GreenSphere: A framework of interventions for urban sustainability
Flagship project in Valle Real Residential
International Master in Sustainable Development and CR
2010-2011

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# Contents

Acknowledgements ........................................................................................................ 5

Preface .......................................................................................................................... 6

1. Green Neighbourhoods ............................................................................................. 7

1.1. Theoretical Background ....................................................................................... 7

1.1.1. Justification ........................................................................................................ 7

1.1.4. Challenges and Benefits .................................................................................... 11

1.2. GreenSphere: A Framework of Interventions for Urban Sustainability ............ 12

1.2.1. The Greening Project ......................................................................................... 13

1.3. Sustainable Cities and Green Neighbourhoods Applications ............................ 31

1.3.1. Masdar City ....................................................................................................... 31

1.3.2. Smart Grid City Boulder, Colorado .................................................................... 32

1.3.3. BedZED, UK ....................................................................................................... 34

1.3.4. Rivas Ecopolis, Spain ........................................................................................ 36

1.4. Guidelines and Recognitions ................................................................................ 37

2. Local Context: An Overview of Sustainability in Mexico ...................................... 38

2.1. General Context for Green Neighbourhoods ....................................................... 38

2.2. General Overview .................................................................................................. 39

2.3. Sustainability Status .............................................................................................. 40

2.4. Environmental Conditions .................................................................................... 42

2.2.1. Conventional Energy ......................................................................................... 44

2.2.2. Renewables ......................................................................................................... 46

2.2.4. Waste and Recycling ......................................................................................... 52

2.2.5. Water .................................................................................................................. 54

2.2.6. Transport ............................................................................................................ 58

2.2.7. Behaviour towards Sustainability ...................................................................... 59

2.3. General financial system and economy ................................................................. 60

2.3.1. Mexican Economy .............................................................................................. 60

2.3.2. Mexican economy, Mexican financial system and housing market .................. 61

2.3.3. Housing strategy for sustainable urban development ....................................... 62

2.4. Financing applied to the Green Sphere project ..................................................... 63

2.4.1. Public Financing .................................................................................................. 63

2.4.2. Private Financing ............................................................................................... 70

2.4.3. Public - Private Partnerships ............................................................................. 70
3. A Greening Project for Valle Real ................................................................. 71
  3.1. Citizen Culture ......................................................................................... 74
  3.2. Energy ....................................................................................................... 77
  3.3. Waste ......................................................................................................... 78
  3.4. Water ......................................................................................................... 83
  3.5. Urban Landscaping .................................................................................. 85
  3.6. Transport ................................................................................................... 86
  3.7. Building ..................................................................................................... 89

Conclusion ........................................................................................................ 91

Annex 1. Images of Valle Real ................................................................. 93
Annex 2. Directory of Possible Partners and Suppliers ......................... 95
List of Acronyms .............................................................................................. 96
References ........................................................................................................ 97
INTERNATIONAL MASTER IN SUSTAINABLE DEVELOPMENT AND CR
GreenSphere Project
Acknowledgements

First and foremost, we would like to thank the EOI’s teachers for being a continual source of inspiration and questioning. It was an honour for us to meet so many interesting and passionate people. The knowledge they provided us with has been very enriching and helpful for the completion of this project.

Also, we would like to express our gratitude to Marcela Huertas for her supervision, guidance and support from the initial to the final steps of our project.

We further acknowledge the collaboration of the Neighbourhood Council of Valle Real and particularly Victor Tapia for granting us some of his precious time and essential information. Besides, we would like to thank Alexandra Sacher for the insights provided by sharing her expertise on cultural sustainability and collective decision-making.

We warmly thank our colleagues for their contribution to our learning throughout the course with interesting participation and genuine companionship.

Finally, the preparation of this report would not have been possible without the precious assistance received from Eva Curto, Juana González and Esperanza Campos. We are extremely grateful for your advice.
Preface

Nowadays, concerns over environmental issues and their impacts on the living beings have been more and more alarming. Climate change is a recognized man-made process that generates various reactions from governments, corporations and society; which are gradually taking responsibility. As Henrik Tikkanen said, “Because we don’t think about future generations, they will never forget us”. Indeed, concrete measures must be urgently taken today so that our descendants do not suffer from our actions.

At the same time, the proportion of people living in urban areas is increasing at a rate that is compromising the quality of life of the people and causing severe damages to the environment. As a result of the growing awareness regarding climate change issues, the real need for healthier and more environmentally friendly living spaces is a significant aspect to consider.

The aim of this paper is to provide an understanding of the measures that can be applied in communities enabling them to move towards sustainability. The possible interventions and applicable sustainable solutions available in the market will be identified to develop a strategic set of suggestions (individual and collective). This strategic approach will lead to reduce the use of resources and increase the efficiency in communities. The interventions are structured in a framework, further referred to as GreenSphere, which is applied to develop a pilot project for Valle Real, a private residential area in Zapopan (neighbour municipality to the city of Guadalajara), Mexico.

One of the most important challenges of creating sustainable communities is the access to financial resources to implement changes. Valle Real Residential was chosen as an example to assess the replicability and adaptability of the framework on other private residential areas in Mexico and Latin America. To increase the probability of success of the project, a high-income community was selected, since in general, they tend to have a higher level of education and an advantageous criterion when raising awareness on environmental issues.

There are rare precedents of green neighbourhoods in emerging economies. Therefore, Mexico is a great case for starting the implementation of green urban communities. Taking into account the high proportion of urban population in Mexico (78%)\(^1\), the replicability of such projects across the country would have a remarkable impact.

\(^1\) CIA The World Fact Book. U.S. Government profiles of countries and territories around the world. It provides information on the history, people, government, economy, geography, communications, transportation, military, and transnational issues for 266 world entities.
To provide a better understanding of what is “green neighbourhood”, the concept will first be explained, followed by the elements encompassed in its definition. Some well-known examples of sustainable cities and communities worldwide will be presented as reference for the current development of green urbanism across the globe. Consequently, it will be easier to evaluate the magnitude and depth of the impacts of the final proposals to Valle Real.

1. Green Neighbourhoods

1.1. Theoretical Background

1.1.1. Justification

In 2007 a report from the Intergovernmental Panel on Climate Change (IPCC)\(^2\) revealed that residential and commercial buildings account for 7.95% of the total world’s greenhouse gas (GHG) emissions, while cities contribute in 60-80% of the total.\(^3\) In 2010 it was accounted that 50.5% of the world’s population was living in urban areas with an annual growth rate of 1.85% expected for the next years until 2015.\(^4\)

An immediate response from society and the government is needed to address the environmental damage of urbanisation. Many indirect impacts from climate change are being anticipated, for instance the interruption of transportation and economic activities as a result of extreme weather events. Adapting current lifestyles to make the urban areas sustainable will avoid high future costs, when solutions will be urgent or mandatory.

The need for creating better and more efficient spaces for living has also increased due to the 3.5 billion people living in cities. “Cities are centers of innovation and can advance clean energy systems, sustainable transportation and waste management to reduce greenhouse gases. With access to up to date climate science, they can also work with scientists and experts to assess impacts and vulnerability, and with local stakeholders to design and implement effective adaptation strategies to respond to unavoidable impacts of climate change.”\(^5\)

The previous planning of the cities was mainly focused on accessibility and infrastructure of public services to fulfil basic needs; roads, electricity, gas and water utilities and others. Today the

\(^2\) The IPCC assesses the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change.
\(^3\) OECD Studies
\(^4\) CIA World Fact Book
\(^5\) OECD Focus on Cities and Climate Change (OECD)
focus has broadened to integrate diverse elements that will increase the sustainability of the cities and neighbourhoods changing the known structure of urban development.

A new energy scheme in Urban Areas

Until now, the electricity system has been unidirectional; power plants generate the electricity and distribute it to the cities. In this system there is a huge potential to generate electricity in different points of the urban developments, which has not yet been exploited. The main problem of the present model is the high inefficiency of the system, due to the losses in the transportation phase. Green neighbourhoods address this issue as they promote the decentralization of electricity production by encouraging homeowners to install their own renewable energy systems. This can also reduce the risk associated with cities relying on one energy supplier.

Figure 1. Energy Generation and Distribution Grids

IEEE SMART GRID

Many large urban areas have not achieved high levels of efficiency in this concept of the urban planning and we are now facing another important challenge when planning the structure and functioning of the cities; achieving sustainability.

1.1.2. Green Neighbourhoods: Concept Around the World

From the several pilot models and attempts of sustainable neighbourhoods, each prototype has a different main focus and definition of a green neighbourhood. Although some differences exist they all have the purpose of preserving the environment while increasing the quality of life of their inhabitants creating welfare.
In the sustainable cities Copenhagen Conference\(^6\) in 2007, there were three challenges identified; the need for a new way of thinking, a new form of planning and a new management style.

Steffen Lehmann\(^7\), in his article “Green Urbanism: Formulating a Series of Holistic Principles” provides a conceptual model with fifteen universal principles that support this framework. Lehmann’s principles are based on three main pillars of Green Urbanism: energy and materials, water and biodiversity and urban planning and transport.

**Figure 2. Principles of Green Urbanism**

```
GREEN URBANISM

ENERGY and MATERIALS
- Embodied energy
- Material specification
- Supply chain
- Renewable energy solutions
- Energy sources and consumption
- Construction systems
- Prefabrication and recycling
- Energy efficiency
- Resource management

WATER and BIODIVERSITY
- Urban water management
- Water recycling and irrigation
- Urban farming
- Urban landscape typologies
- Ecosystems’ biodiversity maximized
- Grey water recycling
- Storage of urban stormwater
- Climate change impact management
- Waste management

URBAN PLANNING and TRANSPORT
- Urban design
- Social sustainability
- Ecological city theory
- Health and walkability
- Mobility, public transport
- Infrastructure
- Energy efficient buildings
- Mixed land use
- Housing affordability
- Reducing car dependency
- Subdivisions

Interaction between three main pillars
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Lehmann green urbanism: formulating a series of holistic principles

“One Planet Living” is a global initiative developed by BioRegional and the World Wildlife Fund; it bases its concept on the integration of 10 main principles:

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6 The Copenhagen Agenda for Sustainable Cities was created at the 51st IFHP conference in Copenhagen, Denmark in 2007. The agenda consisted of ten principles aiming to encourage and strengthen the development of sustainable cities.

7 Dr. Steffen Lehmann is Professor of Sustainable Design at the University of South Australia and Director of the Research Centre for Sustainable Design and Behaviour (sd+b), in Adelaide. He also holds the UNESCO Chair in Sustainable Urban Development for Asia and the Pacific (2008-2010). He is the General-Editor of the Journal of Green Building. His latest books include: Back to the City, Hatje Cantz Publisher (Stuttgart, 2009) and The Principles of Green Urbanism, Earthscan Publisher (London, 2010).
The sustainability of an urban area also relies on other factors that need to be taken into account to obtain better results. Time, place, socioeconomic conditions and regulatory framework are key aspects to the strategic planning of a green neighbourhood. The greening of an urban area should maximise the return on investment increasing the length of its life cycle. Innovation is fundamental all along the process, from the design to the implementation phases, in order to reduce costly repairs in the future and increase the durability of the project.

When trying to reach sustainability two other pillars come hand in hand with the environmental part: economic viability and social participation. In order to obtain effective results, social participation is essential; an engagement from the planning to the support and maintenance phases is one of the most basic factors for a green neighbourhood to succeed.

Education and information practices are the best way to involve community into this greening process. Sustainable practices in neighbourhoods are still a “new” topic and very innovative solutions can come up when promoting constructive learning through knowledge sharing. In addition to the inhabitants’ participation, surrounding businesses, administrations and other institutions’ involvement may also have a positive impact.

Several other initiatives of green neighbourhoods give a specific focus on health issues. Although health is more a social result of proper surrounding conditions and could be easily addressed by environmental solutions, it is a very important driver that motivates people to want a more sustainable lifestyle.

1.1.3. Green Neighbourhood Definition

A green neighbourhood is a limited area where the houses and surrounding infrastructures are adapted to be supportive of the environment. Meanwhile, the society is integrated in the process of creating a better atmosphere that insures the highest possible quality of life. In a green neighbourhood, achieving the highest independency of external inputs is expected in order to satisfy the needs of the inhabitants as well as the environments. The different lines of action that a green
neighbourhood bases on to define itself as such, are: Energy, Waste, Water, Urban Landscaping, Building, Transport and Citizen Culture.

1.1.4. Challenges and Benefits

In order to be able to implement the recommended interventions, three main requirements ought to be fulfilled. The financial viability, the applicability based on local conditions and regulatory framework; and the tangible benefits for the inhabitants of the condominium as well as the citizen culture for them to commit to the project. Several challenges need to be addressed in order to guarantee the success of the project:

- Ecological and efficiency mechanisms as well as infrastructure transformation can imply high initial investment costs. The financing instruments have to be available in order to be able to wait for the long-term returns.
- Developing countries tend to have bureaucracy that can delay legal procedures and permits; however they are working hard to create sustainability related policies that can support environmental projects.
- The market for green products and services is still developing. An exhaustive research has to be conducted in order to find suppliers for the interventions at the most competitive prices.
- Promoting awareness and providing information to the community is key to combat reluctance and scepticism. The inhabitants of the neighbourhood need to have clear incentives to change their habits and apply green measures in their daily lives.
- A strong citizen culture has to be developed through participatory approaches in order to avoid disagreements and confrontations when taking collective measures that require group consensus and commitment.
- Aesthetic concerns have to be incorporated in the project. Establishing architectural styles that are harmonious with the surroundings and creating clear guidelines for the implementation of new technologies can help avoid the rejection of interventions because of their visual aspect.

Taking these situations into account, a deep investigation of the local context is crucial to prevent negative results or failure of the project. The suggested solutions must be developed according to the local conditions in order to promote sustainable lifestyles among communities. The benefits will be measured using indicators such as carbon emission reductions, diminution of the waste and consumed resources, energy and water savings and the creation of job opportunities. The combination of these benefits will eventually generate economic paybacks that can be used as incentives; together with the added value of the properties for being in a community where such sustainable practices are applied. In order to evaluate the impact of the project, the outcomes will
have to be compared to the current performance of these indicators; therefore it is very important to establish the baseline.

1.2. GreenSphere: A Framework of Interventions for Urban Sustainability

This section presents a framework that can be followed by any private neighbourhood or residential as a road map for sustainability. It provides an outline of the stages of the greening process and a description of the different interventions that can form part of the project.

It is intended as a reference guide to create a holistic project in which the interventions are integrated and applied in a systematic and adapted way, the same as the interventions presented in this paper. These interventions are based on the guidelines provided and the criteria required by institutes such as EarthCraft, Enterprise Green Communities and LEED certification for neighbourhoods.

The interventions are categorized in seven broad areas that should be considered and evaluated in any approach to sustainable urbanisation in general, but that particularly applies to existing private condominiums. If the neighbourhood is still at the project stage, other important principles need to be considered for the site selection: the external transportation opportunities, services proximity, density and orientation according to the sites characteristics. For established communities, fewer interventions can be implemented as for the urban planning and transport pillar. Consequently, the main focus is redirected on other potentially changeable and adaptable aspects. In this case, the approach should be similar to acupuncture points; intervening in strategic elements to improve the sustainability of the neighbourhood as much as possible.

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8 For detailed information of the certification processes and requirements refer to the original institutional guides.
9 “Developed in 1999 by the Greater Atlanta Home Builders Association and Southface, EarthCraft is the Southeast’s standard for green building, integrating building science with regional know-how. The EarthCraft Communities program is a certification system for sustainably planned and constructed communities. It offers holistic approaches to development for rural, suburban or urban projects.” (Earthcraft)
10 “Enterprise is an organisation in the US which provides financial support and technical expertise to enable developers to build and rehabilitate homes that are healthier, more energy efficient and better for the environment on a cost-effective basis. They work with state and local governments to ensure their housing and economic development policies are smart and sustainable.” (Green Communities Initiative)
11 “LEED, or Leadership in Energy and Environmental Design, is an internationally-recognized green building certification system. Developed by the U.S. Green Building Council (USGBC) in March 2000, LEED provides owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.” (USGBC)
1.2.1. The Greening Project

The framework should be used to develop projects in respect of the specific characteristics, local context and particular needs of every neighbourhood. The suggested interventions provide an orientation to create particular action plans with tailored solutions. A greening project should have a holistic approach, it includes seven phases that ought to be planned and implemented with the community. These are the different stages to follow:

1. Introduction:
   Observe the social systems involved: individual, family, neighbours, community, local government. Explain the project to neighbourhood residents and surrounding community, as well as the benefits of initiating the process towards sustainability. Develop a citizen culture and commitment required for the success of the project. Engage with local government to incorporate regulations, tax reductions, incentives and possible partnerships for implementing interventions. Establish clear objectives for the greening project.

2. Exploration:
   Explore and analyse the characteristics, needs and potential opportunities of the neighbourhood including population, climate, natural resources and location variables. Research the possible interventions to be integrated in the project.

3. Identification:
   Detect the resources available and the different parties involved in the project. Identify the financial instruments that are suitable for this type of project. Evaluate the applicability of the interventions identified in the previous stage.

4. Design:
   Determine the different phases of the project, develop a plan with clear lines of action, targets and specific activities, define indicators and measurement methods to be used in the monitoring stage. Ensure the viability and approval of the action plan.

5. Implementation:
   Obtain the financing and permits from public administration, execute the planned activities, contact suppliers and perform the interventions.

6. Monitoring:
   Check evolution of the programme and the interventions and their immediate outcomes. Execute the measuring plan established in the design stage.
7. Improvement:
   Make pertinent changes and adaptations to correct mistakes and enhance the approaches that have produced positive results.

8. Evaluation:
   After several years of project completion, namely 10 years, compare the expected impact (social, economic and environmental changes desired) and the actual impact achieved to determine the success of the project.

1.2.2. Interventions

**CITIZEN CULTURE**

Sustainable communities cannot be achieved if people are not included and committed. Engaging the local community and the key stakeholders as well as strong leadership from the directing board of the condominium will enable the support required for the decision-making process. The neighbourhood association can appoint an "environmental coordinator" to support, coordinate and monitor all environmental initiatives within the community.

Several of the interventions for sustainability in a private condominium depend on changes in habits and behaviours of the citizens. Best practices for social sustainability include: building a code of conduct, creating a campaign to raise awareness, carrying out a participatory approach to develop the action plan, training and education workshops. The education programme should inform
the residents on the environmental features of the condominium, their economic and environmental benefits and their responsibility in reaching the goal of becoming a sustainable community.

Manuals and guidebooks are most effective when combined with training sessions or workshops. These sessions should provide an opportunity to share experiences and best practices, obtain technical training and build awareness of the benefits of sustainable habits and behaviour. Consider developing policies to enhance participation and cooperation for the recycling, potable water conservation, wastewater treatment, efficiency and integrated pest management initiatives.

ENERGY

Energy consumption in condominiums will come from the individual houses and from the common areas. In this sector, the goal is to move away from fossil fuels towards emission-free energy supply and reduce consumption by promoting renewable sources of energy and increased efficiency. The use of on-site renewable energy technologies (including solar photovoltaic (PV), solar thermal, wind, biomass or geothermal) can also result in cost savings. The local conditions of the site and availability of the technologies will be basic to decide which solutions are the most suitable in every case. A mixture of renewable electrical generation should be combined with energy storage, smart metres, smart grid and energy efficiency in order to have an integrated solution.

Electricity metres

Providing information to residents on the details of their electricity consumption, costs and peaks of usage can allow them to manage and reduce their energy use. Installing smart metres allows more control over the electricity use that can translate into savings related to off-peak hour consumption. Smart metres can be connected in the future to smart grid systems allow a two way electricity flow that can give exit to a possible surplus of the electricity generated through renewable sources. This will allow for residents to fully realize the environmental and economic benefits of investing in green housing interventions.

Efficiency

Interventions and improvements in energy efficiency result in cost savings from reduced electrical consumption from heating, lights and appliances and at the same time decrease greenhouse gas emissions. Always start with energy-efficiency measures because they are simpler to implement and are generally more cost-effective than renewables.
The use of new lighting technologies combined with lighting controls can reduce lighting energy use in households by up to 75%. Changing traditional incandescent bulbs for compact fluorescent lamps (CFL) result in great energy and cost savings; as they have the lowest efficacy\textsuperscript{12} compared to other lighting options (10-17 lumens per watt) and a short average operating lifetime. CFL have a five times higher efficacy and lifetime. Occupancy sensors detect activity in an area through sound or movement. They can reduce energy use as the lights are turned off soon after the activity stops, avoiding for lights to be left on when they are not needed.

- **Exterior lighting**

In order to improve efficiency of pedestrian and road lighting in the condominium there are several types of exterior fixings that can be combined with automatic controls such as photosensors and timers: solar PV lighting, compact fluorescents or LEDs.

Installing solar street lights is most cost-effective in areas where the utility network does not reach because large infrastructure costs are avoided. However, provided the pertinent feasibility study, it can also be a suitable solution for urban neighbourhoods. Some of the benefits of this technology include the flexibility to be installed anywhere, installation is quick, no wiring needs to be put in place, it feeds on clean energy, there are no costs from electricity consumption and they need low maintenance.

The solar lighting system consists of a lamp-post with an adjustable solar module at the top. The module can be oriented to the best position to take the most advantage of the sun’s incidence; the electrical energy produced then charges the batteries. A programmable timer controls when the lamp lights up and goes off.

- **Appliances**

Encourage A+ or ENERGY STAR labelled house appliances including clothes and dishwashers, dryers, refrigerators, ovens, fans, air conditioners and heaters. Create awareness about the benefits of renewing different machines in the house to substitute them by more modern and efficient ones.

**Renewable Sources**

Thermal and photovoltaic solar panels, wind turbines, or other renewable electric-generating systems can be installed in every household or in common areas for the whole condominium, to provide a percentage of the estimated energy demand.

\textsuperscript{12} Amount of light produced in relation to the energy consumed.
• Solar Electric

Solar electric systems turn the sun’s energy into electricity when the rays excite the electrons of the solar cells. These electrons move, creating an electric current that can be used in the building. Photovoltaic (PV) cells produce direct current (DC) that must go into an inverter to be turned in alternating current (AC), the kind used in conventional appliances. PV cells are arranged on panels to form solar modules; these modules can be linked in series to put together a solar array that provides the power needed.

There are three options to connect this power to the electrical system: it can be connected to the conventional electricity grid and sold to the utility, connected to the building for direct use and to a series of batteries to be stored for when it is needed, or a combination of the two. For an urban residential area that has access to the electrical grid, it is recommended that the system is grid-connected. By using this modality, the energy produced which is not directly used will go into the grid and the electricity bill will only reflect the net electricity consumption, just as with an on-grid small wind turbine. A smart metre has to be installed so that the electricity produced by the solar panels and going into the grid (sold) is recorded and then discounted from the electricity actually used (figure 3).

Figure 3: Grid-Connected Solar System

For solar electric technology, a solar access analysis has to be done to identify the ideal areas and orientation for this technology. Ensure that the panels can be oriented to the South and that there is unobstructed access to sunlight. Always verify with an engineer that the roof can support the weight of the solar equipment.
Solar thermal systems are the most efficient way to produce hot water for residential use. It is a mature and cost-effective technology that needs little maintenance and can produce a large percentage of the annual household hot water consumption thus reducing the use of gas or electricity to heat water. There are different designs of thermal solar systems and each has a specific application, the installer should be consulted to determine which is the most suitable solar solution. Thermal solar systems can be “active” or “passive” depending if the system relies on pumps or uses thermal effects to move the water through the circuit; and “direct” or “indirect” according to the way the solar energy is transferred to the water.

The simplest systems are the direct and passive solar water heaters, where the water circulates inside the collectors without the aid of pumps or the need for transfer liquid, the water heated directly by the sun is the one being used in the household. The warm water can then be stored in conventional a conventional tank. During periods of little sun the water can be kept warm by using supplemental gas or electricity.

**Figure 4: Solar Heating Water System**

In indirect systems, an antifreeze solution or transfer liquid is pumped into the heat collector and then into a heat-transfer unit where it warms the cold water heading to a hot water tank. The antifreeze solution is then pumped back into the solar collector to be heated again; the fluid circulates in a closed loop without ever mixing with the building’s water. This system is recommended in areas with extreme climate with large periods of freezing temperatures, because in direct systems under these conditions the water can freeze and break the tubes.
Wind-electric systems capture the kinetic energy of the wind and convert it into rotary motion to generate clean and renewable energy, which can be then connected to the grid, used locally or to charge batteries. Small wind turbines (SWT) can be a very good electrical system for urban applications in houses and condominiums. The first step is to conduct a resource availability study to see if the wind speed and presence in the area is sufficient to make a wind turbine a cost-effective solution. The space availability, characteristics of the neighbourhood, context, disposition of the neighbours and regulations have to be evaluated as well to see if wind turbines are viable.

The wind electrical systems can be off-grid or on-grid. Off-grid systems are autonomous and are not connected to any larger electrical system except for the one where the energy is going to be used. In this case, a storage or hybrid system (with photovoltaic panels) can be integrated. Stand-alone systems can help avoid the costs of taking utility power lines to remote areas.

On-grid systems are connected to a larger distribution network. This system can work together with the electric utility to power the building. Whenever the wind is not blowing, the electricity comes from the regular company. But when it is windy, the system pivots to face the wind and provides the electricity. If at a certain moment the local system is generating more electricity than what it is consuming, the meter can actually spin backwards: electricity can be sold back to the utility company (figure 5). Evaluate the requirements and local conditions to determine if the SWT can be connected to the grid; create a micro-grid system or a stand-alone system connected to batteries.

Figure 5: Tandem Wind System with Utility Grid

SWTs are especially attractive if the prices for conventional electricity are high or for places without access to the grid. There are a number of small wind systems (20W to 100kW), of different
categories depending on their design, size, power output and cost. Some of the things that need to be considered when thinking of installing one of these small wind systems are:

- Availability of good and exposed wind resource.
- Land space availability.
- Access to the grid and connection to the property installation.
- Conduct the planning approval, permits and community acceptance.
- Average electricity consumption.
- Wind turbines are a long-term investment.

- **Geothermal**

Geothermal energy systems are a very good solution for residential heating and cooling. Although they are more recommended for new construction houses because the access and installation is easier and cheaper, they can also be installed in existing homes. Geothermal technology is based on the principle that the underground temperature is fairly consistent along the year, independent of the climate above ground. The ground absorbs the sun’s heat energy and the geothermal system then uses the temperature difference to heat or cool the building. This happens through an underground loop system that absorbs or disperses the heat according to the function desired. The conditioned air is then distributed through conventional ducts to all areas of the house and can be also integrated with a water tank to provide warm water (figure 6). The system includes a fan, compressor and pump to drive the circulation; these elements require electric power but have a much lower consumption than conventional heating-cooling systems.

**Figure 6: How Geothermal Systems Work**

![Image of Geothermal Systems](image-url)
There are different designs for the underground loop systems, each with particular characteristics and requirements that need to be evaluated according to the specific context to determine the most suitable system. In closed-loop systems a water-based solution circulates through the underground pipes whereas open-loop systems use and existing water source (e.g. well or pond); which, if the conditions are in place, can be the most economical alternative. In both systems the heat is transferred in the same way.

Closed loops can be installed vertically, horizontally or in a pond. The most suitable alternative will depend on the surface area available, the ground characteristics and the presence of water bodies. The ground composition of the site will be critical to determine the kind of loop and the cost of the project because the cost of drilling has to be considered.

Some of the benefits of geothermal energy refer to the costs, performance and cleanness. The high efficiency of the system produces five units of thermal energy for every unit of electrical energy, reduces operating costs. Maintenance costs are also reduced as the units are installed inside or underground and are not exposed to weather deterioration. Apart from reducing emissions related to the electricity consumption, these systems are also environmentally friendly and safe because unlike fossil fuelled heaters; they do not emit greenhouse gases as there is no combustion.

- **Biomass**

Biomass is a renewable source of energy where a variety of organic or biological material can be used to generate electricity (biopower) or heat, or to produce biofuels or bioproducts. The energy comes from the sun and has been stored in the plants through photosynthesis, converting carbon dioxide from the air and water into carbohydrates. It is considered as renewable because the biomass can be re-grown in a short period of time; thus is excludes organic substances that have been transformed by geological processes over long periods of time. Fossil fuels are not included in this category because the carbon stored in them has been out of the natural carbon cycle for a very long time; so, the carbon released from the burning of this material modifies the carbon content in the atmosphere.

The most common way of extracting the energy is direct incineration: burning the material to produce steam that in turn moves a turbine, producing electricity; or burning it in a boiler to use the heat directly. However, in this process a lot of the energy is wasted and polluting particles can be released if not carefully controlled. So, many other processes have been developed to extract
the energy in a cleaner and more controlled and efficient way, such as such as gasification\textsuperscript{13}, co-
firing, and anaerobic digestion.

The material is burned and turned back into carbon dioxide and water, releasing the energy in the form of heat. The biomass can be considered as a temporal storage of energy or a natural battery. It is considered beneficial when the emissions are compensated in the short-term by the posterior growth of the replacement plants, so that the net carbon emissions are very low.

Biomass includes most organic waste material; from forest residues, to agricultural wastes and kitchen leftovers. According to the Union of Concerned Scientists\textsuperscript{14}, there are four main beneficial types of biomass:

- Energy crops that don’t compete with food crops for land.
- Portions of crop residues such as wheat straw or corn.
- Sustainably harvested wood and forest residues.
- Clean municipal and industrial wastes.

An important thing to consider with biomass energy systems and what kind of biomass you use is the amount of energy contained compared to the weight of the material, or energy density. Unprocessed biomass material can have a high content of water that will make it less cost-effective; especially if it has to be transported from another place. Drying, grinding or pressing the material increases its energy density. Energy systems should be designed according to the specific context, so that they use local sources. The sustainability impacts and risks have to be considered in a broad way, taking into account other possible uses for the resource (best to use waste material), air quality and carbon emissions (what substances are released in the combustion), undesired negative effects of harvesting residues from agriculture instead of leaving them on the field (depletion and erosion), etc.

Due to the processes, biomass is mainly considered as an alternative in industrial processes or to diversify the energy mix of the electricity production. In the case of Green Neighbourhoods the feasibility analysis to use biomass has to be a thorough one to see if the household waste is a cost-effective source of energy for the condominium; or other local biomass materials can be a better alternative. In general, the environmental and economic benefits of using biomass will depend on what the material is, how is it grown and harvested, what is its energy density, where it comes from and how is it processed.

\textsuperscript{13} Process by which biomass material is turned into combustible gases, so as to reduce the particulates and polluting emissions released in the combustion.

\textsuperscript{14} The Union of Concerned Scientists is an NGO that began in 1969 as a collaboration between students and faculty members at the Massachusetts Institute of Technology. Today it brings together scientific research and citizen action to develop solutions for a healthier environment and a safer world.
WASTE

Sustainable waste management should be integrated into the operation of the condominium. This includes a change in behaviour of all the residents towards a zero-waste community, through the triple bottom line of waste: reduce, reuse and recycle. Recycling avoids the flow of usable material into the waste stream. Efforts should start with waste prevention and awareness building to reduce the waste produced in the community, followed by promoting the habit of separating the different waste materials to enable their recycling. Organic waste can be composted on site.

Separation

In order to reduce the waste stream of the condominium, build a community recycling centre, aside from the local public recollection service. Establish a “clean point” inside the neighbourhood: designate an easily accessible, permanent and appropriately sized area for the collection and storage of waste materials. Independent and clearly signed containers should be installed for every kind of residue: glass, metal, paper, cardboard, plastic, organic matter, and other non-recyclable waste. Develop a monitoring programme to ensure that the separation process is being done in the correct way and to improve resident participation in the process.

Recycling

Identify local recycling companies or waste management cooperatives and handlers and develop agreements for them to collect and buy the different waste materials. Construct a community composting facility for resident organic and food waste to be recycled. That way, nutrients are kept on-site as the resulting compost can be used as fertilizer for the community gardens and farm.

WATER

Water management will include different solutions for the common areas and for the houses but both should address reducing consumption, promoting efficient use of water, rain water collection and recycling of wastewater.

Conservation of potable water

Water conservation measures directly translate into cost savings for residents. To conserve potable water in common areas the best alternative is to use rainwater or treated wastewater (from the public utility or sourced on-site) for irrigation. However, an exemption should be made in the case of farming areas or community gardens used for food production, which should be irrigated
with potable water. The use of well water, streams or lakes for irrigation purposes should be avoided.

Water conservation strategies must include residents as well. Guidelines and codes should be established to regulate irrigation of private yards and house gardens. Whenever possible, a non-potable source of water should be provided for every lot or develop guidelines that require residents to install rainwater capture systems and efficient landscaping design.

Other recommendations for the residents include installing water-conserving fixtures. Aerators can be fixed to existing faucets to reduce water flow and dual-flush water systems can be installed in toilets. These kind of fixing are an easy measure to implement, their installation is simple and do not require building work. Aerators mix the water with small bubbles of air, which can reduce the water consumption by up to 50%, which translates into cost savings derived from reducing the energy needed to heat the water.

Rainwater management

Reducing water runoff in residential areas reduces the risk of flooding and erosion, maintenance costs resulting from fixing pavements, use of potable water and the costs related, thus preserving the perpetual natural water cycle. Rainwater can be retained, infiltrated or collected on site using a combination of strategies and technologies.

Rainwater can be harvested from the whole area of the condominium, conducting it from non-permeable surfaces such as roofs and pavements through gutters or ditches to storage tanks or cisterns, or even an artificial lake. If possible, design sidewalks to distribute and collect storm water that can then be used for irrigation. To avoid the corruption of the water, it has to be filtered before storage; it then can be used for non-potable purposes or can be further treated for potable uses. The rainwater collection systems can also be used as temporary or emergency water supply units, especially in areas where the water supply from the utility is unreliable. There are commercial solutions in the market for domestic collection of rainwater from the roof, as shown in figure 7.
To increase the permeation and retention of water in the soil the impervious surfaces that do not allow water to infiltrate should be minimized. Permeable paving and porous materials such as concrete grid pavers, perforated brick pavers and compacted gravel should be used on streets, sidewalks and driveways. Green roofs and vertical gardens also retain water and reduce surface runoff.

**Water treatment**

When there is no public wastewater treatment infrastructure available for the condominium to connect; there are different alternative treatment systems that should be considered. To decide which is the most suitable treatment system, the discharge rates need to be calculated and several variables should be evaluated; the site’s topography, the type of soil, the available space and the scale.

Constructed wetlands are an attractive alternative to a conventional treatment plant common to the whole neighbourhood. They are artificially created wetlands that emulate the way natural ecosystems purify water; acting as a biofilter and removing sediments and pollutants from the water. This is an alternative with extra benefits; it promotes biodiversity by counteracting the ecological disturbances caused by urban development and it provides a pleasant landscaping contributing to reduce the heat island effect\(^\text{15}\).

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\(^\text{15}\) The heat island effect occurs on urban areas where the local air temperatures increase due to the absorption of solar energy by the buildings and pavements.
In the case that a treatment plant or constructed wetland for the whole community is not viable, other options can be considered to be implemented individually or by sectors or small groups of houses. Some of the available technologies include: mechanical re-circulating sand filters, anaerobic biological treatment facilities, biological aerobic reactors and septic tanks. Note that in any case, the administration board of the condominium should establish a monitoring and maintenance protocol. To facilitate the treatment process, biodegradable soaps and cleaners should be promoted.

Depending on the water treatment process or technology chosen, there can be great differences on the scale of the building work, the investment costs, the durability of the system and maintenance required. It is always best to consult with an expert on the matter.

Efficient irrigation

Precise, adequate and properly scheduled watering minimizes losses due to evaporation and avoids water wasting. Efficient irrigation eliminates overspray and can be combined with water reuse systems (on-site treated greywater, collected rainwater or municipal recycled water) to avoid the use of potable water. Strategies for efficient irrigation include: drip irrigation systems, zoning turf areas according to the watering needs, timers that control and activate the different zones at the best time of the day, moisture sensor controllers and high efficiency irrigation nozzles and spray heads.

Drip irrigation is the most efficient method and it is easy to install and design, plus it is reasonably inexpensive. The water savings of this system come from two main factors; water penetrates into the soil before it evaporates or runs off and the water is applied where it is actually needed and not generally sprayed.

URBAN LANDSCAPING

Open space and natural resources in residential areas improve quality of life and provide the opportunity for inhabitants to value the environment. Common areas in condominiums serve to integrate landscaping and create communal gardens that reduce the impact of urbanisation, promote biodiversity and reduce the urban heat island effect while presenting leisure and recreation opportunities. Vertical gardens, green roofs and urban agriculture should also be considered to integrate nature in urban areas. The local biodiversity and regional characteristics should be considered to preserve the original ecosystems so that less water and energy has to be invested in the maintenance of the green areas. In any case, landscape and farmland should be managed through organic fertilizers and herbicides, permaculture principles and an integrated pest
management system, avoiding noxious chemical substances that will affect the water quality and soil health.

**Autochthonous species and landscaping**

Areas, which do not apply new landscaping but use autochthonous species, require less watering and maintenance. Encourage the use of native ecological systems and avoid the introduction of invasive species. Turf might be appropriate in some areas but it should be minimized wherever possible. Lawn grass requires large quantities of water to grow well and needs mowing. Mowing machinery runs on fossil fuels that generate greenhouse gas emissions that contribute to deteriorating the local air quality. Cover landscaped areas with mulch to retain moisture. Using appropriate species and native plants means that they are adapted to the local climate and soil conditions and that they are more resistant to the zone’s natural diseases and insects. This in turn, reduces the need for artificial fertilizers, pesticides or herbicides.

To reduce the heat island effect, use light-coloured, open-grid pavement with a minimum solar reflectance. Plant and preserve shade trees along streets and paths that create shade over pedestrian and paved routes on the central hours of the hottest seasons. Different fruit trees can be considered for this matter, depending on the local conditions (type of soil and microclimate) and characteristics of the site, so that they provide a fruit yield as well as a cooling effect.

**Vertical gardens and green roofs**

Vertical gardens and green roofs consist on partially or completely covering the walls and roofs of a building with vegetation, plated on waterproofing membranes. In some cases they also integrate root barriers and drainage and irrigation systems. “Green roof” is a broad term and can also refer to roofs that integrate some kind of “green” technology. They can also be referred to as eco-roofs or living roofs.

Vegetated surfaces have benefits in three main areas:

- **Ecological**: Vegetated surfaces produce oxygen and refresh the air in the city, reducing the levels of pollution. At the same time they retain suspended particles, absorb rainwater and create a habitat for wildlife. This urban design solution reduces the surface area of heat absorbing material in the neighbourhood. This has a cooling effect and increases the local air quality, contributing to combat the heat island effect.
- **Thermal**: This system provides insulation, reducing the difference between the minimum and maximum temperature. This naturally creates a thermal comfort inside the building. Energy consumption is also reduced as the use of cooling systems decreases.
INTERNATIONAL MASTER IN SUSTAINABLE DEVELOPMENT AND CR
GreenSphere Project

- Economical: The decrease in the use of air conditioning can decrease energy consumption by up to 40%. The maintenance of the impermeable system can be reduced because it is protected from the rays of the sun. Another economic incentive is that green roofs and vertical gardens improves the image of the area and increases the value of the real estate.

Urban agriculture

Local farms and gardens can bridge the urban-rural gap and move cities towards more ecological food producing systems. Urban agriculture can reduce the energy use for food transportation, improve the eating habits and provide educational opportunities for residents. At the same time it brings an opportunity to recycle the organic waste from households by creating compost that can then nurture the community produce.

The condominium can work with local farmers or gardening agencies to design and develop an agricultural project. The farm land, community garden or greenhouse should be located in an area suitable for cultivation, with adequate solar incidence and irrigation systems. The administrative board of the condominium will have to determine how this project will be developed, funded, operated and managed; either by a designated group in the community or through an independent farmer or agency. If an agreement is established with a local farming cooperative or similar to farm the land, the conditions should be clear so that the produce is available to be purchased by the residents. If the project is carried out by a group of residents, they should consult with experts to help them establish the garden and maintain its productivity.

TRANSPORT

Enhance sustainable mobility inside the condominium by providing collective transport when possible or promoting carpooling. Pedestrian and bicycle friendly environments need to be created by ensuring safe and properly signalled ways, as well as bicycle parking in strategic points. Construct a network of multiuse paths to encourage residents to walk and cycle as alternative transportation in order to reduce the use of motor vehicles, promote healthy lifestyles and foster community interaction. If no alternative routes can be determined in the developed area, the paths could take the form of on-street clearly signed bike lanes. Bike racks can be installed along street sidewalks and close to the entrances of common use buildings, sports centres or convenience stores.

Sidewalks should be built along all internal streets, providing pedestrian crosswalks at every intersection. Install benches or seating, pedestrian-scaled light and rubbish bins at regular intervals to provide convenient walkways and shady rest stations.
Promote connectivity through various entrances and exits to avoid traffic jams. Improve pedestrian connections with off-site services and adjacent areas by optimizing networks of non-vehicular paths that link the condominium to its surrounding uses avoiding long distance walking. When possible, work with surrounding landowners and local governments to improve safety along existing roads around the community so that pedestrian and bicycle transit can be extended to adjacent neighbourhoods. Other measures include electrical vehicles for services such as vigilance and maintenance.

BUILDING

New projects bound to be developed on available land should also be considered to promote that regional and sustainable materials be used in new houses, reducing emissions generated by their transport. The administration of the condominium can develop policies to encourage landowners to build their houses considering bioclimatic principles and passive architecture design; that reduce the consumption resources and materials while reducing the energy bill.

Bio-construction and passive architecture

Passive architecture is an area of opportunity for new housing projects developing on available land in the condominium. The use of passive solar energy and bioclimatic principles through the architectural design minimizes the need for artificial heating or cooling. It optimizes the solar incidence in winter when it is cool and provides shading in the summer to avoid heat gain.

Building orientation should consider solar positioning so that the roof eaves project shade in summer and allow sunlight to come in in winter. The extension of the eaves will depend on the latitude of the place. Deciduous trees are a good alternative as well, as they lose the leaves in winter and provide a cool shade in summer. Planting these trees on the south face of the house -in the northern hemisphere- is an ideal solution to avoid air conditioning. Interior distribution is also important, spaces that require the most lighting and heating should be placed along the side of the building that has the highest solar incidence. Window glazing can be a solution for already built houses with inappropriate orientation. Passive solar design techniques and materials may require a higher initial investment but the payback can be appreciated in the operation phase, when the lower annual energy consumption and maintenance costs are prolonged over the life of the house.

An open floor plan provides and optimizes daylight and natural ventilation that translates in greater comfort for the residents. To maximize air circulation, operable windows should be placed at the windward and leeward sides of the house. Implementing bio-construction and passive

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16 For more detailed guidelines on passive solar design refer to the Technology Fact Sheet of the U.S. Department of Energy.
architecture principles has a great reduction effect in the electricity consumption of a house. An example of the intended smart home model is shown in figure 8.

Figure 8: Smart House Model

Class material: Energy planning - Carlos Aguirre

Materials

The utilization of building materials that incorporate recycled content reduces the negative impacts from extraction of raw materials. Additionally, locally or regionally sourced materials minimize the energy consumption and pollution associated to their transportation while contributing to the local economy. In many cases this also translates into cost savings.

Permeable materials are recommended for driveways and patios as they reduce water runoff, risk of flooding and erosion, providing a solid base that drains water effectively. The particular conditions need to be evaluated as well as the characteristics of the paver alternatives in order to decide which is the most suitable solution.

Recommendations should be given to landowners and builders to incorporate building materials containing recycled matter and select regional materials. Other requirements such as the use of certified materials and wood products can be incorporated into the condominium policies.

Adapting an existing neighbourhood to be sustainable is more complex than creating a sustainable community from scratch because there are several aspects that might not have been taken into account. Innovative engineering and creative solutions need to be developed and coupled
with technology and behavioural practices to create a holistic approach tailored to the specific context.

1.3. Sustainable Cities and Green Neighbourhoods Applications

As mentioned previously in this paper, in the world there are several examples of urban sustainability projects and they vary according to the approach and the geographical locality. Some examples will be briefly explained in the following section.

1.3.1. Masdar City

Masdar City Project is the building from scratch of a city with zero emissions; the world’s benchmark for sustainable cities. The city is planned to be 100% sustainable, including generation, distribution and consumption, since the energy used will be completely sourced from renewables. Masdar city is designed for 45,000 homes, around 1,500 businesses, 60,000 workers and the MIST University (Masdar Institute of Science and Technology). A wall that ensures efficient ventilation and isolation from hot winds, even in a local desert climate, will surround this city complex. Some of the main objectives of the project include the having no motor vehicles inside the city, zero waste and 80% of water reuse and recycling.

There is no precedent to this kind of project when referring to the scale, time of construction and amount of investment required. The project is being developed in Abu Dhabi (United Arab Emirates) with the support of several important Arabian investors. The estimated investment is around US$18 to 20 billion. The city area will be of six square kilometres and is programmed to be finished in 2025. Despite the efforts, the enormous financial risk will be very complex to assess due to the size of the project.

Conscious of the challenges linked to this outstanding initiative, Masdar city takes into account the need to quickly respond to changes in order to make the project economically viable and replicable.
In order to consider all the factors and risks, different study units have been created; specialized research team in sustainability, renewable energy experts consultancy, alternative renewable energy projects investors, project developers in waste, energy efficiency and carbon capture systems analysts and the city planners unit. All these units share their knowledge between them to form a strategic link for the realization of the project.\textsuperscript{17}

1.3.2. Smart Grid City Boulder, Colorado

In 2008, the city of Boulder, Colorado (US) launched a pilot smart grid city. Around 16,000 smart meters were installed in the first phase of the project and a growth of 9,000 was planned for the end of the second year.

The smart grid system manages a fully inter-connected energy scheme including components such as: a dynamic system of information, high-speed, real-time and two-way communications, sensors throughout the grid enabling rapid diagnosis and corrections, decision-making data and

\textsuperscript{17} For further information refer to www.masdar.ae/
support for peak efficiency, distributed generation technologies (such as wind turbines, solar panels, and plug-in hybrid electric vehicles), automated “smart substations”, in-home energy control devices and automated home energy use.\(^\text{18}\)

**Figure 10. Smart Grid City “Next Generation Grid”**

Xcel Energy

This project was managed by Xcel Energy, a public utility company supplier of energy services, mainly electricity and natural gas. The investment required was of 45 million US dollars. An important part of the project was the market research of the system functioning and the response from the customers to it.

The launch of Smart Grid City required the creation of a smart grid infrastructure, the installation of Smart meters in each household, the “my account software” for the management of the consumption information and programmable thermostats.

The following chart clearly demonstrates the main differences between the conventional electricity grid model and a Smart grid:

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\(^{18}\) Xcel Energy The Smart Grid City information brochure.
Table 1. Grids Comparison

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Today's Grid</th>
<th>Smart Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enables active participation by consumers</td>
<td>Consumers are uninformed and non-participative with power system</td>
<td>Informed, involved, and active consumers - demand response and distributed energy resources.</td>
</tr>
<tr>
<td>Accommodates all generation and storage options</td>
<td>Dominated by central generation - many obstacles exist for distributed energy resources interconnection</td>
<td>Many distributed energy resources with plug-and-play convenience focus on renewables</td>
</tr>
<tr>
<td>Enables new products, services and markets</td>
<td>Limited wholesale markets, not well integrated - limited opportunities for consumers</td>
<td>Mature, well-integrated wholesale markets, growth of new electricity markets for consumers</td>
</tr>
<tr>
<td>Provides power quality for the digital economy</td>
<td>Focus on outages - slow response to power quality issues</td>
<td>Power quality is a priority with a variety of quality/price options - rapid resolution of issues</td>
</tr>
<tr>
<td>Optimizes assets &amp; operates efficiently</td>
<td>Little integration of operational data with asset management - business process silos</td>
<td>Greatly expanded data acquisition of grid parameters - focus on prevention, minimizing impact to consumers</td>
</tr>
<tr>
<td>Anticipates and responds to system disturbances (self-heals)</td>
<td>Responds to prevent further damage - focus is on protecting assets following fault</td>
<td>Automatically detects and responds to problems - focus on prevention, minimizing impact to consumer</td>
</tr>
<tr>
<td>Operates resiliently against attack and natural disaster</td>
<td>Vulnerable to malicious acts of terror and natural disasters</td>
<td>Resilient to attack and natural disasters with rapid restoration capabilities</td>
</tr>
</tbody>
</table>

XCEI Energy

The benefits this project are a better control of the electrical use, less GHG’s emissions, and a higher energy efficiency based on direct consumption and service energy usage.\(^\text{19}\)

1.3.3. BedZED, UK

In UK, another example of green community has had very successful results. BedZED is a neighbourhood focussing on the implementation of innovative measures for sustainable houses. The interventions are innovative, require zero-energy and are applied on a multi-unit scale. From 2002 the neighbourhood has been completely occupied with 82 houses, 17 apartments and 1,405 m² of workspace. In the first stage BedZED had typical inhabitants with normal behaviours regarding sustainability, but over the years they have been deeply influenced by the surroundings and have adapted themselves by raising their awareness and learning to cooperate.

\(^{19}\) For further information refer to the website smartgridcity.xcelenergy.com/
Figure 11. BedZED Principles

1. Zero Carbon
2. Zero Waste
3. Sustainable Transport
4. Local and Sustainable Materials
5. Local and Sustainable Food
6. Sustainable Water
7. Culture and Heritage
8. Natural Habitats and Wildlife
9. Equity and Fairtrade
10. Health and Happiness

BioRegional Solutions for Sustainability

Figure 12. BedZED

BioRegional Solutions for Sustainability

BedZED has a perspective that relies on the changes that design can bring.
“The holistic design works on three levels:

1. The design solves problems such as heating and water usage; roof gardens, sunlight, solar energy, reduction of energy consumption, and wastewater recycling. Using passive solar techniques, houses arranged in south facing terraces to maximize heat gain from the sun. Each terrace is backed by north facing offices, where minimal solar gain reduces the tendency to overheat and the need for energy-hungry air conditioning.

2. The design and services offered help people make sustainable choices such as walking rather than driving; a green transport plan promotes walking, cycling, and use of public transport. A car pool for residents has been established.

3. The community has created their own facilities and groups to improve quality of life and reduce their environmental impact; in terms of materials, BedZED is built from natural, recycled, or reclaimed materials. The Forest Stewardship Council (FSC) or comparable internationally recognized environmental organizations approves all the wood used.

   A centralized heat and power plant (CHP) provides hot water, which is distributed around the site via a district heating system of super-insulated pipes. If residents or workers require a heating boost, each home or office has a domestic hot water tank that doubles as a radiator. The Centralized Heat Power plant at BedZED is powered by off-cuts from tree surgery waste that would otherwise go to landfill. Construction materials were selected for their low-embodied energy and sourced within a 35-mile radius of the site when possible.” (Inhabitat)

BedZED is definitely a good example of a green community, and although it required an important initial investment it can be easily replicated without great efforts of external actors such as the government or investors.

1.3.4. Rivas Ecopolis, Spain

Rivas Vacia Madrid is a small city in the outskirts of Madrid, Spain. The aim is to turn the city into a sustainable living place. Rivas Ecopolis is an initiative from the city council; this enhances the viability of the project in terms of economic resources and regulatory framework.

The goal is to improve the awareness of the inhabitants and to promote energy savings, efficiency and renewable energy sources.
Rivas Ecopolis aims to partner and collaborate with neighbour regions to align their interests and create strategic sustainable solutions. Significant efforts are brought in order to achieve the crucial goal of being carbon neutral by 2030. Accordingly, the action plan is based in three principles: environmental sustainability, citizen involvement and governance.

Although Rivas has faced many challenges in its initial phase, it is now the benchmark for other small cities in Europe and mainly in Spain, therefore orienting the management and development urban strategies.  

1.4. Guidelines and Recognitions

LEED Certification (Voluntary rating system)

LEED (Leadership in Energy and Environmental Design) Certification is a standard for green buildings around the world. LEED is a non-for profit institution that certifies hospitals, buildings, stores, schools and houses. Besides serving as a quality stamp for houses insuring that houses are more efficient in terms of energy and water use, LEED certification also acts as a scorecard. This

20 More information can be found in www.rivasecopolis.org/
way, a quick and clear access to the information regarding the sustainability performance of a real estate property is provided. This scorecard is often compared to the nutritional facts label stamped in food products. Having a LEED certification is also an advantage when comparing, from a market-based perspective, a certified property with a conventional one.

One purpose of LEED is to generate savings in resources such as water and energy subsequently translated into economic value. Health is also an issue that LEED tries to tackle when integrating sustainability into the households. Moreover, it is expected that the use of green products improve the inhabitants’ quality of life while respecting the environment.

Due to the immaturity of the product and market, the information regarding market behaviour of the houses with LEED certification is not complete yet; but it has been highlighted that buildings have been sold faster than conventional buildings.

LEED assesses and tries to integrate all aspects of buildings or neighbourhoods that can lead to a sustainable property. In addition, LEED’s criteria consider the sustainability and location of the sites (no endangered animals or landscaping damage), other aspects such as the efficiency in the use of water, energy, electricity, materials and resources, indoor environmental quality and finally, the homeowners’ awareness and education.

LEED provides different levels of certification: silver, gold and platinum. Regardless of the level of certification of a house, the certification itself demonstrates a higher performance of the house in comparison with the rest of the conventional houses.

Like LEED Certification, there are other institutes that recognize the sustainability of buildings, but so far LEED has taken the leadership.

2. Local Context: An Overview of Sustainability in Mexico

2.1. General Context for Green Neighbourhoods

In Mexico, green neighbourhood initiatives have just newly appeared. For instance, in the district Delegación Venustiano Carranza, in the state of Michoacán, a recent project is being implemented.

This district has a population of 5,900 people, seven schools and other small businesses in an area of around 1.5 square kilometres. The plan includes different measures in households and
schools. The district was chosen due to the educational opportunity that it presented for the large number of teaching institutions in the area and also because of the positive response of the inhabitants towards a previous garbage segregation programme.

The main actions undertaken to green the district were: promoting green roofs in households and schools, the utilization of rain water, solar panels for energy generation and waste and recycling programmes. The project required a 20 million MXN pesos investment (1.8 million Euros). According to the projection given by the district’s administration, the annual electricity bill is expected to decrease by 3 million MXN pesos. Nonetheless, since the project is still in its young phase, the results of its application are not available yet for assessment. However, because the investment is moderated and supported by the public administration, the risk can be considered reasonable and the expectations are rather positive.

The interesting aspect of the project is that it started by the implementation of small-scale measures that have been broadened afterwards.

2.2. General Overview

Mexico is considered as a developing country. Its GDP is ranked number twelve and has the 11th largest population in the world. Mexico counts with a vast diversity of landscapes and climates. Being the 15th largest country in the planet, its landscape ranges from large coastlines to mountains, passing by deserts. Accordingly, this variety of climates makes it an ideal scenario for the development of sustainable projects.

Nowadays, like all the other countries in the world, Mexico faces important environmental issues; scarcity of hazardous waste disposal facilities, rural to urban migration, freshwater scarcity and pollution, deforestation and air pollution, among others.

During the current presidential period, Felipe Calderón -awarded Champion of the earth 2011 of the UN Program for his political leadership in sustainability- has pledged a shift towards environmental practices. Although the country has not yet ratified any treaty, many environmental international agreements have been signed and Mexico is taking many actions to become more sustainable.


21 The World Fact Book
The commitment to these agreements combined with the geographical and climate conditions create an interesting scenario and incentivize investors and entrepreneurs to start green projects. Both the environment and investors would obtain benefits from the implementation of these projects.

The President has developed a National Plan for Development. The goal of the plan is to place Mexico on the right track towards “Human Sustainable Development”. This last concept is described as an atmosphere where everyone can improve its capabilities and where opportunities can be expanded for present and future generations.

Around 50 years ago, Mexico was having a stable and high development rate. In the 70’s, the country was strongly affected by the worldwide oil and capital crisis. Nowadays, Mexico’s economy remains highly dependent on oil incomes. Although before 1982 the revenues generated by these products were substantial, they were inefficiently managed and failed to finance the infrastructure needed for the creation of an efficient framework for the country’s development. Due to this inefficiency in earlier years, Mexico accumulated a high public debt and since then, the country has not been able to completely recover from its vulnerability.

Because of the debt acquired, financial and economic structures became very weak. Consequently, the environmental sector performance was affected due to the lack of a long-term strategy for the exploitation of the natural resources. Materials were extracted with very little regulations. Water, forests, jungles and oil were carelessly exploited. Toxic and regular wastes were discarded in lakes and rivers and air pollution increased significantly because of the uncontrolled growth rate of the cities.

2.3. Sustainability Status

Mexico is very rich and diverse in terms of natural resources. It is considered the fourth wealthiest country according to its biological richness. However, this has unfortunately increased its dependency on the incomes generated by those commodities.
According to Yale University’s Environmental Performance Index, in 2008, Mexico was ranked at the 43rd place in the world with an overall score of 67.3 out of 100. This index measures many environmental factors and it is important to point out that Mexico in the general evaluation had the lowest scores in air pollution, biodiversity and habitat, 40 and 51 respectively.

Aware of the numerous damages made to the Mexican ecosystems, the government is now trying to correct the path with the “Human Sustainable Development” strategy to protect the resources and promote the country’s development. One of the measures of the strategy aims to integrate the participation of all different government sectors taking into account the economic constraints, productivity and competitiveness for economic and social development.

The “Human Sustainable Development” includes different topics with specific lines of action:

- **Water management**: Increase availability, decrease pollution to avoid negative impacts on the surrounding ecosystems and improve efficiency in the agricultural sector.
- **Forests and Jungles**: Avoid deforestation, fires and introduction of non-native species.
- **Biodiversity**: Stop destructive processes linked to the lack of alternative economic activities for the communities that rely on these commodities.
- **Management and environmental justice**: Improve the legislative framework to ensure the protection of the environment.
- **Ecological issues**: Decrease the ecosystems’ vulnerability caused by dependent groups whose economic and social activities rely on commodities generated by natural resources.
- **Climate change**: Reduce the volume of greenhouse gases released into the atmosphere by implementing an efficient transport system and improving technology in industrial, agricultural and farming practices.
- **Solid and hazardous wastes**: Improving planning and infrastructure for disposal that will also contribute to avoid current conflicts between internal governmental offices.
- **Scientific environmental research with social commitment, education and environmental culture**: Increase population’s environmental information and awareness to create a social commitment to protect resources.

2.4. Environmental Conditions

Graph 2. Carbon Intensity Comparison (2005)

The CO2 emissions records of the country are not very complete historically speaking. Although emissions per capita have not yet reached the levels of an industrialized country, the emissions are increasing at high-speed and due to the size of the Mexican population, 113,724,226 inhabitants (July 2011 est.)\(^2\), the impacts on the environment are of significant importance in comparison to other countries.

\(^{22}\) The World Fact Book
The Mexican territory benefits from a large range of climates, mostly dry and warm. This climate variety and the wide range of natural resources give it a high potential to apply sustainable solutions to improve the living standards.

Figure 6. Climate
2.2.1. Conventional Energy

In Mexico, the electricity grid covers 97% of the territory. The remaining 3% represents around 5 million people who have no access to electricity.\textsuperscript{23}

Graph 4. Electricity Availability

![Pie chart showing electricity availability](chart.png)

Anuario INEGI 2009

The country’s historical background has not allowed the development of sustainable sources of energies, despite the abundant resources available. There were no direct benefits of switching from fossil fuel-generated electricity to green energy and cleaner technologies. Indeed, policies were not thought strategically since the country was able to rely on an abundant source of fossil fuels. The lobbying of large energy companies also influences the legislative speed when adopting a more varied energy mix.

México is the 7th largest producer of oil in the world. In addition, 40% of the government’s revenues come from oil exports, including earnings and tax payments of PEMEX, one of the biggest petroleum companies in the world. The company remains publicly owned despite the existence of many debates on the issue.

\textsuperscript{23} INEGI 2009
Mexico is currently one of the three main suppliers of oil to the US. However, despite of the country's abundant oil resources, 60% of the petrol is imported. This can be explained by the lack of nationally based facilities to refine crude oil.

The second source of energy most consumed in the country is natural gas. Although Mexico has natural gas reserves, imports account for around 20% of the national consumption. The electricity production comes mostly from natural gas.

Coal, is the third source of energy after natural gas. Coal, Followed by nuclear (only one plant) energy only represent a small share in the unbalanced energy mix. The rest of the energy comes from renewable sources, notably hydro and biomass (in many small rural areas). Geothermal represents an insignificant proportion of the country’s energy consumption but in comparison, a significant share of the world geothermal power generation.

Graph 5. Energy Consumption in Mexico, by Type (2007)

EIA International Energy Statistics

A deeper analysis will be subsequently developed, analyzing the current status and potential of each type of renewable energy that could be implemented to supply the demands of the country.\(^{24}\)

\(^{24}\) The cited statistics regarding energy where extracted from U.S. EIA
2.2.2. Renewables

Renewable energy generation is currently being promoted in Mexico. The Global Environmental Facility, the United Nations Development Program UNDP and the World Bank have supported several initiatives that would be based on the use of renewables for the country’s development, lending important amounts of economic resources. Nonetheless, some constraints such as the little, non-reliable or sometimes inexistent information regarding the conditions of the potential sites constrain the implementation of renewable energy projects.

Mexico has set the goal to achieve 8% of its energy generation from renewable sources by 2012, excluding large hydroelectric plants. This pledge is already higher than expected, in comparison with other developing countries having similar characteristics as Mexico.

Figure 7. Strong Actors in Renewable Energies

The private sector has been little incentivized to invest in renewables for own use as a result of the strict framework that the national utility -Comisión Federal de Electricidad (CFE)- has instituted when allowing private generation of transmission, transformation and delivery of electricity. Until recently, the private production of energy was not allowed, except for own consumption. If alternative sources of energy are promoted, such as solar and wind, it is most likely for them to be provided as public service.
The senate has been working in this issue approving several instruments to change the legal framework regarding the private use of sources of electricity.

**Initiatives to promote Renewable Energies**

- **Initiative to modify the Income Tax Law**
  - Promotes renewables in the residential sector, fiscal credit of 30% of the investment in renewable energy electricity generation equipment.

- **Project of Special Law on Production and Services**
  - Special tax of 0.5% to electricity imports. Incomes will be redirected to promote renewable energies.

- **Initiative to Modify the Federal Rights Law**
  - “Polluter pays principle”—— Fossil fuels will pay a right based on their CO2 emissions. Incomes will be redirected to promote renewable energies.

- **Official Mexican Norms**
  - Requisites to be fulfilled by private sector regarding environmental protection and solar energy uses in different types of activities. (e.g. construction remodelling, industrial production)

- **Development of Policies**
  - Studies to be completed in partnership with the Inter-American Bank and GTZ (German Technical Cooperation). Based on the results, the Mexican policy on biofuels for transportation will be elaborated.

- **Fiscal incentives**
  - Renewable energy machinery and equipment can be 100% depreciated over a single exercise.

It is expected that the joint implementation of the previously mentioned initiatives and other instruments, will expand the diversification of sources of energy and be better distributed towards renewables.
A general overview of Mexico’s position on the different types of renewables will be provided more in detail in the following section.

GEOTHERMAL

Geothermal energy has two types of use in Mexico; electricity generation and thermal uses. Mexico has, "one of the largest geothermal power producing areas in the world" according the GENI Study of Renewables Potential in Latin America. It occupies the third place worldwide generating more than 6,500 GWh/year. The state of Baja California has over 650 megawatts of geothermal generation currently in place.

Los Angeles city bought in Dec 2008 and January 2009 75 MW. Los Angeles achieved its goal of consuming 20% energy of renewable resources thanks to this trade. Mexico also provides Guatemala and Belize with geothermal energy.
SOLAR

Mexico has a strong industry specialized in manufacturing photovoltaic cells, several applications of biomass and PV electricity in rural areas.

Solar energy is mostly used in rural areas with no access to the electricity grid; where it is mostly used for electrification, water pumping and refrigeration. Mexico, with an average insolation of 5 kWh/m², has one of the highest potentials in the world.

Southeast Mexico is subject to strong trade winds, formed by the difference in temperature of the Pacific and Atlantic oceans. The main areas where wind is used to generate electricity in Mexico are the south of the country (Oaxaca mainly), the state of Baja California and the east zone of Tamaulipas. The potential is estimated to be superior to 40,000MW. As a reference, Spain generates nowadays less than 12,000 MW of wind energy.

In 2005, an important project was launched by the CFE, forecasting that 588 MW would be installed by 2014. In addition, projects of private parties are expected to inject 950 MW into the National Electric System.
Figure 9. Solar Energy Geographic Potential

GENI Report of Potential of Renewable Energies in Latin America

The combination of solar and hydro energy has the capacity of generating 25% of the electricity of the national consumption and 15% of the total country’s generation.

HYDRO

Figure 10. Hydro Energy Geographic Potential Used

GENI Report of Potential of Renewable Energies in Latin America
The production capacity of electricity from water resources is very high. Today, the production of hydroelectricity has greatly increased compared to the growth rate registered for the last 30 to 40 years. Based on the statistics of 2005, the total hydro potential was 77% underused. The CFE estimates that the hydro potential could reach the generation of 42,000 MW of hydro combined cycles, at a mini and large scale.\textsuperscript{25}

**Graph 8. Technically Exploitable Hydro Power Potential Currently Not in Use**

![Graph showing technically exploitable hydro power potential currently not in use.](image)

SENER Secretaría de Energía Mexico

**BIOENERGY**

Although the share of biomass consumed in the country is not really representative, its usage has been lately rising. The two most important types of materials used to produce energy through biomass are sugar cane bagasse and wood chips, mainly used for electricity, heat and cooking. Mexico also annually produces around 45 million litters of bioethanol destined to the chemical industry. The potential for generating bioenergy is rather large since a proportion of Mexico’s agricultural land could be used for the farming of crops to produce bioethanol and biodiesel.

Different projects are in place; the World Bank has notably financially supported some of them.

\textsuperscript{25} GENI Report of Potential of Renewable Energies in Latin America
WAVE AND TIDAL

Wave and tidal energy could also be developed in zones close to coastlines. Little information is available regarding its real potential in Mexico, but since the country is surrounded by sea the application would be easily implemented.

2.2.3 Biodiversity

Figure 11. Comparison of the Ecosystems Status

 According to the SEMARNAT, around 30% of the ecosystems in the Mexican territory have suffered severe damages. The trend indicates that by 2023, the majority of the departments will have among their ecosystems at least one classified with a critical status.

2.2.4. Waste and Recycling

Mexico’s population generated 38,325 tons of waste according to the 2009 records of the National Institute of Statistics and Geography (INEGI). From 1995 to 2009, the total waste generation has risen by 25%. Only 5% of the inorganic waste was recycled in 2005, it reached 7.5% in 2009.
The waste generated in the country is conveyed to different spaces for disposal or recycling, as detailed in the next chart.

Graph 9. Waste Generation

Graph 10. Waste Disposal
In the previous years, Mexico did not have a defined structure for waste segregation. In the end of 2008, an official law came into force in order to tackle this issue. Starting from October 2008, the city councils were given six months to completely comply with the new law. The aim was to pressure the municipalities so that they would implement an effective separation strategy and therefore would reduce the negative environmental impact.

Citizens are now asked to classify organic, inorganic and sanitary wastes and place them in different plastic bags. The municipalities were then made responsible for the waste recollection program preventing the mixing of recyclable wastes on garbage landfills. Organic waste should be transformed into compost and the emitted biogas, collected. Penalties due to failure of compliance with the new regulation are still to be clearly established to reduce the ineffectiveness of the waste management.

In Zapopan, 1500 tons of waste is produced daily. Only 80 districts out of 600 separate up to 75% of their wastes. As a result, only 20 tons (1.3% of the total daily waste) come already classified when getting to the garbage landfill.

Due to lack of compliance and inefficiency, 750 tons of organic wastes are not treated and reused as fertilizer. The administration of the municipality buys poultry manure for gardening purpose. This purchase demonstrates, not only the inefficiency of the waste treatment capacity but also the corruption factors involved. Around 390,000 Euros are annually spent to buy fertilizer (although some competitive suppliers could offer the same amount for 205,000 Euros). These expenditures could be saved and used to finance recycling or separation expenses that would really improve the managing waste system.26

An awareness program is in place to promote waste separation and recycling in the households. The program includes individual household visits that aim to raise awareness within the families. Supplementary equipment for picking up separated waste is available but unless the proportion of districts that segregate their waste increases the government refuses to distribute them.

2.2.5. Water

Given the localisation of the country and climates, many issues emerged from water resources management in Mexico. As a result of climate change, problematic variations in the hydrological cycles are expected:

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26 MURAL Newspaper article.
• Intensification (important increase of storms and longer droughts) of the hydrological cycle with an.
• High risk of flooding in coastal areas of the Mexican Gulf.
• Northern Mexico is expected to become warmer, causing temporary declines in precipitation (a decrease of around 15% in the centre of the territory and 5% in the Gulf region)
• The rise of temperatures and the corresponding evaporation of water will be accentuated, diminishing the humidity of the soils and the infiltration from 10-20% (mainly in northern areas).

Mexico counts with 37 hydrologic regions. The aquifers (653 in 2004) run all along the territory and there is a diverse variety between subterranean and exterior water reserves.

Figure 12. Aquifers in Mexico

SEMARNAT Geographical Atlas

Regarding the precipitation, the overall volume of rainfall is quite large over a yearly period. However, around 68% of the precipitation is mostly concentrated in only 4 months of the year (June to September). Therefore it is difficult to rely on rainwater resources through the year without considering on the hydrological regions. Each year, the rainfall reaches 1,489 thousands of millions
of m³, from which 73.2% is evaporated, 22.1% goes to rivers and lakes and the rest (4.7%) is filtered into the ground.

Graph 11. Average Precipitation rates in Mexico


SEMARNAT Atlas Geográfico

WATER USE

Representing 77% of the total national consumption, the agricultural sector is the main consumer of the country’s water resources. Hence, the creation of a specific program to achieve a sustainable use of water resources improving the efficiency of the water transportation as well as of the water use in the agricultural sector. The industry and personal use account for 14% of the total national water consumption exempting some industries that have their own water supply systems in place accounting for 4%.
Graph 12. Water usage in Mexico

![Distribution of water use in Mexico](image)

SEMARNAT Atlas Digital del Agua CONAGUA

**AVAILABILITY**

In 2008, the coverage of drinkable water was of 90.3% (78.4% in 1990). The target is to achieve a 92% for year 2012, from which 96% is expected in urban areas and 78% in rural ones.

Graph 13. Water Availability and Drainage

![Drainage availability in Households](image)

Anuario INEGI 2009
Graph 14. Water Availability Per Capita

Based on a goal set in 1990, the number of people with no access to drinkable water would be decreased by 50%. In 2007 this goal had already been reached and even overpassed by 11%.

Drainage system still remains a challenge. Although this service covers 88% of the country, there are still 14 million people that do not have a drainage system in their house. In 2009, only 40.6% of the water from sewage was treated. The goal for 2010 was to reach 48.5%, but the information available is insufficient to determine whether it has been achieved.

2.2.6. Transport

It is accounted that around 78% of the population working in the suburbs of Mexico generate 95% of the Gross Domestic Product, hence the importance of the transport facilities in this areas.

The annual growth rate of the vehicle fleet (7.45%) is impressive in comparison with the growth rate of the population (2%) and GDP of (4%). In the cities, the calculations show that 20% to 35% of the population use their private vehicles as their means transportation.

The lack of a suitable quality service and proper management is the major problem of the Mexican public transport. This public service is managed by the private sector complying with a very lax regulatory framework that does not incentivize efficiency and competitiveness. The busy road
traffic in the cities causes a high energetic consumption, environmental damages and important economic losses related with the wasted time in traffic jams. The main cities where the road system is collapsing are Mexico City, Monterrey, Guadalajara and Leon.

Only a few cities in Mexico count with a subway network. The installation of such a transportation system would greatly support the urban planning of the cities. In Guadalajara, many NGOs try to pressure the government publishing public opinion surveys and economic research about the benefits of developing a subway. Although some initiatives have been undertaken to improve the public transport system, no real actions have been notably successful yet.

The public administration should urgently start planning alternative transportation solutions to private vehicles. This would improve the quality of life while reducing the GHGs emissions.

2.2.7. Behaviour towards Sustainability

There is little information or possible explanations allowing the understanding of the lack of awareness and interest from the Latin American population regarding climate change issues. Some hypothesis can be exposed, as potential enlightenments:

Ensuring the sustainable management of the natural resources in developing countries is extremely relevant. In fact, putting these resources at risk could impact on the economic progress of the countries.
2.3. General financial system and economy

2.3.1. Mexican Economy

This part aims to bring an overall view of the financial and economic features in Mexican, addresses the economic system of the Green sphere project. This is an aspect that deserves high focus given the general state of the global economy nowadays. Indeed, Mexico did not escape the worldwide financial crisis and public budgets have been reviewed to tackle the financial system’s shortcomings. This can have a direct impact on projects, such as the sustainably oriented ones since a short-term approach may be prioritized. Nonetheless, the Mexican government pledged, last January 2011, at the Davos Summit to promote a green economic growth.27

According to Alejandro Garduño, advisor to the Mexican Ministry of Treasury, the development of the green economy in Mexico is confronted with two main problems: the shortage of resources from the public sector earmarked for the financing of green projects and the lack of interest from the banking sector in this type of investments. Although these facts reduce to a great extent the development of green projects, a number of specialized funds, real estate companies and other construction companies are engaging in providing green mortgages to households.28

Besides these previously mentioned limitations, other economic variables interfere in the volatile housing market. Indeed, among other factors, the mortgage crisis affecting Mexico’s economy has largely participated to the increase of living costs. According the CIA World Factbook, the inflation rate (consumer prices) increased by an average of 17.65% in 2008 (compared to the previous year’s consumer prices) and 27.50% in 2009 before stabilizing at 3.60% in 2010.29 In 2008, centre of the financial crisis, the Central Bank of Mexico raised three times the interest rates in order to curb inflation.

The Mexican Federal government, implementing restrictive monetary policies, raised its benchmark-lending rate. In order to help the economy recover, the Mexican Central Bank maintains the overnight interbank interest rate at a six-year low level of 4.5%. Accompanying this decision, Governor Agustin Carstens mentions “recent data suggests a moderate deceleration in the pace of growth in aggregate demand”.30

Mexico’s gross domestic product plummeted by 6.5% in 2009 due to the global downturn but is now recovering with a 5.5% growth in 2010. Moreover, the domestic demand is increasingly boosted

27 Presidencia de la Republica
28 El Economista
29 CIA- World Fact Book
30 Bloomberg BusinessWeek
by an improved consumer confidence and accordingly an expected consumer credit growth. Combined with a sky rocketing increase of the demand for housing, the mortgage market is experiencing a significant growth.

2.3.2. Mexican economy, Mexican financial system and housing market

In Mexico, the financial regulation is steered by the Ministry of Finance and Public Credit (SHCP) and the Finance Ministry, the highest authority managing the structure (issuing regulations and licences) of the Mexican financial system. The Central Bank of Mexico (BANXICO) is an independent body regulating the operational functioning of the monetary policies.

As for the inspection of the financial system, this task is ensured by other entities themselves controlled by the Ministry of Finance and Public Credit. Namely, these agencies are:

- The National Stock and Banking Commission (CNBV), in charge of the supervision and regulation of the financial institutions (banks, financial and securities institutions).  
- The National Insurance and Deposit Commission (CNSF), which supervises the insurance companies and trust companies.  
- The National Retirement Saving System Commission (CONSAR) that handles the retirement savings funds.

More particularly, the housing finance market gathers several institutions providing mortgage loans to homebuyers:

- Funds for housing for private sector and state workers:

  The two main financial institutions providing funds to dwellers are the INFONAVIT and FOVISSSTE. These two bodies will be further detailed in section 2. Besides; the low-income communities can also have recourse to microfinance institutions.

- Commercial banks:

  The main players accounting for 45% of the entire banking sector are BBVA Bancomer (a subsidiary of BBVA) and Banamex (subsidiary of Citigroup). Santander Serfin (managed by Banco Santander Central Hispano) and HSBC Mexico respectively comprise 16% and 10% of the total assets.
Although foreign banking group are dominating the market, the two major national banks, Banorte and Inbursa, yet account for 8% and 4% of the market shares.\textsuperscript{35}

This market appears as significantly competitive for the important foreign groups as well as for the smallest players given the relatively high intrinsic variability of the sector.

The commercial bank lending rate, this is to say the annual average interest rate charged by commercial bank on new loans was of 7.56% in 2009 and 8.71% in 2010.\textsuperscript{36} According to the data disclosed by BANXICO, despite of the financial downturn, the Mexican financial system has shown a certain robustness and fast recovery. This is proved by the monthly growth of loans provided from commercial banks and development banks becoming positive starting from the second trimester of 2010.\textsuperscript{37}

- Non-depository financial institutions:

Non-depository financial institutions or SOFOLES (Sociedades Financieras de Objeto Limitado) are financial intermediaries that have been implemented in Mexico since the early 1990s. These institutions receive a licence from the government in order to provide loans to specific sectors or activities (housing, consumers and small and medium enterprises).\textsuperscript{38}

The SOFOLES mostly target low-income segments and receive their funding from the Housing Banking Operation and Financing Fund FOVI. Other sources of funding are the Federal Mortgage Society (SHF) or the issue of commercial papers. Some SOFOLES currently operating are, for instance, GMAC Mexicana, Hipotecaria Crédito y Casa, Consupago, Corporación Hipotecaria and others.\textsuperscript{39}

2.3.3. Housing strategy for sustainable urban development

The access to private property has undergone significant changes as a result of the recent macroeconomic context and the evolution of the legal framework in the country, where the demographic pressure requires efficient and quick adjustments. Indeed, the Mexican Economy’s performances and the development of financing systems have more and more now taken into consideration today’s pressing issues, notably regarding climate change.

\textsuperscript{35} US Commercial Service  
\textsuperscript{36} CIA World Factbook  
\textsuperscript{37} Secretaria de la Hacienda y Crédito Publico  
\textsuperscript{38} Harvard University
The government has created a National plan to foster housing programs within the country, enabling the Mexican families to access housing according to their needs and possibilities. The Federal body in charge of this program, the National Housing Commission, also called CONAVI; is a decentralized agency responsible for coordinating the housing advocacy role and the goals set in the National Housing Programme 2007-2012: Towards a sustainable housing development. 40

The main goals of this programme include running a common platform with public, private and social actors that manages housing, land and urban planning, in order to issue an official Mexican standard integrating technical assistance and simplified procedures across the country.

From early 2011, a special focus has been reinforced towards sustainable development. Indeed, Public Institutions have pledged to assign the major part of their resources to the development of energy efficient housing and have initiated financing of sustainable urban projects via the implementation of the Integrated Sustainable Urban Development Project (DUIS). 41

2.4. Financing applied to the Green Sphere project

2.4.1. Public Financing

Considering the public funding in more detail, the financing of the Government’s projects is mostly carried out by the Institute of National Funds for Workers Housing INFONAVIT, whose financing scheme represents more than half of the total house financing. The second major source is the Fund of Housing of the Institute of Security and Social Services of State Workers FOVISSSTE. 42

The specificities of the loans provided by INFONAVIT and FOVISSSTE are that they are indexed to the minimum wage. They also propose more favourable interest rates than the rest of the financing institutions. In addition, they offer the option to consolidate the loans with the participation of the spouse.

INFONAVIT

INFONAVIT provides a large range of credits tailored according to the allocation of the credit and the personal details of the beneficiary (revenue). The characteristics and conditions of the credit can also vary whether the beneficiary aims to purchase a new or existing house, to improve

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40 Fundación Centro de Identificación y Documentación de la Casa
41 Inter-American Development Bank
42 Secretaria de la Hacienda y de Crédito publico
or repair a house. Moreover, some credits are allocated in joint collaboration with other banking partners such as the FOVISSSTE or the Financing Institutions of Limited Liability SOFOLES.

- INFONAVIT points

Although loans proposed by the INFONAVIT are more accessible than the conventional ones (tougher requirements from the commercial banks), applying for an IFONAVIT loans still requires the applicant to fulfil various criteria. In fact, the INFONAVIT has established a system of credits. In order to obtain a loan, applicants must reach the score of at least 116 points.43

The criteria taken into account are the age, the salary, a current job position, the savings accumulated in the Housing account and at least a consecutive one-year of contribution. Other criteria can directly prevent the candidate from obtaining an IFONAVIT loan. This would be the case if the candidate is retired or pensioned, if the worker already has endorsed a loan.

Subsequent are the criteria44 used by INFONAVIT in order to determine the score reached by each applicant:

- Age and salary: This first criterion is based on the candidates’ age and the integrated daily wage, this is to say, the benefits are included in accordance with the Law of IMSS (the employer allots his employee’s housing sub-account and retirement account with 5% of the employee’s salary, each day).
- Work history: The points add up according to the last bimonthly of continuous work. For instance, 6 to 9 bimonthly contributions generate 34 points, 10 to 11 bimonthly, 39 points and when the bimonthly worked exceed 12, the score reaches the maximum of 55 points.
- Stability in the current job: For every two months of continuous work in the current position, 6 or more bimonthly generates 8 points.

In addition, the savings accumulated in the Housing Sub-account also adds points, so that the cumulative amount of contribution can generate from 17 to 40 points, depending on the applicant’s balance and current income. In addition, if the applicant has put aside voluntary savings, this also increases the scored points. Each month, the amount of the salary voluntarily saved can either reduce the amount of credit or increase the applicant’s score.

- Documents required for a mortgage loan application:45

43 INFONAVIT
44 INFONAVIT
45 Credi Asesoría
Legal documents:

- Certified copies of birth certificate of the applicant and, where applicable, of marriage
- Copies of title (deeds) of the property to be acquired, with data from public registration of ownership
- Copies of the last three real estate tax receipt and water properly paid
- Copy of the promise of sale of property acquired, held between the applicant and property owner
- Valuation of the property, usually no older than three months

Employment records:

- Original and copy of a letter from the employer attesting the current position of the candidate, the salary and benefits as well as the name, title and telephone number of the person signing the letter
- Original and copies of payrolls
- Original and copies of annual income tax return
- Original and copies of the investment portfolio (if any)

Technical Documentation:

- Copy of architectural plans
- Photo of the facade of the acquired property

- Loans requirements process:

1. Consultation of the candidate’s score (see above mentioned criteria).
2. Gather personal documents and the documents related to the house or apartment in which the candidate wants to apply the credit.
3. It is important that the documentation (above mentioned) is complete and correct.
4. Deliver personal and house documents in the nearest office INFONAVIT. Once received, INFONAVIT will analyse the candidate’s application and if approved, a proof of authorization of credit will be delivered.
5. Voluntarily adding extra-savings, the applicant can now decide to increase his points and/or reduce the amount of the loan. After reviewing the documents, if the candidate chooses to add his voluntary savings, INFONAVIT will deliver a receipt that can be deposited in the bank.

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46 Credi Asesoría
6. Subsequent to the analysis of the documentation, if fully and correctly fulfilled, INFONAVIT starts the loan freeing procedures. Meanwhile, the beneficiary will be given a notification with the repayment schedule, which will have to be stamped by the employer.

7. Once stamped by the employer, the notice shall be resent to INFONAVIT.

8. When the title deed of the house is signed, INFONAVIT gives to the seller the amount of the credit, the balance of the housing sub-account (if any), and the possible voluntary savings.

9. Deducting the agreed amount from the beneficiary’s pay will do the repayment of the credit.

- INFONAVIT’s Green Mortgage - Hipoteca verde:47

In line with a project such as the greening of a neighbourhood, among the different types of credits proposed by INFONAVIT, the most adapted for the households of the neighbourhood looking for financing would be a green mortgage. Fortunately, since February 2011, INFONAVIT has launched a New Scheme for Green Housing that now applies for, not only the purchase of new homes but also for used houses, remodelling, expansion, and construction in the beneficiary’s own land.

This loan is proposed to households interested in buying an ecological house or performing changes allowing savings from the implementation of eco-technologies. Those technologies help reduce the energy, water and gas consumption, therefore contributing to the efficient and rational use of local natural resources. These particularities attribute considerable added value to these green houses compare to mere conventional houses.

According to the criteria set by the IFONAVIT - Hipoteca Verde, the applicant must obviously be affiliated, meet the required minimum score of 166 points and be free of any previous INFONAVIT pending debt. Until February 2011, a green mortgage would not be allocated for a house which value exceeds $611,374.40 pesos. From now on there are no limitations for the beneficiaries. This change is particularly relevant for the project financing as all of the houses of the condominium exceed 2,5 million pesos. In addition, houses must prove their eco-efficiency by the presence of appliances generating a certain number of savings.

Indeed, the house’s equipment must be approved by experts of the National Institute for Ecology INE, the National Water Commission CONAGUA, the Trust Fund for Electric Energy Saving FIDE and the National Commission for Energy Saving CONAE.

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47 INFONAVIT
In the previous scheme, an already selected list of eco-technologies was pre-determined. From 2011, the eco-technologies are selected according to the saving necessities (see table below). For instance, if the revenue of the applicant is seven to eleven times the minimum wage (in 2011, the minimum wage range between $56,70 and $59,82 a day (2011) depending on the geographical area)\textsuperscript{48}, this is to say ranging between $12,729.70 and $20,003.80 a month, the savings generated by the instalment of eco-technologies must reach at least $290 a month. Besides, in this case, the amount of credits voluntarily added from extra-savings cannot exceed $27,277.92 (fifteen times the minimum wage).

Table 2: Minimum savings required according to the beneficiary’s monthly revenue

<table>
<thead>
<tr>
<th>Times Minimum wage (TMW)</th>
<th>From</th>
<th>To</th>
<th>Minimum monthly savings required</th>
<th>Maximum amount of additional credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 6,99</td>
<td>$1,818.53</td>
<td>$12,729.69</td>
<td>$215.00</td>
<td>10 TMW</td>
</tr>
<tr>
<td>7 to 11</td>
<td>$12,729.70</td>
<td>$20,003.80</td>
<td>$290.00</td>
<td>15 TMW</td>
</tr>
<tr>
<td>&lt; 11</td>
<td>$20,003.81</td>
<td>&gt;</td>
<td>$400.00</td>
<td>20 TMW</td>
</tr>
</tbody>
</table>

Hipoteca Verde

In order to meet the required amount of savings, INFONAVIT - Hipoteca Verde offers in its website a simulator\textsuperscript{49} calculating the savings generated according to the type of eco-technology chosen. A list\textsuperscript{50} of eco-technologies possibly installed is also available:

**In the power area:**

- Energy saving light bulbs (compact fluorescent lamps).
- Electric current static stabilizer.
- High efficiency or low consumption 1 or 1.5 tons air conditioning.
- High efficiency refrigerator (the INFONAVIT does not finance the purchase).
- Roof thermal isolation
- Wall thermal isolation.

\textsuperscript{48} Servicio de Administración Tributaria
\textsuperscript{49} Hipoteca Verde - INFONAVIT
\textsuperscript{50} Hipoteca Verde - INFONAVIT
- Roof thermal isolation and reflective covers as roof finishing.
- Thermal isolation in wall and reflective cover as wall finishing.
- Reflective cover as roof finishing.
- Reflective cover as wall finishing.

In the gas area:

- Water sun heater with secondary fast recovery heater.
- Water sun heater with pipes and with secondary fast recovery heater.
- Water heater (fast recovery or instantaneous).

In the water area:

- 6 litres toilet.
- Ecological 5 litres toilet.
- Ecological shower with integrated water saving device.
- Faucets valves) with water saving device in washstands.
- Faucets (valves) with water saving device in the kitchen.
- Regulating valve for water flow in pipelines.

In the health area

- Water purifying filters with two spare parts included.
- Drinking water supply

FOVISSSTE

The FOVISSSTE\textsuperscript{51}, founded in 1972, is the agency responsible for granting loans for housing for workers in the State Service.

The Housing Fund is a decentralized body of the Institute of Security and Social Services for State Workers (ISSSTE). Its function is to administer the contributions of public agencies and entities affiliated to the ISSSTE. The credits granted are directed to the purchase, repair, extension or improvement of housing.

The maximum amount granted is $706,426.28, to which can be added the balance of the housing sub-account. The maximum term possibly granted is 30 years. The repayment fees will be directly subtracted from the beneficiary’s salary up to 30%. The interest rates vary according to the

\textsuperscript{51} FOVISSSTE
applicant’s base salary (used by the employer to calculate the amount of contribution), as described in the following chart.

**FOVISSSTE - INFONAVIT: Marital programme**

The conjugal program INFONAVIT-FOVISSSTE is a mortgage credit program launched by the two federal bodies for their respective beneficiaries. Thanks to this union, a couple can endorse a loan on the condition that one spouse is registered with the FOVISSSTE and the other with the INFONAVIT.

This loan only applies to spouses. In fact, applicants will have to prove their marital status. The loan must be used in order to purchase a new or already built home owned jointly. Each agency will determine the maximum amount allotted according to each institution’s own policies. This maximum amount could reach $1,135,409.00.

The interest rate applied by the FOVISSSTE varies from 4% to 6% and from 4% to 10% for the INFONAVIT.

None of the two institutions apply penalties for anticipate payment.

Applicants must comply with the criteria required by the lending agency in which each spouse contributes. Subsequent is the list of requirement for each agency:

**FOVISSSTE requirements:**

- The candidate must be married with an INFONAVIT eligible partner
- Working in public sector (justified by at least one pay slip)
- Having contributed 18 months or more
- No prior credit
- Application form fulfilled and signed in no uncertain terms.

**INFONAVIT Requirements:**

- Married to a FOVISSSTE beneficiary
- No previous received credit
- Complying with the score set by the INFONAVIT
- Application form fulfilled and signed in no uncertain terms.

**Documentation for the registration application (original and copy):**
2.4.2. Private Financing

A large number of banks offer like, for instance, the Bajio bank offers different types of credits mortgage\(^{53}\) (purchase of land, house and in order to tailor the best as possible the needs of the beneficiaries.

The bank requires the applicant to fulfil different criteria in order to obtain the credit. The documents that the client should provide are:

- Credit application requirements and signature in all sections
- Original and copy of current official identification (professional license or passport or immigration form with a valid passport from the country of origin)

**Proof of income:**
- Payroll original slip and copy (of the past 3 months)
- Original: name, position, benefits) with no older than 45 days
- Copy of current registration form at the INFONAVIT or FOVISSSTE

The total annual cost of the loan would reach for the beneficiary 13,7% with fix interest rate. The interest rate varies depending on the allocation of the loan. For the purchase and/or refurbishment of a house, the interest rate reaches 12,5% and 15,25% for the purchase of a plot of land.

2.4.3. Public - Private Partnerships

In 2006, Mexico implemented a new model of Private Public Partnership tailored after the UK’s private finance initiative. Since then alliances between private banks and official bodies have resulted in the development of different types of financial products for households.

For instance, Santander and INFONAVIT propose loans for the acquisition of a new or already built house. The term of the loan can be extended up to 15 years and the funding can be in pesos up to 65%.

\(^{53}\) BanBajio
This loan targets the INFONAVIT’s contributors having, at least contributed during 18 bimonthly. Besides, the applicant must be currently employed and be free of any previous pending credit.

This type of loan presents many advantages for the beneficiary because the amount of the loan is significantly decreased by the contributions put aside by the employer, the amortization of the credit is faster and the interest rate lower. Moreover, if the beneficiary is made redundant, the monthly pay back is levied on the sub-housing account. This way, it does not directly affects the personal finances of the beneficiary. The interest rate of the loans also presents the advantage of being fixed. The monthly payment are also fixed in advance and do not vary along the agreed term of the credit. The requirements to obtain this loan are that the property must have a maximum commercial value of $495,000 and be located in an urban area. As for the applicant, a proof of fix address must be provided as well as a minimum income of $13,500.00 a month and a positive credit history.54

Table 3: Financing Comparison

<table>
<thead>
<tr>
<th>Sector</th>
<th>Public financing</th>
<th>Private financing</th>
<th>Public-Private Partnerships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Each household can apply for a loan or a mortgage provided that the candidate is a beneficiary from the institution. The criteria of eligibility vary depending on the agency and applicant’s characteristics.</td>
<td>Banks are offering to households a large variety of loans and mortgages depending on the final use.</td>
<td>Available in Mexico since 2006, these alliances allow the beneficiary of the loans to combine the advantages of private banks and official bodies.</td>
</tr>
<tr>
<td>Financing entities in Mexico</td>
<td>• FOVISSSTE: only for State-workers • INFONAVIT: employees of which employer is contributing to the institution</td>
<td>Commercial banks: • BBVA Bancomer • Banamex • Santander Serfin • HSBC Mexico • Banorte • Inbursa • Banco Bajio</td>
<td>• INFONAVIT-Santander • INFONAVIT- BBVA Bancomer</td>
</tr>
</tbody>
</table>

3. A Greening Project for Valle Real

Today, urban areas are booming and thus need, more than ever a complete shift adopting sustainable and eco-friendly practices. Inhabitants, the key actors, must therefore be placed at the

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54 Santander
centre of this transformation. Greening a neighbourhood also requires a complete analysis of key variables, location, and land specificities... Obviously, this conversion will not be achieved overnight but step-by-step. This process, encompassing various actors and a plethora of possible actions can appear as complex, hence the idea of creating a roadmap for neighbourhoods willing to go green.

Valle Real is a high-income private condominium, which is eager to initiate a greening process. This condominium will be a pilot project, the flagship for sustainable neighbourhoods. Using the toolkit for green neighbourhoods, Valle Real’s inhabitants will be provided with a concrete set of proposals for interventions that they can simply apply themselves or with the assistance of recommended professionals. Given the lack of data regarding the operative system and the inhabitants’ consumption related information, certain interventions do not go further into detail and therefore will have to be developed in joint collaboration with a team of experts.

Accordingly, this part will describe the prescribed interventions for Valle Real. First of all, the interventions will be divided by sector of action: citizen culture, energy, waste, water, urban landscaping, transportation, and finally building. Then, each intervention will be detailed taking into account to the local conditions and the particularities of the condominium.

Description of Valle Real:

Valle Real is located in the municipality of Zapopan, in suburban areas of Guadalajara, the second largest metropolitan area in Mexico. Valle Real was built in 1987 to be a residential area for medium-high income society.

When starting, the project received the support from the local Government. A larger area in front of the houses was granted by the state, this is the reason why there is no construction but only long garages in front of each parcel. This land extension gives an impression of very spacious areas.

Back in the construction phase, the surrounding area of Valle Real was mostly empty. The nearby land were by empty lots, a starting highly prestigious private university and some medium size factories that had gone to the outskirts of the city to lower their costs given the cheap price of
the land. The high investment of Valle Real and the university influenced the progress in the area. Today many urban developments, industrial parks, small businesses and even a museum have established in the area.

The public lighting with external wiring is visible proof of the original expectations of the residential that were focused on a medium income household buyer. The condominium had much more success than originally thought. Many high-income families started to move to this model of residential areas to have greener spaces and higher security than when living closer to the city centre. Nowadays, the lots and houses in Valle Real have one of the highest added value investments in the city. Many factors contributed to make of Valle Real a symbol of prestige revealing the high acquisitive power of its residents.

The extension of the development is of 200 hectares, from which 17 are green areas. Valle Real has a capacity of 2400 houses (360m² each in average) from which 1850 are already built and 162 are currently under construction. The number of inhabitants of the condominium is around 9250, considering that an average family is composed of 5 members. Within the development there is a Church, a cultural centre and a country club that is managed independently from the condominium in which the people has the choice to become a member without being mandatory.

Accessible green areas and recreational parks surround the blocks and houses. Within the urban development different sub-divisions can be considered as small condominiums; some of them even have a supplementary security service at their entrance. The physical environment also varies; different landscapes, house sizes and construction styles. The main street integrates all the small divisions, which also communicate with the three entrances of Valle Real.

The median of the main street is wide for the residents to walk or exercise, and in the last year a cork runway was built for runners. This street is a long-term concession from the local government and there have been some requests from neighbouring communities and companies to open the main street for public access to cut distances and avoid traffic jams when moving around the zone.

Due to the long distances that need to be travelled to get to the city Centre, residents of Valle Real completely depend on the use of their private vehicle. The speed limit inside the condominium is 40 km/hr. The Internal security moves within Valle Real in trucks, cars and electric golf cars.

The management of the residential is handled by an internal council formed by some residents of the condominium and external people as staff. The services that in a public neighbourhood are commonly provided by the government such as public lighting, streets cleaning,
gardens irrigation and waste collection are completely managed by the residential administration as if they were autonomous.

Green areas are irrigated with grey water (supplied by the local water company) treated in an internal water plant. The rest of the water used by individual households goes in to the municipal system and is managed normally.

Internal trucks recollect the garbage. In 2008, after the waste separation law came into effect serious efforts were done to comply. Nevertheless, when the trucks of Valle Real emptied the content on the municipality landfills, all the waste came into the same place. Some households still segregate their waste but the management has lower their exigency of waste management compliance due to the futility of the condominium’s efforts in front of the municipality.

The average expenses of the condominium are as follow:

<table>
<thead>
<tr>
<th>Monthly maintenance expenses</th>
<th>3,300.00€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year fuel expenses (transport equipment)</td>
<td>150,000.00€</td>
</tr>
</tbody>
</table>

In the past months a natural gas turbine was purchased to supply the condominium’s electricity demand. The main incentive was that the initial investment would be recovered in one year, due to the easy access to natural gas, which was installed in the area because of nearby Coca-Cola production facilities.

The interest of the board and inhabitants of Valle Real in adopting sustainable practices have risen. Awareness and incentives associated with recent environmental federal and local policies are likely to be the main reasons.

3.1. Citizen Culture

Description:

The aim of the Sustainable Development paradigm is to balance the ecological, economic and social aspects. This requires not only planning and technology, but also a different organizational framework. Citizen culture is presented as one of the seven areas of work to reach a “Green Neighbourhood”, but it could be considered the most important of all and where every greening effort should begin. A new mind set and attitude has to be adopted by every individual, one that focuses on every aspect of sustainability configuring a new culture for living in community.
This cannot be achieved if people are not included and committed. Engaging the local community and the key stakeholders as well as strong leadership from the managing board of the residential will enable the support required for the decision-making process.

**Purpose:**

It is common for the people involved in a greening project to have different and many times conflicting expectations and priorities. This why, the social aspects have to be considered to develop a holistic and integrative strategy for urbanisation. It has to include all the technical and organisational aspects that will allow for the transition to be achieved in the smoothest and most successful way. Architecture, urban agriculture, economic cooperatives, transfer of knowhow and technology, habits and behaviour, are basic elements to develop this citizen culture.

**Objective:**

To consolidate a citizen culture in Valle Real that supports sustainable development.

**Expected outcomes:**

- The community understands their issues and has uncovered the potential opportunities to integrate into the project.
- Environmental awareness has increased within the community, regarding the importance of the project and the benefits associated.
- Citizens’ skills and capabilities have been strengthened to ensure that they participate and adopt sustainable livelihoods.
- Local government has been engaged to develop initiatives that go beyond Valle Real’s boundaries, integrating the surrounding area.

**The process:**

The process to develop a sustainable citizen culture has to start before the greening project. A professional to ensure the success should guide this process involving the eight stages included in the GreenSphere framework.

**Lines of action:**

Within this process there are three basic lines of action recommended for Valle Real, which will be further developed into specific activities. In the design phase of the engagement process, these lines of action and activities can be changed or new ones added; according to the findings and results of the exploration and identification stages.
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GreenSphere Project

- **Awareness:**
  Ensure stakeholders’ understanding of the project and their role to promote the new civic behaviour required to increase levels of wellbeing.

- **Participation**
  Facilitate the stakeholders’ involvement in dialogue and deliberation practices associated to the project to enable them to tackle problems of public concern and find solutions.

- **Training**
  Develop citizens’ skills and capabilities to promote proper use of new technology and good environmental practices.

**Activities:**

- In the introduction phase host a public assembly and invite the community to openly discuss the project. Make sure that the majority of the inhabitants of Valle Real support and commit to the project.

- Appoint an “environmental coordinator” and a supporting team to communicate, coordinate and monitor all environmental and social initiatives within the community.

- Create a code of conduct or guide for sustainable culture. Develop positive and/or negative incentives to ensure the positive results of the policies and interventions implemented. Include the measures that will be taken to compensate the participants for their effort and expenses.

- Create an awareness campaign addressed to the local community and external stakeholders of Valle Real, through newsletters, informative sessions, brochures, etc.

- Develop an Internet page or blog to get inputs from Valle Real inhabitants and inform them of the progress of the project and its economic and environmental benefits. The website will also give visibility to the project and portray Valle Real as a sustainable neighbourhood.

- Hold a meeting with government representatives and local leaders to present the project and seek support for public interventions such as transport and waste.

- Carry out a cost-benefit analysis to determine and clearly communicate the advantages of the project.

- Create a program to educate residents about the environmental features of the residential and their responsibility in reaching the goal of becoming a sustainable community. Training and workshops should provide an opportunity to share experiences and best practices, obtain technical preparation and build awareness of importance of sustainable habits and behaviour.

- Conduct workshops on the following issues:
  - Waste reduction, separation and recycling
  - Composting
3.2. Energy

The following table shows the possible energy interventions for Valle Real, the key requirements and limitations for their implementation:

Table 3: Renewables Applicable in Households

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Requirements or Limitations</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Solar Photovoltaic Modules | - Interconnection contract with CFE (national utility), for solar energy small scale production.  
- Smart metre is needed if electricity is transferred to the grid.  
- Solar access analysis to clearly identify the ideal areas for this technology. Evaluate that throughout the year, the area receives as much sun as possible.  
- Systems can be designed from 1.5 kW capacity onwards.  
- Area available, which can support the installation.  
- The investment can be done progressively as the systems are usually modular.  
- As a reference: An installation of 3.8m² made by ERdC in same region as Valle Real, can generate 90kWh/month.  
| Solar Thermal Heating      | - No major installation adaptations are required.  
- Installed in series with conventional boiler to ensure hot water supply at any time.  
- 70% reduction in gas consumption.  
- Models vary in dimension of the tank and temperature of the water (30-85ºC for domestic modules)                                                                                                                                 |                                                                                                                                                                                                                                                                                             |
| Solar Streetlamps          | - Most cost-effective in areas where the utility network does not reach.  
- If infrastructure is already installed, it tends not to be an economically viable solution.  
- Very good solution if there is no access to the grid and a good alternative for new urbanisation.  
- As they are autonomous systems, this translates in cost savings in wire.                                                                                                                                 |                                                                                                                                                                                                                                                                                             |
| Smart Meters               | - Supporting and controlling software.  
- Citizens can benefit from filing a large order, several units at a time.                                                                                                                                                     |                                                                                                                                                                                                                                                                                             |
| Efficient Appliances       | - No technical requirements.  
- Subject to local availability of appliances in the market.  
- Need to assume higher initial cost but get long-term savings in return.                                                                                                                                                      |                                                                                                                                                                                                                                                                                             |
<table>
<thead>
<tr>
<th>Energy Saving Light Bulbs</th>
<th>- Subject to existence of suppliers, maintenance service and technical support in the area.</th>
<th>- Limited offer of products in the market, which restricts the choices.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- No special requirements.</td>
<td>- Fluorescent light bulbs have a higher efficiency than incandescent and have a lifetime of up to 35000 hours.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- LED technology can save up to 50% electricity consumption.</td>
</tr>
<tr>
<td>Wind-electric Generators</td>
<td>- Good and regular wind resource (at least 4m/s).</td>
<td>- Suitable with people who feel comfortable with long-term investment.</td>
</tr>
<tr>
<td></td>
<td>- Permission to install tall structures.</td>
<td>- Costs vary greatly depending on factors such as design, size, power output, location, permits and utility interconnection costs.</td>
</tr>
<tr>
<td></td>
<td>- Planning approval, permits and community acceptance.</td>
<td>- Consider local wind conditions and required power output to determine which model can be the most suitable and obtain the best performance.</td>
</tr>
<tr>
<td></td>
<td>- Interconnection contract with CFE (national utility).</td>
<td>- There are cost-efficient solutions for water pumping in the market.</td>
</tr>
<tr>
<td></td>
<td>- Smart metre is needed to measure the electricity transferred to the grid.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Space availability.</td>
<td></td>
</tr>
<tr>
<td>Geothermal Energy Systems</td>
<td>- Good solution for heating and cooling.</td>
<td>- No fuel input, reduced operational cost.</td>
</tr>
<tr>
<td></td>
<td>- Best recommended for new construction houses.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Need an assessment of the conditions are in place to determine most economical alternative.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Bear the initial cost of drilling, which will vary according to the soil composition.</td>
<td></td>
</tr>
<tr>
<td>Biomass Heaters</td>
<td>- Local fuel supply and delivery service.</td>
<td>- Ash is inevitable in the combustion of solid fuel; however it can be aggregated to the compost to use as fertilizer.</td>
</tr>
<tr>
<td></td>
<td>- Storage capacity.</td>
<td>- Sources of biomass include: food waste, industrial waste and agricultural residues.</td>
</tr>
<tr>
<td></td>
<td>- Not very efficient at low level outputs.</td>
<td>- Mainly used in industrial sector.</td>
</tr>
<tr>
<td></td>
<td>- Source of fuel should always be included in the planning and the equipment specified accordingly.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Carbon dioxide and water vapour emissions are inevitable.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Appropriate maintenance of the equipment is extremely important.</td>
<td></td>
</tr>
</tbody>
</table>

3.3. Waste

Tackling waste management is one of the crucial aspects of the process of greening a neighbourhood. This section details a set of recommendations aiming to transform a conventional...
neighbourhood such as Valle Real in an Eco-district in which recycling facilities perfectly marry the site. The main goal is to take action in the midst of the neighbourhood, so that waste is properly managed from the production to the collection.

Indeed, by the implementation of sustainable practices, reducing, reusing and recycling waste, Valle Real can reach a further and indispensable step towards the complete annihilation of the concept of waste itself. When closing a product’s life cycle, the intrinsic uselessness characteristic embedded in waste simply disappears, waste then forming part of a continual process generating of new resources. As a result, the ecological footprint is decreased and even though this remains at the small scale of a single neighbourhood, the impact cannot be underestimated because of the replicable possibilities.

In order to reach this optimum goal, various measures engaging the local population and promoting responsible behaviours can be executed. First of all, an analysis shall be performed in order to size the amount of waste generated and accordingly the possible actions to be taken. Once figured out what are the needs and opportunities, in accordance with the residents, activities shall be undertaken so that disposable products are reused and waste is efficiently processed.

Meeting this target requires the involvement of all actors. In the epicentre would evidently be placed the residents of the neighbourhood, adults as well as children. Their engagement is fundamental as they are the ones really handling the achievement of the measures set up.

The participation of the external parts such as the companies buying the compost, the waste collectors and other Non Governmental Organizations (NGOs) is to be taken into account within the organisational structure of the plan of actions.

The municipality is another stakeholder that must be engaged, being the closest official institutions and possibly conveying demands to higher ranks.

The principal actions subsequently described will approach first the opportunities linked to the reutilization of disposable goods, then the direct management of households waste and finally the post-waste stage.

**Waste generation in Valle Real:**

The waste collection is a service provided by Valle Real, three times a week. Each household has its own container, in which is placed the bins so that the dustmen can collect it just at the limitation of the property.
Approximately 9250 people are living in Valle Real, representing 1850 households. The annual average national amount of waste generated by one household (4.2 persons in average) in the urban areas of Mexico is around 105kg. Therefore, it can be deduced (data is not available) that Valle Real’s residents produce an average of 194.25 tons of waste per year.

Activities:

- Selective waste sorting

Currently, Valle Real’s inhabitants do not really segregate the waste according to the type and recyclability. The waste segregation is supposedly done following the classification of organic, inorganic (recycled materials all mixed) and sanitary waste. Despite of the 2008 law on waste sorting, still few people have really started sorting their waste. This can be explained by the irregularities in the collection system. Indeed, the municipality does own a fleet of trucks designed for the collection of paper/cardboard and glass. The problem is that because of the low sorting rate, those trucks are not constantly used. Concluding the vicious cycle, the residents are even less incentivised to separate their waste since, in the end; everything ends up in the same skip.

As a result, even though Valle Real is already a step ahead in terms of waste sorting, the process must be rethought and concretely implemented in a didactic and sustainable way. A first proposition would be the distribution of recycling kits including two reusable large baskets, one for the glass, one for the paper and cardboard. Using basket would reduce the risks of breaking of conventional plastic bags. As an example, a basket of 8.5 x 11 high would be adapted so that it needs to be emptied less often and could fit without too much visible nuisance in front of the house.

The organic waste should be specifically treated because of their extra-value. The composting of that waste could generate fertilizer. Each house in the condominium has a variably large garden, generated organic waste by the mowing or gardening activities. The owner could have the possibility to install a composting box in their backyard and earthworms could be used in order to accelerate the decomposition process. Some companies provide services and appropriate tools (earthworms and composting boxes) so that each household can handle its own organic waste. This is the case of Sé Verde S.A. located in Nuevo Leon, Mexico. 56

If a household would not be willing to install these measures, organic waste could be collected and a communal garden created to use the fertilizer generated. (See map below).

56 http://www.severde.com.mx/
This could only be successful if the municipality establish a clear and fix schedule for the collection of recyclable materials and if the community pledge to segregate the waste. Successful partnerships with local companies could also support the waste separation and recycling when buying the recyclable materials and spare compost. An important aspect is to develop a long-term relationship with local recycling and waste managing companies so that the ecological impact is reduce as much as possible.

One of the best partnerships would be formed with Logimorphics, a company managing the solid waste, and focused on the revalorization of recycling materials, in the metropolitan area of Guadalajara. Logimorphics integrates the management of all aspects of waste collection and treatment. In Valle Real, their services could be used for the door-to-door waste collection, in case the municipal service is not properly ensured and the management of the recycling points. Logimorphics also buy the recyclable waste such as aluminium and compost.

A local company, NOVAMEX Comercializadora would be able to buy the plastic waste generated by the community. The advantage is that they buy all types of plastic and ensuring the collection on site. From the plastic waste collected they produce plastic flakes, which are then resold for divers usage.

Coresa Comercial Recicladora, SA de CV would be another possible business partner. This company based in Guadalajara buys all types of waste and also rents different containers. Valle Real could use their services, after comparing the prices proposed by competitors for the collection and purchase of recycle materials.

- Installation of recycling points

Recycling points are special sites providing facilities for recycling a wide range of materials. The recycling points are designated for the treatment of particular waste that, due to their volume or hazardous nature cannot be thrown in the normal bin. For instance, the end user can dispose batteries, large appliances, and furniture... Containers collecting other common types of waste such as glass, cardboard, paper, drinks cans are also available.

The location of the clean points is crucial, especially in a high standards neighbourhood such as Valle Real. Clean points must be easily accessible and as much as possible integrated into the general landscape of the condominium. Households should be able to reach a clean point at a
reasonable distance from the house. In addition, the collection of waste must be done often enough to avoid any overflowing and inconveniences.

In Valle Real, given the population the waste collection in the recycling points ought to be done at least twice a week. The following map shows the possible sites where could be located the recycling point: close to the main roads of the condominium and dispatched in the area.

Figure 13. Valle Real clean points and urban orchards

- Re-use and re-engineering of disposal goods

Nowadays, furniture, appliances, clothes and many other consumption goods are thrown away even well before their end of life. Unfortunately, frequently people do not consider or have the opportunity to give their discarded goods, a second life. Too often, unwanted products end up in the bins whereas still valuable.

Re-engineering wastes would one of the best remedy. This process aims to transform or to change the original use of a good, which is worn out or unwanted, giving it a second life. In,
addition, spare parts could be reused and reassembled in order to create a brand new product. A concrete example could be the recuperation of fabrics for patchworks creations.

Another solution to solve this situation could come from partnerships with organisations in charge of the recuperation, potential reparation and redistribution of the products left behind by others.

Charitable donations events could also be organized four times a year, at the beginning of each season in the common area. This will be an opportunity for the residents to depose their unwanted goods. Most of the organisations in charge of those activities in the area of Valle Real are religious associations. Valle Real’s church is already engage in those types of charitable actions but they could be realized on a more frequent base.

As for the cloth collection, each recycling point could have special containers only for textile.

3.4. Water

The following table shows the possible water interventions for Valle Real, the key requirements and limitations for their implementation:

Table 4: Water Systems in Households

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Requirements or Limitations</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain Water Collectors</td>
<td>- Space to install the water tank for storage.</td>
<td>- It is more cost-effective when there is an even distribution of rainfall along the year.</td>
</tr>
<tr>
<td></td>
<td>- To be potable water, it has to be filtered and treated before storage, to avoid corruption.</td>
<td>- Adoption rates are higher for new buildings as this entails lower capital cost.</td>
</tr>
<tr>
<td></td>
<td>Otherwise it should only be used for irrigation.</td>
<td>- Rainwater collection entails water and cost savings.</td>
</tr>
<tr>
<td></td>
<td>- Impact on water supply is much greater for large buildings that have a large roof area.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Systems are designed according to particular requirements and capacity, and should be installed by a professional.</td>
<td></td>
</tr>
<tr>
<td>Water Purification Systems</td>
<td>- Previous installation of water system.</td>
<td>- A very good and cost-effective alternative to 20lt water bottles.</td>
</tr>
<tr>
<td></td>
<td>- Some systems might require to be installed by a plumber.</td>
<td>- Some of the systems available in the market include:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Ionizers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o Carbon filters</td>
</tr>
</tbody>
</table>
### Drip Irrigation System
- Initial cost can be more than for overhead systems.
- Careful study of relevant factors like topography, type of soil and water quality.
- The continuous and direct incidence of the sun can reduce the lifetime of the tubes.
- If the water is not properly filtered, clogging can occur.
- Relatively inexpensive.
- High long-term water savings.

### Constructed Wetland
- Viability study is key to examine site-specific factors such as soil suitability, vegetation, hydrology and local species, to avoid unintended consequences.
- Planning and maintenance is critical to the success of the project.
- Create a management plan with regular inspections and monitoring to allow quick responses to changes in quantity, quality, depth and flow of the water.
- Cost-effective and technically feasible approach, compared to traditional wastewater treatment systems.
- It takes time for the plants to grow and vegetate the area.

### Septic Tank
- Small-scale sewage treatment system, usually exclusive for one house.
- Space availability.
- Excavation capacity according to local site conditions.
- Periodic maintenance to remove solids, which settle and gradually fill the tank.
- Careful estimate of the inflow to calculate the appropriate size of the tank.
- Costly repairs can result of lack or maintenance.
- A properly maintained system can last for decades or even a lifetime.
- Use water efficiently to avoid overloading the septic system.
- Avoid having trees or shrubs near to the septic system, roots can clog or damage the drain field.
- The septic tank is not a trashcan. Don’t throw into the toilet any sanitary or other waste products other than toilet paper.

### Treatment Plant
- Common system for all houses.
- Large area required.
- Large initial investment for the infrastructure.
- Regular maintenance.
- There are different treatment systems that can combine physical, anaerobic biological and aerobic biological systems.

### Sequencing Batch Reactors
- Suited for wastewater treatment applications characterized by low or intermittent flow conditions.
- Typically used at flow rates of 3,8 million litres per day or less.
- Several stages of the process can be achieved in a single reactor
- Potential cost savings by eliminating clarifiers and other equipment.
- Useful for areas where available land is limited.
- Provides operating flexibility and control.
3.5. Urban Landscaping

Purpose:

The aim of this intervention is to enable the residents to improve their living conditions (e.g. reduction of noise, natural cooling and warming effects of the buildings).

Expected Outcomes:

An urban landscaping plan has been designed for Valle Real. In addition, the atmosphere in the neighbourhood has improved, while reducing the energy bill of the houses and the environmental footprint of the condominium.

Objective:

A significant increase of the green area ratio of the condominium will be achieved by:

- Implementing as many as possible vertical gardens on houses.
- Gradually shifting plants in common areas to more climate-fitted species.
- Creating vegetable gardens assigned per blocks or area of the condominium.

The actors that ought to be involved in the urban landscaping plan are first and foremost the residents, the private gardeners and the ones assigned to the common area, as well as the municipality and specialized architects and providers.

Activities:

Urban landscaping gathers different types of intervention such as green roofs, vertical gardens, or the design of green spaces. The common point of those interventions is that each one should privilege locally adapted vegetation since considerable water saving can be generated.
In Valle Real, most of the gardens and other green spaces are already designed and many trees were planted since the building of the first houses. This idea is not to transform the complete landscape but to progressively integrate within the existing urban design, others types of plants and fruit trees (pomegranates, oranges, lemon, papayas...) adapted to the climate and less water demanding.

Green roofs and vertical gardens are innovative and very aesthetic ways to improve the quality of life while improving the isolation capacity of the buildings. They require a certain expertise as for the best type of plant adapted and the organisation of the space. Interested residents should ten contact specialised green architects (see annexe).

The most common vertical green agriculture elements that can be implemented in Valle Real are the green facades (using ornamental or aromatic plants), anti-noise screens, and space demarcations. The wall chosen to support the structures of the garden shall be carefully selected according to its orientation and wind exposure. The structures, depending on the material used (wood, iron, steel...) need more or less maintenance. Many species having the advantage of having low water consumption such as ivy and vines could be introduced, as they do not require any types of structure. An important aspect to mention to the residents is that plants and building materials are incompatible because of the roots adversely affecting the conservation of the facades.

3.6. Transport

Description:

The implementation of a bicycle renting system in Valle Real and the surrounding area could complement the public transport system. The system would be similar to others already working around the world such as Ecobici, implemented by the local government in Mexico City. This model is an automatized system where the user registers and gets a card that will give him access to bicycles in any of the stations, installed in strategic points. The bicycle can then be returned to any of the other bike stations. There is an annual registration fee that allows the user to use the bicycle as many times as needed for periods no longer than 30 minutes.

The development of a car pull system is recommendable. There are existing schemes that have worked already in other cities. Copying a successful model would speed up the accomplishment of this method.
Purpose:

The purpose of this intervention is to achieve healthy lifestyles and community interaction, through sustainable transportation.

Objectives:

- Reduce the use of motor vehicles in short distance journeys.
- Increase connectivity of Valle Real to the surrounding urbanizations and services.
- Save costs derived from the consumption of gasoline in short distance transportation.
- Reduce greenhouse gas emissions derived from short distance motor vehicle transportation.

The economic and environmental benefits of this intervention can be easily quantified to use as an incentive for commuters to change their transport habits. For instance, a person travelling by bicycle twice a day, five days a week, from Valle Real to the University (14.4kms), will save €4.53 of fuel per week. This person will reduce his emissions by 215.2 kgCO₂ in a four month term.⁶⁰

Activities:

- Engage with different actors in the area that could be interested in the project.
- Build a collaboration agreement or partnership to be able to implement the project.
- Engage with government representatives to build the necessary infrastructure and signalling for safe bicycle rides.
- Promote the use of the bicycle as a vehicle for short distance travelling in the area.
- Install bike stations of 10 bicycles in strategic points, maximum 600m apart in the designated area.
- Contract the services of a Car Pulling site creator. (e.g. “Aventones” in Mexico City)

Stakeholders:

This initiative promotes connectivity and sustainable transport while reducing traffic jams in the area; this it benefits many more people that the inhabitants of Valle Real. When possible, work with surrounding landowners, businesses in the area, schools, universities and local governments to improve safety along existing roads around the community so that pedestrian and bicycle transit can be extended to adjacent areas and not only Valle Real. Partner with Ecobici to develop and manage the bike renting system in the area.

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Lines of action:

The main activity recommended for the installation of the bikes stations is to establish solid partnerships with interested parties:

- Valle Real Management Council
- Trompo Mágico Museum
- Superama Market
- Commercial Center
- Bus Station
- Public School
- Solares Residential
- Jardín Real Residential
- Cima Real Residential Buildings
- Coca-Cola Company
- Local government

Infrastructure:

In order to promote walking and cycling in a neighbourhood, safe and properly signalled ways need to be created, as well as bicycle parking and/or renting stations in strategic points. If no routes can be determined for specific bicycle use in the area, on-street clearly signed bike lanes can be established. Bike racks can be installed along street sidewalks and close to the entrances of common use buildings, sports centres or convenience stores.

To provide convenient walkways and shady rest stations, benches or seating, pedestrian-scaled light and rubbish bins should be installed at regular intervals. It is extremely important to consider the safety and security when promoting bicycle transportation. Traffic lights and the proper signals should be installed along the bike lanes.

Ecobici Stations:

1. Valle Real Main Entrance (Paseo Valle Real Street)
2. Valle Real Ramón Corona Street Entrance
3. Valle Real Aviación Street Entrance
4. Trompo Mágico Museum/ SAT Office (Tax payment building)
5. ITSEM University
6. Small amenities shopping Center
7. Bus Station
8. Superama Market
9. Solares Residential
10. Av. Aviación and Av. Ramón Corona Crossroads
3.7. Building

Description:

In Valle Real 1850 houses are already built and 162 are under construction. It will be difficult for these houses to implement the principles of bio-construction or passive architecture, as it would require large and costly alterations. It is more advisable in existing houses to implement as many of the recommended interventions that do not require construction work.

However, there are still 388 lots that are not yet under construction. These future projects entail a big opportunity to encourage passive architecture and the use of bioclimatic principles in house design.
Impacts can be minimized during the construction process by sourcing regional and sustainable materials and creating a construction waste management system.

To develop a project to promote sustainable architecture, the management board of Valle Real could partner with an architectural firm to give the consulting services, with the university Tec de Monterrey to build the pilot sustainable house and with the real estate agency that sells the property to increase awareness and inform future buyers.

**Purpose:**

The use of passive solar energy and bioclimatic principles through the architectural design minimizes the need for artificial heating or cooling. It reduces the annual energy consumption resulting in cost savings on the long term.

Sourcing local materials will reduce the energy embedded in the transportation of materials while fostering the local economy. Construction waste management diverts debris from landfills and promotes the reuse and recycling of materials whenever possible; which reduces waste and disposal costs.

**Objectives:**

- All new housing projects are designed according to solar passive architecture and bioclimatic principles.
- Promote energy, water and material resource efficiency.
- Reduce consumption of non-renewable sources.
- Obtain LEED certification for as many houses as possible and aim for LEED for Neighbourhoods certification on the long term.

**Lines of action:**

- Collaborating with the real estate agency to promote green building through brochures and informative sessions.
- Partnering with an architecture firm specialized in green building and LEED certification, in order to offer consulting services and recommendations for new construction or rehabilitation projects in Valle Real.
- Creating a detailed list of suppliers of sustainable materials, efficient appliances, energy and water systems and related services.
- Incentivise the adoption of efficiency measures and renewable sources of energy through discounts in the monthly maintenance fee.
- Partnering with Tec de Monterrey to develop a pilot green house in Valle Real to be one of the prices of Sorteo Tec.

**Conclusion**

The **GreenSphere** framework aims to help neighbourhood’s inhabitants to reach better living conditions and environmentally friendly lifestyles. Indeed, such a framework forms part of the solution, clearly answering the growing environmental concerns and issues faced today. The guidelines provided can be followed as a roadmap with the ultimate goal of sustainability.

Oftentimes “green propaganda” can appear as confusing and disturbing, unfortunately generating adverse effects in people's minds. However, with the increasing pressure coming from the new “consum’actors”, the tangible role of legal Authorities and the overall rise of awareness among the population; the implementation of environmental projects has a bright future.

The particularity of **GreenSphere** is that it provides the tools needed to achieve the greening of a neighbourhood. The model is not only adaptable and flexible but it also embraces the fundamental social aspects related to the induced changes. Thus, it places the inhabitants at the heart of the project. In fact, a simple but complete tool is put at their disposition. As a result, through the participatory approach applied and the development of citizen culture; inhabitants are the real decision makers.

As shown in this report, this developing and emerging country offers large opportunities and fulfils the criteria facilitating the implementation of green neighbourhoods. Mexico is working on the regulatory framework to support sustainability; the President has proved to have the political will and the financial instruments are in place to make a **GreenSphere** project economically viable. Citizens are also interested to know how they can contribute; Valle Real’s inhabitants aspire for a more sustainable way of life and can also afford it. Hence the high chances of success of the greening project.

Greening a condominium where a high-income community lives shall be seen as a first step, a case for sustainability. It creates a flagship project in Mexico, which can then be replicated at the whole Latin American level. The project will generate a local economic thrive among green businesses, finally contributing to the development of ecological mind-sets and to democratisation of sustainable technologies, further making them accessible to all.
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Annex 1. Images of Valle Real

Versalles Private Section

Coto las Flores Private Section

Cultural Centre

Median

Irrigation System

Fountain in Park
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## Annex 2. Directory of Possible Partners and Suppliers

<table>
<thead>
<tr>
<th>Company or Organisation</th>
<th>Products</th>
<th>Services</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecobici</td>
<td>-</td>
<td>Bicycle transport system.</td>
<td><a href="http://www.ecobici.df.gob.mx">www.ecobici.df.gob.mx</a></td>
</tr>
<tr>
<td>GDL en bicic</td>
<td>-</td>
<td>Citizen organisation promoting the use of bicycles as a transport system in Guadalajara.</td>
<td><a href="http://www.gdlenbici.org">www.gdlenbici.org</a></td>
</tr>
<tr>
<td>Alqui-Envas</td>
<td>-</td>
<td>Waste containers and clean points.</td>
<td><a href="http://www.alquienvas.com">www.alquienvas.com</a></td>
</tr>
<tr>
<td>Logimorphics</td>
<td>-</td>
<td>Management of solid waste.</td>
<td><a href="http://www.logimorphics.org">www.logimorphics.org</a></td>
</tr>
<tr>
<td>Corpolymers</td>
<td>-</td>
<td>Plastic recycling.</td>
<td><a href="http://www.corpolymers.com">www.corpolymers.com</a></td>
</tr>
<tr>
<td>Coresa</td>
<td>-</td>
<td>Solid waste management, plastic, aluminium, cardboard and paper recycling.</td>
<td><a href="http://www.comercialrecicladora.com">www.comercialrecicladora.com</a></td>
</tr>
<tr>
<td>Grupo Soluciones Ambientales</td>
<td>-</td>
<td>Waste management: recollection, transport and final disposal, design and maintenance of containers.</td>
<td><a href="http://www.gsaemx.com">www.gsaemx.com</a></td>
</tr>
<tr>
<td>Inelecsa</td>
<td>-</td>
<td>Solar, wind, thermal, hybrid, conventional energy systems and efficiency solutions.</td>
<td><a href="http://www.inelecsa.com">www.inelecsa.com</a></td>
</tr>
<tr>
<td>SAECSA</td>
<td>-</td>
<td>Thermal and PV solar systems, solar architecture, wind energy systems, solar streetlights, solar pumping systems.</td>
<td><a href="http://www.saecsaenergiasolar.com">www.saecsaenergiasolar.com</a></td>
</tr>
<tr>
<td>ERDM Solar</td>
<td>-</td>
<td>Solar PV and wind energy systems.</td>
<td><a href="http://www.erdmsolar.com">www.erdmsolar.com</a></td>
</tr>
<tr>
<td>Energía Solar sin Limites</td>
<td>-</td>
<td>Solar PV, thermosolar and wind energy systems.</td>
<td><a href="http://www.energiasolarsinlimites.com">www.energiasolarsinlimites.com</a></td>
</tr>
<tr>
<td>ERdC</td>
<td>-</td>
<td>Solar thermal, PV and wind energy systems. LED lighting and energy efficiency solutions.</td>
<td><a href="http://www.energiaeolicaysolar.com">www.energiaeolicaysolar.com</a></td>
</tr>
<tr>
<td>Solsuco</td>
<td>-</td>
<td>Solar thermal and PV systems, solar streetlights, domes, green roofs, water treatment and rainwater collecting systems, isolating window systems, and eco-architecture.</td>
<td><a href="http://www.solsuco.com">www.solsuco.com</a></td>
</tr>
<tr>
<td>H2O Soluciones</td>
<td>-</td>
<td>Irrigation systems.</td>
<td><a href="http://www.h2osoluciones.com">www.h2osoluciones.com</a></td>
</tr>
<tr>
<td>Menos por Menos</td>
<td>-</td>
<td>Ozonisers, enviro-septic systems, dry toilets, water treatment systems, solar heaters.</td>
<td><a href="http://www.menospormenos.com.mx">www.menospormenos.com.mx</a></td>
</tr>
<tr>
<td>Axán GW</td>
<td>-</td>
<td>Water treatment systems, renewable energies, solid waste management, consulting services.</td>
<td><a href="http://www.axangw.com">www.axangw.com</a></td>
</tr>
</tbody>
</table>
## List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
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<tbody>
<tr>
<td>AC</td>
<td>Alternative Current</td>
</tr>
<tr>
<td>CFE</td>
<td>Comisión Federal de la Electricidad - Federal Electricity Commission</td>
</tr>
<tr>
<td>CFL</td>
<td>Compact Fluorescent Lamps</td>
</tr>
<tr>
<td>CNBV</td>
<td>Comisión Nacional Bancaria y de Valores - National Stock and Banking Commission</td>
</tr>
<tr>
<td>CNSF</td>
<td>Comisión Nacional de Seguros y Fianzas - National Insurance and Deposit Commission</td>
</tr>
<tr>
<td>CONAE</td>
<td>Comisión Nacional para el ahorro de Energía - National Commission for Energy Saving</td>
</tr>
<tr>
<td>CONAGUA</td>
<td>Comisión Nacional del Agua - National Water Commission</td>
</tr>
<tr>
<td>CONAVI</td>
<td>Comisión Nacional de la Vivienda - National Housing Commission</td>
</tr>
<tr>
<td>CONSAR</td>
<td>Comisión Nacional del Sistema de Ahorro para el Retiro - National Retirement Saving System Commission</td>
</tr>
<tr>
<td>DC</td>
<td>Direct Current</td>
</tr>
<tr>
<td>DUIS</td>
<td>Desarrollos Urbanos Integrales Sustentables - Integrated Sustainable Urban Development Project</td>
</tr>
<tr>
<td>FOVI</td>
<td>Fondo de Operación y Financiamiento Bancario a la Vivienda - Housing Banking Operation and Financing Fund</td>
</tr>
<tr>
<td>FOVISSSTE</td>
<td>Fondo de la Vivienda del Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado - Fund of Housing of the Institute of Security and Social Services of State Workers</td>
</tr>
<tr>
<td>GHG</td>
<td>Greenhouse gas</td>
</tr>
<tr>
<td>INE</td>
<td>Instituto Nacional de Ecología - National Ecology Institute</td>
</tr>
<tr>
<td>INFONAVIT</td>
<td>Instituto del Fondo Nacional de la Vivienda para los Trabajadores - Institute of National Funds for Workers Housing</td>
</tr>
<tr>
<td>LEDs</td>
<td>Light-emitting diodes</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
</tr>
<tr>
<td>NGOs</td>
<td>Non-Governmental Organizations</td>
</tr>
<tr>
<td>PV</td>
<td>Photovoltaic</td>
</tr>
<tr>
<td>SEMARNAT</td>
<td>Secretaría de Medio Ambiente y Recursos Naturales - Ministry of Environment and Natural Resources</td>
</tr>
<tr>
<td>SHCP</td>
<td>Secretaría de Hacienda y Crédito Público - Ministry of Finance and Public Credit</td>
</tr>
<tr>
<td>SOFOLES</td>
<td>Sociedades Financieras de Objeto Limitado - Financing Institutions of Limited Liability</td>
</tr>
<tr>
<td>SWT</td>
<td>Small Wind Turbines</td>
</tr>
<tr>
<td>TMW</td>
<td>Times Minimum wage</td>
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</table>
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References


