ECOLOGICAL INFRASTRUCTURE VS TECHNO-FIX: A DESIGN FRAMEWORK FOR RENEWABLE ENERGY INFRASTRUCTURE IN PUBLIC SPACES

Thesis in fulfilment of the requirements for the degree of

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Abstract

As cities rapidly develop new interventions for climate change mitigation, embedding renewable energy in public spaces becomes an important strategy. Most interventions focus on increasing the environmental sustainability of cities by retrofitting spaces and buildings with so called 'techno-fixes' such as green walls and photovoltaic arrays. This study proposes an alternative approach where local electricity production is incorporated into the socio-cultural and ecological purpose of public space to create social and environmental change, while at the same time engaging society, enriching the local economy, and increasing social networks. The purpose of this thesis is to develop a framework to better enable landscape architects and urban designers to sustainably integrate renewable energy into their future projects.

The study employs a multi-method approach, combining both design and research activity. Its first component involves participation in two design competitions — one organised by the International Federation of Landscape Architecture (IFLA 2011), the other by the Land Art Generator Initiative (LAGI 2012) — to establish the hypothesis that an ecologically sophisticated public space design model educates the public about a sustainable energy lifestyle, increases their general environmental awareness, therefore maximises energy efficiency and production in the broader community with long-term benefits. This claim is grounded in the fourth law of thermodynamics, which states that "In the self-organizational process, systems develop those parts, processes, and interactions that maximise efficiency and production" (Odum & Odum, 2008, p. 71). As the result of lessons learned from participation in these two design competitions, the study then poses its research question, which are designed to seek the opinions of the consultants and designers of a built project, to ascertain their current design approach, and the potential relationship between public space and renewable energy in that approach.

To address the research question, the study first conducts a triple-bottom-line case study approach to Ballast Point Park (Sydney, NSW) using mixed methods, including semi-structured interviews, user surveys, and systematic site observations. With a specific focus on renewable energy usage on the site, the study concludes with the development of a new framework entitled the "Optimal Electricity Distribution Framework" (OED). By advancing the OED framework through application of Howard T. Odum's abovementioned fourth law in addition to the fifth law of thermodynamics which states that, "systems processes maximize power by interacting abundant energy forms with ones of small quantity but larger

amplification ability" (Tilley, 2004, p. 122), the study develops overarching criteria to analyse the content of 25 published LAGI 2012 projects. This analysis provides an understanding of the way in which these submissions respond to the design brief, with a particular focus on electricity distribution.

The case study findings from Ballast Point Park show that environmental sustainability is the central focus, both for general design decisions and for renewable energy applications. However, the economic and social aspects of renewable energy in this project are never fully realized and do not contribute to the general sustainability of the park. The findings from this case study and LAGI 2012's speculative entries reveal an electricity distribution imbalance and suggest a lack of in-depth understanding of sustainable electricity distribution within public space designs. In response to these findings, the devised OED framework addresses social engagement related to public interaction; economic engagement related to the quantity of electricity produced; and environmental engagement related to the embodied energy required to construct the renewable energy infrastructure.

At a practical level, the OED framework can be used in both design and assessment practice to facilitate a focus on the production processes and associated relationships around public space, rather than on the type of renewable energy source such as solar, wind, bioenergy that is specific to site and project, itself.

The framework guides designers in the consideration and application of the social, economic, and environmental aspects of the project design process. Because the OED framework operates for the mature ecosystem of public space — the smallest socio-physical segment of a complex urban environment — it can be modified for multiple scales, including household, neighbourhood, city, and region. Therefore, the study opens new possibilities for measuring the sustainability of renewable energy usage in human environments.

At a theoretical level, the study enhances a key theme within landscape urbanism theory, known as the 'process discourse', while it also expands the aesthetic dimensions of sustainability within the emerging functions of local electricity production and its new socio-economic relationships around public space. In addition to the, now commonplace, technical application of the first and second laws of thermodynamics, the study introduces the fourth and fifth laws to energy responsive landscape planning and design. The study identifies the significance of public interactions with produced electricity as an important factor in the energy transformation hierarchy (the fifth law). The greater the number of interactions between renewable energy and public spaces, the greater the likelihood renewable energy will influence a sustainable energy lifestyle.

Additionally, with respect to ecologically sophisticated public space design and its role in carrying useful information[1] for societal change to achieve sustainable energy transition, the study considers the key concepts of *emergy* (the quality of energy) and *exergy* (work capacity). At a methodological level, the study contributes a novel research process that incorporates design practice into empirical research.

Overall, the study concludes that electricity production from renewables be incorporated into the socio-cultural and ecological purpose of public space as an alternative approach against the common technological-fix use of renewables in urban environments. The study reveals that trends in the topic are still holding back mainstream practices and critical thinking more broadly, which are being presented by the more advanced designs that the study identified. The developed OED framework and related new theories as the unique contribution of this study should be tested in order to see the social and environmental change that is necessary for sustainable energy transition. Concepts such as distributed generation, transition from alternative circuit to direct circuit infrastructure and resilient micro and smart grids all signal a shift to new energy environments. However, their integration into the urban fabric is challenging and faces strong political resistance worldwide excluding a few nations. An energy independent public space designed with the OED framework can soften such resistance and can be envisaged as a catalyst for sustainable energy transition. Specifically, when considered as a holistic model, the OED framework unites social and environmental science with energy economy, at the same time it can guide interdisciplinary urban energy studies such as energy independence for impoverished remote settlements, urban exergy and emergy studies, distributed energy neighbourhoods, energy mapping, and energy responsive planning and design.

1 The fifth law of thermodynamics states that information generally has the highest energy quality and the densest form of emergy/energy ratio (H. T. Odum, 2007, p. 88)

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List of Abbreviations

AC	Alternative Circuit
AILA	Australian Institute of Landscape Architecture
BREEM	Building Research Establishment Environmental Assessment Method
CELA	Council of Educators in Landscape Architecture
CEM	Community Empowering Model
CHP	Combined Heat Power
CTC	Cradle to Cradle
DC	Direct Circuit
DLS	Dynamic Loop System
EPT	Energy Payback Times
IE	Industrial Ecology
IFLA	International Federation of Landscape Architecture
LAGI	Land Art Generator Initiative
LEED	Leadership in Energy and Environmental Design
NGO	Non-governmental Organization
OED	Optimal Electricity Distribution
RBD	Research by Design
RFD	Research for Design
ROD	Research on Design
SHFA	Sydney Harbour Foreshore Authority
SITES	Sustainable Site Initiative
TBL	Triple Bottom Line

List of Publications

As per the section 8.10 of the QUT PhD course regulations, this PhD thesis is presented by publications.

QUT permits the presentation of theses for the degree of Doctor of Philosophy in the format of published and /or submitted papers, where such papers have been published, accepted or submitted during the period of candidature; and where the quality of such papers is appropriate to PhD-level research.

This thesis includes the following publications.

Publication 1:

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Publication 2:

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Publication 3:

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Publication 4:

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Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge, this thesis contains no material previously published or written by another person except where due reference is made.

Kaan Ozgun

Signature: QUT Verified Signature

Date: ___05 NOVEMBER 2015_____

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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

The problems surrounding the growing energy demands of cities are well documented. While renewable energy presents a solution to many of these problems, its integration into the urban fabric ultimately depends on societal change. Evidence of sustainable energy transition can be seen in the increasing amount of renewable energy used in cities around the world, which are implementing new policies to promote local clean energy. Energy-independence is an emerging trend at both city and neighbourhood scales. Concepts such as distributed energy neighbourhoods, virtual renewable energy utilities, transition from alternative circuit (AC) to direct circuit (DC) infrastructure, and resilient micro and smart grids all indicate a shift to new energy urban environments (Droege, 2009). In addition, environmental science researchers are exploring the spatial availability of urban environments such as derelict urban terrain for growing bioenergy crops (Rounsevell et al., 2006); and roofs and facades for electricity production from Photovoltaics (Redweik, Catita, & Brito, 2013). These scholars are also investigating power generation from urban wind and water sources such as ambient air, wastewater, and heat extraction from underground infrastructure (Dieter, 2009, p. 251).

These fast changing urban environments require new spatial and aesthetic sensibilities, presenting new questions to Landscape Architecture and Environmental Design research. However, current research into the applicability of renewable energy to sustainable energy landscapes has so far focused primarily on energy-responsive designs at the large, landscape planning, scale (Stremke & Koh, 2010). These designs often neglect the urban micro scale, which for the purpose of the current study, is defined as 'urban public space'. Furthermore, scholars of energy-responsive design and planning mostly apply principles from ecology and the first and second laws of thermodynamics[2] to establish new spatial links between renewable energy and regional landscapes.

2 According to the first law of thermodynamics, energy cannot be destroyed or produced and can only be transformed and conserved. The second law deals with this transformation, and states that the "work capacity" (exergy) of energy becomes extinct, while "disorder" (entropy) occurs (Dincer & Rosen, 2007).

From the time of *Design with Nature*, the seminal work of renowned landscape architect Ian Mcharg (1969), the science of ecology and its various theories have been used to advance Landscape Architecture scholarship. More recently "landscape urbanism" (Corner, 1999; Waldheim, 2006) of the mid-90s to "ecological urbanism" (Mostafavi & Doherty, 2010) of the 2010s, the domain of Landscape Architecture is increasingly applying theories from ecology to create conceptual models for urban landscape studies. Landscape Urbanism theory includes, but is not limited to, concepts of site specificity and context-based design; it draws attention to processes rather than form, is sympathetic to infrastructure, data-scaping and diagramming, is inventive when representing ecology, complexity as well as layering of past and present dimensions of landscape and seeks to incorporate all of these into design (Duncan, 2010; Raxworthy, 2004). It is essential to understand two concepts arising from the content of Landscape Urbanism theory in order to construct an overall theoretical background for this study: *process* and *infrastructure*.

Both landscape design educators and professional practitioners explore process discourse[3] within landscape urbanism theory. Thompson (2004) and Raxworthy (2012) criticise landscape urbanism theory as too representational and imaginary. Rather, they believe that landscape urbanists need to focus on how the envisioned strategies become reality, and on how they connect to local initiatives and collaborate with small-scale emergent social and cultural interactions in cities (Raxworthy, 2004, pp. 24-26; Thompson, 2012, p. 22).

Scholars discuss ways to enrich process discourse with performance activity. For example, Raxworthy (2013, p.2) suggests the use of gardening as a "real-time cultural means of engaging and manipulating growth in a dynamic, improvisatory relationship with natural processes" in addition to the representational approach to current Landscape Architecture theory. He argues that "[r]ather than looking to architectural modes of representation, Landscape Architecture should look to (and reconcile with) gardening for models to produce novel design outcomes that gain qualities rather than lose them over time" (Raxworthy,

3 Raxworthy describes 'process discourse' with "'dynamism', 'mobility', 'process' and 'flexibility' that have featured prominently in publishing in both areas since the mid-1990s. This body of thinking and practice I identify as the process discourse. I have coined this term to describe design projects and theory that focus on processes, notably as a source of form" (Raxworthy, 2013, p. 17).

2013, p. 2). In similar vein, Berrizbeita (1999, p. 199) classifies process as an aesthetic quality in contemporary landscape theory and practice, and reframes it with techniques and material characteristics at Bos Park in Amsterdam.

The second concept that Landscape Urbanism scholars have often used is "ecological infrastructure".[4] Landscape theorists and practitioners of Landscape Urbanism and Ecological Urbanism have used this term over the last decade within various contexts, including, food production, water cleansing, climate regulation, dealing with flood and river systems, drought, and plant succession (Corner, 1997; Reed, 2010; Waldheim, 2006; Yu, 2010). Belanger (2010, p. 348) in reference to the term argues:

> [t]he ecological restructuring of urban infrastructure must include the management of water resources, waste cycling, energy generation, food production and mass mobility. Paramount to both practice and pedagogy, infrastructure needs to be reintegrated and redefined as a sophisticated, instrumental landscape of essential resources, processes, and services that collectively underpins and upholds the ongoing, unfinished urbanization of the twenty-first century.

However, landscape urbanism theory is thus far indifferent to recognising renewable energy as potential "micro-scale" ecological infrastructure. The indifference in the theory is also reflected in practice. For example, over the last decade, designers have been integrating renewable energy into public space projects. These project examples show, however, that the general tendency when integrating renewable energy is to attempt to increase environmental sustainability without giving full consideration to the social and economic relationships around electricity production.

Rather than perceiving renewable energy applications as crude "technological fixes"[5] that simply address the environmental sustainability objectives of a sustainable top-down developmental approach (Moldan, Janoušková, & Hák, 2012, p. 6), scholars and practitioners need to treat renewable energy as "ecological infrastructures". For example,

4 In using the term 'ecological infrastructure', this study does not intend to create a typology. The term is not formally recognized in any discipline but is often used interchangeably by environmental scientists and landscape and ecological urbanists. It is used both metaphorically and scientifically in terms as diverse as "landscape infrastructure", "landscape ecological infrastructure", "infrastructure as landscape", and "green infrastructure".

5 In this study, "Technological fix" and "Ecological Infrastructure" are used as binary terms in a rhetorical context. Huesemann & Huesemann (2011, p. 24), in their book 'Techno-fix', argue that "science and technology, as currently practiced, cannot solve the many serious problems we face and a paradigm shift is needed to reorient science and technology in a more socially responsible and environmentally sustainable direction".

Byrne et al. (2009, p. 88) argue for the location of "energy-ecology-society relations in a 'commons' space", and for a shift in focus on techniques and social arrangements which can serve the aims of sustainability and equity. Public space might therefore be a showcase for the renewable energy commons approach[6,7], a bridge that connects mainstream energy with the emerging alternative decentralised energy movements.

The public space designer Jan Gehl (2010) explains the reciprocal link between society and public space in his dictum paraphrased from Sir Winston Churchill: "We shape cities and they shape us". Perceiving renewable energy as a production activity incorporated within a public space program also provides new ways of interacting in and around public spaces; this circumstance has the potential to heighten the value of the social and economic sustainability dimensions of renewable energy. Both the social and environmental aspects of public space and design as a creative act indicate the connection between public space and renewable energy, and further present unlimited potential to enrich renewable energy applications. Public spaces can then serve as this "commons" space which could potentially contribute to the necessary societal shift that includes an acceptance and understanding of renewable energy.

Scholars suggest that "[n]ew public space designs need to arouse desire in the public to participate, to cultivate and to advocate" (Amidon, 2009, p. 178). Furthermore, current Landscape Architecture theory promotes a dynamic approach to public open spaces that is concerned with programs, infrastructure, and multifunctional and flexible services (Wall, 1999, p. 234). For example, a public park by definition is a non-profit-generating community asset. If economic production, such as the production of electricity from renewable energy sources, occurs within that park, it might then be possible to use the revenue for direct community benefit and to subsidize park maintenance costs (Garvin & Brands, 2011, p. 205). However, implementing these ideas can be a challenge for landscape architects and,

6 "The commons is a way of thinking and operating in the world, a way of organizing social relations and resources" (Eizenberg, 2012). Eizenberg contends that "existing commons should not be seen as a 'return' of some noble but possibly archaic ideal but as a springboard for critiquing contemporary social relations and as the production of new spatiality, initiating the transformation of some fundamental aspects of everyday life, social practices and organization, and thinking" (Eizenberg, 2012, pp. 779-780).

7 Energy commons is not a new approach, and countries such as Denmark and Germany have been experiencing sustainable energy transition as a grassroots, community-based initiative supported by local government policies and cooperative small-scale private decentralised ownership (Droege, 2009, pp. 116,145).

thus far, the social and economic components of sustainable energy usage have not been fully explored in a public space context. Designers do not have tools for integrating renewable energy into public spaces in ways that facilitate social engagement and social change; it is this lacuna that this study seeks to address.

Three exemplary public space projects are discussed in section 2.2 to contextualise the scope of this study. The first project, *Eco-Boulevard*, was recognised with a UN-Habitat award, and is presented herein as a "good practice" exemplar. The second project, *The Forum Photovoltaic Pergola*, represents the common "techno-fix" approach. The third project, *Passage 56*, comprises a community-based self-sufficient neighbourhood public space focusing on "community engagement". The first and the third projects signpost and demonstrate the social and economic relationships of renewable energy.

This study also investigates the recent practices of "designing" and "assessing" the integration of renewable energy into public spaces. These two industry-relevant themes are represented in two significant bodies of knowledge in the literature. For example, the Sustainable Sites Initiative (SITES) framework is discussed in the context of how SITES is used to assess public spaces, and addresses the need for guidelines and performance benchmarks for sustainable design, construction, and maintenance. The SITES framework has been tested in many case studies in the United States and recent years, Australian Institute of Landscape Architects (AILA) also tested the framework's applicability in the Australian context. SITES uses a rating system to assess projects based on a set of criteria, which are predominantly environment driven (SITES, 2014, p. 110). It shares similarities with the LEED (Leadership in Energy and Environmental Design), which is a green building rating system encourages an integrated design approach for green buildings with a points scheme that allots credits for building design features deemed to improve sustainability, which includes reductions in energy use and improvements in indoor environment quality"(Newsham, Mancini, & Birt, 2009, p. 897). However, both LEED and SITES rating systems' attention to the social and economic aspects of renewable electricity production is vague and underdeveloped.

In addition to the SITES initiative, this study investigates current design practices in relation to embedding renewable energy in public spaces. The Land Art Generator Initiative (LAGI) provides the opportunity to explore the current design thinking behind the topic. Over the last five years, LAGI competitions have focused on the integration of renewable energy into public spaces through the vehicles of art practice, Landscape Architecture, and environmental engineering. With its focus on the aesthetics of renewable energy, LAGI aims

to increase public awareness and social acceptance of renewable energy, and thus bring about the societal shift that is indispensably concomitant with sustainable energy transition.

1.2 KNOWLEDGE GAP

After consideration of available evidence, both theory and practice in the Landscape Architecture profession and/or academia, to date, reveal a limited exploration of the relationship between renewable energy and public space. As mentioned above, many projects are a testament to the widespread integration of renewable energy in public spaces. Nevertheless, these projects generally address environmental objectives only, and overlook the social and economic issues generated by the production of electricity from renewable sources, and its relationship to public space and the community. Furthermore, the primary objective of the existing renewable energy public space projects is to use clean energy, become energy efficient, and reduce the carbon footprint. A number of knowledge gaps appear within this limited approach, particularly with regard to the qualitative implications of renewable energy situated within urban public space.

For example, in urban landscape studies, no single study establishes an innovative renewable energy and public space design framework. *Framework* as defined in the Collins English dictionary refers to "a structural plan or basis of a project." Rather than reinventing processes and procedures for particular projects, designers use frameworks as tools to readily achieve practical, efficient, and effective outcomes. Frameworks can also be defined as "experienced and tested pathways", or as "meta-design tools that provide designers with conventional foundational knowledge or guidelines for a specific field".

Edelson (2002) defines a *design framework* as "a prescriptive generalised design solution that is the sum of design guidelines for a specific design problem" (p.114). Van den Akker (as cited in Edelson, 2002) describes a *design framework* as "substantive design principles" as a significant attribute of design research (p. 114). For example, Sloane et al. (as cited in Edelson, 2002, p. 114) develops a design framework "[f]or conducting an embedded performance assessment", and Lenzholzer (2012) proposes a design framework to integrate micro climatic conditions into the design of Dutch public spaces.

This study is situated within landscape urbanism theory and practice. It addresses a current knowledge gap — the holistic assessment of energy embedment in public space in the urban context. The theory of landscape urbanism and its extension — ecological urbanism — oscillate between the positions of "science of ecology" and "ecology as a metaphor" (Thompson, 2000, p. 137). However, Koh (2013) emphasizes the limitation of the science of ecology in landscape ecological urbanism theory and contends that Landscape Architecture scholars need new approaches to empirical research in order to advance existing

landscape ecological urbanism theory (p. 246). For example, energy-responsive landscape design, for the most part, is a science-based approach guided by principles and new knowledge from the science of ecology and thermodynamics, rather than by the concept of ecology as metaphor (See Stremke, 2010). While a number of studies (See Connelly & Koshland, 2001; Huang, Lai, & Lee, 2001; Sciubba, Bastianoni, & Tiezzi, 2008; Van den Dobbelsteen, Jansen, Van Timmeren, & Roggema, 2007) have begun to explore new concepts from ecology and thermodynamics for energy-responsive planning and design at the regional scale, such concepts still need to be applied to advance theory for the public space context and to support a genuinely sustainable energy transition. In other words, there is still the need for design guidelines or frameworks to inform sustainable energy usage in public spaces.

Since LAGI project is a case in point: this study explores the latest design approaches to renewable energy integration in LAGI's speculative proposals. Despite LAGI having an explicit written design brief — requiring detailed energy production forecasts from each entrant — little is published/discussed about the submitted proposals in regard to their sustainable electricity distribution within the public space context. That is, no controlled studies that assess LAGI proposals against their electricity distribution in the public space context have been found. Such objective assessments are critical to an understanding of the genuine sustainability of renewable energy usage in public spaces. LAGI's primary consideration — the aesthetics of renewable energy — only partially affects the sustainability [or the social acceptance (Rogers, Convery, Simmons, & Weatherall, 2012)] of the green innovation. This is despite the fact that a thorough public space renewable energy distribution is essential to boost the social and economic outcomes of electricity production in a public space context. There is little evidence that existing built projects, or LAGI's speculative projects, promote sustainable energy distribution strategies for this public space context.

Current sustainability assessment tools for public spaces, such as SITES, are mostly restricted to limited assessment criteria for renewable energy usage. For the most part, they address environmental objectives, and neglect the social and economic potential of electricity production and distribution in a public space context. Therefore, a thorough assessment method is imperative to understand the real intentions of the project about renewable energy and its management within a public space context.

Landscape Architecture scholars study the relationship between design and research at a methodological level. Such studies are considered as new design methodologies; three of these methodologies are employed in this study, and are described in detail in chapter 3.

Finally, this study contributes novel design research procedures to Landscape Architecture design research and practice. Using multiple methods — including design competitions, design activity, and research — it creates and tests a new design framework — the "Optimal Electricity Distribution Framework".

1.3 METHOD, RESEARCH QUESTION AND OBJECTIVES

This thesis employs a multi-method approach that combines design and research activity. It first uses a design proposal entitled 'Co-existence Landscapes' developed for and submitted to IFLA 2011 competition. This proposal is the earliest design exercise of the thesis that explores the relationship between renewable energy and sustainable human environment at a city scale. The second design exercise carried out for LAGI 2012 design competition includes designing a renewable energy sculpture for Freshkills Park in New York City. Both LAGI 2012 competition site context (public space), design process in developing this proposal and the outcome enable this thesis to narrow down the research topic; in doing so, it establishes the hypothesis and poses the research question and the objectives. The study proposes that electricity production from renewables be incorporated into the socio-cultural and ecological purpose of public space to create social and environmental change by engaging the community, enriching the local economy, and increasing social networks.

The following question is formulated relevant to Landscape Architecture and Urban Design:

- What is the potential relationship between public space and renewable energy, and what principles and methodologies can better contribute to the design of renewable energy-embedded public space?

To address this research question, the study first aims to better understand the existing approaches to integrating renewable energy into public spaces. To achieve this, the study analyses an exemplar built project in Australia then a group of published speculative projects in the US submitted to the LAGI 2012 design competition. The Ballast Point Park project in Sydney (by McGregor Coxall Landscape Architects) is chosen as a case study. To analyse this project, the study employs a triple-bottom-line (TBL) assessment framework with a mixed methods approach for data collection. It is important and relevant that the primary case study be conducted in Australia, because Ballast Point Park project is not only where the study is based but is highly respected and recognised by Australian Institute of Landscape Architects (AILA) (See 2010b) as the first and only Landscape Architecture project to integrate renewable energy into its design.

The study methods include semi-structured interviews (with designers and other experts involved in the project), user surveys, and systematic site observations. Interview questions target the general philosophy of sustainability, TBL, and renewable energy, with a specific focus on renewable energy distribution in and around Ballast Point Park. The research-specific TBL objectives guide the findings, with data collected through the site observations and user survey. The findings of this case study support the second objective of this thesis, which is to develop a framework to better enable landscape architects and designers to sustainably integrate renewable energy into their future projects. The study concludes with the development of a general design framework, Optimal Electricity Distribution (OED), which conceptualises an optimal distribution of onsite electricity produced from renewable sources embedded in public open space.

By advancing the OED framework with relevant ecological and energy theory, the study develops criteria for the analysis of LAGI's published speculative projects. The study considers LAGI as an authority in this emerging subject because LAGI organises design competitions since 2010 and has gathered an archive of speculative projects over three different countries attracting experts, designers, and artists who work on the verge of science, art, and technology. LAGI's design proposals are therefore likely to be a good indicator of the dominant contemporary approaches to the design of renewable energy-embedded public spaces. The study applies a content analysis to the 2012 design competition with the purpose to understand how competition participants respond to the LAGI design brief, with a particular focus on electricity distribution in a public space context. Initial design competition processes and outcomes, the findings of subsequent independent studies, and theories from ecology and thermodynamics, then inform the exploration of the research question. The abovementioned methods are further described in Chapter 3 as well as in the relevant published articles presented in Chapter 5, 6 and 7.

1.4 SIGNIFICANCE

The study's first intended outcome addresses the practical implications of the design framework it develops. This framework can be useful in both design and assessment practices. At a design practice level, the framework will enable designers to reinvent renewable energy as a production activity within a public space context. In other words, the new production dimension of renewable energy can add an innovative enrichment for designers' public space programs. At an assessment practice level, the framework intends to enhance design awareness, agency, and efficacy with respect to embedded renewable energy public space.

In addition to measuring the actual environmental benefits of renewable energy, the framework will reveal the social and economic dimensions of clean electricity production in a public space context. It can also be used as a cross-disciplinary collaborative tool to bring stakeholders together for the common goals of making renewable energy usage more transparent, disseminating public information, and implementing sustainability assessment practices.

From a theoretical perspective, this study has two major outcomes: it advances theory and uses that theory to advance practice. Specifically, it supplements landscape urbanism theory with new knowledge from the science of ecology; thermodynamics; production-centred, new local public space; and social and economic relationships. Landscape urbanism scholars discuss the inability of current theory to generate practical, local and small scale practices (Thompson, 2012), and some argue that performative approaches such as production (Berrizbeita, 1999) and gardening (Raxworthy, 2013) should be included in the process discourse. Steiner (2011) contends that science-based urban ecological research enriches landscape urbanism theory and extends into ecological urbanism, with the expectation that the latter discipline will address the current theoretical gaps, "social and political realities of city conditions, giving more voice to citizens and finding ways to involve them in the creation of the new imaginaries" (Thompson, 2012, pp. 24-25).

Price and Lewis (1993) stress the separation of the productive social relations from the physical material world by treating landscape symbolically. Kevin Olwig (1996, p. 645), too, argues that a deep understanding of landscape is required beyond an image of scenic landscape that embraces "community, culture, law, and custom in shaping human geographical existence – in both idea and practice." As geographer Denis Cosgrove explains: "Cultural products such as works of Landscape Architecture can change human consciousness as well as modes of production like the neo-liberal capitalism that characterizes late 20th- and early 21st century American society" (Meyer, 2008, p. 10). The aesthetic and moral values ingrained in the cultural products such as works of Landscape Architecture are also the products of the economy in which they are produced. Culture regarded as the production of symbols coexists with the economy regarded as the production of material goods and both of which produce social relations continuously through the actions of society (Cosgrove, 1998, pp. 55-56). Cosgrove (1998, pp. 56-57) states that culture and economy "relate dialectically, each structuring the other as it is structured by the other". Therefore, each of them can be used to instigate change in social relations. This study substantiates these ideas by proposing a design framework for public spaces, the purpose of which is to reframe the use of renewable energy as a production activity within an economy

of the “commons”. In doing so, it enriches the process discourse discussion with emerging social relationships around local production and its cultural sphere.

The study advances the theoretical grounding for energy-responsive public space designs and shows a way of putting theory into practice. Until now, the theory has generated solutions for regional scale design, while neglecting micro scale design (e.g., the inner urban fabric). The study intends to increase the knowledge base by introducing Howard T. Odum’s fourth and fifth laws of thermodynamics to the Landscape Architecture profession. Odum, an American ecosystem ecologist, made significant contributions to ecology, systems theory and energy studies in over 300 publications. His theories have recently been applied to Cultural Studies (Abel, 2013a, 2013b; Falkowski, Martinez-Bautista, & Diemont, 2015), and an opportunity exists to apply his recent work to the public space context.

Finally, the study intends to generate discussion on the procedures and methods applied in its research process, particularly the implications of embedding design activity into the overall research by design competitions, and the role of such competitions in developing the research path and outcome. While “research by design” is growing in the discipline, scholars are still expanding and defining what this means for theory and practice. Many scholars and practitioners use design competitions as a way of testing hypotheses, however, the design approach, procedures, and outcome (the design framework) of this particular research are novel from a research by design perspective.

The study undertook the initial design activity within the IFLA 2011 and LAGI 2012 design competitions. The developed framework was corroborated by three different sources: 1) the author’s own collaborative design proposal for LAGI 2012; 2) the analysis of twenty-five LAGI 2012 design proposals; and 3) LAGI’s own design brief and philosophy. These three sources, and their unique approaches to renewable energy-embedded public space, enhance the validity of the process and outcome of this research by design process. More specifically, for example, the earlier version of the design framework was developed and submitted to LAGI 2012 and then, later in the course of this study, the framework was further advanced with the aid of theory from ecology and energy. Finally, to test the framework’s reliability, it was used to assess LAGI 2012’s renewable energy-embedded public space designs. Thus, design activity in this study was used both as a procedural tool, and as a tool for developing the final design framework.

Research procedures, their justifications, and relevant design definitions are described in detail in chapter 3 of this document.

1.5 THESIS OUTLINE

As this study employs design *in* research, its format is unconventional and is by-nature somewhat disjointed, incorporating publications of creative works of design, and qualitative studies. Although four independent publications are presented within a linear narrative, that addresses the research question and objectives as described in section 1.3 — the manuscript inevitably has repetitions in various sections and chapters.

Chapter 2 reviews the relevant research literature to establish the theoretical background of the study. It begins with an exploration of ecology's implications for landscape design theory, including landscape and ecological urbanism. The chapter examines the relationship between public space and renewable energy, and then reviews three current renewable energy-integrated public space exemplars to clarify the scope and purpose of the research. It then introduces energy-responsive planning and design theories and practices, and addresses the knowledge gaps with respect to public space energy-responsive interventions. The chapter concludes with a presentation of the existing design and assessment frameworks that are used both in practice and in academia.

Chapter 3 begins with the study's research design. It details the methods used; discusses the role of design in Landscape Architecture research; and provides justification of the research process, methodologies, and methods. This chapter identifies three relevant research methodologies in Landscape Architecture: (1) Research *by* design, (2) Research *on* design, and (3) Research *for* design. Chapters 4, 5, 6, and 7 are then (respectively) devoted to each of these methodologies.

Research *by* design is represented in chapter 4 by LAGI 2012's design competition submission and its published outcome. The findings of LAGI 2012 then inform chapter 5, a research *on* design study, which is the analysis of the first design competition (IFLA 2011) entry. Both the outcomes and processes of these two competitions helped to 1) narrow the study's focus to electricity production from renewable sources within a public space context (that is, to a micro-scale urban ecological infrastructure); 2) establish the basis of the theoretical background; and 3) shift the author's perception about renewable energy usage in public space and practice the renewable energy embedment in public space through design.

Details of the two published outcomes of these competitions are as follows:

Chapter 4: Research *by* design (RBD)

- Ozgun, K., Feher, K., Fernando, R., & Weir, I. Terra Preta (agriculture + art + algorithm). In C. Klein (Ed.), *Regenerative Infrastructures Freshkills Park, NYC* (pp. 240). **2013**. Munich, London, New York: Prestel Verlag.

Chapter 5: Research *on* design (ROD)

- Ozgun, K., & Buys, L. A sustainable tourism development in Alacati, Turkey: (Re)invention of public space with clean energy. Paper presented at the *Space-Time/Place-Duration for Council of Educator in Landscape Architecture (CELA) Conference*. **2013**. Austin, United States of America. http://eprints.qut.edu.au/59823/

Chapter 6 and 7 explore the research *on* design (ROD) methodology within two independent papers. The overarching aim of these studies is to better understand the existing approach to integrating renewable energy in public spaces. Therefore, the first paper specifically explores the project designers and consulted experts' general opinions of renewable energy and public space.

Focusing on integrated renewable energy in Ballast Point Park, the Chapter 6 ROD study uses a mixed-method case study that includes semi-structured interviews with relevant experts and designers, as well as user surveys, and site observations. The results indicate that environmental sustainability is the central focus of designers when embedding renewable energy into their designs. The results also identify a lack of sustainability assessment of public spaces, and the need for a framework for renewable energy distribution in public space. These outcomes and subsequent recommendations are discussed in section 6.1.6 of this chapter. The paper presented in chapter 6 is published. Specific details are as follows:

Chapter 6: Research *on* design (ROD)

- Ozgun, K., Cushing, D., & Buys L. Renewable energy distribution in public spaces: Analysing the case of Ballast Point Park in Sydney, using a triple bottom line approach. *Journal of Landscape Architecture.* **2015**, 2, 18-31.

The purpose of the second paper presented in chapter 7 is to understand the current design approach to embedding renewable energy in public space. By using new theories from energy and ecology, the study further develops the framework introduced in the previous paper. With the aid of the developed framework, this paper then analyses the

content of twenty five shortlisted and published projects from the LAGI 2012 competition. The results reveal an electricity distribution imbalance in these projects, and suggest there is a lack of understanding of sustainable electricity distribution within public space designs. The findings of this paper are published as follows:

Chapter 7: Research *on* design (ROD)

- Ozgun, K., Weir, I., & Cushing, D. Optimal Electricity Distribution Framework for Public Space: Assessing Renewable Energy Proposals for Freshkills Park, New York City. *Sustainability.* **2015**, 7(4), 3753-3773.

Chapter 8 ends with a re-evaluation of the findings of each publication with respect to the research question posed at the start of the study. The study's practical, theoretical, and methodological implications are discussed. Its limitations and the opportunities it indicates for future research are also addressed.

Figure 1.1 shows each chapter and publication along the research path.

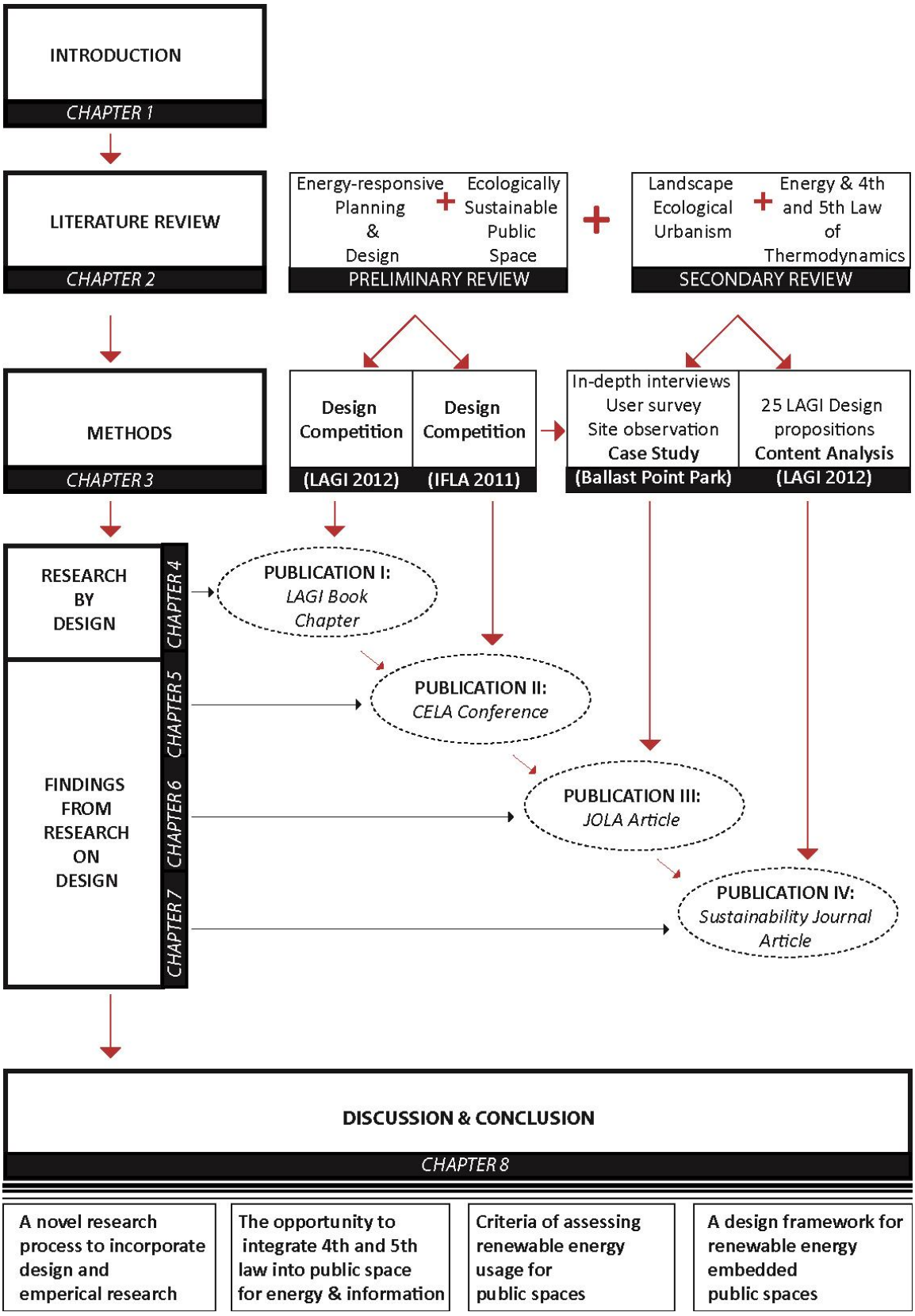


Figure 1.1. Map of overall research.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter establishes a theoretical background around renewable energy and public space. Current landscape theories, including Landscape Urbanism (Connolly, 2004; Corner, 1999; Waldheim, 2006; Wall, 1999) and Ecological Urbanism (Mostafavi & Doherty, 2010), are discussed. It defines ecologically sustainable public space in relation to renewable energy, and conceptualises public space and renewable energy as an ecological infrastructure, rather than a common techno-fix approach. This new definition of public space is in line with its role in educating society about the importance of renewable energy, which is necessary for sustainable energy transition. This chapter then reviews three exemplars of renewable energy-integrated public spaces that demonstrate good practice, community engagement, and the common techno-fix approach in order to contextualise the research problem.

Current energy-responsive landscape design and planning theories are then introduced, and the gap in our knowledge of energy-responsive public spaces at the urban micro scale is highlighted. To fill this gap in the discourse, the chapter presents new knowledge from energy and thermodynamics. Additionally, the chapter identifies triple bottom line (TBL) as a key tenet of sustainability. Other landscape architecture frameworks, including SITES and LAGI — which both deal with renewable energy in public spaces at assessment and design level — are discussed.

The following Figure 2.1 shows the reviewed literature from an overall research view.

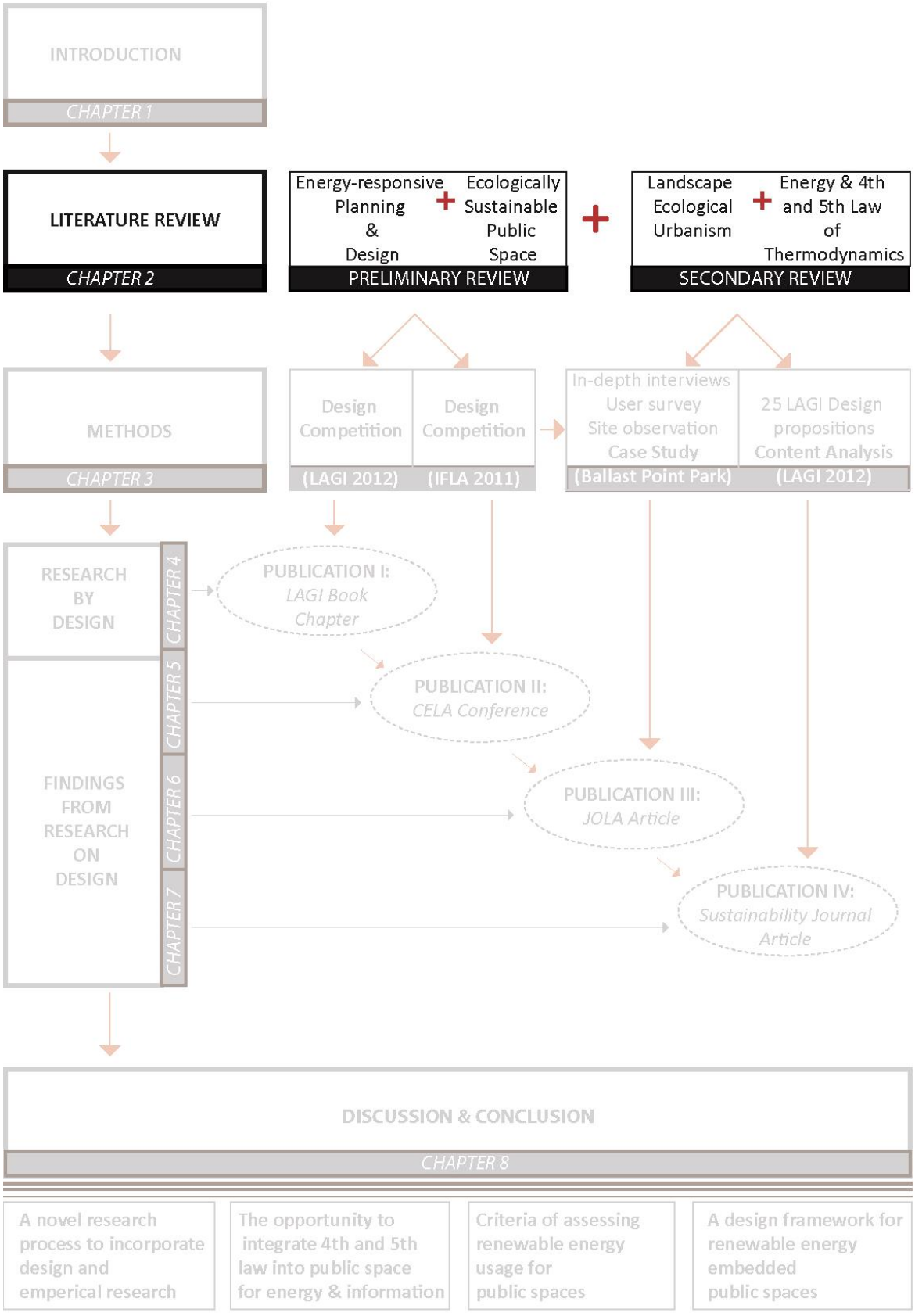


Figure 2.1. Map of overall research.

2.2 ECOLOGY AND ITS APPLICATIONS TO LANDSCAPE DESIGN THEORY

According to Nassauer (2002, p. 217), there is a key relationship between ecology, design, and landscape. While design is a cultural act, and ecology is a scientific study, they both share a common element: landscape. As well as being a scientific study, ecosystem ecology deals with ecosystems, their organisms within, and their interrelationships. The interconnected and integrative domain of ecology provides profound and unlimited possibilities within which environmental designers can create a sustainable human environment (Vasishth & Sloane, 2002).

Ecological processes guide designers in comprehending the new hybrid of natural and cultural systems on globally interconnected scales (Waldheim, 2006, p. 73). Capra (1983) puts it more specifically: "Individuals (human and nonhuman) and societies are embedded in the cyclical processes of nature, in a globally interconnected world, in which biological, psychological, social, and environmental phenomenon are all interdependent. To describe this world appropriately, we need an ecological perspective" (p.16). Indeed, scholars and designers have been using ecological metaphors and techniques in designing human environments since the last half of 19th century (Geddes, 1949; Hough, 1984; Howard, 1898; Lyle, 1996; McHarg, 1969; Mumford, 1965; Newman, 1999; Spirn, 1984).

Nassuer (2002, p. 218) argues that ecology influences landscape design in three ways: there is "ambivalence about the necessity of ecology for design"; ecology is "a source of inspiration for design"; and the "the substance of ecology" is integrated into design. While these influences are understandable, contemporary landscape design theory and practice do not yet treat them equally. For example, Van der Ryn and Cowan (2007, p. 189), in their book *Ecological design,* state that ecological metaphors greatly influence contemporary landscape design theory. On the other hand, they note that ecological design has evolved to mainly focus on the techniques and procedures from ecosystem ecology, rather than on mainstream design aesthetic.

2.2.1 Ecological Design

Ecological Design is an integrative and environmentally aware design discipline. It is both a vision and a pragmatic tool, where ecology and design are integrated to provide specific ways of minimizing energy and material use, reducing pollution, nurturing the habitat, caring for community, and seeking health and beauty (Van der Ryn & Cowan, 2007, p. 10). Ecological Design applies to all scales of landscapes such as bioregion, rural, urban, building/architectural and garden.

For example, permaculture, developed by David Holmgren and Bill Mollison (2002; 1988) in the 1980s, is an alternative practice that employs ecological design principles to

advance holistic gardening and agriculture techniques from a systems thinking perspective. The permaculture framework has become popular, is embraced by many people and perceived to be a solution to the world's growing ecological problems such as, soil erosion, water scarcity, pollution, as well as social problems such as famine, poverty, and inequity (Hathaway, 2015). Although permaculture promises to offer solutions to these problems, it still lacks a common aesthetic language in terms of appearance[8], and requires a mainstream aesthetic approach to be widely accepted and successful. In order to perform socially and culturally (Meyer, 2008, p. 16), an ecological framework needs to consider the issue of appearance as much as it considers function. As Meyer precisely points out, both function and appearance are necessary for the acceptance of any sustainable innovation. This study addresses this issue with a review of the aesthetics of sustainability in the LAGI framework in section 2.5.3.

Ecological design starts with site specificity in the urban context. Its design practice considers and includes the flow, type, quality and quantity of energy; materials; food; waste; toxins; climate; water; and movement (Van der Ryn & Cowan, 2007, pp. 88-92).

Figure 2.2. Mesiniaga Tower by Ken Yeang, Malaysia (Couzens, 2012).

8 Performance and appearance are much-used terms in contemporary Landscape Architecture. The link between appearance and performance (fitness) refers to the field of aesthetics (Meyer, 2008, p. 22). According to this definition, permaculture could be seen to fall short of addressing the full definition of aesthetics.

In the last decade, renowned architect Ken Yeang has been working to integrate ecological design principles into his buildings (See figure 2.2). His ecological design framework bridges the designed system and its environment, including the earth's ecosystems and resources. The physical composition, form, and operational functions of the designed system interact with its surroundings over time. Like a living organism, the designed system requires a continuous input and output exchange with its environment (Yeang, 1995, p. 78).

Yeang later classifies these interactions under 'external or environmental relations', 'internal relations', 'inputs' and 'outputs'. While Yeang's ecological approach is useful, it is limited in its application as a renewable energy public space framework because it is far easier to measure the inputs and outputs of a building compared to a landscape. Yeang's approach needs further specification for the public space and energy context which is later explored within Odum's theories of the behaviour of mature ecosystems and their energy cycle.

While environmental designers have used ecological design principles to develop the new urban landscape conditions, industry and alternative practices have also employed ecological design. For example, efforts to decrease energy consumption in industry have increased in the last decades, leading to the emergence of the Industrial Ecology discipline (Connelly & Koshland, 2001; Stremke, 2010). Industrial Ecology is principally derived from the concept of 'symbiosis' in ecology. It emerged with the study of environmental management and aims to integrate sustainability into environmental and economic systems (Ehrenfeld & Gertler, 1997, p. 68).

The next section discusses the application of ecology within contemporary landscape design theory.

2.2.2 Landscape and Ecological Urbanism

Cultural and natural processes have advanced contemporary Landscape Architecture theory, since McHarg's (1969) seminal work *Design with Nature*. Since the mid-1990s, two substantial discourses — landscape urbanism and urban ecology — have developed to incorporate cultural and natural processes in the design and planning of our cities. According to Steiner (2011, p. 333), "landscape urbanism evolves from design theory within both architecture and Landscape Architecture. It melds high-style design and ecology". He contends that urban ecology is developed within scientific research as design policy and proposals that have little practical application (Steiner, 2011, p. 333).

Landscape urbanism comprises of new conceptions. These include: the reinvention of urban infrastructure; large-scale engineering projects and former industrial developments;

data-scaping and diagramming; and critiques of representations of ecology and complexity as well as the layering of past and present dimensions of landscape; and an emphasis on horizontality and scale (Corner, 2006; Girot, 2006; Mossop, 2006; Pollak, 2006; Raxworthy, 2004). Landscape urbanists play an active role in shaping the new urban environment and in creating unique, liveable public spaces by endowing original built structures with new functions. James Corner, a landscape urbanism theorist and practitioner, exemplifies this trend. His latest projects, Freshkills Park and the High Line (the latter with Diller Scofidio + Renfro, and Piet Oudolf) in New York City, represent the subtleties of landscape urbanism theory such as site specificity; context based design; attention to processes rather than form; sympathy for infrastructure; and a desire to incorporate infrastructure into landscape design (Duncan, 2010).

For a definition of Ecological Urbanism, we can refer to Forman (2010) who defines urban ecology as "the study of the interactions of organisms, built structures, and the natural environment, where people are aggregated around city or town" (p. 312). Contemporary urbanism has to deal with the complex relationships between form, function and space; and flows across and between dynamic layers of economy, society, policy, and culture (Lister, 2010, p. 538). In *Ecological Urbanism*, Mostafavi and Doherty promote the innate contradiction of ecology and urbanism (2010). According to Steiner, their discourse is built upon landscape urbanism, with less attention given to urban ecology. He contends that if "the advances made in urban ecology were incorporated in ecological urbanism, then one might imagine a truly new synthesis: 'Landscape ecological urbanism'" (Steiner, 2011, p. 336). Accordingly, Steiner suggests three research directions: "an evolution of aesthetic understanding, a deeper understanding of human agency in ecology, and reflective learning through practice" (Steiner, 2011, p. 337).

Steiner's research directions are in line with Thompson's criticisms on the landscape and ecological urbanism discourse (2012, p. 24). In his recent article *Ten tenets and six questions for landscape urbanism* (2012), Thompson underpins the contradictions in landscape urbanism theory, and argues that it fails to recognise the social and political realities of cities, and is incapable of producing bottom-up practical innovation that embraces local resources and community empowerment. He concludes his article with the expectation that ecological urbanism will tackle the inadequacies of landscape urbanism.

These criticisms extend to the 'process discourse' of landscape urbanism, which is currently explored by architectural representations and/or simulations (Raxworthy, 2004; Thompson, 2012). In response to a lack of examination of 'process discourse' in the discipline, Raxworthy (2013), for example, studied the change in gardening practice, and

suggests looking to real-time, performative practices rather than to architectural modes of representation. Similar suggestions were made by Berrizbeita (1999, p. 199) at the Amsterdam Bos Park, who related 'process discourse' to the technical and material dimensions of landscape. Meyer reviewed the landscape framework for The Silresim Chemical Plant that was developed by Stoss Landscape Urbanism, and argues that "the project goes beyond ecological performance, it also catalyses social processes and new aesthetic experiences" (Meyer, 2008, p. 19). Similarly, this thesis further explores 'process discourse' by integrating social practice and the local economy of production activities around renewable energy in urban public space.

Both landscape urbanism and ecological urbanism develop new terminologies that assist the more effective application of ecological knowledge. One overarching term increasingly used in the discourse is 'ecological infrastructure'. This term is used interchangeably with 'landscape ecological infrastructure', 'landscape infrastructure', 'infrastructural landscape', 'green infrastructure', and 'landscape as infrastructure' (Bélanger, 2013; Corner, 1999; Czerniak, 2011; Paulo, Jack, & Newton, 2014; Reed, 2010; Waldheim, 2006; Yu, 2010).

Ecological Infrastructure aims to preserve the character of landscape by identifying its cultural, natural, and biological processes. (Shannon, 2013, p. 203). Bélanger provides more detail:

> Born from performance and productivity, newly recognizable morphologies and topologies of the infrastructural landscape meshes – webs, nodes, conduits, gardens, and fields— are most often hybrids of invariable types molded by additional processes of flow, trade, exchange, conveyance, mobility, and communications. Through this lens, we can begin to open a territory of new scales, systems, and synergies, upstream or downstream across the gradient of urban economies (Bélanger, 2013, p. 20).

These discussions signpost multiple scales of ecological infrastructure innovation. Yu categorizes these various scales as 'regional', 'city', 'district' and 'public space' (Shannon, 2013, p. 203). Also, Czerniak (2011, p. 26) indicates a number of micro scale interventions when referring to green infrastructure, including designs for stormwater swales, rain gardens, and bio filter curb extensions. She argues that "these modest installations foreground infrastructure as landscape and create more city, and urbanity, with less building" (2011, p. 28).

After reviewing the relevant contemporary landscape theory, the literature reveals that public space renewable energy applications have not yet been thoroughly explored from an ecological infrastructure perspective. Moreover, the 'process discourse' is still a fertile ground for new definitions to add to the existing architectural modes of representation. Some other performative approaches are suggested (Berrizbeita, 1999; Meyer, 2008; Raxworthy,

2013), and possible and existing social and political realities need to be integrated into these urban ecological infrastructures (Thompson, 2012, p. 22). While the overarching discourse of landscape ecological urbanism provides preliminary frameworks and visions for contemporary Landscape Architecture theory, an independent body of new energy-responsive planning and design theory (Stremke & Koh, 2010) has been emerging within Landscape Architecture itself. However, energy-responsive planning and design is currently focussed on the regional scale and often neglects the micro scale urban environment including but not limited to parks, urban squares, gardens, car park spaces.

In summary, the literature discussed in this section emphasizes three key issues: i) that 'process discourse' as a contemporary theoretical term can be enriched with performance activities, including new local, social, and economic relationships around electricity production; ii) that urban public spaces require new energy-responsive planning and design interventions; and iii) that renewable energy and public space need to be treated as ecological infrastructure, rather than as a techno-fix addendum.

Section 2.2.3 now frames public space and renewable energy in the discussion of ecological infrastructure and techno-fix. Section 2.3 then introduces the knowledge gaps in the area of energy-responsive design and planning.

2.2.3 Public Space and Renewable Energy: Ecological infrastructure vs Techno-fix

The Australian Institute of Landscape Architects (AILA, 2010c) defines 'public space' as "land provided for public use, access or visual or ecological reasons. It is an important part of the community's green infrastructure asset and should be designed, developed and managed with adequate funding and the best professional guidance available".

This current research expands the traditional definition of public space and redefines public space and renewable energy as a micro scale ecological infrastructure for electricity production and the social acceptance of renewable energy. This is in contrast to many definitions where public space is conceptualised as a passive and formal component of cities excluding customised features such as playgrounds, cafes, exercising spaces. Rather than designing for dynamic conditions, which is a necessary attribute for any system that captures natural energy sources, designers of public spaces have commonly focused on the physical conditions of a designed public space, which are, by definition, static.

Landscape urbanism promotes a dynamic approach to public spaces and is concerned with services, programs, infrastructure, and multi-functional and flexible surfaces (Wall, 1999, p. 234). This conception of public spaces as dynamic systems suggests a revitalized role for design professions, and disregards the monotonous standardization of the public

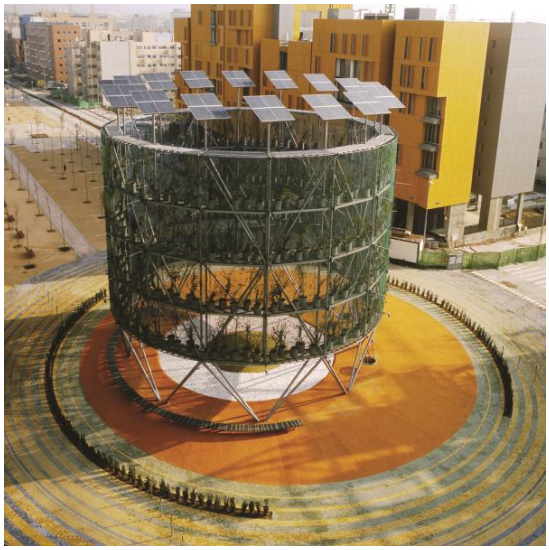
space in cities. North (2011, p. 20) states that a dynamic public space embraces, engages, and supports the community, and evolves with its users when considered as a framework. The multifunctional use of public space can also promote positive synergies between social and ecological functions, while using resources more efficiently from a whole systems perspective (Birkeland, 2008, p. 103).

Corner (1997, p. 86) suggests that "[l]andscape architects should look to ecology less for techniques of description and prescription (and even less for its apparent legitimizing of images of "naturalness") and more for its ideational, representational, and material implications with respect to cultural process and evolutionary transformation". In addition, ecology discourse suggests that only a bottom-up approach can create a sustainable world. This is because humankind is incapable of managing complexity and the dynamic scale of natural systems (Orr, 1992, pp. 29-38; Van der Ryn & Cowan, 2007, p. 23).

Despite emerging knowledge about energy-responsive spatial design intervention for buildings, neighbourhoods and regions, very little existing research can assist the formulation of a framework for the systematic design of energy-responsive urban public spaces. More specifically, mainstream design practices typically follow a techno-fix approach to renewable energy in the public space context. Design proposals lack systems thinking, energy flow, and the guiding principles of thermodynamics. Huesemanns (2011, p. 24) discusses flaws in the techno-fix approach, stating that "science and technology, as currently practiced, cannot solve the many serious problems we face and a paradigm shift is needed to reorient science and technology in a more socially responsible and environmentally sustainable direction". Similarly, Andrew Ross (Cited in Rios, 2013, p. 206) writes about technological fixes in *Bird on Fire: Lessons from the World's Least Sustainable City* and argues that "sustainability can only be achieved through social and political changes that redress the claims of the least powerful and most marginalised, not through technological fixes." Monstadt (2009, p. 1927) therefore stresses that the relationship between technology, ecology, and cities need to be redesigned in the form of new sustainable urban infrastructures with their "analytical concepts" and "theoretical frameworks".

This thesis presents an overview of renewable energy applications in public spaces including three projects which are selected and discussed in detail to reveal three distinctive approaches. The following sections describe first 'ECO-Boulevard', as a good practice exemplar chosen by UN-Habitat, then I discuss the project 'Forum photovoltaic pergola' as a representative of the now common, techno-fix approach. The final project 'Passage 56' represents a self-sufficient neighbourhood public space focusing on community engagement at a design and post production level.

2.2.4 Exemplar of good practice: ECO-Boulevard (Vallecas, Madrid, Spain)



(a) Ludic Tree Pavilion

(b) Media Tree Pavilion

(c) Media Tree Pavilion

(d) Air Tree Pavilion

Figure 2.3. (a) Modular tower with integrated PV panels and plants (Mimoa, 2011a); **(b)** View of interior with vaporised cloud generated by water atomisers, and LED screens connected to weather stations; **(c)** Neighbourhood summer rock concerts; **(d)** Exterior thermal shield made from high-density, multilayer polyethylene film and aluminium (Rutkowski & Wojciechowski, 2009).

Eco-Boulevard (by Ecosistema Urbano) is a campaign project promoting the climatic adaptation of outdoor spaces in Vallecas, a suburb of Madrid. The project addresses social, environmental, and economic sustainability by using a green infrastructure embedded into a series of public spaces. Renewable energy is an important element of the infrastructure in satisfying these project objectives.

The project creates a strong sense of interaction by simply installing a modular tower to transform three dull suburban junctions into a living public space. Each energy self-sufficient modular structure, located on a 500x50 m street, integrates plants and solar panels,

and promotes four different themes as shown in Figure 2.3. The project's electricity production contributes to the main energy grid, and the revenue raised meets the project's own maintenance costs (Mimoa, 2011a).

Rutkowski et al. (2009) identify these temporary modular towers as a new kind of architecture, which represents the temporality, changeability and dynamics of the contemporary world. At the same time, the project does not follow any sophisticated theory or concern about form; rather, it challenges the potential of technology and nature to stimulate public engagement and interest in climate change mitigation.

2.2.5 Exemplar of Techno-fix: The forum photovoltaic pergola (Barcelona, Spain)

During the 2004 Forum of World Cultures, Barcelona's regional planning department developed several projects to improve the city's existing infrastructure and to promote an energy plan. This plan incorporates the renovation of the existing power plant and the removal of part of the electricity transmission lines along the river Besòs. The existing sewage treatment plant has been refurbished (total urban renovation area of 100 hectares), and Photovoltaic (PV) panels have been installed in one part of the plant.

The most iconic part of the project as shown in Figure 2.4, is an architect-designed, PV-covered pergola supported by a sculptural concrete structure. This techno-fix 'Forum photovoltaic pergola' (by Jose Antonio Martinez Lapena & Elias Torres Architects) superficially appends renewable energy apparatus to an architectural icon. Thus, the structure provides shade for the public plaza, while at the same time generating electricity (Ivančić, 2010; Mimoa, 2011b).

Figure 2.4. The public plaza and 'Pergola Photovoltaica' by Jose Antonio Martinez Lapena & Elias Torres Architects (Photo by Raxworthy, 2006).

Ivancic (2010, p. 158) emphasizes that the project is an excellent example of the integration of large-scale solar energy generation in an urban context. It is a symbol of Barcelona's commitment to renewable energy and sustainability and, at the same time, is one of its most symbolic contemporary pieces of urban architecture. A 443 kWp photovoltaic (PV) generator composed of 2,686 PV modules covering a total area of 3,494 m², produces 1250 kWh/kWp; this is relatively small in comparison with total urban consumption. The pergola is expected to generate enough electricity to meet the annual energy demand of 140 Barcelona households estimated at 3,600 kW hours per year per family (Elcacho, October 2008 – March 2009). However, no evidence is found to suggest that the PV-integrated shelter creates public engagement as the result of its onsite-production of electricity. It could be argued that it engages the public by being a landmark as an architectural form and shelter.

Despite its many positive features, the techno-fix 'Forum photovoltaic pergola' exemplifies one of the central issues that motivate this research: that, while renewable energy is displayed on a giant structure sheltering a public space, the opportunity for public use of the on-site electricity produced is overlooked. This significant oversight in the case of the Forum Photovoltaic Pergola is also exemplified in many other renewable energy-embedded urban spaces such as car parks, building awnings, derelict urban terrain, roofs and facades, watercourses and wastewater. Since this study focus on the urban public space context of renewable energy, these spaces are beyond the scope.

2.2.6 Exemplar of community engagement: Passage 56 (Espace Culturel Ecologique, Paris, France)

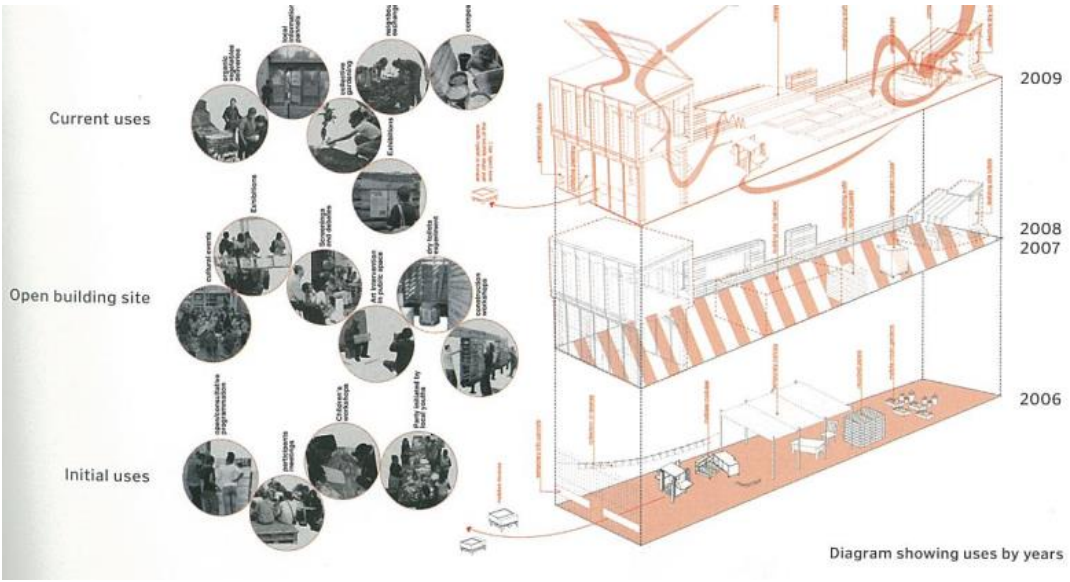


Figure 2.5. Diagrams showing the yearly change in use (Rambert, 2010).

Figure 2.6. Views of 'Passage 56' by Atelier D'architecture Autogeree-AAA (Rambert, 2010).

The third project exemplar, 'Passage 56' (by Atelier D'architecture Autogeree-AAA), differs from the former two exemplars in terms of its scale and type of public space. The project as shown in Figure 2.5 and 2.6 is an emergent public space between two building lots, and is designed for direct community participation and amenity. Its renewable energy aim is to create a self-sufficient community with genuine sustainability objectives.

While the two public space projects described above are part of new developed areas, this project reactivates an existing site as public space. Passage 56 is located in Rue Saint Blaise, a dense and culturally diverse neighbourhood of Paris. The architects were space challenged by the small 200 m2 site, originally a dustbin for local residents. However, the project has transformed this suburban wasteland into a social hub, where residents share knowledge and activities ranging from gardening to political debate. Rambert (2010, p. 83) notes that "Social practise is the key to this project and the spatial practice is based on the uses. Several parallel activities can take place here. There is no room for design in its layout. This is not the purpose".

The idea of a collectively managed space encouraged the residents to participate in collecting recycled materials for the construction of the timber office structure. PV panels are used to generate more electricity than is consumed by the users of the space. However, no explicit data can be found readily available to indicate whether the project sells the surplus electricity to the city grid, or stores it in batteries. The project promotes self-

sufficiency with on-site food production from organic gardening, rainwater harvesting and management, electricity production from PV cells, and waste composting and management.

The Passage 56 project epitomises the fact that an unplanned or unusual situation can evolve into an effective and productive public space. It shows that public space is not necessarily a physical condition of a designed object; rather, it is a continuous process of social, cultural, and political agenda (Rambert, 2010, pp. 84-85).

The synthesis of these three projects signposts the opportunity to integrate renewable energy and public space to create a new type of urban ecological infrastructure. Using the synthesis of the three reviewed projects as its basis, this research proposes a framework for the design of a new type of urban ecological infrastructure. This new type of urban ecological infrastructure repositions integrated renewable energy and public space as a platform for local electricity production – a new function of urban ecology.

Chapter 5, 6, and 7 include additional discussion about public space and renewable energy within the research-*on*-design (ROD) case study and its analysis.

2.3 ENERGY-RESPONSIVE PLANNING AND DESIGN

The International Energy Agency (IEA) has classified three generations of renewable energy technologies developed over the last 100 years. The first generation refers to those technologies that emerged with the industrial revolution and includes hydropower, biomass combustion, geothermal power and heat. The 1970s oil crisis triggered the emergence of the second generation, which comprises solar heating, cooling, photovoltaic, wind power, and bio-energy. Currently second-generation technologies undergo rapid evolution while third generation technologies are still under development which covers concentrating solar-thermal power, rock geo thermal power, ocean energy, bio-refinery technologies and advanced biomass gasification (IEA, 2007, p. 7). Such rapid development in renewable energy technology is also shaping the human environment in an unprecedented speed. Environmental design professions such as architecture, landscape architecture, and urban planning have recently begun to address renewable energy and energy efficiency while energy has long been considered in the environmental science disciplines. These design professions now acknowledge that a new approach to spatial transformation depends on improving energy efficiency, reducing carbon emissions while at the same time, integrating the emerging green infrastructures into human environments.

In the following sections below, I discuss a variety of built and conceptual projects around the world, ranging in scale from regional, urban, and neighbourhood. They include a selected inventory of energy-responsive approaches that are integrated into ecological design

applications. My review of the selected projects focusses mainly on the design procedures related to renewable energy.

2.3.1 Regional Scale

Although the technological advancement of renewable energy was the dominant paradigm in the last decade or two, the sustainability of renewable energy and its integration to human environment has recently become the central topic for planners and landscape architects in particular. For example, Stremke and Koh (2011, p. 197) explored energy-responsive planning and design in a regional Dutch landscape. Their definition of 'energy-responsive planning and design' is to increase the energy efficiency between renewable sources and the human environment by using spatial design practice. Applied to a site in-South Limburg in the south of the Netherlands, they have employed concepts and principles from ecology and thermodynamics, developed a regional spatial design framework, and suggested energy-responsive design propositions. Based on the South Limburg case studies**,** Stremke and Koh tested ecological concepts such as energy flow, energy cascades, primary production (Photosynthesis), material cycling, storage, biorhythm, symbiosis, diversity, source-sink relationship, and system size. They have also explored ways to adapt the constraints and potentials of the physical landscape to renewable energy resources.

In addition, Stremke and Koh have examined so-called source and sink relationships throughout the region. A source and sink relationship is constructed when one area exports excess energy to another without energy loss. In other words, sinks consume more energy and resources than local production provides, and either the import or storage of resources is inevitable. After analysing the potential energy source and sink relationship in the region, the landscape architects devised design and planning solutions, such as situating a new housing development adjacent to a geothermal energy source (Stremke & Koh, 2010, pp. 524-526). Physical proximity and strong connectivity between sources and sinks can cut costs and energy loss during transmission (Ehrenfeld & Gertler, 1997; Stremke, Dobbelsteen, & Koh, 2011, p. 201), as low-energy crops only need to be transported over short distances.

Although the techniques and concepts shown here are mainly region-specific and at the macro planning scale, a further fine-grained design resolution is lacking where otherwise the social, cultural and local specifics might be added to thermodynamic and ecological science as real denominators. Genuine sustainable outcomes are discussed as the product of top-down and bottom up strategies and tactics. In the end, the sustainability of these energy landscapes is not only dependent on power generation and management interventions; it is also dependent on the ways in which these interventions unfold as a fine-grained design response to the social needs of local people.

2.3.2 City Scale

Urban design has also embraced energy-responsive design, with progress in the research into urban energy systems, energy potential mapping, and distributed energy neighbourhoods (Girardin, Marechal, Dubuis, Calame-Darbellay, & Favrat, 2010; Howard et al., 2012; Van den Dobbelsteen, Broersma, & Stremke, 2011). The role of energy in landscape planning and design originated in land-use planning for energy-efficiency (Owens, 1992), and was limited to the selection of plant material and site-planning (R. D. G. Brown, Terry J., 1995). Despite the growth in knowledge of energy-responsive landscape design and planning at the regional scale, the literature lacks evidence of design concepts, principles, and proposals at the urban scale, such as public spaces.

Many architects and design practices make wide use of energy-responsive ecological design principles. For example, the Eco-city concept was first used by the environmental activist Richard Register (2006) some twenty years ago. The concept has emerged as a development initiative to minimize external inputs such as fossil fuel energy, water and food, and reduce outputs such as sewage, garbage, heat, pollution, and CO2 (Puri, 2009, p. 239). Some eco cities are currently under development. One such example is the Masdar Development by Foster and Partners in the United Arab Emirates which is envisioned as the first carbon-neutral and zero-waste city in the world when completed in 2020. However, it remains to be seen how the socio-economic and cultural dimensions of this project will unfold over time (Schuler, 2009, p. 243).

This raises the point that it is virtually impossible to classify large-scale projects as ‘techno-fix’ or ‘ecological infrastructure’, because both the scale and time dimensions involved make the measurement of their sustainability outcomes a very complex task. One can only assess a project’s brief and its designers’ sustainability objectives. For this reason, this study does not categorise and label projects as ‘techno-fix’ or ‘ecological infrastructure’, or create new typologies based on these terms. Rather, it exposes the present relationship between renewable energy, and its implications for the human environment with respect to ecological design and its multiple scales.

Figure 2.7. Arup's visualisation of Dongtan eco-city (Castle 2008, 69).

According to the urbanist Herbert Girardet (Hodson & Marvin, 2010, p. 208), the Dongtan project being developed by Arup in China is intended to be a pioneering eco-city that assures high-efficiency and small-footprint urban design (see Figure 2.7). Together with Dongtan, twenty other eco-cities are planned for China in the near future. Dongtan, in this regard, is a flagship eco-city that promotes a sense of place and culture, and a new economy to preserve tradition and maintain social sustainability. However, Lim (Cited by Castle, 2008, p. 69) states that "[t]he Chinese government has recently presented their new ecological showcase city to the United Nations World Urban Forum — the focus sadly is very much on energy and the environment only. Important social and economic issues are ignored". Although the construction was started in 2006, Dongtan project was stopped proceeding. Sze (2014) in her book *Fantasy Islands: Chinese Dreams and Ecological Fears in an Age of Climate Crisis* labels the project as an engineered 'ecotopia' and depicts the reasons behind why the Dongtan eco-city project could not achieve a completion in the Chinese context.

Despite their promising credentials, the success of sustainable cities is related to policy agreements at local, regional, national, and supra-national scales. Traditionally, cities thrive by seeking resources, even from remote locations. However, this attitude is changing, and bottom-up approaches now need to balance top-down regional energy strategies. Currently, major cities such as New York and London are exploring ways in which to eliminate their reliance on external resources.

The major of London has committed to a campaign for decentralized energy to meet one quarter of its total energy demand by 2025. Combined Heat and Power (CHP) systems connected to district heating networks are shown to be a viable strategy for London's energy decentralization. The city is planning to employ urban energy-responsive planning and design interventions to achieve its sustainability goals. Ecological concepts such as diversity and energy cascades can be a solution in reconceptualising the urban environment (Holbrook & Kirk, 2011). Holbrook and Kirk (2011, p. 94) state that

> Monocultures (large areas of housing for example) create asymmetric pressures on energy supplies and transport, while mixed use neighbourhoods are able to interact more positively by sharing loads throughout the day. For example, the local school might be able to store some of the excess heat generated by nearby offices in its swimming pool, releasing it later in the evening to local houses for warmth as families return home.

These researchers argue that any innovation in the application of energy networks requires a spatial design approach rather than merely a zoning exercise at the planning scale (Holbrook & Kirk, 2011). Both planning and a fine-grained design are critical and need to be realized in concert for any energy project set in the urban realm. One example of such a spatial design approach is the method of Energy Potential Mapping (EPM), which maps the

relationship between space and energy. EPM aims to categorise and quantify various local energy potentials within urban and regional landscapes. In so doing, EPM helps to spatially arrange different functions at urban and regional scale depending on their sustainable energy resource (Van den Dobbelsteen et al., 2011, p. 171).

New York City also has a strategy for energy independence and self-sufficiency (Hodson & Marvin, 2010, p. 215). Terreform — a collaborative centre for urban research — has initiated an advanced urban research project to study a self-sufficient New York City — the so-called 'NYC (Steady) State'. Terreform's study proposes a visionary plan for the city and envisages that it can become almost entirely self-sufficient within its political boundaries (see Figure 2.8).

Figure 2.8. Michael Sorkin's snapshot of New York City (Steady) State (Terreform, 2012).

The study investigates self-sufficiency in New York City under eight themes: food, energy, water, waste, movement, buildings, air, and climate. Each theme explores the history of the system and provides a context to analyse the current demand and supply patterns of the city in order to reconceptualise its own metabolism (Terreform, 2012). However, NYC (Steady) State focuses on a holistic future city image — an urban-rustic utopia — without providing many hands-on practical solutions. Terreform's urban design ideas, as demonstrated in Figure 2.8, require further design resolution in the context of the current urban reality. Furthermore, their research does not provide much detailed information about each theme and these also require further development (Terreform, 2012).

Recent research by Howard, Parshall, Thompson, Hammer, Dickinson, & Modi of Colombia University (2012) on the other hand, analyses New York City's current energy demand on the basis of the spatial distribution of buildings. The research shows a lot-based energy data inventory as a basis for exploring future energy-responsive spatial design possibilities. This research underlines the fact that buildings are responsible for over two

thirds of New York City's energy consumption. These scholars also affirm that energy-responsive spatial design and distributed generation need to be considered simultaneously to reduce primary energy consumption. For example, they suggest utilizing Combined Heat and Power (CHP) networks in the city, as well as the cost-effective re-use of waste heat streams from gas-fired distributed generation. A solar resource on one building's rooftop, for example, could be of value to another building nearby.

NYC (Steady) State advanced urban research is an overarching manifesto, and could be the key to the city's most probable alternative future. The research can potentially guide and inspire many interdisciplinary research studies, such as the one undertaken by Colombia University (cited above). Similar approach to the NYC (Steady) State research, the current research explores renewable energy usage in NYC urban public spaces through the LAGI 2012 design competition in section 4.1.3.

2.3.3 Neighbourhood Scale

On the neighbourhood scale, energy-related innovation becomes more tangible. For example, Beddington Zero energy development (BedZED) in Sutton, Surrey (south of London, UK) was completed in 2002, and was the first neighbourhood-scale multi-use sustainable community. With 100 units, office spaces and community functions, the development has been a continuous inspiration for other sustainable developments across the world.

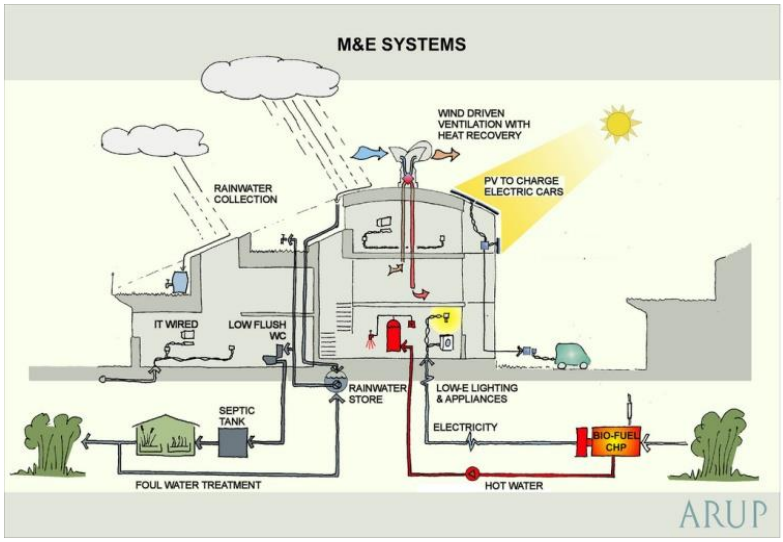


Figure 2.9. BedZED development's mechanical & engineering system by ARUP (BedZED, 2012).

By using a woodchip Combined Heat and Power (CHP) energy plant and PV panels on the roofs, an average BedZED household manages to consume 60% less electricity than a similar sized home meeting its needs from non-renewables (see Figure 2.9). The

development has also succeeded in establishing a strong, sustainable community culture while, at the same time, achieving its environmental goals (BedZED, 2012).

While BedZED showcases a suburban sustainable neighbourhood, new eco-neighbourhoods have also been emerging in the hearts of cities. The proposed Barangaroo development on East Darling Harbour in Sydney (Australia), for example, is planned to be the first climate positive CBD district in the world. By employing onsite renewable energy possibilities, Barangaroo will be able to meet the energy demand of its entire public space, which is planned to occupy 50 per cent of the development site (Release, 2009).

Droege (2006, p. 50) suggests that an open energy market economy where urban dwellers engage in energy production and trading, is imminent. Today, the ubiquitous PV-installed roofs and the latest PV-integrated façade technologies can transform every neighbourhood from an energy consumer to an energy producer. Such projects are perhaps the early proof of the notion that cities can become virtual power plants in a fully sustainable way (Lehmann, 2010, p. 246). The retrofitting of existing buildings with renewable energy devices, or the use of any CHP energy potential in a neighbourhood, results in energy efficiency, less energy consumption, and surplus clean energy.

Despite these promising developments, Howard et al. (2012, p. 142) note that the success of these interventions relies on the development of policies to avoid possible conflict between energy production and the key players in its distribution. While the concept of 'city as a virtual power plant' seems positive and benign from an environmental point of view, the transformation process is still unclear and could negatively impact a city's social, economic and aesthetic future.

Emerging eco-neighbourhoods are good examples of how new sections of cities can be designed off-grid to be self-sufficient, and to require only minimal energy from the main grid. Food production, and water and waste management need to be simultaneously integrated into such systems. The more that ecology underpins a system, and the more that survival functions are closely situated, the less energy is consumed (H. T. Odum, 1976). In other words, all functions and facilities need to be in the vicinity of the consumption node. According to Lehmann (2010, pp. 246-254), each project needs to start with an energy master plan where sources and sinks are highlighted. These analyses then become the basis for all future planning.

Collectively, these speculative and built projects outline a critical role for an holistic urban ecosystem and its interconnected scale types. The most important segment of this complex urban ecosystem , the urban public space, requires special attention and a detailed

sustainability sensitivity, as it is a physical, social, and spatial representation of our rapidly changing global society.

I now discuss energy and its relationship to energy-responsive planning and design theories within the urban public space context.

2.4 ENERGY IN NATURE: THE LAWS OF THERMODYNAMICS

To provide food, water, and shelter, and to improve the quality of our life, energy is required. Energy comes in many forms, and the science of thermodynamics determines energy transfers and energy transformations in processes, systems, and devices. The first law of thermodynamics states that energy cannot be destroyed or produced and can only be transformed and conserved. The second law of thermodynamics deals with this transformation and states that the work capacity —'exergy'[9]— of energy becomes extinct when disorder 'entropy' occurs (Rosen & Dincer, 2007, pp. 1-21).

Howard T. Odum, a renowned 20th century ecologist, made a significant contribution to ecology through his application of thermodynamic laws. As an ecosystem ecologist, he introduced the ecosystem concepts of energy hierarchy, and energy flow to the human environment. Although some of his early theories have been widely criticised (Georg, 2014; Golley, 1993; Hagen, 1992; Månsson & McGlade, 1993), with reference to conventional ecology, scholars of systems ecology (Abel, 2013a; Jørgensen, Nielsen, & Mejer, 1995; Patten, 1993; Ulgiati & Brown, 2009) are now applying his concepts and advancing his theories in various disciplines, including economics, cultural studies, sustainability assessment, and landscape design and planning.

Ian Mcharg was one of the pioneer landscape architects who connected thermodynamics laws with the discipline of Landscape Architecture in the 1960s (McHarg, Margulis, Corner, & Hawthorne, 2007, pp. 79-83). Contemporary landscape architect Robert Thayer emphasizes the importance of the second law of thermodynamics in Landscape Architecture, focusing on the link between entropy and information (Stremke & Koh, 2011, p. 196). Most recently, Landscape Architecture scholars have integrated the first and second laws of thermodynamics as well as the concept of exergy into regional sustainable energy

9 'Exergy' stems from the Greek words 'ex' meaning 'from', and 'ergon' meaning 'work'. It is "defined as the maximum amount of work that can be produced by a stream of matter, heat or work as the medium comes into equilibrium with a reference environment (Dincer, 2000) or into equilibrium with the surrounding environment (Connelly and Koshland, 1997)" (Cited in Stremke et al., 2011, p. 151).

landscapes. They have investigated whether the second law of thermodynamics can advance sustainable landscapes, and whether innovations can facilitate the reduction of exergy destruction in the built environment (Stremke et al., 2011, p. 150).

The relationship between exergy and emergy has been widely discussed (S. Bastianoni, Facchini, Susani, & Tiezzi, 2007; Simone Bastianoni & Marchettini, 1997; Jørgensen et al., 1995). The distinction between conventional ecology and ecosystem ecology has also influenced other disciplines, including sustainability. For example, emergy and exergy are two distinctive discourses that use sustainability assessment methods. Exergy is a measure of the actual state of the system, of its level of organization, and of its information content; emergy, on the other hand, refers to the history of the system, and the time and processes that have contributed to its current state (Simone Bastianoni & Marchettini, 1997, p. 33).

Bastianoni et al.(2007) define emergy as a function of exergy, while Odum (1988) refers to it as 'energy quality'. The letters 'em' of emergy represents 'energy memory' and relate directly to the now more common term 'embodied energy'[10]. According to Uligiati, emergy refers to the system's adaptation capacity to become a mature ecosystem (Sciubba & Ulgiati, 2005, p. 1959). Applying the mature complex ecosystems model to public spaces, therefore, suggests the necessity to include the concept of emergy in the discussion of energy responsive planning and design; that is, in addition to the exergy concept.

Emergy and embodied energy are important components of the theoretical background of this study. However, they have not yet been explored by current Landscape Architecture energy-responsive planning and design scholars. Exergy scholars argue that, due to its complexity, emergy analysis cannot offer an accurate methodology for environmental accounting. However, given the lack of another suitable methodology, the public space framework that this study proposes utilizes both embodied energy and emergy to create measurable sustainable outcomes.

According to Odum's fourth law (the maximum empower principle), systems develop parts, processes and interactions that maximize efficiency and production in the self-

10 For example, embodied energy of a renewable energy device/infrastructure refers to 'energy pay back times (EPT)'; in other words, the energy and revenue spent on a renewable energy device until it is constructed and functioning (Alsema & Fthenakis, 2006; Hammond, 2007; Roberts, 1980).

organization process. An effective ecological public space design needs to consider this maximum power principle. Odum also studied the energy hierarchy in ecosystems, and indicated that mature ecosystems have the highest emergy value.

According to Odum's fifth law, all energy transformations can be connected in a series network depending on the needs of lower and higher orders. One of Odum's important findings from the fifth law is the concept of 'concentrated energy', also known (in his own words) as 'useful information'. Useful information emerges during the self-organization process, which controls and monitors the system to keep it stable.

In chapter 7, this study further explores the maximum empower (fourth law) and the energy hierarchy (fifth law) in the renewable energy public space context and identifies their relationships. The next section now discusses sustainability and its practice-based framework in relation to Landscape Architecture and design.

2.5 EXISTING DESIGN AND ASSESSMENT FRAMEWORK

The most common definition of 'sustainability' and 'sustainable development' originates from The Brundtland Report, "Our common future" (WCED, 1987, p. 40). In this report, 'sustainable development' is defined as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Since this original definition, the term has been evolving as a holistic, overarching concept (Pope, Annandale, & Morrison-Saunders, 2004, p. 597). Renewable energy applications have become an important aspect of sustainable development since the term sustainability was coined. According to Dincer (2000, pp. 172-173), the success of sustainable development depends on a number of successful energy programs and their management strategies. This includes energy innovations; raising awareness through public and professional organizations; informing users about energy usage and type of renewables; increasing environmental knowledge through training and education; encouraging renewable energy usage through finance and tax initiatives and/or policies; and integrating assessment and auditing tools.

To operationalize and implement sustainability into practice, many sub-definitions and frameworks have emerged; for example: 'Triple Bottom Line' (TBL), 'Weak and Strong Sustainability', 'Ecosystem Services', 'Human Well-being', 'Resilience' and, recently, 'Anti-fragile' (Rostami, Khoshnava, & Lamit, 2014; Taleb, 2012; Wu, 2013). In principle, each term focuses on increasing human well-being.

For the purpose of this study, the following sections cover three essential frameworks that are directly related to Landscape Architecture, renewable energy and public space.

2.5.1 Triple Bottom Line (TBL)

TBL, a term coined by John Elkington in the 1990s, was conceptualised as a tool to integrate sustainability into the business world. It was introduced to increase the responsibility of a corporation, and to minimise the detrimental impact of its economic activities on the environment and society (McDonough & Braungart, 2002, p. 252). To achieve sustainability in practice, the relationship between social, economic and environmental aspects at the local, regional, and global scale needs to be clearly identified and developed (Wu, 2013, p. 1002).

Given a changing climate and rapid resource depletion, the Landscape Architecture discourse has gradually integrated sustainability into the various aspects of the profession. Some scholars have criticized this slow and gradual application of sustainability to Landscape Architecture. Its slow application, proven by the fact that the first US-published article about sustainability in Landscape Architecture appeared eleven years after the Brundtland Report, was due, according to Meyer, to the dissonance between neoliberal free market capitalism and sustainability (Meyer, 2008, p. 11). The Australian Institute of Landscape Architects (AILA, 2010a) states that the TBL of landscapes needs to be clearly identified in terms of environment, economy, and society/culture. AILA contends that a TBL perspective raises the potential for new ways of analysing, designing, and managing sites across a wide range of scales.

Although the concept of TBL originated as a business model for companies, the framework can be appropriated for Landscape Architecture projects. For example, a park is a non-profit asset for a community. If production occurs within the park, it may be possible to channel this revenue for direct community benefit and to subsidize park maintenance costs (Garvin & Brands, 2011, p. 205). Nevertheless, implementing the TBL framework into everyday public spaces can be challenging and, to date, the economic and social components of TBL have not been fully explored by designers of public spaces. By bringing production activities and the interrelationships with other TBL components to the forefront, however, we can begin the critical shift to renewable energy acceptance.

A more detailed description of TBL is provided in chapter 6 in relation to the case study of Ballast Point Park.

2.5.2 The Sustainable Site Initiative (SITES)

As the concept of sustainability has evolved, scholars have recognised the importance of a multi-disciplinary approach to the study and practice of sustainability. Cairns (2004, p. 33), for example, states that “the sustainable use of the planet is a policy goal that requires

input from all disciplines, professions and special interest groups. The disciplines are essential for quality control; however, if they remain in the present degree of isolation from each other, sustainability is unlikely to be achieved". Moreover, each discipline creates its own quality control mechanisms, one of which is the assessment of sustainability.

The most relevant assessment methods related to the scope of this research include 'BREEAM' (Building Research Establishment Environmental Assessment Method) in the UK, 'LEED' (Leadership in Energy and Environmental Design) in the USA, and 'Greenstar' in Australia. Such methods have become industry standards for sustainable architecture, and have, by association, also influenced sustainable Landscape Architecture.

SITES — which was jointly developed by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Centre at The University of Texas (Austin) and the United States Botanic Gardens — primarily focuses on ecosystem services and aims to encourage more sustainable land development and management practices (SITES, 2009, p. 5). While SITES aims to "create guidelines and performance benchmarks for sustainable design, construction and maintenance in Landscape Architecture projects" (2009, p. 6), it has not yet gained acceptance by the Landscape Architecture profession in Australia as a sustainability assessment tool for public spaces.

Although the SITES assessment includes renewable energy, their rating scheme uses a point system to assess projects based on a set of criteria that are predominantly environment driven. For example, in their recently updated assessment guidelines (SITES v2), renewable energy is credited as "use renewable energy sources for landscape electricity needs" (SITES, 2014, p. 110). More specifically, if a project addresses fifty percent of annual outdoor site electricity, it scores three points. If a project generates one hundred percent of annual outdoor site electricity, it scores four points. Their description clearly states that renewable energy in a public space context currently does not count as a potential social sustainability initiator, but mainly considers the economic and environmental aspect of renewable energy and electricity production. Although the relevant information in the guideline booklet includes a section about community renewable energy systems, it is more focused on management and leasehold of the produced electricity. The current SITES v2 guidelines leave the social and economic sustainability of local electricity production, and specifically renewable energy usage within a public space context, vague and undervalued with respect to the potential for enriching public space programs with new ways of public engagement that encourages using on-site produced clean electricity.

As the SITES framework is still in its development phase, my research aims to enrich the scope of current assessment applications on embedding renewable energy in public spaces.

2.5.3 Land Art Generator Initiative (LAGI)

While SITES represents the only sustainability assessment method applicable to Landscape Architecture and public space, LAGI on the other hand explores the sustainability of renewable energy by integrating public art and renewable energy infrastructure into the public domain with the aim of educating society about renewable energy while at the same time expanding the scope and scale of public art.

It encourages interdisciplinary knowhow through international design competitions, the first of which was held in 2010. LAGI's typical design framework contains a five-stage process, including: a call to 'artists'[11]; design documentation; tender and award; construction of artwork; and management of the completed public artwork (LAGI, 2010).

Although LAGI's procedural framework and philosophy of renewable energy and public space is highly responsive, their approach to the aesthetics of sustainability, as noted by Elizabeth Meyer, needs to be revisited. Meyer states that the aesthetics of sustainable design need to be considered within two contexts —'appearance' and 'function'— in order to have a significant cultural and societal impact. She argues that 'function', also referred to as 'fitness' or 'performance', cannot be experienced through representation, but through direct interaction (Meyer, 2008, p. 10). This notion relates to the earlier discussion of the emerging social and economic relationships around local electricity production, which are defined in this study as 'performative approaches'. The notion of local electricity and emerging relationships around it would no doubt extend the aesthetics dialogue of renewable energy public spaces beyond LAGI's central focus on their appearance.

LAGI and its philosophy is explored further in both chapter 4 and chapter 7.

2.6 CONCLUSION

The above literature review highlights that the theory surrounding the sustainable integration of renewable energy within public spaces currently lacks a sound knowledge

11 LAGI defines all entries as 'artists' whether engineers, architects, landscape architects who involved and submitted a proposal for its competitions.

base. Equally, its practice currently lacks guidelines. The process discourse in landscape urbanism, for example, has not yet investigated social interactions around local electricity production in renewable energy-embedded public spaces. That is a gap that my research seeks to address.

The study positions a problem that renewable energy in public spaces is commonly perceived as a techno-fix (see 2.2.5, the forum photovoltaic pergola), rather than as an ecological infrastructure. Renewable energy in public spaces is also shown to be either a good practice demonstration of ecologically sustainable design (see 2.2.4, ECO-Boulevard), or an artistic project (see chapter 7, LAGI's speculative projects) focusing on the representation and appearance of the aesthetics of sustainability. Therefore, the study's hypothesis is that a design and assessment framework will address this problem.

The literature discussed also highlights the disconnect between mainstream design culture and current understandings of sustainability (Meyer, 2008, p. 11). To inform future renewable energy public space applications, a knowledge basis/framework that embraces both the science of sustainability and mainstream design and aesthetic qualities, is needed. This study's research question is posed to address this need in a built project, in LAGI's speculative projects, and in the design and assessment frameworks (LAGI and SITES).

Chapter 3 now outlines the research path for this study, and discusses the methods used to develop a framework for renewable energy usage in public spaces.

CHAPTER 3: RESEARCH DESIGN

3.1 METHODOLOGY AND METHODS

This thesis investigated public space designs that integrate renewable energy. This required a multi-dimensional lens, to examine existing built projects, expert opinion, and current design approaches. Coming from a design background, I exercised design activity at many stages in the course of this study. For example, to further understand the research problem, a renewable energy embedded public space was designed and submitted to LAGI 2012 — an international design competition.

This combination of methods is similar to 'triangulation'. Both quantitative and qualitative researchers equally use triangulation in the area of social research (Sarantakos & Sarantakos, 1998, p. 168). Accordingly, this approach can "[o]btain a variety of information on the same issue; use the strengths of each method to overcome the weakness of the other; achieve a higher degree of validity and reliability; and overcome the deficiencies of single-method studies" (Sarantakos & Sarantakos, 1998, p. 169). Thus, this thesis adopted a multi-method approach using design activity in research. Many scholars use the terms 'multi-method' and 'mixed-method' interchangeably, in my research I used these terms to refer to specific non-interchangeable research approaches.

Design research studies have been ongoing since 1960s (Bayazit, 2004). In the past two decades, scholars in the Landscape Architecture discipline have been applying multi-methods approach and integrating design into the research (Van den Brink & Bruns, 2012, p. 13). However, the implication of design activity to a research, and the interaction of design with each research are unique by its own right. From a traditional research perspective, a rigorous research quality test might be essential for a design to be recognized as research if it complies with characteristics such as applicability, consistency, transparency, significance, efficiency, organization, originality and validity (Deming & Swaffield, 2011, p. 207).

Identifying the theoretical stance is the first principle when applying multi-methods (Esteves & Pastor, 2004, p. 70). In traditional scientific research, this theoretical stance refers to 'inductive' and 'deductive' reasoning both of which are described by Dorst as 'context of discovery'. He contends that "hypotheses are then subjected to critical experiments in an effort to falsify them" (Dorst, 2011, p. 523). This process is called deduction. While inductive reasoning leads to discovery in a more direct sense, deductive reasoning leads to discovery through a process of testing and justification. When the activity of design is used as a research tool, another reasoning pattern emerges, best described by

Dorst as 'abduction.' Unlike induction and deduction, abduction does not produce statements of fact but rather aims to create values (Dorst, 2011, p. 523).

Some scholars in Landscape Architecture explored new terminologies in line with inductive, deductive and abductive reasoning (Deming & Swaffield, 2011, p. 9). As quoted from Lenzholzer *et al.* (2013), Landscape Architecture as an academic discipline still is in its developmental phase, hence the theoretical and methodological foundation of the discipline is somewhat immature (Benson, 1998; R. D. Brown & Corry, 2011; Deming & Swaffield, 2011; Milburn & Brown, 2003; Van den Brink & Bruns, 2012). Defining design activity into three distinct reasonings — inductive, deductive and abductive — is necessary to advance the theoretical and methodological foundation of the discipline (Van den Brink & Bruns, 2012, p. 16).

The methods employed herein can be categorised under two of the three strategies[12] in line with abductive, inductive, and deductive reasoning and fall within the following order: *research by design (RBD), research on design (ROD),* and *research for design (RFD) strategies* (Deming & Swaffield, 2011; Lenzholzer et al., 2013, p. 121). While the first two strategies comprise the methods employed in this thesis, research *for* design approach is further discussed in the conclusion as part of future research.

More specifically, the overarching research incorporates a series of independent studies using three distinct methods in the following order.

Research *by* design

1 Design competitions (IFLA 2011, LAGI 2012)

Research *on* design

2 In-depth case study of Ballast Point Park with mixed-method

- Semi-structured Interviews,
- User Surveys,
- Site Observation

3 Content Analysis of LAGI 2012 published competition entries

12 Here Creswell defines 'strategy' as "procedures of inquiry."(Cited in Swaffield & Deming, 2011, p. 35)

The methods are further described in detail within each publication in the chapter 4, 5, 6, and 7 as shown in Figure 3.1. The next section now discusses each of the three research strategies.

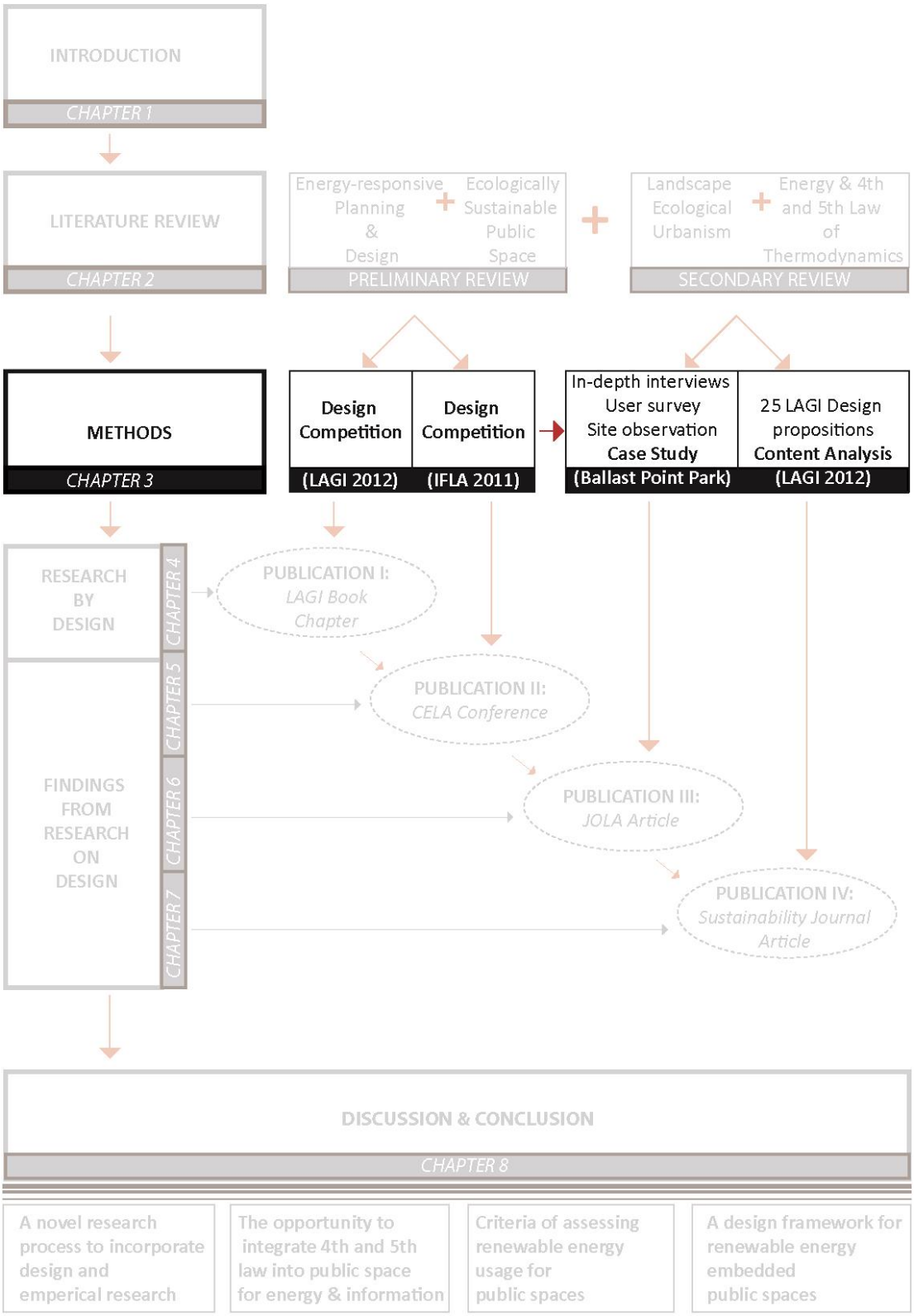


Figure 3.1. Map of overall research.

3.1.1 Research *by* design

A recent paper published in the journal of *Landscape Research* further specified the description of research *by* design. According to Van den Brink and Bruns research *by* design can set out from either design or research. If the emphasis is the design, then the research itself occurs during design activity, with the aim of solving a problem, coming up with several design solutions to develop spatial quality of an area (Van den Brink & Bruns, 2012, p. 15).

James Corner, a renowned landscape architect and theorist suggests that design competitions can be used as an effective research method in design research studies (Corner, 1999; Deming & Swaffield, 2011, pp. 208-209). Generating designs is akin to conducting case studies with the outcomes presenting the same opportunities and limitations of all case-study research (Steenbergen, Meeks, & Nijhuis, 2008, p. 20). Architect Ken Yeang employs design competitions as an academic exercise, a research study that motivates co-workers to stimulate new ideas (Dorst, 2011, p. 526). Design exercises such as competitions are known to become research methods in design research studies if the aim is generating new knowledge in addition to new design solutions. Design can become scientific research if properly organised (Van den Brink & Bruns, 2012) where the design hypothesis may be a 'framework', 'design guidelines' or 'model' that can be further tested with real and/or speculative projects (Lenzholzer et al., 2013; Zeisel, 2006).

A number of Landscape Architecture scholars attempted to further specify research *by* design as knowledge generation. A recent example can be seen in Lenzholzer's design research (Lenzholzer et al., 2013, p. 122) which developed design guidelines for creating thermal comfort at urban squares in the Netherlands. Lenzholzer first investigated the research problem by interviewing users on their spatial perceptions which then informed the design parameters of an optimised spatial layout for microclimatic urban squares (Van den Brink & Bruns, 2012, p. 15).

The integration of design into the research can be complex. Deming and Swaffield (2011, p. 206) argue that design activity can be defined as research when this creative process generates common knowledge with objectives, procedures and results. Clearly, research *by* design can facilitate both strategies to achieve an empirical outcome.

3.1.2 Research *on* design

Many scholars employ research *on* design to reveal as much information as possible about a finished product (substantial) or design process (procedural). This strategy includes, but is not limited to, methods such as post occupancy evaluations, case studies, content and map analysis (e.g Deming & Swaffield, 2011, pp. 72–77, 180–184; Francis, 2001; Groat &

Wang, 2002, pp. 341–374; Cited in Lenzholzer et al., 2013, p. 121). Research *on* design aims to deliver in-depth knowledge for building theory. For example, chapter 6 in this thesis presents a case study that investigates how designers, experts perceive renewable energy in public spaces. The findings and subsequent recommendations in this case study informed the research path. Chapter 7 then presents a content analysis as another method of research *on* design investigating the current speculative designs from LAGI 2012 design competition.

3.1.3 Research *for* design

Research *for* design exists in almost every design practice and process. Examples of research *for* design include 'Biophilia' in urban design and 'Biomimicry' in architecture both of which have long been discussed. Downton (2003, p. 18) describes this process as '[i]ncreasing knowledge of another field or particular theories within it with the expectation that at least some ideas will be able to be appropriated in a way that will be useful to design and designing.'

By employing concepts from other disciplines such as ecology, thermodynamics, climatology, earth sciences, environmental psychology, and phenomenology, research *for* design aims to advance the quality of design via more problem specific design processes. This also includes appropriately applying theories and frameworks to the context of research (Deming & Swaffield, 2011, pp. 90–100; Groat & Wang, 2002, pp. 203–248; Van den Brink & Bruns, 2012, p. 17). However, it has to be clearly distinguished between collecting and combining data and conducting scientific research. The research *for* design strategy may require research *on* design and/or research *by* design processes and procedures to substantiate the research outcome as exemplified in Lenzholzer's research. According to van den Brink & Bruns (2012, p. 15) knowledge used from other disciplines are not only useful to improve technical skills but also participate to new scientific concepts for landscape architectural research and methods.

This thesis brings new knowledge to the Landscape Architecture discipline from ecology and the laws of thermodynamics to expand understanding of how renewable energy might be better embedded into public space. Most of my discussion on these contributions is under the theme of research *for* design in the conclusion.

3.2 JUSTIFICATION OF THE RESEARCH PROCESS, METHODOLOGIES AND METHODS

Landscape architects and designers need a design and assessment framework to better integrate renewable energy into public spaces. As the purpose of my thesis is to design and test a framework, design activity was undertaken *throughout* the study rather than at the end.

According to Edelson (2002, p. 115) a design methodology, similar to a design framework, can prescribe guidelines for the *process* rather than the outcome. Therefore, it is

essential to describe my overall research process in order to achieve a generalizable design research outcome. Guba and Lincoln's 'Alternative Inquiry Paradigms' dialog is useful as a means of articulating this research process and its outcomes. These scholars define paradigm as "basic belief systems based on ontological, epistemological and methodological assumptions" (E. Guba, 1992; E. G. Guba & Lincoln, 1994, p. 107). An ontological question seeks answer to understand the form and nature of reality. An epistemological question focusses on the relationship between the knower (inquirer) and what can be known? Whereas, a methodological question investigates " how can the inquirer go about finding out whatever he or she believes can be known?"(E. G. Guba & Lincoln, 1994, p. 108).

Within these three categories, they located alternative paradigms such as constructivism, critical theory, post-positivism, and positivism. There is an overt transformation from the former to the latter paradigm ontologically, epistemologically, and methodologically.

The following diagram shows the research process, methodology, and outcomes during the PhD timeline.

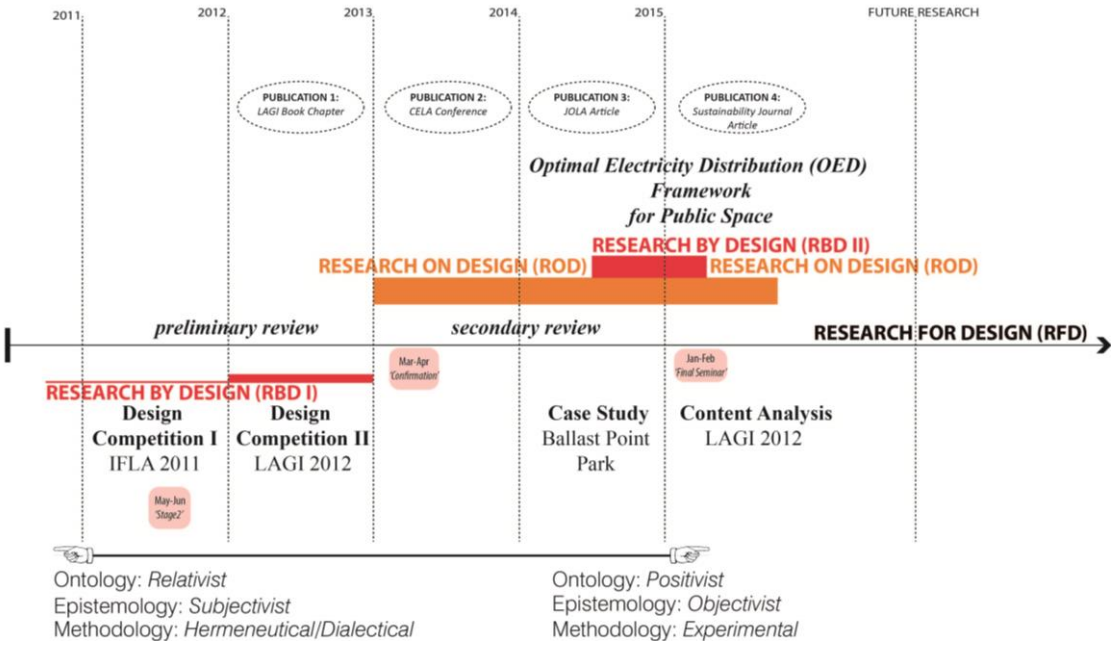


Figure 3.2. Research process and methodology.

This thesis followed a research path that started from a subjectivist approach and ended with an objectivist one. More specifically, I first investigated the values and qualities of energy in public space – and then I realised that I needed objective empirical evidence and methods of assessment. The problems I have identified in the literature, that energy

embedded projects where either 'techno fix' or aesthetic installations (LAGI) was evidence that the two dimensions of energy have to date not been well integrated. For example, landscape architects needed a method of assessing and applying empirical metrics while having greater understanding of the cultural dimensions of energy in public space. The thesis sets out through design-led and case study methodologies, of reconciling these emerging oppositions.

According to Cross (2006, p. 7), the main purpose of design activity is to generate fairly quick satisfactory outcomes rather than a comprehensive analysis of the problem. Cross also defines this as a constructive mode of thinking. For example, at the outset of the study, I employed design competitions as a design activity, each competition informed and sharpened the hypothesis and enabled me to pose the main research question explored with mix-methods of research *on* design described further in chapter 5, 6, and 7. Design competitions are subjective actions because they are based on imagination, with only general knowledge of the topic, limited empirical evidence; and are conducted without detailed analysis of the research problem. However, employing design activity in this thesis is not only limited to the design competitions. I also incorporated design activity into research for developing the framework. The framework is the synthesis of each independent study employed in this thesis.

Therefore, I specified two key roles of design in research under the name 'research by design' strategy. For the purpose of this study and convenience of the reader, they are identified as

- Research *by* Design I (RBD I): Design activity (through design competitions) can be used to generate hypothesis for further research (Corner, 1999; Deming & Swaffield, 2011, pp. 208-209).
- Research *by* Design II (RBD II): Design as the core activity advanced by theories from other disciplines generates design guidelines or framework for the needs of the discipline and society (Edelson, 2002; Lenzholzer et al., 2013; Zeisel, 2006).

The following text justifies the research process and methods employed in this thesis and should be read in reference to figure 3.2.

3.2.1 Research *by* design I (RBD I): Design Competition - IFLA 2011 (June 2011)

In the initial stage of the study, I engaged in research *by* design through a competition organised by the International Federation of Landscape Architecture (IFLA). This research was similar to conducting a preliminary literature review on sustainable development and renewable energy and seeking a hypothesis for overall research. The design proposed a

conceptual master plan entitled 'coexistence landscapes', which investigated the relationship between renewable energy, local food, and tourism within a self-sufficient sustainable community. The ideas were sketchy but like a traditional literature review, it helped to develop a hypothesis for the overall study. It did so by testing the efficacy of design interventions in addressing issues of social engagement and energy transition.

3.2.2 Research *by* design I (RBD I): Publication 1 - LAGI 2012 Design Competition (July 2012)

Following the first design competition, this study further investigated the relationship between renewable energy and sustainable development within a design competition organised by the Land Art Generator Initiative (LAGI), an international enterprise that encourages renewable energy within urban environments. The need for a focused hypothesis for the overall research coincided with the announcement of LAGI 2012 design competition.

Working with three designer colleagues, I submitted a design proposal called *Terra Preta: Art + Agriculture + Algorithm* (Ozgun, Feher, Fernando, & Weir, 2013). The theme of the competition, context, location, and the final design outcome informed the overarching research problem of this thesis. The competition site, Freshkills Park, was a public space where competition entrants were asked to propose renewable energy designs embedding renewable energy in public space. Here LAGI's design philosophy and objectives are also imperative to determine the scope of this thesis since over four years of convening competitions, LAGI has increasingly sought to question what it means to embed renewable energy into daily public life through the agency of art and public space. Therefore, the second design exercise, *Terra Preta: Art + Agriculture + Algorithm*, helped to narrow down my research focus and to concentrate on public open spaces and renewable energy.

From an overall research perspective, the significance of the 2012 LAGI design competition changed my perception about renewable energy usage in public space, shifting the focus away from renewable energy devices, and towards an approach where local electricity production activity integrated into the public space program. This 'Aha' moment is typical of what designers experience and is referred to as the "Sudden Mental Insight" (SMI) (Akin & Akin, 1996). It is also depicted by Akin and Dorst as "breaking the frame of reference"(Akin & Akin, 1996) and "reframing"(Paton & Dorst, 2011). Nevertheless, Akin (1996, p. 348) demonstrates in his study that "breaking out of the frame of reference is not sufficient to reach an SMI; a new frame of reference, must be, simultaneously, established." In the context of my thesis, although I had such an Aha moment right after 2012 LAGI design competition, establishing a "new frame of reference" took me a fair amount of time. My experience validates Akin's observation that the final devised framework in my thesis

refers to the 'new frame of reference'. For example, in 2012 LAGI competition, an initial design framework — so called the 'dynamic loop system' (see section 4.1.3) — was devised to incorporate electricity production into the public spaces of wider New York City. Additional studies then further advanced this framework with theories from ecology and thermodynamics.

3.2.3 Research *on* design (ROD): Publication 2 - CELA Conference (February 2013)

Following LAGI 2012, the overall research question and hypothesis were clearer. The CELA conference paper presented in chapter 5 reframed and detailed the first design competition outcome with further context and site-specific literature. The paper, *A sustainable tourism development in Alacati, Turkey: Reinvention of public space with clean energy* (Ozgun & Buys, 2013) signalled the opportunity to explore the link between public space, public sphere and renewable energy. This was later explored and supported with ideas such as 'energy commons' and 'decentralized local energy communities' within research *on* designs in chapter 6 and 7. The paper concluded with a planning framework (CEM – see section 5.1.9) to empower the community and manage the new designs in the public spaces.

After engaging two design experiments about the research topic, next I investigated the research problem in a built project, an in depth case study about a renewable energy embedded public space: the Ballast Point Park by McGregor Coxall Landscape Architects.

3.2.4 Research *on* design (ROD): Publication 3 - Case study Ballast Point Park (January 2014)

This thesis used Ballast Point Park as an "instrumental case" to develop insight into an issue, focusing on an embedded topic, renewable energy usage in public spaces (Silverman, 2013, p. 142). This project was chosen as a case study because it was recognised by AILA (See 2010b) as the first and only Landscape Architecture project in Australia that integrated renewable energy into its design. Mixed methods were employed to investigate this topic in detail. It is important that the primary case study be conducted in Australia, as this is the territory in which the research is housed.

To better understand Ballast Point Park as the context for renewable energy usage, I interviewed designers and other experts[13] involved in the project. The sustainability of the

13 This study is approved by the Queensland University of Technology Human Research Ethics Committee (no: 1300000817)

park was the focus of the interviews, and therefore I employed a triple bottom line approach to assess the renewable energy and other design innovations in the park. I then compared the findings with data collected through the site observations and user survey. The site observation and user surveys were conducted to better understand social sustainability and patterns of park usage. The paper, *Renewable energy distribution in public spaces: Analysing the case of Ballast Point Park, Sydney* (Ozgun, Cushing, & Buys, 2015) identified an imbalance both in the general sustainability and in the renewable energy embedment of Ballast Point Park.

I posed the main research question drawing upon the need to investigate the research problem in speculative designs and the findings from Ballast Point Park TBL case study: What is the potential relationship between public space and renewable energy, and what principles and methodologies can better contribute to design renewable energy-embedded public space?

3.2.5 Research *by* design II (RBD II): Publication 3 & 4 - Optimal Electricity Distribution (OED) Framework (January 2015)

This thesis classified research *by* design into two types based on the relevant literature. Design as the core activity in RBD II advanced by theories from other disciplines generates design guidelines or framework for the needs of the discipline and society (Lenzholzer et al., 2013; Zeisel, 2006). Similarly, this thesis developed the OED framework addressing the knowledge gaps underpinned by the case study and reviewed literature.

Arguably, the complexities are greater in Landscape Architecture than other disciplines because Landscape Architecture relies so heavily on representation of places to generate an understanding. However, sometimes graphics representations are not sufficient tools to explicitly represent the relationships between the issues, factors, and stakeholders. These conditions can be dynamic and too complex to capture in a single snapshot of one image/one model/one form. As the purpose of this thesis is to create a design framework for public space designers to better enable them to integrate renewable energy sustainably, the design framework is developed within each design and research study. The substantial and procedural outcome is further discussed and presented in the conclusion.

3.2.6 Research *on* design (ROD): Publication 4 - Content Analysis LAGI 2012 (January 2015)

This thesis employed a content analysis to find out the current design approach behind embedding renewable energy in public space. The study selected LAGI proposals for the content analysis because the study considered LAGI as an authority in this emerging subject that has been accumulating knowledge basis for renewable energy-embedded public space over three countries with hundreds of design proposals. Therefore, this gave a rare opportunity to simultaneously apply several design approaches to the research topic. By using theories from ecology and thermodynamics, the paper, *Optimal electricity distribution framework for public space: Assessing renewable energy proposal for Freshkills Park, New York* (Ozgun, Weir, & Cushing, 2015) advanced the OED framework, which was then used as criteria to assess the sustainability of energy distribution of LAGI 2012 entries. In the end, the study not only measured the sustainability of the entries but also tested the devised OED framework and in doing so, it increased the generalizability of the devised framework.

3.2.7 Research *for* design (RFD): Future Research for Design

Following the definition of research *for* design in section 3.1.3, this study introduced and applied new concepts from ecology and the laws of thermodynamics with the aim of creating a theoretical and a practical foundation to better design renewable energy embedded public spaces. Although the research *for* design approach was part of the research process, it was again discussed in the conclusion with the aim of framing future research into how this mode of inquiry has great potential in addressing the issues that the thesis has identified, but were beyond the scope of PhD level enquiry.

CHAPTER 4: RESEARCH *BY* DESIGN

4.1 TERRA PRETA: ART + AGRICULTURE + ALGORITHM

Ozgun, K., Feher, K., Fernando, R., & Weir, I. (2013) Terra Preta (agriculture + art + algorithm). In C. Klein (Ed.), *Regenerative Infrastructures Freshkills Park, NYC* (pp. 240). Munich, London, New York: Prestel Verlag. http://eprints.qut.edu.au/83754/

Statement of contribution of co-authors for thesis by published papers
The authors listed above have certified* that:

1 they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation of (at least) that part of the publication that lies within their field of expertise;
2 they take public responsibility for their part of the publication, while the responsible author accepts overall responsibility for the publication;
3 there are no other authors of the publication;
4 potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5 consistent with any limitations set by publisher requirements, they agree to the use of the publication in the student's thesis, and its publication on the QUT ePrints database.

The authors' specific contributions are detailed in Table 4.1 below.

Table 4.1. Chapter 4's *'Terra Preta: Art + Agriculture + Algorithm'* Publication

Contributor	**Statement of contribution***
Kaan Ozgun Signature Date 04/05/2015	Participated in the design competition; initiated, researched and developed the design; produced graphic elements; and wrote the manuscript
Ian Weir*	Participated in the design competition; helped to develop the design; and reviewed the manuscript
Kylie Feher*	Participated in the design competition; graphic design of competition panels, produced photoshop visualisations, and edited the initial draft for

	publication
Ruwan Fernando*	Participated in the design competition; helped to develop the design with algorithms and related graphics

Principal Supervisor's Confirmation

I have sighted emails or other correspondence from all co-authors confirming their certifying authorship.

Dr Ian Weir		6 November 2015
Name	Signature	Date

Preamble

Following the first design competition (IFLA 2011), this study further investigated the relationship between renewable energy and sustainable development within a second design competition organised by the Land Art Generator Initiative (LAGI), an international enterprise that encourages renewable energy within urban environments. Although both design competitions had different project briefs, sites, and contexts, the LAGI 2012 competition specifically asked for renewable energy sculptures/infrastructures for Freshkills Park in NYC. With three other colleagues, the author submitted a design proposal for this competition.

This second design exercise enabled me to narrow the main research focus to concentrate on public open spaces and renewable energy. In doing so, I tested ways of designing public open space with embedded renewable energy. From an overall research perspective, the LAGI design exercise shifted my perception of the renewable energy concept, from simple renewable energy devices to its role as a local electricity production activity as an integral part of a public space program. In line with this new conception of renewable energy, the design proposal submitted for the LAGI 2012 competition proposed a dynamic renewable energy sculpture: a bioenergy project that complemented the ever changing and productive quality of Freshkills Park.

The design dealt with the time and spatial qualities of this performative approach by engaging the public in the process of growing bamboo. Through web interactions, the public participated in bamboo agriculture practices such as crop growing, maintenance, and harvesting. Extra clean energy was then generated through the burning of the harvested bamboo in a bio-energy station. The design was also envisaged within a process that aimed to increase community participation over time.

The design submission also provided a framework for the incorporation of electricity production into other public spaces of wider New York City so called the ‘dynamic loop system’ (DLS). While retaining traditional public space activities, the proposal suggested converting neighbourhood parks into site-specific renewable energy centres–local energy production nodes where the neighbourhood residents can engage in production activities and obtain data about their energy consumption and production.

In summary, the design activities employed within the design competitions helped to develop two preliminary frameworks for integrating renewable energy into public space, as discussed in sections 4.1.3 and 5.1.9. These design experiments provided the basis for further advancing the framework, as discussed in sections 6.2.6 and 7.1.2. Indeed, the design outcome for Freshkills Park, the LAGI competition methodological framework, LAGI’s

speculative design project inventory, and LAGI's general philosophy were all indispensable guides of this study.

Figure 4.1 below positions *Terra Preta: Art + Agriculture + Algorithm* (Ozgun et al., 2013) within the overall study. The official publication (figure 4.2) included in Klein's (2013) *Regenerative Infrastructures, Freshkills Park, NYC, Land Art Generator Initiative* is then provided. (See Appendix B for the original competition submission.)

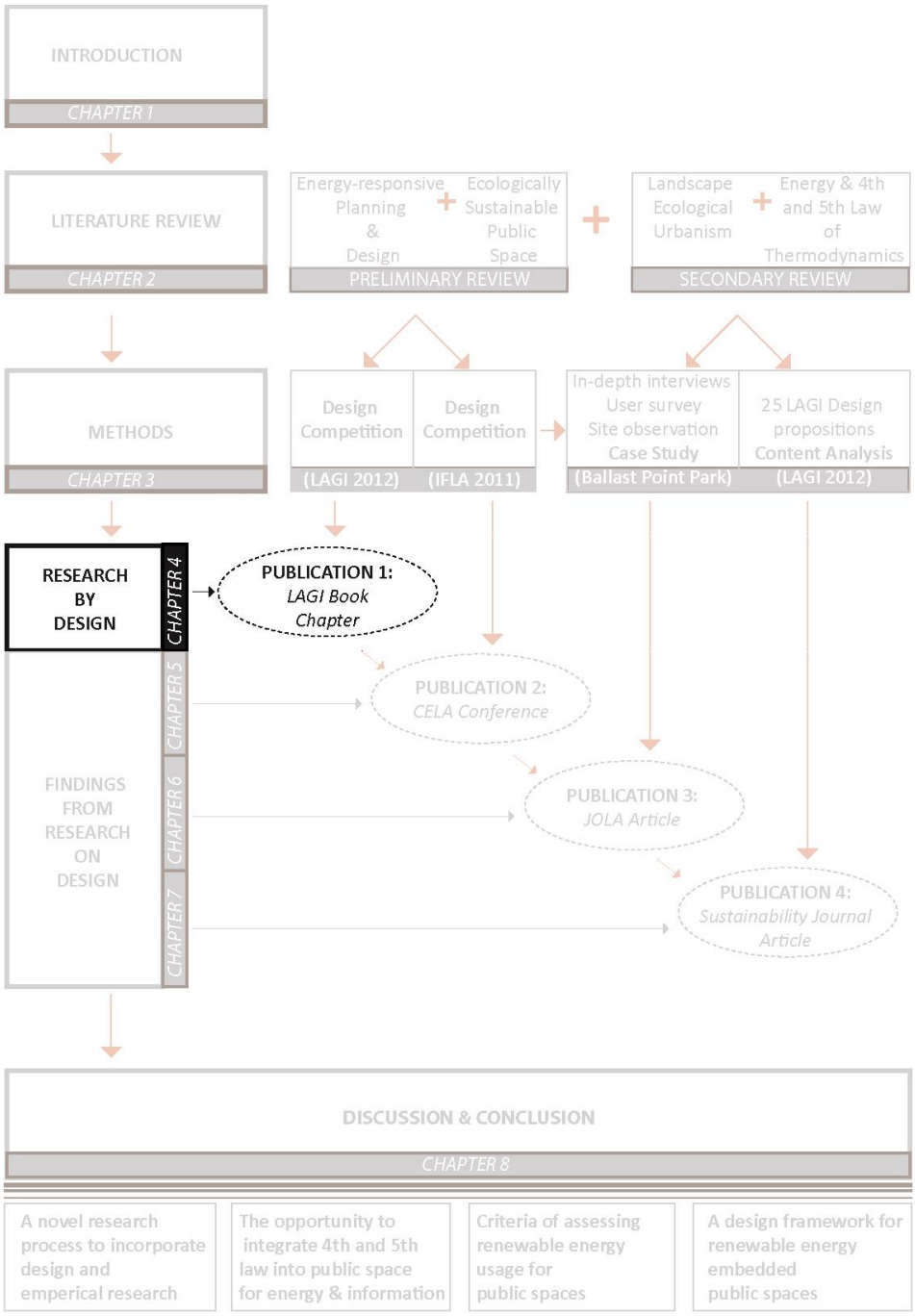


Figure 4.1. Map of overall research.

--Start of published creative work--

Project description[14]

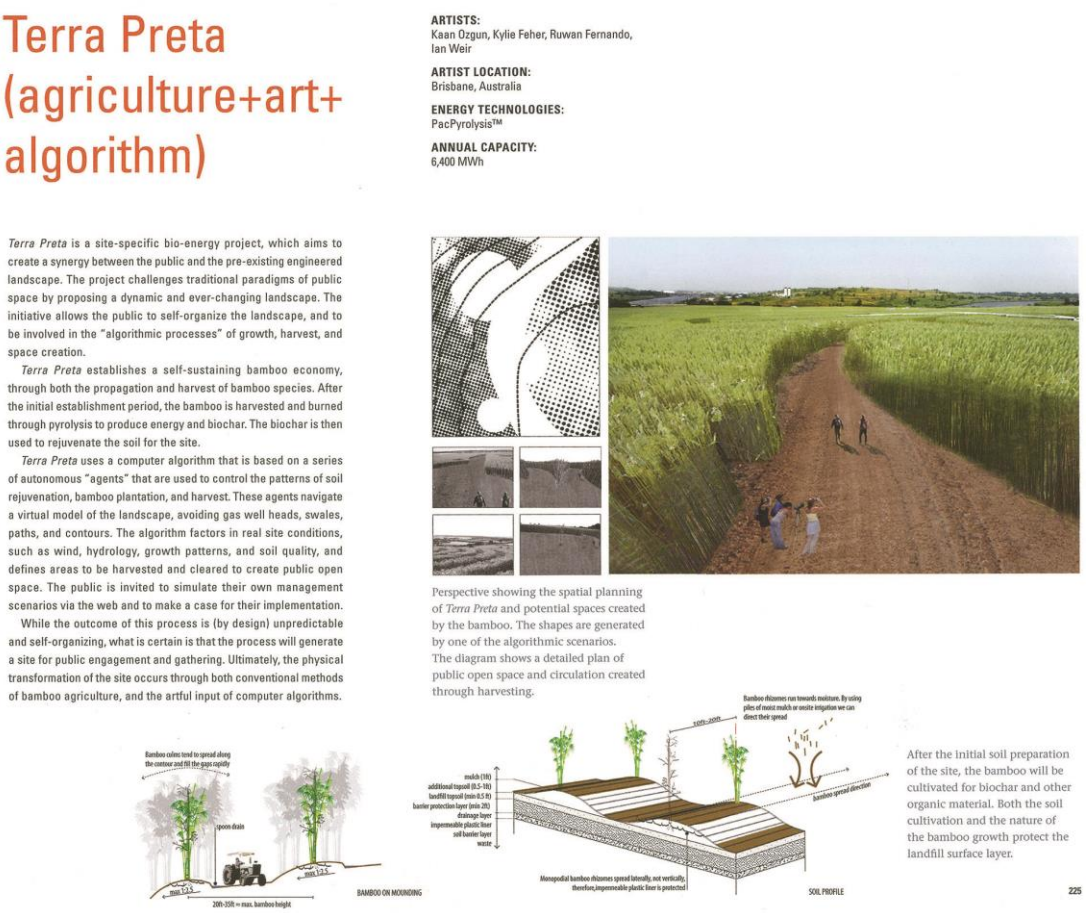
Terra Preta is a site-specific bio-energy project, which aims to create a synergy between the public and the pre-existing engineered landscape. The project challenges traditional paradigms of public space by proposing a dynamic and ever-changing landscape. The initiative allows the public to self-organise the landscape, and to be involved in the 'algorithmic processes' of growth, harvest, and space creation.

The project establishes a self-sustaining bamboo economy, through both the propagation and harvest of bamboo species. After the initial establishment period, the bamboo is harvested and burned through pyrolysis to produce energy and biochar. The biochar is then used to rejuvenate the soil for the site.

Terra Preta uses a computer algorithm that is based on a series of autonomous 'agents' that are used to control the patterns of soil rejuvenation, bamboo plantation and harvest. These agents navigate a virtual model of the landscape, avoiding gas vents, swales, paths and contours. The algorithm factors in real site conditions, such as wind, hydrology, growth patterns and soil quality and defines areas to be harvested and cleared to create public open space. The public are invited to simulate their own management scenarios via the web and to make a case for their implementation.

While the outcome of this process is (by design) unpredictable and self-organising, what is certain is that the process will generate a site for public engagement and gathering. Ultimately, the physical transformation of the site occurs through both conventional methods of bamboo agriculture, and the artful input of computer algorithms.

14 The text is extracted from the original publication. For the images, see the publication (Ozgun et al., 2013).



Terra Preta (agriculture+art+ algorithm)

ARTISTS:
Kaan Ozgun, Kylie Feher, Ruwan Fernando, Ian Weir

ARTIST LOCATION:
Brisbane, Australia

ENERGY TECHNOLOGIES:
PacPyrolysis™

ANNUAL CAPACITY:
6,400 MWh

Terra Preta is a site-specific bio-energy project, which aims to create a synergy between the public and the pre-existing engineered landscape. The project challenges traditional paradigms of public space by proposing a dynamic and ever-changing landscape. The initiative allows the public to self-organize the landscape, and to be involved in the "algorithmic processes" of growth, harvest, and space creation.

Terra Preta establishes a self-sustaining bamboo economy, through both the propagation and harvest of bamboo species. After the initial establishment period, the bamboo is harvested and burned through pyrolysis to produce energy and biochar. The biochar is then used to rejuvenate the soil for the site.

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While the outcome of this process is (by design) unpredictable and self-organizing, what is certain is that the process will generate a site for public engagement and gathering. Ultimately, the physical transformation of the site occurs through both conventional methods of bamboo agriculture, and the artful input of computer algorithms.

Perspective showing the spatial planning of *Terra Preta* and potential spaces created by the bamboo. The shapes are generated by one of the algorithmic scenarios. The diagram shows a detailed plan of public open space and circulation created through harvesting.

After the initial soil preparation of the site, the bamboo will be cultivated for biochar and other organic material. Both the soil cultivation and the nature of the bamboo growth protect the landfill surface layer.

225

Figure 4.2. Creative work: the bioenergy project 'Terra Preta: agriculture + art + algorithm'; published page in LAGI's 'Regenerative Infrastructures of Freshkills Park, NYC' (Ozgun et al., 2013).

--End of published creative work--

4.1.1 Introduction[15]

The primary goal of the Land Art Generator Initiative (LAGI) is to encourage interdisciplinary collaboration for the design of renewable energy infrastructures[16] for public spaces; more specifically, for the design of renewable energy infrastructures that also function as public art performances.

LAGI has organised three design competitions in the last five years. The project presented in this section was submitted to LAGI's second competition, which was organised in partnership with New York City's Department of Parks and Recreation, and focussed on a site within Freshkills Park (the former Freshkills Landfill) in New York City. LAGI's design framework and objectives both strongly aligned with the purpose of this study.

Before discussing the design proposal in detail, it is first necessary to explore the Freshkills Park site context.

4.1.2 Freshkills Park, New York, U.S.A.

The heavily engineered, complex Freshkills site occupies more than 2000 acres on the western edge of Staten Island. It has served the city of New York as a landfill from 1948 to 2001, and the idea of creating a park from a dumpsite requires an extended timeframe. Thus, the site has been planned to become one of the world's largest parks within the next 30 years (see Figure 4.3). The 30-year plan proposes the restoration of the landscape as well as the regeneration of the toxic wetlands that surround the former landfill .Continuous public engagement is indispensable to the future success of the project and its master plan includes the public's engagement in community meetings to reflect on their needs and desires (Field Operations, 2006).

15 Some parts of this section are edited text from the design submission for the LAGI 2012 competition.

16 LAGI uses the terms 'renewable energy sculptures' and 'regenerative infrastructures' interchangeably; for example, in their second publication they use the latter term. It appears that LAGI is inclined to change its embarking point, and to consider both landscape and ecological urbanism theories. For the purpose of this research, the term 'infrastructure' is used in lieu of the term 'sculpture.'

Figure 4.3. Growth of the park over time in 10-year intervals (Field Operations, 2006) .

Freshkills Park challenges the established paradigm of the human/nature dichotomy. This is because landscape ecological urbanism practices advances the established paradigm with spatial and strategic design interventions. In this way, the park (as shown in Figure 4.4) somewhat symbolises a paradigm shift because the integration of landscape ecological urbanism theory into the park, and the blending of natural and social elements through spatial design practice, have the potential to transcend the discussion of what urban public space actually is. Section 4.1.3 now discusses the author's collaborative project submission with respect to this Freshkills Park context.

Figure 4.4. Layers show the site's history, infrastructure and programs; rendering indicates the (future) completed park (Field Operations, 2006).

4.1.3 Creative work, *Terra Preta: Agriculture + Art + Algorithm*

The first impressions of Freshkills Park were its history and proposed future, which were labelled as its 'process'. That is, Freshkills Park represents an ongoing 'process', rather than a finished, or indeed 'finish-able', work. Its ever-changing character inspired us to work with natural processes as a key medium of the design. Rather than showing a snapshot of a sculptural artefact, which was commonly the case in LAGI's project portfolio, we explored the definitions of art and aesthetics, and the traditional paradigms of public open space.

Taking a static sculptural approach appeared to be too time-specific for the expansive time scale of the Freshkills Park project. We were even less interested in the expression of process through static sculptural form, as exemplified by futurist Umberto Boccioni's 1913 time sculpture 'Unique Forms of Continuity in Space' (see Figure 4.5).

Figure 4.5. Umberto Boccioni's time sculpture ' Unique Forms of Continuity in Space'. Source | http://www.artlex.com/ArtLex/f/futurism.html

In contrast, this proposal presents a dynamic approach, an ever-changing artistic project which grows, rejuvenates, regenerates, stores, cleans, engages, feeds, accommodates, creates, and curates. The creation of a park from a dumpsite is a long-term process. We saw the value in this process, and sought to enrich it by adding another layer. What was this layer, and how did we implement and express it as a dynamic artistic gesture? These questions drove our project.

The response to the questions were twofold. We studied Freshkills Park master plan, as well as current renewable energy initiatives in New York City. The city has a target of self-sufficiency in the next two to three decades, and sustainable energy transition is the key to meeting the growing energy demand of contemporary cities. Our proposal, with its public engagement in a decentralized electricity production approach and consequent social acceptance of renewable energy, provides a socially sustainable transition scenario (Assefa & Frostell, 2007; McKenzie, 2004; Rogers et al., 2012).

Secondly, the proposal conceptualises the new clean energy-integrated public open spaces as a new urban zoning tool. In other words, public space as an energy control and monitoring centre constantly informs energy users and the city's main energy hub of the energy data of each neighbourhood. Monitoring and information technology are thus key ingredients of our design proposal.

As is the case with mature complex ecosystems in nature, a loop system concept is required in the design of urban public spaces to achieve ecological succession. Thus, a conceptual loop system model translated from ecology can be beneficial for further design experiments in future urban environments. We proposed a dynamic loop system (DLS) model for urban public spaces to better deal with complex urban factors, including matter, energy, and information flows.

DLS is conceptualized as a site-specific, multi-layered interactive control and monitoring mechanism that enables people to associate urban public space with information, images, sound, and animation. DLS can be integrated in public open space network of cities at the same time can be used as an urban zoning tool works with energy, material and information economy. This is illustrated and demonstrated in the competition submission for Freshkills Park, New York City (and outlined in Figure 4.6). For example, five different coloured circles on the map represent five boroughs of New York City. Numbers within the same colour code (DLS1, DLS2, DLS3, DLSn) indicates the possible open spaces in the same borough where DLS can be integrated.

Figure 4.6. Ozgun et al. proposed clean energy, matter, and information centres (DLS) in New York City.

As Shepard (2011, p. 18) states:

> [t]he data clouds of the 21st century descend on the streets, sidewalks, and public spaces of contemporary cities, we might ask: to what extent are these informatics weather systems becoming as important possibly more important than the formal organization of space and material in shaping our experience of the city?

Future urban environments could be influenced by the interface between public space and its mirror image in the virtual world: information. Negative scenarios painted by some theorists predict the collapse of public space due to the loss of personalized experience of urban life within ubiquitous and advanced digital technology tools. More optimistic scenarios, however, advocate an artistic approach to reactivate urban public space (De Waal, 2011, pp. 192-193) by integrating digital technology tools for the service of the community through the ontological and conventional use of that space. Furthermore, this integration could bridge the gap between the physical and virtual world right at the core of a city, in the urban public space.

The 'Terra Preta' proposal stems from a similar philosophical position that aims to merge physical and virtual public space through public engagement. The proposal integrates bamboo farming, harvesting, bio-energy production, and soil restoration. Since Freshkills Park has a complex infrastructure system, it requires continuous monitoring for the next thirty years. We exploited this monitoring process by proposing another infrastructure layer– a bamboo plantation on top of the current infrastructure, but with additional monitoring and control strategies.

When urban public spaces transform into energy centres, they become new decentralized community activity centres that can assist the development of a self-sufficient city. More DLS centres in a city result in an increase in monitoring capacity, and the creation of more assessable data. A public space within its own or neighbourhood boundaries can be recognised as part of a dynamic loop of networked systems. The creation of a steady state in this dynamic loop should be the aim of urban design.

The LAGI 2012 competition submission was another exploration of public space and renewable energy. It was also an exploration of new virtual and physical relationships and interactions in and around public space. The design outcome–preliminary frameworks–is further advanced in chapter 7 with the help of concepts from ecology and law of thermodynamics.

The next chapter was published in CELA proceedings testing the efficacy of design outcomes of the first competition in addressing issues of social engagement and sustainable energy transition.

CHAPTER 5: RESEARCH *ON* DESIGN

5.1 A SUSTAINABLE TOURISM DEVELOPMENT IN ALACATI, TURKEY: (RE)INVENTION OF PUBLIC SPACE WITH CLEAN ENERGY

Ozgun, K., & Buys, L.(2013) A sustainable tourism development in Alacati, Turkey: (Re)invention of public space with clean energy. Paper presented at the Space -Time / Place - Duration, Austin, United States of America. http://eprints.qut.edu.au/59823/

Ozgun, K., & Buys, L. A sustainable tourism development in Alacati, Turkey: (Re)invention of public space with clean energy. eJournalist : A Refereed Media Journal, **2013**, 13(1). http://www.ejournalist.com.au/v13n1/OzgunBuys.pdf

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Statement of contribution of co-authors for thesis by published paper
The authors listed above have certified* that:

1 they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation of (at least) that part of the publication that lies within their field of expertise;
2 they take public responsibility for their part of the publication, while the responsible author accepts overall responsibility for the publication;
3 there are no other authors of the publication;
4 potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5 consistent with any limitations set by publisher requirements, they agree to the use of the publication in the student's thesis, and its publication on the QUT ePrints database.

The authors' specific contributions are detailed in Table 5.1 below:

Table 5.1. Chapter 5's *'A sustainable tourism development in Alacati, Turkey: (Re)invention of Public Space with Clean Energy'* Publication

Contributor	Statement of contribution*
Kaan Ozgun	Participated in the design competition, collected the data, undertook data analysis, produced the graphics, developed the study, and wrote the

Signature	manuscript
Date 04/05/2015	
Laurie Buys*	Helped to develop the study, reviewed the manuscript

Principal Supervisor Confirmation

I have sighted emails or other correspondence from all co-authors confirming their certifying authorship.

Dr Ian Weir _____ _____ 6 November 2015

Name Signature Date

Preamble

The research reported in the published paper which is the basis of this chapter, engaged the activity of design for a competition organised by the International Federation of Landscape Architecture (IFLA). This design activity was akin to conducting a preliminary review of the literature related to sustainable development, in particular, that related to renewable energy.

The outcome of the (later) Land Art Generator Initiative (LAGI 2012) competition entry guided the researcher to investigate public space as a design framework. This framework empowers the community hosting the sustainable development that was proposed as part of the first IFLA design competition entry. The researcher further developed the earlier IFLA design submission with the incorporation of additional site study and context-specific literature. These advancements also helped to increase the level of design detail of the initial IFLA submission, which are published in this paper.

The study first investigated the potential value of using renewable energy within a designed sustainable development. At this stage, public space was not the primary focus of the overall study, and renewable energy and sustainable development were the main themes of the master plan submitted as the competition entry. The proposed development primarily focused on an alternative sustainable development, which was given the name 'coexistence landscapes'. In this development, local agriculture and renewable energy were incorporated in a scheme to regenerate the town's economy.

The framework explored in this paper, the community empowerment model (CEM), which is a means of engaging the community, NGOs, and local government, with environmental factors such as local agriculture, and importantly, clean energy.

This chapter now presents the official publication, which was included in the Conference Proceedings of CELA (Council of Educators in Landscape Architecture). (See Appendix A for the original competition submission). Figure 5.1 locates *A sustainable tourism development in Alacati, Turkey: (Re)invention of public space with clean energy* (Ozgun & Buys, 2013) with the overall study.

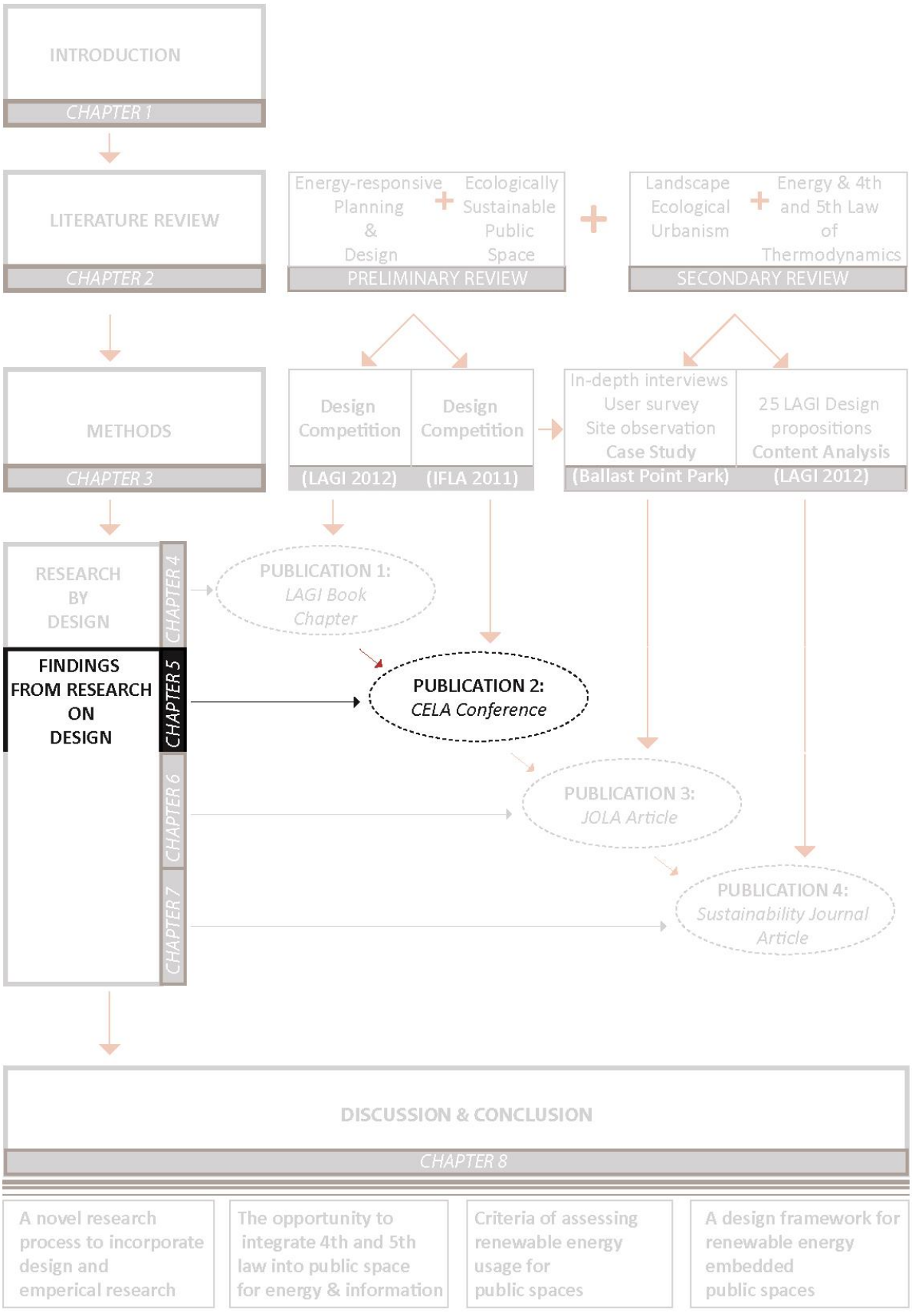

Figure 5.1. Map of overall research.

--Start of published paper--

Abstract

Although there is an increasing recognition of the impacts of climate change on communities, residents often resist changing their lifestyle to reduce the effects of the problem. By using a landscape architectural design as a medium, in this paper we argue that public space, when designed as an ecological system, has the capacity to create social and environmental change and to increase the quality of the human environment. At the same time, this ecological system can engage residents, enrich the local economy, and increase the social network.

Through methods of design, research and case study analysis, an alternative master plan is proposed for a sustainable tourism development in Alacati, Turkey. Our master plan uses local geographical, economic and social information within a sustainable landscape architectural design scheme that addresses the key issues of ecology, employment, public space and community cohesion. A preliminary community empowerment model (CEM) is proposed to manage the designs. The designs address: the coexistence of local agricultural and sustainable energy generation; state of the art water management; and the functional and sustainable social and economic interrelationship of inhabitants, NGOs, and local government.

Keywords

Public space as design framework, site-specificity, sustainable development, ecological systems

5.1.1 Introduction

Cities are increasing their consumption of primary energy at a time when energy resources are decreasing. This global issue requires radical rethinking and a shift from fossil fuel based resources, as well as a change in energy consumption, production, and distribution regimes. The necessity for self-sufficiency of human settlements, given concerns regarding climate change, profoundly influences the production and consumption processes of energy, food, water, and waste. Clean energy and local scale clean energy production has been shown to be a sustainable alternative (Dunster, 2010). Although technological solutions are available, there is strong social resistance to changing lifestyles to achieve such targets. This paper proposes that energy production be incorporated into the socio-cultural and ecological purpose of public space so as to create social and environmental change, whilst at the same time engaging society, enriching the local economy and increasing social networks.

Public space, by its nature, is open and accessible to the public. *Project for public space* (2000) highlights characteristics of quality public space including accessibility, comfort, security, activity diversity, and sociability. The Australian Institute of Landscape Architects (AILA, 2010c) defines 'public space' as 'land provided for public use, access or visual or ecological reasons'. It contends that it 'is an important part of the community's green infrastructure asset and should be designed, developed and managed with adequate funding and the best professional guidance available.' While design based studies are more concerned with physical qualities, public spaces also have a political aspect, by giving community members a place to express themselves through speaking out, being heard and protesting: 'Public spaces do not exist as static physical entities but are constellations of ideas, actions and environments' (Miller, 2007, p. 204).

The capacity of public space to create social change is correlated with such nonphysical qualities as those mentioned above. As Miller (2007, p. 11) states: '…[p]ublic space is a kind of hybrid of physical spaces and public spheres'. Many characteristics of public space have emerged in response to the needs of society. While the social and environmental benefits are well documented, a growing amount of literature stresses the necessity of physical space for a democratic life: 'New public space designs need to arouse desire in the public to participate, to cultivate and to advocate' (Amidon, 2009, p. 178). Public space is a fundamentally social space that can operate as a showcase for a new lifestyle; this may include encouraging the imminent social acceptance of clean energy technologies through the use of educational and information spaces.

Jan Gehl (2010) the renowned public space designer, explained the reciprocal link between society and public space in his dictum: 'We shape cities and they shape us'. This paper explores this link in the urban transformation process of Alacati, an Aegean-

Mediterranean town in Turkey. In the last two decades, this transformation has directly impacted on the lifestyle, economy and physical space of the town. Background literature suggests that the primary function of Alacati's public space significantly changed during privatization within the new tourism development. Monoculture public spaces became a focus for servicing exclusive and expensive cafes and restaurants. The town became a place for wealthy residents and visitors, excluding lower socioeconomic groups (Gürkan, 2008). As there is a significant need for public space in town, this paper identifies the capacity of public space within the historical context of national Turkey.

Based on the available evidence, this paper proposes that public space can be used as a design framework[17] within a sustainable tourism development vision. When used for production, public spaces could engage inhabitants around their natural and cultural assets, enrich the local economy and increase social networks. An asset map using local geographical, economic, and social data is used to develop various sustainable landscape architectural designs, which address the key issues of ecology, employment, public space, and community cohesion. A preliminary community empowerment model (CEM) is suggested to manage the designs effectively. Designs include (but are not limited to): local agricultural-sustainable energy generation coexistence, state of the art water management, and functional social and economic sustainability between inhabitants, NGOs, and local government.

5.1.2 Public space as a design framework

5.1.2.1 Public sphere and public space in Turkey

Harvey (2006) exposes the link between public space and public sphere in the Athenian agora and associates the physicality of urban public space with the performance of democratic governance in the public sphere. Therefore, the idea of using public space as a development framework for the rural based economy in Turkey first requires an analysis of the change in the concept of 'public sphere' over time. During the industrialization process in the 16th-17th century, Jurgen Habermas discussed the notion of public sphere. He defined the 'public sphere' as the product of industrialization; not planned, but self-organised within

17 By the time of writing this paper, the public space and its new programs are named as 'design framework'. To prevent any terminology confusion, 'public space as design framework' refers to the political and managerial condition of the designed public space. This approach in the thesis can also become an important function of 'ecological infrastructure', which is discussed in the literature.

modernization. It is the domain where values, taboos, dogmas, symbols, and actors previously hidden in tradition, become visible. Habermas's definition, however, has advanced with the advent of modernism and the concept now includes (but is not limited to) notions of pluralism, participation, freedom and democracy (Çaha, 2003).

The word 'public' in 'public sphere' has an equivocal meaning that goes back to the time when the Republic of Turkey was first founded. In order to understand this obscurity, one needs to look at the concepts that create the meaning of public sphere in the context of the coexistence of national and religious identity. Traditionally, Turkish social structure is embedded in religion. Since the foundation of the Turkish republic, national policy embraced religion and used it as a tool to unite a multiethnic population. However, the Islamic movement in Turkey has resisted the process of westernization. Despite this, the multi-ethnic identity and minorities were accepted and legitimized in the public eye over time (Yavuz, 2004).

The political power of the public sphere in Turkey usually controls the use of public space. The political character of public space has hitherto dominated its recreational uses. Using public spaces to convey a point or promote an ideology has been a common practice in the history of national Turkey. This has, for example, occurred through processes as different as: a statue of political heroes, a community protest, or a police force action in the public space. The use of public space as the image of new western life was promoted by the new republic; this has significantly impacted on Turkey's westernization process. However, this vision was limited and did not allow ideas about the use of public space to evolve in line with the development of international ideas.

5.1.3 (Re)building the community through energy-responsive public space

It is hypothesized that design and public space have the potential to create a more sustainable society, and can simultaneously respond to global and local issues. From a triple bottom line perspective, any innovations in the public space should address social issues, while also improving the environment. A successfully designed public space should engage the community. As public space has a strong political character in Turkey, this capacity can be channelled into positive societal change. There is the potential for a symbiotic evolutionary relationship between the community and designed physical space when public space is conceptualised as a framework. Such a relationship improves the local economy, the level of education about the environment, and social networks. Metaphorically speaking, a building begins to erode once built; a landscape, on the other hand, continuously evolves. A landscape, then, can be seen as an agent; as a framework for community development (North, 2011, p. 15).

In the past, public space has been conceptualised as a passive and formal component of cities. Accordingly, rather than designing for dynamic conditions (which characterise any system that captures natural energy sources), designers of public spaces have commonly focused on formal objectives which are, by definition, static. Landscape Urbanism discourse in contemporary Landscape Architecture theory, in contrast, promotes a dynamic approach for public spaces which are concerned with services, programs, infrastructure, network flows and multi-functional and flexible surfaces (Wall, 1999, p. 234). Such a dynamic public space suggests a revitalized role for the design professions, and disregards the monotonous standardization of the public space in cities. North (2011, p. 20) states that a dynamic public space embraces, engages and supports the community, and evolves with its users when considered as a framework. The multifunctional use of public space can also promote positive synergies between social and ecological functions from a whole systems perspective, while at the same time using resources more efficiently (Birkeland, 2008, p. 103). Public space can, for example, be a platform for the production of clean energy and for improving its social acceptance.

James Corner (1997, p. 86) stresses that '(l)andscape architects should look to ecology less for techniques of description and prescription (and even less for its apparent legitimizing of images of 'naturalness') and more for its ideational, representational, and material implications with respect to cultural process and evolutionary transformation'. Ecological discourse suggests that only a bottom-up approach can create a sustainable world, due to the incapacity of humankind to manage complexity and the dynamic scale of natural systems (Orr, 1992, pp. 29-38; Van der Ryn & Cowan, 2007, p. 23). From an ecological design perspective, public space can be conceived as a bottom up and fine grained approach.

As public space is at the nexus of the material world and the human social network, it is the smallest socio-physical segment of complex urban environment and, perhaps, more comprehensible than any other urban scale. Complex system theory and self-organised systems, in particular, inspired many social scientists to advance community participation and small action in cities. Self-organising systems start with small actions which can then turn into large-scale events. They are flexible and dynamic, and learn and evolve from their own rules. Johnson (2002, p. 18) explains that self-organisation occurs both from bottom-up and low-level rules to a higher-level of sophistication in intelligence, personality and learning. The behavioural pattern of a self-organised system is inclined to shift into a steady state to sustain resources and achieve self-sufficiency; however, when resources are lacking or a threat occurs, it changes its state slightly to adapt to the new conditions. If a threat turns into chaos, the system can change its behaviour to survive. At the edge of chaos, in other words, a self-organised system behaves creatively in order to survive.

Jacobs also emphasized the link between community led action and public spaces in her seminal work, *The death and life of great American cities* (Jacobs, 1961; Johnson, 2002). People influence others while their actions are exposed. Public spaces have an important role in creating community action. By providing space and using the right design framework, public spaces have the potential to instigate positive change. Conceptualising the built environment on a small scale by working at segment level creates the flexibility and space for creativity and innovation. Each public space within its site specificity has the potential to incubate a community action with the right design framework. To increase the quality of life standards equally, a holistic strategy is required. This requires working with local social, environmental and economic data, rather than simply taking a retrofitting approach by integrating solar panels, green walls or any other technical 'fixes'. As self-organising systems in an ecosystem move towards a steady state of self-sufficiency, public spaces in urban environments can be similarly designed with clean energy resources dependent on their site specific energy potentials (solar, wind, thermal, bio-energy, wave), and their unique social, cultural, environmental and economic merits.

5.1.4 Alacati: the transformation and its agents

5.1.4.1 History and geography of Alacati

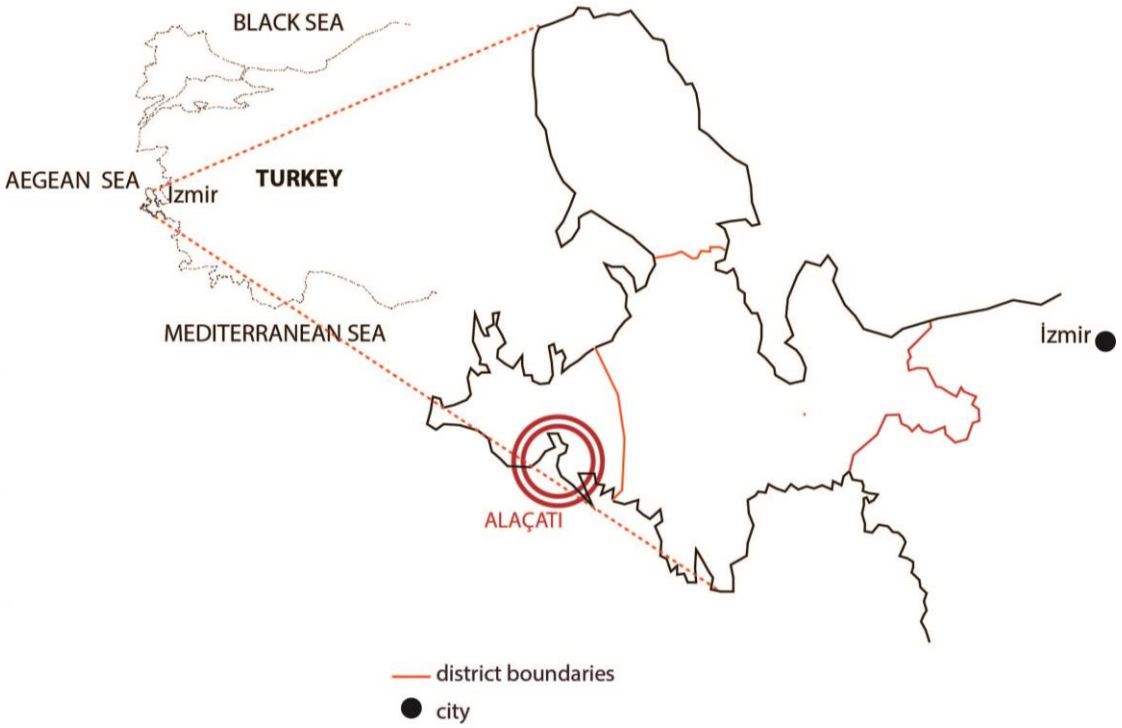

Figure 5.2. Alacati's location context.

Alacati has witnessed numerous demographic and cultural changes throughout history. During the Ottoman Dynasty in the 1830s, the local governor transferred people from the Greek islands to work in construction. By excavating a drainage canal extending to the sea, a malaria breeding marshland was dried and eventually formed the existing ecosystem in the southern part of the historic town centre. Due to increasing population, today's historic town was built in addition to a port settlement (See figure 5.2). At present, nothing of this port settlement remains, but the ruins of a church. The estuary beside the harbor and the historic town centre define Alacati's current political boundary. The Greek minority from these times played an active role in developing the town through construction and viticulture. Soon after, Alacati became one of the primary trade ports exporting wine to France and Italy (Atilla & Ozture, 2005).

During the Balkan war in the 1910s, people from diverse ethnic backgrounds migrated to the town after the Diaspora of Greeks to the island of Crete. This cultural shift was first seen in the change of house ownership and in farming habits. Viticulture, mastic farming, sea weed production, fruit and olive groves was abandoned in favour of tobacco, wheat, aniseed, barley, and rock melon farming. While the cellars of stone houses were initially used to store grapes for vine production, new migrants used them for tobacco storage. Atilla's(2005) interviews with local people and local NGO leaders show that the shift from traditional crops to (mainly) tobacco production was a mistake in the town's development. One interviewer suggests that Alacati needs to embrace its old agricultural products for any development possibilities in the future (Atilla & Ozture, 2005).

After the 1980s, the national government introduced a new tourism policy that opened the land to building development to boost the economy of coastal towns: 'As capital seeks ever more locations where to raise profits, processes of this new cultural economy of space affect all Western, at least, world, but they appear most strikingly in contemporary tourist destinations' (Terkenli, 2007, p. 38). This was the time when the national tourism policy encouraged the locals to become involved in tourism, either directly through tourism services, or indirectly by selling their property for new tourism businesses. Urban transformation in Alacati thus started when property ownership moved from locals to new residents, who were mainly the entrepreneurs and elite of big cities. The original stone houses were renovated to accommodate new functions including boutique hotels, cafes, and restaurants. Terkenli (2007, p. 39) stresses that emerging cultural forms and trends potentially overtake the conventional forms of culture while making them benign to a capitalist economy through spectacle. This has certainly occurred in Alacati; however, based on interviews with local people cited in previous research, the public domain and its facilities have also changed within the new tourism development. Monoculture public spaces are

mainly devoted to exclusive and expensive cafes and restaurants. The town has become a place for the wealthy and excludes the lower socioeconomic classes (Gürkan, 2008).

Today, authentic stone houses, a unique landscape and wind surfing as well as the multicultural ethnic background, attract visitors over the winter and summer seasons, causing a population change from 8,000 to 60,000. Wind surfing, in particular, has a big impact on changing the lifestyle in the town. In 1991, the first wind surfing school was established. Currently, there are over 10 surfing schools, which create an annual revenue of ten million dollars. The geomorphology of the bay is excellent for learning swimming and wind surfing. Alacati periodically invites national and international professional surfers and surf enthusiast from all over the world. As wind is so powerful in the region, 44 wind turbines have been built since 1998. Together with solar and geothermal energy, wind is the best potential clean energy resource of the region and will be used primarily in future developments (Atilla & Ozture, 2005).

5.1.4.2 Tourism and urban transformation in Alacati

During the urban transformation in Alacati, the pressure of tourism has had a significant impact on the physical and social space. Projects were promoted and built, including a freeway that connects the town to the city Izmir. Despite its controversial location, an airport project was planned, but is on hold for the construction approval. The local government has agreed upon a university project with Germany. While big development plans have been on the agenda, local people complain about the local government's insufficient service in improving the water supply, waste water management and garbage collection systems (Gürkan, 2008).

Two main actors had significant roles in transforming the town. First was the civil movement led by big city entrepreneurs who came to Alacati in early 90s. This was not part of a central planning policy and can be called a grass-roots movement. The charm of windsurfing through word of mouth attracted many surf enthusiasts to the town. Slowly, these newcomers took ownership of authentic stone houses and opened new businesses including boutique hotels, cafés, restaurants, and surf schools. The local people, however, were not the primary actors in the transformation process due to their lack of economic and social capacity. Initially, they sold their properties to the newcomers and were not involved in the tourism economy. After a while, some of the new business owners connected with the local people to establish authentic culinary businesses. The new entrepreneurs also developed organisations which acted as NGOs to preserve the natural and cultural assets of the town. However, based on interviews with people from local government, collaboration was lacking between NGOs and local government and needed better management and coordination (Gürkan, 2008, 2010). The emerging local economy and self-conservation

mechanism of this movement could have been supported by local government and top-down planning policy to achieve an ecologically sustainable tourism development. However, a holistic vision was lacking.

5.1.5 Port Alacati project and its criticism

Local government was another key actor in the urban transformation. After recognising tourist potential along the coasts of Turkey, the national government prepared tourism policies for new developments. Following this, an uncontrolled construction boom occurred with a significant impact on natural and cultural landscapes of the coastal settlements. As cited by Knox and Mayer (2009) '…[s]uch big city policies will lead to the development of 'would-be cities' that have lost their unique characteristics stemming from their smallness.'

In 1995, the local council established the Alacati Tourism and Investment Corporation with national and international partners to build the Port Alacati project, designed by François Spoerry (See figure 5.3). Land initially protected by regional environmental law was opened to tourism development. Consequently, Spoerry's team was commissioned by the local government and the Tourism and Investment Corporation to develop a master plan. The project disregarded the existing ecological qualities and excavated the terrain to expand the estuary and accommodate luxury housing. While the first stage of this plan has been implemented, further development ceased over environmental and social concerns.

Figure 5.3. Port Alacati project, the confluence, port and estuary. (2010) Photo by the author.

Issues related to the postponement were twofold. Firstly, the law stated that coastal developments have to be outside of 100m coastal edge line. The law simply reserved the right of coastal edge for public use and rejected any building or construction activity that obscured such use (Topal, 2010). The second issue concerned the possible consequences of the first law which jeopardized the ecological balance of the existing estuary, lagoon and aquifer system, and created the backdrop of social separation and polarization (Yayman, 2011). These criticisms have led to further discussions in local and national media.

Guzer (2010), for example, has discussed the success of the project within its objectives and direct relationship with water. In this sense, the project was provocative and pioneering, while dealing with conservative national planning policies. Given the potential of the development to build meaningful relationships with water, the project retained a pastoral, postcard-like aesthetic (Guzer, 2010). As the development stopped after the completion of first stage, interestingly and exceptionally, such rigid planning policies seem to have worked for the future of Alacati, not against it. Another important criticism, mostly overlooked in Turkey, was the application of sustainability concepts to new developments.

Although the Port Alacati project makes an effort to integrate sustainability, it refuses to go beyond the green-wash demonstration for marketing purposes. Despite a few green technologies, the project does not respond to the equity aspect of sustainability of the town. While offering no positive development for the inhabitants, it privatizes the water edge and discourages the use of public space. 'Sustainability' remains as a buzzword in the project brief. The project disregards site-specific qualities of the town and geography, and envisions a tabula rasa development for the marketing slogan 'First canal development in Turkey'. The purpose of this paper was to develop this criticism and open a new discussion on the basis of design, public space and community engagement.

5.1.6 An alternative proposal for Alacati

Sustainable development principles are well-documented for different scales and types of settlements. As claimed by political scientist David Imbroscio, an alternative economic development for a small town should raise the wealth in society with stable economy and employment, expand the capacity of local assets, distribute the costs and benefits equally back to the community, and improve other foundations for social needs. Such a prospectus would provide the basis for moving towards a self-sufficient economy (Knox & Mayer, 2009, p. 113).

Alacati, back in the early stages of its urban transformation, experienced a grass-roots movement, which has notably shaped the current development dynamics, despite the lack of support from any community economic development model. Such movement though, if implemented and managed by national sustainability policies, would have been pioneering and unique from a social sustainability perspective. By using a landscape architectural design medium in public spaces, the paper proposed a bottom-up sustainable development strategy. Rather than following a top-down sustainable development prospectus, the paper aimed to construct a community economic model that can manage the new designs.

5.1.7 Method

This paper used threefold method: research, planning, and design. The case was studied as part of a student design competition in 2011, for the International Federation of Landscape Architecture (IFLA). The case took our attention first because the town had a controversial agenda of a new canal development. This project has been in the middle of many discussions since its first stage completion. The other stages have failed to be implemented due to the court's decision and growing public criticism. Despite the local and national condemnation so far, neither any idea, policies nor any alternative design proposal has been proposed or disseminated. The paper aimed to bring the discussion one step beyond 'just criticism' and demonstrated an alternative master plan envisioning a sustainable tourism development as well as ecologically designed new public spaces for community development and environment.

5.1.7.1 Literature and previous research

The primary local information concerning the urban transformation of the town has been gathered from the background literature and previous research that were mainly compiled from the interviews with inhabitants, NGOs and local government. The information has been useful to create an analysis map for the design and planning process. As this paper has focussed on the urban transformation and public space in particular, we have identified the key events and their actors who actively took role in transformation process. Once we knew our vision for a sustainable tourism development, we exposed these events and their actors to construct the new relationships for our proposal. We have recognised that local assets were ignored in the controversial Port Alacati project. Considering the importance of locality in building sustainable economies for small towns, we focussed on the local assets in particular to use them for our design proposal.

5.1.7.2 Analysis

A local asset map was prepared on the basis of historical, economic, and geographic data from previous research and existing literature. We compiled these assets and represented them within a timeline, which also showed the expansion of the town (See Figure 5.4). Local NGOs, inhabitants, local government, local and national investors were the key actors in the history of urban transformation. The agreement between such key actors was crucial to determine the right tourism development strategy. However, the paper's primary focus was not constructing a detailed development vision but a preliminary planning and design framework for future research.

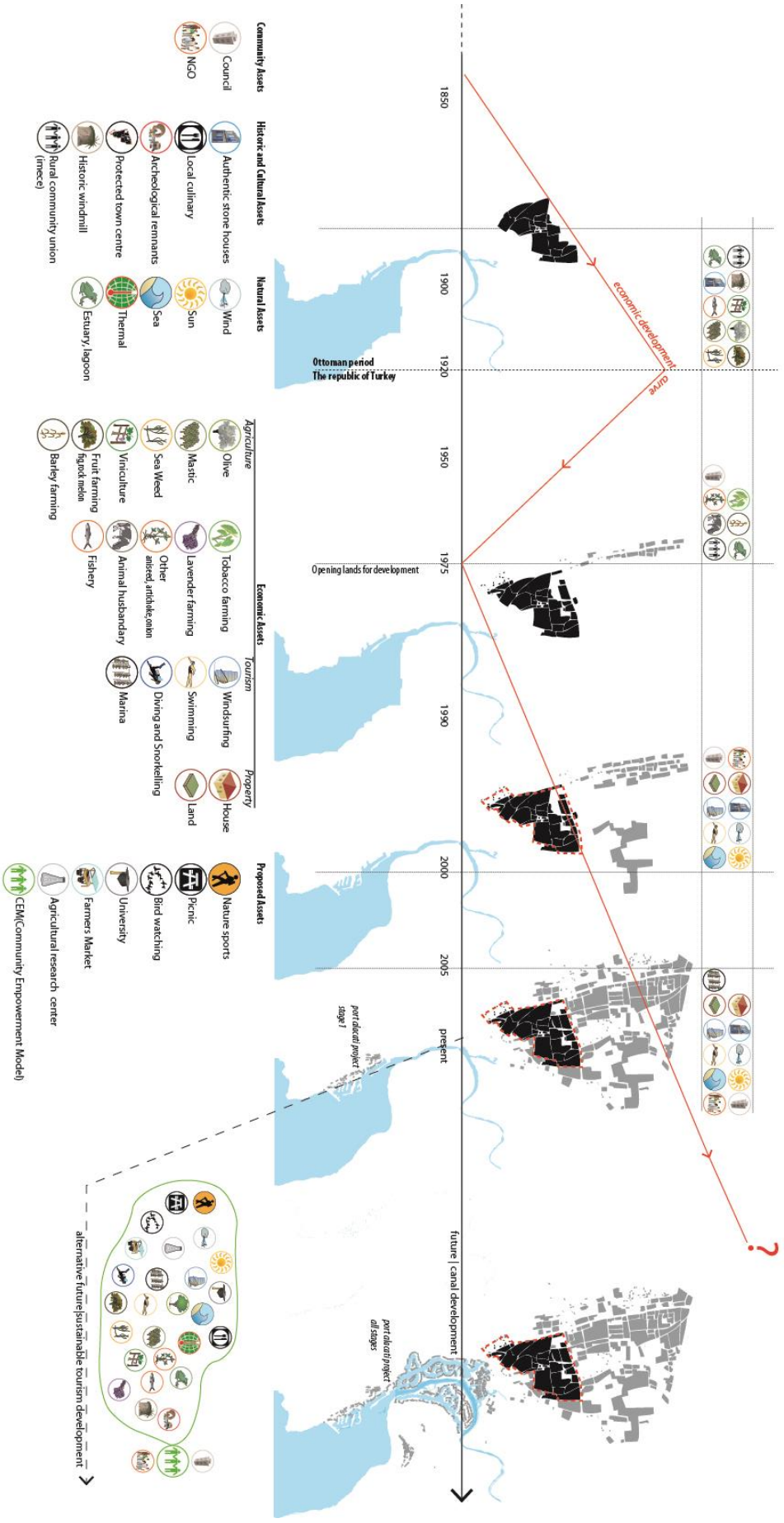

Figure 5.4. Asset mapping analysis and town's expansion.

When the vision was determined and projected on the basis of local assets, we focused on the current issues of Alacati. Given the lack of public spaces and their uses in the town, we recognised a great opportunity to facilitate new public spaces for the community, while introducing production based local economies where people could be actively involved. We proposed the new public spaces as ecologically designed systems managed and delivered by a bottom-up planning framework: a community empowerment model, which was directly tied to local government. In so doing, we used the town's local assets by integrating potential clean energy sources.

5.1.7.3 Planning and design, design and planning

We demonstrated a number of design interventions that could simply be implemented through the proposed planning framework. The specific information concerning the delivery and management of the project was not the scope of this paper and could be further detailed. The design and planning process have been reciprocal and reflect the author's current PhD research on clean energy in urban public spaces.

The planning framework in this paper was inspired by a Japanese community empowerment model, SISDUK, which was used to coordinate and deliver resources in a rural decentralized development in Indonesia. It was successfully implemented in Indonesia and improved the local people's capacity to be directly involved in their future by building sustainable development (Land, 2004).

A primitive version of this model was ingrained in the rural culture of Turkey, and was known as IMECE. IMECE is an unpaid emergent activity that is based on community cooperation. No central authority is involved in any endeavour when tasks need to be done for the benefit of the community. Each individual, depending on their expertise, is voluntarily involved to address the required tasks. Although IMECE showed us how the communities functioned in rural human settlements in Turkey, SISDUK seemed to be a more advanced version that could better deliver the outcomes for a sustainable tourism development when led by a central authority and their related top-down policies.

The model SISDUK works with multiple actors, places the community in the centre of the process, provokes multidisciplinary thinking, and creates new ideas and innovation. The local government of Alacati was the primary actor and worked with internal and external investors and NGOs. In this project, we acted as external investors and illustrated innovations within the new public spaces. Our main concern was capacity building rather than immediate financial results. Innovations were proposed to augment the use of public spaces through the coexistence of local agriculture and sustainable energy generation, and a

state of the art water management system designed within water sensitive urban design principles.

5.1.8 Results

Following the asset mapping analysis, we proposed an alternative master plan (See Figure 5.5) for a sustainable tourism development. Rather than excavating the fragile landscape, we established the link between the estuary and the old historic town centre by extending the fine-grained pattern of the town to the south.

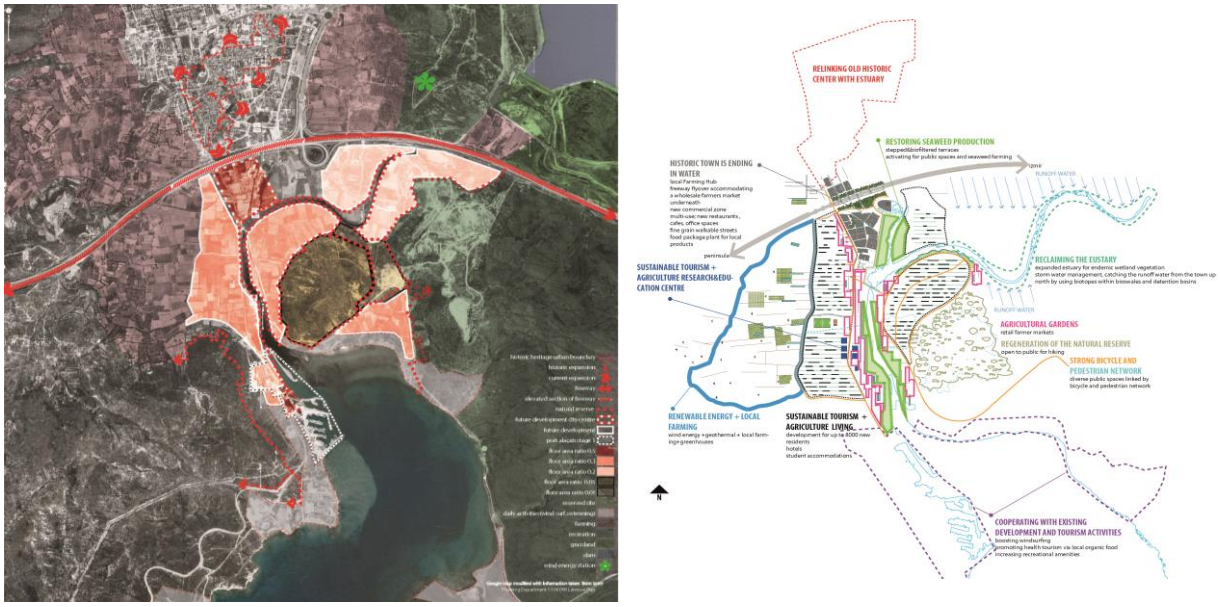

Figure 5.5. Existing land use, future planning decisions, and proposed master plan (See Appendix A for details).

Although the existing freeway flyover physically separates the historic centre from the southern side, we turned this constraint into an opportunity to provide room for the new wholesale farmers' market underneath. Right at the southern edge of the flyover, we proposed a town park which works as a green buffer and a storm water infiltration utility for the runoff water from the town (See Figure 5.6).

Figure 5.6. Proposed wholesale farmers' market under the freeway flyover facing the town park.

We hypothetically doubled the current population and planned to accommodate 8000 new residents in two different types of development in town. The first type (Type A), a multi-use development consolidated between the freeway flyover and estuary consisted of archetypal Alacati streets and houses. The second type (Type B), endowed with state of the art green infrastructure and farm gardens for self-sufficient living, offered agricultural sustainable living. Both types of development suggested an alternative tourism experience that aimed to integrate the society, local government, and tourists.

We proposed seaweed production along the edge of the estuary, while keeping the promenade for public and tourism activities (See Figure 5.7). We protected the estuary simply by using it: we thickened its edge with other agricultural activities.

Figure 5.7. Seaweed farming and public space along the estuary.

Educational agricultural gardens were placed adjacent to the estuary both for production, education, and recreation and tourism purposes. A sustainable tourism and agriculture research centre was proposed to manage these farms and educate the residents and tourists, while also engaging them in local farming practices. In this way, tourists were informed

about local products right in the centre of town where the locals were practising daily, routine farming activities. These gardens were designed to function as the new public spaces of the town.

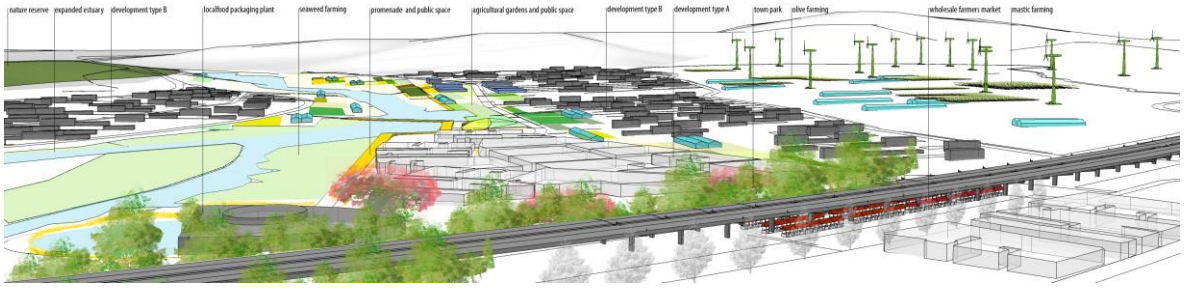

Figure 5.8. General view of proposed sustainable tourism development for Alacati.

On the western part of the master plan, we suggested the coexistence of green house agriculture, wind energy plants, and mastic and olive farming (See Figure 5.8). It is well-documented that a renewable energy sector creates significant employment opportunities both during, and post production. One development strategy for the town could be to lease the land to clean energy investors and to use the energy income to seed and develop an agricultural economy.

We regenerated the natural reserve using endemic planting and opened it to the public for hiking and bird watching. We cooperated with other developments in the southern part, including wind surfing schools, and the marina settlement to integrate them with the proposed sustainable tourism development.

We proposed a water management strategy for the town, which was of particular benefit in cleansing and restoring the estuary. We simply controlled all runoff water arriving at the estuary banks. Our town park proposal was integrated with bio-swales that cleanse the water coming from the town to the north. We have expanded the estuary bed and promoted endemic wetland planting. The outflow from the existing dam and all runoff water was filtered within bio-swales, and retention basins were built on the estuary plane (See Figure 5.9).

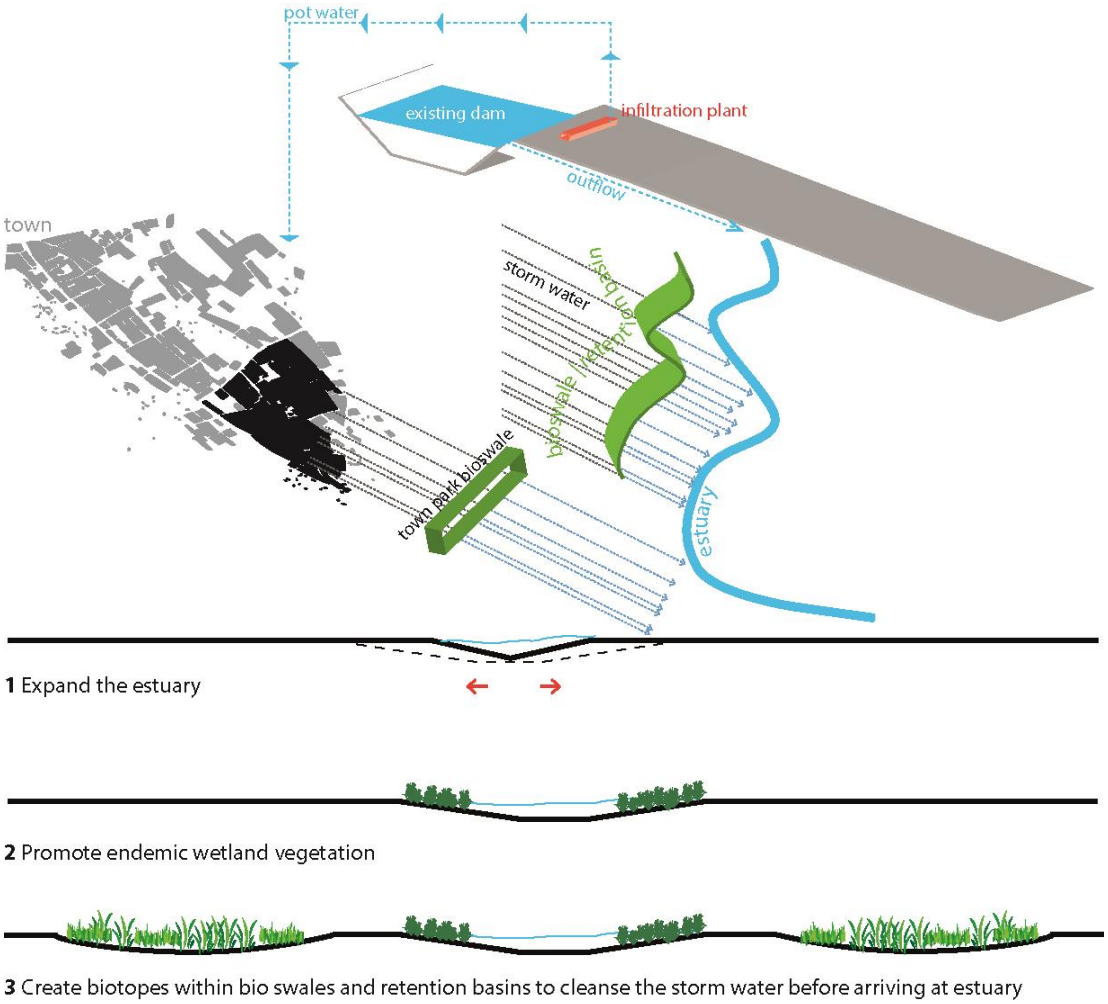

Figure 5.9. Storm water management and estuary restoration.

5.1.9 Conclusion

Social change plays a crucial part in supporting growing research around climate change science and urban studies. This paper argued the potential of design and public space to engage society in achieving a sustainable lifestyle. Through the research, design, planning and representation in Landscape Architecture, this paper explored a proposal in Alacati, an Aegean-Mediterranean town in Turkey.

The Alacati case revealed some important findings for the landscape architectural discipline and constructs the hypothesis through the design process and site-specificity. A new definition of public space was proposed that consists of two distinguishing classifications including;

Site-specific physical material world

- Public space for the design framework
- Designing with local agricultural assets
- Designing with clean energy

    - Site-specific human social network (Grounded in self-organised systems in complexity theory, and local grass root movement in town's history)
- Public sphere for social sustainability (Social change)
- Planning and managing with community empowerment model (CEM)
- Using design process and outcome for educating the public
- Instigating the local economy
- Expecting to create a centrifugal effect to change central policies

In the national historic context, public spaces were used as a propaganda machine to promote westernization in building a new modern Turkey. Therefore, we recommend that public space be re-envisaged to promote sustainability within a sustainable tourism development vision to increase the number and quality of public spaces designed both for the environment and people.

Agricultural gardens and recreational facilities within a promenade along the estuary, as well as a new town park adjacent to the existing freeway flyover, are proposed. Each design proposal incorporates established alternative tourism activities aimed at actively engaging tourists and local residents. These activities utilize the local assets, clean energy and state of the art green technologies, while promoting local production. As the new proposals are dynamic design artefacts, and participation is a priority, a preliminary planning, management and coordination model, entitled 'Community Empowerment Model' (CEM) is proposed (See Figure 5.10). CEM was recommended because of the similarity to the previous grass roots movement that achieved significant success earlier in the town's development. In this sense, CEM has been proposed to reconnect the local government, NGOs and investors with local people.

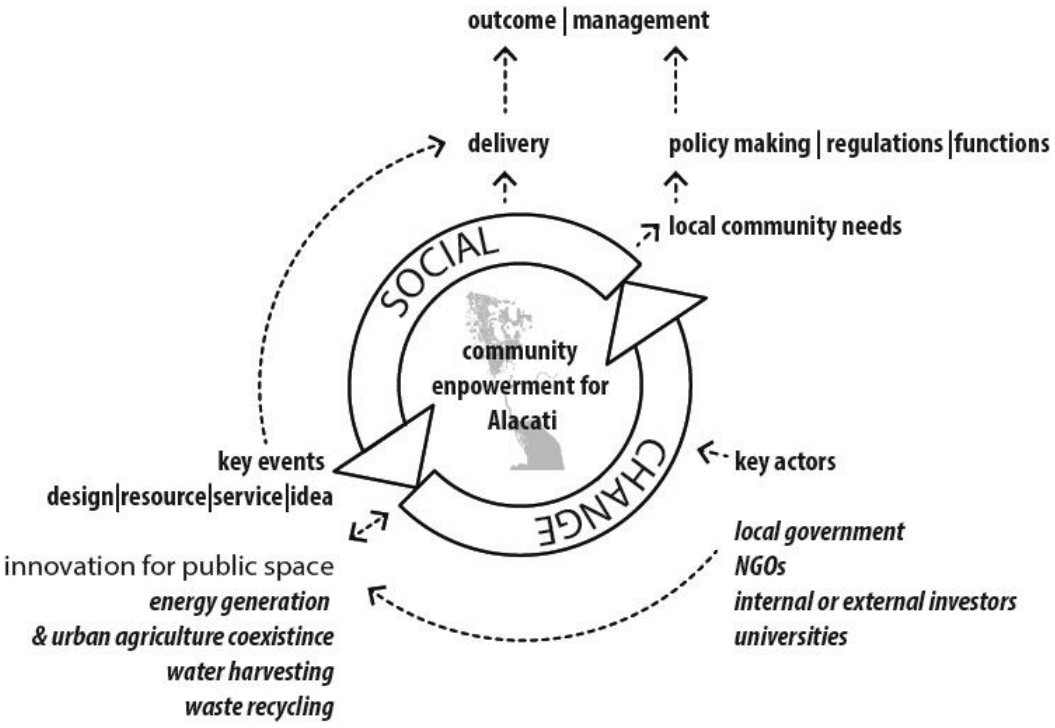

Figure 5.10. Community Empowerment Model (CEM) for Alacati.

Sustainable energy transition is a response to cities' growing energy demands. The most important and difficult part of this transition is likely to be the public consensus and action for making the changes required to address the sources of the problem. This paper conceptualises the importance of public space and design as an agent to instigate positive social change by redefining the use of public space. Landscape architectural design practice in the public space is used to bridge local energy production and its social acceptance by residents. The proposed CEM contributes to the discourse around productive public space designs with clean energy, food production, and state of the art water management to better manage sustainable outcomes. In conclusion, the recommendations are a response to a local problem but, at the same time, reinvent the idea of public space through site specificity to open a discussion and further research possibilities for production based programs in the human environment.

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CHAPTER 6: RESEARCH *ON* DESIGN

6.1 RENEWABLE ENERGY DISTRIBUTION IN PUBLIC SPACES: ANALYSING THE CASE OF BALLAST POINT PARK IN SYDNEY, USING A TRIPLE BOTTOM LINE APPROACH

Ozgun, K.; Cushing, D.; Buys, L. Renewable energy distribution in public spaces: Analysing the case of Ballast Point Park in Sydney, using a triple bottom line approach. Journal of Landscape Architecture, 2015, 2, 18-31.

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http://www.tandfonline.com/doi/full/10.1080/18626033.2015.1058562

Statement of contribution of co-authors for thesis by published paper
The authors listed above have certified* that:

1 they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of (at least) that part of the publication that lies within their field of expertise;
2 they take public responsibility for their part of the publication, while the responsible author accepts overall responsibility for the publication;
3 there are no other authors of the publication;
4 potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5 consistent with any limitations set by publisher requirements, they agree to the use of the publication in the student's thesis and its publication on the QUT ePrints database.

The authors' specific contributions are detailed in Table 6.1 below.

Table 6.1. Chapter 6's *'Renewable Energy Distribution in Public Spaces: Analysing the Case of Ballast Point Park in Sydney, Using a Triple Bottom Line Approach'* Publication

Contributor	Statement of contribution*
Kaan Ozgun	Conceived of and designed the framework, developed the study, conducted fieldwork, site observation, interviews, data analysis, produced the graphics, wrote the manuscript and co-wrote the abstract
Signature	
Date	

04/05/2015	
Debra Cushing*	Helped to develop the study; organised and reviewed the manuscript
Laurie Buys*	Helped to organise and review the manuscript, co-wrote the abstract

Principal Supervisor Confirmation

I have sighted emails or other correspondence from all co-authors confirming their certifying authorship.

Dr Ian Weir		6 November 2015
Name	Signature	Date

Preample

As the result of the two initial design competitions and their outcomes, three research questions were framed:

1. What general opinion do designers and consulted experts have of renewable energy and public space?
2. What is the current design approach to renewable energy-embedded public space?
3. What is the potential relationship between public space and renewable energy, and what principles and methodologies can better contribute to design approaches to renewable energy-embedded public space?

While chapter 6 investigates the first research question in a built project, chapter 7 explores the second and third question within speculative designs.

Previous chapter informed public space and public sphere and renewable energy link. Chapter 6 now further explores and supports with ideas such as 'energy commons' and 'decentralized local energy communities'. It reports the investigation of renewable energy embedded into public space, using Ballast Point Park (Sydney, Australia) as a case study within research *on* design. The key objective of this study was to investigate whether the designers and experts involved in the project were aware of, and whether the design included the social, economic, and environmental interrelationships of renewable energy and local clean electricity production. The interview questions addressed some of the following topics:

- the general understanding of sustainability, triple-bottom-line (TBL), and renewable energy
- how renewable energy was incorporated into the design of Ballast Point Park and
- the original goals of the design (for example, social, ecological, economic, aesthetic)

Two important claims made at the outset of this thesis document are substantiated by the findings of this case study. First, the use of the TBL framework to assess the sustainability of the park's general design reveals that designers and experts involved in the project made general park design decisions based on the environmental component of TBL, with less focus on its social and economic components. A distinct imbalance among the three components of TBL is evident in the general design of the park.

Second, this case study reveals a larger gap in the discipline: the issue of assessing the sustainability of built public space designs. Accordingly, this study devises a framework to guide the recreation of a sustainable balance in the park with the use of renewable energy, electricity production, and its sustainable distribution. Thus, with the help of the devised framework, the findings of this study clearly demonstrate that the social, environmental and economic components of TBL are equally valid in the integration of renewable energy into

the design of public spaces. Later (as reported in chapter 7), this framework is further advanced with the application of concepts from ecology and the laws of thermodynamics.

This study is documented in a double blind peer reviewed paper for the *Journal of Landscape Architecture*, and a final edited version was published in its second 2015 issue. Figure 6.1 locates the study in the overall research.

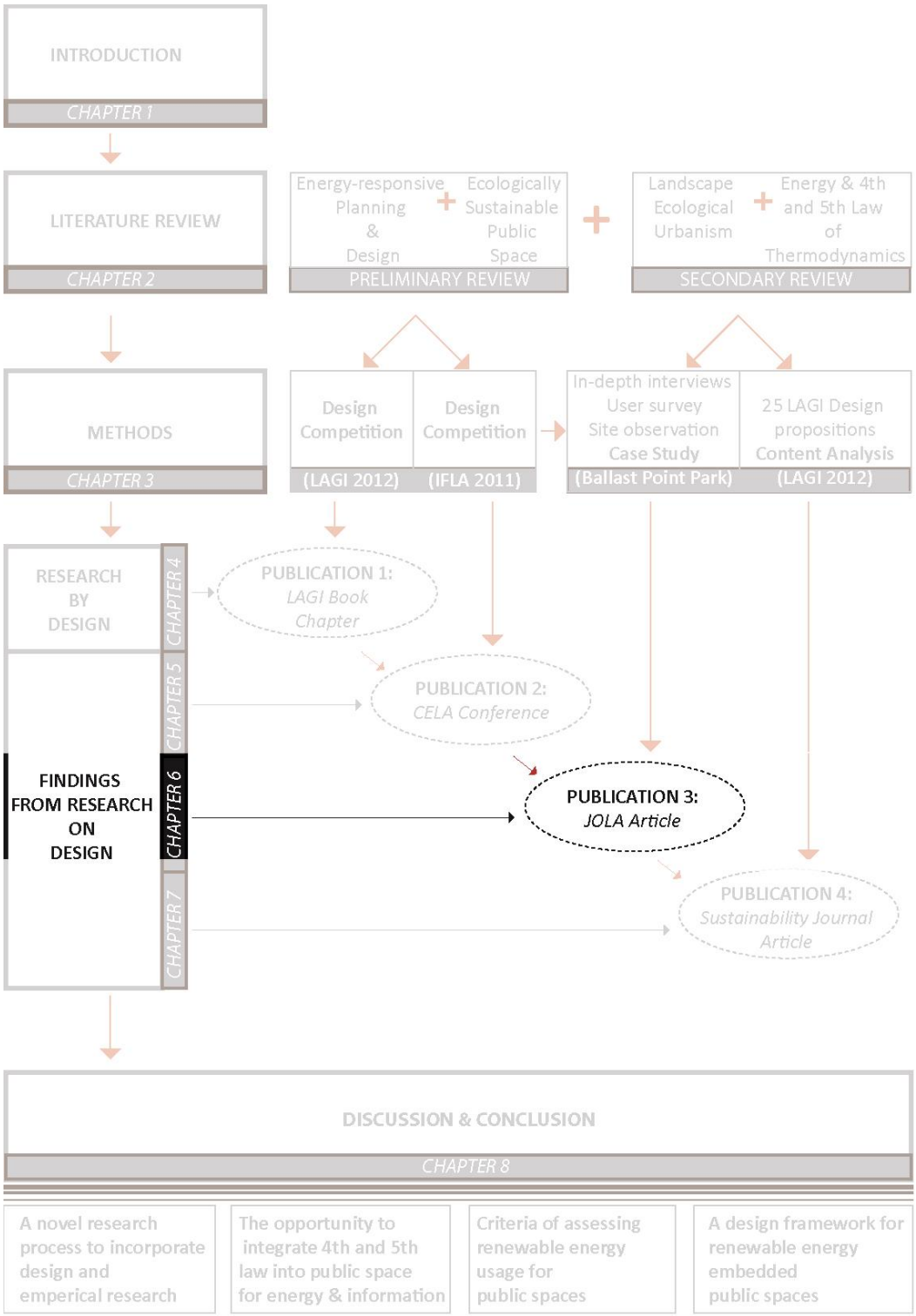

Figure 6.1. Map of overall research.

--Start of published paper--

Abstract

As cities are rapidly developing new interventions against climate change, embedding renewable energy in public spaces becomes an important strategy. However, most interventions primarily include environmental sustainability, while neglecting social and economic interrelationships of electricity production. Although there is a growing interest in sustainability within environmental design and Landscape Architecture, public spaces are still awaiting viable energy-responsive design and assessment interventions. The purpose of this paper is to investigate this issue in a renowned public space, Ballast Point Park in Sydney using a triple bottom line (TBL) case study approach. The emerging factors and relationships of each component of TBL within the context of public open space are identified and discussed. With specific focus on renewable energy distribution in and around Ballast Point Park, the paper concludes with a general design framework, which conceptualises an optimal distribution of onsite electricity produced from renewable sources embedded in public open spaces.

Keywords

Renewable Energy Distribution, Public Space, Sustainability, Triple Bottom Line (TBL), Ballast Point Park

6.1.1 Introduction

Cities around the world are grappling with growing energy demands. As of 2009, between 60 to 80 percent of energy was being consumed by cities, with expectations that the general global demand for energy would increase by 45 percent over the next fifteen years (Kamal-Chaoui & Robert, 2009, p. 17). The transition to sustainable energy resources has been shown as a long-term solution to this problem, yet it requires a deep societal shift in order to sufficiently address the situation. Evidence of this shift is the increasing use of energy from renewable sources in cities around the globe (Droege, 2009, p. 45). While renewable energy is becoming widespread, cities are adapting new policies to promote local clean energy. Energy independent cities and neighbourhoods are emerging. Concepts like distributed energy neighbourhoods, virtual renewable energy utilities, resilient micro and smart grids indicate a transition to new energy urban environments (Droege, 2009). These fast changing urban environments require new spatial and aesthetic qualities, often included Landscape Architecture and environmental design research. However, such research so far has focused primarily on energy-responsive design (Stremke & Koh, 2010) from a planning scale, neglecting urban micro scales. Yet, moving forward, Byrne et al., (2009, p. 88) suggest locating 'energy-ecology-society relations in a commons[18] space […] focusing on techniques and social arrangements which can serve the aims of sustainability and equity'.

Public open space can serve as this commons space, potentially contributing to the necessary societal shift that includes acceptance and understanding of renewable energy. Scholars have suggested that 'New public space designs need to arouse desire in the public to participate, to cultivate and to advocate' (Amidon, 2009, p. 178). In addition, Landscape Urbanism discourse in contemporary Landscape Architecture theory promotes a dynamic approach to public open spaces concerned with programs, infrastructure, network flows and multifunctional and flexible services (Wall, 1999, p. 234). For example, a public park is a non-profit asset for a community. If economic production occurs within a park, such as producing electricity from renewable energy sources, it may be possible to use the revenue for direct community benefit and subsidize park maintenance costs (Garvin & Brands, 2011, p. 205). Yet, implementing these ideas into public spaces can be challenging for landscape

18 'The commons is a way of thinking and operating in the world, a way of organizing social relations and resources'(Eizenberg 2012: 764).He further describes 'existing commons should not be seen as a "return" of some noble but possibly archaic ideal but as a springboard for critiquing contemporary social relations and as the production of new spatiality, initiating the transformation of some fundamental aspects of everyday life, social practices and organization, and thinking'(Eizenberg 2012: 779-80).

architects, and so far, the social and economic components of sustainable energy usage have not been fully explored in a public space context.

To operationalize and implement sustainability into practice, many sub-definitions and frameworks have emerged over time. One of them is 'Triple Bottom Line', which originated in the 1990s as a tool to integrate sustainability into the business world by minimising the detrimental impact of economic activities of corporations on society, and the environment (Elkington, 1998; McDonough & Braungart, 2002, p. 252). The three components of the triple bottom line (TBL) are intertwined and are often referred to as environmental quality, economic prosperity, and social justice (McKenzie, 2004, p. 6). More specifically, and for the purposes of this paper, we focus on the following objectives of each component (Fig 6.2):

- Economic Sustainability: efficient use of limited resources; ethical production of goods and services (Assefa & Frostell, 2007; Baumgärtner & Quaas, 2010).
- Social Sustainability: equitable access and use; social cohesion; social acceptance of green innovation (Assefa & Frostell, 2007; McKenzie, 2004; Rogers et al., 2012).
- Environmental Sustainability: renewable energy usage as part of development, sustained global life support systems; requiring economic and social sustainability (Dincer, 2000; Goodland, 1995; Rostami et al., 2014).

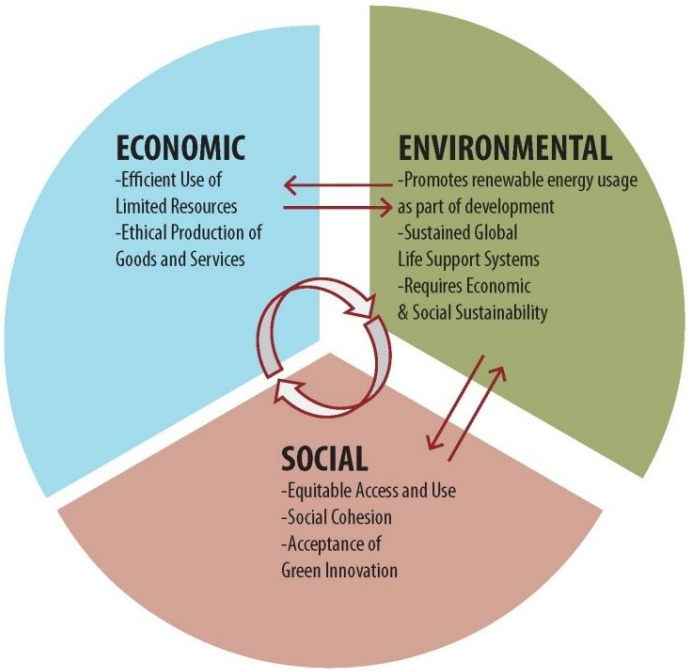

Figure 6.2. Research Focused Triple Bottom Line Objectives.

Economic sustainability seeks efficiency within limited natural and human resources for an ethical future (Baumgärtner & Quaas, 2010). It pursues productivity in the economies of systems, structures, and formal and informal processes to sustain equitable progress. In

order for a system to be economically sustainable, it needs to be able to produce goods and services continuously (Baumgärtner & Quaas, 2010, p. 64). It is imperative that these goods and services are ethical, environmentally friendly, and comply with the purpose of the other two.

Social sustainability aims to empower social wealth by creating equity and justice through economic development (Vallance, Perkins, & Dixon, 2011, pp. 342-345). In a similar vein, McKenzie (2004, p. 18) argues 'social sustainability is a positive condition marked by a strong sense of social cohesion and equity of access to key services, it occurs when the formal and informal processes, structures and relationships actively support the capacity of current and future generations to create healthy and liveable communities.' A healthy community promotes equity for all members, including the poorest and weakest. Another aspect of social sustainability and the focus of this paper in particular, is the social acceptance of green innovation. This means that public opinion and knowledge about a particular green innovation, its interpretation and sensitivity to the sense of place (Rogers et al., 2012, p. 96) are imperative for its acceptance (Assefa & Frostell, 2007, p. 68).

Environmental sustainability stemmed from the idea of sustainable development, which was defined as social and economic development that is environmentally conscious (Moldan et al., 2012, p. 6). Using renewable energy sources is imperative to any sustainable development as they have less environmental impact, unlimited energy capacity compared to fossil fuels and nuclear energy, and they promote self-sufficiency, are locally based, and are less dependent on national energy networks (Dincer, 2000, p. 172). Environmental sustainability seeks to sustain global life-support systems indefinitely and advance human well-being by protecting natural capital with supportable consumption and production (Goodland, 1995, p. 3). Although environmental functions cannot be substituted for social or economic benefits, the European commission's report on sustainable cities argues that the environmental function is achievable if only the economic and social components are in line (Rostami et al., 2014, p. 2). Further, one way to protect environmental functioning is through association with economic value, turning it into a commodity (Mebratu, 1998, p. 509).

Since the three components of TBL are intertwined, we have focused on TBL in its entirety as a framework for design. The TBL framework is recognised and supported by the Australian Institute of Landscape Architects (AILA) (AILA, 2010a), which contends that it raises the potential for new ways of analysing, designing, and managing sites across a wide range of scales. While there is currently no accepted assessment tool for public spaces in Australia that uses the TBL framework, the Sustainable Sites Initiative (SITES) (2009, p. 6) has created a tool with 'guidelines and performance benchmarks for sustainable design, construction and maintenance in Landscape Architecture projects'. This framework has been

tested using many case studies in the United States, and in recent years, AILA tested the framework in Australia. Similar to the U.S. Green Building Council's 'LEED' rating system for architecture, the 'SITES' rating system uses a point system to assess projects based on a set of criteria that are predominantly environment driven. However, this quantitative assessment approach can leave the social and economic aspects of sustainability, and specifically renewable energy use in public space, vague and undervalued.

Therefore, the purpose of this paper is to address the sustainability assessment of built public space designs using a TBL approach. This paper analyses the three components of TBL within an award-winning public space, Ballast Point Park in Sydney, New South Wales and focuses on how designers and experts approach renewable energy. Using this park as a case study, this paper explores TBL as a framework for design. The paper identifies and reflects on the emerging factors and relationships of each component of TBL, specifically focusing on renewable energy. The paper concludes with recommendations for a potential design framework to sustainably distribute electricity produced from renewable sources in public spaces.

6.1.2 Research *on* design: case study method

To more fully understand TBL within the context of public open space design, we employed a case study method within a 'research on design' methodology. The research on design approach particularly focusses on built projects or design processes using post occupancy evaluations, plan analyses and case studies (Deming & Swaffield, 2011; Lenzholzer et al., 2013, p. 121). The case study 'provides the opportunity to apply a multiple method approach to a unique event or setting. Unlike other methods that carve up a whole situation into smaller parts, the case study tends to maintain the integrity of the whole with its myriad of interrelationships' (Sommer & Sommer, 1997, p. 193). The case study method is outlined by Mark Francis and is accepted by the Landscape Architecture Foundation as a viable means to analyse and critique Landscape Architecture projects (Francis, 2001, p. 16). Scholars also recognise case studies as a method to examine a well-accepted theory or framework (Yin, 2005, p. 41). In this case, we are using the TBL framework within the case study.

Further, we see Ballast Point Park as an 'instrumental case' to develop insight into an issue, focusing on an embedded topic, renewable energy usage in public spaces (Silverman, 2013, p. 142). Next, we describe the Ballast Point Park context.

6.1.2.1 Case Study Site: Ballast Point Park

We chose Ballast Point Park, a 2.6 hectare park, located in Birchgrove on the Balmain Peninsula in Sydney Harbour (Fig 6.3).

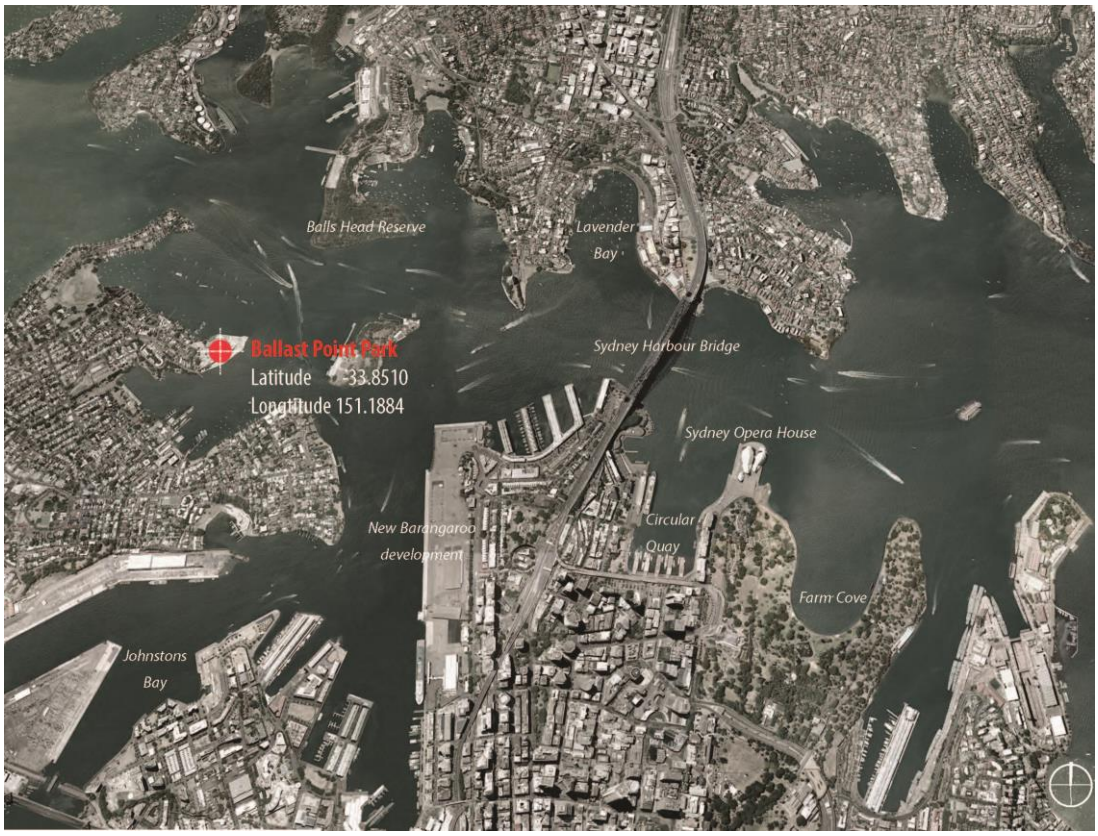

Figure 6.3. Ballast Point Park and its location within Sydney Harbour Context, map extracted from google earth.

The park is the first Landscape Architecture project recognised by AILA for electricity production:

> The design uses world-leading sustainability principles to minimise the project's carbon footprint and ecologically rehabilitate the site. The design reconciles the layers of history with forward-looking new technologies to create *a regionally significant urban park.* The environmental approach is further underpinned by site-wide storm water bio filtration, recycled materials, and *wind turbines for on-site energy production* (Emphasis added by authors) (AILA, 2010b).

The Ballast Point Park site has a complex history that includes an Indigenous sandstone headland, 19th century majestic housing and a petroleum refinery (Hawken, 2009, p. 46). Texaco (later Caltex) obtained the site in 1928 and significantly altered the landscape to accommodate a seaboard terminal, storage facilities and oil tanks, until they explored selling the land to developers for high-density housing (Harding & Hawken, 2009, p. 42). As a prominent headland in Sydney Harbour, the site was also the focus of a massive, decade-long campaign by local activist groups and Birchgrove community members, who wanted to protect the site from development. These efforts attracted significant attention, and in 2002 the Sydney Harbour Foreshore Authority (SHFA) officially acquired the site for public use (Leigh, 2011, p. 118). SHFA led the community consultation process with the Birchgrove community (James, 2014), after which the Landscape Architectures firms, JMD (James Mather Delaney) design and Context, along with the environment and heritage consulting

firm CAB Consulting, completed the master plan and the Landscape Architecture firm Mcgregor Coxall completed the detail design and project management.

Many scholars (Hawken, 2009; Leigh, 2011; Raxworthy, 2011) discussed the park's strong historic character, which is clearly noticeable through the palimpsest design approach and the inclusion of interpretative signage throughout the site. Ballast Point Park tells the story of a 'metamorphosis' (Authority, 2009) from an old industrial site into a post-industrial landscape; from a working class community (Leigh, 2011, p. 117) serving the fossil fuel industry, into an affluent community that fought for the creation of the park. As seen in figure 6.4, the park is designed as a vegetated headland that retains its industrial footprint (O'Neill, 2014).

Figure 6.4. 1943 & 2010 Ballast Point Site, map extracted from maps.six.ns.gov.au

Ballast Point Park has received numerous awards for its intelligent, respectful, and educational design scheme. AILA (2010b) specifically recognised the park's 'design excellence and functional quality; clarity and legibility of expression of design concept; sensitivity to social, cultural, historical, physical and natural context; and relevance to the profession of landscape architects, the public and the education of future practitioners', among other aspects. Similarly, Wallis (2012) compares Ballast Point Park to the renowned Barangaroo development in East Darling Harbour, stating, 'This internationally acclaimed design, which surpasses the sustainability claims of Barangaroo, features the revitalization of a polluted former industrial tank site, the reuse of soil and water, energy production, the use of indigenous plants and the promotion of biodiversity' (Emphasis added by authors).

Using Ballast Point Park as an instrumental case, we deconstruct the TBL framework to examine how designers and other experts address each TBL component and specifically focus on renewable energy. To do this, we employed a multiple method approach described below. In Ballast Point Park, we deconstruct the TBL framework to examine how designers and other stakeholders address each TBL component, specifically focusing on renewable energy production. To do this, we employed a multiple method approach described below.

6.1.3 Methods

6.1.3.1 Semi-structured interviews

To understand Ballast Point Park as the context for renewable energy usage, we interviewed designers and other experts [19]involved in the project. In total, we conducted semi-structured interviews with five people in person and via Skype, including three landscape architects from the lead design and planning firm, one project manager, and one consultant involved in the design, planning and community consultation process. All interviews lasted one to two hours, and focused on the following key topics:

- The general philosophy of sustainability, TBL and renewable energy;
- How renewable energy was incorporated into the park design;
- Original goals for the project (social, ecological, economic, aesthetic, etc);
- Perceived social impact of the project and public reaction;
- The dynamics of the project team (multi-disciplinary); and
- The community consultation process.

We used NVivo software to thematically code the interview transcripts using the components of TBL as the guiding structure. We examined 'sustainable service and goods production', focusing on electricity production in the park. We also focused on concepts of 'equity' to respond to social sustainability. We further explored renewable energy use with 'social acceptance of green innovation' on the basis of 'public knowledge and interpretation'. We then compared these findings with data collected through the site observations and user survey described below.

6.1.3.2 Site observation and user survey

To better understand social sustainability and patterns of park usage, we conducted site observations that involved discreetly recording user behaviour throughout two weeks in January 2014. We commenced the observations during the month of January when summer begins in the southern hemisphere. Selected times included weekends, weekdays and a public holiday with rotating shifts of early morning 7:30-10:00am; morning 10:00am-12:00pm; mid-day 12:00pm-2:00pm, early afternoon 2pm-4pm; and late afternoon 4pm-7pm. We recorded details of the activities and users on a spreadsheet and site map (See

19 This study is approved by the Queensland University of Technology Human Research Ethics Committee (no: 1300000817)

appendix C). Because of the topographical layout of the park, we divided the site into six observation zones and moved between zones every twenty minutes to record the site usage. We also used an anemometer to measure wind speed and direction, temperature, humidity and sunlight levels and uploaded all raw data into Arc GIS to determine patterns. We analysed this data to inform our understanding of the user experience, and the design decisions regarding renewable energy types and locations and to generate design recommendations.

In addition, during the site observation process, we approached thirty-four random park users at different time periods and asked two questions: (1) Do you live in the area?; and (2) Do you realize that this park has the capacity to produce electricity from a renewable source? We analysed responses to determine whether users were predominately local or regional users and whether they were knowledgeable about the electricity production from renewables designed into the park.

6.1.4 Findings

Based on our data analysis and a review of previous literature, we identified several design parameters that indicate landscape architects' alignment with TBL during the design process and compared these parameters with the TBL objectives described earlier. Our parameters include physical features, activities, accessibility, design and interpretation, and process components. Many of these parameters have multiple implications and could be viewed from different perspectives. Figure 6.5 shows one example of how these parameters can be evaluated using the TBL objectives.

Based specifically on our data, we determined if the parameter contributes to the specific TBL objective, the box is fully coloured. If the parameter does not contribute to the TBL objective, the box is left empty. If the parameter fairly contributes to the TBL objective, the box is left half-full. For example, under the process components, the park transforms an old industrial site to a green parkland for community use. This parameter contributes well to the equitable access and use, and social cohesion under the social objective of TBL. Transforming an old industrial site also fully contributes to the efficient use of limited resources as well as ethical production of services within environmental objective. Lastly, a transformation like this highly contributes to the environmental objective.

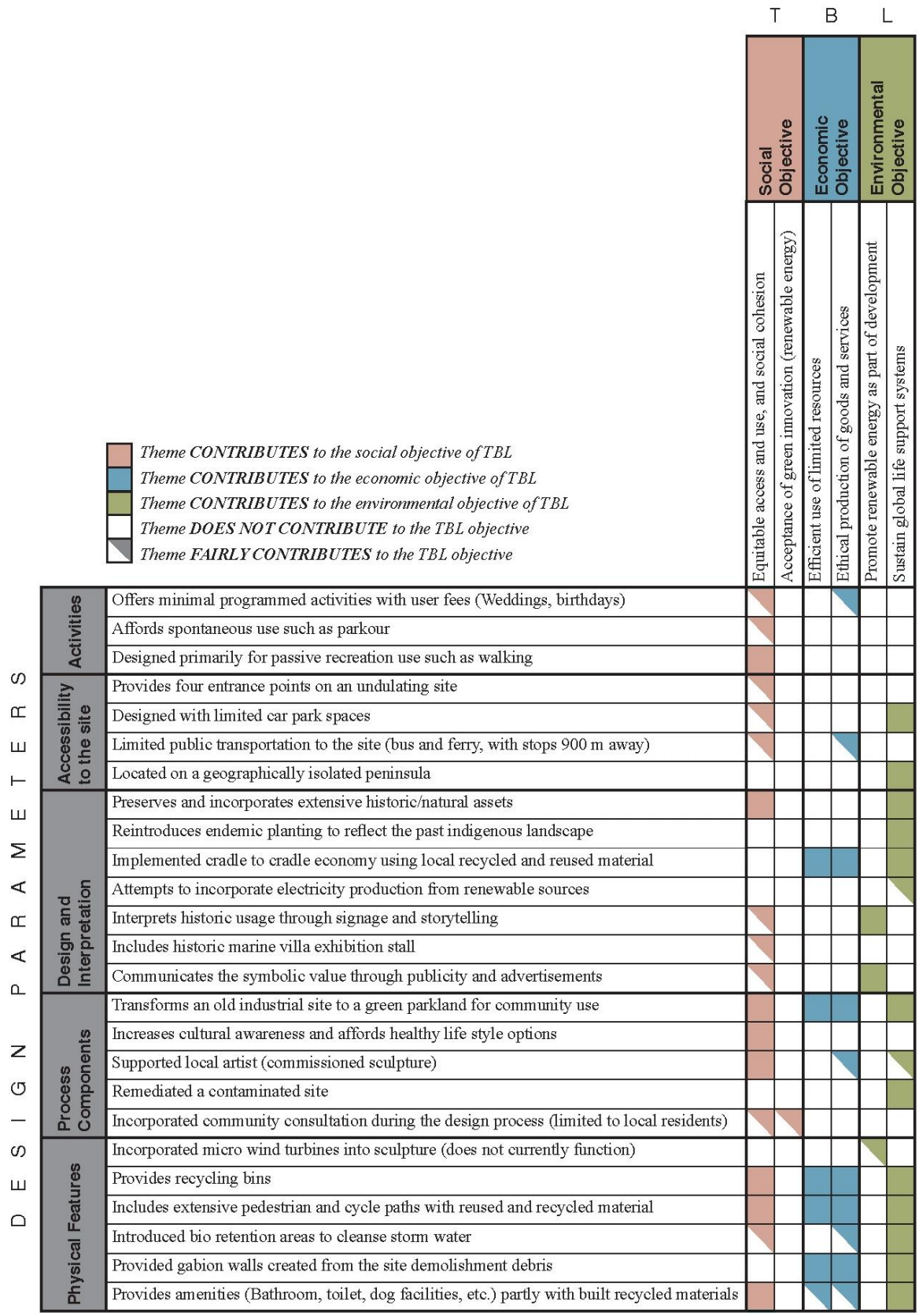

Figure 6.5. Ballast Point Park indicative design assessment based on specific TBL objectives.

We found that environmental sustainability was a key driver for the innovative design of Ballast Point Park. The park, as stated by AILA and other scholars, successfully accomplishes many accepted environmental sustainability objectives, including but not limited to increasing biodiversity, and cleansing air and storm water. Similarly, the intention to incorporate renewable energy as an innovative approach to environmental sustainability, was also well-received by the design community and the public.

In summary, the design parameters of the park primarily contributed to the environmental objectives while contributed less to the social and economic. Later in this part, we describe these in detail.

6.1.4.1 Economic

Through our analysis of economic sustainability ('efficient use of limited resources', and 'ethical production of goods and services'), we determined that the Ballast Point Park design exhibits limited economic sustainability due to its high cost as a local park against less efficient sustainable service and goods production. And although cradle-to-cradle economy was desired for the park, some environmental practices are only partially successful due to the discrepancy between intention and the reality of the current situation. Specifically:

- Costing $25 million (AUD), the park is a state-funded asset that was designed as a regional park to also accommodate a maritime refilling facility. However, it currently functions primarily as a neighbourhood park in the affluent Birchgrove suburb.
- Currently there are only a few programmed activities, such as wedding ceremonies, that require user fees to help meet maintenance costs.
- The wind energy generator installed in the park currently does not function and, therefore, does not supply electricity to the park for daily use and to reduce the costs of maintaining the park.

Ballast Point Park, as emphasized by AILA (quoted earlier in this paper) and reaffirmed by SHFA, is a state asset funded primarily to maintain its regional heritage quality. As discussed by O'Neill, the total project cost approximately $25 million (AUD), including land acquisition, site remediation, planning, design and construction. In addition, O'Neill (2014) argues,

> It has been designed to be a park of regional significance. The value in terms of its basic environmental value is not that it provides a 2.5 ha park to a local area. I think if that was the only value that Ballast Point offered, it would never have been acquired and it would never have been turned into a park. It would be covered in residences right now. What made it significant was the position that 2.5 ha occupied on Sydney Harbour. It was about the significance of being able to provide, or re-establish, a green headland where Ballast Point is, opposite Balls Head and Milsons

> Point, Bradleys Head, Blues Head, Blues Point and Goat Island and soon the headland of Barangaroo. It was about this.

The park size and overall usage observed indicates the park is currently a local park. The open space document for NEW South Wales recommends that a local park is between 0.5 to 2ha, while a district park is between 2 to 5ha and a regional park is more than 5ha (SGS Economics & Planning, 2010). Therefore, at 2.5ha, Ballast Point Park sits at the lower end of the district park category.

Despite the predominately local use, the initial funding amount aligns with the regional significance of the headland park. Although initially part of the master plan, but later excluded from the design and never completed, the maritime refilling facility influenced why the park received initial state funding. O'Neill (2014) explains that many people do not realise the state ownership was partly about 'making sure the government could retain a place on Sydney Harbour where it could refill ferries from a state-owned filling facility.' This regional use was imperative for the project at the beginning, yet the community consultation process led to design decisions based on primarily local views, rather than regional input, which significantly impacted the park's regional use.

According to O'Neill (2014) 'Community consultation […] over the past ten years has been an evolving science. When we started in Ballast Point, it was reasonably new. In some ways I think Ballast Point went out to community a little bit too blue sky.' He contends that a lack of experience in consultation led to asking for community input prematurely rather than going to the community with two or three carefully determined scenarios based on research and site assessment (O'Neill, 2014).

The community consultation process also led to the choice of wind power in the park. A group of community members expressed a desire to keep the post-industrial remnants in the park, including the Tank 101 in which the wind turbines were integrated (Fig 6.6).

Although the design inspiration for wind turbines and wind power is ingrained in the stories of the community, from an economic perspective, the initial intent of producing electricity on site was to balance out the operation demands of the park (Kennedy, 2014; McDermott, 2014). However, the wind turbines in the park are currently dysfunctional and do not produce electricity for the site. In addition, people we talked with during our site visit, including a maintenance gardener, only observed the turbines rotate once or twice during the last five years.

The interviewees indicated that the team lacked sufficient time, expertise and experience for assessing the design and application of the renewable energy (Coxall, 2014; Kennedy, 2014; McDermott, 2014). The entire technology was new, and with newness came risks. In order for the turbines to work efficiently, an inverter was needed and both its

presence and cost was not planned initially. In the end, it was the inverter that caused the majority of the issues (Coxall, 2014).

Figure 6.6. Renewable Energy Sculpture: Micro wind turbines integrated into the structure built with recycled material from the former Tank101 once was standing at the same location. Image by the author.

Despite this limitation, the intent to produce electricity from renewable energy on site and reuse a historical structure aligns with objectives of environmental and economic sustainability. The notion of reusing and recycling is extended to the 'cradle to cradle economy', which the designers persistently, and often quite successfully, tried to implement in Ballast Point Park. Site materials from the demolition, including site soil, mulch material, aggregates and bricks, sand stone boulders, crushed concrete, existing structures such as stairs, pathways, foundations, bund walls, old rusted tanks, were reused and incorporated into the design. However the principle designer also discussed the discrepancy between their genuine intention and the reality of the political system that did not enable some environmental practices to be fully realised. Technical, methodological, and logistical constraints were common. For example, the broken bricks from old structures were to be processed and used on site. However, the designer states 'It worked out that it was more expensive to process the debris on the site, than take it to the processor and get it back to the site' (Coxall, 2014).

The limitations in economic sustainability also have an impact on the social component of TBL. We discuss this in the next part.

6.1.4.2 Social

The level of social sustainability in the park is mixed. As a popular, well-designed, multi-use space, Ballast Point Park improves the quality of life for the neighbourhood residents and has become a well-used gathering spot that promotes community connectedness and social cohesion. However, using 'equity' as a parameter with which we explored social sustainability, our findings show that Ballast Point Park is inaccessible to a large number of regional users.

Through our site observations, we discovered several characteristics that limited equitable access to the park, and thus social sustainability. These included: a lack of public transportation to the site via bus and ferry; the geographic location of the park as a somewhat isolated peninsula; a lack of commercial programming that feeds regional and local use such as a café and gift shop; and a lack of sufficient car parking spaces for people travelling from significant distances. These limiting characteristics were reiterated by the interviewees (Coxall, 2014; James, 2014; O'Neill, 2014).

Two interviewees discussed ideas to increase the regional use of Ballast Point Park, such as the addition of a ferry terminal and ferry tour that could take tourists around all of the key parks in Sydney (Coxall, 2014). Similarly, another interviewee (O'Neill, 2014) suggested that SHFA could organize events within various sites under their management, including the Rocks, Darling Harbour and Cockatoo Island, to attract people from wider Sydney and increase the regional use of Ballast Point Park. However, these ideas have yet to be realised. As a multi-use public space, Ballast Point Park affords activities such as sitting, walking, running, exercising, dog walking, cycling, skate-boarding, kayaking and pushing a pram during the week, and fishing, barbeques and picnics on public holidays and weekends (Fig 6.7). The frequency of each activity, and its occurrence on a weekday, weekend and public holiday as well the occupancy of car park spaces helped us to define regional and local activities.

We also observed spontaneous activities like event photography and birthday celebrations, as well as outdoor events like geo-cashing that occurred on the weekend and public holiday. The park's authentic historical remnants and elegant physical design, along with magnificent harbour views attract couples to have wedding photographs in the park. In particular, the Tank 101 energy sculpture was a prime backdrop for photographs (Fig 6.7, 6.8, 6.9). These events indicate regional use, and therefore align with the equitable aspects of social sustainability.

ACTIVITIES	NOT OBSERVED	REGIONAL	LOCAL
PASSIVE RECREATION USE			
BARBEQUE		■	
WALKING			■
DOG WALKING			■
WALKING A CHILD			■
EXERCISING + YOGA			■
RUNNING			■
SITTING			■
CYCLING			■
SKATE-BOARDING			■
SOCCER		■	■
SKETCHING			■
LYING ON GRASS		■	■
PUSHING A PRAM			■
WALKING WITH POLES			■
FISHING		■	
OBSERVING THE VIEW		■	■
KAYAKING			■
SITE SEEING		■	■
PICNICKING		■	
TAKING PHOTO		■	
KITE FLYING		■	■
FRISBEE		■	■
SPONTANEOUS USE			
EVENTS INCLUDING WEDDING PHOTOGRAPHY AND BIRTHDAY CELEBRATIONS		■	
VOW WALL WHERE PEOPLE PUT LOCKS ON		■	■
EVENT PHOTOGRAPHY		■	
PARKOUR	■	■	■
BOULES	■	■	■
GEO-CASHING		■	■
PROGRAMMED ACTIVITIES WITH USER FEES			
CAFE SHOP, GIFT SHOP	■		
WEDDING CEREMONIES		■	


WEDDING CEREMONY


EVENT PHOTOGRAPHY


GEO-CASHING


VOW WALL


PUSHING A PRAM


RUNNING


OBSERVING THE VIEW


BIRTHDAY CELEBRATION


WALKING


KAYAKING


CYCLING


SKATE-BOARDING


DOG WALKING


SITE SEEING


FISHING


BARBEQUE

Figure 6.7. Passive and Programmed Activities and Spontaneous Use.

Figure 6.8. Standing on the Belvedere and looking down to Sydney Harbour on the right and Tank 101 Energy Sculpture on the left. Image by the author.

Figure 6.9. Standing on the verge of Belvedere and looking down to the nose and Tank 101on the right; the main entrance is on the left. Image by the author.

The recycled gabions are also used as a 'vow' wall on which people attach locks (Fig 6.7). Kayaking, playing soccer, barbeque, and flying a kite are some other activities occurred on site occasionally (Fig 6.7). In addition, the designers reported that the park is a gathering space for 'parkour' and 'boules' groups, although we did not observe these activities during the site observations. The diverse range of activities afforded in the park indicates that it promotes a healthy lifestyle for users, and thus supports aspects of social sustainability.

Additionally, community members were able to have a voice in the design and planning process for the park, which suggests social sustainability. Two interviewees specifically referred to the high level of community involvement amongst the neighbourhood residents. James (2014) associated this with the strong history of community involvement in the neighbourhood.

However, other details, such as the relative affluence of the surrounding neighbourhood, the lack of economic and ethnic diversity of the residents (ABS, 2014) and the missed opportunities for environmental education suggest the social sustainability of the park is mixed. For example, one interviewee raises the possibility of exclusivity, stating, 'I would always argue that open space is for everyone. I think everyone who lives in a particular area always feels a certain ownership of the neighbourhood. But you know open space should never be exclusive' (Kennedy, 2014). Although it was not the intention, the involvement of predominately local residents during the community consultation process impacted the park's regional use, creating inequity.

In addition to equity, we focused on the social acceptance of green innovation by investigating the 'knowledge' of the intended audience (Assefa & Frostell, 2007, p. 69) and

'interpretation' of the specific intervention (Rogers et al., 2012, p. 95). We found a clear intent to communicate sustainability through the design. For example, the principle designer emphasized that the design signals a shift in thinking about energy, 'the biggest fossil fuel tank turned into the biggest wind turbine on Sydney Harbour. There is poetry there.' (Coxall, 2014). In addition, one interviewee who worked on the research, design development and application of renewable energy devices for the project (McDermott, 2014) discussed the choice of wind turbines over solar panels and indicated that solar panels lacked the aesthetic qualities of wind turbines and generally hid the message of sustainability for the purposes of promotion and education. Yet, despite the brilliant initial message that was intended, we found a missed opportunity to effectively interpret the energy story of the site into a complete user experience for local and regional users.

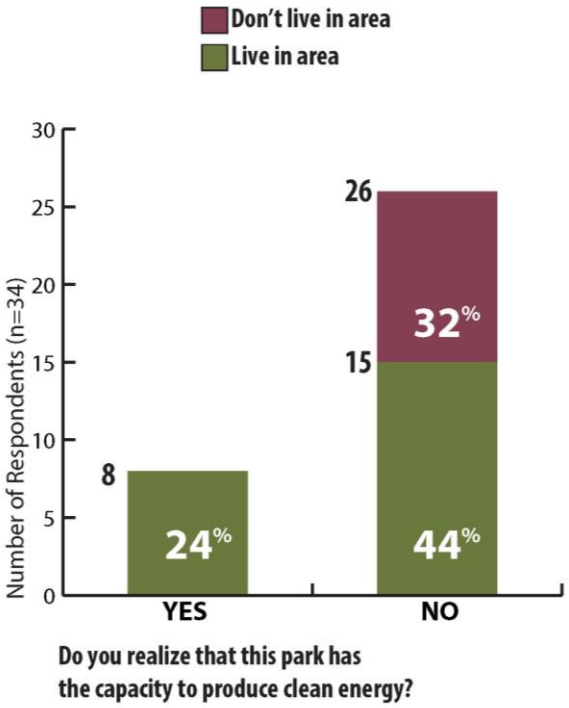

Figure 6.10. Survey demonstrates the response of local and regional users to renewable energy usage in the park.

Through our user survey, we found that only 24 percent of the park users, primarily local users, knew that the site could potentially generate electricity (Fig 6.10). In addition, none of the regional users noted or understood the wind turbines and many actually misunderstand their purpose on the site. For example, one park user thought the turbines were for mobile phone reception. In the next part, we discuss the environmental sustainability of the design.

6.1.4.3 Environmental

Through this research, we found that the park generally meets environmental sustainability objectives, including but not limited to, balancing microclimate factors of the urban heat island effect, increasing urban biodiversity, and using storm water bio-filtration. However, as stated earlier, this paper is primarily concerned with renewable energy as it is embedded into public spaces. Therefore, we have analysed the environmental sustainability aspects of Ballast Point Park using a narrow definition that focuses privileges renewable energy.

According to designers, experts and critiques, environmental sustainability was the main focus for the design of Ballast Point Park and the intention of using renewable energy as an innovative approach to environmental sustainability was well received by multiple

stakeholders, including the public. However, from our site observations and interviews, our research discovered that the wind turbines designed to provide electricity for the park, do not currently function as originally planned. Since the opening of the park in 2009, the park has never produced electricity and there is no record of electricity production that feeds the grid or contributes to the operation of the park.

During our site observations, we discovered that the northern winds were dominant on the site due to the exposed promontory along the Parramatta channel and Sydney Harbour. Using an anemometer to record the wind strength at six observation zones and the location of the original wind turbines for two weeks, we recorded up to 60km/h wind values around the park. The average wind speed for each day ranged from 2.1 to 19.7km/h. We measured an average speed of 5.5 km/h about 6m below the location of the existing wind turbines[20]. Our data showed that the location of the wind turbines did not align with the zones exhibiting the highest wind speeds [21](Fig 6.11).

These observations were supported through our interviews revealing that yearly wind data was not used during the design phase to locate the wind turbines in the best location for the best possible yield. There were no calculations completed, but only estimates based on the specifications of the turbines. Therefore, we found that the choice of reusing the Tank 101 as the location for the wind turbines was misguided by a desire to reuse a historic structure and create a functional art piece in the park.

20 While taking the spot measurements, our limitation was the height of the anemometer which stood on a tripod 1.75m above the ground.

21 General specifications of 8x1kW vertical axis turbines recommends a minimum starter speed (cut-in speed) about 10km/h, and generates maximum 750W, when the wind blows at 50km/h.

AVERAGE WIND VALUES (km/h)							
Date	Zone1	Zone2	Zone 3	Zone 4	Zone 5	Zone 6	Wind Turbines location
DAY 1	19.7	7.1	5.6	8.5	9.6	9.8	7.1
DAY 2	6	7.6	6.9	4.8	7.4	6.5	6.4
DAY 3	19.3	8.4	10.8	9.7	12.7	11.2	11
DAY 4	7.4	8	8.6	4.9	3	7.1	5.2
DAY 5	3.9	4.9	3.5	3.4	3.9	3.8	2.1
DAY 6	9.5	6.7	7.8	6.7	6.3	6.8	2.1
DAY 7	10.4	6.7	14.1	8.1	5.9	10.4	4.3
Average	10.9	7	8.2	6.6	7	8	5.5
Zones were visited several times on each day and the daily average wind speed was calculated from the results. We then calculated an average wind speed over one week.							

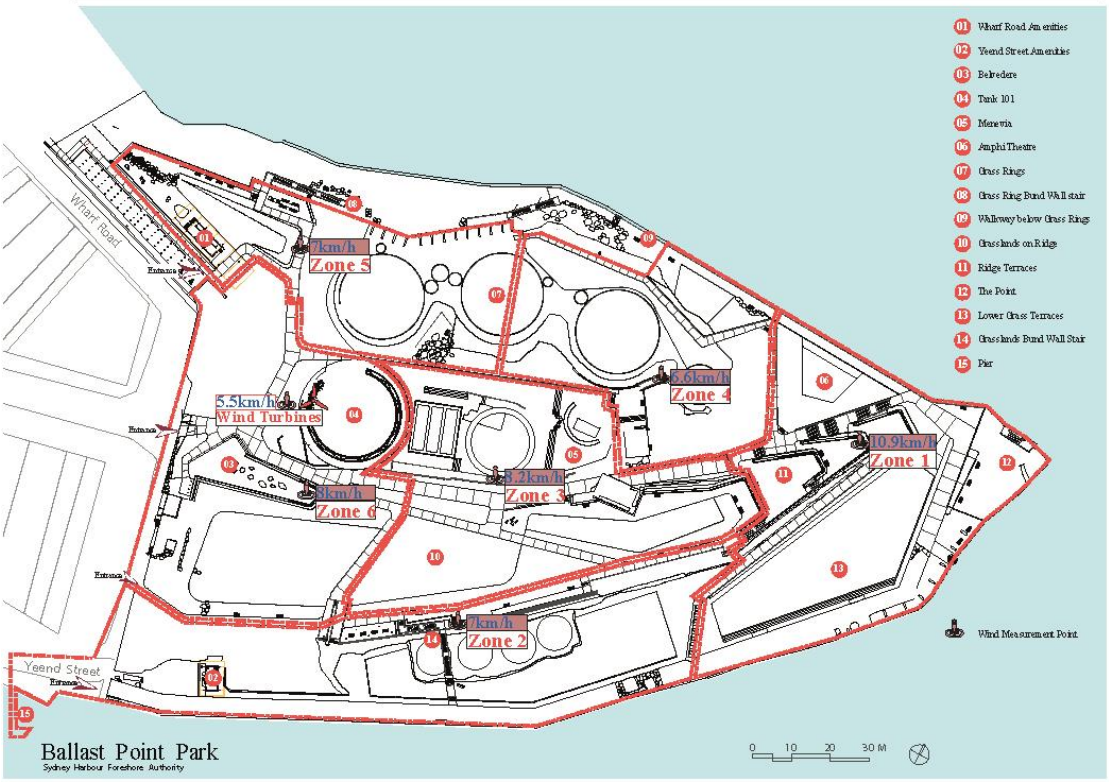

Figure 6.11. Drawing shows existing functions of the park, observation zones and locations (Base map is the courtesy of Mcgregor+Coxall).

6.1.5 Conclusion/Discussion

This paper addresses the need to determine if public spaces meet acceptable standards of sustainability. Focusing on renewable energy distribution within public space, we used a case study method at Ballast Point Park to explore TBL as a framework for design. Specifically, our findings show that in order to design truly sustainable environments, designers of public spaces need to consider all three TBL components, and particularly need to consider how to achieve economic sustainability in addition to social and environmental sustainability.

Our findings indicate that although Ballast Point Park is a successful, well-designed park on many different fronts, it does not yet reach its true potential according to the TBL

framework. Ballast Point Park lacks sustainable services and goods production in order to accomplish economic sustainability. In addition, despite its internal and local social cohesion, equity is problematic due to a lack of regional use and accessibility, thus limiting social sustainability. Consequently, the environmental sustainability, which depends on the other two TBL components, is not sufficiently accomplished. More specifically, using a TBL framework, we determined:

6.1.5.1 Economic

- Ballast Point Park was funded as a state asset that was subsidized by all taxpayers, and was designed as a regional park. Yet, it currently functions as a local park for predominately local users, which may not justify the funding outputs.
- The wind turbines located within the historic structure do not function as originally intended and, therefore, do not reduce park maintenance costs.

6.1.5.2 Social

- Regional use is crucial for long-term social sustainability of the park in order to create true equity within the Sydney context, making the park's strong historic and environmental character, as well as recreational amenities accessible to everyone. However, a lack of programming and public space management limits the regional use.
- The social acceptance of renewable energy use is problematic in Ballast Point Park. Local residents agreed upon having renewable energy in the park during community consultation process. The promotion and advertisements for this award-winning project rely on the assumption of the active electricity production on site. Despite this, or perhaps because of this, people using the park expressed limited knowledge of the potential electricity production from wind turbines. Therefore, the project does not effectively interpret the energy story of the site and misses an opportunity to create a complete user experience for local and regional users.

6.1.5.3 Environmental

- Although the park responds to other environmental sustainability objectives successfully, the environmental pillar in regards to renewable energy is problematic since the wind turbines currently do not function.
- Because environmental sustainability relies on the other two components to be successful, the design has yet to satisfy true environmental sustainability.

6.1.6 Recommendations

With an increased need for renewable energy usage in public spaces, we propose a model for designers to incorporate electricity production from renewables as a design feature. Ballast Point Park, with its unique and controversial history, together with multi-

award winning environmental quality, can better meet the TBL objectives by reinventing the renewable energy usage on site. Fortunately, the designers and experts indicated that there is a plan in place to fix the malfunctioned wind turbines.

In addition, implementing public space management and place-making strategies into electricity production from renewables can attract a diverse range of local and regional users. Considering the sporadic regional events occurring in the park, such as marriages and birthday celebrations, a huge potential exists to facilitate events focused primarily on sustainability. As the managing authority to organize events in other Sydney Harbour venues, SHFA can introduce and manage green events in the park run by on-site renewable energy. In doing so, it would increase regional use as well as create an economy to self-sustain the park and its community in both the short and long term. These suggested interventions would supplement the park's environmental functionality, instigate social and economic momentum, and address the park's reputation promoted through advertisements about electricity production from renewables. In addition, direct electricity uses such as charging points for mobile devices, playful interactive energy toys, and artistic interpretive energy screens can be used to support both local and regional use and could impact the social acceptance of renewable energy by increasing knowledge and establish a communication between designer and user, and also bridge physical, social and environmental aspects of the designed public space. Public space is essentially a social space where renewable energy can be used not just for production, but to change people's understanding and acceptance of renewable energy, and thus change their actions.

On the basis of our findings, we propose a potential design framework for electricity production, consumption and distribution of renewable sources embedded in the public open spaces. Ingrained in Howard T. Odum's (1976, 2007) energy concept of ecosystems, and the objectives of TBL (Rostami et al., 2014) that indicates the environmental function is only achievable when the other two are in line, we devised the following diagram (Fig 6.12). The diagram conceptualises an optimal distribution of electricity produced from renewable sources in public open spaces. Although it is beyond the scope of this paper to fully test this potential framework, it begins to 'decouple' the activity of production from the concept of renewable energy devices, in and around public spaces.

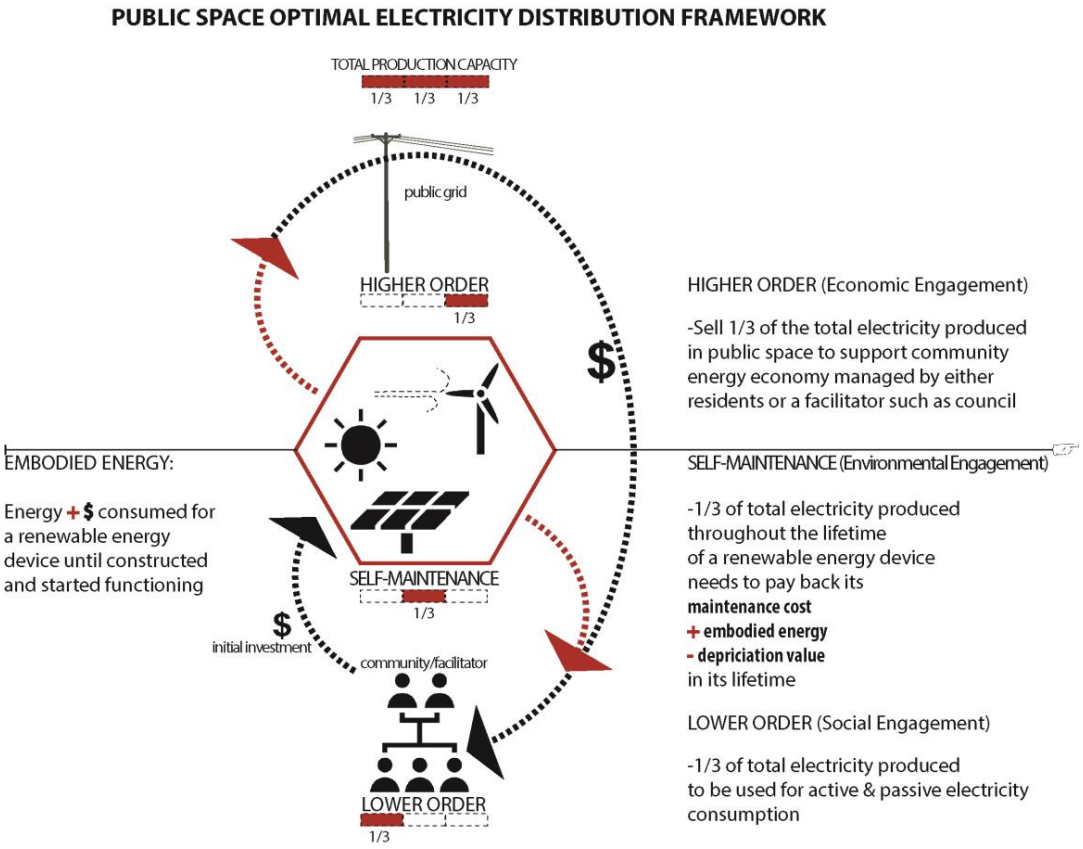

Figure 6.12. Public Space Optimal Electricity Distribution Framework. Diagram by the author.

To equally distribute the produced electricity in public space, we have determined three levels of need based on ecological principles. One-third of electricity produced in the public space will contribute to 'economic engagement' (higher order). It will be sold to the public grid and utilised to support community renewable energy economy managed by either local residents or a facilitator, such as council. The initial investment cost will be either subsidised by the community or the facilitator (e.g SHFA).

One-third of the electricity produced will be utilised for 'self-maintenance', which refers to 'environmental engagement'. This means one-third of the total electricity produced throughout the life of a renewable energy device ideally needs to pay back its maintenance cost and embodied energy[22].The depreciation value of any renewable energy device in its

22 For example, Energy pay back times of Photovoltaic is 1-7 years depending on the module technology (Alsema and Fthenakis 2006). Another research's finding concerning energy pay back times of solar, geothermal, wind wave and tidal power is an average of 3 years (Roberts 1980).

lifetime can be calculated based on existing data and subtracted from the production value. In addition, considering the decreasing cost of these technologies, the device may recoup the cost with one-third of its electricity production. This part of equation includes the daily electricity demands of public space including lighting as well as any possible energy storage facility[23]. Once the capacity of renewables increase in time, the surplus energy can be either sold to the grid or stored to be used for direct and indirect use within public space context.

The last one-third of the electricity produced in public space is designated for 'social engagement' (lower order usage). This is to be used for on-site direct electricity consumption supported by place-making activities and green events. The 'lower order usage' also includes interactive, performance-based, as well as indirect electricity usage incorporated into artistic approaches to increase public engagement. This requires extra attention from the designers of public space, as interpretation and sense of place need to be considered.

Over the last decade, renewable energy use within an urban context has often been considered as a retrofit, and appears as an addition or technological fix to public space designs. The TBL as a framework helped us to investigate this issue in Ballast Point Park in Sydney. We believe changing the understanding of renewable energy from a technological fix to a communal production activity identified new potential relationships in and around a public space not only for community but also for designers of public open spaces. Yet, sustainable energy transition requires bottom up approaches as much as it requires top down policies. With the increasing number of production activities in cities, public spaces offer great opportunities to convey the idea of renewable energy and to educate people to accelerate the sustainable energy transition. By using TBL as a framework for public open space design, we can begin to take a more balanced approach to sustainability and ensure that the social and economic components contribute to the overall design. Thus, improving the sustainability of public open space design.

--End of published paper--

23 According to Odum, it is good to have large amount of production as long as the storage is available with more interaction. He states 'With increasing scale of available energy (the production capacity of renewable energy in public space), storages increase, depreciation decreases and pulses are stronger but less frequent' (Howard T. Odum 2007: 63). This definition depicts the behaviour of mature complex ecosystems and has been applied to national policies under the name 'sustainability' (Howard T. Odum 2007: 54). From a public space point of view, a higher amount of electricity production from renewables means that more social interaction and storage will be required to use produced electricity sustainably.

CHAPTER 7: RESEARCH *ON* DESIGN

7.1 OPTIMAL ELECTRICITY DISTRIBUTION FRAMEWORK FOR PUBLIC SPACE: ASSESSING RENEWABLE ENERGY PROPOSALS FOR FRESHKILLS PARK, NEW YORK CITY

Ozgun, K., Weir, I., & Cushing, D. (2015). Optimal Electricity Distribution Framework for Public Space: Assessing Renewable Energy Proposals for Freshkills Park, New York City. *Sustainability*, 7(4), 3753-3773.

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Statement of contribution of co-authors for thesis by published paper
The authors listed above have certified* that:

1 they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation of (at least) that part of the publication that lies within their field of expertise;
2 they take public responsibility for their part of the publication, while the responsible author accepts overall responsibility for the publication;
3 there are no other authors of the publication;
4 potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and
5 consistent with any limitations set by publisher requirements, they agree to the use of the publication in the student's thesis, and its publication on the QUT ePrints database.

- The authors' specific contributions are detailed in Table 7.1 below.

Table 7.1. Chapter 7's *'Optimal Electricity Distribution Framework for Public Space: Assessing Renewable Energy Proposals for Freshkills Park, New York City'* Publication

• **Contributor**	**Statement of contribution***
Kaan Ozgun	Conceived of and designed the framework for analysis, developed the study, collected and analysed the data, produced the graphics, and wrote the manuscript
Signature	
Date 04/05/2015	

Ian Weir*	Revised the second draft
Debra Cushing*	Helped to develop the study, revised the final manuscript

Principal Supervisor Confirmation

I have sighted emails or other correspondence from all co-authors confirming their certifying authorship.

Dr Ian Weir		6 November 2015
Name	Signature	Date

Preamble

Chapter 7 includes a published article that presents the Optimal Electricity Distribution (OED) Framework — the study's unique and tangible contribution to the field's knowledge base. Chapter 8 presents the overall discussion and conclusions of this study and further discusses the practical, theoretical, and methodological implications of this developed framework. It also explores its limitations and the opportunities the study presents for future research (As the published article includes some of this subsequent discussion in chapter 7, some repetition was inevitable in chapter 8).

This study employs content analysis as a research *on* design method in order to create a framework for future designs. This framework, which was recommended in the previous article presented in chapter 6, is now further advanced with new theory from ecology and energy (Odum's fourth and fifth laws of thermodynamics). The study uses the framework as assessment criteria against which to analyse the content of speculative renewable energy proposals submitted to the LAGI 2012 design competition and subsequently published in *Regenerative Infrastructures of Freshkills Park in New York City*. In doing so, it addresses the purpose of the overall research and responds to the study's research question.

The findings of this study reveal the current design thinking behind renewable energy in terms of electricity production and its sustainable distribution in and around public spaces. Despite the currency of these concepts, both the design and assessment bodies were not fully aware of the sustainable distribution of renewable energy embedded in public spaces. Moreover, current design thinking also shows an imbalance among the environmental, economic, and social aspects of electricity distribution in a public space context. This finding is similar to the findings from the built case study presented in chapter 6. Moreover, assessing the LAGI designs with the devised framework validates the generalizability of this framework.

The framework also needs to be considered as the product of a novel research design process that incorporates research *by*, *on*, and *for* design. The paper included here and published in the *Sustainability Journal* –'Optimal Electricity Distribution Framework for Public Space: Assessing Renewable Energy Proposals for Freshkills Park, New York City'– is an outcome of research *by*, *on* and *for* the design process, while chapter 4 (published in LAGI's *Regenerative Infrastructures of Freshkills Park in New York City*) is an outcome of research *by* design.

Figure 7.1 locates chapter 7 and its published article in the overall research process.

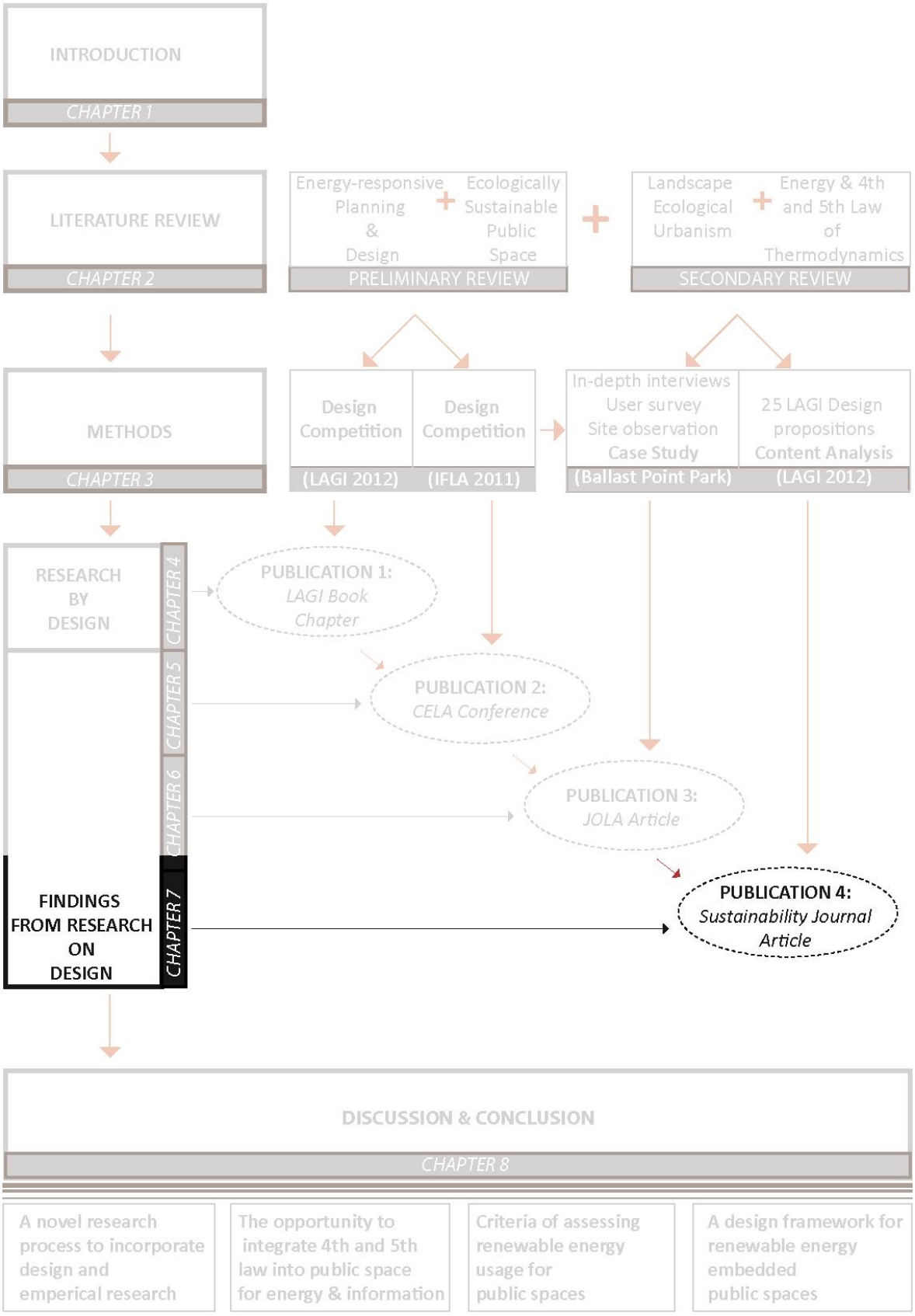

Figure 7.1. Map of overall research.

--Start of published paper--

Abstract

Integrating renewable energy into public space is becoming more common as a climate change solution. However, this approach is often guided by the environmental pillar of sustainability, with less focus on the economic and social pillars. The purpose of this paper is to examine this issue in the speculative renewable energy propositions for Freshkills Park in New York City submitted for the 2012 Land Art Generator Initiative (LAGI) competition. This paper first proposes an optimal electricity distribution (OED) framework in and around public spaces based on relevant ecology and energy theory (Odum's fourth and fifth law of thermodynamics). This framework addresses social engagement related to public interaction, and economic engagement related to the estimated quantity of electricity produced, in conjunction with environmental engagement related to the embodied energy required to construct the renewable energy infrastructure. Next, the study uses the OED framework to analyse the top twenty-five projects submitted for the LAGI 2012 competition. The findings reveal an electricity distribution imbalance and suggest a lack of in-depth understanding about sustainable electricity distribution within public space design. The paper concludes with suggestions for future research.

Keywords

renewable energy distribution; public space; sustainability; LAGI; Freshkills Park; New York City; triple-bottom-line (TBL)

7.1.1 Introduction

A growing body of research suggests energy potential mapping to design more sustainable cities based on local energy potentials at multiple scales (Van den Dobbelsteen et al., 2007). Moreover, the application of renewable energy systems within urban environments is growing rapidly, yet it is still commonly conceived of as an add-on feature rather than as an integral characteristic of urban space. This underestimation of the potential for energy systems is demonstrated in both the urban design profession and their counterpart policy makers, where the focus is on increasing the environmental sustainability of cities by retrofitting spaces and buildings with so called 'techno-fixes'[24](Huesemann & Huesemann, 2011, p. 24), such as green walls and photovoltaic arrays. Commentators have identified a now common trait where designers make "crafty attempts to get on the 'eco' bandwagon without linking the project to the messy and unpredictable dynamics of nature" (Amidon, 2009, p. 178). In these cases, the primary design objective is often one of superficial display, rather than genuine concern for or knowledge of sustainability. Although individual buildings are designed with green infrastructures at ever-increasing rates, landscape architects and urban designers need to investigate the integration of renewable energy within urban open spaces where the contextual issues are more multi layered than in private domains.

First, a new conception of public space is essential – one that addresses the ever increasing complexity of urban environments. For example, swarm planning theory deals with the increasing complexity and uncertain futures of cities, focusing predominantly on the planning process within a regional scale (Roggema & van den Dobbelsteen, 2012, pp. 606-609). The theory explains the transformation of spatial land use over time and enables new self-sufficient and resilient developments. Therefore, rather than perpetuating the idea of public space as a static artefact, or end product, this new conception must embrace a more dynamic definition – one that is concerned with connectivity, network flow and multi-functional participatory space (Wall, 1999, p. 234).

24 Huesemanns (2011, p. 24) argue in their book techno-fix that 'science and technology, as currently practices, cannot solve the many serious problems we face and a paradigm shift is needed to reorient science and technology in a more socially responsible and environmentally sustainable direction.' The paper used the term to indicate the research statement and the need to have a counterpart design solution.

Second, this paper argues that renewable energy can no longer be considered a techno-fix or a mere cosmetic intervention in public space. Instead, designers need to consider renewable energy as an important 'ecological infrastructure' similar to the management of water resources, waste cycling, food production and mass mobility (Bélanger, 2010, p. 348). Renewable energy infrastructures can also be fully recognized as complete localized electricity production, consumption, and distribution systems when integrated in public spaces. For example, Byrne et al.(2009) argue for locating "energy-ecology-society relations in a 'commons' [25] space […]," focusing on techniques and social arrangements that can serve the aims of sustainability and equity. Public space can be a showground for implementing a renewable energy commons approach[26]. It can be seen as a bridge that connects mainstream energy with the emerging alternative decentralized energy movements. This approach must complement the rapidly changing renewable energy technologies and their increasing energy generation capacity. Such an approach also exposes social, environmental, and economic relationships of renewable energy usage, which brings the accepted triple bottom line (TBL) framework to the foreground. Originated in the 1990s as a medium to integrate sustainability into the business world, the TBL framework operationalizes and implements sustainability into practice (Elkington, 1998; McDonough & Braungart, 2002, p. 252). The balance between these three accepted pillars of the TBL[27] becomes a critical aspect to achieve sustainable production, consumption, and distribution. Renewable energy-embedded public space designs that encourage direct and indirect consumption and production of electricity can help to increase public engagement, while also educating the public about renewable energy.

25 'The commons is a way of thinking and operating in the world, a way of organizing social relations and resources; existing commons should not be seen as a "return" of some noble but possibly archaic ideal but as a springboard for critiquing contemporary social relations and as the production of new spatiality, initiating the transformation of some fundamental aspects of everyday life, social practices and organization, and thinking'(Eizenberg, 2012, pp. 764-782).

26 Energy commons is not a new approach, and some countries, like Denmark and Germany, have been experiencing sustainable energy transition starting as a grassroots, community-based initiative supported by local governmental policies and cooperative small-scale private decentralised ownership (Wächter, Ornetzeder, Rohracher, Schreuer, & Knoflacher, 2012)

27 This paper adopts the TBL framework not only to substantiate Odum's provisional idea 'Tripartite Altruism', but also to explicitly reveal the relationships of economic, social, and environmental objectives of the produced clean electricity that exist, but are commonly neglected by public space designers.

In an effort to engage more people with energy in public spaces, the Land Art Generator Initiative (LAGI) is an international enterprise that hosts regular design competitions dealing with renewable energy within urban environments. In comparison to engineering solutions, which often satisfy quantitative metrics of electricity capture, storage, and distribution, LAGI exemplifies a qualitative conception of renewable energy within public spaces and uses the design competitions to promote its motto, "renewable energy can be beautiful." LAGI's philosophy and innovative approach demonstrates an awareness of the societal issues surrounding the production of energy within public spaces and was honoured as a top sustainable solution at the United Nations Rio+20 conference and published in "Sustainia100" (Alslund-Lanthén, Riiskjær, & Gerdes, 2012).

In 2010, LAGI announced its first international competition to design and construct public art installations for three different locations in the United Arab Emirates. In 2012, LAGI organized a second competition for Freshkills Park (Former Freshkills landfill) in New York City. Most recently in May 2014, LAGI held a third design competition for a shipyard site in Copenhagen, Denmark. All competitions advance the same strategic objective to integrate art into the interdisciplinary creative process and re-imagine sustainable design solutions in public domains. Over four years of competitions, LAGI has increasingly sought to address what it means to embed renewable energy into daily public life. The competition recognizes that practitioners of urban design and public art can have agency over the diversity, richness, quality, and types of interactions between the user and energy in public spaces. When successful, designs can effectively communicate new information to the community.

This study focuses on the distribution of produced electricity from renewable sources within a public space context. It introduces an optimal[28] energy distribution (OED) framework for public space design that organizes potential relationships of local electricity production, consumption and distribution by adapting ecologist Howard T. Odum's theories about energy flow and hierarchy in nature. It then uses the OED framework to assess the top 25 LAGI 2012 proposals. The paper concludes with a discussion of results and the

28 For the purpose of this paper, optimal refers to distributing produced electricity for social, economic, and environmental purposes within a public space context. The definition of optimal in this paper was not used as a proven quantitative formula, but an approximation to the ideal design of electricity distribution for creating ecologically sustainable public spaces.

implications of using the OED framework to assess and design new conceptions of energy embedded public space. Areas of future research are also explored.

7.1.2 Linking public space and renewable energy: the optimal electricity distribution framework

"Environmental sustainability", a concept stemmed from sustainable development, is defined as social and economic development that is also environmentally responsible (Moldan et al., 2012, p. 6). Renewable energy has since become associated with sustainable development, enabling projects to have less environmental impact, and much greater energy capacity compared to fossil fuels and nuclear energy, while being self-sufficient, locally based, and less dependent on national energy networks (Dincer, 2000, p. 172). This conception of renewable energy acknowledges its agency over the economic dimensions of sustainable development, including, but not limited to, new jobs, by producing ones' own power facilities, avoiding infrastructure costs (transmission, transport, distribution), promoting decentralized new economic relationships, increasing productivity by having fewer conversion steps and spreading ownership (Scheer, 2007, pp. 75-76). Of particular interest to designers and policy makers, the social aspect of renewable energy needs to be emphasised within the context of well-designed and well-used public space.

To enable this shift, this study developed the OED framework to effectively integrate on-site produced electricity into public space. The framework requires an understanding of the economic-social-environmental triple-bottom-line relationships of the produced electricity. The European commission's report on sustainable cities argues that the environmental function is achievable if only the economic and social components are also in line (Rostami et al., 2014, p. 2). That is, a balance between all three is required for a truly sustainable distribution of produced electricity in public spaces.

Similarly, the renowned ecologist Howard T. Odum, made significant contributions to ecosystems ecology and incorporated thermodynamics law into ecology. One of his provisional ideas (M. Odum, 2014), "Tripartite Altruism[29]," is useful to landscape and environmental design because it identifies an energy/nature equation. For example, this self-regulatory feedback system is applied in permaculture, a holistic gardening practice that works with nature, not against it (Holmgren, 2002, p. 15). Rabbits exemplify the "Tripartite

29 Tripartite Altruism was a provisional idea in the 1980s, which Odum refined in the 1990s' with 'emergy' concept (M. Odum, 2014).

Altruism" theory. 'They eat grass to live, grow and reproduce. Their manure fertilizes the grass that feed[s] them, and they 'sacrifice' weak rabbits to predators to help keep the population fit and in balance' (Holmgren, 2002, p. 73). According to "Tripartite Altruism", approximately one-third of the energy in an organism or a mature complex system[30] (Yeang, 2006) is used for self-maintenance and/or energy storage, one-third is for lower order operations and one third is contributed upward to higher-order system controllers (Holmgren, 2002). The following diagram (Fig 7.2) conceptualizes an optimal distribution of produced electricity from renewable resources embedded in public open spaces, representing the optimum balance between TBL components.

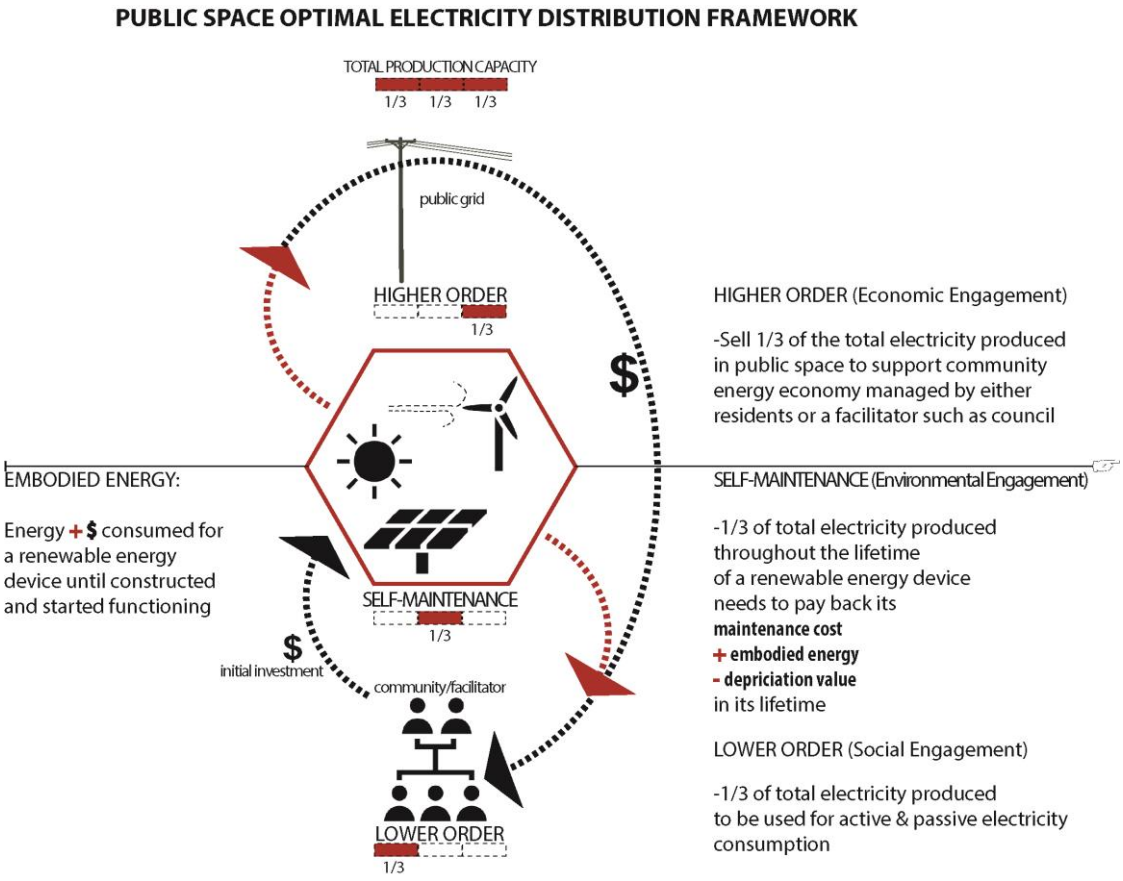

Figure 7.2. Public Space Optimal Electrcity Distribution Framework. This figure was initially published in the Journal of Landscape Architecture, Taylor & Francis Ltd. (Ozgun, Cushing, et al., 2015).

30 One of the key lessons ecology can teach is that as the system's biomass increases and system moves towards to become self-organizing, more recycling loops and complex interactions are needed to prevent it from collapsing. In emulating ecosystems, we must design our human-built environment to contain more recycling loops and interactions (Yeang, 2006, pp. 47-48).

The OED framework illustrated in the diagram simplifies Odum's provisional energy/nature equation, designating one-third of the on-site produced electricity to be used for active and passive engagement, representing "social engagement." One-third of the on-site produced electricity can be sold to the public grid to create a local energy economy, representing "economic engagement." The remaining one-third of on-site produced electricity can be used for self- maintenance, representing "environmental engagement."

7.1.2.1 The OED Framework Lower Order: Social Engagement with Renewable Energy in a Public Space

Generating social engagement by on-site produced electricity from renewable sources is rooted in the innate nature of public space. Public space is a social place where people communicate, interact, and engage with their surroundings. For example, Miller (2007, p. 204) argues "Public spaces do not exist as static physical entities but are constellations of ideas, actions, and environments." The social aspect of public spaces can best be described by Amidon (2009, p. 178) who states that "New public space designs need to arouse desire in the public to participate, to cultivate and to advocate." Unlike embedding renewable energy into a building, designers need to complement the evolutionary and dynamic nature of a public space when embedding renewable energy. Accordingly, North (2011, p. 15) argues "While a building begins to erode once built, a landscape continuously evolves." Lefebvre contends that the spaces of the modern city have to provide not only consumable material goods for its dwellers, but also evoke the need for creative activity and information (Mitchell, 2003, p. 18). Similarly, Gehl (2011, p. 21) states that public spaces provide a source of information about the social world outside, as well as a source of inspiration for action. Public space can, therefore, be seen as an educational and information agent, through which renewable energy can be introduced to a community.

Odum particularly focused on useful information as concentrated energy and as one possible product of the energy cycle in the self-organized systems. "Concentrated energy" has an important role in the energy hierarchy because it monitors, controls, and provides feedback to higher and lower orders constantly. In this instance, an ecologically well-designed public space can play a similar role by interacting with its users as well as its immediate vicinity and the city's greater energy grid. Similarly, Abel describes useful information as (2013b, p. 85), '[f]undamentally a product of the self-organization of systems, wherein its function is to remember successful configurations- of cells, organisms, ecosystems, and human adaptations.'

This paper stresses public spaces as an educational and information agent to encourage a sustainable lifestyle and increase general environmental awareness in an effort to maximize energy efficiency in the broader community. A growing body of literature indicates urban

environments as complex systems (Portugali, 1999; Roggema & van den Dobbelsteen, 2012). When conceptualized as a self-organized system, public spaces can be considered as a platform to create useful information for community, which can thus promote greater uptake of sustainable energy across multiple domains in society. This claim is grounded in the "maximum power principle", which is considered as the fourth law of thermodynamics[31] . According to this law, in the self-organizational process, systems develop parts, processes and interactions that maximize efficiency and production (H. T. Odum, 1996; H. T. Odum & Odum, 2008, p. 71).

For the purpose of this paper, interactions[32] with renewable energy are identified as active and passive. Active social interaction with on-site produced electricity includes activities that promote direct consumption of electricity, including educational, performance or recreational based activities, such as electric car charging points, personal device charging utilities, and wireless services. Active interaction also refers to direct electricity production from users' movements, such as capturing energy from the downforce of footsteps via piezoelectric generators.

Passive social interaction with renewable energy refers to activities that have an indirect relationship with electricity consumption. Passive modes are characterized by activities involving artful play and the interpretation of renewable energy systems including information centres, interactive energy toys, interpretive energy screens and media displays. Simply put, the on-site produced electricity needs to be consumed internally without any external output. For example, a public space user consumes the on-site produced electricity for way-finding using the site through the embedded interpretive energy screen.

Active and passive interactions are imperative for the generation of shared knowledge because they directly connect users with their environment and economics[33] (H. T. Odum, 2007; Shuman, 1998) in the public space, both literally and symbolically. For optimal energy

31 Valyi cited in (Sciubba, 2011) , so far no publications can be considered as an evidence for the applicability of 'maximum power principle' however it should be noted that the results may be interpreted under a different paradigm.

32 Indirect interactions with renewable energy in a public space is termed 'passive interactions' and direct interactions with renewable energy in a public space is termed 'active interactions.'

33 Economics is the science of efficiency dealing with production, consumption and distribution (Shuman, 1998). 'Efficiency is the traditional measure used to represent energy transformations. It is the percentage of input energies that is output energy' (H. T. Odum, 2007, p. 64).

distribution, active and passive social engagement with renewable energy must achieve a combined total of one-third of the electricity production capacity. This comprises the 'lower order usage' in the devised OED framework. The two interaction modes demonstrate the necessity for an integrated approach to renewable energy and public space, to not only achieve meaningful and measureable sustainability, but to also communicate the reciprocal relationship between society and energy. To achieve this, designs must employ best practice principles of interpretation and sense of place into the design.

This paper argues that such enhancements in our interactions with energy correlate with the observed tendencies of self-organized mature ecosystems. For example, the fifth law of thermodynamics states that, "system processes maximize power by interacting abundant energy forms with ones of small quantity, but a larger amplification ability" (Tilley, 2004, p. 122). Therefore, the more ecologically sustainable public space is one that responds to the fifth law by engaging with renewable energy at a high level — through both active and passive interaction. The greater the number of active and passive interactions that exist between renewable energy and public space users, the greater the likelihood the public space will influence society's sustainable energy lifestyle.

7.1.2.2 The OED Framework Higher Order: Economic Engagement with Renewable Energy in a Public Space

In Odum's 'Tripartite Altruism', another one-third is assigned to "economic engagement" where energy distribution contributes to the local energy economy. Applied to the context of public space, produced electricity could be sold to the utility grid and used to support the community renewable energy economy managed by either local residents or a facilitator, such as a local council. The initial investment cost to accomplish this can be subsidized by the community or the facilitator. There is an expanding body of literature about sustainable energy transition that points to a shift from centralized autocratic energy economies, towards *decentralized* modes of electricity production that bring new socio-economic relationships to cities (Hauber & Ruppert-Winkel, 2012; Scheer, 2007; Van Timmeren, Zwetsloot, Brezet, & Silvester, 2012; Wächter et al., 2012).

To understand the potential for a decentralized energy economy based on public spaces it is useful to refer to 'system size' in ecology, which is the spatial extent or physical boundary of a system. The system size measurement of the energy capacity of conventional public spaces would include an assessment of the total energy demand supplied from the main energy grid. A public space also contains, but is not limited to: users; hard landscapes; such as paved floors, stairs, ramps and street furniture; soft landscapes, such as grass and other plant material; infrastructure; the continuous information and matter flow; and the built structures within and around it. Thus, an energy system in a public space has many

components, not unlike ecosystems composed of a community of organisms and chemical cycles (Stremke & Koh, 2010, p. 523).

The concept of system size simply frames the energy demand and supply relationship. When a conventional system requires more energy to sustain its demand, an external energy supply feeds the system. System size becomes more significant because of energy availability that is dependent on the produced electricity from renewables. Both the quantity and quality of available energy in the system determines the optimum system size (H. T. Odum, 1976). As current research (Van den Dobbelsteen et al., 2007) on potential energy mapping underpins the importance of the local energy potentials for sustainable city design and planning, environmental designers also have to consider the optimum system size of each energy resource (Stremke, 2010, pp. 33-34). A public space as an optimum system may be achievable by considering both the quality and quantity of on-site produced electricity. Energy quality refers to the emergy concept, which is discussed in the next section.

7.1.2.3 The OED Framework Self-Maintenance: Environmental Engagement with Renewable Energy in a Public Space

To complete Odum's 'Altruistic Tripartite', the final one-third of the produced on-site energy is designated for environmental engagement. This engagement refers to the electricity utilized for 'self-maintenance' of the public space and to recoup its maintenance cost and embodied energy of the renewable energy devices (Alsema & Fthenakis, 2006; Roberts, 1980).[34] Embodied energy is also directly related to the 'emergy' concept. Emergy represents energy memory emphasized by the prefix (em) in emergy, and defined as the history, the time, and the processes involved up to the present state of a system (Simone Bastianoni & Marchettini, 1997, p. 33). Odum quantifies 'energy quality' in an urban environment and defines it via the emergy[35] concept (H. T. Odum, 1988). This parallels the fifth law of thermodynamics, which states that information generally has the highest energy quality and the densest form of emergy/energy ratio as shown in figure7.3. (H. T. Odum, 2007, p. 88).

34 For example, Energy pay back times of Photovoltaics, 1-7 years depending on the module technology. Another research's findings concerning energy pay back times of solar, geothermal, wind wave and tidal power is an average of 3 years (Alsema & Fthenakis, 2006; Roberts, 1980).

35 'It is a measure of value in the sense of what has been contributed. Self-organizing systems use stores and flows for purposes commensurate with what was required for their formation. To do otherwise is to waste resources, making products without as much effect as alternative designs. Therefore, the higher emergy use there is, the more real work is done, the higher is the standard of living, the more money can buy' (H. T. Odum, 1988).

ITEM	Solar Emcalories per calorie *
Sunlight energy	1
Wind energy	1500
Organic matter, wood, soil	4400
Potential of elevated rainwater	10,000
Chemical energy of rainwater	18,000
Mechanical energy	20,000
Large river energy	40,000
Fossil fuels	50,000
Food	100,000
Electric Power	170,000
Protein foods	1,000,000
Human services	100,000,000
Information	1×10^{11}
Species formation	1×10^{15}

***** calories of solar energy previously transformed directly and indirectly to produce one calorie of energy of the type listed. Source: H.T. Odum 1996 [35].

Figure 7.3. Exemplars show the emergy/energy ratio, the higher number means higher quality of work (H. T. Odum & Odum, 2008, p. 69).

The depreciation value of a renewable energy device in its lifetime can be calculated based on existing data from energy payback time (EPT) and embodied energy values and subtracted from the production value. Applied to the public space context, this would include the basic energy demands such as lighting. This type of electricity consumption is similar to that which occurs in a normal household, including the energy need of appliances. By grouping consumption modes, we can monitor, control, and create better sustainable outcomes.

According to Odum, it is beneficial to have a large amount of electricity production as long as enough storage is available for the lower and higher order interactions to exist in the system. Odum states, 'With increasing scale of available energy (the production capacity of renewable energy in public space), storages increase, depreciation decreases and pulses are stronger but less frequent' (H. T. Odum, 2007, p. 63). This definition depicts the behavior of mature complex ecosystems (H. T. Odum, 2007, p. 54). From a public space point of view, a larger amount of electricity produced from renewables means that more interaction and storage will be required to use the produced electricity sustainably.

The application of Odum's "Tripartite Altruism" to the urban space context establishes the OED framework through which speculative and built projects can be assessed. The next section describes how this study used the OED framework to assess competition entries for the LAGI 2012 competition, set in Freshkills Park, NYC.

7.1.3 Methods

7.1.3.1 Using the Devised OED Framework for Assessment

Out of the 250 entries submitted in LAGI's 2012 competition, 65 projects were selected and published in the book, *Regenerative Infrastructures of Freshkills Park, NYC* (Klein et al., 2013). To better understand current design thinking about renewable energy embedded into public space, the study used the first 25 entries, including four place-winning and twenty-one shortlisted schemes, for content analysis. These schemes were selected for LAGI 2012 by experts from a multidisciplinary jury and a selection committee.

For the purposes of the study, the authors overlaid the devised OED framework with LAGI's judging criteria. Three out of the seven judging criteria directly aligned with the framework:

- The annual electricity production capacity (economic engagement);
- How the proposal engages with the public (social engagement); and
- The embodied energy required to construct the renewable energy infrastructure (environmental) (Klein et al., 2013, p. 30).

The other four judging criteria[36] are not directly related to renewable energy usage and were therefore excluded. The authors determined how the projects responded to the three judging criteria using thematic content analysis of images and text in the *Regenerative Infrastructures* (Klein et al., 2013) book and also LAGI's official website ("Landartgenerator ", 2015).

7.1.3.2 Content Analysis

Thematic content analysis focuses on the occurrence and meanings of keywords and concepts in texts to generate themes, employing either a predefined analytical structure or an interactive structure (Carley, 1993, p. 83). The authors employed NVivo software to thematically code the collected data based on the three criteria.

Competition submissions, active on the official LAGI website at the time of data collection, communicate their designs through A4 pages with project descriptions, as well as four A1 panels with graphics and text. The published content in the book is a refined version

36 The other four judging criteria included 'adherence to the Design Brief and submission requirement; the integration of the work into the surrounding environment; landscape and the draft master plan of Freshkills Park; the sensitivity of the work to the environment, to local and regional ecosystems and to the integrity of the landfill cap and underground infrastructure; the originality and social relevance of the concept ' (Klein et al., 2013, p. 30).

of the original A1 panel submitted through the website. The amount of information published differs, depending on the jury's selection order and editing. While the four place-winning projects have six pages of content published, shortlisted projects have four pages.

This assessment addresses the social, environmental, and economic engagement with on-site produced electricity identified in the devised OED framework. To quantify this, we created a quality impact assessment scoring scale from one to three to align with the framework. The analysis aims to quantify the quality of each project's energy interventions: a score of one for no/low quality, a score of two for medium quality, and a score of three for high quality. Entries obtaining higher scores were perceived as more conscious of renewable energy distribution.

First, the study assessed the social engagement (lower order) aspects of an entry, and determined the extent of public engagement that it was likely to generate by using on-site produced electricity from renewable sources. For example, if an entry does not consider any engagement, or the assessment outcome is unknown, the entry scores a one. If an entry considers *either* active or passive engagement, it scores a two. If an entry considers *both* active and passive engagement, it scores a three.

Next, the study investigated economic engagement of renewable energy (higher order usage). For example, if an entry designates none of its on-site electricity production to be sold to the local grid or if this is unknown, it scores a one. If an entry considers all on-site produced electricity from renewables to be sold to the local grid, without any maintained for self-maintenance described below, it scores a two. If the on-site produced electricity is to be partially sold to the local grid, an entry scores a three.

Finally, the study assessed the environmental engagement (self-maintenance) aspects of the entries, including embodied energy, using a portion of the produced electricity for maintaining the renewable energy installation, energy storage, general public space maintenance, and other primary electricity needs of services within the space. If an entry does not appear to respond to any of these aspects, or the situation is unknown, it scores a one. An entry that partially considers these factors scores a two. If an entry considers most or all of these, it scores a three.

In summary, the content data was analysed against the OED framework and the three LAGI judging criteria relevant to renewable energy usage. The next section discusses the findings from this assessment.

7.1.4 Findings

The following figure 7.4 explicitly illustrates the quality impact level (scores from 1 to 3) of each competition entry, displaying their individual, average and total scores using the

proposed OED framework. The embedded text under the table is a brief summary of the methods in section 7.1.3.

Distribution Assessment for the Lagi 2012 Renewable Energy Proposals							
Quality Impact Level			**Annual Capacity**	**Social**	**Environmental**	**Economic**	
1	2	3	MWh	Lower Order	Self-Maintenance	Higher Order	
Four winning entries							Total
Entry 1-scene-sensor			5500	3	2	3	8
Entry 2-fresh hills			238	1	2	3	6
Entry 3-pivot			1200	1	1	2	4
Entry 4-99 red balloons			14,000	3	2	3	8
(4 entries) Total				8	7	11	26
(4 entries) Average				2	1.75	2.75	6.50
Twenty-one shortlisted entries							
Entry 5-solar loop			10,000	1	2	3	6
Entry 6-power play			100	2	1	2	5
Entry 7-in between scapes of light			4800	2	1	3	6
Entry 8-inefficiency can be beautiful			672	2	1	3	6
Entry 9-field of energy			13,000	2	2	3	7
Entry 10-flightaic			1,000	1	2	3	6
Entry 11-biofuel armature			60,000	1	1	2	4
Entry 12-robo zoo			10	2	1	1	4
Entry 13-flirt			72,000	3	2	3	8
Entry 14-solar cairn			1000	1	2	1	4
Entry 15-electric meadow			unknown	1	3	1	5
Entry 16-art-wind-energy unit			145	1	3	3	7
Entry 17-blossommings			520	3	3	3	9
Entry 18-heliofield			15,000	2	2	3	7
Entry 19-beauty of recycling			3600	2	2	3	7
Entry 20-cloudfield			5910	2	2	3	7
Entry 21-fresh clouds			65,000	2	2	3	7
Entry 22-solar bloom			35,500	3	3	3	9
Entry 23-tree			1700	2	2	3	7
Entry 24-nawt balloons			30,500	1	2	3	6
Entry 25-currents			28,470	2	2	3	7
(25 entries) Total				46	48	66	160
(25 entries) Average				1.84	1.92	2.64	6.40

Figure 7.4. Distribution assessment for LAGI renewable energy proposals

Figure 7.4. Cont.

Distribution Assessment for the Lagi 2012 Renewable Energy Proposals
Economic Engagement (Higher Order)
(1) None/Unknown of the electricity produced to be sold to the local grid
(2) All on-site electricity produced to be sold to the local grid
(3) On-site produced electricity to be partially sold to the local grid
Environmental Engagement (Self Maintenance) *
(1) None/Unknown
(2) Only considers partially
(3) Considers majority/all
Social Engagement (Lower Order) * **
(1) None/Unknown **
(2) Active or passive engagement through direct electricity consumption or production ****
(3) Active and passive engagement through direct electricity consumption or production †

* Electricity demand of permanent functions such as lighting, heating, energy storage and other primary electricity needs of services of public spaces Energy demand of maintaining the energy device/installation Embodied energy consideration; ** No engagement through direct electricity consumption/production;
*** Educational, informative, event and recreational use; **** For example Piezoelectric generator used to generate power from people movement. † Personal device, event, electric car recharge in the car park, wireless.

The content analysis of the four place-winning entries (see figure 7.5) revealed that the designs focused on economic engagement first (higher order), with social engagement (lower order) and environmental engagement (self-maintenance) considered as secondary. Similarly, the shortlisted entries scored higher for economic engagement (higher order), with environmental engagement and social engagement secondary (Fig 7.7).

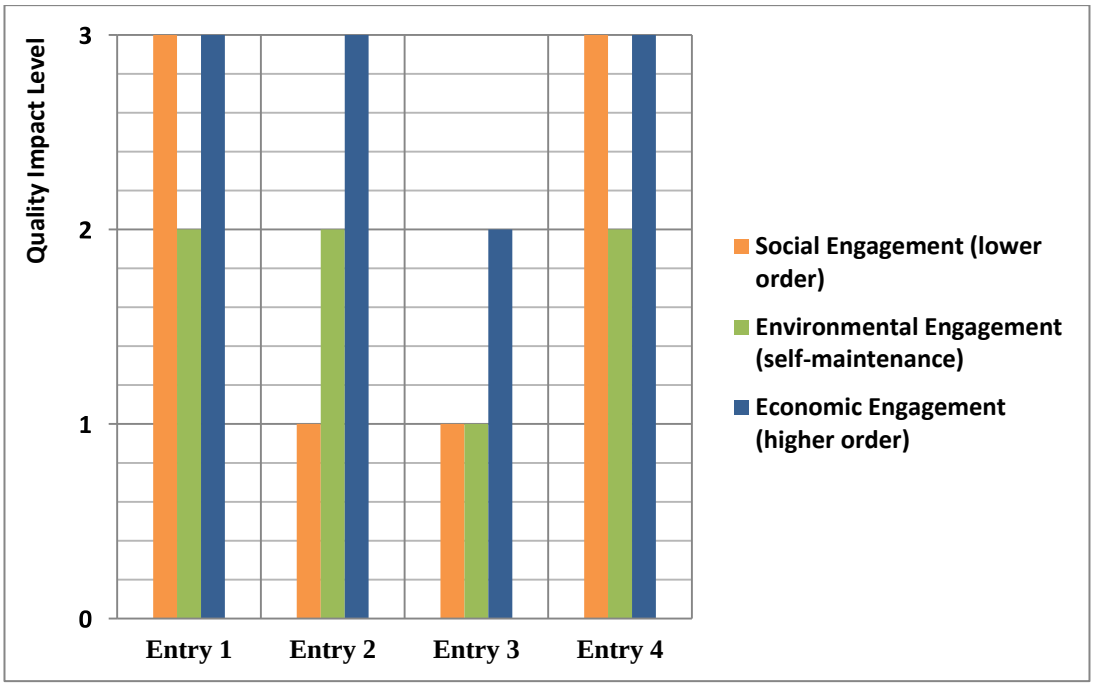

Figure 7.5. Optimal electricity distribution assessment of the four LAGI place-winning entries.

Figure 7.5 shows the assessment quality impact level (scores from 1 to 3) of four place-winning design entries based on economic (blue), social (orange), and environmental (green) engagement. The results showed that the four place-winning design entries did not score overwhelmingly higher than the shortlisted projects, indicating that they do not necessarily promote the most ideal renewable energy distribution according to the OED framework. Instead, the average score for the place-winning entries was 6.25 out of 9, which is slightly lower than the average score for the shortlisted entries, of 6.4 out of 9. (See figure 7.4)

For example, one of the top scoring projects was Entry 22, Solar bloom, which scored nine out of nine (See the appendix D for detailed content analysis). The project addressed the OED framework criteria fully. Entry 22 integrated a sterling-based solar dish engine into a sculptural installation. The installation generates 35,500 MWh of electricity annually and can power 3087 houses every day. While visitors can directly engage with the produced electricity through charging outlets as active engagement, they can also engage indirectly through LED lighting that demonstrates the systems efficacy through visual means and refers to passive engagement with produced electricity. Thus, the project scored a three, addressing economic and social engagement. Lastly, the project is also responsive to environmental engagement because the dish engine is made of an eco-friendly resin that is 40 percent recycled content and 100 percent recyclable. The installation is modular and complies with the LEED (Leadership in Energy and Environmental Design) green building practice to

reduce its environmental impact. The project also includes energy storage units. Thus, the project considered the majority of environmental criteria and scored a three for environmental engagement.

Entry 1, Scene-sensor, scored eight out of nine, using piezoelectric generators for electricity production through people movements and wind power. According to the OED framework, Entry 1 addressed active social engagement through direct electricity production from footsteps, whereas no data were provided concerning the direct on-site electricity consumption. Entry 1 also addressed the passive engagement with the produced electricity through wind mapping and LED lighting performance integrated into the installation. Therefore, Entry 1 scored a three by addressing active and passive engagement through direct electricity consumption or production. From an environmental engagement perspective, only minor data were found with regards to lighting. This enabled Entry 1 to score a two; since other factors underpinned in the OED framework, including embodied energy, energy storage, and other primary electricity needs, were not stated anywhere in the project description. Lastly, at an economic engagement level, Entry 1 produced electricity (5500 MWh annually) for 1200 households while using part of the electricity for LED lighting performance, therefore scoring a three.

One of the lower scoring projects according to the OED framework was Entry 12, Robozoo. This entry produced 10 MWh of electricity annually through solar ivy, a novel solar energy generating system inspired by ivy leaves. However, no data were found in the project submission content about selling the on-site-produced electricity to the city grid. The project proposed a mechanical ecosystem with electricity producers (flora) and electricity consumers (fauna). The visitors can engage with this ecosystem by harvesting the batteries from electricity producers and integrating them into the mechanical creatures. This refers to passive engagement with electricity, and no data were found concerning active engagement with electricity. Therefore, Entry 12 scored a two out of three for social engagement. The project also scored a one from environmental engagement, since no data were identified.

High annual renewable energy capacity requires more environmental engagement (self-maintenance) and social engagement (lower order) to create an optimal distribution, according to the OED framework. Out of twenty-five entries assessed, ten entries produced over 10,000MWh of electricity annually.

The findings show that the total assessment scores for these entries were also higher than the entries producing less than 10,000MWh (Figure 7.6). The table displays the annual energy capacity of twenty-four[37] entries. While ten of twenty-four have more than 10,000-MWh annual capacity, the other fourteen have less than 10,000MWh. This result aligns with the theory reasoning that high production capacity entries not only produce more electricity, but also sell energy to the public grid, generating more income.

Annual Capacity		Social	Environmental	Economic	Total
10 entries	>10,000 MWh	2	2	2.90	6.90
14 entries	<10,000 MWh	1.78	1.78	2.57	6.13

Figure 7.6. Distribution Assessment of LAGI winning entries with their annual electricity production capacity

However, it is important to note that entries with the highest production capacity did not necessarily score highest using the proposed framework. For example, entries 20 and 25 were compared, and both scored seven out of nine (Figure 7.7). Entry 20 produced 5,910 MWh of electricity, and Entry 25 produced 28,470 MWh of electricity, nearly six times more. Therefore, Entry 25 required innovations with a greater intended social and environmental engagement impact, in order to balance the higher energy production. Entry 20 promoted passive engagement through direct electricity consumption for music and theatre events, but did not promote active engagement; whereas, Entry 25 promoted only active engagement and provided electric car plug-ins from electricity produced on-site. Thus, both entries scored a two out of three under the social engagement criterion. However, since Entry 20 provided these interactions with less electricity production capacity, it is actually more energy responsive and sustainable according to the OED framework.

The findings from this study demonstrate a discrepancy between sophisticated designs as chosen by the LAGI jury and their approach to sustainable distribution of on-site produced electricity (indicated by their resulting OED assessment in Figure 7.7).

37 Twenty-four entries were taken into consideration, since Entry 15's annual energy capacity data were unknown.

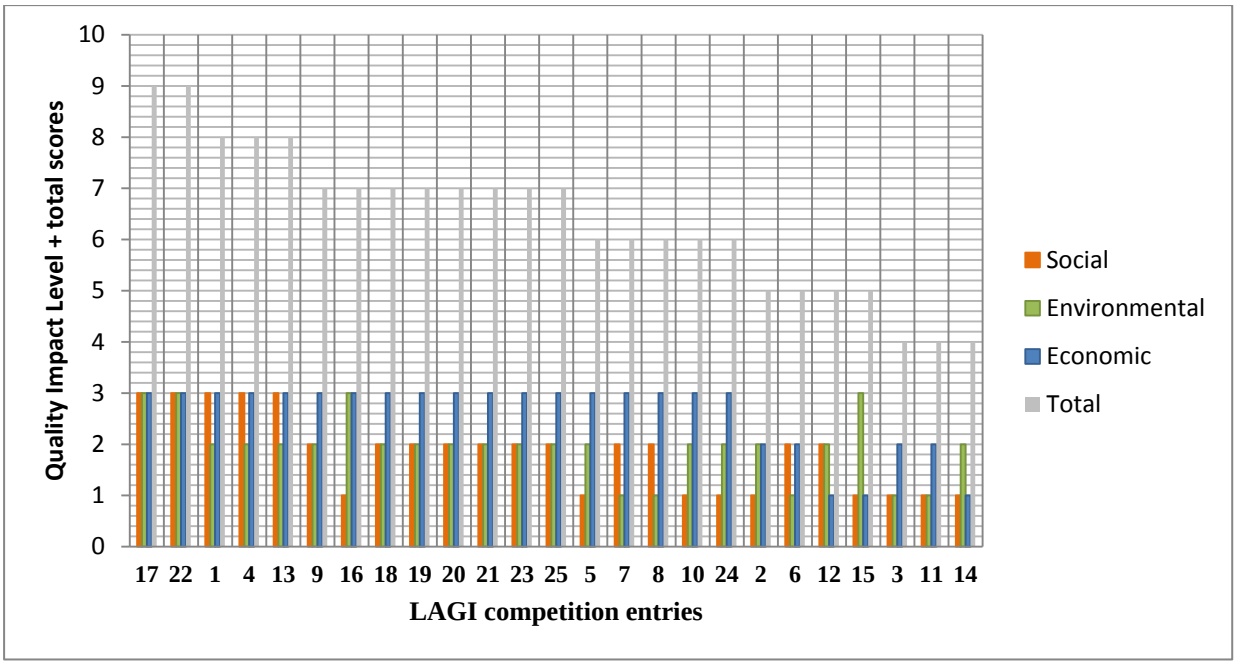

Figure 7.7. The graph shows entries ranked according to the optimal electricity distribution (OED) framework assessment from highest to lowest score. Entry numbers in bold black represent LAGI competition ranking order. For example, Entry 1 refers to LAGI's first place winner project, and Entry 25 is the very last shortlisted project

The next section, therefore, discusses the implications of these findings and the significance of the proposed OED framework from the perspective of current design thinking about renewable energy embedded public spaces.

7.1.5 Discussion

This study set out with the aim of assessing cutting-edge design propositions that integrate electricity production into public space. The assessment of twenty-five LAGI 2012 competition entries using the proposed OED framework described in this paper revealed that the primary focus was on economic engagement with on-site clean electricity production, with a secondary focus on environmental and social engagement.

In addition, the four winning entries did not score highest in the OED assessment. This suggests a lack of association between cutting edge design propositions and the science of sustainability, with respect to optimal distribution of produced electricity from renewable sources. The findings also show that although predefined themes relevant to renewable energy usage were included in the judging criteria list, competition entries did not address them specifically. Likewise, LAGI's assessment criteria are perhaps not precise enough to reveal the relationship between sophisticated designs and their genuine sustainability. This could be attributed to LAGI's highly artistic and conceptual emphasis, which prompts designers and artists to focus heavily on the aesthetic attributes of their entries, rather than sustainable energy production and distribution.

A further reason might be the lack of a well-defined design framework that effectively addresses renewable energy usage within the public space context. LAGI's judging criteria includes three types of engagement; however, the criteria are not specific and, therefore, remain secondary. Instead of embedding the three types of engagement (economic, environmental, and social) into the criteria, the LAGI enterprise could potentially provide this information to designers as foundational public space sustainability knowledge with respect to electricity distribution.

In addition, ecologically-sophisticated public space designs have to address energy more deliberately. Initiatives similar to LAGI are imperative to advancing the uptake of these concepts in the broader society. While LAGI is primarily an art initiative, and therefore, focuses on the aesthetics of renewable energy, our developed OED framework seeks to expand the relationships and interactions between public space users and renewable energy. This includes the production of electricity from on-site renewable sources and its effective and optimal distribution with respect to three different types of public space-specific engagement: environmental, social, and economic. This could be beneficial to LAGI for the continued evolution of their art/science/urban design framework and to leverage LAGI's artistic approach to advance sustainable energy transition. Considering the current conjecture about sustainable energy transition, LAGI's role in promoting renewable energy is indispensable.

The next section concludes with the implications of using the devised OED framework as a method of assessing and designing energy embedded public spaces, the limitations of this study, and recommendations for future research.

7.1.6 Conclusion

Both the findings and the developed OED framework contribute to the sustainable design and assessment of public spaces. The framework, when used as a design tool, enables designers to engage with sustainability throughout the design phases, rather than after the project has been completed, which is what commonly happens. Rather than perceiving renewable energy as a 'techno-fix' addendum to the existing public space designs, this paper introduced a novel path to treat renewable energy-embedded public space as micro-scale ecological infrastructure. This infrastructure would potentially establish new social, cultural, economic, and environmental relationships between the city environment and its dwellers,

complementing the sustainable energy transition and the increasing number of urban production activities. Likewise, when conceived as a method of assessment, the devised OED framework can potential be integrated into the existing sustainability assessment tools[38], which only assess renewable energy as an indicator of environmental sustainability and often downplay the social and economic aspects of local electricity production. Thus, the method employed in this study will serve as a starting point for future research to advance an effective assessment tool.

7.1.6.1 Limitations

The OED framework specifically focuses on clean electricity distribution in public spaces in relation to the economic, social, and environmental dimensions of engagement. Therefore, one limitation is the lack of recognition of the aesthetic dimension of design. Each public space design contains site- and designer-specific features, such as site characteristics, aesthetic sensibilities, historically- and culturally-significant features, the financial context and budget and universal access. Yet, the LAGI 2012 competition entrants are speculative, without real life political, financial, and logistical constraints. Although the proposed OED framework accepts and works with this diversity, assumes designers will accommodate these opportunities and constraints as necessary, further research is needed to apply the OED framework to built projects.

An additional limitation includes the limited detail available for each LAGI 2012 entry. LAGI's entries are conceptual, and therefore the energy relevant data is limited. For example, the available data for each entry does not provide an exact quantity of energy designated for social, environmental, and economic engagement. Therefore, for the purposes of this study, entries were only analysed to understand if their energy interventions aligned with the devised OED framework.

38 The most common ones include 'BREEAM' (Building Research Establishment Environmental Assessment Method) in the U.K., 'LEED' (Leadership in Energy and Environmental Design) in the USA and 'Greenstar' in Australia. These assessment methods have become an industry standard for sustainable architecture and have later guided sustainable Landscape Architecture. Recently developed after 'LEED' by the American Society of Landscape Architects (ASLA) in conjunction with the Lady Bird Johnson Wildflower Centre at The University of Texas at Austin and the United States Botanic Garden, 'The Sustainable SITES Initiative' (SITES) primarily focuses on the ecosystem services and aims to encourage more sustainable land development and management practices. The SITES creates 'guidelines and performance benchmarks for sustainable design, construction and maintenance in Landscape Architecture projects' (SITES, 2014).

7.1.6.2 Future Research

The theories contributing to the OED framework of this study provide several implications for future research. From a Landscape Architecture and environmental design perspective, the extant research focuses on energy-responsive (conscious) planning and design within a regional scale, often neglecting the micro scale. The devised OED framework for renewable energy embedded public space fills this gap.

Scholars of energy-responsive design and planning focus predominately on the first and second law of thermodynamics[39], yet this study integrates the fourth and fifth law into energy-responsive design. This expanded theoretical framework has the potential to connect society, energy and information at a micro urban scale, specifically in public space. Despite the criticisms of Odum's approach to information by conventional ecologists and information theorists, systems ecologists and emergy scholars have started to integrate emergy research into cultural and societal studies (See Abel, 2013a, 2013b). Additional research possibilities exist to apply emergy analysis to public spaces.

Sustainable energy transition can only be achieved with the right policies and tools. This transition can occur when renewable energy in public spaces is regarded as an embedded and context-specific feature of public space, rather than as an add-on or techno-fix to conventional spaces. Such rethinking presents opportunities for new urban perspectives regarding planning policies, new levels, and modes of community participation and engagement, place-making strategies, entrepreneurship, and management of clean electricity-producing public spaces. With the increasing number of production activities in cities, public spaces offer great opportunities to share renewable energy knowledge and to educate the public in order to facilitate a quicker transition to sustainability. Any policy or framework that identifies the relationships between renewable energy and urban environments, considering the social, economic, and environmental perspective simultaneously, supports this transition. This research clearly demonstrates the need for further discussion on the aesthetics of renewable energy technology when electricity production and its emerging TBL relationships come into focus.

--*End of published paper*--

39 According to the first law of thermodynamics, energy cannot be destroyed or produced and can only be transformed and conserved. The second law deals with this transformation and states that the work capacity (exergy) of energy becomes extinct while disorder (entropy) occurs (Dincer & Rosen, 2007, pp. 1-22).

CHAPTER 8: DISCUSSION & CONCLUSION

8.1 INTRODUCTION

Despite the many applications of renewable energy in public spaces, it is still commonly conceived of as an 'add-on' feature, rather than as an integral quality of urban space. To better understand the extant research field, the study followed a multi-method approach, employing both the activity of design and empirical research. The study began with research *by* design (RBD) in the form of submissions to two key design competitions. This activity provided the scope for a reflective process through which to develop the conceptual premise of this research. These initial design activities generated design solutions, and helped to refine the research question and objectives.

Specifically, the research sought to answer the following question:

- What is the potential relationship between public space and renewable energy, and what principles and methodologies can better contribute to the design of renewable energy-embedded public space?

To address this question, the study adopted methods from a research *on* design (ROD) approach, including a case study of a built project and a content analysis of speculative designs for the integration of renewable energy into public spaces. The findings from these two studies revealed an imbalance in the sustainable use of renewable energy.

In order to articulate a more holistic approach to sustainable public space design, this study developed a design framework to better enable designers and experts to integrate the application of renewable energy into public open spaces. With the support of extant literature and theoretical discussion, the OED framework was developed. The next section discusses the findings of the case study — an existing renewable energy-embedded public space as well as the content of twenty-five speculative entries from the LAGI 2012 design competition that proposed renewable energy sculptures for Freshkills Park in New York City. After discussing practical, theoretical, and methodological implications, the study concludes with the limitations and future research.

Figure 8.1 summarizes the study's research contributions and positions them in the overall research process.

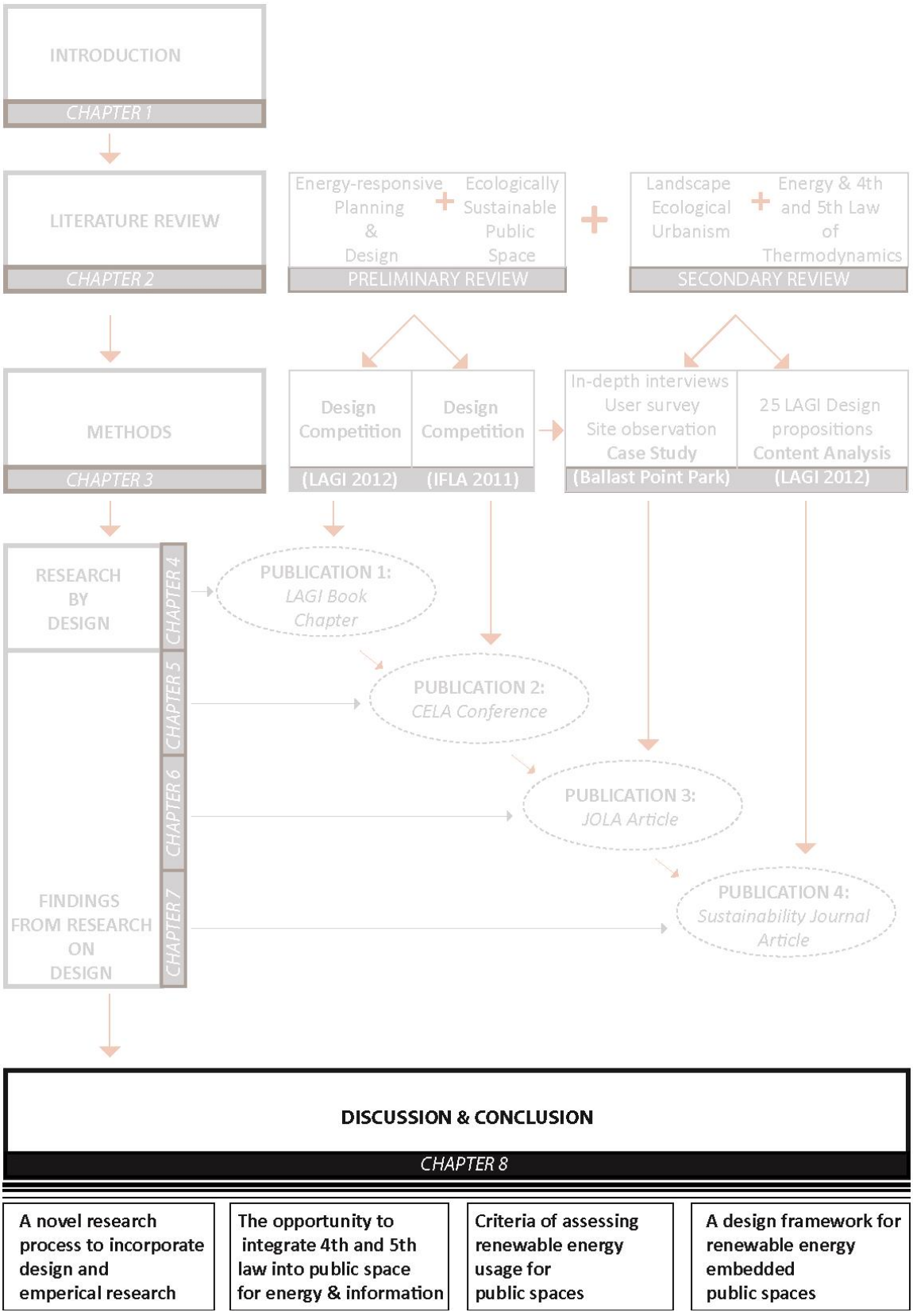

Figure 8.1. Map of overall research.

8.2 OVERALL STUDY FINDINGS

8.2.1 Ballast Point Park Case Study

The study first assessed Ballast Point Park in Sydney using Triple Bottom Line (TBL), an accepted sustainability framework. With respect to renewable energy and public space, the key findings from the analysis of the built project revealed that:

1) Environmental sustainability was the central focus both for general design decisions and for renewable energy applications.
2) The social acceptance of renewable energy use was problematic in Ballast Point Park, where the designers' aesthetic concerns for appearance and visibility, was a key determinant in choosing the type of renewable energy source used in the renewable energy sculpture.
3) The economic benefit of renewable energy was an incentive for the principal designer to include the concept in the park; however, the integrated wind turbines did not function and did not generate any electricity.

The following sections describe the above findings.

8.2.1.1 Finding one

This key finding also validated the initial claim made at the outset of this study that most interventions focus on increasing the environmental sustainability of cities. For example, the 'cradle to cradle' (CTC) design philosophy applied to the park design at each scale indicated a focus on environmental sustainability for general design decisions. However, the economic and social aspects of renewable energy, although considered initially, were never fully realised and did not contribute to the general sustainability of the park.

Whether the park's designers considered embodied energy consciously or subconsciously had important implications for environmental sustainability. This study's devised public space framework identifies that embodied energy is an important criterion for renewable energy devices and/or infrastructure to be considered environmentally sustainable. Embodied energy of a renewable energy device/infrastructure refers to 'energy pay back times (EPT)'; in other words, the energy and revenue spent on a renewable energy device until it is constructed and functioning (Alsema & Fthenakis, 2006; Hammond, 2007; Roberts, 1980). In the case of Ballast Point Park, CTC design philosophy was applied by the designers to the designed energy sculpture. If assessed by the devised framework (OED) of this study, the CTC approach taken by the designers addresses the embodied energy, which partly fulfils the environmental criterion of the OED framework. Since the designers used

pre-existing structures and materials from the site in the construction, thus reducing the cost of the embodied energy of the art piece.

8.2.1.2 Finding two

According to the OED framework devised in this study, simply relying on the environmental aspect of renewable energy is not sufficient to create genuinely sustainable renewable energy integrated public space. The reviewed literature shows that an important factor in accomplishing social outcomes of renewable energy usage is its public acceptance (Assefa & Frostell, 2007; Rogers et al., 2012). For example, some authors suggest that photovoltaic (PV) panels, despite their controversial aesthetic qualities, should be visible to users to increase their social acceptance (Thayer, 2002, p. 192). These aesthetic concerns were reiterated in the case study finding that the designers were hesitant to integrate PV panels into the Ballast Point Park design (McDermott, 2014). Moreover, as the majority of park users did not know the park had the capacity to produce electricity, the socially sustainable knowledge and acceptance of renewable energy was limited (Ozgun, Cushing, et al., 2015). Therefore, some of the issues emerging from these findings relate specifically to the designers' priority of focusing on the aesthetic and technological character of renewable energy, rather than on the potential socio-economic relationships stemming from its local production. The aesthetics of sustainability were discussed in the literature with respect to LAGI's approach. As Meyer (2008) suggests the sustainability aesthetic is about both the appearance and performance of green innovation. In other words, designers need to consider the functional aspect of green innovation as much as its appearance in order to fully grasp its sustainability aesthetic.

8.2.1.3 Finding three

From an economic sustainability point of view, the Ballast Point Park designers intended to use the produced electricity from renewables for reducing the costs of park maintenance; however, due to the lack of technical and expert knowledge, the renewable energy devices did not function as intended, and did not meet the goal of supplying electricity to the park for daily use. Thus, the park did not generate income for itself or the community, and thereby neglected the economic aspect of electricity production. The devised framework demonstrated that the economic value of local electricity production is an important criterion for sustainable renewable energy-embedded public spaces, and Ballast Point Park failed to address this criterion.

It has to be acknowledged that Ballast Point Park has been a critical success in its own right and has deservedly won many awards for addressing numerous environmental sustainability criteria, but in the context of this thesis,— when assessed against the more thorough TBL approach to the energy-embedded urban space potential — it falls short.

In summary, the TBL analysis applied to this park showed an imbalance in the project's general sustainability. It also indicated the ineffectiveness of existing sustainability assessment tools in thoroughly assessing the renewable energy aspect of public spaces. With the devised optimal electricity distribution (OED) framework, on the other hand, the unsustainability of the renewable energy usage in the park was clearly highlighted. These results informed the need for further research and guided the study to investigate this in the speculative projects in LAGI 2012. This study chose LAGI because it has established itself as an authority on renewable energy embedded landscapes and is thus a good indicator of the dominant contemporary approaches to the design of renewable energy-embedded public spaces.

8.2.2 LAGI 2012 Content Analysis

The study analysed the content of twenty-five speculative entries from the LAGI 2012 design competition, each proposing renewable energy sculptures for Freshkills Park in New York City. To analyse the sustainability of the public space electricity distribution in the twenty-five entries, the study first advanced the framework — initially proposed in the case study of Ballast Point Park — with energy and ecology theories based on Odum's 4th and 5th laws of thermodynamics. The key findings from the analyses of the unbuilt projects revealed that:

1) The designs showed an imbalance in the consideration of renewable energy usage (The economic value of electricity production scored higher than social and environmental values).
2) The designs indicated a discrepancy with the science of sustainability.
3) The link between electricity production capacity, storage, and social engagement was underdeveloped.

The following sections describe the above findings.

8.2.2.1 Finding one

The findings from the content analyses demonstrated an imbalance between the social, economic, and environmental engagement in the distribution of the produced on-site electricity from renewable sources. Contrary to the findings from the Ballast Point Park case study reported in section 6.1.4 and 8.2.1, LAGI's speculative projects focused on the economic engagement of produced electricity. That is, the majority of LAGI designers targeted high electricity production as the overwhelming priority in their projects because of its economic value. A possible explanation for this focus might be the speculative nature of design competitions, as opposed to real life situations where financial, political, and logistic obstacles need to be addressed. This result might partly be explained by Rios (2013, p. 203):

that the current green market economy and growth-oriented developments are politically appealing and are mere products of the mainstream design industry that aim to satisfy the tastes of cultural elites.

8.2.2.2 Finding two

The LAGI competition emphasizes an artistic approach to the design of public space. This agenda, which favoured aesthetics and appearance over more comprehensive approaches, appears to have inhibited the sustainable integration of renewable energy into the public sphere of the Freshkills site. For example, the study's findings show little association between cutting-edge designs and the science of sustainability with respect to the optimal distribution of produced electricity. Indeed, there was a discrepancy between LAGI's assessment ranking and the optimal electricity distribution scoring criteria based on the OED assessment. As a result, some of LAGI's highly regarded projects scored low on the electricity distribution criterion. A number of midrange projects, on the other hand, had the highest score for this criterion and can thus be considered more energy responsive from a public space perspective.

LAGI's high artistic and conceptual emphasis, which encourages designers and artists to focus heavily on the appearance of their projects, falls short of encouraging ecologically sophisticated public space designs. Perhaps the future LAGI competitions might then address electricity distribution more deliberately. To this end, the leveraging of LAGI's 2012 artistic approach into a rational approach could advance sustainable energy transition. The devised OED framework addresses this need by providing foundational knowledge about renewable electricity and its ideal distribution for public open space design. This could be beneficial in informing the continuing evolution of LAGI's art/science/urban design framework.

8.2.2.3 Finding three

Another important finding of the analysis with regard to the Odum's fourth law of thermodynamics (discussed below in the theoretical implications section) is that, according to the OED framework, projects with a higher production capacity require more storage and more public engagement in order to be considered sustainable. However, the findings illustrate that some projects with a lower electricity production capacity, promote greater engagement than projects with a higher production capacity. Reconciling this contradiction presents new opportunities for further design research into renewable energy-embedded public spaces.

In the Ballast Point Park case study, the environmental engagement with respect to the embodied energy used in constructing the renewable energy sculptures was a primary consideration. By contrast, in LAGI's 25 projects, the embodied energy used in construction was a secondary consideration. The number of projects that focused on social engagement

with on-site produced electricity is surprisingly low considering LAGI's role in promoting social acceptance of renewable energy through art and science. Despite this, initiatives similar to LAGI's are important in advancing the uptake of these concepts within broader society.

Broadly, both built and unbuilt projects are lacking a framework that can stress environmental, social, and economic information around urban renewable energy usage. Although such information is present, it is not organised in a systematic manner and so does not help practitioners to integrate renewable energy concepts effectively into their projects. Understanding the energy demands of a public open space requires a holistic approach that includes the higher and lower energy needs, akin to what we observe in the natural systems. While LAGI is primarily an art initiative, and therefore focuses on the aesthetics of renewable energy, the developed OED framework expands this approach to include the relationships and interactions between the public and renewable energy. Respectively, it incorporates the production of electricity from on-site renewable sources and its effective and optimal distribution related to three different types of engagement: environmental, social, and economic.

The next sections discuss the practical, theoretical, and methodological impacts of the presented studies.

8.3 PRACTICAL IMPLICATIONS OF THE STUDY

1) Current sustainability assessment tools specific to the Landscape Architecture profession devalue public space renewable energy usage by neglecting the potential social, economic, and environmental engagements of local electricity production that could otherwise increase the sustainability of the public space.
2) If applied to a neighbourhood public space, the OED framework can indicate how energy responsive that neighbourhood is.
3) The OED framework can be scaled for other human environments where it is possible to produce and consume clean electricity.
4) The study forces designers to think 'outside the box' to enrich the activities of public space.
5) The study complements parallel trends in place making, media architecture, urban informatics, interactive media, and public art.
6) The study requires collaborative work at political, technocratic, social, and cultural levels in order to be used effectively in today's cities.

The following sections describe the above implications.

8.3.1 Implication one

One of the important common issues that emerges from the findings of the two previous studies as well as the reviewed literature in this thesis is that although there is a broad range of sustainability assessment tools used for different human environments, ones specific to the Landscape Architecture profession are limited. Therefore, for the purpose of this thesis, the SITES initiative was selected as an exemplar which was a legitimate well-regarded sustainability assessment tool in the profession. As discussed, the sustainable SITES initiative assesses the sustainability of public spaces with a point-based system. I reported however, that SITES' assessment approach to renewable energy-embedded public open spaces was one-sided, often missing the social and economic relationships around electricity production and, thus, only ticking the environmental sustainability box. This was because SITES' focus was only on the renewable energy devices, rather than on the activity of electricity production. The lack of SITES' ability to assess the renewable energy side of a public space led this study to use the Triple Bottom Line (TBL) as a general sustainability framework in Ballast Point Park in Sydney (Ozgun, Cushing, et al., 2015).

As discussed earlier in chapter 6, having a device-based focus on renewable energy is symptomatic of a top-down sustainability development approach. A possible explanation for this might be ingrained in the definition of 'techno-fix', which holds that present market conditions generally satisfy demand with quick solutions to increase consumerism (Huesemann & Huesemann, 2011, p. 23). Arguably, renewable energy use within an urban context has often been considered as a retrofit or an addendum technological fix to public space designs.

Currently renewable energy infrastructures embedded in urban environments have a relatively small capacity of electricity production. In addition, energy storage utilities are expensive, and distributed energy infrastructure systems in cities around the world are not widespread. Therefore, for the time being, existing industry practices might be reluctant to make use of producing clean electricity in cities at maximum potential. However, such parameters indicate only present day constraints and it is foreseeable that these constraints will be overcome in the very near future: perhaps less than five years.

8.3.2 Implication two

The devised OED framework in this study can be used to assess external features of renewable energy-embedded public space. One application is as an indicator of the electricity production and consumption of its neighbourhood. Distributed energy neighbourhoods are common in some European countries such as Austria, Germany,

Denmark, Sweden and the Netherlands (Dóci, Vasileiadou, & Petersen, 2015; Hauber & Ruppert-Winkel, 2012; Scheer, 2007; Van Timmeren et al., 2012; Wächter et al., 2012). The OED-informed public space can showcase its neighbourhood electricity usage as a public space activity. A distributed energy market economy is reliant on smart grid systems, which require active interaction with its stakeholders (Ilic, Da Silva, Karnouskos, & Griesemer, 2012). Each public space design can therefore support such interaction while addressing site-specific social, environmental, and economic data. It can integrate renewable energy technology to support a local energy economy, monitor electricity production and consumption, and inform residents about their energy usage, with a view to helping them to be more energy responsive. Urban administrative policies can then use such data to channel subsidies for energy responsive neighbourhoods, and encourage the transition to sustainable energy. Another application of the devised OED framework might be that some alternative administrative tools are emerging to provide on-site energy services. For example, the Sustainable Energy Utility (SEU) offers on-site energy services to empower private energy markets and facilitate self-finance for communities (Byrne & Taminiau, 2015; Houck & Rickerson, 2009). Although the OED framework sheds new light on the community energy distribution using public space as a point of departure, it requires side information, policies, and administrative innovation similar to the SEU for better integration within human environments.

8.3.3 Implication three

The OED framework can be scaled for household and neighbourhood usage. For example, researchers can identify how much clean electricity a household generates; how much it sells to the city grid; how much is used for its own needs; and how much is used for maintenance, storage, ordering, installation, transportation, as well as its own embodied energy needs. Specific consumption of the electricity has also become the focus of some recent studies that investigates integrated solutions for households' peak energy demand (Buys et al., 2015). The OED framework can guide a multidisciplinary research team in specifying the social, economic, and environmental engagement criteria according to a household's energy needs. Simply put, there needs to be a balance between these three aspects. Although current renewable energy technology might be lacking sufficient production capacity, this parameter will increase over time. The OED framework can also be used for long-term sustainable development to evaluate the efficacy of renewable energy investments of impoverished communities. It might then benefit energy independence studies for energy poverty alleviation in remote settlements (González-Eguino, 2015).

8.3.4 Implication four

One implication of current assessment practice from a design perspective is that it will diminish as design creativity, since the expectation is that designers will only address the environmental side of renewable energy. The function of OED framework criteria, on the other hand, enables designers to think outside the box to open new opportunities for public engagement in their projects by instigating activities that promote on-site renewable electricity. The framework provides a basic foundation/understanding for designers of public spaces to effectively use the electricity produced on-site. It enables designers to engage with sustainability throughout the design of their projects, rather than just through post-occupancy evaluation. It proposes a straightforward recipe for sustainable electricity distribution that any public space designer can apply to achieve effective results. Considering the small amount of electricity that the present-day urban renewable energy devices generate, carefully distributing this energy between three categories of the OED framework may likely activate a designer's creativity and innovation, making the project more feasible, and generating economic return while increasing public engagement.

8.3.5 Implication five

Once applied to a public space, the OED framework can be considered both internally and externally. Its internal use is about public space engagement and place-making through renewable energy and its usage in and around the public space. This usage can be elaborated through site specificity, the designer's approach, and community wishes. The educational purpose of public space has also been discussed. Parallel urban trends are evident in the fields of media architecture, urban informatics and interactive media and public art, which can be used with generated on-site clean electricity for advancing the message of renewable energy. A public space designed with the OED framework can also promote green place-making, as recommended in the Ballast Point Park case study. From a Landscape Architectural design perspective, such an approach is also useful for bringing the profession closer to urban studies at a number of scales. As presented in the Ballast Point Park case study, the discrepancy between designer, community and the planning decisions exposed a missing link: that design decisions at a local scale, although supported by the local community, might require additional innovation to attract regional user groups to the park. Chapter 6 concluded with the recommendations that green place-making could reconnect Ballast Point Park with the local and regional community by reinventing renewable energy usage through the devised OED framework. Accordingly, the generated electricity addressed three different consumption modes depending on well-defined social, economic, and environmental criteria. One third of the locally generated electricity is used to create social engagement through direct and indirect use of that electricity which then becomes an active

agent that can be utilised for place-making activities. The environmental criterion dictates one third of the produced electricity for the maintenance of the renewable energy infrastructure, storage of the electricity produced, and embodied energy of the renewable energy infrastructure. The final one third addresses the economic relationships around locally produced electricity. This includes selling the one-third of the produced electricity thus generating income for its local community.

8.3.6 Implication six

The OED framework works with social, economic, and environmental aspects of generated local electricity. For this reason, it requires negotiation among many stakeholders, including policy makers, local government, neighbourhood residents, public space users, designers, and experts involved in the project. It makes the design process more transparent, and gives each stakeholder equal opportunity for management and/or involvement. It is likely, therefore, that designers can be more cognizant of the sustainability of renewable energy. This in turn, could reduce the propensity for superficial 'green wash' outcomes, and increase the importance of the social and economic factors involved in electricity production.

8.4 THEORETICAL IMPLICATIONS OF THE STUDY

1) The study enriches the 'process discourse' in landscape urbanism theory.
2) The study partly fills the knowledge gap in energy-responsive (conscious) design and planning at the urban micro scale.
3) The study applies the fourth and fifth laws of thermodynamics to energy-responsive (conscious) design and planning.
4) The use of produced electricity in a public space is essential in achieving high-quality energy (useful information) in that public space.

The following sections describe the above implications.

8.4.1 Implication one

The devised OED framework in this study expands the 'process discourse' in Landscape Urbanism theory by augmenting it with a scientific and empirical methodology. Previously, scholars discussed the process discourse through performative approaches such as gardening practices, plant material and change, and landscape production techniques (Berrizbeita, 1999; Raxworthy, 2013). Some other commentators criticised Landscape Urbanism theory for favouring the representation of ecology over social relations (Rios, 2013; Talen, 2013; Thompson, 2012). As stated by Talen (2013, p. 111), the theory is distant

to the themes of urban realities such as "'slum', 'poverty', 'getto', 'white flight', 'racism', 'poor people', or even 'segregation'". Accordingly, Talen refers to Cronon's book, *Uncommon ground: Rethinking the Human Place in Nature* and argues that the social and economic problems of minorities need to align with the environmental concerns and determine the environmental agenda (Donnelly, 2013; Talen, 2013, p. 112). Ballast Point Park case study in Chapter 6 represents these particular flaws in the Landscape Urbanism theory, given that environmental sustainability is the primary focus for its designers. Although the park offers an internal and local social cohesion, equity is problematic due to a lack of regional use and accessibility. The findings from LAGI 2012 design speculations demonstrate similar flaws. For example, the economic aspect of produced electricity is the central focus while environmental and social aspects are secondary. Rios (2013, p. 204) describes this," given the difficulty of measuring social outcomes, it is not surprising that the relationship between ecological impacts and economic output has been prioritised over concerns about social equity". The developed OED framework in this thesis builds upon the findings of the Ballast Point Park case study and the discussed criticism of the Landscape Urbanism theory. At the same time, this framework enriches urban social context through locally generated electricity and associated relationships around a public space. As discussed in Chapter 6 and 7, the OED framework can be operationalised with an energy commons approach (Byrne et al., 2009) as an institutional community strategy for implementing Sustainable Energy Utilities (SEU) (Byrne & Taminiau, 2015). In so doing, it gives ownership and management of the generated electricity back to the community, increases citizenship, connects community with policy makers and rationalises social and economic sustainability in the public space. The challenge for Landscape Urbanism is that such emerging real-life community interactions can hardly be represented with the imaginary spectacle of the present theory, and therefore this requires further exploration. Rios further argues that "inequality in the city is perpetuated because of a failure to operationalise sustainability in social terms (Rios, 2013, p. 206).

One way to operationalise sustainability is by introducing new terms to the discipline. The sharper these terms are defined, the more functional and useful they can become in the practice. Evidently, there are some problems with the broader definition of ecological infrastructure. Currently, this term is used interchangeably with 'landscape ecological infrastructure', 'landscape infrastructure', 'infrastructural landscape', 'green infrastructure', and 'landscape as infrastructure' (Bélanger, 2013; Corner, 1999; Czechowski, Hauck, & Hausladen, 2014; Czerniak, 2011; Paulo et al., 2014; Reed, 2010; Waldheim, 2006; Yu, 2010). It can be argued that one reason for such interchangeability is landscape architecture's proximity to other disciplines such as environmental engineering and science.

Similarly, scholars have criticised Landscape Urbanism theorists for excessive use of jargon (Koh, 2013; Rios, 2013; Thompson, 2012). Lack of theoretical clarity can be problematic and confusing for putting any theoretical idea into practice. For example, Bélanger (2013, p. 20) has often used the term 'ecological infrastructure' to depict the relationships around dynamic activities such as production and performances that have been recently introduced in urban environments with the 'Ecological Urbanism' discourse. Public space and clean electricity production however, have not been thoroughly investigated as a micro scale 'ecological infrastructure' until LAGI published its book, *Regenerative Infrastructures of Freshkills Park, NYC.* For example, Czerniak (2011, p. 26) indicates a number of micro scale interventions when referring to 'green infrastructure', including designs for stormwater swales, rain gardens, and bio filter curb extensions. Such a narrow definition of green infrastructure differs to that employed by Czerniak in *Revising Green Infrastructure* (Czechowski et al., 2014). Essays written by a number of scholars in this book employ 'green infrastructure' interchangeably with 'ecological infrastructure' (JoséJuan, Mery, & Laura, 2014; Rieke, EmilyLorance, & Stephan, 2014).

This study advances the definition of 'ecological infrastructure' at the micro scale of a public space where new relationships emerge around local electricity production.

8.4.2 Implication two

Landscape Architecture and Environmental Design research and practice have been dealing with sustainability and renewable energy at both the design and assessment level in the last decade or two. Thus far, the research relevant to design and renewable energy has focused on energy-responsive design that is advanced at the planning scale (See, for example, Stremke & Koh, 2010). However, this research neglects urban micro scales. The OED framework for public open spaces developed in this study helps to fill this gap.

This has implications for landscape planning and design where it is now possible to integrate sustainable energy at fine-grained design scale, with bottom-up planning strategies such as community engagement, participatory design charrettes, entrepreneurship, site-specificity. The OED framework would support the macro scale planning decisions related to power generation and help create genuine sustainable energy developments.

8.4.3 Implication three

This study contributes to the current research on energy-responsive planning and design with the application of additional theories. The first and second laws of thermodynamics were already employed by Stremke and Koh (2011) at the regional scale. This study now introduces the fourth and fifth laws of thermodynamics and 'emergy' concepts to advance a framework for design and assessment of energy in public spaces.

An ecologically well-designed public space can be used as a tool to educate the public about a sustainable energy lifestyle and to increase general environmental awareness, therefore maximising energy efficiency and production in the broader community, leading to long-term benefits. This claim is grounded in the fourth law of thermodynamics which states that "[i]n the self-organizational process, systems develop those parts, processes and interactions that maximise efficiency and production" (H. T. Odum & Odum, 2008, p. 71). When conceptualised as a self-organising state, public space can be considered, in Odum's terms, "as a platform to create useful information for community", which can thus help to promote a greater uptake of sustainable energy across multiple social domains.

Active and passive interaction with produced electricity in public spaces is recognised as an important attribute of public spaces. There is the need for an integrated approach to renewable energy and public space, to achieve not only meaningful and measureable sustainability, but also to communicate the reciprocal relationship between society and energy.

'Active interaction' refers to the direct consumption of produced electricity; for example, wireless services and energy charging points. 'Passive interaction', on the other hand, refers to the indirect consumption of the produced electricity, such as video artworks and interactive energy signage. In the light of the introduced theory, this study argues that such enhancements in our interactions with renewable energy in public space correlates with the observed tendencies of self-organised mature ecosystems. For example, Odum's fifth law of thermodynamics states that, "system processes maximise power by interacting abundant energy forms with ones of small quantity, but a larger amplification ability" (Cited in Tilley, 2004, p. 122). Therefore, the more ecologically sustainable public space is the one that more effectively responds to the fifth law by engaging with renewable energy at the highest level of interaction, that is, through both active and passive means. The central premise here is that, the greater the number of active and passive interactions between renewable energy and public spaces, the greater the likelihood that renewable energy will influence society's sustainable energy lifestyle.

8.4.4 Implication four

The third key theory introduced in this study is 'the quality of energy', also known as 'emergy'. The 'emergy' concept links public open space and renewable energy in the information domain. The fifth law of thermodynamics states that it is information that generally has the highest energy quality and the densest form of emergy/energy ratio (H. T. Odum, 2007, p. 88). Public space is a social space where people communicate, interact, and learn from their surroundings and from each other. As Miller (2007, p. 204) argues "[p]ublic

spaces do not exist as static physical entities but are constellations of ideas, actions, and environments". Public space is therefore an educational and information space where renewable energy can be introduced to society.

Using the agency of design and art is one way of sharing this new information with the public. While art does this implicitly, design is more explicit and direct. Both means of communication offer different dimensions to the processes and outcomes of renewable energy-embedded public spaces. Information embedded in the design or artistic product transforms into knowledge when the capacity of the receiver and the skills of the designer and artist are attuned. An ecologically sophisticated public space carries high 'emergy' potential because it has the potential to have a greater impact on society. One key principle of 'emergy' is: "[d]o not use high quality products or services for low quality purposes" (H. T. Odum & Odum, 2008, p. 69). For example, using a skilled person for a low quality job indicates that the time spent on training that person is wasted. Therefore, using produced electricity in a public space similarly achieves a high-quality energy (useful information) utilization.

8.5 METHODOLOGICAL IMPLICATIONS OF THE STUDY: FROM DESIGN COMPETITIONS TO THE DESIGN OF OED FRAMEWORK (RBDI-II, ROD, RFD)

This study began by using design competitions as a vehicle to investigate the application of renewable energy in two different scales/contexts: the town planning and public open space scales. While the design submitted to the IFLA 2011 competition investigated the sustainable energy landscapes on a larger scale, the scope of the LAGI 2012 competition focused the renewable energy topic on the public space context. In this way, LAGI's own philosophy was appropriated as a point of departure for the purpose of this study.

The two design competitions, and their processes and outcomes, enabled the study to recognize renewable energy as a production activity. The outcomes of both competitions produced the knowledge basis for the study, as well as context-specific design solutions. For example, each competition proposal incorporated a context-specific framework designed to implement energy innovations into that context. These design exercises established the basis for further research on ideas for integrating renewable energy into public space.

The framework evolved within a number of consecutive research and design activities. For this reason, the study's research procedures need to be discussed under the established research design strategies of the Landscape Architecture discipline, as presented in chapter 3. From a research *by* design perspective, three unique frameworks were developed chronologically with the aid of research *on* design and research *for* design.

The first framework — the Dynamic Loop System (DLS) — was designed and submitted to the LAGI 2012 competition. As illustrated in Figure 8.2 (below), the framework promotes distributed electricity usage through the vehicle of public space in wider New York City. Specific to this proposal, public spaces are envisaged as new production centres where electricity production, consumption, and distribution became new activities for public spaces. Food production and waste management are also incorporated into the designs. Both activities are monitored, and the data is either artistically integrated into the physical design of the public space. The public can simulate their own management scenarios via the web and to make a case for their implementation. This concept was further explored and applied in Freshkills Park with *'Terra Preta: Art + Agriculture + Algorithm'* proposal published and described in chapter 4.

Figure 8.2. Ozgun et al. proposed clean energy, matter and information centres (DLS) in New York City (2013).

LAGI's philosophy and the design outcome *'Terra Preta: Art + Agriculture + Algorithm'* informed the basis of the framework presented in the second publication. The framework, which was devised as the community empowerment model (CEM) illustrated in Figure 8.3, aimed to create a sustainable tourism economy. It was developed to guide residents, NGOs, and local government in facilitating the coexistence of local agriculture and renewable

energy, state of the art water management, and functional and sustainable social and economic interrelationships.

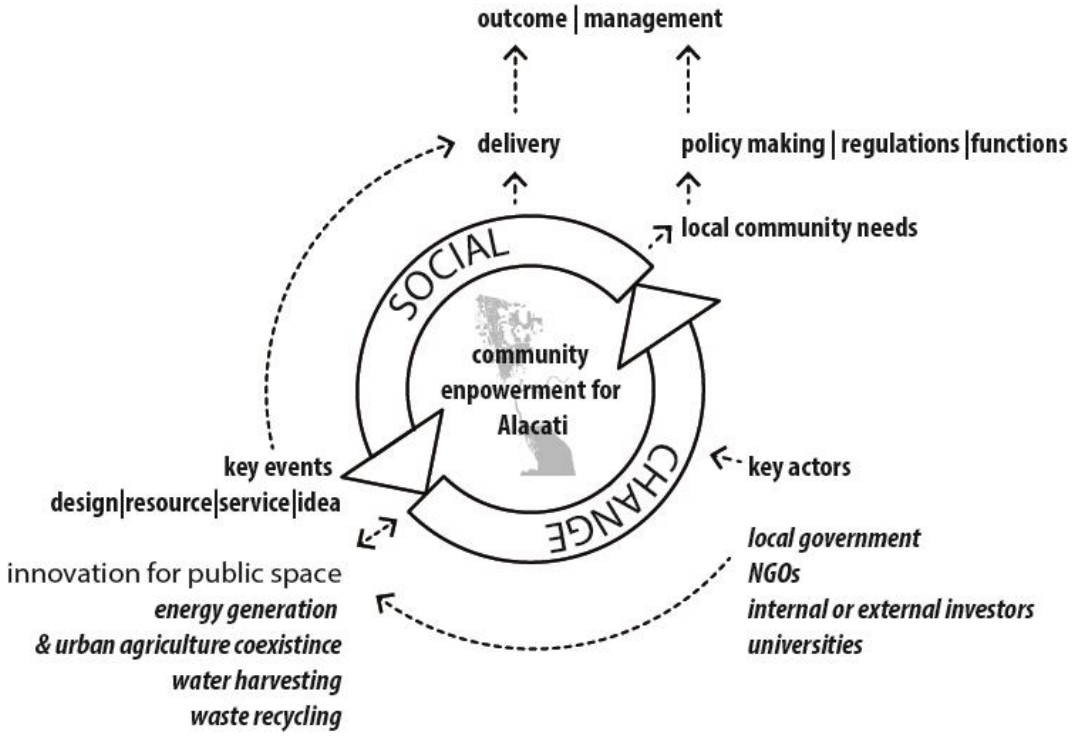

Figure 8.3. Community Empowerment Model (CEM) for Alacati (Ozgun & Buys, 2013).

Built upon the two preliminary frameworks as a point of departure, the TBL case study of Ballast Point Park, as well as the fourth and fifth laws of thermodynamics informed the OED framework. This framework, illustrated in Figure 8.4, demonstrates the optimal distribution of produced renewable electricity, as described in section 7.1.2.

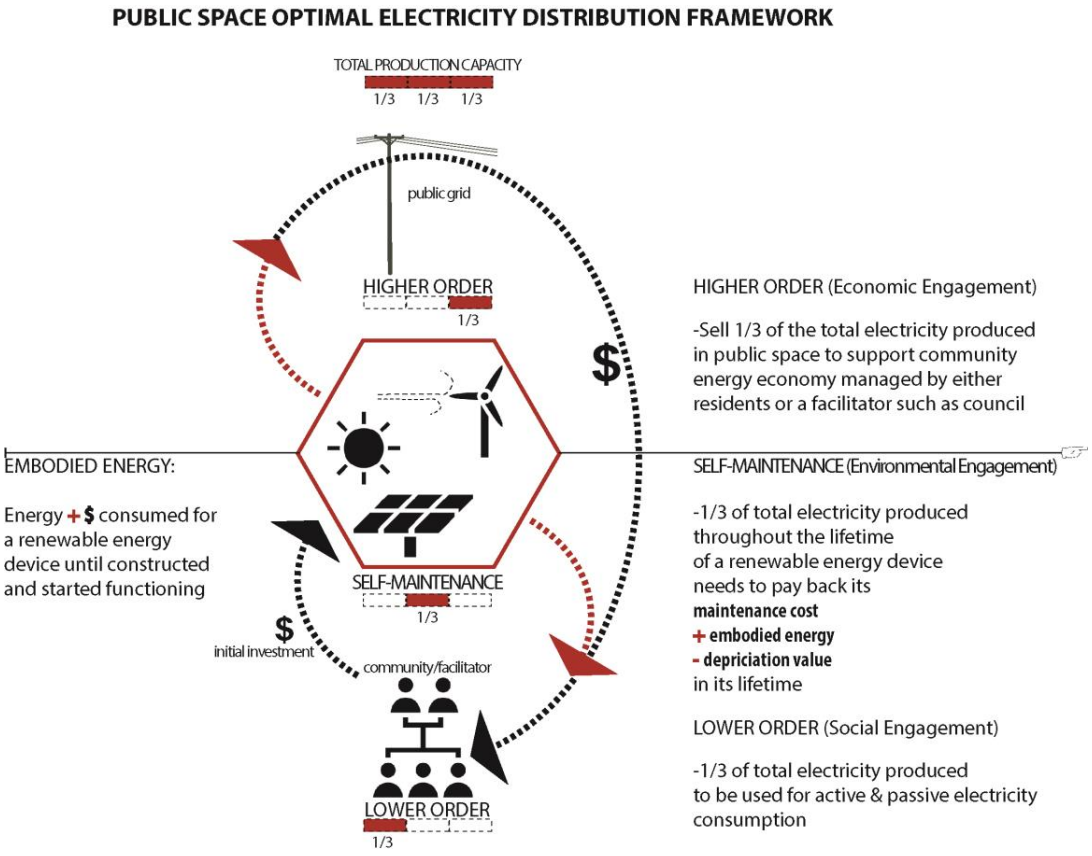

Figure 8.4. Public Space Optimal Electricity Distribution (OED) Framework (Ozgun, Cushing, et al., 2015).

By using the OED framework (Figure 8.4) as a basis, the study developed criteria to analyse the top twenty-five projects submitted for the LAGI 2012 competition. Through this analysis, the study not only tested the reliability and generalizability of the framework, but also provided a basis for future studies to advance the design of an assessment tool.

From a research *by* design perspective, this study initially discovered the need for a framework through design competitions (RBD-I), and developed the OED framework using design activity in research (RBD-II). The study followed a research path that started from a subjectivist approach and ended with an objectivist one. While the competition approach was subjective, such subjectivity was minimised and the research gained validity by introducing new theories from ecology and the law of thermodynamics (RFD), and data from qualitative research on (ROD) the Ballast Point Park case study and, content analysis of LAGI 2012 design proposals The OED framework can be further advanced for future designs (RFD).

The next section discusses the limitations of this research in relation to its procedures, processes, and implications.

8.6 LIMITATIONS AND FUTURE RESEARCH

8.6.1 Limitations

While the study adopted a multi-method approach to investigate the research problem in various contexts, it had, nevertheless, several limitations. A number of limitations arose as a direct consequence of using a single case study — an investigation of the sustainability of Ballast Point Park. For example, the number of designers interviewed was limited to the few key individuals primarily involved in the design project. One of the findings of this case study was that the technology associated with renewable energy devices is formative and not surprisingly such devices can malfunction, despite the genuine intentions of designers. Because of a restricted timeline, a second case study could not be undertaken for comparison purposes. A literature review of existing built projects was included in this study to address this limitation and provide a general project overview.

The content analysis of LAGI was limited to 25 selected published projects from the 2012 competition. At the time of this analysis, LAGI had not announced the 2014 competition results. Future research could include the 2014 winners and short-listed projects to better determine the generalizability of the devised framework.

In addition, the devised framework simplifies various variables to be addressed within a design project that incorporates electricity production. Additional factors need to be considered; in particular: the quality of design; current technological advancements in renewable energy; site-specific energy harvesting possibilities; local and national political conditions; community will to implement the framework. The implication of this limitation is positive from a designer's perspective since it increases designers' creativity in managing the electricity within the public space program.

Another limitation is the OED framework's inability to measure the aesthetic dimension of projects. According to Meyer, the aesthetic of sustainable design needs to be considered within two dimensions, 'appearance' and 'function', in order to have a significant cultural and societal impact. Meyer contends that function as 'fitness' or 'performance' cannot be experienced by representation but through direct interaction (Meyer, 2008, p. 10). Therefore, it can be argued that the OED framework, although it does not address the 'appearance' definition of the sustainability aesthetics, it does supplement the 'performance' definition of the sustainability aesthetics of renewable energy. Nevertheless, this limitation of the OED framework can be advanced if it is integrated with a framework that focuses on art and aesthetics of renewable energy, as was represented with the LAGI's objectives in this study.

Meyer's broader definition of sustainability aesthetic somewhat guides the discussions on the critique of Landscape Urbanism theory presented earlier. Namely, that Landscape Urbanism theory and its representation are not sufficient to embrace real-life performances such as gardening, community engagement. This study suggests that Meyer's two dimensions on the sustainability aesthetic can be extended into Landscape Urbanism theory. While one dimension of Landscape Urbanism theory focuses on the representation and the appearance, other dimension concentrates on the real life performances as well as substantial societal issues such as poverty, segregation, and slum.

A key limitation of the study is the real-word accountability of the OED framework such as the generated electricity of the project (kWh), potential revenue, and maintenance cost. Proceeding down that path would have been too complex and time consuming for this study and therefore; this thesis serves as a departure point for others to take that empirical path in future research. This thesis should instead be taken as 'a call to action' for other researchers and practitioners.

8.6.2 Future research

A natural progression of this work is to increase the case study sampling of built projects and to analyse further the LAGI competition entries. In turn, this will increase the generalizability of the framework. Initially, the framework and its production-oriented approach will be best applied to public open spaces where local electricity production is used in neighbourhoods to create a more sustainable community. This study argued that such a community could be developed when designers, experts, and the public work together to incorporate renewable energy into the design of their public space, while at the same time considering the possibility of deriving income for the community from the onsite produced electricity (Ozgun, Cushing, et al., 2015).

A general impediment to implementing this devised framework might be the conventional energy policies that effectively discourage new local energy investment due to existing socio-economic and cultural ties to carbon intensive power generation. Despite its high solar and wind-potential resources, Australia is delaying renewable energy investments. As Martin & Rice (2015, p. 138) point out "[t]here is no single policy or managerial approach to expediting renewable energy project approvals and implementation". This country appears reluctant to change existing energy policies, and is heavily reliant on cheap, unclean energy. Although there are new renewable energy developments beyond the city limits, these are mainly in scattered, off-grid communities.

In general, Australia's renewable energy investments are limited and lag behind those of China, the US and many European countries (McCrone, 2015, p. 53). While

institutionalised gatekeeping prevents communities from accessing investment, outdated energy policies also influence infrastructure development, therefore delaying sustainable energy transition. The developed framework circumvents this by placing tools in the hands of local governments and local designers — enabling them to take action. It is about the small scale implementation of public space and in so doing each space, space by space, in turn changes society's relationship to renewable energy. From the bottom up! Once favourable political conditions grow to some level of maturity, the framework could be implemented in other types of public spaces in all types of urban environments. In addition, the framework could be tested in other types of open space, such as peri-urban parklands and suburban car parks. In the context of energy independence and sustainable development, the OED framework can be introduced for poverty alleviation in remote settlements (González-Eguino, 2015).

Another area of future research is the application of emergy analysis to public spaces. In the past twenty years, emergy analysis has been used as a common multi-scale sustainability assessment tool that enables experts to examine the energy used in the supply of goods and services. This approach has been predominantly used for agricultural practices (Jiang et al., 2007), industrial systems (Pan et al., 2015), natural conservation studies (Zhou, Jiang, Chen, & Chen, 2009) as well as for large-scale projects (Fang & Chen, 2015; Higgins, 2003; Pizzigallo, Niccolucci, Caldana, Guglielmi, & Marchettini, 2007) to understand the impact of social metabolism on resources during urban development. In recent years, Abel (2013a, 2013b) and Falkowski et al. (2015), for example have applied emergy assessments in cultural studies; however, micro urban scales have yet to be explored. A detailed public open space emergy analysis could be further developed for sustainability assessment of designed public spaces. Furthermore, Odum's energy, information, and flow diagrams could be integrated into the landscape design profession and landscape design education, and promoted as techniques to illustrate and represent processes, flows, and physical space.

The devised framework could also incorporate the latest information technology to monitor public space activities, and to assess the neighbourhood's consumption and production values. Thus, it could be conceptualised as a multi-layered interactive control and monitoring mechanism that enables people to associate public open spaces with information, images, sounds and animations. This effective monitoring of activities such as the flow of energy, information, and/or matter could be expressed as part of a public art performance (Tiffany, 2008) or a spatial design artefact and in so doing it could instigate green place making.

When public open spaces transform into energy centres they become new decentralised production and information activity centres that work with the community to

create self-sufficient cities. More energy centres in a city result in an increase in monitoring capacity and the creation of more assessable data. Thus, the framework's monitoring capacity would allow the framework to be used as an urban zoning tool for open space networks as presented earlier in this study. This study critiqued the technological-fix approach to renewable energy in cities and proposed that electricity production from renewables be incorporated into the socio-cultural and ecological purpose of public space to create social and environmental change by engaging the community, enriching the local economy, and increasing social networks. This initial hypothesis was advanced and tested by design and research activities, and ultimately helped to develop the framework for urban public space renewable energy integration.

8.7 CONCLUSION

This study investigated the potential relationship between public space and renewable energy, and what principles and methodologies can better contribute to the design of renewable energy-embedded public space.

Overall, the study revealed that trends in the topic are still holding back mainstream practices and critical thinking more broadly. Indeed the theory is limited with respect to the level of some of the advanced designs discussed herein. The study explored the true sustainability of renewable energy embedded public spaces. Specifically, it analysed a renowned public space awarded for its environmental sustainability innovations. It then assessed twenty-five design proposals that were published in the book, *Regenerative Infrastructures, Freshkills Park, NYC, Land Art Generator Initiative.*

Since integrating renewable energy in urban public space is an emerging field, the current study is based on, (1) a small sample of built projects that are representative of the experiments about the topic presented in the literature review, (2) an analysis of a single case study, and (3) twenty-five design proposals of LAGI 2012 competition. The synthesis of the findings from these three sources indicated that there is an imbalance of distributing onsite-generated electricity from a public space context (Ozgun, Cushing, et al., 2015).

While speculative projects in general focussed on the economic value of the produced electricity, the analysed case study concentrated on the environmental value of the renewable energy (Ozgun, Weir, et al., 2015). Such discrepancies did also exist in the exemplar projects presented in the literature review (see for example, section 2.2.5). With the aid of the devised framework, the study further demonstrated that, both current mainstream design practices and critical thinking lack the link between electricity production capacity, storage, and social engagement. Accordingly, the developed framework in this study showed that an

ecologically sophisticated public space distributes its generated electricity depending on the following three overt criteria (Ozgun, Weir, et al., 2015):

- Social engagement with the renewable energy involves creating social engagement (through active and passive interaction) with one-third of on-site produced electricity.
- Environmental engagement with the renewable energy includes the maintenance, storage, and embodied energy, which refers to one-third of the produced electricity.
- Economic engagement with the renewable energy refers to selling the remaining one-third of on-site produced electricity to the city grid for supporting a local energy economy.

The devised framework as the key contribution of this study informed the knowledge gap that both design and assessment bodies were not considering renewable energy beyond it being a mere design retrofit. The above-mentioned criteria would be useful for designers to better incorporate renewable energy into their designs. Such criteria would also benefit public space assessment bodies such as the SITES initiative. Importantly, the link between three criteria in this study was proven to become indispensable for an ecologically sophisticated public space design (Ozgun, Weir, et al., 2015).

Another crucial contribution is the acknowledgement of the importance of using generated electricity immediately within public spaces through direct and indirect interactions. An ecologically sophisticated public space design should be energy responsive in the sense that it increases the social, economic, and environmental sustainability of its locale. At the same time, such a public space might generate useful information for the community, which can then be used as an essential basis for sustainable energy transition and social change. This claim stems from the "maximum power principle", which is considered as Odum's fourth law of thermodynamics[40]. According to this law, in the self-organizational process, systems develop parts, processes and interactions that maximize efficiency and production (H. T. Odum, 1996; H. T. Odum & Odum, 2008, p. 71). Odum's fifth law presented in this study posits that active and passive interactions are necessary for

40 Valyi cited in (Sciubba, 2011) , so far no publications can be considered as an evidence for the applicability of 'maximum power principle' however it should be noted that the results may be interpreted under a different paradigm.

consuming the produced on site electricity, and accordingly, the greater the number of active and passive interactions that occur between produced clean electricity and public space users, the greater the likelihood the public spaces will impact on society's sustainable energy life style.

I believe, shifting the understanding of renewable energy from a techno-fix approach to a community activity reveals new relationships in and around a public space not only for the community but also for the designers of public spaces. Cities around the world are gradually taking steps toward building new social, economic, and political frameworks and infrastructures such as resilient micro and smart grids, virtual renewable energy utilities, sustainable energy utilities, and distributed energy neighbourhoods. The spatial and social adaptation of these technologies in cities is as critically important as is their technical capability.

Cities are in crisis. Their increasing energy demands require radical sustainable design solutions at the supra-national to regional, and regional to local scales. Given today's concerns with climate change, there is a need for energy autonomous cities. Such cities would profoundly influence the processes of production and consumption of energy, food, water, and waste. While a transition from fossil fuel to renewable energy is a significant start on the road to energy autonomy, this transition requires systemic bottom-up and top-down policies and interventions to create a truly sustainable society. The outcome of this research is one such intervention that can inform and advance this critical transition process.

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Appendices

Appendix A: Design Competition I | IFLA 2011

SCALES OF NATURE
48TH IFLA WORLD CONGRESS
June 27–29 2011 Switzerland

www.ifla2011.com

Student Landscape Architecture Design Competition

Seize a great opportunity!
Make an entry for the student competition of the IFLA World Congress 2011 Zurich, Switzerland, June 27–29 2011

HSR Hochschule für Technik Rapperswil, University of Applied Sciences is proud to host this year's student competition and wishes you all the success. HSR is a leading institution in landscape architecture and the only university offering a Bachelor's degree in this domain in German speaking Switzerland.

Topic: Urban boundaries

Background

Dealing with land as a resource in a sustainable way is a globally recognized goal. However, towns and villages continue to expand as long as there is sufficient space. The pressure on the landscape is growing. All too often it is still regarded as potential development land. In conjunction with these trends, the urban boundary is becoming critically important – it is the link to the open landscape that allows humans to meet their fundamental need to experience nature.

The following factors have a direct impact on the physical structure of the urban boundary:

- Elements in the landscape such as topography, bodies of water etc.
- Ecology – biodiversity and integration
- The structure of developments and plots of land
- Density of the settlement area
- Intensity of use in the undeveloped landscape
- Ownership / availability
- Function and use, particularly accessibility to the area, access within the area and mobility through the area

www.ifla2011.com

IFLA | HSR Hochschule für Technik Rapperswil Landschaftsarchitektur | BSLA | Stadt Zürich Grün Stadt Zürich

- Aesthetics
- The urban and rural picture and visual references
- Sociological aspects
- Human constants such as the view, proximity to nature, identification and water

Assignment

The population's preoccupation with the value of potential development land plays a crucial role in this expansion. Landscapes have environmental, cultural, economic and other values, all of which influence patterns of development. This competition is based on the thought that the greater the economic value attributed to undeveloped land, the more indiscriminate the inappropriate development will be – and hence the concern about protection.

Entrants should choose one **example of an urban/rural transition/boundary in which the values for land are in conflict**. They should propose **a landscape architectural response to it and show that urban boundaries can be positive transitional elements between the urban landscape and undeveloped land, if they are planned and designed properly**.

Entrants are invited to develop conceptual proposals and plans for the use and design of urban boundaries using a specific example of their choice.

Requirements

Definition and analysis of the problems of the chosen area should be made.

Land uses at the urban boundary and in the adjacent undeveloped land should be described and potential conflicts addressed and resolved.

The proposals should be outlined at conceptual level (scale from 1:10'000 to 1:5'000) and refined at a scale from 1: 2'000 to 1:500.

The conceptual statements on the urban boundary should address the following aspects (although the projects are not limited only to these):

- Function
- Use
- Accessibility to the area
- Mobility through the area
- Access within the area
- View from the area
- View into the area

Detailed concepts will indicate design resolution of the issues, and may include such aspects as facilities, choice of materials and ambiance.

Eligibility

The Competition is open to all students of Landscape Architecture, or allied discipline (where a country or university does not include a formal Landscape Architecture program). Both individual and group submissions will be accepted, and each student or group is permitted only one entry.

Broad interdisciplinary submissions are welcome; however, the project must be about landscape architecture.

The number of members in each participating group shall not exceed five (5).

Professional collaborators and associates of the members of the jury and their relatives may not enter the competition.

Required deliverables

Entries must take the form of three (3) panels as PDF (Portable Document Format) files which when printed at 100% size would be 45cm x 90cm each (landscape format). The panels should be designed so that they will be positioned vertically above one another at the presentation with the final format 135 x 90 cm:

A. Required

- Aerial photograph of the current situation e.g. from Google Earth etc.
- Overview, scale from 1:10'000 to 1:5'000 (typology, zoning, concept etc.)
- Details using an example at a scale from 1:2'000 to 1:500 (preliminary project, functions, facilities)
- At least 2 cross sections through the site that indicate clearly the transitional urban/rural area
- At least one illustration (artist's impression or rendering)
- Explanatory text maximum 2'500 characters including spaces (approx. 1 page of A4 [ISO 216]) including the description of the urban/rural conflict (to be included as a separated pdf file)

B. Optional

Other drawings, diagrams or illustrations to explain the context, the design process and/or the concepts.

Specifics

1. The three panel PDFs and page of explanatory text shall not identify names, faculty sponsors, or schools of teams. Please enclose a fifth PDF file consisting of the completed Declaration of Eligibility (please see page 5 'Student Landscape Architecture Design Competition Declaration Form').
2. PDFs must be titled to indicate the numerical order in which they are to be mounted.
3. Legends, captions and all other text associated with the submission shall be in English.

4. As entries are received, serial numbers will be assigned, and entries shall be referred to by number to ensure anonymity during the judging.

Submission

Please submit the panels as PDF files, including all pictures and graphics via our website www.ifla2011.com by **March 26th 2011**. *(Note: files may not be emailed or sent by mail).*

Submissions received after the deadline date will not be admitted.

Awards

The following prizes are offered through this competition:

1st Place: Group Han Prize for Student Landscape Architecture - USD 3500 and a certificate

2nd Place: IFLA Zvi Miller Prize - USD 2500 and a certificate

3rd Place: BSLA Merit Award - USD 1000 and a certificate

Deadlines

1.	March 26th 2011	Deadline for entries
2.	April 12th 2011	Jury
3.	June 27-29 2011	Presentation

Contact regarding the competition

Address: HSR Hochschule für Technik Rapperswil Oberseestrasse 10 CH-8640 Rapperswil Switzerland	E-mail: kerstin.goedeke@hsr.ch Phone: +41 55 222 49 60	Contact person: Ms Kerstin Gödeke, scientific employee.

Further information

For further information on the Congress, the supporting programme, accommodations, organization committee, programme commission, etc. as well as on registering for the Congress, please visit www.ifla2011.com.

SCALES OF NATURE
IFLA WORLD CONGRESS
June 27- 29 2011 Switzerland

5 / 5

Student Landscape Architecture Design Competition Declaration Form

Please complete the declaration and save as an un-editable PDF file. This file is to be submitted together with your entry. All entries must be uploaded on the website www.ifla2011.com by **March 26th 2011**.

AUTHORSHIP DECLARATION

I/We declare that I/we are the true authors of the work submitted and have met all the competition requirements. I/We declare that I/we are presently enrolled as student/s in a Landscape Architecture program, or allied discipline (where the university does not have a formal landscape architecture program). I/We declare that I/we shall not have the submission published prior to notification of the jury's final decision.

#	Author's Name and Surname	University	Program or Department
1	Kaan Ozgun	Queensland University of Techr	PhD in Landscape Architecture
2			
3			
4			
5			

CORRESPONDENCE

To be used to contact winning teams, and for other correspondence.

Contact Name and Surname	Address, City, Country	Telephone / Fax	E-Mail
Kaan Ozgun	41 Quinn Street, 4066 To Toowong, Qld, Australia	+61424470731	kaan_ozgun@yahoo.com

ENDORSEMENT BY DEAN OF FACULTY or HEAD OF SCHOOL

I certify that the authors and/or team leader is currently a student in the Landscape Architecture program, or program in an allied discipline (only where the school does not have a formal program in landscape architecture).

25.03.2011

Signature Date University/School Stamp

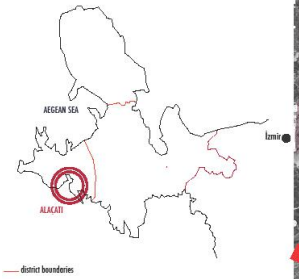
Queensland University of Technology
2 George Street
Brisbane Qld 4000

Print

www.ifla2011.com

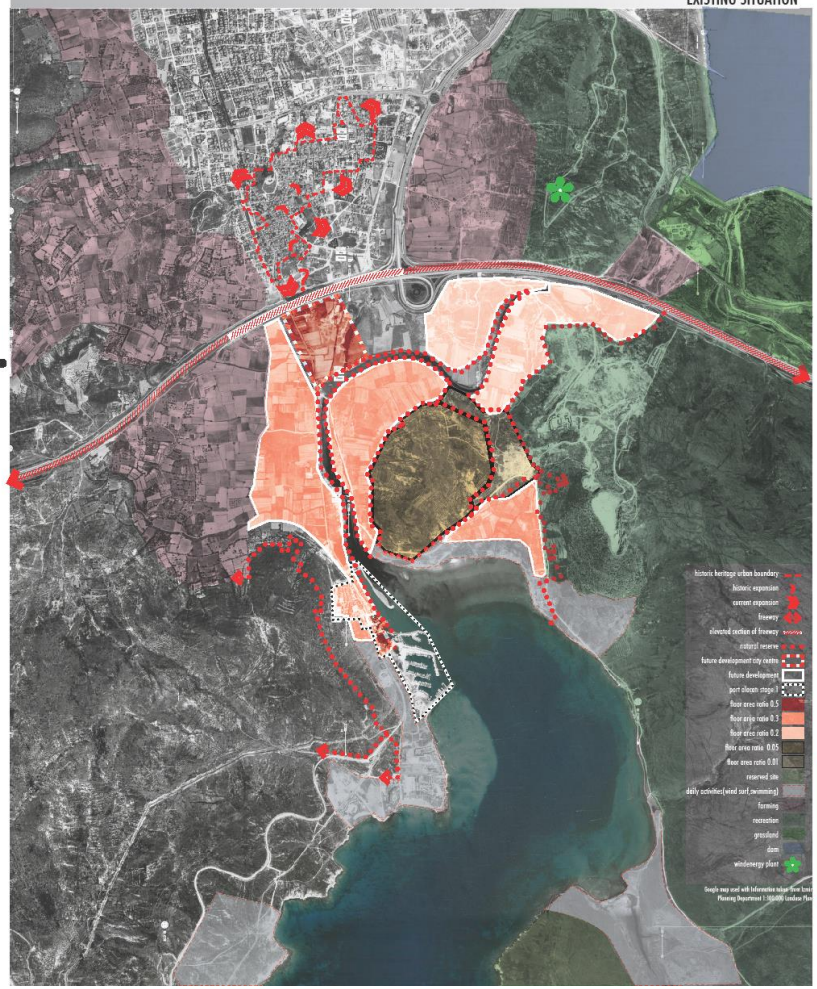
IFLA BSLA Stadt Zürich Grun Stadt Zürich

LOCATION



Alaçatı is an Aegean town of İzmir province located in Çeşme Peninsula on the western coast of Turkey.

EXISTING SITUATION

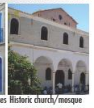


HISTORIC HERITAGE TOWN CENTRE


Historic wind mills


Cobbled narrow streets


Stone houses


Historic church/mosque


Freeway flyover

Historic Town Centre

It was an ancient Ionian port town – a.k.a Agrilia – with a diverse historical background that witnessed different cultural and population changes throughout its history.
One can still experience its past with its 150 years old windmills, stone houses, and cobbled narrow streets of authentic Ottoman Architecture.

Physical Barrier Between Town Centre and Ecological Zone

A recently built freeway connecting the peninsula to Izmir province segregates undeveloped land from town centre.

PORT ALACATI PROJECT PROPOSAL


Stage 1
Images credit: Port Alacati official website

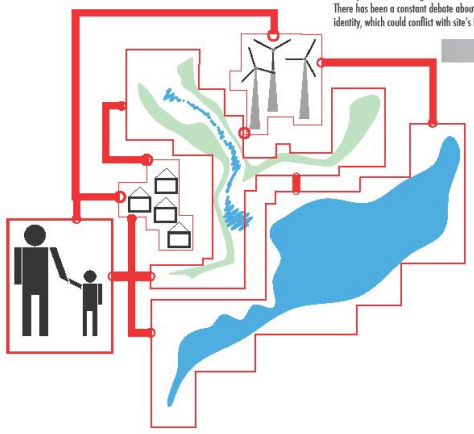
Future Development Site and Political Situation

Alaçatı is also hosting a fragile ecosystem comprising marshlands, an estuary and beaches with crystal clear water on the southern part of town centre. This undeveloped land used to be protected within a Generic Conservation Plan of the Peninsula. 4 years ago the Turkish Ministry of Culture announced the Cesme Peninsula would be divided into six regions and legalised building permits for entire region, including conservation lands. Following the announcement of this law, Alaçatı Tourism Investment and Management inc. commissioned the French firm of Francois Spoerry for the master plan of this site. First stage of the project was built. Next stages was recently halted by a decision of the High Court after it was accused of trespassing the 100m coastal development lines.

'The most critical design problem facing urban transformation therefore is not the design of any particular building or neighbourhood. It is the design of the governance structure. Architects and planners are way ahead of the lawyers and policymakers in thinking about ecological city.'

Port Alacati Project on the current undeveloped land and Its Critique

The transformation from an agriculture to a tourism-based economy was changing the values, life styles, and social system of society in parallel with the built environment and landscapes.
The development dynamics of Alaçatı, in the last twenty years have been attracting entrepreneurs from big cities who were conducting this autonomous development of the town since the beginning by also acting as local NGOs (Non-governmental organisation). On the other hand, the local government formed a counter power striving to attract both national and supra-national big capital to the town in the process. (Gurkan, 2008) Port Alacati Project is the consequence of this strategy. It proposes a new designed residential waterfront by reclaiming and excavating the land, and creating an artificial canal based residential development with 80ha golf course on this ex-preservation site.
There has been a constant debate about how project overlaps with the need of cultural, natural and future dynamics of the town as well as this new imposed identity, which could conflict with site's inherence.



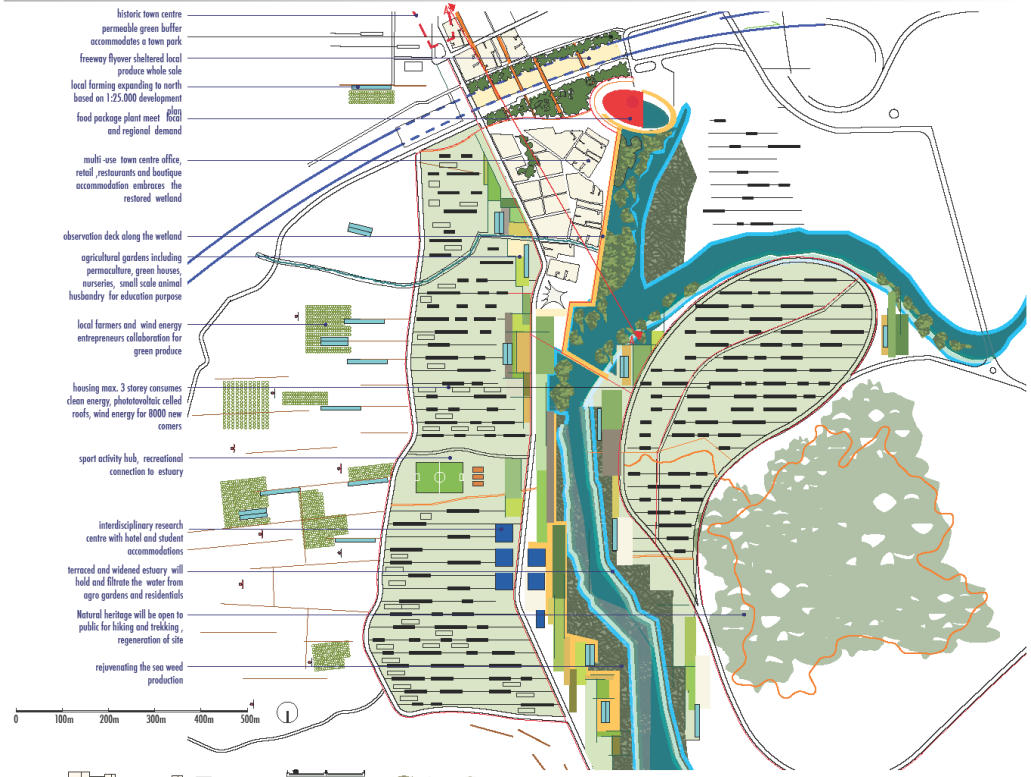
PROPOSITION

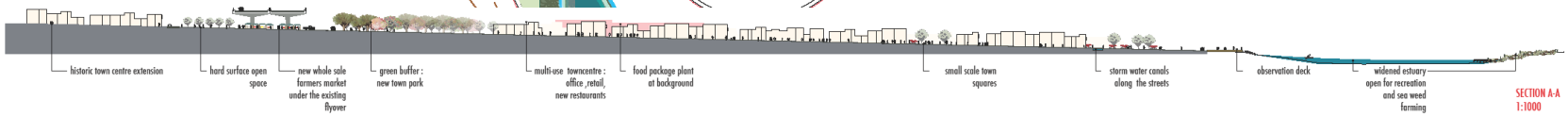
Proposition for Urban Boundary: Coexistent Landscapes

My proposition for Alacati is about reading the pattern of its process in time by looking at physical traces such as architecture, ecology as well as intangible traces such as cultural and social interactions with its nature and physical qualities. The sustainability of any place (Genius Loci) is directly related to its past and legibility of its pattern by future generations. Any intervention doesn't collaborate with this legibility aspect would accelerate the process of coming to an end.

'...there is a harmony between people, the buildings they inhabit, the cities they construct and the natural environment in which they live.'

PLAN





SECTION A-A
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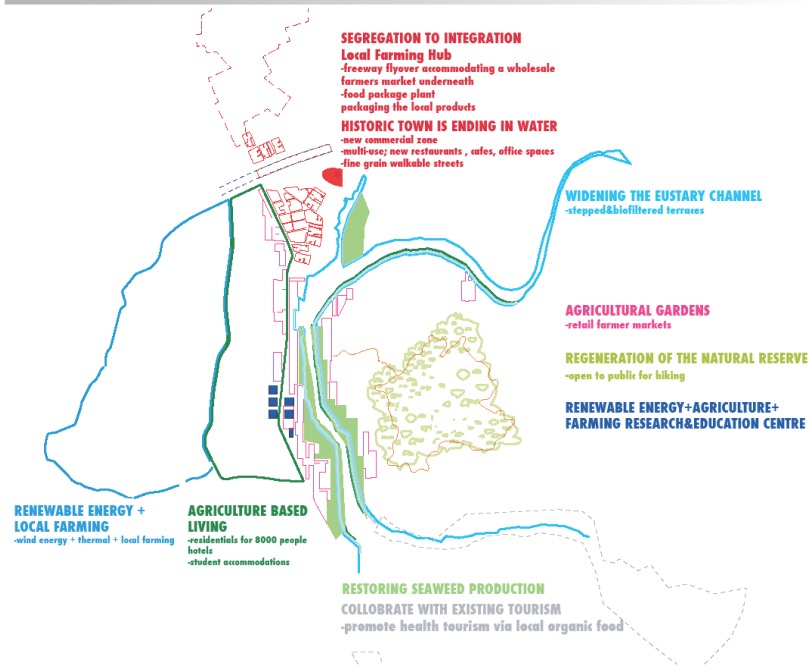
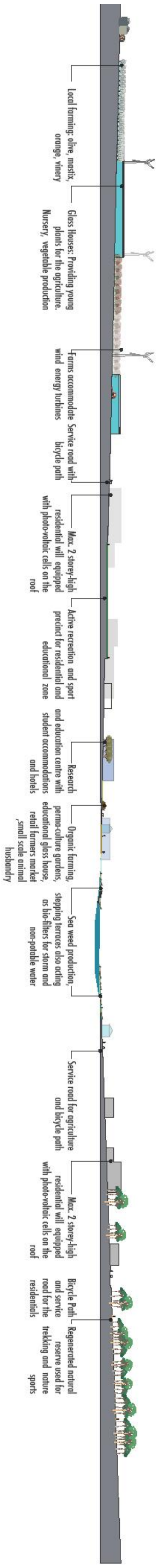
PROPOSITION




Local farming: olive, mastix, orange, vinery
Glass Houses: Providing young plants for the agriculture. Nursery, vegetable production
Farms accommodate wind energy turbines
Service road with bicycle path
Max. 2 storey-high residential will equipped with photo-voltaic cells on the roof
Active recreation and sport precinct for residential and educational zone
Research and education centre with student accommodations and hotels
Organic farming, perma-culture gardens, educational glass house, retail farmers market, small scale animal husbandry
Sea weed production, stepping terraces also acting as bio-filters for storm and non-potable water
Service road for agriculture and bicycle path
Max. 2 storey-high residential will equipped with photo-voltaic cells on the roof
Bicycle Path and service road for the residentials
Regenerated natural reserve used for trekking and nature sports

Appendix B: Design Competition II | LAGI 2012

land art generator initiative

www.landartgenerator.org

In partnership with New York City's Department of Parks & Recreation, the 2012 Land Art Generator Initiative design competition is being held for a site within Freshkills Park (the former Fresh Kills Landfill) in New York City.

2012 LAGI COMPETITION

LAGI 2012 is an ideas competition to design a site-specific public artwork that, in addition to its conceptual beauty, has the ability to harness energy cleanly from nature and convert it into electricity for the utility grid.

The expansiveness of the design site at Freshkills Park presents the opportunity to power the equivalent of hundreds or even thousands of homes with the artwork. The stunning beauty of the reclaimed landscape and the dramatic backdrop of the Manhattan skyline provide an opportune setting from which to be inspired. Freshkills Park offers the perfect environment to showcase the immense potential of aesthetically interesting renewable energy installations for sustainable urban planning.

The monetary prize award will not guarantee a commission for construction; however, LAGI will work with stakeholders both locally (NYC) and internationally to pursue possibilities for implementation of the most pragmatic and aesthetic LAGI designs.

The award ceremony will be in New York City in October of 2012, and the top 30-50 entries for the competition will be included in a book similar to that of the 2010 competition, which was published by Page One Publishing.

A community event will be held in New York City during the summer of 2012 in collaboration with project partners. The workshop will include panel discussions on the artful integration of renewable energy infrastructure and urban ecology. Participants will get a sneak peek at the submitted designs (anonymously attributed by code identifier) and will provide input that will inform the process of jury shortlisting.

Exhibitions of the top entries are being planned in various international venues.

ISBN:
978-981-428-675-6

p 2

DESIGN BRIEF + JUDGING CRITERIA

The 2012 Land Art Generator Initiative, in partnership with New York City Department of Parks & Recreation, calls on artists and designers to submit proposals for a pragmatic art installation for Freshkills Park, Staten Island, New York City. A qualified entry must fulfill the following criteria and be developed to a concept design level of detail. Projects must:

- consist of a three-dimensional sculptural form that has the ability to stimulate and challenge the mind of visitors to the site. The work should aim to solicit contemplation from viewers on such broad ideas as ecological systems, human habitation and development, energy and resource generation and consumption, and/or other concepts at the discretion of the design team.
- be well informed by a thorough understanding of the history, geography and geotechnical details of the site, as well as the broader contexts of Staten Island and New York City. The work should maintain acute attention to details and context.
- capture energy from nature, convert it into electricity, and have the ability to store and/or transform and transmit the electrical power to a power grid connection point to be designed by others. Consideration should be made for artfully housing the required transformer and electrical equipment within the project boundary and restricting access for the safety of visitors to the site.
- minimize their impact on the natural environment and not create greenhouse gas emissions. Each entry should provide a brief environmental impact assessment as a part of the written description in order to determine the effects of the project on the natural ecosystem, and to make clear that no damage will be done to existing engineered systems and infrastructure of the landfill. Mention should be given to a mitigation strategy that will address any foreseeable issues. Reference to the Freshkills Park Generic Environmental Impact Statement (EIS) document will provide additional context. It is available in the downloads section of the competition website.

  Please note that LAGI 2012 does not require a lengthy EIS, but rather only asks for a paragraph that explains the design team's approach at a conceptual design level.
- make pragmatic considerations for preserving the integrity of the landfill cap and all other engineered systems that are in place, including landfill cover, infrastructure, and environmental controls. The cap shall not be penetrated in any manner for any reason. Vehicular access to above-ground landfill infrastructure must be preserved.
- be safe to on-site viewers. Consideration must be made for viewing areas as well as boundaries between public and restricted areas.
- be pragmatic and constructible, employing technology that can be scalable and tested. There is no limit on the type of technology or the proprietary nature of the technology that is specified. It is recommended that the design team make an effort to engage the manufacturers of existing technology in preliminary dialogue as a part of their own research and development of the design entry.
- use a percentage of the site strictly in accordance with the allotment allowances on the Site Plan. The overall footprint and covered area of the work must not exceed 100 acres in total. The installation may be limited to the North Park site, or to the East Park site, or may exist partially within both boundaries.
- work in coordination with the approved Draft Master Plan for Freshkills Park. Within the specific project boundary areas in North Park and East Parks, the preliminary programming activities listed in the Draft Master Plan may be suspended or amended in lieu of the LAGI artwork program.

Successful proposals will combine functional utility with creative concept.

JUDGING CRITERIA

LAGI will be asking the jury to make their decisions on the merits of the designs with the following criteria taken into consideration:

- Adherence to the Design Brief and Submission Requirements
- The integration of the work into the surrounding environment, landscape, and the approved Draft Master Plan for Freshkills Park
- The sensitivity of the work to the environment, to local and regional ecosystems, and to the integrity of the landfill cap and underground infrastructure
- The estimated amount of clean energy that can be produced by the work
- The way in which the work engages the public
- The embodied energy required to construct the work (this criterion relates also to the pragmatism of the proposal and to its return on construction investment period)
- The originality and social relevance of the concept

We are pleased to be working with the following group of esteemed jurors:

JURORS

Bjarke Ingels
BIG-Bjarke Ingels Group

Dr. Henry Kelly
Acting Assistant Secretary and Principal Deputy Assistant Secretary for the Office of Energy Efficiency and Renewable Energy at the U.S. Department of Energy

Jean Gardner
Associate Professor of Social Ecological History, Parsons New School, School of Constructed Environments

Alice Aycock
Public Design Commission of the City of New York

Eric Shiner
Director, The Andy Warhol Museum

Patricia Watts & Amy Lipton
ecoartspace

Melanie Cohn
Executive Director, Council on the Arts & Humanities for Staten Island

Steven Grillo
Program Manager for Planning, Staten Island Economic Development Corporation

Peter Yeadon
Partner, Decker Yeadon

Eloise Hirsh
Freshkills Park Administrator, New York City Department of Parks & Recreation

Phil Gleason
Assistant Commissioner for Waste Management Engineering, NYC Department of Sanitation

Anne Guiney
Executive Director, Institute for Urban Design

James Corner
james corner field operations


Phyllostachys dulcis
Common name: Sweetshoot Bamboo

Maximum Height: 40 feet
Diameter: 3 inches
Hardiness: 0 - 5°F
USDA Zone recommended 6 through 10


Phyllostachys bissetii

Maximum Height: 30 feet, usually 20 to 25 feet
Diameter: 1 inch
Hardiness: -10° F
USDA Zone recommended 5 through 10


Semiarundinaria fastuosa
Common names: "Temple Bamboo"

Maximum Height: 35 feet
Expected Northwest Height: 25 feet
Diameter: 1.5 inches
Hardiness: -5° F
USDA zone 6b through 10


Phyllostachys viridis
Common name: Chinese Timber

Maximum Height: 72 feet
Averages 40 to 50 feet
Maximum Diameter: 5 inches
Hardiness: -0° F
USDA Zone recommended 6 through 10


Phyllostachys viridis 'Aureocaulis'
Common name: Golden viridis

Maximum Height: 70 feet
Typical height in USA: 40 to 50 feet
Diameter: 3 to 5 inch canes
Hardiness: -0° F
USDA Zone recommended 6 through 10


Phyllostachys atrovaginata
Common name: Incense Bamboo

Maximum Height: 35-40 feet
Diameter: 2.75 inches
Hardiness: -10°F - (rated by the American Bamboo Society at -15°F)
USDA Zone recommended 5b through 10.
(may do fine in SA)


Phyllostachys parvifolia

Expected Height: 40 feet and possibly much larger
Diameter: 3.25 inches and possibly larger
Hardiness: possibly -5° to -15°F
USDA Zone recommended 6 through 10


Phyllostachys nidularia

Maximum Height: 40+ feet
Diameter: 3.5 inches
Hardiness: -5° F
USDA Zone recommended 6 through 10


Phyllostachys aureosulcata
Common Name: Yellow Groove

Expected Height: 30 feet
Diameter: 2 inches
Hardiness: -10° F
Recommended for USDA zone 5 through 10


Phyllostachys makinoi

Max Height: 60 feet, avg 35 to 45 feet
Diameter: 2-3 inches
Hardiness: -5°F
USDA Zone recommended 6b through 10


Phyllostachys aurea
Common Name: "Stone Bamboo"

Expected Height: 25 feet, usually 20 feet
Diameter: 1.5 inches
Hardiness: -2° F
USDA Zone recommended 6 through 10


Phyllostachys edulis
Common Name: Moso

Also called: Phyllostachys heterocycla pubescens
Maximum Height: 80 feet, Typical Height: 40 to 50 feet
Diameter: 4 to 7 inches
Hardiness: 0° F
USDA Zone recommended 7 through 10

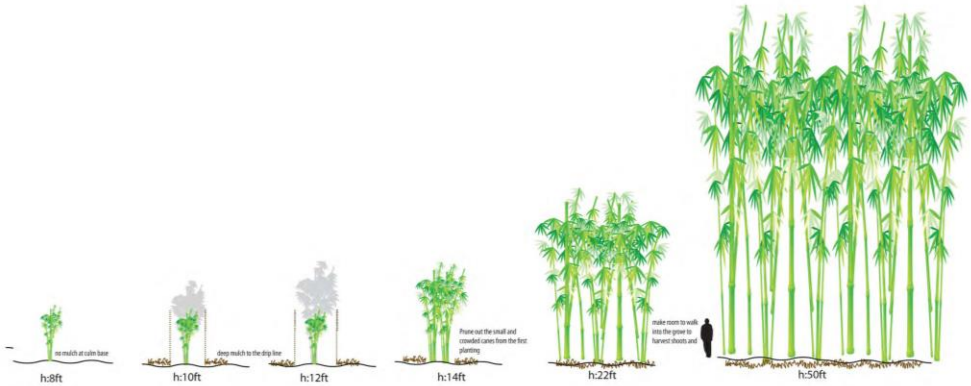

Phyllostachys nigra 'Henon'
Common names: Henon, Hachiku

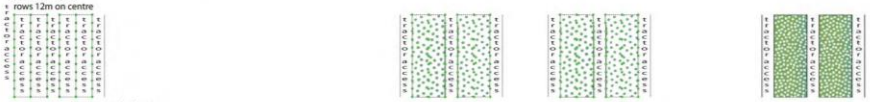
Maximum Height: 50 feet
Maximum Diameter: 3.5 inches
Hardiness: -0° F
USDA Zone recommended 7 through 10
(possibly 6b)

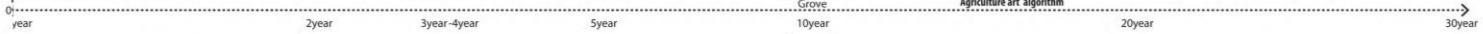

Phyllostachys bambusoides
Common Names: Madake, Giant Timber Bamboo, Japanese Timber Bamboo

Maximum Height: 72 feet, average height 50 feet
Diameter: 4 - 6 inches
Hardiness: 0° F
USDA Zone recommended 7 through 10

These three species most likely would not achieve their max. height, however the lowelfill soil temperature might effect their growth rate







"Enhancing the natural processes that remove CO2 from the atmosphere is thought to be the most cost-effective means of reducing atmospheric levels of CO2."
(US Department of Energy)
Data source: http://biobamboo.org/

BAMBOO

Produce 35% more O_2 than trees
Carbon sink: stores 4 times CO_2 than trees
can be grown without pesticides
art & craft
bio-mass
requires less energy, water to grow
restores soil fertility
reduces soil erosion
bio-char
textile
food edible bamboo shoots(1-10tons/acre/year)
construction - Poles

Soil prearation-bamboo plantation

After first shooting

After second shooting

Thinning Process
Feedstock used for bio-energy
Energy equivalent =4.76MWh
Bi-product= Bio-char
Soil restoration starts in Fresh Kills using bio-char

Thinning Process
Feedstock used for bio-energy
Energy equivalent =4.76MWh
Bi-product= Bio-char
Soil restoration starts in Fresh Kills by using bio-char
Harvest for food and construction
Bamboo poles =min 1000 poles/acre/year
Bamboo shoots(1-10tons/acre)/year

Bamboo achieve maturity : Maximum productivity/efficiency
sustainable yield till the rest of bamboo life time(natural death/ flowering time between 45-70 years)

Bamboo plantation over time 100acre(LAGI site constraint)
Each acre absorbs 40 tons of CO2 every year

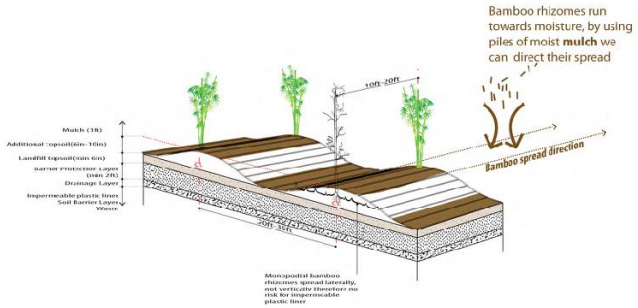
Estimated biomass yield for bamboo based on 500plants/acre initial planting[1]

	wet feedstock(moisture 8-10%, ash content less than 1%)	**Total**
3-4th year	@ 20t/acre	2000t/year
5th year	@ 25t/acre	2500t/year
10th year	@ 32t/acre	3200t/year

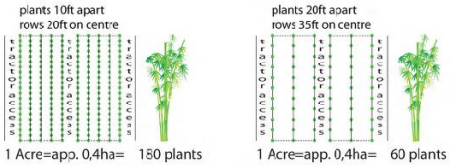
Estimated biomass yield figures for bamboo only meet 10% of the Pacific Pyrolysis Plant capacity, this can be increased by including green waste of Fresh Kills Park and its environs and employing more bio mass acreges

1 www.biobamboo.org

Terra Preta_ Bioenergy_ Soil restoration_ Urban agriculture_ Art Algorithm

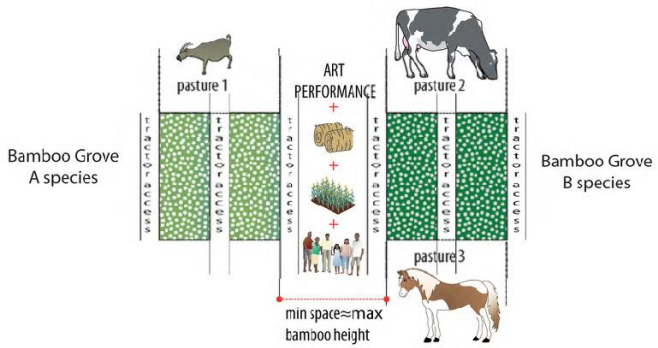


Bamboo on Landfill

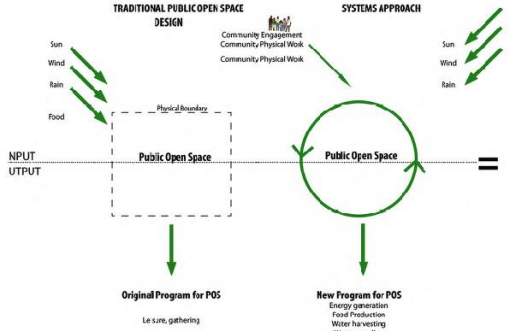


Optimum planting designs for healthy growth and sustainable bio-mass yield
Worldwide implications vary 50-1000 plants/acre. To increase the biomass yield in the first years, acreges can be planted densely, however bamboos planted in ample spaces are able to increase the sustainab lity rate of the yield in time .

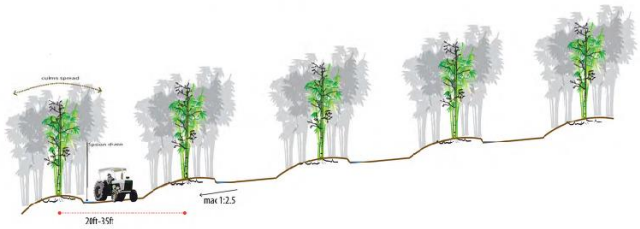
Suggested Bamboo Planting Designs

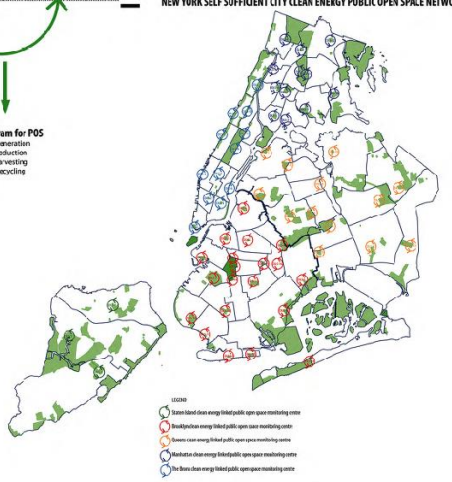


Conceptual Spatial Configuration



Bamboo Following the Contours - Slope Plantation





Base Map of 'New York: A City of Neighborhoods,' used with permission of the New York City Department of City Planning. All rights reserved.

Terra Preta_ Bioenergy_ Soil restoration_ Urban agriculture_ Art Algorithm

TERRA PRETA
black earth

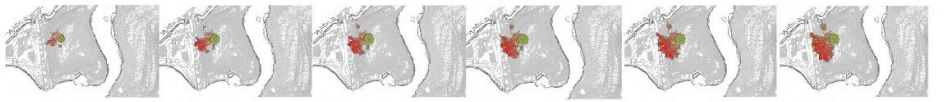
t = 4 t = 5 t = 6 t = 7 t = 8

Each of the scenarios presented shows a simulation with different parameters. The 16 frames represent approximately 10 years of time. During that period, the places where the bamboo is allowed to grow is carefully monitored and the pattern it is allowed to take is calculated using algorithms. These algorithms read data from the web and represent it as an arrangement and pattern. There is a large element of unpredictability as many factors influence the pattern that is formed.

t = 11 t = 12 t = 13 t = 14 t = 15 t = 16

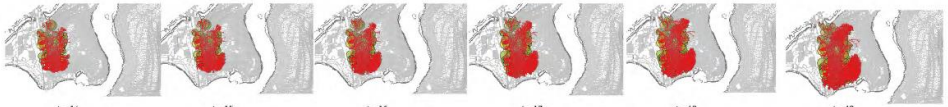
The algorithm is based on autonomous 'agents' which wonder around a model of the landscape, avoiding the gas vents, swales, paths, following the contours.

Algorithm scenario 1



t = 3 t = 4 t = 5 t = 6 t = 7 t = 8

The simulation also aims to ensure that there is adequate spacing between the bamboo plantings and that there is always a clear path to exit every clustering of plants. The algorithm also programmes which areas are to be cleared, harvested and thinned out for maintenance - ensuring that the site is not overrun by the plantation.



t = 14 t = 15 t = 16 t = 17 t = 18 t = 19

Algorithm scenario 2

t = 5 t = 6 t = 7 t = 8

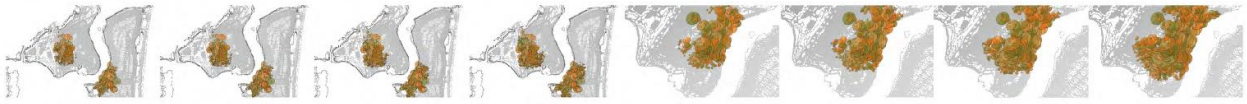
The changes in color also represent the subtle variety in lighting tones that will take place from the lighting devices that are powered from the movement of the bamboo stems in the wind. The energy generated from this movement shall be published online in real-time over the model of the site. Users will also be able to see a current 'prediction' of what the site will look like over the next 10 years and they may intervene by interacting with the interface, upload ng more parameters

t = 11 t = 12 t = 13 t = 14 t = 15 t = 16

Algorithm scenario 3

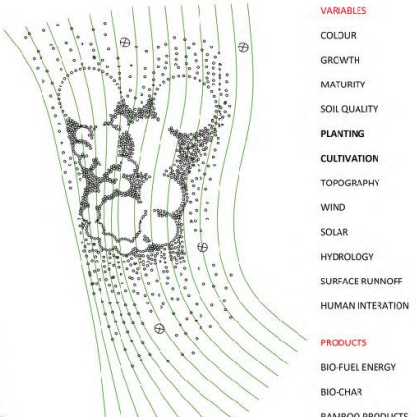
t = 1 t = 2 t = 3 t = 4 t = 5 t = 6 t = 7 t = 8

As the outcome of this process aims to be unpredictable and self-organising each 'outcome' that is shown, is only a possibility and the algorithm itself can change over time. One feature that will be preserved is allowing those who participate in the online experiment to 'tag' a bamboo plant, so that they can visit the park once it has grown. This could mean a connection between the public and individual plants.



t = 9 t = 10 months t = 11 t = 12 t = 13 t = 14 t = 15 months t = 16

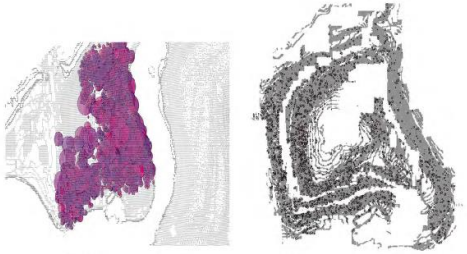
Algorithm scenario 4



VARIABLES
COLOUR
GROWTH
MATURITY
SOIL QUALITY
PLANTING
CULTIVATION
TOPOGRAPHY
WIND
SOLAR
HYDROLOGY
SURFACE RUNNOFF
HUMAN INTERATION

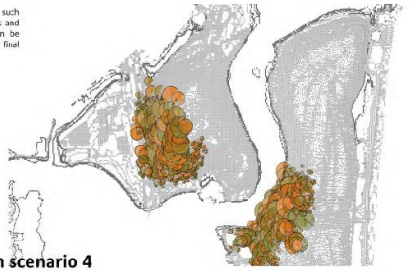
PRODUCTS
BIO-FUEL ENERGY
BIO-CHAR
BAMBOO PRODUCTS
KINETIC ENERGY
SOIL FERTILITY

Spatial plan showing the potential spaces created by the bamboo. The shapes are generated by one of the algorithm scenarios. The spaces will be thinned, harvested and cleared for public use.



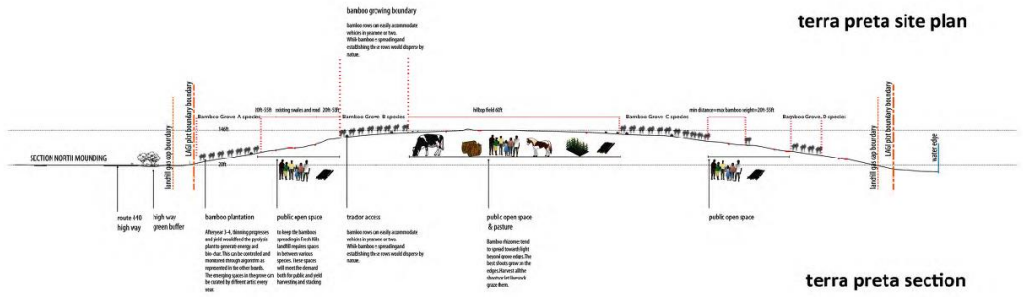
t = 17 t = 19

Different parameters such as the size of clusters and the distance that can be travelled effect the final form.

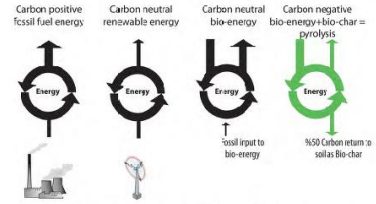


Terra Preta_ Bioenergy_ Soil restoration_ Urban agriculture_ Art Algorithm

terra preta site plan

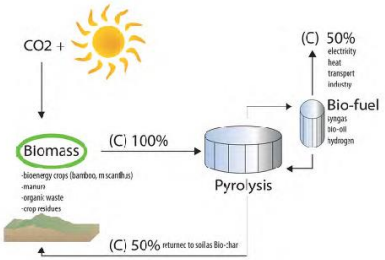


terra preta section



Adopted from Paul Taylor, "The Biochar Revolution-Transforming Agriculture & Environment

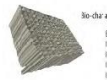
bioenergy + biochar comparison



Adopted from Paul Taylor, "The Biochar Revolution-Transforming Agriculture & Environment

bioenergy + biochar process

Typical erosion control matting as used in Fresh Kills Park



Bio-char as a Sciementieal erosion control matting

Biochar has a porous, high surface area structure
Increase water holding capacity of the soil
Improve fertil ser use efficiency
Increase biomass (crop) production
Increase soil carbon levels
Extremely resistant to decomposition – long
lasting benefit and locks C into the soil
Increase soil pH (liming agent)
Increase CEC, especially over the long-term
Improve structure and cohesiveness of the soil
Improve microbiology of the soil
Improve soil conditions for earthworm populations
Decrease emissions from soil of greenhouse gases
CO2, N2O & CH4
Decrease toxicity: Aluminium, Cadmium, DDT, PAHs

Most methane escapes from old dumps or landfills before the bacteria can co
its work. Biochar helps hold the gas in place.

Fresh Kills Park Total land coverage 2,315 acre
Annual operating cost $35,000-$30,000 per acre
Potential soil evaporation requirement over time 1,400 acre

Bio-char average application rate for soil restoration 25-125t/acre
Fresh Kills Park requires 1,600-21,000 t per 1400 acre
Pacific Pyrolysis typical project cost 36-115 million

Pacific Pyrolysis Plant Capacity	Energy(MWh)/household	Biochar(t)*
2t/dry feedstock/hour unit	1MWe-80€ households	250t/year
4t/dry feedstock/hour unit	5MWe-400 households	500t/year

Pacific Pyrolysis Environmental Benefits:

Carbon stabilization(2t/h unit)	50,300 t/year
Noise	controlled to meeting the relative planning regulations

Terra Preta_ Bioenergy_ Soil restoration_ Urban agriculture_ Art Algorithm

Appendix C: Publication III | Methods of Data Collection

Site observation

Exemplar transcription (intelligent verbatim) of semi-structured interviews

Richard O'Neill from Sydney Harbour Foreshore Authority (SHFA)_the client of Ballast Point Park_24.01.2014_Length: 1:25:39
RO: Richard O'Neill (interviewee)
KO: Kaan Ozgun (principal researcher)

1) KO: What is your definition of sustainability?

   RO: It is type of self-sufficiency. Referring to urban developments and civic spaces, you are trying to create structures and places that to the greatest extent possible utilised resources but over the long term it minimises the natural resources they use and sometimes that is through an initial take of resources and a gradual return of them over time, or through offsetting one use of resource against the creation of another and things like that. That's obviously taking the room much from a built form and natural resource point of view; we haven't started talking about social sustainability, economic sustainability and other things like that. But just take the built form aspect, that's kind of my answer.

2) KO: Do you incorporate aspects of the triple-bottom-line (environment, social, economic) into the work that you do?

   RO: Yes. Absolutely SHFA certainly aims to have a triple line, triple bottom line approach of sustainability through the projects it develops. And in some projects that is easier to achieve than it is in others. So in the case of a project like Ballast Point, if you sort of take it as environmental and cultural and economic sustainability, it is not too hard to construct the environmental sustainability arguments for Ballast Point. The cultural ones? I would say the Ballast Point being hidden missed in terms of its cultural sustainability, I think that actually can be improved. I think SHFA is going to look into look into ways to do that.

   The Financial sustainability argument is basically out the window, depending on how you want to calculate things. But certainly if you look at the acquisition and the cleaning up and construction of Ballast Point Park, there is no financial return to government for doing that. It is no matter which way you cut it, it is cost to the State to do this. Now obviously in doing that the states determine that it is cost that they think it is worth bearing for environmental and cultural reasons. It is not like you can ever create a sort of model to recoup directly the cost of a park like Ballast Point. Whereas a lot of the public and civic domain, other public and civic domain that this organisation has created, it has been possible to do that. Because it has been creating public domain in conjunction with for example commercial uses and things like that in which case you can construct financial models, or create this new public space with new public cultural facility, or whatever, and we will be able to recoup the cost of that through another aspect of the development. Therefore, you can actually have a direct financial balancing Ballast Point as a cost.

KO: *So when you say SFHA going to consider about the social aspect of the sustainability, what is the plan? Are there any tangible decisions already?*

RO: No it is an issue that's at this point only being raised internally which is that Ballast Point has always had a bit of a tension in that it is absolutely a state funded asset, if you like. A state creation. It is I think that it has been designed to be a park of regional significance. The value even in terms of its basic environmental value, the real value of Ballast Point is not providing, its great value is not that it provides 2.5 ha park to a local area, I think if that was the only value that Ballast Point offered, it would never have been acquired and it would never turned to a park. It would be covered in residences right now. What made it significant was the position that 2.5 ha occupied on Sydney harbour, it was about the significance of being able to provide, or I guess re-establish a green headland where Ballast Point is opposite Balls Head and Milsons Point, Bradleys Head, Blues Head, Blues Point and Goat island and soon the headland of Barangaroo so it was about this, the government can knock , you probably aware the land was privately owned, it was going to be developed , there was a local community campaign to try and ask the government to intervene and acquire that and buy it out. I mean governments gets approaches from people to do that all the time. Pretty much everybody who has an apartment development next to them would prefer if their government or council stepped in and made a park instead. So the government cannot respond to all of them, in this case what was significant, what made Ballast Point so significant, they said we will step and respond to this, is actually the regional significance of Ballast Point. It is about how it can create, it is part of replacing a whole network of green headlands, centred around Goat island, It is about creating a mirror in the long term once the trees establish in Ballast Point creating a mirror to Balls Head which is directly opposite which creates this kind of green gateway to the Parramata River. So the government got convinced that it was actually the regional role this headland can play in Sydney harbour as part of the, you know that estate of green headland parks in national parks in Sydney. That was the value and that made it so significant that the government would take what is actually an extraordinary step which is to step in and acquire privately owned land in a compulsory fashion and take it away and pay compensation for, it is very rare thing for governments to do that.

KO: *I guess the regional character which is the headland character is in a way overshadowing its neighbourhood character. I see the community side of the project, the social aspect of it, we somehow, it comes developed as supposed to be developed in a way. Can you say that?*

***RO: I guess so. I think the tension we have now is that it is not, having established that it is a park of a regional significance, it is not getting regional use. The people who are going there, you know if you go there any given dates very evident that the vast, vast vast majority of people who are using it are local residents. **And that's not a problem at all, it is just we are not seeing any uses that are attracting people from wider Sydney.** It is kind of a bit of a silent thing in most of Sydney's mind. And you

know SFHA point of view, that's something having local people use it is great. What you want is there is a lot of foreshore parks in Sydney harbour that obviously if you have the good fortune to live near them, because you can afford to live on Sydney harbour then you can use them locally. But then they also attract people, you know, from other parts of Sydney to come and have picnics and things like that and so far Ballast Point hasn't really done that, now there is all sorts of reasons to do with that, it is there is no parking there, it is right at the end of the peninsula through a suburban area, there isn't at this point a ferry, there is a ferry wharf there but there is no ferry route to it. So, you know, it is sort of brings up questions about whether we should be re-examining whether, for example, this is not a question just to shift routes for Sydney ferries, is it possible to start running Sunday ferry access to there. So you've got at least a public transport method to get people to and from there. It might be the we look at things like staging events there so for example, Sydney ferries did not run a regular service to Cockatoo Island (CI), when there is a major event on in Cockatoo Island then they do. It might be that one way to provide access is to try stage foreshore authority stage a lot of quiet significant event in The Rocks and Darling Harbour, maybe over time we can start staging some events at Ballast Point as a way of providing a specific day when people where it attracts people's attention and they go and they discover the park. Now, whether they do or don't ever come back again? Maybe some will some won't so you got have way to introduce it.

3) KO: Why do architects/l.architects think about renewable energy?

   RO: Why? Well, I think, designers in general I mean it is the minimizing any energy use is become a pretty standard, almost part of a firm's brand proposition now. It is an issue that you have to pay attention to. I mean I think on a personal level people who are attracted to architecture and design as a profession probably more naturally have a personal interest in renewable energy too. But even if they didn't, it is basically, it is a business requirement now. It is being enforced by, increasingly enforced by planning instruments and it has been increasingly factored into particularly any government or larger corporate sector job it has been factored into what is in the brief too.

   KO: *I haven't asked your background. Are you a planner or landscape architect?*

   RO: No I am not qualified in any of those things. I have just a lot of experiences working on projects through their planning stages.

   KO: *I am asking that because my questions could be specific, my concern is that I don't want really ask..*
   RO: If you ask something technically out of my expertise, I would say, that's not my speciality.

4) KO: How would you describe the general approach that other architects/l. Architects use to integrate renewable energy into their projects?

RO: I'd be speculating, I guess that's a question for a landscape architect, I'm going to pass on that one.

a. What is your general philosophy about using renewable energy in design projects?

RO: Look I suppose, from SFHA point of view, in terms of being people who brief people to do this sort of stuff, we would be approaching this from the point of view of trying to obtain… we would be happy to look at renewable energy usage, and we do. Look we see ourselves, this agency sees itself, because it has the fortunate position of being a government agency which means that you don't have the same profit requirements of our development proposals as others do. We do a lot of renewables that do ultimately attract the surplus but we don't have to make the profitability of a project always high priority, we got some flexibility there. Which means we can invest in sometimes in levels of technology that a private developer wouldn't do. And also we have lands and assets at very high value so basically you can afford to, I am thinking less of Ballast Point here some ways more of a project like Darling Quarter, which is a redevelopment we did in Darling Harbour, we finished in 2010. Now I mean that was Australian's first six green star designed and as built building. And that was a very clear project brief from the authority that had to achieve that status. Now the reason why we can take that position is one: the public ownership thing; and two: the sheer value of the land. So because we are dealing with foreshore sites that have a high underlying land value which means you can take this proposal to the development, saying we want to create this combination of commercial office and use of park and this, you can say that everything has to be just fantastic and everything has to be six green star and everything has to be this.. the development sector still can respond to it because they can go well, ok, the underlying value of the asset is still so high that we will be able to ultimately lease this out, to the commonwealth bank in this case, and we still make money out of it. So everybody is ok. If we try to do that in Penrith, it would be very different land economic equation so we can go out and say we want all these things to happen and the development sector would say, well you have to build that yourself, you have no way of making money. So to come back to your question, we try to pursue renewable energy as much as we can but I acknowledge that we do it from position that not every company and not every project can come from. We got a bit luxurious position in that area. We see it as a leadership role, because we have these foreshore sites, because they are publicly owned, because they are very high value, we see it as when we do do a renewable project we have responsibility to sort of try and push the envelope a little bit, so that the projects become kind of yeah, benchmarks than other projects can try to respond to and ideally pioneer some technology that would be then used in other locations.

KO: *When you are saying pushing the envelope, are you also doing that are you actually pushing for landscape architects and designers like investigate in a different way like is it because you know I mean, I am actually asking this question in a way,*

the green wash. So how do you actually know designer architect landscape architect doing not green wash?

RO: Probably getting into a level of a project construction management, that is a little bit beyond me. In the case of Ballast Point it's probably the level of relationship and trust that we have with the design team. We don't, I think designing a park like Ballast Point through both the, master planning and detail design phases is incredibly slow and very very iterative process. In the case of Ballast Point, there was plenty of potential for us to establish with the design team what our larger goals were, but doing it in a very loose way. So without, in any way trying to be prescriptive about what the built form or technological was, we were able to establish that some of the values we wanted to capture around, you know, minimising energy use, and utilising alternative materials and utilising the natural, the remnant materials of the park as best as we can, and all that sort of stuff. So we just set those very broad parameters , the design team have quite a lot of opportunity to come back with different ideas about how that could then be expressed. I can't remember all of them. The reuse of the fill from the park to create the giant gabion walls like that. Finding the left over seat belt material from where the hell they found that, to create the shade structures, the integration of the wind turbines into the sculpture. You know again, I am going beyond the level of details of my speciality but you know as someone who was kind of more an observer to that process (Tom Kennedy is the guy who actually ran it), It seemed to me that that very iterative process probably allowed for ideas to be tested, that would answer your question "how do I know that they weren't just going on a bit of a green wash. I guess my answer is I rely on Tom being a very good project manager but also that it is not a rushed process. There is plenty of opportunity when the designer brings forward and says, this is the way we can do this and this can achieve XY and Z and we've got a bit of a luxury of time, because again we don't have the same time pressures as a commercial developer does. To be able to test the ideas and explore them a lot. That's about the best answer I can give it I think.

5) KO: What problem did the design try to solve?
   a. *Was it solved? If so, how? If not, why not?*

RO: The biggest issue was, look there are number of issues Ballast Point had to resolve and they were competing.

The first was that, the site had to be remediated which meant the site had to be completely stripped so that was created automatically a design tension between the designer to ultimately create a fairly naturalistic headland but prior that happening it was going to be razed, the headland was going be completely razed… of any life forms, basically in order to make sure that all the contaminants from the prior use were gone.

Another competing pressure was desire from some sections of the community to try to retain as much of the industrial infrastructure as possible versus pressures from some parts of community to remove any remnant of industrial infrastructure. So, when you go and acquire a piece of land and say, it is not going to be apartments anymore, we're going to build a park, people initially go yippee, and you realise that people have very different ideas of what a park means, very different. We had to really, covering off a whole lot of issues, it's like on one side we've got people who are literally looking at over the water at Balls Head, which if you have been there, is just completely natural headland apart from a thin asphalt drive running through it. Otherwise it as it was in 1788. A lot of people felt, well this is what Ballast Point should be. Your plan should be, you clean up the site, you maybe allowed some footpaths through it but otherwise you plant a hell of a lot of native trees and you sit back and wait fifty years. Other people completely wanted a Victorian terraced landscape, and unsurprising and other people as many tanks, and buildings, this is the museum to Sydney industrial heritage. All these views are equally valid. They all compete against each other in terms of what the built form is going to be. That's how you wind up with solutions like, well we won't keep all the major tanks, we will keep the frame of one of the major tanks. So that gets you a bit of an industrial element, and you have community pressure to create interpretive art work so what we'll do is with the remaining framework of that tank, we'll also let an artist do some kind of interpretive piece in it and then you have community pressure to use sustainable energy. Let's put some turbines in. One tank can do all these different things at once. So the challenge for the design at Ballast Point was that there were some very fixed issues created by a very unusual landscape, so the landscape become very unusual through if you like not the damage but the reshaping it already been done to it through its industrial use. And there were dilemmas to resolve about, for example, do we leave the fact that it has just been cut away all over the place to create a completely unnatural form. There is an initial conversation about 'Do you leave that as it is. Do you let it be, If you like scarred with these like big circles and big cliffs cut into it. Do you try to reinstate that? Yes or no. The view over Barrangaroo is very different to Ballast Point; they are going try to reinstate to the extent possible what the original form may have been. At Ballast Point we worked through that issue and took a different decision, but they competing tensions, so the design was to try and provide a design that balanced different public views about what this park should be and as result, nobody is terribly unhappy but nobody is completely happy either. So where you pursue a design like that, you know the people who wanted to keep a bit of industrial heritage there, are a little bit but not completely happy. The people who wanted it to be a very natural landscape, I think will become more happy over time is the trees start to establish themselves a bit more. That was it, because the design brief was informed by a master planning process that had a lot of community involvement and was quiet kind of blue sky in a way, I mean it really did, in a way, go to, particularly the local community, and say all right we make a park, now what sort of park should it be. As result you wind up with input from the very beginning that is kind of competing. If you've then made a pact with the community, to say

what we will do make sure the planning instrument reflects this community input, then you wind up with the planning instrument that reflects these competing pressures too. Inevitably the design brief reflects that too. So that was the designers' challenge was to resolve some competing tensions.

KO: *So when you say the participatory thing was working quite well in the master planning stage. Would you say it has impact on the decision making process?*

RO: Look absolutely. I mean the local community, and by that I mean really a handful people, because this is the way community representation works: as much you try, you seldom get to really reach out into a whole community, because in any community of people, the number of people who are actually interested enough in say urban design, to take time out their Thursday night and go sit in the town hall and work on a design charette is maybe one in a thousand people or less. So what you wind up is inevitably the kind of people who volunteer themselves, I am the chair of such and such precinct group, I represent the community. Those of the people you wind up talking to. But we set up a local community reference group which was in turn made up of representatives of all the little precinct groups that operated in that local area. It is quite a politically active area. And they were, we had those as well, some quiet public processes, we just hold workshops in Balmain town hall and we advertised anybody can register and come to them. We used professional facilitators to capture all that staff. Absolutely you know, I can walk around Ballast Point today. I can show anyone from local community, you know numerous examples; this is the way it is because people said this. That isn't here because people said they don't want it. You know that sort of thing. **It is absolutely a design that was shaped by that early community input.** Absolutely.

6) KO: Could you describe how renewable energy was incorporated into (project name)?
   a. *Was the incorporation of renewable energy assigned in the original project brief?*
   b. *If not, where did the idea of integrating renewable energy into the project come from?*

RO: It is the combination of where we've tried to minimize the energy cost of the materials we brought to the site and that also includes the remediation process as well. And then we have taken some efforts to try and create renewable energy from the site through that thing there although I have some questions actually how much that's actually functioning.

KO: *It is not functioning at the moment*

RO: Yes, yes. I saw that myself the other day. I might have to look into why that is. It did initially I know it did.

KO: *I asked couple of people from local and people who work there. It worked in the first year and then they have never seen that's working.*

RO: It hasn't been spinning. Ok just well, quickly sort of start looking into my emails to see if I can find anything on that. Yes. Ok there you go that becomes a bit of a diminishment in the renewable energy if we create the technology and it doesn't. (Silence) Hmm I wonder If I should get you to meet with this chap while you are here. There is the guy by the name of Rafael who is a sustainability manager here.

KO: *That would be great, because I was also thinking asking about any people useful for the project.*

RO: I got a brief email from him this morning that the turbines have seized up and they need to, he is looking into when they are going to be repaired.

KO: *They are in a bad condition, because they are not functioning, it is incredible in four years' time they should be pretty solid. All rusted and they are all fall apart, opening.*

RO: If you don't maintain them. It is a salt water harbour side location if you don't maintain those things, they go very quickly. I think I can even, if you want to, finish your questions and what I will do if I see I can call Rafael if you want to you can try and talk to him today.

KO: *that would be great.*

RO: He may also be able to answer some of the technical questions you've got better than I did.

KO: *Basically, the initial brief was not anything about integrating renewable energy to the project. It came up afterwards.*

RO: It came up during. That would not have been this is what we want to do, it would have come up as this is how we can go about it. The way that we are going to create this park can include these things. It would not have been a primary driver of the project.

7) KO: What was the main reason for using wind turbines? Why not solar panls?
    a. *Was the decision based on specific site information or something else?*

RO: That I don't know. Why wind turbines, the exposed nature of the headland and the fact that it could be actually quite a good site for that use. Why not solar panels, now that I don't know.

8) KO: What were the original key goals for the project (social, ecological, aesthetic)?
    a. *How were they set?*
    b. *Who defined them?*
    c. *Was any negotiation required to accomplish the initial goals?*

RO: The broad goals of the project were set politically. SFHA was given an instruction by government which is to say from the cabinet of the government from the Premier to acquire the site , and then a very broad direction around we want to create, the site need to be remediated.. Acquired, remediated and transformed into a park, it needs to be a park of regional significance, it needs to include there were a number of things to include. It needed to include the wharfage, the wharf access that it had at the time. it actually needed to include provision for a maritime refueling facility and it does actually. That facility has never actually been built but the wharf and infrastructure is there for it. So that was about, I think a lot of people don't realise that, but acquiring Ballast Point the state ownership is partially about building park but also making sure that the government could retain a place on Sydney harbour where it could refuel ferries from a state owned refueling facility. Because I think all the others that exist on the harbour are privately owned with the issue that they can disappear, all they become horrendously expensive if there is only one left. So for example you have the ferries to run, you have the Navy to refuel or whatever.
And the only refuelling harbour is privately owned and that is only one of them. Than it is owned by say Shell, we we're going to charge an extraordinary price to fill your ferries here because we are the only people here do it. Because also the government protecting that they had a place where these ferries could be maintained and serviced. So the master planning actually included provision of full refueling wharf. In the end while we go to detail design a refueling facility was established around on the next point, in White Bay and at the moment that's where marine refuelling on Sydney harbour occurs. And it will occur there for the next 20 to 30 years as far as everybody can see. But if for some reason it vanishes, if you go to fine print of the planning instrument of ballast point and checking it zoning and everything actually it has the provision for that wharf that is there to be developed into a full marine refuelling wharf. At the moment it is just a wharf.

So that was part of the brief. And you know, in terms of the park, park is regional in nature, the idea that it had to ultimately integrate with the surrounding headlands of the harbour, so that sets a very broad parameter, then how do we establish the design brief in more detail, again quite a public process. We ran, you know, those blue sky kind of design workshops where we use facilitators to literally say to not just the local community, they had invited a number of different groups: other harbour uses, boating groups, things like that, design representatives to have these design workshops where we can sort of work though the concept of what is a park? What sort of things should it achieve, what types of recreation can occur? And out of all those different types of recreation, what ones should be prioritised here and you know passive versus active versus this versus that, and that's start to filter through into forming up a design brief.

9) KO: Did the goals change during the course of the project?
    a. *If so, how?*

RO: Not really. Some goals so for example marine refueling facility kind of got taken of the agenda which just if you like kind of create a little bit of relief, it opened up some

design options in terms of other parts of the park previously we couldn't have pursued because that would have clashed with the potential for the use of marine refuelling. So some things dropped away, but the goals didn't really change. I would say the pressures, the competing design pressures I spoke about: heritage versus no heritage; natural versus manmade; landscape that sort of staff, they remained quiet consistent throughout the process. And the other tension, frankly, was regional versus local use. The kind of design elements that you might put in to encourage regional use were discouraged by the local community. So for example, having more parking spaces. Local community view is if you say how many parking spaces should we have? We should have not at all. We don't want to encourage any more parking and traffic and down our street and blah, blah, so have none. If you can walk in, you don't come here. So that's sort of one of view. We asked people in Parramata how many car spaces they should have, well you should have a multi-storey car park. Laugh.. acquire the house next door build the car park on top of it. So you know that sort of thing…

KO: *So that question was not supposed to be asked to community? It should be necessarily discussed by the community, right?*

RO: Look it raises, I agree with you. Community consultation, let's say over the past ten years, it has been an evolving science. When we started in ballast point, it was reasonably a new one, and in some ways I think Ballast point went out to community a little bit too blue sky, we took frankly took too many issues to what on one hand was a local sort of representation of the community, but not in any way in elected one or one that you could really test. So someone start the meeting and say the community thinks this, or the community thinks that, because they are the chair of the whatever such and such group, you don't really have any way of interrogating that knowledge and saying that how do you know , for example there is forty thousand people in this local government area, how do you know them all of them think this? Over time the way that in general governments manage community input in projects the way SFHA does is that now that becomes a lot more targeted. It is very rare now I think, if we were doing BP again we will not have process where we kind of just go out to the world and saying
we're building a park, what do you think it should be? I think, community input is a lot more valuable when you can, you know, there is an expectation on a government agency that's been briefed to build a park, it's going to fundamentally make most of the decisions or least come up with the options. So for example if we doing BP today, we might do this differently. You can instead of saying to people what do you want in park, you can start with questions around you use researchers to do questions around: for example, what are the recreational pursuits of the area? What are the recreational facilities that cover off those pursuits? Which is the areas that have deficiency in these pursuits? Is there any scope to improve, you start looking at some research into community needs and desires about ever saying so what do you think this park should be? That gives you information what the local community need is. You give that to designers and I would say if we are running it today, we are probably at least come up with some master planning options first before we actually engage in any public design

comment process, we wouldn't start at , here is a blank sheet of paper, we would start at: here is the research we have done to this community, and its needs and aspirations all sort of staff, using that we have used design professionals to come up with the following options about what sort of design scenarios we could look at this park , we've brought that down 2 or 3 and we now provide this for comment. So you sort of funnel the discussion. And I think that's better for the organisations, I think it is ultimately better for the community. I think when you have processes where you say to the community, oh what you want?, they tell you what they want, you won't ultimately be able to deliver everything what they want. So then they actually get even more frustrated. Because we told you we wanted this, why did you ask us if you couldn't do it. So it is actually in my view much more preferable and SFHA is getting better at this. Having processes where you say at the very beginning, this is what we need to do, we want the community's input in this decision, this decision and this decision. What about that one? Out of scope, not going to waste your time. But here, here and here this is what you have input, this is what we want to know from you. So we will be doing much much more.
KO: That's the lesson learnt?
RO: Absolutely.

10) KO: Describe any lessons you have learned from this project?
    a. Have you learned anything in regards to renewable energy?

RO: Maintain the turbines, would be the lesson learnt. I might defer that one to Rafael.

11) KO: Have you been involved in similar projects? Or do you know any other built projects similar to this one?

RO: Look I had some involvement in the early planning stages of Barrangarroo. That does have some similarities to this. We haven't done any sort of fully landscaped projects since Ballast Point. I mean there will be there will be some redesign of First Fleet Park, it is going to happen in the next few years. And we've created some new public domain as part of the Darling Quarter development. That's a very different experience, that really large children's playground and water play area and surrounding public domain in Darling Harbour. But quite a different type of public domain than Ballast Point is. Active programmed urban public domain.

12) KO: How would you compare the process with your other designed public space projects?

RO: If I compare to the process of Barangaroo, it is quite different where Barangaroo has kind of alluding to what we just talked about, Barrangarooo has not gone out to the people of Sydney, and said "We are going to make a park, what you think it should look like?" Barangaroo has from the outset, taken an overriding design decision that, the purpose of that headland is to the term that they use now is it is a symbol of country. As it in it is about trying to, that's the term almost combining geographical and indigenous cultural terms together, it is about you can't literally recreate what was there but you can try to create a landscape that

speaks to the natural geography of the harbour as best as you can. I once heard Central Park described this way. I wasn't aware of it until someone mentioned this, but I can see it very clearly, that Central park is actually, one of the design idea was about creating almost a microcosm of the eastern American landscape within. It's not literally a model of it, but it has all these signifiers of the wider landscape of the east coast of America within this one space. I think that it is the similar thing in Barangaroo, they are not trying to recreate, it is very misunderstood, so they have to do quite a long process with the community trying to get this understanding, it is not about literally recreating what was there but to try and create a new space that speaks to what would have been there with integrity. So reflects its surrounding natural headlands and therefore gradually fits in. Now that decision involves taking the existing rectangular form greatly altering it reinstating landscape that wasn't there. Topography that isn't there. I mean that actually got a lot of criticism, it was not a universally liked idea, a lot of Sydney design community said that, ridiculous, it is folly and this and that. But they have endured that process so very different process than BP that they did not go and saying, "hey Sydney we are building the park, what do you think it should be?" They come out with very clear idea. We are building the park, while we can talk about what kind of activity is going to occur within it. It is fundamentally driven by, this has almost a national role as a significant green space of Sydney harbour, that reflects the natural, the indigenous landscape of Sydney in Australia, this is the priority for this. Everything else is secondary to that.

KO: I actually agree with you. I see that the whole area almost like a landscape form of Opera house in a way. It is going to be. I don't think it is regional, it is national. So there is huge argument in architecture and Landscape Architecture environment so what we suppose to preserve the industrial side of it, why we are going back and replicating the old landscape. But I think they are missing that side of it, the national character of it. And it is a prime location in the centre of the city, it is going to be as important as Sydney Opera house, I believe.

RO: It is about, as you know, former PM Paul Keating has had quite a strong interest in that project at the beginning. I heard him the debate, not just about Barangaroo but on various sites whether we should be preserving industrial heritage. I went to a conference where he sort of talked about this issue and he said, when we talk about heritage, there is the question of whose heritage, because people have a different idea of what heritage means, as in which cultural element needs to be prioritised, or which period of time is the most important. And he sort of took the view, expressed in that conference was, you know, you can look at Sydney, we can preserve 20th century stuff, or 19th century stuff or whatever. His view was there is no layer of Sydney or Australia's history that is more important than the pre-settlement layer. So you have an opportunity, his view about you know, people debate what makes, what is the one thing that makes Sydney harbour unique and special, his view is its actually the natural geography of it. The drowned river system, the network of pointing headlands which, through a lot of good luck, so

many of them have been preserved as green as natural headland. His view is that more than anything else defines Sydney Harbour and sort of anything we could build here, that will come and go. But this sort of indigenous geography of Sydney Harbour is the greatest feature of the harbour. So you are right it is kind of creating a second Opera House but it is hard for people to get that idea because people's natural reaction there, it came up with Barangaroos, but why we wouldn't put another building there? Surely we should be trying to build another Opera House and again Keating's view on this is, you can't beat the opera house. It's this one in thousand years you get a design that's that good. If you try to do something, in terms of built form architecture, that's as significant as that, your odds of succeeding are very very low. Whereas if you try to create something just as iconic and just as representative of the national sort of character and national estate, this can be just as iconic a piece of Sydney. It is just one's built but it is talking about landscape character natural character instead, and of course they will in fact a significant cultural structure underneath it.

KO: I agree with the Barangaroo location because of its site specificity, I totally disagree with his own thinking of…

RO: He has got a very particular view, Paul Keating always has very particular views and he doesn't apologise for any of them. I think in the case of Barangaroo I mean, he was quite instrumental actually getting that headland form to get through government because there would have in fact being significant pressure to build on that.

13) KO: How was the program for this project developed?
    a. Who developed it?
    b. Was it modified during the course of the project?

    KO: You mentioned about the program of the park developed through the community and I guess it is also modified during the course of the project. Maybe I should ask the question like how much of these decisions really applied, would you give a percentage?

    RO: I don't know. I would not put any percentage on it as I've said before; it is very easy for me to look at both master planning and detail design and as built form of BP. And you know literally translate the outcomes on the site back to particular community expressed desires and as I said that includes things that are not there. There is not a lot of parking there because that's local community desire. There is no café of any kind there; because it was a local community desire. I can show you what is there and how that was reflected to community process and I can also what isn't there, how that is reflected to community process too.

14) KO: How would you rate/prioritize clean energy production in comparison to other proposed program elements of this project?

KO: I know energy generation was not in that. Current state, how would you prioritize energy production in comparison to other proposed program elements of this project?

RO: I am not sure I follow that, we mean doing it today. Sorry I am not sure I understand that question.

KO: [I describe the question again.]

RO: Ok is this how we manage the park today if you build it again?

KO: If you build it again?

RO: I think we would probably come up in order of priority, I think we begin with higher priority today than it was back in 2003. One of the reason why it would be given a higher priority is because even if you are running a very community process, it would be a lot easier, there is actually a lot more community interest in, and understanding of, that. Again you know you only have to look to five years on BP to Barrangaroo, the amount of different renewable energy, water detention, retention, recycling, the amount of energy minimisation and reuse infrastructure that has been built into that project is huge, they are able to sustain that for a whole lot of reasons, but one of them is that the community interest in these technologies is growing every year. If you had to do BP today, you could absolutely begin with a far stronger sort of position on the level of renewable energy we want to pursue. I mean you would actually be obliged to, because Barangaroo is going for a climate positive rating, you know so and that's including that's on a foreshore project that includes the significant cityscape on it, so I think there would be, I think if we were literally acquiring BP today, there would be an expectation that people would literally be going well if Barangaroo can pursue climate positive surely you would be wanting to get on that, wouldn't you? Instead of becoming a renewable energy is something we can look into as we develop the project actually be brought up to the top. Right ok, how we are going to create a headland park that achieves a climate positive rating. So it would be a different process today because both the technology around renewable energy and more public understanding of it has changed a lot in ten years.

15) KO: How is the community served by this project?
    a. Have you measured or monitored the social impact? [For example, has this project enabled people to learn about sustainability or to engage more in their community?]

    RO: I would have to say we probably haven't. Apart from **anecdotally**, and the feedback we get from the local council there about how it is being utilised, you know, how it has been managed and things like that. We had a lot of conversation and feedback from the community during the design and construction process, we didn't have sort of a fair bit of feedback at the time that it opened. Since 2009

we've managed it but in terms of measuring how it is benefited that local community, it's an interesting exercise, I'm not entirely sure how you measure it. I mean look we have council on how many people use it the day. We have an idea how many people going through the park. We have ideas about how it's integrating like what they using it for. Which is primarily walking. It is basically that the biggest function it serving within the local community is that it is connecting existing public space to existing public space so it is completing a larger network of open spaces that people can walk through, and jog through and access and things like that. That is the primary use of the park. And as you would have seen if you go there, it is quiet tiered, there is the sea level and then there's the upper level. You would notice on any day you go there's vastly more people, simply, there is an ant trail of people around the sea level, that is always much more popular that the upper level, which just tells it primarily. Now again that's something that we are interested in gradually trying to shift is that ideally what you want is have the park more heavily utilised whereby you've got people walking and jogging at the sea level you have also got people using the upper levels thing like that. But my personal view is that at most of the times of the year in Sydney and particularly now the upper level, because it doesn't have a lot of tree canopy at the moment, is pretty harsh except early in the morning and later in the afternoon. That's again a question that SFHA may look into it this year is, how do we alleviate that to some extent? Do we actually need to have more shade structures or some kind?. I know there is an intention that eventually the trees that are there will get larger, they will spread, they will provide a big canopy, and that's great. We might look into things like for example 'do we provide some additional manmade structures now, on understanding that in ten years' time they are removed because they are there providing shading function so that people can access those upper levels and use them and we acknowledge that in ten years' time they can be removed as the trees establish themselves more they will fulfil the shade structure.

16) KO: Are there any challenges for the management and maintenance of this project?

RO: I would say, there must be. The turbines have stopped, beyond that I think nothing is particular interest to you that there is some very minor regulatory stuff that we work out with the local council. One of the bigger challenges is, and again it's a bureaucratic thing every other park in the areas managed by the local government often we build assets like this and we transfer them to the local government. At the moment we still have this. It is still the SFHA managing the park.

KO: Any plan to take over?

RO: I really don't know actually. Because the nature of it means it kind of could go two ways. I think ultimately SFHA won't keep owning it. But whether they divest it to local council or possibly to National Parks and Wildlife because they have a network of foreshore parks, it might fit more neatly into their, their range of parks, so that's very much a bureaucratic question, I think it is one that going to be resolved over time.

17) KO: Is there a management plan for the project that addresses the renewable energy sources?
RO: There is, again not my speciality. There are people I can ask if they can have a talk to you. Gaven Raly is the gentleman who might be able to speak most accurately to sort of day to day management of the park.
KO: In terms of renewable energy side also?
RO: Rafael

18) KO: What are the maintenance costs? How is the project perceived by site managers?

RO: We can get a figure for that. I don't know what it is.

19) KO: Are there any other challenges of the project?
In terms of a part from the turbines, in terms of its physicality we had to do some minor changes to the project in terms of accessibility?
KO: What type of issues?
RO: Minor minor, just some parts, the park because of its topography, was never going to be a park you can completely move around if you are in a wheel chair or things like that. But there have been some so for example there is a section there we got the archaeological finds of the park. Previously if you are in a wheel chair, you couldn't actually get to see those, because there was a rocky sandstone landscape in front of it. So we put in a light kind of metal structure on top of that. If you are on a wheel chair you want to get to see those displayed, you know there is outdoor cabinets, we've recently done a change that if you are in a wheel chair and you want to get see those objects, that's possible to do now. There is also more fencing than there was the beginning. It was designed all over the park there is natural ledges and edges and things, and, you know, I think probably as the parents of young children in Sydney took kids there; they kind of freaked out a bit. Because everybody is used to everything being fenced. It is almost impossible fall off now because we fenced everything. When they went to BP. We got letters we actually got some complaints. I can't believe you actually have this ledge here, people can fall of it. This happens in natural landscapes. We haven't gone and fenced everything but I mean I can probably walk you around the park and go that fence was not originally here when the park opened. We have done particular risk assessments; there is some places where we always had fences where there are drops of several storeys, we put a fence, because anybody who falls off this would die. But there is others where they might not have killed themselves but they might have hurt themselves when they fall off. Some of those we stepped in and put fences around. Others we've left, we haven't fenced everything, we just have to, just trying it is a balance between trying to create a safe environment including for children but you know respect to fact that its design is to try to be a natural space as far as possible. Natural spaces have risks in them. Nature has cliffs.

20) KO: Was the project team multi-disciplinary?
    a. If so, what professionals were involved and what was their role?

b. Who led the team?

RO: There were two project managers over time. Adrianne Crey was the project manager of the project up until I guess the approval of the master plan. She is subsequently moved to, left the authority, she lives in Brisbane now. When Adrianne left, Tom Kennedy took over project management

KO: Did she involve in the master planning stage?

RO: Yeah, yeah. She was absolutely project manager from the inception of the project, certainly got it through to master plan approval and moved on probably at the early stages of detailed design.

21) KO: Do you normally collaborate with those professions or was that specific for this project?

RO: Most of our projects involve a pretty multidisciplinary team but it would be shaped by the particular needs of the project so it is question better for Tom. I can't remember the details. If you like I am one of the disciplines, community management is one of the disciplines. If I pull off the list of the consultants, you know, it is, wind science consultants, sewage and water management consultants, there was sort of, the number of people who got involved in different questions was pretty outstanding. It is almost all external expertise, so it is not possible for the Authority as a public agency permanently have a wind science expert on site, in staff. We don't do that. We have a very small group of basically project managers and every project is relying on heavily on contracting and consulting in expertise so you can get in for a short period of time and then it goes away again. Anyway that's how that team would have been structured.

22) KO: Could you describe the decision-making process relevant to this project? (ie. Permitting process, change in regulations, exemption to regulations, etc.)

a. Did this have an impact on the design process, operations and outcome? If so, how?

RO: I know an exemption have to be found for usual requirements around mobility and accessibility. Obviously you aim to make that fully comply with BCA or whatever the other requirements are , you can then seek an exemption, and as I say, because Ballast Point was the existing topography the level difference between sea level and upper level of the park which we couldn't change, there is no way to actually achieve this. It just wasn't physically possible. So, we then negotiated with access groups, and disability representative, what can we achieve? The compromise was there would be two entrances to the park. There would be the upper entrance and there would be the lower entrance, as long as you can fully navigate the lower entrance if you arrive there, because you can get a vehicle to there. So if you get to that part of the park and that's what you choose to end up, you can get all the around the lower level, you can get back to the vehicle and go to the upper level of the park and you can access to the entire upper level. What you can't do is transition in between the two levels without exiting the park. That was kind of negotiated and agreed in the circumstances that was a pretty good outcome given that we couldn't change the existing shape of the park, but nonetheless that is still an exemption, you have to, you know, get an exemption

from the usual BCA requirements. I don't think there were any particular exemptions.

KO: Did they consider lift?
It would have been considered and discarded I am not sure. That would have been a reason why that was discounted as an idea, possibly… I don't know.

23) KO: What was the initial project budget and the final project cost?

RO: I don't know. I keep hearing 25 million dollars keeps rolling around and around in this building. That would include the land acquisition cost. 25 million dollar figure I believe includes land acquisition, land acquisition from my memory was there were very rough figures around about 12million dollars I think.
KO: 12million dollars?
RO: Yep. So the remainder is the actual remediation and construction cost. It nearly became a lot more expensive. The land acquisition value was challenged by the developer who owned it at the time. And initially they won that challenge, they took it to court wanting 80 million dollars and initially won. And then it was overturned on appeal. So we nearly wound up having to pay 80 million dollars for that site, which would have set a precedent that would have made sure that no government in Australia would ever do this again. It would have been the end of governments acquiring land to build parks, they never would have done it again, but fortunately it got overturned in the Supreme Court.

a. What are the reasons for any differences?
b. Did the budget impact any decision-making process? i.e. Renewable energy type, plant selection, material palette, etc.

RO: It is pretty evident when you go to the site, I don't think, there was obviously a requirement to be reasonably financially accountable and responsible but I don't believe the organisation was ever put under a lot of pressure, by government to do this cheaply. We were given the ability to come up with the design that we believed was going to achieve the right outcome, an outcome of permanent quality for a park of regional significance and then present what the cost that was going be. And then that cost was approved. For memory I don't really recall any point where, you know, there was a sense that there were probably ideas that had to be set aside because they were too expensive, but they would have been particularly high cost or luxurious ideas. Generally I think there was a sense that the park, once its overall design and master plan had been established, it can be designed and constructed in a way where you could expend the money necessary to create a high quality design and high long life material outcome. You know, I actually think as I look around that site, I was there two months ago, having a wander around, you can see that it is not a cheap park. It has been done pretty well which is ideally how it should be if you are creating a regional park.

24) KO: What was the initial public reaction to the project? Has this changed over time?

RO: So the initial public reaction so if you talking about right at the very beginning when it was announced, it is very interesting, I would describe the initial local public reaction as a combination of disbelief and suspicion. So they had been, the local community had kind of been fighting for this thing to be acquired for the development that was proposed for the site to be stopped, for a long long time. And you know when it actually happened, and the state government said no ok we are going to acquire this and, and sent the SFHA to manage it, we had to spend a lot of time at these initial community meetings, actually trying to convince some people that we didn't in fact have a secret plan in our back pocket to build something on it. They were so battle hardened, you know, that we were regularly having to backpack this suspicion. It was kind of like, it was sort of too good to be true, that the state government would actually do this. There must be some ulterior motive that we don't know about. Really quite crazy, one in particular I wasn't present in this meeting. A colleague told me about one of their early community meeting really got quite hostile, these groups demanding to know what the secret agenda was. This poor community rep there going, "we don't have a secret agenda, we have been given an instruction by government and it is to do this". That flared up again when that court challenge happened, and it looked like the government might have to pay 80 million dollars for the site, we straight away, that was over a year later, we had the same people on the phone saying, Oh so this means, the park's off doesn't it? You can't afford it now; you have to just build on it. We had to sort of hose that down again, no we are not, would be a double loss if the government has to pay 80 million dollars for this to build a park and still doesn't even build the park, it is like a double loss to the government politically. And in any case what we actually said was that we are appealing this, everybody just stay calm, they've won, we appeal, and we see what happens. We just have to keep our fingers crossed. But it was really interesting mix of emotions, some people were very happy about it, other people were just… Generally public reaction is that's great, if you tell people we are going to build a park. Oh, good! And it actually makes to some extent getting community engagement a little bit more difficult. Because what we did see as I said you have got your community engagement process, you've got your usual local representatives you know, your very very interested people, what you tried to do is, reach out beyond them to sort of to just the ordinary people living in the community. What we have found is we would widely advertise meetings and opportunities to come to things. What we have found is that we did get a bit of a rush initially, we'd have these events and quite a lot of people would show up. What we saw there was kind of I call it reality testing, by the average mums and dads and people of the community, they heard there's some plan to build a park down there, there is a meeting about it and they go along, they basically sort of you know you hold up a rough plan, it is going to be something like this. And they go, Ah, ok. And then they walk out the door. Because that's the level of knowledge that a lot of people are very happy with. They heard that it is going to be a park; they just want to check, is it really; let's have the drawing, oh that looks like a park. Ok. That's it. You don't hear from them again. Because the level of curiosity they need to know, which is someone is building a park in my neighbourhood, next question when it will open, 5 years time… Ok. That's it. They file that away, they are happy with that. The number of

people who then want to get into, what sort of park, what sort of facilities will include, and you got the people who want to help you design the handrails. We literally did. I think handrails should be.. ok great. Most people are actually happy with the top tier of knowledge, so it's very different to if you are going to build a combination of office buildings and this this and this, people get much more engaged because it is more complex thing and they want to know things like heights and shapes and this and shadows and all sort of stuff, whereas when you say we build a park, for many people it is just I want to check that you are building a park, tick Yes you are , that's good, that's all I need to know.

25) KO: Has the project received any awards/recognition or caused any controversy?
RO: We had some residents who didn't want us to build a toilet block there; it might block part of their view. It is just minor stuff. Controversy as enough to make a mention in a local newspaper. We had to manage number of issues during the construction phase because obviously it generated a huge amount of construction traffic, tons tons of soil in and out of the park, through narrow street. There is fair bit of you know, just very local but there is a fair bit of public debate and controversy through various issues in the start of the project. Once the master plan design was established and the local community got satisfied that you know, there was going to be a park there, and the people building the park, seemed like reasonably competent people who going to do an ok job. They had a plan for the construction; they had a plan for how we are going to minimize the truck movements and all that sort of stuff. When you sort of got that ticked off, it kind of all settles away, and it got quieter and quitter as the project moved on. I think since then the only operating controversy has been New Year 's Eve, but that's a general Balmain area controversy. You know there is always these wonderful places in the Balmain peninsula you can watch fireworks on New Year's Eve, but they get very crowd management about it, so Ballast Point just becomes one of a networks of parks that become involved in police road closures and shutdowns.

KO: How did you see the community of Balmain especially around that area in comparison to other parts of Sydney?

RO: Balmain, is idiosyncratic in terms of the expectation that people have about their ability to directly shape outcomes, is extremely high, extremely high. I would say there is no other area of government that I have worked in where there is this level of expectation. I mean, there are reasons for that, it is quite an educated community, there is a high percentage of people who have architecture and design backgrounds living there, you've got people who are quite interested in urban design issues, but the kind of, some of the meetings we have that in local area and the people you can got to show up to them, the issues they want to talk about, the details they want to talk about, I think there are other parts of Sydney where you just wouldn't get people to show up. Because they would actually regard it as deeply boring, and they would probably regard it as well, isn't that a designer's job? A lot of them, a lot of other parts of Sydney , we want to be interested in telling you about, first, if it is a park, they want to keep the conversation to, well you know , there is a lot of kids around here that are

such and such age and it is really important that we have facilities that are A,B and C. And that's the end of their input. They won't then sit down and go and therefore let me get out the pencil and show you, and there's this piece of equipment, they don't try to, they are less inclined to want to try to describe the outcome.They'll talk to you about what their preferred needs are and also I now want to go home thanks, I don't want to sit here and talk to you guys all night, I've got things to do. In some parts of Sydney, it is like this is almost; it's a real interest for people. They love doing it.

KO: I spent like two weeks there doing site observation. I have never seen this much interested people anywhere. They just come and talk, ask questions. What's going on, what is going on. So much curiosity and they all like knowledgeable, each of them I had pleasure to talk. It was great.

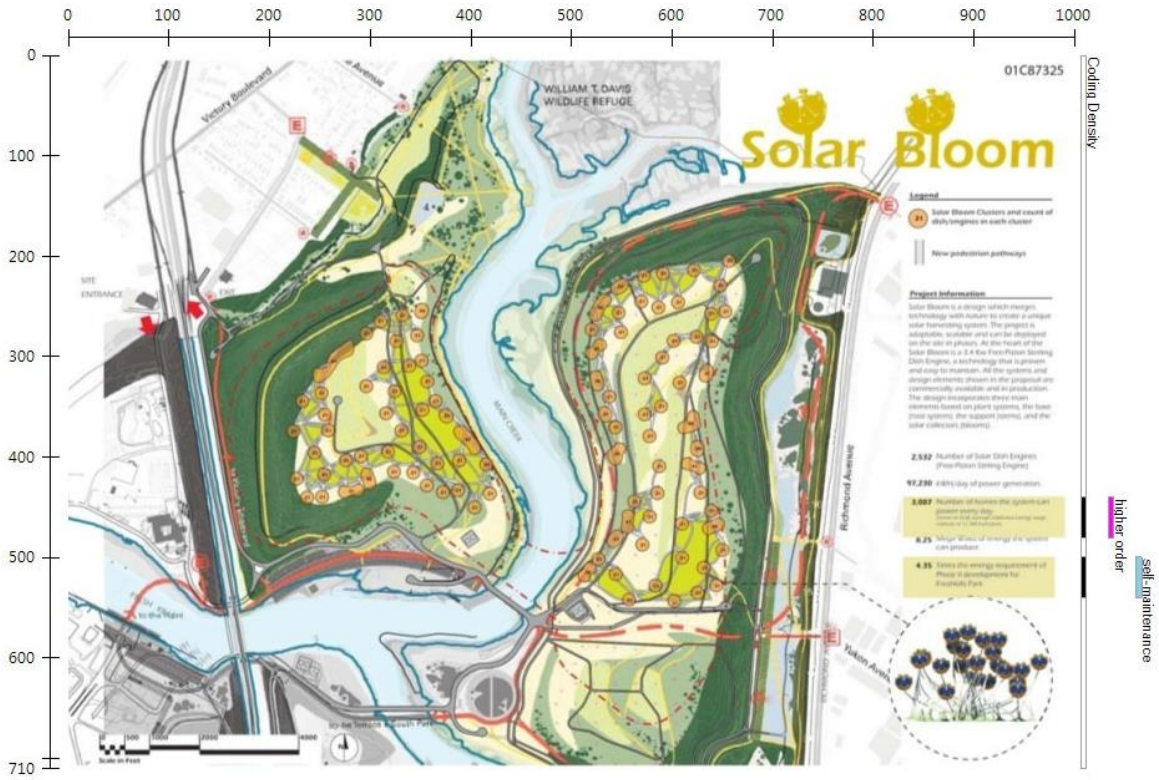
RO: It is a very interesting community and very, very involved community. So yeah, it makes it so you want to run a sort of public engagement process in a place like Balmain, it makes it a lot more labour intensive, it makes it a more expensive process. The issue is when you're building, this is the tension that comes for us a lot, you are building a regionally-funded project in a local area. So what has to be borne in mind is that everybody across the state is paying for Ballast Point. So we sort of have an obligation to…

[Interrupted by someone for another meeting].

RO: Sorry this one's gone over time, I will come over there now. Ok?
KO: Thanks very much it was a delightful conversation.
RO: What I will do is, how about I ask Rafael and Gavin, I will approach them later today, and see if they can get in contact with you for they can nominate someone talk to you.

Appendix D: Publication IV | Methods of Data Collection

Content Analysis: Nvivo software is used for analysing the competition entry 'Solar Bloom', Entry 22 in figure 7.4.

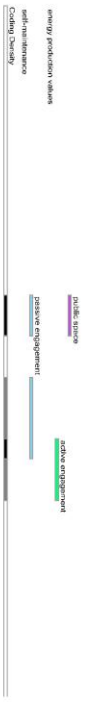


Name: solarbloom

Description: 25

Created On: 25/07/2014 3:50:08 PM
Created By: KO
Modified On: 6/08/2014 3:34:25 PM
Modified By: KO
Size: 5 KB

¶1: 2012 THE LAND ART GENERATOR INITIATIVE COMPETITION
¶2: FRESHKILLS PARK – SOLAR BLOOM
¶3:
¶4: Solar Bloom is a project which merges technology with nature to create a unique solar harvesting system. The project is adaptable, scalable and can be deployed on the site in phases. Visitors will be encouraged to inhabit the Solar Bloom clusters. The design of the clusters is intended to invoke an altered sense of nature, where natural elements intertwine with the man made. The clusters are envisioned as a place of play as well as for social and cultural activities. Visitors can escape the openness of the site and enjoy some shade from the blooms overhead gathering the sun energy. Visitors will be able to directly engage with the energy being harvested by providing outlets to allow charging and powering their devices.
¶5:
¶6: At the heart of the Solar Bloom is a 3.4 Kw Free-Piston Sterling Dish Engine, a technology that is proven and easy to maintain. All the systems and design elements shown in the proposal are easily fabricated or commercially available. The design incorporates three main elements based on plant systems, the base (root system), the support (stems), and the solar collectors (blooms).
¶7:



1 / 3

1A

¶8: The base is made up of an interwoven concrete support system that is designed to stabilize the stem and blooms by distributing the load across a wide surface area. This will help ensure minimal impact to the delicate site condition by putting nominal pressure on the multiple layers which make up the landfill cap. The base also allows for the system to adapt to the varying slopes of the site and navigate around the numerous landfill elements such as the gas vents. The shape of the concrete base will also allow for all of the internal mechanics such as transformers and battery storage to be enclosed and out of sight. The base will also feature a grooved pattern in the concrete to foster the growth of natural moss and ground cover plants.

¶9:

¶10: The design for the clusters stems is based on the idea of grafting. Each bloom will be supported by multiple grafted stems emanating from the base and merging at the bloom. This arrangement allows the system to become structurally stable. Each stem is connected to one or two other stems creating a rigid A-frame or tripod like arrangement. The stems are made of 18 inch diameter structural steel tubes that are curved in a series of 10 typical radii allowing for a modular construction of the stem system. The curved pipe sections are then cut to specific arc lengths and assembled together to create the stems. With the 10 modular radii there are over 2000 combinations possible allowing for varied and unique stem system.

¶11:

¶12: At the top of the stems are the blooms which are the heart of the system. The blooms house a 3.4 kW free piston Sterling Engine with a 15.4 foot diameter reflective dish. The dish engine is enclosed with a translucent panel made of an eco-friendly resin that is 40 percent recycled content and 100 percent recyclable. The enclosure is illuminated at night with a series of energy efficient LED lights. The intensity of the LED lights at night will vary depending on the amount of energy the bloom collected for

2A

that day allowing the visitors to see a visual representation of the systems efficacy. The entire bloom is structured with a lightweight steel and aluminum support structure which is mounted to a 2 axis solar tracking system to ensure optimal collector efficiency.

¶13:

¶14: Environmental Impact Statement

¶15:

¶16:

¶17: The proposed design will accommodate enough energy to sustain the entire phase I and Phase II energy demand of the site. The system is capable of producing 93,230 kWH/day which is over 4 times the energy required for phase II (assuming LEED building principles from table 15-3 of the FreshkillsGEIS). This would allow Freshkills Park to be a significantly net positive energy project.

¶18:

¶19: The design, material, and construction follow LEED Green Building practices to ensure the least amount of environmental impact. The proposed design will not affect existing waterways, engineered systems, or infrastructure. The proposed system was design to float on the existing landfill which will distribute the weight of the system as well as conform to the natural slopes of the site and minimizing the impact on the landfill cap. The design also allows for access to existing infrastructure elements on the site. The design is modular in nature and a significant portion of the clusters can be manufactures off site allowing minimal disruption of the site during construction of the clusters.

3A