

Sustainable Living

Applying a Swedish Case Study in Steering Parc Downsview Park in Toronto in the Development towards a Sustainable User Phase

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Abstract

The 21st century is accompanied by a myriad of urban challenges with respect to energy use, waste management, transportation & mobility, water consumption and ecological space. An increasingly growing influx of people from rural to urban areas coupled with the already significant urban growth is presenting businesses, municipalities and the public with a multitude of challenges in managing and conservation of the aforementioned environmental matters. Constructing as well as transforming communities into sustainable cities is a very desirable vision in many developed urban areas around the world. This paper therefore examines how these goals are achieved in a Swedish case example (the Bo01 district), and how they can be applied to a current project in Toronto led by PDP which is still in the early stages of planning.

It is widely accepted that both development and user phases of city districts are characterized by numerous environmental impacts. It is therefore imperative to integrate environmental consideration not only to the planning and development phases, but also, ensuring that such continue into the user phase of the community. This gives rise to the importance of evaluating sustainable city districts in the user phase and to encourage residents to take environmental impact into account in daily tasks.

The first main component of the thesis provides an account of the Bo01 district case study with respect to how the project was managed, design, education and evaluation. The lessons learned are then imported to the next main component - a chapter providing suggestions for PDP. Both the case study and the recommendation chapters focus on design parameters that are conducive to an efficient performance in the operational phase; education to increase resident awareness in light of the goals; user phase evaluation and a project management approach to improve and reinforce the user phase. The last step drives the necessity to carry out an ongoing approach to evaluation and follow up to ensure that the environmental performance of PDP's user phase is moving closer to the targets.

Executive Summary

The objective of this thesis was to review the Swedish case study of the Bo01 district sustainable community (Western Harbour, Malmö) to provide suggestions to PDP Inc. in Toronto, Canada a sustainable community project which is currently in the stages of planning, to achieve a high performance user phase. Both projects (Bo01 and PDP) include an integration of housing, shops, and businesses. While the Bo01 district is an example of a brownfield redevelopment, the PDP project encompasses the development of a large-scale sustainable community district on a former military site.

The thesis addressed 5 parameters that are of interest to the PDP project: energy, waste management, transportation & mobility, water, and green space. The design parameters were selected as they are important factors behind user phase sustainability and they reflect goals found within the initial draft of PDP's sustainability guidelines. Moreover, the parameters stem from urban challenges faced by the City of Toronto and reflect LEED principles.

The PDP organization is in the process of developing sustainability guidelines which will serve as a steering document to provide environmental standards and expectations to developers. Pursuant to the expansion of the sustainable community guidelines initiated by PDP the Bo01 district case study was subjected to a comprehensive review with respect to the user phase performance. In addition to extracting the positive issues while identifying the flaws in the case study, the recommendations chapter made references to the Canadian LEED program as well as other Swedish examples such as Hammarby Sjöstad. Enriching PDP's development with sophisticated Swedish examples, while ensuring that the district is LEED qualified, aims to steer the project towards recognition as a progressive example of sustainable city design.

To answer the fundamental question of this thesis - what elements are needed to achieve a successful user phase performance, a few central components were extracted while reviewing the Bo01 case study: the importance of structurally and technically well prepared dwellings for residents; evaluation to identify performance issues; the importance of soft measures such as education and communication to engage residents to participate in achieving the common goals.

Correspondingly, the first main component of the thesis reviewed the design concepts in the Bo01 district with respect to the 5 selected parameters. Generous government assistance programs enabled many high quality and environmental design concepts to be materialized in the district. The Bo01 district is characterized by its 100% renewable energy policy. This was achieved by wind power, solar power, naturally occurring heat from the bedrock. The waste management system entails a vacuum concept which has proven to be clean and efficient. There are 8 source separation categories plus composting to reduce the waste stream. The transportation infrastructure was designed to favour cycling, walking, public transportation and hybrid vehicles, while reducing the need for personal vehicles. Lastly, the green space concept was designed to maintain a healthy balance between greenery and developed space. The green space parameter also features a built in system for stormwater management consisting of ponds, channels and green roofs.

As the Bo01 district gained international recognition as a sustainable city district, numerous evaluation activities have been carried out to track the performance. Although the Bo01 district has a more efficient energy performance than the rest of Malmö, the target for this parameter has not been met. Studies revealed the main factor behind the failed target is design, however, developers claimed that the energy performance was attributed to resident

behaviour. The performance of the waste parameter fluctuates, and although the Bo01 district has source separation facilities for more waste types than the rest of the City, the target has not been met. The explanation for this is the fact that education and information initiatives have not been ongoing and detailed enough. With respect to the transportation & mobility parameter, recent studies of personal travel habits revealed that about 70% of the residents favour alternatives to the automobile. Lastly, in depth evaluation studies have been conducted to determine the vitality and performance of the green space parameter. The stormwater channels and ponds are assimilating precipitation accordingly and although species numbers are lower than anticipated, the numbers are expected to rise as the greenery becomes denser.

Aside from the few missed targets, the Bo01 district represents the possibility of a successful outcome when the stakeholders involved share common interest in developing an ecologically sound city district. Here, the strategy was enabled by a strong collaboration between the City of Malmö, the developers, the Swedish Government, the EU as well as local residents and universities. The region is currently benefiting from positive international recognition and increased commercial and tourist activity.

After the Bo01 Case study was reviewed, the key lessons were extracted and compiled in a chapter presenting recommendations to PDP on how to achieve a sustainable user phase. LEED principles and examples from Hammarby Sjöstad were also presented in this section to reinforce the design principles employed in the Bo01 district.

Design for Performance

- Energy: Promote renewable energy, ensure adequate insulation, high efficiency appliances, and heat recovery.
- Waste: Provide facilities for enabling source separation, compost
- Transportation & Mobility: Promote alternatives to personal vehicle use, ensure buildings are situated in proximity to public transportation, provide a network for carpooling, paths for walking and cycling, and storage for bicycling.
- Water: Consider excluding the bathtub in some units, use high efficiency plumbing and fixtures and employ rain collection for irrigation.
- Green Space: Ensure all residents are in proximity to some kind of greenery, install rainwater capture systems, green roofs, provide large and unfragmented habitats to allow species to thrive.

Influence of Performance

Integral to the successful performance of the operation is an education and information sharing plan to engage all stakeholders. It is advised that PDP ensures ongoing education is available to residents where moving in and out is taken into account. Education should be catered to specific groups in order to generate impact. An instrumental option is the establishment of an education centre for enquiries of residents and visitors. Finally, it is recommended to use feedback systems and visuals to inform residents of their performance in accordance with the specified targets.

Evaluation of Performance

- Initiate evaluation activities from the onset of the occupancy phase to have a clear scenario of trends over time and in order to identify flaws immediately. Immediate response and corrections will enhance the efficiency of the district.
- Employ a standardized approach to evaluation allowing for analysis and benchmarking, as well as enabling the process of conveying progress to residents and interested parties.
- Collect extensive data to enable comprehensive results for analysis. This allows identifying the root of the problem prompting follow ups.

Finally, to compensate for some of the drawbacks that were witnessed in the Bo01 district, the thesis presents the application of a project management approach to optimize the user phase. Deming's Plan – Do – Check – Act was employed to demonstrate how a sustainable community district in its user phase can be subjected to a continuous evaluation mechanism where faults are identified and corrected. The purpose of this cycle is not only applied to the phase under study, but also, to import lessons learned to future phases to be developed. Therefore, the ongoing approach to identification and subsequent rectification of areas that fall below the targets ensures that the community's goals are systematized and materialized, and steered towards continuous improvement.

As part of the project management, the steering documents should include clear and specific instructions to provide developers with the desired expectations and direction. Quantifiable targets should be set for each parameter. To manage the environmental goals, a sustainability team should be set up to collaborate with the developers on enforcing environmental criteria. Each developer is expected to operate an EMS to keep an organized account of performance.

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1 Introduction

The widespread increase of population in cities is presenting businesses, governments and the public with onerous challenges in addressing the growth and ensuring that consumption of resources, resource management, transportation and waste management are bound by sustainable processes. In the latter half of the 20th century the populations of cities increased more than ten-fold and the growth is expected to continue in the decades to come (Gumuchdian, 2000). Given the rate of the growth, cities are also focal points with the command of controlling the ways in which urban centres operate and interact with the environment. Urban concerns are giving rise to the transformations of city districts which are enhanced by a characterization of sustainability. “Greening” a city is a very methodical and extensive programme that normally commences with local initiatives among clusters of communities.

It is widely accepted that the life cycle of conventional buildings is associated with numerous environmental impacts such as the depletion of natural resources, generation of toxic wastes, as well as air and water pollution. According to statistics found in developed countries, construction and use of buildings consume about 40% of total energy, 25% of timber production and 60% of electricity (Guidry, 2004), while producing up to 40% of landfill space, and contributing 30% of the total greenhouse gas emissions (Edwards, 1998). Unfortunately, the environmental effects do not vanish after the construction phase, and continue into the occupancy phase. The user phase of a community district and its demand puts pressure on natural resources and waste management solutions. Therefore, designing communities that are characterized by lower figures than the aforementioned and a higher level of efficiency during the user phase leads to a more sustainable and viable urban living. Although instrumental to a high environmental performance, the design itself is not fully accountable for the performance of the community in use; hence this is where the residents play an essential role. Smart resident behaviour positively reinforces the technical design and contributes to the continuous performance of the district.

Measuring and evaluating the results of a community’s performance in the operational phase plays an important role in delivering the goals formulated in the planning and implementation stage. Although progress is underway at local and national levels to create methodologies for evaluating performance of urban districts, it still remains largely unexplored, making it vital to expand the research and examine the knowledge gap on the actual operation phase of sustainable communities. It is important that the evaluation process takes into account the behaviour of the residents, as it contributes to the overall performance. It is essential to carry out evaluation continuously to ensure that the performance complies with the goals and to promote ongoing progress. A city district should not be viewed as a “finished product”, but a “work in progress” where there is no ceiling applied to the level of improvement (Bentivegna, Brandon, & Lombardi, 1997).

As smart ecological design sets fundamental framework for encouraging environmental behaviour among residents, resident behaviour itself epitomizes the continuity of an ecologically sound city district. It is therefore essential to execute evaluation programs, search for means to improve the user phase and focus on the ‘soft’ measures such as driving influential education initiatives on environmental topics in order to engage residents to partake in the ultimate goal. Furthermore, the success of the occupancy phase very much depends on the overall project management process. Therefore, this thesis integrates project management principles as a tool to optimize the occupancy phase performance through a continuous flow.

1.1 Focus of the Thesis

This thesis will focus on steering a current development in Toronto led by Parc Downsview Park Inc. (PDP) towards a sustainable city development as it is being transformed from an old military site to an ecological neighbourhood, with a goal to create “a sustainable community which will showcase the technology and practices needed to accommodate and harness growth in the coming years” (PDP Annual Report, 2004). PDP represents a national initiative to revitalize land in pursuit of creating a holistic sustainable community for its residents and visitors. In addition to considerable environmental ambitions, the organization’s activities will be characterized by soft measures such as numerous social and recreational facilities to bring people together. PDP has particular interest in maximizing the environmental performance of the community. Making this community unique in the Canadian context is that all of the developments within the PDP boundary will have to qualify for LEED¹ standards.

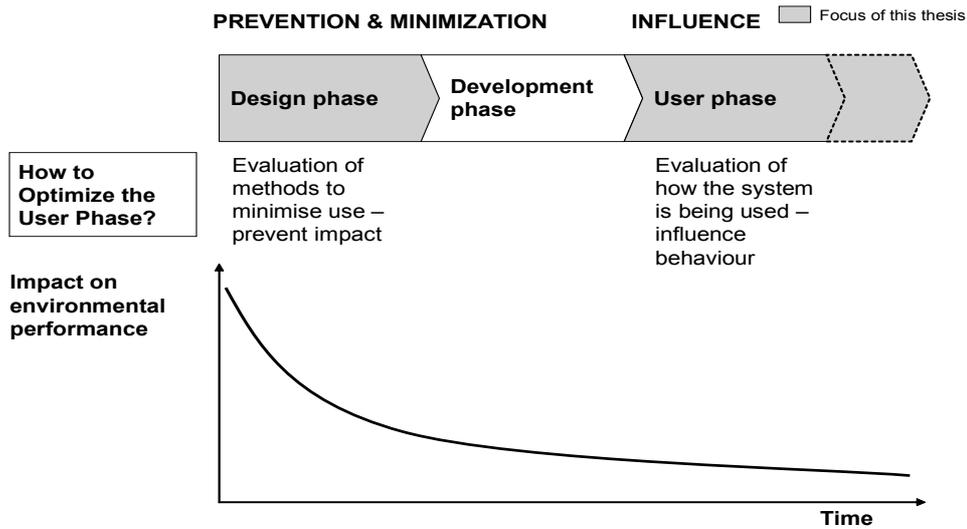
The main case study examples are derived from the Bo01² district, an internationally renowned model of an integrated effort in urban sustainability which demonstrates how a community can be transformed from an industrial site on principles of innovativeness and green approaches (Altomare & Natrass, 2005). Sharing similar objectives to the Toronto development, the case is valuable in steering PDP towards a successful user phase of the sustainable community. Given its ambitious goals, the lessons from the Bo01 district are beneficial to PDP in highlighting the achievements and pinpointing the drawbacks with respect to the occupancy phase performance.

Figure 1-1 is an illustration of the focus of the thesis. It can be seen that the design phase has significant influence at the initial stages of the project, as the user phase influences the continuity of the community. It is therefore crucial to incorporate high performance environmental design in order to enable a successful user phase performance. Suggestions will be made that are practical in curtailing environmental impacts through the design. In turn, it is important to carry out continuous efforts to ensure the performance of the user phase is moving closer to the targets. This includes evaluation and follow-up as well as resident education. A project management approach will be used to deliver ongoing improvement within the occupancy phase.

¹ Leadership in energy and environmental design, a certification scheme for green buildings

² Development in the Western Harbour, Malmö, Sweden

Focus of the Thesis



3

Figure 1-1 Thesis Focus

1.2 Objective

With similar goals to PDP, reviewing the Bo01 district case study enables the identification of the elements that are essential to a sustainable occupancy phase. This takes into consideration the way the project is managed, design features of the district and performance of the user phase. From the case study positive results are extracted while at the same time the drawbacks are identified. Importing successes and failures in turn enables the improvement of the course of the user phase for PDP. In selecting the parameters under study (from a user phase approach), the focus lies on urban challenges that are representative of the interests of the City of Toronto and are consistent with the expansion of the goals that are embedded within the Sustainability Guidelines³ draft initiated by PDP.

The research questions that correspond to the focus are:

1. In the design of a housing project, using the Bo01 district as the main reference, what measures with respect to the selected parameters are vital to establishing a positive environmental performance?
2. In the user phase of a housing project, using the Bo01 district as the main reference, what performance measures are crucial to deliver a successful user phase with respect to the selected parameters?
3. How can the user phase performance be optimized for the Canadian project led by Parc Downsview Park Inc.?

In line with the research questions to provide suggestions to PDP on how to successfully develop a sustainable city district, the thesis is systematized to mirror the objectives.

³ Early draft of the steering document that will outline the expectations of PDP to participating developers to ensure a sustainable community development

Reviewing the case study draws attention to how the project was carried out, and leads to the identification of the parameters that are essential to provide the future residents with dwellings that are characterized by effective environmental design. This then progresses to engaging residents to carry the momentum of the environmental design and reviewing the evaluation of the occupancy phase. Questions 1 & 2 are addressed in chapter 4 (Bo01 District Case Study) and chapter 5 (Recommendations for a Sustainable User Phase).

In Chapter 5 a project management approach is applied to bring forward suggestions on how to successfully implement the lessons learned from the Bo01 district case with an emphasis on continuous improvement of the sustainable user phase. This chapter addresses Question 3.

1.3 Limitations

The parameters chosen for this study are of importance to PDP as they reflect significant environmental matters in Toronto, and efficient management of each is consistent with LEED principles. The five parameters chosen to discuss design measures for a successful user phase are: *energy, waste, transportation & mobility, water, and green space*. As such a study encompasses a vast number of issues to consider, this research focuses primarily on the key factors within the selected parameters that are imperative to the operational phase.

PDP expressed the desire to improve performance and curtail the environmental effects of the first 4 parameters in the preliminary draft of its sustainability guidelines - *energy, waste, transportation & mobility, water*. The evaluation of the selected parameters is approached from the occupancy phase perspective where the focus is formulated based on the inputs and outputs of domestic needs. To provide a comprehensive overview of the parameters, prioritization is based on the most environmentally important factors that fall under each with respect to the occupancy phase. For example in discussing water and energy efficiency issues, the domestic uses that are addressed are the most environmentally intensive. Therefore, not all domestic uses within the selected parameters are covered.

The fifth parameter, *green space*, is relevant as PDP wishes to give particular attention to greenery. Although green space is not directly relevant to resource use and consumption within a home studies have shown that it is an important element in creating environmental awareness and opportunities for education among residents. Green space is also essential for storm water control, support for biodiversity, sheltering residential units from the wind, and providing recreational space. Incorporating greenery in an urban area is vital in maintaining natural areas that are being dominated by development. Given the size of the green space areas in PDP (130 hectares), it is an important parameter to study and is therefore included in this thesis. In the evaluation of the green space parameter the focus is on vitality of the greenery, its abundance and capacity for stormwater control.

There is a limitation to using the Bo01 district as a case example with respect to the water parameter, as water conservation did not receive much attention. Water plays a larger role in the green space context in stormwater management and aesthetics of the district. This example is therefore supplemented with references from other experiences.

With respect to project management principles, this thesis does not scrutinize the entire project development process in great detail. Instead, prioritization is based on factors that have been relevant to the user phase performance. Although there is some discussion about the overall project planning, the project management approach is mainly limited to how continuous improvement can be achieved during the occupancy phase.

Although immensely significant, technical aspects of sustainable district design which the residents themselves cannot directly influence will be excluded from the report. Designing a sustainable city district entails significant efforts and coordination of various disciplines, however; in pursuit of focusing on parameters that are affected by resident performance, issues such as building materials, engineering components of buildings, and construction processes will be excluded. Further, the context of social sustainability and social vitality of a community district is of essential importance to its all-embracing long-term functionality, but it is excluded from this study as the focus is on environmental parameters. The inclusion of social sustainability would limit the thoroughness and scope of the key environmental parameters.

While case studies of green communities are widely available, this thesis focuses mainly on that of the Bo01 district. The Bo01 district represents a showcase example of sustainable housing in Sweden and since PDP harbours a similar ambition, this case study was appropriate. This is also to cover a commendable case example in a thorough and comprehensive approach. Finally, due to the geographical placement of the Bo01 district, it was sensible to incorporate this as the central case in the research because of relatively easy access to view the area and speak to the experts who were involved.

Further, there is an abundant selection of resources on the cases of the Bo01 district and Hammarby Sjöstad⁴, however, most of the literature is published in Swedish. This of course narrows the writer's ability to fully examine all material in relation to the projects in the Swedish language.

1.4 Terms and Definitions

The phrases occupancy phase and user phase are used interchangeably in this thesis and refer to the stage of a housing development when the residents are already living in the buildings.

The word parameter is used to refer to one of the five selected areas that are addressed: *energy, waste, transportation & mobility, water and green space*.

1.5 Justification of the Selected Parameters

To recap, the key parameters selected are Energy, Waste Management, Transportation & Mobility, Water, and Green Space. They do not only reflect important urban environmental challenges for the city of Toronto, but for most urban centres. The selection is validated by the environmental consequences associated with mismanagement of the parameters and that they share an intricate relationship. Careful design and management of the parameters in the community development is of high interest to PDP as it further extends and highlights some of the key issues in the organization's sustainability guidelines draft, making each parameter a valuable focus within this thesis. Moreover, proper design in light of each parameter sets a foundation to enable residents to contribute to an efficient performance of the community. Positive management of the chosen parameters is also parallel to numerous regional, provincial and national environmental goals in Canada, and is consistent with the LEED program. In essence, PDP has the capacity to encapsulate such important environmental matters in setting a framework for high performance community design proceeded by education and evaluation measures to ensure there is progress in meeting the goals.

⁴ Stockholm's largest sustainable district development, Sweden

The below is a background to each of the parameters under study and some environmental explanations to narrow in on the importance of each. This section also includes information on trends and patterns within the use of the parameters in Toronto, which will be given recommendations for more efficient management in the later chapters. The background on the parameters is provided to illustrate a general picture of energy, waste, transportation, water and green space issues in an environmental context and then focuses on their framework within a domestic context.

1.5.1 Energy

Canada has a much diversified electricity generation base comprised of the following sources: hydro-electricity, natural gas, oil, coal, nuclear power and renewable energy (water, biomass, wind, solar, earth and waste stream energy) (Government of Canada, 2005). Some 57% of Canada's electricity generation comes from hydroelectricity, followed by conventional thermal (28%), nuclear (13%), and renewables (1%). The most common source of electricity, hydroelectric plants generate small or negligible results of carbon dioxide and methane as a result of reservoir emissions, but do not emit sulphur dioxide, nitrogen oxides, dust or other combustion related pollutants. Being a fairly reliable renewable resource, hydroelectric power is also the preferred choice in many other countries. Despite the benefits, hydroelectric power does create some environmental disturbance, such as disruption to aquatic ecosystems.

To narrow more specifically on Toronto's status of energy use, virtually the entire source is imported from outside of the city. Nearly 80% of energy is obtained from non-renewable sources, mainly nuclear power and fuels, followed by hydroelectric. Although currently insufficient power is generated by wind and solar sources, recent interest in renewable energy is starting to be manifested (Government of Canada, 2005).

As energy usage is increasing, Canada has the third largest energy use per capita (7.86 tons of oil per capita), where 72% more energy is used than in the average of G7⁵ nations. Extreme weather conditions that compel more energy consumption due to heating and cooling, and the high standard of living in Canada are factors attributing to the high consumption. On the contrary, sharing a similar climate and living conditions, Sweden consumes significantly less (5.87 tons per capita) (Clean Air Partnership, 2005). This calls for the adoption of cleaner energy and better energy efficiency in Canada.

According to a 2001 study, residential greenhouse gas (GHG)⁶ emissions amount to over 5% of national emissions, as each Canadian produces approximately 5 tons per year. Figure 1-2 illustrates personal GHG emissions revealing transportation as the largest source, followed by space cooling and heating and finally appliances. These sources of emission clearly reflect the highest uses of energy in Canada, where one of them can be addressed with more efficient domestic energy use.

In pursuit of reaching goals set out in the Kyoto Protocol, the Federal Government announced an initiative called "One Ton Challenge Program" where citizens are encouraged to reduce individual GHG emissions by a ton. To drive the public towards participation in the program, there are rebates associated with efficient technology installation as well as smart

⁵ The seven leading industrial countries: US , Germany, Japan, France, UK, Canada, Italy.

⁶ Total emissions of greenhouse gases include carbon dioxide (CO₂), methane, nitrous oxides (NO_x), hydro-fluorocarbon (HFC), perfluorocarbon (PFC) and sulfur hexafluoride (SF₆).

renovations⁷. There are numerous municipal and local plans that target energy efficiency in homes and offer incentives to tenants and home owners to facilitate energy reduction goals. The Canadian government is currently in the process of phasing out coal powered plants and plans to have at least 5% of all energy sources in Canada from renewables by 2007 (Federal Ministry of Energy, 2005).

As many studies show that buildings consume about 40% of energy use in developed countries, the energy parameter is crucial to fully explore in the planning and construction phase to design energy-efficient housing, and where proper user behaviour will be consistent with the design. Increasingly, buildings consume more energy for purposes such as water heating, powering common equipment, and electricity. Taking into account the long life spans of buildings, energy flows and usage play a significant role in a community district’s overall efficiency ratings. The energy performance is not only fundamental to environmental conservation, but also, to the utility costs of the occupant. From a financial perspective, energy reduction measures in housing are attractive due to rather quick payback times (Carpenter, Pers. Comm., 2005). Focus on renewable energy and energy reduction measures that reflect goals of PDP will be further described in Chapter 3.

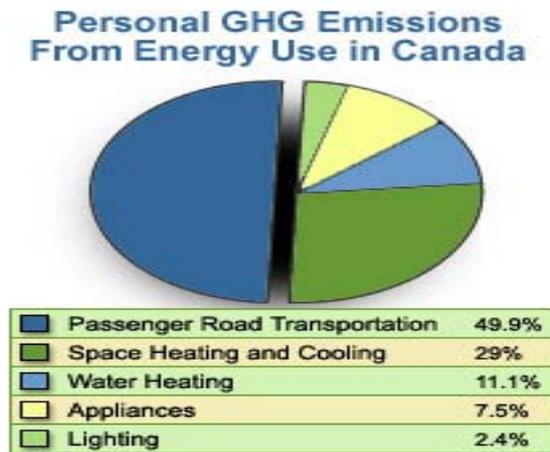


Figure 1-2 Personal GHG Emissions from Energy Use, Canada (Government of Canada, 2005).

1.5.2 Waste Management

OECD defines municipal waste as follows, “waste from households, bulky waste, waste from commerce and trade, office buildings, institutions and small businesses, yard and garden waste, street sweepings, litter container contents and market cleansing waste” (OECD 2003c:10). As improper waste management carries potential risks to human and environmental health, municipal waste further contributes to habitat destruction, surface and groundwater pollution as well as the degradation of soil, air and water quality. Land filling produces substantial volumes of methane, which can be reduced by composting and sending less organic waste to landfills. The current preferred means of waste disposal in Toronto, land filling, carries environmental risks throughout the course of its entire life cycle. Even upon closure there is also a potential risk of explosive gases close to old landfills, and potential risk of leachate and ground water contamination. Old landfills require ongoing monitoring to air, groundwater and soil followed by the potential need of remediation the local environment (City of Toronto Waste Management Plan, 2005).

⁷ The City of Toronto offers up to \$60 - \$150 for a high efficiency washer, up to \$10 for high efficiency lights, and the Ontario Provincial government offers rebates for solar heating systems.

Household wastes form about one half of all municipal waste. In Canada about 490 kilograms of waste is produced per capita, a figure which is just above the OECD average (458 kg). Waste management poses a significant problem to the City of Toronto. In the fall of 2000 the city council was engaged in a debate over waste management when a local landfill (Keele Valley) was to close in 2002. The final decision was a temporary contract to ship Toronto's waste to Michigan, which is currently posing a great financial burden to the city. The need to transport waste is also energy intensive and inevitably contributes to air quality problems as 120 trucks are required per day to transport the waste to Michigan (Waste Management Plan, 2005). Procedures at the border such as investigation often lead to movement delays.

According to OECD recycling is the "reuse of material in a production process that diverts it from the waste stream, except reuse as fuel" (OECD 2003c: 20). A common indicator used to measure the rate of recycling is the percentage of municipal waste that is actually diverted to recycling purposes. Canada's recycling rate for the year 2000 was about 23%, just above the OECD average but lagging behind the leading countries (David Suzuki Foundation, 2005).

In pursuit of lessening waste related issues in 2001 the city announced waste reduction goals of 30% for 2003, 60% for 2006 and 100% for 2010. The first goal was achieved by increasing waste collection, expanding the recycling program to include a wider range of acceptable items and promoting yard and compost collection (Solid Waste Management Services Multi-Year Business Plan, 2005). In further pursuit of the 60% reduction rate goal for 2006, the city plans to increase the Source Separating Organics Program, increase the recovery rate of recyclables, mandatory diversion, enforcement, waste limits and fees. In the meantime, the city is contemplating upon various technologies to deal with the volumes currently sent to landfills. (CMHC, 2005).

A city district and its buildings should be designed to maximize the diversion activities of waste in providing residents with proper access to waste facilities and clear information that enables participation ensuring effective waste disposal and recycling. The city now has a mandate to enforce recycling and can issue a \$55 CAD fine to single family homes who fail to recycle. Apartment buildings are also subject to scrutiny to ensure they are properly equipped for recycling (e.g. whether the number of bins is sufficient) and to ensure that recyclables are not disposed of in the garbage bins.

The waste management parameter within the study is not only an extension of PDP's goals but also emphasizes an important objective that is synonymous with Toronto's waste reduction and diversion targets. Being a large community and by setting up a proper waste management system, PDP has the capacity to carry out activities that will contribute to the above goals. Given the waste problem in the city, talks about new legislation are common and therefore if PDP observes a careful waste management strategy, the community will be prepared for current and future waste-related laws.

1.5.3 Transportation & Mobility

Vital to the development of a sustainable city district is a healthy, functional and accessible public transportation system to encourage residents to commute by public transport rather than by personal vehicles. An infrastructure with a functional and reliable public transportation, pedestrian paths and bicycle access is not only beneficial in light of environmental reasons, but also, for the competitiveness of the city itself. Recent World Bank findings reveal that cities which invest in smart transportation infrastructure enjoy a more internationally competitive image, attract more businesses and visitors as well as thrive on an

improved quality of life. Such cities have are very transit-oriented with integrated rail networks and wide access for commuters (City of Toronto, 2005).

Transportation is the largest and fastest rising source of carbon dioxide emissions in Toronto, leading to air and water quality problems. Transportation is also very energy intensive and according to figure 1-2 nearly 50% of GHG emissions result from transportation.

The rapid urban sprawl witnessed around the border of the city of Toronto, the Greater Toronto Area (GTA) is resulting in low density housing as well as a heavy reliance on motor vehicle use. Further, the population growth in Toronto is expected to rise by 40% in the next two decades, and therefore transportation issues should receive attention. The transit use per capita has been declining in the past decade, as citizens prefer personal vehicles over public transportation. In Canada, about 4 out of 5 urban commuters drive cars or light trucks and mostly commute alone. The growth in personal vehicles and truck numbers as well as the poor capacity of the public transport infrastructure are factors behind the observable air quality problems (City of Toronto, 2005). Moreover, as the city is growing and its borders are expanding, Toronto is challenged by a declining commitment in transportation investment from the provincial and federal levels of government. Consequently, the majority of Toronto residents spend more money on transportation per month than on food (Toronto Atmospheric Fund, 2003). Additionally, billions of dollars are spent annually due to health problems, delays, pollution and accidents.

The numbers of escalating illnesses and deaths that are attributed to poor air quality caused by the transportation sector are equal to \$9 billion in Ontario. The Ontario Medical Association issued a warning that the declining air quality poses public health risks, as increasingly more people are admitted to hospital for cardiac and respiratory illnesses annually as a result of smog⁸ (Toronto Public Health, 2004). In Toronto, the largest source of smog is created by motor vehicles, and substantial volume of smog components originate from the US. Transportation also contributes to water quality problems, as rainwater flows on paved roads collecting pollutants, oils and heavy metals that wind up in the rivers and lakes.

The demand for transportation in Toronto currently occupies 40% of land in Toronto which comprises of streets, parking lots, gas stations, etc. Land demanded by transportation is about 70 times greater than the space required for walking. It is clear that transportation needs place enormous pressure on land use with implications of green space availability (City of Toronto, 2005).

The transportation & mobility parameter must therefore address the need to provide residents with alternatives to automobile use while discouraging single passenger commuting. With plans to develop a lay out that is characterized by efficient transport, PDP has an opportunity to facilitate mobility for residents and visitors alike by creating an infrastructure that offers various alternatives to the automobile. Given the number of people that will be living in the area combined with the commuters, PDP has the capacity to curtail negative effects of transportation.

⁸ Smog is primarily a combination of low level ozone and particular matter, created when NOx and VOCs are combined during sunlight. These pollutants can travel thousands of kilometers creating a challenge to addressing smog as the source can exist outside of the jurisdiction area

1.5.4 Water

Despite the abundance of water on earth, about 97% of it is salty while the majority of the remaining 3% is contained within glaciers and polar ice caps (Pearce, 2006). Water scarcity is escalating as a global concern. Canada has about 9% of the total available freshwater in the world, with nearly half the lakes, numerous major river basins (e.g. Mackenzie, St. Lawrence, Yukon) and a variety of climate catchments and source waters. Although Canada has an abundant freshwater supply much of which is contained within the five great lakes located on the US and Canadian border, the distribution of it is unequal within the country. Despite its abundance in Canada, climate change as well as the utility of the resource itself is mobilizing drought, groundwater depletion and aquifers not being replenished at a sustainable rate. Extracting water from aquifers is also energy intensive. Further, mean stream flows have been significantly decreased particularly in southern Canadian regions over the past 30 years. Depreciating glaciers in the Rockies will have a negative influence over water supply, which may in turn compromise the availability of water for public uses as well as for industries, particularly agriculture (Lawrence & Watson, 2003). Possessing a capital of scientific and engineering resources enables Canada to embark upon an opportunity to contribute to the development of an integrated national and international sustainable approach to water resources.

High water use clearly transforms into increased sewage treatment, triggering more challenges associated with overall water management. In addition to considerable treatment costs, substantial water use generates problems such as eutrophication and pollutants, in turn compromising the quality of water sources as well as the quality of aquatic life. Reducing water use will also alleviate the pressure on Toronto's waste water treatment plants (WWTP) thus reducing the frequency of combined sewer overflows and beach closures. Amidst the availability of current water treating technologies, treatment plant construction and maintenance remains costly and deplorably, three major Canadian cities continue to discharge untreated sewage into the oceans (Hendrickson, 2004).

Costs of replacing aging infrastructures and expanding the current systems that are often overworked render a financial burden for municipalities across Canada. In 2000 the government announced the formation of a Canada-Ontario Infrastructure Program aimed towards urban and rural infrastructure improvements in areas such as water, wastewater and general waste management initiatives. As much of the infrastructure is deteriorating and awaiting replacement while combined-sewer overflow systems that exist in Toronto are to be upgraded, immediate water conservation measures will lessen the loads the above concerns. Further, pollution caused by urban run-off during wet weather, sewer overflows, beach closures are problems that can be alleviated with water conservation techniques (Brubaker, Pers. Comm., 2005).

Water in Canada amounts to one of the lowest fees among OECD countries, and inevitably water is used quite freely in the absence of restrictions. Municipal water amounts to the third largest consumption after thermal power generation and industrial uses (from which agriculture is the most water intensive) (Environment Canada, 2005). From the total municipal water use, domestic use is equivalent to 56%. Toronto residents use approximately 250 L of water per person per day where most of this is used in the bathrooms and for irrigation in the summer (City of Toronto, 2005). It is important to mention that hot water usage is relevant in both the water use and energy context. Hot water heating constitutes one of the highest energy consumptions in the home and therefore reduction of water use is also consistent with energy conservation. Smart design and efficient technology installations are receiving attention

as they reflect Toronto's goal to reduce residential and commercial water use by 15% by 2011⁹ in order to ensure that the water system can meet the demands of an expanding city (City of Toronto, 2005). Decisively, housing designed with water management as an important element will enable residents to conserve more water.

1.5.5 Green Space

Although there is an abundance of green space in Canada, the rapidly vanishing greenery must not be overlooked around Toronto where development is dominating the vicinity. In spite of the prevalent urban environment in the city, the GTA consists of many local parks, valleys, ravines and waterways that form the Toronto watershed. Amidst the development and growth, Toronto still harbours six major watercourses (Etobicoke, Mimico, Highland Creeks, Humber, Don and Rouge Rivers). These watercourses provide habitats for both aquatic and terrestrial animals, north-south links for wildlife migration as well as drainage (Toronto Plan, 2000). Ecosystems that lie within green areas provide direct and indirect services to humanity such as vegetative screening, water purification, prevention of erosion, filtering pollutants from water and air and providing oxygen.

In *Space for All: Options for a Greater Toronto Greenlands Strategy* (2004), 'greenlands' or 'green spaces' are defined as follows:

- significant areas, whether natural, cultural or archaeological;
- areas that have important natural functions; and
- areas that serve as green corridors or open-space areas.

Environmental problems that exist in the air, soil and water compromise the quality of green spaces along with their ecosystems. Being a relatively new city, Toronto has already experienced widespread changes as it has been expanding; these include physical alteration of terrains, loss of natural shorelines, loss of wetlands, streams, forests and meadows. The alteration of land generates sediments and contaminants that affect the quality of water sources. The rampant development has particularly affected water sources because paved surfaces prevent the natural infiltration of rainwater to the ground. Stormwater is released from over 2000 outfalls in the city, winds up in rivers and streams carrying with it heavy metals, organic chemicals, bacteria and phosphorus (City of Toronto, 2005). Green space is perceptibly important in assimilating rainwater to regenerate aquifers and prevent pollution from stormwater.

Green areas do not only harbour biodiversity, but also serve as recreational and aesthetic functions for residents. Greenery provides citizens with an opportunity to discover and learn about nature while reinforcing psychological benefits. Green resources also serve as an important urban indicator in assessing changes in the environment and triggering signals for anticipated change. An important element of being surrounded by greenery is the appreciation and acknowledgement one develops for nature, particularly with frequent exposure. Human behaviour and attitude towards nature is positively elevated when citizens live in proximity to greenery (Kruuse & Widarsson, 2005).

According to the Toronto Region Conservation Authority (2005), about 60 acres (24 hectares) per day are lost due to development – this includes housing, commercial areas, transportation related development such as roads and parking spaces. Moreover, regions across Ontario are

⁹ The City of Toronto offers \$60 - \$150 for city selected water-saving toilets

being developed in the absence of a region-wide vision for greenlands protection, where only about 8.5% of the land within south-central Ontario is fully protected from development and construction (The State of Greenlands Protection in South-Central Ontario, 2004).

Because of the vast park space in possession of PDP and its values associated with preserving ecology, this is a paramount topic to examine. Green Space is an important parameter to consider as park space will account for 44% of the total project area. Development of PDP will carefully consider rainwater assimilation and natural flora and fauna in the surrounding region to ensure that environmental disturbance is minimal. As this is a significant portion of green space, a sound management of the resource is essential in order to achieve a thriving landscape.

1.6 Methodology

The fundamental purpose of this thesis is to employ the case study of the Bo01 district to steer PDP towards developing a sustainable city district with particular focus on the user phase. In this pursuit, the Bo01 district case study was closely followed to observe the results in the user phase with respect to each of the selected parameters. Using the Bo01 district as the central example, a review of this case was necessary to identify the strengths and weaknesses from which PDP could learn to deliver an improved version of the Bo01 district. The first step included a literature review of the progress in the Bo01 district and interview questions (with City of Malmö officials and researchers in the area) filled in the gaps when information was not published. Constructive examples are also taken from Hammarby Sjöstad to supplement the suggestions to PDP particularly in scenarios where the Bo01 district failed.

To recap, the management of the selected parameters, more specifically, the reduction of environmental impacts associated with each, is essential to generate an optimum occupancy phase performance. Therefore, the Bo01 district case study was examined with respect to how each parameter was addressed.

Further, the logic behind narrowing down on the design parameters, user phase performance and project management can be explained by the correlation among the stages. The user phase performance of the district is highly dependent on the success of the design. Having in place a successful design enables conservational behaviour among residents in daily life. This further takes into account the overall project planning because the final design framework and occupancy performance are shaped by the effectiveness of the project management approach. Without an effective plan for carrying out the project, it is unlikely the goals set out by PDP will be delivered.

In providing suggestions to PDP, Chapter 4 gives an account of the Bo01 district case study whereas Chapter 5 integrates the lessons and provides suggestions to PDP on achieving a sustainable user phase.

Project Management

Exposure to project management theories gave insight into how a large scale project was carried out and what are the key steps to materialize the strategies. In order for PDP to adequately deliver the strategies, it was important to examine how the course of the project was carried out in the model example – the Bo01 district case. Finally, to optimize the occupancy phase for PDP project management principles were applied in administering the

goals. The Plan-Do-Check-Act approach¹⁰ is employed to help PDP develop a more systematic evaluation mechanism to follow up on the user-phase performance. This is to ensure a continuous approach to improving the phase under scrutiny and export lessons to future phases while steering the progress to the targets.

Design Measures for a Sustainable User Phase Performance

At the commencement of the thesis, sustainable urban theories were reviewed such as the ecological footprint, and general definitions of sustainable cities. Exposure to the theories was helpful in identifying generic conditions for sustainable communities and learning how some developments gained inspiration. Studying such theories also helped define the requirements of a sustainable district and provided direction in selecting the necessary design features that alleviate pressure to resources. Focusing on design measures is important because in order to incorporate conservational behaviour in daily life, residents need the necessary design framework to enable this.

In examining the design phase of a sustainable district, the following was reviewed: the Bo01 case study and to a lesser extent other ecological districts like Hammarby Sjöstad and Augustenborg¹¹, and finally, the LEED principles. Issues investigated were - what are seen as important design measures in order to achieve a green city district with particular focus on the five selected parameters. Solutions were obtained from case studies (mainly the Bo01 case study) and architects. Literature sources were selected based on a positive outcome of a development for example, cases of LEED certified buildings. Architects interviewed were professionals who have worked on LEED projects to derive experiences from a practical context.

With the abovementioned cases in mind, the thesis presents design measures which are considered in the development of highly reputable residences in order to guide PDP towards an ambitious project on an environmental level. The design measures narrow in on the most environmentally intensive factor within each parameter. Design questions posed were: (1) What are the most water intensive uses in a house and how to address that with water conservation measures? (2) What are the most energy intensive uses and how to address them? (3) How to create a transportation network that promotes more environmentally sound mobility trends? (4) How to set up an efficient waste management system in a residential area? (5) How can green space be designed to be appealing and serve ecological functions? (6) What LEED criteria can be met with respect to each parameter? Furthermore, the focus on design parameters sets the framework for exploring the occupancy phase of a green development. The design framework is treated as a pre-requisite to a successful user phase in a sustainable community development.

The Bo01 case study design section in chapter 4 is organized into intent, outcome and discussion. The intent refers to the contents in the planning stage with respect to each parameter, the outcome refers to results. Finally, design recommendations in light of each parameter are presented to PDP using the experiences from the Bo01 district and LEED principles.

¹⁰ Plan – Do – Check – Act is designed to drive continuous improvement in a project. Initially implemented in manufacturing, but now has broad applicability. First developed by Walter Shewhart, and popularized by Edwards Deming.

¹¹ Located in Malmö, Sweden - an older neighbourhood completed and occupied in the early 50s. There were several failures in urban design: sewage flooding in basements, combined sewer overflow, excessive energy use and deterioration of building material. In pursuit of improving the community MKB initiated a transformation of the residential area.

Influence Measures for a Sustainable User Phase Performance

As design provides users with the framework for an effective environmental performance during the occupancy phase, behavioural issues are significant in the continuity of the goals within the community.

In examining the Bo01 district case study it was important to explore how the residents were engaged to have a positive influence on the district. In this pursuit, education and communication measures that were carried out in the district were studied. The research explored the types of educational measures that were used (verbal, internet, publications) how it was organized (responsibility of carrying out the tasks), their duration and the impact it had on the residents. Further, ways to improve the education measures were also presented.

Evaluation Measures for a Sustainable User Phase Performance

In delivering a successful user phase performance, it is vital to carry out evaluation and follow up studies to track the progress and identify areas for improvement.

Research was done to investigate how the performance evaluation of the occupancy phase was carried out in the Bo01 district in light of each parameter. Where the Bo01 district scored below the targets, examples from other successful case studies are included, particularly from Hammarby Sjöstad.

Questions posed were to determine which parameters worked well and which needed improvement with respect to the user phase and how the evaluation roles were coordinated. Examples of questions are: How was evaluation and follow ups carried out? What targets were met and failed? What was done in response to targets that were not met?

More specifically, for the energy parameter the following were studied: how specific were the evaluations, what were the evaluation activities aiming to investigate, what were the key sources of consumption how the progress has changed since the beginning of the occupancy phase.

For the waste management parameter, the following were studied: what were the results of the waste separation targets, were there improvements with time, how the data was collected, what were the pros and cons.

For the transportation & mobility parameter the following were studied: how were the alternatives used, did the trends change over time, were alternatives seen favourably, what were the preferences with respect to daily mobility trends.

For the water parameter, the aim was to research the daily usage and the outcome of water efficient technologies.

For the green space parameter, the following were studied: how did the greenery change over time, was there satisfaction with the number of species, how did this parameter contribute to the functions of the district.

General Information

The course of the thesis involved interviewing parties in relevant fields such as planners of Bo01, Hammarby Sjöstad, architects, municipality representatives (City of Malmö and City of

Toronto), green building council representatives, management of PDP, researchers and professors.

Internet research included browsing the following websites: project (Bo01, Hammarby Sjöstad, Vauban¹², PDP), municipal departments of the above cities, (city plans, water/waste/energy/urban sprawl/transportation/planning issues), green building councils, architectural firms, ecological conservation organizations, etc. Internet research was commenced by typing in phrases such as the following: “sustainable communities” and “green building districts” as well as “performance evaluation + cities”.

¹² A sustainable city district in Freiburg, Germany

2 Background to Theories

Below is a brief introduction and description of the theories that support the fundamentals of this research project. Relevant to the context of this research are both sustainable city theories as well as project management theories. The former is applicable as it directs focus to current urban challenges and places them in a global perspective. The latter provides a framework under which such city districts can be successfully transformed by shaping the course of the administration with a better structure, planning and continuous response of action.

Sustainable city theories provide a general perspective on the important elements needed to achieve a sustainable community. They create a foundation and vision for many city districts that are currently witnessing a transformation towards a better environmental performance. Such theories enable the process of identifying the requisite elements for a sustainable city district and areas for improvement. Sustainable city theories provide a framework for discussions about resource consumption patterns and waste assimilation, while encourage further advancement as time is revolutionizing technology, challenges and circumstances under which such districts function.

Exposure to project management theories is fundamental to gain a perspective on how large scale projects are administered. Taking into account the number of disciplines, coordination, planning of tasks and multitude of goals within each parameter, integral to a successful outcome is a solid project management approach to structure the course. The application of a project management model strengthens the administration through a circular loop promoting continuity in improvement of the project - a city district in this case. In order to apply project management models in an effective manner, it is important to first review the elements that comprise the approach in a theoretical context.

2.1 Sustainable City Theories

The theories represent a portrayal of a sustainable community in a wider or global context. Understanding their positioning in a global context helps to acknowledge the importance behind each individual sustainable city project. Prior to introducing the theme of evaluating “sustainable city districts”, it is vital to examine this description and what it encompasses as well as the theoretical framework embedded within it. The idea of a sustainable city came to birth at the United Nations Conference on the Human Environment in Stockholm (UNCHE) in 1972 when attention was devoted to sustainable development ideas. The meeting in Stockholm, Sweden was the first global diplomatic meeting to address the relationship between humans and the environment. The Human Environment Conference resulted in a set of principles in the Stockholm Declaration, the formation of the United Nations Environmental Programme (UNEP), and United Nations formed the Centre for Human Settlements (UNCHS) to promote sustainable growth among urban and rural communities (Whitehead, 2003). A sustainable city is where the interaction among social, ecological and economic relations support a functional and thriving community district. A sustainable city is defined by the United Nations Sustainable City Program as:

A city where achievements in social, economic, physical development are made to last. A Sustainable City has lasting supply of the natural resources on which its development depends (using them only at a level of sustainable yield). A Sustainable City maintains a lasting security from environmental hazards which may threaten development

achievements and allowing only for acceptable risk (UNCHS/UNEP, 2001, p1).

The program further stresses the importance of sound urban environmental management, where the problems that are faced by cities as well as created by cities are addressed in order to prevent passing the problems on to future generations. It is believed that although cities are faced with continuous challenges, they are also centres that harbour enormous capacity for applying innovative solutions to existing challenges and to those that may arise. In pursuit of continuous efforts that shape community management, cities should not be perceived as finished products, but instead, should be envisioned in a constant state of becoming (Whitehead, 2003). It is therefore vital to continue excavating for solutions and improvement to stimulate the capacity for positive action and to generate a momentum of perpetual advancement.

“Sustainable communities are places where people want to live and work, now and in the future. They meet the diverse needs of existing and future residents, are sensitive to their environment, and contribute to a high quality of life. They are safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all.” (Whitehead, 2003). They require a balance of integrated social, economic and environmental components of the community while meeting the needs of existing and future generations. There is no specific standard for designing sustainable city districts; therefore the design has to reflect the local circumstances. This gives rise to the importance to consider local conditions when developing a community – to make use of surrounding resources and to ensure vulnerable factors receive special attention.

Some common goals are harboured by sustainable communities in an environmental context: are: minimizing climate change through energy efficiency, focusing on renewable resources, minimizing pollutants and effluents, minimizing waste and practising positive waste management techniques, encouraging sustainable production and consumption, protecting biodiversity, promoting lifestyles that enhance positive impacts – creating opportunities for walking and cycling. Further, a well built design that promotes comfort and satisfaction for residents while being well connected to other parts of the city (Office of the Deputy Prime Minister, UK, 2005).

2.2 Project Management

Integral to the successful execution of any project is a well structured and planned project management process to ensure goals are materialized. The number of stages of a sustainable community project and the number of actors involved in the coordination necessitate an effectively functioning project plan to ensure all activities are carried out as planned and to structure monitoring and evaluation mechanisms throughout the duration of the project.

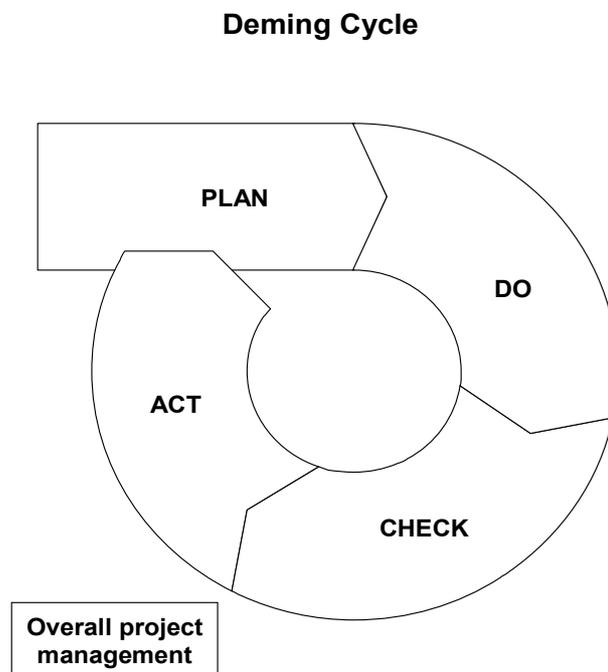
Project management theories are generally prescriptive and provide guidance on how action shapes the goals that are set out in planning. Within the project management theory there are three possible general fundamentals: (1) design of the systems employed, (2) control of those systems in order to deliver what was planned, (3) and improvement of those systems (Howell & Koskela, 2002).

Having such a model in place enables further analysis the design and control, while providing a common framework for the cooperation among the individuals involved thus facilitating the specified processes necessary for the project’s completion. The framework for cooperation

encourages innovative practices and the possibility for testing the validity of the process, which leads to the further development and improvement of the methodology.

2.2.1 Deming's Cycle

A simplistic yet practical model that can be employed during the course of the project particularly for the evaluation phase is **Deming's Plan – Do – Check – Act Cycle**. The plan component encompasses defining the problem/task, goal setting and defining targets according to the final vision; the Do component highlights activities that must be prioritized, analyzed and carried out in a controlled manner to fulfil the goals of the project; The Check step necessitates evaluation of the results of previous two steps to determine the progress and to identify areas for improvement; and Act involves the identification and prioritization of opportunities for performance increase and revisions to planning. This then proceeds to the next cycle where the steps are repeated to ensure continuous improvement. An illustration of the cyclic process can be seen in figure 2-1.



5

Figure 2-1 Deming Cycle

Project management models play an integral role in carrying out the strategy, and in this case, for designing and follow up of a sustainable community development. The design and planning phase of a project reflects the “Plan” component of the Deming’s Circle theory. This should also include prediction or results and analysis. The “Do” component reflects the actual construction phase and design where the concepts that evolved from planning are analyzed and put into practice; the “Check” component then reflects the evaluation and monitoring stage and mechanisms where potential problems are identified; and in turn the “Act” component reflects the actions taken to rectify challenges and errors identified in the “Check” phase. The “Act” step also prompts for improving and standardizing the process based on the results. In applying the model correctly, the cycle should be repeated throughout the course of

the project. Such a structured project management approach can lead the development in the right direction by providing a loop where actions need to be taken in response to failures and changes need to be made to planning and carrying out strategies in the event of a performance that does not reach the goals. The Deming cycle plays an important role in this thesis as it directs focus to evaluation and correction through a cyclical improvement approach. It reinforces the necessity to evaluate and respond to the outcome with rectification. The four phases of Deming Cycle allow for a straight forward and systematic approach to promote ongoing improvement.

3 Park Downsview Parc (PDP) Inc.

This sustainable community development is in the planning stages and when the goals are materialized, the Parc Downsview Park community will be well equipped to represent a successful example of a high performance district. With its interest in adopting a holistic approach in revitalizing a former military site to create a sustainable community, PDP harbours the requisite goals to represent a showcase example. The PDP development plan embraces the need to address the five parameters and promote community design that is characterized by high environmental performance while paying particular consideration to renewable energy, protecting biodiversity, promoting domestic conservation, providing an efficient infrastructure and social cohesion for residents and visitors. According to Tony Genco, the president of PDP, the project's level of ambition is boundless and there is no cap to excellence, where the aim is to be distinguished as an eminent model of urban sustainability not only within Canada but also internationally.

3.1 Background to Park Downsview Parc Inc.

PDP was established by the Canadian federal government with an objective to construct a “unique urban recreational greenspace for the enjoyment of future generations” on a self-financing basis. In 1994 the government of Canada announced the closure of Canadian Forces Base and the transformation of the former military site to a community. PDP became a deemed parent Crown Corporation in September 2003. To clarify the organizational structure, PDP reports directly to Parliament through its responsible minister, currently the Minister of State. This structure ensures transparency and accountability to the Parliament and the public by holding meetings and releasing annual progress reports while having updated information on a website. In May of 2005 the government approved the transfer of the park lands to PDP from the Department of National Defence, however, the corporation is still waiting for the actual transfer to take place in order to assume full responsibility over the lands. Until then, PDP has limited authority over the park area.

The park comprises of about 232 hectares (572 acres) of land in the northwest part of Toronto that will be divided among residential, commercial and park space. About 130 hectares (321 acres) are designated for conventional park space while 102 hectares (252 acres) will be dedicated to revenue generating opportunities (commercial and residential real estate) that will finance the development of the entire area (PDP Inc. Annual Report, 2004-2005). PDP harbours the goal to create a sustainable housing plan and to formulate innovative market housing solutions. This features demonstration projects, and opportunities for types and range of housing possibilities. Specific building performance standards will target all sorts of developments (high and low rise, retail, office, industrial). LEED levels are to be met and a cost assessment of LEED construction compared with conventional buildings will be carried out.

As the project is currently in the early stages of planning, one of many important activities currently carried out by PDP is the creation of Sustainable Community Development guidelines, which are to “facilitate the realization of a national urban park, a self-financing corporation, an agenda dedicated to demonstrating visible and complementary sustainable practices”. Further, these guidelines are to serve as a steering document to set design conditions and to ensure all developers and actors involved are working towards the goals defined by PDP. An overview of the guidelines is provided further in this Chapter. A diagram of the development plan is illustrated in Figure 3-1.



Figure 3-1 Development plan (PDP, 2006)

3.2 Initial Environmental Challenges

The Canadian Defence agency conducted an analysis of the land and soil to identify problem areas that were left behind after ceasing the military activities. Surprisingly, only a few hot spots were found (e.g. barium¹³) and were remediated, while the rest of the land was found to be in satisfactory condition. A current problem lies in the existing buildings that were constructed decades ago and contain chemicals such as asbestos and lead in paints. The main focus is on asbestos, which must be encapsulated in order to prevent exposure to anyone in contact.

3.3 Dialogues

PDP has been collaborating with the Toronto Conservation Authority, City of Toronto, Toronto Wildlife Centre, Toronto Community Housing Corporation and more. The purpose of the dialogues is to identify any challenges that may arise in the development and to obtain recommendations from the above organizations with respect to their field of expertise. A dialogue with developers has not been initiated yet because PDP is in the process of designing detailed general community and building goals. The completion of the environmental guidelines will give rise to the process of seeking interested developers who will be aware of

¹³ A soft, silvery-white alkaline-earth metal, used to deoxidize copper and in various alloys. It is reactive and poisonous.

the goals and targets PDP strives for. Based on the expectations conveyed in the guidelines, developers will be selected according to the best practices and performance each is capable of delivering.

PDP will develop a communication plan with stakeholders to identify methods for dialogues with the residents and other interested parties. Instructions will be outlined for a dialogue process and third party interactions, particularly the public.

3.4 Financing

PDP is a self financing organization and generates revenue through leasing of buildings and land, holding special events as well as educational and sporting programs. The organization will continue its financing activities, and in the real estate area, a combination of leasing and selling units will be employed to maintain a balance of short term (sales) and long-term (leasing) revenues. There are also a number of donors to assist the development. The project will be carried out over a period of 20+ years, where a surplus is anticipated by 2026/27.

3.5 Background to Sustainable Community Guidelines

Below is a brief description of the contents of PDP's Sustainable Community Guidelines draft which is to set the foundation for planning and development with respect to environmental goals. The preliminary sustainability guidelines are in the form of a draft awaiting further development. The final version of the sustainability guidelines will entail specific requirements addressing the development of the community.

3.5.1 Energy

On a large scale, the energy utilization plan will outline a strategy for a district energy system in the presence of conservation measures and endorsement of renewable energy. The plan will take into account Canada's participation and the significance of the Kyoto Protocol while identifying targets and technologies to meet the defined goals. There is interest in developing possibilities for solar and wind energy and use of ground source heat pumps. The current steam plant that delivers electricity to the district has a remaining life span of 5-10 years, and therefore PDP plans to redevelop the energy supply into one that is more modern and to introduce cogeneration or tri-generation (a system for heating, cooling and electricity). Should the energy supply exceed the district demand once the site is fully operational, PDP will entertain the idea of selling the excess to other regions.

On a building scale, the development of all properties on site will be defined by LEED criteria in order to obtain energy optimization. Further design criteria to be taken into account are the following: high efficiency envelopes, solar strategies, alternative heating and cooling methods, insulation and glazing.

3.5.2 Waste Management

Although no specifics have been outlined with respect to waste management, PDP recognizes this parameter as significant in the overall functionality of the community. Attention will be given to increase source separation. PDP will also consider current and future legislation with respect to the waste parameter.

3.5.3 Transportation & Mobility

A set of directional policy statements will be generated that influence different types of transportation facilities and identify transportation demands. Focus is directed to providing public transportation as well as encouraging walking and cycling by creating paths. Land use and relationships are to be addressed to create an efficient mobility infrastructure based on alternatives to single passenger driving. A current development is a plan led by the City of Toronto to extend a subway line to the PDP area in order to provide the community with a convenient transportation system.

3.5.4 Water

On a large scale, storm water management and water quality as well as consumption issues will be considered in the developmental and operational phases. There is interest in potentially setting up an onsite water treatment plant. On the building scale, water reduction approaches will be taken to maximize conservation.

3.5.5 Green Space

This component will define the relationship between development and greenery. Although the ratio of the green space has been identified, a specific layout plan has yet to be developed to maximize the utility aspect for residents and visitors. More specific biodiversity issues also have to be identified to preserve the livelihood of the surrounding ecology.

3.5.6 New Ideas for further Investigation and Innovation

This plan includes a process of review and amendment within the framework to ensure possibilities for improvement will be developed to analyse the components in the PDP plan. The presence of this component gives rise to the potential of including the PDCA project management approach in the development.

4 The Bo01 District Case Study

The Bo01 district represents an internationally recognized example of a sustainable city region which has been materialized in 2001 for a housing exhibition. The commendable energy policy, aesthetically appealing architectural design and ambitious environmental agenda of the Bo01 district attract visitors from around the world. Being a showcase example of a sustainable city district and with similar ambitions to many current sustainable cities under way, the account of this case study outlined below has tremendous value in providing insight in driving similar projects.

In pursuit of reviewing the occupancy phase of the Bo01 district, the first part focuses on the background to provide general information about the neighbourhood, the second part focuses on project management; the third part reviews the design features with respect to the selected parameters; the fourth part covers educational measures; and the final part reveals an account of the evaluation activities with respect to each parameter.



Figure 4-1 The Bo01 district (City of Malmö, 2006)

4.1 Background to the Bo01 District

The upcoming housing exhibition was a driver behind the Bo01 district that started the city development - the transformation from an industrial site and shipyard to a sustainable city development (Olsson, 2005). The Bo01 district is situated in the Western Harbour and occupies 25 hectares of a dense urban region in Malmö, a city of 264 000 people. The future capacity of residents, students and employees in the Bo01 district is anticipated to be approximately 30 000 (Hancock, 2005). Currently there are over 1500 inhabitants in the area. The housing area consists of 500 dwellings in buildings from one and a half to six floors. When constructing the Bo01 district the aim was to “make Västra Hamnen (the Western Harbour) an international leading example of a densely populated, environmentally sound neighbourhood.” (Andersson, Hallin, Hillbur & Nilsson, 2005). The district encompasses residential and commercial units as well as green space that were designed to operate efficiently with special focus directed to renewable energy and thriving greenery. Making the Bo01 district particularly unique and commendable is its energy policy - the project was

recognized in 2000 as the best European example of renewable energy for its success of delivering 100% local energy to the site (Dalman & Persson, 2005).

Embedded in the Swedish energy policy is the goal to secure the supply of energy on competitive terms with regard to both short and long term perspectives. At present already 60% of Malmö's district heating system that has been supplying the city for nearly 50 years is derived from renewable energy. The energy focus makes the Bo01 district a progressive example of a 21st century sustainable city. Further, the energy factor in the Bo01 district is designed to facilitate the comparison of the cost of supplying renewable energy with reducing energy use in buildings. The energy particulars will be elaborated further in this chapter (Nilsson, 2005).

The birth of the Bo01 district resulted from the idea to host a housing exhibition, where Malmö won the opportunity to lead the exhibition in a competition against 7 other municipalities. The inspiration of the Bo01 district was conceived by a professor, an architect and two representatives from SVEBO¹⁴ while the coordination of financial arrangements was provided by the State. The City of Malmö and SVEBO shared roles in forming a housing exhibition project organization (also named Bo01). The Swedish Housing Exhibition Association appointed people to the Bo01 organization and selected the site. The mandate of the Bo01 organization was to run the planning activities for the exhibition, marketing and to conduct the exhibition itself. Moreover, as such a large scale project involves many stakeholders, the Bo01 organization was to manage the relations among the key interested parties: the City of Malmö, SVEBO and the developers (Olsson, 2005).

The Bo01 district now ranks as Malmö's third most popular tourist attraction. Current and future business plans include greening of businesses in the area to enhance the image and to heighten the level of sustainability present in the district, an example is the inclusion of "green" restaurants. With respect to current demographics, the 20-29 age group makes up 45% of the population while people over fifty make up only 17%. As the Western Harbour area is continuing to develop, the links from the Bo01 district to the rest of Malmö are still characterized by an industrial landscape, however, this is slowly changing (Gronland, 2005).

¹⁴ Organization formed by the National Board of Housing, Building and Planning and 10 other municipalities



Figure 4-2 The Bo01 District (home.att.net, 2006)

4.2 Project Management

This section of the thesis describes the project management activities that enabled the Bo01 organization and the joining partners to carry out the development. The first discussion is about the planning of the project followed by the components of the steering document that set out standards for the development.

4.2.1 Planning

Numerous meetings were held to coordinate plans and share information among the developers group, the Bo01 organization, Sydkraft and the City of Malmö. At the commencement of the planning stage, the Bo01 organization publicized schedules for information meetings to invite prospective residents to dialogues, and some 300 people gathered regularly to engage in planning discussions. Although the panel group was not truly representative of the Malmö population, it was helpful in the planning of the Bo01 district (Nilsson, 2005).

About 30 to 40 different types of meetings took place in the 3-4 year planning time frame to allow for extensive discussions and improvements of planning. At the initial stages of communication the developers did not want to reveal extensively about the building plans, and the delay of the process was blamed on the City of Malmö for not being prepared. In turn, the City blamed the developers for delaying the construction. The construction started slightly

past the planned schedule which put significant time pressure on the projects. Additionally, a 3 day strike among the trades workers interrupted the process, when the construction phase had begun, leading to further delays and thus putting even more pressure on the time constraint to have the exhibits completed by the housing exhibition opening date. In preparation for the housing exhibition, most of the buildings were erected simultaneously creating traffic and backlog problems. Although the project was considered a success, logistical problems and the brief time constraint encumbered the development (Andersson, Pers. Comm., 2005).

4.2.2 Steering Documents

The Quality Programme (QP) was a voluntary steering document developed through the collaboration of the City of Malmö, Sydskraft and developers and compiled by the Bo01 organization in order to set minimum standards and promote consistency in terms of environmental requirements among the participating housing projects. The steering document was developed over a year before the commencement of the Bo01 district. The QP was an operative instrument in the planning and construction phases included in development and housing exhibition agreements. During land allocation agreements with the City of Malmö the developers assured that they would comply with QP. In addition to providing developers with basic standards, QP outlined measures for attractiveness of the city, architectural criteria, and high quality services and technology. In fact, there was substantial focus on the development of IT networks to facilitate communication and to develop a community that favours IT communication as opposed to commuting. The programme had a continuous focus which was effective past the signing of contracts to promote ongoing coordination among the City of Malmö, the Bo01 organization and the developers. QP also promoted environmental excellence in aim of “presenting the project as the world’s leading example of a green compact settlement” (Larsson & Wallström, 2005).

The QP consisted of various qualitative and quantitative measures to define expectations for the district during the development. The programme encompassed the following parameters: **public space and green areas, transport, energy, waste management, water and sewerage, buildings and courtyards**. Each of these categories was subdivided into numerous specific targets that had to be fulfilled. Based on QP guidelines the architects and structural designers set the framework for the contractors, who were then instructed to develop environmental management systems for each project. The program was predominantly characterized by qualitative requirements such as what materials cannot be used and which should be analyzed from a life cycle perspective. However, energy measurement and green space calculation are parameters measured more quantitatively. The QP made specific requirements about evaluating the energy aspect, reflecting the most important issue in the project to demonstrate the ambitious renewable energy goals and stringent targets. Developers were instructed to carry out consumption and comfort related measurements for two years following the completion of the housing projects. To a small extent the QP addressed the importance of resident behaviour and included plans that targeted educating residents in efficiency promoting measures (Larsson & Wallström, 2005).

QP intentions and design features will be presented in accordance with each parameter in section 4.5 of this Chapter.

4.3 Discussion

The project management process that underlined the Bo01 district development was rather disorganized and dynamic. The pressure to prepare for the housing exhibition and the financial problems that arose during the course of the development resulted in structural

changes within the Bo01 organization that compromised the quality process. Initially, given the substantial government grants, the City of Malmö assumed that the environmental criteria would receive significant attention, however, due to financial constraints the restructuring changes within the Bo01 organization, only one individual was left in charge of the environmental matters. Given the extensive list of criteria found in QP, one person overlooking the process was simply inadequate. Although the QP was ambitious, the developers did not follow all the requirements. For example, the condition to run an EMS was not adopted by any of the developers (Dalman, Pers. Comm., 2006).

The developers stated that the process of carrying out QP would have been more efficient if the program provided further guidelines such as matched the professions or actors to the given targets in order to clarify distribution of responsibilities. The developers had to assume the responsibility of assigning roles (Larsson & Persson, 2005). Although the Bo01 QP outlined a general role distribution, there was a problem with follow up activities after the Bo01 organization dissolved. According to QP the Bo01 organization was to be involved with various evaluation and follow-up activities in partnership with the City of Malmö and municipal service companies. Carrying out all the responsibilities in planning can be challenging as during the course of the development turnovers in organizations can alter the prioritization of environmental goals. Consequently, the City of Malmö assumed the majority of the follow up activities after the dissolution of the Bo01 organization.

With respect to developer involvement in drafting of QP, engaging developers in the process transferred a level of ownership and accountability to the developers unlike simply distributing a finished copy that is to be followed. The integrated process of the QP development also gave rise to a dialogue between planners, the city and developers to reach a consensus between very ambitious goals and what was technically and financially viable. Despite some discrepancies like the energy target, the developers were cooperating with the Bo01 organization and Malmö during the housing exhibition as it gave them a marketing advantage and many buyers expressed interest in high quality and environmental performance (Andersson, Pers. Comm., 2005).

One of the shortcomings was that QP did not outline a systematic plan for user phase performance evaluation except for making references to monitor energy. With respect to the program status, the instructions given were that “each player involved is responsible for ensuring that work proceeds in accordance with the QP”. This was rather ambiguous as it failed to specify roles, the objective of evaluation itself, verification processes and subsequent approaches to correcting flaws.

Furthermore, many experts identified limitations (Larsson & Persson, 2005) to QP stating that it was based more on qualitative rather than quantitative evidence, however both types of measures served a great importance in evaluating such a district’s performance. Dealing with quantitative measures allowed for a more systematic and structured evaluation and quantifiable progress tracking, but such cannot be applied to all factors within each parameter. For example, resident satisfaction or user friendliness of certain facilities required a qualitative evaluation approach. A lack of quantitative requirements was seen in the recommendation to employ a “proper selection of materials” and “encouraging LCA studies where possible”. Moreover, phrases such as “environmentally adapted” and “resource efficient” were used as guidelines, and such entail an element of ambiguity.

The program could also have included more incentives to steer developers towards the adoption of more efficient technologies, however, in the absence of incentives, sanctions or penalties, it was in essence a moral agreement. This is a challenge in such steering documents,

as the targets must be stringent enough to deliver environmental excellence, but flexible enough for developers to participate and fulfil the goals. There were attempts of incentives such as further subsidies and performance competitions but the participation rate was too low to make such initiatives effective.

4.4 Design for Performance

The following section describes the design efforts present in the Bo01 district categorized according to the 5 parameters of interest. Each parameter is expressed in the following order: the original design intent, the outcome of the design, and concluded by a brief discussion. A more detailed account of the activities and progress will be discussed in the section 4.5 (Evaluation of Performance).

4.4.1 Energy

According to QP, choice of energy sources and usage were fundamental issues because of the long-term implications associated with energy consumption in buildings. Being the most intensive resource in a building and in order to implement the sustainable energy policy, such issues had to be considered thoroughly (Andersson, Hallin, Hillbur & Nilsson, 2005).

With respect to the energy supply in the district, the goal was to utilize local renewable sources, however, QP included the permission to import wind power and biogas if needed. In terms of housing, the QP dictated that the energy consumption in the buildings did not exceed an average of more than 105 kWh per m² UFA (usable floor area) annually. This was an average target of all the Bo01 district buildings summed up but deviations among individual properties were allowed – as long as the average met the target. The QP target was considerably lower than the current standard for conventional buildings and included all property related energy including energy recovery.

Further, QP required the construction of common facilities to save space and energy, these included cold storage and waste/recycling areas. Having common facilities in place eliminated the necessity of having such in each unit thus saving energy needed to heat the additional space. QP also required the installation of energy-efficient appliances (Quality Program, Bo01, 2000).

Electricity supply for the buildings is produced by a local wind turbine and to a lesser extent, the solar cells found on buildings across the district. The 2 MW wind turbine¹⁵ generates 6 300 000 kWh annually which is enough to supply about 2500 units. The wind turbine produces enough electricity for household consumption, heat pumps and a recharging station for electric cars. The wind energy supplies over 90% of the requirements and photovoltaics supply the remaining energy requirement. The area is equipped with 120 m² photovoltaic cells which produce more than 5000 kWh – enough electricity for 2 dwellings. The solar collectors on roofs of 10 buildings make up a total of 1400 m² for space heating and some of the domestic hot water heating.

¹⁵ Located in the Northern Harbour to minimize disturbance to residents, but can be seen from the Bo01 district



Figure 4-3 The Bo01 district (City of Malmö, 2006)

Heat is obtained from the local aquifers with the use of heat pumps. Cold water in the winter enables cooling in the summertime through the district cooling network and the same system allows for heating in the winter. The heat extracted from seawater is stored in a natural underground aquifer. In the summer, warm water fills the cavities in the limestone ground and cold water is used in the district cooling system. In the winter a heat pump increases the temperature of the water to generate heat. The electricity is fed into the current power supply network while the heat is fed into the district heating network. This system enables a storage function for the electrical and thermal energy eliminating the necessity for seasonal facilities. When onsite energy production exceeds demand, the surplus is sent to the main Malmö district; similarly, when demand exceeds the supply the Bo01 district receives electricity and heating from the Malmö network. In essence, this leads to an annual balance, and on a yearly basis the Bo01 district is self sufficient (Lövehed, 2005).

The buildings were equipped with a mechanical supply of heating and plumbing; controlled ventilation systems and heat recovery from the systems, use of heat exchangers, energy efficient equipment and appliances. Thick layers of mineral wool wall insulation and triple-glazed low-e¹⁶ windows (average R-value 6.5) were important properties to consider in terms of energy conservation. Despite some design flaws, most of the above features were materialized (Elmroth, 2005).

Organic matter from sewerage and food is digested in a plant to generate biogas which is fed into the natural gas grid to provide heat for some of the apartments. In addition to generating biogas, the nearby water treatment plant treats sludge, and separates phosphorus which is then used in agriculture.

¹⁶ Properties of low-E (emittance) glass reduce heat loss but admit solar gain. These are best suited for buildings located in heating dominated climates.

Outdoor lighting features skylight like fixtures, low level light set in the timber or around the boardwalk. These consist of fluorescent lamps, low voltage lamps and fibre optics in consistency with the energy reduction goals.



Figure 4-4 The Bo01 district boardwalk (City of Malmö, 2006)

The combination of the utilization of the natural cooling and heating enabled by the aquifer, solar technology, the 80 meter diameter wind turbine and the back up connection to the rest of the City's district heating system create a commendable energy production system.

The energy requirement was a contentious issue between the Bo01 organization and developers, as the Bo01 organization wanted a stricter energy target where the developers claimed that the goal was too ambitious. The attempt to meet this target was an arduous task, one that required cooperation among various stages of construction and planning.

There were communication problems and initial design challenges between the developers and architects such as not taking into account the height restrictions of the buildings. In a few cases the buildings met the height restrictions prior to the installation of the solar panels. This led to the construction of flat solar panels on some buildings which do not generate as much power as panels that are placed on a slant (Andersson, Pers. Comm., 2005). During the summers of 2002 and 2003 the solar power equalled to 300 000 kWh heat per year instead of the 500 000 kWh - which was expected. The shortage was also attributed to design flaws in the solar technology. In addition, problems were experienced with the aquifer where malfunctions in obtaining heat through the heat pump interrupted the operations (Lövehed, 2005).

In encouraging sustainable design, money from the LIP programme was used to purchase triple glazed windows for the Bo01 district buildings. In anticipation of this, one of the buildings took it for granted and did not put effort into maximizing insulation and wall thickness, assuming that the high efficiency windows would compensate for the deficiencies in insulation. Consequently, in the absence of adequate insulation and air-tightness, the windows contributed less to the indoor climate (Green, Pers. Comm., 2005).

4.4.2 Waste Management

The objective in the waste collection department was to develop a full scale system that maximizes recovery and recycling of materials and resources. It was prioritized in the following order: Re-use, material recovery and energy recovery.

In pursuit of diverting wastes, the categories of waste bins for separation specified by QP were: newspapers, cardboard, metal, plastic, coloured glass, plain glass, residual waste and organic waste. In pursuit of diverting 80% of the combustible waste, the systems were to be well labelled and user-friendly, and residents were to receive a continuous flow of information.

Each apartment was meant to have a separation system (temporary storage space for each fraction) to make the process of pre-sorting easier for residents (Quality Program, Bo01, 2000).

Waste recycling was a major part of the Bo01 district *Ecocycle* where food waste rich in nutrients was used arable lands as fertilizer. This was practiced at the beginning of the occupancy phase, however, now all food is converted to biogas (methane) to generate electricity and fuel for service vehicles (Bissmont, Pers. Comm., 2006).

The Bo01 district has a detailed system for household separation of the 8 various categories of wastes as specified by QP, plus containers for organic waste. This system has more source separation fractions than the average of Malmö (Bissmont, Pers. Comm., 2006). Users sort waste into separated food waste fraction and a combustible residual fraction. Food waste is collected in tear and moisture resistant paper bags. Separated waste is collected down 2 chutes from the ground - green for food and grey for residual waste. Each fraction is then collected regularly by a vacuum collection vehicle which connects to a central point and empties the tanks, while paper bags are collected from recycling rooms. The rest of the fractions are collected in special garbage storage rooms (Aspergren, Fagerström, & Gruvberger, 2005).

An innovative feature is a fitted disposer found in kitchen sinks of about 50 flats. This mechanism contains units that are separately drained into a local tank set into the ground that employs sedimentation to separate food waste from wastewater. The waste is disposed in the kitchen where food scraps do not even have to be removed from the sink and are ground immediately. This disposer accepts most food waste and residents have a manual on what cannot be placed in the sink (e.g. fish skin, bones and corn cob) (Bissmont, Pers. Comm., 2006). Food waste remains in place while water is sent to the sewer system. The food waste is then removed from the tank by a vacuum collection vehicle and sent to digestion tanks where it is digested with sludge (Aspergren, Fagerström, & Gruvberger, 2005).



Figure 4-5 Vacuum Waste Collectors (City of Malmö, 2006)

Malmö City Water and Wastewater Works in conjunction with Sysav¹⁷ carried out large scale tests of two systems of food separation (vacuum collection and food disposers). The former is

¹⁷ Solid waste company of Southwest Scania responsible for waste management, treatment and recovery of solid household waste, and industrial waste in southwest Scania. Strong proponent of waste to energy concept.

based on collection points for domestic refuse existing on or near the properties though each has a chute and collection tanks. The vacuum collection system has demonstrated to be reliable and hygienic. Problems with odour and flies do not occur with this system as they do with bins (Bissmont, Pers. Comm., 2006). The extensive list of items collected for recycling and the vacuum system for food collection enables residents to increase source separation.

The sink disposer is part of an experiment to test further possibilities to facilitate the separation of food waste. The ability to dispose the food in the sink prevents odours associated with storing the food under the sink.

4.4.3 Transportation & Mobility

In planning the transportation & mobility parameter, QP intended to minimize traffic pollution, consumption of fossil fuels and noise. The Bo01 district was to be designed to minimize the need for vehicle use while encouraging alternatives to the automobile.

In its design the QP created a goal to establish a transport network that was both safe, and environmentally sound in reducing the negative effects that stem from motor vehicle use. QP featured site planning that facilitates walking and bicycling and ensuring precedence is given to pedestrians and cyclists over motorists. With respect to sustainable transportation, meetings were coordinated for local companies to review their transportation needs and to help the businesses with approaches to more efficient transportation habits. QP also required that developers offer carpool services to residents to reduce the need for vehicle ownership. The use of telecommunications to minimize passenger travel was an idea that gained additional support. Essentially, the aim of this parameter was to encourage transportation efficiency (Quality Program, Bo01, 2000).

The planning of a reliable public transportation system to service the area was an important element in the Bo01 district. Bus stops are situated not farther than 300 meters of any building block to provide residents with convenient access to public transport. Public bus departures are available every 6 minutes during peak hours to ensure residents can rely on the public transportation system while discouraging personal vehicle use (Fridh, Nilsson, Ryden, 2005).

The Bo01 district was designed to give residents opportunities for walking and cycling. The passages and garden streets provide pedestrians with good access and a variety of walking possibilities around the area. Buildings feature storage facilities for bicycles to encourage ownership and cycling as a means of transportation (Fridh, Nilsson, Ryden, 2005).

In pursuit of discouraging personal vehicle ownership, the Bo01 district carried out a strategy to minimize the number of vehicles in the neighbourhood. The ratio of parking spots to the number of apartments is 0.75 to 1. Because of the high real estate value occupied by the housing development and to minimize traffic while improving safety for cyclists plus pedestrians, most parking spaces are underground and parking facilities for visitors are just outside the area.

The QP also encompassed a plan to establish a new public carpool network. The local carpool system was originally operated by a car hire company and Sydkraft, but the car hire withdrew after the housing exhibition. Unfortunately, the carpool network failed due to a lack of resident demand. Further, the fact that Sydkraft failed to find a partner interested to partake in the business to replace the old car hire led to the termination of the service in 2003 (Fridh, Nilsson, Ryden, 2005).

The Bo01 district has an onsite filling station for hybrid cars which also have parking privileges over standard cars. Further, the local parks and property maintenance staff operate environmentally-friendly vehicles to promote the principle within the community (Fridh, Nilsson, Ryden, 2005).

Another feature was the creation of a website *trafiken.nu*, enabling residents to access traffic and travel related information in the Western Harbour. There is also an interactive bike path map to provide residents with cycling information and directions in the area. Finalizing the interactive bike path is still in progress. This is an ongoing process requiring updating as the rest of the Western Harbour is still being developed (Andersson, Pers. Comm., 2005). Each block was equipped with a data network allowing residents to view bus schedules and to make carpool arrangements with neighbours by using their computers. To enable residents to substitute commuting, the development of an IT system is in progress to provide web conferencing for online meetings and presentations (Fridh, Nilsson, & Ryden, 2005).

Extensive studies were conducted to ensure a high reliability on the public transport system within the community and that there are attractive alternatives to driving. The ratio of cars to apartments represented a compromise between the Bo01 organization and the developers, where the Bo01 organization pushed for an even lower ratio, while the developers argued for a higher one.

With respect to the failed carpool system, a car pool service must be very competitive in terms of practicality and flexibility to appear more attractive than the choice of a personal car. In the Bo01 district the problem with the failure of the carpool was due to organizational issues. To compensate for that failure the City of Malmö outsourced to a car sharing organization that is currently initiating the service enabling residents to subscribe. Basic monthly fees and payments for usage will be applied in order to enable the service. Such a service may discourage car ownership for individuals that do not rely on automobiles on a daily basis (Nilsson, Pers. Comm., 2006).

4.4.4 Water

It should be noted that although water conservation was of some interest to the Bo01 organization, it was not on top of the environmental agenda. The abundance of water in Sweden and low prices of the resource are reasons behind the weak water policy.

No specific targets have been set with respect to the water parameter. Although, the Bo01 organization did not have a strong approach to water conservation, some references have been made to the reduction of water use such as the encouragement of high efficiency fixtures. The residential units were equipped with high efficiency water fixtures and dual flush toilets. Some apartments have web portals indicating consumption to make residents aware of usage.

Being a resource used by residents in many daily tasks in addition the energy implications in hot water usage are adequate reasons for paying special attention to water conservation. The availability of water efficiency plumbing and fixtures on the market facilitate water savings and the conservation of this parameter is quite achievable.

4.4.5 Green Space

The greenery in the Bo01 district was to provide the area with better air quality, to promote biodiversity, and to provide residents with the ability to enjoy nature. In designing greenery, the Bo01 organization made special requirements with respect to the balance of green space

and developed areas. QP also featured a strong emphasis on water as a key element of the greenery theme for aesthetic purposes.

In the Bo01 district there were 3 fundamental motives behind giving high priority to creating and sustaining greenery: (1) providing the residents with an aesthetically pleasing environment, (2) value of biodiversity, and (3) support to stormwater management. Green space was to be designed in a creative manner giving residents a variety of possibilities for walking on footpaths and across canals. Another requirement was that each apartment had to have a view of some green space. QP also encouraged the development of corridors so that animals were able to access fragmented green areas (Quality Program, Bo01, 2000).

A concept known as *green space factor* (GSF)¹⁸ was employed in Sweden for the first time to achieve an acceptable amount of green space in the Bo01 district. GSF supports a balance between greenery and asphalted surface by allocating a specified segment of the land to green space and ensuring that paved surfaces do not dominate the landscape. The development of GSF dictated that each courtyard was to include one new habitat per 100 m² exclusive of the garden land. Further, a higher point score was allocated for greenery and lower points for paving, construction space. The calculated average of all the factors had to be at least 0.5 to ensure that the neighbourhood features a healthy balance between developed attributes and green space. The aim of GSF was also to provide specified areas for vegetation and local stormwater management. One of the most common results of GSF was the adoption of green roofs as nearly all Bo01 buildings have them (Persson, 2005).

Another program employed was the *green points system*. All the developers were committed to choose at least 10 of the 35 green points developed by the Bo01 organization in cooperation with the City of Malmö. The points each had an ecological focus and were allocated for performance and numbers of animal, vegetation species as well as pond habitats. The ecological concept underlying the activities undertaken was based on four elements: prolonging irreplaceable natural features, minimization (carrying out development with as little ecological impact as possible), and a healthy balance between developed areas and greenery. This parameter also included habitat substitution for natural areas that have been replaced by the building district (Persson, 2005). The total area of green space to developed space in the Bo01 district is 53% excluding green roofs (Kruuse, Pers. Comm., 2005).

Prior to the development of the Bo01 district, there was a vast nesting area for birds which was abandoned during the construction. In order to compensate for the loss, a habitat of 18 000 m² was arranged by Malmö in the Northern Harbour. The woodland habitats featuring oak, beech and alder fen were too small to develop according to the models, but are starting to develop rich plant life (Kruuse & Widarsson, 2005).

The process of planning local storm water management was conducted with focus on reducing surface run off and systems to retain water. The entire stormwater system was opened from all downpipes thus stormwater is reduced and run off is more evenly distributed. The city of Malmö encouraged the construction of ponds, as they provide shelter for species while preventing the possibilities of flooding. Further, ponds contribute to cleaning the stormwater by sedimentation and breaking down pollutants (Kruuse & Widarsson, 2005).

The outdoor vicinity was built with natural materials such as granite, limestone, slate, wood and water for decorative and habitat enriching purposes. Aside from being ecologically

¹⁸ Originally developed in Berlin, Germany

intelligent, the Bo01 district is rich in open and green public spaces (total of 53% of the entire site + green roofs) (Kruuse, 2005).

Ultimately, the green space factor and green points system encouraged the developers to give high priority to greenery in every decision in the planning and construction phases (Persson, 2005). Providing developers with very clear and quantitative instructions such as the ratios of developed to green space was effective in achieving the green space target. Although the specific requirements were established after the creation of QP and during the development, the developers were very cooperative in terms of green space criteria. The choice of green roofs was particularly useful to stormwater management as the roofs serve similar functions to those of wetlands. Overall, residents of the Bo01 district were pleased with the green space structure and canals.

4.4.6 Summary of Design

Below in table 4-1 there is a representation of the key design features in accordance with each parameter.

Parameter	Design Features
Energy	Solar collectors, wind turbine, geothermal, heat pumps, ventilation recovery, high efficiency appliances.
Waste Management	Facilities for 8 recyclable items, food waste, and combustible waste, vacuum collection system, kitchen sink food waste disposers in selected flats.
Transportation & Mobility	Proximity to public transportation, bike paths, storage space for bikes, car-sharing organization in progress.
Water	High efficiency plumbing fixtures.
Green Space	Stormwater channels and ponds, green roofs, habitats for animals, view of greenery from all apartments, 53% of the entire site covered by greenery.

Table 4-1 Summary of Design

4.5 Influence of Performance

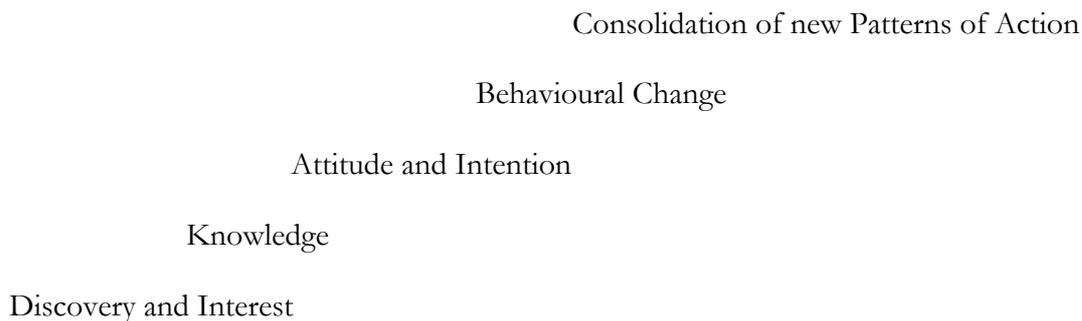
As both design and resident behaviour factors play a role in the overall performance in the district, each key parameter has to be shaped accordingly. While engineers, mechanics and architects normally deal with design problems and make corrections to identified flaws, resident behaviour should also be addressed in accordance with the goals as it carries implications to the overall performance. In fact, QP considered education as an important tool to positively influence resident behaviour and resident participation was invited through carrying out exhibitions and seminars. Although QP made references to resident education, no

specific instructions were outlined, for example, the context of the education, clear objectives or targets of education. Instead, education initiatives were developed shortly prior to and during the occupancy phase.

In order to engage residents to participate in environmentally efficient activities, several initiatives were launched in the Bo01 district. Among several programs, internet and television were seen as powerful tools in influencing the public (Nilsson, Pers. Comm., 2006).

4.5.1 Approaches to Resident Education

The environmental communication projects believed in a staircase like scheme that illustrates how people accept new information. The staircase model is as follows:



This model aimed to first trigger attention of the public by providing them with important and interesting sources of information. It was then meant to stimulate dialogue in order to give rise to debates and discussions. Conclusively, it was anticipated that the education, exposure to knowledge and discussions would influence residents by encouraging them to act accordingly in an environmentally friendly manner and consider environmental principles in every day tasks (Nilsson, Palm & Persson, 2005).

4.5.2 Education Programs

Below is a brief description of various educational programs launched by the City of Malmö to engage residents and visitors in the environmental activities of the Bo01 district.

MiljöTV på nätet (Environmental TV on the web) was a web based program to communicate with residents and encourage them to adopt environmentally sound lifestyles. This program showed a variety of films from which residents learned and was also the largest among the public education projects developed in the Bo01 district. The program was effective as of 2000 and ended in 2005.

MiljöEko Bo01 was a project whose focus was mainly to market the housing exhibition and released information packages with environmentally related education. These included brochures, green maps, exhibitions, and info on participation and arrangement of conferences. This initiative gave rise to the www.ekostaden.com website. The program was launched during the housing exhibition and ended in 2005.

Klimat-X was a program specifically catered to school children where students could explore environmental phenomena at their level. Here, students got exposure to environmental matters such as pollution and resource management. This program was also part of a larger initiative that aimed to interest children in science and technology. *Klimat-X* was launched during the housing exhibition and ended in 2005.

Public education projects also included lecture series, seminars and town walks. Such programs gave rise to discussions about defining a sustainable community, requisites for a good urban environment, and involvement of public participation (Nilsson, Palm, & Persson, 2005).

An innovative communication initiative was carried out through the presence of a Sustainability House during the housing exhibition, where people were exposed to a variety of environmental information through seminars and smaller exhibitions. There were always staffs present at this centre to respond to public enquiries. Upon entering the centre, the visitors encountered a long tunnel with flashes of information about numerous local and global environmental trends, such as recycling returns in Malmö and deforestation of tropical forests. The construction of this facility reflected the ecological ambitions of the Bo01 district and was built of recycled as well as recyclable materials. The sustainability house hosted a seminar nearly each day for prospective Bo01 district residents. This information centre along with other ecological surroundings attracted about 200 000 visitors. In all, activities, lectures and seminars were held to cater to a multitude of target audience from children to professionals (Nilsson, Fridh, & Ryden, 2005).

To a smaller extent, there were educational programs to reinforce each of the parameters. With respect to waste, the educational initiatives targeting residents were very thorough at the commencement of the project, but as time progressed, the City became less involved in addressing residents with waste issues as the initial approach was too exhaustive. Considerable effort was dedicated to preparing information for users, and surveys regarding collection. The administration's public relations officials have visited the residents in the district informing them about waste management and source separation. Upon identifying flaws effective 2006 the City of Malmö started to resume education and information initiatives.

With respect to the transportation & mobility parameter, a Mobility Management Office was set up during the housing exhibition to communicate to the public and residents about the advantages of changing travel behaviour. The office received about 10 000 visitors during the housing exhibition and shared information about personal travel behaviour. After the exhibition, this responsibility has been transferred to the Parks and Highways Department of Malmö City (Nilsson, Fridh, & Ryden, 2005). Further, measures included a letter and phone calls to the residents to educate them about sustainable mobility issues. Residents were given advice on how to adopt more environmentally sound mobility activities and the phone calls were well received. There have been no follow up studies to determine the level of impact of such initiatives (Nilsson, Pers. Comm., 2006).

4.6 Discussion

Two years after the Malmö housing exhibition 16 interviews were conducted with technical directors, park superintendents, city architects and environmental managers on behalf of Malmö City. According to the interviews, most individuals remembered quite extensively about the housing exhibition, or at least were familiar with the activities. It has been noted that individuals well remembered the unique stormwater management and the presence of green roofs. Many professionals admitted to discussing design principles seen in the Bo01 district with their colleagues. Even children demonstrated interest which they then passed on to parents, in turn motivating the adults to visit the housing exhibition. It was more challenging, however to attract the age group between 16-25 years, from which only a few attendants were visible with the exception of some class visits. According to the education and communication experience, it was particularly valuable to hold events for specific target groups, as such were

more influential. Another factor of success was the “word-of-mouth” effect that spread the information from visitors to visitors and children to parents (Nilsson, Palm, & Persson, 2005).

The Society, Opinion and Media Institute at Gothenburg University conducted an annual questionnaire to determine the national environmental concern among residents. A similar survey was conducted just for the Bo01 district residents. Amidst minor variation, both survey results (Bo01 and national) indicated a high level of environmental participation and concern, however, the residents of the Bo01 district scored slightly lower than the national average. Examples of questions asked were: the willingness to recycle, refrain from using toxic materials, drive less, choose organically grown food, etc. The survey results were surprising and some explanations for the lower scores have been formulated. For example, there was a question asking if individuals would use their own time to volunteer for environmental purposes. The response of the Bo01 district residents here was much lower than the average, implying that the residents are well occupied with jobs and their urban lifestyle have less spare time (Dalman & Sandstedt, 2005).

A follow-up has been carried out half way into *MiljöTV på nätet* to determine its practicality and usefulness. A final study is being carried out during 2006 to determine its success in the latter stage. According to the study, over half of the residents logged on to the website. At the start of such educational initiatives, the approach was primarily internet based which did not cater to all users. Although the Bo01 district was well equipped with IT connections, not all of the residents are internet/computer users. From this study, the education parameter was diversified to provide information uniformly and thus more seminars and exhibits stemmed from the results of the evaluation. Another effective information sharing activity was the organization of green fairs of various themes to attract organic restaurants, organic producers, etc. This allowed for open face to face interaction and an opportunity to discuss issues in an informal manner. Although no formal evaluation of the impact of the fair was carried out, the visitors to the fairs expressed enjoyment and interest in environmental issues (Nilsson, Pers. Comm., 2006).

During the housing exhibition there was an onsite office providing residents and visitors with environmental information, however, this was not continued further into the occupancy phase. In the absence of an information centre the Bo01 organization did not have the same ability to penetrate the residents with a physical presence. To replace the housing exhibition information centre there were talks about establishing an ecological forum which would also provide residents with information and tips on how to incorporate sustainability in their everyday lives. Unfortunately, because this idea was conceived too late and the lack of funding the ecological forum was never materialized (Nilsson, Pers. Comm., 2006).

With respect to the energy parameter, residents do have limited control over energy usage, yet education initiatives were not launched in response to promote better practices upon determining that the houses consumed more energy than expected. Although the cause of this was believed to be mainly due to design, user behaviour could have lessened the energy use at least to some extent. Correspondingly, this gives rise to the importance of educating, informing residents and involving them more in optimizing the district’s environmental performance.

Most of the waste related information consisted of how the residents can help with daily waste separation, but included little insight on how the waste management systems tie with other waste management practices in Malmö. This is an important element for the users to grasp in order to visualize each resident’s role in the grand scheme of the city’s waste management process (Bissmont, Pers. Comm., 2006).

The education and information measures proved to be difficult, as there is no ceiling to the amount of effort that can be carried out in this area. According to the Bo01 district experience, starting with smaller and simpler information while ensuring its continuity is paramount to success (Bissmont, Pers. Comm., 2006).

According to the Bo01 district experience residents take pride in their housing and it is therefore vital to reiterate the ecological goals of the district, as this has a positive impact on inhabitants. When confronted, the residents were responsive to the environmental performance issues and were willing to endorse sustainability tips. Ensuring that dwellers live in housing they are pleased with is important – satisfaction and pride are key drivers behind the motivation to perform tasks in accordance to the goals of the district (Nilsson, Pers. Comm., 2006).

Determining the effectiveness of the influence of the education parameter is important in making further improvements in the campaigns if necessary. Perhaps the quality and effectiveness of the campaign itself should have been examined. An idea to explore this is to select a panel in order to provide feedback to the education measures.

4.7 Evaluation of Performance

This section will describe the measures that were taken in the Bo01 district to evaluate the performance once the project reached the occupancy phase. The relevance of the course of evaluation activities in the Bo01 district provides insight into the challenges and positive outcomes associated with this step. The evaluation activities that were carried out are categorized according to each of the five parameters. Each parameter is expressed in the following order: the original design intent, the outcome of the design, and concluded by a brief discussion.

4.7.1 Energy

According to QP the evaluation of energy was to last for two years starting at the beginning of the occupancy phase. Most of the evaluation was outsourced to third parties such as Lund University, Malmö University as well as Sydkraft¹⁹ for further energy measures particularly on the production side (Elmroth, 2005). This was also done for practical reasons, since the Bo01 organization ceased to exist in 2001.

When the evaluation was commenced the energy target was not met in any of the buildings. A study conducted by the Lund Institute of Technology revealed that the apartments used more electricity than initially expected. Ten buildings were selected for special monitoring and calculations dictated that the buildings should reach between 77 and 107 kWh per m² UFA annually while operational measures showed use levels between 113 and 350 kWh per m². Essentially, the actual average per flat was 132 kWh per m² per year - 25% higher than the target. This figure, however, was still significantly lower than the rest of the city average which is 175 kWh per m² per year (Elmroth & Nilsson, 2005).

Although initially not one of the houses met the target, after corrections and improvement a successful example can be illustrated with the LB-hus, which was a special energy project coordinated between the Bo01 organization and the Swedish Energy Agency. This was one of two projects that also involved the input of researchers (Green, Pers. Comm., 2005). This house achieved an annual measure of 87 kWh per m², which exceeded its goal of 80 kWh;

¹⁹ Swedish energy company

however, it was significantly within the QP average target. What made this house very energy efficient is its insulation; the wall thickness is 30 cm and it is particularly well sealed around the windows, where about 1/3 of leakage occurs. Heat from ventilation is extracted before it is released outdoors and is re-used to heat radiators and water. Sensors monitor the temperature to prevent falling or increasing too much (Elmroth & Nilsson, 2005).

In calculating hot water use in the district, consumption has been estimated from the amount of district heat delivered during the summer when heating of the apartments was not necessary. The results revealed a lower use of hot water than expected.

In selected buildings detailed measurements of heat and electricity have been recorded for a year starting October 2002, which was the second year after the completion and in most cases also the occupation of the buildings. The hourly measurements of temperature, output ratings and flows have been recorded at about 400 stations with respect to the production and user sides. The meters were recorded to assess the energy performance according to the 105 kWh per m², while some buildings were subjected to more specific measures such as heat pumps and individual appliances to determine the usage. This revealed precisely how much energy is produced and consumed in each source, for example, how much is produced by a heat pump or solar power. The monitoring system was employed on an hourly basis, making it unique in the frequency and consistency of the evaluations (Elmroth & Nilsson, 2005).

In the past 3 years improvements have been made to the buildings in response to the follow ups and subsequently the latest results (2004) revealed that 3 buildings out of 14 met the 105 kWh per m² target. This was indicated in the reduced consumption of heat from the district heating system. Improvements were achieved by making corrections to the design (i.e. insulation, leakage) and also with time, insulation properties improved in some houses that were made of concrete. Concrete takes a long time to fully dry, and in the meantime, the presence of moisture affects the thermal insulation (Bagge, Pers. Comm., 2006).

Further, a qualitative approach in the form of a survey was taken to learn about the indoor climate and resident satisfaction. The main focus here was to follow up on the indoor atmosphere and comfort, but noting the indoor temperature gave some indication about energy usage in the flats. Although these surveys provided some indication as to how resident trends can affect the energy performance, at the time there were too few people occupying the buildings to provide the study with significant depth. The study is to be repeated during the latter part of 2006 now that the district is fully occupied. With respect to resident contentment, surveys indicated that residents were satisfied with the indoor air quality, but not with thermal temperature: draughts, and inability to control the heat in some units (Bagge, Pers. Comm., 2006).

In the design phase computer modelling was applied for energy use calculations so that the building features were aligned with the energy goal set out in the planning stage. It must be noted that computer modelling used in pursuit of meeting the targets had limitations as the measurements were based on a simplified model that was not necessarily representative of energy use in the operational phase. The calculations revealed some uncertainties (Elmroth & Nilsson, 2005). The results of the calculations, which required the input of building features (thickness of walls, insulation properties, window sizes, size of the dwelling, etc.) were too optimistic and failed to reveal the factual outcome given the properties (Green, Pers. Comm., 2005).

One reason behind the flaws in the calculations was that each developer took a different approach to calculate design measures correspondent to the energy goal. Although the Bo01

organization recommended the application of the Enorm spreadsheet program, there was no clear procedure on how to work out the calculations to meet the targets and consequently this led to inconsistencies as well as flaws.

In order to avoid this same fault the tactic has changed in the new development phases. Currently there is an onsite consultant helping developers with the calculations and ensuring the process is defined with consistency (Bagge, Pers. Comm., 2006). The blueprints designed by developers have to be submitted to a consultant who does the calculations uniformly across the development. After analysing the properties of the design should the drawings not meet the target, the consultant works with the developers on making suggestions in order to reach the target. It is noteworthy to mention that the new target in the Boo1 district is now 120 kWh per m² (Nilsson, Pers. Comm., 2006).

The planning of calculations was conducted with focus on the actual design and no consideration was given to the variation among resident behaviour. At the time of planning the Bo01 district there were little discussions about resident trends, and the lack of skill and experience compromised the ability to refine the calculations and performance evaluation to better reflect user consumption issues. There have been recent discussions in Sweden about specific energy simulations with respect to occupancy behaviour, and such specific studies are expected to take place in the Bo01 district by the end of 2006. Furthermore, because this is a recent topic of interest, there are currently no standardized approaches for integrated design and user phase energy performance (Bagge, Pers. Comm., 2005).

Domestic energy use was also measured by observing the output of the district heating system and electricity. Although a few of the buildings have been subjected to very meticulous monitoring to precisely identify domestic energy needs, for the most part there was no specific data available revealing a comprehensive domestic consumption (for e.g. how much is used by each appliance or room). Knowing where over-consumption takes place allows for either technical or behavioural improvements, wherever necessary. Detailed data for analysis was very beneficial for identifying flaws and then corrections; however, such frequent monitoring is often not carried out in projects because of the extensive effort needed and financial challenges. In the absence of detailed data and quantifiable results, the thoroughness of evaluation is compromised (Bagge, Pers. Comm., 2006).

Several factors were identified which explain the lower than expected energy performance. One factor mentioned is the poor use of space - where unnecessary space in the apartments leads to unnecessary energy use. Because the buildings were also characterized by their aesthetically pleasing architectural design, most have large windows. Although large windows allow the sun to light up the rooms lessening need for electricity, it was observed the windows lead to excessive heat in the summer and losses in winter. Even the energy efficient windows have approximately a thermal insulation capacity that is 7 times lower than an outer wall which consequently leads to heat losses. The solar gain available from window areas in the winter was not as high as expected. In practice, large windows can facilitate solar gain, but the utility of that heat is dependent on its interactions with the installation systems and temperature fluctuations. The design should have also employed more technical measures to prevent draughts and increase air-tightness (Elmroth & Nilsson, 2005).

The explanation for the heat usage to be higher than expected may be due to several reasons: residents misusing (eg: opening windows while increasing heating) and flawed climate shell (Elmroth & Nilsson, 2005). It is often difficult to balance efficient design and resident comfort and satisfaction in the aesthetics of the building. For example, achieving good insulation properties while having large windows or the presence of Jacuzzis in many units

which increases the use of energy, but residents consider such features as important elements. However, according to Elmroth & Nilsson (2005) LB-hus had the lowest heat consumption and the highest thermal comfort satisfaction, implying that comfort and energy efficiency are factors that can both be achieved.

The argument that residents used too much electricity was often used to explain when actual numbers exceeded estimates in planning. Although tenants have control of hot water and electricity, heating is primarily influenced by technical qualities, as is common electricity, which is also influenced by the design of the building. The developers also determined the choice of appliances, which heavily affected the electricity used by each unit. (Elmroth & Nilsson, 2005) Lastly, it is important to determine what percentage of resource use is attributed to the design and the residents respectively. Knowing such figures facilitates further actions of improvement – whether it's the design or user behaviour that has to be addressed.

Another factor behind not meeting the goal was the time constraint and subsequent hustle to complete the projects in time for the housing exhibition (Andersson, Pers. Comm., 2005), which meant that developers overlooked some elements.

An interesting assumption stems from fact that the LB-hus, the house with the best energy performance, was also the only project involving researchers. This suggests that the contribution of researchers to the building design adds a valuable perspective. This house represents a coordinated effort between the Bo01 organization and the Swedish Energy Agency (Green, Pers. Comm., 2006).

This fall (2006) the studies with specific focus on resident behaviour are enabled by Formas²⁰ who is funding various research studies with respect to sustainable living (Nilsson, Pers. Comm., 2006). Plans also include measuring use and transmission of energy, ventilation losses, district heating and electricity consumption in each unit with particular focus on resident trends. The district heating transmission will indicate the warm water and heating consumption, while electricity will indicate cooking, lighting etc. As various energy and comfort studies are being carried out that require the evaluation team to visit each apartment, residents seem to express interest in the energy performance and are willing to take extra steps to reduce consumption (Bagge, Pers. Comm., 2006).

Finally, the evaluation activities were wide ranging and outsourced to various organizations and institutions, and there was little coordination and synchronization among the various studies. Although numerous studies were carried out, no system existed to compile data to facilitate evaluation analysis which made it difficult to benchmark the district's performance and make holistic inferences about the result. In fact, some research (Rolen, 2005) revealed that experts still have difficulties confirming whether the buildings are sustainable or not. This is because of the gaps in monitoring and evaluation and coordination.

4.7.2 Waste Management

During the early development stages of the Bo01 district, waste targets and the necessity to evaluate performance were already embedded within the QP. There were also general references to carrying out education measures (Quality Program, Bo01, 2000).

The initial target was to reach 80% source separation of waste, however, this was not achieved. The percentage reached was about 50% but cannot be confirmed due to a lack of

²⁰ Swedish National Research Organization

data. According to the analysis of waste, some waste sources remained unsorted, and in order to reach the 80% target these wastes have to be properly disposed of. Residents often placed plastic with organic wastes and they put organic in the regular waste bin, while recyclables were not always properly sorted. The packaging waste separation was working well. Problems with waste separation were also detected in the waste plants or when the driver that emptied the chutes noticed an improper mix of wastes (Bissmont, Pers. Comm., 2006).

To further increase the waste sourcing results, the City of Malmö is giving an option to residents to have bins for separating waste in their flats where they can arrange their waste prior to disposing of it – making it easier to source separate prior to disposing waste in the common bins. Although this has been advised by QP, individual bins for pre-sorting were not made available to all apartments (Bissmont, Pers. Comm., 2006).

Residents were positive about the process but some were displeased by the extra work and the unpleasant responsibility of handling the bags. Food collected through the organic food system was usually pure, making up about 85% of the food waste; however, presence of contaminants occurred when users combined plastic and paper bags with food scraps. Purity of food waste collected has been constant during the experiment, but quantity separated decreased with time - from half of the total amount of food waste in December 2002 to a one-third in May 2003 as fewer people continued to sort waste. The food waste sorting remains to be more challenging as it is unfavourable to handle, unlike packaging that is clean and therefore easy to handle (Bissmont, Pers. Comm., 2006).

Surveys and questionnaires were used to determine the opinions of users and their behavioural patterns, which then lead the authorities to improvement measures. A recent problem has been found in bins not being labelled properly for the residents to sort waste accordingly. Being aware of this, the City of Malmö is in the process of correcting this problem and ensuring clear instructions are posted in the waste facility with respect to where each type of recyclable item should be placed (Bissmont, Pers. Comm., 2006). To further determine the waste management performance, residents of the Bo01 district were interviewed regarding their thoughts on the system. The City of Malmö officials believed that asking direct questions to the residents triggered honest and prompt responses

There was noticeable improvement with the use of the kitchen food disposer. Residents were more familiar with the technology in disposing of the right wastes and officials suspected that most food was disposed in the device. Residents were generally pleased as the process did not require pre-treatment, and they felt the system was easy and practical while eliminating the need to collect waste in bags. The food disposer experiments showed that food was of high quality, but the quantities were small. This was due to the limitations of the design (some food ended up with wastewater). Another explanation for the low quantity was that residents disposed food waste with combustible residual waste instead of using the dispenser (Appelqvist, Aspegren, Fagerström, Gruvberger, Hallmer, & Mare, 2005).

One problem with measuring waste result was that different companies collect the various sources of waste (glass, paper, food, etc.) and the city of Malmö had difficulties tracking waste levels and obtaining reliable data. Although there have been some specific studies to identify the Bo01 district waste performance, there was an aggregate number for the entire City to account for the combustible waste, making it difficult to identify the specific Bo01 district results. To determine packaging waste results, the contents of the bins were examined, however, with food waste and regular waste the analysis was more detailed where individual bags were opened to examine the loads. The individual bag evaluation has been done twice during the occupancy phase (Bissmont, Pers. Comm., 2006).

With respect to the waste parameter, it is believed that the problem in reaching below the target was not so much attributed to the lack of resident cooperation, but the lack of continuous education and information measures. The Malmö City Water Supply and Sewerage Administration were to ensure a system was in place to provide feedback to users regarding the waste management effectiveness. According to the waste management division in Malmö, monitoring and feedback was not given to residents to a sufficient extent. Upon carrying out the analysis, a letter was sent to the residents notifying them about the problems and what needed change. This was insufficient in terms of providing feedback to the residents and engaging them in the common goal. Problems also escalate when people move in and out of the apartments, as new residents have not received the amount of education and information (Bissmont, Pers. Comm., 2006).

The strength of the waste program was that the idea of carrying out information and education initiatives was well embedded within planning. However, this implies that even if monitoring and evaluation activities are integrated in the initial planning, does not mean the task will be carried out flawlessly. Procedural drawbacks may be experienced, and the lessons can be exported to subsequent phases as the realization of targets is often preceded with a trial and error condition.

4.7.3 Transportation & Mobility

At the commencement of the Bo01 organization's development, there were no specific plans for the evaluation of the transportation and mobility trends. Further, no targets have been set with respect to this parameter (Quality Program, Bo01, 2000).

The evaluation studies for the mobility parameter are currently being carried out (Winter/Spring 2006) to study the sub-components of the transportation infrastructure, and a report is being prepared to the government (Nilsson, Pers. Comm., 2006). Surveys have been conducted to determine daily travel trends among residents for the report. The draft report included responses of 85% of the Bo01 residents. The findings of daily mobility trends revealed that 33.7% of the residents cycle, 29.5% drive, 9.5% take the bus, and 6.3% walk (Veijalainen, 2004). Further statistical studies have also been outsourced to a consulting firm to gather information. Personal preferences were also revealed in a study that examined family needs, as residents with children are the most likely to own vehicles; studies showed that 60% of the families use cars, followed by 13% by train, 14% by walking, and 4% by bus. This group is more difficult to influence because families particularly with small children prefer the comfort and convenience of vehicle travel (Nilsson, Pers. Comm., 2006).

An initiative that received follow up was a bicycling campaign encouraging residents to cycle by educating them about the positive environmental and health impact. This was a small study of only 25 residents. Follow up measures revealed that the majority of residents who participated in this study were more likely to cycle instead of driving (Nilsson, Pers. Comm., 2006).

The mobility aspect is problematic in the summers according to the residents, as there is an influx of Malmö residents that live outside of the Bo01 district. There have been complaints about the traffic, noise and excessive number of visitors (Fridh, Ryden & Nilsson, 2005).

A limitation of the transportation & mobility parameter is the lack of setting a target in the QP. As targets have been set for the other parameters, transportation & mobility featured general goals such as encouraging cycling, walking, and car-sharing, but no specific targets were presented. In the absence of a target, evaluations have a vague objective and when results

are available it is less constructive to carry out follow up measures without a specific target to reach for.

The survey result indicating that 70% of the population use alternatives to the automobile was a very promising result. Having the proper infrastructure in place – bike paths and proximity to public transportation clearly has a positive impact on personal mobility trends.

Evaluation of the transportation & mobility parameter was not of significant importance at the commencement of the occupancy phase because it was believed that transportation trends change very gradually and that it takes time for residents to develop consistent habits that correspond to the transportation infrastructure. Conversely, observing the types of trips and frequencies among residents over time can provide insight on how to target this parameter for improvement. Furthermore, the Bo01 district is connected to the rest of the city by roads, pedestrian and cycle paths. Because people do not only commute within the Western Harbour, but mainly to the rest of Malmö and farther, it is difficult to quantify the mobility performance (Andersson, Pers. Comm., 2005).

Although there were websites and information letters to inform the public of more sustainable transport trends, there seemed to be a lack of follow-up studies and feedback measures. Value in evaluation and follow up was witnessed in the cycling study where residents were given information about sustainable transportation and the benefits of cycling. Although this was a small study focusing on 25 residents, it proved the benefits of education and subsequent follow ups. Not only is giving feedback to the residents important in providing them with progress updates, it is also important to collect information from residents on how to improve services and the infrastructure to facilitate the engagement in better environmental practices.

4.7.4 Water

Because the Bo01 organization did not consider water conservation as a major goal, only two houses were subjected to water usage studies.

Two houses included special meters to monitor water use, however the results were not available.

Because of such a strong emphasis on energy, waste, green space and transportation issues, whether water evaluation activities were carried out is unclear. References are made to small evaluation attempts, however, no monitoring results have been collected nor disclosed.

4.7.5 Green Space

There were no references to evaluation of green space and water in the QP. Evaluation initiatives were conceived during the development phase and close to the commencement of the occupancy phase.

The effectiveness of the green roofs and stormwater ponds is satisfactory. Channels carrying stormwater run down to the sea on one side and to a saltwater canal on the other. When there is precipitation, the surplus water flows into the saltwater canal and when the water levels are insufficient it is taken from the municipal network. There are no witnessed problems of excess stormwater as it is assimilated well by the channel and green roofs. Because the system is open some garbage ends up in the ponds and channels and it is cleaned out regularly (Kruuse & Widarsson, 2005).

Bird inventories were carried out between 2002 and 2004 to monitor bird species and compared with results of a similar sized area in the southern part of Ön Limhamn. Numbers of birds in Limhamn were twice the number of birds in the Bo01 district (Kruuse & Widarsson, 2005).

Unfortunately, a few of the ponds lack flora and fauna because of the paved surfaces that surround them which inhibit natural growth. Monitoring of meadow species revealed unfavourable results showing a substantial decrease from 23 different meadow species to 11 over a period of a year (Kruuse & Widarsson, 2005).

Five of the many stormwater ponds were monitored and the vegetation was thriving in the presence of only a few invasive species. Both saltwater and stormwater pond habitats were working effectively due to the design and proper selection of vegetation that was planted. Aquatic life monitoring systems have been employed in the canals to determine the patterns of fish, and results revealed that seven fish species were observed (Kruuse & Widarsson, 2005).

The numbers of birds in the Bo01 district were lower than on Limhamn because of the fact that the latter is 10 years older and the area is not maintained. Subsequently, vegetation and insects can thrive, thus providing ideal habitats for birds. Out of 18 bats that were visible in Malmö, only one type has been observed in the Bo01 district. The explanation for the lower number in species than expected was that the green spaces were fragmented into several smaller portions, and consequently not large enough to support the habitats (Persson, 2005). The habitats were also too small and in need of corridors to ensure adequate movement among the species. However, the numbers are expected to rise as the area's habitats flourish and become denser with time (Kruuse, Pers. Comm., 2005).

The vegetation that was planted in the Bo01 district was selected according to which species are desired. The selection of vegetation is important in attracting new species. For example, if there is a desire for a butterfly habitat, plants that attract butterflies will be planted on the site. The same principles apply to birds, bats and insects (Kruuse, Pers. Comm., 2005).

Public perceptions and attitudes toward the green initiatives were explored through questions and answers. Questionnaires were distributed among residents to determine their attitude toward the greenery in the district as well as the practicality of the open stormwater system. The average scores out of 5 in total were 4.5 for the greenery and 3.2 for the stormwater management. The stormwater management is sometimes found to contain garbage and parents have concerns about the safety of their children with an open drainage system, therefore the score was not as high as the greenery (Kruuse & Widarsson, 2005).

4.7.6 Summary of Evaluation

The following is a brief summation of the design parameters in the Bo01 district in relation to the goals, extent of evaluation and follow up activities.

- As seen in the energy section the evaluations were quite exhaustive, however the process of identifying the exact root of higher energy consumption was ineffective; nevertheless the energy performance in the Bo01 district is more efficient than the rest of the City.
- The waste evaluations were satisfactory however more specific monitoring could have been done than just two times and there should have been ongoing information provided to residents. Also, more specific data pertaining to the Bo01 district could

have been requested from municipal service companies. Source separation in Bo01

Parameter	Target Status	Evaluation	Follow Up Comment
Energy	Target not met	Extensive	Specific causes of missed targets not defined, design improvements, 3 buildings met the target, no specific education initiatives.
Waste	Target not met	Adequate	Communication with residents stronger at the start of project, little feedback to residents. Estimated figure for source separation: 50%.
Transport & Mobility	No target set	Inadequate	Communication with residents, outcome of daily mobility trends- 70% use alternatives to the automobile, no feedback to residents.
Water	No target set	Inadequate	Water conservation was not a top priority and results were not available.
Green Space	Target met	Extensive	Stormwater ponds function well, species numbers lower than expected. Overall satisfaction among residents.

generated better results than the rest of the City.

- Domestic water use was not prioritized as an important parameter and therefore was not accounted for.
- The absence of a target in the transportation & mobility parameter compromised the opportunity for a constructive evaluation and follow up approach. On a positive note survey results revealed that 70% of the population prefer alternatives to the automobile.
- The green space parameter was subjected to intense evaluation such as monitoring numbers and health of flora and fauna, quality of storm water channels.

Table 4-2 Summary of Evaluation

Future of Evaluation

Unfortunately, due to the fact that the LIP funds are coming to an end, many of the evaluation and education activities are being discontinued. As 2006 is the last year for official evaluation and education, the City of Malmö representatives are trying to provide citizens with knowledge to ensure that domestic tasks are carried out effectively. Currently, a manual of instructions is being prepared for the residents so that they are equipped before the involvement of the City of Malmö discontinues. After the city stops monitoring, the responsibility is given to owners and inhabitants; however, the city will intervene should problems occur (Andersson, Pers. Comm., 2005).

5 Recommendations for a Sustainable User Phase

This chapter presents suggestions to PDP which aim to optimize the user phase performance with respect to the following parameters: energy, waste management, transportation & mobility, water and green space. The suggestions stem from the positive experiences of the Bo01 district while attempting to improve the aspects that were subjected to criticism. By following the Bo01 case study and assessing the pros and cons, several components have been identified which are required for a successful occupancy phase of a housing project: A project management model, design, resident involvement (education) and evaluation. Correspondingly, the first section of this chapter will present a project management approach that can be employed in delivering a sustainable user phase; the second section outlines design measures which also include the Canadian LEED criteria, and is therefore commenced with a background to the LEED program; the third section will discuss measures to influence performance; and the final section will discuss evaluation measures.

5.1 Project Management

A common approach in such community developments and transformations is the fulfilment of “plan” and “do” and little or no follow-up of “check” and subsequent response of the “act” step. Referring to the Bo01 district experience, in developing such projects one can affirm that there is substantial effort devoted to planning and carryout out the design, however, the effort diminishes as the project enters the occupancy phase. As a large scale project, continuous improvement of a community district is vital for a high performance occupancy phase. Therefore, in presenting the first recommendation, what would make PDP a truly unique and commendable example of a 21st century sustainable city district is an all encompassing approach to carrying out the development defined by a loop of continuity. This would include the initial design, resident involvement and evaluation embedded in a continuous project management approach to drive ongoing improvement.

As seen in Malmö’s sustainable city district, the Bo01 organization contributed to carrying out the project plan and was present for the development but dissolved shortly thereafter. The Bo01 organization did not ensure an explicit responsibility plan for the duration of the Bo01 district’s existence after the design. The Bo01 organization was to participate in some education and evaluation measures, however, after the dissolution these activities were taken over by the City of Malmö. In other words, the Bo01 organization represents a linear project that was involved in “plan” and “do” but failed to materialize the “check” and “act” components.

As an organization in command of the project, PDP should ensure steps for a successful user phase are well incorporated in the initial plan in order to add structure to the occupancy phase. Seeing that PDP plans to be running the operations for a minimum of 20+ years (Genco, Pers. Comm., 2005), the organization has the possibility to assume a leadership role in materializing the aforementioned components. Given the efforts required for such a project and the level of coordination required, it is advisable to adopt a cyclic approach.

The complexity and coordination of efforts required for achieving a sustainable user phase give rise to the significance of an ongoing mechanism overlooking the performance of the district in accordance with the targets. A PDCA cycle will therefore provide structure to follow ups and drive a continuity of improvements.

Essential to a well operating user phase of a sustainable city district is a well structured project management tactic. A project management approach will characterize the PDP development with a systematic method of moving towards the targets and ensuring a continuity of improvement within the user phase performance. Such a great effort involving the public, developers, the organization leading the project (PDP in this case) necessitates an approach that envelops the goals in a structured and organized fashion. Standardizing the components of the user phase performance will establish a uniform process of moving towards the goals. As seen in the Bo01 district case study, the process lacked a structured approach to addressing the user phase. The instructions for evaluation and education were rather vague and there was little synchronization between the design, education and evaluation and also among the projects. The important elements were present (good design, resident involvement & evaluation) however, the specifics were not outlined in the initial plan or QP and there was no structured nor uniform method to address targets in a continuous manner.

It is important to note that the process of moving closer to the targets is gradual and it is unlikely that targets will be achieved immediately, and therefore a continuous effort towards improvement should be applied to drive a performance that is aligned with the original vision of the development. This trial and error tactic can be managed with a repeated follow-up approach that identifies the status of the target, the reason behind not reaching it and the necessary step towards corrections. This further gives rise to the value of analyzing each cycle of the project management approach which enables the improvement of the project phases by exporting lessons learned from each cycle. This may prompt a change to the “plan” step to incorporate the lessons in the next phase of the cycle. For example, the current Western Harbour district developments are to meet a target of 120 KWh per m² instead of the original Bo01 105 KWh per m². The learning lessons from previous phases can be incorporated in the steering document, which should be subjected to continuous revision based on experiences in order to refine planning.

5.1.1 Planning

To convey expectations and enhance the user phase with a structured process, details for design, education and evaluation should already be incorporated in the planning stage. Embedding these requirements in the planning conveys the expectations to the developers while clarifying the level of commitment required. More on evaluation and education will be provided in further sections.

As seen in the Bo01 district, developers were challenged by the targets and this necessitates the creation of a body that will provide capacity building as well as verification to ensure compliance. More specifically, the developers participating in the Bo01 district had challenges with meeting the energy goal which led to inconsistencies in the calculations. Based on this learning experience, the current process entails the assistance of a consultant verifying the design process. As part of the community development, PDP can set up an independent sustainability team consisting of field experts in each parameter to overlook the design process, work with developers in meeting targets and to assume verification. During the design process, the sustainability team can organize workshops in accordance with the themes of each parameter to educate the developers and respond to enquires. Frequent communication among the actors involved will lead to the identification of any challenges in the early process while conveying the requirements of PDP. A positive example of this was seen in Hammarby Sjöstad; emphasis on verification and regular communication took place and monthly meetings to discuss issues. An independent group was created to overlook the process and ensure verification, and consequently the compliance of meeting the requirements reached 95-97% during the development (Freudenthal, Pers. Comm., 2006). The sustainability

team will be instrumental in verifying that the developers are fulfilling design requirements. (For more information on Hammarby Sjöstad see Appendix 1.)

Moreover, important to a successful community district is a reasonable time table to allow developers to carefully fulfil the requirements set out by PDP. As seen in the Bo01 district, failing to meet targets was partly attributed to a tight time schedule in preparation for the housing exhibition. The schedule has to allow developers enough time to carry out the measures effectively in terms of planning, identifying design features and discussions. To promote top quality, the consultation process in a project of such nature entails an exhaustive effort as it necessitates the coordination among a multitude of disciplines and stakeholders who have to exchange knowledge and agree on how issues within each parameter should be addressed. As seen in the Bo01 district case study, some design failures such as the misunderstanding regarding the solar panels and height restrictions resulted from the lack of communication and time pressure. It is therefore important to establish a time table that takes this intensity of the communication required for such projects into consideration while promoting an open dialogue to give rise to discussions.

In addition to consultations among experts in the field, the planning stage should involve the public. An open dialogue with the public and potential residents should be a significant component of planning to ensure communication, transparency and the inclusion of public concerns and ideas. In planning the Bo01 district meetings were held once a month to keep the public informed about the progress. This ensures communication with the public about the development and provides the opportunity to raise concerns.

To promote a high level of ambition in the project, a measure to consider is holding competitions and identifying high and low performers with respect to the developers. Competitions provide marketing opportunities to developers who can thrive on positive publicity and attract more business.

5.1.2 Steering Documents

PDP should create steering documents similar to the one created by the Bo01 organization – Quality Programme. As in the Bo01 district, the steering documents should be developed in conjunction with the developers in a shared effort. This promotes a consensus based approach while transferring some level of responsibility to the developers. The integrated effort will further enable a dialogue between the developers and PDP and promote closer collaboration.

According to the Hammarby Sjöstad experience (Freudenthal, Pers. Comm., 2006) integral to a successful user-phase are strict preconditions for the developers. The more effective are the results in the design of the building, the easier it is for residents to live more efficiently. It is therefore essential for PDP to be demanding with respect to design criteria and promote the adoption of high standards among the projects. High performance design provides users with the necessary framework to promote conservation and relies less on the user behaviour.

One option is for PDP to set targets and then allow the developers to contrive individual approaches to meeting the goals as in the Bo01 district, while the other option is to define the conditions for meeting the targets. The QP defined energy requirements, however, it failed to provide instructions to developers to guide them on how to best achieve this target. Instead, developers were devising methods of how to design the buildings and carried out numerous calculations to meet the energy goal, however, time wise and taking into account consistency issues, it would have been more beneficial for developers to have clear instructions to narrow in on what steps to take to reach the target. This should at least take into account the basics

such as types of windows, wall thickness and ventilation recovery. Although the former approach is characterized by flexibility and may be more favourable to developers, the latter will promote more consistency and avoid the challenge of devising the procedures necessary to fulfil the targets, as they will already be specified. In order to generate the requisite ingredients within the occupancy phase, it is advisable that the steering documents define exactly how each component should be carried out – the procedures necessary to reach the targets and the occupations that correspond to each.

With respect to consistency, a requirement to apply a uniform tool such as the Enorm spreadsheet in Bo01 can contribute to standardizing the process, but it should be mandatory. Further, this is where the sustainability team can overlook the methods which the developers choose to fulfil the targets and provide further assistance. This problem may be solved with the application of the LEED program; LEED provides tools for measuring design criteria and since all of the buildings will be LEED certified, these tools will ensure consistency. The application of LEED will be further described in section 5.2.1.

It is advisable that quantifiable targets are set for each parameter such as:

Energy: Energy use per m² as in the Bo01 district

Waste: Percentage of source separation to be reached

Transportation & Mobility: Percentage of individuals using alternatives to automobiles or kilometres per person per year

Water: Maximum water consumption per person per year

Green Space: Green space and pond water minimum (percentage of entire site)

Each parameter should also be expanded to include targets for sub-components that are of interest to PDP. For example, the water parameter can include standards for the following: fixtures, irrigation, plumbing equipment, etc. More such measures will be presented in the Design for Performance section 5.3.

Furthermore, the steering documents should be characterized by clear and specific language and criteria should be specified quantitatively when possible. As seen in the Bo01 organization the QP was characterized by ambiguity. To recap some examples, QP included phrases such as “proper selection of materials”, “environmentally adaptive” and “resource efficient”. Such unspecific requirements do not provide developers with any direction in terms of expectations. Contrarily, standards that are set in quantities and percentages convey clear expectations while avoid the confusion that can be created by qualitative language. To clarify the expectations such recommendations should request minimum or maximum percentages of the particular materials while setting a requirement for acceptable and unacceptable LCA results.

Each developer should be required to implement and run an environmental management system (EMS) or maintain a spreadsheet with progress in accordance with each target. Keeping an account of each parameter transfers a level of accountability to the developer while facilitating the management of sub-components of each parameter. Attached should be a list of distribution of roles, evaluation process and a response mechanism to missed targets. This system should be accessible to all actors within the project to promote communication and awareness of progress and challenges. PDP should request the submission of such a document on a regular basis to keep track of the status of each development. A general idea of this process is illustrated below in figure 5-1.

Target Management

Parameter	Target	Status	Personnel In Charge	Verification	Evaluation	Follow Up	Time Table
Energy							
Waste							
Transport & Mobilit							
Water							
Green Space							

Figure 5-1 Target Management

A complex matter is the actual process of meeting the goals. Because targets are not legally binding in such projects (as in the Bo01 district case), it is difficult to achieve full compliance with respect to the targets. Upon not meeting goals, the organization running the developments does not have much authority to resolve the issues except for providing knowledge and capacity sharing. PDP should consider mandatory compliance with the requirements of the steering document in the form of a binding contract.

5.1.3 Deming Cycle

Referring back to the draft of PDP’s sustainability guidelines, the component called *New Ideas for further Investigation* can potentially include the Deming Cycle as the selected project management approach. Should PDP accept the recommendation of applying a project management approach to the development of the community, below in the text boxes is a brief outline of the key points that should be taken into account.

Plan

1. Definition of the problem: Identifying key domestic resource consumption.
2. Set targets for each of the parameters. Targets should be formulated through a consensus among PDP, the developers, municipality and experts involved.
3. Learning from Bo01, it is instrumental to integrate strict measures for the developers to maximize the design quality and efficiency, and also to reinforce the commitment. Being aware of the measures that have to be carried out during the course of the project brings clarity and expectations to the process. Requirements found in the steering document should be part of the contract and therefore enforceable.
4. Develop a framework for evaluation and follow up. Identify roles for evaluation and follow-up as well as the frequency. Formulate an approach to rectifying problems should the performance reach below the targets, and specify roles and timeframes. The actors involved in the development have to be aware of the commitment required by the entire cycle of the project, as being aware of roles clarifies the commitment in the early stages. Evaluation should be standardized to generate uniform performance measures.
5. Include a plan for education for the user-phase. The education should be carried out in a general manner and additional initiatives should cater to specific groups (seniors, children, professionals, etc.). Ensure the education system exemplifies the correlation between small tasks residents can perform at home to the larger environmental scheme in the City of Toronto.
6. Educational programs should also target the actors involved. Education should be provided to all developers and contractors, etc. and a communication approach should be in place with respect to goals and targets.

Do

1. Carry out the design measures presented in section 5.2 and analyse the operations.

It must be noted that PDP should not limit the evaluation to the “check” component of Deming’s cycle. It is in fact encouraged to carry out some level of evaluation mechanism simultaneously with the “do” step. Carefully following the activities carried out in “do” will likely alleviate the difficulty of the “check” step and in turn lead to a better operation of the whole process.

2. Have onsite assistance with materialization of targets. As seen in the Bo01 district, there were calculation uncertainties and inconsistencies in the energy parameter and therefore an onsite consultant has been introduced to the site to work with the developers on achieving targets. This leads to a uniform approach in designing the buildings with respect to the targets. A standardized approach to meeting targets should be required of all developers. This leads to consistency and also facilitates verification if all the projects follow the same process. Setting up a sustainability team is an option to enforce this.

3. To follow up on the requirements, it is critical to have the sustainability team monitoring the site to ensure criteria is being met and for overall verification. During the construction thorough verification should be conducted at least once a month. PDP should ensure that goals have to be met prior to allowing the project to proceed to the next phase.

4. Establish an information centre for residents and visitors like in Hammarby Sjöstad. The process should be defined by a high level of accountability and transparency. Extend the education program during the course of the entire project for professionals involved. Fully communicating and discussing issues as they arise early in the development will reduce and perhaps prevent flaws in the implementation stage.

Check

1. Carry out extensive and systematic evaluation methods. The more evaluation - the more extensive the data - enabling a more comprehensive analysis. Identify the cause of a missed target because knowing the root of the problem the correction process.
2. Standardize the evaluation process to ensure consistency in monitoring and benchmarking results.
2. Have a framework in place to analyse data and combined results, communication and info sharing for experts. Developers should be required to maintain EMSs or spreadsheet tools where evaluation material is recorded and can be submitted to PDP.
3. Gather feedback from residents to contrive potential means of improving the system framework for them. This can be done through surveys, a website and personal communication.

Act

1. Upon identifying the problem, make corrections. If it's a design or technical problem, the technical specialists address it. If it is a behavioural problem, initiatives must be taken to influence the public.
2. Employ feedback systems as seen in Hammarby Sjöstad. Visual exposure to consumption patterns is likely to prompt conservational measures. Monetary visuals may also be effective (for e.g. a display of the cost associated with energy usage in the apartment). Ensure that the progress and shortcomings of resident behaviour are well communicated.
3. Follow up after the education and feedback measures to determine the level of impact on the residents. Continue the feedback to residents about the progress and the status of the targets.
4. From accumulating results from evaluation and follow-ups, make revisions to planning if necessary (revisions to processes, targets, etc.).

5.2 Design for Performance

This section combines the design measures implemented in the Bo01 district in conjunction with LEED (Leadership in Environment and Energy Design) principles as a framework for providing design suggestions to PDP. To a lesser extent examples are derived from other case studies.

To recap the goals of the Bo01 district, and show a further correlation between the projects table 5-1 illustrates the similarities between design parameters of the case study and the preliminary goals of PDP. The goals are quite synonymous and therefore the Malmö development is a good model for the Toronto project. It is clear that the goals of the Bo01 district are more defined and specific as the district has already gone through the development and is now 5 years into its user phase. Contrarily, PDP is still in the planning stages where general goals have been outlined but the specifics and targets have not yet been defined.

A portrayal of the LEED standard is consistent with the goals of PDP as all of the buildings within the project boundary are to meet LEED requirements. The correlation between the PDP goals and LEED principles is shown in table 5-1. Demonstrating LEED principles and examples will further contribute to the expansion of design measures PDP wishes to implement when developing the community. Furthermore, the design measures presented supplement the attributes witnessed in the Bo01 district and are presented in the order of the 5 selected parameters.

Where the Bo01 organization failed, and to get further insight on design measures and how they were carried out in another successful sustainable city district, experiences from Hammarby Sjöstad will also be depicted in this chapter. The Stockholm example is used to illustrate the waste and transportation parameters as the performance of these is commendable; the performance of the two parameters are very close to the actual targets (Freudenthal, Pers. Comm., 2006). For more information on Hammarby Sjöstad please see Appendix 1.

The application of the Bo01 district case study combined with LEED principles and references to Hammarby Sjöstad aims to provide inspiration to PDP with respect to design measures. Prior to the introduction of the suggestions based on the key target areas within each parameter, this section will provide a brief background of the Canadian LEED program.

Parameter	Bo01 District	PDP Project (preliminary)	LEED Criteria
Energy	Focus on renewable energy (solar, wind), addressing in house conservation, aquifers.	Focus on renewable energy (solar, wind, geothermal) addressing in house conservation.	Points awarded for energy reductions and renewable energy.
Waste Management	Focus on source separation, recycling, vacuum collection, waste to energy.	Focus on source separation, recycling, waste to energy.	Point awarded for a recycling minimum that includes: paper, corrugated cardboard, glass, plastics and metals.
Transportation & Mobility	Focus on alternatives to automobile use, efficient public transport, car sharing, bicycling, IT.	Focus on alternatives to automobile use, efficient public transport, bicycling.	Points awarded for proximity to public transportation, cycle storage facilities, and special parking access for hybrids.
Water	Focus on stormwater control, nearby treatment, in house water reduction (to a small extent).	Focus on stormwater control, nearby treatment, in house water reduction.	Points awarded for conservation of domestic water and irrigation water.
Green Space	Focus on green roofs, biodiversity, and opportunities for learning.	Focus on green roofs, biodiversity and recreation.	Points awarded for replacing impervious space with vegetation, green roofs, and stormwater management.

Table 5-1 Similarities among the Bo01 district, LEED and the PDP project

5.2.1 The Canadian LEED Program

In pursuit of reducing impacts of construction the Canada Green Building Council (CaGBC)²¹ employs the LEED program to encourage green architecture and building practices which are awarded by various levels of the scheme. LEED is a design guideline and certification tool to improve occupant satisfaction, environmental performance and economic returns of buildings using innovative and standardized practices and technologies. The environmental performance criteria are organized within five key performance categories: **Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources** and **Indoor Environmental Quality**. LEED offers ratings that correspond to a number of points earned during the evaluation process with the possibility of obtaining Certified, Silver, Gold or Platinum certifications (CaGBC, 2005).

LEED Canada for New Construction and Major Renovations is imported from the US Green Building Council's (USGBC) LEED rating system, but adapted specifically to the Canadian climate, building practices and regulations. The LEED program recognizes progressive buildings that encompass innovative design and deliver high quality performance while minimizing environmental impacts of construction and life cycle operations. The LEED system sets out a voluntary, consensus based and market-responsive set of criteria used to assess the performance of a project from a full life cycle perspective. The criteria provides a standardized approach to define a "green building" in the Canadian real estate industry (CaGBC, 2005).

The official recognition is decided by a third body consisting of design professionals who follow the LEED methodology (CaGBC, 2005). Project ratings are certified by the CaGBC based on the total point score, following an independent review and audits of selected credits. The LEED Calculator from the Green Building Council is used as a design checklist to calculate points in order to determine the appropriate rating. With four possible levels of certification LEED is flexible enough to accommodate a wide range of green building strategies that best fit the constraints and goals of clients (Gowri, 2004).

Developers favour the advantage that the program does not outline strict measures to be followed. The developers have to assume the task of devising methods to meet the goals. Further, LEED points can overlap, for example, if a product is regionally produced and made of recycled material the project can be awarded points for satisfying both of the criteria (Steffes, Pers. Comm., 2005). For drivers behind LEED certification please see Appendix 3.

Evaluation of LEED Finished Products

Performance evaluation tools and integrated assessment tools are required for design and documentation. Such tools play a fundamental role in the design phase as well as subsequent performance of a building. Various software tools are used for energy simulation, daylighting and life-cycle assessments as well as surface water run-off calculations. The information derived from such calculations is regularly used by design professionals to assess design criteria, material, equipment and monitoring the performance of various aspects of building design. The rating systems also rely on information generated by these tools, awarding a rating of LEED that corresponds to the number of points met within the criteria. Upon completion of LEED designed construction or renovation, a valuable proceeding step is to evaluate the performance of the building and compare it with the initial plan (Gowri, 2004).

²¹ Coalition of representatives from various industry and government sectors formed to revise building standards, develop best practices, endorse green buildings and develop tools to support members in the field of sustainable design.

The LEED program awards a point for ongoing accountability of building energy consumption over time where the project is to be evaluated for no less than a year. Energy simulation and engineering analysis are carried out to perform this task. Metering equipment is installed to compare actual energy performance versus the anticipated and the measurements are recorded in a log book (Gowri, 2004).

5.3 Design Measures to Consider for a Successful User Phase

This section outlines measures that are provided to PDP as potential recommendations to include in the design planning to enable a successful user phase performance. Figure 5-1 displays a general overview of the key areas to address regarding each parameter and the correspondent success criteria. In the first four parameters design recommendations are limited to target the most environmentally intensive factors within each; while the greenery parameter outlines desirable features in a sustainable community and rainwater assimilation system.

The format of this section first presents key concerns within each target, consideration for design improvement, and practical examples from LEED and Swedish cases which are presented in text boxes.

Key Design Areas to Address

	Areas to Address	Success criteria
Energy	<ul style="list-style-type: none"> • Heating • Cooling • Appliances <i>design (i.e. insulation)</i> 	<ul style="list-style-type: none"> •Conservation •Use of renewable sources •Reduction of emissions
Waste	<ul style="list-style-type: none"> • Household waste 	<ul style="list-style-type: none"> •Reduction •Source Separation •Composting •Biogas production
Transport & Mobility	<ul style="list-style-type: none"> • Personal automobile use 	<ul style="list-style-type: none"> • Access to public transport, carpooling, cycling, walking • Usage reduction • Pollution minimisation
Water	<ul style="list-style-type: none"> • Bathroom (Toilets, Showers, Sink) • Irrigation • Kitchen (Dishwashing, Sink) • Laundry 	<ul style="list-style-type: none"> • Conservation • Reduction of waste water • Reusing (rainwater for irrigation) • Pollution minimisation
Green Space	<ul style="list-style-type: none"> •Stormwater control •Ratio of greenery •Flora & fauna at risk 	<ul style="list-style-type: none"> •Abundance of greenery •Stormwater channels •Green roofs •Thriving flora & fauna

Figure 5-2 Key Design Areas to Address

5.3.1 Energy

The goal of the design recommendations in this section is conservation. To address domestic energy consumption, a breakdown of energy use should be examined. Table 5-2 below illustrates how domestic energy is used in Ontario. Recognizing the most energy intensive

domestic uses allows for target areas and the prioritization of energy saving measures. As seen, most of the energy consumed is through space heating and water heating amounting to about 70% of total domestic energy use. This is followed by appliances which account for about 12% (Clean Air Partnership, 2005). An important element of design is insulation and airtightness properties. Further, consideration should be given to renewable energy to minimize environmental impacts of domestic energy use.

How Energy is Used in a Typical Ontario Home

Space Heating	57 - 62%
Water Heating	20 - 21%
Appliances	12 - 13%
Lighting	4 - 5%
Cooling	0 - 7%

Table 5-2 Energy Use in an Ontario Home

Considerations for Design Improvement

- The LEED program requires that the energy consumption is at least 25% lower than the national (conventional) requirement. Although no specific criteria are outlined in the energy section of LEED, points are awarded according to amount of energy saved. The program also awards a point if a minimum of 5% of energy is derived from renewable sources and the number of point increases with the percentage of renewable energy used.²²
- LEED also awards one point for implementing a measurement and verification plan to evaluate ongoing energy performance of the building. Metering equipment is to be installed for lighting and controls, heating and cooling performance. This requirement is for the time duration of one year.

• ²² Energy efficiency is the single largest LEED credit category representing a total of 27% of all LEED points (Kats, 2003).

- Points are awarded for ventilation effectiveness and if at least 75% of interior is exposed to day-lighting to reduce dependence on electricity. A point is also awarded for the controllability of systems to individual occupants.
- According to LEED experiences, the selection of high efficiency appliances is one of the priorities in promoting efficient energy performance (James, Pers. Comm., 2005). This is a relatively simple credit to obtain as there are government programs that label efficient home equipment and provide incentives. (For more information on the government incentives see Appendix 2).
- For example, new refrigerators are up to 75% more efficient from 20-yr old ones, and residents should be encouraged to replace older models with higher efficiency ones (Clean Air Partnership, 2005). Size is also an important factor to consider when selecting an appliance and should be proportional to the household's needs to avoid unnecessary energy use.
- Attractive as a model to PDP, the Bo01 district is entirely powered by renewable energy sources; electricity is generated by both solar and wind power; hot water heating is obtained by seawater and solar energy. The planning of the Bo01 district took into account the local conditions such as geothermal properties, and this is also something PDP should explore. Given the availability of aquifers in Ontario, PDP has the opportunity to introduce an energy system similar to that of Bo01 district (renewable energy such as wind and solar) in addition to implementing the tri-generation system.
- As seen in the Bo01 district, leakage and insulation were some main factors behind not reaching the energy target. It is therefore essential to set out standards for the insulation capacity that all developers have to follow. Basic requirements for wall material and thickness, ventilation recovery and window proportions should be defined by PDP.
- Given that heating comprises the highest use of domestic energy - select an appropriate heating system to promote environmental and economic efficiency. Size is an important attribute to consider as an oversized system leads to unnecessary energy consumption. The design should encompass the possibility to use solar gain and recover heat for secondary heating. According to LEED experiences, an average of 30% savings is achieved annually by energy efficiency measures such as the re-circulating heat, ventilation recovery and waste heat recovery, and the selection of more efficient appliances (Kats, 2003).
- Although more costly, solar water heaters obtain energy from the sun that is collected by solar panels and transferred by circulating fluids to a storage tank. Solar water heaters are typically supplemented by an electric water heater (fuelled by oil, natural gas or propane) to supply hot water back up on low sunshine days. Solar power heaters are designed to provide up to 75% hot water needs (Enermodal, 2005).
- In pursuit of efficient usage of space, a measure to consider in the light of energy savings is common cold storage in apartment buildings and common waste/recycling areas to save space in individual units. As seen in the Bo01 district, the layout for the above factors was designed as efficiently as possible to avoid unnecessary heating of unused space.

- The selection of thermostats is conducive to energy savings. The installation of a set-back thermostat that can be programmed automatically to lower the temperature when the home is empty or at night generates about 5% cost savings per month (Government of Ontario, 2005).
- Another practical feature is an all-off switch at the entrance door ensuring residents all lights are off, eliminating the unnecessary usage of electricity.
- Important to consider is the orientation of the building which can influence the energy use. Figure 5-3 illustrates several simple measures that can be applied when building housing, which encompasses the concept of integrating passive energy-conserving strategies responsive to local climate. Taking into account the angles of the sun in the winter and summer and designing the house accordingly can reduce electricity demand. For example, positioning the windows to ensure maximum sunlight is reached in the winter and positioning roofs to minimize heat from the sunlight during summer months.

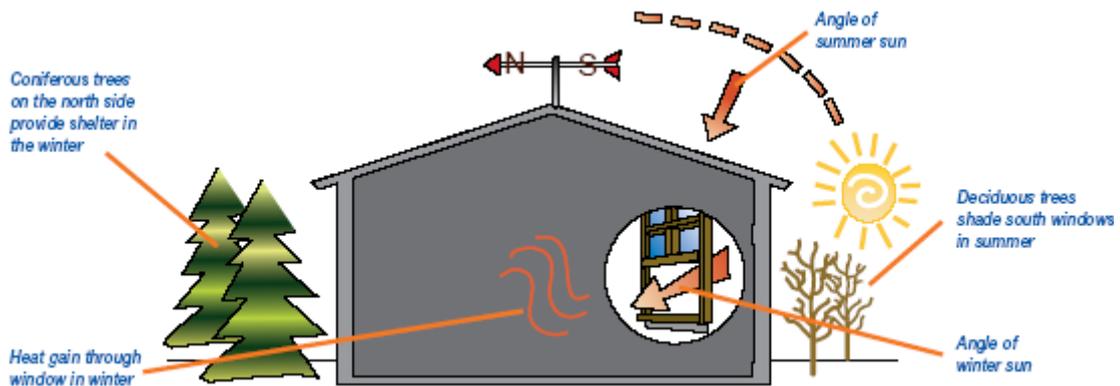


Figure 5-3 Example of Building Orientation (Ontario Ministry of Energy, 2005)

Practical Experiences

An innovative example of solar energy utilization is also seen in Augustenborg, a neighbourhood that has a soil-covered sports field with a solar panel beneath to generate electricity for a small number of the apartments.

The LEED accredited ecological inn, E'terra, is an example of how energy savings and application of renewable energy is achieved in practice. This facility uses 20 m² of roof mounted solar panels for the purpose of water heating, supplemented by high efficiency boilers. Additional features that allow this facility to save 45% of energy annually in comparison with the national code for energy are: double glazed windows with low-e and argon gas fill, natural cooling with high efficiency ceiling fans, high r value insulation in roof and wall assemblies, and ventilation energy recovery (Enermodal, 2005).

5.3.2 Waste Management

The main goal of the design recommendations is to provide residents with access to a wide range of waste compartments to enable source separation. To give an overview of how the waste parameter should be prioritized – in 2004 plastics made up 28% of the entire litter volume in Toronto, a number that has significantly increased since the commencement of the audits in 2002. The litter comprises mainly of wraps, bags, drink cups, jars, bottles, sandwich bags, etc., while paper waste comprises the second largest source of waste according to the audits, a figure of 25% (Litter Audit Backgrounder, 2005). In addition to designing a system that targets reduction of the combustible waste stream, this parameter should specifically address the above trends.

Considerations for Design Improvement

- LEED awards points for an easily accessible area dedicated to the separation, collection and storage of materials for recycling. The recycling minimum includes: paper, corrugated cardboard, glass, plastics and metals.
- Additional bins can be provided to include organic waste in the separation process. The waste disposal layout should facilitate waste management that equips residents with clearly labelled and user-friendly bins.
- As in Bo01's QP, it would be beneficial to set out a target for minimizing the residual waste fraction in order to drive progress towards a goal.
- To facilitate waste disposal for residents, each apartment should have space for pre-sorting of wastes. This will make waste disposal in the common facilities easier for residents.
- In the Bo01 district the problem of distance discouraged some laggard residents, therefore PDP should consider to place the bins as accessible as possible to the residents so that the distance of walking is not hindering participation. This may entail setting up additional facilities for waste.

- The concept of extracting biogas from the waste is also a possibility which can be imported from the Bo01 district to promote efficiency in PDP.

Practical Experiences

The waste component in Hammarby Sjöstad generated a very high performance. Analysis of garbage was conducted to determine levels of organic and combustible waste. Based on the analysis of the organic waste done 2 years ago there was a 97% rate of pure organic waste found in the bin. The figure since then was slightly reduced as new residents moved in, however, the city is in the process of reaching the former rate. The target was achieved with the efforts of residents who received information brochures once a year on how to sort wastes and how to use the corn starch bags to dispose of the waste. This was preceded by phone calls to follow up. To facilitate source separation for residents, three bins were placed under the sink for residents – one for combustible waste, one for organic and a third for whatever is practical for the residents (e.g. can or paper recycling) (Freudenthal, Pers. Comm., 2006).

5.3.3 Transportation & Mobility

The goal of the design recommendations for this parameter is to minimize vehicle travel by diverting the number of single commuters, facilitating public transportation access and promoting alternatives to the automobile. The ultimate goal is to encourage more sustainable transportation trends which will have subsequent benefits on air quality and energy use.

Considerations for Design Improvement

- LEED awards a point for locating buildings either 800 m of a commuter rail or subway station, or 400 m of 2 or more public bus lines.
- LEED awards a point for creating storage space for bicycles of residents in the building. It is advisable to PDP to request that each building provides a specified area for storage.
- LEED awards a point for facilitating ownership of hybrid cars by allocating parking just for hybrids or providing close access to re-fuelling stations for such vehicles.
- It is recommended to define a desirable length of paths to provide residents with a cycling network that is well integrated and positioned conveniently ensuring many possibilities for access. PDP should specify a percentage of the entire area that will be allocated to walking and cycling paths.
- Setting up an integrated carpooling network for the district's commuters will discourage single passenger travel and instead encourage residents to network together if they have to travel at the same time to destinations within a reasonable proximity. Another possibility is setting up a car sharing organization where residents can hire a car if necessary.
- Promote car free lots, pedestrian streets, speed restrictions to form a culture that is less dependent on motor vehicles.
- The availability of basic shops, services, cafes and restaurants in the vicinity will reduce car travel as residents would be able to walk to access such local conveniences.

Practical Experiences

In the Hammarby Sjöstad district the transportation network has been improving significantly since the onset of the development and observations show that there is a declining trend in personal vehicle use. The transportation target was to reach an 80% rate among residents who choose alternatives to the vehicle. Recent studies showed that the rate is just over 70% which is quite satisfactory. The carpool system is working very well and 10% of all residents are members of this program. Ongoing surveys and questionnaires are distributed to residents to determine levels of satisfaction and suggestions for improvement. For example, a relatively recent study shows general satisfaction in the transportation system but residents feel that there should be a bus operating on weekends that drives to the main shopping area which is about 15 min walking distance. To facilitate shopping and to encourage public transportation usage, the City of Stockholm is now in the process of delivering this service to the residents. This demonstrates the importance of follow up measurements to track resident performance and also to receive input from residents on how the infrastructure can be optimized to promote more environmentally sound travel habits (Freudenthal, Pers. Comm., 2006).

5.3.4 Water

The goal of these design recommendations is to promote domestic water conservation. Research shows (City of Toronto, 2005) that bathroom use and irrigation make up the largest source of water consumption. Nearly 65% of all domestic water use is consumed in the bathrooms, where more than half of this is attributed to flushing of toilets.

In addition to daily peaks which occur during mornings and evenings, water use is substantially increased in the summer to irrigate lawns, where as much as 75% of the municipal treated water is sprayed for gardening (City of Toronto, 2005).

Considerations for Design Improvement

- According to LEED the use of high water efficiency appliances and tools in homes (dishwashers, front load washing machines, low flowing taps and shower heads, dual flush toilets) is gaining momentum across building development to promote water conservation and to obtain a reduced need for water heating. Further water savings are achieved by installing lower capacity bathtubs or the exclusion of bathtubs since standard baths require about 60 L of water (Enermodal, 2005).
- Pursuant to enhancing water efficiency, LEED experiences reveal that the installation of high performance amenities generates at least 20% water savings in comparison to conventional technology (Steffes, Pers. Comm., 2005).

Conventional Equipment	Feature	High Efficiency Equipment
15-19 L per flush	Toilet	6 L per flush
20 L per min	Showerhead and faucet	9.5 L per min

Table 5-3 Domestic Water Use with High Efficiency Equipment source

- Water conservation initiatives generate fairly easily attainable credits under LEED. Such measures often do not require additional costs over standard plumbing equipment and fixtures (Steffes, Pers. Comm., 2005).
- Although more common in public buildings, automatic faucets lead to increased water savings and are thus gaining popularity in residential projects. Studies reveal that automatic faucets can save about 30% additional water used (Ballanco, 2005).
- Under the Water Efficiency component of LEED, a credit is allocated to projects that capture rain water or recycled water to reduce the use of potable water by 50% over conventional means.

Practical Experiences

Water reduction under the LEED program can be reduced by 50% according to cases such as the 77 Governor Rd. condominium project in Toronto led by Enermodal Engineering LTD which made use of water efficient fixtures. Further savings of 75% compared with a typical new housing were witnessed by the Waterloo Green Home as a result of additional technological installations. This included the creation of a pond that evaporates waste heat from the chiller, which does not require cooling tower. The cooling tower pond is filled by rainwater and that is why no additional water is required. The pond conserves about 500 m³ of water per year. Another progressive water savings measure is seen in E'terra Inn in Tobermory Ontario, which uses non-potable water for toilet flushing and cold laundry (Enermodal, 2005).

A successful water conservation measure can be seen in Stockholm's Hammarby Sjöstad. In pursuit of meeting a target of 100 L per person per day, high efficiency fixtures with filters were installed that release air in combination with the water flow to maintain an adequate pressure while reducing the flow of water. Such technical measures led to a reduced water use of 145-150 L per day in comparison to 200 L in the rest of Stockholm. The original target was 100 L and is difficult to reach as residents are unwilling to reduce their water consumption (Freudenthal, Pers. Comm., 2006).

5.3.5 Green Space

The goals of these design recommendations is to provide the residents with an abundant green area that addresses stormwater control, create space for habitats allowing species to thrive, and provide a source for learning and awareness.

Considerations for Design Improvement

- Site design components of LEED award a point for reducing environmental impact of building and avoiding construction on ecologically sensitive land and habitats which have rare or endangered species. A point is awarded for building at least 30.5 m away from wetlands *or* for restoring a minimum of 50% of the site area (excluding building footprint) by replacing impervious surfaces with vegetation.
- LEED awards a point for a stormwater management plan such as ponds or stormwater channels. PDP should install rainwater capture systems that collect the water from roofs and divert the flow to shallow channels located by buildings as seen in the Bo01 district – a connected stormwater management system to collect rainwater which is used for irrigation and to refill onsite ponds.
- To prevent stagnant water and collection of bacteria, the water should be continually pumped because of the ecological importance. Ponds are often used by animals, and such traces can build up in animals and in eggs of birds (Kruuse & Widarsson, 2005).
- LEED awards a point for limiting disturbance and clearing of vegetation to 12 m beyond building perimeter. To obtain a rich and spread out greenery, PDP should follow this criteria and set restrictions regarding proximity to greenery to maintain a healthy balance of pervious space.
- LEED awards points for minimizing heat island effect²³ to reduce impact to microclimate and habitats. A practical example of this is the installation of green roofs that cover 50% of roof area. While contributing immensely to rainwater assimilation, green roofs also preserve the longevity of the roof material, which deteriorates due to weathering, particularly UV rays, and it also improves insulation.
- Setting a ratio of green space as seen in the Bo01 district is promising in maintaining a healthy balance between developed areas and greenery. This provides developers with an exact target they are to reach with respect to land management.
- Setting a maximum time or distance limit between residents and green space ensures equal benefits for the entire neighbourhood. For example, in the Bo01 district all residents live within 5 minutes walking distance to greenery.
- To address the substantial increase of irrigation water use in the summer months, the selection of vegetation in plants becomes quite important. From a water efficiency perspective, it is practical to favour indigenous and low water requiring, drought-resistant plants.
- Development should not ignore the importance of large sections of greenery which are more conducive to animal and vegetation life than small fragmented areas. Smaller areas should be reconnected to provide movement possibilities for species.
- In Ontario attention should be given to planting trees that loose leaves in fall on the east, south and west side of the house – this provides shading in the summer while allowing sun rays in the winter. Planting deciduous vegetation on the north side of the

²³ Thermal gradient differences between developed and undeveloped areas

house shelter from the wind, while planting trees that shed leaves in the winter enable the sun's thermal gain (Government of Ontario, 2005).

Practical Experiences

The application of green roofs has several purposes and is gaining momentum across Europe. In addition to the Bo01 district, another remarkable example of its use can be seen in the transformation of the Augustenborg district of Malmö. Green roofs absorb about 50% of the rainwater that comes into contact with the surface, thus greatly reducing stormwater runoff during days of heavy precipitation. In this district there are measuring devices installed in the roofs to measure the runoff versus the actual rainfall, and the results have been consistent in absorbing the rainwater. Solar energy is used to circulate the ponds in order to maintain their cleanliness.

An excellent example of eliminating potable water use for irrigation was witnessed by E'terra Inn the ecological lodge in Ontario. Irrigation water was reduced by 100% by planting drought resistant, adapted and native vegetation on the landscape that does not require irrigation (Enermodal, 2005).

5.4 Influence of Performance

The residents themselves play a remarkable role in the operational phase of the community and influencing behaviour will optimize the performance of the district. Waste disposal, amounts of electricity and water use, mobility trends are factors heavily influenced by resident behaviour, and therefore PDP is strongly advised to prioritize educational campaigns to involve residents in the maintenance of the district. Education is instrumental to achieving a sustainable user phase, as the residents themselves have a remarkable impact on the longevity of the city district with respect to daily domestic usage. Although intelligent construction design defines the standards for residents, education is needed for the residents to contribute with ecologically smart behaviour. Therefore, the more educated, informed and aware the residents are about the environment, energy, water, transport, waste efficiency the higher is the overall performance of the city district. Education should be provided with respect to how conservation activities can be carried out regarding each parameter. Furthermore, it is important to follow up on the effectiveness of the education to determine whether residents were influenced.

5.4.1 Approaches to Education

The turnover of residents has to be taken into consideration when initiating educational and informational measures. As seen in the Bo01 district, the waste parameter had undergone several fluctuations particularly during moving in and out (Bissmont, Pers. Comm., 2006). This prompts the necessity for ongoing and regular information sharing not only to ensure that residents are reminded of what needs to be addressed, but also, to keep the residents that are moving in to the district well informed.

An important lesson extracted from the Bo01 case study is providing residents with feedback in response to the evaluation studies. Being aware of the performance of the user phase and

how it compares with the target is a valuable factor in driving further participation. PDP has to ensure feedback is given to residents to a sufficient extent, meaning regularly and in various forms: internet, letters, and personal communication.

5.4.2 Educational Programs

While general education programs should be available to the public in the form of a visitor's centre, PDP (via the sustainability team) should dedicate effort into preparing specific educational campaigns for a variety of stakeholders. As seen in the Bo01 district, education that is specifically catered to target groups is more effective. Educational measures can be divided into groups such as: school children, prospective residents and professionals.

According to the Bo01 district experience, not having an education centre like the glasshuset in Hammarby Sjöstad is a major disadvantage (Nilsson, Pers. Comm., 2006). It is therefore advisable for PDP to set up an information centre to enable the opportunity for education for visitors and residents, where one can obtain responses to enquires about conservation and environmental matters. The glasshuset is a popular facility that has been attracting residents and visitors alike from the onset of its opening (Freudenthal, Pers. Comm., 2006).

From the Bo01 district experience it was discovered that giving residents instructions in the form of simple tasks is not always effective and it is vital for inhabitants to have an understanding of how their individual behaviour is positioned in a larger context. In addition, using visuals is very effective and should be more widespread. Visuals should be employed with a nature correlation, for example, indicating a source separation result with the land area saved from landfilling, the number of trees saved by recycling paper or the emission reduction as a result of diverting waste.

A suggestion to PDP here is to employ a model such as the Ecological Footprint where residents can visualize their impact individually, as a community or as a city. A visualization of resident impact can be an effective tool to portray consequences of poor environmental performance and steer behaviour towards the targets. Similarly, it is important to illustrate the targets and results to ensure that both progress and areas needed of improvement are brought to the attention of the residents.

5.4.3 Ecological Footprint

The ecological footprint²⁴ is an approach to quantifying the human impact on the planet by identifying the biologically productive area required (in global acres) to produce resources consumed and assimilate wastes. It answers the question "how large an area of productive land is needed to sustain a defined population indefinitely?" This model can be applied to an individual, a community, a country or the entire globe, and has been accepted as an effective means of summarizing human impact with respect to resource consumption, pollution and waste (Citizens for a Sustainable Community, 2005).

Sustainable community living reinforces conservational and efficient behaviour to reduce consumption (inflows) and waste (outflows). To narrow in on Toronto's consumption and waste patterns the ecological footprint model can be exhibited to illustrate how the city's behaviour fits in the global scheme of urban impact. Four more planet earths would have to

²⁴ Developed in the early 1990s by Dr. William Rees and Mathis Wackernagel, Canada.

exist if the entire world consumed as much energy, resources and produced the amount of waste produced by Toronto (City of Toronto, 2005). With time, as new projects are developed and old ones are transformed with special attention around environmental management, significant reductions can be made to the city's ecological footprint. Subsequently, the prevalence of ecological urban developments can enable residents to live in a more environmentally smart manner and therefore have a positive bearing on the use and management of resources.

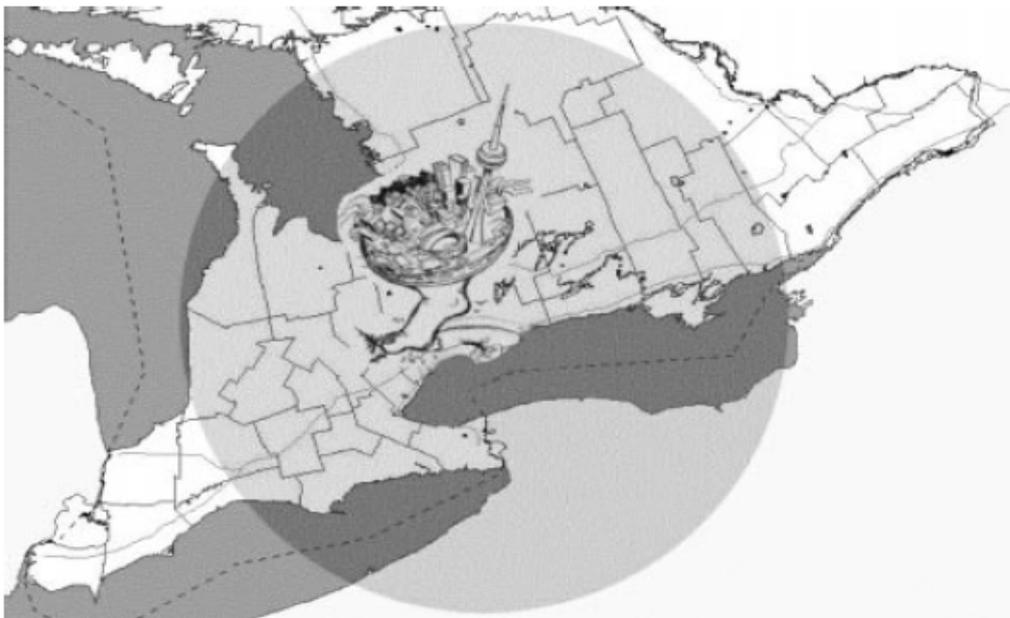


Figure 5-4 Ecological Footprint of Toronto (City of Toronto, 2006)

5.5 Evaluation of Performance

The following section of this component will employ the Bo01 district case study as a reference and identify the key recommendations with respect to evaluation of each parameter. This section commences with a general approach addressing evaluation which is applicable to all of the parameters. It then progresses to some individual requirements that are unique to each one of the parameters.

Overall, the follow-up processes carried out in the Bo01 district were adequate however this could be improved with respect to integrating the results, and having a structured approach to evaluation. A recommendation to PDP is therefore to devise an integrated system for collecting and comparing results. Although many of the evaluation activities in the Bo01 district were quite comprehensive, the process was outsourced to various actors and there was little synchronization with respect to the outcome of the evaluation. The value of an integrated system that collects evaluation results is witnessed in Hammarby Sjöstad. The officers at the information centre, glasshuset, have access to a database with results and are able to provide residents or interested parties with information about how the district is progressing. An integrated system (such as the EMS suggestion presented under the Steering Documents

section) would provide fast access to information regarding the progress as well as areas needing improvement.

Furthermore, PDP should also consider standardizing the process where developers follow the same methodology within a specified time table. A uniform approach to evaluation will promote consistency in the process and also facilitate benchmarking against the targets and among the projects. PDP can set out the requirements with respect to the evaluation details and then the sustainability team can verify the results and provide expertise when this step necessitates corrections. The developers themselves should take the responsibility for conducting evaluation for parameters such as energy and water, however, given that the remaining parameters entail more broad implications, waste, transportation and green space should be evaluated by the sustainability team set up by PDP. Further, evaluation should be ongoing where each parameter is monitored, prompting for analysis of the results followed by a response to rectifying any identified flaws. Recording the outcome allows keeping track of progress and facilitates the process of analyzing results.

Another important point is to carry out evaluation at the commencement of the operational phase in order to obtain a clear picture of the full progress and the changes that take place within each parameter. Identifying problems at the onset of the occupancy phase enables prompt responses and therefore enhances the level of efficiency in the community.

A valuable lesson to import is the inclusion of resident responses in the evaluation component. Interviewing residents can provide qualitative data for the evaluation purposes and may lead to improvements identified by residents who experience the design of their dwellings daily. This was successfully carried out both in the Bo01 district and Hammarby Sjöstad.

5.5.1 Energy

According to the Bo01 district experience (Bagge, Pers. Comm., 2006) frequent and detailed monitoring is optimal as it provides substantial data for analysis, from which areas for improvement can be identified. Integral to generating thorough and reliable evaluation studies is a systematic and detailed monitoring component where hourly readings are suggested, however, this requires a substantial amount of effort both in terms of human and financial resources. In fact, increasing the frequency and depth of monitoring has been one of the lessons Bo01 learned which was applied to future phases. In addition to monitoring stations, it is beneficial to conduct studies to examine domestic use as precisely as possible. In the Bo01 district monitoring process, there were difficulties identifying the main cause behind not reaching the energy target. It is essential to conduct evaluation studies that are comprehensive enough to identify specific energy consumption factors and root causes of over consumption. This enables a more efficient process of responding and corrections.

It is advisable to PDP to take resident behaviour variation into account. Although energy performance is influenced primarily by design, residents have some control of electricity and indoor temperature and equipment such as bathtubs. An important distinction to make is how much of the consumption is attributed to user performance and how much to the actual design. In turn, if it is a design problem technical experts can address it and if it is due to user behaviour, educational measures can be employed.

The value of following up was witnessed in the Bo01 district after none of the houses reached the target. Upon identifying the errors, design corrections have been made and there were subsequent improvements where 3 of the houses met energy targets. To strengthen the

evaluation, this approach should be carried out continuously to deliver ongoing improvement. As the shortcomings are identified in the evaluation step, corrections can be made and with each cycle improvements will be witnessed.

5.5.2 Waste

Ensuring that accurate data on waste disposal trends is available is instrumental to adequately track progress and to identify inadequacies. This enables the results of evaluation to be transformed into a feedback system to residents and subsequently urge residents to adopt better practices.

In order to obtain a clear representation of the waste results, it is vital to carry out detailed monitoring of the waste contents. The problem in the Bo01 district was that collection was outsourced to municipal services companies which were unable to provide an accurate account of the waste contents. To avoid this uncertainty in obtaining results, it is advisable to PDP to carry out evaluation studies specific to the community boundary. During the occupancy phase waste monitoring is recommended more frequently than what was conducted in the Bo01 district. The Bo01 district was monitored only twice which is insufficient for a 5 year time frame. Ensuring at least two clear monitoring results per year provides more insight into trends and areas identified for improvement. More frequent evaluation provides the possibility for analysis, and in turn, a faster response system. Furthermore, in order to obtain a high rate of source separation it is important to identify results of each source – the recycling materials, combustible waste and compost. Identifying where shortfalls occur enables the response of corrections specific to the key problems.

A positive measure seen in the Bo01 district that is also advisable to PDP is the exhaustive effort taken to visit each dwelling asking about the overall satisfaction with waste disposal and if any assistance was needed to clarify the process. This also opens up opportunities for a dialogue to obtain feedback from residents and supplements the quantitative data with qualitative sources. For example, interviews with residents led to the improvement of labelling the waste facilities in the Bo01 district, which was problematic prior to the discussions.

5.5.3 Transportation & Mobility

Referring back to the Bo01 district case study, a drawback of this parameter was the absence of setting a target. Having a target allows for benchmarking evaluation results against a goal, and in turn provides direction with respect to further improvement. It is advisable for PDP to define a target such as the percentage of the population who use alternatives to personal vehicle use or the number of kilometres driven per person per year.

As in the Bo01 district, personal mobility habits should be carried out to obtain a representation of general trends within the district. It is essential to identify the percentage of residents that travel alone in their vehicles and upon discovering the results, education initiatives can be employed to encourage a more widespread use of alternatives or PDP can make any necessary improvements to the design. It is important to initiate evaluation studies from the onset of the occupancy phase to derive a clear picture of this parameter and work towards improvement. The weakness in the Bo01 district was the commencement of mobility studies 3 years into the occupancy phase. Such a late start prevents the ability of incorporating measures for optimizing the transportation efficiency from the onset and thus generating more efficiency in the district.

In order to improve the transportation infrastructure, resident feedback should be invited and incorporated if possible. This has been successful in Hammarby Sjöstad where resident surveys that revealed mobility needs led to the expansion of the public transportation system.

5.5.4 Water

Evaluation of water consumption should take form of a detailed approach to identify how much is used for each purpose: bathroom, kitchen, irrigation, etc. Identifying the key sources of water consumption enables a better response system to promoting conservation. This should be conducted at least semi-annually to determine consumption patterns and to be able to respond by promoting conservational measures.

A practical approach to hot water monitoring is assessing the usage of the district heating system during the summers – when residents are not heating their homes. This allows for identification of how much hot water is used.

An idea that is largely underused is a feedback mechanism to residents indicating how much water has been used by each appliance or faucet. The visual recording of daily water use will provide users with the awareness of the consumption, and likely lead to more economical use. Although web portals indicating consumption were employed in the Bo01 district, there were no studies to determine the effectiveness of such tools.

5.5.5 Green Space

In the Bo01 district the most important element of the green space was the function of assimilating rainwater and providing residents with access to greenery. To maintain the adequate running of this system, evaluation must be carried out to determine the functionality and assimilative capacity of ponds and green roofs to ensure performance is as expected.

As witnessed in the Bo01 district, a practical method of evaluating the livelihood of flora and fauna in the greenery of the park space is counting the number of species over time. An increasing number of species provides a positive indication to PDP about the natural growth, and if the numbers are declining, PDP must identify the factor behind this – whether the greenery is too fragmented, not dense enough, etc.

Given the importance of greenery to resident satisfaction, it is essential to evaluate perceptions about the local greenery. Ensuring that residents are satisfied with their surrounding will more likely lead to a stronger effort with respect to conservation and environmental awareness.

5.6 Summary of Recommendations

Project Management

- Employ a Plan-Do-Check-Act cycle in the project to drive continuous improvement.

- Coordinate planning in conjunction with developers and the public. Create steering documents in collaboration with developers to share accountability and promote dialogue.
- Steering documents should convey clear and specific instructions and include quantifiable targets.
- PDP should establish a Sustainability Team to work with developers in managing environmental criteria. Each developer should be required to maintain an EMS to have a clear account of performance.

Design

- Energy: Promote renewable energy, ensure adequate insulation, high efficiency appliances, and heat recovery.
- Waste: Provide clearly labelled facilities for enabling source separation for the waste fractions; consider composting and waste energy recovery.
- Transportation & Mobility: Promote alternatives to personal vehicle use, ensure buildings are situated in proximity to public transportation and services; provide a network for carpooling, paths for walking and cycling, and storage for bicycling.
- Water: Consider excluding the bathtub in some units, use high efficiency plumbing and fixtures and employ rain collection for irrigation.
- Green Space: Ensure all residents are in proximity to some kind of greenery, install rainwater capture systems, green roofs, and provide large and unfragmented habitats to allow species to thrive.

Influence of Performance

- Ensure ongoing education is available to residents and take moves into account. Cater education to specific groups in order to generate impact.
- Set up an education centre for enquiries of residents and visitors like glasshuset.
- Use feedback systems and visuals to inform residents of their performance in accordance with the specified targets.

Evaluation

- Initiate evaluation activities from the onset of the occupancy phase to have a clear scenario of trends over time and in order to identify flaws immediately. Immediate response and corrections will enhance the efficiency of the district. Engage residents in the process as they will likely have valuable input.

- Employ a standardized approach to evaluation allowing for analysis and benchmarking, as well as enabling the process of conveying progress to residents and interested parties. Ensure evaluation results are well managed in a database for prompt access to results.
- Particularly for energy collect extensive data to enable comprehensive results for analysis. This allows identifying the root of the problem prompting follow ups.

6 Discussions

Up to this point sustainable city theories have been touched on, background to the PDP project has been given, the design and evaluation along with education measures of the Bo01 district have been discussed. Further, recommendations for PDP design measures and project management optimization have been provided. To complete the course of the design, evaluation and project management implications, below is a series of general discussions as a wrap up for PDP.

6.1 Project Management

Distinct from the Bo01 district, PDP has the opportunity to be recognized as a unique sustainable community development by taking on a leadership role in carrying out the project. Although there were evaluation and follow-up studies in the Bo01 district, the responsibility was assumed by the City of Malmö with little contribution of the Bo01 organization. This approach represents a linear model project and the absence of continuity in terms of the involvement of the user phase. The adoption of a circular approach like a Plan-Do-Check-Act model presented in the previous chapter would differentiate PDP as an organization leading projects of such nature and strengthen the strategy of delivering the final vision. Contrary to the linear model, a cyclic approach embeds the structure of the project within a method that promotes ongoing improvement*.

From the Bo01 district experience it is fair to state that if targets are set in the absence of continuity, goals are unlikely to be fulfilled. Seeing the complexity and level of coordination required to deliver a sustainable user phase in a large scale project, it is necessary to carry out the PDCA cycle, as targets are unlikely to be materialized in the first phase, and therefore have to be subjected to repeated efforts. According to the Bo01 district experience, the first phase was the most difficult to carry out as it was the very first time that the actors were involved in coordinating the plans. During the development of the Bo01 district, many valuable lessons have been learned which will be applied to the current and future construction projects in the area. The experiences that will be transferred to the new phase will particularly focus on meeting goals set out in planning without additional costs and examining the district from a life cycle perspective (Andersson, Pers. Comm., 2005).

This necessitates a cyclical approach in ensuring the materialization of goals. When optimization of the operational phase will be characterized by a Plan-Do-Check-Act loop each fundamental step can be observed and subsequently improvements can be made within each phase subjected to the cycle and the development of future phases. As new issues are identified, corrections can be introduced to improve the entire cycle and reshaping the planning of future phases as well as changes to the current phases under study.

6.1.1 Planning

Referring back to the Bo01 district process and restructuring changes gives rise to the importance of careful planning at the commencement of the project in order to ensure a responsibility structure that is conducive to materializing goals. The considerable magnitude of QP (numerous parameters and subcomponents) necessitated a sufficient number of personnel to overlook the process, however, this was not done. As in the Bo01 organization, it was impossible and unrealistic for one person to administer environmental management and do this effectively. There were too many developers and criteria to meet within a short time frame, and this lack of capacity compromised the ability to verify that QP requirements were met. For example, QP required that each developer set up an EMS to manage targets,

however, this was not achieved. Such shortfalls prompt the necessity to set up a larger team administering the environmental management component in order to do it successfully. Setting up a sustainability team will be much more effective than allocating all the tasks of overlooking to process to one individual.

Given that financial circumstances lead to constraints in such developments, it is important to assess the capacity and determine what is financially and technically feasible. Should there be a lack of finances or personnel to adequately administer the process, it is then advisable to narrow down on the environmental parameters and prioritize them. In fact, according to Eva Dalman, the chief architect at the City of Malmö (2006) the current phases in the Bo01 district are now focusing on fewer requirements and a closer cooperation in the process to ensure communication among the actors. Furthermore, given the lack of fulfilment of targets, it is more desirable to have fewer criteria that are slightly less rigorous than excessive parameters and unrealistic targets that are never materialized.

Another challenge is carrying out all the parameters simultaneously, which may compromise the quality and meticulousness of the development. Prioritizing and allowing a time table that divides the parameters may be the solution to the challenge of multi-tasking and falling short of the targets.

6.1.2 Steering Documents

Requiring each developer to run an EMS for the developments while establishing a sustainability team to work with the developers with respect to each target will ensure that the accountability will be balanced between PDP and each participating developer. As the sustainability team will have duties to carry out (workshops, helping developers with targets, verification, etc.) the developer will have the mandate of carrying out tasks and managing sub-components of each target. The sustainability team and creation of an EMS will prompt close collaboration between PDP and the developers through a conjunction of shared efforts. Because both parties will be responsible for the given tasks, this will ensure accountability on both parts as well as provide opportunities for identification of process challenges.

Furthermore, this ongoing cycle will give rise to new findings while allowing learning lessons to be employed and making revisions to the sustainability guidelines which should as well be subjected to improvement.

A challenge that PDP may encounter is the process of collaborating with the developers on setting targets. Targets have to be stringent enough to achieve a good environmental performance, but feasible financially and technically in order to be executed. Contriving less expensive methods for improvement with each phase is an important consideration.

As the complexity and extent of effort in materializing all the goals is resulting in a focus on prioritizing a few criteria, this allows developers and the City of Malmö to devote substantial attention to the specified goal. Balancing the level of ambition among the targets as well as finances is something important to consider in such a development. Given financial constraints, the Bo01 district's new decision to focus on fewer targets but subject each to a comprehensive process is very sensible. Currently, the key goals focus on building material, energy and biodiversity. This time, there is an optimistic outlook on the possibility of reaching the targets (Dalman, Pers. Comm., 2005).

6.2 Design for Performance

The application of the Bo01 district examples in addition to the LEED program will enable PDP to achieve a high performance design as it will incorporate concepts employed by a commendable international example coupled with cutting edge Canadian building criteria. However, given the complexity in designing dwellings that are congruent with the targets, special consideration has to be given to this phase in ensuring that necessary features are in place.

The role of LEED will be valuable in the design phase, however, when the course of the project necessitates the evaluation step, activities will have to be extended beyond what LEED dictates. While points are available for energy measurements, LEED treats parameters other than energy as qualifying criteria and does not require follow ups. It is understandable as the green space requirements or the distances to bus stops will not change with time. From a design perspective, it is adequate just to focus on energy performance, however, from a holistic approach to community performance, additional evaluation measures have to be added beyond LEED. The program nonetheless provides a valuable basis for a successful design.

Furthermore, an interesting observation is that the house that featured the contribution of researchers during the design was also the one that achieved its energy target. This challenges the conventional process of carrying out construction to one that is more all-encompassing.

6.3 Influence of Performance

To strengthen the educational measures residents have to be addressed in a larger context with respect to energy conservation, waste separation and transportation. Simple instructions given to residents without providing full reasoning and how the tasks fit into the larger scheme of sustainability in Malmö or Sweden are not always effective. In order to encourage full participation, residents must understand how the small tasks fit into the overall goal to realize the importance of each inhabitant's role. Education is also an aspect that renders gradual improvements and not immediate results. It is inevitable that residents move in and out and such a turnover will likely affect the performance of the district unless education is continuous. MORE

6.4 Evaluation of Performance

The Bo01 project sparked substantial interest among professionals and educational institutions and therefore received considerable attention with respect to evaluation and research studies. Several researchers chose the Bo01 district as a study example, and these studies enriched the course of the project. It is in the best interest of PDP to also endorse this example of a showcase exhibition in order to attract independent researchers to assist in the studies. In the Bo01 district, in the absence of researchers, the extent of the studies would have been impossible both financially and from a human resource perspective.

As in the Bo01 district case study, some targets were missed and although there were coordinated evaluation and follow up efforts during the occupancy phase, such activities could have been improved by having a structured process to monitoring the user phase. Various evaluation activities started out a few years into the occupancy phase, while with others there was a lack of follow up. A continuous project management cycle will ensure that the user phase be subjected to a structured evaluation and follow up scheme until targets are reached.

An advantage in PDP's development may be the requirement of LEED criteria, which necessitates the application of standardized tools set out by the program to evaluate building measures. Such programs will enable consistency and set up a framework for PDP with respect to further evaluation

A challenge in sustainable districts is the continuation of the community once the developers and municipalities leave it to prosper on its own. In the presence of monitoring and analysis, problems can be identified and rectified, bringing the community as close to success as possible. Discontinuing involvement leaves any future challenges and issues to the district itself, with uncertainty about how issues will be handled. It is in the best interest of the city district to promote evaluation mechanisms for as long as possible to ensure the community is performing in accordance with the goals set out in planning. With a limited budget such activities will obviously have to be curtailed, however, a possibility should be explored that appoints an interested party to carry out ongoing performance measures. The interested party can be formed by a group of interested residents, university departments or a local NGO.

7 Conclusion and Further Research

An ecologically ambitious development such as that of PDP will demonstrate a remarkably positive example to businesses and municipalities and prove to the public that a city district can function more efficiently than the conventional approach with respect to environmental performance. With ambitious plans to develop a sustainable city district and capitalizing on local circumstances, PDP has the opportunity to become a commendable example of a world renowned high performance community. This will hopefully trigger a momentum for positive transformations in other parts of the city, province or country.

From reviewing the case study of the Bo01 district, it can be concluded that focus on planning and design is insufficient to deliver a successful user phase, and the development of a sustainable city district necessitates a plan for resident education and evaluation enveloped within a project management approach. Particularly in a case where an organization has the mandate over the development for an extensive time frame, a focus on the occupancy phase and ensuring the above elements receive attention through a cyclic loop will contribute significantly to the overall performance.

Referring back to the introduction, a city district should not be viewed as a “finished product”, but a “work in progress” (Brandon, Lombardi & Bentivegna 1997). Moreover, as the city is in its “constant state of becoming” (Whitehead, 2004) the continuity of a project management approach will reinforce this concept while steering the community towards a successful user phase.

Suggestions for Further Research

Seeing that there is not much knowledge on the actual influence of residents in a sustainable city district, an idea to expand this research gap is to devote more studies focusing specifically on impact of residents. When assessing the progress of a community in its operational phase, it is often challenging to identify the ratio of design to resident behaviour which is a factor behind the performance. Taking the variation among resident behaviour into account during evaluation and being able to identify the root cause of a missed target will facilitate the process of correction. There have been discussions in Sweden about evaluating community performance from a resident behaviour perspective, which indicates the relevance of this aspect as well as the fact that it is fundamentally unexplored.

Furthermore, as resident behaviour plays an important role in the overall performance of a city district, more studies should be carried out to determine how to engage people more to adopt conservational measures in domestic activities. Efficient resident behaviour can contribute to moving the district performance closer to the targets. This does not only refer to education, but also incentives. The applicability of financial instruments to engage people in a more conservational behaviour could be taken into consideration.

As there are many disciplines and activities involved in developing a city district, and given the variation among such projects, an idea to investigate is a method to standardize sustainable community initiatives. This can perhaps be achieved by a certification scheme similar to that of LEED, but catered specifically to the operational phase of the community as a whole rather than just the design of a building. Such a program would promote the recognition of sustainable community design and perhaps increase the popularity of sustainable design projects.

Another idea to endorse is the consideration of attracting businesses that share visions analogous to those of PDP. Promoting the operation of commercial enterprises that observe environmental matters (such as organic restaurants or fair trade shops) will complement the community by providing the residents with services that mirror the goals of the community as a whole. In completion of the PDP community it would be valuable to research market potential of commercial activities that may be of interest to PDP.

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Abbreviations

CaGBC – Canada Green Building Council

EU – European Union

GHG – Green house gas

GTA - Greater Toronto Area

LCA - Life Cycle Analysis

LEED – Leadership in Energy and Environment Design

LIP – Local Investment Program

MKB - Malmö's Kommunaler Bostäder AB

MwH – Mega watt per hour

PDCA – Plan, Do, Check, Act

PDP – Parc Downsview Park

PM – Project management

QP - Quality programme

SVEBO - Organization formed by the National Board of Housing, Building and Planning and 10 other municipalities

WWTP – Waste water treatment plant

UFA – Useable floor area

USGBC – United States Green Building Council

Appendix 1

Hammarby Sjöstad

Being the largest construction project in Stockholm, this area is developed to “become a model environmentally-well-adapted city district in the international forefront of sustainable development in a densely populated urban area”. Agenda 21 was the fundamental theoretical framework applied to transform the industrial and port site to an innovative and sustainable residential area of 8 000 flats, 8 000 workplaces and 15 000 residents. The projected investment is about 15 billion SEK and the forecasted time span is approximately 12 years. Hammarby Sjöstad represents Stockholm’s largest continuous urban development project. Currently, 80% of the environmental goals were materialized – therefore, in addition to Bo01 this project can be used as a constructive example for PDP (Freudenthal, Pers. Comm., 2006).

The challenge of meeting the energy target in both Hammarby Sjöstad and the Bo01 district should prepare PDP for an arduous task with respect to devising a target, meeting the target and carrying out evaluation. The energy target in Hammarby (60 kWh per m² annually) has been set about 10 years ago and now there is little understanding of how this figure was derived. The original figure presented to the politicians was 120 kWh and somewhere in the process it was cut by half. Evaluation was carried out to measure electricity use and the heat and hot water usage, the results were provided by the electricity companies and the heating district companies respectively. Although there is room for improvement, the Bo01 district was subjected to more effective evaluation processes than Hammarby Sjöstad. The environmental program in Hammarby Sjöstad made references to evaluation and follow ups but they were not specific enough. In the Western Harbour, the LIP program made specific requirements with respect to follow up, evaluation and research. Consequently, the actual operational energy targets at Hammarby Sjöstad are not revealed. There are some unofficial numbers in the properties, however, the developers failed to submit progress reports to the government. Such requirements should be made clear and specific enough to hold developers responsible to act accordingly.

Two blocks of houses in the development have displays in the kitchen indicating the number of water litres used (both warm and cold), the amount of electricity and heating used. An interesting question here is if such visual displays encourage residents to be more conservative in terms of using water and energy, however, no difference was observed in Hammarby Sjöstad between the smart design houses and regular buildings. An explanation for this may be that these are co-operative buildings where most utilities are shared, and therefore users don’t have as much incentive to reduce consumption, as it will not be reflected in the bill unless all residents participate.

The Stockholm water company also carried out educational measures in response to excessive waste contents in the municipal sewage, because residents were using toilets as a garbage disposal. Strong education initiatives and campaigns at subway stations increased public awareness about the problem and the response was tremendous. The waste was cut by more than half. There were also follow up studies done to determine awareness levels and that has increased by 25% after the educational measures. Such an example proves that there is value in effective educational measures, which do have impact on residents (Freudenthal, Pers. Comm., 2006).

Appendix 2

Programs Facilitating Energy Efficiency Measures

There are in place government sponsored programs to assist consumers in the selection of higher efficiency appliances, heating, ventilation and air conditioning products. A program known as EnerGuide was developed by Natural Resources Canada, and the Heating, Refrigeration and Air Conditioning Institute of Canada. In addition to product information, this program is extended to servicing homes which want to receive an assessment of energy efficiency and measures. Next is Energy Star, a voluntary program that awards certification to energy efficient products in pursuit of CO₂ emissions. Energy Guide allows for comparison in energy consumption among products while Energy Star allows consumers to identify the products that are of higher efficiency. These programs provide consumers with info such as the lifetime savings and the reduction in fuels associated with energy savings. Currently, there is also a rebate program on the purchase of solar energy systems. The above programs have proven to be beneficial for enabling home owners to make choices that are more favourable to efficiency as well as facilitating the purchases due to the various rebates available (Clean Air Partnership, 2005).

Appendix 3

Drivers behind LEED Certification

According to Stephen Carpenter from Enermodal Engineering (2005) who has been involved in several LEED projects thus far there are three main drivers for LEED certification in Canada that apply to the projects. The first is energy efficiency; the second is the desire for a green image and for improved environmental performance. Being the most desirable aspect to achieve, energy efficiency is the key driver among the LEED parameters due to the anticipated cost savings in the operational phase and financial incentives.

Below are brief descriptions of current financial incentives that motivate developers to pay attention to energy issues in development.

Energy Innovators Initiative (EEI)

EEI is a federal program designed to encourage commercial and institutional organizations to introduce energy-savings measures in existing facilities. The policy offers financial incentives to applicants who adjust equipment or renovate to achieve a minimum of 25% energy savings compared with conventional operations. The program will contribute 25% of the costs of pilot projects if the applicant can achieve comparable energy savings in at least 25% of the remaining facilities (Federal Government of Canada, 2005).

Commercial Buildings Incentive Program (CBIP)

This policy entails a financial incentive for the incorporation of energy efficiency measures in new commercial as well as institutional buildings. An incentive of up to \$60 000 is provided to applicants whose designs are compatible with the commercial building incentive program. The requirement is that the applicant must reach a minimum of 25% more efficiency than facilities that meet the national energy code for buildings (Federal Government of Canada, 2005).

Green Marketing

Many projects believe in the marketability of LEED which is clearly an incentive for many buildings as it has the reputation for enhancing the environmental performance. This is applicable to the condominium market where the management is run by the ownership of all tenants. For one of the largest residential developers in Canada, Tridel, it is imperative to maintain the market leadership position by continuing to build the reputation on quality and differentiation. Accordingly, companies like Tridel are looking for new means to market their condominium units and choose LEED as the tool to appeal to prospective buyers (James, Pers. Comm. 2005).