide information for customers' management of energy, heating and water consumption.

Multiple partnerships is a component present in all the cases, thus revealing the complexity of sustainable, innovative technologies for the provision of energy. Case 5

[25] Desley, V., Laurie, B., & Peter, M. (2013). The effectiveness of energy feedback for conservation and peak demand: a literature review. Open Journal of Energy Efficiency and ERGEG (2010), "Status Review on Implementation of Good Practice Guidance for Billing". Available at : http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Customers/Tab1/E10-CEM-36-03_EC%20billing%20guidance_8-Sept-2010.pdf

(Stockholm) invoved the systematic collaboration among 33 developers and 29 architectural firms. The collaboration between a wide range of stakeholders is needed because different segments of the private and public sectors can bring know-how from their areas of expertise. In Case 1 (Málaga), Case 2 (Ithaca), Case 4 (São Luiz do Paraitinga) and Case 9 (Taipei), universities worked hand in hand in the creation of the project and in setting out the specific objectives to follow, also allowing each country to develop knowledge about smart grids. Case 7 (Puerto Princesa) also included the cooperation between the city government and the iCSC NGO. Projects in developing countries, such as Case 6 (Buenos Aires), often include the involvement of international institutions such as the World Bank, which can provide technical and financial cooperation.

But partnerships are also highly heterogeneous among themselves. Case 1 (Málaga) is a PPP that was designed, built and operated by a consortium of 12 companies and 14 research institutions. Case 8 (Dezhou) is not a traditional ,PPP but a public-private cooperation to foster the industry of renewables. In Cases 3 (Fernando de Noronha) and 4 (São Luiz do Paraitinga), funding comes from the net revenues of the companies, as requested by the national agency's program, which pushes private companies to implement projects for increasing energy efficiency in Brazilian cities. Case 7 (Puerto Princesa) leverages potential international and private partnerships in terms of funding. The financial investment of Case 5 (Stockholm) consists of €0.5 billion from the public sector and €3 billion from the private sector.

Many projects tried to diversify the energy mix, increasing the share of clean and renewable electricity and reducing the share of fossil fuels. In Case 10 (Paris), geothermal energy and PV panels were installed in the new buildings. Case 6 (Buenos Aires) involved the improvement of the electricity network with the inclusion of renewable sources. Case 3 (Fernando de Noronha) stimulated the use of distributed microgeneration, thus contributing to the diversification of the energy matrix of the island (still dependent on the coal power station of Tubarao), through the installation of solar panels in residential and public buildings. Case 7 (Puerto Princesa) included the construction of a biodigester that will promote the decomposition of the city's biowaste, feeding methane to a gas turbine that will power zero-emission public vehicles.

Many projects promoted, more specifically, the distributed resources, which, as opposed to conventional power stations, are decentralized technologies located close to the user. Case 2 (Ithaca) supports distributed energy resource developers and local government planners in the development of energy plans and processes. One of the objectives of the reference model of Case 4 (São Luiz do Paraitinga) was the introduction of distributed generation in low voltage points through solar and wind energy. As shown in Case 5 (Stockholm), an integrated water, waste and energy management system can also provide biofuel energy to complement the solar and hydro sources.

Overall, having a holistic view and strategy of how neighborhoods will develop is another important aspect of developing long-lasting sustainable cities of the future. Making use of the principles of the circular economy, as, for example, in Case 5 (Stockholm), can create synergies both in the production and in the consumption of energy in the city.

Projects should also incorporate an evaluation of the project itself. And, indeed, some of the cases incorporate the collection of information to monitor the project. For instance, Case 1 (Málaga) includes a KPI monitoring system of the new technologies.

In the Table 2, we present a summary of lessons learned from the analysis of the cases regarding sustainable neighborhoods. You can see that, for a same lesson learned, different practices were required, according to the specificities of the city, such as the level of socio-economic development, environmental conditions and availability of capital.

SUSTAINABLE URBAN MODELS

Table 2. Good practices and lessons learned from case studies

SUSTAINABLE NEIGHBORHOODS: INTEGRATING RENEWABLES FOR A BETTER QUALITY OF LIFE		
Lessons learned	**Case study**	**Good practice**
Distributed and renewable energy sources as an instrument for cost savings, reduction of GHGs and other emissions, and an increase in energy efficiency.	**Clichy-Batignolles** **Hammarby Sjöstad**	Sustainable neighborhoods are characterized by being compact, integrated and connected. In terms of energy, increasing efficiency is essential and on-site renewable sources is a viable alternative. A mixed energy matrix must be developed in accordance with the available sources. For instance, an integrated water, waste and energy management system, as is the case in Hammarby Sjöstad, can provide biofuel energy to complement the solar and hydro sources. In the case of Clichy-Batignolles, geothermal energy is addressed to the heating system.
Digitalization in the energy sector to foster sustainable behavior of customers through the access to information about consumption. It can impact customers' behavior in terms of managing, planning and controlling energy usage. Lower energy use and lower energy costs may come from behavior change.	**BMW i ChargeForward**	The access to information stimulated the use of EVs. In order to achieve this, BMW designed a system of demand response based on a smartphone application to manage users' vehicle charging times. It boosts electric grid optimization and users have incentives to reduce usage during periods of high-peak demand. It allows lower energy costs and lower environmental impact.
	São Luiz do Paraitinga	The access to information to raise people's awareness and stimulate a more sustainable energy use. Through an online portal with information regarding energy consumption, customers can manage their energy use.
	Hammarby Sjöstad	The access to information makes inhabitants co-participants in the efforts to promote energy efficiency, in terms of production or consumption. Residential devices provide information for customers' management of energy, heating and water consumption, integrated with local energy production sources.
Implementation of smart grids to improve investment and operations and to include renewables in the energy matrix: automation and distributed generation allow the inclusion of different renewable sources. It balances the intermittency of renewables and leads to a more reliable and efficient energy system.	**São Luiz do Paraitinga** **Fernando de Noronha** **Ithaca** **Málaga** **Buenos Aires**	The implementation of advanced metering, distributed generation, IT and automation guarantee better energy provision, reduce costs and allow the interface with customers. This system allows the integration of renewables, ensuring the continuity of energy provision through different energy sources used to tackle the intermittency of renewables. An important factor is the monitoring system that identifies problems and fosters a constant upgrade of the grid. For developing countries, smart grids are seen as a solution for the high costs and the low quality of the existing infrastructure.
Circular economy for the improvement of quality of life in cities: strategies that enhance the quality of the environment and deepen the experience of people's everyday life under urban planning. Promoting compact, integrated and connected neighborhoods requires integrated energy provision and consumption.	**Clichy-Batignolles** **Hammarby Sjöstad**	One of the dimensions of sustainable neighborhoods is self-sufficiency in terms of energy. Re-designing new models of energy production and consumption, in which waste is transformed into input, is key. The Hammarby model exemplifies this through its closed loop system that integrates energy, water and waste management. Clichy-Batignolles became a benchmark in terms of building design integrated with on-site renewable sources.

Table 2. Good practices and lessons learned from case studies (cont.)

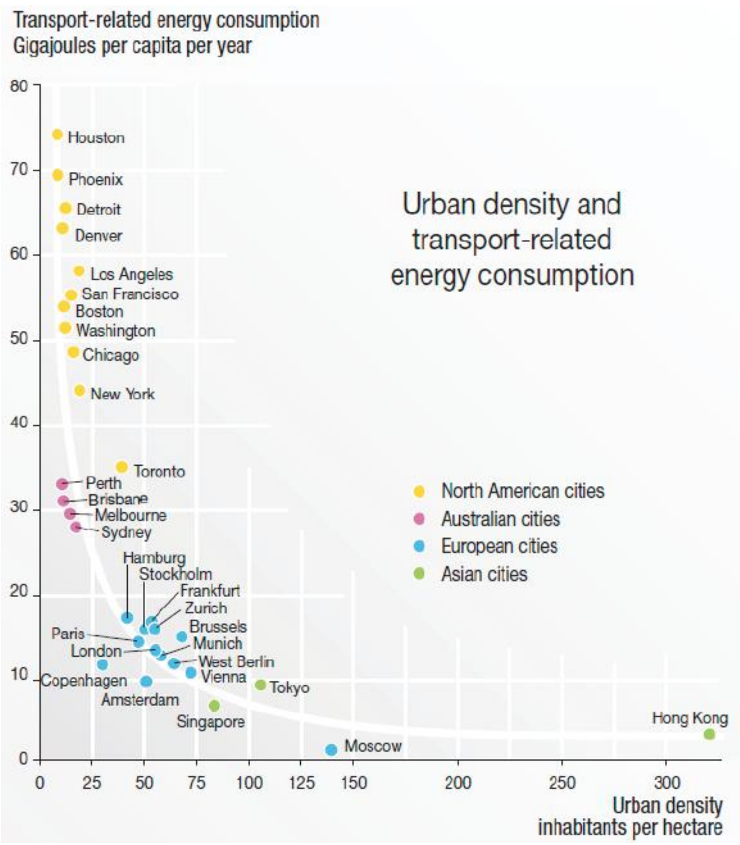
SUSTAINABLE NEIGHBORHOODS: INTEGRATING RENEWABLES FOR A BETTER QUALITY OF LIFE		
Lessons learned	**Case study**	**Good practice**
Encourage the private sector to come up with innovative solutions for energy access and consumption through policies, integrated planning and management, and financial incentives.	**Dezhou Solar City**	The local government of Dezhou provided tax incentives and subsidies to energy companies, which has fostered the development and production of accessible (low-cost) solar panels for Dezhou citizens.
	BMW i ChargeForward	BMW was chosen by the California Energy Commission to develop a system to make EVs usage more reliable and accessible in terms of charging and energy consumption.
	Taipei	Platform that matches citizens' and government's needs with business sector proposals. It fosters innovative solutions and partnerships for implementation.
Specific public entities and agencies to coordinate, engage the private sector, monitor the accomplishment of objectives and fit the project to a broader urban development plan.	**Hammarby Sjöstad**	Stockholm's various departments have been integrated into a single fabric led by a project manager and an environmental officer whose responsibilities have included guiding and influencing all stakeholders, public as well as private, to realize the environmental objectives of the project. The project involved 33 developers and 29 architectural firms in total.
	Clichy-Batignolles	Paris Batignolles Aménagement sets specific management tools to engage property developers in sharing the project's ambitions regarding environmental requirements, such as a financial guarantee equal to 4% of the sale price that is placed in escrow and returned only when compliance with the specifications has been verified.
Investment in R&D is key to promoting a sustainable energy sector: the provision of energy depends on geographical and climate conditions, in addition to the availability of technologies. Designing and implementing compatible technologies for the provision of renewable energy requires massive investments in research and pilot projects.	**Ithaca** **Málaga**	One of the key partnerships in these cases involves research institutions and universities.
	São Luiz do Paraitinga **Fernando de Noronha**	This pilot projects were designed and implemented in strict collaboration with research institutions, contributing to knowledge production that stimulates innovative solutions in the Brazilian energy sector.
	Dezhou Solar City	The objective to create a renewable energy cluster in Dezhou required massive investments in R&D, both from the public and private sector. In this specific case, fiscal stimulus from the government has boosted private investment in the sector.
Multiple partnerships as a path for effective sustainable solutions regarding energy access and provision in cities.	**Ithaca** **São Luiz do Paraitinga** **Fernando de Noronha** **Málaga** **Buenos Aires** **Puerto Princesa** **Taipei** **Clichy-Batignolles** **Hammarby Sjöstad** **Dezhou Solar City**	Projects for the inclusion of renewables in cities, for the implementation of smart grids and other innovative solutions, require a variety of technologies and expertise. It involves the engagement of different levels of government for funding, the engagement of local companies and citizens, as well as a wide range of private actors specialized in different fields. For instance, the living lab in Málaga engaged 11 companies and 14 research institutions, which includes knowledge production, technology implementation by different specialized companies and coordination by the large ones.

SUSTAINABLE AND ELECTRIC TRANSPORT SYSTEM

Historically, there have been a number of transport revolutions, brought about by major advances in transport technology. For example, the development of inland canal systems in the eighteenth century, coupled with advances in maritime shipping technology, greatly reduced the costs of freight movement and stimulated the industrial revolution and the early stages of globalization. Similarly, the development of railway networks in the nineteenth century stimulated economic development, fostered freight traffic, and enabled large numbers of people to move around their countries relatively quickly and cheaply.[26] All of these advances fueled great social changes and a wave of prosperity, and helped to create what we know today as *modern* cities.

At the beginning of the twentieth century, with the start of mass production, the car industry emerged. As automobiles became more and more common, cities had to be redesigned and rebuilt around the motor vehicle: high-capacity roads, wide streets and fast highways began to pervade cities. With the exponential growth of the motor vehicle in more advanced economies, cities like Los Angeles and Mexico City saw great increases in urban sprawl. Effectively, private vehicles allowed citizens to get to any point in a city quickly without the need to use any other mode of transport. In line with policies that encouraged private vehicle usage and investment in highways and roads, cities started to develop as car-centered urban areas. Over the decades, they became examples of inefficient, energy-consuming and polluting models of urban organization.

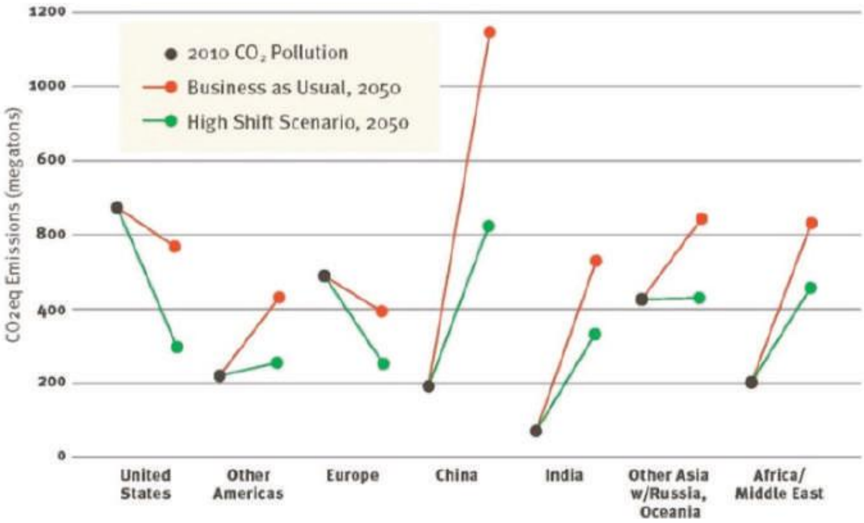
Figure 6. Urban density and transport-related energy consumption



Source: Newman & Kenworthy 1989, via UNEP.

[26] http://ac.els-cdn.com/S038611121400017X/1-s2.0-S038611121400017X-main.pdf?_tid=7184136c-738d-11e7-91ae-00000aacb361&acdnat=1501243880_fa65a789b164518e6ffe825b5cf48dfb

Figure 7. Total CO_2 Pollution from Urban Passenger Transportation



Source: Science Daily, https://www.sciencedaily.com/releases/2014/09/140917073300.htm, last accessed May 2018.

Low levels of density, and the associated high levels of car dependency, are the main determinant of the amount of transport-related GHGs and other pollutants cities emit. A study[27] by the European Environment Agency has warned that air pollution causes around 467,000 premature deaths in Europe every year. Another study by the World Health Organization estimated that in 2012 around seven million people died worldwide as a result of air pollution exposure, with a significant share being as a result of urban transport.[28] Sprawling cities will inevitably need to consume more energy in order for their citizens to effectively move from one place to another.[29]

But the effects go well beyond health–the European Commission has estimated that congestion, accidents and pollution, mainly caused by oil-powered cars and trucks, are problems that cost EU citizens more than €100 billion, which accounts for 1% of the EU's GDP annually.[30] Another study by Bouton et al. (2015) estimated that congestion costs are as much as 1% to 5% of GDP as a result of lost time, wasted fuel and/or increased cost of doing business.

All these effects have opened the door for a deep reconceptualization of the 21st century's transport systems. If cities continue to promote car-centered urban areas, the cities of the future will suffer and, effectively, will fail to mitigate climate change. Indeed, under a business-as-usual scenario, energy use and GHG emissions from the land transport sector are expected to increase nearly 50% by 2030 and more than 80% by 2050, as compared to 2009 levels (UN, 2014). Urban mobility systems may use 17% of the planet's bio capacity by 2050, equivalent to about five times of the amount they used in 1990. The current interdependence between oil and non-renewable fossil fuels and transport magnifies current environmental challenges: 90% of transport fuels are oil-based and 50% of oil produced worldwide is consumed by the transport sector.[31]

Still, it's not all bad news. If proper actions are put in place, cities can help tackle climate change and improve the lives of millions of citizens worldwide. The rise of electric mobility and new forms of transport, such as car-sharing systems, is leading the way towards new ways of mobility in urban areas. Electric mobility is seen as one of the most promising ways to reduce pollution and GHG emissions, and will be crucial to promote renewable energy worldwide. The recent developments in electric mobility, such as major investments in new battery lives and the rise of information technologies that are opening new business models, have created opportunities for the public and the private sector in cities to cut down emissions and meet the Paris 2020 pollution targets.

[27] http://www.bbc.com/news/world-europe-38078488

[28] WHO, 2014 (from Chapter 2: Urban Mobility Trends and Challenges)

[29] http://www.who.int/hia/green_economy/giz_transport.pdf

[30] https://ec.europa.eu/transport/themes/urban/urban_mobility_en

[31] UITP, 2015b.

Investing in Sustainable Transport and Coordination Among Stakeholders Influences all Aspects of Sustainability in a City

Governments and businesses around the world have recognized electric modes of transport as an essential part of a smarter and more sustainable future. The multiple environmental and economic benefits offered by EVs and other modes of electric transport have shaped a broad consensus on why this transformation is essential.

The question raised, however, is how the public and the private sector can help to create a sustainable urban transport system. Importantly, one of the characteristics of the transport system, and one of the things that make it a crucial policy area for all local authorities, is that its effects on the urban ecosystem go well beyond the dynamics of transport; it has effects on health, on economic development and employment, and on the way the urban structure develops. This multidisciplinary nature of transport, which touches every aspect of sustainability, is what it makes it a central issue. A well-planned transport system can help achieve a more sustainable city and reach a wide number of UNSDGs. But, a transport system that is built under an uncoordinated strategy can have extremely negative effects on the city of the future.

Public-private collaboration is key in this area. Coordination failures are common when putting in place urban projects, especially in transport, as multiple stakeholders do not necessarily undertake socially desirable projects. Indeed, many projects require simultaneous investments in complementary production processes. For example, firms may not develop a smart charging grid for EVs in a neighborhood without a significant presence of EVs. But, without the possibility of getting the energy necessary to power their vehicles, consumers will not buy EVs. Public authorities may need to take the lead to alleviate the potential problems that might arise from this type of coordination failure.

But coordination alone will not solve the problem. As mentioned in the previous section, new ICTs can help make processes more efficient and integrate all stakeholders.

We have identified four different types of cases from which we can learn about how to electrify the transportation system in cities and how the cities of tomorrow can coordinate in order to develop a sustainable urban transport. In order to do this, we have organized this section into four different parts: (1) creating an effective and successful EV **charging station network,** (2) implementing electric **car-sharing services,** (3) **building and retrofitting public infrastructure** transportation networks so that they are green and sustainable, and (4) building a **holistic strategy** for the electrification of mobility in cities that integrates many different plans at once.

1. Charging Stations

For EVs, the access to charging facilities is a concern. Local authorities can incentivize the EV usage in cities only with a good system of charging stations. Without the possibility of getting the energy necessary to power their vehicles, consumers will not buy EVs. But setting up a system of charging stations is not enough: the system requires accessibility for all types of EVs, as well as affordability for consumers.

The costs for the large-scale deployment of charging infrastructure are too high to be borne by the public sector alone (one slow, two-plug charging station costs around €2,000 in hardware alone, and two charges per vehicle are required). As a result, one of the most critical challenges for the EV sector is to achieve commercial viability in the deployment of charging infrastructure in the coming years.

This is the example of Case Study 11, where an energy company, Fortum, is offering a network of charging stations all over the city of Oslo. The capital of Norway is experiencing a great increase in the sales of battery-powered cars. They represented 29% of all new car sales in 2016.[32] With this reality, Fortum has seen an opportunity to offer a new product by installing more than 104 charging stations throughout the city.

This example shows the need for a mature market to introduce new services. But, at the same time, it also shows how the local authority can play a role in incentivizing the deployment rather than deploying a specific facility itself. The city council offered free parking places to EV owners and the possibility of using the bus lanes. Of course, the city loses revenues from parking tickets. But, the charging stations may be subject to local taxes and, more importantly, the reduction of traffic emissions enhances the quality of the air (and reduces public health costs). We can consider this kind of agreement as an institutional PPP. There is no contract between partners, but a mutual objective is reached by combining efforts.

[32] https://www.economist.com/news/business/21717063-ever-more-electric-cars-are-road-next-step-build-charging-network-support

In the same case, there was a partnership between two private companies, Fortum and Nissan. The partnership originated because the charging stations fit 100% with Nissan Leaf, an EV build by the automobile company. Thanks to this agreement, and the fact that Fortum has extended its Charge & Drive network to the highways connecting the Nordic countries, this allows Nissan drivers to drive all across Norway, Sweden and Denmark, overcoming the challenge of autonomy of EVs.

A similar case is Case Study 12, which focuses on Cambio, the car-sharing company based in Cologne. Besides the car-sharing system, which will be explained later, an agreement between an energy company, RheinEnergie, and the city council has encouraged the use of EVs. In Cologne, the network of lampposts, owned by this energy company, has been used to install charging stations for EVs. The city council has also offered free parking for EVs, but only for those using the charging stations. Cambio, together with other private users, has taken advantage of this initiative. Here again, an institutional PPP arises as an option to achieve the same goal.

Case Study 11: Charge & Drive

Source: https://www.google.com/maps

Case Study 11	
City	Oslo, Norway
Population	634,293
Wealth	High
Type of project	Sustainable transportation
Subtype	Charging stations

Summary

Charge & Drive is a project undertaken by Fortum to develop a charging network of EV vehicles in Oslo. The Charge & Drive project consists of a charging network that sells electricity at a premium for EV vehicles through fast-charging services provided via the prior installation of a charging network in Oslo (Norway).

In Norway, the sales of green vehicles are booming; therefore, it has become necessary to build up a charging network to provide charging points to supply the necessary electricity to the new EV owners, as most residents in Oslo live in apartments (seven out of ten residents) and have no charging options at home. Therefore, it provides a great opportunity for companies like Fortum to launch projects such as Charge & Drive, in order to satisfy the new automotive energy demand.

They also sell the infrastructure to others (real estate companies, retailers) and offer software to other companies so that they can operate and provide the service themselves.

Factors of Success

- Provision of EV charging stations to an underserved market. Also, great provision capacity compared to competitors;
- Early adopter: they were the first charging station network in Sweden, and thus they had valuable experience when implementing the charging station network in Oslo;
- Different types of charging (fast, medium and slow) makes service provision more flexible;
- Collaboration between city council and Fortum (Charge & Drive) ensured that there was an overall strategy that fueled the use of EVs so that the business model is sustainable (privileges for EV usage, such as free parking, enabling EV drivers to use bus lanes, etc.);
- Partnership with other companies, such as Nissan, also enabled them to connect Nordic cities, giving value propositions to citizens beyond the city of Oslo.
- Value-proposition is mostly related to the use of efficient software and the demand management of EV charging.

Agents Involved

- Fortum Charge & Drive;
- Oslo city council and national government;
- Nissan.

Energy and Environment Technologies

- Smart charging;
- Super charging stations;
- Apps and software that ensure the service is delivered properly.

Impact (Good Practices, Lessons Learned)

- More than 104 charging stations located throughout the city;
- Incentivized the use of EVs in the city, as well as nationally;
- Private provision of service and close collaboration with the public sector; the public sector ensured that the service was financially sustainable by encouraging EV usage and also by giving privileges to the company.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action

High Impact	High Impact	High Impact	High Impact	High Impact

2. Car Sharing

Car sharing is a new form of mobility, both within and between urban areas. It is estimated that cars go unused for 90% of their lives, being the epitome of an inefficient and resource-consuming transport system. Car sharing, combined with high-capacity public transport, could remove nine out of every ten cars in mid-sized European cities. Car sharing thus represents an opportunity to significantly reduce traffic levels.

Car-sharing systems that are electric offer, in addition, the chance to foster the use of EVs, having a significant impact on air and noise pollution. The impact of electric car sharing in cities can be very significant, and thus local authorities should try to learn how to include it in their urban areas. Also, it has been found that the inclusion of a car-sharing system in a city incentivizes the creation of car-sharing fleets, as other firms may subsequently be attracted by the potential profits of the sector.

The car-sharing cases presented in the following pages show similarities but also differences between each other. In all of them, a private company is a partner of the car-sharing system, although in the case of Autolib' (Case Study 14), the car-sharing company is owned by a syndicate of municipalities. The presence of public authorities is also permanent in all the cases, although the level of implication of the city council differs from case to case. For example, in the case of Autolib', there is intensive participation by public authorities, as main drivers of the car-sharing system. In contrast, in the case of Car2Go (Case Study 13), the government of Madrid has been a passive actor in terms of the business model. However, it has helped the project's development by offering free parking for EV in areas where, and at times when, parking is limited. In between these two extremes, is the case of Cologne, which has been actively promoting car sharing by creating Mobility Hubs, integrating the car-sharing system into the public transport system with the possibility of using the Mobilticket for this kind of transport, and offering free parking for EV charging in lampposts near parking places.

Another common factor across cases is the presence of a third party; another private company, complementary to the car-sharing one. In some cases, such as that of Cambio and that of Autolib', an energy company offers solutions to the problem of charging batteries. RheinEnergie for Cambio and EDF for Autolib' are the industrial partners that guarantee the charging stations. In the case of Autolib', this relation with EDF comes from the fact that EDF already had an agreement with Bolloré Group (responsible for the design of the battery technology) and Pininfarina (responsible for the design of the vehicles). In Madrid, Car2Go has an agreement with Daimler that offers a fleet of Smarts.

Case Study 12: Cambio

Source: https://www.google.com/maps

	Case Study 12
City	Cologne, Germany
Population	1,060,582
Wealth	High
Type of project	Sustainable transport
Subtype	Car sharing

Summary

Cambio is a car-sharing company based in Cologne and working in 21 cities in Germany. The case in Cologne is interesting because, besides the car-sharing service, there are some complementary smart solutions that provide a more sustainable mobility. Some lampposts have incorporated charging stations for EVs. These lampposts are strategically located next to parking places that are free for EV users charging their vehicles. In addition, Cologne Transport Authority offers a transport ticket (Mobilticket) that can be used for different transport modes, such as the bus and train, but also bike sharing and car sharing, and can be used in the cities of Cologne, Bonn, Hürth and Bergisch Gladbach.

To improve sustainable mobility, Mobility Hubs have been created in the different cities, where there are places to park the fleet of cars from Cambio and also to park bikes included in the bike-sharing system, Some parking places are also charging stations for EVs.

Cambio is one of the largest independent car-sharing providers in Germany, with 93,600 customers and a fleet of more than 2,625 cars in 21 German and 34 Belgian cities.

The company's roots are found in the ecological movement. In 1990 and 1992, groups of dedicated people started sharing vehicles in Aachen, Bremen and Cologne. Steadily growing customer numbers led to an increase in professionalism in the 1990s. In March 2000, the hitherto independent car-sharing providers from Aachen, Bremen and Cologne united and founded the Cambio group. Together they improved and expanded services into other cities. Today the majority of the Cambio group is still owned by customers and employees.

Forty-five percent of all Cambio trips are work-related. Currently more than 1,550 businesses and agencies use Cambio.

Factors of Success

- Car sharing without fixed stations;
- Fuel, such as charging EVs, is included in the tariff;
- Fleet management software to use the vehicles;
- Network of cities where the service can be used (especially in the Rhine Valley);
- Integrated into the Mobilticket system, allowing the user to change the mode of transport.

Case Study 12: Cambio (cont.)

Agents Involved

- Cambio;
- RheinEnergie;
- City council of Cologne.

Energy and Environment Technologies

- Super-fast charging stations installed by the power company RheinEnergie;
- EVs for both positive environmental impact as well as lower levels of noise pollution in cities;
- App for customers, which eases registration and allows them to visualize cars;
- Transport ticket that can be used for the car-sharing system but also for other modes of transport (bike sharing, buses and train).

Impact (Good Practices, Lessons Learned)

- Collaboration between Cologne city council (city council and the regional transport authority), RheinEnergie and Cambio;
- Creation of Mobility Hubs by the city council (a pool of car-sharing and bike-sharing stations next to public transport hubs);
- Allowance of free parking for EVs charging in the lampposts owned by RheinEnergie;
- The use of each vehicle in the car-sharing system represents at least 11 fewer cars in the streets.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	11. Sustainable Cities and Communities	13. Climate Action	17. Partnerships for the Goals
Medium Impact	**High Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- Easy replicability in cities with regulation that allow these private initiatives to flourish;
- The capacity to replicate the charging station system is conditioned by the ownership of the lampposts;
- A mature regional transport authority can improve a sustainable mobility system by implementing a transport ticket that can be used for different modes of transport.

Case Study 13: Car2Go

Source: https://www.google.com/maps

	Case Study 13
City	Madrid, Spain
Population	3,141,991
Wealth	High
Type of project	Sustainable transportation
Subtype	Car sharing

Summary

Car2Go is a car-sharing company based in multiple cities around Europe and America. Madrid's case is particularly interesting because all cars are electric. It is a perfect example of a company with success in the field of electric mobility. Although electricity is not necessarily from renewable sources, Car2Go contributes to the reduction of pollution in cities by (1) reducing traffic and (2) fostering the implementation of non-polluting EVs in cities. Also, the introduction of new car-sharing services such as Car2Go has helped to increase the car-sharing fleet of a city, as more firms are attracted to the sector by potential profits.

In Madrid, Car2Go has a fleet of more than 500 cars for citizens to move around the city center, inside the perimeter of the M-30 highway. The company now has more than 112,000 users in Madrid and its fleet of 500 Smart Fortwo cars has already travelled 5.8 million kilometers, representing a saving of 568 tons in CO_2 emissions in a city that has long been plagued by pollution. Moreover, thanks to the regional transport authority, Car2Go can charge its fleet in a super-fast charger, making it easier for the firm to manage the energy consumption and the batteries of its cars.

Factors of Success

- Fleet management software to efficiently and effectively manage vehicle downtime;
- Successful demand management thanks to big data and ICTs, which look at how many individuals will be in a certain area at a certain time. This model helps successful fleet management and is based on advanced machine learning technologies;
- Car sharing without stations gives a more flexible service to customers;
- Efficient batteries that allow each car to be driven between 125 kilometers and 200 kilometers after being charged;
- Flexible tariff system for customers;
- As they are electric, the car fleet can park for free and without time limits in parking regulated areas (both blue and green zones).

Case Study 13: Car2Go (cont.)

Agents Involved

- Daimler (Smart);
- Car2Go;
- Europcar;
- Madrid's local council.

Energy and Environment Technologies

- Super-fast charging stations belonging to the regional transport authority;
- EVs for both positive environmental impact, as well as lower levels of noise pollution in cities;
- App for customers that eases registration and allows them to visualize cars;
- App for customers also allows their cars to be tracked and identified.

Impact (Good Practices, Lessons Learned)

- Collaboration between Madrid city council (regional transport authority) and Car2Go;
- Regulation from city councils (such as free parking for EVs) can incentivize EV car-sharing fleets;
- Saving of more than 568 tons of CO_2 emissions in a city that has been plagued by pollution.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action
7 AFFORDABLE AND CLEAN ENERGY	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	11 SUSTAINABLE CITIES AND COMMUNITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION
High Impact	**High Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- Easy replicability in cities with regulation that allows these private initiatives to flourish

Case Study 14: Autolib'

Source: https://www.google.com/maps

	Case Study 14
City	Paris, France
Population	10,601,122
Wealth	High
Type of project	Sustainable Transportation
Subtype	Car sharing

Summary

In December 2011, the city of Paris introduced the Bluecar, a three-door EV designed by Pininfarina and Bolloré, available for short-term use at any one of 250 stations in the city of Paris and municipalities in its vicinity. Following the successful Velib bicycle-sharing program, which was subsequently copied in various cities of the world—including London and Mexico City—and smaller-scale experiments in the provincial cities of La Rochelle and Lyon, Paris local authorities introduced EVs as a complement to public transport and an alternative to private vehicle ownership.

Autolib' provides the availability of electric cars for short-term leasing to any member of the public with a subscription. Among the many emerging EV ecosystems in the world, the case of Autolib' is one of the first to be fully functional and established within a large European metropolis with an existing customer base.

Autolib' is managed by a syndicate of municipalities in the Paris metropolitan area and is operated by a horizontally integrated transport, logistics and infrastructure company, Bolloré. Its revenue structure is therefore still dependent on public financing. The subscription fee includes fuel (electricity) costs, as well as the other costs of driving: insurance, maintenance and repairs, and parking.

From the initial 250 vehicles, the program grew to 1750 EVs and more than 5,000 charging points at 710 stations in 2012 in the Paris metropolitan area, including 45 surrounding communes. In the final stage, Autolib' is expected to provide 3,000 vehicles and 6,600 charging stations.

An important aspect of the business model is its versatility: the charging stations can also be used to charge private EVs for a subscription fee of €180/year.

Factors of Success

- New ownership structure: end users do not need to own a car to drive one;
- Revenue and cost structure appears in mobility services: end users pay a subscription fee that includes all ancillary costs, such as insurance, maintenance and refueling, while the service company bears all of the upstream and downstream risks;
- Allowing other cars to use the charging station for a fee;
- Using ICTs: software is the most important value proposition;
- Autolib' drivers can save about €7,000 per year by using the service rather than buying a car in Paris–a total of €315 million over all users per year;
- Last-mile transport to citizens;
- Parking around the city in busy areas;

Case Study 14: Autolib' (cont.)

- Road tax exemption, registration tax exemption, access to bus lanes;
- Subsidies (amounting to more than €4 million) at the beginning of the project;
- Loan for R&D by the European Investment Bank (€130 million).

Agents Involved

- Bolloré: management of service and provision of batteries;
- Pininfarina: design of cars;
- Cecomp: manufacturing of cars;
- Havas: communications.

Energy and Environment Technologies

- EV cars;
- Charging stations;
- Lithium metal polymer battery, allows between 150 kilometers and 250 kilometers of autonomy

Impact (Good Practices, Lessons Learned)

- In contrast with Car2Go, this project is an example of a full PPP between the local city council and a private company, Bolloré;
- By 2023, Autolib's fleet of cars is expected to have replaced more than 25,000 privately owned cars, reducing CO_2 emissions by 75 million metric tons;
- Reduction of roughly 90 % in drivers' transportation costs.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	11. Sustainable Cities and Communities	13. Climate Action	17. Partnerships for the Goals

Medium Impact	**High Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- Cities who face limited EV use due to pricing and congestion may find the Autolib' project a good example of how partnerships can lead to new relationships between city residents and cars.

3. Public Transportation Networks: Electrifying Metro, Bus and Tram Systems

Private EVs are not the only type of transport that cities need to take into account when electrifying their transport services. Underground and bus networks, as well as other forms of electric mobility, will need to be developed in parallel to create sustainable and unpolluted cities.

The following cases: Metrocable, (Case 15); Curitiba's Bus System (Case 16); Metrorrey (Case 17); and Bluetram (Case 18), present examples of how public authorities have introduced the use of EVs for different modes of transport. The general characteristic for all of them is that the public authority is responsible for the impetus of the project and the private company provides technological support to the project. This model is quite different from that of the car-sharing system. Here, the initiative comes from the public sector, and the private sector helps it to reach the goals. In the three Latin American cases at least, the project is part of the strategy of the city. This shows that being a smart city is not only about technology but about the strategy of the city.

The private partners are a combination of national and international firms. Some of combinations in these cases show how private alliances can help with the development of these types of initiatives in countries with a lack of mature industrial partners. The national partners provide the knowledge on how to work with national authorities, while the international partners contribute the knowledge on how to work with the specific technology. Examples of this type of partnership include the first successful PPP in Egypt.[33]

[33] http://www.ieseinsight.com/fichaMaterial.aspx?pk=136139&idi=2&origen=3&idioma=1&_ga=1.159016179.836782899.1473066037

Case Study 15: Metrocable

Source: https://www.google.com/maps

	Case Study 15
City	Medellín, Colombia
Population	2,464,000
Wealth	Medium
Type of project	Sustainable transportation
Subtype	Public transport

Summary

The city of Medellín stretches from a narrow valley to vast areas on hilly slopes. Such geography resulted in many informal settling processes, called barrios. Given the insufficient transport and lack of public services, people living in these areas experienced marginalization. It led to an increase in poverty and violence.

Medellín's Metrocable project emerged as a solution to serve the dense informal settlements on the city's mountainous marginalized areas. It is part of the Proyecto Urbano Integral, a broad urban development plan that incorporates social inclusion and improves the quality of life in the peripheries of the city: "by integrating the design of the system with other forms of mass transit and improving access for pedestrians, the city's Metrocable system has helped connect low-income residents to their city and put urban mobility at the heart of equity."[34]

The publicly owned Metro de Medellín Company presented the project to the mayoral candidates in 2000. The proposal was accepted by the elected mayor, Luiz Perez, who committed to implementing it in the following years. Since it began operating in 2004, the Medellín Metrocable has been integrated into the main Medellín Metro, carrying over 30,000 people per day, and has expanded to include three lines: Lines K, J and L.

The cost of the first line was close to US$24 million and the second almost US$47 million. The first line to be built was Metrocable Line K, to the Santo Domingo Savio neighborhood, which reaches around 230,000 inhabitants in 12 localities and links northeastern Medellín with the city center. Metrocable Route J serves 315,000 inhabitants in 37 districts.

The project was implemented by the Metro de Medellín company and the Union Temporal Telecabinas Medellín consortium, involving the Colombian companies Conconcreto S.A. and Termotécnica Coindustrial S.A. and the French company Pomagalski. However, the Line J system was designed by another consortium formed by the Colombian companies Pablo Emilio Bocarejo Ingenieros Constructores and the French companies Alpes Etudes and ERIC.

This project became a prototype for social interventions in some of the poorest areas of the city. Because of this, the Proyecto Urbano Integral won The Veronica Rudge Green Prize in Urban Design, the foremost award recognizing achievement in this field.

[34] www.medellin.gov.co

Case Study 15: Metrocable (cont.)

Factors of Success

- Urban mobility center within a broader urban development plan (Proyecto Urbano Integral) with the aim of urban improvement through a combined strategy of mobility, environment, housing and public space: a coherent policy of integrating cable-car systems into the urban fabric.

Agents Involved

- Local government of Medellín;
- Metro de Medellín public-owned company;
- Consortium Union Temporal Telecabinas Medellín.

Energy and Environment Technologies

- Technology for aerial cable system;
- Cabins;
- Technology for electric energy usage;
- Towers for cables;
- Solar energy and batteries.

Impact (Good Practices, Lessons Learned)

- This is a successful case of promoting social inclusion through urban mobility: the Metrocable connects the marginalized mountainous area to other regions of the city;
- The Metrocable has halved the average travel time from the barrios to the center, from roughly two hours to one. Its integration with Medellín's main public transport system has increased the comfort of passengers and reduced the cost and duration of their journeys.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	11. Sustainable Cities and Communities	13. Climate Action	17. Partnerships for the Goals

Medium Impact	**Medium Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- The replicability of this project is conditioned by the morphology of the city. If the morphology is similar to that of Medellín, it is easy to replicate.

Case Study 16: Curitiba's BRT System

Source: https://www.google.com/maps

Case Study 16

City	Curitiba, Brazil
Population	1,752,000
Wealth	Medium
Type of project	Sustainable transportation
Subtype	Public transport

Summary

Curitiba was the first city to develop Bus Rapid Transit (BRT) in 1974 and today the city continues to be a transit innovator, having recently launched a program to implement hybrid and electric buses. Curitiba's BRT system was developed as an integral part of an overall Masterplan (1966), its main objectives include radial expansion of the city along five corridors, integrating land use and transport, and creating a dedicated planning institute, IPPUC. The Masterplan is revised every 10 years, and the latest revision includes a comprehensive urban sustainable development plan for the next 50 years.

Today, 80% of travelers use the BRT system, and it carries around two million passengers per day. The BRT has 30 hybrid buses, reducing overall fuel needs by 35% and limiting pollutant emissions. It has been replicated in more than 150 cities worldwide.

This project is also known for creating a transport network authority to coordinate all different modes of transport effectively, which is the reason behind the success of the project.

BRT systems provide developing cities with the opportunity to alleviate traffic congestion, while being extremely cheap compared to other modes of transport, such as tram lines or subways.

In 2011, BRT expanded its carrying capacity with the implementation of the Direct Line–a bus with fewer stops, reducing the travel time for those who travel longer distances. In 2012, the city added hybrid buses to its transport network, cutting carbon emissions by reducing overall fuel needs by 35 %. These hybrid buses also cut down on pollutants such as NOx and smoke. Today, there are 30 vehicles of this type in operation in Curitiba's fleet.

Since 2014, Curitiba has been promoting 100 % electric buses, including testing a model from Chinese company BYD that is totally silent, has a range of 250 kilometers and consumes 75 % less power than its diesel counterpart. Curitiba has 13 fully electric vehicles, including 10 cars and three minibuses, which it obtained through a partnership with Portugal. In the first five months of the project–called Ecoelétrico–the 10 electric cars showed savings of 82 % compared to the consumption of gasoline-powered vehicles and avoided an estimated three tons of carbon emissions. The project's aim is to show how EVs can provide savings and reduce environmental impact at the same time.

Case Study 16: Curitiba's BRT System (cont.)

Factors of Success

- Creation of an integrated transport network authority to manage all the modes of transport in the city (governance);
- One fare covers the entire system–integration of different lines and modes of transport.

Agents Involved

- Chinese company BYD;
- Private bus operators;
- Curitiba's transportation planning agency;
- Curitiba's urban development authority.

Energy and Environment Technologies

- Electric and hybrid buses;
- Charging stations for electric buses;
- Monitoring of passenger behavior in order to determine peak hours in the transport system.

Impact (Good Practices, Lessons Learned)

- Example of how cost and resources are not a decisive limiting factor;
- Example of how old systems can be retrofitted to include renewable and sustainable energies;
- Integrated mode of transportation that encourages citizens to use public transport: 80% of travelers use the BRT system and it carries around 2 million passengers per day;
- Reduction in air pollution by using EVs (75% less consumption of power than diesel), use of hybrid buses (reduction of 35% in pollutants).
- Impact in terms of SDGs.

7. Affordable and Clean Energy

Medium Impact

9. Industry, Innovation and Infraestructure

Medium Impact

11. Sustainable Cities and Communities

High Impact

13. Climate Action

High Impact

17. Partnerships for the Goals

High Impact

Feasibility and Replicability

- The capacity for replication of this case is high, and it has already been replicated in other cities; for example, in the Barcelona bus system.

Case Study 17: Metrorrey

Source: https://www.google.com/maps

Case Study 17	
City	Monterrey, Mexico
Population	4,520,329
Wealth	Medium
Type of project	Sustainable transportation
Subtype	Public transport

Summary

Since 2006, the public transportation system of Monterrey has had an agreement with Bioénergia Nuevo Leon for the provision of clean electric energy. According to Metrorrey, the use of clean energy allows savings of US$738,100 million.

It comes from the Monterrey Cinco (Monterrey Five) project, adopted in 2006 by the city of Monterrey to supply several urban services with biogas produced from the decomposition of the municipal landfills. The plant converts methane into electricity used in street lighting in Monterrey and used to power the Metrorrey public transit system. The methane capture system and power plant is located at Simeprodesco's landfill in Salinas Victoria, just outside Monterrey.

Currently, the facilities generate 20.8 megawatt-hours (MWh) and serve the public lighting of the metropolitan area of Monterrey, governmental offices and the Metrorrey transport system (Tecnológico de Monterrey, 2013).

Simeprodesco, the metropolitan solid waste processing system of Mexican city Monterrey, has chosen the Bioenergía de Nuevo Leon consortium to carry out a waste-to-energy pilot project. London-based waste-to-energy company Combined Landfill Projects (CLP Envirogas), Costa Rica's Saret Group and Mexico's SEI make up the consortium, which was the top ranked of the seven pre-qualified bidders.

Factors of Success

- Integrated strategy between Metrorrey and Bioenergía for the provision of biogas.

Agents Involved

- City of Monterrey;
- STC Metrorrey;
- Simeprodesco;
- Bioenergía de Nuevo Leon consortium (Combined Landfill Projects, Saret Group and SEI).

Case Study 17: Metrorrey (cont.)

Energy and Environment Technologies

- Uninterrupted energy supply system;
- Building plant for the biogas system:
  - 248 extraction wells with monitoring valves;
  - Collecting pipes, conduction and control (≈ 25 kilometers);
  - Three vacuum pumps;
  - Filters;
  - Two flare stations for gas burning (operates as needed) ;
  - Integrating biogas system and metro station.

Impact (Good Practices, Lessons Learned)

- The use of a circular economy model;
- The industrial investment related to the project (biogas plant).
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action	17. Partnerships for the Goals
High Impact	**High Impact**	**High Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- To replicate the project there is a need to have a somewhat mature industrial sector able to implement the project.

Case Study 18: Bluetram

Source: https://www.google.com/maps

Case Study 18	
City	Paris, France
Population	2,244,000
Wealth	High
Type of project	Sustainable transportation
Subtype	Public transport

Summary

Bluetram is an entirely electric vehicle that was first used on the Champs Élysées in Paris at the beginning of December 2015 for COP21. Its innovative technology allows a recharge of only 20 seconds, while passengers get on and off. Each new charge gives Bluetram a range of up to two kilometers. To enable this quick recharging, each stop is equipped with energy storage capacity equal to the vehicle's. It is still in a pilot phase, while Blue Solutions is preparing to deliver a tramway management system, including vehicle stations and a computerized management system.

Factors of Success

- The development of supercapacitor technology that enables the storing of high loads of energy.

Agents involved

- Blue Solutions company;
- Municipality of Paris.

Energy and Environment Technologies

- Energy storage capacity in each tram stop;
- Electric tram;
- Telescopic charging connector;
- Supercapacitor technology.

Case Study 18: Bluetram (cont.)

Impact (Good Practices, Lessons Learned)

- Project under development.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action	17. Partnerships for the Goals
High Impact	**High Impact**	**High Impact**	**High Impact**	**High Impact**	**High Impact**

Feasibility and Replicability

- Project under development.

4. Building an Integrated Strategy for Electric Urban Transport

Although specific projects can have significant effects on the electrification of transport, only through a holistic and effective strategy that integrates many different innovative projects can local authorities fully make cities sustainable, green and electric.

This holistic view can be seen in the case of Amsterdam Electric (Case 19) and, to some extent, in the cases of Metrorrey, Curitiba's bus system or Metrocable, where the initiatives are aligned with the mobility strategy. In the case of Amsterdam, the city council is deploying a variety of measures to increase the use of EVs in the public transport and car-sharing systems, as well as in the private car fleet. In the case of BMW (Case 20), the strategy focuses on the energy sector, where the fostering of EVs is based on vehicle-grid optimization and the integration of renewable energy sources in this grid.

Both cases have a new central actor: the citizen. Citizens have been present in all the previous mobility cases, as they are meant to be the main beneficiaries. But in Amsterdam and BMW, they are also meant to be active. In the case of the former, they have been participating in the design of a strategy to develop a city with global sustainable mobility and, in the latter, they are managing their EV charging process, giving themselves the opportunity to reduce the costs of the operation and maintenance of the grids.

Case Study 19: Amsterdam Electric

Source: https://www.google.com/maps

	Case Study 19
City	Amsterdam, The Netherlands
Population	1,351,587
Wealth	High
Type of project	Sustainable transportation
Subtype	Transport strategy

Summary

The city of Amsterdam has implemented a long-term strategy for the development of a transport system, putting in action electric transport systems, EV charging stations, investing in R&D, offering subsidies for clean energies, and, most importantly, using big data and new technologies to provide policy direction and strategies in the long term. Beyond being the city with the highest density of charging stations in the world and having car-sharing companies like Car2Go in its streets, Amsterdam has excelled for being a city that has created a holistic strategy for the implementation of electric mobility solutions at all levels around the city. It is the best example of how cities can incentivize the use of electric mobility by combining electric public transport, new forms of mobility, subsidies to private companies, investment in R&D, and limits on non-renewable/non-green modes of transport, among others. Most of these projects involved collaboration between public and private actors.

By creating a strategy and a detailed plan, the city of Amsterdam is planning to become emission-free by 2025. At the moment, all the electricity supplied to the city's public charging points is generated locally and sustainably using Amsterdam wind power. The plan envisions giving privileges to sustainable modes of transport like electric taxis, introducing zoning that prevents polluting cars to enter the city center, abolishing new parking permits for older vehicles and combining electric mobility with sustainable modes of production of energy. The design of the plan was carefully studied in partnership with the city council, research institutions and the private sector.

Factors of Success

- Close collaboration between most actors ensured a holistic strategy that profited from synergies;
- Use of technologies and big data to ensure an efficient delivery of services, such as the charging station network, and to develop policy strategies and direction (for example, smart charging network);
- Collaboration between a research institution and the city council to analyze the city data has come up with answers to questions that policy makers did not even realize they had;
- Helping startups and innovation by granting privileges and subsidies, ensuring that new ways of delivering services arise, and helping Amsterdam to benefit from new technologies;
- Use of innovative car-sharing companies to provide alternative and sustainable modes of transport to citizens.

Case Study 19: Amsterdam Electric (cont.)

Agents Involved

- Amsterdam city council;
- Amsterdam University of Applied Sciences;
- Nissan;
- Renault;
- Mitsubishi
- E-mobility Nuon;
- Taxi Electric;
- Abel (taxi company);
- Tesla;
- EV-Box;
- EV Consult.

Energy and Environment Technologies

- Public smart charging network (both for taxis, private vehicles and car-sharing systems);
- World's largest private charging database;
- EVs.

Impact (Good Practices, Lessons Learned)

- 2,351,935 zero-emission kilometers charged;
- More than 25,336 individual users and 2,040 charging points;
- Efficient use of public space and energy in charging networks through the use of big data and data analysis;
- Big data should be used for creating policy strategies and direction.
- Impact in terms of SDGs.

7. Affordable and Clean Energy

High Impact

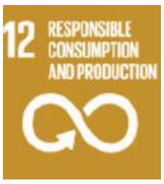
9. Industry, Innovation and Infraestructure

High Impact

11. Sustainable Cities and Communities

High Impact

12. Responsible Consumption and Production



High Impact

13. Climate Action

High Impact

17. Partnerships for the Goals

High Impact

Feasibility and Replicability

- The use of big data can be implemented in any city;
- Creating a holistic plan is something that every city authority can foster. Every city has private and public actors, as well as citizens and research institutions.

Case Study 20: BMW i ChargeForward

Source: https://www.google.com/maps

Case Study 20	
City	San Francisco, United States
Population	864,816
Wealth	High
Type of project	Sustainable transportation
Subtype	Charging stations

Summary

In this project, under a partnership with California-based utility provider PG&E, BMW wants to set the path for the future of electromobility and, in order to do so, it explores the relationship between the utility grid, plug-in EVs and renewable energy sources. Through vehicle-grid optimization and integration of renewable energy sources, it is possible to reduce the costs of EV ownership and minimize the grid impact of plug-in EV charging. In Phase I of the project, through the customers own management of charging via a smartphone application, it was possible to obtain lower costs with the operation and maintenance of the grid. While Phase II, which will take place in December 2018, seeks to demonstrate the benefits of charging optimization through management of both current and projected future charging events.

The California Energy Commission has awarded a grant to BMW to research the benefits and opportunities from shifting vehicle charging over time to meet the needs of the grid, while prioritizing each driver's expressed mobility needs. There is an increase in sales of EVs, and the evolving electrical grid in California has the challenge to integrate large amounts of renewable energy—characterized as being unpredictable.

Managing the charging of EVs is one way to ensure that the supply of electricity equals the demand at every moment. So, the BMW project provides a solution with the introduction of an advanced smart charging program that leverages communication to support utility grid efficiencies through the management of vehicle charging times. This communication system helps to optimize the electric grid through demand response, which improves grid reliability, lowers costs and helps the environment by incentivizing customers to reduce usage during periods of high-peak demand.

Factors of Success

- Communication system that allows management of vehicle charging times. This system stimulated demand response that, through October 2016, reached the full grid load reduction of 100 kW, as requested by the California-based utility provider PG&E.

Agents Involved

- BMW;
- California-based utility provider PG&E.

Case Study 20: BMW i ChargeForward (cont.)

Energy and Environment Technologies

- Charging stations: demand-response commitment from BMW;
- Smartphone app: gathers information from participants to ensure that their needs are always met.

Impact (Good Practices, Lessons Learned)

- This project demonstrated the technical feasibility and grid value of managed charging of EVs;
- It is also an example of how EVs can be an effective grid resource from a technical and customer-engagement perspective. For the latter, the interface of the company with the vehicle owners through the smartphone app with instantaneous information was essential;
- By August 2016, more than19,000 kilowatt-hours (kWh) were shifted as a result of ChargeForward events–enough to power the electricity for two homes over one year–avoiding costly and carbon-intensive electricity generation.
- Impact in terms of SDGs.

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action	17. Partnerships for the Goals
High Impact	High Impact	High Impact	High Impact	High Impact	High Impact

Feasibility and Replicability

- It is easily replicable for other EV producers.

5. Good Practices and Lessons Learned

The mobility solutions presented have a clear relation between them. They all help to reach more sustainable mobility, basically by reducing air pollution and by improving the traffic flow. In Table 3, we provide specific conclusions of these cases and, in the rest of this section, we present a summary of the lessons learned.

Energy Companies as an Active Actor

We can observe that energy companies are a key actor in fostering sustainable mobility, as they have the knowledge to develop the charging stations and the financial capacity to extend a strong and complete network of charging stations, giving EV drivers the security that they can refuel their vehicles. RheinEnergie in Cologne (Case 1) and EDF in Paris (Case 2) are good examples of how the energy companies can enter these markets. The participation of the California Energy Commission in the San Francisco case shows how important it is to have energy actors in the deployment of these smart solutions, as they are a key partner to guarantee their success. Except for the Metrorrey case, which uses a model of circular economy, the rest of the cases need to implement energy storage and charging solutions. Here again, knowledge of energy management and distribution is crucial. In summary, energy companies are needed to implement successful, sustainable mobility solutions.

Strategic Partnerships Between Private Firms

Energy and automotive companies should develop partnerships to develop EV. By joining forces, the R&D departments of both companies should guarantee that the charging stations are compatible with the charging points in EVs. This might be obvious, but a brief look at the different plug-in electric systems worldwide shows that this alignment is not secured. The case of Charge & Drive in Oslo—and also Autolib' in Paris—with EDF, Bolloré and Pininfarina working together to offer a new EV, show that these agreements are happening and can be crucial to expand the use of EV. Amsterdam, Cunitimba, Metrocable and California's cases are also examples of how partnerships between industrial partners are key to implementing mobility initiatives.

Institutional Partnership With Local Authorities

When it comes to the promotion of the use of EV, local authorities can also be active by, for instance, installing charging points in public infrastructure. However, Oslo (Case 11) and Cologne (Case 12) have shown that the private sector may also provide the charging points. The city council may just help by giving free parking places to EVs. As we have seen in the section on neighborhoods, incentivizing can be as efficient as implementing public policies. Still, Paris, in the case of Autolib', together with other public authorities, shows that the public sector can also be an active actor in these initiatives. Active participation of the public authorities is present in all the cases where EV solutions are implemented in the public transport network. But, in other cases (for instance BMW and Amsterdam), the public sector has more of a supplementary role, and it is the one that sets out the strategy, defining the vision about where they want to be in the next decades in terms of sustainable mobility.

Figure 8. Elements to reach a smart governance

	SMART GOVERNANCE		
STRATEGIC URBAN PLANNING	COLLABORATION	OPENEES & TRANSPARENCY	NEW BUSINESS MODELS
Diagnosis of the current state of a City	Internal Breaking Silos	Transparency	Collaborative Economy
A Vision, What the City Wants to Become in the Future	Multilevel & Networked with Cities & Institutionals Bodies	Better Management	Digital Economy
Planning, How to Reach this Vision	Public-Private Partnerships	Participation	Green Economy
	Citizens		Adapting Legislation

Source: Based on "Smart Cities, Sustainable Progress" by Juan M. Barrionuevo, Pascual Berrone and Joan E. Ricart. IESE Insight 2012

Being Smart Is About Governance

Ricart et al. have observed the introduction of smart solutions into the strategy of the city in several research papers. To reach this smart governance there is a need for four pillars: strategic urban planning; collaboration; openness and transparency; and new business models (see Table 3). Strategic urban planning has to have the traditional elements of strategy planning; that is, a good diagnosis that shows the strengths and the weaknesses of city, but also the opportunities and the threats. Once the strategic plan is made (as in the case of Amsterdam, Case 19), to overcome the challenges observed and to reach the goals, there is a need for collaboration: collaboration within the city administration but also with other administrations and with other cities, as in the car-sharing system in Paris that collaborates with a group of cities offering the Autolib' service (Case 14). Partnerships may also be developed with the private sector, as seen in all the cases. The private firms may offer technological solutions and/or new business models, such as the car-sharing systems or the implementation of charging stations in lampposts. These new business models will imply that legislation will need to be adapted. These smart solutions will also help to create more openness and transparency, promoted by city councils, as there will be a capacity for improving management thanks to the use and analysis of data, as shown in the cases of BMW and Cambio. This data will allow more participation from citizens, who will be the last actor to partner with. This kind of partnership will feature prominently in the cases of the section about energy access.

Beside these general conclusions, we set out, in Table 3, a set of lessons learned from the different cases.

Table 3. Good practices and lessons learned from case studies

BUILDING A SUSTAINABLE URBAN TRANSPORT THROUGH RENEWABLE ENERGIES AND ELECTRIC MOBILITY		
Lessons learned	**Case study**	**Good practice**
Financing does not have to be a limiting factor: building modes of transport that are adequate for the city and that bring innovative business models in order to make the most value-for-money out of projects.	Curitiba: BRT system	Cost-efficient way of providing new and effective technologies to solve transport problems in developing countries.
	Madrid:Car2Go	Car sharing could be implemented in a city by easing regulatory constraints and giving certain privileges to companies.
Success depends less on new technologies and more on appropriate technologies: sometimes simple renewable energy technologies are sufficient to electrify the transport system of cities.	Medellín:Metrocable	Very effective and simple system for public transportation that connects the periphery and central areas of the city. It consists of cables, cabins, towers and electric energy—powered to a certain extent by solar energy.
Renewables and circular economy can be a force for good to reduce pollution while ensuring efficient and reliable public transport systems.	Monterrey: Metrorrey	Using circular economy to power the metro system, using waste generated from city.
Although EVs are important for air pollution reduction, it is key that the source of energy also comes from renewables to limit emissions.	Amsterdam: Amsterdam Electric	The strategy of Amsterdam Electric is to incentivize that all energy for the charging station system comes from renewable sources.
Integrating ICTs will be the main value proposition of a number of projects related to electric mobility and renewables in the future. Utilities need not just become energy service companies. They can build up expertise in applying ICT solutions to become providers of more far-reaching infrastructure modernization, utilizing their close ties with households, industrial consumers and grid operators to create resilient, resource-efficient, smart infrastructure to the benefit of all. And that includes the environment where the saving of CO_2 will be considerable. **This is definitely applicable to the transport system, where ensuring efficient charging systems for EVs will be parallel to the development of their new business models.**	Oslo: Charge & Drive	In an interview with people from Charge & Drive, they explained the importance of software and giving consumers the ability to have a comprehensive app that is easy to use. Also, distributing energy efficiently is a challenge that they are working on through the development of smart parking.

Table 3. Good practices and lessons learned from case studies (cont.)

BUILDING A SUSTAINABLE URBAN TRANSPORT THROUGH RENEWABLE ENERGIES AND ELECTRIC MOBILITY		
Lessons learned	**Case study**	**Good practice**
Ensuring an efficient and stable grid is key: slightly related to the previous point, enabling the infrastructure for renewable energies and electricity has to go hand in hand with the creation of new technologies that ensure a stable grid, as the volatility of renewables can be detrimental to its integration in the energy system and thus to the practicality of the integration of sustainable models of transport. The move towards a more electric transport system needs to ensure that electricity distribution is efficient, stable and clean. Otherwise, a more electric transport system might cause an increase in energy use from non-renewable sources, since at times of high electricity demand there might not be enough electricity available, and thus it might be necessary to use electricity from coal plants, for example.	Oslo:Charge & Drive	Without the proper infrastructure for charging, citizens will not buy EVs
	San Francisco:BMW i ChargeForward	By building a connected grid for EV, we can ensure a more stable supply and demand of electricity, and provide reliable electric services for cities
Finding the right solutions: every city has its own problems and its own ways of limiting traffic, reducing pollution and encouraging electric mobility. Sometimes, cities will need to learn how to accommodate mobility demand without expanding infrastructure.	Curitiba: BRT	Expensive to build metro system or tram. BRT was cheap and a quick way to provide the necessary transport services for the future.
	Paris: Autolib'	Previous charging stations were used for this car-sharing system.
	Paris:Bluetram	Perfect for the development of an electric transport system in low-populated cities.
Building an **integrated strategy** is a necessary condition for success.	Amsterdam: Amsterdam Electric	Coordinating all actors and stakeholders will effectively ensure having a number of objectives to fulfill and will foster synergies between all projects. Amsterdam electric combines electric transport, new forms of mobility, subsidies to private companies and investment in R&D, as well as limits on non-renewable/non-electric modes of transport. It is a perfect example of collaboration between public and private actors.
	Curitiba:BRT system	When the project started, a public institution was created to coordinate all the different companies in order to build a holistic strategy and ensure that the whole system worked in a coordinated manner.

ENERGY ACCESS

Our everyday lives depend on reliable and affordable energy services. A well-functioning energy system supports all sectors of the economy, and it is vital for the creation of wealth, prosperity and a fair society. From businesses to medicine, education, agriculture, communication and technology, energy access ensures that economies have the basis from which to produce, consume, live, innovate and develop.

However, over 1.2 billion people—that is, one fifth of the world's population—do not have access to electricity. The majority of them are concentrated in regions of Africa, Asia and South America. Without electricity, people (mainly women and girls) have to spend hours fetching water, clinics cannot store vaccines, schoolchildren cannot do their homework at night and competitive businesses cannot be run. Moreover, another 2.8 billion people rely on wood, charcoal, dung and coal for cooking and heating, which results in over four million premature deaths a year due to indoor air pollution.

Ensuring energy access can have deep beneficial effects in communities worldwide. If people or production systems can reach electricity, there may be significant benefits in terms of quality of lives and competitiveness. In terms of quality of life, having a reliable source of energy is important to purify water—a key factor when considering health issues in a community. Electricity can enable water to be pumped and distributed more efficiently. This is what the UN considers an energy security benefit for having energy available. Besides pumping water, the energy security category also includes backup energy supply systems or street lighting. Other benefits include the ability for people to improve communication methods (Internet, radio, television and GSM networks).

In the following pages, we present projects of energy access from three different perspectives: (1) clean and affordable energy in urban and rural communities, (2) energy access for excluded populations, such as those living in slums and refugee camps, and (3) ensuring access to clean energy for basic services, such as health and education.

1. Rural Electrification

According to the World Bank, around 45 % of the world's population lives in rural areas. Analyzing the trend, it is clear that this percentage has been constantly decreasing in the last decades. In 1960, this figure was more than 60 %. As part of globalization, people have departed from rural areas to start new lives in urban environments. Globalization redefines how and where people want to live, their production methods and their cultures. In consequence, rural exodus has increased in recent decades as people leave rural areas in search of new opportunities.

In many cases, the lack of opportunities in rural areas can be explained by deficiencies in terms of energy access. The most basic problem is in the infrastructure, leaving many people with a poor or non-existing connection to the grid, thus generating problems in heating, cooling, lighting, pumping or communications systems, among others. Such problems directly or indirectly affect the more basic, quotidian tasks in people's lives in certain areas. But they also affect the productivity of these areas, often generating a competitive disadvantage with respect to other areas, regions or countries.

A community may have reliable sources of energy, but the price for accessing it may be too high. The cost of energy should take into account not only the cost of producing it but also the purchasing power of the population. People may be able to afford the price of energy but not the technology needed to access it (e.g., substation motors or home installations). This technology may be expensive, as one may need to adapt entire systems to the energy source. The cost of energy, either its price or the technology needed to access it, explains why some rural areas have inadequate energy access.

A connection with a sustainable source of energy can generate significant positive externalities. Efficient, reliable, sustainable, clean and sufficient access to energy services can increase productivity, generate economic activity, enhance competitiveness and decrease inequality. The increase in productivity and economic activity should imply an improvement in profitability, salaries and, in general, average incomes. In turn, this allows the society to invest in better energy systems, in terms of grid connections and energy sources, for fulfilling the necessities of the improved productive sector. If this happens, a consequent increase of productivity could happen again, repeating the process, all other factors being constant.

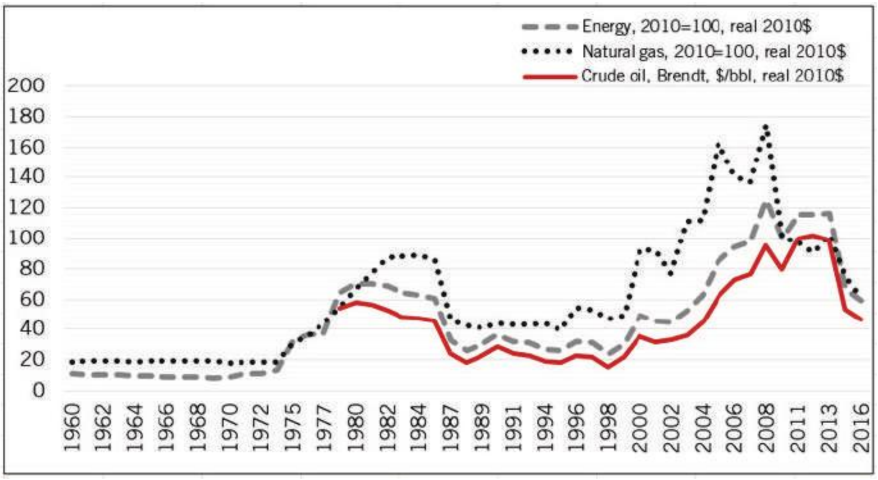
Thus, there may be inefficiencies in terms of private investment in infrastructure. When considering the benefits of the investment in improving energy infrastructure, companies may take into account part of the value generated by the investment. The benefits may be higher thanks to the positive externalities of having good accessibility to an energy source. The discrepancy between who captures and who generates value could discourage investment in energy infrastructure and the exploration of new formulas to deploy it. The role of public administration is, thus, fundamental.

Public institutions are key to enhancing energy access in rural areas. This is for two main reasons. First, as mentioned before, financial profitability and private return on investment may not compensate for the opportunity costs of funding the infrastructure. Second, a reduction of uncertainty and favorable regulation may be necessary to make private investment profitable. The public sector may need to assume transaction costs, subsidize, assure the financial credibility of a borrower and/or manage guarantees to ensure the financial viability of the energy access investments. According to the UN, government policy and regulatory instruments are the most effective tools for improving energy services in rural areas.

In summary, energy accessibility is key to reducing poverty in rural areas. Accessibility, however, depends on prior increases in income, which are difficult to achieve without energy access. Subsidies from public administrations may thus prove to be fundamental. But public administration may also need to put legislation in place to make investment attractive for the private sector and to liberalize the energy market, ensuring that there is no competitor distorting the market with monopolistic practices. An unfavorable regulatory framework is, in some countries, the main reason for the underdevelopment of the energy market and why energy access levels in rural areas are low.

As illustrated by the following two cases (Cases 21 and 22), rural areas in developing countries may prefer to reduce their dependency on fossil fuels in the process of electrification. Indeed, in recent times, the price of this type of energy source has been increasing. As shown in the figure 9, since the mid-1970s and the first oil crisis, energy prices have been fluctuating significantly. In recent years, the trend seems to be a decrease; however, this could change, since these prices have been demonstrated to be volatile and have not been stable since then. In real terms, the price of energy is currently at one of its lowest points in recent times, but is at least twice as much as it was in the late 1960s.

Figure 9. Price of energy and commodities (The World Bank)



Source: World Bank Data Base (2018), https://datacatalog.worldbank.org/dataset/gem-commodities.

The Microgrid case (Case 21) shows that ensuring energy access in rural areas can be a profitable investment, thanks to the use of renewable energy sources and an innovative business model. The case of Illuméxico (Case 22) presents a business model that offers, to highly marginalized communities, an affordable opportunity to have access to solar lighting systems through a microloan scheme. The production of solar energy, thanks to Mexican solar technology, allows dwellers to purchase a solar system over the course of a year, with no interest rates. After the payment is made, rural dwellers can produce their own energy from solar power for free, making them self-sufficient. Both cases are interesting as they show different business models related to the use and production of energy that seem sustainable with the help of the public sector.

Case Study 21: Microgrids by SteamaCo

Source: https://www.google.com/maps

Case Study 21	
Region	Rural areas of Kenya
Population	35,834,906 (rural population)
Wealth	Low
Type of project	Energy access
Subtype	Rural electrification

Summary

African countries face the challenge of providing affordable energy to their population, especially in rural areas. People that have access usually pay 20 to 100 times more than developed countries to power their homes. The use of microgrids is seen as a viable solution to tackle this problem.

In this sense, the company SteamaCo, based in Kenya, adopted a downstream approach to provide technological tools for grid owners and operators, so that they can properly manage energy production and use. Through hardware installed at their power stations, they can monitor the technical and financial performance of grids remotely via cloud-based software. It is possible to identify problems, such as dips in battery voltage. It also provides flexible access to electricity, as customers can manage credit using a PAYG phone system.

Should electricity regulators approve the idea, a microgrid using SteamaCo technology could buy a connection from the mains grid and share the cost with its users. SteamaCo supports 42 grids (most of them in Kenya and in six other countries) that provide a total of 350 kW of power to 3,000 homes and small businesses.

Factors of Success

- Inclusion of energy management technologies in off-grid systems for affordable and reliable access to energy;
- Integration of smart metering platforms with mobile money services to enable micro-payments and flexible tariff schemes;
- Real-time information, from the whole grid down to the individual user, means that problems can be identified early and performance optimized.

Agents Involved

- SteamaCo company;
- Private company providers of off-grid systems, such as Vulcan Impact Investing and Development Ventures;
- Energy users;
- Small-grid owners.

Case Study 21: Microgrids by SteamaCoa (cont.)

Energy and Environment Technologies

- Hardware bitHarvester: the CONNECT board monitors the power use and controls the power lines for up to 15 customers. It includes a power sensor, a relay (so that the line can be switched on or off) and a circuit breaker (to limit the maximum allowed power) for each electricity customer. The CONNECT board keeps track of the credit associated with each customer line and automatically switches them off once their credit runs out. The THINK board saves data from up to 30 CONNECT boards (400 customers) and other sensors, and communicates with the web-based SteamaCo software dashboard;
- Cloud-enabled smart meter;
- Steama cloud software: it processes the monitoring information received from bitHarvesters along with the payment notifications from mobile money providers, updating the bitHarvester when someone makes a payment;
- Mobile phone payment system.

Impact (Good Practices, Lessons Learned)

- Affordability is a crucial element to provide energy access to poor people and an effective instrument is the system in which people can buy power in line with their earning patterns and domestic needs;
- Reliable access to energy fosters entrepreneurial activity in these areas;
- The utility industry in emerging markets requires high technology and service development to evolve from single solar home systems to sophisticated off-grid infrastructure. In order to achieve this, the presence of different agents involved in engineering and construction and in intelligence and technologies is an effective way to reach better solutions for this reality;
- Once customers move to minigrid power energy, they no longer use kerosene lamps and batteries, which brings health and environmental benefits.
- Impact in terms of SDGs.

1. No Poverty	2. Zero Hunger	3. Good Health and Well-Being	4. Quality Education	6. Clean Water and Sanitation
1 NO POVERTY	2 ZERO HUNGER	3 GOOD HEALTH AND WELL-BEING	4 QUALITY EDUCATION	6 CLEAN WATER AND SANITATION
High Impact	**Moderate Impact**	**Moderate Impact**	**Moderate Impact**	**Moderate Impact**

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	10. Reduced Inequalities	12. Responsible Consumption and Production	13. Climate Action	15. Life on Land
7 AFFORDABLE AND CLEAN ENERGY	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	10 REDUCED INEQUALITIES	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	13 CLIMATE ACTION	15 LIFE ON LAND
High Impact	**High Impact**	**Moderate Impact**	**High Impact**	**Moderate Impact**	**Moderate Impact**

Feasibility and Replicability

- It is feasible to replicate this model in other emerging markets, as it relies on small-scale power grids and local consumption.

Case Study 22: Iluméxico

Source: https://www.google.com/maps

	Case Study 22
Region	Rural areas of Mexico
Population	26,361,155 (rural population)
Wealth	Low
Type of project	Energy access
Subtype	Rural electrification

Summary

Over 600,000 households have no access to energy in Mexico. The social enterprise Iluméxico, with the aim of promoting community development through energy access, started a program in 2009 that designs and manufactures solar charge controllers and integrates solar solutions for rural communities in Mexico. In addition, it provides microloans to rural inhabitants and seeks to engage communities for sustainable use of energy. After the payment is made, rural dwellers can produce their own energy from solar power for free, making them self-sufficient.

The program includes the provision of energy access to houses, businesses, schools and hospitals in rural areas. In each area there is an ILUCentro, a branch of Iluméxico that is responsible for supporting the clients, distribution and maintaining the system. The program seeks to be 100% market-based.

Factors of Success

- Off-grid technologies at an affordable price through microloans;
- Support of Iluméxico (ILUCentro) to the communities in terms of installment and maintenance of the system, as well as incentives for the sustainable use of energy.

Agents Involved

- Iluméxico social enterprise
- Rural community in Mexico.

Energy and Environment Technologies

- Prometeo system: solar panel, battery, charging controller unit (own design and manufacture) and LED spotlights. There are two models: the Prometeo Basic (a system used exclusively for lighting) and Prometeo Duo (a system used for lighting and low-energy consumption appliances).

Case Study 22: Iluméxico (cont.)

Impact (Good Practices, Lessons Learned)

- 2,100 solar home systems were installed in 11 states in Mexico, as well as 20 schools and four community centers. That means the replacement of diesel lamps, kerosene and candles by solar energy, with an environmental impact of 340 tons of CO_2 per year, as well as a positive impact on health;
- Iluméxico also estimates an average of 18% of income savings due to the displacement of energy sources and an increase of 10%—12% in income from the increased working hours. In addition, schools with energy access enabled an increase of two to three study hours for children.
- Impact in terms of SDGs.

1. No Poverty	2. Zero Hunger	3. Good Health and Well-Being	4. Quality Education
High Impact	**Moderate Impact**	**Moderate Impact**	**Moderate Impact**
6. Clean Water and Sanitation	7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	10. Reduced Inequalities
Moderate Impact	**High Impact**	**High Impact**	**Moderate Impact**
12. Responsible Consumption and Production	13. Climate Action	15. Life on Land	
High Impact	**Moderate Impact**	**Moderate Impact**	

Feasibility and Replicability

- Each rural branch requires US$10,000 investment and a monthly cost of US$1500, and solar home systems are sold for between US$200 and US$800 on credit. With 25+ clients every month, it is possible to reach a positive cash flow by month 6.

2. Energy Access in Excluded Population

The Reality of Slums

Many slum areas are not electrified or have deficient and illegal electric connections. There are many different reasons, ranging from culture to income and regulation. Traditionally, electrification of poor areas involves three different types of stakeholders: the energy company, the consumers and the government. But, as suggested by an analysis by USAID, "Innovative Approaches to Slum Electrification," traditional approaches do not always work in slums. In general terms, most urban areas are totally electrified, but the quality of service may be low and the electricity may end up not being paid for but stolen. This may of course generate health and safety problems.

The socioeconomic context and governance structures are responsible for some of the problems of slum electrification. Cultural factors may impede traditional services from operating. Willingness to pay for electricity is very low, as there is no habit of paying for it. If a non-paying culture has been established, it supposes a clear entry barrier. Residents prioritize use of their (low levels of) income on other goods and services, such as food or purified water. People living in slums are extremely impoverished, making it very difficult for them to pay for an energy bill. Slum residents usually have temporary jobs without fixed incomes, thus discouraging them to pay fixed, monthly invoices.

In addition to the cultural and economic factors, the high costs of providing energy services in slum areas represent an entry barrier for energy suppliers. Typically, slum areas are not being planned by governments and consist of a set of narrow and chaotic streets, without any type of urban planning or public services. Slums, commonly, do not represent a legal site construction and, for this reason, basic energy infrastructure is not available or is inefficient, discouraging energy companies from starting to provide energy services there. Energy providers also need to take into account the low levels of income of slum residents and the low levels of demand for energy. So, the high cost of providing energy, the revenue expectations and the returns on investment do not justify, from a financial point of view, the decision to start operating.

The USAID document summarizes the lessons learned when studying different slum electrification projects throughout the world and, in particular, in Manila in the Philippines, Cape Town in South Africa, Ahmedabad in India, and Rio de Janeiro and Salvador in Brazil. Our document also analyzes the project carried out since 2001 in Ahmedabad (Case 23) and adds an electrification project in São Paulo, Brazil (Case 24).

Refugees and Conflicted Areas

Below we analyze the provision of energy access in a refugee camp in Ethiopia (Case Study 25), analyzed in depth in a document produced by Alianza Shire, a partnership formed by a group of Spanish energy companies offering renewable energy and lighting services. For these types of projects to be sustainable, it is necessary to create a group of technicians with enough skills to maintain the infrastructure. Refugees should be made aware of the importance of these types of solutions and know how to use them. Thus implementing a training toolkit is key in order to transfer the required knowledge.

When it comes to building microgrid solutions in these environments, it is also vital to involve different stakeholders—from local partners and authorities to private investors and energy companies—and refugees. Participation processes, as well as transparency and mutual accountability, are key. Information necessary to start such projects is not only about the technical details but also about the social environment the project is addressed to. Communication between the different stakeholders, and working in partnerships, is basic, not only for coordination in terms of material allocation and financial resources but also to exploit know-how, capacities and human resources.

Case Study 23: Ahmedabad Slum Electrification Project

Source: https://www.google.com/maps

	Case Study 23
City	Ahmedabad, India
Population	5,571,000
Wealth	Low
Type of project	Energy access
Subtype	Slum electrification

Summary

This slum electrification project in the city of Ahmedabad, launched in 2001, targeted 700 households of five slums and, later, more than 2,000 households. It arose from a collaboration between Ahmedabad Municipal Corporation (AMC)–responsible for the civic infrastructure and administration of the city, the USAID and the Ahmedabad Electricity Company Ltd (AEC), the latter being the coordinator of the project.

The NGOs SAATH and Gujarat Mahila Housing SEWA Trust (MHT) gave support to the project, through the mobilization of the community and in the implementation of the project. In each of the identified slum areas, community based organizations (CBOs) were set up by the AEC to facilitate the implementation.

The objectives of the project were to ensure a safe and legal electricity supply to the slums, minimize the connection time and establish a bill recovery system, eliminate unauthorized connections and regularize existing connections while reducing the techno-commercial losses, involve community participation in the supply of bills and the recovery of dues by setting up CBOs, and develop strategies to scale up the project.

Factors of Success

- Multiple partnerships in which the NGOs ensured the support and mobilization of the communities for the implementation of the project and USAID provided grants and expertise, while the local government engaged in changing local rules;
- A change in local rules allowed new electricity connections, as AEC didn't need to require proof of residence anymore, given that most slum settlements are irregular;
- A change in bill collection from a bi-monthly basis to a monthly basis;
- NGOs and CBOs provided important support in terms of filing applications for new connections, collecting connection fees, checking meter readings, collecting bill payments and training the slum dwellers to use electricity judiciously.

Agents Involved

- AMC;
- USAID;
- SAATH NGO;
- MHT NGO;
- Community-based organizations.

Case Study 23: Ahmedabad Slum Electrification Project (cont.)

Energy and Environment Technologies

- Private meters;
- Compact fluorescent bulbs.

Impact (Good Practices, Lessons Learned)

- Poor communities are willing to bear the cost if a quality and reliable service is provided to them and they have access to loans, which were facilitated by SAATH and MHT through SEWA bank for the payment of one-time connection costs;
- The CBOs helped AEC identify and target needy families, and AEC provided connections to them at a subsidized rate cost of Rs.1,700 (US$27);
- Service costs and incidences of theft were reduced, with dedicated slum personnel and the use of appropriate technology such as standard meters, wiring kits and underground service drop;
- It has increased productivity levels of residents, the number of hours children stay in schools and it has had a positive impact on health.
- Impact in terms of SDGs.

1. No Poverty	2. Zero Hunger	3. Good Health and Well-Being	4. Quality Education	6. Clean Water and Sanitation
High Impact	**Moderate Impact**	**Moderate Impact**	**Moderate Impact**	**Moderate Impact**

7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	10. Reduced Inequalities	11. Sustainable Cities and Communities	12. Responsible Consumption and Production
High Impact	**High Impact**	**Moderate Impact**	**High Impact**	**High Impact**

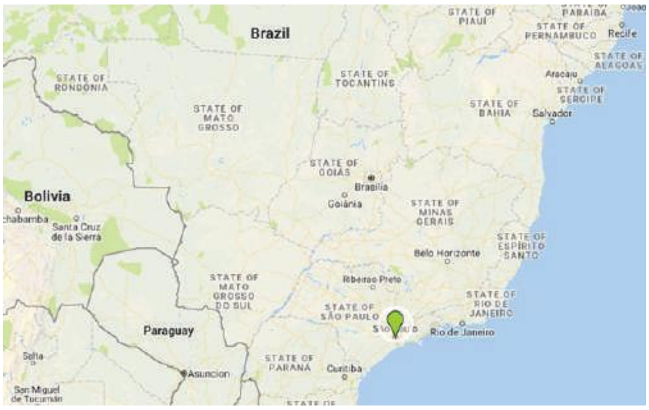
13. Climate Action	15. Life on Land	16. Peace, Justice and Strong Institutions	17. Partnerships for the Goals
Moderate Impact	**Moderate Impact**	**Moderate Impact**	**High Impact**

Case Study 23: Ahmedabad Slum Electrification Project (cont.)

Feasibility and Replicability

- This system is highly affordable for households, which paid only Rs.560 (US$92) as the upfront cost of the electricity connection while the rest of the charges were deducted from their monthly bills. The rest of the amount was divided into 10 installments, which were recovered on a monthly basis from the households' electricity bills;
- This is a typical base-of-The-pyramid market where margins were low but the spread of the project turned out to be very high;
- The project has the potential for replication with the involvement of local NGOs in mobilizing the community to partner with the government.

Case Study 24: Energy Access in Paraisópolis



Source: https://www.google.com/maps

Case Study 24	
City	São Paulo, Brazil
Population	100,000 (Paraisópolis slum)
Wealth	Medium
Type of project	Energy access
Subtype	Slum electrification

Summary

This project was conducted by AES Eletropaulo (local utility), USAID, and the International Copper Association (ICA), with local community and industry partners.

The slum of Paraisópolis was characterized by a large amount of illegal electricity connections, including dangerous irregular local grids and wiring conditions. This led to large energy inefficiencies as well as offering no incentive to reduce energy consumption, as people didn't pay for the service.

The objective of this project is to develop and test new approaches for regularization and improvement of electricity services in the slum of Paraisópolis, converting consumers of "free" electricity into satisfied and paying customers. From the experience of this project, it is expected that this will expand into a larger regional program.

A responsibility matrix was developed in which AES Eletropaulo picked up the bulk of the project costs, including the distribution network upgrades, metering and consumer registration, and—with ICA—paid for new refrigerators; ICA arranged for energy efficient transformers—with the support of the manufacturer Itaipu—for the coaxial distribution and service drop cables—cost-shared with the wire and cable company Nexans—and the rewiring of households, as well as the preparation of a financial model. USAID covered the community campaign costs, audits of each household and selected commercial customers, post-project survey, and efficiency recommendations to targeted commercial customers. The total cost of the project was around US$1.8 million at the average rate of exchange over the project period.

This project initially provided 4,000 safe energy connections, being expanded to 500,000 connections.

Factors of Success

- Effective coordination of activities between the partners;
- Efforts to educate customers about the importance of paying electricity bills and of implementing efficiency measures to reduce consumption and costs. This was effected by community campaigns carried out over several months and supplemented by door-to-door visits by community agents;
- The households were not charged a connection fee and debts owed were cancelled;
- A governmental energy efficiency program that enabled low-income customers to receive reimbursement from the government for the difference between the low-income tariff for which they were eligible and the cost-recovery tariff that normally applies to non-low-income residential customers;
- Use of new technologies and techniques to reduce theft and to improve energy efficiency and reliability of the distribution network.

Agents Involved

- AES Eletropaulo (local utility);
- USAID;
- ICA;
- Local community;
- Industry partners.

Energy and Environment Technologies

- Metering and wiring technologies.

Impact (Good Practices, Lessons Learned)

- These energy efficiency and safety measures, combined with the regularization effect, reduced consumption in the targeted 4,365 households and commercial entities from an average of 250 kWh down to 151 kWh per customer, with an average reduction of 40%;
- Increase in safety related to electricity because of the replacement of wiring;
- Evaluation of the project through KPIs was important to improve the project and determine which customers would receive additional available benefits.
- Impact in terms of SDGs.

1. No Poverty	2. Zero Hunger	3. Good Health and Well-Being	4. Quality Education	6. Clean Water and Sanitation
High Impact	**Moderate Impact**	**Moderate Impact**	**Moderate Impact**	**Moderate Impact**
7. Affordable and Clean Energy	9. Industry, Innovation and Infraestructure	10. Reduced Inequalities	11. Sustainable Cities and Communities	12. Responsible Consumption and Production
High Impact	**High Impact**	**Moderate Impact**	**High Impact**	**High Impact**
13. Climate Action	15. Life on Land	16. Peace, Justice and Strong Institutions	17. Partnerships for the Goals	
Moderate Impact	**Moderate Impact**	**Moderate Impact**	**High Impact**	

Case Study 24: Energy Access in Paraisópolis (cont.)

Feasibility and Replicability

- The aim of the pilot project was to develop a sustainable service model for AES and other distribution companies that would meet the needs of consumers in low-income urban areas and could be widely replicated;
- Similar projects are favored in the Brazilian context, given the federal government program that promotes and supports solutions for bringing a legal electricity service to the urban poor.

Case Study 25: Alianza Shire

Source: https://www.google.com/maps

	Case Study 25
Region	Refugee camps in Ethiopia
Population	8,000 (Adi-Harush camp)
Wealth	Low
Type of project	Energy access
Subtype	Refugee and conflict areas

Summary

The large displacement of people around the world raises concerns about providing refugees with basic services, such as food, water and energy.

With the aim of addressing the energy needs and improving the quality of energy services, the Humanitarian Action Office from the Spanish Agency for International Development Cooperation (AECID) and the Universidad Politécnica de Madrid (UPM) fostered the creation of Alianza Shire in 2014. A multi-actor partnership, including Iberdrola, Philips Lighting and ACCIONA Microenergía Foundation, are collaborating to develop innovative and sustainable solutions for energy provision for refugees and displaced persons. The United Nations High Commissioner for Refugees (UNHCR) is a collaborating partner and the NGO Norwegian Refugee Council (NRC) is the implementing partner on the field.

This project is being conducted in three refugee camps in the Shire region of Ethiopia. The first experience has been at Adi-Harush camp, where more than 8,000 Eritrean people live and where the electric supply is extremely irregular and dangerous. The UNHCR, through the Administration for Refugees and Returnees Affairs (ARRA), is currently covering the electricity costs in the camps by paying the Ethiopian Electric Utility (EEU), which is the national electrical company. However, the poorly installed electrical wiring and the irregular power supply jeopardizes the availability of the service and causes power cuts, so there are only six hours of electricity per day.

The small businesses at the camp use individual diesel generators to get electrical energy. The main problem is the high cost of this supply. Energy use at household level is mainly required for cooking, firewood being the main source of fuel at the camps. Nevertheless, due to the continuous collection over the last few years and climate conditions, the surroundings of the camps are totally deforested and women and girls have to walk longer distances in order to get firewood for cooking.

The pilot project covers the improvement and extension of the electricity grid in this camp and includes the installation of protection devices at the communal services, rehabilitation of equipment and connection to new services, such as the primary school, two communal kitchens and markets hosting 36 small businesses. It is expected that the project avoids the collection of around 1,500 tons of firewood and emissions of 2,000 tons of CO_2 per year. In economic terms, a saving of €30,000 in diesel consumption is calculated.

Factors of Success

- It was crucial to involve all local partners from the identification phase as well as to coordinate all stakeholders in the energy sector: Iberdrola, ACCIONA Microenergía Foundation and Philips Lighting (technical expertise); governmental agencies and multilateral organizations (institutional support and wider knowledge of the humanitarian context) and Universidad Politécnica de Madrid (coordinator);

- Design phase that started by assessing energy needs, followed by technical solutions. Then, feasibility studies were conducted and, after deciding the model of the project, all the partners mobilized resources;
- Refugees' participation through training: basic knowledge about the technologies being implemented was provided.

Agents Involved

- Innovation and Technology for Development Center from the Universidad Politécnica de Madrid;
- Spanish Agency for International Development Cooperation (AECID);
- Energy companies: ACCIONA Microenergía Foundation; Iberdrola; Philips Lighting;
- United Nations High Commissioner for Refugees (UNHCR);
- Norwegian Refugee Council (NRC).

Energy and Environment Technologies

- Division of the electric distribution grid into two;
- Use of insulated wire and extension of the LV grid with insulated aluminum wire;
- Connection of seven communal services to the grid and improvement of the connections;
- Installation of protection devices in 14 communal services;
- Installation of four kilometers of public street lighting in the camp with 64 light points (LED luminaries).

Impact (Good Practices, Lessons Learned)

- The pilot project will contribute to improving the livelihoods of the training participants: some of them are employed by NRC to maintain the facilities and the remaining participants can set up a business related to electricity at NRC markets. In addition, public street lighting allows the realization of productive activities during more hours per day;
- A thorough and detailed identification is crucial in order to gain deep and up-to-date knowledge of the context as well as design solutions of context-applied technology;
- For the intervention's sustainability, it was crucial to train refugees and to form a group of technicians who are able to repair the equipment and do maintenance work.
- Impact in terms of SDGs.

1. No Poverty	7. Affordable and Clean Energy	10. Reduced Inequalities	11. Sustainable Cities and Communities	16. Peace, Justice and Strong Institutions	17. Partnerships for the Goals
High Impact	High Impact	High Impact	High Impact	Moderate Impact	High Impact

Feasibility and Replicability

- The existence of context knowledge, adapted material for the camps (training toolkit, grids audit) and synergies among different stakeholders offers the possibility to upscale the pilot project.

3. Basic Services: Education, Health Care and Clean Water

Education

Productivity, and therefore economic growth, is strictly related to the level of education of the population. Having schools with a connection to an electricity supply and electric lights is thus fundamental. The UN, through its department of Economic and Social Affairs (UNDESA), has published many reports on the importance of having electricity in schools. As suggested in these reports, electricity helps to introduce, in classrooms, ICT equipment such as televisions, projectors, computers, tablets and the Internet. In addition, having connected schools, with a reliable energy supply, can help to retain and recruit qualified teachers, which, in turn, helps to achieve better educational outcomes for the pupils. Electricity is crucial in extending the opening hours of education buildings, making it possible to open them earlier and close them later. This also results in greater equality of opportunities, including gender empowerment.

However, there are barriers to, or difficulties in, implementing energy accessibility projects. Some of these difficulties are listed and described in a more extensive manner in the UNDESA report. Having electricity in schools can be very expensive, independent of whether it is through connecting them to the public grid or through off-grid and microgrid solutions, including renewable energies. This is even more problematic in rural or isolated areas. Some schools cannot afford the cost of electricity. In addition, due to the costs of developing entire grids to supply energy to new neighborhoods and schools, local energy providers may not be able to afford the investments and the risks. If the average customer also has difficulties in paying the bills, energy companies could consider stopping the supply of energy to some areas, damaging the schools in those locations.

The lack of household energy access to enable studying at home is another problem. We present a case (Soular Backpacks, Case 27) where students are provided with solar-powered backpacks in order to have a source of energy when returning home. In this regard, school electrification programs should consider the possibility of providing energy solutions for households as well.

For school electrification programs, one may need to leverage innovative financing streams and partnerships. Subsidizing fees and permitting easy accessible loans—to be provided by public institutions and private banks and organizations—are two examples.

However, as highlighted by the UN, the innovative solution that has been gaining strength in recent times is the PPP. This type of partnership can attract private investments, as part of the risks may be assumed by public institutions. Also, the private sector could benefit from public resources and possibilities, such as the channel that public administrations represent for interacting with citizens.

Health

Energy can be used not only for improving the education system but also for improving the health-care system. The final goal is to improve the quality of life and the equality of opportunities; a first-order condition to achieve sustainable growth. A 2017 document published by the International Bank for Reconstruction and Development institution under the World Bank umbrella, highlights the importance of modern energy access in human health, emphasizing the critical role played by energy when determining the capabilities of health care services.

As for educational facilities, having electricity access in health-care facilities is basic for having essential services. It is particularly important in terms of reliability and sustainability, without breakdowns or blackouts. Some clinical operations can only be carried out by having a constant power supply. The importance of having basic electricity services in a hospital is also important at birth, helping reduce complications affecting mothers and newborns. Another example of the benefits of having electricity is the increase in the capacity of reaction when there is some kind of health emergency. It is important not only for the possibility of having better medical equipment but also for having more efficient communication systems. Most of the basic needs in a hospital require electricity to be able to use some medical instruments.

The World Bank Report Modern Energy Access and Health highlights the importance of ICT technologies for telemedicine and e-health. Thanks to these technologies, operational costs can be highly reduced. In the report, the World Bank also identified the most important barriers to having better energy access and reliability in health-care facilities. A common barrier is a weak institutional environment, in terms of regulation and technical standards. The affordability and lack of financing options can represent another barrier, especially in the poorest countries. Underdeveloped regions are also those with the most deficiencies in their health-care systems. Economic resources are important, not only when purchasing medical equipment or implementing energy access, but also for maintaining or replacing parts. Some rural zones suffer even more from this because of the distance from qualified people capable of repairing the equipment.

Poorer families generally use less clean and more contaminating heating and cooking methods, often involving fossil fuels and/or antiquated technologies. The use of such fuels can be harmful for their health. Families using them are more prone to suffer from diseases, with the added problem of having fewer economic resources to cure them. In this regard, clean energy sources and heating systems could be a solution, but, again, the cost of these solutions can represent a barrier.

Some opportunities and options can be explored to implement energy access solutions affecting health. In this regard, the international adoption of sustainable development goals is shown as a great opportunity. Some solutions can be incorporated within the following categories: decentralized renewable energy solutions, through the use of batteries and clean energy sources; the combination of hybrid, solar and diesel solutions in order to cover energy demand, even in peak times; the extension and the improvement of the reliability of the grid; and the implementation of energy-efficient medical equipment. In fact, the case study that we present with this document is an energy-clean solution to help to improve the supply chain of vaccines in Tunisia (Case Study 28).

Case Study 26: Solar Lighting in Schools

Source: https://www.google.com/maps

	Case Study 26
City	Koraput, India
Population	1,377,000
Wealth	Low
Type of project	Energy access
Subtype	Education

Summary

Koraput is one of the most underdeveloped districts in the state of Odisha in India. This is made worse by tribal dominance and lack of infrastructure. In terms of education, the district has a scheme of residential complexes for tribal children close to their habitations to promote enrollment and retention at school. However, there are still high drop-out levels.

With the aim of improving the infrastructure of the schools and to tackle drop-outs, the Integrated Tribal Development Agency, which is responsible for the maintenance of the residential schools, established a collaboration with the Energy and Resources Institute (TERI). This collaboration led to the implementation of solar charging stations to recharge the solar lanterns of students from 23 schools.

Factors of Success

- PPP between the Integrated Tribal Development Agency (ITDA) and TERI: ITDA provided access to the schools and funds, while TERI designed and implemented the technologies;
- Training of operators by TERI on basic operations, upkeep and maintenance of the equipment and on the guidelines for usage, and training of students on proper use of the lanterns;
- TERI conducts the monitoring of the project through the Project Management System, Field Monitoring System and Impact Study, which allows the improvement of the project.

Agents Involved

- ITDA;
- TERI;
- School administrations;
- Students and local community.

Energy and Environment Technologies

- Solar charging stations;
- Solar lanterns.

Case Study 26: Solar Lighting in Schools (cont.)

Impact (Good Practices, Lessons Learned)

- The solar lanterns lowered the consumption of kerosene and, being a more efficient light source, increased students' study time;
- The reduction in kerosene consumption from 25 liters to 100 liters per month per school to somewhere between 5 liters and 15 liters has resulted in a decrease in expenditure of fuel for lighting as well, from Rs.300–Rs.1600 to Rs.100–Rs.200. This money is being utilized for the food and nutrition of the residents.
- Less consumption of kerosene also resulted in health benefits, as 80% of the students suffered from breathing problems due to the smoke emitted by kerosene lanterns;
- Use of a renewable energy available and compatible to the geographical conditions of the area;
- The responsibility of everyday operation and maintenance was handled in an innovative manner through the creation of a student cabinet, with responsibilities being allocated to different students. The students leading the team that was responsible for it was called the energy minister.
- Impact in terms of SDGs.

1. No Poverty	4. Quality Education	10. Reduced Inequalities	16. Peace, Justice and Strong Institutions
1 NO POVERTY	4 QUALITY EDUCATION	10 REDUCED INEQUALITIES	16 PEACE, JUSTICE AND STRONG INSTITUTIONS
High Impact	**High Impact**	**High Impact**	**Moderate Impact**

Feasibility and Replicability

- ITDA has funded 32 other schools in the same district, out of which solar lanterns have been installed in 17 schools, based on the outcome of this project;
- PPPs are crucial for the feasibility of further projects to supply the scarcity of resources in these areas.

Case Study 27: Soular Backpack

Source: https://www.google.com/maps

Case Study 27	
Region	Rural areas of Kenya
Population	35,834,906 (rural population)
Wealth	Low
Type of project	Energy access
Subtype	Education

In face of the restricted access to energy and its impact on education, the social enterprise Soular seeks to provide backpacks to schoolchildren. These backpacks have solar panels connected to a light bulb. By charging the solar panel during the day on their way to school, children can do their homework at night, even after the sun goes down.

This initiative, launched in 2014, seeks to foster the development of rural communities through energy access that enables education. Moreover, it seeks to substitute kerosene, used by 92% of Kenyans as source of energy, with renewable sources.

In 2016, Soular formed a partnership with UNICEF and UNHCR, and also received subsidies from the government of Kenya, to distribute the backpacks to families.

It is expected that this product will also be included in other markets, following a one-for-one business model.

Factors of Success

- Simple model of providing free and clean energy access to children in remote areas;
- Funding based on social enterprises' crowdfunding campaigns and support from the Kenyan government.

Agents Involved

- Soular;
- Customers.

Energy and Environment Technologies

- Solar panels and a light bulb in a backpack.

Case Study 27: Soular Backpack (cont.)

Impact (Good Practices, Lessons Learned)

- It reduces the use of kerosene, which families living under US$1 a day, usually spend 25% of their income on every month. In addition, it provides health benefits.
- Impact in terms of SDGs.

1. No Poverty	4. Quality Education	10. Reduced Inequalities	16. Peace, Justice and Strong Institutions

High Impact	**High Impact**	**High Impact**	**Moderate Impact**

Feasibility and Replicability

- This model is easily replicable through crowdfunding campaigns. This was the case of the first 2,000 backpacks, for which the campaign raised 25% more than the goal;
- New products can also be designed based on the backpack's technology, essentially being a business model to ensure financial sustainability.

Case Study 28: Project Optimize

Source: https://www.google.com/maps

	Case Study 28
Region	Rural areas of Tunisia
Population	3,667,916 (rural population)
Wealth	Low
Type of project	Energy access
Subtype	Health care

Summary

Energy plays a vital role in strengthening health systems, particularly health-care delivery. It powers health facilities, the medical services they provide and related areas such as staff housing. Yet a recent analysis of access to energy in health-care facilities in 11 sub-Saharan countries, commissioned by the World Health Organization (WHO), revealed that, on average, more than a quarter of facilities reviewed lack access to electricity. While the majority of large hospitals have access to electricity, access rates drop to below 25% for rural clinics in some countries. Reliability of energy supplies also remains a challenge. Even when health facilities are connected to the grid, many suffer from frequent power outages.

Storage and transport of vaccines are key components in health-care systems. In the case of Tunisia, similar to other developing countries, the supply chain is poorly managed and, in terms of energy, there is a large use of fossil fuels and a non-reliable energy supply. In addition, transportation of vaccines and supplies is a weak link because of the lack of operational budges to maintain vehicles in good working order and to pay for fuel and petrol to run them. As such, the transport of vaccines is irregular and can compromise the ability of the supply chain to ensure vaccine availability at all levels.

These energy supply problems can be overcome by transitioning to renewable energy sources that have great potential for saving energy and ensuring a more reliable and green supply chain system for vaccines.

This concern is part of Project Optimize, a partnership between the WHO and PATH, to look for solutions to optimize supply chains and meet the demands of vaccines. Between 2009 and 2012, Optimize collaborated with the Tunisian Ministry of Health to meet three objectives:

- Net-zero energy: solar energy produced by PV panels used during the day and an electrical grid for energy used during the night. Over the year, the difference between the solar electricity generated and the electricity consumed during the storage and transport of vaccines and medicines is measured. If positive, the surplus renewable energy is credited to the Tunisian Company of Electricity and Gas. If negative, the electricity bill is paid by the Tunisian Ministry of Health;
- Preventing vaccines freezing during transport;
- Temperature monitoring.

Factors of Success

- The net-zero energy system fostered the use of more economical technologies, such as EVs, the increase of passive thermal efficiency of buildings and transport containers, and the large use of PV panels;
- Monitoring of energy consumption in real time to assess performance;

Case Study 28: Project Optimize (cont.)

Agents involved

- WHO;
- PATH;
- Tunisian Ministry of Health;
- Industry partners.

Energy and Environment Technologies

- EVs;
- LED-based tubes and lamps;
- PV panels.

Impact (Good Practices, Lessons Learned)

- The net-zero energy demonstration showed that the quality of vaccine handling in storage and transport can be raised by monitoring temperatures, procuring appropriate cold chain equipment and establishing a regulated delivery system using EVs;
- The energy cost of storage and transport of vaccines and medicines can be entirely offset by generating and crediting electricity by solar electricity production.
- Impact in terms of SDGs.

1. No Poverty	3. Good Health and Well-Being	10. Reduced Inequalities
High Impact	High Impact	High Impact

Feasibility and Replicability

- The project is feasible and replicable, training is required for personnel to manage the new technologies being implemented—namely EVs and solar panels;
- Without accounting for the amortization of the equipment (solar panels and EVs), the energy savings in the supply chain can be significant. This translates to recurrent cost savings for storing and transporting vaccines, and reduction of the carbon footprint;
- Given the high costs of solar panels, the value proposition is favorable in the long run and it will also improve if the structure and insulation of existing buildings are improved or, ideally, if more thermally efficient warehouses are built.

The Provision of Clean Water—a Basic Need

Water is becoming one of the most precious natural resources, and its scarcity is increasing year after year. For some regions in the world, water scarcity is generating first-order humanitarian problems, such as displacement of entire populations, increases in deceases and even armed confrontations between communities and countries.

Case Study 29 shows the challenges faced by water management projects. First, given the initial investment typically required to build a water management plant, a water treatment plant or a dam, obtaining financial resources is a priority. Because of a lack of those resources, many countries suffer from a deficit in water management infrastructure, damaging environmental sustainability and quality of life. Funds can come from tariffs and bills and, in some cases, designing adequate tariff schemes can affect consumers' behavior. This price-sensitiveness should be exploited by regulators and public administrations in order to achieve energy and water savings.

As new technologies are being developed, it is important to rely on the right ones. Technologies are a crucial tool for reducing energy consumption and increasing productivity, and the lack of sufficient and appropriate technology (equipment or software) is disastrous, requiring technology transfers to overcome the problem. An example is the implementation of new technologies for water treatment systems. These technologies can improve the quality and quantity of the output (better purified water).

A final challenge, mentioned previously, is the improvement of governance. Ensuring good regulatory frameworks is crucial and is important to avoid contradictions between local, regional and supranational regulations. For instance, in the case of the EU, the European Commission has its own directives, which can potentially conflict with individual countries' regulations. Legal contradictions should be resolved in order to draw clear regulatory frameworks. This is the example of Albania, which is described in a UN brief report regarding the implementation of water resources management. In this report, it is stated that strategic planning, national policies, transboundary agreements and integrated water resource plans, are often non-existent or inadequate, highlighting the need for institutional reforms.

Case Study 29: Renewable Energy Desalination Pilot Program

Case Study 29	
Country	Abu Dhabi
Population	1,145,000
Wealth	Medium
Type of project	Energy access
Subtype	Food supply and water

Source: https://www.google.com/maps

Summary

In a world with an increasing limitation on the access to clean and drinkable water, due to the pollution of natural water sources and climate change, it becomes more and more necessary to find new ways of achieving access to drinkable water that are not only innovative but also sustainable. One example is the Renewable Energy Desalination Pilot Program, a project launched in 2013 in Abu Dhabi. It aims to research and develop energy-efficient, cost-competitive desalination technologies that are suitable to be powered by renewable energy.

The desalination project is sponsored by the Abu Dhabi government, with co-funding provided by industry partners, winners of a tender process. Masdar is leading the project management and coordinating the program with key Abu Dhabi stakeholders.

The program consists of two phases:

- Pilot phase (2013 to 2017): four companies who were winners of the tender—Abengoa, Suez Environnement, Sidem/Veolia and Trevi Systems–were selected to construct and operate four small-scale desalination pilot plants for at least 18 months. These plants are testing a range of innovative approaches in boosting operational efficiency, and performance will be assessed and rigorously monitored and tested. A fifth pilot was installed in October 2016 by Mascara NT; a unique off-grid solar-powered solution without batteries, ideally suited for remote locations.

- Implementation and development (after 2017): scaling up of technologies that meet predefined criteria, such as commercially viable, large-scale, seawater desalination plants that are totally powered by renewables.

Masdar Institute of Science and Technology is helping to support the program through a series of research projects, including studies and evaluation of membrane and development of an optimized design of a full-scale, solar-energy-powered, seawater reverse osmosis plant.

Factors of Success

- Partnerships that allow the transformation of advanced R&D in innovative solutions for desalination processes;
- Pilot projects of different companies allow the development and scaling up of cost-effective technologies;
- Coordination and management of the program by Masdar, which also fosters R&D in the area.

Case Study 29: Renewable Energy Desalination Pilot Program (cont.)

Agents Involved

- Abu Dhabi government;
- Masdar;
- Abengoa;
- Suez;
- Veolia;
- Trevi Systems.

Energy and Environment Technologies

- Off-grid PV-powered reverse osmosis technologies;
- Membrane distillation technologies;
- Reverse osmosis filtration technologies;
- Deionization technology;
- Energy Recovery Devices.

Impact (Good Practices, Lessons Learned)

- Energy-efficient technologies applied to the desalination process can lead to estimated annual cost savings of US$94 million from 2020 onwards, given 15% of Abu Dhabi's newly built desalination capacity;
- Power desalination plants with renewable energy sources can reduce dependence on natural gas for the production of water, through the use of highly energy efficient desalination processes.
- Impact in terms of SDGs.

6. Clean Water and Sanitation	7. Affordable and Clean Energy	13. Climate Action
6 CLEAN WATER AND SANITATION	7 AFFORDABLE AND CLEAN ENERGY	13 CLIMATE ACTION
High Impact	**Moderate Impact**	**Moderate Impact**

Feasibility and Replicability

- In the long term, there is the will to replicate this program on a larger scale and to implement renewable energy-powered desalination plants in the United Arab Emirates, as well as the wider MENA region, and to have a commercial scale facility operating by 2020.

4. Good Practices and Lessons Learned

This section incorporates nine different case studies on improving energy accessibility. Although different, all cases share some characteristics, not only in terms of their humanitarian mission but also in terms of methodologies and lessons learned. Table 4 provides a short summary about what we can learn in each case and also identifies the most important good practices.

For instance, the importance of stabilizing PPPs has been demonstrated in all cases. In fact, many of them engage a wide range of stakeholders from the provider site, energy companies being the most important ones for customers. In addition, other private companies are required, not only as providers of physical assets or services but also to serve as intermediaries. Sometimes local companies, thanks to their knowledge of the environment, offer their services more efficiently. The role of the public sector in that sense is not negligible, being even more remarkable. This may be the case in the slum electrification projects, such as those in the cities of Ahmedabad and São Paulo presented in this document. As observed in these cases, public administrations are fundamental in engaging residents in projects. In addition, other projects that could serve as an example of PPPs and public intervention for engaging customers and for helping to facilitate communication between agents are the cases of rural electrification or the Alianza Shire refugee camp project.

The role played by governments and public administrations goes much further than being a channel between private sector and individual customers, it is also crucial when it comes to providing legal and economic environments that are credible and attractive to private investors. Recently, in many countries, regulation has been changing rapidly due to the emergence of new solutions and new technologies. However, in some countries, with less governance quality and with low-income habitants, where these types of projects are being implemented, regulation has not been adapted to modern times, representing an entry barrier for those energy companies willing to deliver their solutions to those who need them. The projects analyzed demonstrated the importance of designing business- and consumer-friendly regulations for projects that are trying to help improve energy accessibility, taking into account not only the preferences of private investors but also the interests of citizens and all the different agents involved in these types of projects. The case study of Ahmedabad, a slum electrification project, represents the paradigm in this regard; it is dependent on having an adequate legal framework and the collaboration of local authorities.

In addition, the role of public institutions can be fundamental for funding projects and attracting investors. Subsidies—not for investors, but for customers—could also be addressed. As a lesson learned, subsidies can be received not only by private investors but also by customers, in order to afford the solutions implemented by private investors or PPPs. To summarize the lesson, subsidies can be justified by taking positive externalities into account, some of which take the form of an economic reward (better quality of life and productivity, which in turn can generate more economic activity and income for the public sector). Public subsidies represent a method in which poor citizens can rely on them as a source of income, making it easier for them to pay. However, as has been pointed out in this report, facilitating payments and ensuring financial sustainability can be achieved using different approaches. The case study in Kenya, which consisted of the implementation of a microgrid, considers some flexibility and advanced methods of payment. It is a case in which, without it being necessary to reduce the total amount of energy bills, people could afford payments by paying how and when they want, within a certain margin of manoeuvrability. Other projects—for instance, Iluméxico—prefer to directly subsidize by providing microloans to rural inhabitants, but with a more orthodox tariff scheme. It is a clear example of the importance of helping to ensure economic and financial viability of a project. The case demonstrates that, thanks to public subsidies, private investors can see the attractiveness in terms of monetary returns on investments. Another analyzed case that takes place in Kenya, is the Soular Backpack solution, consisting of solar-powered backpacks for children so they can do their homework every night at home. In this case, payment methods should be completely adapted to customers. It is the example of an extremely poor population with no electricity at home. Flexible payment methods are the only ones that make sense in this case.

Besides regulation and funding, public administrations can play key roles in many other fields—coordinating and serving as a channel between other stakeholders as has already been mentioned, but they can also assume the role of coordinator or analyst of the results (benefits) of the projects on energy accessibility. In the case of the renewable energy desalination program in the United Arab Emirates, it is clear that the local government should verify the results, as water is a basic resource to which the viability of the country (and of any other country) is inextricably linked.

PPPs can also create the possibility for, and encourage the proliferation of, solutions for energy accessibility, which otherwise would not easily emerge. Thanks to these models of private and public collaboration, risks can be assumed by both parties; sharing risks can make the difference as to whether a project is carried out or not. In some cases, risks cannot be assumed individually; the uncertainty in each case can determine this factor. In this regard, Project Optimize represents a good example of the experimentation and innovation of PPPs in the health-care field, something mandatory to be able to later decide the scalability and replicability of the solution.

Finally, energy access projects have to focus on two main objectives: creating sustainable cities (by ensuring environmental sustainability through the adoption of renewable sources of energy) and reducing poverty. In this sense, to provide energy to rural communities or impoverished urban areas, like slum neighborhoods, could be the first step. To do this, a very important factor, in order to guarantee the success of a project, is to involve local communities (not only the administration, but citizens and social groups as well).

As a general conclusion of the energy access section, beyond public and private partnerships, the electrification of underdeveloped areas—whether rural zones, peripheral slum neighborhoods or refugee camps—has been demonstrated to be an essential tool in helping to improve basic aspects in the life of human beings in underdeveloped countries. Making electricity something more accessible is important in order to provide other basic services to the population; for instance, education, health care or clean water. The nine cases included within this document demonstrate this hypothesis. Therefore, an improvement in the quality of life of citizens can be directly explained by the implementation of measures that favor energy access. Economic development, poverty reduction, empowerment of women, and better education and health care, among other factors, are explanatory variables of the quality of life. For this reason, improving access to energy in a sustainable manner has an effect on many Sustainable Development Goals (SDGs).

Table 4. Good practices and lessons learned from case studies

INCREASE ENVIRONMENTAL SUSTAINABILITY AND QUALITY OF LIFE THROUGH IMPROVING ENERGY ACCESSIBILITY		
Lessons Learned	**Case study**	**Good Practices**
This case presents an innovative business model for ensuring energy access that has been proved to work in parts of rural Africa. It can be easily replicable in other parts, and thus its use is recommended.	Kenya - Microgrids by SteamaCo	There are two main good practices that define the uniqueness of this type of project, this is the flexibility method to pay chosen to ensure to motivate to pay for the service and also to make easier to face energy bills, consisting implementing metering platforms to mobile money services to enable micro-payments and flexible tariff schemes; and the second one is the possibility to have real-time information in order to optimize performance, identify problems earlier thus reduce costs.
This project has an innovative business model that is easily replicable, and thus presents an opportunity for governments to implement it in rural areas.	Mexico - Ilumexico	A shared good practice for nearly all the projects related with energy access topics, the provision of micro-loans to rural inhabitants is a crucial good practice. Other very important good practice is the customer support in order to maintain customers engaged with the value proposition of the project and help them in case there is an issue.
This case shows that poor communities are willing to bear the costs of electricity provision if a quality and reliable service is provided to them. This was favored by a rule from the High Court that set that slums did not need building permission to obtain access to services. NGOs worked to build up capacity within the slum community to negotiate and secure their own demands. In this case, specific training programmes were also conducted for women to train them on energy-efficiency measures as a means to keep the household electricity bills under control. In addition, the project continued after the end of the pilot phase, in charge of the Ahmedabad Electrical Corporation. The project helped improve the living conditions of the slum dwellers and inculcated in them a sense of trust towards the authorities.	Ahmedabad - slum electrification project	The most important good practice, or in this case, key activity, is the change in local rules, allowing new electricity connection. The change in bill collection methods from a bi-monthly basis to a monthly one, is a singular good practice deserved to be highlighted in this final conclusion table.
We can learn from a successful case of creating a safe and efficient energy grid for slums in developing countries through standard PPPs.	Sao Paulo - Energy access in Paraisopolis	A good practice, common denominator for many other energy-access related projects, is the coordination of the different key activities and between partners. The efforts to educate customers in terms of raise awareness about the need to pay for energy are considered a really good practice, jointly with the efforts of proportionating funding methods and tariff schemes adjusted to customers.
This project is a full Public-Private Partnership, and thus can give us insights into what local governments do in order to provide the right environment for students and teachers to thrive.	Koraput - Solar Lighting in schools	The Public-Private method is the crucial practice per definition not only for delivering the right technologies but also for ensuring the funding. Other good practice, mandatory in order to ensure the long term sustainability, is the training of operators and the maintenance of the equipment
Innovative case of stakeholder involvement, as well as a project that is affordable and with a sustainable business model that has proved to transform rural communities.	Soular backpack	Funding methods have to be completely adjusted to the necessities of the low-income users. Otherwise its sustainability cannot be ensured.
Innovative solutions for healthcare problems by using renewable energies. It is also a Public-Private Partnership between PATH and WHO, and thus we can learn good-practices related in order to put forward such projects in other parts of the globe.	Tunisisa - Project Optimize	Monitoring of energy consumption in real time to assess performance. As happens with other education related projects, these measures need to count on adjusted funding methods, a crucial practice to deliver the solution and be sustainable for the final beneficiaries.
We can learn how to design and develop new efficient and commercially viable ways of achieving clean water through renewable energy desalination methods.	UAE - Renewable Energy Desalination Pilot Programme	Build partnerships in order to boost research and development solutions. Implementation of pilot projects in order to determine the scalability degree and the good practice of being well coordinated.
It is a perfect example of public-private collaboration to successfully bring energy to the most needed: refugees and displaced persons. It is also an example of how to effectively integrate refugees into the implementation of the project.	Ethiopia - Alianza Shire	To involve all local stakeholders, including private partners and implementing training programs for the final beneficiaries.

GENERAL CONCLUSIONS

This report aims to provide an overview of how the use of smart solutions is having an impact on the production and consumption of energy in cities. The report has been divided into three areas: sustainable neighborhoods, sustainable electric urban transport and energy access. For each of these areas, a series of cases has been analyzed. The common characteristic between them is the use of smart solutions, some of them pushing for the use of renewable sources of energy and others improving the use of fossil fuels. The smart solutions shown in the different cases provide an overview of the opportunities for a change of behavior in all the actors in the energy sector.

Change 1. Impact on the Mitigation of Climate Change and Air Pollution, Thanks to the Transformation of Passive Consumers Into Active Consumers

The cases analyzed show how customers can become active players. This has several consequences, leading to the reduction of air pollution and climate change:

1. The capacity to have a more efficient consumption of energy, and therefore
2. An opportunity to reduce the use of fossil fuels in the energy sector, or
3. An improvement in the use of renewable energy, and therefore
4. A reduction of pollution, and
5. A mitigation of climate change

Improving the UNSDGs

As pointed out by several forecasts, the 21st century will be considered the century of the city, as almost 75% of the world's inhabitants will be living in urban areas by 2050. As almost 70% of energy demand is concentrated in cities and 75% of CO_2 emissions occur in cities, cities will be where the battle against climate change will take place.

As smart solutions mitigate climate change, they have to be promoted, scaled up and replicated so as to make sure that a greater number of citizens has the opportunity of using them and humanity has the opportunity to reduce climate change.

This objective is completely linked to the UNSDGs; a set of goals, adopted by all UN countries, to end poverty, protect the planet and ensure prosperity for all by 2030 as part of a new sustainable development agenda. About 17 UNSDGs are directly related to the mitigation of climate change and specifically related to energy; for instance, goal 7 (affordable and clean energy), 11 (sustainable cities and communities) and 13 (climate action). So, there can be a positive relationship between the implementation of smart solutions and reaching the UNSDGs. This is another reason to enhance the use and implementation of these smart solutions.

The Promoting of Smart Solutions and Its Consequences

The next question is how to escalate, replicate and promote smart solutions, and who should promote them. As shown in the case studies, there are multiple answers to this question as there are several actors willing, or who have the capacity, to promote smart solutions:

- **Active public sector.** In some cases, the local authorities have been an active actor and implemented these solutions, as in Taipei for housing solutions, Medellín for mobility solutions, or São Paulo for accessibility solutions. Other public administrations may be engaged in the implementation of smart solutions, such as in Brazil-Iberdrola National or Paris with Autolib' or the Bluetram project.

- **Passive public sector.** In other cases—such as in the case of Car2go, for example—the local authority is not participating in the promotion of the solution but it can help it; for instance, by giving free parking places, as in Cologne (see the case of Cambio). National authorities can also play a strategic role, as in the cases of California or Amsterdam.

- **Private sector.** The private sector may also be an active promoter of smart solutions. In some cases, such as in Fernando de Noronha or in Málaga, the energy sector is the one implementing the smart solutions. In other cases, the private company promoting the solutions is not directly related to the energy sector, as in the case of BMW.

- **NGOs and communities.** The participation of communities and of NGOs may also be present, as we have witnessed in the Philippines with the Puerto Princesa case. These examples show us that a new actor is appearing in the energy sector.

It is therefore clear that there are a variety of actors participating in the promotion of smart solutions. We may then have to take into account the indirect negative impacts on third parties that may be generated. For example, an increase in the use of car-sharing systems might have an impact on the activity of private transport; i.e., taxi drivers, or the use of solar lighting can reduce the willingness of energy companies to expand their grids. These consequences have to be considered by public authorities, which will need to study how to reduce the impacts. The distribution of competences among public authorities will determine which administration has to be responsible for the regulation of the use of smart solutions.

Change 2. Revisiting the Roles of the Public Sector

Smart solutions are changing the role of the public sector in the smart solution sector. The public sector can become a promoter of smart solutions; sometimes from an active point of view, when it pays for them, or from a passive point of view, when it facilitates them. Local, regional and national authorities can also be a prescriber of smart solutions. For instance, in the case of Curitiba's Bus Rapid Transit system, the public authority has been a prescriber of the use of new electrical and hybrid buses, which have been bought by the transport companies. As explained previously, the public sector has to play a role in the regulation of this new economic sector.

As a promoter of smart solutions, the public sector can affect the kind of energy that will be produced and consumed. This is not new. The public sector has incentivized, in the last few decades, and especially after the oil crisis in the 1970s, the production of power from alternative sources to those coming from fossil fuels. But now, with smart solutions and their responsibility for the mitigation of climate change, the public sector's role to promote renewable energy has increased. The energy sector has a long tradition of regulation. Nevertheless, this regulation might need to be reviewed in the near future to consider the new kinds of self-production of energy, the new potential micro-distributors of energy, and the new kinds of usage and storage of energy that smart solutions promote. Regulation might also be reviewed to take into account the new business models that appear in energy markets as a result of smart solutions.

Change 3. New Business Models for the Energy Sector

Smart solutions are pushing energy companies to review their business models. The main questions behind the appearance of smart solutions are:

- Who will the customer be? Will the citizens still be the final consumer or will it be the smart solution company? Will it be a mix of the two?

- Besides maybe being a customer, what will the relationship be between smart solution companies and energy companies? Will the latter get into the smart sector, or the other way around? Will there be mergers between energy and smart solution companies?

The answers to some of these questions are outside the scope of this report, but the cases surveyed provide some hints. In the case of Autolib', EDF's first client is the car-sharing company, whereas, in the case of RheinEnergie, the industrial partners guarantee the charging stations. The other questions might require a more in-depth analysis, but it seems clear that the appearance of smart solutions is re-shaping the energy sector by shaping the cities of tomorrow.

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