

Economic Development, Decoupling and Urban Infrastructure: the role of innovation for an urban transition in Cape Town

by

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Declaration

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March 2011

Abstract

This thesis investigates the case of the Cape Town Central City Provincial Government Revitalisation Initiative (CCPGRI) as a means to further understanding of socio-technical transitions. The departure point for this research is the recognition that the current economic growth and development trajectory is unsustainable. Despite this, deeply institutionalised frames of reference for decision-making reinforce and perpetuate the utilisation of (incumbent) socio-technical systems which diminish finite resources and deteriorate eco-system services.

The theoretical notion of decoupling, however, offers an alternative economic development paradigm. Decoupling has been identified, within this thesis, as the guiding framework through which adaptation strategies should be carried out. This was identified through a comprehensive literature review and an assessment of Cape Town's critical networked infrastructure. Networked infrastructure conveys flows of resources across vast urban spaces, in a linear configuration, thus conditioning resource flows and consumption. The case of Cape Town, however, illustrates that a linear configuration of infrastructure is both financially and environmentally unsustainable. Moreover, the case provides the empirical evidence for decoupling, reinforcing the argument for the adoption of the notion as an alternative development paradigm.

Networked infrastructure has furthermore been identified as a socio-technical system, and therefore is considered as the component requiring a system transition and the subsequent intervention point for decoupling economic growth from resource consumption. From an implementation perspective, socio-technical system transitions, achieved through innovation, are the necessary component for realising sustainable urban development.

It is argued that innovation, necessary for socio-technical system transitions, should be the product of sustainability-orientated innovation systems (SOIS's). SOIS's are implicitly linked to decoupling through the shared goal of enabling greater sustainability. The Cape Town CCPGRI has been extrapolated onto the multi-levelled perspective (MLP) model and is used to further understanding about how socio-technical system transitions are achieved. Findings indicate that socio-technical systems transitions are possible in urban areas that have multiple niche innovations developing simultaneously. Of significance is the presence of an intermediary, who is able to facilitate and manage the development of niche innovations emerging from SOIS's. It is therefore argued that high quality networking is critical for achieving socio-technical transitions which emerge from SOIS's.

Opsomming

Hierdie tesis ondersoek die geval van die 'Cape Town Central City Provincial Government Revitalisation Initiative' (CCPGRI) as 'n manier om die begrip van sosio-tegniese oorgange te bevorder. Die vertrek punt vir hierdie navorsing is die insig dat die huidige verloop van ekonomiese groei en ontwikkeling onvolhoubaar is. Ten spyte hiervan versterk en verleng geïntitutionaliseerde verwysingsraamwerke vir besluitneming die gebruik van (opgelegde) sosio-tegniese sisteme wat uitputbare bronne verminder en ekosisteme dienste laat agteruitgaan.

Die teoretiese idee van ontkoppeling bied nogtans 'n alternatiewe paradigma vir ekonomiese ontwikkeling. Hierdie tesis identifiseer ontkoppeling as die rigtinggewende raamwerk waardeur aanpassing strategië uitgevoer behoort te word. Dit is geïdentifiseer deur 'n omvattende literatuurstudie en 'n beoordeling van Kaapstad se kritiese infrastruktuur netwerk. Netwerke van infrastruktuur vervoer die vloei van bronne in 'n liniêre konfigurasie oor wye stedelike ruimtes en kondisioneer daardeur die vloei en verbruik van bronne. Die geval van Kaapstad illustreer egter dat 'n liniêre konfigurasie van infrastruktuur beide finansiëel en omgewingsverwant onvolhoubaar is. Verder voorsien hierdie geval die empiriese bewyse vir ontkoppeling en versterk daardeur die argument vir die aanvaarding van die idee as 'n alternatiewe paradigma vir ontwikkeling.

Infrastruktuur netwerke is verder geïdentifiseer as 'n sosio-tegniese sisteem en word daarom geag as die komponent wat 'n sisteem oorgang vereis en die gevolglike punt van ingryping om ekonomiese groei van bron verbruik te ontkoppel. Uit 'n implementering oogpunt is die oorgang van sosio-tegniese sisteme, voltrek deur innovering, die noodsaaklike komponent om volhoubare stedelike ontwikkeling te realiseer.

Daar word geredeneer dat innovering – noodsaaklik vir sosio-tegniese sisteem oorgang – die produk behoort te wees van volhoubaar geïoriënteerde innovering sisteme. Hierdie sisteme is implisiet verbind aan ontkoppeling deur die gedeelde doel om groter volhoubaarheid moontlik te maak. Die Kaapstadse CCPGRI is op die meervlakkige perspektief model ge-ekstrapoleer en is aangewend om begrip te bevorder van hoe sosio-tegniese sisteem oorgang bereik word. Bevindings dui daarop dat sosio-tegniese sisteem oorgang moontlik is in stedelike gebiede waar meervoudige *niche* innoverings gelyktydig ontwikkel. Die teenwoordigheid van 'n tussenganger, wat die ontwikkeling van *niche* innoverings wat voortspruit uit die volhoubaar geïoriënteerde innovering sisteme kan fasiliteer en bestuur, is belangrik. Daar word dus geredeneer dat hoë kwaliteit netwerk daarstelling krities is vir die uitvoer van sosio-tegniese oorgange wat uit volhoubaar geïoriënteerde innovering sisteme voortspruit.

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List of Acronyms and Abbreviations

BLA	Black Local Authorities
CBD	Central Business District
CCPGRI	Central City Provincial Government Regeneration Initiative
SURF	Centre for Sustainable Urban Development and Regional Futures
CCT	City of Cape Town
CCDS	Central City Development Strategy
CDM	Clean Development Mechanism
CHEC	Cape Town Higher Education Consortium
DE	Domestic Extraction
DMI	Direct Material Input
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
GDP	Gross Domestic Product
GGP	Gross Geographic Product
GJ	Giga Joule
HDI	Human Development Index
kWh	kilo Watt hour
KV	Kilo Volt
IDP	Integrated Development Plan
IPCC	International Panel on Climate Change
IEP	Independent Energy Producer
IMEP	Integrated Metropolitan Environmental Policy
MEA	Millennium Ecosystem Assessment
MLP	Multi-Level-Perspective
MFA	Material Flow Analysis
MW	Mega Watts
MVA	Mega Volt Amperes
NIE	Newly Industrialised Economies
NGO	Non-governmental Organisation
NFSD	National Framework for Sustainable Development
NSSD	National Strategy for Sustainable Development

OECD	Organisation of Economic Cooperation and Development
PFMA	Public Finance Management Act
PPP	Public Private Partnership
PRASA	Passenger Rail Agency of South Africa
RICS	Royal Institute of Chartered Surveyors
SDF	Spatial Development Framework
SEA	Sustainable Energy Africa
SOIS	Sustainability Orientated Innovation System
SWH	Solar water heaters
TMI	Total Material Input
TMR	Total Material Requirement
TNC	Transnational Corporation
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN-Habitat	United Nations Human Settlement Programme
UAW	Unaccounted for Water
WC	Western Cape
WCPG	Western Cape Provincial Government
WCED	World Commission on Environment and Development
WLA	White Local Authorities
WWF	World Wildlife Fund
WDM	Water Demand Management
WSDP	Water Services Development Plan
WTW	Water Treatment Works
WWTW	Wastewater Treatment Works

Chapter One: Introduction

“A spring flowing out of the ground appears new.

We call it a source of fresh water

Yet the water is ancient, having circulated between earth and sky for eons...”

(World Resources Institute, 2002:02)

1.1 Background

The structure of human life within an urban context is conditioned by the configuration of networked infrastructures (Lee, 2007). Infrastructure, through its configuration, dictates how individuals negotiate their daily lives. The continuation of the c. 21st human condition is wholly dependent on functioning infrastructure which conveys resource flows, thus providing access to nutrition, shelter, transport, information and technology. The role that infrastructure plays in enabling the functioning of cities and conveying resources therefore warrants attention within the sustainability debate.

Attention is warranted since towns and cities have become the context for understanding future development in both literature on urban studies and literature on sustainability and sustainable development, due to the demands urban areas place on natural resources and ecosystem services (Martine *et al*, 2008). As a global entity, human kind is approaching resource thresholds (Wackernagel and Rees, 1996). The most noticeable symptom is the unprecedented acceleration of climate change experienced over the past four decades (IPPC, 2007), while the less conspicuous symptom is the deterioration of ecosystem services that have degraded by 60% during the same period (Millennium Ecosystem Assessment (MEA), 2005). Evidence indicates that cities, which house the majority of the global population, are the locality of concentrated processes and systems which contribute to the unsustainable development trajectory of human kind (Kamal-Chaoui and Robert, 2009; Lee, 2007; Pieterse, 2008; Swilling, 2004, 2006; Martine *et al*, 2008; Tukker, 2005).

Cities contribute to environmental degradation and will continue to do so to a far greater extent if the current systems and processes remain intransigent. Cities of the global South will be the locality of all future population growth, placing additional pressure on already stressed

environmental systems (UN-Habitat, 2008). It has been proposed, therefore, that such cities have a role to play in the restoration of the ecosystems, due to their nature as a locality of knowledge exchange, diversity and culture, within a spatial boundary (UN-Habitat, 2008; Swilling, 2008; Martine *et al*, 2008; Birkeland, 2008; Geels, 2010). The implicit notion when considering the role of infrastructure in cities and the cities' role in the sustainability debate is thus that the configuration of urban infrastructure contributes to unsustainable resource use but also has a role to play in the panacea for development and sustainability.

Conceptually, if the 'configuration of infrastructure' is unsustainable, a possible response is to 'reconfigure' infrastructure in a manner based on sustainability principles and thus decrease the demand that cities have on natural resources and ecosystem services. The theoretical notion for this approach is decoupling and technological interventions provide the solution. Infrastructure is however the physical manifestation of a complex interaction between ecological, social, economic, institutional and technological structures. Urban management practices generally ignore the relationship between these components, thus resulting in the failure of technological interventions for the resolution of urban challenges (UN-Habitat, 2008). Isolated techno-fixes are therefore inadequate, as infrastructure is a long-term, inflexible investment, thus limiting opportunities for intervention (Lee, 2007). Intervention strategies therefore need a systemic approach which accounts for both socio-economic and technical components within a particular system.

The purpose of this thesis is to explore the relationship and interactions between the diverse components of the urban system which influence the configuration of infrastructure. Infrastructure is understood as *networked infrastructure*, articulated as *socio-technical networks* or the *socio-technical systems*, which support a complex system of resources flows, enabling the city to exist (Guy *et al*, 2001; Girardet, 2004). This research aims to provide insight into how an integrated, systemic approach to socio-economic and technical components of a socio-technical system can allow for the development of appropriate (sustainability) interventions for cities. Therefore, this thesis focuses on the role of cities when endeavouring to develop sustainably and the contribution of the theoretical notion of decoupling to this endeavour. In addition, emphasis is placed on the role of a sustainability-orientated innovation system (SOIS) as the means through which decoupling can be implemented using socio-technical systems as an intervention point.

This brief overview in this introductory chapter provides the background for the enacted research. What follows is an explanation of how the research topic was formed, as well as an explanation of the research design and methodology, and clarification of critical concepts. Furthermore, this

chapter provides insight into the significance of the research. Finally, key concepts are clarified, followed by an overview of this thesis.

1.2 Refining the topic

During the initial stages of preparing a research proposal, I spent time considering various topics of interest that had a potential opportunity for research. The overarching theme of sustainability as a normative statement created the framework for this research, while the role of the urban and built environment within that framework appealed to me. I was intrigued by a paper astutely named *Lights! Water! Motion!* by Doshi *et al* (2007), which clearly reveals that 'world' infrastructures are in a state of crisis and require major investment over the next several decades. I was thus faced with the question of how to understand the role of infrastructure within the era of an ecological crisis and the desire for sustainability. Interesting work by Guy *et al* (2001) which conceptualises infrastructure as a socio-technical system, offered a framework through which I could begin to grapple with the complex nature of cities and their underlying support system.

After scanning a wide range of literature and brainstorming the possibilities around this theme, I concluded that an opportunity for research presented itself in the links between *sustainable development* within the context of the *urban environment*, particularly the relationship between the *infrastructure as a socio-technical system* and *decoupling* as a theoretical notion. The additional theme of *sustainability-orientated innovation systems* (SOIS's) caught my attention, in relation to the socio-technical transitions. Based on Mouton's (2008) approach, I conducted a preliminary literature review to transform my areas of interest and ideas into research objectives and aims.

Whilst refining my topic, an opportunity arose for me to be a student participant in the Cape Town Central City Provincial Government Regeneration Initiative (CCPGRI), a Western Cape Provincial Government initiative. The information about the project provided an overview of its vision to use public sector assets to leverage private sector investment and thus regenerate and revitalise the Cape Town Central City. The language adopted to describe the project was consistent with my areas of interest. Reference was made to sustainability principles within regeneration planning in Cape Town as an urban context and reference to the investment in and enrichment of urban infrastructures. This project therefore provided an interesting context through which my research could be conducted, to potentially understand the relationship between socio-technical systems in an urban context juxtaposed to the theoretical notions of decoupling and SOIS. Both Cape Town and the Cape Town CCPGRI are considered the units of analysis.

From this departure point I finalised the aims and research objectives for this study, which would then inform my research design.

1.2.1 Objectives

1. To determine the relationship between socio-technical system transitions and the theoretical notion of decoupling within the context of innovation systems.
2. To provide the empirical evidence for the theoretical notion of decoupling, using Cape Town metropolitan area as a context.
3. To advance the understanding of urban socio-technical transitions.

1.3 Research design

I concluded that, due to the nature of this research, it would be necessary to utilise both non-empirical and empirical research to ensure credibility of research findings. This method is used because the overarching lens of sustainable development requires that the research be understood from a complexity and systems perspective (Gallopín, 2003; Clayton and Radcliff, 1996). Non-empirical research would be conducted using a comprehensive literature review, followed by empirical research which makes use of ethnographic research methods; more specifically participant observation, and data collection, including self-reported data collection through semi-structured interviews and secondary data analysis (SDA). Access to this data was made possible by my role as a student participant in the CCPGRI. Furthermore, due to the low level of control, representative of the nature of participant observation, I was unsure of what additional research techniques might be required at various stages and therefore adopted O'Reilly's approach of conducting "...iterative-inductive research (that evolves in design through the study)..." (O'Reilly, 2005: 3).

A literature review was identified as the most appropriate way to provide the context within which this research would be conducted. Chapter 2 therefore includes an overview of unsustainable resource use trends and social development trajectories, which were then located within the context of an urban setting. The foundation created provided the opportunity to meet the first research objective, outlined in section 1.2.1, through a review of literature which identified infrastructure or socio-technical systems as the conveyor of resource flows and how these systems, normatively, offer an opportunity for the implementation of decoupling, thus providing a conceptualisation of the role of socio-technical system transitions in the context of decoupling.

A literature review was also distinguished in chapter 3 as the means through which Cape Town's development trajectory should be illustrated, and thus provided the context in which the second

research objective, outlined in section 1.2.1, could be demonstrated. This objective, however, requires empirical evidence and therefore fieldwork to accumulate the required data. In order to provide the empirical evidence that supports the notion of decoupling, an up-to-date analysis of Cape Town's resource flows would be conducted using critical infrastructures: Cape Town's socio-technical systems (energy, water, waste water and solid waste) are therefore utilised as the unit of analysis.

The initial research design for data collection was the use of SDA and content analysis. Mouton (2008) defines SDA as the analysis of existing data while content analysis is the analysis of texts or documents. In order to interrogate the flow of resources in Cape Town fully, use was made of departmental budgets, department reports, business plans, speeches, service development plans, previous empirical studies and annual reports. As the research developed, it became clear that the data was either incomplete or missing, thus requiring the use of semi-structure interviews with relevant individuals to fill in the gaps.

Using the logic developed in chapter 3, the CCPGRI provided the departure point for meeting the third objective of the research. For chapter 4, which would be written as a case study in narrative form to explain the progression of the project, a process of data collection was essential to determine the capacity of infrastructure in the Central City. Collecting this data was necessary to support the rationale of the argument made in chapter 5. An ethnographic research method of participant observation was utilised, as well as SDA and semi-structured interviews. Chapter 5 uses a research approach of narrative analysis, described by Mouton (2008) as an exploratory approach which allows a researcher to "...reconstruct a chain of events and identify[ing] those events that caused or triggered other significant events" (Mouton, 2008:170). This approach allowed the freedom to select key events from the case and build an argument from the process that unfolded.

The conclusions drawn from these varying sections were then synthesised to meet objective 3, outlined in section 1.2.1 and discussed in chapter 6 in order to advance understanding of urban socio-technical transitions.

1.4 Research methodology and process

While the research design was constructed to provide the means of achieving the objectives and aims of the study, the remainder of this section describes the methodology and process through which this design was carried out. The research processes employed throughout the research

overlapped with each other and therefore this explanation will be done according to methods used as opposed to the chronology of use.

1.4.1 Literature review

Mouton (2008) makes the argument that a literature review is the cornerstone of any research project, regardless of its nature. A literature review is an ongoing process that includes a selection of literature relevant to the research topics and develops as new ideas and perspectives arise, requiring additional research (Bless & Higson-Smith, 2000). This latter perspective is closely linked to O'Reilly's (2005) explanation of iterative-inductive research. Therefore, adopting a fairly loose research design allowed me to engage with various topics through the research process, which then informed the development of my argument.

1.4.2 Search process

My search topics were informed by the aim of meeting research objectives; however, I primarily had to provide the theoretical framework which would contextualise my research. Based on my research interests, I embarked on a broad search of literature to augment my preliminary literature review. An overview of the global ecological challenge is provided, using the logic of unsustainable resource use trends, located within the context of an urban setting. This foundation was then used as the departure point for the remaining part of the study. As the process evolved, the initial topics were elaborated on while links were between literary sources.

Two broad searches for literature were conducted, using the database at the JS Gericke Library at Stellenbosch University. In the first instance, and according to the research design, I sought to meet objective 1 outlined in section 1.2.1. It was important to locate as much up to date literature pertaining to key research themes as possible, from which any additional key themes could be discerned by following up on 'key words', thus allowing the research to gain momentum and develop a search criteria. I attempted to consult as many sources of information as possible, broadening my search to include journal articles, books, conference papers, international reports and completed theses. A synthesis of those search themes are as follows:

Table 1.1: Research themes identified for literature review

Sustainable development	Resource use Ecosystem services Climate change Poverty/inequality Population growth
The urban environment	Urbanisation trends

	Footprint Metabolism Material flow analysis
Decoupling	Resource efficiency Resource productivity
Socio-Technical Systems	Infrastructure Innovation Socio-technical transition Urban transition

A similar methodology was adopted for the investigation into Cape Town's development trajectory and history. However, I was less familiar with the context; I therefore approached my supervisor for a literature sample from which I could gather additional sources to expand my research. This section of work particularly included the use of reports and censuses conducted by the City of Cape Town, which were available online at the City of Cape Town website¹. The search for literature included:

Table 1.2: Research themes identified for the Cape Town literature review

South Africa	City Urban Apartheid Urban planning Governance
Cape Town	Economic growth Social development Population Spatial development Metabolism
City of Cape Town Metropolitan	Service delivery Municipal finances
Infrastructure	Energy Solid waste Water Wastewater Transport

In both instances, the key phrases were used in an interchangeable manner allowing the broadest possible scope of literature to be collected. I scanned all results, selected the most relevant to the research topic, and systematically re-read the articles making notes of the key arguments in my

¹ Available at: <http://www.capetown.gov.za>

research journal, a habit formed during the first year of my M.Phil. Following Spradley's (1979) approach, I kept a field work journal (Hyman, 2010a) which allowed me to record all data and relevant experiences that contributed to the finished product.

I consulted my research design when determining how to structure my literature review and decided that it was necessary to contextualise my argument to ensure that an adequate theoretical framework was developed for any reader, regardless of their background. I therefore used, as my departure point, Morin's (1999) concept of a *polycrisis* which provides the space to contextualise the development trajectory of humanity through an explanation of a number of unsustainable trends. From there it was possible to locate the argument within the context of cities and build the discussion around three key themes:

1. Networked urban infrastructures as socio-technical systems.
2. Socio-technical systems as the intervention point for decoupling.
3. Innovation, SOIS, and socio-technical transitions.

This process was, however, not as clear when I began the review. It was only once I reflected on the summaries I had transcribed that links between literary sources and data became apparent allowing logic to surface. A fascinating and unexpected component was the inclusion of the discourse on innovation that emerged along with the literature on decoupling and socio-technical systems, providing an interesting opportunity for the implementation of decoupling, using socio-technical systems as an intervention point, in the practical sense.

The literature review provided a thorough examination of the research themes out of which logic has formed for the development of the arguments made. I specifically concentrated on finding links in the literature, which would allow me to meet my research objectives and thus provide an integrated approach to understanding the relationship between infrastructure and decoupling. However, as Bless and Higson-Smith (2000) warn, the predetermined framework created a bias for certain work that complemented my approach, enabling me to meet my objective. Therefore, the literature review may be limited by a degree of neglect for unconsidered themes.

The literature on Cape Town created an archetypal context for understanding the challenges of the *polycrisis* due to its multifaceted nature from which one could imagine an alternative future, using the logic developed in the preceding chapter. Reviewing the literature was an enriching process, as it provided the background to Cape Town's institutional history and social development trajectory, both of which influence the construction of socio-technical systems. Furthermore, because I developed a thorough understanding of the background to Cape Town's development, my fieldwork was more productive, as I was able to contextualise results of the data collected. Cape

Town's socio-technical systems served as the unit of analysis for meeting objective 2 (section 1.2.1). Critical to this process, was the isolation of those infrastructures that would be used in the analysis; particularly energy, water, wastewater and solid waste. These four are used primarily because they fit the criteria of 'critical infrastructure' (Graham, 2010). Moreover, a significant amount of research, albeit dated, had been conducted on Cape Town's water and sanitation, energy and solid waste infrastructure for a UNDP-funded project entitled *Integrated Resource Management for Urban Development*. Extensive use was made of the research produced from this project as a departure point for my own research.

1.4.3 Empirical data collection

The literature review and background description to Cape Town is complemented by the empirical evidence which supports the notion of decoupling. Empirical data was identified as the most effective way of meeting objective 2 (section 1.2.1), given that it was required to provide the empirical evidence for the theoretical notion of decoupling. Meeting this objective was to be done through an analysis of Cape Town's critical resource flows. I considered research conducted by Pithey (2007), Sustainable Energy Africa (2007) and Engledow (2007) on water and sanitation, and energy and solid waste infrastructure respectively for the *Integrated Resource Management for Urban Development* Project as 'critical' texts, using them as a framework for the structure of this section of work. This allowed more time for fieldwork.

As previously mentioned, I had access to information, through my role as a student participant in the Cape Town CCPGRI. This was afforded through the partnership that was arranged to ensure the project came to fruition; namely between the WCPG, City of Cape Town (CCT) and Cape Town Higher Education Consortium (CHEC). I was located within the network of participants and had access to the most appropriate people who could assist me with my research. It was, however, an arduous process to first establish, through referrals, the 'right' contacts and then follow up these leads via electronic mail, with little result, except in the case of Barry Coetzee of CCT. He provided extensive and valuable information as well as directing me to employees within the CCT who were able to assist me further with my research. Furthermore, according to the research design, in the context of the Cape Town CCPGRI as a case study, empirical evidence had to be collected to support the rationale of the argument regarding the role of socio-technical systems in an urban setting. Therefore, I simultaneously collected both sets of data, as the type and source of data were similar. The first objective was to determine the resource flows of Cape Town socio-metabolic system for chapter 3, while the second was to determine the state and capacity of infrastructure in the Cape Town Central City for chapter 4.

To ensure all necessary data was accrued, I used three research methodologies: semi-structured interviews, SDA and content analysis. Semi-structured interviews were used following the advice of Weller, who argues that while “...people can *recall* fewer items than they can *recognise* when presented with a complete list of relevant items ... the less that is known about an area the more appropriate are unstructured, open ended methods” (1998:366). She therefore suggests a combination that allows opened-ended and flexible questions to explore different topics, which can then be directed through facilitation once a thorough understanding of responses has been developed to allow for systematic data collection (Weller, 1998).

Three basic questions or topics were used in a covering letter via electronic mail to attract the attention of various potential participants within the public and private sector, these topics were namely: the *state* of infrastructures in Cape Town, the *capacity* of infrastructures and the current *demand* on infrastructures. While these topics were not complete, and did not fit into the academic jargon of socio-technical systems and resource flows, I found that they provided both a structure and degree of flexibility. The questions allowed the informants time to collect data which they could recognise as relating to my research without confusion and alienation arising from the language used. During interviews, the three questions were used as a departure point from which I could navigate the meeting and extract relevant information; these questions together formed what Spradley (1979) identifies as ‘*elicit purpose*’, which clarifies the purpose of the meeting for the informant. Furthermore, the format followed is indicative of what Weller (1998) described as exploratory interviewing and item generation, in that their open-ended nature allowed informants to provide information which I could explore and refine as the interview progressed, and finally ask the ‘*right*’ questions through a process of learning and experience.

The sources of data utilised were: self-reported data through semi-structured interviews and documentary sources, such as official departmental documents, including annual reports, periodic (business) plans and budgets, that I collected during interviews and via electronic mail. Semi-structure interviews allowed me to gather tacit knowledge from individuals who had experience and knowledge that would assist my research. Furthermore, secondary data such as official unpublished reports, plans and budgets provided the evidence necessary to meet the research objectives. I also used electronic mail to clarify uncertainties or request additional information. This information is depicted in table 1.3 and are considered primary sources used in this research. These sources of data were collected from both officials from the CCT, project participants and private firms.

Self- reported data was collected during these interviews as well as a significant amount of electronic data, either on removable hard drives or through an electronic mail account. This was a

result of succinct questions directed to the appropriate informant, who was then able to produce the required data. For these data sources SDA was employed in conjunction with content analysis, as both numeric and textual data was received. Below is a summary of the interviews held, which includes the organisation and designation of the informant as well as the specific data collected.

Table 1.3: Summary of interviews held

Date	Informant Information	Data Received
8 February 2010 9 February 2010	John Spiropoulos: Associate, Urban Genesis	
4 March 2010	Mansoor Mohammed: Executive Director of Economic and Social Development and Tourism, CCT	
4 March 2010	Kendall Kaveney: Development Facilitator for the Development Facilitation Department, CCT	Kaveney (2010c)
10 March 2010	Clive September: Civil Engineer, Arcus Gibb	
11 March 2010	Barry Coetzee: Technical Strategic Support for Utility Services, CCT	
22 March 2010	Mokena Makeka: Director of Makeka Design Laboratory	Arup (2009) Arcus Gibb (2010a) Ubunye Engineering Services (2009a, 2009b)
9 April 2010	Francois Joubert: Senior manager for Public Works for the Provincial Department of Transport and Public Works, Western Cape Province	
10 June 2010	Jaco de Bruyn: Manager of the Water Services Development Planning branch for the Water Services Department, CCT	CCT (2010d; 2010k; 2010l; 2010m; 2010n).
10 June 2010	Mike Hyde: Manager of Forward Planning and Investment Branch of the Electricity Department, CCT	Hyde (2010a) Hyde and Capes (2010) CCT (2010c; 2010h; 2010i; 2010j).
30 June 2010	Hanre' Streicher: Director, GLS Consulting.	GLS (2010a; 2010b; 2010c; 2010d)

17 July 2010	Yachika Reddy: Project Coordinator, Sustainable Energy Africa	
17 August 2010	Melumzi Nontangana: Head Research and Development for the department of Solid Waste Management, CCT	
16 September 2010	Berendine Irrgang: Senior Professional Officer in the Urban Design Branch within the Spatial Planning and Urban Design Department, CCT	CCT (2010g)

To determine, in the first instance, the resource flows of Cape Town's socio-metabolic systems, I compared numeric data to findings from research conducted for the *Resource Management for Urban Development Project* and began a process of updating that work through an integrated approach that synthesised the findings in the textual data, as well as interviews. Conclusions were drawn based on the findings, thus achieving research objective 2 (section 1.2.1). However, in the second case, determining the state and capacity of infrastructure in the Cape Town Central City, I had neither a preconceived structure through which these infrastructures could be described nor familiarity with the technical aspects of infrastructure. Fortunately, participants were willing to answer questions and engage on certain issues regarding the information they had provided, thus enriching my learning experience and enabling me to provide more credible conclusions. In this instance I utilised email correspondence when requiring additional information from informants. This created the framework to support the arguments made to meet objective 3 (section 1.2.1).

Throughout this process of data collection I recorded my interviews, informal conversations and findings in a research journal (Hyman, 2010a, 2010b, 2010c). The records included dates and times of self-conducted fieldwork and fieldwork with CCPGRI participants, issues raised in discussions with participants, notes from interviews and a record of the documents provided from various CCT departments. Furthermore, all the primary data sources collected, outlined in table 1.3, have been recorded in the source list and are indicated on the column named 'data received'. Copies of all the data, notes, transcripts and emails are recorded and stored with my supervisor, Mark Swilling, at the Sustainability Institute.

The value of this research is in the thorough and up-to-date analysis of the socio-economic metabolic flows of Cape Town, thus providing the empirical evidence for the theoretical notion of decoupling. Moreover, from the evidence it is possible to provide a rationale for the deliberate

implementation of decoupling using socio-technical systems as the intervention point. The research also implicitly demonstrates the lack of co-ordination and information sharing between the various departments, which became evident throughout the research. However, the findings, based on numerical and textual data, are reliant on record keeping of the CCT, which can be “...constrained in analysis by original objectives of the research” (Mouton, 2008:165).

1.4.4 Ethnographic research methodology

Participant observation is a method which allows the observer to participate in the activities of a group under observation and thus assimilate into the group; this is an unstructured environment for data collection, realised through time spent with different members (Dewalt *et al*, 1998). Therefore, the selection of participant observation as research methodology resulted from the nature of my role in the Cape Town CCPGRI. The group under observation was not a fixed community, but rather an ad hoc formation that would disperse after completion of the project. As a student participating in the project, I was able to establish an easy rapport with the group and was kept informed of the various meetings. I learnt early on during my research that it was essential to be proactive and visible and to be available for any potential engagements relating to the project. I therefore nurtured particularly good relationships with key participants to ensure that I was not excluded in any way. Table 1.4 is a summary of the meetings of the steering committee for the Cape Town CCPGRI.

Table 1.4: Summary of the meetings I attended

Date	Meetings for the Cape Town CCPGRI
10 February 2010	Cape Town Partnership: steering committee Meeting
15 February 2010	Francois Joubert and John Spiropoulos Meeting: Information Gathering <ol style="list-style-type: none"> 1. WCPG Meeting re: institutional arrangements 2. CCT Meeting re: possible development constraints
3 March 2010	CHEC: Brainstorming Session
18 March 2010	CHEC: Follow up meeting
09 April 2010	Public consultation meeting
17 May 2010	Formal handover meeting

Whilst observing the behaviour and expressions of those participating in the meetings, I documented the formal proceedings as well as casual conversations and informal interviews which are the “...primary materials of participant observation” (Dewalt *et al*, 1998:270). This was an

exploratory process in order to further my understanding of urban socio-technical transitions, as opposed to demonstrating a predicative theory. I kept notes of all events and conversations I participated in or overheard (Hyman, 2010a, 2010bb, 2010c). Flyvbjerg (2006) argues that case studies are useful for theory construction through the development of an understanding of context-dependent knowledge and therefore contribute to the “cumulative development of knowledge” (Flyvbjerg’s, 2006:241). I furthermore made extensive use of the communication that transpired using electronic mail between the project participants. These sources are indicted in chapter 4 and provided in the source list while copies of all the transcripts and emails are recorded and stored with my supervisor, Mark Swilling, at the Sustainability Institute.

However, while I made every effort to take notes and construct an objective narrative, they are determined by my own “...biases, predilections, and personal characteristics” (Dewalt *et al*, 1998:291). My role as a student participant within the project therefore represents a concern. While my research is based on the project, I was also involved with the progression of the project forcing one to question what role I played in influencing the outcome. Furthermore, Flick (2009) states that an observer has a ‘limited observational perspective’ in that one cannot perceive all aspects of a particular scenario simultaneously.

When time came to describe the process, I elected to adopt Flyvbjerg’s (1998) approach of narratology, which uses a method of storytelling to explain a case. “Narratives can be used as innovative methodology to study... [the] culture, experience and beliefs” of groups (Cortazzi, 1993:5). A narrative therefore provides a way to capture the experience of participating in the Cape Town CCPGRI and preserving it for future use, thus creating a window through which one can view past events. I attempted to write the story as it unfolded gradually, in reality, to create awareness for the reader of the various issues that confronted the participants. I consciously avoided summarising recordings of events, but rather integrated all my observations to construct a narrative the demonstrated the complexity of the events that transpired. This narrative is an ‘episodic’ (Flick, 2009) account of the events. Once the project had concluded and I had begun to construct a narrative of what had transpired, I was able to understand the meaning of certain events which I had previously not comprehended.

I initially intended to ‘write the story’ with an analysis and description of elements pertaining to my research topic, but, on reflection, this structure would not have done justice to the events that transpired. I therefore elected to describe the process in much greater detail, giving an objective view isolated from analysis and a true representation of the proceedings. This narrative is

supported by an evaluation of the network of infrastructures present and relating to the Central City.

The value of using the Cape Town CCPGRI as a case within this study arose out of the close parallels it presented to my areas of interest. It provided an opportunity to understand socio-technical systems not only from a theoretical perspective, but also to begin to understand how socio-technical transitions occur within an urban context, using decoupling as a departure point. The narrative was constructed so as to give readers the scope to interpret for themselves the events that transpired and therefore draw different conclusions. The purpose of my research was to further knowledge of socio-technical transitions and consequently the analysis would not extend to all facets of the case in question; in this way I hoped to leave space for further examination.

Narrative analysis was selected as the most appropriate approach to analyse the Cape Town CCPGRI as a case from which conclusions could be made. Narrative analysis seeks to understand the past through a reconstruction of events (Mouton, 2008), but requires a reduction of the complexity experienced in reality to isolate key events and sequence them (Cortazzi, 1993), as well as interpret those events. I selected key triggers from the narrative constructed to understand what processes or occurrences affected the outcome of the project pertaining to the subject of interest, thus identifying the 'sequential thematic' (Hauptert in Flick, 2009).

The analysis has been structured separately from the narrative to ensure the story told was complete and the reader could understand the history, motivation and events holistically before engaging with the analysis of 'certain' events. Furthermore, this isolated approach allowed me to dip in and out, and weave around the narrative, thus providing insight into the processes and changes that occurred. This insight is however subjected to my own predilections and goals for my research. I focused on the underlying aspects of the social structure in place, using literature encountered during previous studies; thus generating conclusions around the social dynamics of group interactions which influence socio-technical transitions. Furthermore, in order to meet research objective 3 outlined in section 1.2.1, I integrated the analysis into a framework, the Multi-Levelled-Perspective (MPL) of socio-technical transitions (Geels, 2002) and explored the nature of the Cape Town CCPGRI from that perspective.

1.5 Significance of this study

The significance of the research is the contribution to the academic field of sustainability through the demonstration of the importance of and need to construct sustainable resource flows through urban areas. Human kind is fundamentally reliant on natural resources and ecosystem services for

existence (World Resources Institute, 2002). Furthermore, it has been established that access to these resources is possible via a set of networked infrastructures configured in a particular (unsustainable) fashion (Guy *et al*, 2001). These networked infrastructures are the means by which basic needs² are provided to society while simultaneously functioning as the foundation for economic activity. From a physical perspective, networked infrastructure configured in a business-as-usual manner determines the ecological impact of accessing basic needs and economic activity. Configuration will determine: the consumption pattern of resources, including land use, water demand and materials extracted, the degree of pollution emitted and the consequential impact of ecosystem services. Therefore every functioning city that configures infrastructure in a fashion that can be considered as business-as-usual will suffer a fate of diminishing resources and ecological distress (the argument for this will be made in chapter 2). Establishing a thorough understanding of these systems, from a socio-technical perspective is critical; therefore the practical relevance is that this research furthers the understanding of those factors that contribute to unsustainable resource use in cities, what the possible intervention points are and how one embarks on a process of intervention which goes beyond the established approach of techno-fixes.

More significant, however, is the articulation of the relationship between socio-technical systems and decoupling as a theoretical notion and thus the establishment of an intervention point for the effective adoption of sustainable principles in urban areas. Using socio-technical systems as an intervention point provides decision-makers with the tools to develop the conditions necessary for the realisation of a socio-technical transition. The value of this research is further enhanced by the provision of empirical evidence for the theoretical notion of decoupling, thus reinforcing the identification of socio-technical systems as the intervention point within urban areas.

The theoretical underpinnings are equally relevant. The thesis merges literature on sustainability, in particular decoupling; innovation systems, in particular SOIS's; and socio-technical transitions, using the MLP as a framework. This is relevant, as there have been few attempts to link innovation systems literature with sustainability literature (Stamm *et al*, 2009). Moreover, the merging of this literature enables the conceptualisation of intervention points for sustainability in the practical sense. As there is a limited body of literature regarding these systems, Stamm *et al* (2009) have suggested investigating the emergence of using 'in-depth case studies' to develop empirical evidence. The intention is therefore to understand how these systems innovations emerge and are shaped through dynamic social processes, using the CCPGRI as a case study. This thesis

² Basic needs in this instance are considered access to nutrition, fresh water, sanitation and shelter.

therefore provides an insight into the context within which SOIS's emerged and their value within the sustainability debate.

It has been identified that knowledge of the role of the spatial context of socio-technical transitions is limited (Hodson and Marvin, 2010). The Cape Town CCPGRI, however, offers an example from which general conclusions can be drawn regarding how spatial contexts influence or shape a particular transition. In this case, the role of the city, from a social and technical perspective, is relevant in demonstrating how interactions between decision-makers influence actions. The findings of the Cape Town CCPGRI do not only contribute to a greater body of knowledge regarding socio-technical transitions, but they have the potential to contribute to the regeneration project itself. The project is still in its incubation stages and therefore there is an opportunity to make use of the findings for informed decision-making amongst the participants. There is also the potential to use sections of this research in various feasibility studies for the completion of the Cape Town CCPGRI.

At a practical level, this research provides a current analysis of data relating to resource flows and thus gives an insight into Cape Town's ecological resource base, as well as the institutionalised practices which continue to undermine the resource base. The research is furthermore aligned ideologically with the sentiments expressed at a Provincial and local level within the CCT – both explicitly identify resource efficiency and sustainability as strategic objectives and critical to development.

1.6 Clarification of key concepts

1. *Sustainable Development*: Sustainable development is widely considered as development which allows the current generation to meet their needs and improve their quality of life in an equitable manner without infringing on the future generations' ability to do so (WCED, 1987; Mebratu, 1998; Gallopin, 2003).
2. *Urban metabolism*: Urban metabolism is defined as "...the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste" (Kennedy *et al*, 2007: 44).
3. *Socio-technical system*: This notion reconceptualises the orthodox approach of urban resource flow management in which the social and technical components of the urban system are considered to be independent and thus isolated from one another (Guy *et al*, 2001). The concept of a socio-technical system recognises the interconnectedness between the "...physical production processes shaping the construction of cities and the changing social dynamics of urban consumption" (Guy *et al*, 2001:23).

4. *Decoupling*: Decoupling as a concept is the means of achieving a higher degree of economic growth while the demands on natural resources and ecosystems services are decreased (Swilling and Fischer-Kowalski, 2010; Schepelmann *et al*, 2010).
5. *Innovation*: An innovation, whether it is cumulative, radical or incremental (Lundvall, 2007), is generally considered to be the result of a systematic procedure, from research and development to the implementation thereof, on a large scale (Stamm *et al*, 2009).
6. *Innovation Systems*: Innovation systems can be distinguished as and exist at a national, regional, structural or technological level of system innovation the main focus is the interactions between various actors and institutions (Lander, 2010). The emphasis of innovation systems is the "...non-linear, interactive character of innovation that involves a variety of factors that can be either consciously created or evolve over time" (Lander, 2010:01). An innovation system is therefore the network of actors at various levels, within various sectors, who stimulate innovation through interaction.
7. *Sustainability-orientated innovation system (SOIS)*: SOIS's are innovation systems which use the principles of sustainability and sustainable development as the overarching goal and thus develop processes or technologies that foster sustainability (Montalvo, 2008; Stamm *et al*, 2009).
8. *System Innovation*: A system innovation is the transition from one socio-technical system to another socio-technical system (Stamm *et al*, 2009).
9. *Intermediary*: Intermediaries are organisations that manage and facilitate socio-technical transitions (Hodson and Marvin, 2009b).

1.7 Thesis outline

Chapter One provides an introductory background to the research and provides an account of how the research objectives were identified and refined. It furthermore includes an explanation of the research design created and the methodology used for enacting research. The significance of this research is identified and clarification of key concepts given.

Chapter Two consists of a literature review which contextualises the research. It provides an overview of the current development trajectory of humankind and asserts that an alternative development paradigm is required. The review identifies the relationship between socio-technical systems and decoupling in the context of innovation. The chapter therefore provides the literature base for the remainder of the thesis.

Chapter Three provides a case in point for understanding the rationale for the adoption of the theoretical notion of decoupling. The Cape Town metropolitan area is used as the context for

discussion. It provides a comprehensive review of the current social and economic dynamics of Cape Town and an analysis of resource flows of the city. Furthermore, this chapter provides the empirical evidence for the theoretical notion of decoupling and the rationale for the adoption of decoupling within economic development strategies.

A case study of the Cape Town CCPGRI is presented in Chapter Four. An introduction to the Central City provides an overview of the context within which the CCPGRI will be enacted. Furthermore, a narrative describes the events that unfolded during the development of the project, illustrating the dynamic social process that occurs within groups. Lastly, this chapter includes an analysis of the critical infrastructure, or technical aspect, of the Central City.

Chapter Five is an analysis of the narrative in chapter four that seeks to explore and understand the dynamic social processes that occurred during the development of the project. The chapter identifies the triggers which determined the outcome of the CCPGRI and analyses how such an outcome was determined. Furthermore, the chapter uses the framework of the MPL to explore the possibility of a socio-technical transition within Cape Town.

Chapter Six provides a thorough synthesis of the arguments made in this thesis and provides concluding comments.

Chapter Two: Literature Review

2.1 Introduction

Whispers of change that one heard during the late 1980s, when Gro Harlem Brundtland released the Brundtland report, have more recently evolved into clear and ringing demands by a substantial number of factions within civil society, certain public affiliates and a portion of the private sector for an alternative future. The famous 1987 dictum of sustainable development, which is clearly defined in the report as “development which meets the needs of the present without sacrificing the ability of future generations to meet their needs” (WCED, 1987), has been interpreted in a multitude of ways depending on the field of interest, resulting in limited recognition of the challenges facing humanity and, consequently, inadequate action (Sneddon *et al*, 2006). In spite of this, a considerable body of literature has emerged which seeks to understand, comment on and resolve the controversial and loaded term ‘sustainable development’, as well as to highlight the causes and consequences of unsustainable resource use. The following section will not provide a definition of sustainable development (for an overview of this literature see Sneddon *et al*, 2006; Mebratu, 1998, Dresner, 2002; Pezzoli, 1997), but rather explain several trends that contextualise the challenges that demonstrate the unsustainable trajectory of the socio-economic system and offer insight into an alternative option for the future³.

2.2 Understanding our current state

A growing body of knowledge has emphasised that, as a global entity, humankind is fast reaching its resource thresholds. This has recently become more evident, allowing for the emergence of what Morin (1999) identifies as a global *polycrisis*, which “consists of a multiple set of nested crises that tend to reinforce one another” (Swilling, 2009a) irreducible to linear relationships. This particular *polycrisis* is the result of a series of shifts in social, economic and environmental systems that occurred during the c. 20th and leading up to the global economic crisis in 2008 parallel to growing awareness of accelerated climate change. McLaren (2003) argues that these shifts have resulted in development⁴ that has occurred beyond the limits of the earth’s carrying capacity. The following section will attempt to describe the *polycrisis* by demonstrating the impact and consequences of the particular development paradigm adopted over the past century; this will provide the context for discussion for the remainder of this paper.

³ This will by no means be a complete account of current trends and this paper is written with full cognizance of the limits of a reductionist approach.

⁴ Development in this context is ‘economic development’ as envisioned and realised via mainstream, orthodox economics.

2.2.1 Environmental degradation: breaching critical thresholds

As identified in the Millennium Ecosystem Assessment (MEA) (2005), destructive anthropocentric consumption patterns during the past 50 years account for the rapid deterioration of 60% of ecosystem services which are critical to the survival of a vast majority of living species, as well as the significant diminishment of the diversity present on earth. However, “[e]very aspect, human development and security are closely linked to the productivity of ecosystems. Our future rests squarely on their continued viability” (World Resource Institute, 2002:4). Therefore, this is in itself one of the first elements of the current *polycrisis*. The MEA (2005) discusses the unprecedented acceleration in demand for the *provisioning* (productive services such as food and fresh water), *regulating* (the benefits received from natural processes such as climate and disease regulation) and *cultural* (inanimate benefits such as aesthetic quality) services placed on ecosystems by humankind. Simply put, we are using up our natural resources and degrading our ecosystem services at a greater pace than they can be replenished and are therefore reaching what Crane and Swilling call our ‘resource thresholds’ (2008). This is despite the fact that as early as the 1970s Meadows *et al* (1972) offered warnings regarding the earth’s limited resources and its ability to meet the demands of the population, and that the unsustainable nature of the globalised economy was contributing to accelerated use of resources (Norberg-Hodge, 2000; Stiglitz, 2002).

While the use of these resources has contributed to significant material benefits, economic growth and improved human well-being, it has occurred at the expense of ecosystem degradation and unpredictable (negative) consequences as a result of non-linear changes which, by and large, exacerbate the plight of the poor (MEA, 2005: 18-22). Furthermore, these services not only directly contribute to human well-being as described by the MEA, the entire socio-economic system is embedded within and dependent on these services (MEA, 2005). Therefore, the challenge humankind is facing is that these services on which humans are dependent are at risk, and without conscious action to adopt a different approach to meet the demands of humans they will collapse.

2.2.2 Climate change and the fossil fuel addiction

A top priority in a number of current global policy debates⁵ is the question of climate change, which is another component of the *polycrisis*. The 4th Intergovernmental Panel on Climate Change (IPCC) demonstrated that “[w]arming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level...” (IPCC, 2007:2). Furthermore, the unprecedented increases in temperature and regional climate changes, which have contributed to

⁵ This evident in the recent United Nations Climate Change Conference, commonly known as COP15.

changes in natural systems as discussed in section 2.2.1, are the result of human activities, which have increased by 70% between 1970 and 2004, allowing for concentrations of greenhouse gases (GHG) in the atmosphere to increase (IPPC, 2007). These activities include the unsustainable use of fossil fuels and deforestation, which increase carbon dioxide levels, which account for 77% of GHG, and large-scale agricultural production, which increases levels of methane and nitrous oxide (UN-Habitat, 2008). Continuation of anthropocentric activities at a similar rate as seen in the c. 20th will have a greater impact in the c. 21st than previously noted; it is estimated that temperature will increase by 1.8 to 4 degrees centigrade without intervention, resulting in greater extremes in weather patterns, and limiting the ability to secure basic needs, which will in turn threaten livelihoods (IPPC, 2007:26).

The Stern Review (2006) concluded that the poor are most vulnerable and will be severely affected by accelerated climate change, as it will limit the ability to access basic needs such as: "...access to water, food production, health, and the environment. Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms" (Stern, 2006:vi). With adequate attention and investment, the effects of crises can be limited. There is irrefutable evidence of the economic benefit of pre-emptive action, whereas inaction will inhibit future economic production on a global scale and will have a negative impact on economic growth and development (Stern, 2006). Adopting mitigation strategies (to decrease green house gas emissions) and adaptation strategies (to increase resilience to the effects of global warming), will not prevent climate change that is set to occur over the next two to three decades; however, there is room to provide a degree of security for societies and economies alike if appropriate action is taken.

The crisis of climate change, which according to the World Resource Institute (2002) is the most serious challenge that humankind has ever had to face, is closely linked to the unbridled use of fossil fuel-based energy, in particular oil. The IPCC (2007) identified CO₂, a by-product of oil refining, as the principal contributor to greenhouse gas emissions, increasing by 80% between 1970 and 2004 due to anthropocentric action. Humankind's reliance on oil is therefore absolute – it meets 60% of the worlds energy needs (International Energy Agency, 2008).

Fossil fuels not only provide energy in a natural form, they represent the primary input for an array of basic goods on the market, and despite the fairly broad acknowledgment of climate change and its consequences, the addiction has not subsided. Fossil fuels have made significant contributions to the growth of the global economy and development, in terms of mass production of goods and agriculture as well as trade and transport. However, this major source of energy is no longer reliable (International Energy Agency, 2008). Fluctuations in supply and demand and resultant

price spikes and slumps provide characteristic evidence that the phenomenon known as 'oil peaking'⁶ is currently being experienced (Lerch, 2007). Lerch argues that oil peaking significantly diminishes the certainty of gaining access to oil at an affordable price rendering the global economy vulnerable. Insecure access to cheap energy and inputs for secondary and tertiary goods will negatively affect trade, industry and agriculture sector due to their reliance on oil. The consequence of volatile oil prices was felt in 2008 when fluctuations were extended directly to the food and transport sectors, as well as creating a ripple effect in other sectors of the global economy.

Environmental degradation, climate change and the presence of the oil peaking phenomenon are symptomatic of the unsustainability of the current resource-intensive global economy. In reality, when the threat of oil peaking is juxtaposed alongside the threat of climate change and ecosystem degradation, it is clear that an alternative economic paradigm which is resource light is imperative. The collapse of the global economy in 2008 and the implicit plea to end worldwide consumption financed by debt, provided the clearest indication that change was necessary. Investing in alternative, clean energy sources offers an opportunity for sustained economic growth and development. However, development strategies need to be placed in the context of reducing dependence on fossil fuels considering the increasing relevance of cities and the built environment for future development. It will be argued that emphasis must be placed on investments in ecosystem service restoration and infrastructure which conveys natural resources within the socio-economic system. While environmental degradation and diminishing resources created by ill-conceived precedents present significant challenges, they are just some of the components within the *polycrisis*. The context of population growth and urbanisation provides the framework for the future, adding another level of complexity to the *polycrisis*.

2.3 Envisioning the future

The trends of ecosystem degradation, accelerating climate change and oil peaking provide an overview of the current unsustainable nature of the socio-economic system. While these trends speak to the role of anthropocentric action and its impacts on the environment, they furthermore need to be located in the context of a rapidly urbanising global South, which will soon feel the weight of significant population growth amongst those who do not have the means to hedge against the effects of these trends.

⁶ The 'oil peaking' phenomenon is a scenario in which oil production reaches a stable state and starts declining thereafter (Association for the Study of Peak Oil and Gas, 2006)

2.3.1 The social condition: an urban population

In 2006, the United Nations released the *State of the World's Cities* while in 2007 the World Watch Institute released the *State of the World Report* entitled *Our Urban Future*. These two documents, along with a vast body of supporting literature, offer a window on certain elements of the future. In the first instance, it is shown that by 2030 the world's population will grow from the current 6 billion to a staggering 8 billion and by 2050 this population will increase to 9 billion, at which point population growth will begin to stabilise (United Nations, 2006). This exponential growth is highlighted by the fact that at the beginning of the c. 20th, there were only 1.5 billion people on the planet (UN-Habitat, 2008). This puts in sharper perspective the demands placed on natural resources, as discussed in section 2.2.

Since 2007 it was noted that more people were living in urban than in rural areas and by the year 2030, 5 billion people will be living in cities (United Nations, 2006; World Watch Institute, 2007). The cities that will house this massive population expansion will be predominantly the secondary and tertiary cities of Africa and Asia (UN-habitat, 2008; World Watch Institute, 2007). Demographers show that the number of mega-cities (10 million or more inhabitants) will stabilise, while population growth will occur in cities of between 1 million and 5 million people with a major surge in the emergence of settlements of less than half a million people (World Watch Institute, 2007).

The significance of these trends is twofold: the first being that population growth and urbanisation trends are indicative of an urban future (Swilling, 2004); the second that, if trends do not alter course, Davis's realistic phrase a *Planet of Slums* (2007) will be realised. Already, one in three urban dwellers live in slums, which occur primarily in developing regions (UN-Habitat, 2003). This reflects how urban transitions have occurred in these areas thus far. By and large this ad hoc 'second urbanisation wave' has evolved at a faster rate than urban transition seen in the global North, resulting in negative connotations of urbanisation being coupled with the developing South (UN-Habitat, 2008). Growing populations place pressure on inadequate city administrations, which results in backlogs in service provision and, consequently, exacerbate poverty and inequality (UN-Habitat, 2008). Paradoxically, the global South has not seen the advantages of urbanisation expected by Martine *et al* (2008), such as economic growth, poverty reduction and population stabilisation.

2.3.2 A paradox realised

Martine *et al* (2008) argue that urbanisation, as opposed to a large rural population, is the key to achieving desirable levels of economic growth and development. However, this hypothesis is

based on instances in those countries that have used a model of industrialisation-induced and improved socio-economic conditions as an incentive for urban living.

This is hardly the case for the cities of the 'future', which are facing the dual challenge of poverty and inequality. Poverty and inequality, albeit not directly related, reinforce one another due to the "systemic connection between them" (Vayrynen, 2005:11). Although the massive increase in both private and public consumption and the economic growth of the past 50 years have made a significant contribution to human development (MEA, 2005) there are vast disparities in the distribution of these benefits, resulting in rampant inequality (UNDP, 1998). This is demonstrated by a series of findings of the Human Development Report (UNDP, 1998). According to the report, the richest 20% of the population account for 86% of the world income expenditure while the poorest 20% account for 1.3% (UNDP, 1998). The disparity follows a similar trend for other resources, food and access to services and infrastructures. Furthermore, despite growth in the global economy and increases in total world income, according to Stiglitz (2002) the number of people living in dire poverty has increased during the same time period. In this way the notion that cities are an 'escape' from rural poverty is negated; instead, there has been a steady transferral of rural poverty to urban poverty (Davis, 2004:17-18) which, without aggressive intervention, will be the reality for the future. Therefore, "[t]he social dimension of sustainability is inescapable" (McLaren, 2003:21).

Social aspects of development are embedded within the environmental system. There is a highly organised arrangement of power relations present, which determines patterns of consumption via a mesh of complex economic structures, allowing for disproportionate allocation of resources (McLaren, 2003). As a result, the benefits of unsustainable resource use are allocated to the rich while the costs thereof are born by the poor (McLaren, 2003), proving Stern's (2006) statement that the poor and vulnerable will be most severely affected by climate change and ecosystem degradation. Therefore, the challenge of sustainable development is not only one of environmental degradation but of social exclusion. Sachs (2002) argues emphatically that one cannot separate the global ecological challenge from the eradication of poverty and inequality. At the core of the Millennium Development Goals are the challenges of poverty and ecological sustainability, for which measurable targets have been set in an attempt to encourage action from both developing and developed countries (Maxwell, 2003:7).

Therefore, when considering development, it needs to be understood in a way that encourages development that serves all of humanity's needs in an equitable manner, including both intergenerational and intragenerational aspects, while considering the ecological limits of the earth.

These factors should be understood through the lens of an urban context which brings the attention the centrality of cities within the development debate.

2.4 Centrality of cities

When considering that the future is most certainly an urban one, the centrality of cities is brought to the forefront of the discussion, in particular when considering sustainable development and the need to reconcile both environmental degradation and resource limits with urban poverty and inequality. While the priority of this section is to understand the critical role of cities in achieving sustainable development, it is important to examine how they have contributed to the current *polycrises* and what their further potential impact might be.

2.4.1 Consumption centres and warehouses of waste

Martine *et al* argue that cities are a central component of “global and environmental change” (2008:4). They are localities of high population concentrations and what Girardet calls ‘intense economic processes’ (2004:8) that, due to their structural nature, create momentous environmental pressure on both natural resources and ecosystem services (Martine *et al*, 2008). Swilling (2004) provides the rationale for these statements by describing the nature of the linear metabolism present in cities. Higher concentrations of population, consumption and economic activity, which are seen in urban contexts, result in an elevation of demand for provisioning, regulating and cultural services from ecosystems. However, due to the nature of complex urban throughput systems, large quantities of virgin resources are required while an unprecedented amount of waste is generated that is subsequently returned to natural systems (Swilling, 2004). Figure 2.1 illustrates the linear nature of urban systems in which large quantities of inputs are required for the urban metabolism which produces large quantities of outputs. This is the result of having a built environment planned in an era of cheap oil and energy, coupled with a frame of reference which does not recognise the limits to growth. This has fundamentally transformed consumption, distribution, replenishment and accumulation processes of earth’s resources in an irreversible manner (Swilling, 2004).

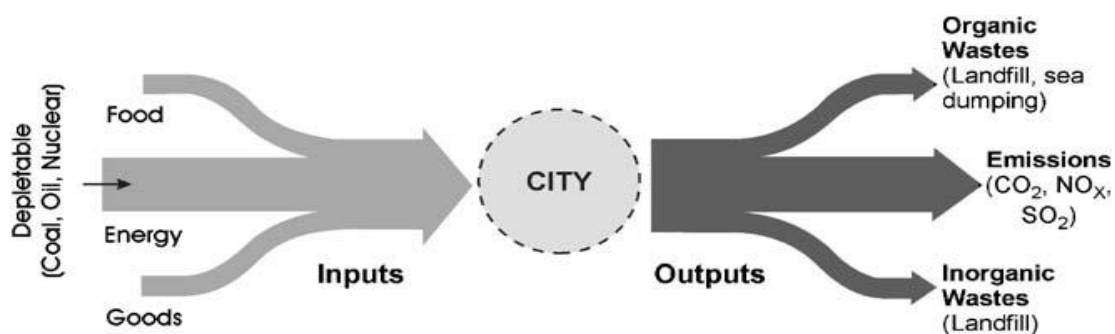


Figure 2.1: Linear metabolism of cities

Source: Doughty and Hammond, 2004

This linear system, as depicted above, is based on the premise that there is an infinite supply of resources available to meet demand⁷; Lerch (2009) argues that a significant number of cities have been developed based on this particular notion. This is demonstrated by the fact that cities currently consume 75% of the world's energy and produce 80% of the greenhouse gas emissions (Hodson & Marvin, 2009a), the effect of which was discussed in section 2.1.2. Modern⁸ cities claim the majority of fossil fuels, metals and concrete, as well as up to half of all photosynthetic capacity, on which all life on earth is dependent (Haberl *et al*, 2004a), and in light of this, they 'transcend local ecological boundaries' (Girardet, 2004:10). Doughty and Hammond (2004) argue that cities are dependent on 'ever-expanding hinterland' to supply the substantial resource demand.

As an alternative, Girardet (2004) argues that the systems present in cities should be organised, planned and reconfigured in such a manner that they mimic the natural ecosystems on which they depend. These natural systems are *circular*; "every output discharged by an organism also becomes an input that renews and sustains the **continuity** of the whole" (Girardet, 2004:122; emphasis added). The notion of a circular metabolism is interchangeable with the notion of a circular system of material flows. It complements Capra's (1996) notion of the 'web of life' in which all things are embedded within the 'cyclical process of nature', connected by a continuous flow of energy (Girardet, 2004). In this process, the total input consumption of a city is reduced, while the efficiency of throughputs is increased and the waste generated is converted into productive inputs (Swilling, 2004; Doughty & Hammond, 2004) as seen in Figure 2.2. In this way, a circular metabolism has the potential to not only reduce resource requirements but increase natural capital (Birkeland, 2008). These factors offer some of the building blocks of achieving sustainable cities, as they have the potential to reduce the ecological footprint by decreasing urban metabolisms. By utilising resource flows sustainably, the viability of a city can be realised over the long term (Girardet, 2004). The creation of a circular metabolism is however dependent on understanding the nature of the current linear metabolism, how it emerged and the consequences. This will be discussed in section 2.4.3 Making sense of urban systems 2.4.3. Therefore we return to the notion of cities expanding beyond their ecological boundaries.

⁷ A fundamental premise of mainstream economics is that of substitutability; if a natural capital is depleted technology or human capital will be a perfect substitute for it (Blanchard, 2006).

⁸ Refers to those cities developed during and after the industrial revolution (Girardet, 2004).

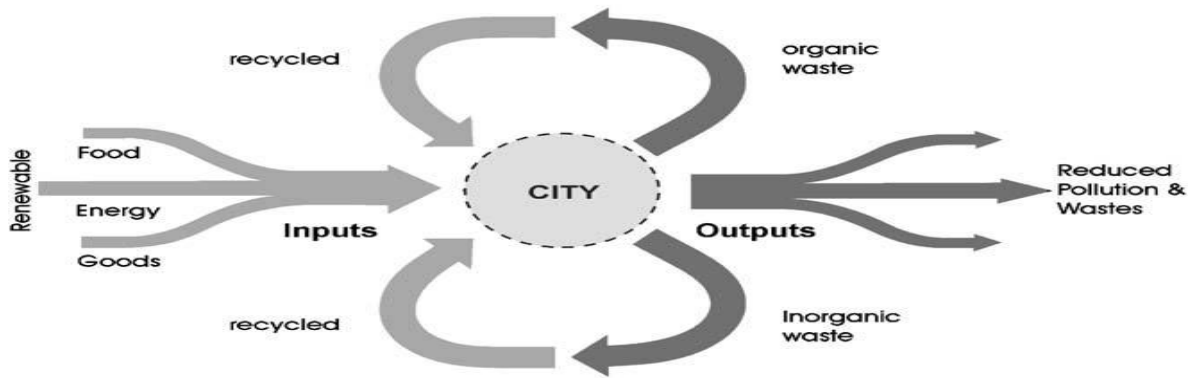


Figure 2.2: Circular metabolism cities

Source: Doughty and Hammond, 2004

2.4.2 Ecological footprinting

The concept of ecological boundaries draws attention to the notion of ‘ecological footprinting’, a term developed by ecological economists Wackernagel and Rees (1996), which examines the ‘city–hinterland relationship’ (Gasson, 2002). Ecological economics, as an alternative to mainstream economic approaches, is a transdisciplinary field (Costanza, 2009) which includes the notion of ‘limits to growth’ (Meadows *et al*, 1973) and the vital role that the eco-sphere plays in the economy, which considers inputs as not substitutable (Wackernagel & Rees, 1996). The notion of ecological footprinting draws on the concept of ‘carrying capacity’, which is “...the maximum ‘load’ that can safely and persistently be imposed on the eco-sphere by people” (Wackernagel & Rees, 1996:50). At the core of this type of economics is the question of whether the ecosphere has the capacity to service the expected future demand the economy will place on it while maintaining that ecosphere (Wackernagel and Rees, 1996). However, the carrying capacity of a particular piece of land is, in reality, impossible to determine, due to our increasingly globalised world being highly contextualised to cultural preferences and geographical locations (Wackernagel and Rees, 1996).

In light of these difficulties, ecological footprinting was developed as a tool to measure the total demand for land and water ecosystem services from the biosphere, for the production and consumption of goods and the assimilation of wastes, by reducing them to total quantity of inputs and outputs in terms of the land area requirement (Wackernagel and Rees, 1996). Therefore, the ecological footprint of an individual, economy or, in this case, a city is demonstrated by an area of ecologically productive land (Wackernagel and Rees, 1996). In 2008 the World Wildlife Fund released the *Living Planet Report* which provided data of the global ecological footprint. It was

determined that for 2005 the average per capita ecological footprint was 2.7 global hectares⁹, while the average available in terms of supply was 2.1 global hectares (WWF, 2008). A dilemma therefore arises, as the earth is a closed system with a fixed amount of stock of natural capital (Gasson, 2002). These figures indicate that, as a population, we have exceeded the available biosphere capacity and are in what Wackernagel and Rees (1996) call overshoot, a condition which is exacerbated by the growing population and consumption patterns. Schepelmann *et al* (2010) reveal that the global ecological footprint has at least tripled since 1960. Furthermore, an ecological footprint is not fixed; rather it is dependent on a number of auxiliary factors which include individual preferences, access, income and cultural factors, which have allowed some to occupy more than their *fair share* of available resources (Wackernagel and Rees, 1996). “Ecological footprinting is useful to identify how this demand is distributed between different groups of people” (Haberl *et al*, 2004a). This accounts for inequities within the current generation and imposes significant cost on future generations, potentially limiting their ability to service their needs. These conclusions demonstrate the benefits and uses of calculating an ecological footprint.

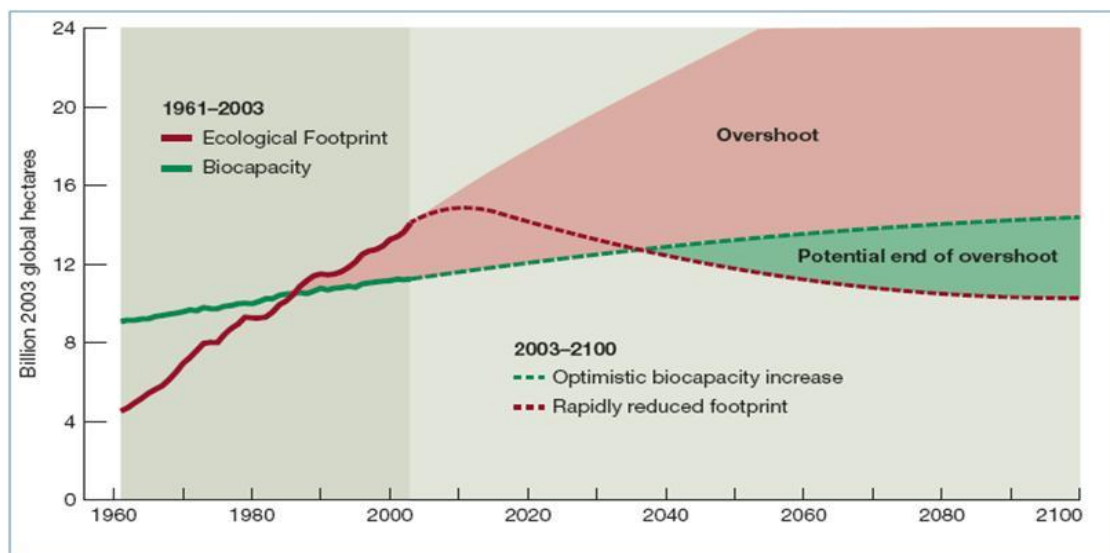


Figure 2.3: Ecological footprint vs. bio-capacity

Source: WWF, 2008

While understanding the limits of reductionist approaches (Morin, 1992), the calculation converts an aggregate of highly complex resource flows into a single number which contributes to decision-making processes (Costanza, 2000) and allows for comparisons to be made. In this way it allows

⁹ “A global hectare is a hectare with world-average ability to produce resources and absorb wastes” (WWF, 2008:14).

the “consequences of human consumption to be graphically viewed” (Doughty & Hammond, 2004:1229) as described by the linear metabolism. Therefore, it illustrates the impossibility of developing along a similar trajectory and it provides a departure point for a strategy toward sustainable development via the reduction of an ecological footprint.

2.4.3 Making sense of urban systems

The current trajectory of development is indicative of a series of social and economic processes which have become institutionalised by the constant reinforcement of systemically flawed systems by decision-makers with stunted frames of reference who create urban centres.

When considering the city scale, one can examine it as a whole or as a series of individual parts. In terms of the former, the city scale is the result of a number of decisions which are made within institutional structures, both formal and informal, and thus carried out through policy-making instruments and markets. In terms of the latter, the city scale can be examined at the level of the components it consists of: for example, the manner in which the urban form has been developed and in what way it affects the mobility of individuals, commuting patterns and the distribution of goods and services; or the way in which the urban form affects the systems that need to be put in place to service both organisation and human inhabitants in terms of basic needs like energy, water, sanitation and waste disposal. Guy *et al*, (2001) identify these spatial elements as the ‘patterns’, in terms of both technical and social aspects, which shape functions and behaviours within a city. In this way, the metabolism of a city is constructed.

2.4.3.1 Urban metabolism

The recognition of humanity’s unsustainable trajectory as illustrated by the ecological footprint demonstrates the shortcomings of the metabolism present in cities. The biological metabolism is the result of a series of processes which occur within organisms, allowing them to exist (Starr and Taggart, 2004; Girardet, 2004). Hugh emphasises the notion of homeostasis: the phenomenon whereby relative balance is created between the metabolism of organisms present and the ‘regenerative’ and ‘absorptive’ capacity of a particular system (Gasson, 2003).

The same notion of a biological metabolism can be extended in the urban sense as identified by Abel Wolman who developed the concept of urban metabolism in a seminal article in 1965. He defined the metabolic requirements of a city as “...the materials and commodities needed to sustain the city’s inhabitants at home, at work, and at play.... The metabolic cycle is not completed until the wastes and residues of daily life have been removed and disposed of with a minimum of nuisance and hazard” (Wolman cited in Fischer-Kowalski, 1998: 70).

This concept has been developed over the years and can be explained as “...the sum total of the technical and socioeconomic processes that occur in cities, resulting in growth, production of energy, and elimination of waste” (Kennedy *et al*, 2007:44). Fischer-Kowalski (1999) argues that when examining a city from an environmental or ecosystem perspective, wherein a socio-economic system is embedded within the greater natural environment, a relation can be made between the input and outputs allowing metabolism to take place and the ‘stock’ and ‘flows’ of the larger system.

Following Wolman, the requirements of a city include the inflow of extracted raw materials, which are converted to energy and materials providing commodities for domestic and foreign use which sustain the social and economic demands of a particular system. A portion of these materials stay within an urban system as the ‘material stock’ while the subsequent waste and emissions are the outflows (Niza and Ferrao, 2006). Fisher-Kowalski (1999) identifies biomass, oil, coal, gas, metals and minerals which are used in industrial and construction processes as the core indicators of metabolism. These are the socio-economic ‘flows’ or ‘metabolism’ of an urban system (Krausmann *et al*, 2009), which constitute the physical basis of an economy (Bringezu *et al*, 2004). As the socio-economic urban systems are embedded within a greater environment, the size and structure of the metabolism both directly and indirectly affect the ecological footprint of a city (Krausmann *et al*, 2009) and form the “bridge between human activities and environmental impacts” (Bringezu *et al*, 2004:98). Therefore, the unprecedented expansion of the global socio-economic system over the past 50 years and subsequent unparalleled anthropocentric-stimulated environmental degradation is the result of an increase in the metabolic rate (Krausmann *et al*, 2009). Following this statement, when a metabolism is linear, the scales are out of balance and the capacity of the urban system is diminished; earth cannot replenish resources or absorb waste at the required rate.

2.4.3.2 Material flow analysis

While the ecological footprint is useful as a tool to demonstrate the total demand of population on resources and ecosystem services, and the distribution of those resources at a particular moment in time, it cannot measure the metabolic rate of socio-economic systems as such over a period of time (Rees, 2000). In this way its strength of being simple is perhaps also a weakness.

The Material Flow Analysis (MFA) has been developed as a means of calculating material flow and quantifying the relationship between the environment and its embedded systems (Niza & Ferrao, 2006). From these findings, the size and structure of an economy can be determined, as well as the resource productivity (Bringezu *et al*, 2004). This framework considers the first law of thermodynamics; the total input of an economy equals the output plus the net accumulation of

material present in the system (Niza and Ferroa, 2006; Behrens *et al*, 2007). The methodology is based on calculating the input material indicators which include the Direct Material Input (DMI), Total Material Input (TMI) and Total Material Requirement (TMR) (Behrens *et al*, 2007). Behrens *et al* (2007) explain that the mutual base of these indicators is Domestic Extraction (DE) which is separated into 'used DE', or that which enters the economic system and increases in value, and 'unused DE' which does not reach the economic system and becomes a 'hidden flow'. The advantage of such a method when concerned with sustainability is the allowance it makes for calculating what is extracted, what is used and the total amount that is extracted and not used.

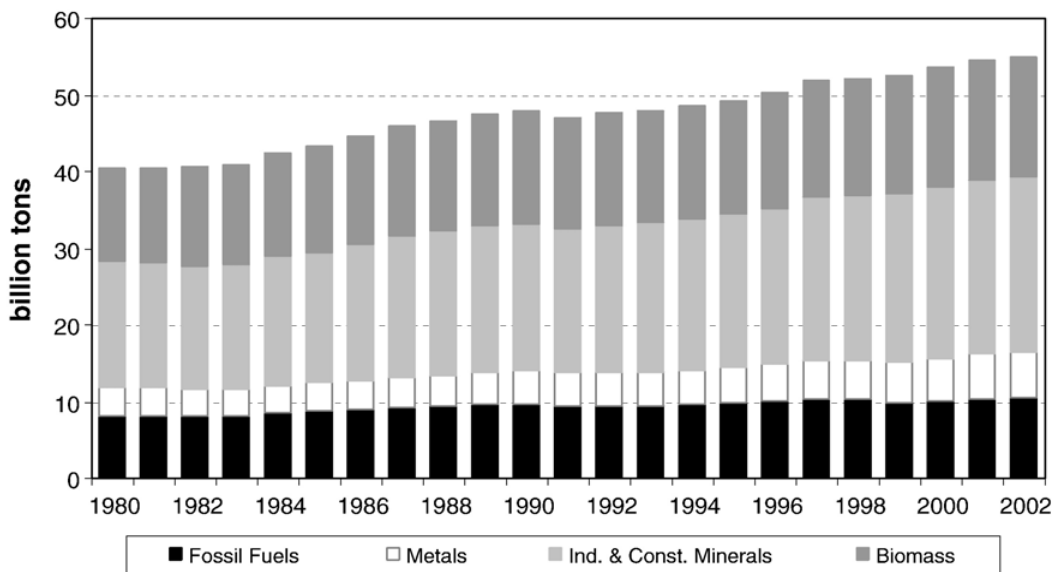


Figure 2.4: Global used resource extraction by material category

Source: Behrens *et al*, 2007

2.4.3.3 Global metabolic flows

Krausmann *et al* (2009) have used the MFA to calculate the global material flows from 1900 to 2005. Their findings indicate that total material extraction has increased by a factor of 8, reaching a total extraction of 59 billion tons in 2005 (Krausmann *et al*, 2009) while Behrens *et al* (2007) demonstrate that between 1980 and 2002 an increase of 15 billion tons was noted, which indicated an aggregate growth of 36%. Swilling and Fischer-Kowalski (2010) conclude that without intervention this trend will continue. Resource extraction is increasing in absolute terms on a global level (Behrens *et al*, 2007) indicative of an increase in the global metabolism which has multiplied a number of times during the c. 20th; a period in which growth of the physical economy was greater than population increases, allowing for an increase in per capita consumption (Krausmann *et al*, 2009). Consumption per capita approximately doubled between 1900 and 2005 (Behrens *et al*,

2007). This acceleration should be understood in the context of the rise of the new middle class consumers who strive to achieve lifestyles similar to those seen in the Global North.

Furthermore, the structure and composition of material extraction has changed dramatically – there has been a transition from the predominant extraction of renewable biomass (or ‘throughput materials’ which are consumed within a year) to the extraction of non renewable and finite minerals (or ‘accumulation materials’ which accumulate as socio-economic material stock) which indicates a shift from an agricultural to a mineral economy (Krausmann *et al*, 2009). This increase in mineral resource extraction is a result of the increase in GDP per capita (Swilling, 2009b). Krausmann *et al* (2009) argue that this transition to a mineral economy is investment intensive, as minerals accumulate in “infrastructure and durable artefacts” as socio-economic stock. Furthermore, Haberl *et al* (2004b) argue that sprawl infrastructure, in itself a sustainability issue, requires investment or additional resource flows for usage, maintenance and eventual destruction. This has the potential to diminish the capacity to reduce resource consumption (Haberl *et al*, 2004b). The environmental impacts associated with resource extraction have been discussed in section 2.2.

2.4.3.4 Metabolic distribution

The current average metabolic rate per capita is between 8.5 (Behrens *et al*, 2007) and 10 tons of extracted material (Krausmann *et al*, 2008). However, in industrialised economies the metabolic rate is double, on average reaching a massive 40 tons per capita in low-density developed countries (Swilling, 2009b). On the other hand, in developing countries, which house approximately 65% of the population, the average metabolic rate is between 5 and 6 tons, indicating poor satisfaction of material needs (Swilling, 2009b). These figures highlight the disproportionate use of resources and contributions to environmental degradation. However, while rapid resource extraction was in the past attributed to industrialised countries, Behrens *et al* (2007) show that the Newly Industrialised Economies (NIE’s), predominantly in Asia, have increased their extraction rates dramatically due to urbanisation.

Swilling and Fischer-Kowalski (2010) demonstrate that within the context of population growth of an urbanising world, as the population density increases there is a corresponding decrease in the need for material; however, the increasing metabolic rate per capita as indicated by Behrens *et al* (2007) raises significant concerns for future demands of finite non-renewable resources.

In light of these trends indicated above, the International Panel for Sustainable Resource Management has developed, on the assumption that the global population will total 9 billion, three

scenarios for 2050 from which comparisons can be made to the baseline year 2000 scenario of 55 billion tons of extracted materials (Swilling and Fischer-Kowalski, 2010):

The first of these is the 'business-as-usual' scenario, which complies with recent trends and propels extraction from the current 55 billion tons extracted to approximately 140 billion tons per year. The average per capita metabolic rate will reach 16 tons; this allows for developing countries to 'catch-up' with developed countries that, in turn, 'freeze' their extraction at the current rate (Swilling & Fischer-Kowalski, 2010). This increase is equivalent to the rate of resource extraction tripling by 2050; in the context of scarce, non-renewable resources, there is little evidence to suggest these resources are available (Swilling and Fischer-Kowalski, 2010). In the meantime, environmental degradation associated with resource extraction and use indicates that humanity is already in overshoot, so an increase of this magnitude will be catastrophic. An alternative approach to development is essential.

The second scenario, in which industrialised countries moderately contract their extraction by a factor of 2 while developing countries are given room to catch up to this reduced metabolic rate, is more sustainable in that by 2050 the global material extraction will reach a total of 70 billion tonnes per year (Swilling and Fischer-Kowalski, 2010). In this way, an alternative is adopted which Swilling & Fischer-Kowalski (2010) argue will require both structural changes in production and manufacturing systems, and consumption patterns and institutional economic changes.

The last, more radical, scenario sees significant contraction, in which global extraction is frozen at the baseline metabolic rate, allowing developing and developed countries to converge at an approximate metabolic rate of 6 tonnes per capita (Swilling & Fischer-Kowalski, 2010). This approach will require a fundamentally new way of achieving economic growth and development, which does not rely on the linear extraction and disposal of valuable and finite resources but adopts a circular metabolism in which waste and emissions become valuable inputs.

Three forced future scenarios for 2050

Global metabolic scales in billion tonnes

Global metabolic rates in t/cap

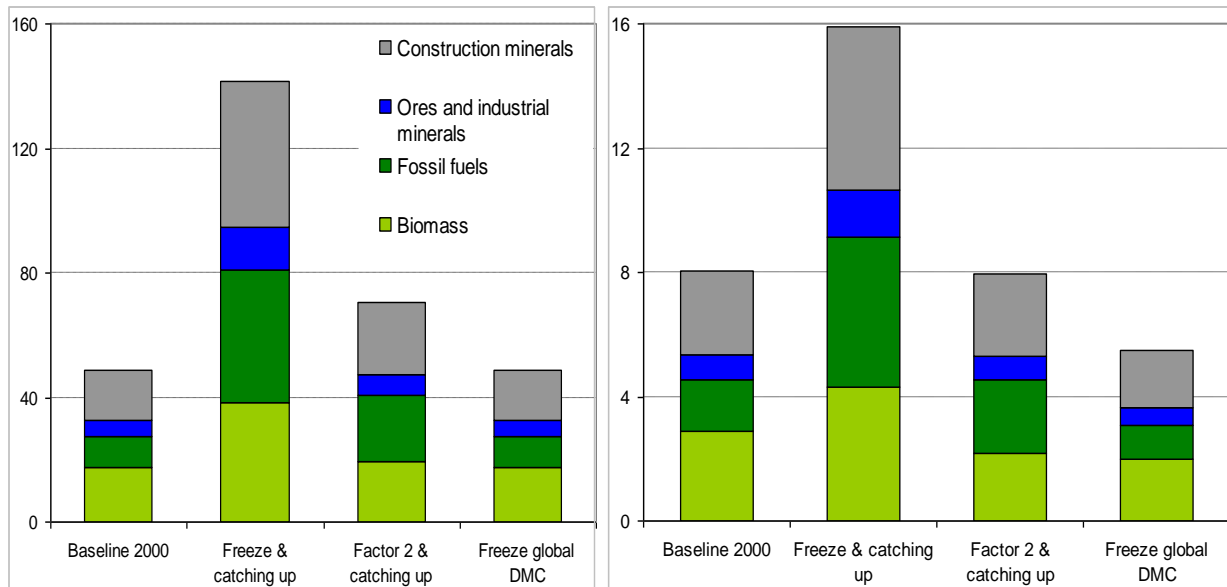


Figure 2.5: Three forced future scenarios for 2050

Source: Swilling, 2009b

Figure 2.5 provides a graphical illustration of the forced future scenarios for 2050. These scenarios provide invaluable information in that they offer insight into future resource extraction rates. From this, one can deduce the potential impacts of extraction rates without intervention by modelling the environmental impacts of current extraction rates; quite simply, this would be catastrophic. However, urbanisation trends place a prerequisite on the provisioning of a certain level of socio-economic stock, such as infrastructure, in line with 'some' level of development or human well-being and the inevitable socio-economic metabolism for the future tertiary and secondary cities of the South. However, the question of how these socio-economic metabolisms are configured remains critical to development within a resource-constrained world.

The material flows of the global economy and the metabolic rate thereof are tightly linked to the way urban network infrastructures are configured; material flows are distributed via a complex network of systems (Swilling, 2004). Therefore, infrastructure has a significant role when trying to make sense of urban systems; it is the means by which socio-economic metabolic flows are processed and distributed (Guy *et al*, 2001). Guy *et al* (2001) argue that when examining a city through the lens of networked infrastructures – the roads, bridges, tunnels, conduits, and wires –

that connect the city, “...modern urbanism emerges as an extraordinary complex and dynamic socio-technical *process*” (Guy *et al*, 2001:8; authors’ emphasis). Therefore, when conceptualising networked infrastructure as a socio-technical process one can conclude that the management thereof is the result of complex economic, social, technical, political and environmental processes which shape the configuration of socio-technical systems (Guy *et al*, 2001). In this way, the ‘metabolism’ of the economy, by means of resource extraction, allowing growth and investment, simultaneously becomes the means of achieving socio-economic metabolism via the interaction within a highly complex set of infrastructures.

2.4.3.5 Infrastructure as socio-technical systems

The book *Disrupted Cities: when infrastructure fails* (Graham, 2010) is a compilation of recent works that demonstrate the importance of urban infrastructures and the consequences of potential disruption and failures. Graham argues that despite the reality that infrastructure and technologies are generally taken for granted and ignored, “they continually bring into **being** the modalities and circulations of the city and the world” (2010:1; emphasis added). These intertwined and interdependent infrastructure networks, which include energy, water, sewerage, transport, trade and communication (Guy *et al*, 2001), connect the flows on which the city is reliant, allowing social and economic metabolism and therefore the existence of a city (Little, 2010). According to Graham (2010), ‘flows’, ‘connections’ and ‘metabolisms’ are inherent properties of urban systems which rely solely on the ability of infrastructure to transform environmental inputs into those properties that make up a city. Little (2010) goes further to argue that without these networked infrastructure systems, the c. 21st ‘urban complex’ would cease to function. These infrastructures are not the permanent, stable entities which are seemingly present as a given set of technologies impervious to disruption (Graham, 2010). Graham (2010) argues that infrastructure networks are the result of a series of deliberate actions which require continuous effort and vigilant maintenance to ensure their continuous, albeit precarious, functioning and should not be taken for granted.

Increasing interest in the importance of urban infrastructure is emphasised by three points identified by Graham (2010): firstly, infrastructure networks are ‘assemblages’ of components made useful via multiple interactions in which both inanimate and animate elements are critical; secondly, these assemblages not only combine technical and social elements present in urban areas, they influence the interaction between natural processes and the city; and finally, urban infrastructures can no longer be regarded as apolitical and left to technicians – instead, they are the result of ‘political construction’, balancing on a foundation constituted by layers of social and vested interests (Graham, 2010; Pieterse, 2008). By drawing the conclusion that urban infrastructure networks are the emergent characteristic of a series of political and technical

assemblages which play a role in the 'social production of urban natures', a greater degree of complexity emerges when examining systems disruptions and potential solutions (Graham, 2010). The significance of this lies in the potential uncertainties of ecological degradation, climate change and energy uncertainty within the context of a rapidly urbanising world.

The nature of the built environment and the reliance of urbanites on complex infrastructure systems which span across vast geography generate 'inevitable vulnerabilities' (Graham, 2010) and expose cities to a multiplicity of risks (Little, 2010). These sentiments are echoed by Doshi *et al* (2007) in the following excerpt:

Cairo, Los Angeles, Beijing, Paris, Moscow, Mumbai, Tokyo, Washington, Sao Paulo: Each major city has its own story of electricity, transportation, or water systems in crisis. Although the circumstances vary from one urban area to the next, they all have one thing in common: The critical infrastructure that is taken for granted by both their citizens and their government leaders is technologically outdated, woefully inadequate, increasingly fragile, or all of the above. (Doshi *et al*, 2007:40).

The state of urban infrastructures as characterised above, led Booz Allen Hamilton to determine the extent of this particular challenge. Findings indicated that over the next two to three decades, \$40 trillion will be required for the maintenance and modernisation of 'critical infrastructures'; these include energy, water and transport infrastructures (Doshi *et al*, 2007). However, this is not a mere technical problem. Cities are the result of a multiplicity of complex interactions, rich with culture, history and institutions with interdependent infrastructure and consequently it cannot be individually addressed (Doshi *et al*, 2007). This interdependence of infrastructures is echoed in Little's (2010) definition of infrastructure failures: 'Cascading failure' refers to the disruption of one system that has a ripple effect, disrupting other systems. Doshi *et al*, (2007) recognises the importance of proactive planning which is an alternative to a business-as-usual approach and takes into account the future demands of the urban population as well as the ecological crisis.

According to Hodson and Marvin (2009a), in light of the challenges faced in terms of climate change and resource constraints, cities need to re-tool infrastructures to prepare for the '*polycrisis*'. In this way, through a process of promoting "secure urbanism" and developing and investing in "resilient infrastructure", cities can achieve "urban ecological security" (Hodson & Marvin, 2009a). This can be translated simply into the combined effort of local governing bodies, corporations and non-governmental organisations within a city's boundaries securing access to the resources it depends on. This argument is made in lieu of financial, institutional, technological and sociological elements within the city, which together provide the intellectual capital for a new urban development paradigm. The rationale provided by Hodson and Marvin (2009a) is the development

of self-sufficient decentralised networked infrastructures that are less reliant on external resources and more efficient in terms of their energy use, and in this way generate a circular metabolism as discussed by Girardet (2004). The longer and more complex supply chain logistic systems are, the more vulnerable they are to being disrupted; cities consequently need to become more autonomous (Hodson & Marvin, 2009a; Doshi *et al*, 2007; Little, 2010). In urban areas of developed countries, the ways in which nutrition, transport and built environment infrastructures are configured are accountable for 70% of environmental impact (Tukker, 2005) and consequently need to be addressed urgently. Accordingly, Girardet (2004), complementing Doshi *et al* (2007), calls for the deliberate investment in the construction of feedback loops as a means of achieving viable infrastructural flows. Reference is also made to the concept of localism through the development of local resources; this can include urban and organic agriculture or localised processing. This new paradigm, as put forward by Hodson and Marvin (2009a), suggests the use of green technology¹⁰ and infrastructure investment as the means through which we will be able to reconfigure urban metabolic flows in the hopes of resolving the oncoming '*polycrisis*' and creating sustainable cities. In this way cities can remain within their ecological boundaries and functional regions.

While Hodson and Marvin (2009a) are focussing on mega-projects originating in global cities of well developed countries, there is a lesson for the secondary and tertiary cities of Africa and Asia, where future population growth will occur. The rationale follows the same advice offered by the Stern Review (2006) – that the benefits of acting early and preparing for a resource-constrained world are greater than waiting for a big shock to enforce change. Therefore, emerging cities have an opportunity to prepare and invest in those infrastructures that will provide a degree of resilience through sustainable socio-ecological systems.

2.5 Rethinking the city of the future

On reflection, one is left with a sense of despair after reading the above account of how humanity is fast reaching environmental thresholds and causing unprecedented degradation. This ecological crisis needs to be addressed urgently; however, massive poverty and inequalities persist and there is no consensus on the correct solution. Furthermore, this condition will be exacerbated by population growth and urbanisation, particularly of those cities of the developing South that have little or no institutional and infrastructural capacity (United Nations, 2006). It has been shown that cities are generally localities of unsustainable consumption, attaining resources far beyond their

¹⁰ Green technology for the purposes of this study refers to technology with a sustainability orientation based on the principles of sustainability.

boundaries, which, in turn, is indicative that cities, especially those with growing consumption patterns, will be vulnerable to inevitable resource constraints.

These conditions are a consequence of the pursuit of 'development', interchangeable with human well-being, via a socio-economic system which has not fully considered the limits to growth, and thus plundered natural resources. This approach has fundamentally undermined the ability for further human development and progress (Swilling, 2008). This scenario, however, is not the only option.

Swilling (2008) argues that cities have the necessary components for imagining and realising an alternative sustainable future. For the sake of simplicity, these components can be considered from two perspectives: first, the technical (physical) aspect and second, the social (interactive) aspect. While these concepts are interdependent, this perspective allows a theoretical understanding to be formulated for the purpose of this paper.

As noted above, the connotations of urbanisation are those of high resource demand and waste production; however due to the dense concentration of activities "... urbanisation often creates opportunities for reducing environmental pressure" (Martine *et al*, 2008:3). Martine *et al* (2008) further argues that utilising the benefits of proximity and concentration for the provision of infrastructure and services will however require an alternative and proactive approach to planning. Birkeland (2008) agrees, and extends the argument to encompass an alternative approach which includes the redesign of institutions and infrastructures, as well as decision-making processes. Guy *et al* (2001) focus on the role of new technologies which require less resources and increased efficiency; effectively the development of technologies which limit the negative environmental impacts of economic growth and development. This is the vision of Girardet's (2004) circular metabolism, and becomes the technical (physical) component for imagining a sustainable future. The theoretical framework which has been developed to realise this is the notion of **decoupling** which will be elaborated on below.

The second element which positions cities at the centre of resolving the sustainability crisis, is the social (interactive) aspect. Urban areas, due to their density, are complex hubs of people, knowledge, energy, finances, diversity and institutional capacity with their own specific context, culture and history; these are resources that can be harnessed, creating centres for **innovation** (UN-Habitat, 2008; emphasis added). The capacity to innovate lies at the heart of the solutions to the sustainability challenges, potentially absolving urban areas. Innovation, in particular technological innovation, is a prerequisite of decoupling (Stamm *et al*, 2009; Swilling, 2009b).

Therefore, innovation is tightly linked to realising sustainable urban systems as envisioned by Girardet (2004).

Recent publications by Hodson and Marvin (2010a) illustrate that while there is a logical link between innovation and socio-technical system transitions, and the urban context, the spatial aspect of transitions has been neglected despite the relevance of cities and networked infrastructures within the sustainability challenge. The neglect of the spatial context has created a void when trying to conceptualise socio-technical transitions and limits practical implementation of circular metabolism in urban areas. None the less, this creates an opportunity for research. This emerges through the association between socio-technical networked infrastructures in conveying resources flows along an unsustainable trajectory and the role of urban areas as a locality for transitions using decoupling as a intervention point for socio-technical systems, realised through innovation. The remainder of this section will discuss the concepts of decoupling and innovation.

2.5.1 Economic growth vs development

The notion of 'decoupling' can be adopted as a theoretical concept that provides a potential 'solution' to the resource consumption/economic growth and human development quandary in that it negates the belief that development necessarily occurs via the increase of resource consumption. This is also referred to as 'dematerialisation'. This concept has as its foundation the recognition that economic growth and development does not, as a rule, result in improved human well-being (UNDP, 1996; Smil in Haberl *et al*, 2004b). Gallopin (2003) argues that 'development' refers to increasing quality of life, which is not restricted to material human need, but includes non material human needs, and therefore human development can be realised by 'non material growth' (Gallopin, 2003). In this way he demonstrated that human development is not reliant on resource consumption. The relationship between economic growth and resource consumption is an emergent characteristic of the widespread use of GDP as the measure of human development, or more precisely the 'standard of living' within a particular country (Schepelmann *et al*, 2010). "The Gross Domestic Product is the market value of all final goods and services produced within a geographical entity within a given period of time" (Schepelmann *et al*, 2010:14). Blanchard (2006) explains that over time the value of GDP increases as the production of goods and services increase and the prices thereof increase. In this way, a country's standard of living is indicated as GDP per capita¹¹ (Blanchard, 2006). Therefore, when using GDP as the indicator, from a theoretical perspective, an increase in the standard of living is dependent on price hikes and/or an increase in the rate of resource extraction. It should be noted that this relationship is the framework

¹¹ GDP per capita is the total output of an economy divided by the population (Blanchard , 2006)

through which decisions are made when considering development; however, in reality the rate of economic growth as measured by GDP has been greater than the rate of resource extraction which indicates a weak correlation, thus disproving the rationale (Swilling & Fischer-Kowalski, 2010).

While GDP has had the monopoly on measuring 'standards of living' or human development (Schepelmann *et al*, 2010), a number of alternative means of measuring progress have subsequently emerged. The Global Footprint Network (2006) identified the Human Development Index (HDI) developed by the UNDP which includes life expectancy, education and GDP; this places the individual's capabilities as the main determinant of development (Schepelmann *et al*, 2010). In addition, Stiglitz *et al* (2009) recommended the adoption of the Happiness Index which represented both human well-being and environmental impact. This is a strong indication that GDP and economic growth, via the orthodox neoliberal economic paradigm which does not recognise the limits to growth, is not the only contributor to human well-being and development. Non material growth can occur within an economy in terms of an increase in value without increasing the physical size of the economy by means of resource consumption (Swilling & Fischer-Kowalski, 2010). Therefore, this creates the opening for the adoption of the theoretical notion of decoupling, in that decoupling provides the rationale for non material growth.

2.5.2 Decoupling

Furthermore, if we return to the notion that the (orthodox) global economic system is based on material flows which, despite its past contribution to human development and well-being, is unsustainable, then two options can be presented to resolve the *polycrisis* which emerges. The first is to halt resource consumption and economic growth, thereby creating a steady state economy and the second is to break the bond between economic growth and development and the use of natural resources and the environmental impact thereof. In 2001 the OECD recognised the need for decoupling and described the notion as separating the 'economic goods' from the 'environmental bads' (OECD, 2001), which is now translated into decoupling economic growth from environmental impacts.

This conceptualisation has been developed further by the International Panel of Sustainable Resource Management who has extended the definition. Decoupling as a concept is the means of achieving a higher degree of economic growth while the demands on natural resources and ecosystem services are decreased (Swilling & Fischer-Kowalski, 2010; Schepelmann *et al*, 2010). Bringezu *et al* (2004) argue that as a prerequisite, "reduced resource requirements and material throughput" is necessary for sustainable development. In this way sustainable economic growth

becomes possible within the resource-constrained economy. Haberl *et al* (2004b) distinguishes between (1) decoupling resource consumption from economic growth and considers an increase in efficiency as a means of realising 'dematerialisation'; (2) decoupling resource consumption from social well-being; and (3) decoupling social well-being from economic growth. For the purpose of this paper, focus will be placed on the dematerialisation component as a means of reconceptualising the role that infrastructure plays in conditioning socio-economic metabolic flows of a city. The dematerialisation focus is the starting point for reconceptualisation of human well-being and development. This argument follows the logic that decoupling economic growth from resource consumption is the acknowledgement that social well-being is not directly equated to resource consumption and therefore economic growth cannot directly be equated to social well-being. This is the rationale that allows the possible intervention at an urban scale for a socio-technical system transition, using decoupling as the theoretical framework for discussion.

2.5.2.1 Decoupling defined

Decoupling can be considered as either absolute or relative; the former is applicable when the rate of resource consumption is stable or decreasing while the economic growth rate is increasing, the latter is applicable if resource consumption is increasing but at a lower rate than economic growth (Swilling & Fischer-Kowalski, 2010; Schepelmann *et al*, 2010; Haberl *et al*, 2004b). Furthermore, Swilling and Fischer-Kowalski (2010) differentiate between resource decoupling and impact decoupling. Resource decoupling is associated with both the rate of resource consumption and the productivity or efficiency thereof; this can be measured in real terms using quantitative methods (Swilling & Fischer-Kowalski, 2010). In this way, resource decoupling speaks to the use of finite resources and the scarcity thereof, consequently addressing the challenge in intergenerational equity and encouraging the more efficient use of resources, as well as a reduction of the environmental impact associated with rapid resource extraction (Swilling & Fischer-Kowalski, 2010). On the other hand, impact decoupling considers the relationship between economic growth and the environmental impacts; these impacts occur over the entire life cycle of resources and while determining impacts is more taxing, impact decoupling, via more efficient processes during use, is generally achievable (Swilling & Fischer-Kowalski, 2010).

2.5.2.2 Decoupling in practice

Economic growth rates which are not dependent on rising rates of resource extraction have been noted. An increase in economic growth, as measured by GDP, at a greater rate than resource extraction, was experienced during the c. 20th with the resource productivity increasing at a rate of 1% per annum; this indicates a trend towards relative and impact decoupling during the process of development (Krausmann *et al*, 2009). In light of this, dematerialising the global economy is

possible; Steinberger *et al* (Swilling & Fischer-Kowalski, 2010) provide additional empirical evidence and demonstrate the weak link between resource use and economic activity (measured as by GDP). A greater degree of correlation is found when examining the population size and metabolic rates which account for the continuous increase in resource use (Krausmann *et al*, 2009). “During the last century, it has been a combination of global population growth and first rising and then stabilizing per-capita materials use of industrial countries that has driven global materials use” (Krausmann *et al*, 2009:8). However, Swilling and Fischer-Kowalski (2010) argue that metabolic rates are dependent on the development status of a particular country; this draws attention to the developmental strategies of developing countries which are “now beginning the transition towards an industrial type social metabolism” (Krausmann *et al*, 2009:8). This transition is pertinent to the scenarios described in figure 2.5, which clearly demonstrate the unsustainable trajectory of a business-as-usual approach to development; this provides the rationale for adoption and greater appreciation of decoupling for both developed and developing countries.

It is important to note that both impact and resource decoupling are crucial to achieving sustainable development. In developed countries, a trend of relative and impact decoupling seems to occur spontaneously (Swilling, 2009b), but in order to realise the necessary reduction in metabolic rates, these countries should commit to absolute decoupling, in terms of both resource and impact, through fundamental changes to patterns of production and consumption (Swilling, 2009b; Krausmann *et al*, 2009; Behrens *et al*, 2007). Behrens *et al* (2007) argue that this will provide ‘environmental space’ for the developing South to achieve the necessary level of material development. This can be achieved through the attainment of relative decoupling initially and then shifting to absolute decoupling (Swilling, 2009b). A reduction in resource use may contribute to more sustainable use of finite non-renewable resources, however, considerable environmental impacts will be realised through that which is extracted while extraction is still necessary for progress in developing countries. On the other hand, more efficient systems may limit some environmental impacts, but these resources are finite. Therefore, both a resource and impact decoupling must be realised, which forces the reconceptualisation of the notion of economic growth.

2.5.2.3 Decoupling as an alternative

From this perspective, it would be valuable to reconsider Gallopin’s (2003) notion of non-material growth. It has been argued that material extraction as means of achieving growth and development only contributes to human progress up to a certain point, thereafter improvements in human well-being are achieved without material input. Costanza (2009) recognises that material consumption beyond real needs has proven to diminish well-being. Therefore, reaffirming the goal of economic

growth, which is to achieve sustainable human well-being, offers an opportunity to invest in capital that contributes to this goal, for example investments in social capital and human capital (Costanza, 2009), which contribute to non-material growth. This is the link that provides the rationale for adopting alternative strategies for development, by understanding what contributes most to human progress.

Investments in social and human capital or 'human capabilities' and 'high quality institutions' drive economic growth and human progress; they provide the means of generating the greatest return on investment (Evans, 2006). This is attributed to the link between knowledge, information and networks and innovation, which is an emergent characteristic of the interaction between knowledge, information and networks (Swilling, 2008; Stamm *et al*, 2009, Sauter and Watson, 2008). Therein is a means of implementing decoupling and reducing the global socio-economic metabolism.

2.5.3 Innovation

Sufficient decoupling, which has a broad effect and contributes to sustainable development, is not only dependent on innovation, but radical technological innovation associated with far-reaching impacts on resource productivity (Stamm *et al*, 2009, Nill and Kemp, 2009; Tukker, 2005). Innovations, characterised by uncertainty, are considered either as cumulative, radical or incremental processes, which arise out of a series of interactions within localities of social networks and innovation, and are therefore also the result of diffusion and absorption of innovation (Lundvall, 2007). Radical innovation refers to 'entirely new solutions' whereas incremental innovation refers to 'modifying existing technology' (OECD, 2009). Furthermore, an innovation is the result of a systematic procedure, from research and development to implementation, on a large scale (Stamm *et al*, 2009). It is different from an invention in that it reaches the market (Lundvall, 2007) after transferring through what Tukker (2005) identifies as a four stage process. This process is in the form of a simple S-curve graph which is initiated at the 'preparatory phase', which 'takes off', experiences 'acceleration' or a 'breakthrough' and then 'stabilises' or is 'saturated' by the market (Tukker, 2005). The actualisation of the entire process is, however, dependent on and influenced by the context in which it occurs; the current market, culture, incentives, investments, policy and regulations will either contribute or detract from innovation (Stamm *et al*, 2009; Lundvall, 2009; Swilling, 2009b).

Montalvo (2008) explains that the economic development policies of the past 50 years, based on mainstream economic perspectives, resulted in 'innumerable innovations' and technological developments within the global economy, which contributed to the unprecedented growth

experienced. However, these innovations are responsible for environmental degradation and thus represent “a massive failure of current technological paradigms” (Montalvo, 2008:2). Stamm *et al* (2009) propose that this is the result of innovation policy and environmental policy being considered as separate entities with separate research centres, exacerbated by the fact that interaction between research communities and policy makers is generally poor. This highlights the importance of networks and interaction for successful innovation. Furthermore, Stamm *et al* (2009) argue that innovation systems are by and large present within the private sector, which, according to Swilling (2008), is notorious for under-investment in “human capital, innovation and networks because the direct returns to the investor are impossible to predict” (Swilling, 2008:22), whereas the public sector plays a supporter role and is in most cases a consumer of innovation (Lander, 2010).

Innovation in the past has been concerned with economic competitiveness and growth, contributing to an extraordinary increase in production, consumption and economic growth and therefore improvements in the average human welfare. This however has occurred along an unsustainable trajectory. Innovation now needs to be harnessed for environmental protection and restoration. Merging these seemingly separate themes of *sustainability* and *systems of innovation* offers an opportunity to realise ‘*sustainable systems of innovation*’ (Montalvo, 2008; author’s italics), or ‘*sustainability-oriented innovation systems*’ (Stamm *et al*, 2009; italics added). This is primarily concerned with the creation of innovations which reduce environmental pressure and contributes to sustainability during economic activities (Stamm *et al*, 2009; Montalvo, 2008). Reference will be made to a notion provided by Stamm *et al* (2009) of a *sustainability-oriented innovation system* (SOIS) in which a ‘system innovation’ “refers to the transition from one socio-technical system to another, qualitatively different one” (Geels & Elzen in Stamm *et al*, 2009:26).

Stamm *et al* (2009) present a case that demonstrates how innovation has been linked to sustainability through the notion of ‘system innovation’ in which socio-technical systems provide the lens through which systems transitions can be analysed and understood. Therefore SOIS’s provide a framework for socio-technical systems, as discussed in section 2.3, which act as the departure point for decoupling, a reduction socio-economic metabolism and thus sustainability. Geels (2004) extended the narrow focus of innovation at the sectoral level to encompass a broader perspective of technology; this includes production, distribution and use within society. This furthers understanding of transitions which affect both technology and the system in which that technology is embedded (Geels, 2004); in these cases the system and technology adapt and co-evolve (von Malmborg, 2007). This is similar to the notion of understanding technical systems or infrastructure, as socio-technical systems. Furthermore, Tukker (2005) argues that the scope

provided at the system scale allows for the radical innovation (paradigm shift) needed to address sustainability challenges. This is therefore the locality of socio-technical transitions. However, von Malmberg (2007) argues that the 'radicalness' of innovations is dependent on the actors present within the system, the learning that occurs and behavioural changes, which are attributed to the process of system innovation during which new knowledge is learnt and explored, while old knowledge undergoes creative destruction. Figure 2.6 demonstrates the difference between incremental innovations, which have been described above as technological improvements, and systems innovation. Changes at the system level offers the most effective way to improve resource efficiency and fulfilment of human needs (Vollenbroek, 2002).

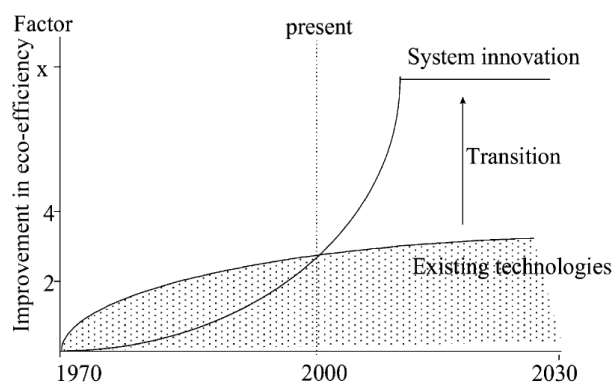


Figure 2.6 System innovation

Source: Vollenbroek, 2002

Understanding innovations from this perspective offers a bounty of opportunities for the sustainability agenda: through the deconstruction of notions about particular systems, and exploration of new knowledge, decoupling generates the potential for a new development paradigm. Innovations are an emergent characteristic of a multiplicity of interactions between learning networks, knowledge and expertise; this culture of innovation is the result of deliberate investments in social and human capital and capabilities based on a paradigm of non-material growth. The particular attention to socio-technical systems in innovation literature is evidence of the recognition of the role that networked infrastructure plays in the *polycrisis*; however; it is also evidence of the important role that networked infrastructure will play in addressing ecological and economic challenges through SOIS's.

2.5.3.1 Sustainability-orientated innovation systems

While SOIS's are the means through which socio-technical processes of urban areas can be reconfigured, for these innovations to be realised at the rate required to hedge against, and eventually reverse, environmental impacts from material economic growth, there is need for "...new

dynamics in innovation that would increase the frequency of technological innovations and their depth and outreach, triggering much higher impacts on resource productivity” (Stamm *et al*, 2009:18). In particular, Hodson and Marvin (2010) argue that there is need to renew the spatial context of transitions in which these SOIS’s occur, as it has been severely neglected, limiting decisive action at an urban scale. Lundvall contends that innovations are the result of incentives and investments, as opposed to random occurrences (Swilling & Fischer-Kowalski, 2010), and therefore conscious effort must be made to understand how to encourage SOIS. The concept of incentives and investments for the development of an SOIS complements Hodson and Marvin’s (2010) argument for ‘purposive’ urban transitions, which will be elaborated on below.

In order to encourage SOIS’s in a desired direction, the State needs to play a more central role. System transitions should be organised by government, who should initiate a ‘*transition team*’ that would in turn adopt the management role; this team would be made up of a number of actors and stakeholders including government officials, academic and scientific institutions, the private sector, civil society etc. (Vollenbroek, 2002; author’s italics). Similarly, Hodson and Marvin (2010; 2009b) suggests that a strategic ‘*intermediary*’ should intervene to manage the transition process. Swilling (2008) agrees and argues that ‘state-led investments’ are the key to ‘innovation-led economic development’; these investments include research and development grants, university programmes or NGOs. Furthermore, attention needs to be paid to the strengthening of poorly constructed networks which foster little innovation due to poor knowledge retention or learning capacity (Lundvall, 2007). Jänicke and Jacob (2009) argue that system transitions or “radical change requires (1) competent and globally networked governments capable of strategic action, (2) informed voters and consumers open to innovation, (3) a significantly higher degree of readiness for innovation on the part of companies and national economies, and (4) a highly productive system of innovation” (Jänicke & Jacob, 2009:12). This is dependent on governments providing the regulatory environments which activate SOIS’s (Montalvo, 2008). While governments can contribute to achieving transitions to sustainability, there is no certainty that a desired outcome will be realised, as socio-economic factors within a system have an unpredictable effect on innovation localities, and there is little consensus on how to govern them (Tukker, 2005).

A significant socio-economic factor that will affect innovation capacity and the implementation of new systems is the development status of economies (Tukker, 2005). As identified in section 2.3.2, countries at different stages of development will approach decoupling in different ways; these different stages of development will also influence the ability of countries to innovate. For industrialised economies, which generally have the capacity for radical innovation and systems transition, a major challenge lies in the ability to implement system change, due a high level ‘sunk

cost' in particular technologies, processes and systems of which a significant portion are fixed (for example complex networked infrastructures) (Tukker, 2005). In developing economies, the major challenge is the general lack of capacity in technology and innovation, while the 'clean slate' offers an array of opportunities to experiment in new systems, alternative to those unsustainable technologies seen in developed economies (Tukker, 2005). Montalvo (2008) argues that developing economies may, in fact, have an advantage over industrialised economies with regard to SOIS's for the following reasons: developed economies have more rigid structures which could inhibit their reaction time; dominant technologies in developed economies are a barrier to diffusion of new technologies or development paradigms; developing countries have a greater capacity to leap-frog; the presence of unsaturated and underdeveloped markets in developing economies; and the consumption patterns in developing countries are more adaptable to embracing SOIS's.

In light of this, developing countries offer an opportunity "...to experiment with wholly new production and consumption systems" (Tukker, 2005:8). A shift in the mainstream approach to socio-technical systems, in which the departure point for innovation is a decrease in resource consumption, increased productivity and low environmental impact, potentially acts as the framework for realising decoupling. SOIS transitions are therefore not only technological but also economic and social transitions through which a new development paradigm is adopted. However, *in situ* infrastructure in both developing and developed economies will influence the way in which socio-technical systems are configured and reconfigured using an SOIS as the departure point. Understanding the contextual circumstance within which a transition will occur, is therefore a critical component that requires knowledge exchange and learning. This has been expanded on by Geels (2002; 2004; 2010).

2.5.4 System transitions

Geels (2010) argues that a multi-level-perspective (MLP) provides a framework for "...understanding sustainability transitions that provides an overall view of the multi-dimensional complexity of changes in socio-technical systems" (Geels, 2010:495). The MLP is a three-tiered framework which consists of the landscape (macro), regime (meso) and niche (micro) levels. The socio-technical landscape, or macro level, provides the context within which a socio-technical system exists; in this way it is considered as an external or exogenous factor and it provides the greater structure for activities in a system (Geels, 2002; Geels, 2004). Geels (2004) goes on to explain that because the landscape is an exogenous factor, it is out of the control of actors within the system and thus cannot be changed or adapted according to preference. Therefore, it is in a relatively stable condition which adapts slowly according to indirect adjustments at a lower level; however, the landscape by nature is unpredictable, responding to variations in macro-economic,

environmental and social conditions (Tukker, 2005). At the micro level of socio-technical systems are socio-technical niches. Niches are isolated protected pockets which act as the locality for creation, development and testing of radical novelties and innovations (Geels, 2002). These novelties are by and large learning experiments in response to changes or demands from the meso and, more particularly, the macro level; while the isolation provides a mechanism for protection against other market products, niches are the starting points for change (Geels, 2002; Geels & Schot, 2007). Furthermore, niche innovations usually occur within a small network of actors who provide the financial and technical support for the realisation thereof (Geels & Schot, 2007). Lastly, the meso level, or socio-technical regime, represents the existing configuration of institutions, rules, culture and techniques, and therefore forms the set of practises, exhibiting dynamic stability, carried out by social groups (Geels, 2002).

This stability is reinforced by the consistent reference to a particular regime – whether it is science, technology, economics, politics or culture – identified according to its function, which hampers the introduction of niche innovations (Geels, 2004). Geels and Schot (2007) argue that the meso level is deeply embedded within ‘cognitive routines’ of engineers, policy makers, the private sector and even academic institutions, consequently inhibiting the entry of radical innovations onto the market.

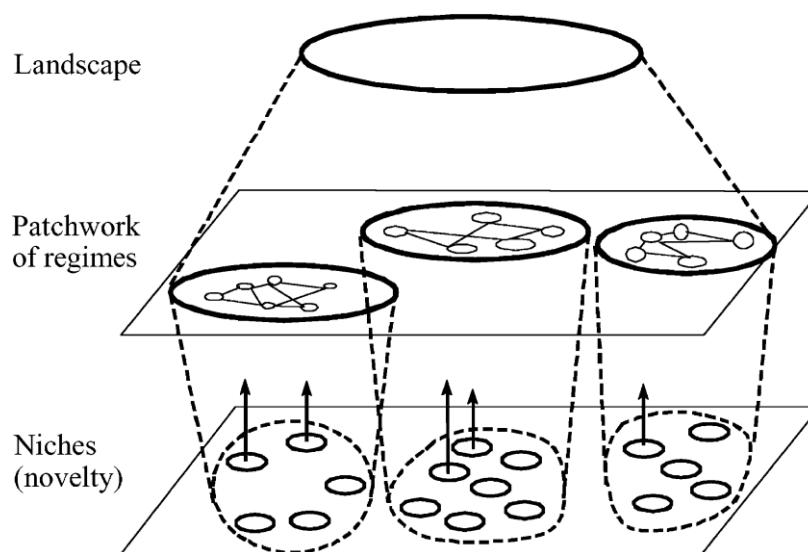


Figure 2.7: Multiple levels as a nested hierarchy

Source: Geels, 2002

Figure 2.7 illustrates the relationship between the three levels of the MLP. The MLP consists of three embedded interconnected and interdependent components, which, through interaction, allow for the emergence of socio-technical transitions (Geels & Schot, 2007). Geels (2002) explains that changes at the macro and micro levels exert pressure on the socio-technical regime, which leads

to a transition. In terms of the micro level, small networks developing radical innovations exert upward pressure through a build up of internal momentum (Geels & Schot, 2007), which weakens the barrier of the regime level; eventually 'breaking through' when sufficient and simultaneous pressure has been exerted from the macro level (Geels, 2002). This breakthrough or 'window of opportunity' is created via the mutual tension from the macro and micro levels which destabilise the particular socio-technical regime, allowing competition between new and existing regimes, be it technological, cultural, political, economic or scientific (Geels, 2002). Geels (2002) argues that these changes have the capacity to influence or change the landscape level. Significantly, however, Geels and Schot (2007) argue that the landscape and regime levels directly affect or influence the niche innovation level. Important to note that, while numerous radical innovations are necessary to contribute to the resolution of the ecological crisis, technological transitions occur via step by step processes as opposed to radical regime changes (Geels, 2002). Therefore, regime changes can occur over an extended period of time as a result of the accumulation of various niche innovations which, when connected, accrue to a system transition (Geels, 2002).

Despite the extensive coverage of this framework in terms of the role it can play in understanding transitions as a function of the relationship between the various levels of the socio-technical systems, there is little reference to the spatial context for these transitions to sustainability (Hodson & Marvin, 2010). The weight of this argument is significant when considering urban sustainability. Infrastructure, as a socio-technical system, becomes a chief concern due to the role it plays in urban metabolism; however, innovation offers an opportunity to reconceptualise these systems to allow decoupling and therefore a reduction of metabolic flows through the creation of circular metabolisms allowing cities to meet their material needs without experiencing an increase in material use. Therefore, the city becomes a spatial context for socio-technical transitions and there are, in fact, numerous examples of cities reconfiguring socio-technical regimes at the urban scale: this phenomenon has occurred in South America in Curitiba and Bogota, while there are projects currently underway worldwide in London, New York, Johannesburg, Melbourne, Bangkok and Mumbai. Hodson and Marvin (2010) suggest that these projects are strategic responses from 'world cities' seeking to build resilience against climate change and ecological constraints through the reconfiguration of infrastructures and the development of new infrastructures which influence the relationship between the spatial context of cities and the natural resources cities are dependent on.

In light of the absence of sufficient reference to the spatial scale within the socio-technical transitions juxtaposed to the centrality of cities within the sustainability discourse, Hodson and Marvin (2010) have opened a discussion to determine whether cities are the "purposive contexts

for urban transitions” (Hodson & Marvin, 2010:5). They consider the role of cities in ‘shaping transitions’ with deliberate intention, via a framework of localised action for system change, in which socio-technical regimes are within the influence of local decision-makers, including policy makers and officials, developers, businesses and citizens. This is in response to the lack of available expertise on how to ensure the transition from a niche innovation at the micro level to changes at the regime level, and thus the realisation of a full-scale transition. Within this framework they note that the ability of cities to respond to resource insecurity will vary and will, at least, be influenced by three factors:

1. How the pressures are experienced and perceived in a particular city and by whom, and how this translates into a shared understanding of an urban socio-technical transition;
 2. The current and historical organisation of infrastructure in relation to a city and the level of capacity and capability to develop and operationalise this shared understanding processually; and
 3. The degree of learning that takes place within and about the urban transition.
- (Hodson & Marvin, 2010: 5)

Evidently, urban transitions will not simply occur due to a series of resource constraints present; rather, an urban transition will be the result of a purposive action from relevant stakeholders within networks present in the particular urban context, who participate in a process of decision-making for a socio-technical system transition. Therefore, the reconfiguration of infrastructures as technology is dependent on social and institutional adjustments at a regime level through the development of capacity to do so. This can be achieved through the extension of networks and allowing contributions to be made from additional sets of expertise to allow for social learning. This is explained by Hodson and Marvin (2010).

Hodson and Marvin (2010) assert that urban socio-technical transitions are the result of a shared vision amongst multiple actors and institutions that, through a participatory process of struggle and negotiation, develop reference points out of which coalitions and networks are formed. The type of vision developed for an urban transition will be shaped and informed by the various social interests, or more contentiously, vested interests of those who participate, and will therefore necessarily have diverse priorities and motivations (Hodson and Marvin, 2010). These participants will include those responsible for or influenced by critical infrastructures, and are generally profit and efficiency orientated rather than being concerned with the sustainability of resource flows and minimization thereof. Ensuring that an appropriate vision is developed using sustainability as a lens, will therefore be dependent on sufficient learning amongst stakeholders by utilising the

knowledge that already exists within a system, generating knowledge, and exploring it through a process of creative destruction as discussed above.

While a vision is a useful reference point for a purposive transition it is not sufficient to transform the socio-technical systems as well as the urban governance regime; critical to the transformation is the presence of effective capacity and capability which is mobilised and coordinated by what Hodson and Marvin (2010) call a 'intermediary organisation' that can translate the vision as well as mediate varying social interests. The relevance of intermediary organisations is considerable in the current climate of decentralised and increasingly polycentric type governance with regard to control of socio-technical systems; intermediaries therefore intervene to "shape relationships strategically between technology and local context" (Hodson & Marvin, 2009b:521). Intermediaries, through their multi-disciplinary makeup and wide-ranging understanding of operational city logics and an envisioned future, facilitate flows of knowledge and consequently manage the transition process (Hodson and Marvin, 2009b). Hodson and Marvin (2009b) provide two key activities which identify intermediaries. The first role involves the development of the contextual understanding of the city in terms of its geographical nature, which enables a thorough appreciation of the various possible technological interventions for provisioning systems of production and consumption within the local urban systems (Hodson and Marvin, 2009b). The second key activity involves the governance of transitions. Governance should be understood in the sense of control and organisation within an institutional structure which allows formal and informal interaction between actors at the local, national or international scale and in various sectors (Hodson & Marvin, 2009b). The significance of the role of intermediaries is in the outcome produced when they are involved in system transitions, which, according to Hodson and Marvin (2010a), would not have been possible without their intervention.

2.6 Chapter summary

System innovations, in which socio-technical urban system transition from one to a qualitatively different system, transpire within different contexts. Multiple technological innovations which use the principles of SOIS's as a framework, are required to observe the necessary transitions within socio-technical systems. It has been demonstrated that cities offer themselves as the locality for the implementation of these systems transitions due to the scope available for change; however, transitions are influenced by the ability to innovate through learning and knowledge exchange networks as well as the perceptions of those individuals and networks that engage with urban challenges. Therefore the lack of capacity and capability to foster support for development of SOIS's will hamper opportunities for sustainable socio-technical system transitions within urban systems significantly.

The framework of the MLP offers a means to understand system transitions through innovation, however there is a lack of reference to the spatial aspect of transitions. An attempt to contribute to this debate will be made through the case of Cape Town in the following chapters. The discussion offers an opportunity to understand how purposive urban transitions can occur within urban systems, as well as provides the empirical evidence of the relevance of decoupling which can be realised through system innovation. The case of Cape Town lends itself to an understanding of what actions can be taken when facing the challenge of the *polycrisis* practically. The sustainability debate is multilayered and, due to its non-linear nature, forces one to examine the challenge as a whole, often negating action and intervention; actions have unpredictable results. However, within an urban context, and based on future trajectories of the urban condition, an intervention point at the level of socio-technical systems presents using the framework of decoupling which can be realised through a socio-technical transition which emerges from a SOIS's. Therefore, cultivating a culture of new knowledge, learning and innovation using the concept of SOIS's offers an opportunity for urban infrastructure transitions and therefore the adoption of the theoretical notion of decoupling in the practical sense.

Although this may be difficult to implement, it re-emphasises that proactive planning and anticipation of the impending increase in demand for resources and natural services are critical to providing a level of ecological security for urban areas in a resource-constrained world. A critical element that needs to be taken into account when considering the rapid urbanisation of developing countries is the significant role that complex systems of infrastructure play in sustaining modern cities. This is in light of the overview of the current global trends; cities in general will continue to struggle to meet the consumption demands of their inhabitants. Furthermore, in the context of exponentially growing secondary and tertiary unplanned urban centres, which house polarised, poverty-stricken societies, the threat of these uncertainties is far more pressing. If the intention is to encourage development, a holistic approach must be adopted, one which uses the notion and principles of sustainable development as a context out of which a realistic future framework can be executed.

Chapter Three: Cape Town Metropolitan

3.1 Introduction

The literature review has provided a context for understanding the current position of cities of both the North and South in terms of the global *polycrisis*. Oncoming changes to the natural environment in which cities are embedded will manifest in a multiplicity of ways within different contexts, and therefore will be understood and reacted to differently by actors present within urban systems, which have varying capacity to cope. Regardless, urban systems will be the locality of action and therefore the case of Cape Town Metropolitan offers an opportunity to understand how cities can approach socio-technical system transitions using a framework of SOIS's and decoupling as the departure point. This case offers the empirical evidence for the theoretical notion of decoupling, as well as lessons on how cities, as the spatial context for urban transitions, respond to challenges and what lessons can be extrapolated for the improvement of urban systems.

The case of Cape Town demonstrates the limits of creating an inclusive, equal society by extending traditional, identical, large technical systems to entire populations within a city. Cape Town, as a spatially divided city with growing informality, presents a scenario similar to other cases in the Global South, despite its relatively greater capacity to cope with the *polycrisis*. This offers the empirical evidence that socio-technical systems which extend across vast urban landscapes, are unsustainable, due to their resource-intensive nature and therefore provides the rationale for using a system transitions approach for exploring an alternative approach to development. As Cape Town struggles to address a series of social issues, both financial and ecological constraints add pressure to attempts to realise development. Therefore, an argument will be made for the adoption of the theoretical notion of decoupling at all levels of decision-making and strategies for change, using the context of critical urban infrastructures as a framework for discussion.

What follows, is an update of the current state of resource flows in Cape Town which demonstrates the unsustainable nature of the urban metabolism. This section creates the context for a discussion regarding the need for socio-technical systems transition, which can only occur once sufficient pressure has been exerted from the micro and macro levels on the incumbent socio-technical regime. It will be demonstrated that Cape Town presents itself as potential spatial locality for purposive urban system transitions. Critical, however, is the adoption of an SOIS approach which will allow knowledge exchange with reference to sustainability principles, without which Cape Town will be unable to cope with the challenges urban centres face within the context of global ecological destruction.

3.2 A perspective of Cape Town

Cape Town is internationally renowned as a world-class tourist destination. As South Africa's 'Mother City', it is widely known for its exquisite scenery and unique culture. Located in the Western Cape Province, it is the country's legislative capital and the seat of the National Parliament. The origins of the city lie in its role as a port for the Dutch East India Company, thus illustrating the extent of Cape Town's multicultural history.

Like all post-apartheid cities in South Africa, Cape Town is, however, fraught with social and economic challenges as a result of spatial dislocation under the segregation policies of the apartheid regime. These policies have resulted in unequal access to services, both tangible and intangible, the results of which have been manifested in severe poverty, inequality and unemployment. Attempts to resolve this multilayered set of challenges via economic growth, poverty eradication and the extension of services, have been made with varying degrees of success.

The incumbent approach to redressing Cape Town's social and economic concerns is no longer viable, as the means used to create an inclusive society have placed significant financial burden on the City of Cape Town (CCT) metropolitan municipality. Furthermore, the creation of an inclusive society has remained elusive as the spatial dislocation according to racial characterisation is ever present. The poor and marginalised remain on the peripheries of the city. The financial burden incurred through attempts to create an inclusive society has in many ways reinforced the segregated city; this is a challenge that needs to be resolved within the context of severe and critical ecological constraints. Significantly, these ecological constraints are, in part, the result of the approach adopted by the CCT to create an inclusive society via economic growth and the extension of standardised utility services. Cape Town's metabolism is linear. In this way, Cape Town faces its own *polycrisis* in that there are multiple challenges from a financial, social and ecological perspective which reinforce one another through non linear feedback loops.

In an attempt to provide insight into the current context of Cape Town, the remainder of this chapter will argue that the current trajectory of development is unsustainable. The argument will demonstrate that the ecological base for socio-economic development, enabled via the flow of resources through networked infrastructures allowing socio-economic metabolism, is being undermined.

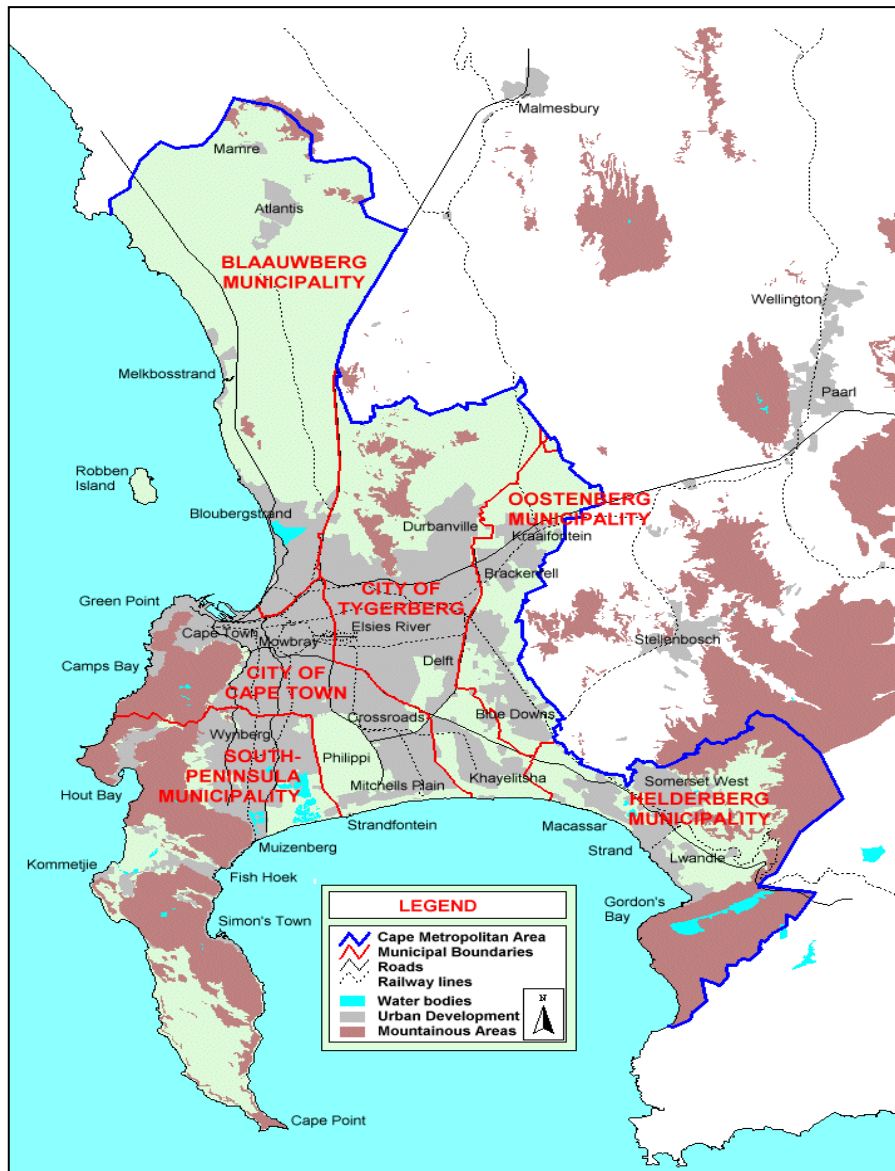


Figure 3.1: Cape Town

Source: Pithey, 2007

3.3 Cape Town's current state

This section offers insight into the current socio-economic development patterns of Cape Town and will consider the population and urban growth rates, the distribution of that growth, economic growth rates and the employment status.

3.3.1 Social dynamics

Cape Town's total population in 2007 was 3.4 million, extending across 2461 km² (CCT, 2009a). Small (2008) demonstrates that this total is by and large the result of growth that has occurred over

the previous two decades, the population having increased by 36.4% since 1996; or as demonstrated by Romanovsky (2006), the population increased by 700 000 people between 1996 and 2006. The average growth rate will however decrease dramatically between 2006 and 2021 when the population will grow by approximately 300 000 people (Romanovsky, 2006). Furthermore, population growth in Cape Town will chiefly be attributed to migration from the Eastern Cape, which is estimated to account for 87% of the future population growth (Romanovsky, 2006). This type of population growth is tightly coupled with a large degree of low-density urban sprawl. During the twenty years between 1985 and 2005 the land footprint of Cape Town increased by 40% and is now developing at an average rate of 1 232 ha per year (Small, 2008). Figure 3.2 illustrates the dramatic growth of Cape Town between 1970 and 2000.

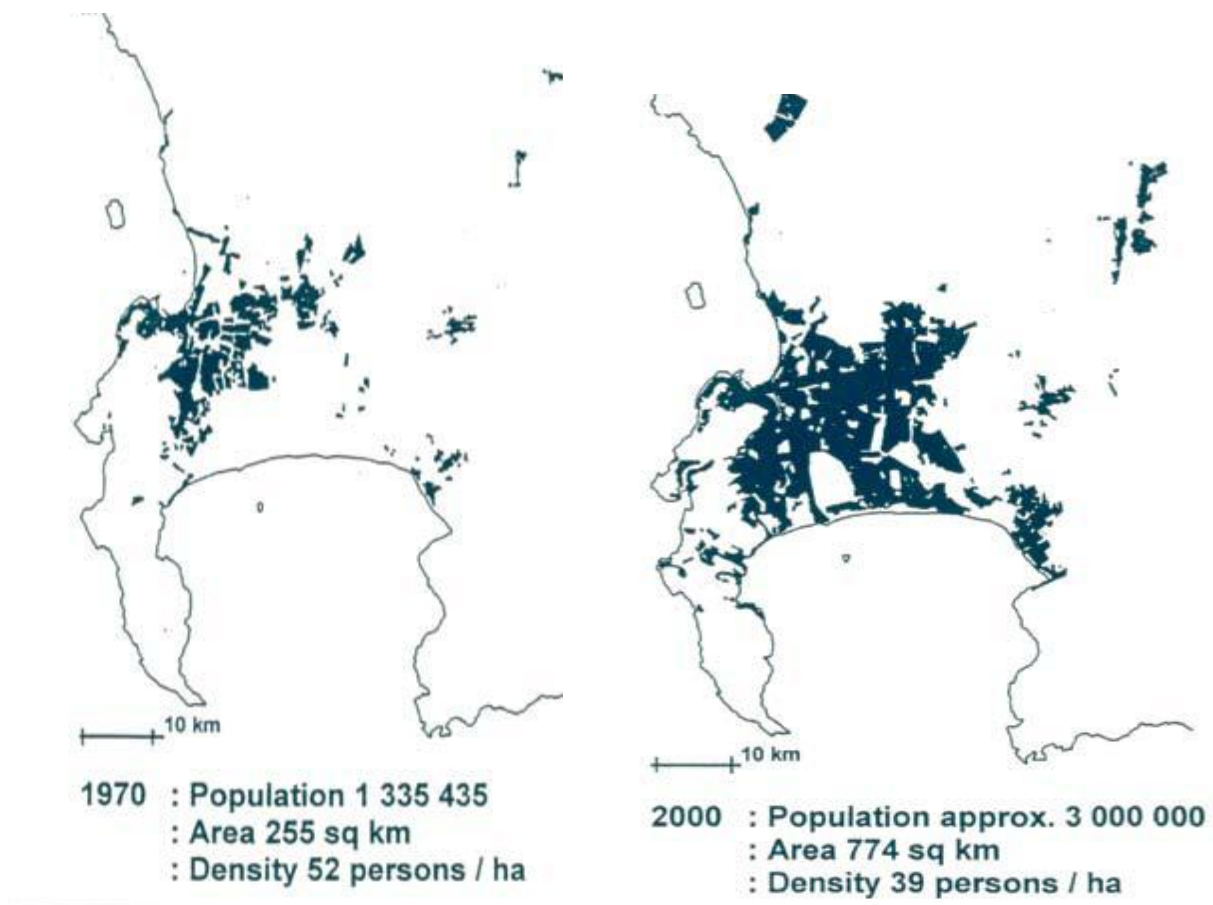


Figure 3.2: The expansion of Cape Town's footprint during 1970 and 2000

Source: CCT, 2007g

Within the 3.4 million-strong population of Cape Town, the total number of households in 2007 was 902,279 indicating an increase of 38.2% since 1996 (Small, 2008). Of the total number of households, in 2007 83% lived in formal dwellings while 15.6% or 115 000 families lived in what is

considered informal dwellings (Small, 2008). Recent findings illustrate that this informality is growing at an average of 13% year on year rate (Reddy, 2010). Cape Town currently has a housing backlog of 300 000 houses which places an unprecedented strain on financial resources, as 20 000 new houses will have to be built each year to meet the demand; this contributes to the challenge of providing adequate water, energy, waste and sanitation services to the segregated society (CCT, 2009a; de Wit *et al*, 2008). Furthermore, the spatial development of the city has occurred in an *ad hoc* manner in which additional informal settlements have mushroomed on the city's periphery, requiring additional bulk infrastructure investment as well as reticulation infrastructure in order to ensure access to metabolic flows for the entire population (CCT, 2007a).

As identified by Swilling (2006), there are three sub categories within the class structure of the population of Cape Town: 16% of households are high income, elite groupings; 31% are middle income households; while a staggering 51% are poor working class households thus highlighting the severe disparities within Cape Town society. With that being said, Cape Town is unique in that, although there is a significant housing backlog, 93% of all households have access to services, which includes electricity, piped water, sanitation and refuse removal (Small, 2008). While services have been extended, investment in bulk infrastructure and existing infrastructure, as well as the maintenance thereof, has been insufficient. Ageing and failing infrastructures urgently need to be upgraded or replaced, putting additional pressure on municipal authorities (CCT, 2007a; de Wit *et al*, 2008).

Table 3.1: Access to services in Cape Town

Service	1996	2001	2007
Access to electricity for lighting	86.8%	88.8%	94.4%
Access to piped water	98.2%	98.7%	99.5%
Access to flush or chemical toilet	89.3%	87.5%	93.0%
Households using bucket toilets	3.1%	4.4%	2.9%
Households having no toilet facility	4.9%	7.2%	3.5%
Weekly removal of refuse	88.6%	94.2%	94.2%

Source: Small, 2008:6

Table 3.1 demonstrates that services have by and large been extended throughout the population; however, this table is insufficient in that it does not account for the differentiated services provided for different sectors of the population according to class divisions. Furthermore, these figures should be read with caution; Reddy (2010) advises that these findings should be questioned, as service delivery figures are often articulated in a manner which emphasises preferable circumstances or outcomes depending on who is set to benefit by publishing such findings. Contrary to figures provided by the CCT, is an argument made by Adlard, (2008). If informal and

backyard dwellings are considered, a total of 400 000 or 44% of households can be classified as informal (Adlard, 2008). Closer examination of the term 'access' is used even when approximately 5 households share one toilet and for every 11 households (approximately) one tap is available (CCT, 2009a). The CCT has recognised the challenge of significant backlogs in terms of water, sanitation, energy, waste and transport which arise out of the housing backlog and poor maintenance of existing infrastructures over the past 20 years (CCT, 2009a). The provision of adequate services is however hampered by financial constraints, inefficient institutional capacity and the technical approach to providing of networked infrastructures, which does not take into account the limited environmental space available for development.

3.3.2 Economic dynamics

Economic growth and development is crucial if the CCT want to meet its goals set for poverty reduction and the resolution of inequality. The economy of Cape Town over the last decade grew by an average of 4% per year in terms of the gross geographic product (GGP) and constitutes 82% of the West Cape economy while contributing 11.58% to the National GDP (CCT, 2007b). This growth has predominantly been stimulated through growth in the tourism sector and infrastructure investment (Small, 2008). The dominant sectors are finance and business services, retail and wholesale trade, and manufacturing; however, the contribution of the latter has been declining as the economy shifts toward a service-orientated economy (CCT, 2007a; de Wit *et al*, 2008).

The steady shift away from a predominantly manufacturing economy toward a service-orientated economy has contributed to an increasing unemployment rate due to a generally low skill level amongst the working class (CCT, 2009a). This indicates 'jobless' growth, exacerbating the existing challenge of high unemployment levels. In 2007 the unemployment rate in Cape Town was 16.9% while the percentage of discouraged¹² workers amounts to 5.1%, which when combined indicates a 23% unemployment rate in Cape Town (Small, 2008). Haskins and Smith (2006) estimated that if the CCT wants to realise a considerable reduction in the unemployment rate, an economic growth rate of 6-7% or the creation of 40 000 jobs annually is necessary. In this way it can be argued that the unemployment rate is a function of a skills shortage. Therefore an improvement in employment figures will require investment in skill development (Haskins and Smith, 2006).

Investment in skill development will play a key role in alleviating poverty, which is a major inhibiting factor for human development. The percentage of people living below the poverty line increased

¹² Discouraged workers are those individuals that are unemployed not actively seeking employment despite their eligibility (Blanchard, 2006).

from 25% in 1996 to 38% in 2005 as reflected in the monthly expenditure of households (CCT, 2007a). Poverty and inequality, coupled with high levels of unemployment, create a complex scenario in which infrastructure services are extended and will be in the future. As indicated by Swilling (2006), 51% of the Cape Town population are poor and working class, and as discussed above 38% of the population live below the poverty line. These disparities have resulted in differentiated service delivery which does not follow the general trend of service extension in cities of developing countries but rather of provision within an unequal society, as discussed by Jaglin (2008), in which an increasing percentage of the population are dependent on municipal financing and grants (de Wit *et al*, 2008).

This profile of Cape Town indicates a development trend which is unsustainable. The city faces a complex interrelated series of challenges in which increasing poverty and inequality is exacerbated by unemployment and low skill levels. This is within a context of economic constraints and a significant backlog of housing, infrastructure and services. The CCT has explicitly stated these complex challenges need to be resolved in part through **infrastructure-led** economic growth, and have repeatedly called for the provisioning of **sustainable urban infrastructure** (CCT, 2007a; CCT, 2010a; CCT, 2006a; emphasis added). This, however, raises a series of questions regarding the type of infrastructures needed within the context of a resource-constrained world, and the role of the city in the future, as discussed in chapter 2, which is noteworthy as "...there have been no changes to the way in which energy, water, sanitation, and solid waste are delivered and distributed" (Swilling & de Wit, 2008). The critical question is, who will make the decisions regarding sustainable urban infrastructures? This will be explored in the following section. First, however, attention needs to be given to the historical developments which have occurred, creating the context for the current state.

3.3.3 Historical developments shaping Cape Town

The historical context of Cape Town, like many other South African cities has significantly contributed a scenario in which the provision of infrastructure has become a means of creating an inclusive or unified society. Since the first local democratic election in 1996, the local government has undergone fundamental reconstruction in which segregated 'white local authorities' (WLA's) and 'black local authorities' (BLA's) were integrated in order to standardise systems of governance, thus resolving the 'illegitimacy' of WAL's and 'inefficiency' of BLA's (Jaglin, 2004). WLA areas were traditionally well developed with sufficient social, human and financial capital while BLA areas were notoriously underdeveloped and lacked adequate capacity to cope with the demands of the population within the allocated areas; these areas were generally overcrowded due to segregation policies of the apartheid regime (Smith, 2004). As part of the process of integrating urban society

and reducing in the level of inequality by providing standardised services to all in Cape Town, the number of local authorities was reduced from 61 municipalities to 7 local governing authorities (de Wit & Swilling, 2008). This structure of local government was however, not efficient in rearranging the socio-economic conditions in Cape Town, evident in the growing unemployment and 'informalisation' within the city (Unicity Commission¹³, 2000). Therefore, to address the social and economic disparities within the fragmented city, the City of Cape Town was created.

In 2000, the separate local governing authorities were amalgamated, in accordance with the Municipal Structures Act, forming the Unicity of Cape Town, known as the City of Cape Town (CCT), which held sole executive and legislative authority (de Wit & Swilling, 2008). Centralised power strengthened the authority of the metropolitan of Cape Town, creating a single metropolitan tax base which provided the financial resources to address the challenges of spatial division, poverty and inequality more effectively and efficiently (de Wit & Swilling, 2008). Consistent with the national trend for local governments, responsibility and accountability was transferred to the CCT after 1994, in particular the role of extending services to previously disenfranchised individuals in segregated areas; this included physical and social infrastructures within the built environment (McDonald & Smith, 2004; Mirafatab, 2004). The provisioning and standardisation of infrastructure and services on an equitable basis was a primary responsibility for the CCT, based on the standard set out by national government (Unicity Commission, 2000). The rationale for extending network infrastructures was the need to connect the entire population to the resources flows of a city, and therefore offer the opportunity to participate in the socio-economic metabolism and unify the racially segregated society.

During this process of creating an integrated Unicity, financial constraints steered local authorities toward a neo-liberal, market orientated policy approach in which the role of extending services was outsourced to the private sector. State-owned enterprises were privatised/corporatized and public-private partnerships in which 'delivery on cost recovery' approach was generally used were encouraged (McDonald & Smith, 2004; Mirafatab, 2004; Smith, 2004). Smith (2004) argues that engineers have played a central and critical role in realizing the cost recovery mechanism, using the rationale of 'efficient service delivery'. Therefore, while service delivery has firmly remained in the control of the CCT, the model of service delivery, determined by engineers, placed profit and efficiency as a priority, while redistribution and equity was envisioned to be the outcome of the model. Service delivery was standardised by integrating the arrangement of technical services in

¹³ "The Unicity Commission was established in November 1999 as a multi-party political body to supervise the transition to the Unicity for Cape Town which came into being at the local government elections on 5 December 2000" (Unicity Commission, 2000:34).

informal areas and townships with the greater infrastructure network (Jaglin, 2004; Smith, 2004; Jaglin, 2008). This was considered as the most feasible way of realising urban integration.

Urban integration, as envisioned by engineers responsible, is the process of extending standardised infrastructure in the most efficient manner available and thus producing what has been identified by Moss (2001) as 'large technical systems'. The predominant production factors which influence an engineer's approach to developing such a system is the efficiency thereof. While this is technologically sound, attention is however not paid to social factors that influence the system in the long run (Smith, 2004). Therefore, socio-economic challenges of poverty or the haphazard nature of informal settlements in Cape Town were not considered, and while the supply was managed, the demand side had not been considered (Smith, 2004; Jaglin, 2004). Nonetheless, since the inception of the Unicity, significant investments have been made in improving and extending infrastructure in poor areas and townships with the aim to converge standards of previously Black areas with those of White areas. Within the electricity and water services advancements were made via capital expenditure for upgrading and instalments, while levels of service for solid waste were improved (Jaglin, 2008). Mirafteb (2004) however argues that this has resulted in differential service provision, negating attempts to foster equality, and despite the progressive nature of service delivery goals and policy, the structure of inequality has not altered dramatically and racial divisions have remained more or less the same.

The presence of fragmented and differential service provision seems to indicate that Cape Town meets the criteria of splintering urbanism, the phenomenon through which differentiated services, due to neo-liberal market and economic dynamics, create and entrench inequality (Guy *et al*, 2001). This argument cannot, however, be emphatically applied to Cape Town. "...Cape Town is strongly resisting a pattern of unregulated differentiation triggered by uncoordinated market strategies" (Jaglin, 2008:1905) despite the presence of a historically splintered society due to apartheid policies. Moreover, Jaglin (2008) contends that, although differentiated basic services are present, such as water, sanitation, energy and waste, due to institutional and financial constraints within the CCT, this has a 'progressive potential' within certain conditions as it offers an opportunity to provide affordable access for the urban poor according to their needs. In other words, services can be extended using a demand side approach. While an alternative approach such as this does pose a risk in that poor urban areas may be indefinitely exposed to 'inadequate' services and excluded from standardised networked systems, the municipal authority maintains control and has overall say on quality and tariffs (Jaglin, 2008). The 'progressive potential' is demonstrated by the fact that only a small percentage of people are not connected to services in Cape Town: 2% of households do not have weekly refuse removal, 6% of households are without

piped onsite water, 9.7% of households do not have a flush toilet and 3% of households do not have electricity supply (CCT, 2007a). These percentages are however within the constraints of the criteria for basic service provision in South Africa in which provision does not necessarily mean each household has the same access, discussed in section 3.3.1.

The success in service provision was made possible through tariff policies of the CCT which benefit the poor and have become the means through which equitable delivery has been promoted (de Wit & Swilling, 2008; Jaglin, 2004). In other words, tariffs have diffused the tension between the cost recovery centred approach of the private sector and the redistribution and equity goals of the local governing authority (de Wit & Swilling, 2008). The process of tariff convergence is discussed by Jaglin (2008), while the tariffs have been updated according to the most recent budget (CCT, 2010b):

1. Water Provision: a five-tiered structure was introduced in which the price of water increased according to the increase of consumption. This curbs water consumption as well as assists indigent households in securing access to water (CCT, 2010b). Furthermore, 7% surtax was placed on commercial entities, which subsidises the 6 kilolitres of free water per month as stipulated by National Government (Jaglin, 2008).
2. Sanitation Provision: the first 4.2 kilolitres are provided free each month, while prices escalate according to consumption (CCT, 2010b).
3. Solid Waste/Refuse Collection: is provided free of charge to properties valued at less than R 100 000 while properties valued at less than R300 000 are heavily subsidised; this collection is based on a standardised service for 240 litre container bins. These amounts are present in the 2010/11-2012/13 budget (CCT, 2010b).
4. Electricity Provision: as Eskom, a private service provider which charges more for electricity than the CCT, provides a significant portion of Cape Town's energy, implementing a creative structure is more complicated. Even so, the City has reached an agreement to pay Eskom for 'free' units provided to subscribers (Jaglin, 2008). Domestic users who use an average of less than 400 kWh per month receive free basic supply of 50kWh per month and are thus charged at the LifeLine Tariff. The structure of LifeLine tariffs is set to change due to expected electricity price increases over the next financial period; this will be a 3-block inclining block structure in which the price increase from Eskom escalates according to electricity consumption increase (CCT, 2010b)

This approach to redistribution is financially unsustainable. Jaglin (2008) found that as early as 2003, the CCT was hampered by significant financial burdens and the distribution policies conflicted with the ability to deliver as well as maintain services. Therefore, while infrastructures

and services have been extended through investment via the capital budget, provisions for maintenance and refurbishment of existing infrastructure within the operating budget have been neglected, resulting in a series of disruptions due to stressed and ageing infrastructure (de Wit & Swilling, 2008) which “is impairing sustainable service delivery, social development and economic growth in Cape Town” (CCT, 2007a:27). This scenario has been attributed to the “limitations of the current budget as well as budgeting method to implement these and other service requirements” (CCT, 2007a:27). This is illustrated in the 2010/0211-2012/2013 budget draft (CCT, 2010b). A slight increase from R18 818 million in 2009/2010 to R19 354 million in 2010/2011 can be noted for the operating budget allowance with particular reference to repairs and maintenance in order to resolve infrastructure backlogs¹⁴. The capital budget, however, has decreased from R5 594 million in 2009/2010 to R3 548 million in 2010/2011 (CCT, 2010b). The decrease in the capital budget will result in decreases in expenditure for 2010/2011 for wastewater management, water management and waste management while an increase in expenditure is allocated toward electricity. These budget developments should be considered in parallel to the findings of de Wit *et al* (2008) regarding the municipal finances of Cape Town. De Wit *et al* (2008) found persistent under-spending of allocated budgets and question whether the allocation itself is in fact sufficient to meet the massive backlogs in water, energy, sanitation and waste services while arguing that the revenue-generating capacity of Cape Town is in itself extremely limited, as reflected in the dependence on National grants. De Wit *et al* (2008) concluded that the arrangement of municipal financing in Cape Town perpetuates the reliance of cross-subsidies and tariffs while limiting the ability to meet infrastructure service demands. As a consequence, the scope for encouraging socio-economic development and creating an inclusive urban society is inhibited.

3.3.4 Section summary

The description of Cape Town’s social and economic dynamics indicates that the city faces a combination of challenges when attempting to encourage socio-economic development. The incumbent approach to addressing Cape Town’s social and economic challenges is no longer viable, as the means used to create an inclusive society have placed significant financial burden on the CCT metropolitan municipality. While economic growth had been experienced, the extension of large technical systems across the vast urban landscape has resulted in financial constraints on the CCT, as well as ageing infrastructure due to a lack of maintenance of existing systems while severe service delivery backlogs hamper further development. Furthermore, there is limited institutional and technical capacity within the CCT to manage the immense scope of these

¹⁴Backlogs are considered as either a basic service backlog, derived from the need to refurbish and upgrade existing infrastructure, or infrastructures needed for future growth of the city (CCT, 2007a).

interrelated challenges. The approach to development is therefore unsustainable and an alternative development paradigm must necessarily be adopted. The CCT has indicated that these challenges should be addressed through infrastructure-led economic growth, and has repeatedly called for the provisioning of sustainable urban infrastructure (CCT, 2007a; CCT, 2010a; CCT, 2006a). Herein lies an opportunity for the adoption of decoupling within a new economic development paradigm. The following chapter will provide insight into the resource flows of Cape Town's urban metabolism. It will provide the empirical evidence for the notion of decoupling as well as demonstrate the opportunity for an intervention point using infrastructure (socio-technical systems) as the unit of analysis.

3.4 Cape Town's urban metabolism

The unsustainable use of natural resources is the result of unsustainable resource consumption, which can be demonstrated by the ecological footprint of Cape Town and the way in which networked infrastructures have been extended across the vast Cape Town urban landscape to provide services to the population and create an inclusive city. An examination of Cape Town's urban metabolism will demonstrate that if the city continues to use the current approach to human development, resource thresholds will be reached, resulting in a system collapse. Furthermore, the negative impact of the configuration of infrastructures which dictate the city's metabolism will be exacerbated by supply-side disruptions which have been described in section 2.2. In light of this, if Cape Town wants to resolve the twin challenges of poverty and inequality present within the spatially divided city, economic growth and development is fundamental. The socio-economic metabolism will however have to be adapted to allow for a circular system and therefore Cape Town will need to include decoupling within its strategy for economic growth and development. This will be demonstrated in the following section.

3.4.1 The ecological footprint of Cape Town

It has been shown that cities, due to their nature, are high consumers of and reliant on finite and non-renewable energy and natural resources sourced from foreign localities, and consequently generally have an ecological footprint which is beyond their geographical boundary. Furthermore, it has been shown that cities, for the most part, have linear metabolisms and are reliant on natural sinks for waste disposal. These factors have contributed to the ecological unsustainability of Cape Town as indicated by its ecological footprint.

As early as 2002, Gasson (2002) demonstrated that the metabolism of Cape Town has an ecological footprint that depends on an area covering 128 264 km², which is almost equivalent to the entire Western Cape or 52 times larger than the jurisdictional area, with the per capita footprint

equalling 4.28 global hectares. The available biocapacity per capita is 1.9 global hectares, which indicates the degree to which Cape Town's demand has exceeded supply. Cape Town as a city is in 'overshoot'. This condition was 'confirmed' by Hansen (2010), who identified various 'hotspots' for unsustainable resource consumption within the socio-economic metabolism of the regional city of Cape Town.

3.4.2 Socio-economic metabolic flows of Cape Town

The ecological footprint indicates that Cape Town's demand is far exceeding the supply for natural resources and ecosystem services which enable the functioning of the socio-economic metabolism. This is the result of the economic paradigm in place through which economic growth and development is realised. In order to understand Cape Town's unsustainable growth path, the metabolic flows of the city will be described and evidence provided for the argument that ecological thresholds are being reached (Crane & Swilling, 2008), and thus underscore the rationale for the adoption of a new economic growth paradigm. While ecological resources on which Cape Town is dependent are being threatened, there are instances which demonstrate the possibility of an alternative approach. Evidence is provided through an examination of Cape Town's critical infrastructures which convey a flow of resources. While resource use and ecosystem services are not limited to the flow of energy, water, wastewater and waste, the remainder of this paper will focus on these four components of the Cape Town system and the state of the 'critical' networked infrastructures which convey resources in a particular fashion.

3.4.2.1 Energy

The State of Energy Report for Cape Town (CCT, 2007c) provides an overview of Cape Town's energy demand and supply with particular attention being paid to energy security and energy access, as well as the role of energy usage within the context of climate change. Cape Town is reliant on an external (national and international) supply of energy sources to meet the majority of its energy demands (SEA, 2007).

Table 3.2 summarises the sources of Cape Town's energy, the actual use thereof and the use by sector. Electricity, petrol and diesel combined are the major energy sources; electricity is by and large coal-fired and accounts for 66% of carbon emissions in Cape Town, whereas petrol and diesel account for 28% of carbon emissions (CCT, 2007c). The transport sector accounts for the majority of energy use, while commerce and industry and residential use trails behind (CCT, 2007c). What this table fails to highlight is the distorted relationship between energy supply and demand; the demand for energy, which is approximately 136 million GJ per annum, is greater than the supply, which is approximately 110 million GJ per annum (CCT, 2007c).

Table 3.2: Cape Town's energy consumption profile

Energy source/supply	% Use in CT	Energy use/demand by source	% Use in CT	Energy use by Sector	% Use in CT
Electricity	33%	Electricity	28%	Transport	55%
Petrol/diesel	55%	Petrol/diesel	43%	Residential	14%
Coal	3%	Coal	6%	Industry and Commerce	31%
Other sources (oil-based)	7%	Other Sources (oil-based)	23%	Mining and Agriculture	
Wood	1%				

(Source: CCT, 2007c)

Cape Town purchases, then distributes the bulk of its electricity from Eskom¹⁵, whose power is derived from a mix of coal, hydro and gas turbine power, and nuclear energy (SEA, 2007). In total, Eskom provides 6021 MW to Cape Town. The remaining electricity is supplied by the CCT from the city-owned Steenbras Pump Storage Plant (168 MW) and the privately owned Darling Wind Farm (5.2 MW), as well as production from solar panels and solar water heaters (SEA, 2007a; CCT, 2007c).

Table 3.3: Sources of Cape Town's electricity supply

Eskom	National transmission lines	2600 MW
	Koeberg Nuclear Power	1800 MW
	Palmiet Pumped Storage	400 MW
	Acacia Gas Turbines	171 MW
	Open gas turbines	1050 MW
City of Cape Town	Steenbras Pumped Storage	160 MW
Independent Power Producer	Darling Wind Farm	5.2 MW
	Privately owned solar water heaters	4.2 MW (10 000 SWH in Cape Town)
<u>Total</u>		<u>6090.4 MW</u>

¹⁵ Eskom is a State Owned Enterprise managed as a private entity.

Sources: CCT, 2007c; SEA, 2007a, Roggen, 2010

The secure provision of electricity has proved to be challenging for Cape Town within the context of energy constraints across South Africa. Typical electricity infrastructure is used to **generate** energy at power stations, usually using 6 x 600 MVA units, which is then **transmitted** at 132 kV across the country, using 400 kV lines, to bulk intake points in Cape Town at various locations around the city (Hyde & Capes, 2010). Electricity is then **distributed** to switching stations and from switching stations to bulk transforming stations, eventually reaching consumers from distribution transformers in suburbs (Hyde & Capes, 2010). This flow of energy can however be disrupted at any point; generation may be inhibited by the lack of an input such as coal or oil, while transmission and distribution may be inhibited by systems failure. During 2006-2007 Cape Town suffered regular power failures that were a result of the 15% reserve ratio, which is less than that of the internationally accepted percentage range of 15%-30%, and thus experienced load shedding when transmission lines tripped or during the routine maintenance of sections of the system, such as the nuclear reactors at Koeberg which meets 18% of the Western Cape's total electricity demand (Crane & Swilling, 2008). This supply pressure was marginally alleviated by the addition of the open gas turbines (which provide an additional 1050 MW) in 2007.

If one takes into account the demand for electricity, evident in Table 3.4 showing the annual flow of kWh into the system in Cape Town over the past six years, there is a definitive increase in demand. It is, however, increasing at a decreasing rate. Data was not available for the last two months of 2010, however, on close examination of energy sales, it is evident that **relative decoupling** is in fact present within the electricity sector: in 2006/2007 the percentage electricity demand increase peaked at 3% and decreased slightly to 2.7% the following year, culminating in substantial decrease to 0.48% increase of electricity demand. Table 3.5 demonstrates the distribution of energy by sector.

Table 3.4: Electricity demand (2004-2010)

2004/05	9 767 333 152 kWh
2005/06	9 972 008 301 kWh
2006/07	10 281 064 836 kWh
2007/08	10 564 549 548 kWh
2008/09	10 616 271 093 kWh
2009/mid 2010	8 683 899 814 kWh

Source: CCT, Electricity Department, 2010c

Table 3.5: Distribution of electricity

Electricity use by sector	% Use 2009/ mid 2010
Domestic use	39%
Commercial and Industrial	56%
Municipal	3.8%

Source: CCT, Electricity Department, 2010c

Most liquid fuels used in Cape Town are imported in the form of crude oil, then processed at the locally based Calref oil refinery (SEA, 2007; CCT, 2007c). Liquid fuels, in particular petrol and diesel, meet the bulk of Cape Town's energy demand, 55% of which is used by the transport sector. This scenario is by and large attributed to the nature of the spatial development of the city, particularly as there has been no extension of a viable public transport system with the exponential growth of formal and informal settlements over the past three decades, as shown in Figure 3.2. These phenomena, along with population growth, increasing affluence and the transition to privately owned vehicles, will increase the already excessive demand for liquid fuel. This on the other hand, offers an intervention point for the practical implementation of the notion of decoupling through viable public transport and higher densities.

Cape Town is therefore by and large reliant on finite non-renewable sources of energy which are imported, leaving the city vulnerable to supply shocks and system failure and indicating the need to diversify energy sources to ensure energy security and economic growth (CCT, 2007c). In other words, Cape Town is reliant on resources beyond its jurisdictional and geographic boundary and is therefore vulnerable to electricity supply disruptions and the subsequent impact on economic stability, as experienced across the country between 2006 and 2008. Additionally, concerns linking the burning of fossil fuels to accelerated climate change will most likely see the implementation of carbon taxes, exacerbated by fuel prices hikes brought on by imminent oil peaking scenarios discussed in section 2.2.2. This is a demonstration of the nature of a fossil fuel intensive economy, and how future economic growth will be constrained. Energy insecurity provides the rationale for adopting decoupling within the energy sector.

The evidence indicates that spontaneous **relative decoupling** has however occurred. The numerical evidence is provided by a decreasing rate of the increase in energy demand during a period of economic growth. Furthermore, the presence of renewable energy services and energy saving technology, in the form of the Darling Wind Farm and smaller IPP's demonstrates an opportunity to exploit this sector as an intervention point for a system innovation through the purposive adoption of decoupling.

3.4.2.2 Water and wastewater

Water

The Western Cape Water Supply System (WCWSS) is owned and operated by the CCT and the Department of Water Affairs (DWA) in an integrated and cooperative manner, and supplies water to Cape Town through a network of storage and conveyance infrastructure (Rhode, 2010). Cape Town, a winter rainfall area, obtains the majority of its raw water, 98.5%, from surface water sources. The water is stored in reservoirs to ensure supply throughout the year, especially during summer months when demand is at its highest (CCT, 2010d). The remainder, 1.5%, is obtained from groundwater resources from the Atlantis Groundwater scheme and Albion Springs (CCT, 2010d). Water from the Albion spring is directed into Cape Town's reticulation system after being treated with lime and chlorine, while the Atlantis Ground water scheme extracts water from aquifers using boreholes which are recharged with treated effluent and storm water. Ground water sources remain unexploited and offer an opportunity to increase the supply of fresh water; however, the sustainability of such a water source is reliant on extraction that is not greater than the recharge capacity of an aquifer (CCT, 2010d).

Surface water sources include the Berg, Riviersonderend and Voëlvlei river schemes, owned by the DWA and the Steenbras and Wemmershoek river schemes owned by the CCT; combined, these have a total storage capacity of 898 million m³ (CCT, 2010d). In June 2009 the total storage was at 91.6% of the total capacity, only three years prior, in April 2006, dam levels were at a 12 year low of 26% of the total storage capacity. While successful water demand management and restrictions were implemented, this scenario provides a glimpse into Cape Town's water future. Population and economic growth trajectories coupled with the impacts of climate change indicate that Cape Town will be the first city in South Africa whose demand will exceed potential yield (DWAF, 2004). There is evidence that the effects of climate change are already being felt in terms of irregular and heavier rainfall, which limits the absorptive capacity of soils often resulting in water runoff and erosion (DWAF, 2004; CCT, 2006a). Furthermore, higher temperatures and wind speeds which increase surface water evaporation are anticipated, decreasing available water

(CCT, 2006a). This scenario is the rationale for investment in sustainable water supply options, using decoupling as the overarching framework for intervention.

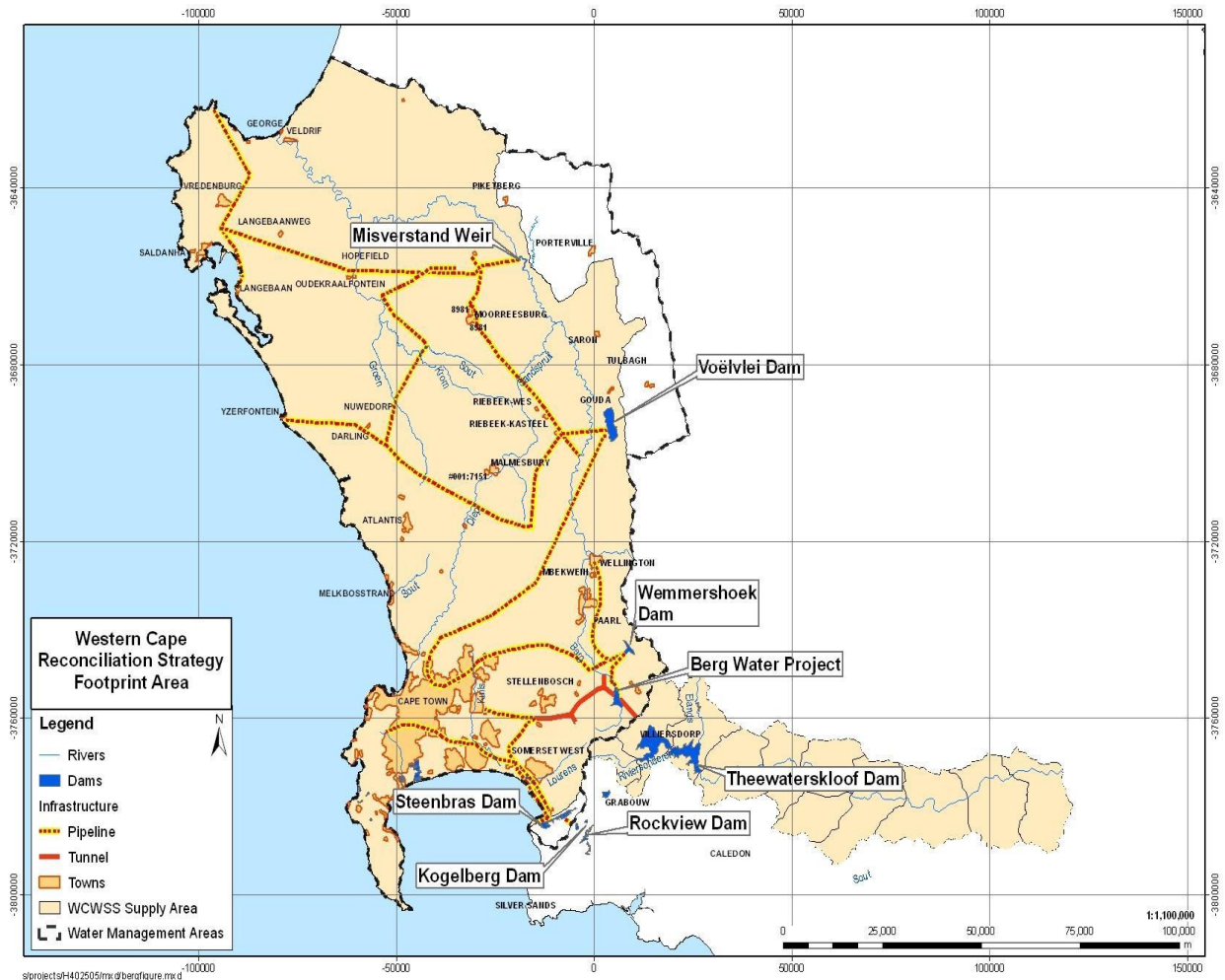


Figure.3.3: Cape Town's water sources

Source: CCT, Water and Sanitation Department, 2010d

The total annual yield of the WCWSS is 556 million m³ which includes the recently completed Berg Water Scheme. Cape Town receives 398 million m³ of that total; 73% is supplied by DWA schemes, of which Theewaterskloof and the Berg River contribute approximately 50% to the total yield while the CCT contributes 27% via its operated schemes, the Wemmershoek and Steenbras dams supplying the bulk (CCT, 2010d). As illustrated in Figure 3.3, 87% of Cape Town's water is obtained from sources beyond its municipal boundaries and is therefore reliant on a vast network of infrastructures which convey a flow of water to the city. Furthermore, this concept of 'beyond boundaries' resonates with the discussion regarding the ecological footprint of a city and the subsequent environmental impacts.

Water supply infrastructure is subdivided into two interconnected systems; the bulk water supply systems and the reticulation distribution system which includes 12 dams owned by the DAW and CCT, which supply raw water to 13 water supply treatment works via 10 400 kilometres of reticulation networks (CCT, 2010d). Furthermore there are 108 water pump stations, 138 water reservoirs and 21 depots. The total replacement cost of water infrastructure is approximately R 18 billion; Table 3.6 provides a breakdown of the estimated replacement cost of water supply as well as wastewater service infrastructure. The extent of the replacement cost, totalling R 27 billion, offers insight into the state of Cape Town infrastructure and demonstrates the lack of investment in maintenance in the past.

Table 3.6: Water and wastewater infrastructure - estimated replacement cost

Description	Asset Count	Repl Value (R M)	Annual Maint req, Bulk Water separate(R M)
Bulk Water (including water pump stations, water reticulation and reservoirs)			68.9
Dams and Catchments	12 No	1 322.5	6.7
Water Treatment Works	13 No	1 449.0	30.2
Waste Water Treatment Works incl Sea Outfalls	23 No	2 014.4	41.8
Water Reticulation (incl Bulk Lines) (length escalated from 2003)	10 438	12 896.0	58.6
Sewer Reticulation (length escalated from 2003)	9 021	6 643.9	59.0
Depots	21 No	83.4	0.4
Water Pump Stations	108 No	445.6	7.1
Sewer Pump Stations	377 No	403.3	10.5
Reservoirs	138 No	1 799.1	3.7
<u>Total</u>		27 057.2	287.0

Source: CCT, Water and Sanitation Department, 2010d

These components of this ageing water system distributed a total volume of 325.7 million m³ of treated water during the 2008/09 year, which is an amount 25.7% below that of the unconstrained demand (CCT, 2010d). Of the total amount, only 229.3 million m³ reached consumers while the remaining 21.9% is considered as unaccounted for water (UAW) or non-revenue demand. The amount of both treated water which entered the system and UAW increased (the latter to 24.35%) between 2009/10 (CCT, 2010m). UAW is that water that enters the system but is lost somewhere

along the way due to leaks, breakages or burst mains, collectively called ‘technical’ losses, or unmetered consumption and usage collectively called ‘apparent’ losses.

At the time of writing this paper, the data concerning the distribution of water for the time period had not yet been updated, however, trends over the past several years have indicated that the bulk of water is consumed by domestic users, who accounted for 58.7% of the demand in 2007/08 (CCT, 2010d). Domestic use is followed by UAW and industrial and commercial use, accounting for 16% (CCT, 2010d). There has been a year on year percentage increase in demand for water since 2004/05; however, this increase is occurring at a decreasing rate (CCT, 2010m). The demand for and supply of water is expressed in the graph below. This is yet another indication of **relative decoupling**.

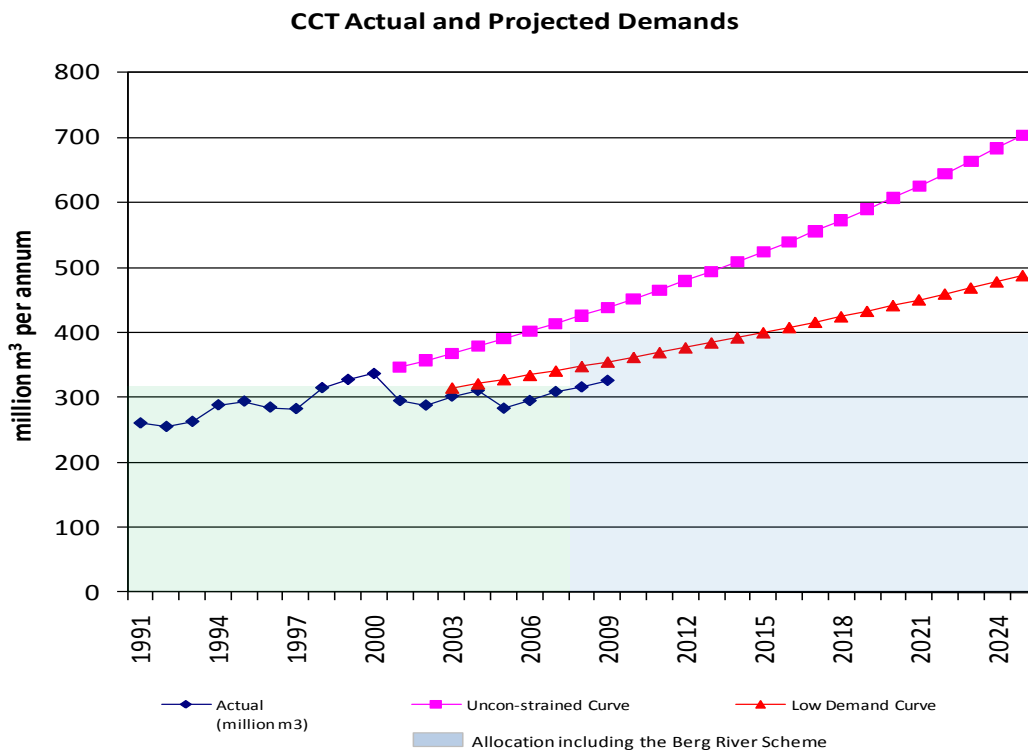


Figure 3.4: Demand growth projections compared to supply available

Source: CCT, Water and Sanitation Department, 2010d

Figure 3.4 reveals that future demand is far greater than current supply within Cape Town and that without significant and effective intervention, demand will outstrip supply by 2015. Herein lies the rationale for the adoption of decoupling. The sharp increase in supply during 2008 is due to the commencement of the Berg River Scheme which increases raw water supply to the CCT by 81 million m³ per annum. Cape Town’s water demand can however be curtailed; water restrictions and demand management implemented since 2000 have resulted in demand for water increasing

at a decreasing rate (CCT, 2010d). This indicates that relative decoupling has been realised and that there is potentially room to manipulate these trends to decrease the demand further. The severity of the situation has however not been grasped at the right level and it could be argued that the amount of unaccounted for water is due to poor infrastructure and an ageing water system which require massive investment, as indicated by the replacement costs.

Despite the massive replacement cost of infrastructure, the budget allocation for the 2010/11 year is less than the allocated amount for the 2009/10 year, indicating a cutback in spending on water and sanitation services and, therefore, investment replacement, upgrades and new infrastructure (CCT, 2010b). While this is a general cutback, it is indicative of the precarious financial situation of the CCT, and therefore its limited capacity to cope with demand for and maintenance of water and wastewater infrastructure. This is despite an increase in water and sanitation tariffs across the board, which was rationalised by the need to invest in infrastructure conveying the flow of resources (CCT, 2010b).

Wastewater treatment

While the supply of water is in a precarious position, the state of sanitation and wastewater treatment services, in particular sewage infrastructure, in Cape Town has been described by the Cape Times as 'dysfunctional' (Pithey, 2007; Crane & Swilling, 2008). The CCT is currently under significant pressure to provide services to informal settlements, of which 11% or 30 000 households do not have access to basic sanitation (Crane & Swilling, 2008). This pressure will continue to increase as population growth occurs. This is furthermore aggravated by the massive housing backlog which continues to divide the attention and stretch the financial capacity of departments responsible, limiting the ability to service the demand. The backlog has been further exacerbated by the growth of the property market and the subsequent formal nodal development placing strain on existing services, some of which are already operating at their maximum capacity. In other words, infrastructure investment has not been sufficient to meet the growing demand.

The wastewater infrastructure system is a network comprising 20 wastewater treatment works, 3 marine outfalls, 9 000 kilometre sewer reticulation network, 377 sewer pump stations and 21 depots (CCT, 2010d). As demonstrated in Table 3.6, the total replacement cost of sewage infrastructure alone is approximately R 9 billion; the bulk of this is directed toward wastewater reticulation networks which, together with water supply reticulation, make up 72% of the overall total value of R 27 billion. The CCT emphasised in 2009 that focus would be directed toward the upgrading of water and sanitation infrastructure, dedicating to it R786 million or 15% of the capital budget for the 2010/11 financial year (CCT, 2010u). The rate of pipe replacement is however

approximately 0.5% per annum while international standards are between 1% and 2% while the budget allocation falls short at R 500 million. This has reinforced the trend of underinvestment in critical infrastructure which conveys the socio-economic flows of the city.

Infrastructure which treats flows through Cape Town has the capacity of 677.7 Mℓ of water per day, while the current hydraulic loading, for annual daily average, on these systems is 666.56 Mℓ of water (CCT, 2010d). These figures encapsulate total capacity and loading, however, out of the functioning wastewater treatment works, 8 are running over their capacity. Moreover, effluent accounts for approximately 70% of billed water in Cape Town. Of the 20 wastewater treatment works, 8 are considered to be below standard and the quality of treated effluent has an average of 80% compliance with national regulations. Furthermore, storm water ingress remains a constant challenge to the system as a whole, as it constrains capacity and contributes to degradation of water resources.

This is a major concern when considering the flow of water through the urban metabolism. Approximately 70% of all water consumed in Cape Town finds its way through sewage networks to various wastewater treatment works; once treated, 90% is expelled from these plants, into the natural environment. Due to the nature and state of sewage infrastructure, raw water that enters from the natural system is dumped as treated effluent of sub-standard quality. In this way valuable reusable effluents are discarded, representing a linear metabolism with significant negative impacts on the environment. This is evident by the state of Cape Town's 27 rivers and water bodies; 2 of them have been identified as being in 'good' condition while the general recommendation of Cape Town's Inland and Coastal Water Quality report was that the City's urban rivers are unsuitable for recreation due to the high *E. coli* levels (CCT, 2006b).

These findings illustrate the general disregard for water as scarce resource, which is fast reaching its thresholds. The extension of the same infrastructure will however not resolve the challenge of diminishing water resources, despite efforts to lower consumption. Action has been taken in the form of the Water Conservation and Water Demand Management Strategy (CCT, 2007h). This deliberate strategy intends to reduce the rate of water demand growth, as well as ensure that all existing infrastructure systems are used optimally. Relative decoupling is the result of effective demand management, and a decreasing increase in demand has been noted (Pithey, 2007). Successful projects include Mfuleni and Protea Park Integrated Leak Repair Projects, the Fixit Project, as well as education campaigns and the roll-out of individual water demand management devices (CCT, 2010d). Other strategies include effluent re-use, pipe replacement, water restriction and a stepped tariff structure (CCT, 2010d). Deliberate strategies such as these have decreased

the water demand as illustrated in Figure 3.4 The state of water and waste water infrastructure is however dire, requiring massive investment, and therefore offers an opportunity to invest in alternative technology for replacement of infrastructures at the end of their life cycle. An opportunity is therefore present for the implementation of decoupling, using infrastructure as the intervention point.

3.4.2.3 Solid waste

Without many people noticing, due to the rapid rate in increased waste production, solid waste has surreptitiously become the fastest growing utility sector in terms of demand for waste removal services and is consequently one of the biggest challenges facing Cape Town. Since 1999, waste disposal per capita has increased by a staggering 60% percent; this has been accounted for by several factors, including an increase in economic growth, an increase in affluence and therefore consumption, the population growth rate, the improvement and extension of services, improved record-keeping, as well as external sources of waste being disposed of by the CCT (CCT 2007a; de Wit, 2009a). The CCT services 99% of the population (CCT, 2009a) which, on average, produced 1.31 kg of waste per person per day in 2009, as demonstrated by Figure 3.5; however, this is a fairly large decrease from 2007, during which the average waste production per capita was 2.08 kg per day.

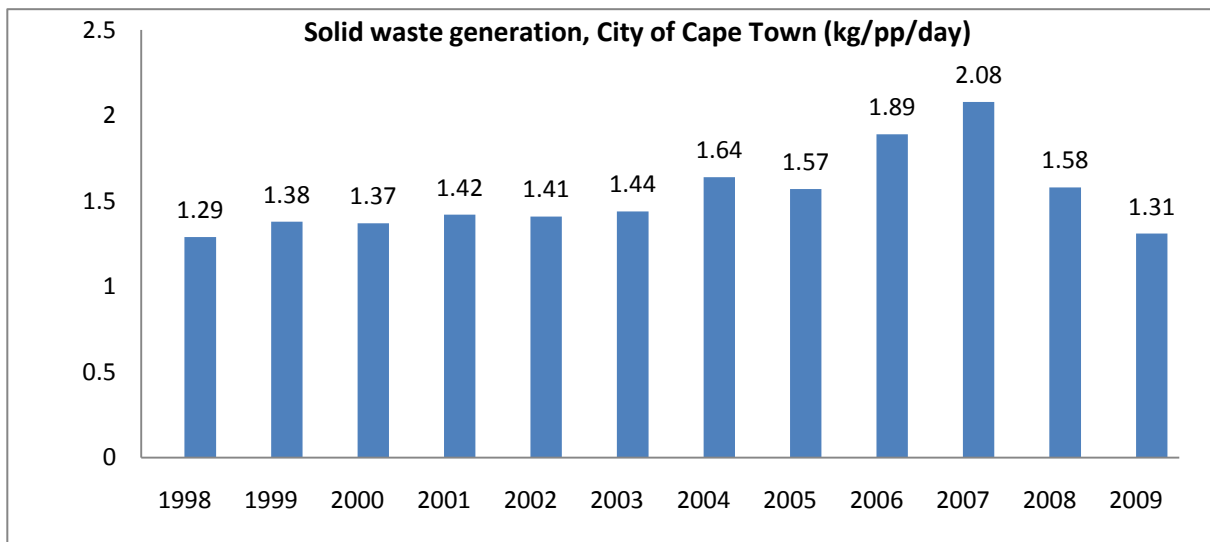


Figure 3.5: Solid waste generation for Cape Town per capita during 1998-2009

Source: De Wit, 2009b

De Wit (2009b) concluded that the average amount of waste taken to the landfill per year between 2005/6 and 2007/8 was approximately 2.5 million tonnes. Trends over the last decade have demonstrated a constant of 8%-8.5% increase in waste, which has now decreased to about 7%

(de Wit, 2009a). This is evident in more recent data collected from the CCT, which indicates that the average total waste production between 2006/07 and 2009/10 is approximately 1.98 million tonnes per year; this is demonstrated by Figure 3.6. This decrease has been rationalised by the global economic downturn which disrupted the consumption rates as well as recycle programmes. This reflects **absolute decoupling** within the solid waste sector since 2006/7.

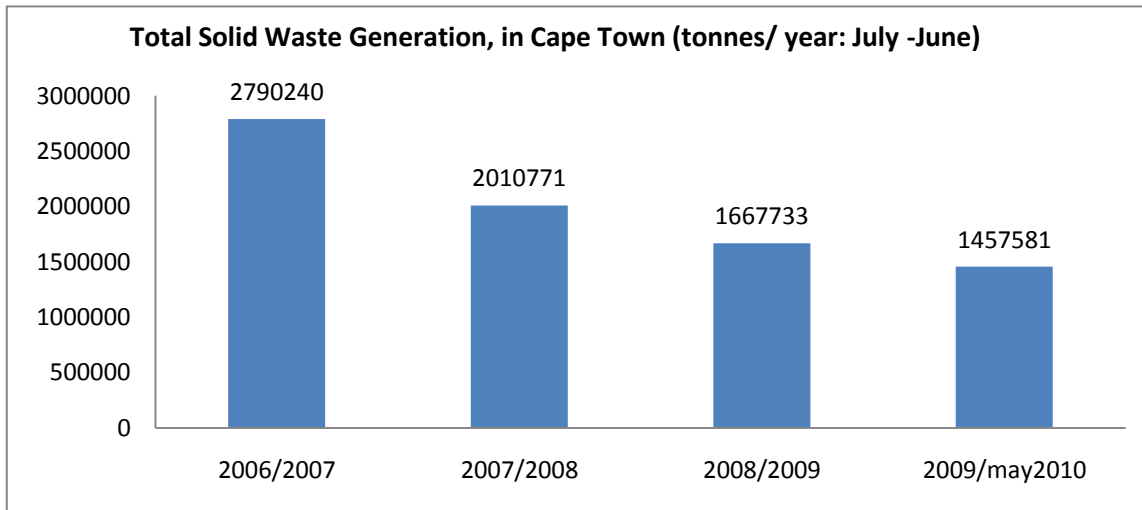


Figure 3.6: Solid waste generation for Cape Town per capita between 2006 and 2010

Source: CCT Solid Waste Department, 2010e

Solid waste, in this case, refers to household, commercial, industrial, hazardous and electronic waste. A study by Arcus Gibb demonstrated that the industrial and commercial sector accounts for 60% of waste production, while the residential sector contributes 40% (De Wit, 2009b). Furthermore, Coetzee (2010) stated that, on the whole, green waste accounts for 30% of waste generation, construction for another 35%, while other waste makes up the rest. A significant portion of the waste produced by households is potentially recyclable, including glass, paper, garden, and food waste. While the obvious challenge here is that higher levels of waste means the loss of valuable resources and economic inputs during disposal, which perpetuates the demand for virgin input materials from sources beyond geographic boundaries. An equally pressing matter emerges when examining the means used to dispose of waste, namely landfilling.

The CCT uses the process of landfill disposal to manage solid wastes; landfills are historically situated according to need and convenience as opposed to efficiency and environmental and social desirability (Engledow, 2007). In the past, landfill sites were therefore not designed nor located appropriately, which has resulted in the pollution of water and soil resources in some instances, as well as a degree of air pollution; these have an impact on low income households

which have been historically concentrated in the vicinity of landfills (Engledow, 2007). The increase in waste production over the past decade has placed significant pressure on available landfill facilities, which are fast reaching their maximum capacity. Infrastructure used to manage the flows of waste includes roads and vehicles which transfer waste, refuse transfer stations, which are drop-off sites that compact waste before landfilling, and landfill sites.

Currently there are only three available landfill sites operating in Cape Town: Visserhok and Coastal Park, which will be at capacity within the next 12 years, and Bellville South which will be decommissioned by 2013 (Coetzee, 2010). However, if the current rate of waste to landfill continues at Bellville South, it will reach its maximum capacity by June 2011 (Nontangana, 2010). Waste is therefore being diverted to Visserhok and Coastal Park in order to extend the lifespan of the Bellville landfill due to its strategic position between Coastal Park and Visserhok. Visserhok has recently been expanded to double its land footprint to ensure sufficient capacity for the next ten years (Nontangana, 2010). This extension was in response to slow progress on the new regional landfill site.

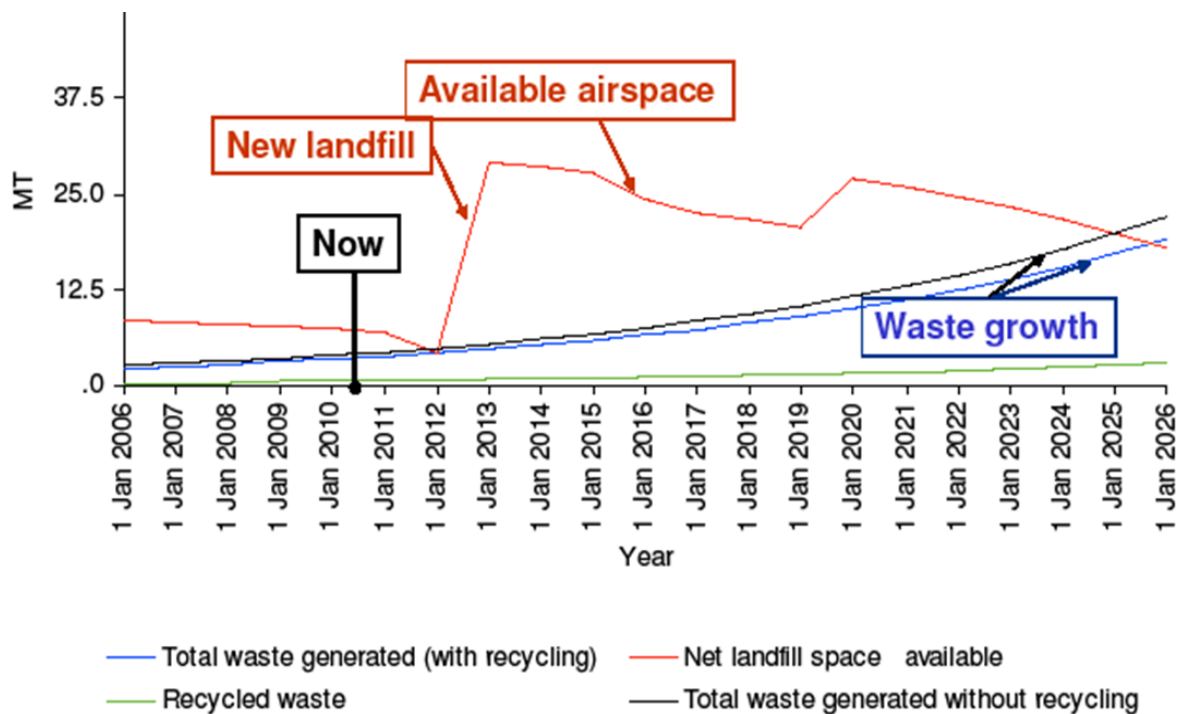


Figure 3.7: Increasing waste (growth and development) vs. available land fill capacity

Source: Coetzee, 2010a

Figure 3.7: Increasing waste (growth and development) vs. available land fill capacity illustrates the trajectory of waste generation in Cape Town in comparison to available airspace. Available

airspace will increase by 2012 due to the commissioning a new regional landfill site. Due to demand on land from the residential and commercial sector, the only viable option for a new landfill site is located 50km North of the city. There has however been significant controversy regarding the location of the original proposed site near Atlantis. Even though all the necessary Environmental Impact Assessments, zoning and feasibility studies had been conducted, it was deemed inappropriate and Kalbaskraal, a location beyond Atlantis, was identified as the regional landfill site. Protest against this plan by the community of Kalbaskraal however forced the authorities to reconsider Atlantis. Unfortunately the designated land at Atlantis had already been purchased by a private property developer, which placed upward pressure on land prices rendering that site unfeasible (Nontangana, 2010). Plans for a regional landfill site are still in place but the actual commencement date has yet to be decided due to 'red tape' regarding approval of the site in terms of social and environmental consequences which are still to be determined (Coetzee, 2010b). One such consequence is additional carbon emissions arising from transporting the waste and one could argue that costs will escalate with the inevitable rise in petrol prices as the oil peaking phenomena becomes more severe.

The development of the regional landfill site is to be complemented by the roll-out of several transfer stations as the current landfill sites close down; these are the Oostenberg transfer station opening in September 2010, the Tygerberg transfers station in operation from 2013 and the Helderberg transfer station from 2015-2016 (Nontangana, 2010). These transfer stations will provide the drop off point for collections of vehicles; waste is compacted at these transfer stations will be transported to the regional site via road. This can be considered as the 'master plan' for solid waste infrastructure in Cape Town.

A regional landfill site is seen as the only option for the CCT in the context of the rate of increase in solid waste production and the lack of investment in alternative waste management options. Over the last decade the bulk of the solid waste capital budget has been directed toward the development of landfill infrastructure, fleet expansion and the related maintenance expenditures (Engledow, 2007). The 2010/11 budget allocation for solid waste is R 290 901 070, of which approximately 60% will be allocated toward the development of landfill infrastructure. An additional 20% is allocated toward the extension of the fleet and 12% of the remaining 20% is for rehabilitation and closure of existing sites (CCT, 2010f).

These figures illustrate that the approach to managing solid waste in the near future will be much the same as it has been in the past: emphasis is placed on the expansion of an unsustainable service rather than investment in secondary and tertiary industries to encourage recycling and

waste minimisations. This is despite the fact that absolute decoupling has occurred within the waste sector. Deliberate action is furthermore needed for impact decoupling within the waste sector. A significant contribution to the occurrence of absolute decoupling for potential impact decoupling is the introduction of the Integrated Waste Management Policy (CCT, 2006c). This policy classifies waste management as "...the **avoidance, separation, re-use**, containment, diversion, cleaning, handling, transportation, interim storage, recycling and disposal of waste" (CCT, 2006c:82; emphasis added). Targets are structured to encourage separation at source with an emphasis on minimisation and re-use of waste (Engledow, 2007). Action for incentivised implementation is needed for the Integrated Waste Management Policy to have the required far-reaching results to reduce waste production and its environmental impact.

3.4.2.4 Section summary

This section provides the empirical evidence for the theoretical notion of decoupling. Using Cape Town's critical infrastructures as the unit of analysis and identifying the resources flows which allow the city to function, demonstrate that decoupling has occurred within the critical infrastructures of this urban context. Empirical evidence provided demonstrates that electricity and water demand have been increasing, albeit at a decreasing rate, over the last several years, indicating relative decoupling as well as impact decoupling. The decrease in solid waste on the other hand, indicates absolute decoupling. These occurrences are by and large spontaneous, resulting from supply shocks. Purposive interventions from the CCT have however had a positive impact and indicate that intervention strategies based on decoupling can decrease the urban metabolism. Therefore, the evidence suggests there is the opportunity for greater intervention. It has also demonstrated that behaviour changes are possible, a phenomenon that should be exploited by authorities.

3.5 Chapter summary

The resource flows on which Cape Town is dependent are placing significant pressure on the natural resources available. This is accounted for by unsustainable resource consumption patterns; pertinent to this, however, is the role that infrastructure has played in the shaping of these consumption patterns. In the instance of energy, while the source thereof is of an unsustainable nature, disruptions in the past have led to the decrease in use. The solution however, as seen by the CCT, was to extend the existing infrastructure in an identical fashion without seriously considering the possible alternative energy sources. Consequently Cape Town will inevitably be vulnerable to system disruption in the future. In the case of water, demand will exceed supply. During periods of drought; however, the decrease in consumption is an indication that it is possible to change consumer habits. The story of waste furthermore highlights that the technical solutions in place to manage growth in a particular service are unsustainable. The basic formula is an

extension of the service in response to increased demand, which in turn overexploits the limited natural resources available in Cape Town. In this manner, the socio-economic metabolic flows of Cape Town are configured in a linear fashion.

There are instances of purposive action for an alternative approach to managing resources. These are however inadequate to stimulate the significant system change required, and Cape Town's economic growth and development will subsequently be constrained.

This configuration of infrastructure directs the flow of resources across city space without necessarily considering the ecological integrity of Cape Town. This is dictated according to the political and technical preferences of decision makers, based on a historical frame of reference. The extent of the ecological footprint, expanded on via an explanation of the linear flow of resources as conveyed by a set of networked infrastructures, is both financially and ecologically unsustainable and consequently threatens social and economic development. Over-exploitation of the natural resource base and ecosystem services indicates that there are real limits to growth. In the context of Cape Town's spatially divided city, massive housing and infrastructure backlogs, poverty and unemployment, socio-economic development is crucial; however, this cannot occur using conventional technology. Without resource flows as inputs for socio-economic metabolism, the system will inevitably break down; conversely, due to the specific context of Cape Town, the conditions present an opportunity to construct and adopt an alternative growth paradigm.

The need to invest in new and upgrade ageing infrastructure is increasingly present in Cape Town and the provision of **sustainable urban infrastructure** has been identified as a *Strategic Focus Area* in the IDP by the CCT, as has **infrastructure led economic growth** (CCT, 2007a; emphasis added). Herein lies an opportunity for an alternative economic growth paradigm, in which economic growth does not rely on a continuous increase in the flow of resources but adapts the socio-economic metabolism to create a circular urban system.

The tried and tested method of service provision is no longer viable from a financial or ecological position. Therefore, the nature of the particular context presents the rationale for investment in alternative infrastructure technologies that use the theoretical notion of decoupling, both absolute and relative, as a departure point. The question then arises whether this can be a locality or a purposive urban transition, which brings into focus the role of decision-makers and actors who influence socio-technical systems. Purposive action is currently insufficient, however what action has been taken illustrates the CCT and other actors and stakeholders in Cape Town can initiate a purposive urban transition through system innovation. The adoption of such a notion will require institutional acceptance and collaboration between a series of actors who have the foresight to

invest in sustainability-orientated innovation systems for 'innovation led economic growth'. Geels (2002) identifies 'innovation niches' as the departure point for system innovation; these are currently present, albeit isolated, in Cape Town and will be elaborated on in chapter 4. Moreover, the success of innovation niches is unpredictable and therefore needs to be supported by a robust learning network to ensure sufficient pressure is exerted on the incumbent socio-technical regime. The next section will describe in more detail an opportunity for regime change through a socio-technical system transition using the case of the Cape Town Central City Provincial Government Regeneration Initiative (CCPGRI).

Chapter Four: A case study of the Cape Town CCPGRI

4.1 Introduction

As demonstrated, Cape Town is currently presented with a series of ecological and financial constraints which inhibit the potential for future growth. There are also the onerous challenges, due to the historical development trajectory, of having to resolve poverty and inequality, addressing major service and housing backlogs and providing meaningful employment for a significant portion of the population. This is the context within which future human well being and development must occur. Extending access to the socio-economic metabolism of the urban system to all, via the investment in infrastructure through (tangible) physical development, is a component of achieving human well being and development. The question of infrastructure, as a conveyer of metabolic flows, thus remains pertinent to the discussion of realising human well being and development in Cape Town. This development potential will however be limited if the current economic paradigm or a business-as-usual approach is upheld. It was argued that the adoption of decoupling as a theoretical notion offers an alternative economic development paradigm, which contributes to human wellbeing while allowing the physical development of Cape Town. While there are instances of decoupling in Cape Town resource flows, these are neither sufficient nor deliberate, despite the ample scope available for intervention in networked infrastructure. If this is accepted as an intervention point for decoupling, then stock must be taken of the infrastructure present. The state of Cape Town's infrastructure is dire and requires massive investments for its refurbishment and extension, in parallel to development in the city. Herein lies the opportunity to adopt an alternative approach to the configuration of infrastructure and thus socio-technical transition. Pertinent to the discussion of alternative socio-technical systems is (1) **how** infrastructure be will configured to convey flows of resources and (2) **who** makes the decisions for investment.

One of the more recent strategies for creating a platform to foster human development in Cape Town is the Cape Town Central City Provincial Government Regeneration Initiative (CCPGRI). This project is an initiative of the Western Cape Provincial Government (WCPG). At its core is a financial incentive for the Provincial Government, championed by the Department of Transport and Public Works, which intends to leverage public sector assets for private sector investment and, in the process, realise the regeneration the Cape Town Central City.

The following section provides a narrative of the project, from the perspective of a participant. The narrative illustrates the novel approach taken by WCPG as well as the interesting stakeholder interaction that has carried the initiative to its present point. The significance of using this case as a contextual example is the role the actors and stakeholders, within a particular spatial context, have

played and the further potential for participants to contribute to the realisation of an urban scale socio-technical transition, using SOIS's as a framework and decoupling as a departure point. In this way, there is an opportunity to grapple with the engagements between decision-makers who construct the complex social, technical, economic and environmental processes which constitute socio-technical systems. Therefore, the project provides a case in point for furthering understanding of purposive urban transitions.

While this project is still in its initial phases, there is evidence that robust interaction amongst stakeholders through a series of engagements have forced critical project inhibitors to the surface and thus inform the way forward. These inhibitors act as components which apply pressure to the current regime approach, and may potentially create 'windows of opportunity' for a regime change.

The particular focus is the question of infrastructure within the Central City as the intervention point for decoupling. It has been argued that the socio-economic metabolism of a city is reliant on a set of networked infrastructures or socio-technical systems which convey flows of resources in a particular fashion. The configuration of Cape Town's systems is linear, which has particular ecological connotations and as a consequence Cape Town is reaching its resource thresholds (Crane & Swilling, 2008). Furthermore, the realisation of the CCPGRI is dependent on the socio-economic metabolism of Cape Town; however, the question arises as to whether networked infrastructure systems in the Central City have the ability to metabolise what is needed for the initiative within the context of the financial and ecological constraints present in Cape Town. It has been demonstrated that the infrastructure is in a precarious state and therefore a second question emerges: what are the appropriate responses from decision-makers to ensure the necessary interventions are planned and managed in a manner which contributes to sustainable economic growth and human development?

What follows is a brief overview of the socio-economic conditions of the Central City, together with an in-depth description of the case study as a narrative, as well as an overview of the infrastructure in place in the Central City. The critical argument to be revealed is whether this initiative reinforces a business-as-usual approach to physical development of the city, or whether the learning process that occurs within the network of participants is sufficient to realise a purposive urban socio-technical system transition, using the notion of decoupling as a principle for this development.

4.2 An overview of the socio-economic profile

The bounded area under discussion includes Green Point, the Foreshore, the Harbour Port and Victoria and Albert Waterfront, the Cape Town Central Business District (CBD) and as far as the

urban edge which meets Table Mountain, District Six and parts of Woodstock. These accumulatively make up the Central City. This is illustrated by the area bounded in Figure 4.1.



Figure 4.1: Map of the study area, the Cape Town Central City

Source: Arcus Gibb, 2008

This area is part of District A municipal planning district. District A has the second smallest population of the districts in Cape Town with an average population density of 1551 people per km² (CCT, 2009b).

While Figure 4.2 does not assist one in understanding the population of the project area under discussion, the map offers insight into the particular densities of the areas included for the Cape Town CCPGRI. This map illustrates the very low population densities in the Green Point, Foreshore and CBD area and only slightly higher densities for other areas, which consist of mainly smaller households, over half of which consist of 1 or 2 people, while the average age of the population is under 30 (CCT, 2007e).

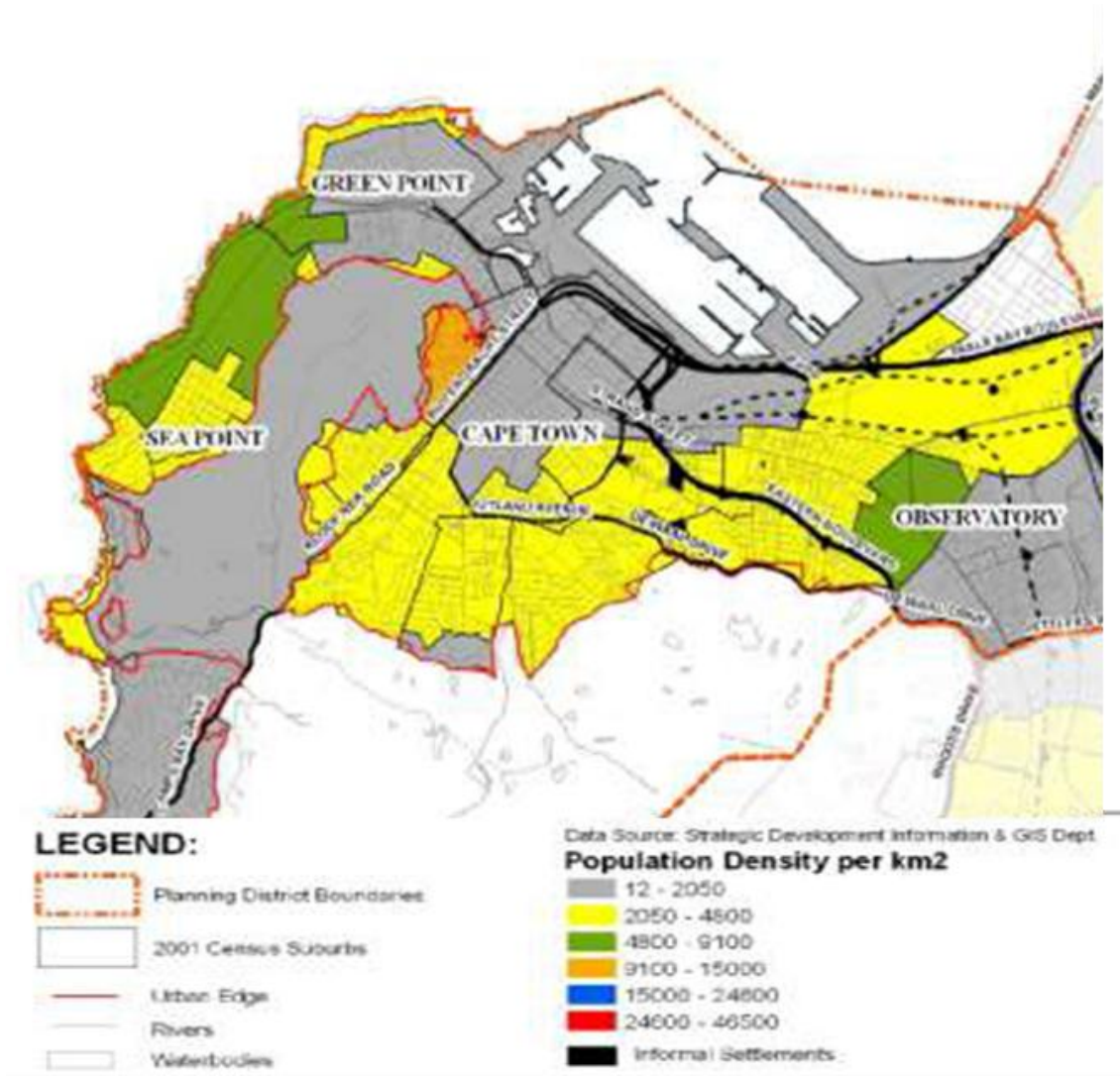


Figure 4.2: Population density of study area

Source: CCT, 2009d

The Central City is a hub of economic opportunity and already acts as the area with the densest concentration of economic activity, making the highest contribution to the economic turnover for the city; the service sector being the most predominant (CCT, 2009b). The CBD, in particular, has been the location for numerous changes over the past several years. While the number of office occupancies has decreased, the number of residential occupancies has increased due to the conversion of old office blocks and the simultaneous relocation of office space as well as residential development to the Foreshore and Waterfront (CCT, 2009b).

The most recent and substantial developments in the area include the Cape Town Station upgrade and the Green Point Stadium. Furthermore, there have been several proposed developments which include the significant Cape Town Station 2030 Project, which will change the dynamic of

the Central City dramatically, and several potential projects by the Victoria and Albert Waterfront, including redevelopment of certain areas for residential, office and commercial space. In addition, there is the potential sale and subsequent redevelopment of the Transnet-owned Culemborg , plus the mega extension of Cape Town International Conference Centre which includes an exhibition centre; additional buildings and a hospital; development of the Parliamentary Precinct and Parliamentary Village; District Six; and Motor City (Kaveney, 2010a).

4.2.1 Central City as a focus area of development

These developments and future potential developments demonstrate the role of the Central City as an economic hub and provide insights into the future trajectory of development of the area. This statement is demonstrated by the creation of the Cape Town Partnership, a section 21 company that emerged out of collaboration between the CCT, South African Property Owners' Association (SAPOA) and the Cape Town Regional Chamber of Commerce and Industry (Cape Town Partnership, 2010a). This Private-Public-Partnership (PPP) was formed during 1999 in response to the trend of decreasing investment in the Central City (Cape Town Partnership, 2010a). The mandate of the Cape Town Partnership is to promote and facilitate development within the Central City using private, public and social resources by targeting property developers, national and international investors, corporate business, smaller business and informal traders (Cape Town Partnership, 2010a). The Cape Town Partnership is involved with numerous projects to realise the vision; one in particular is related to the Cape Town CCPGRI.

The Central City Development Strategy (CCDS) (Southworth *et al*, 2008), co-ordinated in partnership with the CCT, is related to the CCPGRI. The CCDS has established a vision of the development trajectory for the Central City. This strategy document is designed to capture the imagination of the public for the potential development, thus mobilizing action around the regeneration of the Central City to create an internationally renowned business centre, a local and tourist destination and a sustainable urban environment with the capacity for knowledge generation (Cape Town Partnership, 2010b). Core strategies of the CCDS are to encourage residential development through densification and affordable housing, to create viable public spaces and to ensure space is available for growth and investment in the Central City (Southworth *et al*, 2008). The redevelopment of the Cape Town Station Precinct is emphasised with the intent to improve and provide accessible public transport (Cape Town Partnership, 2010b). The CCDS was produced by Urban Genesis, the core participant being John Spiropoulos, and by City Think Space, the core participant being Barbara Southworth (Southworth *et al*, 2008). This document was furthermore complemented by an Infrastructure Investigation for the Central City conducted by Arcus Gibb (2008), a multidisciplinary engineering consultancy. The budget for the infrastructure

investigation was, however, insufficient, thus limiting its scope – a situation exacerbated by poor information sharing between CCT departments (Spiropoulos, 2010a). Nonetheless, the CCDS is an influential document because it informs development within the Central City as per the desires of the CCT and the Cape Town Partnership; the latter representing the property sector in Cape Town. The challenge of the Cape Town CCPGRI is therefore to locate itself as a valuable contributor to the development of the Central City through the project enactment within the context of these other initiatives, as opposed to a governmental development framework which does not come to fruition.

The vision established by the Cape Town Partnership as articulated in the CCDS, the proposed developments to occur in the Central City (Kaveney, 2010a), and the vision of the CCPGRI raise two relevant concerns. The first concern is how these developments will be enacted within the spatial context of the Central City. Conventional approaches to development by and large occur in an ad hoc fashion, negating an integrated approach necessary for long term planning, enabled by information sharing. This brings to attention to the second concern regarding the supporting networked infrastructures that enable development, generally neglected during conventional development processes. It is unclear whether supporting infrastructures in the Central City have the capacity to meet the inevitable increased demand which will be incurred during development. Moreover, this scenario is exacerbated by financial constraints of the CCT, which will limit investments and refurbishment potential for these infrastructures, as well as the ecological constraints which face Cape Town as a whole.

Critical to the provision of adequate urban infrastructure is the development of a *Strategic Urban Infrastructure Development Plan* which creates the long-term development projection that informs future decision-making (The Centre for Sustainable Urban and Regional Futures [SURF]-Arup, 2010). Such a plan has the potential to generate resilience in an urban area in the context of rapidly changing social and ecological environments. The necessity of a *Strategic Urban Infrastructure Development Plan* is illustrated by a recent publication by Moving Forward: the Northern Way titled “Utilities as a Barrier to Regeneration” (Arup and the Royal Institution of Chartered Surveyors [RICS], 2010). This research paper illustrates utilities and infrastructure as constraints to urban regeneration projects, often resulting in the delay or total abandonment of regeneration, due to the exorbitant cost of infrastructure. This scenario is the result of the current economic climate which has impacted property values, restricted liquidity of investors and resulted in a decrease in public sector funds (Arup and RICS, 2010). As a result of a collaborative effort between SURF and ARUP, evidence has been provided for the need to develop an integrated, strategic and long-term plan for infrastructure that in effect leads to an urban infrastructure

transition (SURF-ARUP, 2010). This 'manifesto'-like document is a response to the fragmentation of knowledge between those stakeholders who influence networked infrastructure systems and the lack of governance frameworks to manage these stakeholders. Furthermore, a case is made for the adoption of a systemic transition approach and the integration of infrastructure and spatial planning departments to allow for a horizontal flow of knowledge. Cape Town has no such plan in place.

The Cape Town CCPGRI will create the context through which a study will be made to illustrate how socio-technical regime changes occur within the spatial context of an urban system. Therefore, it is an account of the progression of the initiative and it offers insight into the process through which system innovation emerges. In addition, it offers an opportunity to understand how the theoretical notion of decoupling can be used as an intervention point through which an alternative approach to economic growth and human development can be adopted.

4.3 Cape Town Central City Provincial Government Regeneration Initiative

This story will be told on a timeline trajectory which describes the events that occurred between December 2009 and May 2010. While the description will not be complete, it will take the reader through the project from my perspective in a narrative manner as I acted as an observer and participant in the first phase of this project. The intension of this documentation is to (1) explore the interactions which led to the emergence of a possible alternative approach for the regeneration of the Central City, which demonstrates (2) the acknowledgement of critical infrastructure capacity constraints and thus presents (3) an opportunity to use this regeneration initiative as a spring board for the development of a strategic urban infrastructure development plan which takes into account the long-term development trajectory of the Central City. The materialisation of a long-term Strategic Infrastructure Development Plan in Cape Town would be the starting point for the realisation of a socio-technical transition at an urban scale.

4.3.1 Overview

The origins of the Cape Town CCPGRI are rooted in the vision for the revitalisation of the Central City as expressed by WCPG Minister for Transport and Public Works, Robyn Carlisle (WCPG. 2010a). The result of this vision is a comprehensive and holistic document which provides the *terms of reference* or guiding framework for the Cape Town CCPGRI; this 'end' product is a the result of several months of interaction between actors who have participated in a series of rich engagements, each bringing with them particular preferences for the realisation of a viable urban system.

The CCPGRI is an initiative by the WCPG which intends to re-imagine and redefine the Cape Town Central City, using a financial incentive as the rationale – one that is embedded within a greater strategy that seeks to stimulate development. In its inception in November 2009, the project had a clear dual purpose: the first was to solve the accommodation and maintenance dilemma of the Provincial Government's Head Office that is currently spatially fragmented, reducing the efficiency of governance and thus placing a high financial burden on the Province. This first goal would be informed by the second: the creation of a more accessible, higher density, liveable urban space in the City Centre. This urban space would therefore house adequate infrastructure that has the capacity to support the complex flows of resources, people and information, while recognising the ecological constraints. The project goal was articulated as the use of public sector assets (provincial properties) to leverage investments from the private sector and in so doing stimulate the 'regeneration' of the Cape Town Central City, thus creating a 'world-class city' (Badsha, 2009). The vision, goal and means of achieving this would be articulated in a document which can be regarded as the '*terms of reference*' developed by an identified consultant. It was intended by the WCPG that the spin-offs of this project would be the enhancement of the long-term sustainability of the Central City through an increase in investment within the city centre, a viable public transport system, employment opportunities and higher density and mixed income accommodation that serves the diverse society (WCPG, 2010a). A further aspect, and critical to the project, would be the ability to replicate it in other areas in the Western Cape (Hyman, 2010c).

4.3.2 Participating actors

It was recognised by the WCPG that these goals could only be realised if the appropriate partnerships were made with various actors who were committed to bringing the regeneration project to fruition. In light of this, the WCPG Department of Transport and Public Works approached the Cape Higher Education Consortium (CHEC), an organisation affiliated with universities in the Western Cape, to act as the project manager. CHEC then invited various key players to be included in the project. These included designers and planners, members from the private property development sector, architects, engineers, public officials, academics and students.

Cape Higher Education Consortium (CHEC)

CHEC is a registered section 21 company which was established to represent the four universities within the Western Cape with the intension of fostering greater co-operation between higher education institutions through regional collaboration (CHEC, 2010a). CHEC has collaborative agreements with the Provincial Government of the Western Cape (a Memorandum of Understanding) as well as the City of Cape Town (a Collaborative Protocol) which seeks to

enhance capacity through engagement and the development of shared strategies, each with a common goal (CHEC, 2010b).

Due to the nature of CHEC's relationship with the WCPG, their services were procured without a tendering process. The WCPG designated CHEC as the professional team which would coordinate the first phase of the project with the end goal of presenting a document (the *terms of reference*) to the Minister of Transport and Public Works, Robyn Carlisle. The document in question would then become the vision and plan of action for the future phases of the project. It was decided that the project be implemented in three phases. The initial phase would be the process of constructing a credible and inspiring story which captures the vision of the project in question through a statement of intent. The document created in the first phase would be focussed on mobilising support from key stakeholders, providing the *terms of reference* for the way forward and an implementation plan. The *terms of reference* would be used in the second and third phases. The second phase would be a process of more detailed planning and the identification of the resources needed for project to come to fruition. This would be conducted through a series of feasibility studies. Lastly, the third phase would be the implementation process.

Core steering committee

CHEC, represented by Nasima Badsha, the CEO acting as the project manager, was given the task of identifying a team of experts who would produce the *terms of reference* within a strategic framework for the envisioned regeneration project. As the mandate of CHEC is the inclusion of academic institutions in public projects, a core steering committee, comprising Edgar Pieterse, Mark Swilling and Gordon Pirie, representatives from various Universities in the Western Cape, was appointed to oversee completion of the work during the first phase (Badsha, 2009).

University of Cape Town: Edgar Pieterse

Professor Edgar Pieterse is currently the director of the African Centre for Cities (ACC) at the University of Cape Town. His academic interest lies in the different dimensions of urban and city spaces, both in the theoretical and practical sense and on a local and global scale (ACC, 2010). In particular, his research encapsulates the various and appropriate policy responses to 'differential patterns of urbanism'; the nature of 'African urbanism' through an exploration of 'informality' and 'creativity'; 'regional development policy and planning' in South Africa; 'cultural planning and politics'; and the conditions of urban Africa through visual representations (ACC, 2010). Professor Pieterse, significantly, is linked to a number of prominent organisations in South Africa currently engaged with the complex nature of the urban context; he is a co-founder and Board member of

the Sustainability Institute and a co-founder and Board member of the development policy think-tank, the Isandla Institute (Sustainability Institute, 2010a).

Stellenbosch University: Mark Swilling

Professor Mark Swilling is the academic director of the Sustainability Institute and head of Sustainable Development in the School of Public Management and Planning at Stellenbosch University (Sustainability Institute, 2010b). Professor Swilling's academic history is in the social sciences, particularly South African politics, institutional structures and governance. This interest has evolved to focus on system transitions at various levels and sustainability with particular reference to resource use, urban infrastructures and technology, as well as ecological design (Sustainability Institute, 2010b). Professor Swilling co-founded the Graduate School of Public and Development Management at the University of the Witwatersrand and the Sustainability Institute, and is an active member of the International Panel for Sustainable Resource Management (Sustainability Institute, 2010b).

University of the Western Cape: Gordon Pirie

Professor Gordon Pirie, University of the Western Cape, focuses on Human Geography with particular emphasis on cities and urban spaces with regard to access and the mobility within and between them (Academic.edu, 2010). Professor Pirie seeks to examine and reveal the relationship between mobilities from multiple contexts to understand the significance and implications thereof (Academic.edu, 2010).

It was intended that these academic actors guide the work done by the CHEC appointed lead consultant, John Spiropoulos, of Urban Genesis. Furthermore, the steering committee identified Mokena Makeka and Andrew Boraine as key participants to extend the steering committee.

Additional members contributing to the network

Mokena Makeka

Mokena Makeka is the Creative Director and Managing Director of his own architecture firm, Makeka Design Lab (Property, 2010a). A dynamic individual, he is also renowned for his cutting-edge design work. Makeka Design Lab has been commissioned by Intersite, the property management subsidiary of the Passenger Rail Agency of South Africa (PRASA), to coordinate and provide the architectural strategy for the Cape Town Station 2030 Revitalisation Project.

Andrew Boraine

Andrew Boraine has been prominent in South Africa's development processes for three decades; he has contributed to legislation and constitution building and acted in advisory roles to South African Ministers in matters relating to urban and development strategy and policy (Cities for People, 2010). Boraine is currently the CEO of the Cape Town Partnership and lectures at the African Centre for Cities in the School of Architecture, Planning and Geomatics, at the University of Cape Town (Cities for People, 2010). Furthermore, he is held in high esteem and considered a central component for the realisation of development within the Central City, due to his profile amongst the private and public sectors and his position at the Cape Town Partnership.

Private sector**John Spiropoulos**

John Spiropoulos, from Urban Genesis, was appointed as the lead consultant for the construction of the *terms of reference*. Urban Genesis is a multi-disciplinary company which specialises in consulting and urban and place management services, with an explicit focus on the creation of sustainable neighbourhoods (Urban Genesis, 2010). Spiropoulos has a wide range of skills pertaining to the creation of property packages which are released to the private sector for development. He has worked on and contributed to numerous project strategies across South Africa; most notably in Johannesburg and Cape Town in which he has developed strategies for the marketing, improvement, management and planning of various districts, as well as the development of infrastructure solutions (Urban Genesis, 2010). He is a business-minded individual, providing consulting services to both the public and private sector, whose network is across various areas of expertise due to his years of experience. Spiropoulos produced the CCDS with Barbara Southworth from City Think Space.

Barbara Southworth

Barbara Southworth is the owner and director of City Think Space. Southworth and her team at City Think Space were contracted to provide the visual representation of the urban space and logistical impact of increased densities, thus creating the vision, intent and development principles. She was previously employed by the CCT in the planning department, in particular the Spatial Development Framework (SDF) for Cape Town (Property, 2010b). She is an architect by profession, but has a keen interest in the transformation of cities and the sustainability thereof, and therefore combines her architectural background with urban planning (Property, 2010b).

The members of the core steering committee as well as those additional committee members identified, formed a network of individuals. Significantly, these individuals were very familiar with one another having both personal and professional relationships due past engagement with one another on similar projects albeit in different capacities.

4.3.3 The evolution of the project

The commencement of the project, for the purposes of this case study, is the point at which CHEC undertook the responsibility for the work until the handover of the *terms of reference*. Table 4.1 provides a detailed set of dates identifying the events that transpired during the initiative. It is followed by a detailed narrative of the events and process that unfolded.

Table 4.1: Chronology of events for Cape Town CCPGRI

Date	Event
19 October – 9 November 2009	Project conceptualisation: <ul style="list-style-type: none"> • Development of common vision • Approval of process
December 2009 - January 2010	Appointment of steering committee and additional participants <ul style="list-style-type: none"> • Selection of CHEC as project coordinator the inclusion of academic experts for consultation
22 January 2010	CCPGRI Steering committee meeting <ul style="list-style-type: none"> • Identification of Andrew Boraine from the Cape Town Partnership and Mokena Makeka of Makeka Design Lab as key stakeholders to be invited to join the Steering Committee
9 February 2010	John Spiropoulos: Private sector meeting
10 February 2010	Cape Town Partnership: steering committee Meeting
15 February 2010	Francois Joubert and John Spiropoulos Meeting:

	<p>Information Gathering</p> <ol style="list-style-type: none"> 3. WCPG Meeting re: institutional arrangements 4. CCT Meeting re: possible development constraints
3 March 2010	CHEC: Brainstorming Session
4 March 2010	<p>Personal interview</p> <ol style="list-style-type: none"> 1. Mansoor Mohammed (CCT) 2. Kendall Kaveney (CCT)
10 March 2010	<p>Personal interview</p> <ol style="list-style-type: none"> 1. Clive September (Arcus Gibb)
11 March 2010	<p>Personal interview</p> <ol style="list-style-type: none"> 1. Barry Coetzee (CCT)
18 March 2010	CHEC Follow up meeting
22 March 2010	<p>Group Meeting: Mokena Makeka</p> <ol style="list-style-type: none"> 1. Explanation of initial research findings of Cape Town Station 2030
26 March 2010 - 28 March 2010	Consultation draft document development and circulation
09 April 2010	Public consultation meeting
12 April 2010 – 06 May, 2010	Rich interaction amongst participants for final draft development
17 May, 2010	Formal handover meeting

Source: Hyman, 2010a, 2010b, 2010c

Period 1: Information accumulation and data collection

The point of departure for the lead consultant Spiropoulos can be identified from explicitly noting what was expected of the CCPGRI, which would fulfil his contracted mandate (Badsha, 2009). The expected deliverable can be considered in three categories: the 'why', the 'what', and the 'how'. The first deliverable was to provide a credible and inspiring narrative, as well as a strategic vision for the realisation of the Provincial Government's goals, thus fulfilling the category of 'why' this project should and would be enacted. A process of investigation into the current context of the public properties that would be released to the private sector for investment fulfilled the category of the 'what'. The investigation included the identification of the properties which were to be included in the project, and an accumulation of the information about the conditions, occupancy, use and size. 'How' the CCPGRI would be enacted was identified through a thorough understanding of the potential institutional arrangements which could be adopted. Such arrangements, along with the legal and policy constraints, had to be investigated. Spiropoulos was responsible for identifying these components to meet the stipulations of the expected deliverable.

Visual representation of the urban space, with an explanation of potential building uses for maximum impact which would complement the CCDS, was required. City Think Space was therefore subcontracted to compile the visual representation of the urban space and logistical impact of increased densities, thereby creating the vision, intent and development objectives for the Provincial properties. Spiropoulos undertook an examination of the potential policy and legal constraints as well as accumulation of information for each building. In this way there were two interconnected processes occurring simultaneously.

City Think Space, using a combination of empirical research and previously accumulated knowledge, compiled a series of images which identified the position of the buildings in their particular context. This was complemented by a fact sheet containing necessary data for each building. The scale of the project was managed by isolating clusters of publically owned buildings into precincts, which were then discussed as entities within their greater precinct context; this enabled the development of a potential reality for the future of the buildings. The team at City Think Space adopted a proactive approach in their attempt to contextualise the precincts for readers of the *terms of reference* (Hyman, 2010a). Fieldwork and site visits were conducted to capture images of buildings in their everyday environments as well as accessing intellectual capital from Makeka Design Laboratory, who had been particularly involved in certain precincts in the past. This was complemented by the identification and illustration of the recent developments and planned future developments. Public transport upgrades, building retrofits and renovations in the various precincts were thus indicated on the maps to demonstrate the 'energy' present and what would

stimulate or detract from envisioned development. The combination of this work acted as the departure point from which recommendations were made regarding future development potential according to the current use and character of the precinct. These recommendations were made by extrapolating the vision captured in the CCDS as a framework in order to retain consistency between various projects applicable to the Central City.

At the same time Spiropoulos embarked upon a process of accumulating information that would inform the *terms of reference*. A description of the way forward was required to reflect necessary due diligence and ensure that administrative and political risks are avoided during project implementation. In other words, Spiropoulos focussed on determining the structure of the most appropriate institutional vehicle for the planning and implementation of this project. Determining the institutional structure was considered a critical and primary goal by Pieterse (CHEC, 2010c). Furthermore, Spiropoulos placed significant emphasis on determining the greatest investment opportunity for a particular property asset and therefore focussed on data mining and information collection to conduct an adequate building audit to determine the condition thereof (Hyman, 2010a). Spiropoulos looked to the private property sector as a source of information.

While I was not present at an informal meeting (9/2/2010) Spiropoulos held with selected members of the private property sector, he explained their position and opinions regarding the regeneration of the Central City. Spiropoulos conducted this meeting in order to gain insight into the mood of the property sector in Cape Town and identify what design of institutional mechanisms would lure the property sector to support the project (Hyman, 2010a). He noted a discontent about the provisioning of 'so much' additional space within the Central City which could potentially 'flood the market' (Spiropoulos, 2010b). Furthermore, there seemed to be general consensus that the market had already been saturated, allowing little room for the WCPG to manoeuvre (Spiropoulos, 2010b). This brought to Spiropoulos's attention the importance of determining how the Provincial properties would be released and in what time frame (Hyman, 2010a).

Initial findings were presented at a meeting (10/2/2010) at the Cape Town Partnership; those who were present included Pieterse and Swilling of CHEC guiding the project, and Joubert representing the WCPG and acting as the client (Hyman, 2010b). In addition, Boraine, Spiropoulos, and Southworth were present (Hyman, 2010b). Spiropoulos indicated that the process of accumulating property information was arduous, as various sets of data were conflicting or incomplete (Hyman, 2010b). Nonetheless, an overview of the strategic goals and vision was presented to the client, the Provincial Department of Transport and Public Works. The overview expanded on by Spiropoulos, highlighted the fundamental regarding investment opportunities to leverage the greatest possible

profit for the WCPG (Hyman, 2010b). The vision to be articulated in the *terms of reference* was based on four assumptions regarding the goals of the project for urban regeneration. These assumptions included the aspects of sustainability, connectivity, cohesion and employment opportunities (Hyman, 2010b). What emerged from the discussion that followed was the realisation that the project would be influenced by three factors: the financial viability, the risk management and the institutional arrangements (Hyman, 2010b).

In addition to the information provided by Spiropoulos, Southworth presented an overview of the work that the team at City Think Space had completed. A set of maps gave the participants a visual indication of the precincts in question, demonstrating the extent the project with reference to the characteristics of the properties in relation to existing developments in various precincts. Preliminary conclusions based on recommendations for building use and precinct development indicated that the existing height regulations, zoning and land use would not inhibit plans and therefore the completion of the project (Hyman, 2010b). However, Southworth explicitly expressed concern for the potential infrastructural constraints in the Central City. These concerns, she explained, pertained to the energy, water, sanitation and transport infrastructures, as no recent and extensive investigations had been done within the Central City, which provided insight into the state and capacity of these critical infrastructures (Hyman, 2010b). Southworth thus placed a 'disclaimer' on the conclusions and recommendations drawn, in that they would be subject to an extensive investigation to establish whether the infrastructure in place could cope with the additional current and future demands of the project in conjunction with other developments occurring in the Central City (Hyman, 2010b). Another constraint was therefore added to the mix that would influence the realisation of the project: urban infrastructure.

The question of urban infrastructure investigation prompted an additional discussion on the financial resources for such an undertaking. It was revealed by Boraine that no funds had been made available from the CCT for an infrastructure investigation and therefore would require an examination of the potential financial mechanisms available to fund this (Hyman, 2010b). (Note should be made of Boraine's specific interest in ensuring the planning of adequate infrastructure which stems from his role representing the general interest of the property development industry. The vested interest of the property sector is an increase in rental space which is dependent on adequate urban infrastructure). In response, Joubert expressed the willingness of the WCPG to use an innovative approach to reshaping the urban environment, including the supporting networked infrastructures (Hyman, 2010b). Joubert encouraged the focus to include the buildings in question, as well as to create a vision and solutions for the precincts that are unique (Hyman,

2010b). It was suggested that the CCPGRI should be designed to use the provincial properties as a catalyst for additional regeneration initiatives.

Spiropoulos however reiterated his concern regarding the accessibility of valid data which would inform the *terms of reference* and goals for solving the Provincial Government accommodation dilemma. This would require a comparative investigation between ownership and rental arrangements (Hyman, 2010b). Conversely, Borraine redirected attention to the institutional arrangements for management of investment and transactions, thus bringing into sharp focus the underlying business incentive for this project (Hyman, 2010b). The meeting was concluded by outlining the way forward to develop the *terms of reference*; to continue collecting the necessary data and to determine the appropriate institutional and financial mechanisms for the release of properties.

Spiropoulos continued his investigation and research by meeting with various actors from the CCT and the WCPG. His goal was to ascertain the extent of the various potential constraints the Province would encounter during the process of releasing properties for development.

Spiropoulos and Joubert hosted a meeting (15/2/2010) with various department heads from within the WCPG, including the Chief Financial Officer and the Property and Facility Manager, as well as employees of the Strategic Planning Department and the Provincial Quantity Surveyor at the department of Public Works and Transport (Hyman, 2010b). An overview of the project provided a platform for discussion regarding the procurement processes and potential obstacles for the project. The goal was to learn about property and asset management and to establish the most effective way of releasing properties for the private sector while generating interest for investment (Hyman, 2010b). This was to ensure that procedures for the project are legally sound, since it needs to be sustainable and stable (Hyman, 2010b).

The discussion was centred on the role of the Government Component which is an ad hoc institutional arrangement within the public sector that allows the streamlining of governmental activities (Hyman, 2010b). The process of Private–Public–Partnership (PPP), as described by the Public Finance Management Act (PMFA), was furthermore discussed in terms of the possibilities for property transactions (Hyman, 2010b). In addition, reference was made to the appropriate funding mechanisms. This is closely linked to the institutional arrangements and therefore needed to be simultaneously identified. Few conclusions were drawn at this meeting; however, it provided insight into the possible procurement processes available for the realisation of this project. Furthermore, the role of the different spheres of government was clarified; it was stated that while the WCPG would play the lead role, it would rely on the CCT to remove any constraints in terms of

restrictions regarding town planning and infrastructure, as well as review policy to ensure the compatibility with the vision for the Central City (Hyman, 2010b). The information gathered at this meeting was synthesised with previously collected information as part of the initial development concept and compiled in a power point presentation by Spiropoulos (2010c).

This initial development concept with regard to the procurement process and the institutional arrangements were presented during a meeting (15/2/2010) at the CCT, with the goal of reaching a degree of consensus concerning an approach which allows both the CCT and the WCPG to benefit (Hyman, 2010b). This meeting was conducted at the CCT offices; present were Piet Van Zyl, the Executive Director of Strategy and Planning, Mansoor Mohammed, the Director of Economic and Social Development and Tourism, and Kendall Kaveney, the Development Facilitator, as well as Spiropoulos, Southworth and Joubert.

Joubert expressed a wish to adopt a pragmatic approach in terms of a partnership with the CCT which would diversify the risk encountered when embarking on a project of this scale (Hyman, 2010b). The rationale provided was that the CCPGRI was likely to contribute to other projects initiated by the CCT. The meeting was conducted using an approach that encouraged the removal of restrictions to development, such as town planning or infrastructure constraints, which is the responsibility of the CCT as the metropolitan authority. The fundamental question raised at the meeting with the CCT was, therefore, what the potential constraints to development are that could prevent investment from the private sector in the Central City (Hyman, 2010b). Conclusions were not drawn; there were however several key statements of interest which provide insight into the CCT's reluctance to make a commitment to cooperate. Mohammed indicated that, with reference to infrastructure, the Central City was able to cope with additional development due to recent investment in the reinforcement and upgrading of the Athlone wastewater treatment plant and electricity distribution systems in the area (Hyman, 2010b). The CCT therefore suggested that the CCPGRI should inject additional energy into areas in the Central City, thus creating synergies (Hyman, 2010b). Van Zyl argued that the infrastructure reinforcements provide an opportunity for 'low hanging fruit' or 'easy wins' for the project without excessive capital investment. It was also emphasised by the CCT that developments should be driven by 'demand' as opposed to what they saw as the Province's 'desperation' to 'supply' (Hyman, 2010b).

Period 2: Research

The period of information accumulation and data collection culminated in a meeting (3/3/2010) with the entire core steering committee: Badsha, Swilling, Pieterse, Pirie and additional supporting members Boraine and Makeka, as well as Spiropoulos at CHEC Head Office (Hyman, 2010b). This

was a feedback session for the project manager and the remaining members of the steering committee, who had not been active in the information accumulation period. It was also a session to determine the future trajectory of the project and to ensure that it would be adequately guided by the steering committee (Hyman, 2010b). Spiropoulos, as the lead consultant, provided an overview of the work completed to date in the form of a discussion draft of the *terms of reference* (see Spiropoulos, 2010d). He reiterated concerns regarding the accumulation of relevant data needed for a thorough examination of the property conditions (Hyman, 2010b). The story line and envisioned goals of the project were to be extrapolated from already published documents which describe an idealistic future for Cape Town and in this way generate a mission statement that remained consistent with the CCT's broader development agenda. The envisioned goals were expanded on to include the notion of being 'connected, cohesive, innovative and sustainable', while introductory comments on the strategic objectives of the project were made (Hyman, 2010b). Pieterse highlighted the generic nature of the strategic objectives and appealed for a substantive approach which reconnected them to the former ideals of the project (Hyman, 2010b).

Overall, emphasis was given to the institutional arrangements, described by Spiropoulos as the 'creative stuff' and therefore requiring significant attention (Hyman, 2010b). The attention to institutional arrangements is warranted by the attempt to establish 'how' the project will be enacted. The inclusion of this aspect distinguishes the CCPGRI from other regeneration initiatives, which generally exclude this critical element for the realisation of intended goals and project completion. The particular institutional structure selected was the PPP, due to an agreement between the Province and Treasury which promised to expedite the process (which has historically taken up to four years) (Hyman, 2010b). It was explained that the Corporate Structure or Agency would, in accordance with the PFMA, be a unit within the Provincial Transport and Public Works Department that would retain a supervisory role when entering into PPP's (Hyman, 2010b). The role of the agency, with its own identity and assigned powers, was therefore to ensure the process was completed using the *terms of reference* developed by CHEC as a departure point, with specific reference to fulfilling strategic objectives envisioned (Hyman, 2010b).

This brought the discussion back to the question of strategic objectives. Spiropoulos explained that he had spent time at Arcus Gibb to understand the condition of infrastructure in the Central City which would influence the realisation of the various objectives. Spiropoulos stated that Arcus Gibb confirmed that there are no concerns with the bulk capacity for the Central City, but the reticulation and connecting infrastructure would require investment and at least an investigation (Hyman, 2010b). Swilling contradicted this statement, expressing significant concern for the underlying infrastructure backlogs. Recent research overseen by the Sustainability Institute for the UNDP

funded *Resource Management for Urban Development* Project as well as his personal research demonstrated that massive investment is needed for the bulk and reticulation infrastructure, as well as the investigation into the ecological resource constraints present that would inhibit development (Hyman, 2010b). Boraine concurred with the concerns regarding infrastructure and stated that Kaveney from the CCT had raised funds for an infrastructure investigation and was in the process of putting out to tender the *terms of reference* for such an investigation for the Central City (Hyman, 2010b). Insufficient information regarding infrastructure capacity in the Central City as well as missing information with regard to provincial properties indicated that additional work needed to be done.

With these contradictory statements concerning infrastructure in mind, I sought to meet with Mohammed who had made confident remarks at a prior meeting at the CCT, and to engage with engineers at Arcus Gibb to confirm Spiropoulos's findings. During a meeting (4/3/2010) with Mohammed, he reconfirmed his statements regarding infrastructure capacity in the Central City, which had recently been upgraded to accommodate the additional demand stimulated by the FIFA World Cup (Mohammed, 2010). Mohammed could not say much more on the subject due to a lack of information (Hyman, 2010c). He did, however, provide the contact details of the most appropriate individual in the CCT, Barry Coetzee, who would provide information regarding the infrastructure capacity within the Central City. He furthermore, directed me to Kaveney, the Development Facilitator for the CCT, who was involved with the production of the CCDS and complementary infrastructure investigation.

During an interview (4/3/2010) (Hyman, 2010c), Kaveney explained his role in determining where investment is allocated in Cape Town with the view to fulfil the CCT's mandate to use a 'development led infrastructure planning prioritization model' (Kaveney, 2010b). With regard to the infrastructure capacity within the Central City, he explained that the first investigation conducted by Arcus Gibb (2008) was a foundation study which needed to be expanded on before significant development could go ahead (Kaveney, 2010b). Kaveney (2010b) revealed, however, that the budget allocated for this second phase of the infrastructure investigation would be insufficient to fulfil the scope required. Kaveney provided me with a copy of the *terms of reference* for infrastructure investigation that he would be putting out to tender (Kaveney, 2010c). This document was generic with no reference to sustainability issues in Cape Town. Furthermore, phase 2 would use the phase 1 infrastructure investigation conducted by Arcus Gibb (2008) for the CCDS as the foundation study on which a more thorough investigation could be conducted. Since the phase 1 investigation was inadequate, the probability of the proposed phase 2 assessment adopting a business-as-usual approach was high.

Kaveney provided the name and contact details of those employees of Arcus Gibb he thought could assist my research. My encounter (10/3/2010) (Hyman, 2010c) at Arcus Gibb was, however, brief. In an interview with Clive September, I attempted to form an understanding of the approach used for the CCDS Infrastructure Investigation. September (2010) referred me to the document which provided a methodology. Furthermore, September was unable to provide any information regarding the capacity of infrastructure other than that described in the investigation findings (Hyman, 2010c).

I subsequently met (11/03/2010) with Barry Coetzee, who offered extremely insightful information regarding infrastructure systems in the Central City as well as Cape Town as a whole (Hyman, 2010c). He furthermore identified the relevant actors in the water, sewer, energy and solid waste departments who would be able to assist in my research and, as expanded upon in section 4.4, made invaluable contributions. In terms of the information provided about the Central City, the sentiments echoed those of Mohammed (Hyman, 2010c). Coetzee (2010b) confirmed the refurbishment of electrical infrastructure and indicated that water and sanitation infrastructure was not currently a concern for the CCT with regard to the Central City. However, in the case of solid waste, this infrastructure does not directly apply to the Central City, due to the nature of collection. What was evident in both cases was the vagueness of the exact capacity of infrastructure and therefore to what extent development could occur within the Central City in the future.

The next meeting (18/3/2010), hosted by CHEC, was conducted to ensure that the work being done by the lead consultant was consistent with the goals of the client via the guidance of the steering committee (Hyman, 2010b). As the institutional arrangements had previously been discussed at length and the receipt of all necessary information regarding various properties had now been confirmed, particular attention was paid to the vision and strategic objectives. The *terms of reference* would soon be discussed at a public consultation meeting, which would include members of the private and public sectors. Therefore the vision and strategic objectives needed to be constructed in a manner that would ensure the achievement of the project goals and generate broad-based support, while recognising the potential constraints for development (Hyman, 2010b). In particular, the strategic objectives were expanded on as specific quantitative goals, both specific to precincts and cross-cutting thereof, which would contribute to the realisation of the broader vision. These cross-cutting objectives refer to social, economic, and environmental issues which Swilling used as a platform to open a discussion on infrastructure in the Central City (Hyman, 2010b).

Swilling, referring to my findings through discussions with Kaveney and Mohammed and his own research regarding the resource flows of Cape Town raised the issue of the necessity of an infrastructure investigation (Hyman, 2010b). He stated that without such an investigation, credible recommendations for the development potential could not be made. Swilling went on to argue that the production of a credible investigation required an adequate budget allocation which would clearly not be available from the CCT (Hyman, 2010b). Out of this comment emerged the possibility of the creation of a 'kitty' to which various stakeholders, including WCPG, CCT and Intersite (in light of the potential of the Cape Town 2030 Station Revitalisation project) would contribute, thus creating a sufficient budget for a credible infrastructure investigation (Hyman, 2010b). This concept was supported by Makeka who had an interest in ensuring adequate infrastructure capacity in the Central City in light of his relationship with Intersite and through this PRASA. Makeka therefore offered the participation of his clients, Intersite, as well as access to preliminary infrastructure capacity studies conducted for the purpose of implementing the first phases of the Cape Town Station Regeneration project (Hyman, 2010b). This was further supported by Boraine and Joubert; the former put forward that the latter would meet with the MEC, Robyn Carlisle, to confirm the a proposal of a kitty (Hyman, 2010b).

Swilling furthermore mentioned to the group that he had discussed the strategic objectives with Boraine and they were in agreement that the strategic objectives required serious refining and editing, and offered to make an attempt at the reconstruction (Hyman, 2010b). The meeting was concluded by allocating most of the responsibility for constructing the *terms of reference* to Swilling and Spiropoulos, who would then circulate a draft to the remaining members for editing, thus allowing for a more diverse representation of interests (Hyman, 2010b). In a similar tone to Pieterse in the previous meeting, Pirie emphasised the need to adjust the language of the draft and in particular the vision and strategic objectives, as the technical and generic tone had the potential to alienate readers. Pirie alternatively requested the 'peopling' of the Draft Document (Hyman, 2010b). The goal was to circulate the Draft Document to identified actors from a variety of areas of expertise for critical feedback on the content, as well as to analyse and comment on the complexity of the project. This process of stakeholder engagement would then assist CHEC's steering committee to construct the final draft for submission to the MEC.

As a result of the comments made by Swilling, Makeka invited him and I to examine the preliminary findings of the infrastructure investigations conducted for the Cape Town Station Regeneration Project (Hyman, 2010a). At this meeting (22/3/2010) Makeka (2010a) described the rationale of the Cape Town Station Regeneration Project which was to meet the future demand for public transport in the context of oil peaking and the likelihood of a decrease in the use of private vehicles. To

ensure a viable expansion for public transport, high density nodal development would be required; for this reason, an extensive infrastructure investigation was necessary (Makeka, 2010a). The engineering documents, produced by Arup (2009), Arcus Gibb (2010a) and Ubunye Engineering Services (2009a, 2009b) highlight how a lack of energy (electricity), water and sanitation infrastructure will inhibit the potential for development in the Cape Town Central City. This reaffirmed Swilling's sentiments, expressed at the previous meeting, and also provided the empirical rationale for an infrastructure investigation that uses sustainability as a lens (Hyman, 2010a).

The first two periods of the CCPGRI was an intensive process of accumulating information and data which, through research and exploration, became internalised knowledge for the participants. Out of the process, agreement was established regarding the initiative vision and principles. This indicated that the participants had reached a compromise on how they each envisioned the development trajectory and future of the Central City. Furthermore, a degree of consensus had been attained regarding the structure of institutional arrangements, thus determining how the project would be enacted. What remained elusive was the question of urban infrastructure. Inferences to infrastructure constraints within the Central City made by Southworth and Swilling were contradicted by Mohammed and Spiropoulos's statements, thus creating doubt amongst the steering committee. The importance of this issue was emphasised during the meeting with Makeka (Hyman, 2010b). Research conducted by Arup (2009) implied that the project would fail if it was not recognised that the lack of infrastructure is a major obstacle. Failure to recognise infrastructure as barrier to development has often result in the collapse of regeneration initiatives (Arup and RICS, 2010)

Period 3: Realising sufficient consensus

The draft document to be distributed for consultation and critical feedback was primarily constructed by Swilling and Spiropoulos, with input and revisions from the remaining members of the steering committee (see Swilling and Spiropoulos, 2010). There were multiple interactions via email during this process, with each of the members making contributions relevant to their fields of expertise. In this way, Swilling provided the basic structure, contextualising Cape Town's growth path, to which layers were added. The draft was circulated several times, and because the technical elements of the institutional arrangement had been concluded with regard to an implementation plan, the priority was to articulate the vision and strategic objectives in the most appropriate manner for the realisation of all goals. Borraine, in light of his long-term engagement with and therefore knowledge of the Central City, used Spiropoulos's 'generic' strategic objectives as a base from which changes were made; Swilling then crafted these by complying with Pirie's

request for ‘peopling’ through an expression of statements which could be transformed into measurable objectives (Hyman, 2010a). As observed by Swilling (2010a) in an email to the steering committee, both Boraine and Spiropoulos had neglected to reference infrastructure explicitly and therefore he included within the strategic objectives, elements pertaining to urban sustainability and infrastructure. In the process of completing the draft, the steering committee was pressured to respond to comments; a correspondence ensued between Swilling (2010b) and Makeka (2010b) regarding sustainability, autonomous utility development and the importance of long-term planning thereof.

Furthermore, Swilling and Spiropoulos, as the principal contributors to the document in the last stage of its development, had private correspondence in which Swilling (2010c) put forward the idea to include a page on strategic infrastructure issues, describing the challenge and the necessity of ensuring that the ‘right’ infrastructure investigation be conducted. Subsequently, Swilling (2010d) again expressed his concern to the steering committee for the underlying infrastructure backlogs and consequential challenges, urging consensus for the inclusion within the document of a page that addresses the issue. In particular the *terms of reference* needed to reflect that the regeneration of the Central City is irrevocably linked to major investment in networked infrastructure in conjunction with the upscaling of the public transit systems and data communications infrastructure using a sustainable resource use perspective as a framework (Swilling, 2010d).

There was little response to this proposal due to time constraints and these sentiments were not included in the distributed draft document for the public meeting. Moreover, on the morning of the public consultation meeting, in an informal discussion, Joubert (2010a) confided that while the MEC had confirmed the idea of a ‘kitty’, he had met with Kaveney to discuss, among other things, the question of an infrastructure assessment kitty (Hyman, 2010c). During their meeting, Kaveney however stated he was reluctant to enter into such an agreement and ‘other matters seemed more important’ and thus took precedence over the question of infrastructure (Joubert, 2010a).

The public consultation meeting (09/4/2010) was held at Webber Wentzel Offices in Cape Town. Table 4.2 provides a detailed list of those in attendance and their affiliate organisation.

Table 4.2: List of attendees

<u>Organisation</u>	<u>Name</u>	<u>Role</u>
<u>CCT</u>	Van Zyl, Piet	CCT Planning

	Irrgang, Berendine	CCT Urban Design
	Kaveny, Kendall	CCT Infrastructure
	Walters, Cheryl	CCT Land Use Management
<u>Provincial Government</u>	Joubert, Francois	PGWC
	Mlandu, Pakama	PGWC
	Pillay, Joey	PGWC
	Roese, Ann	PGWC
<u>Interested Parties</u>	Robinson, Shirley	Economic Rise
	Makalima-Ngewana, Bulelwa	Cape Town Partnership
	Lundy, Guy	Accelerate Cape Town
	Robinson, Laura	Cape Town Heritage
	Van Donk, Mirjam	Isandla Institute
<u>Private Sector</u>	Bremner, Gavin	Rand Merchant Bank
	Eberhard, Rolfe	Palmer Development Group
	Evans, Mike	Webber Wentzel Attorneys
	Gardner, Neil	Old Mutual Properties
	Matya, Lindelo	Intersite
	Rippon, Martin	Eris Properties
	Stansbury, Jim	Arcus Gibb
	Yach, Theodore	TYPS

The public consultation meeting (9/4/10) was conducted in a similar fashion to previous meetings and the following was provided: a contextual overview of the project, with particular reference to the vision of the Provincial Government and strategic objectives; an overview about the implementation approach; and an overview of the precincts and recommendations for each (Hyman, 2010b). The floor was then made available for comments and critical feedback from those present. Synthesising the discussion made it possible to identify several key points that were continuously referred to.

Although a summary narrative of the meeting limits the conceptualisation of what was significant about the event, the structure of the meeting allowed for numerous contributions from participants to be made. It was not possible to capture all the nuances and complexities, because these players were all clearly very familiar with each other and were in a negotiation mode.

In terms of the vision, emphasis was placed on the importance of the way in which strategic objectives are framed, as they are the yardstick for measuring the success of the project (Hyman, 2010b). Comments were made regarding what the vision encompassed and the lack of adequate reference to economic activity and productivity of the Central City (Hyman, 2010b). This was a critical talking point in a post debt financed consumption period as it illustrated the need to direct economic growth along a specific trajectory which takes into account the relative strengths and weaknesses of Cape Town in its greater context of the Western Cape. This furthermore contributed to a discussion regarding the value chain required to realise 'productivity' and therefore the infrastructure necessary, be it social or physical, for the development of the Central City, based on its strengths (Hyman, 2010b). The private property sector responded by remarking that they are willing to fulfil the role of stimulating productivity and economic growth, as long as the infrastructure is in place and investment is demand-led (Hyman, 2010b). It was suggested that the context of the regulatory framework, within which this project will be enacted, be described; this includes planning and policy initiatives which would influence development (Hyman, 2010b).

The public consultation meeting provided an opportunity for the steering committee to test their rationale, receive critical feedback and reflect on aspects not previously considered. What were seen as useful comments were drafted to be incorporated into the *terms of reference*. Significantly however, Spiropoulos (2010e) was seconded to another project during this process and thus Swilling was appointed to coordinate the production of the final draft, accompanied with a 'to do' list sent to the steering committee. In addition, Joubert (2010b) relayed several of his own comments, those of the MEC, Robyn Carlisle, as well as insightful arguments made by a member of the private property sector, Theodore Yach, for inclusion in the *terms of reference*. These comments pertained to the institutional arrangements, financial mechanisms and strategic approach, as well as development priorities (Joubert, 2010b). The process of editing and producing the final version of the *terms of reference* once again generated rich interaction between participants.

The third stage represented a turning point of the project in that it was characterised by a greater presence of the steering committee to determine how the draft document was prepared. In other words, a greater share of the responsibility for producing the document was transferred from the 'consultants' to the 'academics'. The transferral of responsibility altered the role of the participants,

and therefore the hierarchy of decision-makers. Furthermore, attention was drawn to the elusiveness of infrastructure, despite attempts by Makeka and Swilling, and to a certain extent Boraine, to address the issue. The issue being the exclusion of infrastructure as a constraint to development within the draft document for consultation and that gathering financial resources for the infrastructure investigation was not considered a priority. The consultation process was however rewarding, with consensus regarding the need for development to be aligned with Cape Town's strengths. Ecological constraints are one of Cape Town's most pressing weaknesses and therefore the infrastructure development plan must account for this. Furthermore, the property sector was adamant that infrastructure should be in place prior to property development, thus highlighting the importance of an infrastructure investigation and the financial obligations of the CCT and WCPG.

Period 4: Assertion of values

The final draft version of the *terms of reference* had well-constructed sections on the subjects of institutional arrangements, financial mechanisms and spatial plans. A section on the problem of infrastructure as a key constraint was however excluded. Well-constructed sections were the result of extensive correspondence between the participants, stimulated by the MEC's request that the report be a 'blue print' with very specific 'bold' proposals (Joubert, 2010c). The neglect of the topic of infrastructure, on the other hand, was explicitly highlighted by Swilling (2010e) in an email to Spiropoulos who, in his expert academic opinion, considered strategic infrastructure issues as the major challenge for the realisation of this project or what he called the 'condition precedent'. Swilling (2010e) therefore explicitly stated that he would not support the document unless appropriate reference was made to the question of infrastructure with specific reference to an alternative approach, using the lens of sustainability and resource efficiency to ensure that the appropriate 'way forward' would be in place. This would then negate the possibility of approaching infrastructure from a business-as-usual perspective which takes urban infrastructure for granted (Swilling, 2010e). Spiropoulos (2010f) responded by explaining that he did not deem it appropriate for inclusion in the document and argued that the reference within the document to a Strategic Infrastructure Plan was sufficient. Spiropoulos (2010f) furthermore argued that CHEC would be in a position to draft the *terms of reference* for the infrastructure study in the second phase and should include Swilling's demands within that document. Swilling (2010f) countered this argument and asserted that the exclusion of a strong statement regarding infrastructure backlogs would close the door to any alternative approach based on sustainability principles. He supported his argument by referencing the intensive research he and Pieterse conducted over the past five years on Cape Town infrastructure and resource flows. In their expert opinion, infrastructure would be the major constraint for development; conventional systems would not resolve the problem, due to the

ecological limits present, and the CCT cannot afford the required investment (Swilling, 2010f). From this one must conclude that the investment in infrastructure must come from the private sector.

Spiropoulos (2010g) hereafter agreed with Swilling's perspective. A section of the *terms of reference* was dedicated to infrastructure, while an addendum was attached to the final version of the document which referenced infrastructure as a significant barrier to development in Cape Town. The addendum explained the need for an **urban infrastructure development plan** for the city which uses sustainability principles as a departure point. In particular the Cape Town CCRGRI Final Document (WCPG, 2010b) highlighted that adequate urban infrastructure is the key constraint to development in the Central City and requires long-term investment. Investments should be made in infrastructure designed to use natural resource sustainably, allow for the re-use of wastewater and solid waste, limit the use of private vehicles and increase the use of renewable energy sources (WCPG, 2010b). Authority for making these statements was obtained by quoting a speech of the Premier's, Helen Zille, who explicitly notes Cape Town's ecological constraints and the significant role of adequate urban infrastructure plays in future development (WCPG, 2010b).

Period 5: General consensus

The amended text of the document was distributed to the steering committee and subsequently approved for handover to the MEC. At the handover meeting (17/5/2010), comments were made about the institutional arrangements of the two spheres of government – the Province and CCT – and their role within the project (Hyman, 2010b). This was discussed in the context of the two spheres agreeing on the priority precincts, as well as determining the constraints within each precinct. In this way the commitment from the CCT was required to ensure their co-operation in the removal of the barriers to the project initiation. Furthermore, a general consensus was reached vis-à-vis infrastructure as the biggest constraint to development; most notably stressed from the MEC (Hyman, 2010b). Critical, in the view of the MEC, was the role of the CCT in determining the infrastructure constraints, identified as a priority for the realisation of the project (Hyman, 2010b). In other words, Carlisle was adamant that both the Provincial Government and the CCT had to contribute in monetary terms to an infrastructure investigation (Hyman, 2010b). Boraine informed the group that the budget allocated by Kaveney for the second phase infrastructure investigation was no longer available and therefore the question of an infrastructure kitty was revisited, as well as the role of Cape Town Partnership as a manager of the kitty (Hyman, 2010b). Van Zyl, Executive Director of Strategy and Planning in the CCT, added that the document lacked sufficient direction as to the type of development (Hyman, 2010b). He reiterated that for this project to advance, additional work was required to ensure this transition from a strategic framework to an

implementation plan. Three foundation studies would therefore have to be completed to provide insight into the constraints identified, namely an infrastructure study to understand the predicted growth and relevant capacities; a market study to understand the business conditions; and a residential study describing the residential market conditions. It was suggested that these studies be used collectively by partners, that is the Cape Town Partnership, CCT and Provincial Government, and to furthermore 'share' infrastructure to allow development to occur (Hyman, 2010b).

The foundation studies would be the starting point for this project in its second phase. Swilling noted however that their viability would emerge through the capacity of the appointed steering committee to implement findings (Hyman, 2010b). In other words, the responsibility for the construction of the *terms of reference* will inform the future trajectory of the project.

4.3.4 Synthesis of storyline

The storyline of the Cape Town CCPGRI is one that emerged from the interaction between various stakeholders from various fields of expertise and sectors, which allowed for a thorough and holistic interrogation of the possible means by which this initiative will move forward. These actors have thus determined the trajectory of the project.

The outcomes of several critical meetings which occurred during the five periods have been described. During these periods a learning process unfolded amongst participants who responded to the different characteristics of the project that emerged throughout the project lifecycle; responses were determined by their interest in and reading of the context. This process allowed for a seemingly irrelevant topic of networked infrastructures, in terms of ecological and financial constraints, to become a core element in determining how the project would proceed. Furthermore, because of the way in which the addendum on infrastructure has been written within the document known as the *terms of reference*, the study should be conducted through a framework that considers ecological constraints as critical to the development of Cape Town. The question of ecological constraints is by and large ignored by engineers, urban developers, planners and consultants and this subsequently results in the reinforcement of the institutionalised business-as-usual approach to development. What is of further great value, is the inclusion of 'how' this project would be implemented: the description of the intuitional mechanisms which are also generally excluded from strategic documents of this kind.

An interesting component, which emerged as the project progressed, is the change in the approach to infrastructure. There are two elements to this argument: infrastructure, initially not

considered as a critical constraint to development, became **the** constraint to the realisation of this project. This can be extrapolated to signify the role that networked urban infrastructure plays in an urban system and how it can potentially influence the ability of all cities to grow and develop. Secondly, it is evident that through a series of interactions and engagements within as well as beyond the immediate system, a clear learning process evolved. Initially the group conceptualised urban infrastructure as a given technical component within the system, but this was later re-conceptualised as a socio-technical system. This is not explicit, but the evidence is clear. Networked urban infrastructure, which will service the future Central City as envisioned by the steering committee, will only exist through complex social engagement and a decision-making process that unfolds during the development of institutional arrangements. These institutional arrangements are necessary to manage the complex partnerships between different spheres of governance and the private sector. In other words, the steering committee acknowledged that the challenge of infrastructure could not be addressed with a technical fix to be dealt with at a later stage. Rather, it emerged that the configuration of infrastructure, and by whom, would be dependent on a series of institutional arrangements negotiated by the key actors. In short, it was accepted that a socio-technical solution was needed.

The acceptance that infrastructure is a socio-technical solution illustrates the novelty of the outcome of the CCPGRI. The inclusion of the recommendation for an urban infrastructure development plan which uses the principles of sustainability is an uncommon phenomenon, and thus the CCPGRI can be distinguished as a niche innovation which has emerged from an SOIS. SOIS's are those innovation systems that result in innovations that enable and foster sustainability (Stamm *et al*, 2009). While the innovation system within the SOIS is the network of participants who contributed to the CCPGRI, the triggers that stimulated the emergence of the specific outcome remain unclear. Therefore the factors, present in the innovation system, that determined the SOIS will be discussed in. Emphasis on infrastructure as a constraint to development in the Central City however dominated a significant portion of the narrative in section 4.3 therefore section 4.4 provides an overview of the critical infrastructures in the Central City.

4.4 Infrastructure in the Central City

Questions relating to the capacity of infrastructure in the Central City are critical for development and economic growth and, through this, human development. Networked infrastructures bring into existence the metabolism of the city by transforming natural inputs into useable 'goods' and managing the consequential output. It has been demonstrated that as the Cape Town CCPGRI developed over time, infrastructure became the critical constraint to development within the Central City. Furthermore, initial concerns were raised regarding the financial constraints of ensuring that

the infrastructure capacity was available for development. As the project progressed, greater realisation of the ecological constraints to development were understood and included within the strategy. The following is a preliminary investigation into the capacity of infrastructure in the Cape Town Central City. This is an update of the investigations done in 2007 by the CCT Spatial Development department and by the private engineering consulting firm Arcus Gibb (2008).

The Growth Management Branch of the CCT City Spatial Planning and Urban Design Department conducted an informal investigation into the state of infrastructure in Cape Town in 2007 (CCT, 2007f). This in itself was a high level assessment using a methodology which sought to map the infrastructure constraints using the extensive knowledge of individuals within the department as opposed to a physical investigation (Walker, 2010). The basic question was posed to determine where in Cape Town constraints were present, in order to map them and draw conclusions about spatial development and infrastructure investment hot spots (CCT, 2007f). These findings clearly indicated constraints throughout the Central City in terms of bulk water and reticulation, bulk wastewater and reticulation, energy and storm water (CCT, 2007f). The conclusions emphasise that participants were concerned that without capital investment, capacity constraints would be experienced within the next five years. This anticipated infrastructure capacity constraint pertained to bulk and reticulation infrastructure for water and wastewater as well as energy infrastructure, while for storm water it was considered to be adequate (CCT, 2007f).

What follows is a high level update of that work which could potentially inform the Cape Town CCPGRI.

4.4.1 Electricity

The information for this section was provided directly by the department of electricity of the CCT. It was collected during a series of discussions and email correspondence with Mike Hyde from the Forward Planning and Investment Branch within the CCT Electricity Department. A preliminary meeting (10/6/2010) was held with Hyde (2010b), complemented by the email correspondence (Hyde, 2010c and 2010d). Furthermore, I drew conclusions from both textual and numerical data provided by Hyde (2010b); these include: Hyde (2010a), Hyde and Capes (2010) and CCT (2010c; 2010h; 2010i; 2010j).

The decision to upgrade infrastructure or invest in new infrastructure is based on two connecting factors. The first is a reactive approach to servicing existing infrastructure – this occurs when there are known disruptions, or if there is evidence of the maximum capacity of infrastructure being reached (Hyde, 2010b). The second is the result of planned developments in particular areas,

which will then result in additional demand being placed on a system (Hyde, 2010b). In the case of the Central City and the provision of electricity, the 2010 FIFA World Cup played a significant role in accelerating refurbishment of and investment in infrastructure. The future demand for electricity was therefore determined by (1) the specific construction for the 2010 world cup, (2) the development that would arise due to initial investment, as well as (3) the predicted year on year growth (Hyde, 2010b). Particular attention is directed toward probable land use, according to zoning rights which indicate to the department what type of development will potentially occur; this in turn influences the infrastructure requirements (Hyde, 2010b). This method of determining where infrastructure investment should be allocated is flawed, as evidence provided by de Wit *et al* (2009) demonstrates that electricity demand has a relatively high elasticity and does not necessarily move along the same demand trajectory as population growth and economic growth. Furthermore, as demonstrated in chapter 3, the demand for electricity decreased during a supply shock, demonstrating that behaviour change is possible and therefore negating the conventional approach to electricity supply.

4.4.1.1 State of electricity infrastructure in the Central City

Eskom's Acacia Power substation supplies electricity for the Cape Town Central City. Energy is purchased in bulk and then transmitted to the CCT owned Montague Gardens main substation via two 132 kV underground circuits to a number of main substations in the Central City from which electricity is stepped down to 11 kV and transmitted through the underground network (Hyde & Capes, 2010; Hyde, 2010a; CCT, 2010j). The substations which supply the Central City include the Roggebaai, Foreshore, Tamboerskloof, Woodstock and Constitution Street substations (CCT, 2010i).

In 2006 the combined load was 249 MVA (CCT, 2010j). Moreover, according to the load forecast, the total firm capacity of 295 MVA in the Central City, provided by the Roggebaai and Woodstock switching stations, would be exceeded by 2012 (CCT, 2010j). This growth in demand would be the result of the development of vacant land and densification, as well as upgrading and refurbishment of existing buildings (Hyde, 2010b). The building of the Green Point Stadium however placed an additional, unexpected demand on the Central City electrical system, which would as a consequence reach its maximum capacity by 2009 (CCT, 2010j). Therefore, this load acceleration resulted in the recent upgrading of several main substations within the Central City.

Currently the Central City is serviced by the new 132 kV Foreshore switching station as well as the recently upgraded Foreshore main substation (Hyde, 2010a). Previously the Foreshore main substation was supplied from Roggebaai switching station, whereas the load is now supplied by

the new Foreshore switching station (Hyde, 2010a). The expected long-term load growth for the Foreshore main substation is 250 MVA, which will suffice until approximately mid 2022. Thereafter it is likely that an additional 50 MVA transformer will be installed to suffice until 2050 (Hyde, 2010c).

Prior to this infrastructure investment, Roggebaai main substation was operating at 106% capacity or at 42.5 MVA. Two 50 MVA and one 90 MVA power transformers, classified as 'ageing infrastructure', were therefore replaced (Hyde and Capes, 2010). The Roggebaai substation now has the capacity to meet the projected demand until 2025 after which the load will be transferred to the CCT substation (Hyde, 2010d). The development of the Green Point Stadium as well as the surrounding area required the building of an entirely new substation to provide the medium voltage network (CCT, 2010j). This station has two 50 MVA 132/11 kV transformers which are supplied by the Foreshore Switching Station. The Montague Gardens Switching Station has also recently been upgraded so as to relieve the bottleneck at this station (Hyde, 2010a). This has been complemented by new 132 kV cable circuits from the Eskom intake point to the Foreshore switching station (Hyde, 2010a).

Although the Woodstock main substation is operating at 36.3% of the total capacity, the Tamboerskloof main substation is operating at 108% of its capacity and the transformer has been identified as having an extreme risk profile (CCT, 2010i). In spite of this, the replacement of the Tamboerskloof substation transformer has been budgeted for in 2011/2012 (CCT, 2010h). This demonstrates that although the reliability of electricity provision has increased with the upgrades made to the Foreshore station, there is still a capacity shortfall due to ageing infrastructure. While there is currently adequate capacity until at least 2022, the projections are based on historical load growth. Any additional unplanned development that occurs, such as Culemborg, the Cape Town Station Revitalisation 2030 or the Cape Town CCPGRI, will therefore have to be addressed by establishing new main substations.

The logic follows that major development within the Central City is reliant on the addition of new substations that will be able to meet the increased demand on the system as in the case of the Green Point Stadium development (Hyde, 2010a). Moreover, and specific to the case of the Cape Town CCPGRI, the financing of such an investment would require funding other than that from the city, as was the case with the Green Point Stadium, which was not entirely funded by the CCT (Hyde, 2010a). These findings are supported by the findings of the infrastructure investigation by Arcus Gibb (2010) for the Cape Town Station Revitalisation 2030. The scale of the development will require investment for the addition of bulk infrastructure systems (Arcus Gibb, 2010).

4.4.2 Water systems

The information for this section was provided directly by the Water Services Department of the CCT. It was collected during a series of discussions and email correspondence with Jaco de Bruyn, the Manager of the Water Services Development Planning branch of the Water Services Department. A preliminary meeting (10/6/2010) was held with de Bruyn (2010a), complemented by the email correspondence (de Bruyn, 2010b). Furthermore, I drew conclusions from both textual and numerical data provided by de Bruyn (2010a); these include: CCT (2010d; 2010k; 2010l; 2010m; 2010n). Additional information was provided by Hanre Streicher (2010a) from GLS Consulting in Stellenbosch, which was complemented by email correspondence (Streicher, 2010b). GLS also provided findings of their research pertaining to the Central City; these include GLS (2010a; 2010b; 2010c; 2010d).

During the process of conducting this research there have been several conflicting opinions and findings regarding the state of water infrastructure in the Central City, which includes bulk water supply and reticulation, and sewerage reticulation and disposal. Water systems are the accumulation of highly interconnected and co-dependent components. These systems are however generally not considered by society, as they are hidden below the ground, out of sight and out of mind. While the energy or electricity challenge is evident to the general public and therefore remedied expeditiously, disruptions of water and wastewater infrastructure are often neglected. Such is the case for Cape Town's water and sanitation infrastructure.

The CCT has for the first time commissioned work from an engineering firm to conduct an investigation into the infrastructure in Cape Town with the intention of developing a Master Plan (de Bruyn, 2010a). The means used to determine the capacity of infrastructure is a test of the hydraulic capacity of the reticulation and bulk system networks (de Bruyn, 2010a). From these findings a model is built which allows one to test existing as well as future scenarios (Streicher, 2010a). This methodology allows the CCT to determine whether the current or future land use complies with the accepted standards with regard to water flow and treatment capacity (Streicher, 2010a). There are however several shortcomings in such an investigation, including the reductionist or tick box approach, which does not encourage a thorough understanding of the infrastructure as a set of networked infrastructures. Moreover, the investigation is conducted by an isolated specialist engineering team which is focussed purely on hydraulic capacity and, as a consequence, the results are incomplete. Despite this, decisions regarding density, land use and development are made based on these findings, which will potentially lead to service disruptions in the future.

Generally speaking, bulk water supply, reticulation, wastewater and sewer networks in the Central City have not been a particular concern for the CCT (de Bruyn, 2010a). In other words, the need for additional new infrastructure capacity has not been urgent. This conclusion is based on current land use, the water and sanitation demand arising from that and projected future land use (de Bruyn, 2010b). This is not to say that the CCT is not concerned with maintaining existing ageing systems, some of which, such as the brick sewer culvert, dates back to the 1800s (de Bruyn, 2010).

4.4.2.1 Bulk Water

The bulk water supply for the Central City is stored in the Molteno Reservoir which is fed by Blackheath and Wemmershoek water treatment works, after being stored at the Tygerberg Reservoirs, via the Paarden Eiland Booster Pump Station (Arcus Gibb, 2008; CCT, 2010d; Streicher, 2010a). Due to the position of the Molteno reservoir, there is sufficient static and residual pressure to ensure the flow of water (Streicher, 2010a). The Central City faces the same challenge as the rest of Cape Town in terms of securing a source of bulk water, discussed in section 3.4.2.2. Furthermore, infrastructure which services this area, like other infrastructure in Cape Town, is in need of maintenance and refurbishment.

4.4.2.2 Water reticulation

GLS, a Hydraulic Engineering Consultancy, is currently in the process of constructing a model of Cape Town's existing water and sewer network (Hyman, 2010c). While this work has not been completed, several of the graphic illustrations were provided for the purpose of this study. An illustration of the existing water network, with diameter of each pipe, peak flow velocities and spare capacities indicated was provided (GLS, 2010a). The preferable flow velocity is between 0.5 m/s and 1.5 m/s and this is the optimum utilisation of the asset. Flow velocity of less than 0.5 m/s is an indication of the underuse of an asset while flow velocity over 2 m/s is over-utilisation of an asset and will require reinforcing (Streicher, 2010b).

After extensive examination of the existing water network, it is evident that, generally speaking, there is adequate hydraulic capacity for additional development based on current land use and projected future land use (GLS, 2010a). On average, the peak flow velocity is by and large below or in between the recommended optimal flow; therefore there is no indication on the diagram to cause particular alarm in terms of capacity. The questions asked for this particular study are, however, pertinent to the hydraulic capacity of the pipes and answered by measuring the water flow at different times during the day (Streicher, 2010a). In this way, several critical elements which could potentially assist the investigation in providing significantly more thorough conclusions are

excluded. These include the age and type of pipes used, the degree of 'packing', a result of sediment build, as well as the ecological impacts of conveying the flow of water in such a manner. The neglect of such elements are evidence of the conventional approach to an infrastructure investigation conducted by engineers acting as consultants, as well as the method or means to extend utility services in the future.

Moreover, the conclusions drawn from GLS's study will be used to develop a master plan for water distribution for Cape Town as a whole. In the case of the Central City, while the water distribution in terms of hydraulic capacity is sufficient for the current and projected land use, the challenge of ageing infrastructure remains acute and will at best be addressed reactively. Furthermore, the findings of this work are not consistent with the concerns regarding anticipated reticulation constraints expressed three years prior by City Spatial Planning and Urban Design Department (CCT, 2007f).

4.4.2.3 Sanitation System

Conventional waterborne sanitation systems are used in the Cape Town Central City as the means of disposing of sewage. All effluent gravitates to the Green Point Sea, located at Mouille Point beachfront outfall, via the reticulation system and finally the major trunk sewer (CCT, 2010d). Screened sewage reaches Green Point Sea Outfall, and is conveyed to a point 1.7 km into the sea through a submarine pipeline (Taljaard, 2006). Screening sewage removes 550 m³ of solid waste per annum from effluent (CCT, 2010d). This wastewater treatment works has the capacity to treat and dispose of approximately 40 Ml/day (Streicher, 2010a). The permitted effluent volume is 10 950 Ml/annum and it is currently operating at 80% of that capacity (Streicher, 2010a). None of the effluent is re-used (CCT, 2010d). Certain electrical and mechanical components of the Green Point pumping station require upgrading and refurbishment to ensure the continuous adequate running of the plant. Within the Bulk Waste Water Treatment Works budget, R 5 000 000 has been allocated for upgrading of treatment pumps over the period 2010-2020, and is to be spent in 2011/2012 (CCT, 2010k).

The several pump stations located within the Central City and servicing the surrounding area include the following: Coen Steyter which has the hydraulic capacity of 10 l/s; Long Street which has a 65 l/s hydraulic capacity; Jan Smuts which has a hydraulic capacity of 107 l/s; Pirrow Street station has 13 l/s capacity, New Market has 10 l/s; and Tollgate has 30 l/s hydraulic capacity (GLS, 2010b). While this is evidence of the capacity of these systems, information regarding the capacity at which they are currently running is unavailable.

Similar to water reticulation systems in the Central City, evidence suggests there is little cause for alarm in terms of the capacity of wastewater reticulation. GLS provided information regarding the existing sanitation network, with the pipe diameter indicated, as well as spare capacities in the existing sanitation system (GLS, 2010b; 2010c). Sanitation systems are based on the measurement which allows 30% additional volume for wet weather infiltration; these spare capacities therefore exclude the 30% and are measured in dry weather (Streicher, 2010b). An examination of the sanitation reticulation system indicates that across the board the infrastructure has large relative spare capacity. Reticulation pipes have a spare capacity of approximately more than 90% (GLS, 2010c). Larger feeder sewer lines have on average a relative spare capacity of between 90% and 60% (GLS, 2010c). There is evidence of a few sewer pipes running at or beyond their capacity, but disruptions are addressed as required. Therefore, while ageing infrastructure in the Central City is a challenge, the capacity of the infrastructure at present is sufficient to cope with the future projected demand according to current land use.

Note has not been taken, however, of the potential erosion of sewer pipes as a result of the toxic methane gas emitted from effluent, which has in the past resulted in significant disruptions of infrastructure. Furthermore, and pertinent to the Central City, there is the packing, or a build up of sediment that occurs within the pipes as a result of the expansion of the food and catering industry; in particular the Central City has a strong presence of guesthouses and hotels, which can cause an increase in blockages as a result of an increase in the amount of fats and oils being discharged into the system. An increase in antibiotics in the systems during certain seasons also results in blockages.

While the capacity of this infrastructure is sufficient for projected development according to current land use, 'projected development' as considered by the CCT Water Services Department, has not taken into account the tremendous development that will arise from the CCPGRI in conjunction with the Cape Town Station and other developments mentioned in section. These developments will place a significant additional demand on existing networked infrastructures. The Athlone wastewater treatment has some redundant capacity, which will be used by the Central City once the Green Point outfall is beyond its capacity; however, this will only be able to support a small percentage of the additional requirement (Streicher, 2010a). In light of this, entirely new bulk infrastructure to ensure sufficient hydraulic capacity will be required to service the additional development demand.

It should be acknowledged that the study undertaken by GLS under the direction of the CCT Water Service Department, deliberately excluded the potential for 'mega-development' within the Central

City (Streicher, 2010a). This indicates reluctance from the CCT to develop and increase the population density within the Central City. Furthermore, this is contradictory to the suggestion of the Draft Land Use Change Management (CCT, 2010g) currently under construction. Nonetheless, the model being constructed by GLS makes it possible to calibrate numerous future scenarios and draw conclusions regarding development requirements (Streicher, 2010a).

The wet services report constructed by Ubunye Engineering Services (2009a, 2009b) for the Cape Town Station Revitalisation 2030 provides an extensive examination of the possible sustainable options for the development. The approach used reveals a concern for the capacity of water and sanitation systems, as well as the ecological impact of conventional infrastructure. This is reflected by the Arup's (2009) Strategy Guidance report which uses a framework of sustainability through which suggestions are made. These reports demonstrate the importance of adopting sustainability principles within infrastructure design.

4.4.3 Solid waste

While solid waste is generated and collected from within the study area, it is removed to site beyond the study boundary and therefore isolating infrastructure in the Central City is both a challenge and has little value. However, solid waste removal and disposal systems provide the ideal scenario from which one could consider the reality of networked infrastructure systems which are configured in a linear fashion. Disposal of solid waste is dependent on a set of interconnected infrastructures, including landfill sites, transfers stations, transport vehicles and roads, which enable disposal. The means of Cape Town's linear disposal was demonstrated in section 3.4.2.3. It was demonstrated that solid waste generation is significant in Cape Town and there is currently little airspace available to meet the disposal demand. Accumulation of waste results in contamination and pollution, and the CBD has been identified as a 'hot spot' for air pollution as a result of a high concentration of particulate matter (CCT, 2005). It is shown that 98.24% of households in planning district A have regular waste removal services (CCT, 2007e).

4.5 The future of infrastructure in the Central City

These findings demonstrate that the addition of bulk infrastructure will be required for the provision of electricity and water and sanitation services for development expected on the scale envisioned by the CCPGRI in conjunction with other potential developments mentioned. Furthermore, while there is sufficient hydraulic capacity in terms of water and sanitation services, the challenge of ageing infrastructure is ever present. This scenario is similar for the case of electricity infrastructure in which distribution and transmission could be constrained by equipment near the end of their lifecycle, requiring replacement. September (2010) from Arcus Gibb, explained how infrastructure

investigations are usually conducted; the chief question is whether investigations consider the 'capacity' or conduct an 'assessment' (September, 2010). While the former notion of capacity is investigated, the latter reference to assessment is neglected. An assessment includes the condition, make up, and lifecycle of the particular infrastructure as well as the original use intended, based on land use and zoning assessment (September, 2010). Therefore, the lack of a thorough interrogation into the historical usage of infrastructure, intended capacity and use, current use and capacity, and infrastructure material makeup has contributed to the deterioration and ageing of critical infrastructures.

The deterioration and ageing of critical infrastructures is further exacerbated by the fact that conclusions are drawn based on the concept of 'current and projected land use'. Infrastructure and utility service departments plan for future infrastructure provision by predicting future land use, using the current land use as a baseline for projection. Infrastructure in the Central City was constructed for a particular purpose at a particular point in time. Renovations and the altered use of spaces throughout the Central City have however changed that particular purpose, which influences the demand on infrastructure in the Central City. Therefore the pressure on ageing infrastructure will be exacerbated without a comprehensive assessment of infrastructure in relation to land use and demand for resource flows.

In an analysis of a series of planning documents with the view to determine the future development areas, GLS located and illustrated the planned areas for future development of Cape Town (GLS, 2010d). GLS consulted the Cape Town Spatial Development Framework and Land Designation Study and gathered information from CCT departments including the Housing Department and from various district planners (Streicher, 2010a). This map has been used to develop a master plan for the Water Services department for the whole of the Cape Town Municipal area (Hyman, 2010c). An examination of this map indicates that there has been no recognition that **significant** or multiple developments, which would lead to an increase in density, will occur in the Central City. Based on this conclusion as well as an examination of the 2010/2011 to 2012/13 budget allocations from the various departments, it is evident that no plans are made for major bulk investment and upgrading within the Central City, bar the provisions made for the reactive approach seen in the past (CCT, 2010f; 2010h; 2010k). This is reiterated by the fact that a CCT employee and consultants working for the CCT admitted, on separate occasions, that if large-scale development occurs, entirely new bulk infrastructure systems will be needed (Hyde, 2010b; Streicher, 2010a).

The map created by GLS (2010d), however, neglected the development intent prescribed by the vision of the CCDS (Southworth *et al*, 2008) and the CCDS Development Guidelines for Land Use Management (CCT, 2010g). This latter document is the land use component of the CCDS, which draws on policy and strategy documents for the Central City as well as the broader Spatial Development Frameworks and District plan for Cape Town (the latter two are still in their consultation processes) (CCT, 2010g). The specific intent, aligned with these policies, is higher density around public transport nodes and a focus on mixed use development which increases the residential population of the Central City (CCT, 2010g). In this way there is an explicit strategy from the CCT, as expressed in policy and frameworks, for high density mixed use development. This intent, however, is not reflected in infrastructure planning for the Cape Town Central City.

It is evident that there is an inconsistency between how the various actors who influence socio-technical systems consider long-term planning. There is a definite lack of co-ordination between strategy and implementation of long-term infrastructure investment plans across various departments. This is a symptom of the fragmented nature of service delivery and planning departments. The CCT the Spatial Planning and Urban Design department is responsible for the future planning for Cape Town from a spatial perspective through the Spatial Development Framework (SDF) (Irrgang, 2010). The Urban Design department, on the other hand, has been involved with constructing the development intent, through the Land Use Management strategy for the Central City; however, the mandate of the Zoning department is to determine the particular land use (Irrgang, 2010). These departments form part of the Strategy & Planning Directorate, which informs policy and strategic frameworks. At the level of implementation there is little engagement with these 'strategic' documents – evidence of a disjointed approach to development.

Currently numerous high level plans, which have the intention to direct the type and trajectory of development within the Central City, are being produced. Interestingly though, these plans have not been developed in consultation with service and utility departments of the CCT. It is however at the level of delivery and implementation where tacit knowledge regarding the infrastructure systems is most highly concentrated within individuals who have been part of the system for an extended period of time, in some instances decades. This unexplored resource would contribute to the development of a viable plan for long term infrastructure development. Without an integrated approach, however, infrastructure investment will remain ad hoc and disjointed.

4.6 Chapter summary

The nature of infrastructure planning has led to a situation that renders development, as envisioned by the CCPGRI in the Central City, inhibited by bulk infrastructure capacity, which

requires major investment. In light of this, consideration must be given to the arguments made in Chapter Two: Literature Review . Due to the ecological impact of development and the extension of the linear metabolism of the urban system, there is a rationale to either halt economic growth and development or decouple economic growth and development from resource use. In the case of the CCPGRI and in most other cases in the South, development will continue in the hope of contributing to the resolution of a series of socio-economic issues. Ecological constraints illustrate that investments in socio-technical systems should use decoupling as the framework to ensure efficient use of resources. This is the logic of the sentiments expressed in the *terms of reference* for the CCPGRI, which expresses the importance of investment in strategic urban infrastructures to secure the approval of developments in the future.

The CCPGRI is therefore an opportunity to reconsider seriously the way in which urban infrastructures are conceptualised. This not only includes energy, water and sewer systems, but also solid waste management, mobility within the Central City and IT infrastructure. The reconsideration of urban infrastructures, stimulated by the CCPGRI as a product of an SOIS, creates a scenario out of which a meaningful urban scale socio-technical system transition could emerge. The significant change component would be a decrease in resource consumption, increased productivity and low environmental impact, i.e. decoupling. SOIS's can be interpreted as the framework through which decoupling can be realised, using socio-technical systems as the intervention point. When trying to understand a system change such as this, which is based on the principles of sustainability, it is useful to refer back to SOIS's from the perspective of 'transition literature' and the multi-level-perspective (MLP).

Chapter Five: Examining Cape Town's Potential

5.1 Introduction

The framework of the MLP, which includes three levels which are the macro, meso and micro levels (Geels, 2002), offers a means through which the Cape Town CCPGRI can be analysed as niche innovation that stimulates a socio-technical regime transition. The particular nature of the initiative, attributed to the SOIS from which it emerged, indicates the potential present for the realisation of a transition to a more sustainable urban system using socio-technical systems as the intervention point for decoupling. In section 2.5, however, that Hodson and Marvin (2010a) identify a knowledge gap and therefore posed the question whether cities can be the contexts for purposive socio-technical transitions. In other words, the overarching uncertainty is how a niche innovation develops as an SOIS to a point where a transition occurs in the reality of dynamic urban socio-technical processes.

It has been demonstrated that Cape Town is fast reaching its ecological thresholds and a case has been made for adoption of the theoretical notion of decoupling. Chapter 4 provided a narrative of the social aspect of the CCPGRI and an overview of the Central City networked infrastructures which demonstrate the complexities socio-technical systems when considered simultaneously. The technical overview of the infrastructure systems in the Central City is the empirical evidence that infrastructure is a constraint to development. This is therefore the rationale for the explicit recommendation for an infrastructure investigation, from which a strategic urban infrastructure plan can be developed, within the *terms of reference*. Responding to Hodson and Marvin's (2010a) question, however, requires an analysis and interrogation of the social process that unfolded between the actors who participated in the CCPGRI. Understanding the dynamic social process will further understanding of the factors which influence the formation of SOIS's and provide insight into the role of urban areas as the context for purposive system transitions. The logic of this argument will be followed by extrapolating the CCPGRI onto the MLP, discussed in section 2.5.4 Through an analysis of the three levels one can notice the potential to realise a breakthrough or 'window of opportunity' as envisioned by Geels (2002) for a system transition stimulated by the CCPGRI at the urban scale.

Lopolito *et al* (2010) provide an interesting methodology for understanding the development process of the CCPGRI. Niche innovations are the starting point from which one can determine the potential for an innovation to mature to the point where it can place adequate pressure on the incumbent socio-technical regime, allowing an urban scale transition to emerge. Understanding the development of the CCPGRI as a niche innovation will provide additional insight into socio-

technical urban scale transitions. Of primary importance at this stage is an analysis of the narrative provided in chapter 4.

This chapter will therefore provide an analysis of the narrative of the CCPGRI, described in section which is then extrapolated onto the MLP at the micro, meso and macro level. The CCPGRI will be examined closely, as a developing niche innovation which has the potential to exert sufficient pressure onto the socio-technical regime level. Furthermore, an attempt will be made to make sense of the process of engagement through which the niche innovation developed.

5.2 Analysis of the Cape Town CCPGRI

A narrative analysis is the identification of key events which result in a particular outcome (Mouton, 2008). Therefore the description in section 4.3 can be understood by mapping the events, or 'triggers', that contributed to the inclusion of the explicit recommendation for a strategic urban infrastructure plan which uses the principles of sustainability as framework, as well as the theoretical notion of decoupling as intellectual rationale. The key events, which correspond with an expansion for each, have been mapped in Table 5.1.

Table 5.1: Key events in CCPGRI

Period	Key event	Expansion
1	<p><u>Cape Town Partnership: Steering Committee Meeting (10/2/2010)</u> Southworth expressed concern regarding the capacity of infrastructure, stating that the conclusions drawn are dependent on an extensive infrastructure investigation.</p>	<p>This statement brought to the group's attention the potential inhibitory role infrastructure could play, as well as the financial implications of such an investigation. Boraine, Makeka and Swilling had an interest in ensuring adequate urban infrastructure.</p>
2	<p><u>CHEC: Brainstorming Session (3/3/2010)</u> The contradictory nature of Spiropoulos's findings, accumulated through a discussion with Arcus Gibb, and Swilling's findings, synthesised from personal and international research.</p> <p><u>CHEC Follow up meeting(18/3/2010)</u> The presentation of findings accumulated during this period of research indicated that determining capacity and state of infrastructure was a precondition to determining the development potential.</p>	<p>The way in which these two contradictory findings surfaced, created confusion among participants, ensuring that the issues remained a point on the agenda for future discussion.</p> <p>While this notion had previously been brought to attention by Southworth, the provision of evidence, matched by an agreement to create a 'kitty', provided the platform from which infrastructure could be considered as critical.</p>

	<p>The allocation of the responsibility to construct the document to both Spiropoulos and Swilling.</p>	<p>While the document would be distributed for comment, Swilling's interest in sustainability and adequate urban infrastructure would influence the way in which the <i>terms of reference</i> was constructed, which then influenced the outcome.</p>
3	<p><u>Email correspondence and exchange amongst steering committee</u> (27/3/2010 - 28/3/2010) The lack of reference to infrastructure as a key constraint in the draft document despite a series of correspondence highlighting the importance thereof.</p> <p><u>Public consultation meeting</u> (9/4/2010) The private sector demand for <i>in situ</i> infrastructure.</p> <p><u>Spiropoulos formally allocates the role of co-ordinator to Swilling</u> (12/4/2010)</p>	<p>The lack of reference despite the specific dialogue between Makeka and Swilling (publically) and Spiropoulos and Swilling (privately), brought to the surface the preferences of the group participants. The lack of response to the proposal put forward for a dedicated section for urban infrastructure indicated sufficient consensus had been reached among participants for its neglect.</p> <p>This brought into sharp focus the need to address the issue of infrastructure.</p> <p>The nature of Swilling's interest in the project was the inclusion of a reference to infrastructure constraints and the use of a sustainability perspective to address these constraints.</p>
4	<p><u>Rich interaction amongst participants for final draft development</u> (12/4/2010 – 6/5/2010) Swilling's intention to dissociate himself from the project if the importance of infrastructure investigation which used sustainability as a framework was not explicitly noted.</p>	<p>Concerned by the consistent neglect, Swilling responded to Spiropoulos's perspective that infrastructure was the responsibility of the CCT. Swilling, using both his and Pieterse's name explained his position. Spiropoulos reacted to information from Swilling and responded by making explicit reference to infrastructure as a constraint to development within the Central City, and the potential for inhibiting the fruition of the project</p>
5	<p><u>Formal handover meeting</u> (17/5/2010) Confirmation of the findings of the steering committee regarding infrastructure.</p>	<p>The MEC confirmed the importance of a Strategic Urban Infrastructure Plan, stating a thorough investigation was the foremost priority for the realisation of the project. Thus the groups finally established a general consensus.</p>

5.2.1 An examination of the development process

The triggers that have been extracted from the case, are those which led to the recommendation by the steering committee for the development of a strategic urban infrastructure plan. While these triggers provide insight into the sequence of events that led to an outcome, additional value is added through the expansion of processes that allow for the emergence of that outcome, using the theoretical notions of *sensemaking* and *leadership*, as well as reference to the role of the *minority influence*. In other words, an exploration of the interaction between participants assists the endeavour to determine what influences the development of SOIS's. While there are several components which contribute to this project, what follows will only exhaust the element of urban infrastructure.

Reaching a degree of consensus on the importance of investigating strategic urban infrastructure from a sustainability perspective, and including this as explicitly noted point within the *terms of reference*, was not easy. The process which unfolded was indicative of the challenges experienced when attempting to determine common ground amongst actors within a particular network (Hyman, 2010c). The vision, or overarching goal, for this initiative by the Provincial Government is the use of public assets as a means of leveraging private sector investment and therefore realising the revitalisation and regeneration of the Cape Town Central City. While the vision is clear, it is a loaded statement which can be interpreted in numerous ways by the various participants. Expectations vary, and therefore there is the question of what 'regeneration' means to each participant and how it is to be achieved.

The theoretical notion of sensemaking provides a means to understand why our expectations differ and how they may be altered. Sensemaking offers insight into the way in which, as individuals, we endeavour to, literally, make sense of a particular scenario through **interpretation** (Weick, 1995; emphasis added). Weick (1995) contends that the process is reflexive by nature, as people impose past experiences, or what they believe in, onto a current event, thereby framing their understanding of occurrences in the world. The frame represents interactions from the past, out of which connections are made to certain recognisable cues that are experienced in the present. Meaning emerges from the construction of a relation between the past and present (Weick, 1995). In this way, an individual extracts cues from a flow stimulus or information, through the recognition thereof and uses them as a point of reference to simplify and interpret a situation. The actors present within the CCPGRI system each have varying frames of references from which they construct meaning.

Weick (1995) explains that sensemaking, and therefore our frames of reference, are embedded in identity construction. Identity is constructed and constituted through a socialisation process in which interactions inform one's frame of reference. This pertains to the ideology, values, morals and ethics of an individual. Numerous different encounters accumulate in each actor participating in the project and, consequently, become embedded as their frames of reference for the interpretation of stimuli. The socialisation process of an individual will influence how circumstances are interpreted, as well as the environment or context that is enacted or created by the individual (Weick, 1995).

Each participant included in this initiative has a different frame of reference for what the 'right' course of action would be for the construction of the *terms of reference*. Whether their expertise lie in institutional arrangements, inherent knowledge of the City's development process, the political arrangements, Cape Town's urban planning structure or the ecological constraints present; all their previous experiences influence how they interpreted the 'goals' of the CCPGRI. Due to Spiropoulos's vast experience in the field of property development and management, he was selected as the lead consultant, and was able to outline what had to be accomplished to fulfil his contracted mandate. In this way he not only responded to the environment in which he was embedded, as the lead consultant for the project, he also constructed, or as articulated by Weick (1995), 'enacted' the environment in which further action would be taken by the group. This enactment is based on experience. This is similar for all participants within in the project. Boraine reacted to the project from his position as the representative of the property sector; Makeka's role in the Cape Town Station 2030 project influenced his interpretation of events; and Swilling's position on the International Panel for Sustainable Resource Management influence his interest in the project.

Sensemaking occurs through retrospection, in that people can only understand what has been done after the point of action, and in this fashion attention is allocated to cues that have been previously experienced (Weick, 1995). People therefore attempt to understand stimuli in the present by looking back at events from the past; hindsight, however, inevitably forces assumptions about causal relationships and couples complementary events, which lead to a conclusion about an outcome prior to the fact (Weick, 1995). So, through a selection of past experiences, Spiropoulos was able to construct meaning from the cues provided by the WCPG and CHEC, and thus determine what needed to be done to reach the end goal. Coupling past events with current, recognisable cues, however, leads to plausible conclusions as opposed to accurate conclusions (Weick, 1995).

The primary example of this, within the case study, is the general neglect or avoidance of the topic of networked infrastructure as a critical constraint to development in the context of the precarious financial position of the CCT. This is not without reason. Spiropoulos undertook the project work with clinical precision. During the first period, particular emphasis was placed on accumulating information which would allow the formulation of conclusions required to inform the way forward. This approach to the project was outlined by Spiropoulos before he was formally accepted as the lead consultant and therefore from a sensemaking perspective, he enacted his environment in order to collect the necessary cues, from which he could create meaning for the context of Cape Town. His priority was to focus on the public properties and institutional arrangements, while considering the connecting infrastructure to be an isolated component, not relevant within his pre-determined boundary of work.

The cues from Southworth regarding the need for infrastructure investigation before conclusions could be drawn to determine the development potential, and Joubert's suggestion to approach this project in an innovative manner during first meeting at the Cape Town Partnership did not resonate, due to Spiropoulos's pre-determined approach. Rather, determining the institutional and financial arrangements for the release of the properties was considered priority by Spiropoulos and confirmed by Pieterse and Boraine. As the project progressed, Spiropoulos's frame of reference for urban infrastructure was reinforced. Mohammed's comments about infrastructure in the Central City indicated that it had been upgraded and thus did not require significant attention within the *terms of reference*. Furthermore, this reinforced Spiropoulos's belief that municipal authorities were responsible for the removal of constraints, be they zoning or infrastructure.

There are two possible arguments that could be made, using the theory of sensemaking, to understand Spiropoulos's perspective. On the one hand, Spiropoulos's previous involvement with the CCDS (Southworth *et al*, 2008) and the complementary Infrastructure Investigation (Arcus Gibb, 2008) could have led him to believe that the capacity of infrastructure in the Central City was adequate for the proposed development. This reflects the property of plausibility, in that Spiropoulos coupled a past event with a recognisable cue. On the other, urban infrastructure constraints have historically been resolved via the extension of infrastructure systems without serious concern for the ecological implications and, in some instances, the financial implications. A case in point was demonstrated in chapter 3. When infrastructure was conceptualised in this 'consultant'-based approach, the meaning created would lead to the plausible conclusion that an extension of the systems would resolve constraints and could be dealt with during the implementation phase of the CCPGRI.

After observing the approach to the project during the first period as a whole, there is value in understanding the role of leadership within a social system such as this. While, as individuals, we attempt to make sense of unfamiliar and uncertain situations, Heifetz (1995) shows that it is also during times of unfamiliarity that leaders are sought out to provide solutions, and authority is bestowed upon them to take action and implement such a solution. As individuals, we are socialised by the 'voices', if you will, to whom we confer power, giving them the authority to influence, fundamentally, our values, beliefs and mores, which we then internalise Heifetz, 1995). This links us to the culture which we belong and adhere to (Heifetz, 1995). Hosking (1997) discusses the process of decision-making and determines that it is based on a series of judgements that are based on individual values and beliefs, about the casual relations between actual and potential events. In other words, decision-making à la sensemaking.

It is in this capacity that leadership and sensemaking converge; we make sense of stimuli by recognising cues that stem from our identity, while our identity can be influenced by an innovative or visionary leader (Gardner, 1996). Leaders are individuals who, through direct or indirect means, significantly influence the "thoughts, behaviours, and/or feelings of others" (Gardner, 1996:6). Leadership can therefore play a significant role in mobilising societies and individuals around a common purpose, alternative to that which is embedded in their ideology or culture, and thus allow for a construction of new meanings during sensemaking processes.

The relevance of leadership within an analysis of this kind is the contribution it makes towards identifying the nature of a particular problem or challenge and the potential to find resolutions. In the context of the CCPGRI, the Provincial Government approached CHEC in the hope of developing a programme of action that would allow them to obtain their goal of using public sector assets as a means to leverage private sector investment and thus regenerate the Central City. Spiropoulos was elected as the leader to whom power was given to determine the *terms of reference* for the way forward, under the guidance of the steering committee identified by CHEC. However, during the first period, the pre-determined approach – to accumulate *certain* information – echoes what Heifetz and Linsky (2002) refer to as an approach used in the instance of a technical problem. In the case of a technical problem there is a general consensus or understanding regarding the crux of a problem and the consequential action needed for the resolution thereof through the application of 'know-how' present within a system (Heifetz & Linsky, 2002). The use of this approach therefore neglects the inclusion of alternative perspectives and leads to 'non-contingent reinforcement' of responses to certain cues, in an attempt to discover some absent structure through invention and a trade-off between accuracy and plausibility (Weick, 1995).

This can, potentially, be avoided if the problem or challenge is approached using what Heifetz and Linsky (2002) identify as adaptive leadership. In the case of adaptive challenges, the nature of the problem is unclear, rendering the resolution thereof limited. In these circumstances, it is required that a leader is able to embrace the complexity of adaptive challenges by working with various stakeholders to realise an adequate change or solution through experimentation and discovery (Heifetz & Linsky, 2002). Through a process of shared responsibility and interactions with stakeholders, a new pattern of thinking emerges to alter one's values and thus prompts a change in behaviour (Heifetz in Benington & Turbitt, 2007:383-38).

During the second and third period of this project it became evident that the potential constraints to the fruition of the project were not as easily grasped as previously thought, and additional research was required. While the technical aspects of how the project would be carried forward were resolved, the additional interaction amongst the group brought back into focus the question of infrastructure capacity in the Central City. Furthermore, the tactic adopted for problem solving shifted from a technical to an adaptive approach, as evident in the more open-ended and less structured manner that allowed greater participation from the steering committee.

In the case of the distorted nature of adaptive challenges, adaptive leadership offers an opportunity to engage with a challenge, discover the critical elements and experiment with potential solutions. When a goal or solution is uncertain, experimentation and learning enables the attainment of the insight to know what should be done in a particular situation (Grint, 2007). Grint (2007: 237) argues that this involves taking initiative and action which will direct the process in a particular direction; while it might not be the right direction, it will further one's understanding of the situation, encouraging and stimulating further innovation in uncertain contexts. Capra sees the benefits of this approach; he identifies leadership as creating adequate spaces and conditions for "...facilitating the emergence of novelty..." (Capra, 2004:122). In this way, the authority bestowed on a leader can be transferred by them to other stakeholders through facilitation, consequently empowering them and giving them a share of the responsibility.

Furthermore, adaptive leadership can be understood from Hosking's (1997) perspective. She describes leadership as the process of the organisation of influential acts, and emphasises the structuring of interactions and relationships. In this way, adaptive leadership enables what Hosking (1997) identifies as networking, which gives the participants a better grasp of core problems and how to then transfer this understanding into implementation. Furthermore, networking reveals contradictions and distortions, according to Steinbruner (Hosking, 1997), and promotes feedback processes which assist in determining the most viable solutions to problems (Hosking, 1997:309).

Both the transferral of responsibility and an increase in networking were evident during the second period, in which intense research was carried out in a short space of time to resolve the contradictory interpretations of capacity of infrastructure that were in place. Swilling and I, albeit in different contexts, took a share of the responsibility and conducted independent research to understand the 'infrastructure contradictions' in an attempt to reveal distortions. The information and knowledge accumulated from various sources, through a process of interaction and networking, were used in a credible manner at the following meeting, which allowed for the emergence of a novel idea. The general comments made by Spiropoulos at the first CHEC meeting regarding the state of infrastructure were crowded out by Swilling's comments. In addition, information about the implications for infrastructure without the financial means to conduct an appropriate infrastructure investigation, contributed to the emergence of a new pattern of thinking. New information therefore created a way to understand the challenge of constraints and develop a viable solution. The agreement from Borraine and Makeka, both significant actors in their own context and field of expertise, allowed for creation of an informal coalition through which power was indirectly transferred to Swilling, who thereafter played a more significant role in the construction of the *terms of reference*.

Capra (2004:123) contributes an additional argument for the benefits of networking and feedback processes. As networks are built up, the degree of connectivity increases and consequently amplifies the voices of those usually drowned out by dominant actors. These voices initiate a new discussion which would not have emerged originally, leading to a healthier learning environment. This phenomenon is evident in the third period, in which levels of interaction increased among the steering committee for the production of the *terms of reference*. Each member contributed learning points from their own sets of experience through robust engagement, allowing for a thorough interrogation of the end product. Robust and urgent interaction furthermore encouraged a more explicit approach to expressing concerns to the way in which the infrastructure question had 'not' been addressed. An assertion of this kind therefore reflects the opinion or 'voice' which had not necessarily been drowned out, but neglected.

Furthermore, the network was extended through the process of public participation during which a number of insights and questions not been previously considered were revealed. In this way, the process mirrored that of an approach used when trying to resolve adaptive challenges. The introduction of new stimuli from participants, each with their own frames of reference, contributed further to reaching more accurate conclusions. Interesting links became more apparent at the public participation meeting when applying the theory of sensemaking to the meeting.

Throughout the process, Spiropoulos erred on the side of caution when determining whether to include the urban infrastructure within the *terms of reference*. However, a historical relationship between the private and public sector was revealed. During Spiropoulos's first informal meeting with members of the private sector, there was a desire to learn how to package the development opportunities to earn the maximum financial return from the private sector. From this point on, there were hints, at the meeting with the Province and the CCT, that Spiropoulos was attempting to secure support from the private sector by meeting the private sector's demands. It was, however, revealed at the public participation meeting that the private sector expected both physical and social infrastructure to be provided prior to their investment commitment. In this way, an additional argument can be made for why the question of infrastructure was approached in such a manner. The inclusion of the need to investigate infrastructure, within the *terms of reference*, as a significant constraint that requires private sector investment, could potentially alienate potential private sector investors. This reflects what Wieck (1995) identifies as construction of an absent structure through the 'non contingent reinforcement' of an individual's response to stimuli.

The learning that emerged from the interactive process of public participation, encouraged additional engagement between the steering committee for the development of the final edited version of the *terms of reference*, using an adaptive process of discussion and negotiation. The period shortly after the public consultation meeting was characterised by creativity during the process of producing the final version of the *terms of reference*. While the interaction and networking amongst participants account for the particular outcome, of more interest is the limit of their conclusions. The presence of a higher degree of interaction could have resulted in a far more progressive *terms of reference* through a process of knowledge facilitation. Furthermore, at this time the power to coordinate the construction of the final document was formally conferred to Swilling, providing him a platform from which his 'voice' could be heard.

An interesting offshoot from the discussion about adaptive leadership, is the recognition of the minority voice within a system of actors. De Vries and De Dreu provide an introduction to an influential work which discusses *Group Consensus and Minority Influence* in response to the lack of attention to the "...processes by which groups change and innovate" (2001:1). This work pays tribute to the role of minority factions in society in stimulating change in the majority through persuasion or inspiration, thus leading to the recognition of unconsidered perspectives. The discussion uses Moscovici's conversion theory which postulates that if a minority asserts an opinion, alternative to that of the majority, both **consistently** and with **confidence**, the majority will attempt to understand that opinion, due to the emergence of a cognitive conflict brought on by the said deviant position (De Vries & De Dreu, 2001; emphasis added). As individuals adjust their

attitude, they validate the alternative opinion (De Vries & De Dreu, 2001). De Vries and De Dreu (2001) illustrate that this validation process is delayed, as there is a degree of reluctance from the majority to align themselves with the minority. Furthermore, new ideas need to be formed.

This is clearly the case when considering the engagement between actors regarding the question of infrastructure capacity for the Central City. Swilling can be identified as the minority voice that consistently and with confidence asserted his opinion concerning infrastructure as a major constraint to the realisation of the project. While there are indications throughout the project that the participants of the steering committee agreed with his argument, no-one explicitly aligned with his perspectives. More plainly stated, no other members consistently argued for the recognition of infrastructure as a critical constraint to development. Makeka is an exception and agreed with Swilling; however, he was not a consistent force for change.

It was only during the fourth period of the project that infrastructure was noted as a constraint. Swilling was able to sway Spiropoulos by indicating that he would disassociate himself from the project and explicitly stating convincing evidence, to which Spiropoulos allocated attention. Weick (1995) provides the rationale for this change in attitude from Spiropoulos. Sensemaking is an ongoing process which has no definite start or end point. Flows of information or stimuli are continuous, but if a scenario encountered is unfamiliar, this flow is interrupted (Weick, 1995). Unfamiliarity and uncertainty regarding a novel or salient set of cues 'shock' people into attention as a result of necessity, opportunity or threat (Weick, 1995). Swilling shocked Spiropoulos into attention. Circumstances which lead the initiation of sensemaking, include information load, an increase in the level of complexity or the presence of turbulence and instability (Weick, 1995). In this way, prior to Swilling's threat, Spiropoulos had not recognised the cues regarding infrastructure as a key constraint to development. Potential instability forced Spiropoulos to recognise the argument put forward by Swilling and make the necessary changes to his perspective. Furthermore, the general consensus achieved during the final meeting for the submission of the document is an example of a validation process that occurred from the participants.

5.2.2 Section summary

The value of using the perspective of the minority voice is that it can be coupled with sensemaking. The introduction of an unfamiliar or novel opinion or, in the language of sensemaking, a cue, may be overlooked because it is not recognised by an individual. Through consistent assertion, the interruption of the flow of information will 'shock' the individual or group into allocating the cue sustained attention, due to cognitive conflict experienced. Sustained attention allows for the acknowledgment of a novel cue and the consequential attempt to create meaning by connecting

the cue to content from a frame of reference, which leads to potentially plausible rather than accurate conclusions. Sensemaking is an ongoing process, therefore the content of our frame of references is constantly changing. The factors that determined the formation of a SOIS in this instance, was the presence of numerous frames of references, provided by a multiplicity of participants with various sets of expertise, which made it possible to draw more accurate conclusions through interaction and networking, enabled by an adaptive leadership approach. In this way, adaptive leadership, with the capacity it has for the provision of space which allows the emergence of novel content, is a valuable option for problem solving and sensemaking.

Therefore, the CCPGRI, within the context of understanding urban socio-technical transitions, has offered an opportunity to understand how stakeholders engage to reach a particular outcome. From this analysis, it is possible to understand how alternative decisions can be made for development strategies through a process on knowledge exchange via networking. If the goals envisioned in the *terms of reference* are to be achieved, an adaptive leadership approach is required, that allows experimentation and exploration of novel ideas and pays attention to minority perspectives in networking processes. The innovation system therefore developed into a SOIS, due to rich networking between participants who represented a sustainability perspective. The high quality of networking, however, was the result of deliberate intervention from an intermediary, as opposed to a spontaneous emergent characteristic of the system; this will be discussed in section 5.3.4 From this departure point one can begin to understand the social processes that create SOIS's, as well as the implications for socio-technical system transitions using the MLP.

5.3 The multi-levelled-perspective

It has been demonstrated that the process leading to any particular outcome is the result of complex social interactions amongst a multiplicity of stakeholders, who contribute a set of unique experiences to the system. While an analysis of the process has been provided, it is not sufficient for drawing conclusions for further understanding of purposive urban transitions. The CCPGRI, as an SOIS, now needs to be placed in the context of a socio-technical system and therefore extrapolated onto the MLP framework. The looming questions that remains unanswered are what is needed to ensure a transition and how this is to be achieved.

5.3.1 The CCPGRI as a niche innovation

The potential for a window of opportunity to emerge is greater when there are numerous innovations occurring simultaneously, which eventually break through to the meso level. Cape Town, over the past decade, has experienced a surge in the number of possible opportunities for innovations for sustainability. These are in the form of policy documents and by-laws from the

CCT, research for sustainability interventions undertaken by the CCT in partnership with academic institutions and/or private consultants, financial investments from the CCT and the private sector in SOIS's, greater presence of a sustainability agenda within the context of Cape Town in research and academia, as well as strengthened networks working towards a central goal of sustainability. The multiplicity of these (micro) niche innovations combined has the potential to assert the appropriate amount of upward pressure, simultaneously with (macro) landscape downward pressure, to create the window of opportunity for regime change. The CCPGRI will be discussed as a niche innovation which contributes to regime change. An analysis of the development of the niche innovation will be conducted to further understanding of urban socio-technical transitions.

The CCPGRI, as a niche innovation, offers an opportunity to construct a strategic urban infrastructure plan for city-wide urban infrastructure development which is conscious of the approaching ecological constraints and urban population variances – this being the foremost topic within the spatial context of an urban environment. It has been established that key events during interactions between the participants for the duration of the CCPGRI acted as triggers for the inclusion of a recommendation to conduct an infrastructure investigation, using the lens of sustainability. This recommendation is an unconventional outcome when compared to the business-as-usual approach to consultant-based project planning, during which networked infrastructure systems are taken for granted, neglected or considered as permanent technical fixtures. This line of argument illustrates the critical role that decision-makers play in the formation, functioning and future development of an urban context. Therefore, attention has to be paid to how actors within urban systems are influenced by development or influence development.

If the CCPGRI and its participants are considered as a system under examination, cognition of the novel outcome makes this an SOIS, due to the inclusion of sustainability principles. From this departure point, the niche innovation will be placed within the MLP. The overarching spatiality of this particular system within the MLP is the urban context of Cape Town.

5.3.1.1 The maturity of the CCPGRI

The value of the MLP as a framework can be explained by referring to the work of Lopolito *et al* (2010), who elaborate on the role and development of niche innovations for socio-technical system transitions. For clarification, a socio-technical system transition should be considered system innovation. The emphasis on niche innovations stems from the technique of Strategic Niche Management which aims to encourage the maturity of radical innovations. Maturity is a precondition for the realisation of sustainability-orientated regime transitions (Nil & Kemp, 2009). Lopolito *et al* (2010) use this framework to understand why some innovations manage to create a

window of opportunity while others do not, despite their apparent superiority in comparison to incumbent socio-technical regimes. Three niche mechanisms have been identified: willingness, power and knowledge, which are described as the preconditions for niche innovations which create a window of opportunity once they reach a certain level of maturity.

5.3.1.2 Development status

Lopolito *et al* (2010) explain **willingness** as the establishment of common ground amongst stakeholders, whose expectations of a new or alternative set of knowledge converge to allow for the decision by actors to be active participants within an innovation niche. The establishment of a common perspective and expectations is, however, a significant obstacle to overcome, and thus the generation of willingness requires significant effort on the part of those introducing a novel body of information or endeavour. While managing expectations is critical, it is furthermore as important to articulate them appropriately. Expectations act as the incentive for participation from additional actors and resources at an early development phase; create the terms of reference for 'design process'; and contribute to coalition building amongst actors who have common expectations (Lopolito *et al*, 2010). The strongest incentive for the willingness to invest time and effort, is supportable evidence of the significance of a new set of knowledge (Lopolito *et al*, 2010).

The participants involved in the CCPGRI expressed willingness to be active in the project. Reaching consensus on all issues was however a more contentious process, due to vested interests of participants. Each player had different expectations, representative of their field of interest or profession. The vision articulated by the Provincial Government was to bring together academics and professionals from the private sector, as well as interested parties from within the public sector to allow for a series of rich interactions that would contribute to a particular outcome. It has been demonstrated that throughout the project lifespan, project expectations were developed and adjusted according to the introduction of new information at different stages. Expectations only converged during the final stage, period 5, during which the group reached general consensus on the way forward. However, as expectations adjusted, the structure of the network which emerged through these interactions also adjusted, due to distribution of power and knowledge, which further impacted on the outcome.

Niche innovation formation within a socio-technical system is reliant on an adequate level of **power**. Lopolito *et al* (2010) argue that actors are required to undergo an 'actual networking process' for an adequate level to be reached. This is particularly pertinent to small actor networks, generally associated with niche innovation, and therefore the identification and presence of powerful stakeholders is critical. "A powerful actor is any stakeholder who brings an 'extra value' to

the emerging network” (Lopolito *et al*, 2010:4). This extra value could be presented in the form of considerable financial resources within a firm, relevant know-how within a public institution, or even providing access to numerous resources. The value of this power is determined by the structure of the network, and although an individual actor (be it an individual or firm) may hold a degree of power, it must be executed through and by the network, which, when sufficient power is accumulated, is a mechanism to manipulate the socio-technical niche process (Lopolito *et al*, 2010). Lopolito *et al* (2010) conclude that it is therefore the presence and distribution of power within a network which influences the niche formation.

The value of stimulating willingness from the various participants becomes evident in the ‘power’ they contribute to a group. This is not to be understood as power which dictates actions, but rather an accumulation of power which leads to a credible endeavour being developed, that can be told in a convincing manner to obtain support, which is critical for the realisation of the Cape Town CCPGRI. Each actor contributed, some extra value; be it the expertise of Spiropoulos for the development of property packages which entice the private sector, the prominent position of Borraine as the CEO of the Cape Town Partnership or the academic capacity of the core steering committee. These individuals represent themselves as well as the intellectual and financial capital of the institutions they are affiliated to. The accumulation of these ‘powerful’ stakeholders creates a force for change, regardless of what that change represents. Change will however be directly influenced by what knowledge is accumulated and how that knowledge is distributed through the network.

Knowledge accumulation is the third and final mechanism for innovation. Knowledge is accumulated through a multiplicity of interactions within learning activities occurring within and between large and diverse groups of actors, allowing the thorough integration and generation of an adequate amount of knowledge (Lopolito *et al*, 2010). Learning processes are however largely informal, as tacit knowledge is shared and transferred through direct communication and experimentation, during which knowledge is internalised (Weick, 1995). As with power, the structure of the network directs the flow of knowledge. In other words, critical to the usefulness of knowledge accumulation is the type of knowledge accumulated and ensuring the appropriate selection, which complements the expectations of actors (Lopolito *et al*, 2010).

The structure of the network created during the Cape Town CCPGRI facilitated informal learning between actors, allowing them to refine their expectations. Through formal engagement at group meetings, as opposed to individual exploration of the project, learning occurred, due to a constant flow of information which was grappled with and then internalised. This process occurred during

formal meetings, as well as interactions during the construction and editing of the document. A social structure allows actors to assert their desires and form appropriate coalitions through negotiation, thus determining the future of the project. Knowledge was therefore accumulated through dense networking processes, with actors, within and beyond the immediate system allowing more comprehensive understanding of the constraints and opportunities for development.

The three mechanisms according to (Lopolito *et al* (2010) are a prerequisite for the development and formation of niche innovation that can exert sufficient pressure on the incumbent regime. This argument is supported by Hodson and Marvin (2010), discussed in section 2.5.4, who make the case that a vision for the future is created through struggle and negotiation. These factors are reflected by Lopolito *et al* (2010) who refer to 'willingness' and 'power'. What Lopolito *et al* (2010) refer to as the mechanism of 'knowledge', can be interpreted as similar to Hodson and Marvin's (2010) notion of the necessity of capacity and capability building through knowledge exchange and learning networks, as managed by an intermediary.

The development of the CCPGRI reflect those crucial factors, illustrated by Lopolito *et al* (2010) and Hodson and Marvin (2010), that make niche innovation development, and thus a possible socio-technical transition, possible. An examination of the process of interaction amongst stakeholders, using the three mechanisms as a framework, allows one to identify certain levels of maturity, represented by the mechanisms, from which one can determine development stage as well as the potential for a successful socio-technical transition. There are turning points in the development process from which one can discern the level of maturity of the niche innovation (Lopolito *et al*, 2010). Lopolito *et al* (2010) classify these turning points within a four stage process. In the first stage, all three mechanisms are absent and there is general indifference to the new body of knowledge. In the second, actors' expectations converge through a process of dense networking, and a general willingness to participate emerges. In the third, a social structure emerges which acts as the frame for the future development of a mature development niche, and in the fourth, communication becomes possible through robust networks which are able to facilitate learning. At this point the niche innovation can be considered to have reached its full maturity and, according to Lopolito *et al* (2010), in its fully developed form the niche innovation meets the preconditions for a socio-technical transition. Hodson and Marvin (2010) would argue that an intermediary intervenes to manage the process by facilitating learning and knowledge exchange.

The process of niche innovation formation is nevertheless unpredictable, and the development occurs due to non-linear interactions which are mutually reinforcing. Identifying turning points within a process is not simple, and slotting events into this framework is not practical for the

purposes of analysis. Using such a framework is therefore limited, due to the omission of feedback loops. More realistically, these mechanisms continually overlap and reinforce one another for the realisation of a particular outcome. Therefore, system innovation is a result of system transitions, influenced at the various levels as changes occur simultaneously at the micro, meso and macro levels of the MLP (Stamm *et al*, 2009). Furthermore, system transitions are multi-actor, involving numerous stakeholders, and multi-factor, in that change is stimulated by a combination of factors – technical, institutional or behavioural (Stamm *et al*, 2009). The non-linear nature of system transitions has been the case throughout the development of the CCPGRI. Expectations were adjusted as the participants' roles changed and new knowledge was introduced. In the last period of the project, the steering committee finally reached a 'general consensus' about how the project should be approached in the future. Even during this final stage, negotiations took place and knowledge was exchanged, providing evidence of the robust structure which had been created during the second and third phase of the project.

Cape Town is at the forefront of developing policies and strategies as well as the successful implementation of projects with a sustainability commitment of one sort or another. These should be identified and exploited for learning purposes to ensure the fruition of the CCPGRI in the second and third phases. The challenge is to identify and create links between these seemingly isolated networks. These will be discussed in section 5.4.3.2. What follows is an overview of the meso and macro levels of the current system. An interrogation of these levels of the MLP, within with the CCPGRI is embedded, offers insight into the socio-technical system. Furthermore, it will demonstrate the potential for simultaneous pressure from the micro and macro levels discussed to stimulate a regime transition.

5.3.2 Socio-technical regime

The incumbent socio-technical regime is represented by the dominant policy, frameworks and approaches to the provision of critical infrastructure within Cape Town. This can be considered as the business-as-usual approach which dictates decision-making with regard to the extension of services for development. The most deeply embedded frame of reference is the priority of providing basic and equitable municipal services to all. The manner adopted is discussed in section 3.3 in which the most efficient way was considered the extension of uniform services across Cape Town. Not only is this a priority, but there is an expression of urgency within South

Africa, as evidenced by service delivery protests¹⁶ across the nation, to extend service delivery, a measure of success for a democratic and equal society.

Furthermore, in Cape Town decision-making for infrastructure investment occurs in a generally ad hoc manner within isolated pockets of various line departments. Infrastructure plans within the various departments are in the form of budget allocations over financial period. These allocations are for maintenance, system disruptions and service extension, based on historical load growth. The plans are thus based on a supply side approach. Critical to the future of sustainable urban infrastructure is the presence of an integrated infrastructure plan inclusive of all infrastructures which convey flows of resources. Infrastructure which is provided to meet a demand does not necessarily have to be uniform, but rather context specific for optimum use.

The challenge in Cape Town is the lack of co-operation, interaction and, therefore, knowledge exchange between departments. In other words, decisions are made within isolated departments and strategic planning is inconsistent with implementation. A strategic infrastructure plan is therefore dependent on decision-making in a horizontal manner, across the various line departments. The integration of decision-making is currently missing.

5.3.3 Socio-technical landscape

The socio-technical landscape is the macro environment in which Cape Town's urban system is embedded. The landscape is the terrain that socio-technical systems exist on and in, and thus provides the contextual conditions which apply pressure on the regime at meso level (Geels, 2002). Factors which could influence socio-technical system transition in Cape Town at the macro level are innumerable and it is not possible to include them all. There are however those that are pertinent to this research and demonstrate what pressure points can stimulate a breakthrough or window of opportunity.

The '**polycrisis**' and the role of cities in the future, as described in chapter 2, provides the overarching context within which decisions regarding future planning agendas should be made. This context provides the overarching pressure which is exerted on the socio-technical regime, constantly challenging existing conditions at the meso level. Furthermore, Cape Town is exploiting vital natural resources, ecosystem services and waste sinks as described in chapter 3. As a result, the city is facing its own *polycrisis* from an ecological and social, as well as economic perspective, placing considerable pressure on the existing socio-technical regime. It has been argued that the

¹⁶ Service delivery protests have been increasingly present in South Africa as the population demands to be connected to socio-economic resource flows.

configuration of networked infrastructures is contributing to the breaching of resource thresholds in Cape Town. This has been attributed to the attempt to create an inclusive society via the extension of a series of networked infrastructure across a vast, previously segregated landscape, in order to redress the historical legacy of poverty and inequality. This has however placed **financial** constraints on the CCT, which further inhibits development; a scenario exacerbated by an unsustainable economic paradigm. These three aspects coupled together act as a component exerting pressure on the current regime. The combination of these pressures can potentially exert the required pressure to realise system transition.

The precarious financial position, while contributing to the pressure on the incumbent regime, becomes an incentive for a socio-technical regime transition at an urban scale. The CCT Department of Economic and Human Settlements wrote a paper entitled 'The Economic Imperatives of Environmental Sustainability' (CCT, 2007d). The paper argues that future economic growth in Cape Town is dependent on the sustainability of ecosystem services and waste sinks, without which attempts at poverty alleviation and employment generation will be fruitless. The findings of the paper were:

- The non-renewable resources needed to service the economy will amount to R18.3 billion every year by 2012.
- Cape Town's vulnerability to oil price shocks will affect the poor most significantly, as the majority of budgets are allocated to oil-related products.
- These costs incurred can be reduced by approximately 30% if solar water heaters are installed in 400 000 of the poorest households in Cape Town.
- The cost effectiveness of providing rainwater tanks to the most affluent households in Cape Town would have been greater than the building of the Berg Dam, and provide an advanced system of sustainable and efficient water use (CCT, 2007d).

These findings emphasise the rationale for investment in technologies which are based on the principles of decoupling: low carbon-emitting and less resource-intensive technology. Herein lies an opportunity for skill development and employment creation within a green technology market. Furthermore, as indicated in the title of the paper, it is imperative to invest in environmental sustainability, as the pressure of the precarious financial position of the CCT is not conducive to a business-as-usual development path using the current socio-technical system.

Furthermore, pressure for regime change at an urban scale is also exerted from a National level in South Africa, as there have been a series of policy shifts which are based on the principles of sustainability. Most significant, is the National Framework for Sustainable Development (NFSD)

which was adopted by cabinet in 2008 (Republic of South Africa, 2008). This framework recognises the unsustainable growth trajectory South Africa is following and the negative influence the current economic paradigm has on the health of ecosystems and waste sinks, which are critical for generating economic growth, poverty alienation and human well-being in South Africa. This is acknowledged within a systems approach to sustainability, in which the economy is embedded in the wider ecosystem (Republic of South Africa, 2008). Through this framework, South Africa makes a commitment to realise sustainable economic growth by decoupling economic growth and poverty alleviation from resource consumption. Five strategic priorities for sustainable development have been identified, they are:

1. “Enhancing systems for **integrated** planning and implementation
2. Sustaining our ecosystems and using natural resources **efficiently**
3. Economic development via investing in **sustainable infrastructure**
4. Creating sustainable human settlements
5. Responding appropriately to emerging human development, economic and environmental challenges” (Republic of South Africa, 2008:10; emphasis added).

These guidelines exert pressure on the current regime due to the obligatory nature of the structure of the framework which is developed in a three phase process, from visioning, to planning to implementation.

Out of this framework, the Draft National Strategy for Sustainable Development for 2010-2014 (NSSD) developed, which is a proposed strategy and action plan for the facilitation of the implementation of visions, priorities and goals laid out by the NFSD (Republic of South Africa, 2010). The strategy includes directing South Africa’s development path along a sustainable trajectory; encouraging behaviour and attitude change; and the restructuring of governance systems (Republic of South Africa, 2010). The action plan has been developed by adapting the strategic priorities identified in the NFSD; they encompass all priorities and are complemented by strategic goals to be realised through interventions and measured by a series of indicators (Republic of South Africa, 2010). While the NSSD is still in the draft stage, it in itself is an adjustment of the landscape environment within which the socio-technical regime in Cape Town will have to adjust, due to the pressure it exerts.

The landscape in which incumbent socio-technical regime is embedded has exerted significant pressure. These pressures force decisive action from relevant stakeholders within the regime;

these actions will be considered a step toward creating a purposive urban context for a socio-technical transition.

5.3.4 The role of the intermediary

The progression of the CCPGRI was managed by CHEC, which can be distinguished as the 'strategic intermediary'. In other words, if CHEC had not played the role of project co-ordinator, the particular outcome, which distinguishes the CCPGRI as an SOIS, would not have been realised. Due to the unique nature of CHEC's organisational structure in terms of its multidisciplinary makeup, it can be considered as the key intermediary that has played the role of knowledge organiser, bringing together various actors and mediating actions of various participants, thus managing the development of the niche innovation. CHEC's influence increased as the project progressed and greater interaction occurred between the steering committee and the lead consultant. This is evident within the three mechanisms identified in section 5.3.1.2. CHEC created the institutional structure through which interactions have occurred between various relevant actors at different scales of governance and within various sectors. The structure of the system created was one that allowed for a free flow of information amongst various networks, thus developing willingness to participate; power within the system; and knowledge.

There is however evidence that in some instances CHEC fell short in fulfilling the role of an intermediary. In period 4, during the final stages of producing the final version of the *terms of reference*, a process of rich interaction unfolded between participants, which can be considered as the moment of maximum creativity. The question that arises is how much more could have been achieved for the development of a purposive urban transition if CHEC had extended that network at that stage to include critical knowledge for a purposeful approach to achieving urban transition.

Critical for the realisation the project goals, is a multiplicity of interactions between actors to ensure the robustness of the network and the extension thereof, and the inclusion of critical knowledge for purposive urban transitions. This requires the extension of learning networks to ensure that actors are able to engage with the potential means for meeting expectations of the CCPGRI. Learning networks, which enable the transition to what Lopolito *et al* (2010) call the fourth stage of development, are currently being set up. The infrastructure investigation of the CCPGRI for the development of a strategic urban infrastructure plan, that is due to take place in late 2010/early 2011, is *envisaged*, by the *terms of reference*, as a process that will draw on areas of expertise from various sectors, which will encourage the maturity of the project. Retaining the inclusion of sustainability principles is however under threat. The conceptual framework (WCPG, 2010c) developed to undertake the CCPGRI Infrastructure Investigation, suggests a conventional

approach will be adopted, thus losing its distinction as an SOIS. While the specifics of this conceptual framework, in terms of the process of its development, the actors involved and terms of reference, are beyond the scope this paper, it brings to attention the importance of indentifying a strategic intermediary to ensure the second and third phase follow direction from the first phase.

The scope of the CCPGRI, however, seems to be outgrowing CHEC as an intermediary, thus bringing to attention the importance of identifying a strategic intermediary or a collaborate institution to extend the capacity of CHEC. An intermediary should facilitate the future development by ensuring the investigation is conducted using the recommendations of the *terms of reference* as a departure point. Badsha (2010) expressed concern that in its second phase the development process of the CCPGRI became more 'technically and otherwise' involved. Therefore, an appropriate intermediary which has the capacity to service the complexities of the CCPGRI, needs to be identified.

An alternative organisation that would have the capacity to fulfil the role of an intermediary to ensure the fruition of the Cape Town CCPGRI is the Cape Town Partnership, discussed in section 42.1. This capacity stems from the current role of the Cape Town Partnership, which is the facilitation of investment within the Cape Town Central City. As a core function, this organisation seeks to "[c]oordinate and facilitate urban regeneration programmes" (Cape Town Partnership, 2010c) in the Central City. The significance of this organisation is its position of influence in terms of directing development in light of the interdependent working relationship with the CCT (Hyman, 2010c).

From a theoretical perspective, the Cape Town Partnership fulfils criteria for activities which characterise intermediaries (Hodson & Marvin, 2009b) discussed in section 2.5.4. The first is the development of a thorough understanding of the particular context, enabling the ability to re-think the local context (Hodson & Marvin, 2009b). The nature of the Cape Town Partnership is such that it has already developed a thorough understanding of the context within which CCPGRI will be enacted, attributed to their mandate of stimulating investment in the Central City through mobilisation of social, private and public resources. Furthermore, through their role in the development of the CCDS, a vision of the Central City has been established, as well as various investment opportunities. The second characteristic identified by Hodson and Marvin (2009b) is related to the governance of spatial transitions. This is significant in light of the social networks, typically built by intermediaries but also located by intermediaries, or self-indentified, positioned within a transition, which should be recognised as part of a particular institutional structure and therefore governed accordingly (Hodson & Marvin, 2009b). The Cape Town Partnership is formally

associated with organisations from within the public and private sector, and the community sector as well as civil society; the CCT, the WCPG, Wesgro¹⁷, and Accelerate Cape Town¹⁸, for example (Cape Town Partnership, 2010d). These characteristics indicate that the Cape Town Partnership has the potential to manage the CCPGRI, and should align its current activities with the CCPGRI to ensure it retains its nature as an SOIS and stimulates a socio-technical system transition.

Retaining a definite link to CHEC is, however, critical. CHEC offers unique expertise from an academic perspective, vital for knowledge generation and extensive learning, beyond that of network interaction. Moreover, Cape Town Partnership does not have a strong research agenda, which limits its possible contribution to policy development in parallel to its current mandate. The lack of a research agenda can be attributed to its informal function as the marketing arm for the private sector within the Central City, which limits decisive action (Hyman, 2010c). The maintenance of such an informal role will diminish the future potential of the Cape Town Partnership as an intermediary, and the Cape Town Partnership should therefore work towards a greater capacity for initiating, facilitating and accomplishing an urban socio-technical system transition.

5.4 Intermediary and network extension

When examining the process that has unfolded through the duration of the CCPGRI, there is evidence of the presence of the mechanisms discussed by Lopolito *et al* (2010) who argue that one can measure the development status of a niche innovation. The development of the niche innovation to its full maturity, however, is reliant on the extension of the network to allow for additional learning to ensure that sufficient capacity and capability is developed. This network extension should specifically focus on the current responses within Cape Town to ecological constraints which are present, as well as learning networks other than those in Cape Town. Therefore, if one used the lens of urban transitions within the framework of MLP, there are a number of niche innovations which have not reached an adequate level of maturity to exert sufficient pressure on the existing regime. The partnership established to drive the CCPGRI in cooperation with the WCPG, the CCT, and the private sector, and with the Cape Town Partnership, in conjunction with CHEC acting, as the intermediary, creates a potential to draw on the knowledge present within existing developing niche innovations within Cape Town and generate enough

¹⁷ Wesgro is the Investment and Trade Promotion Agency of the Western Cape (Cape Town Partnership, 2010d)

¹⁸ Accelerate Cape Town is a private sector initiative which identifies stakeholders within the greater Cape Town City Region with the intention to create a long term for sustainable, inclusive economic growth (Cape Town Partnership, 2010d)

momentum to realise an urban scale transition. What follows is an example of the accessible networks and developing niche innovations present.

It was identified that the CCPGRI is a developing niche innovation which has emerged from an SOIS. Identifying the CCPGRI as an SOIS is attributed to the novel approach to project planning in the Cape Town context and the recommendation for a strategic urban infrastructure investigation that uses the lens of sustainability. Therefore the success of the niche innovation, which stimulates a regime change, is closely linked to the construction of a conceptual framework for the infrastructure investigation which reflects the need to decouple resource use from economic development.

This will be influenced by the ability and capacity to generate a coordinated response to infrastructure planning from various line departments of the CCT which have thus far been isolated. The role of the experience of other urban system transitions, using a similar approach, will contribute to the rich and robust interactions that stimulate innovation within the Cape Town context. To ensure this is realised, international, national and local knowledge networks must be established and managed by an intermediary.

5.4.1 International knowledge networks

There are several networks which could significantly contribute to the appropriate strategic infrastructure development plan. In particular, The Centre for Sustainable Urban and Regional Futures (SURF), which is a centre affiliated with the University of Salford in the UK, conducts research for the purpose of generating knowledge of how the future of urban and regional contexts will be affected by environmental, economic, social, technological and political changes (SURF, 2010). The particular focus of this centre is highlighted under three key cross-cutting themes, namely Governance; Knowledge and Innovation; and Environment and Energy, which are approached in a multidisciplinary manner (SURF, 2010). Numerous publications have emerged from this research including journal articles, research reports and conference papers, which would emphatically contribute to development of an infrastructure framework for Cape Town.

SURF is furthermore associated with Arup, a multidisciplinary consulting firm which encompasses engineering capacity, technical specialties, planners and designers, and is known as the world's 'leading authority' on sustainable design (Arup, 2010). SURF and Arup collaborated to create a Strategic Infrastructure Development Framework to assist decision makers and designers to develop integrated infrastructure plans for urban areas in the long term, which are based on the principles of sustainability (SURF-Arup, 2010).

5.4.2 National knowledge networks

In accordance with the trend from National Government, a ‘Strategy for a Developmental Green Economy for Gauteng’ has been developed for the Gauteng Province Department of Economic Development (Gauteng Province, 2010). It was identified that, as Gauteng is the economic hub of South Africa, initiative must be taken to ensure “**sustainable economic growth and sustainable job creation**” as the overarching strategic goal for the province (Gauteng Province, 2010:06). Key initiatives have been identified for the implementation of the envisioned green economy with reference to food, energy and water security, zero waste and sustainable mobility initiatives. The initiatives are designed with recommendations, targets, benefits, costs and job creation potential. This draft strategic document explicitly adopts the notion of decoupling as the means through which economic growth and development will be realised in the long term, as well as the means to resolve poverty and unemployment. It is recommended that the Provincial Government plays the role of enabler by identifying priority areas which can be realised through facilitated information and knowledge sharing amongst formal and informal networks.

The significance of this document is that it demonstrates the presence of a commitment to incorporating the principles of sustainability into economic development strategies within other provinces of South Africa and presents the opportunity to share knowledge. The document is in itself the manifestation of a series of interactions between several individuals, embedded in a range of networks, who were able to offer expertise drawn from diverse bodies of knowledge relating to the ‘green economy’ and thus this offers itself as an important resource for the CCPGRI.

While there is ample learning networks present in South Africa, there is also a vast amount of knowledge and expertise available locally that could contribute to the development of the Cape Town CCPGRI.

5.4.3 Local knowledge networks

The Climate Change Think Tank is an initiative of the CCT, funded by the Royal Danish Embassy, that aims to inform the planning and implementation of climate change adaptation and mitigation strategies and policies which can be integrated into existing frameworks present in Cape Town (Oelofse, 2010). This Think Tank acts as a research group which facilitates and enables the collaboration between various learning networks within Cape Town, including academic institutions, researchers and experts, as well as relevant local government officials; participating institutions include Sustainable Energy Africa, African Centre for Cities which is affiliated with UCT, and the Stockholm Environment Institute (Oelofse, 2010). The objective is to foster learning for the subject of climate change to understand the implications thereof better, create a forum for

discussion, build capacity for knowledge exchange and develop a legal framework and the financial mechanisms for the roll-out of the adaptation and mitigation measures (Oelofse, 2010). This Think Tank has been running since September 2009

5.4.3.1 Policy representing niche innovations in Cape Town

There is a plethora of policies which speak to the need for adopting a more sustainable approach to the future in Cape Town (Faure, 2009). The first Environmental Policy, adopted in 1996, was deemed insufficient to address the multilayered environmental and social challenges present in Cape Town. In response the CCT identified the need for a thorough investigation to develop a policy framework that would enhance the capacity of the CCT to grapple with environmental and sustainability concerns (Cities Alliance, 2007). The result was the introduction of the Integrated Metropolitan Environmental Policy (IMEP) (CCT, 2003a) that creates “a clear set of policies and strategies for sustainable growth and development” for “a sustainable, world-class African city” (CCT, 2006d:6).

The IMEP has been adopted as the framework that can be referred to when making decisions for the development of various strategies or programmes. This ‘statement of intent’ is based on sustainability principles and acts as the overarching guidelines to be adhered to when developing sectoral strategies (CCT, 2003). This policy has created a vision for the Cape Town environment in 2020 in which the term ‘environment’ encompasses the natural, social, economic, urban, rural and cultural context of Cape Town (CCT, 2003). The general policy principles identify the need to integrate environmental concerns with decision-making at all levels of government, with reference to the current and future population to ensure universal and sustainable service delivery. These policy principles are embedded within a framework which provides various tool kits for the implementation thereof within various sectors which include air, water resources, infrastructure, housing, energy, waste, etc. In this way, these principles inform a variety of City strategies, including the Energy and Climate Change Strategy, Air Quality Management Plan, State of Energy Report, Biodiversity Management Strategy, Coastal Management Strategy, Environmental Education and Training Strategy and the City of Cape Town Environmental Agenda (2009-2014) (CCT, 2010o). These strategies then inform the Integrated Development Plan (IDP) for Cape Town. There are also a number of by-laws which influence decision-making in terms of water and sanitation, energy and waste.

This creates the institutional support for socio-technical transition; however, only with facilitated learning amongst networks of actors who are willing to participate in the development of a niche innovation can considerable changes be made. What follows, is an indication of some learning

networks which have the potential to contribute to the development of the CCPGRI as a mature niche innovation.

5.4.3.2 Initiatives that reflect an alternative approach

There are a number of networks present within Cape Town, which could contribute to development of the knowledge mechanism within the network of actors participating in the CCPGRI. Institutional support is provided by a number of policies and strategies in relation to securing a sustainable source of electricity for Cape Town, while others speak to augmenting the water supply and sustainable waste management. These policies and strategies have in some cases been guidelines for several implemented projects, which demonstrate potential scope for a greater degree of change with the appropriate regime pressure.

Energy frameworks and strategies

Decision-making for the energy sector is informed by the State of Energy Report (CCT, 2007c), the Draft Green Building Guidelines for Cape Town (CCT, 2009e), the Energy and Climate Change Strategy (CCT, 2006d) and the City of Cape Town Environmental Agenda (2009-2014) (CCT, 2009f). The latter two have identified targets for the development of renewable and sustainable energy systems. According to the Energy and Climate Change Strategy, Cape Town must obtain at least 10% of its electricity from renewable energy sources, while Environmental Agenda has a target of 10% increase in electricity efficiency, thus reducing the total consumption by 10% (CCT, 2009f). This is complemented by a target to reduce the per capita carbon footprint (CCT, 2009f). These policies therefore identify decoupling of resource use from economic growth as critical to ensuring access to electricity – resource decoupling in terms of the addition of renewable energy to the energy mix and impact decoupling in terms of an increase in electricity efficiency. Furthermore, the 2009 Draft Review of the Economic Development Strategy explicitly states that new infrastructure or development should be appropriately designed and situated to ensure that there are no unnecessary economic burdens arising from a negative impact on natural resources (CCT, 2009c). This statement is in specific reference to a strategic focus point that identifies the ‘Building of a Resilient, Low Carbon City’ as critical to economic development (CCT, 2009c). Interventions include incentivising investment for the diversification of the energy mix, energy efficiency and renewable energy, as well as the revitalisation of the manufacturing industry for green technology manufacturing and, through this, the creation of green jobs (CCT, 2009c). Both wind generation and solar water heaters are obvious examples of interventions that could increase the amount of renewable energy in Cape Town’s energy mix.

Darling Wind Farm and green electricity certificates

One of the CCT's most well known responses to climate change and energy-related constraints is the relationship it has with the Darling Wind Farm. The Darling Wind Farm is an independent energy producer (IEP) located 70km north of Cape Town, privately owned and supported by funding from the Danish Government, the State owned Central Energy Fund and the Development Bank of South Africa (CCT, 2010p). Construction began in 2007 and by 2008 wind energy was produced and it thus became the archetype for future development of the wind industry in South Africa (Darling Wind Farm, 2010). The project is the result of an unprecedented negotiation between this IEP and Eskom to secure their services for the use of the national grid for distribution, as well as the CCT with whom a 20 year agreement was made to ensure the presence of a sustainable market as the City would purchase electricity generated (Darling Wind Farm, 2010).

Currently there are four (1.3 MW) wind turbines which, when combined, produce 8.6 GW hours of green energy per year. The output current from the turbines is converted on site to usable energy at small transformer houses, which is transmitted to the Eskom national grid high voltage line via substations (Darling Wind Farm, 2010). The initial investment amounted to R75 million and its lifespan is an estimated 20 years. It makes use of a freely available renewable source of energy and it is a highly competitive method of generating electricity, while conventional energy systems are reliant on non-renewable inputs for the energy generation (Darling Wind Farm, 2010). The use of this renewable energy source over the wind farms' lifespan will generate savings of 118 000 tons of coal and 443 million litres of water, as well as prevent the release of 222 000 tons of CO₂ into the atmosphere (Darling Wind Farm, 2010).

Renewable energy generated at the Darling Wind Farm is distributed through the National Grid. The CCT purchases the right to the associated environmental benefits. The CCT then makes the right to own the associated benefits, available to households or firms via Green Electricity Certificates, which is a financial mechanism that allows consumers to purchase green electricity and the right to claim the use of green electricity if the amount purchased is equal to the amount used during the same period (CCT, 2010p). The cost of these certificates is 25c for 1kWh for the 2010/11 financial year which is paid in addition to monthly electricity bills. This price has not been altered since the 2009/10 financial year. These certificates are managed as a 'virtual stock' of renewable electricity. This stock is equal the number of green electricity certificates and as the certificates are purchased so the stock decreases (CCT, 2010p).

Harnessing energy from the sun

In addition to investing in wind power, there is, a far greater potential for renewable energy production present that has not yet been exploited (Prasad, 2007). There is a considerable amount of potential for energy generation using solar technology across South African, Cape Town's relatively cloudy winters result in lower solar potential (CCT, 2007c). The State of Energy Report (CCT, 2007c) has however identified Cape Town's conditions as ideal for solar water heaters and passive solar building design. From a business case perspective, a conventional geyser and water heating is responsible for approximately 40% of electricity cost while solar water heaters can reduce that cost by 80%; this is significant when considering the planned electricity price increases from Eskom over the next three-four years (CCT, 2007d). This installation of solar water heaters is actively promoted by the CCT in accordance with the target of equipping 10% of all households in Cape Town, as stated in the Energy and Climate Change Strategy (CCT, 2006d). There is an upward trend in Cape Town for the installation of solar water heaters.

Energy Efficient Water Heater By-law

To meet its targets as envisioned by the IMEP and Energy and Climate Change Strategy, an Energy Efficient Water Heater By-law has been developed and is currently in its draft stage. It seeks to standardise the incorporation of "energy efficient water heaters for the production of sanitary hot water in buildings in the City of Cape Town; and to provide for matters connected therewith" (CCT, 2009g:1). This by law is applicable to all new buildings (over 100m²) and renovated ones which will need hot water, with certain exceptions. By-law objectives include the reduction in use of electricity and the resultant waste products associated with conventional energy, the securing of energy sources, improving quality of life and creating employment in Cape Town within the solar water heater industry (CCT, 2009g).

Solar water heater advancement programme

The project has been complemented by the solar water heater advancement programme, which is a broad based initiative with the goal to promote and facilitate the installation of solar water heaters (CCT, 2010q). Furthermore, the mass roll-out of solar water heaters across South Africa through the establishment of a viable industry is underway. This project is funded by the Renewable Energy and Energy Efficiency Partnership (REEEP) and run by Sustainable Energy Africa (SEA). The goal, overseen by SEA, is to ensure the Energy Efficient Water Heater By-law is passed by the end of 2010, as well as ensuring the availability of funding to create an attractive business case for the industry (SEA, 2010). The presence of legitimate institutional support in the form of

legislation, by-laws and policy, will therefore support the development of a growing niche innovation and enable action for change.

Kuyasa

Although the Energy Efficient Water Heater By-law has not yet been enacted, due to a series of legalities, the CCT has been proactive about installing solar water heaters. The Clean Development Mechanism (CDM) is a tool provided by the Kyoto Protocol which allows foreign investment in projects in developing countries which have a focus on reducing GHG emissions and are based on sustainability principles (CCT, 2010r). Kuyasa is such a CDM project which has been developed by a non governmental organisation (NGO) called SouthSouthNorth in partnership with the CCT (Kuyasa, 2010). The focus of this project was the instalment of energy efficient technology, including solar water heaters, and energy efficient lighting for 2 300 low cost homes in Khayelitsha, Cape Town, as well as the installation of ceilings to improve thermal efficiency.

Green building guidelines

Green Building Guidelines has been drafted by the CCT as a reference point for the development of new or existing buildings in an effort to reduce the resource consumption and the environmental impact of resource use, as well as improve the social and economic spin-offs through integrating the principles of sustainability throughout the building's life cycle (CCT, 2009e). This document identifies principles which should be considered as intrinsic to the Green Building Guideline and are included at each point of the implementation process, from planning to demolition. The overarching principle is sustainability, and despite the reference to the over-quoted Brundtland Report definition, these principles are fairly far-reaching, considering resource use and procurement as well as social aspects of development. These principles are incorporated into each aspect during the design and implementation of Green Buildings.

The value of such a guideline is the universal applicability for development, provoking thought throughout the entire development process.

Water frameworks and strategies

By 2013, Cape Town, as a spatial context, will be in dire straits; partly because water demand will have outstripped supply. Water constraints have been present in the region for some time. Drought occurred in Cape Town during 2005/6 and the Berg River augmentation scheme will only suffice until 2013. In 2007 the DWA and the CCT finalised the WCWSS Reconciliation Strategy which provided a strategic approach to addressing critical water shortages to meet the expected future demand using augmentation schemes. The Environmental Agenda (2009-2014) has set targets for

per capita water consumption and has identified a water use ceiling which will cap water consumption in 2014 (CCT, 2010o). Furthermore, the Water Conservation and Water Demand Management Strategy is a strategy which informs decision-making for water services and explicitly highlights the need to reduce water consumption; the consequences of not reducing water consumption; where opportunities exist for decreasing water consumption; and provides a comprehensive framework for action (CCT, 2007h).

Reclaim Camissa

Reclaim Camissa is a project, developed by the Public Benefit Organisation (PBO), RECLAIM CAMISSA. Initiated in response to ecological constraints, and specifically water constraints in Cape Town (Reclaim Camissa, 2010). The organisation has stewardship over the water that flows from Table Mountain to the Atlantic Ocean which has been enclosed in sewer and storm water pipes for over a century (Reclaim Camissa, 2010). This project has been constructed as a development framework which uses water as a mechanism for initiating change within the Cape Town Central City via the re-establishment of this ecological link and reclamation of those lost public spaces once associated with this flow of water.

This project seeks to negate the business-as-usual practice of addressing sustainability issues by using technological mechanisms. As an alternative, RECLAIM CAMISSA will construct infrastructure which connects the Cape Town public to this ancient water resource, using parks, pedestrian walkways, and open public spaces within the urban context (Reclaim Camissa, 2010). The project will adapt water utility and stormwater infrastructure, thus reclaiming the Central City's connection to this source and allowing for the provision of ecologically sound water (Reclaim Camissa, 2010). The abundance of water, originating from a dual system of mountain run-off and artisan springs, which currently flows directly from Table Mountain, via water reticulation infrastructure, into the Atlantic Ocean, will be directed to a 6.5 km urban river to eventually arrive at the Green Point Urban Park to be used for irrigation (Reclaim Camissa, 2010). This urban river provides an alternative means of utilising water resources. The primary concern in this case is the securing of a renewable water source within a water stressed area. In light of this, the project structure is designed in a manner that allows public interaction with this natural resource, which is not possible with conventional water systems thus stimulating a reconnection of society and nature.

Desalinisation pilot scheme

Desalination technology has been identified by the CCT as a key resource project through which the water constraints can be addressed in Cape Town to meet the projected future demand by

increasing supply. This process uses reverse osmosis, during which water is forced through a membrane at high pressure. Approximately 40%-45% is used as potable water and the remainder is considered waste as it has high salinity content. A pilot project developed to study sea water desalination at a pre-feasibility level, has recently been transformed from a full feasibility study into in full scale desalination scheme (de Bruyn, 2010b). This was approved by Mayco in June of this year and therefore will proceed as a full scale sea water desalination scheme in the first quarter of 2010/11 after an amendment of the Service Delivery and Budget Implementation Plan target (de Bruyn, 2010b).

While information has not been disclosed regarding the Cape Town feasibility study, a sea water desalination plant has been constructed in Knysna – a town on the Southern Cape Coast which has recently experienced dramatic shortages in water supply due to drought. Similar to Cape Town, Knysna relies on surface water to meet the demand of the growing population, and in light of this the Knysna Municipality's long-term water augmentation plan has been re-use and desalination. The urgency of the matter, noted in the winter of 2009, indicated the area would potentially run out of water by February the following year. In light of this 'worst case scenario' the choice was made to invest in a desalination plant (Turner, 2010). This plant uses reverse osmosis, complemented by the mixing of brine with treated effluent before it is expelled into the Knysna estuary (SSI, 2010). The physical footprint of this plant is approximately 30 m by 50 m and it has the capacity to produce 2 Ml/day (Turner, 2010). The capital investment for a plant of this size is approximately R 24 million, including extraction from boreholes, pretreatment, reverse osmosis units, product water pump station and pipelines, as well as bulk electrical costs. Professional fees and environmental authorisations, specialist studies and monitoring amounted to approximately R 4 million (Turner, 2010).

The recurrent question regarding sustainability relates to the salinity of expelled water and the energy demand of such a plant. In the case of Knysna, the technology used, which dilutes the saline content by mixing treated effluent with brine, offers an alternative approach to desalination. In the case of energy, the electricity demand for sea water desalination is 4-4.5 kWh per Kl of water (Turner, 2010). Cape Town, however, already has a market for green electricity which could be accessed to make this water production process more sustainable.

Solid Waste frameworks and strategies

The objective of the Integrated Waste Management Policy, discussed in section 3.4.2.3 is to ensure basic waste services are extend to all residents; remove waste from illegal disposal sites; decrease waste that is land filled and protect the environment through the conservation of

resources (CCT, 2006c). The Integrated Waste Management By-law, which was promulgated in 2009, supports this policy and aligns itself with national imperatives (CCT, 2010s). The purpose of the Integrated Waste Management By-law is “[t]o regulate the avoidance, minimisation, generation, collection, cleaning and disposal of waste; and for matters related thereto” (CCT, 2009h: 1603). The ultimate intention of the Solid Waste Management Sector of the CCT is to augment economic activity and minimise the impacts of waste through the introduction of waste minimisation and recycling initiatives (CCT, 2010s). The CCT has, furthermore, a number of waste generation minimising and recycling initiatives. These include general drop-off facilities where general household or garden waste can be dropped off; also the ‘think twice’ campaign, which encourages a decrease in waste generation, and Wastewise campaign which are educational programmes for schools, commerce and industry, as well as residents (CCT, 2010t).

5.5 Chapter summary

Even a brief overview of the networks provided reveals an awareness within Cape Town’s numerous sectors of ecological and resource constraints. This overview indicates that this is present within civil society, the public sector and the private sectors. One must conclude, therefore, that there is a vast amount of knowledge present within these networks, which are theoretically niche innovations with the characteristics of SOIS, albeit at difference stages of development. Making the link between these systems will be critical to the realisation of the substantive regime transition necessary to make in-roads into the aggressive impact of the *polycrisis*. While the CCT has made great strides in developing strategies, policies and plans, there are still obstacles which inhibit such change, in particular the distortion between planning and implementation. Through an accumulation of responses, nevertheless, one can realise the potential for a socio-technical urban transition.

The groundwork for the development of an infrastructure development plan, which uses the principles of sustainability as a lens, has been completed through the work of the CCPGRI. This outcome was the result of a series of interactions between participants within the project who, through an interactive process, allowed for the recognition of infrastructure as a critical constraint to development. From this departure point, it has been shown that, as a developing niche-innovation, the CCPGRI has the characteristics of an SOIS, which can exert the required pressure on the incumbent socio-technical regime, thus stimulating a transition at the urban scale. The role of a strategic intermediary will become more and more relevant as the project progresses toward the tipping point of a transition.

An intermediary, in this case, is required in light of the disjointed nature of the services provisioning and strategic planning departments within the CCT. Therefore facilitation and management of the networking process, ensuring the continuous development of capacity and capability through conflict and negotiation, will be critical for the realisation of the socio-technical system transition.

Chapter Six: Concluding Arguments

6.1 Introduction

The purpose of this chapter is to synthesise the arguments developed thus far through the preceding chapters. It is structured around the research objectives and therefore gives an insight into the relationship between socio-technical system transitions and decoupling in the context of innovation. It provides the empirical evidence for the theoretical notion of decoupling and, through a synthesis of findings, advances the understanding of urban socio-technical transitions.

6.2 An alternative approach to development

The objective of the research was to identify the relationship between socio-technical systems transitions and the theoretical notion of decoupling within the context of innovation. A comprehensive literature review was provided to identify the links between these three discourses.

The value was determined by contextualising the global development trajectory of humankind, which indicates that the current economic development paradigm is unsustainable. Evidence of this is found in a series of trends. The first is that currently the planet is experiencing severe resources constraints and ecosystems services have deteriorated by 60% during the last four decades (MEA, 2005). In addition, the planet is currently experiencing an unprecedented acceleration in climate change which will exacerbate already stressed ecosystem services (IPCC, 2007). Both ecosystem degradation and climate change are directly attributed to anthropocentric action (IPCC, 2007), while the poorest sections of the population, who have contributed least to this scenario, will suffer the most (Stern, 2006). Furthermore, humanity is currently using non-renewable energy resources at a faster rate than the earth can replenish them, as evident by the oil peaking phenomenon (Lerch, 2007).

The localities of such detrimental anthropocentric action are urban areas. Since 2005, half the world's population live in cities, while urbanisation trends demonstrate that all future population growth will occur in cities of the developing South (UN-Habitat, 2008). This places cities at the centre of the sustainability debate and thus urban transitions have been identified as critical for realising future growth and development. However, an understanding of that which is not sustainable within cities, is crucial before action can be taken for change within the built environment. Research revealed that infrastructure, as a conveyer of natural resource flows within the built environment, is an important component for determining what is unsustainable in urban

systems. This concept emerged from the notion that infrastructure enables urban socio-economic metabolism, without which cities would cease to exist (Little, 2010). It was established that the urban metabolism of cities is linear and therefore unsustainable (Girardet, 2004). An alternative to this is the adoption of circular metabolism, which is a closed loop system that requires fewer inputs and produces fewer wastes and thus reduces the socio-economic metabolism of cities (Girardet, 2004). In this way, infrastructure was identified as a point for intervention in urban systems for reducing the demand on natural resources. Herein lies the first point for reaching research objective (1). Networked infrastructure systems are conceptualised as socio-technical systems (Guy *et al*, 2001:8). Socio-technical systems provide a theoretical concept to understand how to grapple with the complexity of decreasing the resource flows through the built environment and consequently decreasing the urban metabolism. In this way **socio-technical systems** have been considered as the **intervention point** within urban systems.

Decoupling was subsequently identified as the **means** through which a reduction in the urban metabolism could be achieved. This finding emerged out of the logic created by locating the discussion of global resource flows within the urban context and the implications of future development along the current trajectory. It was evident that a decrease in resource flows is necessary for sustainable development, yet economic growth is necessary for human development. Decoupling, however, negates the mainstream economic paradigm that suggests that development necessarily occurs via the increase of resource consumption. Gallopin (2003) describes this as non-material growth. Decoupling economic growth rates from resource consumption is therefore a valuable notion for achieving sustainable human well-being. Furthermore, decoupling is related to socio-technical systems, as it provides the theoretical basis for **action** in an urban system. This is, thus, the second point for reaching research objective (1).

Achieving decoupling, however, requires radical innovation to influence resource efficiency and productivity (Stamm *et al*, 2009, Nill & Kemp, 2009; Tukker, 2005). In this way the relationship between decoupling and socio-technical systems in the context of innovation becomes clearer. Decoupling economic growth from resource consumption is the overarching goal, while it has been identified that socio-technical systems provide an intervention point for decoupling. Furthermore, innovation is necessary for the development of new systems to realise a system innovation in which socio-technical systems transition from one system to an inherently different one. It was identified that SOIS's provide the framework through which system innovations, that represent decoupling, should be enacted. This is attributed to the nature of SOIS's, which seek to reduce environmental pressure and contribute to sustainability during economic activities (Stamm *et al*,

2009; Montalvo, 2008). SOIS's therefore encourage decoupling. This is, thus, the third point for reaching research objective (1).

The final point, which must be identified before research objective (1) is realised, is a clear understanding of socio-technical system transitions. This was provided by an exploration of the various levels – the micro, macro and meso – of an MLP, which provided a perspective of complexity experienced during socio-technical systems transitions (Geels, 2010). It was demonstrated that there is constant interaction between the three levels. A socio-technical system transition through system innovation, occurs when sufficient pressure is exerted from the micro level simultaneously with the macro onto the meso level of the MLP. Herein is the link to SOIS's: niche innovations at the micro level must develop, using SOIS as framework, if the intention is to adopt decoupling as the theoretical notion for socio-technical systems transition.

Therefore, merging the theoretical notions of socio-technical systems and decoupling, in the context of innovation, offers an insight into accomplishing sustainable urban transitions. Providing the empirical evidence for the theoretical notion for decoupling was important for accomplishing wide-ranging adoption of such a notion within urban systems. This is the rationale for research objective (2).

6.3 Providing the empirical evidence for decoupling

The goal of research objective (2) is to provide the empirical evidence for the theoretical notion of decoupling. The rationale is to provide evidence of this notion to stimulate a wide range of acceptance of decoupling, due to the possibilities it offers within the context of urban sustainability. The Cape Town Metropolitan was identified as the study area. Cape Town demonstrates the existence of decoupling at an urban scale if infrastructure or (socio-technical systems) is adopted. This therefore reinforces the argument that socio-technical systems are a viable intervention point for decoupling. This presents an opportunity to contextualise the findings in research objective (1).

Cape Town faces a *polycrisis* within its own context, in that there are multiple challenges from a financial, social and ecological perspective, which reinforce one another through non linear feedback loops. The historical development trajectory is one which has resulted in poverty, inequality and unemployment for a significant portion of the population. An attempt to address these social challenges to create an inclusive and equal society was made through the extension of infrastructure services across the vast landscape of the city. This, however, has led to critical financial constraints for the CCT, the neglect of existing infrastructure services, placing them in a precarious position, and an acute service delivery backlog. While economic growth has been

experienced in Cape Town, it is not occurring at a sufficient rate to generate adequate employment opportunities and alleviate poverty. Moreover, ecological constraints indicate that Cape Town is reaching its environmental thresholds (Crane & Swilling, 2008). In short, the ecological base for socio-economic development, enabled via the flow of resources through networked infrastructures allowing socio-economic metabolism, is being undermined by the way in which the socio-economic metabolism has extended across Cape Town.

Decoupling has been identified as an alternative development paradigm for Cape Town and should be adopted within economic development strategies. Based on a statement of intent from the CCT, that complex challenges will be addressed by infrastructure-led economic growth and the provisioning of sustainable urban infrastructure, the adoption of decoupling is a viable option.

The provision of empirical evidence for the theoretical notion of decoupling, using Cape Town's critical infrastructures as the unit of analysis reinforces this argument. The findings demonstrate that Cape Town is energy insecure and vulnerable to further supply shocks, while simultaneously indicating that spontaneous relative decoupling has occurred for electricity consumption. Demand for water will soon exceed supply, despite relative decoupling, while augmentation is managed via the extension of the existing system. In the case of solid waste, it was found that absolute decoupling has occurred, however, the means used for the disposal of solid waste is nudging Cape Town closer to the tipping point of resource thresholds. Furthermore, empirical evidence focussed attention on the poor state of critical infrastructures in Cape Town. With that being said, the situation lends itself to the emergence of a socio-technical transition through purposive action. Deliberate interventions within the water and solid waste section indicate that action at the urban scale can stimulate change. Therefore, the possibility for extensive decoupling must be exploited through the adoption of an alternative development paradigm.

The challenge, however, is to negotiate the institutionalised technical and political approach to services delivery and, thus, the frame of reference for decision-making. The role of learning and capacity building therefore becomes critical for purposive socio-technical transitions within the urban context. Furthermore, innovation re-emerges as a critical factor to realise systems transitions through creative destruction of old, embedded knowledge and the construction and exploration of new ideas and knowledge for development.

6.4 Furthering understanding of urban socio-technical transitions

The third research objective was included to further current understanding of urban socio-technical transitions. There are several lessons which have developed as the argument was formulated. The

argument, as concluded in chapter 2, for meeting research objective (1), identified infrastructure as a socio-technical system and an intervention point for decoupling, realised through socio-technical transitions. It was argued that radical innovation, emerging from SOIS's, would be necessary for meaningful socio-technical transitions – SOIS's and decoupling are closely related through their capacity to enable greater sustainability. Furthermore, the MLP was identified as a model upon which a socio-technical system could be placed to understand the opportunity present within a context for transitions. Several questions however remain: what are the factors that determine the development of SOIS's and niche innovations; how are socio-technical transitions realised; and how does the spatial context influence socio-technical transitions. This concluding section will clarify these issues.

The case of the Cape Town CCPGRI was used as a contextual example in an attempt to understand socio-technical transitions. It allowed for an examination of the role that actors and stakeholders have played within a particular spatial context to contribute to the realisation of an urban scale transition. By exploring the engagements between actors who construct the complex social, technical, economic and environmental processes which constitute socio-technical systems, awareness was developed of the role that social processes play in determining an outcome.

6.4.1 Factors determining SOIS's and niche innovation formation

It was asserted that the Cape Town CCPGRI is a niche innovation that emerged from an SOIS and has the potential to exert sufficient pressure on the incumbent socio-technical regime to stimulate a socio-technical transition. It is, however, unclear what factors influenced the innovation system to transform into a SOIS. An attempt was made to address this question by exploring the dynamic social process that unfolded between the participants of the CCPGRI. The participants of the CCPGRI were identified as the system and the CCPGRI as the process.

The most important factor contributing to SOIS's can be identified as the process of dense and rich networking. This argument stems from the rationale that when isolated, individuals are limited by their own experience and frames of reference embedded within their identity. Decision-making processes are therefore reliant on existing knowledge that connects cues experienced in the present to past events through retrospect, thus limiting innovation. The continual reinforcement of a business-as-usual approach is therefore the result of reliance on existing knowledge as the basis for decision-making. However, decision-making stems from identity, which develops through socialisation processes and interaction, and in this way networking, through feedback processes and increased connectivity, can contribute to the emergence of new ideas.

Developing a culture of rich interaction for the formation of new ideas does not, however, occur spontaneously. As this niche innovation evolved, there is evidence that deliberate action was taken to enrich the process through the inclusion of an additional stakeholders with diverse perspectives. The creation of a structured 'space' for networking through facilitation, that enables exploration, experimentation and discovery of new knowledge, is therefore an important determining factor for SOIS's. The presence of new information increases the complexity of decision-making and draws the attention away for pre-conceived, plausible, as opposed to accurate, solutions, stimulating the possibility of alternative outcome. More importantly, therefore, is the presence of a facilitator who is able to organise and manage what knowledge and how knowledge is generated – the inclusion of a multiplicity of stakeholders with varying frames of reference forces a process of sensemaking, out of which new understanding and alternative outcomes can be generated.

Facilitation and knowledge management is therefore the last determining factor for SOIS's that can be learnt from the process that evolved during the CCPGRI. Ensuring the quality of networking is dependent on the presence of an intermediary who has the capacity to structure adequate 'space' for networking to allow the possible alternative approaches to development to be recognised and engaged with. The quality of networking is dependent on **how** the context in question is understood and **who** is subsequently included within the innovation system. It is therefore the responsibility of an intermediary to ensure the presence of a multiplicity of stakeholders who represent those who influence or will be influenced by an eventual outcome of an innovation. This is to negate the common reinforcement of a business-as-usual approach. An outcome of a niche innovation is shaped by those present in the system, and therefore critical to the creation of SOIS's is the presence of alternative development perspectives. Intervention from an intermediary can in this way shape the trajectory of a socio-technical transition.

6.4.2 Understanding socio-technical transitions

The trajectory of a socio-technical transition is shaped by the actors who participate in the formation of a niche innovation. Evidence of this is found in the case study of the Cape Town CCPGRI. The outcome of the CCPGRI is a novel approach to development that seeks to enable greater sustainability, using Cape Town's socio-technical systems. The presence of a multiplicity of actors from diverse backgrounds accounts for the novel outcome, which would have not have been realised without the presence of an intermediary. The niche innovation is furthermore extrapolated onto the MLP to determine the possibility for a socio-technical transition.

By extrapolating the CCPGRI onto the MLP it was possible to examine the factors which contribute to socio-technical transition within a specific spatial context. It was furthermore possible to analyse the Cape Town CCPGRI, using the MLP as a framework from which one can determine the

opportunity for realising an urban socio-technical transition. The foundation for this approach is that in the presence of a multiplicity of innovations, when sufficient pressure is exerted onto the incumbent socio-technical regime in conjunction with pressure from the landscape level, a window of opportunity emerges and allows a socio-technical system transition (Geels, 2002). It was determined that a niche innovation has to mature to a certain point before sufficient pressure can be exerted for a system innovation. Lopolito *et al* (2010) identified willingness, power and knowledge as the three mechanisms which determine maturity.

These mechanisms are present in the CCPGRI as a niche innovation, indicating it has a high level of maturity. The mechanisms however emerge throughout the development process and an intermediary plays a critical role in the establishment thereof. Intermediaries recognise novel endeavours and are able to contextualise them within a specific context. From this point, through the extension of the network, expectations converge through facilitation of engagements, and thus willingness to participate develops. However, this is intertwined with the identification of appropriate networks for high quality interaction for the accumulation of power and knowledge. Therefore, the development of maturity is the result of non linear feedback processes which continually overlap and reinforce the mechanisms which develop the maturity of a niche innovation. It was thus determined that there is no definite method for stimulating and realising a socio-technical transition, but who is included within the network will ultimately determine the development of a niche innovation.

Non-linear feedback processes could be the result of ecological, economic, institutional, technical or behavioural changes at any level on the MLP, which are continuously interacting with one another. There is a continuous process of negotiation, struggle and adjustment between and within the levels of the MLP which influence maturity of niche innovation both directly and indirectly. In this way, the role of networking an interaction is critical for the development of maturity within niche innovations. Significantly, the role of an intermediary emerges here, facilitating and managing the development process of niche innovation maturity and intervening when slow or weak development is evident.

In the case of the Cape Town CCPGRI, when extending the examination to other niche innovations present at the micro level and the meso and macro level of the MLP, the possibility of an urban socio-technical transition becomes clearer. Evidence suggests that the socio-technical systems present in Cape Town require a system innovation, while at the macro level significant pressure is already being exerted. Furthermore, there is a multiplicity of development niche innovations present. The dual pressure system, from the macro and micro level, creates the scenario in which a socio-technical transition is possible. It is in this capacity that an intermediary is furthermore

important. Intermediaries can facilitate an understanding of the various pressures, at different levels, on a socio-regime by utilising existing knowledge within a particular context and extending knowledge networks.

While cities, as spatial context, influence transitions, the extent to which localised action can stimulate a purposive urban transition remains to be seen. Purposive interventions into the water and solid waste sectors discussed in section 3.4.2.4, to decrease resource consumption, have been successful in Cape Town. In addition, there are numerous niche innovations, at varying stages of development, which reflect a framework of local action. Despite their presence, these niche innovations have an ad hoc and disjointed nature and therefore a relatively small scope to initiate change. Intermediaries, on the other hand, have the capacity to develop these niche innovations within a spatial context for purposive action. Dense networking processes, afforded by intermediaries, local decision-makers, including policy makers, officials, developers and citizens, can influence learning processes during which niche innovations mature and therefore influence the trajectory of the transition. Systemic purposive action, necessary for the realisation of a socio-technical system transition, requires mediation, facilitation and management by an intermediary who is able to understand the various pressures at each level of the MLP. Gathering the appropriate stakeholders, to generate a networking process out of which a niche innovation matures to the point when a window of opportunity emerges, is therefore critical for a system transition.

6.5 Chapter summary

This chapter has provided a synthesis of the arguments made in this thesis. The desirability of engaging with the complex socio-technical processes, which are constituted by the interaction between institutional, technical, economic, ecological and social processes, becomes increasingly significant in the context of natural resource threshold.

It has been demonstrated that the paradigm for achieving economic growth and development is unsustainable. It has been argued that the adoption of decoupling offers an opportunity to decrease resource consumption and the impact thereof. Furthermore, socio-technical systems have been identified as the intervention point for the implementation of decoupling. Implementing decoupling however requires that incumbent socio-technical regimes undergo a system innovation. Using the theoretical notions of socio-technical transitions and the MLP as a model, has provided a means to determine the possibility of a socio-technical transition within a particular context. It has furthermore been demonstrated that purposive interventions from actors within a particular spatial context can shape the transition experienced, as urban socio-technical transitions are dependent on the actions of those present within the system.

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