# 4. Energy Efficiency Options

This chapter highlights the potential impact of implementing energy efficiency interventions on a mass scale in Gauteng, both in energy saving and $CO_2$ offset terms. It also looks at the additional technical, economic and institutional requirements to ensure that the interventions are implemented in the most effective way possible.

Energy efficiency interventions by definition reduce the energy consumption levels of a particular energy service without reducing its quality. In this light this chapter considers the following interventions:

### Residential (disaggregated into low income and high income)

i. Efficient water heating (Solar water heaters/Heat Pumps) – high income only

ii. Efficient lighting

iii. Efficient showerheads

iv. Hot boxes - low income only

v. Insulated ceilings in houses - low income only

### Commercial

i. Efficient Lighting

ii. Efficient HVAC

### Industrial

i. Efficient Motors

ii. Variable Speed Drives

iii. EE lighting

iv. HVAC

In order to quantify the potential for energy efficiency in Gauteng, use was made of an energy efficiency modelling tool which was developed by Sustainable Energy Africa. Details on the tool, its assumptions and calculations per intervention are given in Appendix A of this report.

While it is very difficult to make precise predictions around energy efficiency potential, it is possible to make credible 'ballpark' predictions using sound assumptions based on research available in this area. This chapter focuses exclusively on electricity based energy efficiency interventions.

Using the baseline electricity data gathered for the Gauteng Integrated Energy Strategy in the tool, it has been established that were all the energy efficiency interventions discussed above implemented to 100% in Gauteng, an electricity use reduction of 26.7% could be achieved from the annual baseline. This includes both technological (23.4%) and behavioural (3.3%) interventions. The per sector breakdown shows that most impact can be achieved in the residential sector (17.9%), followed by the commercial sector (5%) and then the industrial sector (3.9%). The table below provides a summary of the interventions modelled for this study.

Looking at it from another angle, the potential electricity savings within each sector as a proportion of the current sector consumption are as follows:

- Residential - 41% efficiency gain,
- Commercial - 29% efficiency gain
- Industrial - 10% efficiency gain

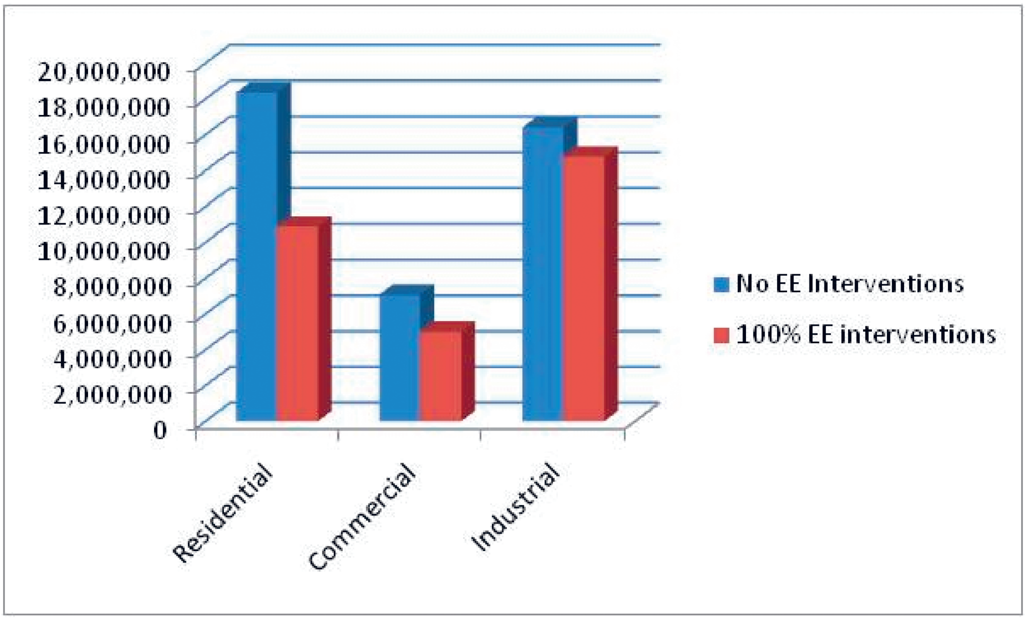



*Figure 7*

| | Technology | Behavioural | Total | Cost of Intervention per unit (retrofit) | kWh Saved over lifespan | c/kWh Saved | MWh saved/annum |
|---|---|---|---|---|---|---|---|
| **Residential (44% of total consumption)** | | | | | | | |
| EE Lighting (mid-high inc) | 2.9% | 0.5% | 3.4% | R 25.20 | 480 | **5.25** | 1,409,007 |
| EE Lighting (low inc) | 1.8% | 0.3% | 2.1% | R 25.20 | 480 | **5.25** | 862,958 |
| Geyser thermostat adjusting (10 degrees) | 0.0% | 0.8% | 0.8% | R 0.00 | 1848 | **0.00** | 332,198 |
| Aerated Shower Heads** | 1.5% | 0.0% | 1.5% | R 230.00 | 5070 | **4.54** | 609,030 |
| Geyser Blankets* | 1.6% | 0.0% | 1.6% | R 110.00 | 2560 | **4.30** | 664,397 |
| SWH (high income) | 8.7% | 0.0% | 8.7% | R 14,500.00 | 29740 | **48.76** | 3,654,182 |
| SWH (low income) | 0.5% | 0.0% | 0.5% | R 3,500.00 | 2030 | **172.41** | 230,234 |
| Hot Boxes | 0.4% | 0.0% | 0.4% | R 119.00 | 2044 | **5.82** | 151,990 |
| Ceilings in RDP houses-gypsum* | 0.7% | 0.0% | 0.7% | R 1,600.00 | 5680 | **28.17** | 292,512 |
| Ceilings in RDP houses-isoboard | 1.1% | 0.0% | 1.1% | R 2,587.50 | 9240 | **28.00** | 476,182 |
| **Sub Total** | **16.3%** | **1.5%** | **17.9%** | | | | **7,482,170** |
| | | | | | | **% efficiency in sector** | **41%** |
| **Commercial (17% of total consumption)** | | | | | | | |
| EE Lighting | 1.0% | 0.5% | 1.6% | R 172.00 | 360 | **47.78** | 658,141 |
| HVAC | 2.4% | 1.0% | 3.4% | R 950.00 | 325 | **292.10** | 1,415,357 |
| **Sub Total** | **3.4%** | **1.5%** | **5.0%** | | | | 2,073,498 |
| | | | | | | **% efficiency in sector** | **29%** |
| **Industrial (39% of total consumption)** | | | | | | | |
| Efficient Motors | 1.5% | | 1.5% | R 14,700.00 | 90560 | **16.23** | 640,591 |
| Variable Speed Drives | 1.2% | | 1.2% | | | | 492,762 |
| EE Lighting | 0.8% | 0.2% | 1.0% | R 890.00 | 1030 | **86.41** | 426,732 |
| HVAC | 0.1% | 0.0% | 0.2% | R 950.00 | 325 | **292.10** | 72,272 |
| **Sub Total** | **3.6%** | **0.3%** | **3.9%** | | | | 1,632,356 |
| | | | | | | **% efficiency in sector** | **10%** |
| **Streetlights (0% of total consumption)** | | | | | | | |
| HPS Streetlights | 0.0% | | 0.0% | R 1,150.00 | 300000 | **0.38** | 0 |
| **Sub Total** | **0.0%** | **0.0%** | **0.0%** | | | | 0 |
| Total | 23.4% | 3.3% | 26.7% | | | | 11,188,024 |

In quantified amounts, this translates to a potential annual energy saving of 11,188,024MWh and an associated annual $CO_2$ saving of 12.3 megatons.

While the potential savings are substantial, the reality of actually achieving the mass implementation of these interventions is difficult. This is due to the dispersed nature of energy efficiency interventions, often spanning over an entire sector. Financing and rollout mechanisms as well as institutional, policy and legislative support are critical to ensure that these figures can be achieved. Possible workable combinations of these will be discussed in more detail on a per intervention basis in the rest of this chapter.

## 4.1 Efficient Water Heaters

The efficient water heater technologies analysed for this report were both for low and mid-high income use.

For the mid-high income group, the technologies chosen were electrically backed up SWHs and heat pumps. Both technologies have electricity efficiency gains of 66% when compared to an electric geyser, based on the research available. This means that the mix of the technologies doesn't affect the final efficiency levels gained. It is assumed that the technology used per application is appropriately designed to meet its full daily demand for hot water. For example a household that requires 200l of hot water per day has as a minimum a 200l SWH or suitably sized heat pump to provide this.

For the low income (RDP) houses, low pressure SWH technology with no electrical backup was analysed. These houses do not come equipped with electric geysers. However, research does show that in these households kettles, paraffin stoves and fires are used to heat water on average 4 times per day. In this light, using preheated water from the SWH for cooking, tea and washing will make the overall electrical energy use of the household more efficient.

### *Technical Assessment*

**1. Savings potential**

**Table 12**

| *Intervention* | *Potential electricity efficiency gain in Gauteng* | *Potential Electricity saved per year (MWh) in Gauteng* | *Potential $CO_2$ saved per year (T) in Gauteng* | *Estimated no. of units to achieve potential* |
|---|---|---|---|---|
| Mid-High income Solar Water Heater / Heat Pump | 8.7% | 3,654,182 | 4,019,601 | 1,860,826 |
| Low income SWH | 0.5% | 230,234 | 253,257 | 1,134,156 |

Efficient water heaters have been highlighted for many years as one of the most effective means to make a sizeable shift down in electricity consumption in South Africa. Modelling around the potential impact of this intervention in Gauteng shows a potential 8.7% reduction in electricity use in the province were all electric geysers replaced with efficient water heaters. This is based on 1.8 million units being installed in Gauteng. The impact of this intervention alone will achieve 33% of the potential electrical efficiency gains in the province. The energy saved from a low income SWH rollout will result in 0.5% reduction in electricity use in the province.

### 2. Standards

Solar water heaters are becoming a mature technology worldwide. Both international and local (SABS) Standards for their manufacture, performance and installation are in place. Most of the reputable solar water heater manufacturers and installers in South Africa comply with these standards. More specifically most of the above have also registered their products with the Eskom SWH incentive scheme, which inter alia requires that they undergo and comply with the SABS solar water heating test procedures and standards.

Local Standards available are:

***Table 13***

| # | *SANS Number* | *Description/ Title* |
|---|---|---|
| 1 | SANS 1307:2005<br>(SABS 1307) | Residential solar water heaters |
| 2 | SANS 6210:1992<br>(SABS SM 1210) | Residential solar water heaters - Mechanical qualification tests |
| 3 | SANS 6211-1: (or part 2) 2003 | Residential solar water heaters Part 1: Thermal performance using an outdoor test method (part 2 is an indoor test method) |
| 5 | SANS 60335-2-21:2000 | Household and similar electrical appliances - Safety Part 1: General requirements |
| 6 | SANS 151 | Fixed Electrical storage water heaters |
| 7 | SANS 10252-1:2004 | Water drainage for buildings |
| 8 | SANS 10106:2006 | The installation, maintenance, repair and replacement of domestic solar water heating systems |

Heat pumps are usually used for large applications such as hotels, residences and prisons. However smaller heat pumps are being introduced into the residential market. There is no local heat pump standard in place, but most heat pump installation companies guarantee a 60-70% saving in water heating costs and give a 1 year guarantee on their product.

### 3. Skills and job creation potential

A mass rollout of these technologies will result in widespread skills gained and jobs created for South Africans. Low income community based SWH installation and maintenance will ensure that local skills are created in these areas.

The evacuated tubes for SWHs and compressors for the heat pumps are generally imported from China. Other components of the technologies can be locally manufactured. The skills required to supply, implement and maintain these technologies are available locally.

## *Financial Assessment and Rollout Mechanisms*

Substantial increases in the price of electricity over the last few years have made efficient water heating technologies financially viable, particularly if monthly payback financed solutions can be found. Additionally, solar water heaters currently receive a performance based subsidy from Eskom DSM of up to 20% of the installed cost.

From a government based perspective, it is useful to consider the cost of each energy efficiency intervention against the electricity it saves over its lifetime. This figure (R/kWh saved) is a useful comparison to the cost of generation technologies (R/kWh generated). It is often the case that energy efficiency interventions are less expensive to implement than new generation technology.

Calculations based on a typical SWH system indicate that the cost per kWh saved (R/kWh) over its lifetime to be R0.49, which is fairly high based on other interventions considered in this report. A heat pump can range from R0.10 to R0.74, depending on whether it is used to its full potential or not. However, if a financial model can be found to incentivise the interventions sufficiently, then these should be implemented as the impact from efficient water heating on the provincial electricity baseline is too large to be ignored. The following results from the financial modelling of the technologies have been obtained:

### Mid-High Income SWHs

i) In straight payback terms a SWH takes 8-9 years if it replaces an already working geyser

ii) In straight payback terms a SWH takes 4 years if a SWH is chosen over an electric geyser for a new build/blown geyser replacement scenario, or for a SWH installation which uses the existing geyser

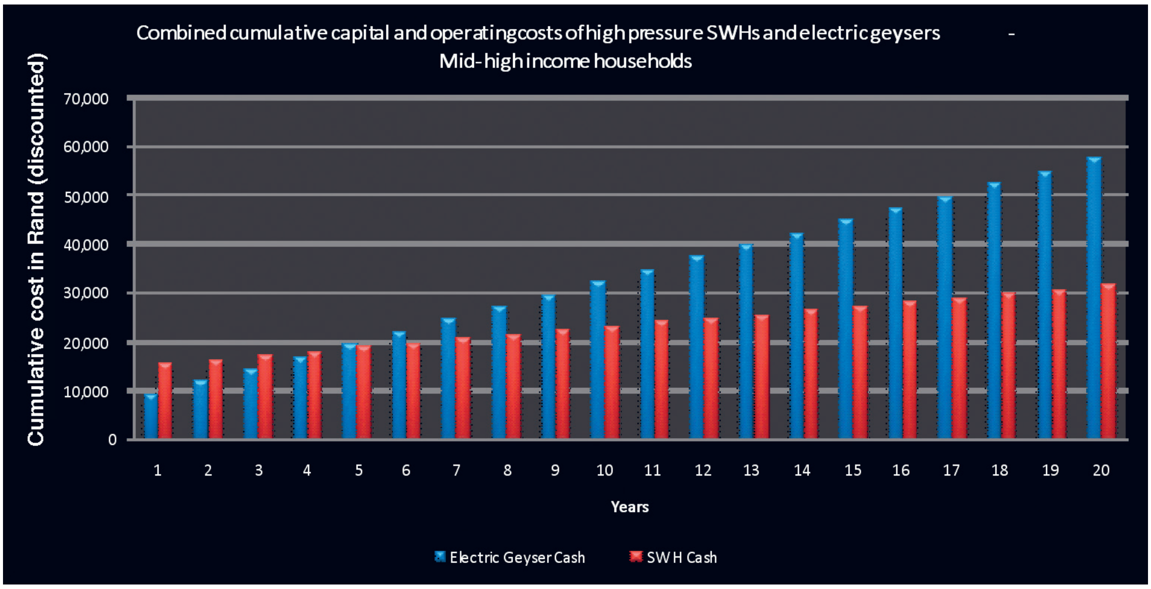



*Figure 8*

iii) Financed repayments over 6 years or more result in immediate monthly savings for the scenarios listed in point ii) above. This makes a very strong case for the legislation and incentivisation of SWHs in these scenarios

Based on this modelling, it is clear that financed solutions for mid-high income SWHs can make the units very attractive to the end user. Large business opportunities are available in this area. Implementation can be either independent or government supported. For more details on how to rollout SWHs in this manner, go to www.cityenergy.org.za/implementation

### Low income SWHs

A financed solution for a 100l low pressure SWH, based on a monthly repayment of around R25 per month is achievable. This solution must include CDM income, the Eskom incentive, attractive financing and an effective collection mechanism. The graph below shows the cost of boiling 12l of hot water per day in a kettle or on a stove (around R20 in electricity per month) against the cost of getting 100l of hot water per day from a financed SWH. For more on LI SWH rollout models go to www.cityenergy.org.za/implementation

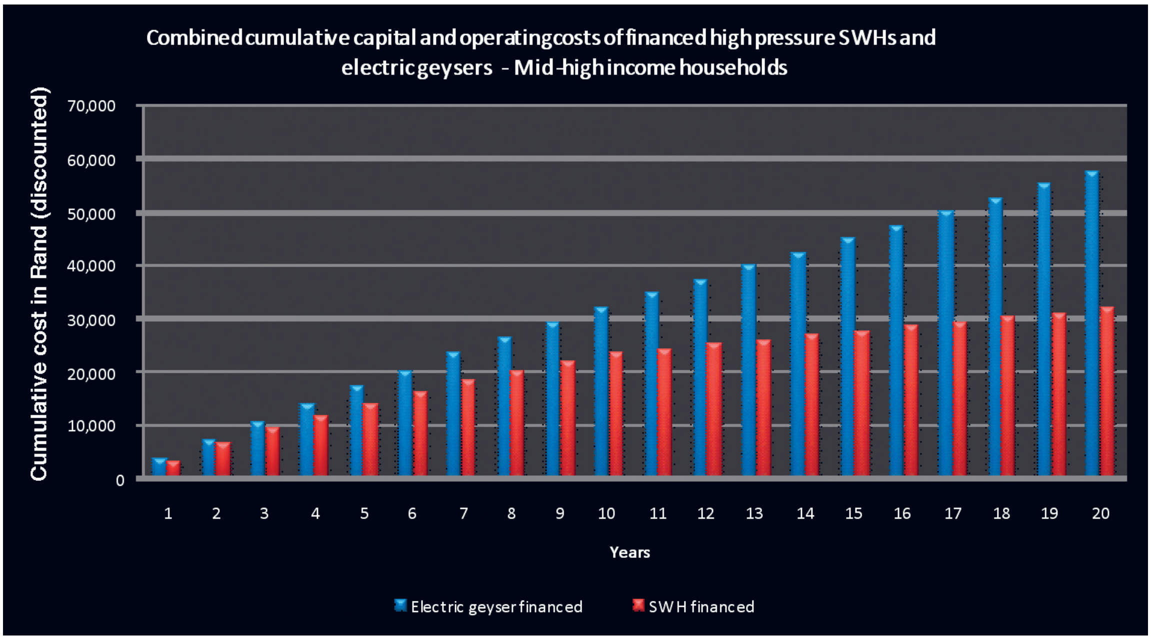



*Figure 9*

### Heat Pumps

For large scale projects, heat pumps are often more financially viable than SWHs. However heat pumps have not been downscaled sufficiently for the residential market and are usually overrated and subsequently overpriced. A current example of the smallest heat pump on the market is a 1kW system which can deliver 1400l of hot water per day, but costs R22 000 to install.

The payback for such a system is 6-7 years, and needs to be financed over 10 years minimum to make immediate financial sense, for hot water users of 300l/day. However, if 1400l of hot water was used per day payback would occur in under 2 years and financing would make it immediately financially beneficial. A sufficiently smaller and cheaper heat pump for the residential market could make a potentially huge impact, as unlike SWHs they produce hot water consistently throughout the year.

### *Legislative, policy and institutional support*

The following mechanisms should ideally be in place in order to support the mass rollout of efficient water heaters in Gauteng:

i) Programmatic CDM methodology

Putting programmatic CDM methodology for solar water heaters (both mid-high and low income options) in place will ensure that the cost of the units can be further reduced to make the financing term shorter and more attractive to the end user. Programmatic CDM will mean that small projects/ SWH businesses will be able to access CDM financing without the exorbitant start up costs associated with a normal CDM project. Efforts to establish this methodology are currently underway.

ii) Energy Efficient Water Heater Bylaws in Municipalities/ Integrate SANS 204 into the National Building Codes

As can be seen from the financial modelling above, a SWH in a new build/blown geyser scenario is immediately financially viable if financed over 6 years or more. Therefore including the SWH cost into the bond, particularly over 6-20 years will make it immediately financially beneficial to the end user. Legislation can occur at local level in the form of a bylaw (Cape Town is currently pursuing this) or be integrated into the national building codes as a part of SANS 204 (national energy efficiency in buildings standard)

***It is critical to note that the implementation of any legislation must run concurrently with capacity building of and additional staff support for municipal building plan approval and inspectorate staff.***

iii) Government incentive scheme (Eskom DSM, access to attractive financing)

There is currently a SWH subsidy in place through Eskom's DSM programme, which has been successful in standardising the SWH market in South Africa, and reduces the mid to high income unit cost by up to 20%, and the low income unit by up to 30%.

Businesses and municipalities looking to start mass rollout programmes would be further incentivised by gaining access to attractive financing options facilitated by government.

iv) Municipal, Provincial and National targets (Energy and Climate Change Strategies)

Integrating energy efficiency interventions into government targets prioritises them and creates leadership and institutional momentum around their implementation.

## 4.2 EE Lighting

Energy efficient lighting can be applied across all sectors of the province. For this report the various EE lighting technologies used per sector are as follows:

i) Residential - largely the replacing incandescent light bulbs with compact fluorescent lights (CFLs).

ii) Commercial - CFLs, efficient fluorescent tubes (electronic ballasts over magnetic ballasts) and LED, lighting control systems

iii) Industrial - changing mercury vapour lights to high pressure sodium lights.

iv) All three sectors have a 10% behavioural efficiency component built into them.

### *Technical Assessment*

i) Savings potential

***Table 14***

| *Intervention* | *Potential electricity efficiency gain in Gauteng* | *Potential Electricity saved per year (MWh) in Gauteng* | *Potential $CO_2$ saved per year (T) in Gauteng* | *Estimate of units required to achieve potential* |
|---|---|---|---|---|
| EE Lighting Residential (mid-hi inc) | 3.4% | 1,409,007 | 1,549,908 | 7,756,878 |
| EE Lighting Residential (low inc) | 2.1% | 862,958 | 949,254 | 5,140,800 |
| EE Lighting Commercial/Industrial | 1.6% | 658,141 | 723,955 | 4,060,,856 |
| EE Lighting Commercial/Industrial | 1% | 426,732 | 469,405 | 477,936 |
| **Total** | **8.1%** | **3,356,838** | **3,692,522** | **13,375,614** |

In terms of the energy efficiency interventions analysed for Gauteng, efficient lighting implementation has the second biggest potential impact on reducing the province's bottom line after efficient water heating, at 8.1%. This will largely come from a residential rollout of compact fluorescent lightbulbs (CFLs) (5.5%). It is estimated that 13 million CFLs would need to be rolled out and installed to achieve this in the residential sector alone. Substantial savings are also possible from commercial and industrial implementation (2.6%). These come in the form of more efficient fluorescent lights for commerce and a 10% improvement in current industrial lighting efficiency.

ii) Standards and acceptance of technology

National CFL standards are currently being developed to ensure that good quality CFLs are constantly available in the market place. CFL technology has received widespread acceptance. An example of this is Eskom DSM in the Western Cape indicating that they have saturated the Cape Town market through their mass rollout programmes.

iii) Skills and job creation potential

The implementation of an efficient lighting rollout in Gauteng will require a huge team for co-ordination, distribution and monitoring. The mechanisms for rollout could be ESCO based or directly funded through Eskom DSM exchange programmes (swapping incandescent globes for CFLs).

### *Financial Assessment*

The financial case for energy efficient lighting is a very strong one. Paybacks of a few months up to 2.5 years are typical, depending on technology choice and usage, making a very strong case to both the residential and the commercial/industrial sectors.

From a government based perspective, it is useful to consider the cost of each energy efficiency intervention against the electricity it saves over its lifetime. This figure (R/kWh saved) is a useful comparison to the cost of generation technologies (R/kWh generated). It is often the case that energy efficiency interventions are less expensive to implement than new generation technology.

For residential lighting, that cost is R0.05/kWh saved, making it a highly attractive intervention. Commercial lighting at R0.47/kWh saved and industrial lighting at R0.86/kWh saved are more costly, but still financially viable based on the payback models.

### *Legislative, policy and institutional support*

There is such a strong financial case for EE lighting in South Africa, that legislation is a possibility, particularly for CFLs over incandescent globes. More analysis on the impact on the lighting industry of such legislation would have to take place initially. Other areas to be considered are

i) Safe disposal of CFLs

ii) The fact that CFLs cannot be used for dimmer applications.

Until legislation becomes a reality, government policy and processes to support efficient lighting implementation must be in place. This should include:

- Retrofitting government owned buildings and housing
- CFL swap programmes through Eskom DSM
- Facilitation of ESCO establishment to drive implementation
- Targets to achieve EE implementation in all sectors

For more information on this go to www.cityenergy.org.za/implementation

## 4.3 Ceilings and insulation in low income households

The benefits of including ceilings in low income households are many:

i) Improved comfort levels for occupants - indoor temperatures warmer in winter and cooler in summer

ii) Lower energy use for space heating due to insulating properties of ceiling board (gypsum) or insulated ceiling board (iso-board). Energy modelling shows that the energy required to keep a comfortable indoor temperature in winter decreases by 43% with a gypsum ceiling and 70% with an isoboard ceiling.

iii) Improved health benefits through a reduction in condensation levels in houses, and a reduction in the amount of paraffin or coal used for space heating.

### *Technical Assessment*

i) Savings potential

***Table 15***

| *Intervention* | *Potential electricity efficiency gain in Gauteng* | *Potential Electricity saved per year (MWh) in Gauteng* | *Potential $CO_2$ saved per year (T) in Gauteng* | *Estimate of units required to achieve potential* |
|---|---|---|---|---|
| Ceilings in low income housing- gypsum | 0.7% | 292,512 | 321,763 | 1,445,702 |
| Ceilings in low income housing-isoboard | 1.2% | 476,182 | 523800 | 1,445,702 |

Data on energy use for space heating in low income households in Gauteng is very thin. Energy modelling shows that up to 3800 kWh can be saved per household per annum from space heating alone if an insulated ceiling is installed (SEA, 2008). This however is an overinflated figure, as it assumes that the low income household has the means to keep their space at a comfortably warm temperature throughout winter. This would require a monthly electricity bill of R900 (@ 50c/kWh) for space heating alone over the three cold winter months for houses without a ceiling or insulation, and R513 pm and R270 pm for houses with ceilings and insulation respectively.

Research from the ERC feeding into the Gauteng Energy Strategy shows space heating in low income households to be 14% of total electricity used in the sector. This doesn't paint the entire picture as coal and paraffin stoves are often used for space heating in low income households. However, from an electricity consumption perspective this translates to about 661kWh per year or R138pm over the three cold winter months.

From this framework, it is difficult to determine the potential impact of ceilings from an energy efficiency perspective, as it is difficult to ascertain whether less energy will be used to keep warm in winter, as the amount currently used is already insufficient. For the sake of this study however, it is assumed that the impact of the intervention will reduce energy use in space heating by the percentage determined by the energy modelling from SEA, coupled with the ERC space heating figure of 14%. Therefore houses with insulated ceilings will use 70% less electricity for space heating and houses with ceilings 43%. This results in an electricity reduction figure of 0.7% for gypsum ceilings and 1.2% for isoboard (insulated) ceilings.

It should be noted that the efficiency figures provided do not include additional coal and paraffin savings where these are used for space heating.

ii) Standards and Acceptance of Technology

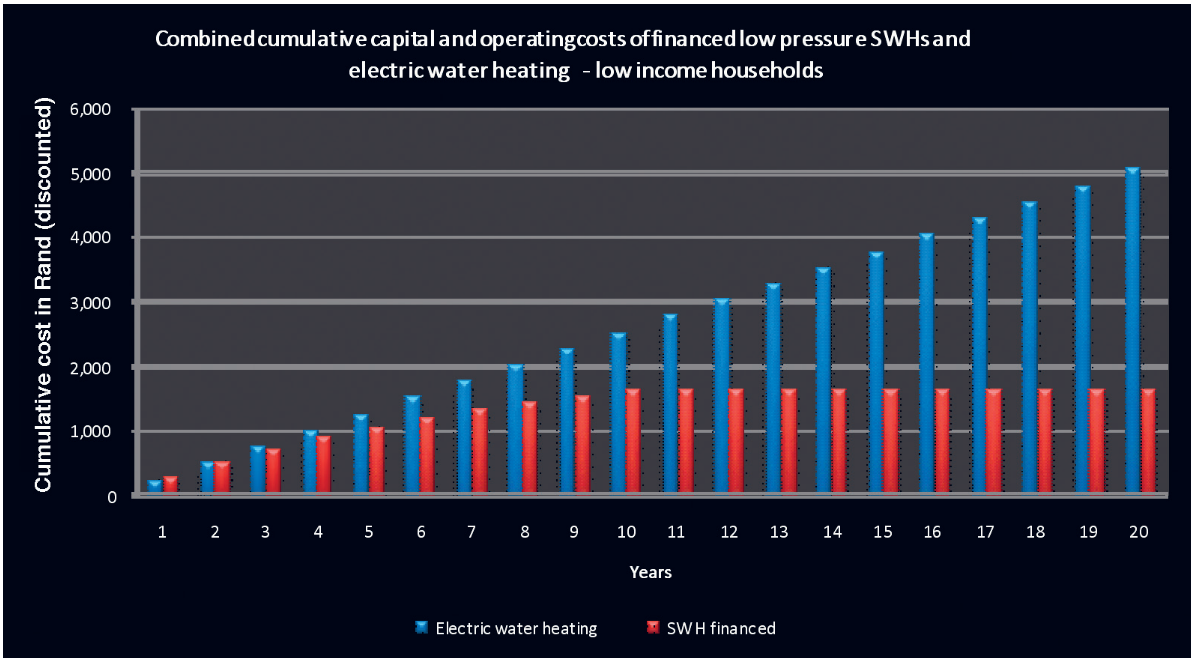
Ceilings and insulation materials (such as isoboard) are widely accepted and used materials which meet national health and safety standards.

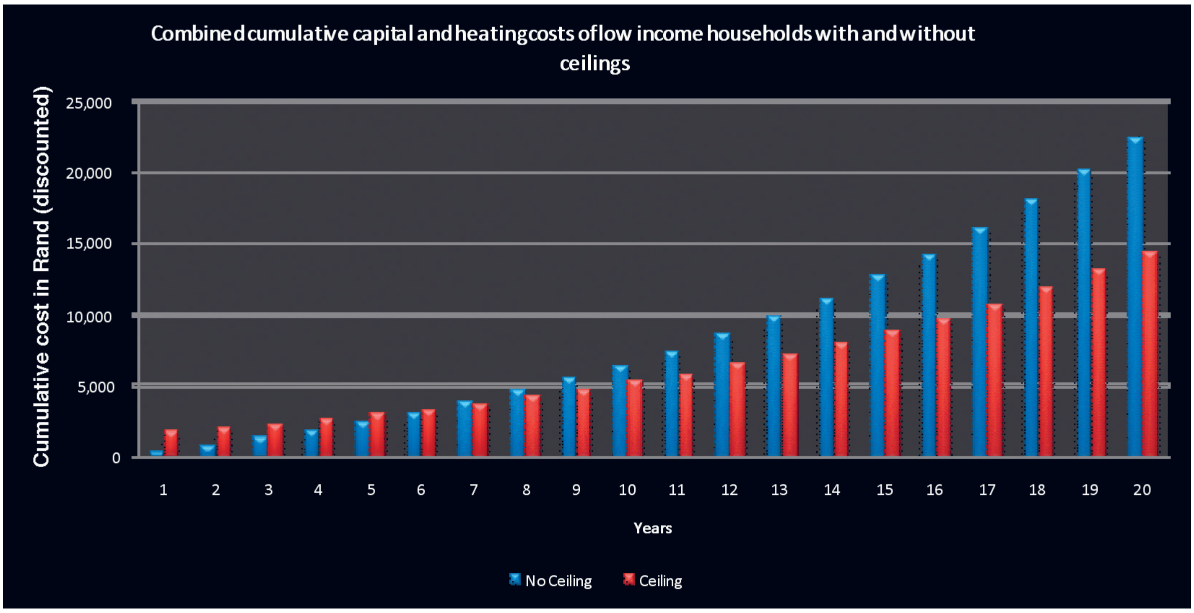
iii) Skills and Job Creation Potential

A nationally co-ordinated programme to rollout ceilings in low income houses in Gauteng would certainly create jobs in those communities. The skills level required to manage and implement ceiling installation is undoubtedly available in the province, and more specifically in the communities where the work will occur. Ceiling board and insulation materials are produced locally and a mass rollout would bolster this industry.

### *Financial assessment*

The impact of ceilings or insulated ceilings on low income houses in financial terms is difficult to quantify, as indicated in the technical assessment above. However, based on the figures used in the technical assessment, the payback periods for ceilings or insulated ceilings (in this case isoboard) are both in the region of 7 years as shown in the graphs below. It is assumed that the end user will not pay for this, so essentially it means a poverty alleviation mechanism to the order of R178 per year for ceiling end users and R290 per year for insulated ceiling end users.




*Assumptions for fig 10 and fig 11: Discount rate 5%, electricity increase rate 15%pa, ceiling R1600, insulated ceiling R2587.50.*

From a government based perspective, it is useful to consider the cost of each energy efficiency intervention against the electricity it saves over its lifetime. This figure (R/kWh saved) is a useful comparison to the cost of generation technologies (R/kWh generated). It is often the case that energy efficiency interventions are less expensive to implement than new generation technology.

For ceilings the cost is 28.17c/kWh saved and for insulated ceilings 28c/kWh saved. Note that this is an average figure, and individual households could be substantially more or less depending on space heating usage.

## *Legislative, policy and institutional support*

Ceilings for low income houses are a hugely beneficial intervention as indicated in the information above, but will require some government support to roll out. The following approaches are considered useful:

- Including ceilings in the national specification for RDP houses is a national imperative given the energy saving, health and comfort level benefits of the intervention. Indications are that at the time of writing this report, this is indeed happening. However, this still leaves an enormous amount of existing households to be retrofitted with ceilings.
- Accessing funding from Treasury to co-ordinate a mass rollout of ceilings in RDP houses, preferably through the Working for Energy Programme, would be a sensible implementation approach which will also create employment.

## 4.4 Efficient HVAC (Heating, Ventilation and Air Conditioning) Systems

HVAC systems are predominantly used in commerce and industry, and as such only these sectors are considered here. Of this the majority is used in the commercial sector, predominantly for regulating the temperature of office spaces.

### *Technical Assessment*

i) Savings Potential

***Table 16***

| *Intervention* | *Potential electricity efficiency gain in Gauteng* | *Potential Electricity saved per year (MWh) in Gauteng* | *Potential $CO_2$ saved per year (T) in Gauteng* | *Estimate m2 of floor space required to achieve potential* |
|---|---|---|---|---|
| Efficient HVAC (Commerce) | 3.4% | 1,415,357 | 1,556,892 | 16,916,620 |
| Efficient HVAC (Industry) | 0.2% | 72,272 | 79,499 | 833,321 |
| Total | 3.6% | 1,487,629 | 1,636,391 | 17,749,941 |

The use of more efficient HVAC systems in the commercial and industrial sectors has the potential to reduce electricity use in Gauteng by 3.6%. Calculations are based on a 30% improvement in efficiency through the utilisation of new HVAC technology (2.5%). A further reduction in electricity use is possible through behavioural changes (1.1%). Behavioural changes include:

a Using natural air for cooling in the morning

b Adjusting temperature settings to keep within 10 degrees of outside temperature,

c Allowing building temperature to move towards outside temperature at the end of the day

As building sizes differ substantially in the commercial and industrial sector, calculations are based on the floor area required to be affected by more efficient technology

ii) Standards and Acceptance of Technology

HVAC systems are well established technologies with widespread acceptance, given the large quantities currently installed in the country. More efficient versions of the same technology will receive acceptance, particularly if attractive payback cases can be made.

iii) Skills and job creation potential

The country does currently have the skills to implement HVAC technology. A growth in the HVAC sector through increased installation will naturally result in more jobs being created.

### *Financial Assessment*

The calculations used for this analysis are based on the following assumptions:

a Efficient HVAC R950/m2 as opposed to R700/m2 for inefficient HVAC

b Annual electricity savings of 30%

c Electricity increase rate of 20%pa

d Discount rate 15%

The use of efficient HVAC over inefficient HVAC in a new build or ‘blown’ system replacement scenario will typically show a payback for the end user in 6-7 years, with further savings realised from this point on.

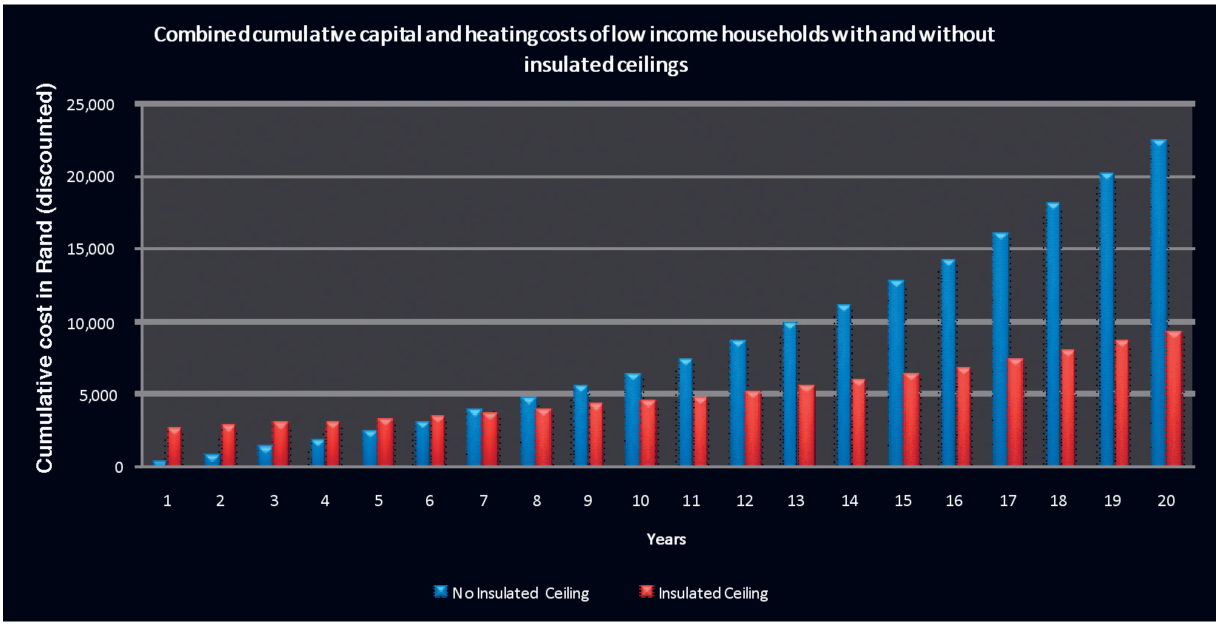



*Fig 12*

HVAC systems are expensive to install and figures of R2.92 per kWh saved are typical in a retrofit scenario. However, for a new build scenario 77c per kWh saved is a fairly typical figure. The latter comes very close to current purchase costs for the end user, and as such should be considered as a financially viable alternative.

### *Legislative, policy and institutional support*

- Government awareness raising around the potential Return on Investment (RoI) of efficient HVAC systems in appropriate industry forums could lead to increased uptake of the technology.
- Setting minimum national efficiency standards for HVAC technology in the national building codes would be an effective method to ensure new build scenarios are covered.

## 4.5 Efficient Motors

Approximately 60% of electricity in industry is used by electric motors (Eskom). New developments in electric motor design have resulted in efficiency levels improving by 6.5%. Eskom DSM is currently incentivising the replacement of old inefficient motors with new efficient counterparts in an effort to roll out the new technology in industry.

### *Technical Assessment*

i) Savings Potential

***Table 17***

| *Intervention* | *Potential electricity efficiency gain in Gauteng* | *Potential Electricity saved per year (MWh) in Gauteng* | *Potential $CO_2$ saved per year (T) in Gauteng* | *Estimate of 22kW units required to achieve potential* |
|---|---|---|---|---|
| Efficient Motors | 1.5% | 640,591 | 704,650 | 70,737 |

Use of more efficient motors (Eff 1 instead of Eff 3) in industry can typically improve efficiency levels by 6.5%. Applying this to the 60% of industrial electricity use by electric motors yields a 1.5% efficiency gain in Gauteng. As the number and variety of motors in industry in Gauteng is unknown, the quantity of motors required of 70,737 to achieve this has been based on a 22kW generic motor. In reality though, it is likely that the real number is substantially different given the range of motors in industry being 1-90kW.

ii) Standards and Acceptance of Technology

All Eff1 efficient motors used in the Eskom rollout have been SABS approved.

iii) Skills and job creation potential

An increase in the purchase and installation rate of energy efficient motors will grow the industry, resulting in skills transferral and new jobs created.

### *Financial Assessment*

Efficient motors are financially viable, and a good energy efficiency option, costing the end user 16c/kWh saved over the motor's lifetime.

The Eskom incentive currently reduces motor unit costs from R400 for a 1.1kW motor to R3500 for a 90kW motor. Current calculations sourced from the Eskom DSM website show a simple payback of 2.89 years. It should be noted that the Eskom incentive only applies to motor replacements and not new motor purchases. The table below shows the financial argument for efficient motors.

*(Source http://www.eskomdsm.co.za/?q=Energy_Efficient_motors_How_to_participate#suppliers)*

***Energy price (R/kWh) - 0.56 (Megaflex, peak, high-demand season)***
***Power factor - 88%***
***Purchasing price (Eff1) - R 16 100***

***Table 18***

| Motor Characteristics | Old motor (EFF3) | Replacement motor (EFF1) | |
|---|---|---|---|
| Type | 22kW 4 pole | 22kW 4 pole | |
| Efficiency | 86,6%(Original) | 93,1% | |
| Efficiency loss operating life | -2% (due to repairs) | - | |
| Savings | | | Energy savings |
| Differential cost (R) | | 14,700 | |
| Energy use (kWh/yr | 129,524 | 120,468 | 9,056 |
| | | | |
| Energy cost (R/yr) | 72,533 | 67,462 | 5,071 |
| Total Savings (R/yr) | 5,071 | | |
| Simple Payback (yrs) | 2.89 | | |

### *Legislative, policy and institutional support*

- Government awareness raising around the potential Return on Investment (RoI) of efficient motors in appropriate industry forums could lead to increased uptake of the technology.
- Continued incentivisation through the Eskom DSM programme

## 4.6 Variable Speed Drives

### *Technical Assessment*

i) Savings Potential

***Table 19***

| *Intervention* | *Potential electricity efficiency gain in Gauteng* | *Potential Electricity saved per year (MWh) in Gauteng* | *Potential $CO_2$ saved per year (T) in Gauteng* | *Estimate of units required to achieve potential* |
|---|---|---|---|---|
| Variable Speed Drives | 1.2% | 492,762 | 542,038 | |

Variable speed drives are very effective interventions for applications where the load requirement on a motor fluctuates during the course of its operation. As each application for the technology is unique, it is very difficult to determine an average saving from the intervention. Efficiency gains can be as high as 10%, but for this analysis a conservative gain of 5% has been used and applied to all areas of industry where the technology is appropriate. This includes pumps, coolers, compressors, fans, material handling and processing.

Using this information as a basis for calculation, it has been determined that a 1.2% reduction in Gauteng's electricity use can be achieved from the complete rollout of the technology

### *Financial Assessment*

As applications of variable speed drives are so diverse, it is difficult to make a generic financial case for them. However, given their increased use within industry, VSDs clearly do make financial sense through energy savings.

### *Legislative, policy and institutional support*

Government awareness raising around the potential Return on Investment (RoI) of variable speed drives in appropriate industry forums could lead to increased uptake of the technology.

## 4.7 Aerated Showerheads

Aerated showerheads combine air and water, to recreate the feeling of a water intensive shower while using considerably less water. The use of aerated showerheads in mid-high income households can be a cheap and effective energy efficiency intervention. Efficiency is gained through less hot water being used per day. This intervention also has the benefit of reducing water consumption in a household.

### *Technical Assessment*

i) Savings Potential

***Table 20***

| *Intervention* | *Potential electricity efficiency gain in Gauteng* | *Potential Electricity saved per year (MWh) in Gauteng* | *Potential $CO_2$ saved per year (T) in Gauteng* | *Estimate of units required to achieve potential* |
|---|---|---|---|---|
| Aerated Showerheads (no SWHs) | 1.5% | 609,030 | 669,933 | 1,223,422 |
| Aerated Showerheads (100% SWHs) | 0.5% | 207,070 | 222,277 | 1,223,422 |

Based on the assumptions listed below, a mass rollout of aerated showerheads in mid-high income households can result in a 1.5% efficiency gain in Gauteng, provided no solar water heaters are installed in the province. This figure would reduce by 1% if SWHs were installed in these households due to the typical efficiency of the SWH being 66%.

The figures indicated in the table above are based on supplier data that aerated showerheads result in a 40% reduction in water use, equating to approximately 6 litres of water saved per minute of shower use, of which approximately 3 litres will be hot water. Assuming two 5 minute showers per mid-high income household per day this equates to approximately 30 litres of hot water saved per day. This equates to 1.39kWh of electricity saved per day or 507kWh per year.

ii) Standards and Acceptance of Technology

It is not clear whether standards are in place for aerated showerheads, and most suppliers offer between a one to ten year guarantee. Given that paybacks are usually within a year, there is not too much concern in this area.

iii) Skills and job creation potential

A mass rollout programme could create jobs

### *Financial Assessment*

The following table shows the strong financial case for the end user to use an aerated showerhead, with a payback in less than a year. It should be noted that if an aerated showerhead is used in conjunction with a SWH, payback is more likely to be around 2 years.

***Table 21***

| *Payback for Aerated Showerheads* | |
|---|---|
| Unit Cost | R 230 |
| Saving/month (electricity) | R 27 |
| Payback (months) | 8.38 |

Assuming that the showerhead lasts for ten years, the cost per kWh saved for the intervention is 4.5c/kWh saved. This figure is substantially less than the residential purchase price for electricity of between 65c and 90c per kWh and makes a strong case for the implementation of the technology in households that shower regularly.

### *Legislative, policy and institutional support*

- An aerated shower head swapping programme, similar to the Eskom DSM CFL programme could be a useful intervention
- Setting minimum national efficiency standards for shower head flow rates in the national building codes would be an effective method to ensure new build scenarios are covered.

## 4.8 Hot Boxes

Hot boxes have for many years been seen as an energy saving option for the residential sector, and particularly as a means to address energy poverty in the low income sector. Essentially, hot boxes can be used to keep food cooking once it is brought up to the required temperature without the further use of a stove. The cooking pot is placed in an insulated box which keeps in the heat and continues to cook the food.

### *Technical Assessment*

i) Savings Potential

***Table 22***

| *Intervention* | *Potential electricity efficiency gain in Gauteng* | *Potential Electricity saved per year (MWh) in Gauteng* | *Potential $CO_2$ saved per year (T) in Gauteng* | *Estimate of units required to achieve potential* |
|---|---|---|---|---|
| Hot Boxes | 0.4% | 151,990 | 167,188 | 819,493 |

The figures obtained in the table above are calculated based on the assumption that the hot box is used for one meal per day, and can provide a saving of 563Wh per meal (45minutes of simmer time on a stove plate at 750W).

### *Financial Assessment*

The current cost of a hotbox is around R120. Based on a saving of 560Wh per day, this equates to a monthly saving of R10.53, which will provide a payback to the end user of under a year. The graph below indicates the cumulative benefit of using a hot box over several years.

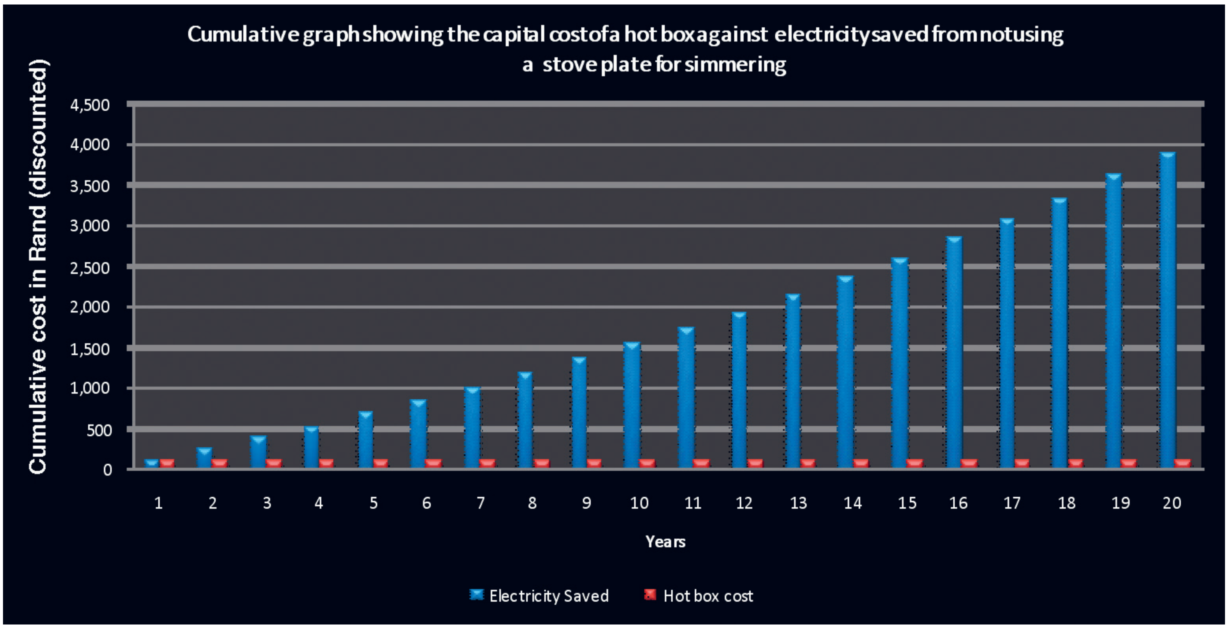



*Fig 13 Assumptions: Hot box cost R119, Electricity increase rate 20%, Discount rate 15%, Electricity saved per month R10.53.*

Assuming that the hotbox lasts for ten years, the cost per kWh saved for the intervention is 5.82c/kWh saved. This figure is substantially less than the low income residential purchase price for electricity of between 65c and 90c per kWh and makes a strong case for the implementation of the technology in households that use the hotbox at least once a day.

### *Legislative, policy and institutional support*

Manufacturing and distribution of hotboxes through the Working for Energy programme

Awareness raising in communities around the benefits of the technologies

## 4.9 Scenarios Building – Linking potential to targets

The potential of the electrical energy efficiency interventions listed above has been quantified in terms of full implementation in Gauteng in 2007. Based on this sectoral electricity efficiency gains of

- 40% for residential,
- 10% for industrial and
- 29% for commercial

are possible in Gauteng. Although not considered specifically above, government efficiency gains are similar to commercial given the nature of the working space. As such a 29% gain for government is also considered feasible. Using these achievable figures as a reference point, the Gauteng Integrated Energy Strategy sets realistic electricity based energy efficiency targets per sector for 2014, 2025 and 2055. The table below lists these.

***Table 23 Energy efficiency targets***

| *Action* | *2014* | *2025* | *2055* |
|---|---|---|---|
| Overall provincial energy efficiency against business as usual scenario - Electricity | 7% | 15% | |
| Electricity and other fuels | 8% | 18% | |
| Transport energy efficiency | 7% | 15% | |
| Residential energy efficiency - Electricity | 13% | 37% | |
| Industry energy efficiency - Electricity | 10% | 15% | |
| Commercial energy efficiency - Electricity | 13% | 25% | |
| Government energy efficiency - Electricity | 13% | 25% | |
| Solar water heaters installations: Mid-hi income | 20% | 95% | |
| **Low income** | **20%** | **50%** | **80%** |

The industrial figure of 15% by 2025 is the only figure to exceed the determined sector potential. This assumes that further technological developments will ensure greater electrical efficiencies are gained in the future.

In order to achieve these targets a realistically achievable mix of electrical energy efficiency interventions needs to be achieved. The following table indicates the penetration levels of each intervention required in Gauteng to meet the targets.

***Table 24***

| *Sector* | *End-Use* | *2014* | *2025* | *2055* |
|---|---|---|---|---|
| **Mid-Hi Income** | Lighting | 60% | 95% | |
| | Efficient Water heating | 20% | 95% | |
| **Low Income Elec.** | Lighting | 40% | 80% | |
| | SWH | 20% | 50% | 80% |
| | Ceilings | 20% | 95% | |
| **Government** | HVAC | 50% | 95% | |
| | Lighting | 50% | 95% | |
| | Efficient Water heating | 5% | 21% | |
| **Commerce** | HVAC | 50% | 95% | |
| | Lighting | 50% | 95% | |
| | Efficient Water heating | 5% | 21% | |
| **Primary Industry** | Electricity | 10% | 15% | |
| **Secondary Industry** | Electricity | 10% | 15% | |

These figures have been inserted into LEAP energy modelling software to verify their linkages to the targets[3], given factors such as future economic and population growth. The following table indicates the energy savings for the target years if the efficiency targets are achieved:

***Table 25***

| | | Energy Saved (MWh) | | | |
|---|---|---|---|---|---|
| **Sector** | **End-Use** | **2007** | **2014** | **2025** | **2055** |
| Mid-Hi Income | Lighting | 0 | 836,111 | 2,218,445 | 4,073,250 |
| | Efficient Water heating | 0 | 1,122,639 | 7,546,139 | 13,855,334 |
| Low Income Elec. | Lighting | 0 | 642,598 | 1,489,414 | 1,344,556 |
| | SWH | 0 | 446,898 | 1,201,686 | 1,369,003 |
| | Ceilings | | | | |
| Government | HVAC | 0 | 150,199 | 386,225 | 834,182 |
| | Lighting | 0 | 59,289 | 152,457 | 329,282 |
| | Efficient Water heating | 0 | 2,372 | 13,480 | 29,115 |
| Commerce | HVAC | 0 | 790,639 | 2,033,111 | 4,391,167 |
| | Lighting | 0 | 370,639 | 953,028 | 2,058,361 |
| | Efficient water heating | 0 | 14,825 | 84,267 | 182,003 |
| Primary Industry | Electricity | 0 | 116,635 | 203,819 | 282,995 |
| Secondary Industry | Electricity | 0 | 1,970,722 | 3,443,889 | 4,781,695 |
| | Total | 0 | 6,523,565 | 19,725,961 | 33,530,945 |

## 4.10 Conclusion of EE section

This chapter has shown that the potential gain from electrical energy efficiency interventions in Gauteng is in the region of 27% off the current electricity consumption figures. Most of these interventions have been shown to be financially feasible, once again underlining the benefit of implementing energy efficiency before providing new generation capacity. There is also huge potential for job creation through the manufacture and installation of the various interventions.

Realistic targets which link with the potential for energy efficiency in Gauteng have been set by the Gauteng Integrated Energy Strategy. These have been verified based on the assessment of this chapter, and for for the target years on a per intervention basis using LEAP modelling.

Energy efficiency is difficult to roll out given its dispersed nature, and it is anticipated that this will be the largest challenge facing the Gauteng Province in its efforts to become more efficient. However, the targets set are realistic and achievable if the correct programmes, policies and incentives are put in place.

3. *See Chapter 6 for a more detailed analysis of the LEAP work.*