

Economic Analysis of the City of Cape Town Solar Water Heater Programme



Prepared for:

The City of Cape Town

Energy and Climate Change Unit

Prepared by

Barry Standish
Antony Boting
Brian Swing

February 2013

Contact:

Strategic Economic Solutions

3 Avery Avenue

Constantia, 7806

Tel: 021 794 9406

083 320 8670

Fax: 021 794 9406

Email: barry@stratecon.co.za / antony@stratecon.co.za

Disclaimer: While every effort has been made to ensure the accuracy of this report, no responsibility is taken for errors or financial losses or any other incidental or consequential damages arising as a result of its use.

Headline Findings

This report examines the economic consequences of the City of Cape Town's Solar Water Heater (SWH) Programme. Three sets of results are presented, namely an economic cost benefit analysis, a financial stakeholder analysis and a macroeconomic analysis.

Results of the Economic Cost Benefit Analysis

The Cost Benefit Analysis indicates that the cost of the SWH programme has a present value (PV) of R1 744m. The benefits, when calculated according to different societal values for electricity generation savings, could have a PV ranging from a low of R2 028m to a high of R6 414m, with a weighted average of R3 824. The corresponding benefit-cost-ratio (BCR) varies from the low of 1.17 to a high of 3.68, with the weighted average being 2.19.

The general conclusion to the economic cost benefit analysis is that since most of the BCRs are higher than 2.0 the project can be considered economically efficient. However, since the BCRs for two of the five cases are less than 2.0 they could be considered marginal because of the number of assumptions employed. A sensitivity analysis was conducted on a number of the variables, including extreme combinations of the least and most favourable variables. For the least favourable combination the BCR does reduce to less than one but for most other combinations is above one. The conclusion to the sensitivity analysis, and therefore to the economic cost benefit analysis, is that the project remains economically efficient for realistic changes to, and under most extreme combinations of, the assumptions.

Results of the Financial Stakeholder Analysis

The net present value of the cash flow to all the stakeholders is based on a 20 year time horizon. It is estimated that¹:

- Households installing the SWH units have the highest savings with a NPV of R5 046m.
- This is followed by Eskom with a NPV of R1 399m (excluding VAT)...
- Installation Companies have a NPV of Net Profit to the value of R356m.

¹ Unless otherwise stated all amounts include VAT. In certain circumstances VAT is excluded because from the point of view of the City of Cape Town, for example, it is able to pass on VAT. VAT is therefore not relevant from that perspective.

- The City of Cape Town would have lower net revenue with a PV of R3 201m (excluding VAT) than without the SWH programme. In other words, the City of Cape Town would have revenue losses because of the programme and it would need to explore ways to recoup these losses.
- There would be reduced VAT receipts by the National Government to the value of R388m.

The financial stakeholder analysis therefore shows that while the households installing the SWH units, the installation companies and Eskom are all winners while the City of Cape Town loses out. The financial NPV of all the parties combined is R3 213m and the financial IRR is 51%.

The balance of payments to Cape Town (i.e. its municipal government and all its citizens) is positive from year 1. The PV of the balance of payments to Cape Town over the twenty year analysis period is a positive R3 796m.

Results of the Macroeconomic Analysis

There are many macroeconomic benefits that would arise as a result on the expenditure from the manufacturing, installation and maintenance of SWH units (which includes sales, marketing and administration costs). The proposed SWH programme is expected to make a cumulative contribution to GDP of over R3.1bn by the end of year five (the end of the rollout period) and of over R2.8bn to Western Cape GGP.

Total direct jobs are expected to increase from 88 in year 1 to as many as 701 in the fifth year of the programme. Most of these jobs are in manufacturing and installation. Similarly, total indirect jobs are set to increase from 90 in the first year to 720 by the fifth year.

Total direct and indirect jobs in the Western Cape are expected to amount to 177 in the first year and 415 in the following year. It is expected that total direct and indirect jobs would amount to 892 in the third year, followed by 1 405 and 1 421 in the fourth and fifth years respectively. Total jobs nationally are expected to increase from 286 in the first year to 2 292 in year 5.

Overall Conclusion

The overall conclusion from the economic analysis is that the project appears to be economically efficient. It has a generally robust benefit cost ratio across most permutations that were tested. This initiative has the potential to create a new industry in the Western

Cape. From a macroeconomic perspective the project will generate income and jobs, particularly in the manufacturing and installation industries.

The single negative aspect of the proposed project is the loss in revenue to the City of Cape Town Electricity Services Department (ESD), although this loss in revenue is less than the overall financial savings to the households that install SWHs. In other words there is a net overall benefit to Cape Town. The revenue loss to the ESD may be offset by natural demand growth and some cost savings. However, should the City of Cape Town need to recover its losses from all its citizens then the fact is that all citizens would bear the financial burden of those households that install the SWH units. This in itself might encourage more households to install SWH units. The more people who install SWHs the less the degree of cross subsidisation and the greener the city. Such an approach could see a marked movement away from coal fired electricity to renewable energy in the city of Cape Town. It would also be seen as part of the contribution of the City of Cape Town to reducing climate change.

Executive Summary

During the course of 2008 South Africa suffered a series of power outages. These power outages caused immense economic damage and general inconvenience. Three new base load generators have been commissioned but electricity supply will remain in jeopardy until they are operating. In the light of this the City of Cape Town is evaluating a variety of interventions to reduce demand for electricity. One of these is the evaluation of the potential to stimulate the growth of an embryonic solar water heater industry in Cape Town. The process that would be followed would be through the acceleration of the installation of solar water heaters by private households. .

Some of the current impediments to the significant uptake of solar water heaters include upfront capital costs and uncertainty about the actual financial savings. The City intends to address the capital cost constraints by supporting a scheme that puts in place financial arrangements so that the capital costs will be paid off monthly over five years. The intention is also that households that install solar water heaters will have overall net electricity and financial savings from the moment of installation. The financial savings will increase over time as the electricity price increases in nominal and, probably, real terms. There will be a jump in these savings when the capital cost of the solar water heaters is fully paid off.

The local manufacturing of solar water heaters has the potential to incubate a nascent industry. It is hoped that the economies of scale from mass production runs will drive down costs and grow productivity. This, in turn, has the potential for the industry to sell to the rest of South Africa, Africa and the world. Such success would create jobs and generate incomes. These jobs and income might start at the skilled level but these would be distributed on a wider scale through the multiplier effects.

In addition there can be little doubt that a move to renewable energy will position Cape Town as a green city and a smart city.

Financial assistance for the CoCT SWH programme has been provided by AFD (French Development Agency) and as part of its due diligence process AFD requires an appraisal of the potential economic benefits of the programme. The City of Cape Town appointed Strategic Economic Solutions to undertake this economic evaluation (refer to the Terms of Reference in Appendix A). This was done using two approaches. The first was by calculating the present economic value of the programme through the economic costs and benefits of the project. This was done by using both an economic and a financial cost benefit approach.

The second was a macroeconomic analysis. These macroeconomic effects include the contribution to national GDP, provincial GGP, direct and indirect jobs and taxes.

This executive summary has three main sections.

- The first outlines the approach that was taken, the assumptions underlying the analysis and international experiences in the development of a renewable energy sector.
- The second reports the results of the analysis.
- The third concludes the executive summary.

Approach, Assumptions and International Experiences

This section has three objectives:

- First it outlines the approach.
- Second is to specify the assumptions underlying the costs and benefits.
- Third is to report on international experiences resulting from the development of local capacity to manufacture and install renewal energy equipment.

Approach

Two different types of analysis were undertaken. These were a cost benefit analysis and a macroeconomic analysis.

Economic Cost Benefit Analysis

Two types of cost benefit analyses were followed in the study. The first was an economic cost benefit undertaken from a societal perspective. The second was a financial cost benefit analysis from a stakeholder perspective. The costs and benefits of each of these sets of analyses are outlined in Table ES 1.

The methodological approach in a cost benefit analysis is to compare the proposed project to the base case or business as usual case. In this particular instance the base case assumes that there would be a small take up of solar water heater units among the targeted households. All the costs and benefits over this period are discounted to present day values by using a real social discount rate of 8%. Although the SWH programme is a five year programme the economic analysis is performed over twenty years. This is done in accordance with international best practice and because this is the assumed life of the solar

collector. Although all the costs and the benefits are concentrated in the Western Cape, the analysis has been conducted from a country wide, i.e. South African, perspective. An economic analysis includes all costs to society. This is done by adjusting for shadow prices and wages and removing the distortions caused by taxes and subsidies.

Table ES 1: Cost Benefit Analysis – Perspective and Approach

Stakeholder	Costs	Benefits	CBA Approach
Society	SWH installation and maintenance costs	Reduction in Electricity Supply Reduction in peak load electricity demand Reduction in emissions Potential to reduce power outages	Economic
SWH users	SWH installation and maintenance costs	Savings on the electricity bill	Financial
Service Providers / Manufacturers	SWH installation and maintenance costs	Mark up on installation and interest rates	Financial
City of Cape Town (local government)	Administrative cost of the program Reduced revenue from lower electricity sales	Reduced risk of load shedding Increased GDP and jobs	Financial Input Output
ESKOM	Loss of revenue from electricity sales & Rebates	Avoided costs of marginal electricity generation	Financial

The outcomes of the analysis are reported as a net present value (NPV), a benefit cost ratio (BCR) and an internal rate of return (IRR) for those cases where the project is compared to a do minimum alternative. A NPV shows the total value of future costs and benefits reduced to a present day value. The BCR measures the changes in benefits and costs that would result from an investment. BCRs are typically used when there are many competing alternatives and projects need to be funded from a limited set of resources. If the evaluated benefits of a project are indeed greater than the overall project costs then the BCR ratio would be greater than 1. Low BCR's, even if greater than 1, provide a warning that a project could be risky and may turn out to become an economic liability instead of an asset.

Financial cost benefit analysis

Financial cost benefit analysis focuses on individual stakeholders and how the financial position of each stakeholder changes as a consequence of the SWH programme. Four stakeholders were analysed:

- Households who install SWHs as part of the programme. Their costs are the monthly cost of paying off the SWH and maintenance costs while their benefits are electricity savings owing to a decrease in the amount of electricity purchased.
- Service providers who manufacture and/or install SWHs. Their net benefits are profit on the mark up on SWHs and mark up on interest charges.
- The City of Cape Town which would have financial implications from less electricity sales and the administrative costs of running the programme. The benefits are in the form of reduced electricity purchases from Eskom.
- Eskom would have costs from the rebate given to SWHs and reduced income from electricity sales but it would then benefit from not having to generate electricity particularly during peak load periods. This benefit would manifest itself as not having to invest capital in new generation plants to cover both base and peak demand.

Macroeconomic Analysis

The size of a national or regional economy is measured in terms of the total of all economic activities taking place within the area concerned, both in the public and private sectors. The name given to the measure of the size of the economy is Gross Domestic Product (GDP) for the country as a whole or Gross Geographic Product (GGP) for a province or other sub division of the nation.

While there are a number of different types of macroeconomic effects, the two most important are contribution to GDP and creation of jobs. The importance of job creation is obvious. Increases in GDP are synonymous with increases in peoples' economic standards of living. Increased GDP – i.e. increased production – is experienced in the form of more jobs, higher wages and reduced economic hardship. It is clearly an important measure. In the first instance it may be more skilled people who are employed on the production of SWHs and who are likely to benefit from the programme. However because they have increased income their expenditure is also likely to increase and, through the multiplier effect, less skilled people throughout the economy will ultimately also benefit.

Assumptions

Costs and Energy Savings

The costs of the project are the manufacture and installation costs of the units and on-going maintenance costs. Sales, marketing and administration costs as well as the cost of delivery have been included in the manufacture and installation costs of the units.

The SWHs include 150 litre, 200 litre and 300 litre units. It has been assumed that 57 600 of the 150 litre units would be rolled out and 43 200 units of both 200 litre and 300 litre capacities over the five year programme period.

The efficiency of the SWH's is assumed to be 60% (annualised average), meaning that they use electricity for 40% of their heating needs and 60% is provided by the sun. The average monthly electricity savings are 153.1 kWh for the 150 litre units, 195.7 kWh for the 200 litre units and 282.7kWh for the 300 litre units. There has been some debate around the certainty of this efficiency level. Experience in South African conditions is limited and although preliminary results are tending towards this level it was decided to vary this assumption in a sensitivity test. The results are reported later on in the analysis.

Total retail installation costs are expected to start at R93m in the first year building up to R216m, R464m, R726m and R726m in subsequent years. Maintenance costs are expected to be R1m in the first year building up to R29m by year five. All costs are in real 2012 values.

Benefits

In an economic cost benefit analysis the benefits are those to society at large and not to the individual home owner. As a consequence the benefits are not the sum of the individual savings from installing SWH units. Rather they are the savings from not having to produce electricity. A large part of these savings are measured as the levelised cost of electricity (LCOE). It is typically reported per MWh of electricity. LCOE includes all capital, fuel, fixed and variable costs for operation and maintenance. Interest rates, inflation and taxation are included as are carbon costs. LCOE excludes transmission and distribution costs, localised externalities like the morbidity and mortality impacts of NO_x and SO_x emissions from coal fired generators without flue-gas desulphurisation (FGD) and opportunity cost of the use of water in water cooled coal fired generators.

Internationally the lowest cost is natural gas (\$66/MWh), followed by hydro (\$89/MWh), wind (\$96/MWh) and conventional coal (\$98/MWh). Some of the highest are coal with CCS

(\$139/MWh) and solar PV (\$153/MWh). However, this is very much location dependent. In South Africa, as is well known, the bulk of Eskom's generation capacity is coal based. In 2011/12 coal provided 90% of the electricity generated by Eskom. In 2011/12 the cost of electricity generation was \$49/MWh.

The key issue in this analysis is what type of electricity generation the SWH rollout needs to be compared to. Arguably the cost comparison should be made to future generation options and not existing capacity. The reason for this is that the SWH rollout will offset the need for future capacity. Existing capacity is, by and large, fully utilised and any comparison of SWH to existing capacity would also have to include the cost of potential power outages.

For the purposes of this analysis the SWH rollout is compared to the cost of a number of renewable and non-renewable electricity generation options. These options are chosen on the basis of the IRP2010-2030 and related developments such as the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP).

There are currently three large power stations under construction in South Africa. These power stations are Medupi, Kusile and Ingula. Medupi and Kusile are both dry cooled coal fired power stations. Medupi was started in 2007 and Kusile in 2008. Kusile is designed with FGD and is carbon capture and storage (CCS) ready but not installed. Medupi does not have CCS and FGD will be retrofitted in 2018. Ingula is a pumped storage station. It is located in the Little Drakensberg and is expected to be operational by 2014.

Both coal fired stations have a considerable advantage over their international counterparts. According to the latest Eskom Integrated Report (2012) Medupi, has a LCOE of \$54 per MWh and is therefore remarkably lower than the international norm for advanced coal without CCS at \$110.9 per MWh. Kusile, with a LCOE of \$73 per MWh, has a clear advantage over other advanced coal with CCS with an international average of \$139 per MWh. Ingula has a projected LCOE of \$96 per MWh.

Arguably the lowest cost future electricity generation option will be at least as expensive as Kusile. It will not have a cost equivalent to Medupi. This is the case for at least two reasons. As mentioned, Medupi had no CCS mechanism and is only being retrofitted with FGD in 2018. The latter, in itself, reduced the present value of the LCOE. The second is that if Medupi were replicable then Kusile would have similar costs.

The second issue to consider is whether South Africa has the luxury of adding more coal fired capacity. There was a major international outcry when Medupi and Kusile were initially commissioned and major pressure was brought to bear on the World Bank not to fund the

projects. It can be expected that the commissioning of further coal fired power would result in even more international pressure.

As a consequence the SWH rollout is compared to the costs of Kusile, Ingula, combined wind and solar PV, a threshold value² below which DSM projects are considered beneficial as determined by ESKOM in their IRP 2010-2030 analysis and a weighted average³ of the four. It would however be incomplete to compare LCOE to SWH because two costs are not included in LCOE. These are the costs of distribution, on the one hand, and transmission losses on the other. In personal communication with NERSA in 2010 the distribution costs were quantified as 12.5 c/kWh. Updated to 2012 prices this is 13.85c/kWh. According to Eskom's Integrated Report 9.8% of electricity sales were lost during transmission and distribution. The dollar LCOE are converted to Rands at an exchange rate of R8.36⁴. Distribution costs and transmission losses are added to this giving an overall cost of 82.3c, 116.3c, 154.7c and 236.4c per kWh for Kusile, Ingula, wind and solar PV combined and the DSM threshold value respectively. The weighted average for the four generation options is 151.3c per kWh.

In theory there are additional benefits in the form of emission savings from the SWH programme compared to electricity generation by Kusile. Eskom has an emissions factor of 1.03kg of CO² for every kWh of electricity sold with its current mix of electricity generation⁵. However, the value of Carbon Credits had dropped considerably in recent times and is currently trading at less than R20 per ton⁶. Consequently this is not factored into the base analysis. A sensitivity analysis is done on including carbon credits in order to capture the much higher perceived social value of carbon emissions.

International Experiences

International experiences suggest that a renewable energy manufacturing and generation industry can be job intensive. It is found that:

- Across a broad range of scenarios, the renewable energy sector generates more jobs than the fossil fuel-based energy sector per average megawatt.

² This is quoted as R2.13/kWh in 2010 prices, which is R2.36 in 2012 prices.

³ Weighted according to their respective supply capacities as indicated in the IRP2010-2030

⁴ Source: South African Reserve Bank, average rate for 2 July 2012 to 26 October 2012

⁵ Eskom 2012 Integrated Report.

⁶ <http://www.cdm-watch.org/wordpress/wp-content/uploads/2012/09/AAU-banking-briefing-paper-Point-Carbon.pdf>

- While the majority of jobs in the fossil fuel industry are in fuel processing, and operations and maintenance the majority of jobs created in the renewable energy industry are in manufacturing and construction. Biomass energy is an exception, where the majority of jobs are also in fuel production and processing (in agriculture), and operations and maintenance.
- There is not such a clear distinction between fossil-fuel and renewable technologies in the number of jobs created in operations and maintenance and fuel processing. Reliable, low-maintenance wind turbines are estimated to require fewer jobs to operate than are needed to fuel and operate coal and gas plants. However, more jobs are created in operations and maintenance of PV systems than in the operations and maintenance and fuel processing for coal and gas plants, while biomass plants may create more or fewer jobs in operations and maintenance and fuel processing than do coal or gas plants, depending on the way biomass collection is organized.
- A study for the World Economic Forum states:
 - Newly constructed solar PV generates seven times more job-years than gas generation, primarily because solar panels are modular and require a lot of labour in manufacturing and installation.
 - Solar PV creates more than five times as many domestic job-years as gas generation. The large amount of labour required in solar PV installation must be done locally because installation services cannot be imported. The solar PV industry is relevant because it requires a similar number of jobs for installation and maintenance as the SWH industry.
- Industries that would benefit:
 - Glass and glass product manufacturing;
 - Plastics packaging materials and un-laminated film and sheet manufacturing;
 - Ornamental and architectural metal products manufacturing;
 - Wiring device manufacturing;

Country Specific Impacts

- In the EU between 2006 and 2010 the renewable energy industry has increased its workforce from 230 000 to 550 000 (IHS CERA 2012, p.36);
- In Germany it is estimated there were 370 000 jobs in the renewable energy sector in 2010, with more than a quarter of those jobs in the wind sector and nearly a third in solar PV (IHS CERA, p.34);
- In the USA:

- According to a 2004 meta-analysis from of the Renewable and Appropriate Energy Laboratory (RAEL) at the University of California, Berkeley, which examined 13 studies on the economic benefits of renewable energy, approximately 240 000 jobs could be created and maintained if the country passed a 20% by 2020 renewable portfolio standard (RPS). If the U.S. relied solely on fossil fuels, the country would only maintain around 75 000 jobs (<http://www.renewableenergyworld.com/rea/news/article/2007/04/the-economic-impact-of-renewable-energy-48201>).
- A study by the Centre for American Progress estimated that that clean-energy investments in the US generates (Pollin et al. 2009, p.30) :
 - Roughly three times more jobs than an equivalent amount of money spent on carbon-based fuels;
 - Clean-energy investments create 16.7 jobs for every \$1m in spending;
 - Spending on fossil fuels, by contrast, generates 5.3 jobs per \$1m in spending;
 - Relative to spending on fossil fuels, clean-energy investments create 2.6 times more jobs for people with college degrees or above, 3 times more jobs for people with some college, and 3.6 times more jobs for people with high school degrees or less.
 - Spending \$150bn on clean-energy investments would create roughly 1.7m jobs. This is even after assuming a reduction in fossil fuel spending equivalent to the increase in clean-energy investments.
- In South Korea (IHS CERA 2012, p.40):
 - Number of manufacturing companies in renewables increased from 41 in 2004 to 146 in 2009, employment increased from 689 to 9 151 over the same period.
 - Exports of renewables increased from US\$65m in 2004 to US\$2bn in 2009, and solar PV and wind are expected to continue to play a key role.

Results

This section gives the results of the economic analysis.

Macroeconomic Results

The macroeconomic results that are presented here are only for the manufacture and rollout of the 144 000 SWHs targeted in the programme. It is clearly the intention of the programme

to establish a competitive solar water heater programme in Cape Town. This would result in macroeconomic contributions well in excess of those reported here particularly if a successful export industry is established. An example of an extended roll-out in excess of the City's programme is given at the end of the macroeconomic section.

Direct and Indirect Jobs

The SWH programme would create two types of jobs. The first are the direct jobs that would be created as a result of the programme. These are jobs in the manufacturing, installing⁷ and maintaining the SWH units. The second are the so-called indirect jobs resulting from multiplier effects of the various forms of expenditure. Some of the indirect jobs would occur in the province and the balance would occur elsewhere in the country. These jobs would need to be balanced against the possible job losses in the current electric geyser industry. Since the extent of the local electric geyser industry is not known these job losses could not be quantified. Consequently only the new jobs are reported here and not potential job losses. The impact of changes in household disposable income has also been excluded from the analysis. Any increase in disposable household income in Cape Town as a result of lower spending on electricity would be offset by lower revenue in the electricity generating sector.

It is expected that:

- 87 direct jobs would be created in manufacturing and installation and one maintenance job in the first year of the rollout
- 202 in manufacturing and 3 in maintenance in the next year;
- 433 in manufacturing in the third year and,
- 679 jobs sustained in manufacturing in years 4 and 5.
- 22 direct jobs would be sustained in maintaining the units at the end of the rollout. (This estimate is based on a conservative maintenance schedule. If the units are maintained as often as once a year there could be as many as 96 direct jobs sustained. This higher estimate is based on a team of two people servicing on average ten SWH units a day.)

Indirect jobs resulting from the rollout are expected to increase from 90 in the first year to 720 in the fifth year of the programme.

⁷ This includes jobs in sales, marketing and administration

Total direct and indirect jobs in the Western Cape are expected to amount to 177 in the first year and 415 in the following year. It is expected that total direct and indirect jobs in the province would amount to 892 in the third year, followed by 1 405 and 1 421 in the fourth and fifth years.

Total jobs nationally are expected to increase from 286 in the first year to 2 292 in year 5.

Western Cape Gross Geographic Product

Naturally while many of the direct effects of the programme will be felt within the province there will be indirect effects on other provinces. As a result the contribution to GGP is less than that to GDP. Total contribution to GGP is expected to amount to:

- R117m in year 1,
- R274m in year 2,
- R589m in year 3,
- R927m in year 4 and
- R938m in year 5.

Based on these projections, the proposed SWH programme is expected to make a cumulative contribution to Western Cape GGP of over R2.8bn after five years. The majority of this contribution would occur in Cape Town since the manufacturing would take place in the city rather than elsewhere in the province.

The contribution to Western Cape GGP and total jobs in the province is illustrated in Figure ES 1. The values are in constant 2012 Prices.

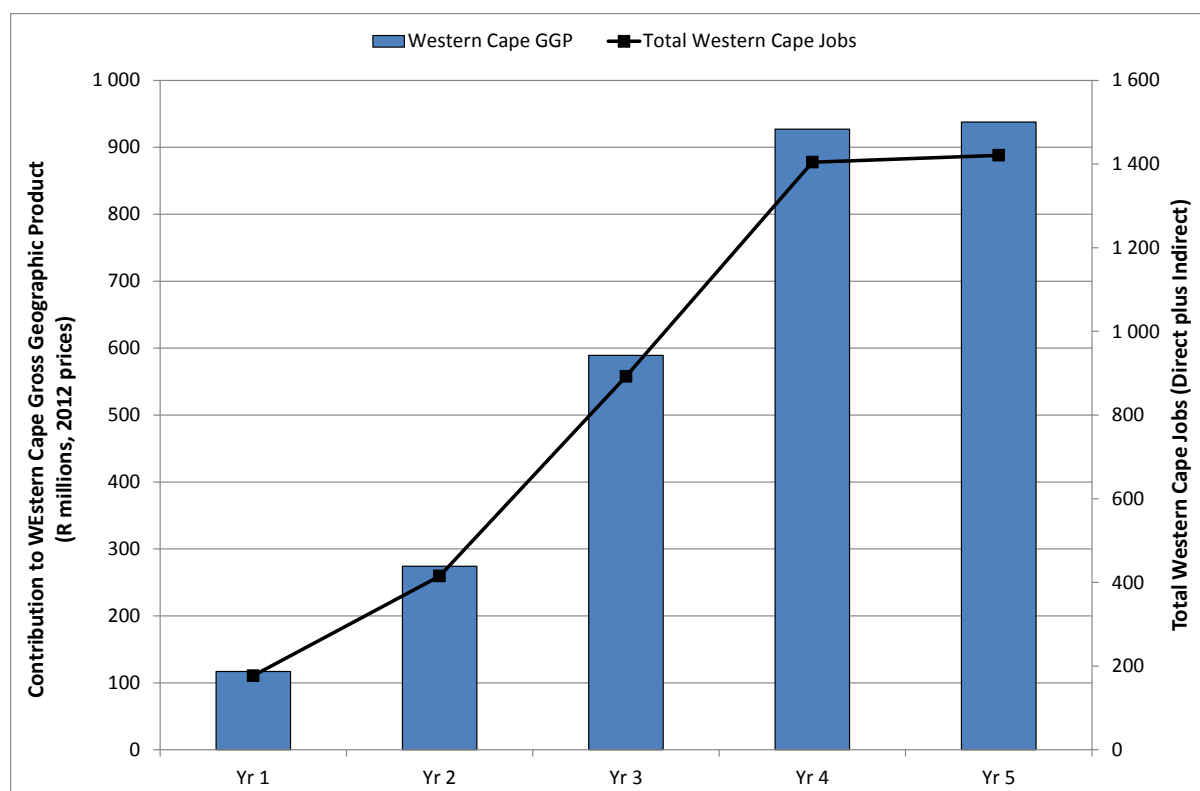


Figure ES 1: Contribution to GGP and Total Jobs

Gross Domestic Product

Total contribution to GDP is expected to amount to:

- R131m in year 1,
- R307m in year 2 and
- R660m in year 3.
- By years 4 and 5 this would be R1 039m and R1 050m.

GDP is important not just because it is income but also because income has the capacity to add to wealth. Based on these projections, the proposed SWH programme is expected to make a cumulative contribution to GDP of over R3.1bn by the end of the roll out.

Potential Economic Impact of a Sustained Industry

One of the objectives of the City of Cape Town's Solar Water Heater programme is to establish a sustainable industry. An exercise was performed to determine the impact should 47 000 SWH units (the rate aimed at in the fourth and fifth years of the programme) be supplied annually to the rest of the Cape Town households for an additional five years. This

would mean that at the end of ten years 379 000 households would have installed the SWH units.

- The contribution to GDP as a result of the additional SWH rollout would increase from R1 061m in year 6 to R1 105m in year 10. Over the same time period the contribution to Western Cape GGP would increase from R948m to R990m.
- In the tenth year of the rollout it is expected that there could be as many as 737 new direct jobs in the Western Cape and 766 indirect jobs. This would bring the total jobs in the province to 1 503 in that year. Total jobs throughout the country would amount to 2 418.
- Direct and indirect taxes would increase from R115m in the sixth year to R120m in the tenth year. Over the same time period indirect household income would increase from R320m to R333m.
- Cumulatively, over the ten year period:
 - the contribution to GDP is R8 601m;
 - the contribution to GGP is R7 691m;
 - the contribution to direct and indirect taxes is R929m
 - the contribution to indirect household income is R2 591m.

The conclusion is that there are major benefits to Cape Town from this extended rollout. These economic benefits would increase even more if the SWH units were manufactured locally and exported elsewhere in the country or outside of South Africa.

Financial Cost Benefit

This section quantifies the financial cost benefit analysis of the SWH rollout programme on four stakeholders.

Households Installing SWHs

After paying the monthly loan installment a household installing a 150 litre unit would save R36.27 a month during the first year (R41.34 including VAT). There would be a monthly saving before VAT of R42.25 from a 200 litre unit and R56.56 from a 300 litre unit (excluding VAT). This is based on an Eskom rebate of 35% to 38% of the SWH installation cost, a loan of five years repaid at an interest rate of prime plus 2% and a current applicable cost of electricity of R1.40/kWh, increasing at 10% in real terms per annum for the next five years.

Before meeting the loan re-payment costs, the annual household savings for all households installing the three different size units are R23m in the first year and increase rapidly each

year until year 5 when all 144 000 households have installed their SWH units. In this year the electricity savings amount to R807m. The net savings (electricity savings less the cost of the SWH) for households is positive from the first year. The savings then continue to increase each year thereafter. In year 5, the last year of the rollout programme, the net savings amount to R367m. This increases to R417m in year 6 and by year 10 totals R859m. In year 20 the savings total R1 054m.

The NPV of the financial benefits to households, over a 20 year period, is R5 046m (including VAT).

The results were subjected to a sensitivity test on the repayment lending rate, the efficiency of the SWH units and the real increase in the price of electricity (after the real annual increase of 10% in the first five years). It was found that within the range tested households would always benefit from the rollout programme.

Suppliers of SWH Units

The estimates made here are only for the planned SWH rollout and do not include the successful growth of the industry after the rollout.

It is expected that the installers of solar water heaters would benefit from profit installation and maintenance and might generate income on loans provided to households. It is estimated that total net income to the installation companies would increase from R15m in the first year to R139m in the fifth year. This then reduces until the tenth year when the only source of net income is the profit margin on the maintenance of the units. This would amount to R1m in that year and for the rest of the 20 year analysis period.

The NPV of the financial benefits to the installation companies is R356m.

City of Cape Town

The City of Cape Town would lose revenue on the difference between what it pays Eskom and what it charges households. The reduced revenue to the City of Cape Town would amount to R20m in the first year, increasing to R782m in the tenth year and R953m in the twentieth. The cost that the City incurs in purchasing the saved electricity from Eskom would be reflected as a reduced cost. This amounts to R9m in the first year and increases in real terms to R347m in the tenth year and further to R424m in the twentieth. The overall net loss to the City amounts to R11m in the first year and increases to R434m in the tenth year. In the twentieth year the overall net loss amounts to R530m. The NPV of all these losses is R3 201m (excluding VAT).

The net loss in revenue to the City of Cape Town would only occur if there is no alternative demand for that electricity. If the City of Cape Town is currently constrained in the amount of electricity that it can supply its customers then the electricity losses would be recouped from other customers.

If there is no take up of the electricity savings then the City of Cape Town would be faced with the net loss of revenue indicated in the table. This loss in revenue would need to be recovered by increasing electricity tariffs.

The net impact on households should the City of Cape Town recover all its losses from households would be a reduction in net household income for six years. The peak reduction in household income would amount to R83m in years four and five. From year seven onwards (when many of the SWH loans are paid off) there is a net increase in household disposable income and this then increases each year as more and more of the SWH loans are paid off and the real price of electricity increases. This increase in the latter years more than compensates for the reduction in the first six years and the NPV over a 20 year period is a positive R1.40bn.

Eskom

Eskom would have three financial changes as a result of the SWH programme. There would be reduced revenues because of lower electricity sales. Costs would increase because of the rebate and costs would fall because of the reduction in producing less electricity.

- Eskom would lose R9m in revenue in the first year of the programme rollout. This would increase to R347m in the tenth year and R424m in the twentieth.
- There would be reduced generation costs amounting to R19m in the first year and increasing, in real terms, to R615m in year 10. By year twenty there would be a reduction of R749m in generation costs.
- The rebates are estimated at R34m in the first year of the programme and then increase to R263m in the fourth and fifth years.
- The net real financial position for Eskom is a R24m loss in the first year, increasing to R99m in the fourth year. Once the rebates are paid there is a net increase in revenue to Eskom. In year 6 this amounts to R247m, increases to R267m in year 10 and R326m by year 20.
- The NPV of the financial benefits to Eskom is R1 399m (excluding VAT).

Three variables were subjected to a sensitivity test. These are the effective price that the City of Cape Town would pay for the saved electricity, the marginal generation cost to

Eskom and the real increase in the price of electricity after the first five years of the programme. It was found that Eskom remained a financial beneficiary over most of the range of assumptions that were tested.

Net Present Values of All Stakeholders

The net present value of the cash flow to all the stakeholders is based on a 20 year time horizon. It is estimated that:

- Households installing the SWH units have the highest savings with a NPV of R5 046m.
- This is followed by Eskom with a NPV of R1 399m.
- Installation Companies have a NPV of Net Profit to the value of R356m.
- The City of Cape Town would have lower net revenue with a PV of R3 201m than without the SWH programme. In other words, the City of Cape Town would have revenue losses because of the programme and it would need to explore ways to recoup these losses.
- There would be reduced VAT receipts by the National Government to the value of R388m.

The financial NPV of all the parties combined is R3 213m and the financial IRR is 51%. The citizens of Cape Town would benefit from the increased economic activity in the form of GGP, with a PV of R2 643m.

Balance of Payment to Cape Town

The balance of payments to Cape Town (i.e. its municipal government and all its citizens) is positive from year 1 and amounts to R103m in that first year, increasing to R849m in the fifth year. This then drops to R36m in the sixth year as the Eskom rebates and the financing institution loans dry up. However, the net inflows then increase each year thereafter because the loans are being paid off and the real price of electricity is increasing. In the tenth year the net inflows amount to R408m and in the twentieth amount to R498m.

The PV of the balance of payments to Cape Town over the twenty year analysis period is a positive R3 796m.

Economic Cost Benefit

This section presents the results of the economic cost benefit analysis and the sensitivity analysis.

Table ES 2: Economic Cost Benefit Results

R million, 2012 Prices	LCOE of Kusile	LCOE of Ingula	REIPPP of Wind & SPV	Value of DSM	Weighted Average
	R0.82/kWh	R1.16/kWh	R1.55/kWh	R2.36/kWh	R1.51/kWh
Manufacture and Installation Costs	1 545	1 545	1 545	1 545	1 545
Maintenance Costs	199	199	199	199	199
Total Costs	1 744	1 744	1 744	1 744	1 744
Electricity Savings Benefit	2 038	2 881	3 832	6 414	3 824
Carbon Credits	0				0
Total Benefits	2 038	2 881	3 832	6 414	3 824
Net Benefit	294	1 137	2 088	4 670	2 079
BCR	1.17	1.65	2.20	3.68	2.19
IRR	11.2%	20.1%	30.7%	68.2%	30.6%

The results of the economic cost benefit analysis are given in Table ES 2. The table includes the present value (PV) of all the costs as well as the benefits. It lists the Net Benefits (NPV) and the Benefit Cost Ratio (BCR). Five sets of results are given: two are on the LCOE (plus distribution costs and transmission losses) of Kusile and Ingula, the third is a weighted combination of the bid prices for Wind Power and Solar PV in the REIPPPP process, the fourth is on the value ESKOM has determined from its IRP 2010-2030 analysis to be the threshold value for DSM projects. The fifth is the weighted average of the four previous options. The weighted average is determined from the relative generation capacities (or savings in the case of the DSM programme) as indicated in the IRP 2010-2030.

The following results can be seen in the table:

- All options have the same total costs with a PV of R1 744m because these are the costs of the SWH programme:
 - Installation and replacement costs have a PV of R1 545m;
 - Maintenance costs have a PV of R199m.
- Compared to the LCOE of Kusile (R0.82/kWh):
 - The total benefits have a PV of R2 038m;
 - The net benefit (the project NPV) is R294m;
 - The BCR is 1.17;
 - The IRR is 11.2%.

The project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R1.17. Since the BCR is less than 2.0 the project could be considered to be marginal because of the number of assumptions made.

- Compared to the LCOE of Ingula (R1.16/kWh):
 - The total benefits have a PV of R2 881m.
 - The net benefit (the project NPV) is R1 137m;
 - The BCR is 1.65;
 - The IRR is 20.1%.

The project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R1.65. Since the BCR is less than 2.0 the project could be considered to be marginal.

- Compared to the REIPPPP bid prices for Wind Power and CSP (R1.55/kWh):
 - The total benefits have a PV of R3 832m.
 - The net benefit (the project NPV) is R2 088m;
 - The BCR is 2.20;
 - The IRR is 30.7%.

The project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R2.20. Since the BCR is greater than 2.0 the project is robust.

- Compared to the threshold value placed on DSM projects (R2.36/kWh):
 - The total benefits have a PV of R6 414m.
 - The net benefit (the project NPV) is R4 670m;
 - The BCR is 3.68;
 - The IRR is 68.2%.

Based on the results above the project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R3.68. Since the BCR is greater than 2.0 the project is robust.

- Compared to the weighted average of the four previous values for electricity savings (R1.51/kWh):
 - The total benefits have a PV of R3 824m:
 - The net benefit (the project NPV) is R2 079m;

- The BCR is 2.19;
- The IRR is 30.6%.

The project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R2.19. Since the BCR is greater than 2.0 the project is robust. The result is tested in a sensitivity analysis.

The BCRs for the above set of results range between a low of 1.17 and a high of 3.68. These values indicate that the project is economically efficient no matter which LCOE is used. However, since the BCRs for two of the five cases are less than 2.0 they could be considered marginal because of the number of assumptions employed in this analysis.

A sensitivity analysis was conducted on four main assumptions:

- Installation and replacement costs. The range tested was from 25% cheaper costs to 50% more expensive than envisaged.
- Value of carbon credits. The range tested was from R0 per ton (i.e. ignoring carbon credits) to R750 per ton (which covers the social costs of carbon mentioned in the literature).
- Number of units rolled out. This was varied from no units being rolled out in the fifth year to 75% of the annual units being rolled out to the critical mass level in order to achieve the cost economies of scale.
- Efficiency of the SWH units. This was varied from a low of 30% efficiency to a high of 70% efficiency.

It was found that the results are:

- sensitive to variations in the manufacture and installation costs but that the project remains economically efficient for the full range tested. The switching value for the installation costs is a 134% increase. In other words, the manufacturing and installation costs would have to more than double for the project to become economically inefficient. If the Kusile LCOE is used to value the benefits of saved electricity (which is the lowest value for electricity savings assumed in this analysis) the costs would need to increase by 19% for the project to become inefficient.
- only slightly sensitive to variations in the value of carbon credits. The higher the value of carbon the more beneficial the project becomes to society, particularly when valued against the Kusile LCOE.

- not sensitive to the number of units rolled out in the programme, as long as the critical mass of units are achieved and the subsequent economies of scale required to reduce the average unit costs are realised..
- not particularly sensitive to the efficiency of the units. The switching value for the weighted average BCR is an efficiency level of 27%. In other words, the SWH units would need to save less than 27% electricity for the weighted BCR to be less than 1 and the project to no longer be efficient.

Less favourable assumptions were combined to determine if the SWH programme remains viable for such an extreme combination. The variables for the least favourable combination are:

- Installation costs are 25% higher than expected;
- Carbon credits are valued at R0 / ton of CO₂;
- The value of saved energy is the Kusile LCOE of 82c/kWh.
- The efficiency of the SWH units is 50%.

The BCR reduces to below breakeven point to 0.80 for this least favourable combination. It is the inclusion of the LCOE of Kusile that results in a BCR of less than one. If the LCOE of Ingula is used the BCR is 1.13.

Overall conclusion

The overall conclusion from the economic analysis of the intention to roll out solar water heaters is that the project appears to be economically efficient. It has a generally robust benefit cost ratio across most permutations that were tested. The fact that some of the BCRs were less than two is a cause for concern. On the one hand these are low BCRs which could be considered marginal. On the other the sensitivity analysis and, in particular, the combination of less favourable assumptions generally all returned a BCR of 1.0 or greater. In other words, it would require an extreme combination of unfavourable variables for the proposed rollout of SWHs to become economically inefficient.

This initiative has the potential to create a new industry in the Western Cape. From a macroeconomic perspective the project will generate income and jobs, particularly in the manufacturing and installation industries. Strategic interventions may result in the industry exporting solar water heaters to other provinces and internationally. This would result in sustainable increases in income and job creation. These do, however, need to be offset against potential job losses in the existing electric geyser industry.

The single negative aspect of the proposed project is the loss in revenue to the City of Cape Town. What is important is that the total benefit to the households that install SWHs is greater than the loss in revenue to the City. In the stakeholder analysis it was shown that households have a benefit with a NPV of R5bn. While the City of Cape Town (municipal government) has a negative NPV of R3.2bn the City and its citizens have a net overall benefit of R1.8bn.

There would be some years in which the net household disposable income in Cape Town would be lower should the City of Cape Town recover its losses from households through increased electricity tariffs. This occurs while loans are being repaid. There would be a net increase in household disposable income after the loans are repaid. This increase in net household disposable income in the later years is enough to more than compensate for the earlier losses.

The fact is that under the rollout the initial target is 144 000 households but that all households may end up bearing the burden of the loss in revenue to the City. This revenue can be raised in a number of ways:

- A general increase in the price of electricity which could potentially undermine the competitiveness of local industry.
- An increase in the price of electricity to households. This again would result in cross subsidisation but it may also have the effect of persuading more and more households to install SWHs. The more people who install SWHs the less the degree of cross subsidisation and the greener the city. Such an approach could see a marked movement away from coal fired electricity to renewable energy in the city of Cape Town. It would also be seen as part of the contribution of the City of Cape Town to reducing climate change.
- A reduction in the contribution to the rate-funded services by ESD which is currently determined as 10% of electricity sales revenue.

Table of Contents

Headline Findings	i
Executive Summary	iv
Table of Contents.....	xxv
List of Tables	xxvii
List of Figures	xxviii
List of Abbreviations.....	xxix
Introduction	1
1 Information Constraints	2
2 Approach	3
2.1 Cost Benefit Analysis	3
2.1.1 Economic cost benefit analysis	4
2.1.2 Financial cost benefit analysis	6
2.2 Macroeconomic Analysis	7
2.2.1 International Experiences	9
2.2.2 Country Specific Impacts	10
3 Analysis and Results.....	13
3.1 Economic Cost Benefit.....	13
3.1.1 Programme Assumptions.....	13
3.1.2 Societal Benefits	15
3.1.3 Results.....	20
3.1.4 Economic Sensitivity Analysis	22

3.2	Financial Cost Benefit	27
3.2.1	Households Installing SWHs.....	27
3.2.2	Suppliers of the SWH Units.....	31
3.2.3	City of Cape Town	33
3.2.4	Eskom.....	35
3.2.5	Net Present Values of All Stakeholders.....	37
3.2.6	Cape Town's Balance of Payments	38
3.3	Macroeconomic Results.....	39
3.3.1	Gross Domestic Product	39
3.3.2	Western Cape Gross Geographic Product	40
3.3.3	Direct and Indirect Jobs	41
3.3.4	Other Macroeconomic Effects.....	43
3.3.5	Potential Economic Impact of a Sustained Industry	44
4	Conclusion	47
	References	57
	Appendix A: Terms of Reference	59

List of Tables

Table 1: Cost Benefit Analysis – Perspective and Approach	4
Table 2: Jobs Created per MW Capacity.....	10
Table 3: Renewable energy job creation based on New Hampshire's Renewable Portfolio Standard	11
Table 4: SWH Annual Rollout and Critical Mass.....	13
Table 5: SWH Rollout by Size	14
Table 6: Costs and Energy Savings	14
Table 7: Total Cost.....	15
Table 8: LCOE of Selected Energy Generation Technologies	16
Table 9: Eskom: Key indicators FY 2011/12.....	17
Table 10: Cost of Power Generation in South Africa	18
Table 11: Economic Cost Benefit Results	20
Table 12: Installation Costs Sensitivity Analysis	23
Table 13: Value of Carbon Credits Sensitivity Analysis	23
Table 14: Sensitivity on Roll-out of SWH Units.....	25
Table 15: Sensitivity Analysis on the Efficiency of SWH Units.....	26
Table 16: More and Less Favourable Assumptions.....	26
Table 17: BCR Results Extreme Combinations	27
Table 18: Financial Savings to Households (excluding VAT).....	28
Table 19: Annual Household Savings (R millions, 2012 Prices, VAT Inclusive).....	29
Table 20: Household Sensitivity Analysis (R millions, VAT inclusive)	30
Table 21: Cash flow to installation companies (R millions, 2012 prices).....	31

Table 22: Installation Company Sensitivity Analysis (R millions)	32
Table 23: Annual Loss in Revenue to the City of Cape Town (Rm, 2012 Prices, excl VAT)	33
Table 24: City of Cape Town Sensitivity Analysis (R millions, VAT exclusive)	34
Table 25: Annual Change in Cash Flow to Eskom (R millions, 2012 Prices, VAT exclusive)	35
Table 26: Eskom Sensitivity Analysis (R millions, VAT exclusive)	36
Table 27: NPV of Cash Flow to Stakeholders (R millions, 2012 Prices)	37
Table 28: Balance of Payment for Cape Town (R millions, 2012 prices)	38
Table 29: Contribution to Gross Domestic Product.....	39
Table 30: Contribution to Western Cape Gross Geographic Product.....	41
Table 31: Contribution to Direct Jobs in the Western Cape	42
Table 32: Contribution to Indirect Jobs in the Western Cape.....	42
Table 33: Contribution to Total Jobs in the Western Cape.....	42
Table 34: Contribution to Total Jobs in South Africa.....	43
Table 35: Contribution to Taxes	44
Table 36: Contribution to Indirect Household Income	44
Table 37: Macroeconomic Impact of Sustainable Industry	45

List of Figures

Figure 1: Detailed Contribution to GDP	40
Figure 2: Contribution to GGP and Total Jobs.....	43
Figure 3: Detailed Contribution to GDP of Sustainable Industry	46

List of Abbreviations

BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
CoCT	City of Cape Town Municipal Government
CCS	Carbon Capture and Storage
DSM	Demand Side Management
ESD	Electricity Services Department
FGD	Flue-Gas Desulphurisation
GDP	Gross Domestic Product
GGP	Gross Geographic Product
LCOE	Levelised Cost of Electricity
NPV	Net Present Value
PV	Present Value
RE	Renewable Energy
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SAM	Social Accounting Matrix
SCC	Social Cost of Carbon
SWH	Solar Water Heaters

Introduction

During the course of 2008 South Africa suffered a series of power outages. These power outages caused immense economic damage and general inconvenience. Three new base load generators have been commissioned but electricity supply will remain in jeopardy until they are operating. In the light of this the City of Cape Town is evaluating a variety of interventions to reduce demand for electricity. One of these is the evaluation of the potential to stimulate the growth of an embryonic solar water heater industry in Cape Town. The process that would be followed would be through the acceleration of the installation of solar water heaters by private households. . It aims to achieve a mass roll-out of about 144 000 units over a five year period. By rolling out these units it aims to:

- i. decrease electricity consumption in the city (which includes decreasing both energy consumption and the necessary system peak capacity) and
- ii. create a sustainable SWH industry in the Western Cape and in so doing to transform the market from low-volume/high-margin to high-volume/low-margin. In other words from early adopter “specialist” niche to mainstream.

Financial assistance for the SWH programme has been provided by AFD (French Development Agency) and as part of its due diligence process AFD requires an appraisal of the potential economic benefits of the programme. The objective of this study was therefore to perform an economic analysis of the CoCT SWH programme (refer to the Terms of Reference in Appendix A). This was done using two approaches. The first was by calculating the present economic value of the programme through the economic costs and benefits of the project. This was done by using both an economic and a financial cost benefit approach. The second was a macroeconomic analysis. These macroeconomic effects include the contribution to national GDP, provincial GGP, direct and indirect jobs and taxes.

The report has four main sections.

- The first discusses the information limitations and the constraints to the study.
- The second outlines the approach that was taken.
- The third reports the assumptions and results of the analysis.
- The fourth presents the conclusion.

1 Information Constraints

The analysis faced a number of constraints about information. The major constraints were:

- There is no clear idea of the likely costs of manufacturing and installing SWHs. The tender process was not complete and the analysis could not access information in the tender submissions in the time that was available for the analysis. Estimates were given by City officials.
- The replacement cycle of solar heater panels is not known. A 20 year estimate was given by City officials.
- It is not known how many households might install SWHs even if the City programme is not implemented. Rather than speculate about this the base case assumed that there would be a zero uptake without the City programme and then tested this in a sensitivity analysis. The findings were that the results are not very sensitive to changes in this assumption as long as the economies of scale assumed to reduce the manufacturing and installation costs are achieved.
- The cost to Eskom of generating electricity during peak load times. Eskom generated electricity at a cost of 41.28 c/kWh in 2011/12 (Eskom Integrated Report 2012). This is an average cost of generating electricity and does not reflect the marginal cost of generating electricity, particularly during peak load times when the SWH could reduce demand. For the financial stakeholder analysis the LCOE of Ingula is taken as the value for electricity generation costs. This is tested in a sensitivity analysis.
- The average price that the City of Cape Town would pay Eskom for the “saved” electricity as a result of the SWH programme. Sustainable Energy Africa, the technical consultants for the project, have done some modelling around the likely cost of this electricity based on the seasonal Megaflex rates and the times of use of the SWH units. This value was determined as 60.75 c/kWh. This was subjected to a sensitivity test.
- Future electricity prices. The debate about future electricity prices continues to be fluid. It is likely that there will be increases in real electricity prices over the next few years but the extent and duration of these real increases are not known. As a consequence an assumption has been made that electricity prices would increase annually by 10% for the next five years. After the five years electricity prices with real increases of 0%, 2%, 5% and 10% are subjected to a sensitivity analysis. This correlates with Eskom's latest MYPD application.

- City administration costs for running the SWH programme. They are expected to be relatively minor and were excluded.
- The cost of power outages. There are various estimates of the cost of power outages. These costs have not been included in the analysis because virtually any type of electricity generation option would be preferable to the cost of power outages.
- The morbidity and mortality impacts of NO_x and SO_x emissions from coal fired generators without flue-gas desulphurisation (FGD). These impacts are localised and differ from location to location. The dose response functions differ from location to location and could only be estimated through a dedicated air study. As a consequence these benefits are noted but could not be included.
- The terms of the loans provided to the households to install the SWH units are not known. Consequently assumptions regarding these terms have been made and are outlined in the presentation of the financial cost benefit analysis results. A sensitivity analysis on these terms is performed.
- The operating costs of the financing institutions are not known. This only has implications for the stakeholder analysis and consequently this user group is excluded from the analysis.

2 Approach

There are a variety of different types of economic analysis, some of which can be quantified and some of which cannot. For the purposes of undertaking an economic analysis of the SWH rollout programme macroeconomic and cost benefit analysis are the appropriate tools. The purpose of the first part of this section is to describe these two types of analyses and explain how to interpret the results of the analysis.

2.1 Cost Benefit Analysis

Two types of cost benefit analysis were followed in the study. The first was an economic cost benefit undertaken from a societal perspective. The second was a financial cost benefit analysis from a stakeholder perspective. The costs and benefits of each of these sets of analyses are outlined in Table 1.

Table 1: Cost Benefit Analysis – Perspective and Approach

Stakeholder	Costs	Benefits	CBA Approach
Society	SWH installation and maintenance costs	Reduction in Electricity Supply Reduction in peak load electricity demand Reduction in emissions Potential to reduce power outages	Economic
SWH users	SWH installation and maintenance costs	Savings on the electricity bill	Financial
Service Providers / Manufacturers	SWH installation and maintenance costs	Mark up on installation and interest rates	Financial
City of Cape Town (local government)	Administrative cost of the program Reduced revenue from lower electricity sales	Reduced risk of load shedding Increased GDP and jobs	Financial Input Output Analysis
ESKOM	Loss of revenue from electricity sales Rebates	Avoided costs of marginal electricity generation	Financial

Two additional stakeholders were identified but not analysed. These are the financing institutions and national government. The financing institutions would provide the loans and receive income in the form of the monthly payments. However, what is not known are their operational and institutional costs in administering these substantial loans. Similarly, national government would be affected by a reduction in VAT receipts as a result of the electricity savings. These would be balanced by an increase in VAT receipts as a result of the manufacture & installation and maintenance of the units. However, there would also be income and company tax implications as a result of the programme and since the tax structures of the individual companies and households are not known this was excluded from the analysis.

2.1.1 Economic cost benefit analysis

Economic cost benefit analysis (CBA) treats the national economy, or a provincial economy, as an entity in and of itself. It assumes, with some important caveats, that what is demonstrably good for the economy as a whole is a reasonable approximation of what would be good for the majority of the people living and working in that area.

The methodological approach in a cost benefit analysis is to compare the proposed project to the base case or business as usual case. The base case would be the number of households that might install SWHs or heat pumps in the absence of the City programme. The challenge is that this number could not be determined (in the time that was available for the analysis). As a consequence, rather than speculate, the base case assumed that there would be a zero uptake without the City programme and then tested this assumption in a sensitivity analysis. The findings were that the results are not very sensitive to marginal changes in this assumption. The analysis was therefore based on the 144 000 units proposed by the City.

All the costs and benefits over this period are discounted to present day values by using a real social discount rate of 8%. This corresponds to the rate prescribed by the South African National Treasury. The cost benefit analysis is based on best practice and in consultation with the guidelines of the Manual for Cost Benefit Analysis in South Africa (Conningarth, 2007) and Cost-benefit analysis: A practical guide (Snell, 2011). Although all the costs and the benefits are concentrated in the Western Cape, the analysis has been conducted from a country wide perspective.

An economic analysis includes all costs to society. This is done by adjusting for shadow prices and wages and removing the distortions caused by taxes and subsidies.

The cost benefit analysis focuses purely on direct costs and benefits and does not take any indirect costs and benefits into account. Indirect costs and benefits would include those costs and benefits obtained through multiplier effects. For example, the process of manufacturing the components for the SWHs would have spin-off effects for the materials supply industries. These, in turn, would have backward linkages with other commodity suppliers and retail industries. These lie in the realm of macroeconomic analysis.

The outcomes of the analysis are reported as a net present value (NPV), a benefit cost ratio (BCR) and an internal rate of return (IRR) for those cases where the project is compared to a do minimum alternative. A NPV shows the total value of future costs and benefits reduced to a present day value. The BCR measures the changes in benefits and costs that would result from an investment. BCRs are typically used when there are many competing alternatives and projects need to be funded from a limited set of resources. Finally, the IRR is the discount rate that returns a NPV of zero and shows the likely economic returns to society of a project in relation to other investment opportunities.

If the evaluated benefits of a project are indeed greater than the overall project costs then the BCR ratio would be greater than 1. A BCR greater than 1 indicates that the completed project would constitute an economic asset; a BCR less than 1 implies that the project would be an economic liability. The higher the BCR the less risk there is that the proposed investment could turn out to be economically unviable. Low BCR's, even if greater than 1, provide a warning that a project could be risky and may turn out to become an economic liability instead of an asset.

2.1.2 Financial cost benefit analysis

Financial cost benefit analysis focuses on individual stakeholders and how the financial position of each stakeholder changes as a consequence of the SWH programme. Four stakeholders were analysed:

- These are households who elect to install SWHs as part of the programme. Their costs are the monthly cost of paying off the SWH and maintenance costs while their benefits are electricity savings.
- Service providers who manufacture and/or install SWHs. Their net benefits are profit on the mark up on SWHs and mark up on interest charges.
- The City of Cape Town which would have a reduced contribution to the rates funded services from reduced electricity sales and the administrative costs of running the programme. The benefits are in the form of reduced electricity purchases from Eskom.
- Eskom would have costs from the rebate given to SWHs and reduced income from electricity sales but it would then benefit from not having to generate electricity during peak load periods. This benefit would manifest itself as not having to invest capital in new generation plants to cover both base and peak demand. This benefit is quantified in the financial analysis as the LCOE of the Ingula pumped storage scheme but is subjected to a sensitivity analysis.

There were two stakeholders that were not analysed:

- The financing institutions would provide the loans and receive income in the form of the monthly payments. However, what is not known are their operational and institutional costs in administering these substantial loans.
- National government would be affected by a reduction in VAT receipts as a result of the electricity savings. These would be balanced by an increase in VAT receipts as a result of the manufacture & installation and maintenance of the units. However, there

would also be income and company tax implications as a result of the programme and since the tax structures of the individual companies and households are not known this was not included in the analysis. Furthermore, the accounting and tax implications regarding lease agreements and loan repayments is beyond the scope of this report.

In addition, and using a different form of analysis, there will be benefits to some people in Cape Town who benefit from jobs and increased incomes as a consequence of the successful growth in an emergent solar water heater industry. This analysis is based on a macroeconomic analysis and is described below.

2.2 Macroeconomic Analysis

The size of a national or regional economy is measured in terms of the total of all economic activities taking place within the area concerned, both in the public and private sectors. The name given to the measure of the size of the economy is Gross Domestic Product (GDP) for the country as a whole or Gross Geographic Product (GGP) for a province.

While there are a number of different types of macroeconomic effects, the two most important are contribution to GDP and creation of jobs. The importance of job creation is obvious. Increases in GDP are synonymous with increases in peoples' economic standards of living. Increased GDP – i.e. increased production – is experienced in the form of more jobs, higher wages and reduced economic hardship. It is clearly an important measure. In the first instance it may be more skilled people who are employed on the production of SWHs. However because they have increased income their expenditure is also likely to increase and, through the multiplier effect, less skilled jobs are also likely to result.

The effects of any project on the size of GDP arise as a result of the myriad ways in which businesses, public service providers and ordinary people find their normal daily activities affected, hopefully for the better, by the changes brought about by the new project.

The actual task of calculating the macroeconomic impact of the proposed project demands a detailed and multifaceted approach not least because of the so-called multiplier effects. It is well recognised that the simple act of spending – manufacturing a solar water heater, for example, - leads to other economic effects. Demand for steel and metal components can lead to increased production in those industries. Increased demand for metal components, in turn, leads to increased demand for mining output which uses wood, water, electricity and so on. These are the so-called multiplier effects. While this process unfolds, each industry employs people and pays wages. Employees, in turn, spend their wages and cause further

multiplier effects through the economy. Measuring this is further complicated by the fact that different industries demand different types of skills. This leads to different wage structures across the various industries. People earning different wages have different spending patterns. Thus, the change in overall spending patterns is dependent on which industries are affected.

Input-output analysis was largely used for the measurement of the macroeconomic impact of the Solar Water Heater Programme. Input output tables were developed from a South African and a Western Cape Social Accounting Matrix (SAM) and converted into industry multipliers. This approach demands that all expenditure in and around the project be identified and estimated. This expenditure, in turn, needs to be linked to the 43 SAM economic sectors for South Africa and 47 for the Western Cape (the Western Cape SAM contains a higher degree of disaggregation of the Agriculture sector). In addition, if employment is part of the expenditure then estimates must be made of the likely items of expenditure as a result of wage payments. Allowances must also be made for the fact that workers at different income levels have different spending patterns.

The following items were included in the macroeconomic analysis

- Installation expenditure which includes the cost of manufacturing, installation labour, marketing and administration;
- Maintenance expenditure.

The impact of changes in household disposable income has been excluded from the analysis. Any increase in household income in Cape Town as a result of lower spending on electricity would be offset by lower incomes in the electricity generating sector.

Four steps are required to measure the overall economic impact of the SWH Programme:

- First, to identify the appropriate costs and benefits.
- Second, to determine the relative proportions of profit, labour, plant and material for each cost item.
- Third, to assign each item of material and plant to the appropriate SAM code. Spending patterns of Western Cape households were used for the changes in net disposable household income
- Finally, all the SAM coded items are brought together. The total multiplier effect is calculated as the aggregate product SAM coded spending on plant and material, as well as SAM coded spending by workers multiplied through the industry multipliers.

Therefore the macroeconomic estimates that are made in this report relate directly to the manufacturing, installation and maintenance expenditure due to the SWHs. Included in the macroeconomic calculations are all the backward economic linkages from this expenditure and the forward economic linkages that occur when workers spend their salaries.

Direct jobs were calculated with the use of the Social Accounting Matrix (SAM) for South Africa. From the SAM it is possible to calculate both the average salary that is paid in any one sector and the proportion of salaries to overall turnover in that sector. This was then used to calculate direct jobs based on the amount of spending in each economic sector resulting from the SWH Programme.

Indirect jobs are determined through the same process as the calculation for GDP described above and makes use of industry multipliers calculated from the SAM.

2.2.1 International Experiences

International experiences suggest that a renewable energy manufacturing and generation industry can be job intensive. Some of the evidence for this is presented in Table 2. It is found that:

- The renewable energy sector generates more jobs than the fossil fuel-based energy sector per average megawatt compared to a broad range of generation options.
- The majority of jobs in the fossil fuel industry are in fuel processing and operations & maintenance while the majority of jobs created in the renewable energy industry are in manufacturing, construction and installation. Biomass energy is an exception, where the majority of jobs are also in fuel production & processing (in agriculture) and operations & maintenance.
- There is not such a clear distinction between fossil-fuel and renewable technologies in the number of jobs created in operations, maintenance and fuel processing. Reliable, low-maintenance wind turbines are estimated to require fewer jobs to operate than are needed to fuel and operate coal and gas plants. However, more jobs are created in operations and maintenance of PV systems than in the operations and maintenance and fuel processing for coal and gas plants.
- A study for the World Economic Forum states:
 - Newly constructed solar PV generates seven times more job-years than gas generation, primarily because solar panels are modular and require a lot of labour in manufacturing and installation.
 - Solar PV creates more than five times as many domestic job-years as gas generation. The large amount of labour required in solar PV installation must

be done locally because installation services cannot be imported. The solar PV industry is relevant because it requires a similar number of jobs for installation and maintenance as the SWH industry.

Table 2: Jobs Created per MW Capacity

<u>Jobs created per MW capacity installed</u>			
Energy Technology	Average Employment Over Life of Facility (jobs/Mwa)		
	Construction, Manufacturing, Installation	O&M and fuel processing	Total Employment
Photovoltaic 1	6.21	1.2	7.41
Photovoltaic2	5.76	4.8	10.56
Wind1	0.43	0.27	0.7
Wind2	2.51	0.27	2.78
Biomass - high estimate	0.4	2.44	2.84
Biomass - low estimate	0.4	0.38	0.78
Coal	0.27	0.74	1.01
Gas	0.25	0.7	0.95

Mwa refers to avg installed megawatts de-rated by the capacity factor of the technology
Source: Kammen et al. (2004)

- Industries that would benefit:
 - Glass and glass product manufacturing;
 - Plastics packaging materials and non-laminated film and sheet manufacturing;
 - Ornamental and architectural metal products manufacturing;
 - Wiring device manufacturing.

2.2.2 Country Specific Impacts

- In the EU between 2006 and 2010 the renewable energy industry has increased its workforce from 230 000 to 550 000 (IHS CERA 2012, p.36);
- In Germany it is estimated there were 370 000 jobs in the renewable energy sector in 2010, with more than a quarter of those jobs in the wind sector and nearly a third in solar PV (IHS CERA, p.34);

Table 3: Renewable energy job creation based on New Hampshire's Renewable Portfolio Standard

Renewable energy jobs per MW			
Renewable Energy Source	Manufacturing & Construction jobs per MW 20 yr life	Operations & Maintenance per MW	Total
Wind	2.57	0.29	2.86
Geothermal	4	1.67	5.67
BioMass	4.29	1.53	5.82
LFG/BioGas	3.71	2.28	5.99
Solar Thermal	5.71	0.22	5.93
Solar PV	7.14	0.12	7.26
Small Hydro	5.71	0.12	5.83

Source: Gittell & Magnusson (2007)

- In the USA:
 - According to a 2004 meta-analysis from of the Renewable and Appropriate Energy Laboratory (RAEL) at the University of California, Berkeley, which examined 13 studies on the economic benefits of renewable energy, approximately 240 000 jobs could be created and maintained if the country passed a 20% by 2020 renewable portfolio standard (RPS). If the U.S. relied solely on fossil fuels, the country would only maintain around 75 000 jobs (<http://www.renewableenergyworld.com/rea/news/article/2007/04/the-economic-impact-of-renewable-energy-48201>).
 - A study by the Centre for American Progress estimated that clean-energy investments in the US generates (Pollin et al. 2009, p.30):
 - Roughly three times more jobs than an equivalent amount of money spent on carbon-based fuels;
 - Clean-energy investments create 16.7 jobs for every \$1m in spending;
 - Spending on fossil fuels, by contrast, generates 5.3 jobs per \$1m in spending;
 - Relative to spending on fossil fuels, clean-energy investments create 2.6 times more jobs for people with college degrees or above, 3 times more jobs for people with some college, and 3.6 times more jobs for people with high school degrees or less.
 - Spending \$150bn on clean-energy investments would create roughly 1.7m jobs. This is even after assuming a reduction in fossil fuel spending equivalent to the increase in clean-energy investments.

- In South Korea (IHS CERA 2012, p.40):
 - The number of manufacturing companies in renewables increased from 41 in 2004 to 146 in 2009, employment increased from 689 to 9 151 over the same period.
 - Exports of renewables increased from US\$65m in 2004 to US\$2bn in 2009, and solar PV and wind are expected to continue to play a key role.

3 Analysis and Results

This section presents the results of the economic cost benefit, the financial and macroeconomic analyses.

3.1 Economic Cost Benefit

This section starts by describing the assumptions made about the programme. This is followed by a discussion of the benefits of the programme. The results of the analysis are then presented as well as the results from the sensitivity analysis.

3.1.1 Programme Assumptions

The costs of the project are:

- The manufacturing and installation costs of the units. These in turn include:
 - The manufacture of the various components;
 - Installation labour costs;
 - Delivery;
 - Sales, Marketing and Administration Costs.
- On-going maintenance costs
 - Routine maintenance;
 - Faults: Repairs/replacements.

It is understood that economies of scale and the consequent reduction in manufacturing costs can only be achieved once a critical mass is reached. This critical mass and the projected annual rollout are given in Table 4.

Table 4: SWH Annual Rollout and Critical Mass

SHW Rollout Programme	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
Critical Mass	4 200	10 800	15 000	15 000	15 000	60 000
Annual Targetted Rollout	6 000	14 000	30 000	47 000	47 000	144 000

Source: City of Cape Town RFP 473C/2011/12 (p23)

The SWHs include 150 litre, 200 litre and 300 litre units. It has been assumed that 40% of the units rolled out would be 150 litre units, 30% would be 200 litre units and 30% would be 300 litre units⁸. Based on this the detailed rollout per unit size is illustrated in Table 5. A

⁸ Pers. com., Andrew Janisch, project manager from Sustainable Energy Africa - SEA

total of 57 600 of the 150 litre units would be rolled out and 43 200 units of both 200 litre and 300 litre capacities over the five year programme period.

Table 5: SWH Rollout by Size

SHW Rollout Programme	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
150 litre units	2 400	5 600	12 000	18 800	18 800
200 litre units	1 800	4 200	9 000	14 100	14 100
300 litre units	1 800	4 200	9 000	14 100	14 100
All Units	6 000	14 000	30 000	47 000	47 000

The installation and maintenance costs and energy savings parameters of the three different sized units are shown in Table 6. The installation costs, including the cost of manufacturing, are R10 500, R15 000 and R22 500 for the three units (all costs exclude VAT). Maintenance costs are expected to total R1 000 per unit over 5 years. These costs have been continued for the 20 year analysis period.

The average efficiency of the SWHs is assumed to be 60%, meaning that they use electricity for 40% of their heating needs and the sun for the remainder. Average monthly electricity savings at this efficiency level for the different size SWH units is:

- 150 litre units – 153.1 kWh;
- 200 litre units – 195.7 kWh;
- 300 litre units – 282.7 kWh.

The average efficiency is varied in a sensitivity analysis to see its impact on the overall results.

Table 6: Costs and Energy Savings

	SWH Assumptions		
	150 l	200 l	300 l
Installation (Rands per unit)	10 500	15 000	22 500
5 year Maintenance (Rands per unit)	1 000	1 000	1 000
Eskom rebate (Rands per unit)	4 000	5 333	8 000
Efficiency of SWH	60%	60%	60%
Average daily hot water usage (litres)	125	166	250
Monthly energy requirement (kWh)	255.20	326.14	471.15
Monthly electricity savings (kWh)	153.1	195.7	282.7

Source: City of Cape Town RFP 473C/2011/12 (p27), Annexure III SWH cost benefit analysis spread sheet

The analysis is based on the following assumptions:

- The overall analysis is done over twenty years because this is the assumed life of the solar collector. Some brief research indicates that this could be longer although the panels could then lose efficiency over time.
- Geysers have a shorter life span of somewhere between 5 and 7 years and would need to be replaced at least twice during the twenty year cycle. However this replacement cost has been excluded because ordinary electric geysers have a similar replacement cycle. This cost is therefore common to both types of geysers.
- All costs and benefits are kept in constant 2012 prices. Inflation is not factored into the analysis and all costs are discounted to present day values using the real social discount rate of 8%.

Table 7: Total Cost

Installation Costs (Rm)	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
150 litre units	25	59	126	197	197
200 litre units	27	63	135	212	212
300 litre units	41	95	203	317	317
All Units	93	216	464	726	726

Maintenance Costs (Rm)	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
150 litre units	0	2	4	8	12
200 litre units	0	1	3	6	9
300 litre units	0	1	3	6	9
All Units	1	4	10	19	29

Table 7 gives the total installation and maintenance costs as the programme is rolled out. Installation costs end after five years. Maintenance costs continue for the rest of the 20 year analysis period at year 5 levels. All costs are given in 2012 values and exclude VAT.

3.1.2 Societal Benefits

In an economic cost benefit analysis the benefits are those to society at large and not to the individual home owner. The households that will be targeted for the installation of the SWH units are the middle to upper income households who will be charged the higher electricity rates, which in turn may be used to subsidise electricity to the lower income households. As a consequence the economic benefits are not the sum of the individual savings from installing SWHs. Rather they are the savings to the country from not having to produce more expensive electricity. The savings are the resources that are saved from not having to produce electricity. A large part of these savings are measured as the levelised cost of electricity (LCOE).

LCOE is the present value of the cost of energy production. It is typically reported per MWh of electricity. LCOE includes all capital, fuel, fixed and variable costs for operation and maintenance. Interest rates, inflation, taxation and carbon costs are included.

LCOE excludes a number of important costs. These are:

- Transmission losses and distribution costs;
- Localised externalities like the morbidity and mortality impacts of NO_x and SO_x emissions from coal fired generators without flue-gas desulphurisation (FGD).
- Opportunity cost of the use of water in water cooled coal fired generators. Water prices are likely to increase as South Africa's water resources come under increasing pressure, making this an increasingly important issue.
- Non quantifiable benefits such as stable SWH costs versus unpredictable electricity costs and supply.

The LCOE of a selected number of energy generation technologies internationally are shown in Table 8. Internationally the lowest cost is natural gas, followed by hydro, wind and conventional coal. Some of the highest are coal with CCS and solar PV.

Table 8: LCOE of Selected Energy Generation Technologies

U.S. Average Levelized Costs (2010 \$/megawatthour) for Plants Entering Service in 2017						
Plant Type	Capacity Factor (%)	Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Dispatchable Technologies						
Conventional Coal	85	64.9	4	27.5	1.2	97.7
Advanced Coal	85	74.1	6.6	29.1	1.2	110.9
Advanced Coal with CCS	85	91.8	9.3	36.4	1.2	138.8
Natural Gas-fired						
Conventional Combined Cycle	87	17.2	1.9	45.8	1.2	66.1
Advanced Combined Cycle	87	17.5	1.9	42.4	1.2	63.1
Advanced CC with CCS	87	34.3	4	50.6	1.2	90.1
Conventional Combustion Turbine	30	45.3	2.7	76.4	3.6	127.9
Advanced Combustion Turbine	30	31	2.6	64.7	3.6	101.8
Advanced Nuclear	90	87.5	11.3	11.6	1.1	111.4
Geothermal	91	75.1	11.9	9.6	1.5	98.2
Biomass	83	56	13.8	44.3	1.3	115.4
Non-Dispatchable Technologies						
Wind	33	82.5	9.8	0	3.8	96
Solar PV1	25	140.7	7.7	0	4.3	152.7
Solar Thermal	20	195.6	40.1	0	6.3	242
Hydro2	53	76.9	4	6	2.1	89.0

Source: US Energy Information Administration, ANNUAL ENERGY OUTLOOK 2012,
http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

In South Africa, as illustrated in Table 9, the bulk of electricity supplied from the national grid (i.e, electricity supplied and used in Cape Town) is coal generated. In 2011/12 coal provided 90% of the electricity generated by Eskom. For comparative purposes the US\$/MWh are provided. It can be seen from the table that the cost of electricity generation, including depreciation, is US\$49.32/MWh. This is considerably lower than any of the generation options listed in Table 8.

Table 9: Eskom: Key indicators FY 2011/12

Eskom sales and operating statistics FY 2011/12		
Electricity generated	GWh	
Coal	218,212	
Nuclear	13,502	
Hydro	1,904	
Pump storage	2,962	
Gas turbines	709	
Wind power	2	
Renewable energy independent power producer (IPP)	4,107	
Total (GWh)	241,398	
Electricity sales	GWh	
Municipalities	92,141	
Residential	10,521	
Commercial	9,270	
Industrial	58,632	
Mining	32,617	
Agricultural	5,139	
Traction	3,270	
International	13,195	
Sales volume (GWh)	224,785	
Financial performance	c/kWh	US\$/MWh
Revenue (incl. Environmental levy)	50.27	60.06
Cost of electricity (incl. depreciation)	41.28	49.32

Source: Eskom Integrated Report 2012

The key issue in this analysis is what type of electricity generation the SWH rollout needs to be compared to. A strong argument can be made that the cost comparison should be made to future generation options and not existing capacity. The reason for this is that the SWH rollout will not only offset the need for future capacity but they will also shift demand from peak load times to base load times. Existing capacity is, by and large, fully utilised and any comparison of SWH to existing capacity would also have to include the cost of potential power outages.

For the purposes of this analysis the SWH rollout is compared to the cost of a number of renewable and non-renewable electricity generation options. These options are chosen on

the basis of the IRP2010-2030 and related developments such as the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP).

The LCOE of three power stations currently under construction in South Africa are given in Table 10. These power stations are Medupi, Kusile and Ingula. Medupi and Kusile are both dry cooled coal fired power stations. Medupi was started in 2007 and Kusile in 2008. Kusile is designed with FGD and is carbon capture and storage (CCS) ready but not installed. Medupi does not have CCS or FGD but FGD will be retrofitted in 2018, although this date may be pushed out because the construction programme is behind schedule.

It is clear from a comparison of the two tables that both coal fired stations have a considerable advantage over their international counterparts. Medupi, with a LCOE of \$54 per MWh is remarkably lower than the international norm for advanced coal without CCS at \$110.9 per MWh. Clearly the inclusion of FGD during the initial construction would have increased these costs but are unlikely to have doubled them. Kusile, with a LCOE of \$73 per MWh, has a clear advantage over other advanced coal with CCS with an international average of \$139 per MWh.

Table 10: Cost of Power Generation in South Africa

Project Levelised Cost (2012 values)						
Power Station	Medupi	Kusile	Ingula	Wind	CSP	DSM
LCOE (\$/MWh)	54	73	110			
LCOE (R/MWh)	452	611	920.7			
LCOE or REIPPPP Offer (c/kWh)	45.2	61.1	92.1	89	165	236.4
Distribution costs (c/kWh)	13.8	13.8	13.8	13.8	13.8	
Generation and distribution costs (c/kWh)	59.0	74.9	105.9	102.8	178.8	
Transmission losses of 9.8% (c/kWh)	5.8	7.3	10.4	10.1	17.5	
Total Costs (c/kWh)	64.8	82.3	116.3	112.9	196.4	236.4
Weighted Average of Wind & CSP (c/kWh)				154.7		
Weighted Average (c/kWh)				151.3		

Source: Eskom integrated Report for the year ended 31 March 2012, NERSA Consultation Paper on the Review of Renewable Energy Feed-In Tariffs, <http://www.engineeringnews.co.za/article/second-crop-of-renewables-preferred-bidders-named-2012-05-21>

Included in Table 10 is Ingula, a third power station also under construction. This is a pumped storage station. It is located in the Little Drakensberg and is expected to be operational by 2014. It has a projected LCOE of \$110 per MWh. The National Energy Regulator of South Africa (NERSA) has published a Consultation Paper on the Review of Renewable Energy Feed-in Tariffs. In the paper they give the LCOE of Wind as R0.945/kWh and that of CSP with 6 hours of storage as R1.845/kWh in 2012 prices (NERSA, table 5, p25). According to Engineering News, the second round of competitive

bids for the REIPPPP process has yielded prices for Wind at 89c/kWh and for Solar PV at 165c/kWh⁹.

Arguably the lowest cost future electricity generation option will be at least as expensive as Kusile. It will not have a cost equivalent to Medupi. This is the case for at least two reasons. As mentioned, Medupi had no CCS mechanism and is only being retrofitted with FGD in 2018. The latter, in itself, reduced the present value of the LCOE. The second is that if Medupi were replicable then Kusile would have similar costs.

A further issue to consider is whether South Africa has the luxury of adding more coal fired capacity. There was a major international outcry when Medupi and Kusile were initially commissioned and major pressure was brought to bear on the World Bank not to fund the projects. It can be expected that the commissioning of further coal fired power would result in even more international pressure.

As a consequence the SWH rollout is compared to the costs of Kusile, Ingula, combined wind and solar PV, a threshold value¹⁰ below which DSM projects are considered beneficial as determined by ESKOM in their IRP 2010-2030 analysis and a weighted average¹¹ of the four. It would however be incomplete to compare LCOE and REIPPPP to SWH because two costs are not included. These are the costs of distribution, on the one hand, and transmission losses on the other. In personal communication with NERSA in 2010 the distribution costs were quantified as 12.5 c/kWh. Updated to 2012 prices this is 13.85c/kWh. According to Eskom's Integrated Report 9.8% of electricity sales were lost during transmission and distribution. These amounts are included in Table 10. The dollar LCOE are converted to Rands at an exchange rate of R8.36¹². Distribution costs and transmission losses are added to this giving an overall cost of 82.3c, 116.3c, 154.7c and 236.4c per kWh for Kusile, Ingula, wind and solar PV combined and the DSM threshold value respectively. The average for the four generation options is 151.3c per kWh.

In theory there are additional benefits in the form of emission savings from the SWH programme compared to electricity generation by Kusile. Eskom has an emissions factor of 1.03kg of CO₂ for every kWh of electricity sold with its current mix of electricity generation¹³. However, the value of Carbon Credits had dropped considerably in recent times and is

⁹ (<http://www.engineeringnews.co.za/article/second-crop-of-renewables-preferred-bidders-named-2012-05-21>)

¹⁰ This is quoted as R2.13/kWh in 2010 prices, which is R2.36 in 2012 prices.

¹¹ Weighted according to their respective supply capacities as indicated in the IRP2010-2030

¹² Source: South African Reserve Bank, average rate for 2 July 2012 to 26 October 2012

¹³ Eskom 2012 Integrated Report.

currently trading at less than R20 per ton¹⁴. Consequently this is not factored into the base analysis. A sensitivity analysis is done on including carbon credits in order to capture the much higher perceived social value of carbon emissions. Stern (2006, p16) cites a Social Cost of Carbon at \$85 per ton while in its review of the Social Cost of Carbon the Stockholm Environment Institute (2010, p17) concludes that a central Social Cost of Carbon, based on mitigation costs, would be \$85 per ton. These upper ranges will be incorporated into the sensitivity analysis.

3.1.3 Results

The results of the economic cost benefit analysis are given in Table 11. The table includes the present value (PV) of all the costs as well as the benefits. It lists the Net Benefits (NPV) and the Benefit Cost Ratio (BCR). Five sets of results are given: two are on the LCOE (plus distribution costs and transmission losses) of Kusile and Ingula, the third is a weighted combination¹⁵ of the bid prices for Wind Power and Solar PV in the REIPPPP process, the fourth is on the value ESKOM has determined from its IRP 2010-2030 analysis to be the threshold value for DSM projects. The fifth is the weighted average of the four previous options. The weighted average is determined from the relative generation capacities (or savings in the case of the DSM programme) as indicated in the IRP 2010-2030.

Table 11: Economic Cost Benefit Results

R million, 2012 Prices	LCOE of Kusile	LCOE of Ingula	REIPPP of Wind & SPV	Value of DSM	Weighted Average
	R0.82/kWh	R1.16/kWh	R1.55/kWh	R2.36/kWh	R1.51/kWh
Manufacture and Installation Costs	1 545	1 545	1 545	1 545	1 545
Maintenance Costs	199	199	199	199	199
Total Costs	1 744	1 744	1 744	1 744	1 744
Electricity Savings Benefit	2 038	2 881	3 832	6 414	3 824
Carbon Credits	0				0
Total Benefits	2 038	2 881	3 832	6 414	3 824
Net Benefit	294	1 137	2 088	4 670	2 079
BCR	1.17	1.65	2.20	3.68	2.19
IRR	11.2%	20.1%	30.7%	68.2%	30.6%

The following results can be seen in Table 11:

- All options have the same total costs with a PV of R1 744m because these are the costs of the SWH programme:

¹⁴ <http://www.cdm-watch.org/wordpress/wp-content/uploads/2012/09/AAU-banking-briefing-paper-Point-Carbon.pdf>

¹⁵ Based on the projected generation capacity for each respective option

- Installation and replacement costs have a PV of R1 545m;
 - Maintenance costs have a PV of R199m.
- Compared to the LCOE of Kusile (R0.82/kWh):
 - The total benefits have a PV of R2 038m;
 - The net benefit (the project NPV) is R294m;
 - The BCR is 1.17;
 - The IRR is 11.2%.

The project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R1.17. Since the BCR is less than 2.0 the project could be considered to be marginal because of the number of assumptions made. The robustness of this result is tested in a sensitivity analysis.

- Compared to the LCOE of Ingula (R1.16/kWh):
 - The total benefits have a PV of R2 881m.
 - The net benefit (the project NPV) is R1 137m;
 - The BCR is 1.65;
 - The IRR is 20.1%.

The project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R1.65. Since the BCR is less than 2.0 the project could be considered to be marginal.

- Compared to the REIPPPP bid prices for Wind Power and CSP (R1.55/kWh):
 - The total benefits have a PV of R3 832m.
 - The net benefit (the project NPV) is R2 088m;
 - The BCR is 2.20;
 - The IRR is 30.7%.

The project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R2.20. Since the BCR is greater than 2.0 the project is robust.

- Compared to the threshold value placed on DSM projects (R2.36/kWh):
 - The total benefits have a PV of R6 414m.
 - The net benefit (the project NPV) is R4 670m;
 - The BCR is 3.68;
 - The IRR is 68.2%.

Based on the results above the project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R3.68. Since the BCR is greater than 2.0 the project is robust.

- Compared to the weighted average of the four previous values for electricity savings (R1.51/kWh):
 - The total benefits have a PV of R3 824m;
 - The net benefit (the project NPV) is R2 079m;
 - The BCR is 2.19;
 - The IRR is 30.6%.

The project is economically efficient. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R2.19. Since the BCR is greater than 2.0 the project is robust. The result is tested in a sensitivity analysis.

The BCRs for the above set of results range between a low of 1.17 and a high of 3.68. These values indicate that the project is economically efficient no matter which LCOE is used. However, since the BCRs for two of the five cases are less than 2.0 (and for Kusile is only slightly greater than 1.0) they could be considered marginal because of the number of assumptions employed in this analysis. These results are tested further in the following section.

3.1.4 Economic Sensitivity Analysis

A sensitivity analysis was conducted on four main assumptions:

- Installation and replacement costs;
- Value of carbon credits;
- Number of units rolled out;
- Efficiency of the SWH units.

In addition a combination of more and less favourable assumptions was analysed to determine the overall robustness of the proposed project. The sensitivity analysis uses the weighted average of the four electricity generation options. Switching values are however calculated where relevant for each generation option.

3.1.4.1 Installation and Replacement Costs

The effect of varying the estimated installation costs (including manufacturing costs) is illustrated in Table 12. In this test the installation costs are varied from 25% less (75% of the estimated costs) to 50% more (150% of the estimated costs) than estimated. The base case of the actual estimated infrastructure costs is illustrated in bold in the table.

Table 12: Installation Costs Sensitivity Analysis

Installation Costs	BCR
75%	2.82
100%	2.19
125%	1.79
150%	1.52

It can be seen from the table that the BCR would increase from 2.19 to 2.82 if the infrastructure costs are 25% lower than estimated. The BCR would drop to 1.79 if costs increased by 25% and to 1.52 if the costs increased by 50%.

The conclusion is that the results are sensitive to variations in the manufacture and installation costs but that the project remains economically efficient for the full range tested. The switching value for the installation costs is a 134% increase. In other words, the manufacturing and installation costs would have to more than double for the project to become economically inefficient. If the Kusile LCOE is used to value the benefits of saved electricity (which is the lowest value for electricity savings assumed in this analysis) the costs would need to increase by 19% for the project to become inefficient.

3.1.4.2 Value of Carbon Credits

As mentioned above, there has been a marked decline in the value of carbon credits and, as a consequence, these were excluded from the analysis. This sensitivity analysis looks at the impact of including them. The impact is examined on both the Kusile BCR and the Weighted Average BCR. Kusile is the only generation option comparison that would generate carbon credit benefits when compared to the SWH programme, while the weighted average case is affected by the impact on Kusile.

Table 13: Value of Carbon Credits Sensitivity Analysis

Carbon Credits (R/ton)	Kusile	Average
R 0	1.17	2.19
R 20	1.20	2.20
R 300	1.63	2.31
R 750	2.33	2.48

The effect of varying the value of potential carbon credits is illustrated in Table 13. The value of carbon credits in the sensitivity analysis is varied between zero and R750/ton. The high end of the range tested covers the higher Social Cost of Carbon of \$83 / ton (Stockholm Environment Institute, 2010, p16) and \$85 / ton mentioned in the Stern Review (2006, p16). Other values that are tested are R20/ton (which is the current market value for carbon) and an intermediate value of R300/ton.

- If carbon credits are valued at R20 per ton then the BCR for Kusile would increase from 1.17 to 1.20. The BCR for the weighted average of the four cases would increase marginally from 2.19 to 2.20.
- If carbon credits are valued at R300 per ton then the BCR for Kusile would increase to 1.63. The BCR for the weighted average of the four cases would increase from 2.31.
- If carbon credits were valued at R750 per ton (the social value mentioned in the literature) then the Kusile BCR increases to 2.33 and that of the average of the four cases to 2.48.

The conclusion is that the results are only slightly sensitive to variations in the value of carbon credits. The higher the value of carbon the more beneficial the project becomes to society, particularly when valued against the Kusile LCOE.

3.1.4.3 Number of Units Rolled Out

In an economic cost benefit analysis the project scenario is always compared to a 'business as usual' scenario. In this analysis the assumption was made that the full target of 144 000 SWHs would be rolled out within the programme. In reality the business as usual scenario should take account of the fact that people would still install SWHs even without the programme. What was not known is how many people would do this and this could therefore not be included. As a consequence this sensitivity analysis looks at the impact of reducing the number of units rolled out to account for the fact that in the business as usual scenario people would continue to install SWHs, just not as many as with the programme.

The results of varying the number of SWH units rolled out are shown in Table 14. In addition to the base case scenario where 144 000 SWH units are rolled out three additional scenarios are tested. These are a scenario where no SWH units are rolled out in the fifth year of the programme (years 1 to 4 remain the same) – called No Year 5 in the table - and a scenario where 75% of the SWHs are rolled out in each of the years. The latter scenario is the equivalent of assuming that 25% of the SWHs would have been installed by households

in the absence of the SWH Programme. A third scenario is examined in which the critical mass of SWH's in order to achieve the cost economies of scale are rolled out.

Table 14: Sensitivity on Roll-out of SWH Units

SWH Rollout	Year 1	Year 2	Year 3	Year 4	Year 5	Total	BCR	NPV
Base Case	6 000	14 000	30 000	47 000	47 000	144 000	2.19	2 079
No Year 5	6 000	14 000	30 000	47 000	0	97 000	2.22	1 502
75% In All Years	4 500	10 500	22 500	35 250	35 250	108 000	2.19	1 560
Critical Mass Level	4 200	10 800	15 000	15 000	15 000	60 000	2.21	908

- Under the scenario where no SWHs are rolled out in year 5 the BCR increases from 2.19 to 2.22. The reason for the counter-intuitive increase in the BCR is that the costs reduce in the early years but the associated benefits only reduce at a later stage. The discounting process is affected more by the reduction in costs than the benefits, hence the higher BCR.
- Under the scenario where only 75% of the SWHs are rolled out in each of the five years the BCR remains constant at 2.19. In this scenario the costs and the benefits all reduce by the same proportion, so the BCR remains constant. The project NPV is affected and reduces from R2 079m to R1 560m.
- Under the scenario where the critical mass level of SWHs are rolled out the BCR increases slightly to 2.21. The project BCR, however, reduces from R2 079m to R908m. Under this scenario it is still economically beneficial to implement the programme.

The conclusion to this sensitivity analysis is that the results are not sensitive to the number of units rolled out in the programme. What is important and is not factored in here is that the rollout still needs to achieve the critical mass of units shown in Table 4 in order to achieve the economies of scale needed to make the local industry price competitive.

3.1.4.4 Efficiency of the SWH Units

In the base case analysis the efficiency of the SWH units is 60%. This means that 40% of the heating is done by electricity. In the City of Cape Town's RFP for the rollout of the SWH units a conservative efficiency of 60% is provided while an optimum efficiency of 70% is mentioned¹⁶. There appears to be a sense that this might be on the high side. Consequently, this sensitivity analysis looks at varying the efficiency of the SWH units between 30% and 70%.

¹⁶ City of Cape Town RFP 473C/2011/12 p27

Table 15: Sensitivity Analysis on the Efficiency of SWH Units

Efficiency of Units	BCR
30% Efficiency	1.10
40% Efficiency	1.46
50% Efficiency	1.83
60% Efficiency	2.19
70% Efficiency	2.56

- At a 30% efficiency level the weighted average BCR reduces from 2.19 to 1.10.
- At a 40% efficiency level the weighted average BCR reduces from 2.19 to 1.46. At a 50% efficiency level the BCR is 1.83.
- At a 70% efficiency level the weighted average BCR increases to 2.56.

The switching value for the weighted average BCR is an efficiency level of 27%. In other words, the SWH units would need to save less than 27% electricity for the weighted BCR to be less than 1 and the project to no longer be efficient. For the case where the Kusile LCOE is considered, however, the switching value for the efficiency is 51%.

3.1.4.5 Combination of Assumptions

Less favourable assumptions were combined to determine if the SWH programme remains viable for such an extreme combination. This was also done for the more favourable assumptions to see the potential upside for the programme. These combinations are shown in Table 16.

Table 16: More and Less Favourable Assumptions

Variables	Least Favourable	Base Case	Most Favourable
Installation Costs	125%	100%	90%
Carbon Credits	R0 / ton	R150 / ton	
Value of Saved Energy	82c/kWh	134c/kWh	236c/kWh
Efficiency of SWH Units	50%	60%	70%

The variables for the various scenarios are as follows:

- For the least favourable combination:
 - Installation costs are 25% higher than expected;
 - Carbon credits are valued at R0 / ton of CO₂;
 - The value of saved energy is the Kusile LCOE of 82c/kWh.
 - The efficiency of the SWH units is 50%.
- For the most favourable combination:

- Installation costs are 10% lower than expected;
- Carbon credits are ignored because the threshold value of DSM projects (which would result in zero incremental carbon credits) is used;
- The value of saved energy is the DSM threshold value of 236c/kWh;
- The efficiency of the SWH units is increased to 70%.

The results of this exercise are shown in Table 17.

Table 17: BCR Results Extreme Combinations

Extreme Cases	BCR
Least Favourable	0.80
Base Base	2.19
Most Favourable	4.71

The BCR reduces to below breakeven point to 0.80 for the least favourable combination. For the most favourable combination the BCR increases to 4.71. Under the least favourable conditions it is the inclusion of the LCOE of Kusile that results in a BCR of less than one. If the LCOE of Ingula is used the BCR is 1.13.

The overall conclusion from the cost benefit analysis of the intention to rollout solar water heaters is that the project appears to be economically efficient. It has a generally robust benefit cost ratio across most permutations that were tested. The fact that many of the BCRs were less than two is a cause for concern. On the one hand these are low BCRs and could be considered marginal. On the other the sensitivity analysis mostly all returned a BCR of 1.0 or greater. In other words, the project is economically efficient under most conditions.

3.2 Financial Cost Benefit

This section quantifies the financial cost benefit analysis of the SWH rollout programme on households in Cape Town, the installation companies, the City of Cape Town and Eskom.

3.2.1 Households Installing SWHs

Table 18 presents the assumptions and the results of the financial savings to households installing the different size SWH units. The analysis is based on the following assumptions:

- The finance period is five years (60 months);
- The average prime lending rate over the finance period is 10.0%. It is currently 8.5%;
- The lending rate to households for this project would be prime plus 2%;

- The Eskom rebate for the 150 litre, 200 litre and 300 litre units is R4 000, R5 333 and R8 000 respectively (City of Cape Town RFP 473C/2011/12 - Annexure III SWH cost benefit analysis for CCT SWH programme spread sheet);
- The applicable household electricity rates are R1.29/kWh for the 150 litre units and R1.40/kWh for the 200 litre and 300 litre units (City of Cape Town RFP 473C/2011/12 - Annexure III SWH cost benefit analysis for CCT SWH programme spread sheet).
- These costs all exclude VAT. Households, as end users, would need to pay VAT on the installation costs and the electricity. Consequently, VAT will be added to their costs. However, to be consistent with the information supplied, the amounts shown in Table 18 exclude VAT.

Table 18: Financial Savings to Households (excluding VAT)

	SWH Information		
	150 l	200 l	300 l
Installation Costs	R 10 500	R 15 000	R 22 500
Eskom Rebate	R 4 000	R 5 333	R 8 000
Amount to be Financed	R 6 500	R 9 667	R 14 500
Monthly electricity savings (kWh)	153.1	195.7	282.7
Applicable electricity price (R/kWh)	R 1.29	R 1.40	R 1.40
Monthly electricity savings (Rands)	R 197.52	R 273.96	R 395.77
Initial Monthly Repayment (exc VAT)	R 144.59	R 215.04	R 322.54
Monthly Maintenance Costs	R 16.67	R 16.67	R 16.67
Total Monthly Payment	R 161.26	R 231.70	R 339.21
Monthly Savings	R 36.27	R 42.25	R 56.56

The following methodology was employed:

- The first step was to determine the net installation cost to be financed. This was calculated by reducing the installation costs by the Eskom rebate. This makes the amount to be financed R6 500 for the 150 litre units, R9 667 for the 200 litre units and R14 500 for the 300 litre units.
- The monthly repayment costs are therefore R144.59, R215.04 and R322.54 for the three units.
- Monthly maintenance costs of R16.67 need to be included.
- These total monthly costs are compared to the monthly electricity savings of R197.52, R273.96 and R395.77 respectively.
- The net monthly savings in the first year amount to R36.27, R42.25 and R56.56 for the three units (all amounts exclude VAT).

What the results mean is that a household installing a 150 litre unit would realise an average savings of R36.27 a month during the first year (R41.34 if VAT is included in the analysis).

The annual household savings for all households installing the three different size units are given in Table 19 (all amounts are given in R millions and in 2012 prices and now include VAT). For ease of presentation only the first ten years of the twenty year analysis period are given. In calculating the future savings some additional assumptions had to be made:

- The average annual inflation rate is 5%. The reason for specifying this assumption is that while all costs are in real terms (2012 prices) the average future inflation rate is important because with a constant repayment of the loans in nominal terms the real cost would reduce by 5% each year.
- The real annual increase in electricity (i.e. over and above inflation) for the first five years of the programme is 10%. Thereafter it is reduced to a 2% real growth per annum. This latter growth rate is varied in a sensitivity analysis.

Table 19: Annual Household Savings (R millions, 2012 Prices, VAT Inclusive)

Annual Household Cashflow	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Repayment of SWH Loans	-18	-59	-146	-280	-408	-374	-323	-238	-116	0
Maintenance Costs	-1	-5	-11	-22	-33	-33	-33	-33	-33	-33
Electricity Savings	23	84	232	494	807	824	840	857	874	891
Annual Savings	4	21	74	192	367	417	484	586	725	859

For all households:

- The repayment of the loans will increase from R18m in year 1 to a maximum of R408m in year 5. The increase is due to the rollout programme as more and more households install the SWH units over the five year rollout period. Thereafter the payment amounts reduce as the households that installed the SWH units in the first year will have paid off their costs. The final year of repayment is in year 9, in which the repayment amount is R116m.
- Maintenance costs increase from R1m in year 1 to R33m in year 5. This remains constant for each year thereafter.
- Gross total electricity savings amount to R23m in the first year and increase rapidly each year until year 5 when all 144 000 households have installed their SWH units. In this year the electricity savings amount to R807m. Electricity savings will then continue at a constant rate in kWh terms but will increase at 2% in monetary terms in line with the assumption of a 2% real increase in the annual price of electricity.
- The net savings for households is positive from the first year. The savings then continue to increase each year thereafter. In year 5, the last year of the rollout programme, the net savings amount to R367m. This increases to R417m in year 6 and by year 10 totals R859m. By year 20 this totals R1 054m.

The NPV of the financial benefits to households, over a 20 year period, is R5 046m. The effect of varying some of the key assumptions in this analysis is presented in Table 20. The three variables that are tested are the repayment lending rate, the efficiency of the SWH units and the real increase in the price of electricity (after the real annual increase of 10% in the first five years). The base case assumptions are shown in bold in the table.

Table 20: Household Sensitivity Analysis (R millions, VAT inclusive)

Interest Rates	prime - 2%	prime	prime + 2%	prime + 5%
Household NPV	5 160	5 104	5 046	4 958
Efficiency of SWH Units	30%	50%	60%	70%
Household NPV	1 762	3 952	5 046	6 141
Real Increase in Electricity	0%	2%	5%	10%
Household NPV	4 372	5 046	6 296	9 244

The first variable that is tested is the lending rate. This is varied from prime less 2% to prime plus 5%. The NPV of the effect on households varies from R5 160m to R4 958m. The conclusion is that the household results are not sensitive to the conditions of the loan.

The second variable test is the efficiency of the SWH units. They are tested in the range of a 30% efficiency level to a 70% efficiency level. The results are extremely sensitive to changes in the assumed efficiencies of the SHW units. However, at the lower efficiency level of 30% the impact on households is still positive (NPV of R1 762m). Although they would incur increased costs in the first few years while they pay off the installation loans, once this is done there are sufficient benefits in the succeeding years at the 30% efficiency level to offset these increased costs.

The last variable that is tested for the households is the impact on the real price of electricity. In the first five years of the programme it has been assumed that Eskom will be granted its 10% real price increase per annum. However, the annual increases in the fifteen years thereafter are varied in the sensitivity analysis. The range tested is a 0% real increase to a 10% real increase per annum. The results are sensitive to this assumption but as the real increases per annum get larger so the savings to the households improve and the net effect is always positive (even at a 0% real increase after five years).

The conclusion to the sensitivity analysis is that households that install the SWH units would always benefit from the rollout programme. The benefits are of sufficient magnitude and robustness that extreme variations do not change their net position. Even an extreme combination of the above variables (i.e. lending rate of prime plus 5%, efficiency level of 30% and 0% real increase in the price of electricity after five years) still returns a net positive benefit to the value of R1 336m.

3.2.2 Suppliers of the SWH Units

The cash flow of the companies manufacturing and installing the units is shown in Table 21. It is assumed that there are two areas of profit for these companies. The first is a profit margin on the installation and maintenance costs. The second is the possibility of generating income on the loans provided to the households. For the purposes of this exercise the following assumptions have been made:

- The installation companies mark up a 5% profit on the installation and maintenance charges;
- They receive low interest loans, at 2% below prime. This is varied in a sensitivity analysis. The actual interest rate is not known.
- The manufacture and installation companies are VAT vendors and therefore pay back the VAT portion of their income or claim the VAT portion of their expenses. However, for the financing costs of the loans, VAT is included in the repayment costs.

Table 21: Cash flow to installation companies (R millions, 2012 prices)

Rm, 2012 Prices	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Eskom Rebate	34	78	168	263	263					
Financing Institution Loans	67	157	337	528	528					
Income from Household Loans	18	59	146	280	408	374	323	238	116	0
Maintenance Income	1	4	10	19	29	29	29	29	29	29
Total Income	120	299	661	1 090	1 227	403	352	266	145	29
Cost of Installation	-88	-205	-440	-690	-690					
Repayment of Loans	-16	-54	-133	-255	-372	-341	-295	-217	-106	0
Maintenance Costs	-1	-4	-10	-18	-27	-27	-27	-27	-27	-27
Total Expenses	-106	-263	-583	-964	-1 089	-368	-322	-244	-133	-27
Total Net Income	15	36	78	127	139	35	30	22	12	1

Table 21 illustrates the sources of revenue for the installation companies. These are the Eskom rebate, the loan capital from the financing institutions, the repayment of the loans from the households and the maintenance income. This revenue needs to be offset by the expenses of manufacturing and installing the SWH units, the repayment of the loans and the actual cost of maintaining the units. The income from the Eskom rebate and the loan capital and the manufacture and installation costs last for five years. The income from households paying their loans and the cost of repaying the loans back to the financing institutions lasts for a total of 9 years, while the maintenance income and costs would continue until the end of the analysis period.

Total income to the installation companies would increase from R120m in the first year of the programme and peak at R1 227m in the fifth year. At this stage no further income is derived from installing units in the programme and income also declines as the houses in the first year of installation will have paid off their loans. Total net income therefore declines each year thereafter until in year 10 it amounts to R29m, which is only due to the maintenance that these companies perform on the units. It would continue at this level until year 20.

The expenses of the installation companies would be R106m in the first year and also peak in the fifth year. Thereafter it would reduce until in the tenth year when it only amounts to R27m.

Total net income to the installation companies would increase from R15m in the first year to R139m in the fifth year. This then reduces until the tenth year when the only source of net income is the profit margin on the maintenance of the units. This would amount to R1m in that year and for the rest of the 20 year analysis period.

The NPV of the financial benefits to the installation companies is R356m. The effect of varying some of the key assumptions in this analysis is presented in Table 22. The two variables that are tested are the repayment lending rate (this is the rate that the installation companies would repay their loans and is different to that which the households would receive) and their profit margin.

Table 22: Installation Company Sensitivity Analysis (R millions)

Interest Rates	prime - 3%	prime - 2%	prime	prime +2%
Installation Company NPV	383	356	300	243
Profit Margin	0%	2%	5%	8%
Installation Company NPV	262	299	356	412

The first variable that is tested is the interest rates for the repayment of the loans. The results are sensitive to these terms and vary from an NPV of R383m at prime less 3% to R243m at prime plus 2%. Since prime plus 2% is the assumed rate that households would be paying, if the installation companies had to repay their loans at this same rate then their only net income would be their profit margin on installing and maintaining the units. This would effectively amount to an NPV of R243m.

The second variable that is tested is their profit margin. This is varied between 0% and 8% and the impact is to change the NPV from R262m to R412m.

The conclusion is that the installation companies' results are sensitive to changes in these variables but that the impact is essentially on their profit margin. Even if they charge only a

2% markup on the installation and maintenance costs and offer a 1% difference on their loans (which would equate to prime plus 1%) they would still have a profit with an NPV of R215m.

3.2.3 City of Cape Town

The City of Cape Town would lose revenue on the difference between what it pays Eskom and what it charges households. This loss in revenue is shown in Table 23. The amounts are all presented in real prices and exclude VAT. The analysis is based on the following additional assumptions:

- Although Eskom supplies power to the City at an average rate of approximately 50.0c/kWh (Gary Ross of City of Cape Town in communication to Andrew Janisch of SEA) the SWH units would save the City from purchasing electricity during peak and higher demand times. An applicable rate for electricity savings by the SWH units of 60.75c has been calculated by SEA (e-mail dated 5 November 2012). This is based on the demand profile, time of use, availability of the sun and the Megaflex home rates. This is a key assumption and will be varied in a sensitivity analysis.

Table 23: Annual Loss in Revenue to the City of Cape Town (Rm, 2012 Prices, excl VAT)

Change in Cash Flow - Rm	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Loss in Electricity Sales	-20	-74	-203	-434	-708	-722	-737	-752	-767	-782
Reduced Purchases from Eskom	9	33	90	193	315	321	327	334	341	347
Net Real Loss in Revenue	-11	-41	-113	-241	-393	-401	-409	-418	-426	-434

The loss in revenue to the City of Cape Town would amount to R20m in the first year, increasing to R782m in the tenth year and R953m in the twentieth. The cost that the City incurs in purchasing the saved electricity from Eskom would be reflected as a reduced cost. This amounts to R9m in the first year and increases in real terms to R347m in the tenth year and further to R424m in the twentieth. The overall net loss to the City amounts to R11m in the first year and increases to R434m in the tenth year. In the twentieth year the overall net loss amounts to R530m. The NPV of all these losses is R3 201m.

The net loss in revenue to the City of Cape Town as indicated in the last row of Table 23 would only occur if there is no alternative demand for that electricity. If the City of Cape Town is currently constrained in the amount of electricity that it can supply its customers then the electricity losses indicated in Table 23 would be recouped from other customers. However, if there is no take up of the electricity savings then the City of Cape Town would be faced with the net loss of revenue indicated in the table. This loss in revenue would need to be recovered by increasing the electricity tariffs.

There would be a reduction in net household income for six years should the City of Cape Town recover all its losses from households. The peak reduction in household income would amount to R83m in years four and five. However, from year seven onwards (when many of the SWH loans are paid off) there is a net increase in household disposable income. This then increases each year as more and more of the SWH loans are paid off and the real price of electricity increases. This increase in the latter years more than compensates for the reduction in the first six years and the NPV over a 20 year period is a positive R1.40bn.

A sensitivity test was performed on the real increase in the price of electricity as well as the price that the City of Cape Town pays for electricity purchased from Eskom. The results are shown in Table 24.

Table 24: City of Cape Town Sensitivity Analysis (R millions, VAT exclusive)

Real Increase in Electricity	0%	2%	5%	10%
City of Cape Town NPV	-2 872	-3 201	-3 810	-5 247
Electricity Purchase Price	50.00c/kWh	60.75c/kWh	95.79c/kWh	116.4c/kWh
City of Cape Town NPV	-3 654	-3 201	-1 725	-856

The first variable tested is the real increase in the price of electricity after the first five years (during which electricity increased at 10% annually). If there is a 0% increase in the real price of electricity then the NPV of the losses to the City of Cape Town reduces to R2 872m. If the real increase in electricity were to be 10% per annum for the full twenty year analysis period then the losses would increase further to R5 247m (excluding VAT).

The second variable that is tested in the sensitivity analysis is the price that the City of Cape Town pays Eskom for the electricity that would be saved by the SWH units. The city pays on average 50.0c/kWh. However, this rate would vary depending on the time of day and the season. Sustainable Energy Africa has estimated the value of a saved kWh of SWH electricity to be 60.75c/kWh. The effect of varying this cost is illustrated in Table 24 where the cost of electricity is varied between 50.0c/kWh and 116.4c/kWh. The results for the various prices are as follows:

- The base case assumption for the cost of saved electricity of 60.75c/kWh returns a negative NPV for the City of Cape Town of R3 201m.
- If the cost of the saved electricity were to reduce to the average rate of 50.0c/kWh then the NPV for the City of Cape Town would worsen to negative R3 654m.
- If the cost of the saved electricity was valued at 95.79c/kWh (this is the weighted average cost of the winter and summer Megaflex peak tariff) then the NPV for the City of Cape Town would improve to negative R1 725m.

- If the cost of the saved electricity was valued at 116.4c/kWh (this is the generation cost for the Ingula pumped storage scheme) then the NPV for the City of Cape Town would improve to negative R856m.

The switching value for the purchases of electricity from Eskom (i.e. the value at which the financial impact of the project on the City of Cape Town would be zero) is 136.7c/kWh in 2012. At this value the NPV of the City is R0m. The conclusion to this sensitivity analysis is that the City of Cape Town loses income for the entire range of electricity costs tested.

3.2.4 Eskom

Eskom would have reduced revenue as a result of the saved electricity and would incur costs with the rebate for the SWH units. The impact on cash flow to the national utility is shown in Table 25 and once again for ease of presentation only the first ten years of the twenty year analysis period are shown.

Table 25: Annual Change in Cash Flow to Eskom (R millions, 2012 Prices, VAT exclusive)

Change in Cash Flow - Rm	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Real Loss in Revenue	-9	-33	-90	-193	-315	-321	-327	-334	-341	-347
Reduced Generation Costs	19	67	175	357	557	568	579	591	603	615
Subsidy Costs	-34	-78	-168	-263	-263					
Net Real Loss in Revenue	-24	-45	-83	-99	-21	247	252	257	262	267

Eskom would lose R9m in revenue in the first year of the programme rollout. This would increase to R347m in the tenth year and R424m in the twentieth. This loss in revenue in the tenth year represents 0.3% of the total revenue received by Eskom in 2012 (2012 Integrated Report). These losses in revenue need to be offset against the loss in electricity generation costs. For the purposes of this exercise the marginal cost of generating the SWH electricity is assumed as the LCOE of Ingula (116.4c/kWh and as described in section 3.1.2). This cost of generating peak load electricity is increased annually in accordance with the IRP generation costs. There would be reduced generation costs amounting to R19m in the first year and increasing, in real terms, to R615m in year 10. By year twenty there would be a reduction of R749m in generation costs. In addition to these losses in revenue and reduced generation costs are the rebates that Eskom would provide for the installation of the SWH units. These rebates are calculated to amount to R34m in the first year of the programme and then increase to R263m in the fourth and fifth years.

The net real financial position for Eskom is a R24m loss in the first year, increasing to R99m in the fourth year. Once the rebates are paid there is a net increase in revenue to Eskom. In year 6 this amounts to R247m, increases to R267m in year 10 and R326m in year 20.

The NPV of the financial benefits to Eskom is R1 399m.

The effect of varying some of the key assumptions in this analysis is presented in Table 26. The three variables that are tested are the effective price that the City of Cape Town would pay for the saved electricity, the marginal generation cost to Eskom and the real increase in the price of electricity after the first five years of the programme.

Table 26: Eskom Sensitivity Analysis (R millions, VAT exclusive)

CoCT Purchase Price	50.00c/kWh	60.75c/kWh	95.79c/kWh	116.4c/kWh
Eskom NPV	1 852	1 399	-77	-945
Generation Cost	R0.82/kWh	R1.16/kWh	R1.55/kWh	R2.36/kWh
Eskom NPV	65	1 399	2 906	6 090
Real Increase in Electricity	0%	2%	5%	10%
Eskom NPV	1 197	1 399	1 774	2 658

The first variable that is tested is the effective price that the City of Cape Town would have paid for the electricity saved by the SWH units. The results are sensitive to changes in this assumption and the closer the cost of the saved electricity gets to Eskom's generation cost the lower its NPV.

The second variable that is tested is the marginal generation cost of the saved electricity. This is varied between 82c/kWh (the LCOE of Kusile) to 155c/kWh (the weighted average REIPPPP of Wind and Solar) and up to 236c/kWh (the threshold value of DSM projects). Changes in the assumed generation cost have a marked effect on Eskom, although their net position is always positive:

- At a generation cost of 82c/kWh Eskom's NPV is R65m.
- At a generation cost of 155c/kWh Eskom's NPV is R2 906m.
- At a generation cost of 236c/kWh Eskom's NPV is R6 090m.

The switching value for the generation cost is 80.7c/kWh. This is higher than the current average cost of generation (41.28 c/kWh¹⁷) but is also lower than the LCOE of Kusile at 82c/kWh. It should also be remembered that the SWH units are being installed at a time when the supply – demand balance on the national electricity grid is precarious. The SWH's could reduce power outages, the result of which would have higher benefits to both Eskom and the economy.

¹⁷ Eskom's 2012 Integrated Report

The third variable that is tested in the sensitivity analysis is the real increase in the price of electricity after the first five years of the programme. Although Eskom's results are sensitive to changes in this assumption its financial NPV remains positive for the full range tested.

The conclusion to these sensitivity analyses is that Eskom's position is robust as far as the rollout of this programme is concerned.

3.2.5 Net Present Values of All Stakeholders

The net present value of the cash flow to all the stakeholders is shown in Table 27. Although the time lines shown in Table 19 through to Table 25 are shown as 10 years the NPV calculations presented in Table 27 are based on a 20 year time horizon. This has been chosen to be consistent with the time period used in the economic analysis.

Table 27: NPV of Cash Flow to Stakeholders (R millions, 2012 Prices)

Stakeholder	NPV
Households NPV	5 046
Installing Companies NPV	356
City of Cape Town NPV	-3 201
Eskom NPV	1 399
Change in VAT Receipts	-388
All Parties NPV	3 213
All Parties IRR	51%
Citizens of Cape Town (GGP NPV)	2 318

From the results shown in Table 27 it can be seen that households installing the SWH units have the highest savings with a NPV of R5 046m, followed by Eskom with a NPV of R1 399. The Installation Companies are also winners, with a NPV of Net Profit to the value of R356m. The City of Cape Town would endure reduced net revenue with a PV of R3 201m excluding VAT, which would need to then be recouped from its citizens in the form of increased electricity tariffs. Reduced VAT receipts to the National Government would amount to R388m.

The financial NPV of the five parties combined is R3 213m and the financial IRR is 51%. Also shown in Table 27 is the NPV to the citizens of Cape Town. This is the present value of the contribution to provincial GGP (presented in the next section) and this amounts to R2 318m. This amount needs to be compared to the loss to the City of Cape Town (R3 201m) which would in effect be recouped from its citizens.

3.2.6 Cape Town's Balance of Payments

There will be changes in the flow of funds between Cape Town and the rest of the country – in effect Cape Town's balance of payments. This section reports on these flows by quantifying all the inflows and outflows to and from the city as a result of the programme. The results are shown in Table 28.

Table 28: Balance of Payment for Cape Town (R millions, 2012 prices)

Rm, 2012 Prices	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Eskom Rebate	34	78	168	263	263					
Financing Institution Loans	67	157	337	528	528					
Total Inflows	101	236	505	791	791	0	0	0	0	0
Repayment of loans	16	54	133	255	372	341	295	217	106	0
Reduced Purchases from Eskom	-9	-33	-90	-193	-315	-321	-327	-334	-341	-347
Reduced VAT Payments	-9	-24	-54	-93	-115	-56	-57	-58	-59	-61
Total Outflows	-2	-2	-11	-31	-58	-36	-90	-176	-294	-408
Net Inflows	103	238	516	822	849	36	90	176	294	408

The inflows are from the Eskom rebate and the loans from the financing institutions. In total these are set to increase from R101m in the first year of the programme to R791m in the fifth year.

There are three outflows. These are the repayment of the funding institution loans, the reduced purchases of electricity from Eskom and reduced VAT payments to the National Government (these latter two could be considered as a negative outflow – in essence an inflow - since it is a reduction in purchases or payments). The outflows reduce from negative R2m (essentially an inflow) in the first year of the programme to negative R408m in the tenth year.

On balance the net inflow of money to Cape Town amounts to R103m in the first year, increasing to R849m in the fifth year. This then drops to R36m in the sixth year as the Eskom rebates and the financing institution loans end. However, the net inflows then increase each year thereafter because the loans are being paid off and the real price of electricity is increasing. In the tenth year the net inflows amount to R408m and in the twentieth R498m.

The PV of the balance of payments to Cape Town over the twenty year analysis period is a positive R3 796m.

3.3 Macroeconomic Results

This section reports on the expected macroeconomic contribution of the proposed City of Cape Town's SWH programme. The results are reported for a five year period (which equates to the rollout period) and takes into account only those items that could be quantified.

The macroeconomic effects are based on the expenditure from the manufacturing, installation and maintenance of SWH units. The impact from electricity savings was not included. The latter might mean that there is less chance of electricity outages and there might be a marginal impact on Eskom's growth. The electricity savings will also be recovered by the City of Cape Town in the form of higher electricity tariffs or higher property rates.

3.3.1 Gross Domestic Product

Gross Domestic Product is the total value of all final goods and services produced in the country. It is clearly fundamental to the economic quality of life of people in the country. It is also the most important and all-encompassing measure of the macroeconomic effect from the City's SWH programme. Table 29 and Figure 1 report on the contribution to GDP. All amounts are presented in real terms (2012 prices), which excludes inflation.

Table 29: Contribution to Gross Domestic Product

Contribution to Gross Domestic Product - South Africa					
Rand million, 2012 prices					
Financial Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Manufacture and Installation	130	303	648	1 016	1 016
Maintenance Costs	1	5	12	23	34
Total Contribution to GDP	131	307	660	1 039	1 050
Cumulative Contribution	131	438	1 099	2 137	3 187

The contribution to GDP from the manufacturing and installation increases from R130m in year 1 to R1 016m in both years 4 and 5, as more units are rolled out. The contribution to GDP from maintenance increases from R1m in year 1 to R34m in year 5. The R34m would then remain constant for the rest of the twenty year analysis period because there will be on-going maintenance.

The total contribution to GDP is expected to amount to R131m in year 1, R307m in year 2 and R660m in year 3. As the project reaches maturity in years 4 and 5 so the total contribution to GDP would amount to R1 039m and R1 050m in each of those years.

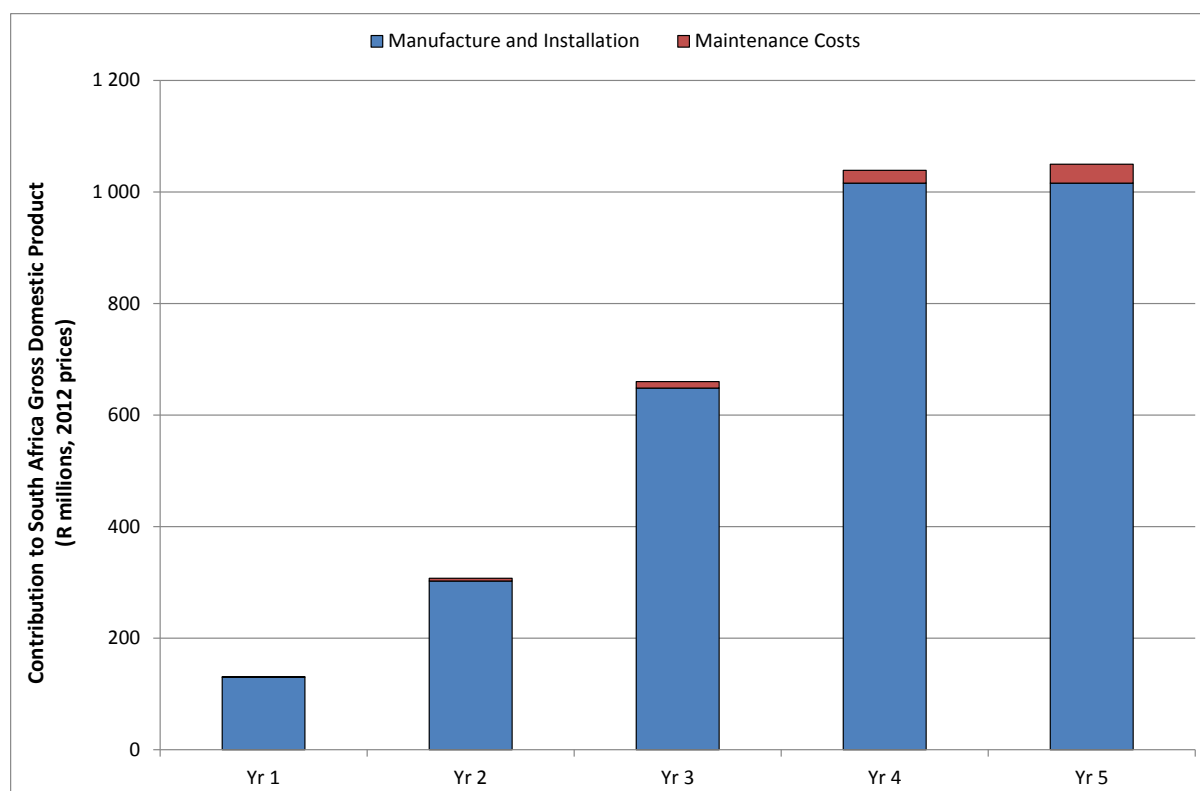


Figure 1: Detailed Contribution to GDP

The detailed contribution to GDP is shown in Figure 1. Since the amounts are all shown in real prices (inflation is excluded) the growth in contribution is from more units being rolled out. A striking feature of the graph is the comparison between the manufacturing and installation costs and maintenance costs.

GDP is important not just because it is income but also because income has the capacity to add to wealth. Based on these projections, the proposed SWH programme is expected to make a cumulative contribution to GDP of over R3.1bn by the end of the roll out.

3.3.2 Western Cape Gross Geographic Product

Table 30 reports on the contribution to Western Cape Gross Geographic Product (GGP). Naturally while many of the direct effects of the programme will be felt within the province there will be indirect effects on other provinces. As a result the contribution to GGP is less than that to GDP.

The manufacturing and installation costs are expected to contribute R116m to GDP in year 1 and R270m in the year thereafter. By years 4 and 5, when 47 000 units are being rolled out in each year, the contribution to GGP is expected to amount to R906m. The contribution to

GGP from the maintenance of the units is expected to increase from R1m in year 1 to R32m in year 5.

Table 30: Contribution to Western Cape Gross Geographic Product

Contribution to Gross Geographic Product - Western Cape					
Rand million, 2012 prices					
Financial Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Manufacture and Installation	116	270	578	906	906
Maintenance Costs	1	4	11	22	32
Total Contribution to GDP	117	274	589	927	938
Cumulative Contribution	117	391	980	1 908	2 845

The total contribution to GGP is expected to amount to R117m in year 1, R274m in year 2, R589m in year 3, R927m in year 4 and R938m in year 5. Based on these projections, the proposed SWH programme is expected to make a cumulative contribution to Western Cape GGP of over R2.8bn after five years. The majority of this contribution would occur in Cape Town since the manufacturing would take place in the city rather than elsewhere in the province.

3.3.3 Direct and Indirect Jobs

The SWH programme would create two types of jobs. The first are the direct jobs that would be created as a result of the programme. These are jobs in the manufacturing, installing and maintaining the SWH units. The second are the so-called indirect jobs resulting from multiplier effects of the various forms of expenditure. Some of the indirect jobs would occur in the province and the balance would occur elsewhere in the country. These jobs would need to be balanced against the possible job losses in the current electric geyser industry. Since the extent of the local electric geyser industry is not known these job losses could not be quantified. Consequently only the new jobs are reported here and not potential job losses. Table 31 reports on direct jobs, Table 32 on indirect jobs in the Western Cape and Table 33 sums the two to give total job creation in the province. Table 34 reports for the country as a whole.

Table 31 indicates that 87 direct jobs would be created in the first year as a result of the manufacturing and installation, followed by 202 in the next year, 433 in the third year and then 679 jobs sustained in years 4 and 5.

It is expected that as many as 22 direct jobs would be created and sustained at the end of the rollout programme in the maintenance of the units. (This estimate is based on a conservative maintenance schedule. If the units are maintained as often as once a year

there could be as many as 96 direct jobs sustained. This higher estimate is based on a team of two people servicing on average ten SWH units a day.)

Table 31: Contribution to Direct Jobs in the Western Cape

Contribution to Direct Jobs - Western Cape					
Financial Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Manufacture and Installation	87	202	433	679	679
Maintenance Costs	1	3	8	15	22
Total Contribution to GDP	88	205	441	694	701

Total direct jobs are expected to increase from 88 in year 1 to as many as 701 in the fifth year of the programme.

Table 32 illustrates the potential indirect job creation in the Western Cape. Indirect jobs resulting from the manufacturing and installation of the SWH units are expected to increase from 88 in the first year to 692 in the fourth and the fifth years of the programme. Indirect jobs from maintenance are more muted and are expected to amount to 28 in the fifth year of the programme.

Table 32: Contribution to Indirect Jobs in the Western Cape

Contribution to Indirect Jobs - Western Cape					
Financial Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Manufacture and Installation	88	206	442	692	692
Maintenance Costs	1	4	10	19	28
Total Contribution to GDP	90	210	451	711	720

Overall, total indirect jobs in the province are expected to increase from 90 in the first year to 720 by the fifth year.

Table 33: Contribution to Total Jobs in the Western Cape

Contribution to Total Jobs - Western Cape					
Financial Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Manufacture and Installation	175	408	875	1 371	1 371
Maintenance Costs	2	7	18	34	50
Total Contribution to GDP	177	415	892	1 405	1 421

Total direct and indirect jobs in the Western Cape, as reported in Table 33, are expected to amount to 177 in the first year and 415 in the following year. It is expected that total direct and indirect jobs would amount to 892 in the third year, followed by 1 405 and 1 421 in the

fourth and fifth years. As mentioned earlier these job numbers must be considered against possible job losses in the existing electric geyser industry.

The contribution to Western Cape GGP and total jobs in the province is illustrated in Figure 2. As with Figure 1, the values are given in constant 2012 Prices.

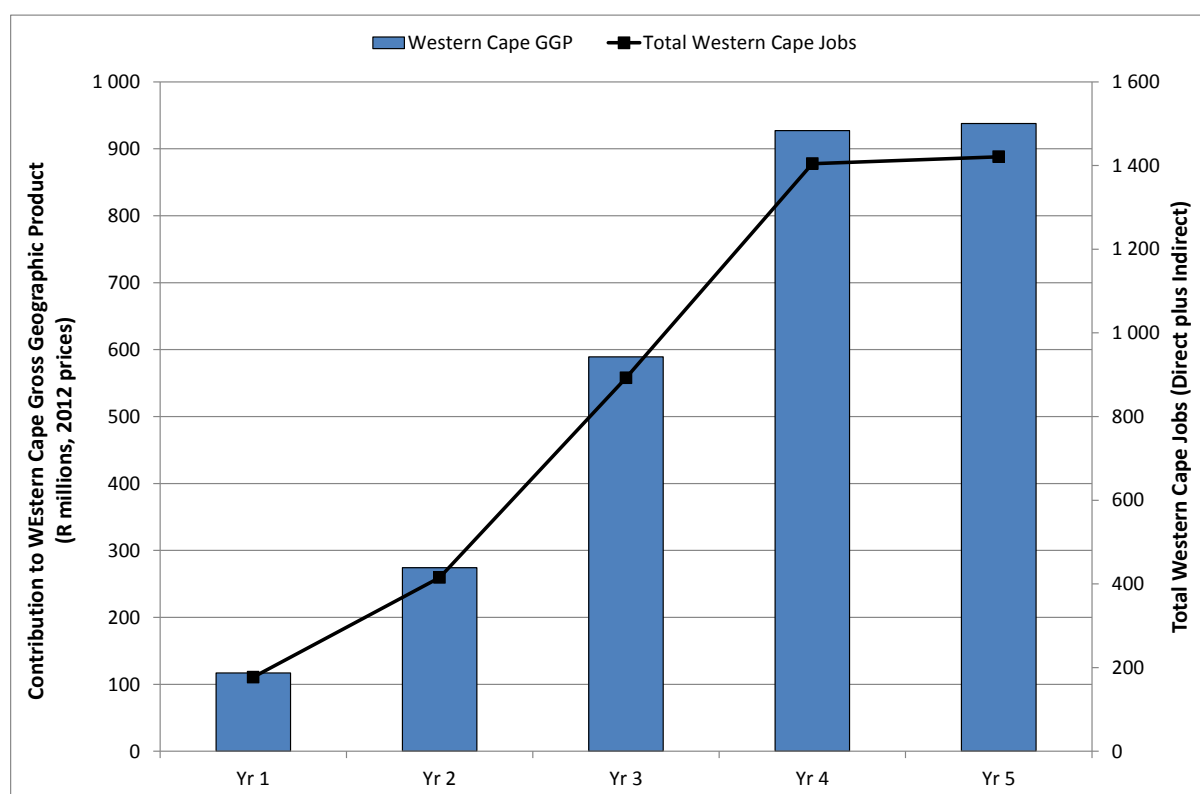


Figure 2: Contribution to GGP and Total Jobs

Total jobs in South Africa are presented in Table 34.

Table 34: Contribution to Total Jobs in South Africa

Contribution to Total Jobs - South Africa					
Financial Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Manufacture and Installation	283	660	1 414	2 215	2 215
Maintenance Costs	3	11	27	52	77
Total Contribution to GDP	286	670	1 441	2 267	2 292

Total jobs nationally are expected to increase from 286 in the first year to 2 292 in year 5.

3.3.4 Other Macroeconomic Effects

Apart from the key macroeconomic effects discussed above, there are many other macroeconomic effects that would flow from the SWH programme. These include the

generation of income tax, company tax, indirect household income and the generation and usage of foreign exchange. Table 35 reports on total taxes that would be generated and Table 36 on the indirect generation of household income.

Table 35: Contribution to Taxes

Contribution to Taxes - South Africa					
Rand million, 2012 prices					
Financial Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Manufacture and Installation	14	33	70	109	109
Maintenance Costs	0	1	1	3	4
Total Contribution to GDP	14	33	71	112	113
Cumulative Contribution	14	47	118	230	344

Total taxes as a result of the programme are expected to increase from R14m in year 1 to R113m by year 5. Cumulatively, it is estimated that the SWH programme could generate R344m in direct and indirect taxes over the five year rollout.

Table 36: Contribution to Indirect Household Income

Contribution to Indirect Household Income - South Africa					
Rand million, 2012 prices					
Financial Year	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Manufacture and Installation	39	91	195	305	305
Maintenance Costs	0	1	4	7	11
Total Contribution to GDP	39	92	199	313	316
Cumulative Contribution	39	132	331	643	959

The project would also contribute to indirect household income. The expected contribution to indirect household income increases from R39m in the first year to R316m by the fifth. By the fifth year it is expected that the project would have added a cumulative R959m to indirect household income.

3.3.5 Potential Economic Impact of a Sustained Industry

One of the objectives of the City of Cape Town's Solar Water Heater programme is to establish a sustainable industry. An exercise was performed to determine the impact should 47 000 SWH units (the rate aimed at in the fourth and fifth years of the programme) be supplied annually to the rest of the Cape Town households for an additional five years. This would mean that at the end of ten years 379 000 households would have installed the SWH units.

The results are presented in Table 37 and Figure 3. Table 37 presents all the macroeconomic indicators for years 6 to 10 (years 1 to 5 would remain the same as

previously) while Figure 3 shows the detailed contribution to GDP for the full ten year SWH rollout period.

The contribution to GDP as a result of the additional SWH rollout would increase from R1 061m in year 6 to R1 105m in year 10. Over the same time period the contribution to Western Cape GGP would increase from R948m to R990m.

Table 37: Macroeconomic Impact of Sustainable Industry

Impact of Sustainable Rollout					
Rand million, 2012 prices					
	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
Gross Domestic Product	1 061	1 072	1 083	1 094	1 105
Gross Geographic Product	948	959	969	980	990
Direct WC Jobs	708	715	723	730	737
Indirect WC Jobs	729	738	748	757	766
Total WC Jobs	1 437	1 454	1 470	1 487	1 503
Total SA Jobs	2 317	2 343	2 368	2 393	2 418
Taxes	115	116	117	118	120
Indirect Household Income	320	323	326	330	333

In the tenth year of the rollout it is expected that there could be as many as 737 new direct jobs in the Western Cape and 766 indirect jobs. This would bring the total jobs in the province to 1 503 in that year. Total jobs throughout the country would amount to 2 418.

Direct and indirect taxes would increase from R115m in the sixth year to R120m in the tenth year. Over the same time period indirect household income would increase from R320m to R333m.

The detailed contribution to GDP can be seen in Figure 3. The contribution from the manufacture and installation of the units increases to a steady R1 016m from year 4 to 10 as 47 000 SWH units are manufactured and installed annually. The contribution due to the maintenance of the units is small by comparison, nevertheless this component does contribute R89m to GDP by the tenth year.

The total contribution to GDP increases from R131m in year 1 to R1 050m in year 5 (as before). In year 6 the total contribution to GDP is R1 061m and by year 10 this is expected to increase to R1 105m.

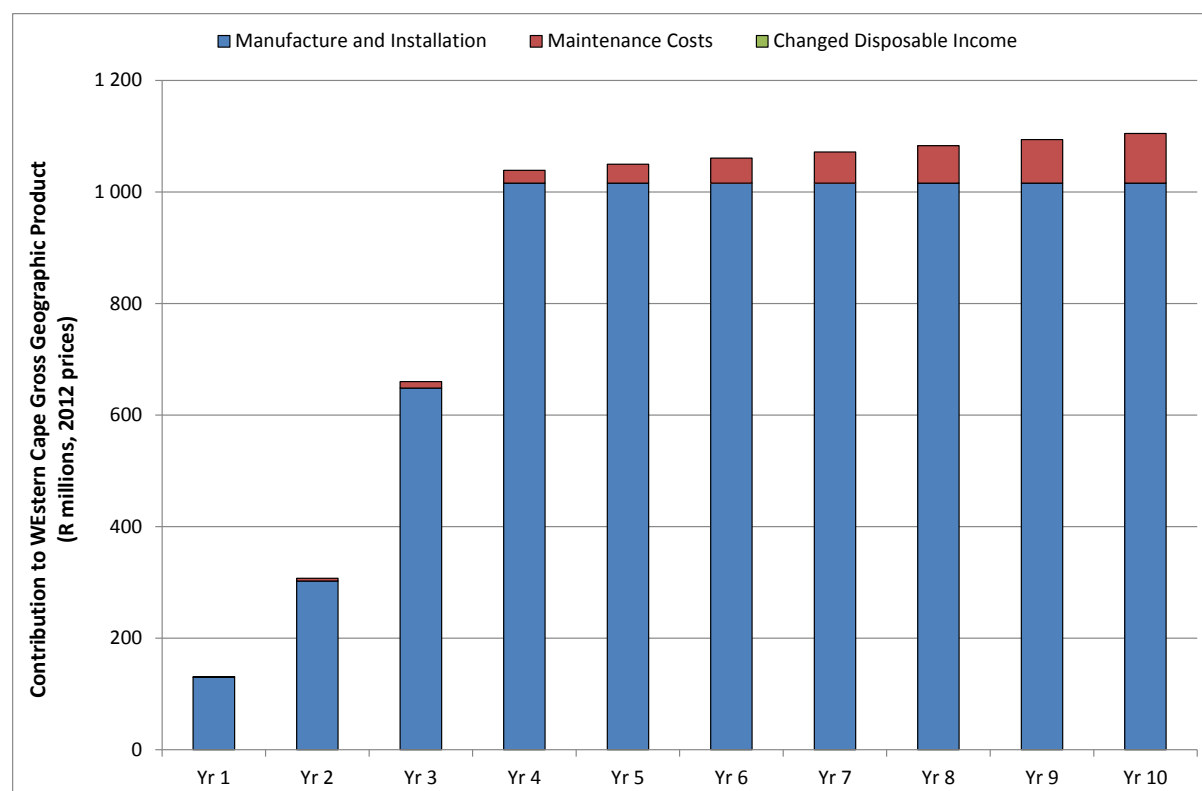


Figure 3: Detailed Contribution to GDP of Sustainable Industry

Cumulatively, over the ten year period:

- the contribution to GDP is R8 601m;
- the contribution to GGP is R7 691m;
- the contribution to direct and indirect taxes is R929m
- the contribution to indirect household income is R2 591m.

The conclusion is that Cape Town would benefit economically from this extended rollout. These economic benefits would increase even more if the SWH units were manufactured locally and exported elsewhere in the country or outside of South Africa.

4 Conclusion

The City of Cape Town wishes to facilitate the bulk provision of solar water heaters (SWH) to households in Cape Town. It aims to achieve a mass roll-out of about 144 000 units over a five year period.

The City commissioned Strategic Economic Solutions (SES) to undertake an economic study of this proposal. The objective of the economic study was to perform an economic analysis of the CoCT SWH programme. This was done using three approaches. The first was by calculating the present economic value of the programme through the economic costs and benefits of the project. The second was a financial stakeholder analysis. The third was a macroeconomic analysis.

Results

This section gives the results of the economic cost benefit, financial stakeholder and macroeconomic analyses.

Economic Cost Benefit Results

The costs of the SWH programme were compared against the benefits of reduced electricity supply from four generation options and a weighted average of these generation options. The four generation options are Kusile, Ingula, a combination of Wind Power and Solar PV and finally the threshold value of electricity generation costs below which DSM projects are financially viable. The fifth is the weighted average generation cost of the four, based on the contribution of each to future generation capacity.

The following conclusions were drawn:

- The project is economically efficient compared to Kusile. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R1.17. The BCR is less than 2.0 so the results are considered marginal because of the number of assumptions made.
- The project is economically efficient compared to Ingula. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R1.65. The BCR is less than 2.0 so the results are considered marginal.

- The project is economically efficient compared to the REIPPPP bid prices for Wind Power and CSP. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R2.20. The BCR is greater than 2.0 so the results are considered robust.
- The project is economically efficient compared to the threshold value for DSM projects. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R3.68. The BCR is more than 2.0 so the results are considered robust.
- The project is economically efficient compared to the weighted average of the four. This is shown by the positive NPV and the BCR of greater than one. For every R1.00 spent on this project society benefits by R2.19. The BCR is greater than 2.0 so the results are considered robust.

The BCRs for the above set of results range between a low of 1.17 and a high of 3.68. These values indicate that the project is economically efficient irrespective of which LCOE is used. However, since the BCRs for two of the five cases are less than 2.0 they could be considered marginal because of the number of assumptions employed in this analysis.

A sensitivity analysis was conducted on the assumptions made for installation and replacement costs, value of carbon credits, the number of units rolled out and the efficiency of the SWH units.

It was found that the results are:

- Sensitive to variations in the manufacture and installation costs but that the project remains economically efficient for the full range tested. The switching value for the installation costs is a 134% increase (i.e. they would have to more than double).
- Slightly sensitive if carbon credits are included in the analysis. The project becomes economically more viable if carbon credits are included in the analysis.
- Not sensitive to the number of units rolled out in the programme, as long as the critical mass of units are achieved and the subsequent economies of scale required to reduce the average unit costs are realised.
- Not particularly sensitive to variations in the assumed efficiencies of the SWH units. The switching value is an efficiency level of 27% when comparing to the weighted average generation cost. When compared to the LCOE of Kusile the required efficiency level is 51%.

An exercise was undertaken where least favourable assumptions were combined to determine if the SWH programme remains viable for such a combination. These combinations are.

- Installation costs are 25% higher than expected;
- Carbon credits are valued at R0 / ton of CO₂;
- The value of saved energy corresponds to the Kusile LCOE of 82c/kWh.
- The efficiency of the SWH units is reduced to 50%.

The consequence of this combination is that the BCR reduces to below the breakeven point at 1.00. However, when compared to the higher generation costs of Ingula the project remains economically efficient. The conclusion is that the project remains economically efficient for realistic changes to, and under most extreme combinations of, the assumptions.

Financial Cost Benefit Analysis

This section quantifies the financial cost benefit analysis of the SWH rollout programme on four stakeholders.

Households Installing SWHs

After paying the monthly loan installment a household installing a 150 litre unit would save R36.27 a month during the first year (R41.34 including VAT). There would be a monthly saving before VAT of R42.25 from a 200 litre unit and R56.56 from a 300 litre unit (excluding VAT). This is based on an Eskom rebate of 35% to 38% of the SWH installation cost, a loan of five years repaid at an interest rate of prime plus 2% and a current applicable cost of electricity of R1.40/kWh, increasing at 10% in real terms per annum for the next five years.

Before meeting the loan re-payment costs, the annual household savings for all households installing the three different size units are R23m in the first year and increase rapidly each year until year 5 when all 144 000 households have installed their SWH units. In this year the electricity savings amount to R807m. The net savings (electricity savings less the cost of the SWH) for households is positive from the first year. The savings then continue to increase each year thereafter. In year 5, the last year of the rollout programme, the net savings amount to R367m. This increases to R417m in year 6 and by year 10 totals R859m. In year 20 the savings total R1 054m.

The NPV of the financial benefits to households, over a 20 year period, is R5 046m (including VAT).

The results were subjected to a sensitivity test on the repayment lending rate, the efficiency of the SWH units and the real increase in the price of electricity (after the real annual increase of 10% in the first five years). It was found that within the range tested households would always benefit from the rollout programme.

Suppliers of SWH Units

The estimates made here are only for the planned SWH rollout and do not include the successful growth of the industry after the rollout.

It is expected that the installers of solar water heaters would benefit from profit installation and maintenance and might generate income on loans provided to households. It is estimated that total net income to the installation companies would increase from R15m in the first year to R139m in the fifth year. This then reduces until the tenth year when the only source of net income is the profit margin on the maintenance of the units. This would amount to R1m in that year and for the rest of the 20 year analysis period.

The NPV of the financial benefits to the installation companies is R356m.

City of Cape Town

The City of Cape Town would lose revenue on the difference between what it pays Eskom and what it charges households. The loss in revenue to the City of Cape Town would amount to R20m in the first year, increasing to R782m in the tenth year and R953m in the twentieth. The cost that the City incurs in purchasing the saved electricity from Eskom would be reflected as a reduced cost. This amounts to R9m in the first year and increases in real terms to R347m in the tenth year and further to R424m in the twentieth. The overall net loss to the City amounts to R11m in the first year and increases to R434m in the tenth year. In the twentieth year the overall net loss amounts to R530m. The NPV of all these losses is R3 201m.

The net loss in revenue to the City of Cape Town would only occur if there is no alternative demand for that electricity. If the City of Cape Town is currently constrained in the amount of electricity that it can supply its customers then the electricity losses would be recouped from other customers.

If there is no take up of the electricity savings then the City of Cape Town would be faced with the net loss of revenue indicated in the table. This loss in revenue would need to be recovered by increasing electricity tariffs.

The net impact on households should the City of Cape Town recover all its losses from households would be a reduction in net household income for six years. The peak reduction in household income would amount to R83m in years four and five. From year seven onwards (when many of the SWH loans are paid off) there is a net increase in household disposable income and this then increases each year as more and more of the SWH loans are paid off and the real price of electricity increases. This increase in the latter years more than compensates for the reduction in the first six years and the NPV over a 20 year period is a positive R1.40bn.

Eskom

Eskom would have three financial changes as a result of the SWH programme. There would be reduced revenues because of lower electricity sales. Costs would increase because of the rebate and costs would fall because of the reduction in producing less electricity.

- Eskom would lose R9m in revenue in the first year of the programme rollout. This would increase to R347m in the tenth year and R424m in the twentieth.
- There would be reduced generation costs amounting to R19m in the first year and increasing, in real terms, to R615m in year 10. By year twenty there would be a reduction of R749m in generation costs.
- The rebates are estimated at R34m in the first year of the programme and then increase to R263m in the fourth and fifth years.
- The net real financial position for Eskom is a R24m loss in the first year, increasing to R99m in the fourth year. Once the rebates are paid there is a net increase in revenue to Eskom. In year 6 this amounts to R247m, increases to R267m in year 10 and R326m by year 20.
- The NPV of the financial benefits to Eskom is R1 399m (excluding VAT).

Three variables were subjected to a sensitivity test. These are the effective price that the City of Cape Town would pay for the saved electricity, the marginal generation cost to Eskom and the real increase in the price of electricity after the first five years of the programme. It was found that Eskom remained a financial beneficiary over most of the range of assumptions that were tested.

Net Present Values of All Stakeholders

The net present value of the cash flow to all the stakeholders is based on a 20 year time horizon. It is estimated that (all amounts include VAT):

- Households installing the SWH units have the highest savings with a NPV of R5 046m.
- This is followed by Eskom with a NPV of R1 399m.
- Installation Companies have a NPV of Net Profit to the value of R356m.
- The City of Cape Town would have lower net revenue with a PV of R3 201m than without the SWH programme. In other words, the City of Cape Town would have revenue losses because of the programme and it would need to explore ways to recoup these losses.
- There would be reduced VAT receipts by the National Government to the value of R388m.

The financial NPV of all the parties combined is R3 213m and the financial IRR is 51%. The citizens of Cape Town would benefit from the increased economic activity in the form of GGP, with a PV of R2 643m.

Balance of Payment to Cape Town

The balance of payments to Cape Town (i.e. its municipal government and all its citizens) is positive from year 1 and amounts to R103m in that first year, increasing to R849m in the fifth year. This then drops to R36m in the sixth year as the Eskom rebates and the financing institution loans dry up. However, the net inflows then increase each year thereafter because the loans are being paid off and the real price of electricity is increasing. In the tenth year the net inflows amount to R408m and in the twentieth amount to R498m.

The PV of the balance of payments to Cape Town over the twenty year analysis period is a positive R3 796m.

Macroeconomic Results

This section reports on the expected macroeconomic contribution of the proposed City of Cape Town's SWH programme. The results are reported for a five year period (which is the rollout period).

The macroeconomic effects are based on the expenditure from the manufacturing, installation and maintenance of SWH units. The impact from electricity savings was not included. The latter might mean that there is less chance of electricity outages and there might be a marginal impact on Eskom's growth. The electricity savings would also be recovered by the City of Cape Town in the form of higher electricity tariffs or higher property rates.

Gross Domestic Product

Gross Domestic Product (GDP) is the total value of all final goods and services produced in the country. It is clearly fundamental to the economic quality of life of people in the country. It is also the most important and all-encompassing measure of the macroeconomic effect from the SWH programme.

The total contribution to GDP is expected to amount to R131m in year 1, R307m in year 2 and R660m in year 3. As the project reaches maturity in years 4 and 5 so the total contribution to GDP would amount to R1 039m and R1 050m.

GDP is important not just because it is income but also because income has the capacity to add to wealth. Based on these projections, the proposed SWH programme is expected to make a cumulative contribution to GDP of over R3.1bn by the end of year five.

Western Cape Gross Geographic Product

The total contribution to gross geographic product (GGP) is expected to amount to R117m in year 1, R274m in year 2, R589m in year 3, R927m in year 4 and R938m in year 5. Based on these projections, the proposed SWH programme is expected to make a cumulative contribution to Western Cape GGP of over R2.8bn after five years. Most of this contribution would be in Cape Town since manufacturing would most likely happen in, rather than outside, the city.

Jobs

The SWH programme would create two types of jobs. The first are the direct jobs that would be created as a result of the programme. These are jobs in the manufacturing, installation and maintenance of the SWH units. The second are the so-called indirect jobs from the multiplier effects. Some of the indirect jobs would be in the province but others would be elsewhere in the country. These jobs would need to be balanced against the possible job losses in the current electric geyser industry. Since the extent of the local electric geyser industry is not known these job losses could not be quantified. Consequently only the new jobs in the SWH industry are reported here and not the possible job losses. The impact of changes in household disposable income has also been excluded from the analysis. Any increase in household income in Cape Town as a result of lower spending on electricity would be offset by lower incomes in the electricity generating sector.

Total direct jobs are expected to increase from 88 in year 1 to as many as 701 in the fifth year of the programme. Most of these jobs are in manufacturing and installation. It is

expected that there would be 202 jobs in manufacturing and installation in year two, 433 in the third year and then 679 jobs sustained in years 4 and 5.

It is expected that 22 direct maintenance jobs would be sustained by the end of the programme. (This estimate is based on a conservative maintenance schedule. If the units are maintained as often as once a year there could be as many as 96 direct jobs sustained. This higher estimate is based on a team of two people servicing on average ten SWH units a day.)

Indirect jobs from manufacturing and installation are expected to increase from 88 in the first year to 692 in the fourth and the fifth years. Indirect jobs from maintenance are more muted and are expected to amount to 28 by the fifth year of the programme. Overall, total indirect jobs are set to increase from 90 in the first year to 720 by the fifth year.

Total direct and indirect jobs in the Western Cape are expected to amount to 177 in the first year and 415 in the following year. It is expected that total direct and indirect jobs would amount to 892 in the third year, followed by 1 405 and 1 421 in the fourth and fifth years respectively.

Total jobs nationally are expected to increase from 286 in the first year to 2 292 in year 5.

Potential Economic Impact of a Sustained Industry

One of the objectives of the City of Cape Town's Solar Water Heater programme is to establish a sustainable industry. An exercise was performed to determine the impact should 47 000 SWH units (the rate aimed at in the fourth and fifth years of the programme) be supplied annually to the rest of the Cape Town households for an additional five years. This would mean that at the end of ten years 379 000 households would have installed the SWH units.

- The contribution to GDP as a result of the additional SWH rollout would increase from R1 061m in year 6 to R1 105m in year 10. Over the same time period the contribution to Western Cape GGP would increase from R948m to R990m.
- In the tenth year of the rollout it is expected that there could be as many as 737 new direct jobs in the Western Cape and 766 indirect jobs. This would bring the total jobs in the province to 1 503 in that year. Total jobs throughout the country would amount to 2 418.

- Direct and indirect taxes would increase from R115m in the sixth year to R120m in the tenth year. Over the same time period indirect household income would increase from R320m to R333m.
- Cumulatively, over the ten year period:
 - the contribution to GDP is R8 601m;
 - the contribution to GGP is R7 691m;
 - the contribution to direct and indirect taxes is R929m
 - the contribution to indirect household income is R2 591m.

The conclusion is that there are major benefits to Cape Town from this extended rollout. These economic benefits would increase even more if the SWH units were manufactured locally and exported elsewhere in the country or outside of South Africa.

Overall conclusion

The overall conclusion from the economic analysis of the intention to roll out solar water heaters is that the project appears to be economically efficient. It has a generally robust benefit cost ratio across most permutations that were tested. The fact that some of the BCRs were less than two is a cause for concern. On the one hand these are low BCRs which could be considered marginal. On the other the sensitivity analysis and, in particular, the combination of less favourable assumptions generally all returned a BCR of 1.0 or greater. In other words, it would require an extreme combination of unfavourable variables for the proposed rollout of SWHs to become economically inefficient.

This initiative has the potential to create a new industry in the Western Cape. From a macroeconomic perspective the project will generate income and jobs, particularly in the manufacturing and installation industries. Strategic interventions may result in the industry exporting solar water heaters to other provinces and internationally. This would result in sustainable increases in income and job creation. These do, however, need to be offset against potential job losses in the existing electric geyser industry.

The single negative aspect of the proposed project is the loss in revenue to the City of Cape Town. What is important is that the total benefit to the households that install SWHs is greater than the loss in revenue to the City. In the stakeholder analysis it was shown that households have a benefit with a NPV of R5bn. The City of Cape Town (municipal government) has a negative NPV of R3.2bn. In other words there is a net overall benefit of R1.8bn.

There would be some years in which net household income in Cape Town would be lower should the City of Cape Town recover its losses from households through increased rates or electricity tariffs. This would only happen while loans are being repaid. There would be a net increase in household disposable income after that. This increase in net household disposable income in the later years is large enough to more than compensate for the earlier losses.

The fact is that under the rollout the initial target is 144 000 households but that all households may end up bearing the burden of the loss in revenue to the City. This revenue can be raised in a number of ways:

- A general increase in the price of electricity. This would have the same effect as the above increase in property rates as well as potentially undermining the competitiveness of local industry.
- An increase in the price of electricity to households. This again would result in cross subsidisation but it may also have the effect of persuading more and more households to install SWHs. The more people who install SWHs the less the degree of cross subsidisation and the greener the city. Such an approach could see a marked movement away from coal fired electricity to renewable energy in the city of Cape Town. It would also be seen as part of the contribution of the City of Cape Town to reducing climate change.
- The net impact on households should the City of Cape Town recover all its losses from households would be a reduction in net household income for six years. The peak reduction in household income would amount to R83m in years four and five. From year seven onwards (when many of the SWH loans are paid off) there is a net increase in household disposable income and this then increases each year as more and more of the SWH loans are paid off and the real price of electricity increases. This increase in the latter years more than compensates for the reduction in the first six years and the NPV over a 20 year period is a positive R1.40bn.

References

Ackerman, F & Stanton, E.A. (2010) *The Social Cost of Carbon, A Report for the Economics of Equity and the Environment Network*, Stockholm Environment Institute.

Akella, A.K., Saini R.P. & Sharma, M.P., (2009), Social, economical and environmental impacts of renewable energy systems, *Renewable Energy*, Volume 34, 2009. Available at: http://greenenv.blog.com/files/2009/06/akella_2009_renewable-energy.pdf

City of Cape Town, (2012) *Request for Proposals, Bulk Provision of Solar Water Heaters (SWH) Programme*, Tender Number 473C/2011/12

City of Cape Town, (2012) Spreadsheet: *Annexure III SWH cost benefit analysis for CCT SWH programme*

Conningarth, (2007) Manual for Cost Benefit Analysis in South Africa.

Eskom (2012) *Integrated Report for the year ended 31 March 2012*

Gittell, R, & Magnusson, M., (2007). Economic Impact of a New Hampshire Renewable Portfolio Standard, University of New Hampshire

IHS Cambridge Energy Research Associates, (2012). Energy for Economic Growth, Energy Vision Update 2012. Report prepared for the World Economic Forum. Available online: <http://reports.weforum.org/energy-for-economic-growth-energy-vision-update-2012/>

Lacey, S., (2007). The Economic Impact of Renewable Energy. Renewable Energy World website Available at http://www.renewableenergyworld.com/assets/documents/2007/unh_rps_report_final.pdf

McKinsey, (2010) *Roadmap 2050: A practical guide to a Prosperous, Low Carbon Europe, Technical Analysis*

NERSA, (2011) *NERSA Consultation Paper: Review of Renewable Energy Feed-in Tariffs*

Pollin, R. et al., (2009). The Economic Benefits of Investing in Clean Energy. Center for American Progress. Available at: <http://www.americanprogress.org/issues/green/report/2009/06/18/6192/the-economic-benefits-of-investing-in-clean-energy/>

Snell, M., (2011), *Cost-benefit analysis: A practical guide, Second edition*

South African Department of Trade and Industry, Industrial Action Plan 2011/12 – 2012/13.
Available online at: <http://www.info.gov.za/view/DownloadFileAction?id=144975>

Stern, N (2006) *Stern Review on The Economics of Climate Change, Executive Summary*,
HM Treasury, London

Wolfaardt, H. (2012) *Cape Town Electricity Price Increase of 5 to 18% from July 2012*,
available at <http://www.scenicsouth.co.za/2012/06/cape-town-electricity-price-increase-of-5-to-18-from-july-2012/>

<http://www.engineeringnews.co.za/article/second-crop-of-renewables-preferred-bidders-named-2012-05-21>

<http://www.cdm-watch.org/wordpress/wp-content/uploads/2012/09/AAU-banking-briefing-paper-Point-Carbon.pdf>

Appendix A: Terms of Reference

1. City of Cape Town Solar Water Heater Programme Background

The City of Cape Town (CCT) has committed itself to facilitate the bulk provision of solar water heaters (SWHs) in the mid to high income and low income housing sectors.

The programme design aims, with the support of the CCT, to achieve a mass roll-out of some 100,000 to 200,000 units over a five year period by local business, and will require local manufacture to maximize local economic development and sustainable job creation.

The objective of the programme is twofold:

- i. to decrease the electricity consumption in the City of Cape Town and
- ii. to create a sustainable SWH industry in the region of the Western Cape thus creating sustainable jobs in manufacturing, installation, financial management, client relations and maintenance.

It is expected that through the CCT SWH programme, the conditions for local economic development will be maximised through

- i. mass SWH production and implementation using local resources,
- ii. overall programme management using local resources
- iii. financial benefits from and lower SWH costs and electricity savings to end users, and
- iv. a reduction of electricity imports into the City.

In early July 2012, the CCT issued the first phase Request for Proposals (RFP) in a two-phase RFP process to select service providers to implement the SWH programme in Cape Town. The objective of the first phase is to request information from potential bidders and to prequalify potential bidders. The results of this first phase RFP are expected by September 2012. The technical specification for the first phase Request for Proposal (RFP) is attached to this specification in Annex 2, in order to provide additional information around the SWH programme to the consultant.

The AFD (French Development Agency) will potentially provide financial assistance for the CCT SWH programme. As part of its due diligence process for this, the AFD requires an appraisal of the potential economic benefits of the programme. The CCT, as the programme facilitator also has an interest in the local economic development potential of the project. As

a result both the CCT and the AFD have been involved in the design of this study, and both have an interest in its results.

2. Objectives

The objective of the study is to perform an economic analysis of the CCT SWH programme, that is, to calculate the present economic value of the programme to the economy in general by determining the economic costs and benefits of the project to all stakeholders, both internal and external.

3. Activities

The consultant will evaluate the economic costs and benefits of the programme over a 20 year period from implementation, and compute the Economic Internal Rate of Return (EIRR) and the Economic Net Present Value (ENPV), calculated at a discount rate to be determined according to the country's practice or regulation. The ENPV per stakeholder of the project must also be calculated.

Two scenarios will be defined in consultation with the CCT. The "programme scenario" will correspond to the expected situation when the programme is implemented. A reference scenario should correspond to a "no programme scenario", taking into account underlying trends in technology, policy and local economy sectors in South Africa, in order to reflect changes that would have occurred without the project. By comparing the reference scenario with the project scenario, the consultant will define and evaluate the economic costs and benefits associated with the project, including non-market impacts and indirect effects.

The City of Cape Town will provide the data available on the project, including relevant studies to the Consultant, on request. The City of Cape Town will also facilitate the support from the SEA (Sustainable Energy Africa) who has been in charge of informing the market studies for the project.

The City of Cape Town will introduce the consultant, at its request, to the persons the consultant will have to meet to obtain the information necessary to carry out the study.

4. Outputs

The consultant will provide a spreadsheet containing the tables with the flow of cost and benefits and the calculations of the EIRR and the ENPVs, together with a table containing all the assumptions made for each scenario and the calculation. The consultant will perform sensitivity tests of the EIRR and the ENPVs against the following parameters (i) cost of the

SWH and timeframe of implementation, (ii) quantity of SWH installed, (iii) maintenance costs, (iv) costs of financing.

5. Work Arrangements

5.1. Timeframe

The study should start in August 2012 with the background work and should be informed by the first phase RFP. It is expected that an effort of approximately 20 man-days will be needed for the study. The study must be complete and submitted by 28 September 2012

5.2. Consultant's skills and qualifications

The consultant will provide the following skills:

- knowledge of the South African green economy context
- expertise in economic analysis
- knowledge of energy efficiency solutions and economics, and in particular of SWHs

5.3. Monitoring

The consultant shall liaise from time to time with the CCT and the AFD's office in Johannesburg so as to:

- Organise relevant interviews with the CCT and the AFD
- Validate the scenarios
- Validate the reports

5.4. Reports

The consultant will send at least the following reports to the City of Cape Town according to the timeframe indicated :

- An inception report following the background work, before the release of the result of the first phase RFP showing the main assumptions taken and the costs and benefits considered.
- A draft report containing all the required information, on which the AFD and the City of Cape Town will provide comments within 2 weeks.
- 2 weeks after having received the comments from the City of Cape Town and the AFD, the consultant will deliver its final report.

The final report will include at least an executive summary, a presentation of the assumptions and reference situation, the analysis of the main results and of the sensitivity tests. The consultant will provide the spreadsheet in a workable format of all the calculations and analysis.