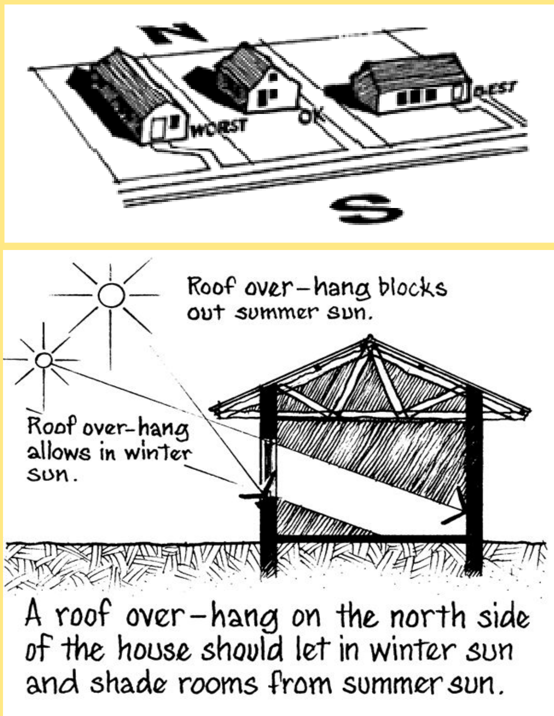
6. Energy efficient building implementation

6.1 Overview

Efficient building encompasses several areas, from efficient design and orientation methods right through to the technology used inside a building to make space heating or cooling more efficient.



Some efficient building concepts:

- Passive solar design is used to reduce energy consumption and to ensure comfortable accommodation. Some examples of this are:
  - good insulation in the roof and walls to keep the inside temperature warm in winter or cool in summer.
  - north orientation ensures that as many well-used spaces face north as possible
  - suitable roof overhangs to let in the lower winter sun but shade from the hot summer sun.
  - sensible fenestration (windows) – let in the light and catch the winter sun, but not too much window area so that warmth or coolth cannot be retained inside when needed.
  - suitable ventilation for fresh air and cool breezes - rooms can be ventilated using air-bricks, forced ventilation or by opening windows.
  - natural lighting through windows and light wells.

- install efficient heating, ventilating and air conditioning (HVAC) systems if required, ensure they are efficiently used

- install solar water heaters – these are relatively expensive but result in substantial savings on your electricity bills (water heating is the biggest part of most household's electricity use profiles).

- if needed, energy efficient light bulbs are usually more expensive than conventional incandescent light, but have a much longer life-span and use far less electricity. They pay themselves back in a few months and are a very sound environmental choice.

6.2 The case

For the purposes of this manual, only two areas of efficient building will be highlighted:

i) Fitting ceilings into low cost houses

ii) More efficient use of heating, ventilating and air conditioning (HVAC) systems in commercial and local government buildings

Both of these energy efficiency interventions can easily be achieved on a mass scale, and lead towards more sustainable living.

Energy consumption

'Normal' commercial building: ~300+ kWh/m^2/yr

Existing efficient examples:
Multinational corporate head office ~115 kWh/m^2/yr
Small commercial office block ~30 to 50 kWh/m^2/yr

An evaluation of 33 Green Buildings in California sums up the situation in many countries, including South Africa…

"It seems obvious: the reason only a tiny percentage of new American buildings and retrofits aren't green isn't cost. It's lack of ingenuity or knowledge of new construction techniques -- architects and builders wed to the 'same-old,' lenders leery of anything unconventional."

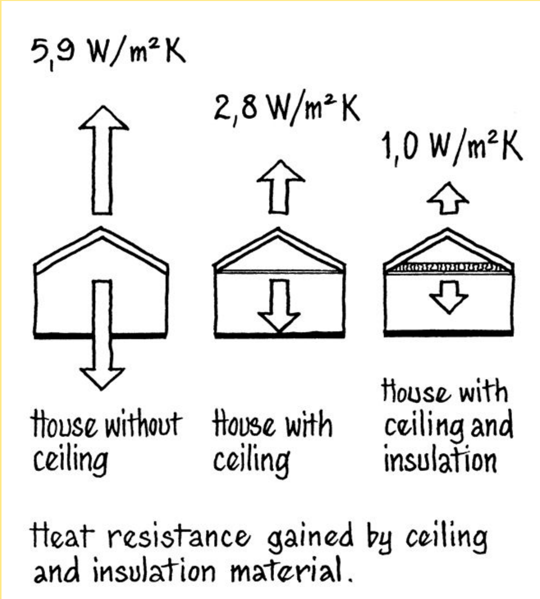
The Green Building, Cape Town

Fitting ceilings in low income houses

One of the best ways to make a house more energy efficient is to reduce the flow of heat into and out of the house. This is achieved through insulation. Insulation keeps a house cooler on a hot day and warmer on a cold day. As most heat in a house is lost through the roof, the most effective way to insulate a house is to fit a ceiling. In areas with cold winters, a ceiling can reduce space heating costs by up to 50%.

In South Africa, most of the low cost houses built by government don't have ceilings fitted. This means that large amounts of additional energy are required to heat these houses in winter. For a household that has little money, the cost of this extra heating can be exorbitant. Installing a ceiling will therefore have several benefits:

- Less money spent on heating in impoverished households.
- Improved indoor air quality (where paraffin stoves and fires are used for heating), health and comfort.
- Less energy used means less non renewable resources being used and less CO_2 being produced.
- In poor households that cannot afford heating, ceilings will have a positive affect on the health of the household. This is good for the city economy as well as fewer working days will be lost through illness.



Although the energy saved over 20 years from installing a ceiling probably doesn't cover the capital cost entirely, one needs to consider the other benefits, particularly health (due to cleaner air and a more stable internal temperatures) and quality of life, to low income residents. These translate into indirect and unquantified, but substantial, financial benefits in areas such as health department costs and economic work days achieved.

Recent work by the Energy Research Centre of the University of Cape Town concludes that "a relatively small additional investment in housing for poor communities creates more comfort and reduces household energy costs, as well as cutting emissions from the residential sector. Energy efficiency in social housing is an area where a policy of direct state financial support to promote energy efficiency seems warranted. In practice, municipal government would need to play an important role in administering a subsidy scheme and providing bridging finance" (Winkler, (ed), 2006).

Efficient use of heating, ventilation and air conditioning systems

Eskom reports that HVAC systems contribute an estimated 5 400 MW to electricity demand in peak periods. This is approximately 15% of South Africa's current peak demand consumption.

Simple behaviour changes outlined below can make HVAC systems at least 10% more efficient.

- Using 'fresh' air to cool a building down at the start of the day. The outside air, even in summer, is fresh and cool early in the morning and by switching the air conditioning system's fans on, the cool, natural air is drawn into the building. Not only does it lower the inside temperature, but it also flushes out the stale air from the previous day. In this way, the building is cool and fresh when the employees and customers arrive, and the energy intensive chillers need only start operating towards mid-morning.

- Slight adjustments to the temperature setting of the air conditioning system can result in substantial savings. It is advisable that the difference between the inside and outside temperatures should not exceed 10 degrees Celsius. Compared to current practices, this means that air conditioners can be set a degree or two higher in summer and a degree or two lower in winter. Not only would the air conditioning not have to work quite so hard to maintain the desired temperature, but health wise it is also wiser to not subject the body to severe temperature contrasts. If the outside temperature is 35 degrees, for example, and the inside temperature is maintained at 25 degrees instead of 20 degrees, a 33% saving in energy consumption will be realized.

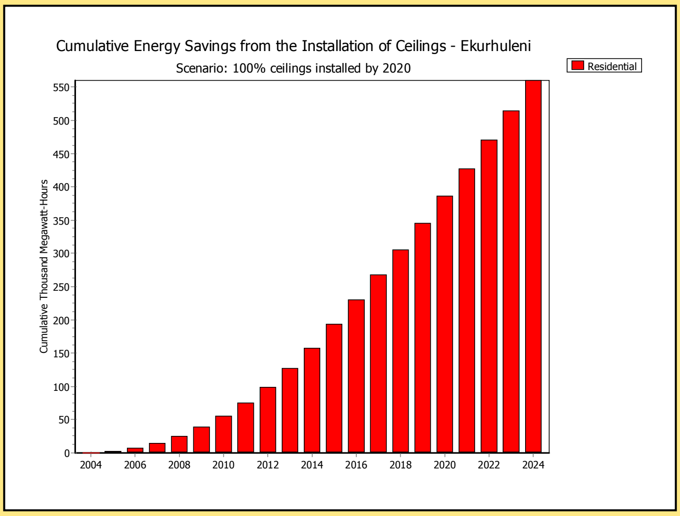
- Towards the end of the working day, the building's air conditioning system could "wander". This means allowing the temperature to gradually increase, given that employees are due to leave soon and will then encounter the temperature outside. It is not energy efficient to maintain a cool interior long after the people who needed it, have gone.

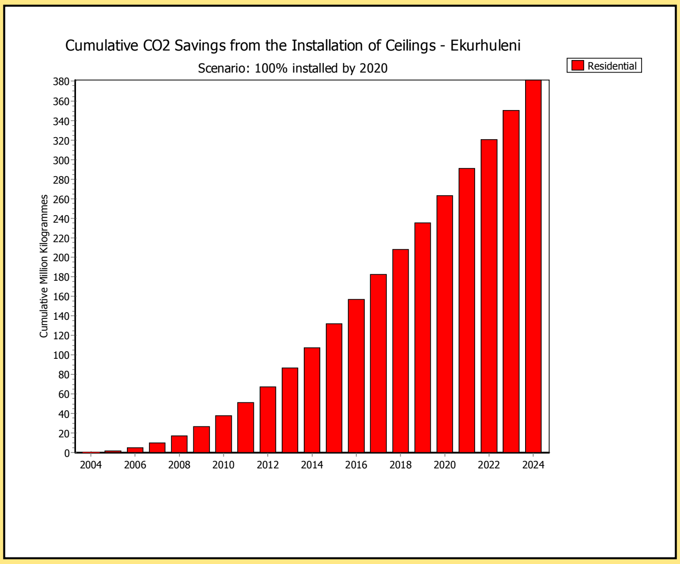
- HVAC technology has also improved greatly over the last few years, and efficiencies of these systems are far better. For example some new air conditioning systems are 30% more efficient than their older counterparts.

To see the complete set of outputs from LEAP for all the cities modeled, visit the Sustainable Energy for Cities website at www.sustainable.org.za/cities

6.3 Potential for rollout

There is great potential for a mass roll-out of energy efficient building interventions in cities around South Africa. To demonstrate this, 5 South African cities have been modeled using LEAP (See 'How to use this Manual'), firstly using a business-as-usual (no energy efficient building) scenario, then using an energy intervention (energy efficient building) scenario. For the purposes of this manual, we will consider the case of Ekurhuleni.





The impact of large energy efficient building interventions in the city: The case of Ekurhuleni

- **Fitting Ceilings in Low Income Houses**

Ekurhuleni set the following target in their Energy Strategy:

- 100% ceilings installed by 2020

- **Energy savings**

If Ekurhuleni achieves its targets by 2024, 550 thousand MWh of electricity will have been saved. In power station capacity terms, in 2024, it will negate the need for an 8MW facility (including transmission line losses and a reserve capacity of 30%). This is slightly more than the Darling Wind Farm produces.

- **Carbon savings**

On the carbon saving side, if the city achieves its targets, over 380 thousand tonnes of CO_2 will have been saved by 2024.

Poverty alleviation

Good energy saving benefits and improved health benefits for poor households make installing ceilings an excellent intervention.

Efficient use of HVAC

Ekurhuleni set the following target in their Energy Strategy:

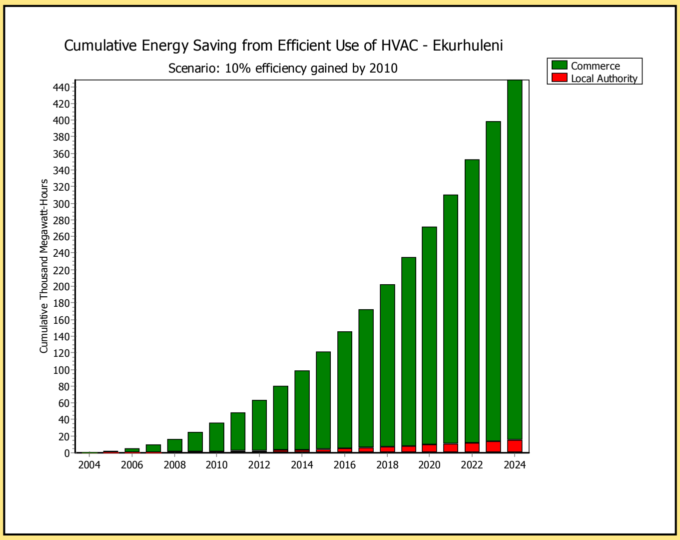
- 10% efficiency gained by 2010

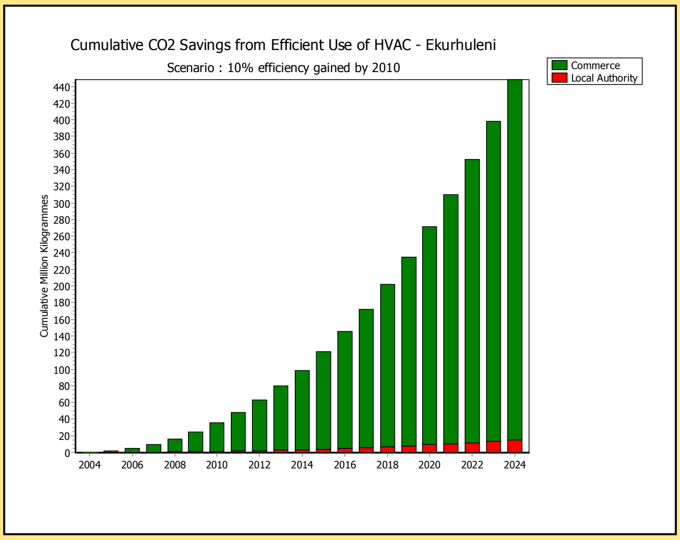
Energy savings

If Ekurhuleni achieves its targets by 2024, 450 thousand MWh of electricity will have been saved. In power station capacity terms, in 2024, it will negate the need for a 7MW facility (including transmission line losses and a reserve capacity of 30%).

Carbon savings

On the carbon saving side, if the city achieves its targets, over 440 thousand tonnes of CO_2 will have been saved by 2024.





6.4 Barriers to implementation

From the installation of ceilings side, barriers include the following:

- Due to the high capital cost of installing a ceiling (at least R2000), most low income houses can't afford it. Subsidisation is essential for this to become a reality.
- The space heating energy saved over 20 years will not necessarily cover the cost of installing the ceiling.
- Difficult to measure real energy savings from fitting a ceiling.
- Difficult to measure indirect savings achieved through better health and warmer homes.

On the HVAC side, barriers include:

- Lack of information and awareness amongst building users and administrators. Behavioural patterns need to change to achieve the efficiency targets.
- Lack of knowledge amongst people working in procurement of the benefit of using more efficient HVAC systems.

6.5 How to go about implementation

Ceiling installation in low cost housing delivery

Current subsidised housing in South African cities does not include ceilings in the top structure, with the exception of those cities falling within the Southern Cape Condensation area, which receive a top-up subsidy for ceiling and plastering of houses in a bid to combat the damp-aggravated TB epidemic in the region.

Installation of ceilings in homes is identified at an important intervention within the Department of Housing's Draft Framework on Environmentally Efficient Housing. The mechanisms through which to ensure this intervention remain unclear. Cities need to consider inclusion of ceilings within their minimum requirements for low cost housing development and lobby national government for an extension of the "top up" subsidy to all areas in South Africa to cover additional costs. Local government would then administer this subsidy.

Create awareness around savings from efficient use of HVAC and develop efficient HVAC management practices

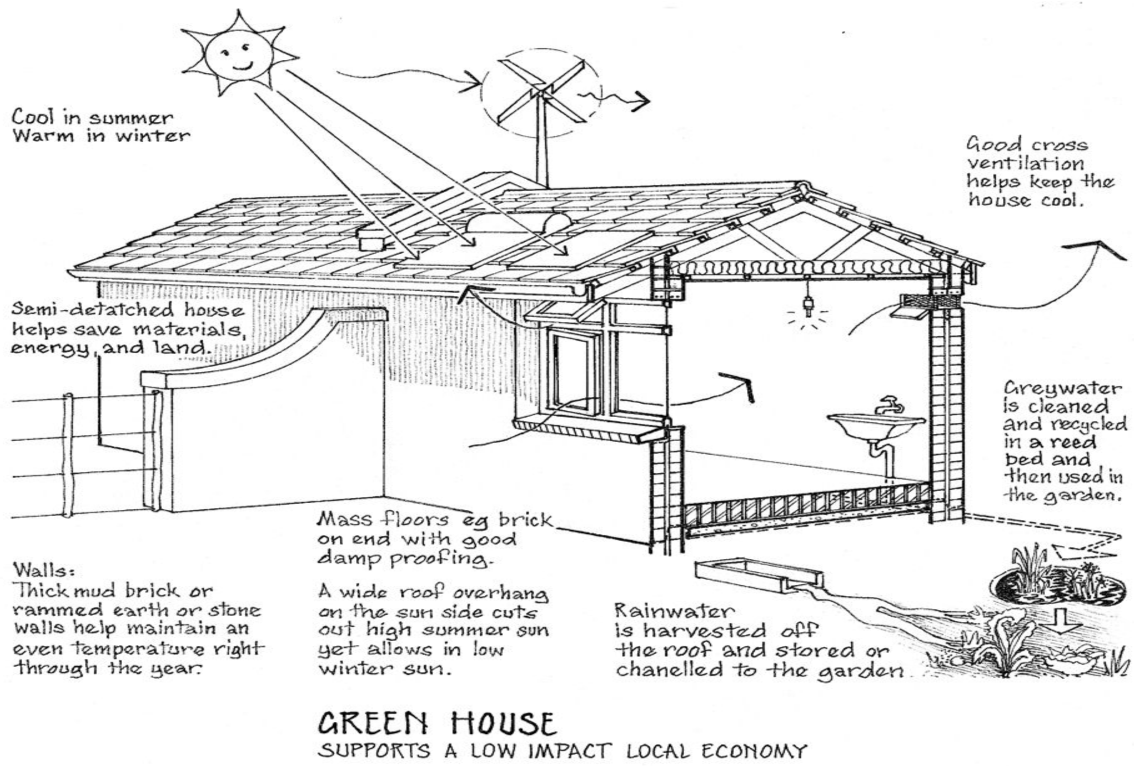
Educate building users and administrators as to the benefits of efficient use of HVAC. Also make them aware of potential savings from using more energy efficient technology. Cities can do this amongst their own staff and building administrators. They can also, through partnerships with business, encourage such awareness within the business sector.

For long term impact it is important that procurement policies be adjusted to ensure efficient HVAC systems are installed in buildings, and efficient HVAC practices are built into the operational practices of buildings and responsibilities of building managers.

Develop a set of green / energy efficient building guidelines or codes

Cities are mandated to enforce building regulations established by national government. As all new building plans must pass through the City for approval, this provides an important opportunity to intervene to either encourage (guidelines) or prescribe (regulation) energy efficient building interventions. Some cities have explored developing local energy efficiency building regulations, but have since abandoned this process given that building regulations are established nationally in order to promote uniformity within a vast sector, where a plethora of local standards creates conflict.

National government is in the process of exploring how to incorporate energy efficiency into the National Building Standards. Legal opinion is being sought on whether this could involve a relatively quick change to the regulations flowing from the Act, or a revision of the National Building Standards Act itself (6 – 8 years). If latter, alternative approaches may be considered by DME in order to meet their commitments regarding energy efficiency targets.



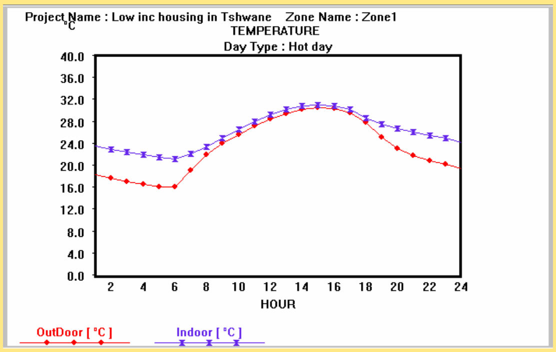
In the absence of local regulatory powers, cities can consider developing local guidelines or standards. For uniformity and acceptability these should ideally be based on existing standards or norms. The South African Bureau of Standards are in the process of developing energy efficiency standards for residential (SANS 283) and commercial buildings. These have not yet been published. A set of South African Energy and Demand Efficiency Standards (SAEDES) guidelines for new and existing commercial buildings have been developed (and form the basis for the SABS standards) and may provide an interim guideline. The City of Potchefstroom have shown interesting local initiative whereby they have made the SAEDES standards guidelines mandatory for all new municipal buildings. Where commercial building applications must go through an environmental impact assessment process, the City works to introduce the SAEDES standards as a condition for development

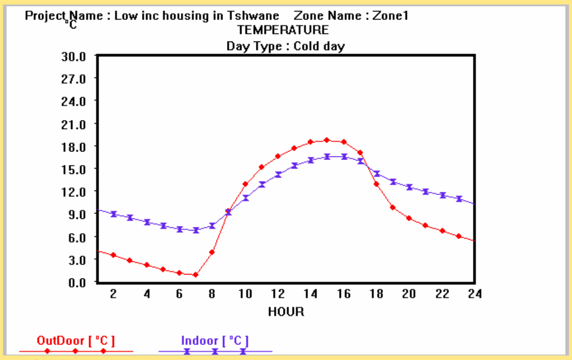
For residential housing the National Department of Housing has recently developed a Framework for Environmentally Sound Housing (currently out for public comment) and the SABS standard should be published at some point. Local government does not have the power to enforce these standards, but could actively promote and encourage their adoption through awareness and capacity building programmes within the building and architectural industry. The national utility may cooperate within such an initiative as part of their Demand Side Management programme.

Limiting building energy footprints

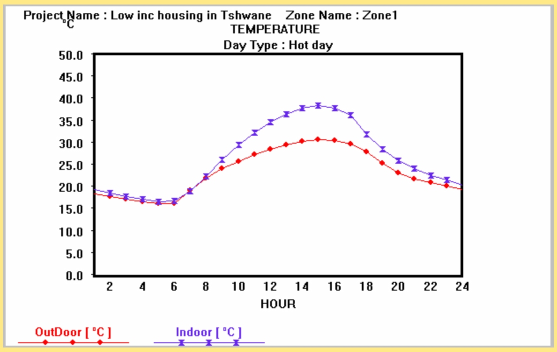
Given that local authorities may not be well placed – legally and technically - to tackle the complex task of establishing local building regulations, the possibility of local authorities approaching the problem 'from the other side' could be considered. This would involve local authorities limiting the quantity of energy consumption in buildings through setting maximum energy/m^2 caps within building applications. This approach requires exploration in terms of whether cities may legally apply such quantity limitations, as well as what computer tool and capacity would be needed to apply such a system within the building applications process.

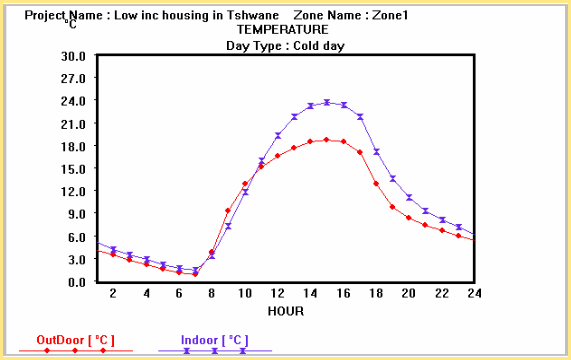
Passive solar design of houses results in their being more comfortable and healthy, and reduces the energy costs of heating and cooling.





The graphs show indoor and outdoor temperatures for a low income house in Gauteng – without passive solar design features (below), and considering key passive solar interventions such as proper orientation, window shading, roof insulation and wall materials (above). The temperature extremes experienced by the former are excessive, and are greatly reduced in the house where such intelligent design is considered.





6.6 Case study

Case study: Improving energy efficiency of the Tygerberg administration building in the City of Cape Town

The Tygerberg Administration building in Parow, Cape Town was chosen as a lead building energy efficiency project after an energy audit was performed and huge saving opportunities were identified. The project, initiated in 2003, aimed to reduce energy use, expenditure and greenhouse gas (GHG) emissions through introducing technological interventions and the promotion of behavioural change amongst building users (city staff).

Based on an initial energy audit, a 20% savings target was established for the project. Regular project meetings were held with relevant staff members to plan for the interventions, provide feedback on successes and problem areas of the project and decide on what follow-up actions were required.

The Tygerberg building housed 200 staff and comprised 150 offices, 6 kitchens, 4 meeting rooms and one council chamber. The building contained a range of electricity appliances, ranging from air conditioners and computers to printers and fridges.

The technological interventions included the replacement of 500 incandescent light bulbs with compact fluorescent light bulbs (CFLs), installation of a solar water heater, installation of geyser timers on hot water cylinders, the replacement of some of the tea urns with insulated urns (hydroboils), installation of more efficient fluorescent tubes/ballasts and adjusting air conditioning thermostat settings and use times.

The behavioural change component of the programme involved regular contact with staff members via email updates, a display board set up at the entrance of the building displaying savings from the project; information pamphlets and newsletters keeping staff constantly updated on project achievements and requesting staff to take action to reduce their electricity bill.

Table 1: Total savings

	Saving/mth	Saving/yr
kWh/month	12 000	144 000
Tons CO_2	13.2	158.4
Rands	3 240	38 880

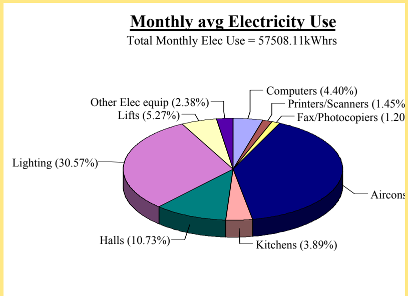
The average monthly electricity consumption was 57 507 kWh prior to project implementation. Air-conditioning systems and lighting were the largest consumers of electricity. The project achieved a saving of 12000 kWh per month amounting to annual saving of 144 000 kWh of electricity – a 22% saving. This translates to saving of R 39 000 per year and 158.4 tons of carbon emissions avoided per year. The benefits were substantial. Approximately 14% of the savings was achieved in the technical phase (when the technological interventions were implemented) and a further 8% achieved in the 'staff participation' behaviour change phase.

The total reduction in carbon dioxide emissions was 13.2 tons of carbon per month. The payback period for the project was estimated at 2 years.

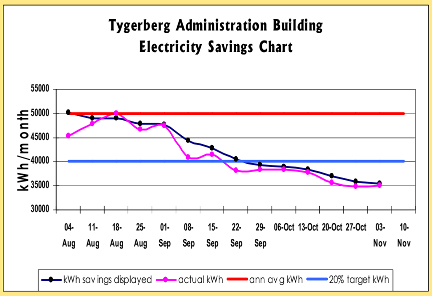
Lessons learned

The project reflected huge savings potential from the interventions used, shown by the project targets being easily met and a short payback period. This implied that the application of such interventions in other City of Cape Town buildings would likely be technically and financially feasible, save substantial amounts of money and reduce greenhouse gas emissions.

Tygerberg Administration building



Electricity use profile of the Tygerberg Administration building



It was difficult to determine a clear distinction between change attributed to technical interventions and staff awareness (behavioural change). This was due to change in staff behaviour already occurring on hearing about the project being performed in the building, well before the behavioural changes were requested.

Substantial support from external consultants was provided during project implementation. At the time of the project it was noted that internal city capacity was not adequate to undertake such initiatives in other City of Cape Town buildings.

6.7 Support organisations

Key roleplayers to support Energy Efficient Building Implementation

CSIR

Technical support

CSIR can offer support in the areas of research and technology (including testing), training and capacity building. Cities can engage with them as necessary.

CSIR is involved with a Green Building for Africa Programme working on green labelling of buildings. Cities should keep abreast with developments of this programme.

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Fax: 012 841 3504
Email: saparsons@csir.co.za
Christelle Beyers
CSIR – Housing
Tel: 012 841 2704/2566
Cell: 083 407 8433
Email: CBeyers@csir.co.za

Department of Housing (DoH)

Capacity building and policy development

DoH are busy finalizing a Framework for Environmental Efficiency in Housing in South Africa

Namso Baliso
Chief Town and Regional Planner: Human Settlement Policy and Integration
Tel: 012 421 1443
Cell: 082 333 0337
Email: Namso@housing.gov.za

Department of Minerals and Energy (DME)

Capacity building, policy development

DME is engaged in Building Energy Manager training support for government. This could potentially extend to cities.

Elsa du Toit
Director: Energy Efficiency
and Environment
Department of Minerals and Energy
Tel: 012 317 8216
Fax: 012 322 8570
Cell: 082 494 5133
Email: elsa.dutoit@dme.gov.za

Development Bank of Southern Africa (DBSA)

Debt Financing and a limited Technical Assistance grant facility

DBSA is able to support cities through offering a carbon finance facility in association with the World Bank.

DBSA will consider debt financing of commercially viable clean energy projects

DBSA also has a technical assistance facility that may support cities to finalise a component of their detailed clean energy feasibility study.

Kumesh Naidoo
Programme Manager
Tel: 011 313 3538
kumeshn@dbsa.org

Eskom

Financial assistance

Eskom Demand Side Management (DSM) provides financial support to energy efficiency projects.

Tsholo Matlala
DSM Energy service manager
Tel: 011 8006228
Fax: 011 800 5839
Cell: 084 578 5792
Email: tsholo.matlala@eskom.co.za
Website: www.eskom.co.za

National Energy Efficiency Agency (NEEA), a division of CEF (Pty) Ltd

Technical and financial assistance, as well as 'aggregated bulk procurement' opportunities from accredited suppliers.

NEEA is a division of CEF (Pty) Ltd and will initially oversee various components of the national (Eskom) Demand Side Management (DSM) and energy efficient projects in the country. These would typically include the retrofitting of public facilities (at a National, Provincial and Local government) level, general awareness creation and the formulation and recommendation of policy and regulatory tools required to meet the targets set in government's National Energy Efficiency Strategy for South Africa. NEEA will also look at a broader energy mix than electricity alone, in-