

City of Cape Town

The Economic Imperatives of Environmental Sustainability

Department of Economic and Human Development

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"Only when the last tree has been cut down, only when the last river has been poisoned, only after the last fish has been caught; Only then, will you find that money cannot be eaten." Cree Indian Prophecy

In a world driven by economics, it is not enough to be green. Whether you believe sustainability is an ethical choice or the next big competitive trend, innovations that bring more value along with less impact are poised for strong growth in potentially huge markets – PS Reilly.

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1. Executive Summary

Establishing an Enabling Environment for Economic Growth

This paper establishes that future economic growth in Cape Town is dependent on environmental sustainability. There is no longer a conflict between developmental objectives and ecological preservation. Alleviation of poverty and unemployment will in future depend largely on the success of ecological preservation. Economic growth is the means through which these objectives will be achieved. Therefore, environmental sustainability is a strategic priority for the City.

Main Findings

- The cost of non-renewable resources to support current economic activity will reach R18.3 billion Rand per annum by 2012, assuming that the economy grows relatively slowly. If it grows faster, these costs will rise proportionally as their volume of consumption is determined by economic growth rates.
- Cape Town and South Africa are particularly vulnerable to global oil price shocks. The economy is highly dependent on imported oil. Oil-related products constitute the majority of the poor's budget, along with being the most prone to inflation, which is damaging to the entire economy. Therefore, given the effect of even a US \$10/barrel rise in the oil price on South Africa's Gross Domestic Product (GDP), it is essential that all future policy decisions are mindful of the need to reduce the economy's dependence on oil.
- The Economic Model illustrates that the environmental, opportunity and blackout costs of business as usual – costs not currently captured by conventional financial statements – will reach R2.5 billion by 2012 if action is not taken immediately. It is important to note that this is an understatement of the true costs.
- If the City were to subsidise the installation of solar water heaters for the 400 000 poorest households in Cape Town, the abovementioned costs would be reduced by approximately 31%. This, combined with financial savings in light of impending Eskom tariff hikes, illustrates the prudence of investing in renewable energy technologies. The benefit of this kind of initiative exists also in the immeasurable benefits of creating a private market in renewable technology.
- It would have been less expensive for the City of Cape Town to provide rainwater tanks for its most affluent residents (who are by far the biggest consumers of fresh water) than to build the Berg River Dam. This would provide an advanced system of water efficiency, utilising grey water for gardens and toilets, thereby reducing pressure on the traditional water supply infrastructure, which is currently under great pressure. Given that the Berg River Dam project will only provide temporary relief from Cape Town's water supply shortage, this option should still be carefully considered.
- In order to take the lead in energy efficiency (as an essential contribution to greening Cape Town), the City should implement the recommendations of the Civic Centre Electricity Audit and retrofit the Centre with the recommended Tri-Phosphor lamps. This would serve both as an extraordinary cost saving, but also as a signal to the market that the City is serious about environmental sustainability.

The Bottom Line: Calculate and know the monetary benefits of environmentally friendly initiatives

This paper argues that the "Economic Model" should be used as a policy tool to assess the monetary benefits of any environmentally friendly initiatives that the City proposes to undertake. Conventional financial statements fail to capture the environmental, opportunity and blackout costs of economic activity. However, these costs are real.

Any initiative that relieves pressure on existing basic service infrastructure and improves the condition of the environment carries enormous economic benefit, as this is a highly practical way of creating the “enabling environment for economic growth” that are strategic priorities of the Integrated Development Plan (IDP) and Economic and Human Development Strategy (EHDS).

Recommendations

- a. This model should be used to ensure that all new buildings built in Cape Town are fitted with energy efficient lighting, solar water heaters and rainwater tanks. This should be built into policy governing building applications and any building which the City itself is responsible for maintaining, upgrading or building. The installation of solar water heaters and rainwater tanks provides an opportunity to provide a new skill for the currently underskilled and unemployed. These skills will be in ever-increasing demand as the pinch of climate change starts making itself felt both physically and in consumers’ consciences. In the face of jobless economic growth, skills development in growing markets is a highly sensible undertaking.
- b. The City is to use the Economic Model as a policy tool by which to indicate the environmental and economic costs and benefits of any new development or project. In particular, the Department of Economic and Human Development (EHD) should include the use of the model as part of the sustainable model for all new projects.
- c. The City should retrofit the Civic Centre with energy efficient lighting. Option 3 in the Civic Centre Audit of 2004 should be implemented with immediate effect. It is a cost-saving option with both seen and unseen benefits. As far as competing priorities are concerned, the sooner the investment is made, the sooner is cash freed up to achieve other development priorities. There is no justifiable reason for resisting this project. Every argument in its favour is sound economically, financially and environmentally.
- d. In as far as the MFMA allows, the City should undertake to provide solar water heaters for the poorest households. This is a once-off subsidy which will provide a much-needed incentive for local producers of renewable energy to become competitive, thus making it more attractive for higher-income users as well (as manufacturers experience increasing returns to scale through higher sales volumes). Again, the argument that there are more important priorities is untenable. Conventional electricity will become increasingly expensive and not much cleaner in the next twenty years. If the City is serious about committing to the creation of an enabling environment for economic growth, which is socially and environmentally responsible, then there is no reason why a project of this magnitude should not be undertaken. Economic growth is a national strategic priority. Reducing pressure on current infrastructure capacity and providing the platform for a private market in renewable energy are two highly practical steps towards creating this enabling environment.
- e. This work provides a basis for City business support towards the creation of a local market in renewable energy. A special purpose vehicle (SPV) could be established to guide this process. The “greening” of Cape Town will reduce the current untenable pressure on basic service infrastructure capacity, and thus attract necessary local and foreign direct investment, which will grow the economy and contribute to the environmental preservation of the city at the same time. This is the mandate of the EHDS, and it must be given practical efficacy as soon as possible.
- f. Finally, the City should run an awareness campaign, and provide a possible subsidy, for residential rainwater tanks. That water supply security will soon become the greatest global issue, Cape Town would do well to get ahead in terms of planning. The region’s rainfall is more than sufficient to supply perennial water needs. This would free existing supply capacity to aid agricultural endeavours that will increasingly suffer the effects of global warming. Again, this is a practical step to ensuring an enabling environment that is so necessary for sustainable economic growth to occur. If water supply is not secured as soon as possible, there is a significant chance that economic growth will be retarded altogether.

2. Introduction

The Economic and Human Development Strategy stipulates the importance of creating an “enabling” environment in which economic growth can flourish. This paper is a contribution to how that environment can be created. It is a national strategic priority and therefore demands to be given significant attention. The paper examines Cape Town’s current natural environment, explores international best practices that have been successful in ensuring ecological preservation and economic growth, and finally presents an economic model that is a useful tool to illustrate the benefits of any environmentally friendly initiative.

In a landmark article titled “Up and Down with Ecology,” Anthony Downs argued that “Public attention rarely remains sharply focused upon any one domestic issue for very long – even if it involves a continuing problem of crucial importance to society.”¹ He went on to illustrate that a serious problem will arrive on the public radar screen, be met with great alarm and then fade from the political agenda (remaining largely unsolved) as new problems arise. His analysis has turned out to be somewhat prophetic, given that it was written in 1972, and we have seen much evidence of its truth since then.

Environmental degradation continues to be a challenge that evokes fear and great promises to change, yet remains defiantly stubborn to those changes. Invariably, it is relegated to the back of the public policy agenda where it remains in obscurity. This paper is designed as a complementary tool to the Draft Energy and Climate Change Strategy (for Cape Town), although it hopes to provide an impetus to meet the prescription of “10% energy from sustainable sources by 2020”² before then. It also stands as part of the work that has been recommended by the Draft Report on “Renewable Energy and the City of Cape Town”, Environmental Resource Management Department (ERMD).

The purpose of this paper is to demonstrate the economic benefits of environmental sustainability, as they are applicable to Cape Town. For firms and individuals alike, there are conceivable future benefits to changing current consumption and production patterns. These patterns have hitherto remained environmentally damaging, in part because the economic arguments for alternative means of production and consumption have been largely absent. Also, the ethical imperative to change behaviour has been dissipated by a lack of action on behalf of those expected to lead the process, namely government.

The world has come to a point, though, where we can no longer afford – quite literally - to ignore the impact of our behaviour on the planet:

“It now seems certain that we need a 60% cut in our emissions within 25 years if we are to stop ourselves reaching the point where the “climate feedback” becomes unstoppable, and our world becomes largely uninhabitable.”³ It is important to note that Cape Town’s behaviour on its own will make very little difference to impending climate change. However, the economic opportunities inherent in the threats of climate change should be immediately exploited, benefiting both the economy of Cape Town, the local community and the environment.

Changing behaviour has always been an unenviable task. However, that there is a solution - achievable through an appropriate mix of ethics and demonstrable economic benefits - means that it must be pursued. This paper will therefore illustrate the costs of inaction against the benefits of changing behaviour.

Within the framework of the Economic and Human Development Strategy (EHDS), economic growth is seen as the primary vehicle through which to address the development goals of reducing poverty and unemployment. Within that, environmental sustainability forms a principal tenet - as one of the “5 stars” - of the strategy. This is also a crucial aspect of the City’s Integrated Development Plan (IDP 2007-2012), and this paper also informs this process.

1 Downs, A. “Up and Down with Ecology: The “Issue-Attention Cycle””, in *The Public Interest*, Vol. 28 (Summer 1972), pp. 38-50.

2 City of Cape Town, (2006) *Energy and Climate Change Strategy*

3 Monbiot, G. 2006. *Heat, How to stop the planet burning*. In a highly charged debate, Monbiot presents the most well-researched work to date, taking a ‘middle of the road’ approach and sidestepping the pitfalls of fanaticism. The 60% here refers to the globe’s collective necessary reduction.

3. Cape Town: Current State of the Environment

There are two important things to consider in evaluating Cape Town's current environmental situation, namely the *Urban ecological footprint* and the *Urban Metabolism*⁴. This will give an indication of Cape Town's prospects of environmental sustainability. A sustainable city is defined as: "One that meets its present and future human development objectives without growth in throughput of matter and energy beyond the regenerative and absorptive capacities of its local, national or international hinterland."⁵

- The ecological footprint concept starts from the assumption that every category of energy and material consumption and waste discharge requires the productive or absorptive capacity of a finite area of land or water. If we sum the land requirements for all categories of consumption and waste discharge by a defined population, the total area represents the "*Ecological Footprint of that population on the Earth whether or not this coincides with the population's home region*". In short, the Ecological Footprint measures land area required per person (or population), rather than population per unit area."⁶
- Urban Metabolism is an extension of the concept of biological metabolism. It is the internal process common to all living organisms that enables them to build and repair their body tissues by processing a variety of biochemical inputs and to discard unwanted waste and heat outputs.
"The metabolism of a city can be defined as all the material and commodities needed to sustain the city's inhabitants at home, at work, and at play. Over a period of time these requirements include even the construction materials needed to build and rebuild the city itself. 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. As man has come to appreciate that the earth is a closed ecological system, casual methods that once appeared satisfactory for the disposal of wastes no longer seem acceptable. He has the daily evidence of his eyes and nose to tell him that his planet cannot assimilate without limit the untreated wastes of his civilization."⁷

These concepts will now be more fully described and analysed.

a. Cape Town's Ecological Footprint

- The Cape Metropolitan Area (CMA)'s ecological footprint (EF) is 128 300 square kilometres. It therefore depends upon an area of the earth's surface roughly equivalent to the entire Western Cape Province for its resources and the absorption of its wastes.
- This is 52 times larger than its jurisdictional area and 166 times the area of its built footprint.
- Its per capita Ecological Footprint is 4.28 hectares, slightly larger than South Africa's per capita of 4, 02 hectares.
- The planet's "fair-share" of biologically productive land available is about 1.9 hectares per person.

Table 3-1 below indicates the breakdown and calculation of this figure.

4 Gasson, B. "The Ecological Footprint of Cape Town: Unsustainable Resource Use and Planning Implications" in www.sapanners.org.za/SAPC/papers/Gassonpaper.pdf, accessed on 19 July 2007

5 Ibid footnote 3

6 Wackernagel, M and Rees, W. (1996) *Our Ecological Footprint – Reducing Human Impact on Earth*.

7 Wolman, A. (1965) *The metabolism of cities*, Scientific America.

Table 3-1: Cape Town's ecological footprint (first approximation)

Metabolic inputs	Tons	sq. km equivalent
Fresh water	327500000	1430
Energy		
Coal	378732	1326
Oil	1138097	6359
Gas	21816	95
Wood	108492	660
Materials		
Building	5994113	31
Timber	69844	425
Paper	395000	3091
Food ⁴	1327301	112349
Metabolic outputs	Tons	Land area (sq. km)
Liquid wastes	200300000	13
Solid wastes	2050800	4.9
Gaseous wastes	5209200	2480
Total EF		128264 sq km
Jurisdictional Area		2487 sq km
Built footprint		774 sq km

Source: Gasson, B. University of Cape Town, School of Architecture and Planning, 2005

The table indicates that the absorptive and regenerative capacity of the land in Cape Town is under severe pressure. Of particular concern is the unconstrained use of non-renewable resources as a contributing factor to this ecological footprint. The following sections focus on some of these examples of over-consumption.

b. Cape Town's Current Non-Renewable Resource Demand and Supply

Table 3-2 below indicates that Cape Town:

- Consumes 6.5 million tons of raw materials each week. The bulk of this (96%) is fresh water.
- Correspondingly, it discharges 4 million tons of waste products each week, or about 600 000 tons a day into the local water, air and land sinks (which form the heart of environmental absorptive and regenerative capacity.)
- It also discharges 236 million mega-joules of heat daily into the sea and atmosphere."⁸

The last bullet point is a serious environmental cause for concern, which will be substantiated shortly.

⁸ Gasson, B. "The Ecological Footprint of Cape Town: Unsustainable Resource Use and Planning Implications" in www.sapanners.org.za/SAPC/papers/Gassonpaper.pdf, accessed on 19 July 2007

Table 3-2: Cape Town's metabolic inputs and outputs in tons/yr 1996 – 98

Table 2: Urban Metabolism Cape Town

Inputs	Tons/yr	%	Outputs	Tons/yr	%
Salt Water	25,985,664,001		Salt Water	2,598,566,400	
Fresh Water	3,275,000,002	95,8%	Liquid Wastes	200,300,000	96,5%
Oxygen	4,379,363	1,3%	Gaseous Wastes	5,342,635	2,5%
Energy	1,647,137				0,5%
Coal	378,732		Carbon Dioxide	5,209,000	
Oil	1,138,097		Sulphur Dioxide	32,225	
Gas	21,816		Oxides of Nitrogen	28,352	
Wood	108,492		VOCs	55,341	
			PM ₁₀	11,594	
			PM _{2.5}	6,123	
Materials	6,825,257	2,0%	Solid Wastes	2,050,800	1,0%
Stone agg.	3,465,000		Residential	895,900	
Bricks	1,926,413		Commercial	409,800	
Cement	600,000		Industrial	499,900	
Steel	120,000		Wet sludge	245,200	
Timber	69,844				
Glass	24,000				
Paper	395,000				
Plastic	225,000				
Food	1,327,301	0,4%			
Total	341,679,058	100,0%		207,693,435	100,0%
			Waste Heat	86026 x 10⁶ Mj₁₀	

Source: Gasson, B. University of Cape Town, School of Architecture and Planning, 2007

Carbon Dioxide emissions, at 5 209 000 tons/annum - the primary contributor to global warming and consequent climate change – are disturbingly high in Cape Town. These must be reduced in the most efficient manner possible, understanding that firms and households will necessarily incur short term costs for the sake of long term gain. A reduction in greenhouse gas emissions can only produce economic, social and environmental benefits.

There is, however, much debate over the best economic instrument to use to achieve this reduction:

“Analysts generally conclude that uncertainty about the cost of controlling carbon dioxide emissions makes price instruments preferable to quantity instruments because they are much more likely to minimize the adverse consequences (excess costs or forgone benefits) of choosing the wrong level of control.”⁹ Therefore, the price of CO₂ emissions would have to be set at a level which equalled the cost of reducing them. To simplify, the argument for an emissions market (as opposed to an emissions limit) is built on an economic principle that profit and efficiency are maximised at the point where marginal benefit is equal to marginal cost. If a quota was imposed, it would create inefficiency in the market and an incentive for firms to cheat in the absence of strong regulation enforcement. Price mechanisms are therefore more realistically effective. There is much discussion in the current policy environment about the creation of a carbon emissions market in South Africa, and this paper thus excludes economic modelling of a potential market.

⁹ Terry M. Dinan and Robert Shackleton, Jr. “Emissions Prices are more efficient than Emissions Caps” in <http://www.cbo.gov/ftpdoc.cfm?index=6148&type=0>, accessed 03 August 2007

The following section will focus on Cape Town's current energy usage. These costs are not currently accounted for in any formal manner and thus non-renewable fossil fuels are consumed as though they were free goods. This must be addressed as a priority. There is work (largely by the UN) near completion on changing the international System of National Accounts (SNA) to reflect the costs of non-renewable resources which are currently treated as free goods.

4. Energy Demand and Supply

Table 4-1: Cape Town's Energy Use by Sector in 1996¹⁰

ENERGY USAGE BY SECTOR (1996) in Kilowatt hours					
Energy Forms	Useful Energy (KWh)	Transport	Industry/Commerce	Domestic	Other
Electricity	7,368,000,000	0	3,809,000,000	3,239,000,000	320,000,000
Oil	11,086,000,000	9,244,000,000	1,495,000,000	347,000,000	0
Coal	1,948,000,000	0	1,875,000,000	73,000,000	0
Wood	512,000,000	0	0	512,000,000	0
Gas	302,000,000	0	0	302,000,000	0
TOTALS	21,216,000,000	9,244,000,000	7,179,000,000	4,473,000,000	320,000,000

Source: Gasson, B. University of Cape Town, School of Architecture and Planning, 2007

a. Energy

Energy is of particular interest in this paper as it illustrates the flows of non-renewable fossil fuels that drive the city's metabolism. Above the mere economic costs associated with consumption, one must also consider the environmental impacts of the following variables:

- Oil is shipped in from approximately 10 000 km away to Saldanha bay and then pumped 120km via pipeline to reach the Caltex Refinery, north of Cape Town.
- Coal supplies are railed from 1500km away in Mpumulanga, although Koeberg's nuclear facility meets most of Cape Town's electricity demand. However, when nuclear-powered energy supplies in Cape Town are interrupted, power has to be transported from coal-fired stations across South Africa. These are geographically distant, and thus the transmission costs are high.¹¹

b. Water

The most crucial inputs to Table 4-2 are water and oxygen. The salt water input is not included in the calculations, but the figures give the reader an idea of the sheer scale of salt water being used to cool Koeberg and being pumped back into the sea at higher temperatures. This has implications for marine ecosystems and will invariably have a damaging effect on the mariculture industry that is a substantial employer on the West Coast.

Furthermore, the importance of fresh water, how quickly it is running out (despite the efforts of the Berg River project) and its consequent impact on future economic growth are demonstrated by the following:

"The growth in water consumption has grown roughly at the same rate as the economy over the decades. However, every expert in the water sector agrees that South Africa only has between 1.2% and 1.7% extra fresh water capacity left. The result of reaching that ceiling will be the retardation of growth and the increasingly costly implication of over-exploitation which, in turn, will loop back to undercut growth as the costs of remedial action kick in. The economically sensible thing to do is, therefore, to invest in technologies and systems that uncouple economic growth from rising raw water

¹⁰ The reason we have used this dated figure is simply because it is the only one available that disaggregates energy use by raw material (which is part of the connection that has to be made in this exercise)

¹¹ Gasson, B. "The Ecological Footprint of Cape Town: Unsustainable Resource Use and Planning Implications", in National Conference of the South African Planning Institution, 18-20 September 2002, Durban

consumption. Investing in new ways of doing things is an economic growth stimulant, and the result of such interventions will prevent later growth retardation."¹²

Table 4-2: Cape Town's Water Consumption by use sector in millions of tons/yr (1998)

WATER THROUGHPUTS		
Use Sector	Million Tons/yr	%
Residential: Homes	122.3	37.34
: Gardens	69.9	21.34
Industry	48	14.66
Commerce	21.8	6.66
Public: Municipal	21.8	6.66
: Sports	13.10	4.00
Unaccounted	30.6	9.34
TOTAL	327.5	100.00

Source: DWAF 1998

"Cape Town depends for its water supplies on a steadily lengthening infrastructure of pipelines (397 km), tunnels (45km), canals (41km) and pumping stations that tie it to five major reservoirs in the high-rainfall catchments of its eastern hinterland. As 85 % of river flow takes place in the wet winter months, but 60% of urban-industrial demand is in summer, reservoirs have to be built with massive storage capacities to meet dry season demands."¹³

Recommendation:

It is for this reason that all future building plans (and plans to renovate existing homes) be of architectural design that enables houses to employ renewable and sustainable water use in the form of rainwater tank systems. As the economic model will illustrate, it is less costly (environmentally and economically) for each household to be supplied with a rainwater system than it is to continue building dams. As an additional economic bonus, the cost of transporting new water through already constrained infrastructure would be largely eradicated. These kinds of practical strategies and actions should be encouraged in Cape Town, with the City (local municipality) taking the lead by ensuring the capture of rainwater from its own buildings, and will be further expounded on in the Recommendations Section (10, page 31).

5. Economic and Environmental Costs of Ecological Footprint

a. CO₂

In order to limit Carbon Dioxide emissions by 60% by 2030 through an emissions trading scheme (mentioned earlier), it is estimated that the cost per ton should reach equilibrium at around US\$40¹⁴. While it is not clear whether this will happen, it is clear that a market for carbon emissions is growing phenomenally, having tripled in size over the last decade¹⁵. At a cost of US\$40 a ton, the annual cost to the Cape Town economy – working on an assumption that Nitrous Oxide emissions translate to approximately 310 tons of CO₂ – is **R 1,655,816,425**. This equates to roughly 1.34% of the city's Gross Geographic Product.¹⁶ That this is a hypothetical cost should not detract from the argument that it is the effective social/environmental cost of current economic activity. This cost, and the significance thereof, will be factored into the economic model.

¹² Crane, W and Swilling, M. "From LED to SLED? Local Government and The Politics of Sustainability" in Briefing Number 6, May 2007, accessed on 01 August, 2007, http://www.khanya-aicdd.org/photo_root/newsletters/led/led%20policy%206.pdf

¹³ Gasson, B. "The Ecological Footprint of Cape Town: Unsustainable Resource Use and Planning Implications", in National Conference of the South African Planning Institution, 18-20 September 2002, (Durban)

¹⁴ ibid

¹⁵ <http://www.icbe.com/emissions/commodity.asp>, accessed September 2007

¹⁶ Economic Model of Environmental Costs, City of Cape Town 2007

b. Cost of Energy

A brief examination of the cost of energy is also important, as the costs of traditional sources of energy (fossil fuels) are likely to rise exponentially, both as global warming is taken more seriously and the impending changes in the SNA take effect.

In South Africa, the problem is particularly acute because the current selling price of electricity (18c/KWh) "is only half of Eskom's 36c/KWh replacement cost of its generation, transmission and distribution assets."¹⁷ This impacts negatively on Cape Town's electricity costs because coal and nuclear power are fed onto the same distribution grid. Thus, nuclear power cannot be differentiated from coal-fired power and even though only a sixth of Cape Town's power comes from coal, the cost of building new coal-fired power stations across the country will still be felt by Cape Town residents and businesses alike. The expected price rises (based on Eskom's request to the National Energy Regulator of South Africa (NERSA) for tariff hikes of 18%, 17% and 30% respectively for 2008, 2009 and 2010) are depicted below. It is important to bear in mind that South African electricity, despite these increases, will still be the cheapest supplier of electricity in the world – 73.6% cheaper than the closest competitor, Canada.¹⁸

Table 5-1: Projected Cape Town Electricity Costs 2007-2010 (Rand Values)

	2007	2008	2009	2010
Electricity Costs	R 3,315,600,000	R 3,912,408,000	R 4,577,517,360	R 5,950,772,568
	15.63%	18.44%	21.58%	28.05%

Source: Own calculations (factoring in predictions on Rand fluctuations), based on Gasson, B. University of Cape Town, School of Architecture and Planning, 2007

The above costs are calculated on an average electricity price of R0.45 per Kilowatt hour¹⁹. Work in the economic model will illustrate these costs against the costs of renewable technologies. The percentages indicate the contribution of electricity to Cape Town's total 'useful energy' demand. Households form 43.96% of the total electricity demand for Cape Town, and industry the remaining percentage.

These cost considerations will be built into the economic model and inform the subsequent recommendations.

6. Renewable Technologies: An Examination

a. Solar Power

"Enough sunlight falls on the earth's surface each minute to meet world energy demands for an entire year. The sun is a fusion reactor delivering 1.52 x 10¹⁸ kWh/year to earth. All of mankind's energy needs total less than 0.1% of this amount. The United States receives more energy in the form of sunlight in less than 40 minutes than from all the fossil fuels they burn every year."²⁰

The above quote serves as a provocative thought regarding the amount of sunlight that Cape Town receives each year but is not harnessing. The sun's energy is renewable and sustainable, and with Cape Town receiving an average 8.42 hours of sunlight per day per annum²¹, there is no reason why solar power should not become a feasible and reliable source of power. Of course, there are debates around the efficacy and expense of solar power and these must be heeded, with the necessary warning that much of the efficacy and efficiency of a system depends on the expertise of the design (both of the Photovoltaic (PV) system and the building). To begin, though, we simply introduce the concept. The debate will be covered thereafter.

17 Joffe, H. "Costs of warming to the challenge" in Business Day Editorial, July 20, 2007.

18 NUS Consulting Group Survey, April 2007, accessed on 17 August, <http://www.nusinc.com/downloads/2007ElectricitySurvey.pdf>

19 Eskom "Tariffs and Charges: April 2007 to March 2008, p.42" accessed 17 August on http://www.eskom.co.za/live/content.php?Category_ID=287

20 Solar Energy Research and Education Foundation, quoted at <http://www.solar4power.com/solar-power-construction.html>, accessed 24 August, 2007

21 http://www.bbc.co.uk/weather/world/city_guides/results.shtml?tt=TT000580

Photovoltaic (PV) principles are used to produce solar electricity. PV (referred to as 'solar') panels are made of the natural element, silicon, which becomes electrically charged when subjected to sunlight. This electrical charge is then consolidated in the PV panel and directed to the output terminals to produce low voltage (Direct current) – usually between 6 and 24 volts. The most common output is intended for nominal 12 volts, with an effective output usually up to 17 volts.

Cape Town receives, as mentioned above, an average of 8.42 hours of sunlight per day. One hour of full sun provides 1000Wh per m², which represents the solar energy received in one hour on a cloudless summer day on a one-square metre surface directed towards the sun. To place this in perspective, the amount of solar energy that hits the earth's surface every hour is greater than the total amount of energy that the entire human population requires in a year²².

The output of a solar panel is stated in Watts, determined by multiplying the reference voltage by the amperage. Therefore, in Cape Town, a 12V, 60 Watt panel (measuring 20X44 inches), that receives an average 8.42 hours of sunlight per day, produces 505 Watt-hours of power per day. Cape Town's residential demand for electricity is 8,873,973 Kilowatt hours per day. That equates (on a 2004 measurement of 875,774 households) to 10.13 Kilowatts per day per household. Therefore, on average, each household would have to purchase +/- 22 Solar Panels to power their entire household by solar energy.

It is estimated that geysers constitute, on average, 40% of residential electricity bills. Providing a 100 litre solar geyser to all households (411,000) in Cape Town earning less than R1800 a month would cost the City R 1,676,738,214. The Net Present Value (NPV) of this investment (using the concept of opportunity cost²³ and the time value of money over a project period of 5 years) is R 412,521,104²⁴. This might seem like a large NPV, but it is worth noting that if it was taken over 4 years it would be marginally negative. The project thus becomes feasible if it has a projected lifespan of five years or more. Of course, solar geysers last for up to 20 years, which adds to the credibility of the argument. The fullness of these calculations will be demonstrated in the section titled "Economic Modelling."

b. Nuclear Power

A discussion on nuclear power necessarily involves a debate, as it is the one alternative source of energy that has managed to create rifts in all environmental movements across the globe. This section serves to summarise the debate and to discern the implications thereof for Cape Town.

Cape Town is home to the only Nuclear power station in South Africa. Koeberg produces 13 688 Giga-Watt hours of electricity per annum.

"The reactor at Koeberg is cooled by cold water from the Atlantic Ocean pumped through an isolated circuit at 80 tons a second. Low and intermediate level waste from Koeberg is transported by road in steel and concrete containers to a rural disposal site at Vaalputs, 600 km away in the Kalahari Desert. The grounds of the nuclear plant form a 22 km² nature reserve open to the public containing more than 150 species of birds and half a dozen small mammal species."²⁵ What Eskom fails to mention, however, is that the water used to cool the reactors is pumped back into the sea at higher temperatures than it was extracted at, thus contributing quite severely to the problems of melting ice caps and a rising sea level.²⁶

While the pro-nuclear school argue that nuclear power is far more economical²⁷ than coal-fired power (South Africa's predominant source of electricity) in an area that is geographically distant from coal

22 Solar Energy Research and Education Foundation, quoted at <http://www.solar4power.com/solar-power-construction.html>, accessed 24 August, 2007

23 Opportunity cost is the net benefit of a particular endeavour – it measures profit in terms of forgone opportunities. In this case, the opportunity cost of solar power is the amount of electric power forgone (which is initially less expensive, but with high operating costs. We therefore calculate the savings in terms of the time value of money (using a 10% discount rate) which would otherwise have been spent on the operating costs of an electric geyser.

24 These calculations can be accessed on the accompanying Excel spreadsheets

25 http://www.eskom.co.za/live/content.php?Item_ID=173, accessed on 27 August, 2007.

26 Swilling, M. 2006. "Sustainability and Infrastructure Planning in South Africa: A Cape Town Case Study in International Institute for Environment and Development, Vol. 18 (1):23-50

27 The word in this sense is used to refer to cost-effectiveness, notwithstanding all of the economic costs and benefits

supply (Cape Town is approximately 1500km from its nearest coal supply), the financial arguments often fail to capture decommissioning and nuclear waste costs. It is thus necessary to redefine the debate in some way to include the social costs of nuclear power in the economic model.

Electricity produced by a pressurised light water reactor, when all its carbon costs have been taken into account, emits around 16 tonnes of carbon dioxide per Megawatt hour. Gas produces 356 tonnes and coal 891. If the United Kingdom (UK)'s nuclear plants, for instance, are replaced by thermal plants, its annual output of CO₂ would rise by 51 million tonnes, or 8% of the total.²⁸ To place this in perspective, they would only save some 4 million tonnes of CO₂ through energy efficiency measures – this sheds some light on the minimal benefit of Eskom's efficiency drive against the benefits of Nuclear replacing coal.

Unfortunately, anti-nuclear campaigners often lose credibility by unthinkingly claiming statistics that are highly questionable. For instance, June's edition of *The Ecologist* magazine, contended that 14 million tonnes of concrete are required to build a nuclear power station, resulting in a massive release of carbon dioxide.²⁹ However, an examination of Calder Hall nuclear power station in the UK (opened in 1956), required only 108 000 metric tonnes of concrete, which is less than 1% of Jones's estimate. In addition, 40 to 50 years of assured global uranium reserves (not taking into account the possibility of identifying new sources) is, contrary to criticism, actually an unusually high level of assurance as far as mineral assurances go. As a refutation of the argument that mining uranium is dangerous, the same can unfortunately be said of mining any mineral deposit, thus reducing that argument's credibility too (especially in light of the fact that 1 tonne of uranium produces as much energy as 75000 tonnes of coal.)³⁰ Finally, (according to Monbiot) an accident like that of Chernobyl is unlikely to ever occur again in new nuclear power stations.³¹ However, this presumption is shaky, as the probability of an accident necessarily rises with an increasing number of power stations. Furthermore, the sheer volume of waste from future nuclear facilities poses significant risk.

Having noted the above, there are a few points in rebuttal worth noting. The world has still not provided convincing arguments for what happens to nuclear waste. It is irresponsible to start building Peddle Bed Modular Reactors (Eskom's PBMR programme) when the plan is simply to bury the waste 600 km north of Cape Town in the Kalahari Desert. The environmental cost of this plan is unclear, although it is clearly risky given the uncertainty of the extent of the latent impact of radioactive waste material, particularly in an area like the Kalahari, which is environmentally sensitive. Beyond the risk pertaining to uncertainty, it then becomes impossible to ascertain the true costs of building a nuclear power station if its decommissioning components and costs are unknown. Finally, "the world will not be rid of nuclear weapons until it is rid of nuclear power. Every state which has sought to develop a weapons programme over the last 30 years has done so by manipulating its nuclear power programme."³²

Monbiot goes on to suggest that the UK can do without nuclear because of the vast wind resources and carbon capture and storage methods that can reduce carbon emissions by the same amount that nuclear power would. However, given that many countries across the world do not have the kind of gas supplies or wind opportunity that the UK has, this is actually a problematic conclusion. Furthermore, Clive Hamilton takes Monbiot to task on the recommendation of burying carbon dioxide in underground aquifers, arguing powerfully against it due to the uncertain environmental consequences.

The argument around nuclear power is therefore by no means conclusive. The South African government's current approach is to allow Eskom to continue with their PBMR rollout plan regardless

28 Sustainable Development Commission, March 2006. "The role of nuclear power in a low carbon economy" in Paper 2: Reducing CO₂ emissions - nuclear and the alternatives, pp21-22. <http://www.sd-commission.org.uk/publications/downloads/Nuclear-paper2-reducingCO2emissions.pdf>

29 Jon Hughes, June 2006. "Building a Nuclear Power Station" in: *The Ecologist*.

30 The UK Department of Trade and Industry notes that "A nuclear station consumes much smaller amounts of fuel per unit of electricity generated than a fossil fuel station, some 40 tonnes of uranium fuel per annum as opposed to some 3 million tonnes of coal per annum at stations of comparable generation capacity" in: www.dti.gov.uk/energy/nuclear/technology/reactors

31 Sustainable Development Commission, March 2006. "The role of nuclear power in a low carbon economy. Paper 6: Safety and security, pp9-10" at <http://www.sd-commission.org.uk/publications/downloads/Nuclear-paper6-SafetyandSecurity.pdf>

32 <http://www.monbiot.com/archives/2006/07/11/thanks-but-we-still-dont-need-it/>, accessed on 27 August, 2007

of the uncertainty. This is cause for concern: As a general rule of thumb in environmental economics, any development can be justified on the grounds of the probability attached to the risks. In a case where risk fades into uncertainty (no probability can be attached to the risk), and the environmental impacts of the development are unknown, the development should not go ahead. It is thus the recommendation of this paper that the National Energy Regulator of South Africa (NERSA) and Eskom think more carefully about creatively employing safer alternatives such as wind and solar before turning to Nuclear as the primary source of alternative energy.

c. Wind Power

Any visitor to Cape Point Nature Reserve will understand the power of the wind in Cape Town. Winds are created by uneven heating of the atmosphere by the sun, irregularities of the Earth's surface, and the rotation of the Earth. As a result, winds are strongly influenced and modified by local terrain, bodies of water, weather patterns, vegetative cover, and other factors. The wind flow, or motion of energy when harvested by wind turbines, can be used to generate electricity.

The City of Cape Town has signed a 20 year contract with Darling Wind Power for the supply of environmentally friendly electrical energy, giving Cape Town residents the opportunity to make a positive contribution towards addressing global warming by purchasing "Green Electricity".

The Darling Wind Farm is a R70m national pilot project to build South Africa's first commercial wind farm. It has been designed to explore the technical, commercial and environmental viability of converting wind energy to electricity in the Western Cape and other regions of the country. The wind farm will initially comprise four 1,3MW wind turbines, to be located near the town of Darling in the Western Cape. It will produce an estimated annual 13 200 MWh of clean electricity, which comprises roughly 0.18%³³ of Cape Town's electricity demand.

The green electricity is to be sold at a premium to electricity consumers who have recognised the potentially devastating effects that global warming will have on Southern Africa and on the Western Cape in particular and who want to take positive action to reduce the emission of green house gases which cause this warming.

The generation of green electricity by the wind farm is expected to commence in 2007 and will assist the City in reaching one of the targets of its Draft Energy and Climate Change Strategy, that of sourcing 10% of all its "overall energy requirements from sustainable sources by 2020".³⁴

The social benefits of wind-generated electricity are quite clear:

Over 20 years, the Darling Wind Farm will result in the following environmental benefits (based on Eskom generation data, year 2004/2005):

Saving of resources:

- 140 000 tons of coal
- 333 million litres of water.

Reduction in pollutants:

- 254 000 tons of Carbon dioxide
- 2 321 tons of Sulphur Dioxide
- 1 022 tons of Nitric Oxide
- 74 tons of Particulates
- 41 448 tons of Ash

One should also consider two aspects of the net present value of these resource savings. On the one hand, the opportunity cost value will illustrate the purely economic benefit. On the other hand, and more importantly, the value of the environmental saving will be greater the sooner action is taken –

³³ Own calculations, based on City of Cape Town website and Energy Research Centre, UCT.

³⁴ "Cape Town goes green" in <http://www.sagoodnews.co.za/search/environment/872453.htm>, accessed 28 August 2007

the benefit of acting now far outweighs the benefit of acting years from now as the world is still within the time window to make the necessary carbon footprint reductions. The environmental costs of inaction will grow exponentially with each incremental rise in global temperatures.

Furthermore, it is a project which will serve as a catalyst and positive example for further renewable energy investments in the Cape Metropolitan area. This is particularly promising in view of the City Region's objective to position Cape Town as a "green city", thus preserving the environment for future generations at the same time as meeting its developmental objectives of reducing poverty and unemployment.

7. Cape Town: Civic Centre Case Study

This section serves as a 'bridge' between the previous section and the economic model (next section). It illustrates how the City of Cape Town can lead the way in greening the city by reducing its dependence on conventional electricity supply through energy efficiency measures and the purchase of green electricity when it comes online.

An official energy audit of the City of Cape Town's Civic Centre reveals consumed electricity as follows:

Table 7-1: Civic Centre Energy Audit

Month	Civic Centre Consumption MWh			
	2004	2003	2002	2001
January	1650	4224	2616	2184
February	3300	2310	1740	1494
March	1788	2196	1974	1620
April	1836	2031	1908	1374
May	1548	2031	1944	1596
June	1380	1728	1482	1146
July	2700	2040	1698	1524
August		1974	1860	1488
September		1962	1788	1290
October		3744	5376	1488
November		1944	1944	1596
December		1806	3156	852
Total	14202	27990	27486	17652
Cost	R 4 726 426	R 9 315 072	R 9 147 341	R 5 874 586

Source: Cape Town Civic Centre, *Lighting Feasibility Study, October 2004*

The electricity costs for 2008 to 2010 will be as follows, unless the suggested measures are implemented from 2007 onwards:

2008	2009	2010	2010
R 14,202,126	R 16,616,487	R 21,601,434	R 21,601,434

Source: Own Calculations based on Cape Town Civic Centre *Lighting Feasibility Study, 2004*

The Cape Town Civic Centre Lighting Feasibility Study recommended in October 2004 that the current Fluorescent U Shape bulbs (which consume 84% of the Centre's lighting requirements, which are in turn 32% of the Centre's electricity requirements), be replaced by Tri-Phosphor Compact Lamps. This would have cost the City a mere R5.3 million, at a cost saving of R1.5 million per annum due to improved efficiency. Furthermore, there would be an annual maintenance saving of R136,400. The future cost savings, combined with the significant benefits of taking the environmental lead (reduced

CO₂ emissions), make this a quick-win project. The benefits will be calibrated into the model and further expounded in Energy Efficient Lighting for Civic Centre (page 30, section 9.c (Practical Illustrations of how to use the model.) See also page 31, section 10.c

8. Economic Model of Current and Future Productive and Consumptive Behaviour

a. Non-Renewable Resource Use

This section forms the backbone of the argument for positioning Cape Town as a global green hub. It looks first at the projected financial costs of natural non-renewable resources in a 'business as usual' approach. It then considers the environmental and opportunity costs³⁵ of this approach. It is out of these that the strongest argument for renewable energy arises, along with a robust argument for rainwater tanks and other environmental management tools, all of which will contribute to the City's Constitutional Mandate to create an enabling environment for economic growth.

Table 8-1: Business as Usual Cost Forecasts of Raw Material Costs (2008 to 2012)

INPUT	2008		2009		2010	
	Energy (tons/yr)	Cost	Energy (tons/yr)	Cost	Energy (tons/yr)	Cost
Coal	571,885	R 225,429,338	590,422	R 227,059,614	609,559	R 229,168,232
Oil	1,718,526	R 7,874,933,888	1,774,229	R 9,390,071,168	1,831,736	R 11,196,720,861
Gas	329,423	R 205,209,000	340,101	R 242,146,620	351,124	R 283,311,545
Water	494,525,000	R 1,483,575,000	510,553,875	R 1,531,661,626	527,102,289	R 1,581,306,868
Uranium*	68	R 63,057	80	R 74,408	94	R 87,057
Econ Growth		3.2413%		3.2413%		3.2413%
Totals		R 9,789,210,283		R 11,391,013,436		R 13,290,594,563

2011		2012		Total	NPV
Energy (tons/yr)	Cost	Energy (tons/yr)	Cost		
626,757	R 234,631,387	644,441	R 241,251,379	R 1,157,539,950	R -880,465,812
1,883,417	R 13,350,969,954	1,936,557	R 15,919,696,574	R 57,732,392,445	R -45,221,832,325
361,031	R 368,305,009	371,217	R 478,796,512	R 1,577,768,686	R -1,245,318,062
541,974,184	R 1,625,922,553	557,265,681	R 1,671,797,043	R 7,894,263,091	R -6,018,941,248
122	R 113,174	158	R 147,126	R 484,822	R -382,665
	2.8214%		2.8214%		
	R 15,579,942,077		R 18,311,688,634	R 68,362,448,994	R -53,366,940,111

Source: Own Calculations, *Econometric Modelling of Social Costs, City of Cape Town (2007)*

This table is a representation of the Total Net Present Value (NPV)³⁶ of Cape Town's current consumption of raw materials projected between 2008 and 2012 in a "Business as Usual" scenario. The assumptions and detailed description of the forecasts appear in the Excel Spreadsheets (available on CD), but the main finding is clear: Cape Town's economy will consume R53 billion worth of raw material over the next 5 years in present value terms. This is unsustainable as the insecurity of supply will create an irreversible limit to growth unless a 'silver bullet' technology comes online before then. This is unlikely even by the most optimistic accounts.

Increases in the costs of local raw materials are high, but not as significant as the increase in price of imported oil. With the global oil price already nearing US\$100 a barrel, the impact on Cape Town's

35 Please see Glossary for explanation of terms

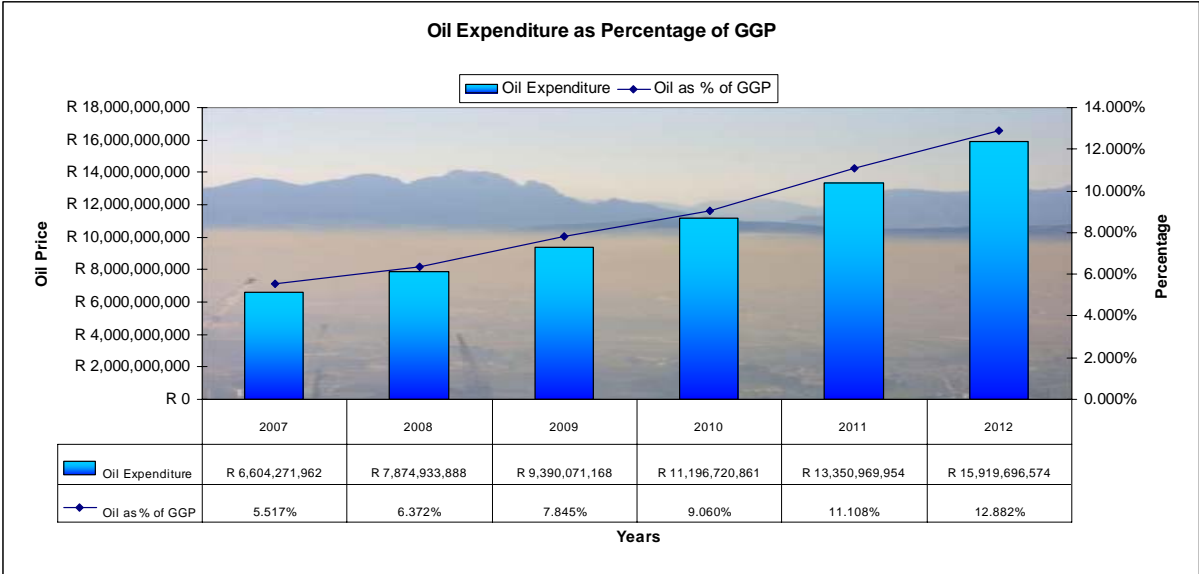
36 See Glossary for definition. We have used a discount rate of 10% (the current Repo rate)

economy is of particular concern. The graph below indicates the expected rise in oil prices as a percentage of GGP. GGP increases are projected in line with the City of Cape Town's updated Economic Growth Scenarios Model 2007 (which includes the impact of these same oil price projections.)

Oil constitutes close to 50% of Cape Town's energy consumption. Cost increases over the years have been insidious for the wealthy, with consumers largely unconscious of the danger or the latent impact. For the poor, however, the impact is immediately recognisable. Continuing increased oil prices – without a slowdown in demand – will have a significant effect on the economy:

- First, it carries knock-on inflationary effects. Price rises, coupled with the rising prices of imported material for South Africa's current construction boom, will further widen the country's Current Account Deficit. This in turn creates inflationary pressure in the economy. Inflation weakens the value of the currency, aiding exports but nonetheless hurting the poor whose wages have decreased as the quality of employment has declined.
- Second, Cape Town and South Africa are particularly vulnerable to oil price shocks as the import dependency to GGP ratio is approximately 50%. Thus, GGP is likely to fall with every major oil price increase, as it also has a recessionary effect on the global economy. On the other hand, Petro SA is expected to increase local fuel production (by synthetic production from offshore coal and methane beds) by building a 200 000 barrel a day refinery at Coega. However, the following warning appears in Business Day editorial, November 5 2007. "As taxpayers, we had better hope that the partner has very deep pockets. Internationally, the lowest-cost refineries have capacities of 300000 to 400000 barrels, so that becomes the aspiration of anyone looking to build one. But that is a lot more than SA is expected to need any time in the foreseeable future. The plan would be that PetroSA's refinery would export a large proportion of its production, but SA has no crude oil of its own and no particular competitive advantage in refining it. So it's hard to see why this is a business we'd want to be in. If public money is going to be required, PetroSA's plan needs to be scrutinised very carefully indeed."
- Third, and most importantly, the poor have a propensity to spend the majority of their income on products whose prices are directly influenced by the oil price such as food and transport. This makes the poor incredibly vulnerable to oil price shocks and rises. This means that for the poor, inflation is likely to be closer to the oil price increase than to the CPI.

Figure 8-1: Oil Expenditure as a percentage of Cape Town's GGP 2007-2012



Source: City of Cape Town (2007), built on Gasson, B. (2003)

The increase in price and its effect on the poor should be carefully considered. Increasing local production capacity is risky at best, given falling margins over the last 20 years, (with the exception of

increasing margins between 2002 and 2005). It is also cause for concern that neither Shell nor BP have shown interest in partnering with Petro SA. Furthermore, there is no pipeline to transport fuel from Coega to the economic heartland of Gauteng, although one is currently being built by another Para-statal, Transnet, from Durban to Johannesburg.

Table 8-2: Vulnerability of Cape Town to Oil Price Shocks

Vulnerability of Cape Town to Oil Price Shocks - Ratio of Net Oil Imports to GGP		
Oil Imports/GGP = (oil imports/total oil use)*(Total oil use/total energy use)*(total energy use/GGP)		
Oil Imports/GGP =	0.0196	1.63% (test)
Oil Imports/Total Oil use =	0.3661	:1-self sufficiency in oil production
Total Oil Use/Total Energy =	0.5225	dependence on oil as energy source
Total Energy use/GGP =	0.0854	energy intensity

Source: Own Calculations, Econometric Modelling of Social Costs, 2007, City of Cape Town

The above table indicates that Cape Town's economy, as a net importer of oil, is exposed to the fluctuations of the international oil price. The oil import to GGP Ratio is at 1.96%, with oil use constituting 52.5% of Cape Town's total energy use. The economy is also particularly energy intensive at a ratio of 8.5% to GGP.

Table 8-3: Impact of the Oil Price on National and Local Gross Product (GDP and GGP)

	Impact on GDP of a \$10/bbl increase in oil prices - in %	Population: Millions	GDP per Capita (US\$)	Oil Vulnerability	Oil Dependency	Energy Intensity BTU per 1995 US\$ of GDP	Net Oil Exports as % of GDP
South Africa	-0.8	43.76	\$2,844.00	0.54	0.209	24928	-1.9
Cape Town	-0.8	3.042	\$5,909.88	0.52	0.209		

Source: Own Calculations, Econometric Modelling of Social Costs, 2007, City of Cape Town

What this means for Cape Town is that **a \$10 rise in the oil price will have a -0.8% direct impact on GGP growth**, notwithstanding the latent inflationary impact of higher food and transport prices on GGP growth too. Furthermore, the reduction in global GDP attributable to the same shock is 0.5%, which translates into a further 0.5% reduction in the GDP of oil importing countries³⁷.

On average in Cape Town (2004), households spent approximately 40.58% on products that are either directly or indirectly influenced by the oil price (own calculations, Quantec 2006 data). The breakdown on oil-related expenditure per income bracket is unfortunately not available. However, the UNDP paper (referenced above) suggests:

"Calculations show that low-income deciles are more severely affected than higher income groups. For example, a study of Yemen of a possible price increase of petroleum products, equivalent to US\$15 a barrel, raised the cost of acquiring the same bundle of goods as before by 14.4%, while for the top decile the increase was only 7.1%. An important component of this total cost of living increase came from impacts on non-fuel expenditures, especially those on transport and food, which are impacted by higher diesel prices."³⁸

37 "The Impact of Higher Oil Prices on Low Income Countries and on the Poor", March 2005. United Nations Development Program (UNDP), in association with the World Bank's Energy Sector Management Assistance Programme.)

38 ibid

Table 8-4: Historical Petrol and Diesel Price Increases

Average Petrol Price Increase p/a	2000	2001	2002	2003	2004	2005	2006
Price	312.25	373.00	402.83	393.08	442.67	555.00	596.80
Increase		19.46%	8.00%	-2.42%	12.61%	25.38%	7.53%
Average Diesel Price Increase p/a	2000	2001	2002	2003	2004	2005	2006
Price	280.40	313.80	347.51	326.96	372.58	565.10	770.40
Increase		11.91%	10.74%	-5.91%	13.95%	51.67%	36.33%

Source: Own Calculations, extracted from South African Fuel Price History

The cost calculations indicate that diesel price inflation stands at a cumulative figure of over 100% for the four years between 2003 and 2006. If the cost of acquiring the same bundle of goods as before is 14% higher for the poor as a result, and these price increases create further barriers to entry in the labour market, then there is even more impetus for local policies to be directed at ensuring high quality, affordable public transport.

Finally, small and medium enterprises are also likely to suffer from higher fuel costs, and the size of the price rise, coupled with the volatility of oil prices in general points to a possible barrier to the sustainable development of these sources of growth. This is of particular importance in Cape Town, where 5% of businesses employ approximately 90% of the local labour force. Small and medium enterprises are crucial to employment growth, and thus it would make sense for government to protect them from oil price shocks.

It should be noted that this is simply the financial outlook. On these grounds alone, there is a strong argument for the government to drive policies which reduce dependency on oil and increase fuel efficiency.

b. Environmental and Opportunity Costs

The environmental costs of Business as Usual are difficult to define within any measurable parameter. There are a number of studies, though, which can be undertaken that go beyond the scope of this paper. For instance, one could measure the health costs associated with increased particulate matter in the air or the devaluation of property near a polluting factory. However, such a specific study would exclude the more generic and cutting point that the current rate of natural resource exploitation will retard economic growth when it reaches a supply ceiling. Furthermore, continued environmental degradation and reliance on coal-fired power create two fundamental economic problems:

- First, electricity supply insecurity will become an increasing deterrent to both local and foreign direct investment. It is also likely to reduce equity inflows as investors lose confidence in the ability of the economy to sustain growth. Eskom are operating within a tight excess capacity margin. Most estimates sit at 8-10%, which is significantly lower than international norms of roughly 20%. The costs to the economy of continued blackouts are likely to exceed the cost of subsidising newcomers to the renewable energy market or the cost of efficiency measures.
- Second, foreign direct investment will be increasingly unforthcoming as global pressure mounts to reduce Greenhouse Gas Emissions. This has negative consequences for business and job creation. Global businesses are required to meet Triple Bottom Line Accounting standards, which includes contributions to environmental preservation. Furthermore, shareholder awareness of the need for environmental sustainability will deem it increasingly difficult for companies to undertake new business ventures in countries that are insufficiently dedicated to ecological preservation.

Table 8-5: Environmental Costs of Cape Town's Energy Usage

Inputs	Tons/yr	Outputs	Tons/yr	Carbon Equivalents (Metric tonnes)	Monetary Value
Energy	2,783,658	Carbon Dioxide	7,865,590	2,145,161	R 616,164,725
Coal	571,885	Sulphur Dioxide	48,660		
Oil	1,718,526	Oxides of Nitrogen	42,812	3,619,519	R 1,039,651,700
Gas	329,423	VOCs	83,565		
Wood	163,823	PM ₁₀	17,507		
		PM _{2.5}	9,246		
				Total	R 1,655,816,425

Source: Own calculations, City of Cape Town (2007) based on Gasson, B (1996)

The importance of this table cannot be overemphasised. Currently, non-renewable resources are accounted for as free goods. Furthermore, emissions are "zero-priced," meaning that there is no monetary value placed on the earth's carbon cycle capacity. At the least, resources should be accounted for as assets that depreciate over time, and emissions costs should be reflected by the market value that would bring environmental equilibrium. Plans are afoot at the UN to change the System of National Accounts (SNA) to reflect this sentiment. The implications for South Africa are that the country's balance sheet will look significantly different, given its high commodity base.

Table 8-5 places an economic value on environmental degradation. The most reliable value ascribed to greenhouse gas emissions is by a proxy indicator: their price in a Carbon trading market. While there is much debate around the efficacy of a carbon market in actually reducing global greenhouse gas emissions to safe levels, it at least allows decision-makers to place a value on the cost of degradation, from which the benefits of investing in renewable technologies can be illustrated. The important thing to note is that the monetary value provided above is a serious understatement of the true environmental cost. It does not consider the increased burden on the state's health budget to deal with respiratory illnesses, nor does it consider the cost of increased pressure on the infrastructural system to deal with solid waste and increasing traffic congestion. Finally, it also fails to represent the cost of reducing the regenerative capacity of the land upon which it is making a footprint. (These will be covered in more detail in the section labelled "shortcomings of the model".)

Fortunately, utilising an understatement enhances the credibility of the argument that Cape Town has no choice but to reduce its ecological footprint if it is at all serious about ensuring sustainable economic growth.

Below is a representation of the City's annual secured direct investment figures for the 2006/2007 financial year. The striking reality is that the city's environmental costs outweigh the value of investment coming into the city by a significant R500 million (Table 8-5). This is the lens through which civil society, all three spheres of government and business have to start viewing their consumption behaviour costs.

Table 8-6: Direct Investment in Cape Town 06/07

	Direct Investment
• Trade and Investment Promotion – Wesgro	R605,114,642
• Call Centres, Bus Process Outsourcing - Calling the Cape (annual survey done in November)	R240,000,000
• Film – Cape Film Commission	R306,380,000
• Craft – Cape Craft and Design Institute	R4,300,000
• Total	R 1,155,794,642

Source: City of Cape Town, Corporate Scorecard (2007)

An additional point to consider is the cost of continued electricity blackouts to the Cape Town Economy. "Power is a sore point in the city, where increased demand on the conventional grid has triggered a number of outages in the past three years, reportedly costing Cape Town businesses at least US \$81 million in lost revenue."³⁹ This equates to approximately R200.3 million per annum. It is an opportunity cost to the extent that it captures income forgone as a result of electricity supply insecurity.

Table 8-7: The Environmental and Opportunity Costs of Business as Usual (The Model)

COSTS	2007	2008	2009	2010	2011	2012
Environmental Costs	R 1,655,816,425	R 1,709,485,856	R 1,764,894,856	R 1,822,099,810	R 1,873,509,332	R 1,926,369,344
Blackout Costs	R 200,396,327	R 206,891,707	R 213,597,619	R 220,520,888	R 226,742,761	R 233,140,181
Sub-Total	R 1,856,212,752	R 1,916,377,563	R 1,978,492,475	R 2,042,620,698	R 2,100,252,093	R 2,159,509,525
Opportunity Costs	R 346,738,392.60	R 357,977,110	R 369,580,103	R 381,559,181	R 392,324,659	R 403,393,879
Total	R 2,202,951,145	R 2,274,354,672	R 2,348,072,579	R 2,424,179,879	R 2,492,576,752	R 2,562,903,403

Source: City of Cape Town, Econometric Modelling of Social Costs (2007)

c. Assumptions of the Economic Model

Assumptions are often the most contentious element of an economic model. It is therefore important that they stand up to criticism. Either way, they are predictive, based on imperfect knowledge of the future, and by no means definitive. However, they remain a useful tool, and their inadequacies do not render them implausible.

In light of the substantiation below, the opportunity costs (of business as usual) are conservatively calculated at 30% of current direct investment flowing into the city, broken down as follows.

- Any physical development, particularly in an environmentally sensitive area, carries irreversibility and uncertainty with regard to its ecological footprint. Of course, Cost-Benefit Analyses are carried out along with environmental impact assessments, but the opportunity cost is often overlooked. For instance, the new Berg River Dam Project will temporarily secure more water for Cape Town, but the uncertainty of the impact on downstream farms (especially in the context of climate change models that reliably predict a drier and warmer Western Cape in the near future), means that agriculture could suffer significantly. Furthermore, the stream of future benefits that could be derived from the development of a nature reserve (ecotourism, etc.) is now forgone. To drive the point home, the expenditure could have paid for sustainable water reticulation and recycling systems for residential households and waterless urinals. These options will be examined in the Recommendations section. Given the above, opportunity costs in this regard are estimated at approximately 13% of current direct investment into the city.
- Second, approximately 10% of current investment opportunities in Cape Town are forgone, attributable both to continued expected blackouts over the next 5 years (as Eskom continues its load-shedding strategy in building future supply) and Cape Town's weak signal of intent to become more environmentally friendly. The weak signal of intent is reflected partly in the City's inability to implement the Energy and Climate Change Strategy that was formulated in 2003. While any initiatives undertaken in Cape Town alone are unlikely to impact this figure, it stands as an argument to harness national collective action.
- Third, the remaining 7% is an estimate of the decommissioning and waste costs of Nuclear electricity generation. While these costs will only be felt by future generations, they must be calculated as a part of our current footprint. Their value is estimated at approximately R176

³⁹ http://www.sacities.net/members/sustainable_news.stm, accessed on 30 October 2007

million a year, notwithstanding the possible future environmental costs of radioactive landfill sites. (Reference: <http://www.uic.com.au/nip13.htm>)

d. Calculations of the Economic Model

The Environmental Cost shown above is calculated at US \$38.7 per ton of Carbon. This is based on a paper published in the international journal *Ecological Economics*⁴⁰, which suggests that a properly functioning Carbon market would have to place a value of roughly \$40 per ton of Carbon in order to reduce greenhouse gas emissions to within acceptable limits. Using this as a premise, we estimated Cape Town's current Carbon output by increasing the 1996 figures by 51% (the size by which the Cape Town economy has grown since then). The assumption, substantiated by Swilling, is that resource use occurs at a highly correlated level to economic growth.

The projection to 2012 is calculated according to the differing economic growth levels as predicted by the Economic Growth Scenarios work, and the Rand value equivalent is also derived from that work.

In order to calculate the Carbon Equivalent of the Carbon Dioxide and Nitrous Oxide emissions, the following equations were used:

$$\text{CE of CO}_2 = (\text{MMTCE}) * (\text{GWP}) * (12/44) \text{ and CE of NO}_2 = (\text{MMTCE}) * (\text{GWP}) * (12/44)$$

Where CE is Carbon Equivalent, MMTCE is Million Metric Tons of gas, and GWP is Global Warming Potential. The Global Warming potential of Carbon Dioxide is 1, whereas the GWP of Nitrous Oxide is 310.⁴¹ The 12/44 is used because the molecular weight of Carbon is 12/44 times as much as Carbon Dioxide.

Therefore, the figures that appear in the model represent the cost of emissions in Cape Town that have been credibly translated into a Carbon Equivalent (CE).

e. Debate

The credible premise underpinning the notion of Carbon Trading proposes that the earth's carbon-cycling capacity must be treated as a commodity if it is to be respected and preserved. In other words, the earth acts both as a carbon sink (absorptive capacity) and as a generator of natural resources (regenerative capacity), and the only way to save it is to market it as a scarce resource and asset. The journal article from which we derived the Carbon price argues that: "Simulation models and theory prove that emission trading converges to market equilibrium at US \$38.7."⁴² In other words, it is at this price that global Carbon outputs would be neutralised.

There is much debate on the efficacy of such a market in achieving its goal, perhaps best summed up in the following line: "price cannot be an adequate substitute for the intrinsic value of carbon-cycling capacity or its survival value, and this would demonstrate climate, scientific, social, economic and political misunderstandings."⁴³ Of course, the continued downfall of the Kyoto Protocol (particularly the US's refusal to ratify it) is perhaps a case in point of the difficulties of collective action, but the point remains that a global mechanism is necessary.

While the debate is important in pragmatic terms for setting up international Carbon markets, it does not reduce the efficacy of this model's intention, namely to use price as a minimal indicator of damage from "Business as Usual". It is unquestionable that price is not a sufficient mechanism to capture the costs of 'business as usual', but it does put a figure on the table which can be used as a platform for practical policy deliberation; this is the purpose of the model.

40 Klaassen, G, Nentjes, A and Smith, M. "Testing the Theory of Emissions Trading" in *Ecological Economics*, Vol 53, Issue 1, April 2005, pp.47 to 58. The abstract can be read at http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VDY-4FFGJJ6-4&_user=10&_coverDate=04%2F01%2F2005&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=64c60c0fc9139ea5d806742d21d6d2bc

41 http://www.cogeneration.net/Global_Warming_Potential.htm

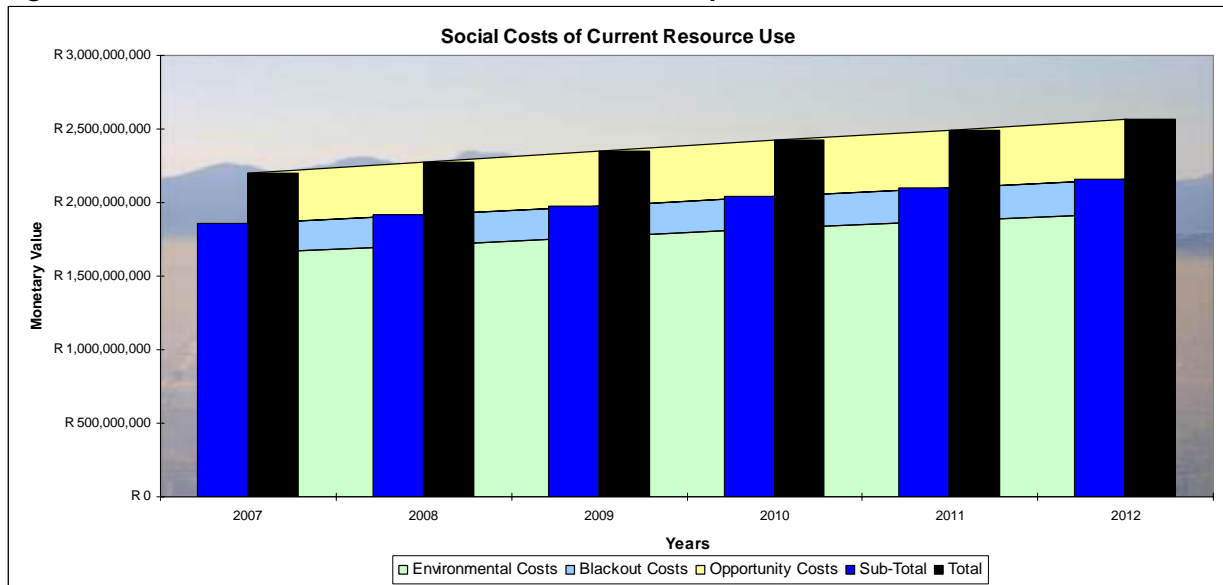
42 42 Klaassen, G, Nentjes, A and Smith, M. "Testing the Theory of Emissions Trading" in *Ecological Economics*, Vol 53, Issue 1, April 2005, pp.47 to 58.

f. Results

The figures are elucidating. **At best, “business as usual” will cost Cape Town over R2 billion Rand a year in addition to the exponential financial increase in the cost of the fossil fuels it currently consumes.**

While this figure will not be formally presented on any balance sheet, it is closer to reality (the “true” cost) than current financial reporting would portray. As such, it should be utilised in any decision-making process that the City or its residents undertakes.

Figure 8-2: Social Costs of Current Resource Consumption 2007-2012



Source: City of Cape Town, *Econometric Modelling of Social Costs (2007)*

The costs illustrated above will rise over time, with the majority of the social cost constituted by the environmental cost. From a policy perspective, it now becomes more viable to present an argument for the City to vigorously pursue the implementation of the Energy and Climate Change Strategy. These scenarios, with practical recommendations, will be explored in the next section. The value of the model is that any potential project can be inserted into it to illustrate the costs and/or savings for the local economy.

g. Shortcomings

Any model faces shortcomings; these are presented below.

- First, it fails to capture the costs of water that returns to the sea at higher temperatures after having been used to cool the turbines at Koeberg. The potential damage to the mariculture industry from this behaviour remains undetermined.
- Second, this model captures nothing of the potential economic impact of climate change on Cape Town. Climate change will not be affected by Cape Town’s actions. It is more important for Cape Town to put strategies in place to deal with the impending effects of climate change, than to attempt to prevent it. The potential impact on agriculture is one such challenge that must be addressed as soon as possible. Having said this, the figures in the model call for immediate investment in renewable and efficient technologies; this can only stand Cape Town in good stead to deal with the effects of impending climate change.
- Third, there is no monetary value placed on the harmful effects of solid and nuclear waste dumps. This is waste from which toxins seep into the soil, destroying its agricultural potential and contaminating underground aquifers.

- Finally, the model is unable to quantify the cost of biodiversity loss attributable to current resource use. Biodiversity is, in a sense, the source of life on earth, and its value can never be determined by a market. However, that is not to say that an economic value cannot be placed on biodiversity hotspots (such as the Kirstenbosch Gardens.) The opportunity cost of that endeavour, for instance, is the amount of revenue which could be generated from selling the land as residential property. However, that would fail to capture the environmental and social value of Kirstenbosch.

These shortcomings do not detract from the model's efficacy of illustrating at least part of the cost of current and future economic activity, but they do point to the need for capturing social costs and benefits (including environmental) in more decisions that are traditionally decided on the basis of a financial balance sheet alone.

h. Macroeconomic Implications

For the Macroeconomic implications of current and future non-renewable resource exploitation, please refer to the Updated Growth Scenarios work produced by the City of Cape Town (2007). The updated model illustrates the effect on economic growth of heightened natural resource and electricity constraints, likely future exchange rate and interest rate values, along with massively increasing oil prices.

In short, with these changes taken into consideration, economic growth between 2005 and 2010 is expected to drop from 4.4% (original projection) to 3.2%, and from 3.9% (original projection) to 2.8% between 2010 and 2015. As mentioned in the explanation of the importance of the effect of the oil price on poor households, a drop in GGP growth to this extent will have a severe negative impact on the poor.

9. Practical Illustrations of How to Use the Model

a. Solar Water Geysers

Around 40% of the average household electricity cost is from heating water (this percentage is even higher in low income households)⁴⁴. Solar geysers would allow a savings of up to 80% of that amount.

The graph and tables below indicate the cost differential between solar geysers and conventional electric geysers.

Table 9-1: Comparison of Electric to Solar Water Heaters

Solar						
Geyser Size	Total Initial	Year 1	Year 2	Year 3	Year 4	Total
100 litre solar	R 7,926.00	R 246.38	R 290.72	R 340.15	R 377.94	R 9,181.18
150 litre solar	R 9,701.00	R 344.93	R 407.01	R 476.20	R 529.11	R 11,458.25
200 litre solar	R 11,973.00	R 443.48	R 523.30	R 612.26	R 680.29	R 14,232.33
Electric						
Geyser Size	Total Initial	Year 1	Year 2	Year 3	Year 4	Total
100 litre electric	R 3,847.00	R 1,215.45	R 1,434.23	R 1,678.05	R 2,181.47	R 10,356.20
150 litre electric	R 3,995.00	R 1,724.63	R 2,035.06	R 2,381.02	R 3,095.32	R 13,231.02
200 litre electric	R 5,169.00	R 2,217.38	R 2,616.50	R 3,061.31	R 3,979.70	R 17,043.89

Source: Own Calculations based on Eskom tariff increases and "Solarzone" tariff structures

After 4 years, the initial higher value of capital investment in the solar geyser is paid off in nominal terms. In terms of Net Present Value, it takes a further year for the project to become viable (the NPV to become positive.) The average lifespan of a solar geyser is approximately 20 years, whereas the

⁴⁴ <http://www.gildergeyser.com/>

average expected lifespan of a conventional geyser is approximately 8 years⁴⁵. Furthermore, electric geysers contribute up to a third of residential CO₂ emissions.⁴⁶

Thus, the argument is not merely financial. A 40% (of the 43% electricity demand incurred by households) reduction in residential demand on coal-fired power would reduce the Carbon Dioxide emissions by the same percentage, but also alleviate supply concerns, thus reducing both part of the opportunity and blackout costs. The combination of these benefits is reflected using the model below:

Table 9-2: Cost Savings of subsidising 411 000 households with Solar Water Heaters

Scenario: Every Poor Household Solar Water Heater						
COSTS	2007	2008	2009	2010	2011	2012
Environmental Costs	R 1,364,657,665	R 1,408,889,863	R 1,454,555,745	R 1,501,701,779	R 1,544,071,451	R 1,587,636,559
Overall reductions	17.58%	17.58%	17.58%	17.58%	17.58%	17.58%
Blackout Costs	R 0	R 0	R 0	R 0	R 0	R 0
Sub-Total	R 1,364,657,665	R 1,408,889,863	R 1,454,555,745	R 1,501,701,780	R 1,544,071,451	R 1,587,636,559
Opportunity Costs	R 138,695,357.04	R 143,190,844	R 147,832,041	R 152,623,672	R 156,929,864	R 161,357,551
Total	R 1,503,353,022	R 1,552,080,707	R 1,602,387,786	R 1,654,325,452	R 1,701,001,315	R 1,748,994,110
Overall reductions	31.76%	31.76%	31.76%	31.76%	31.76%	31.76%

Solar geysers use approximately 40% of residential electricity use⁴⁷, and Cape Town's proportion of residential electricity demand (as a percentage of total useful energy consumption) is 43.96%. Therefore, 40% of 43.96% equates to an overall reduction in Carbon emissions of 17.58%.

Explanation

- The element of environmental costs that is constituted by Carbon Dioxide emissions is reduced by 17.58% per annum (in the above table), and this equates to an overall saving of 31.76% of Cape Town's environmental cost through this simple action.
- A reduction of 17.58% of demand on Eskom Supply means a radically reduced chance of blackouts, thus reducing that element of the 'unseen' costs of business as usual. The blackouts are now thus presented as R0. However, this is dependent on all cities taking the same action at the same time, as Cape Town will not necessarily be insured against blackouts by its own responsible actions. It must therefore encourage and lobby the use of Solar Water Heaters in all cities across the country.
- Furthermore, the element of opportunity cost that was associated with businesses choosing to invest elsewhere - because of electricity supply insecurity and partly not being "green enough" - is removed, equating to only 12% (as opposed to the original 30%) of current investment into the city.
- Overall, then, solar water geysers installed in all households would reduce the 'business as usual' environmental and opportunity costs by approximately 30%. In addition, it could be the catalyst for spurring serious environmental awareness and other significant behavioural changes.

Practical Options

- **Subsidisation at the 'low end' of the market.**

Hot water constitutes the largest component of poor households' electricity consumption. For those not currently connected to the grid, paraffin, gas and wood are being used in large quantities to satisfy the need for hot water, contributing to the infamous brown haze that settles over the Cape Flats in the absence of the prevailing South Easter. There is therefore both an equity and environmental argument for the subsidisation of solar water geysers at the low end of

45 <http://www.solien.co.za/compare-electric.htm>

46 iafrica.com/diy/bright_ideas/434323.htm

47 www.eskom.co.za

the market. The disclaimer is that subsidies run the risk of unsustainable dependence, but in this case it is a once-off investment that requires no repeat subsidy. The table below illustrates the Net Annual Savings of a project that would provide 100-litre solar water geysers to Cape Town's 411 000 poorest households at a once-off cost of R1,6 billion.

TOTAL INITIAL COST	Year 1 Saving	Year 2 Saving	Year 3 Saving	Year 4 Saving
R -1,676,738,214.00	R 398,353,783	R 470,057,465	R 549,967,234	R 741,368,260

According to Quantec 2006 Data, there are 411 000 households that earn under R1800 per annum. To provide solar water geysers for each household would cost the City R1,67 billion (see Table above). This is 7.98% of the City's annual Budget. Against a saving of R 647,278,957 in terms of the environmental and investment benefits it would bring, the effective nominal financial cost is only R1.03 billion. The Net Present Value of the R1,67 billion investment would become positive after only 5 years. Future cash flows of annual savings (the difference between solar and electric) provide a net present value of approximately R412 million.

The evidence is clear that the City should commit to this project. In fact, it does not have to fund it alone; a partnership with the private sector would be ideal.

Beyond the mere financial figures, the economic benefits of such a project would be as follows:

- Injection of capital into an industry that is vital to the environmental sustainability upon which economic growth can pivot. Current demand for solar water geysers is low – due to high start-up costs. A project of this nature would induce a shift in the demand curve, thus preceding future economic growth. Furthermore, and most importantly, it would provide the kind of output volume opportunities on which firms depend to achieve increasing returns to scale (IRS).
- The City has an opportunity to create highly necessary competition in the sector of renewable energy. Eskom's involvement in this segment of the market is to be carefully understood so as to avoid the crowding out of private investment, which is economically and socially optimal. Competition and scale in the market of solar geyser production and installation will also bring the initial start-up costs down, thus incentivising middle and upper income households to invest in the sustainable, medium term cost saving option.

➤ **Insurance/Finance Schemes at 'high end' of the market**

One of the major barriers to the production of photovoltaic (PV) equipment (solar panels) is the high import duties imposed on products that are essential to their production. These keep costs high, and thus hinder voluntary consumer investment. In order to overcome this, there are 2 solutions that should work together.

- The first is that work must be done to ensure the reduction of import duties. Decreased tax revenue for the state in this regard is preferable to a market in renewable energy that continues to struggle with barriers to entry.
- Second, because solar geysers are more reliable than electric geysers, there is an argument for developers to partner with insurance companies in reducing premiums for customers who purchase solar water heaters. It is important, however, to ensure that the "savings" are not then squandered on luxury items, but that there be a condition which ensures - for instance - a sustainable household water reticulation system.

The marketing of the second option will be crucial to its success. The City should partner with insurance firms to advertise the proposed scheme. In order for solar water geysers to become a feature of middle and higher income households, both the moral environmental argument and the economic argument must work together. There is truth in both of them, and that is what must be driven home.

Water Constraints

There is much international debate about the efficacy of water desalination plants as a means of securing water supply and preventing environmental damage: “Seawater desalination may have a place in the world’s future freshwater supplies, but regions still have cheaper, better and complementary ways to supply water that are less risky to the environment,” according to Jamie Pittock, Director of WWF’s Global Freshwater Programme. Potential impacts of desalination include brine build-up, greenhouse gas emissions, destruction of prized coastal areas and reduced emphasis on conservation of rivers and wetlands⁴⁸. For this reason, other options should be considered first. Residential rainwater tanks are one such option.

b. Rainwater Tanks

Rainwater tanks have a number of advantages. First, they aid self-sufficiency during times of drought and relieve pressure on the municipality to provide water in the face of increasing demand. This is an important consideration for the City, as the reduction of pressure on its infrastructural capacity is a necessary imperative to creating that enabling environment for economic growth which is nationally mandated. Second, they can provide cost-effective retention of on-site stormwater. Third, and most importantly, reticulated water use can be reduced by 50 to 100% in urban areas. This reduces the demand for new dam construction, thereby preserving natural river flows (which are globally in danger of drying up.)⁴⁹ Also, it reduces the infrastructure demand on the City’s water, stormwater and sewerage supply. Finally, it reduces the energy used in pumping water, thus decreasing associated greenhouse gas emissions⁵⁰.

To the extent that the model captures the social cost of ‘business as usual’, the costs and benefits of residential rainwater tanks are expounded against the model.

The table below illustrates the cost and percentage composition of Cape Town’s water consumption. While the savings from Rainwater tanks will reduce the City’s income revenue, it will relieve pressure on the infrastructural capacity that is currently being exerted.

Table 9-3: Water Usage in Cape Town

Cost/annum	WATER THROUGHPUTS		
	Use Sector	Kl/annum	%
R 668,981,000	Residential: Homes	122,300,000	37.34
R 382,353,000	:Gardens	69,900,000	21.34
R 279,840,000	Industry	48,000,000	14.66
R 127,094,000	Commerce	21,800,000	6.66
R 112,270,000	Public: Municipal	21,800,000	6.66
R 67,465,000	: Sports	13,100,000	4.00
R 169,218,000	Unaccounted	30,600,000	9.34
R 1,807,221,000	TOTAL	327,500,000	100.00

Source: Own calculations, based on DWAF and City of Cape Town 2007

The average cost of a 2000 litre home rainwater tank is \$100 (Australian) or R6009. A tank of this capacity is estimated to be sufficient to water a residential garden annually on top of its other use requirements. On this premise, the following tables illustrate the benefits of all high income households in Cape Town acquiring a 2000 litre tank against the costs of the Berg River Dam project (which is being built to sustain demand in Cape Town) and the projections⁵¹ of what it will cost the City to meet infrastructure backlogs and future ongoing demand.

48 <http://www.wrc.org.za/downloads/waterwheel/sep-oct%2007/desalination%20p%2024-26.pdf>

49 Pearce, F. 2006. “Introduction” to *When the Rivers Run Dry* (Transworld Publishers, London)

50 <http://www.greenhouse.gov.au/yourhome/technical/fs22.htm>

51 Swilling, M. “Cape Town 2025: A City of Sustainable Neighbourhoods”, Sustainability Institute, University of Stellenbosch.

Table 9-4: Water Consumption by Income Group

Water Consumption by Income Group			
Income Group	Litres/cap/day	%Consumption 1990	%Consumption 2020
Low income	80	11.00%	23.00%
Middle Income	100	30.00%	35.00%
High Income	150	59.00%	42.00%

Source: P. Little, Ninham Shand Inc; Spies and Barriage, 1991

Table 9-5: Projections of Business as Usual Water Consumption

Scenario: Business as Usual - Water						
COSTS	2007	2008	2009	2010	2011	2012
Water Costs	R 1,807,221,000	R 1,807,221,000	R 1,807,221,000	R 1,807,221,000	R 1,807,221,000	R 1,807,221,000
Berg River Project	R 250,000,000	R 250,000,000	R 250,000,000	R 250,000,000	R 250,000,000	R 250,000,000
Infrastructure Costs	R 296,000,000	R 296,000,000	R 261,000,000	R 225,000,000	R 208,000,000	R 194,000,000
Opportunity Costs	R 34,673,839	R 35,797,711	R 36,958,010	R 38,155,918	R 39,232,466	R 40,339,388
Total	R 2,387,894,839	R 2,389,018,711	R 2,355,179,010	R 2,320,376,918	R 2,304,453,466	R 2,291,560,388

Table 9-6: Rainwater tanks for richest households in Cape Town

Scenario: Rainwater Tanks for richest households						
COSTS	2007	2008	2009	2010	2011	2012
Water Costs	R 1,271,615,878	R 1,271,615,878	R 1,271,615,878	R 1,271,615,878	R 1,271,615,878	R 1,271,615,878
Berg River Project	R 250,000,000	R 250,000,000	R 250,000,000	R 250,000,000	R 250,000,000	R 250,000,000
Infrastructure Costs	R 149,480,000	R 149,480,000	R 131,805,000	R 113,625,000	R 105,040,000	R 97,970,000
Opportunity Costs	R 17,510,289	R 18,077,844	R 18,663,795	R 19,268,739	R 19,812,395	R 20,371,391
Total	R 1,688,606,167	R 1,689,173,722	R 1,672,084,673	R 1,654,509,617	R 1,646,468,273	R 1,639,957,269
Percentage Reductions	-41.41%	-41.43%	-40.85%	-40.25%	-39.96%	-39.73%
Rainwater Tanks Costs	R 737,658,831					

Source: Own Calculations, Econometric Modelling of Social Costs 2007.

Calculations and Assumptions

- Water costs over the next 5 years are expected to remain constant (Table 9-5). According to Swilling, high income residential homes will use between 59% and 42% of water between now and 2025. Given that residential use accounts for 58.68% of all water usage in Cape Town, we calculated an average between 0.59 and 0.42, and multiplied that against 0.5868 to calculate the reduced water cost to residents. This is simply to illustrate the savings. If all wealthy households were to purchase rainwater tanks, the total water cost would decrease substantially. In terms of practical options, it should be noted that the City again has an option to subsidise rainwater tanks for poor households, but as the poor use a very small proportion of Cape Town's water, the benefits would not be as pronounced.
- The capital cost of the Berg River project has been split equally over the 6 years in Table 9-6. Given that the project will only increase Cape Town's water supply by 18%, and rainwater tanks for affluent households would reduce conventional demand by around 40%, it would have made far more sense to provide the R737 million for rainwater tanks as opposed to the R1.5 billion of the Berg River project. In addition, the R737 million is only marginally higher than the annual amount spent by residential homes on water use every year. A once-off cost against the prospect of having to pay annually again makes clear economic sense.

- Opportunity costs in the 'business as usual' projections were calculated at the value of expected water supply constraints to the economy and its impact on economic growth. They would be reduced by approximately 50% by the use of rainwater tanks.
- The infrastructural costs of meeting future demand are taken directly from the work of Swilling, 2005. Again, the use of rainwater tanks would reduce these by approximately 50%.

Taking all of the above into account, the City is strongly encouraged to promote the use and purchase of residential rainwater tanks. In addition to the cost savings from reduced demand on infrastructure, the City will be able to improve the quality and efficiency of water provision to poorer households.

c. Energy Efficient Lighting for Civic Centre

The City Energy Audit of the Civic Centre in 2004 made the strong recommendation (as noted in section 6) that the current Fluorescent U-shape bulbs (which provide 84.4% of the Centre's lighting requirements) be replaced by CFL 2X Dulux-L 36/840 Triphosphor lamps. The audit estimated an annual cost saving of approximately R1.5 million. Below are illustrated 2 scenarios for calculating the benefit of undertaking the necessary investment. The first is derived from the Energy Audit, the second is derived from the City's own document on "How to implement Energy Efficient Options". The latter provides a far greater annual cost saving as it assumes that the CFL option is 80% more efficient than conventional. For project purposes, Scenario 1 should be used as it is the more conservative option, and therefore more reliable.

Table 9-7: Scenarios for Civic Centre Cost Savings with Energy Efficient

Scenario 1: Cost Savings for Civic Centre - Energy Efficient Lighting. Source: Energy Audit 2004					
	2008	2009	2010	2011	2012
Lighting Costs	R 4,588,422	R 5,368,454	R 6,978,990	R 9,072,687	R 11,794,494
Fluorescent U shape	R 3,872,477	R 4,530,798	R 5,890,037	R 7,657,048	R 9,954,163
2x Dulux-L 36/840 triphosphor	R 5,340,000	R 2,862,670	R 4,221,909	R 5,988,920	R 8,286,035
% Reduction	26.90%	-46.59%	-36.14%	-28.04%	-21.76%
Total Cost Savings	-R 1,041,843	R 2,110,836	R 2,128,544	R 2,146,961	R 2,166,114
New Annual costs	R 4,914,319	R 2,419,962	R 3,761,493	R 5,510,088	R 7,788,049

Scenario 2: Cost Savings for Civic Centre - Energy Efficient Lighting. Source: "How to Implement Energy Efficiency Options..."					
	2008	2009	2010	2011	2012
Lighting Costs	R 4,588,422	R 5,368,454	R 6,978,990	R 9,072,687	R 11,794,494
Fluorescent U shape	R 3,872,477	R 4,530,798	R 5,890,037	R 7,657,048	R 9,954,163
2x Dulux-L 36/840 triphosphor	R 5,340,000	R 906,160	R 1,178,007	R 1,531,410	R 1,990,833
% Reduction	26.90%	-89.77%	-87.82%	-86.25%	-85.00%
Total Cost Savings	-R 1,041,843	R 4,067,346	R 5,172,446	R 6,604,472	R 8,461,316
New Annual costs	R 4,914,319	R 463,452	R 717,591	R 1,052,577	R 1,492,846

Source: Own calculations, based on Economic Model (2007) and Civic Centre Energy Audit (2004)

d. Calculations

The original cost is represented in the 2nd row of each scenario. The new costs are represented in row 3. The total cost savings are derived from the difference between the 2, but with the addition of the monetary value of the Carbon Dioxide emissions reductions. Based on the calculation that 1Kwh of electricity produces 0.89kg of CO₂, the table below indicates the emissions costs and volumes of the savings. In other words, the KWh savings with the new lights are multiplied against 0.89 to calculate the CO₂ savings. These are then multiplied against 12/44 to find the Carbon equivalent, which is finally multiplied against \$38.7 per ton to establish the total cost savings. Thus, the initial cost saving in Scenario 1 was R1.5 million per annum; with the aid of the economic model, it is more accurately reflected as roughly R2.1 million per annum.

Given the above work, it is imperative that the City take the lead in retrofitting its buildings with energy efficient lighting. The cost savings alone – approximately R2.2 million per annum - are adequate reason to undertake the investment of R5.3 million, let alone the immeasurable benefit of creating the truthful perception that the local government is serious about reducing its ecological footprint.

10. Recommendations

- a. This model should be used to ensure that all new buildings built in Cape Town are fitted with energy efficient lighting, solar water heaters and rainwater tanks. This should be built into policy governing building applications and any building which the City itself is responsible for maintaining, upgrading or building.
- b. The City is to use the Economic Model as a policy tool by which to indicate the environmental and economic costs and benefits of any new development or project. In particular, the Department of Economic and Human Development (EHD) should include the use of the model as part of the sustainable model for all new projects.
- c. The City should retrofit the Civic Centre with energy efficient lighting. Option 3 in the Civic Centre Audit of 2004 should be implemented with immediate effect. It is a cost-saving option with both seen and unseen benefits. As far as competing priorities are concerned, the sooner the investment is made, the sooner is cash freed up to achieve other development priorities. There is no justifiable reason for resisting this project. Every argument in its favour is sound economically, financially and environmentally.
- d. In as far as the MFMA allows, the City should undertake to provide solar water heaters for the poorest households. This is a once-off subsidy which will provide a much-needed incentive for local producers of renewable energy to become competitive, thus making it more attractive for higher-income users as well (as manufacturers experience increasing returns to scale through higher sales volumes). Again, the argument that there are more important priorities is untenable. Conventional electricity will become increasingly expensive and no cleaner in the next twenty years. If the City is serious about committing to the creation of an enabling environment for economic growth, which is socially and environmentally responsible, then there is no reason why a project of this magnitude should not be undertaken. Economic growth is a national strategic priority. Reducing pressure on current infrastructure capacity and providing the platform for a private market in renewable energy are two highly practical steps towards creating this enabling environment.
- e. This work provides a basis for City business support towards the creation of a local market in renewable energy. A special purpose vehicle (SPV) could be established to guide this process.
- f. Finally, the City should run an awareness campaign, and provide a possible subsidy, for residential rainwater tanks. That water supply security will soon become the greatest global issue, Cape Town would do well to get ahead in terms of planning. The region's rainfall is more than sufficient to supply perennial water needs. This would free existing supply capacity to aid agricultural endeavours that will increasingly suffer the effects of global warming. Again, this is a practical step to ensuring an enabling environment that is so necessary for sustainable economic growth to occur. If water supply is not secured as soon as possible, there is a significant chance that economic growth will be retarded altogether.

11. Conclusion

The above paper and model signify a necessary and important departure from viewing expenditure as it is narrowly defined by conventional balance sheets. The reality of the necessity of environmental preservation as a means through which economic growth can be achieved at all is clear. There are costs to 'business as usual' which currently do not appear on any formal financial statements. However, the inability of financial statements to capture very real costs is simply a signal that other

means must be utilised to conceptualise and 'proactively react' to the challenges of environmental degradation. This work is one such tool.

It has been shown that the environmental costs of 'business as usual' are large and serious cause for concern. Furthermore, and with more immediate effect on society's pocket, there is the threat of consistent power blackouts over the next few years as Eskom builds further capacity in coal-burning power that has been hitherto neglected.

However, economic theory suggests that every threat carries a market opportunity, and Cape Town has the opportunity to create a functioning, healthy, competitive market in renewable energy. Building this market will require both technical and negotiating skill to ensure the necessary market structures are in place. In other words, care must be taken to ensure that private sector investment is not crowded out by monopoly or oligopoly interests.

Opportunity costs are difficult to measure, but when one considers the conservative estimates offered by the model (bearing in mind that the Cape Chamber survey estimated blackout costs at approximately R5 billion – much higher than our R200 million figure - in 2006 alone), we believe that the costs are reliable. The primary objective of the demonstration of these costs is to engender a different means of conceptualising the benefits of a project. In any development, the cost of forgone opportunities must always be carefully considered, especially in the face of irreversibility and uncertainty.

Natural resource constraints are a major obstacle to future economic growth. The sooner we act to prevent the medium and long-run effects of these constraints, the healthier for the economy and the environment. Water reticulation, particularly through the use of rainwater tanks, is a highly viable means of mitigating at least the water constraint. Given that water will soon become the scarcest resource on earth, the R6000 it costs for a 2000 litre tank that lasts for 20 years is a modest investment in the face of benefits of large future savings and the knowledge of valuable contribution to environmental preservation.

The model has demonstrated a world of economic possibilities that present themselves through the objective of sustaining the natural environment. In line with the recommendations (on page 31) mentioned in the previous section, the following clearly spell out the benefits of going green.

- First, the installation of solar water heaters and rainwater tanks provides an opportunity to provide a new skill for the currently underskilled and unemployed. These skills will be in ever-increasing demand as the pinch of climate change starts making itself felt both physically and in consumers' consciences.
- Second, the City has an opportunity to stipulate the use of local content and local labour if it is involved in the financing of such projects. This will go some way to alleviating poverty and reducing unemployment in line with the EHDS objectives.
- Third, and most importantly, the "greening" of Cape Town will reduce the current untenable pressure on basic service infrastructure capacity, and thus attract necessary local and foreign direct investment, which will grow the economy and contribute to the environmental preservation of the city at the same time. This is the mandate of the EHDS, and it must be given practical efficacy as soon as possible.
- Finally, there are many hidden benefits to the greening of Cape Town, the monetary value of which cannot be measured. Nonetheless, the model provides a reliable and accurate estimation of the costs of inaction against the benefits of acting to "green" Cape Town now.