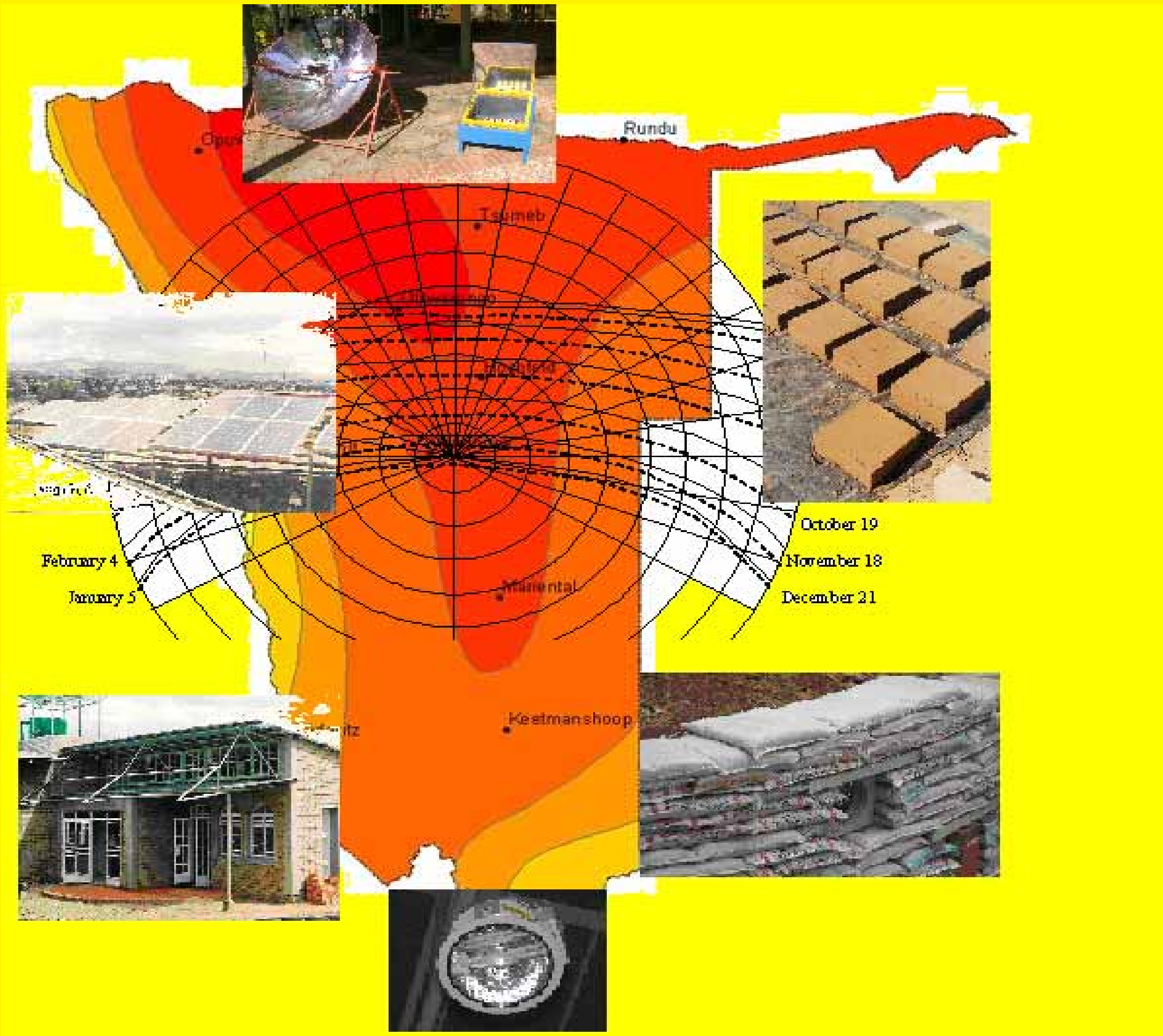
Guidelines For Building In An Energy Efficient Manner



Renewable Energy & Energy Efficiency Institute

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Guidelines For Building In An Energy Efficient Manner

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FOREWORD

The project aims to provide guidelines on how to incorporate EE and RE technologies and principles into housing designs. This will ensure that houses constructed in future by individuals, organisations and the GRN incorporate these EE principles. It is believed that the incorporation of these principles will ultimately contribute to the improvement of living standards and reduction of energy consumption by homeowners.

The Habitat Research and Development Centre was requested to compile this guide as part of the Renewable Energy and Energy Efficiency Capacity Building Project (REEECAP), which was funded by the Danish International Development Agency (DANIDA).

The objectives of this guideline document are:

- To develop a technical instruction guide focussing on energy efficient building methods and measures in the housing environment
- To empower persons in the housing sector to construct energy efficient houses
- To mainstream energy efficiency in the housing sector of Namibia

The HRDC is demonstrating and testing various energy efficient designs, materials and technologies. The Centre serves as an example for the utilisation of alternative designs and materials for energy efficiency. Therefore many of the proposals have already been utilised and experiences gained. Interested persons are encouraged to visit the HRDC to view issues discussed in this document.

The Commonwealth of Australia (2005) has pointed out that the Building Industry as a whole is directly and indirectly responsible for significant:

* Consumption of the earth's resources (especially energy),
* Generation of polluting toxins and waste,
* Creation of conditions leading to loss of soils and biodiversity, and
* Interference with life support systems (e.g. the water cycle, soil systems and air quality).

It is estimated that about 60% of all energy consumed on earth goes towards the manufacturing of building materials, the physical building of structures, their operation throughout their life-span and eventual demolishing and recycling.

In addition the guide also serves as an educational tool to inform individuals and groups about energy saving measures, especially in the light of projected increases in energy costs for the next five years. The suggestions made can be utilised for buildings in urban as well as rural areas. By raising awareness and providing solutions or ideas, the guide assists in providing information on choices that can be made by an individual or group, which can save households, offices or working places substantial expenditure on energy usage.




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INTRODUCTION

Namibia is the most arid country south of the Sahara. This means that solar energy is one of the most abundant resources available. Grid electricity is becoming more expensive and power blackouts in the Southern African region are now a common occurance and bound to continue in the future. It is therefore necessary to reduce energy consumption and to find additional renewable energy sources. There are numerous ways of utilising this energy, from active interventions to passive benefits. Energy efficient buildings are more comfortable to work and to live in and have lower running and maintenance costs.

The easiest way to achieve the objective of energy efficiency is when a new building is planned. If existing structures are to be refurbished, the costs of such an exercise are usually higher than planning correctly from the start. However, there are opportunities to improve such buildings. This requires careful planning and an awareness of possible solutions.

This building guide will describe ways of using the sun's energy throughout the year. It is useful for existing buildings and those who are planning to build a new house or office. The guide offers theoretical as well as practical proposals, to illustrate what and how energy efficiency can be incorporated in buildings. Therefore the guide is a resource for alternative ideas and practices, which aim at saving energy and as a consequence, money. It is not a technical design document, but aims to inform the reader on the concepts of energy efficiency (EE) principles and their application during the planning and construction of residential buildings.

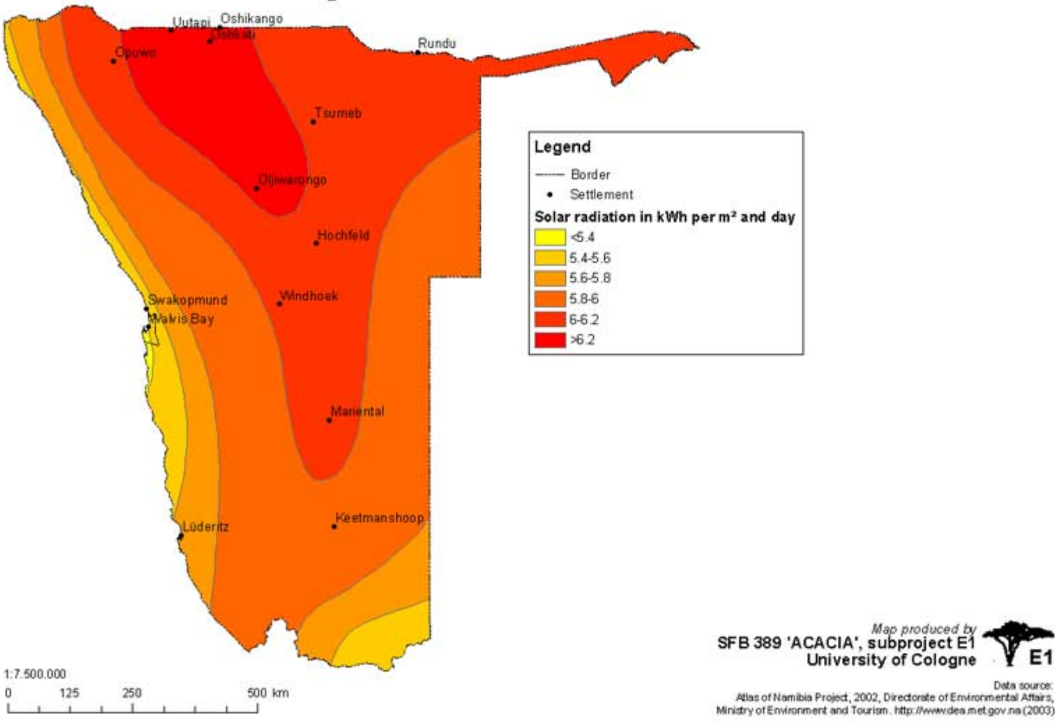
FORMS OF ENERGY

Solar

Namibia is a country with high values of solar radiation. About 300 sunny days per annum are experienced. It is therefore ideal to utilise solar radiation, which can be done by selecting solar hot water geysers, PV panels, and passive solar design.

The diagram below illustrates the average values for solar radiation in kWh per m². Solar radiation is lowest along the coast at up to 5.2 kWh per m². Frequent cloud and fog cover accounts for the low radiation levels. Solar radiation gradually increases inland along the coastal plain to about 5.8 kWh per m². The highest total radiation values are recorded on the plateau in central northern Namibia with values of between 6.2 and 6.4 kWh per m² as a result of the high sun elevations. The southern parts have lower values due to lower sun elevations on average, while in the north eastern regions more cloud cover accounts for the lower radiation levels.

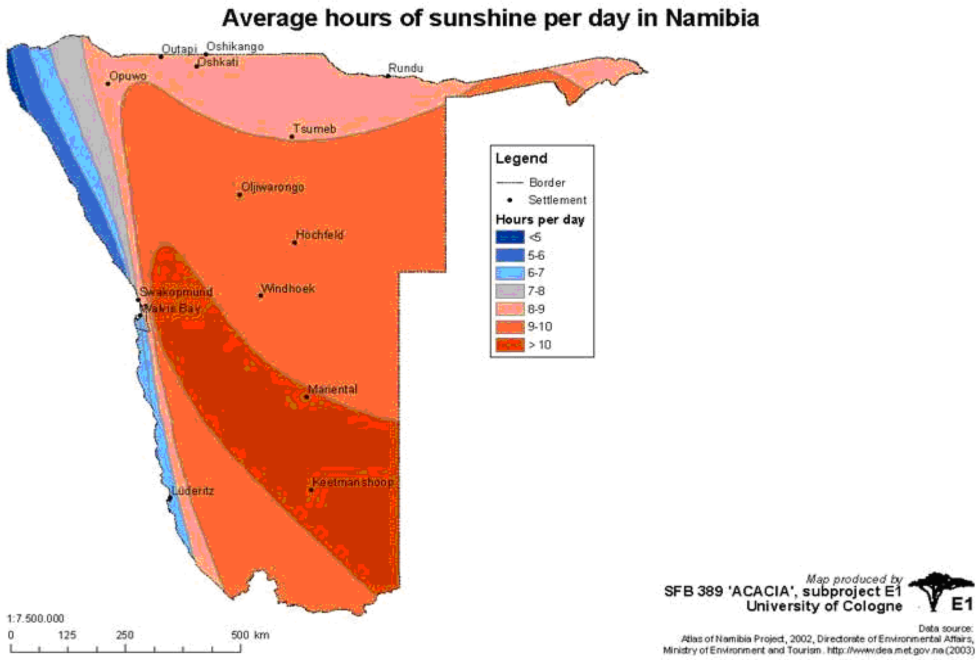
Average values of solar radiation in Namibia



Sunshine hours

Namibia enjoys sunny days throughout the year. Sunshine determines the amount of radiation that reaches the earth's surface. The map below illustrates the number of hours of sunshine per day. Sunshine hours are lowest along the coast – up to 5 hours - due to fog and cloud cover. The number of hours increases as one proceeds eastwards inland with a zone stretching from the central Namib desert south-eastwards enjoying between 10 and 11 hours of sunshine per day. The central and northern parts of the country enjoy less sunshine hours (between 8 and 10 hours) due to cloud-cover during the summer months.

The aridity is the result of many cloudless days, therefore Namibia has high solar radiation levels.



Embodied energy in building materials

Two types of energy are embodied in the physical structure of a building: initial and recurring embodied energy. The first refers to energy used in the construction of buildings and the manufacturing of materials, including the extraction of raw materials and their processing. It also refers to the transport of materials and components from the factory to the building site. The energy used is non-renewable. The second refers to energy required to repair, replace, and refurbish components or parts of a building; in other words, the maintenance aspect of a building.

There are wide ranging differences with regard to embodied energy, as for example used in the production of building materials. Aluminium is among the most energy intensive materials in its production. Similarly, other widely used energy intensive building materials are cement and steel. Alternative materials, such as clay (adobe), do not require any energy inputs. To reduce the content of embodied energy, choices between materials to be used can be made. Some examples (see Commonwealth of Australia. 2005):

Material	Per embodied energy MJ/kg	Material	Per embodied energy MJ/kg
PVC	80.0	Copper	100.0
Cement	5.6	Glass	12.7
Galvanised steel	38.0	Concrete blocks	1.5
Aluminium	170.0	Stabilised earth	0.7
Hardboard	24.2	Acrylic paint	61.5
In situ concrete	1.9	Synthetic rubber	110.0
Glue-laminated timber	11.0	Plywood	10.4

The choice of building materials in construction determines the embodied energy of a building. Energy saving and energy consciousness generally, in building construction, also requires proper planning. It is obvious from the materials listed above that in order to save energy and therefore reduce the amount of embodied energy of a building one would have to avoid the use of some high embodied energy materials like aluminium. For example, concrete blocks could be substituted with stabilised earth blocks where structural requirements permit.

Renewable energy

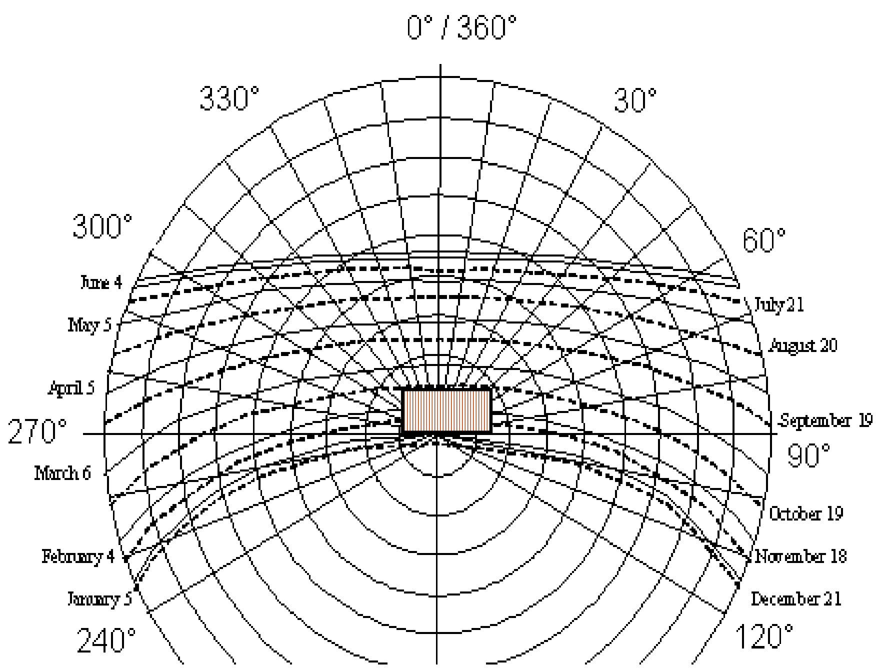
Several forms of energy are regarded as renewable. They include solar, biogas, biomass,bio-oil, wind and hydro. In Namibia the most abundant form of renewable energy is solar energy, which can be utilised to heat water or to generate electricity (see *SOLAR ENERGY*).

PASSIVE SOLAR DESIGN

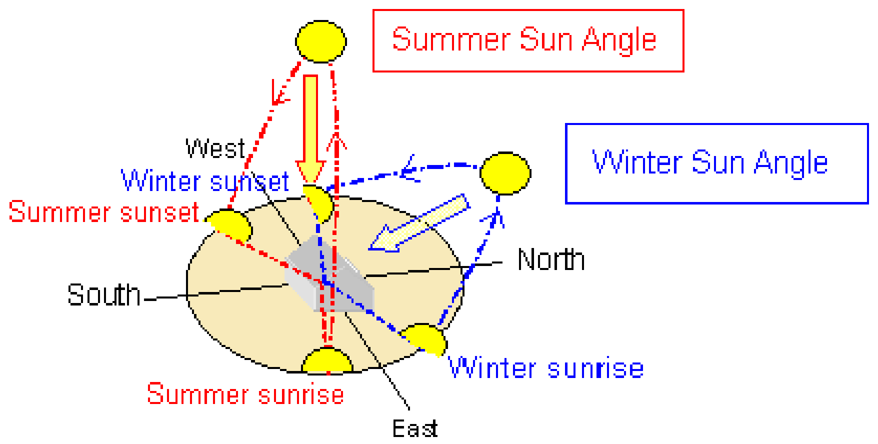
Utilising solar energy without the use of any mechanical equipment is called passive solar design. The aim is to make a building more comfortable, by reducing heating and cooling, and to eliminate contributions to climate change. A building's envelope (walls, roofs, windows, floors and doors) determines how much heat is gained in summer and how much heat is lost during winter. This is of importance in a country with large temperature differences between day and night time, such as Namibia.

Orientation of buildings

The orientation of a building is of utmost importance if solar passive design is considered. Most building sites are not oriented in a north-south direction. Any deviation from the north-south direction reduces the effects of passive design of a building. The longest side of a building with most windows should be facing north. In Namibia during the winter months; due to the low angle of the sun; the northern face of a correctly oriented building should receive adequate solar energy. In summer when the sun's angle is higher, the sun does not shine directly on the northern side, thus the interior of the house is cooler. This is illustrated below:



Path of the sun throughout the year



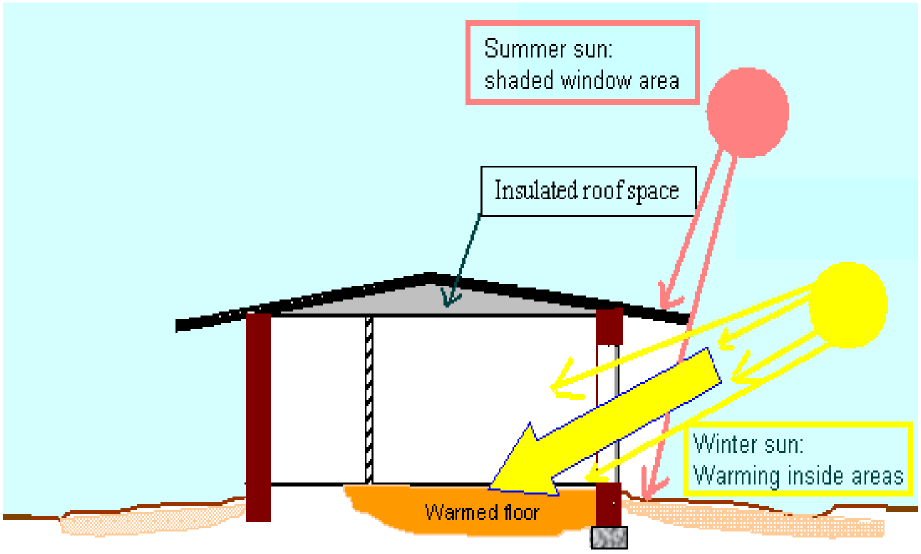
Path of the sun and highest position at noon during summer and winter (not to scale)

It is recommended that a building's long side should be oriented in an East-West direction, and the shorter side of the building should face North-South (see also *Principles of passive solar design*).

The main problem occurs around October when the sun's warmth is becoming more intense, and in May with the onset of winter. Some of the heat can still be transferred into a building if no shades are provided. If shades are fixed, it will keep out the sun in winter and the rooms will become very cold without artificial heating.

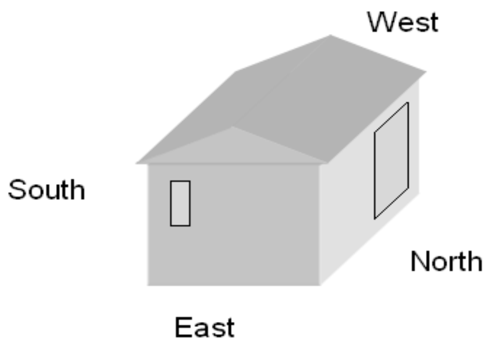
Principles of passive solar design

In the design of a building, which incorporates solar passive principles, the use of dense building materials is crucial, as they have the ability to store heat, for example in the floor and walls (see BUILDING MATERIALS). These components then heat the ambient air during the night. Short wave radiation can pass through glass and is absorbed by dense materials, such as walls and floors. This thermal mass can be concrete, clay, stabilised soil blocks or stone.



Principles of passive solar heating

Large windows enable the sun's energy in the form of heat to be stored in the floor and walls so that during the night, the warmth is radiated back into the room. Thick outside walls, built with materials that take a long time to warm up, also enhance the indoor climate. Permanent shading in front of the windows/doors may obstruct the sunlight in winter. An example is shown below with a large window on the northern side of the building:



Orientation of windows

Bathrooms, kitchens and store rooms should be located on the southern side of a building, whereas the bedrooms and living areas should be on the northern side.

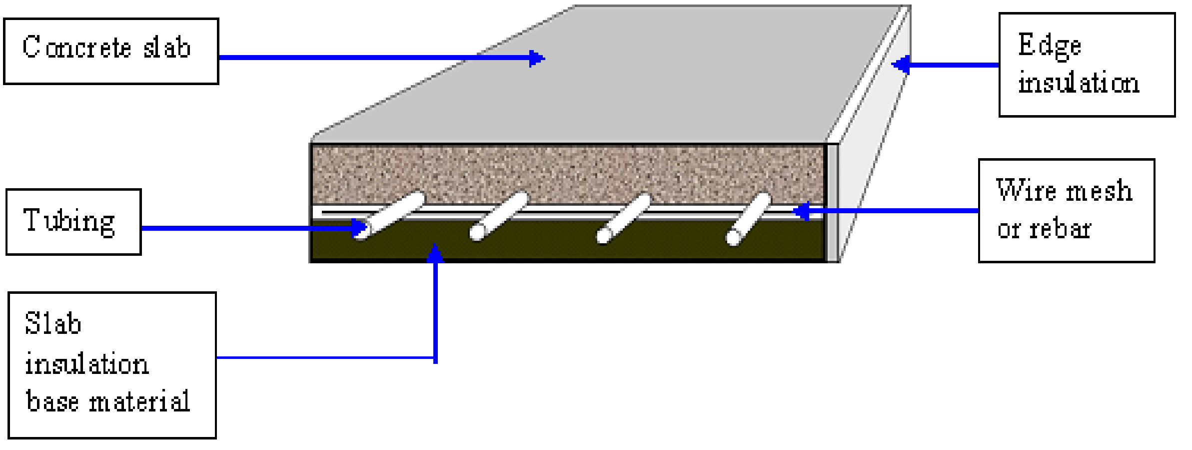
UTILISING SOLAR HEATING AND COOLING

When solar heating and cooling are considered for a building, two aspects need attention. The first is part of the planning and the design, the second refers to physical components of a building. A bad design is difficult to change after a building is completed. Therefore, the principles of both heating and cooling require deliberation.

Solar floor heating

Heating floor areas with the help of technology and the sun, guarantees a constant temperature of, for example, 23° C throughout the winter. This requires an initial investment in specialised technologies, such as solar collectors, a storage tank with a heat exchanger, and a distribution system consisting of pipes and a pump. The latter serves to circulate warm water through the pipes embedded in the floor.

Each room can have its own circuit and all circuits are connected to a distribution manifold, which is connected to a water storage tank. Each room can also have its own circuit. To apply individual room temperature control, a thermostat can be fitted in each room, which is connected to a valve on the circuit serving that particular room.



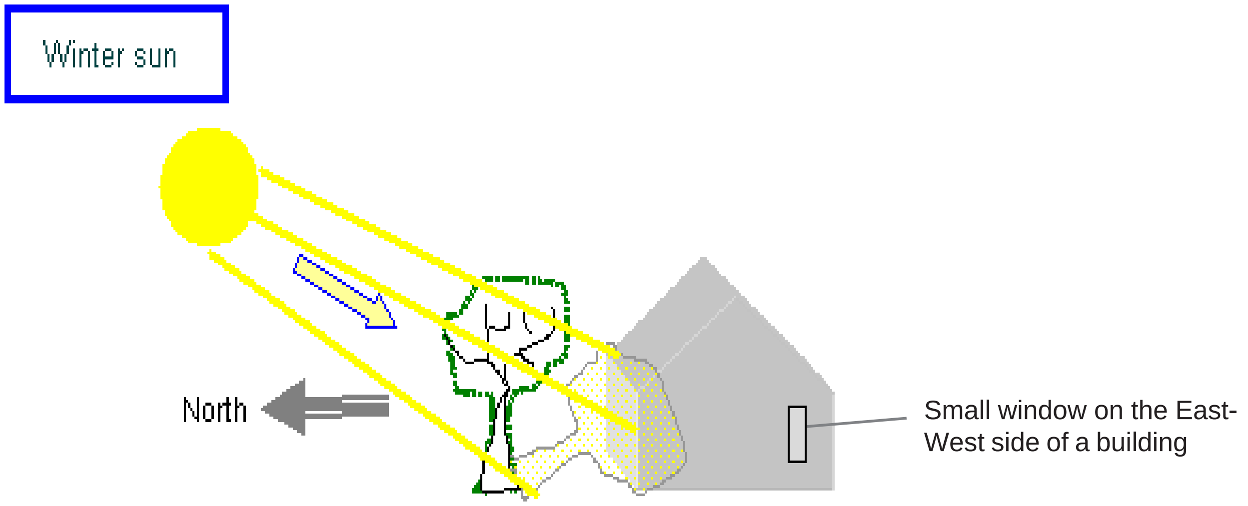
Section of floor of a solar floor heating system

The installation of solar floor heating systems should be done by a qualified artisan in order to ensure that the system works without problems.

The water tank and floor heating connections for a residence at the Harmony Centre, Aris

Passive solar heating

Another method to take advantage of the sun's energy is by passive solar heating, especially during winter. Passive solar heating entails keeping the summer sun out while letting in the winter sun. Certain cost effective design aspects including northerly orientation of window areas, thermal mass to store heat, insulation, draft sealing, have to be taken into consideration to ensure effectiveness. In addition, large windows should be on the northern side to let the sun's heat into the building. It is recommended that small windows are placed on the East-West side of a building.



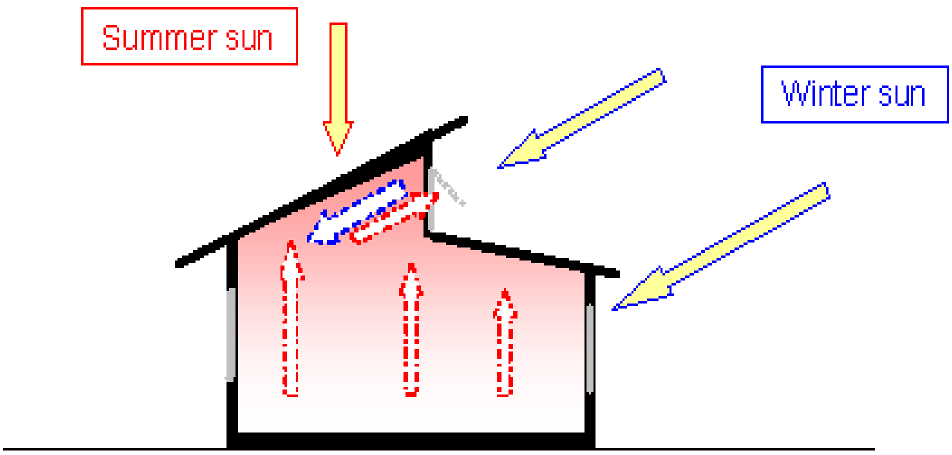
Deciduous trees enable the warming of a building in winter

If trees are planted, it is necessary to have trees that shed leaves in autumn. Sunlight can then penetrate the rooms, which are shielded from the sun in summer (see Principles of solar passive design).

Cooling

When designing and constructing a building incorporating the passive cooling technique, the focus is on the envelope of the building. In addition consideration has to be given to available natural cooling sources, and adapting one's life-style. The envelope is crucial in achieving cooling without unnecessary cost, i.e. the insulation properties of the various elements of the building and the materials used.

The design of a building can also help to reduce the heat inside rooms in summer. By including windows under the roof (see *Figure below*), heat can escape during summer and during the winter, if the building is positioned correctly, the sun's warmth can enter the room. In addition, natural light can reduce the need for artificial lighting.



Design to maximise comfort levels inside a building

Roof insulation

Insulating the roof is one of the most important factors in cooling a building. Most of the heat in summer is radiated through the roof, whereas in winter warmth is lost through a non-insulated roof. Air tightness of the roof is therefore important in reducing the loss of warmth in winter and minimizing heat gain in summer.

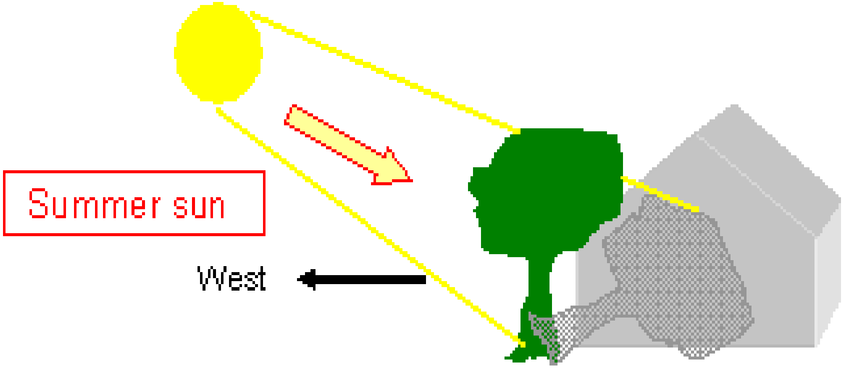
To insulate a roof various means are available. The roof space can be filled with glasswool or shredded paper. The HRDC has used old cardboard boxes, which were flattened and placed in the space between the ceiling and roof sheets. Another method is sheep wool put into old plastic bags, with some lavender to keep insects out.

Insulating walls and roofs

Special foils can be placed on purlins before the roof sheets are fastened. They form a barrier between the inside and the outside of the roof space. Special reflective paint on the outer surface of the roof sheeting can also reduce the interior temperatures.

Shading

Shading is a natural way to cool a building during summer time. Various possibilities can be considered, such as pergolas, roof overhangs, awnings or louvres, creepers and trees. Trees that shed leaves during winter are most suitable if they are planted in such a way that they shade the walls of a building. In summer the leafy trees will protect the walls from direct heat gain and keep the inside cool. The trees should be indigenous trees, in order to save water.



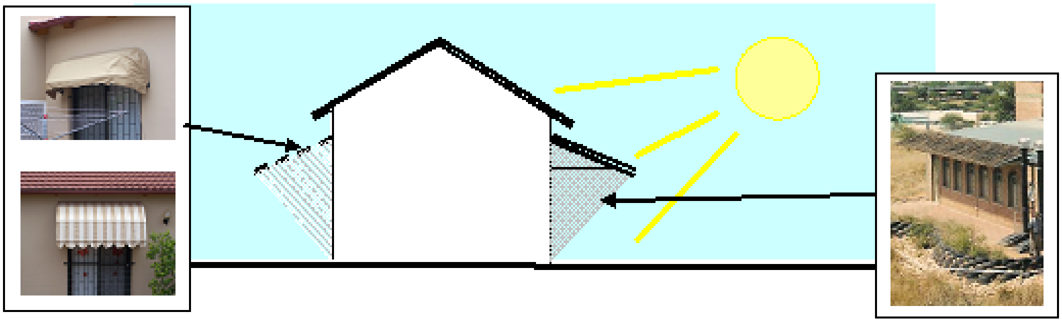
The shade of trees cools a building in summer

Windows

Windows are another factor of heat gain or loss. The orientation of a building (see *Orientation*) and its windows plays a major role in the heating up of an internal space. Glass can be fitted with a special coating, which reflects light and heat. In this way the transmission of solar heat is reduced.

If windows are used to reduce heat gain during the hot season, the warming up of internal space is also reduced in the cold season. Therefore, in case of a passive solar design, the northern side of a building should not be fitted with windows that reduce heat gain.

Heat gain through windows can also be reduced if external shading is installed. This can be in the form of fixed installations or shades that can be retracted, such as an awning blind or roller shutter. Heat build up in the outside areas, e.g. the garden, can be reduced if plants and natural surfaces are used. Paving will absorb heat and re-radiate it to the surroundings.



Retractable shading

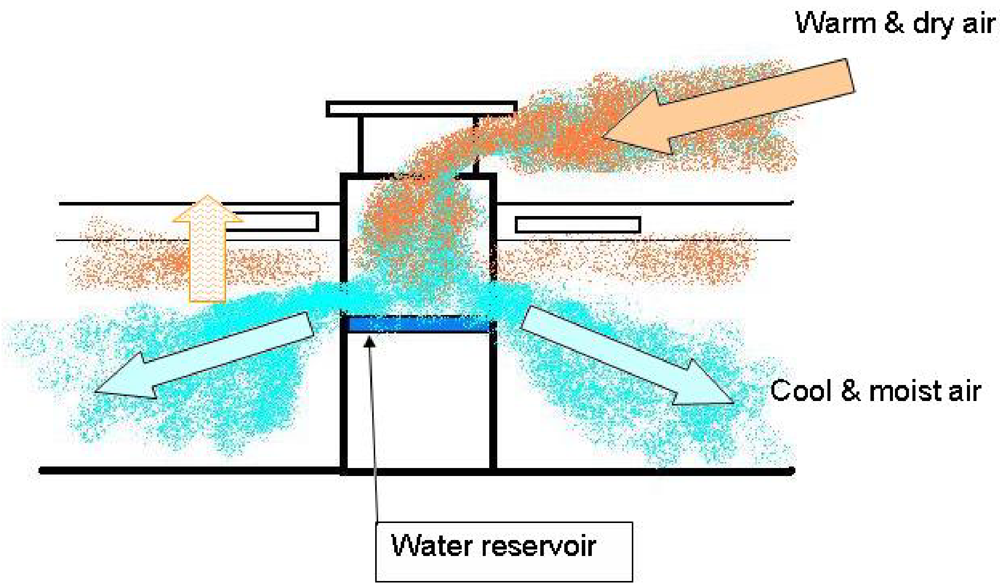
Fixed shading

Shading techniques

Wind towers

In hot and dry climates wind towers are a simple technology to cool the inside of buildings. Utilising natural processes, such as evaporation and wind, cooling is achieved by channelling wind into a tower, where water cools down the air and moistens it. This heavy air then flows into the rooms, replacing the warm air of a room, which can escape, for example, through windows or roof ventilation.

The principles are as follows (as demonstrated at the HRDC):



Operations of a wind tower

Sky lights

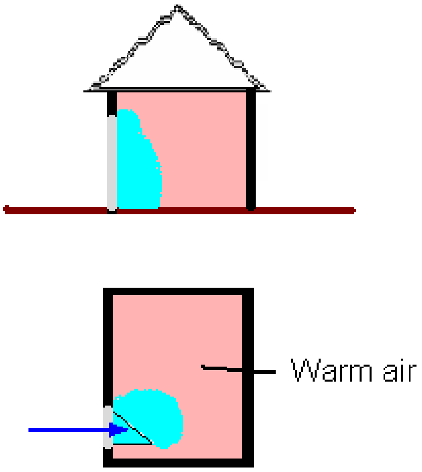
Existing roofs can be modified by installing a sky light. Natural day light is provided to a room, whereas heat can escape to prevent the warming up of a room during summer. Some skylights can be covered to avoid the transmission of solar heat into a room.



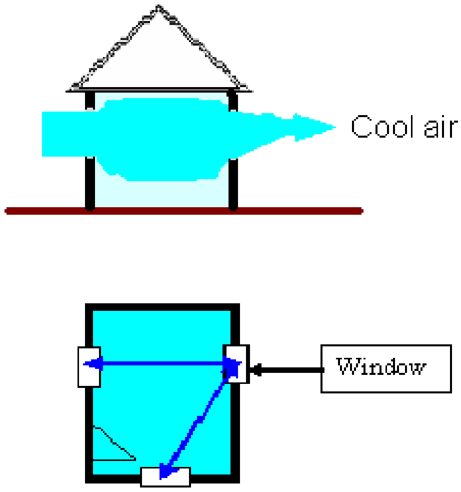
Skylight on a flat roof, a solar tube and a skylight for a sloping roof (Source: VELUX)

Ventilation

One simple way of cooling a space is by cross-ventilation as this encourages the movement of air. Care has to be taken to ensure that ventilation in summer does not increase air leakage and heat loss in winter (see also *Windows*).

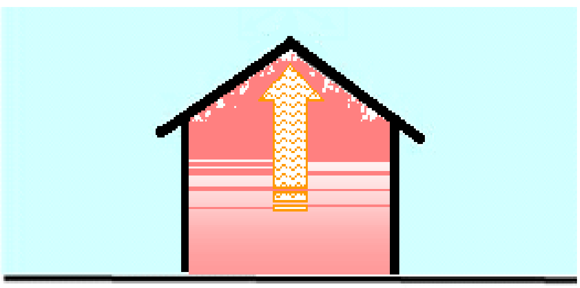


No ventilation

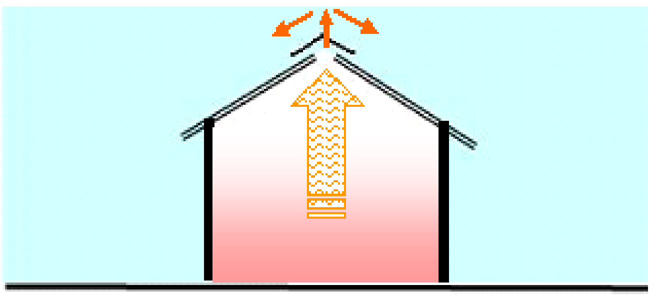


Cross ventilation

In hot arid areas ventilation under the roof is an effective way of reducing the inside temperatures. Warm air rises and stays, for example under a ceiling, if no escape is provided for. Therefore roofs can be built in such a way that at the highest point, roof ventilation is provided for, by constructing a high and sloping ceiling (see also *Cooling*).



No roof ventilation



Roof ventilation

Passive Roof ventilation at HRDC.

Passive Ventilation Industrial Product

If new buildings are designed, the following window design can be incorporated to provide a flow of air through a room and to enable warm air to escape (see also *Cooling*):

Clerestory windows for ventilation and light

BUILDING MATERIALS

Construction methods and building materials can influence long-term energy usage and the interior climate of a building. The durability, life cycle costs and energy consumption needed for maintenance, possible transportation of components or materials, the recycling potential at the end of a life cycle, and the environmental impact, determine the energy used. The cheapest materials, from an energy point of view, are those which are locally sourced and available, as they do not require long distances to transport. In other words these have low embodied energy and therefore their impact on the environment is minimal.

Industrial

Industrial materials usually require heavy investment in energy. The route from mining to processing to the finished product is energy intensive. Various machines and equipment are used in the mines, the ore is then transported for further processing, after which it is again shipped to factories, and then to warehouses and to retailers. Transport costs add to the price consumers have to pay. Examples include steel imported from South Africa, burned clay brick manufactured in Kombat and Mariental, or ready mixed concrete in Windhoek. Industrial products contribute significantly to the problem of pollution and global warming.



One way to reduce several of the problems is to use what is locally available. This requires an investigation into local resources. The latter refers to building materials and human resources, such as builders, artisans or artists.

Natural

Natural building materials often only use the energy from the sun, for example thatch requires sunlight to grow, or clay blocks use the sun's warmth for curing. Stone does not require any energy, except if transport is required or cement mortar is used during the construction. Sometimes different types of materials can be combined, for example in the case of soil cement blocks, where soil and cement are mixed.

Clay, straw bales, reed and stone

Walls can be built with non-conventional building materials for example sand bags, rammed earth, gabions filled with building rubble or stone, or natural stone (see above). It is necessary that the bottom of the trench is compact and level. The sides have to be plumb to provide for a solid foundation.

Rammed earth foundation and clay wall construction

Once the foundations have been completed, the construction of foundation walls and walls can proceed, similar to conventional building methods. The difference is the materials, for example adobe (sun dried clay blocks) and clay mortar.

Suitable material consists of about 65% sand, 20% clay, and 15% silt. The suitability of material can be tested as follows:

- Take some moistened soil and compress it in the hand.
- drop the lump on the floor from a height of about one meter.

If the lump breaks up into a few pieces, then the material can be used for construction. If the lump breaks up and scatters into many small pieces, more clay needs to be added.

Good quality clay does not require any additions. However, if the material needs reinforcement straw or grass can be used. Reinforced clay balls formed by hand are then used to build the walls by twisting them to form a solid mass.

Clay blocks several can be produced either from moulds made of wood or steel, or from ice cream containers.

Building a wall with clay follows the same rules as any conventional construction.

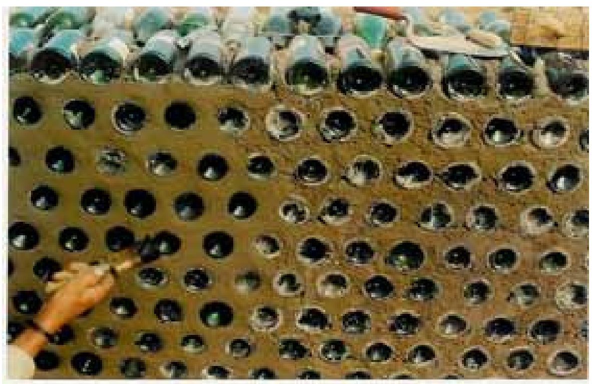
Once the wall is completed, chicken mesh is fastened to the walls. The wall can then be plastered.

In regions with a lot of sand, sand bags offer an opportunity to build houses. Plastic bags are used, which are filled with local soil and stacked as shown below:

Soil-cement blocks can also be produced using the so-called hydraform machine to produce the blocks. Around 75% of Namibian soils can be utilised. Cement or lime can be added to ensure the required strength of the blocks. At the HRDC, blocks with a cement content of 4-8% were manufactured, thereby savings on cement usage were achieved. These blocks do not require mortar in between, except for the first layer to obtain a level surface. This constitutes another saving. However, they have to be cured for a week to ensure that these stabilised blocks are of good quality before they are used in construction.

Manufacturing, curing, and construction with stabilised soil blocks

Recycling and reuse
Many industrial products can be recycled such as glass, steel components, building rubble, and old tyres.



Alternative wall construction materials (building rubble in gabions, tyres, bottles)



Recycled construction elements (steel pieces, broken tiles, second hand windows)

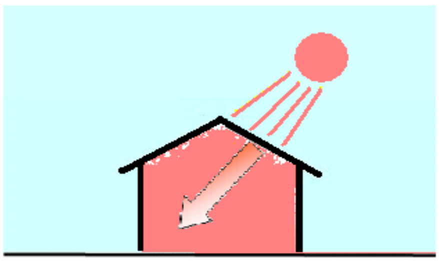
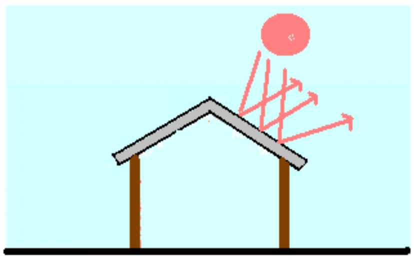
The local soil may be used for the filling of tyre walls as shown below, by ramming the materials into the tyres. The material is compacted in this process, which provides the necessary strength of the wall. The construction follows the same principles as those for a conventional wall.

Tyre wall construction

Insulating roofs

Roofs can contribute to the warming or cooling of inside spaces (see also *Roof insulation*). The material used could be an industrial product such as glass wool or it can be recycled materials, for example old cardboard boxes, fiberglass, polystyrene board or packing, silver foil or bubble foil, cellulose fibre, and shredded paper. Plastic bags filled with sheep wool were used at the HRDC, as shown below:


Ceiling made from reed, old plastic bags and wool filling

An insulated roof does not transmit the sun's heat into the interior of a building

SOLAR ENERGY

Cooking

Cooking always requires energy. According to the 2001 census, energy sources for cooking were dominated by wood in 64% of all Namibian households. About 25% used electricity, ten percent used paraffin or gas, and less than 0.2 percent undertook solar cooking.

Two types of solar cookers are available: the box cooker and the parabolic mirror. In the first case, food can be baked or cooked without any fear of burning. The second concentrates the sun's light at one point, which results in very high temperatures. Here care must be taken not to cook for too long as food can easily burn. Looking into the centre of the mirror must be avoided as the concentrated light can injure the eyes.

Solar cookers (parabolic and box cooker)

Water heating

Various types of hot water geysers are available in Namibia for domestic and industrial use, whether on flat or sloping roofs. The majority at present are flat plate systems that collect the sun's radiant heat. They consist of an insulated tank and solar thermal collectors. Fluid is circulated through in the tubes of the collector. This exchanges the heat from the absorber and transports it to the water tank.

Indirect Solar Water Heater Systems with heat collector.

Another system has entered the market, consisting of a series of modular transparent tubes, or rows of parallel transparent glass tubes. Inside the tubes are absorber tubes, where a fluid or gas is heated. This heat is then transferred to the water tank. These evacuated tube systems are lighter than the flat plate systems. However, the tubes are much more fragile than the flat plate. All systems should be installed by qualified companies.

Direct Heat Exchange via Vacuum Pipes

Electricity generation from the sun

Photo Voltaic (PV) panels generate electricity from the sun by converting direct sunlight into energy. These systems do not have moving parts and as a result require minimal maintenance. The electricity is generated with no emissions and no noise. Multiple cells make up a PV panel. They consist of two or more thin layers of semi-conducting material, such as silicon. When the cell is receiving sunlight, an electrical charge is generated. There are four types of of these cells namely: 1. mono crystalline, 2. polycristalline, 3. thin film, and 4. armophous.

IMPORTANT:
The panels should be oriented towards the **NORTH** and tilted to generate electricity efficiently.

Photo-voltaic (PV) panels

Solar PV modules

Stand-alone systems require batteries to store the energy generated. This enables households to utilise electricity after sun set. The batteries need cool surroundings to extend their life-span to the maximum. Suppliers should be requested to provide information on how to store the batteries.

Another possibility is wind energy, which can be converted into electricity. The higher the mast on which a turbine is mounted, the higher the effectiveness of the system, as more energy is generated due to the higher wind speeds at a higher altitude. This energy is stored in batteries to ensure that electricity is available whenever needed.

SAVING ENERGY

The cheapest and easiest way of saving energy is not to use it or using reducing consumption. Passive solar design is one option. Another includes skylights or clerestory windows to maximise the use of daylight and distribute the light in a room (see *Skylights*). One possibility of saving energy, is replacing energy intensive appliances and light bulbs. Fluorescent bulbs save up to 85% of energy consumed by an equivalent incadescent bulb for the same amount of light. Although they are slightly more expensive than the “regular” bulbs, the money saved on electricity consumption is more than the extra costs paid over the life time of a compact fluorescent bulb.

Footnote:
The Namibia Renewable Energy Programme (NAMREP) is responsible for compiling a Namibian code of practice including quality standards for solar technologies.



Electrical appliances and equipment should be compared to determine the amount of energy they consume. Below is a list of the most commonly used appliances in the home with their electricity consumption loads, average hours used per day and the approximate electricity consumption costs per month at current Windhoek prepaid meter electricity prices. The last column is a projection of monthly costs at a constant electricity price increment at 10% per annum over 5 years.

Appliance	Electricity Demand (w)	Hours used per day	Monthly Cost (N$)	10% price increase over 5 years(N$)
Geyser	2 500	5	285.00	427.50
Heater	1 600	4	145.92	218.88
Two plate cooker	2 000	2	91.20	136.80
Oven	2 500	1	57.00	85.80
Fridge	300	3	20.52	30.78
Kettle	2 200	0.5	25.08	37.62
Incadecent bulb (x3)	60	6	24.62	36.94
Iron	1 000	0.5	11.40	17.10
T. V. (colour)	80	4	7.30	10.94
Radio	6	4	0.55	0.82
Fluorecent bulb (x3)	15	6	6.16	9.23
sewing machine	100	3	6.84	10.26

Over the five year period, the running cost of the appliances would on average increase by about 33%.

However, the costing of appliances used in the home does not consists only of purchase and operation costs. An appliance costs have to be considered for its operational life - what is termed life cycle costing ."Life Cycle Costing is a process to determine the sum of all the costs associated with an asset or part thereof, including acquisition, installation, operation, maintenance, refurbishment and disposal costs" (GAMC, no date). Below are estimated lifecycle costs of common appliances used in the home. The costs include the cost of electricity connection, appliance costs, appliance replacement costs, and energy costs at current prices. The lfecycle cost is calculated for a period of five years.

Appliance	Electricity Demand (w)	Hours used per day	Monthly Cost (N$)	Estimated Lifecycle cost over 5 years(N$)
Geyser	2 500	5	285.00	22 608.73
Heater	1 600	4	145.92	12 274.20
Two plate cooker	2 000	2	91.20	8 941.95
Fridge	300	3	20.52	7 330.20
Kettle	2 200	0.5	25.08	5 019.75
Iron	1 000	0.5	11.40	4263.90
T. V. (colour)	80	4	7.30	6 617.00
Fluorecent bulb	15	6	6.16	3 711.16

FEATURES OF AN ENERGY EFFICIENT BUILDING:

1. Planned and designed in terms of energy efficiency principles before construction
2. Is located in a properly designed neighbourhood that facilitates the sustainable use of resources and close to amenities and services
3. Doubles as a working environment to reduce transport and additional office buildings
4. Is just large enough to satisfy demand and built with materials with minimum embodied energy
5. Has multi-functional open plan spaces to reduce circulation area and walling structures.
6. Is designed to maximise the advantages of correct orientation first, prevailing wind directions second and lastly aesthetic natural views.
7. Is an elongated building oriented to the north, with the long sides facing North / South and the short sides facing East / West
8. Has its service rooms on the East / West sides to act as a buffer against the warm afternoon sun
9. Has large windows/ openings on the northern side with small vertical ones on the east and western sides
10. Has shading over windows / openings to keep out direct summer sun
11. Has windows that allow for cross ventilation for cooling
12. Has security doors and burglar bars over windows to allow ventilation during the evenings
13. Has windows of the correct size and ideally placed to maximise natural light and restrict the use of artificial light during day time
14. Has high and sloping ceilings with roof opening to allow hot air to escape
15. Has thick outside walls constructed out of heavy natural materials with long heat transfer periods
16. Uses well insulated and / or reflective roof materials that prevent heat transfer to the inside of the house
17. Has floors constructed of high thermal mass materials in order to collect heat from the winter sun and releasing it slowly thus heating the house at night
18. Is painted in light colours internally and externally; internally to maximise light, externally to reflect heat
19. Has water saving indigenous trees planted on the western side to shade the building from the afternoon sun
20. Has a biogas digester to recycle human and other organic waste to produce (methane) gas for cooking, fertiliser and water for gardening
21. Is fenced rather than walled in order to permit the circulation of cooling breezes
22. Has outside security lights shining downward and controlled by motion sensors to reduce electricity consumption
23. Uses Energy Efficient / low energy rated / low emission appliances, light fittings and bulbs
24. Has a solar water heater to supply the kitchen, bathroom and laundry
25. Uses solar cookers and liquid petroleum gas or biogas stove
26. Has a vegetable and fruit garden fertilised and watered with effluent from a biodigester

Adapted from: Nina Maritz. 2008. Energy Efficiency Guidelines For Namibian Home Builders

BASIC CHECKLIST FOR BUILDERS AND HOMEOWNERS

The recommendations for EE building apply to areas in the southern hemisphere with the following climatic features:

- Low rainfall and low humidity
- Cool to cold winter months
- Hot to very hot summer months
- Significant day / night temperature range

Orientation

The longest side of the building with most windows should face north in order to take advantage of the winter sun.

Layout

The living areas should be located on the northern side with north facing windows so as to capture the winter sun. Bedrooms and bathrooms should be located on the southern side. Arrange spaces to promote the easy penetration of light and air circulation.

Insulation

Add insulation to roof and ceiling in order to slow down heat loss in winter and heat gain in summer.

Windows

Design the house such that north facing windows let through maximum sun energy in winter. Avoid window areas on the east and west sides. Use small glass areas on the south side of the house.

Shading

The most effective way to keep summer heat out of the house is to use adequate external shading including vegetation. North facing windows can be easily shaded with fixed shading devices, such as an eaves overhang, horizontal shade or awning, and pergolas. These shading devices must be designed so that they allow sun entry in winter and totally shade the windows in summer.

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VELUX. http://www.velux.com/

ANNEXURE 1:

Accredited Solar Technicians for the Supply and Installation of Solar Systems

Source: http://www.mme.gov.na/energy/renewable.htm (March 2008)

NAME	ORGANISATION	Tel. (t) – Fax (f)	Postal Address (P.O. Box)
1. Amukwaya Tomas	Super Sun Tec Electronic cc	081 246 1939	2337 Windhoek
2. Awene Albert	NEC Technology cc	081 122 1711 / 065 - 224363	903 Ondangwa
3. Epafras Nambinga		081 281 8091 / 065 - 230007	15300 Oshakati
4. Ferdinand Tunjendapi	Tuyendapi Solar Solutions cc	081 297 9924 / 061 - 253550	25096 Windhoek
5. Hailume Polly	Energy Solutions cc	081 272 5776 / 065 - 260038 (f)	501 Oshikango
6. Helmuth Beukes	HGB Electric cc	081 209 1378 / 062 - 524429	61698 Katutura
7. Josty Lubinda		081 206 1280 / 066 - 253711 (t) 254700 (f)	258 Katima Mulilo
8. K. Epafras	Northern Solar Energy Systems cc	081 297 2927 / 065 - 2236026 (t) 2236045 (f)	Private Bag 5543 Oshakati
9. Kauaria Tjaa J	Omaheke Electronic	081 253 6188	94 Gobabis
10. Kachab Richard	OTT Solar Energy	081 242 2826 / 067 - 302413 (t) 303757 (f)	29 Otjiwarongo
11. Kuutondokwa Vitalis	Vitalis Electronics cc	081 239 9622 / 065 - 221300 (f)	898 Oshakati
12. Kwayo Willem	W Kweyo Electrical	081 129 0291 / 065 - 220229 (t) 222688 (f)	2759 Oshakati
13. Letisia Shikokola	JLT Solar Electronics	081 289 3208 / 065 - 220688(t) 220687 (f)	15378 Oshakati
14. Martin Goagoseb	Jackson Solar Energy	081 129 6337 / 061 - 272357	50361 Katutura
15. Mateus U Nyambali	MU Nyambali Electro cc	081 243 2192 / 065 - 245882	2333 Ondangwa
16. Muroko Mesag	Okakarara Electro tech	081 246 9943 / 067 - 317069 (t) 317227 (f)	Private Bag 2112 Okakarara
17. Nailika Nangungo	Omaruru Solar Energy services	081 271 1539 / 067 - 222568	248 Omaruru
18. Ngalolo Johannes	Sun Energy Enterprises cc	081 257 6633 / 065 - 221300 (f)	Private Bag 644 Oshakati
19. Ngupahua Williams	Speedy Solar Solutions	081 071 4406 / 061 - 22303003 (f)	80955 Katutura
20. Peter Kalimba	Kalimba Home Power	081 279 3436 / 065 - 224063 (f)	1784 Oshakati
21. Petrus Hamutenya	JPP Electrical	081 278 2521	284 Swakopmund
22. Sackarias N Namadhila	La-Vida Solar Outlet	081 256 5008 / 061 - 225648 (t) 229961 (f)	96774 Windhoek
23. Sakaria Leonard	Solar Plus Renewable Energy cc	081 280 9497 / 081 280 9497	449 Oshikango
24. Sean van den Heever	Jade Electrical Systems Technology	081 122 0740 / 061 - 301371	6584 Ausspannplatz
25. Shiyayagaya Abisai	Forever Electrical	081 124 6969 / 065 - 222012	2674 Oshakati
26. SisamU Francis	Zambezi Renewable Energy cc	081 275 2204 / 066 - 254111 (f) 252526 (t)	2638 Ngweze, Katima Mulilo
27. Siyamo Blasius	HOFWA Tech cc	081 317 0920 / 066 - 267370 (t) 267371 (f)	215 Rundu
28. Tjamburo Prescott	Future Solar Power	081 128 7168 / 061 - 222649	8987 Bachbrecht
29. Torras Shigwedha	DRWS	081 257 6774 / 065 - 251901	Private Bag 527 Ombalantu
30. Victor Shanduka	Shaddy Electrical Works	081 124 3868 / 065 - 224560	2086 Oshakati
31. Ukaurua Kangumine - Kavendjaa		081 357 0950	61609 Katutura
32. J. Tjitoropa		081 318 5713	72 Opuwo

ANNEXURE 2:

Accredited Solar Companies for the Supply and Installation of Solar Systems

Source: http://www.mme.gov.na/energy/renewable.htm (March 2008)

Name	Tel. (t), Fax (f)	Postal Address (P.O. Box)	Sub- category
1. AE Services	081 124 8924 / 063 - 270634 (f)	273 Karasburg	PVP
2. Alternative Energy systems cc	081 149 2969 / 061 - 301677 (t) 301668 (f)	86579 Windhoek	SHS, SWH, PVP
3. Conserv	081 127 1666 / 061 - 236336 (t) 256726 (f)	6422 Windhoek	SHS, SWH, PVP
4. Electro Amwela	065 - 240 414	401 Ondangwa	SHS
5. Excel construction & Services cc	064 - 572800 (t) 572801 (f)	40 Omaruru	SHS, SWH, PVP
6. Johnny's Auto Electric	063 - 222442 / 222359 (t) 2223897 (f)	4 Keetmanshoop	SHS, PVP
7. Kühler Kutz	081 128 7776 / 061 - 2356056	55 Windhoek	SWH
8. Lic Pool Center	061 - 232839 / 235879 / 238602	5940 Windhoek	PVP
9. NEC	061 - 236720	5052 Windhoek	SHS, SWH, PVP
10. Orujaveze Solar cc	081 127 5409 / 061 - 260338	2439 Bachbrecht	SHS, SWH, PVP
11. Pupkewitz Megatech	081 127 5917 / 061 - 374456	40756 Ausspannpltz	SWH
12 .RES	081 212 2546 / 061 - 248404	80262 Olympia Windhoek	SHS, SWH, PVP
13. SK Holdings	061 - 230459	24801 Windhoek	SHS, SWH, PVP
14. Solar Age Namibia	061 - 215 809	9987 Windhoek	SWH
15. Soltec cc	061 - 235 646	315 Windhoek	SHS, SWH, PVP
16. Suntank	081 128 8343 / 064 - 401009	3856 Vineta Swakopmund	SWH
17. Terrasol	061- 239454	6036 Windhoek	PVP, SWH
18. Solar Systems Namibia	064 - 209952	1861 Walvis Bay	SWH
19. H J Civil Works cc	061 - 265079	2023 Windhoek	SWH
20. HPS Engineering	063 - 223399	924 Keetmanshoop	SHS, SWH, PVP, Wind Turbines
21. Derken Enterprise cc	061 - 227611	5215 Ausspannnplatz	SHS, SWH, PVP, Pool Heating
22. Thompson technologies	061 - 237533	5684 Windhoek	SHS, SWH, PVP
23. K & K Solar cc	064 - 463779	2837 Swakopmund	SWH
24. Gobabis Electrical Works	062 - 563171	682 Gobabis	SHS, SWH, PVP
25. ELWIWA	065 - 242055	1232 Windhoek	PVP

SWH Solar Water Heater **SHS** Solar home system **PVP** Photovoltaic Pumping

Renewable
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REEECAP

Renewable Energy and Energy Efficiency Capacity Building Programme