Sustainable Technologies

People, Products and Practices

A handbook for deliberating Climate Change adaptation and ecosystem restoration

Acknowledgments

This Sustainable Technologies Handbook has been compiled by Rob O'Donoghue of the Rhodes University Environmental Education and Sustainability Unit and Wayne Peddie of WESSA SustainEd. Additional support was provided by Jim Taylor (WESSA), Clare Peddie (WESSA Share-Net), Liz Taylor (Project 90 by 2030), Nokuthula Dubazane (WESSA KZN), Scott Walker (WESSA), Avril Wilkinson (WESSA ESKOM E&S Programme), the Makana United Nations University Regional Centre of Expertise (Makana UNU RCE) and the KwaZulu-Natal United Nations University Regional Centre of Expertise (KZN UNU RCE).

About this book

In 2010, WESSA, with support from USAID, launched the 'Stepping Up to Sustainability' project, incorporating the establishment of 'Sustainability Commons'. A 'Sustainability Commons' is a rich and diverse pool of sustainability-focused learning, technologies, and tools; whose resources are deployed locally for the benefit of the community and the environment.

A 'Sustainability Commons' is more than a physical space. It is the culmination of historical trends and practices within the field of environmental education; it is an experiment in social learning, and an argument for and against science and technology. It is a meaning-making exercise in facing environmental risks, and a movement towards social ecological justice through sustainability practices. It supports the communal 'moments' of learning.

Each 'Sustainability Commons' includes a range of sustainability technologies which are available for demonstration and testing. The 'Sustainable Technologies Handbook' aims to guide and support this fore-grounded practice of environmental active learning. The uptake of more sustainable practices may include the selection of technologies which enable lifestyle enhancement and climate change adaptation. This book provides guidance for interactive deliberation around the selection of possible technologies and sustainable practices. These practices and corresponding technologies can be categorised into four themes – biodiversity, energy, waste and water.

This book focuses on Sustainability Technologies and Practices which support environmental learning and education programmes at a 'Sustainability Commons'.

The book provides space for additional technologies. Please contribute to the growing collection of sustainable technologies handbook by e-mailing any additional sustainability technologies to sharenet@wessa.co.za

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Contents

Rainwater Harvesting

How it fits

The history or cultural use of the practice or technology.

A story of rainwater harvesting

Lobatse is a small town in Botswana which was placed under severe water restrictions in 1983 after a 3 year drought. A major difficulty was getting water to the schools and clinics. All government vegetable garden programmes in the town were drying out. The town council owned two water trucks and collected water from the town's stadium borehole. Schools and clinics were given old water drums which were filled once a day with borehole water. The drums were, however, insufficient for the needs of the schools and clinics. Rainwater reservoirs were built in all the public buildings to capture rainwater, and were kept half-full with borehole water until needed. By 1986 all schools and clinics had their own rainwater harvesting systems. Within 3 years the overall storage capacity was sufficient to meet the town's needs. (Source: http://ces.iisc.ernet.in/energy/water/paper/drinkingwater/rainwater/introduction.html)

How it works

Water follows the path of least resistance to the lowest point. Water takes the shape of the container. Water storage is best understood as an interruption in water flow. The higher the water is stored the more potential it has for further flow. A small volume of water high off the ground will have more potential for unaided flow than a large volume of water lower down.

Generally the larger the diameter of pipe used to carry a liquid, the better the flow. Friction on the inside of the pipe slows the flow.

Opaque containers prevent algae growing by limiting photosynthesis.

How is it used?

1. Place tanks on flat solid surfaces. Built raised platforms are useful to gain height and provide better flow. Tractor tyres filled with building rubble and topped with sand make good low-cost raised platforms.
2. Use captured water for watering gardens/vegetables. Hosepipes or watering cans can be used to transport water.
3. Connect raised tanks to laundry and lavatory water inlet (water pressure dependent).
4. Pump water to high storage tank for improved pressure. Small solar powered water pumps are ideal (windscreen wiper water pump is a low cost alternative).

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"Southern Africa is the headquarters of a vast and varied family, the mesembryanthemums … One species retains liquid in tiny bladders on the surface of each bloated leaf that glisten in the sunshine and so give it the name, apt though improbable in these sun-baked lands, of 'ice plant'." (Attenborough 1995:278)

"Epidermal bladder cells contribute to succulence by serving as a water storage reservoir and to salt tolerance by maintaining ion sequestration and homeostasis within photosynthetically active tissues of *M. crystallinum*." (Agarie et al. 2007:1957)

Audit

to check current practice related to this technology - measure the amount of water you and your family use every day for a week.

Day	Drinking and cooking	Washing – bathing, showering and hand washing	Cleaning – dishes, clothes and other cleaning
1			
2			
3			
4			
5			
6			
7			

Measure the amount of water for a shower by capturing all the water in a bucket with the shower running for 1 minute x time taken for a shower.

Investigation

experiment and model

Calculate the amount of water you could capture in a year.

1. Measure the area of catchment (roof area) ________________
2. Find out the average annual rainfall in your area. ________________
3. Area of catchment x annual rainfall = volume of water in one year.
4. Audit the water use for a week and calculate the water use for a year.
5. How big a catchment area would be needed to supply the water needed

Rainwater tanks can be purchased from most hardware stores.

http://www.jojotanks.co.za

ontvangs@jojotanks.co.za

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Rainwater tanks for garden				
2. Rainwater tanks for vegetables				
3. Rainwater tanks for laundry				
4. Rainwater tanks for all domestic use				
5.				

First-Flush Excluder

How it fits

The history or cultural use of the practice or technology.

A story of collecting clean water

The early peoples of southern Africa had common sense ways of collecting clean water. The Nguni people used a simple hand motion to brush aside the surface film and create a 'hole' in the surface. Clean water could then be collected from the 'hole' using a small collecting bowl and was subsequently poured into a larger water pot. Since a high proportion of bacteria are found on the surface film, this practice effectively reduced the collection of bacteria. By means of this practice, a 'first-flush exclusion' helped early Nguni people collect clean water (Source: WESSA Share-Net).

How it works

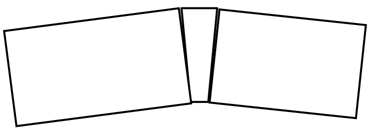
Principles at work in the first-flush excluder include density, buoyancy and suspension.

The first flush of rain water carries the most dust from the roof surface. The water flows into the gutters and down the downpipe. The downpipe is blocked, except for a slow trickle. The sediment is thus no longer buoyed by upward thrusts of moving water and the solid sediment, being denser than water, is unable to be held in suspension. The sediment begins to settle at the bottom of the blocked downpipe. The outlet near the top of the downpipe then allows clean water to flow into the water tank.

How is it used?

1. Block the down-pipe from a gutter system. The downpipe can be blocked by using a plug of wood or resin or other suitable material.
2. At the bottom of the downpipe attach a hose-pipe with a flow adjustment nozzle, to allow the full downpipe to drain and empty, after the rain has stopped.
3. Near the top of the downpipe, attach a T-junction to flow into the tank.

PVC plastic pipes can be cut and joined using PVC Cement Weld. Any angle or turn needed to 'fit' into the tank can be achieved by simply manufacturing the desired turn. A 2cm wide section of downpipe cut to make a large clip can be used as an 'outside seal'. PVC Cement Weld and a small piece of the PVC to fill the gap will hold any angle or turn in the pipe.



Nature's solutions

Example of the principle enabling this technology in nature – www.asknature.org

Most mountain streams have rock pools which 'capture' sandy sediment. The sandy deposits of rivers act as natural sand filters for the water. Removal of the natural sandy filters from streams and rivers require extra filtering and cleaning for human consumption.

The sandy sediment is produced through the action of attrition and abrasion while rocks are rolled and carried in the fast flowing water.

Audit

to check current practice related to this technology - measure the amount of water you and your family uses every day for a week.

Day	Drinking and cooking	Washing – bathing, showering and hand washing	Cleaning – dishes, clothes and other cleaning
1			
2			
3			
4			
5			
6			
7			

Measure the amount of water for a shower by capturing all the water in a bucket with the shower running for 1 minute x time taken for a shower.

Investigation

experiment and model:

Investigate the amount of solid sediment in the first flow of water from a downpipe.

1. Mass empty container ___________
2. Collect one litre of rainwater at the start of a rain fall from a downpipe.
3. Allow the rain water to stand for 24 hours and pour off excess water without disturbing the sediment at the bottom of the container.
4. Allow the sun to evaporate the remaining water and mass the container again _____________
5. Start mass – End mass X amount of litres collected in one year = sediment for one year

First-flush excluders can be purchased from hardware stores or constructed from PVC piping and PVC Cement Weld.

http://www.jojotanks.co.za

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Rainwater tanks without first-flush excluder				
2. Rainwater tank with first-flush excluder				
3. Borehole water				
4. Municipal water supply				
5.				

In-line Filtering

How it fits

The history or cultural use of the practice or technology.

The earliest recorded attempts to find or generate pure water date back to 2000BC. Early Sanskrit writings outlined methods for purifying water. These methods ranged from boiling or placing hot metal instruments in water before drinking it to filtering water through crude sand or charcoal filters (Baker & Taras, 1981).

In ancient Greece, Hippocrates conducted experiments in water purification. He created the theory of the "four humors," or essential fluids, of the body. According to Hippocrates, in order to maintain good health, these four humors should be kept in balance. Hippocrates recognized the healing power of water. He acknowledged that the water available in Greek aqueducts was far from pure. Hippocrates designed his own crude water filter to "purify" the water he used for his patients. Later known as the "Hippocratic sleeve," this filter was a cloth bag through which water could be poured after being boiled (Baker & Taras, 1981).

How it works

Physical filters - as water passes over the filter, the granules of the filter trap large water sediments and stop them from passing through with the water. The process is very similar to river water passing through rocks and emerging cleaner on the other side.

Chemical filters - smaller contaminants are attracted to compounds in the filter (using a process of positive and negative charges similar to magnets) and encourage these contaminants to break their bond with water.

Water filters reduce contaminants by either physically blocking their passage through the filter or chemically attracting them to the filter (Source: http://www.aquasanastore.com/water-faq_a07.html).

Rainwater filter

How is it used?

Many different in-line water systems are available. They are suitable for the filtration of cold domestic water.

1. Most remove solids using a cotton wound cartridge (filter).
2. Some have chemical advantages like: polyphosphate crystals keeping lime in suspension, which prevents the scaling of pipes and any electrical appliances.
3. Activated carbon is used to remove bad smells and tastes from the water.
4. In-line water filtration systems will solve most domestic water problems.

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"One group of whales, have baleen, sheets of horn, feathered at the edges, that hang down like stiff, parallel curtains from the roof of the mouth. The whale takes a huge mouthful of water in the middle of the shoal of krill, half-shuts its jaws and then expels the water by pressing its tongue forward so that the krill remains and can be swallowed. Sometimes it gathers the krill by slowly cruising where it is thickest. It also can concentrate a dispersed shoal by diving beneath it and then spiralling up, expelling bubbles as it goes, so that the krill is driven towards the centre of the spiral. Then the whale itself, jaws pointing upwards, rises in the centre and gathers them in one gulp." (Attenborough 1979:242)

Audit

to check current practice related to this technology - measure the amount of drinking water you and your family uses every day for a week.

Day	Drinking: direct drinking water	Cooking	Additive drinking: tea, coffee, flavoured drinks
1			
2			
3			
4			
5			
6			
7			

The human body requires water for metabolic processes. These processes operate at a body temperature (37°C). If drinking water is cooler than body temperature, the body will use energy to heat the water to the required metabolic temperature.

Investigation

Use a simple Methylene Blue Test to investigate the effectiveness of the In-line Filter.

1. Fill two small clean bottles with water collected before and after the In-line Filter. Fill a third bottle with boiled water as a Control. Add a few drops of Methylene Blue to the three bottles.
2. Replace the caps of the bottles and label the bottles Before, After and Control.
3. Place the bottles in a dark cupboard for 12 hours.
4. If there is a difference in the colour of the 'test' bottles, the In-line Filter is having some effect
5. If there is a change in both 'test' bottles compared to the Control, further water quality testing should be conducted.

Filters can be purchased from most agricultural stores.

http://www.mcbeans.co.za

ontvangs@jojotanks.co.za

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Physical and chemical in-line filter				
2. Physical in-line filter				
3. Sterilizing rainwater by boiling				
4. Sterilizing rainwater using Jik				
5. Sterilizing rainwater using sunshine				

Ceramic Filtering

How it fits

The history or cultural use of the practice or technology.

Early Nguni people collected water in areas where it could be heard running over stones or dripping down rocks *(well oxygenated water supports natural biological cleansing processes).* If a spring was for human use, it was protected by a circle of rocks with a small outlet. Cattle drank elsewhere. An area nearby was cleared and the site soon became a meeting place for young people. A water source would always be approached with care so as not to frighten crabs and other small water animals. When disturbed, their movement would stir up sediments and the collector would have to wait for the silt to settle. The surface film was brushed aside for "sweet water" to be collected. *(Sediments and surface films have higher bacteria numbers than the middle waters of pools and rivers.)* Clay pots were filled with water and covered with a collecting bowl, a piece of skin or a mat made from incema (*Juncas kraussii*) grass. The water would thus stay cool and fresh. *(Water evaporating through the sides of a porous clay pot cooled the contents. Most water bacteria cannot reproduce in cool, dark conditions. Some micro-organisms envelop themselves in a calcium secretion in the pores of clay pots. Scientists spoken to were uncertain about the detail of these issues but it is of note that, in earlier times, great care was taken to scour out a calcium-like scale in water pots).*

How it works

Ceramic water filters are an inexpensive and effective type of water filter, that rely on the small pore size of ceramic material to filter dirt, debris, and bacteria out of water. Water flows to one side of the filter, which acts to block the passage of anything larger than a water molecule. Additionally, many ceramic water filters are treated with silver, which is in a form that will not leach away. The silver helps to kill the bacteria and prevents the growth of mold and algae in the body of the filter (Source: http://en.wikipedia.org).

Ceramic filter and Water-Pot

How is it used?

Make a low-cost sand water filter.

You will need:

- 1 x Plastic container with a screw-on lid
- Filter cotton (normal fish tank filter cotton)
- 4 x Handfuls of clean coarse sand
- 4 x Handfuls of clean pebbles
- 4 x Handfuls of clean charcoal
- 2 x Tap connectors

Drill a hole the size of the tap connector in the lid and in the bottom of the container. Connect the tap connectors to the holes in the container. At the bottom of the container, place the filter cotton, add a layer of pebbles, then a layer of charcoal, and then a layer of clean coarse sand.

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

Fiddler crabs are deposit feeders, ingesting organic matter from exposed mud at low tide. "Sediment is sorted within the buccal cavity. The outermost mouth parts, the third maxillipeds, play little active part other than helping to retain sediment and water during the sorting process. The inner surface of the second maxillipedries carries quite large numbers of long setae, some with spoon tips and others feathery. Facing these on the outer surface of the first maxillipeds is a brush of stiff setae. The sediment is rolled between two maxillipeds. The spooned setae of the second maxillipeds hold sand grains against the brushlike setae of the first maxillipeds, and diatoms and bacteria adhering to the grains are brushed off and moved towards the mouth itself. While this is going on, water is pumped out of the gill chamber into the buccal chamber. This helps the sorting process which takes place essentially in suspension" (Macnae 1968; Miller 1961; Ono 1965, Hogarth 1999:94-95)

Audit

to check current practice related to this technology - measure the amount of water you and your family uses every day for a week.

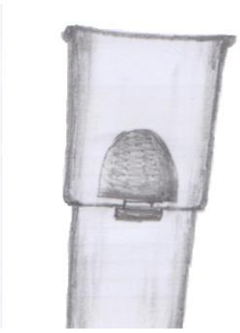
Day	Drinking: direct drinking water	Cooking	Additive drinking: tea, coffee, flavoured drinks
1			
2			
3			
4			
5			
6			
7			

The human body requires water for metabolic processes. These processes operate at body temperature (37°C). If drinking water is cooler than body temperature the body will use energy to heat the water to the required metabolic temperature.

Investigation

experiment and model:

Build a simple Water-Pot by using two buckets and a Ceramic Filter. Make a hole in the bottom of the upper bucket and secure the Ceramic Filter. The two buckets should fit together but **not** slide into each other. A tap can be fixed on the lower bucket for easy use. Place the Water-Pot on a low stand to give space for placing a cup under the tap.



Ceramic filters can be purchased from most hardware stores.

http://puritech.co.za/ceramic-filter-for-mineral-pot-p-94.html

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Rainwater tanks for garden				
2. Rainwater tanks for vegetables				
3. Rainwater tanks for laundry				
4. Rainwater tanks for all domestic use				

Grey Water System

How it fits

The history or cultural use of the practice or technology.

This is a Grey Water System used during the Occupy Wall Street demonstrations in New York City, USA in 2011. The cleaned water is being used to water plants.

How it works

Grey water is made up of bath, shower, bathroom sink and washing machine water. Most grey water has been heated which drives out the dissolved oxygen. Oxygen-deficient water is largely anaerobic and aerobic bacteria essential for the degradation of organic wastes are destroyed thus the water becomes stale and smells. Laundry water promotes anaerobic bacteria due to the depleted oxygen supply and high phosphate content (largely from sodium tri-poly-phosphate). Anaerobic bacteria generate sulphide gases, which when dissolved in water, forms sulphuric acid. Thus the main principles then to treating grey water are to re-oxygenate the water, stimulate the growth of aerobic bacteria, and limit the storage of cleaned water by using it as quickly as possible.

Grey Water System

How is it used?

1. Install a grey water system which collects the bath, shower, laundry and possibly kitchen water.
2. The system should include a filtration unit, some form of aerobic bacterial stimulation and an aeration unit.
3. Use of the cleaned water could be for gardens (spray or even drip irrigation systems), toilets or outside cleaning.

Nature's solutions

Example of a similar principle enabling this technology in nature www.asknature.org

Algal turf scrubbers (ATS) have been used for water quality improvement since the 1980s. They integrate water flow and surge with high light intensity and frequent harvest to reach high levels of primary productivity and control water quality in a considerable variety of enclosed microcosms and mesocosms of coral reefs, estuaries, rocky shores, and freshwater systems. HydroMentia, Inc. has ATS that can handle 1 to 25 million gallons per day and when combined into a single facility can clean hundreds of millions of gallons per day.

Audit

to check current practice related to this technology - measure the amount of Grey Water you and your family discards every day for a week.

Day	Kitchen water	Washing – bathing, showering and hand washing	Cleaning – dishes, clothes and other cleaning
1			
2			
3			
4			
5			
6			
7			

Measure the amount of water for a shower by capturing all the water in a bucket with the shower running for 1 minute x time taken for a shower.

Measure the amount of kitchen water by calculating the amount of water in one sink x number of sinks per day.

Investigation

experiment and model:

Design simple experiments to test the nutrient content effect of Grey Water.

Construct two closed ecosystems using 4 empty plastic 2lt coke bottles. Create the ecosystem by cutting the tops of the bottles off and filling 2 bottles with the same soil, and plants. Use treated water for one bottle and Grey Water for the other bottle. Cover the two bottles with the tops of the two remaining coke bottles and leave the Closed Ecosystems in a semi-shaded area. Monitor the growth of the plants in the two Closed Ecosystems.

Grey Water Systems can be purchased from some hardware stores.

http://www.biosystemssa.co.za

http://www.greywater.co.za

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Sink basin for watering plants after washing dishes				
2. Grey Water System				
3. Grey Water flow to septic tank system				
4. Municipal waste water system				
5.				

Parabolic Solar Cookers

How it fits

The history or cultural use of the practice or technology.

A condensed timeline of solar cooking

1200s - People have sun-dried fruits, vegetables, fish and meats for eight centuries to preserve them

1600s - A German physicist, E.W. von Tschirnhousen, made large lenses to boil water in a clay pot. This was originally reported in the first-published study of solar cookers in 1767 by French-Swiss scientist Horace de Saussure (Halacy, p. 3). Saussure's was the first recorded effort to solar cook food. He built a miniature greenhouse with 5 layers of glass boxes turned upside down on a black table and reported cooking fruit. He later built a cooker of 2 pine boxes topped with 3 layers of glass, and later still added wool insulation between the two boxes. He predicted, "Someday some usefulness might be drawn from this device…(for it) is actually quite small, inexpensive, (and) easy to make" (Saussure, pp 55,59). French contemporary, DuCarlu, added mirrors and reported cooking meat in one hour (Halacy, 1992, p. 3).

1830 - English astronomer Sir John Herschell cooked food in a similar insulated box on an expedition to South Africa.

1860s and 70s - Augustin Mouchot was the first to combine the box/oven heat trap and burning mirrors concepts to create a solar oven, a solar still, a solar pump and ultimately the first solar steam engine.

1876 - In India W. Adams developed an octagonal oven with 8 mirrors which cooked rations for 7 soldiers in 2 hours (Narayanaswamy, 2001, p. 72).

How it works

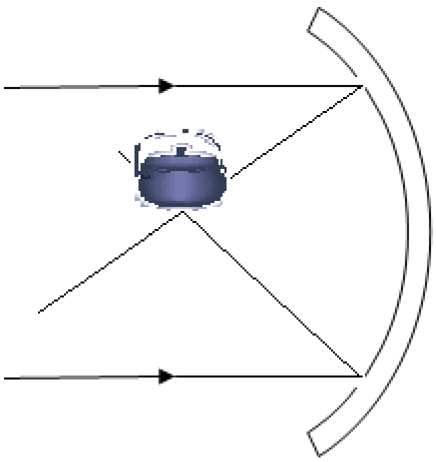
Most Parabolic Solar Cookers are really Spherical Solar Cookers because of the difficulty with manufacturing a parabola.

Radiant energy from the sun is reflected to a focal point using a Spherical Mirror. If a dark (light absorbing) cooking pot is placed at the focal point, the current reflected energy from the sun can be used to cook food, or boil water.

A Spherical Solar Cooker has no means of insulating the cooking pot and so needs to be constantly adjusted to keep the pot at the focal point.

How is it used?

Position the cooking pot at the focal point of sunshine. A wide range of foods may be cooked using sunshine - from stews to soups and even samoosas!



Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"Begonias, which also grow on the floor of Asiatic forests, have a trick. Some cells in the upper surface of their leaves are transparent and act as tiny lenses, gathering the feeble light and focussing it on to the grains of chlorophyll within" (Attenborough 1995:48).

Audit

to check current practice related to this technology

Type of stove used: ....

Cost of stove: .... Safety rating 1,2,3 ....

Day	Time used for day	Amount of fuel used for day	Cost of fuel for day
1			
2			
3			
4			
5			
6			
7			

Measure the amount and cost of fuel used per day for a week and calculate the cost per year.

Calculate the amount of CO_2 emitted by the stove per year .

Investigation

experiment and model: Design a simple experiment and model to test the efficiency of solar cooking technology.

1. Record the temperature of 1 litre (1kg) of water: ....

2. Record time, in seconds, for how long it takes to boil the water (raise the temperature to 100°C) on the solar cooker: ....

3. Calculate how many Joules of energy it took to boil the water: 4200 x 1 x temp change = ... Joules

4. How much electricity? 1 Watt = 1 Joule / second

Solar Cookers can be purchased from:

Sunfire Solutions 082 954 0144

crosby@sunfire.co.za

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Gas cooker				
2. Biomass cooker				
3. Solar cooker				
4. Electric induction stove				
5.				

Hotbox (Heat Retention Cooker)

How it fits

The history or cultural use of the practice or technology.

Although there is some debate as to where and when insulated or “retained heat” cooking was first used, there is a general consensus that this technology is centuries old. Due to combined efficiency and simplicity of the “Hotbox” technique, it is believed that straw, cloth and other insulators have been used in cooking since the advent of the very first ceramic cooking pots. The cooking of food through the retention of heat (rather than continuously re-supplying it), can be seen as an obvious step in food preparation. Over the centuries that followed the primitive innovators, Hotbox cooking has experienced varied popularity and social awareness – an awareness that is experiencing a remarkable upswing in contemporary society.

Source: http://www.thehotboxco.co.za/history.html

How it works

The Hotbox uses the principle of insulation to cook food.

- Heat is the transfer of energy.
- The transfer of energy requires a medium. Particles within the medium vibrate and collide with one another thus transferring energy.
- Air is a poor conductor of heat since the particles are further apart.
- Any material which is able to trap air can be a good insulator – grass, wool, newspaper, polystyrene.

How is it used?

A Hotbox is used to cook food, to transport and continue cooking food and as a warming oven. It can be used as a plate warmer, or a cooler box. Hotboxes have been used as an incubating chamber for making yoghurt and breads. Hotboxes are used to slow cook supper during the day while at work, and are then taken home to feed the family.

Samp and Beans

1. 1 cup of samp and beans in a bowl, cover with water and soak overnight. Rinse and drain.
2. Bring samp and beans to the boil in 3 cups of salted water, allow to simmer for 20 minutes. Return to a rapid boil and place in the Hotbox for 4-5 hours or until soft and all the water is absorbed.
3. Add butter, freshly ground pepper, salt and crumbled feta cheese for a light meal.

Nature’s solutions

Example of the principle enabling this technology in nature - www.asknature.org

"One of the warmest nests in the world, the eider duck's nest, is lined with soft down from the female eider duck's breast. Eider ducks nest on tundra-covered islands in the arctic, so it is not surprising that they have developed the warmest known down. When they hatch, the chicks already have their own eiderdown coats." (Foy and Oxford Scientific Films 1982:111)

Audit
to check current practice related to this technology

Type of stove used: ....

Cost of stove: .... Safety rating 1,2,3 ....

Day	Time used for day	Amount of fuel used for day	Cost of fuel for day
1			
2			
3			
4			
5			
6			
7			

Measure the amount and cost of fuel used per day for a week and calculate the cost per year.

Calculate the amount of CO_2 emitted by the stove per year .

Investigation
experiment and model: Design simple experiments to test the range of this technology. Build simple models to illustrate the practice or technology.

1. Heat 2 litres of water to about 50°C.
2. Place 1 litre of water in each of 2 identical containers and record the temperature for each:
   Container 1 =......................
   Container 2 =......................
3. Place Container 1 in the Hotbox for 1 hour.
4. Record the temperature of the water for both containers again:
   Container 1 =......................
   Container 2 =......................
5. Calculate the energy transferred from each container. 4200 x 1 x temp change =...................... Joules

Hotboxes can be purchased from:

Sunfire Solutions 082 954 0144

crosby@sunfire.co.za

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Hotbox – made with grass and cardboard box				
2. Hotbox – made with material and polystyrene				
3. Blankets wrapped around hot pot				
4.				
5.				

Solar Ovens

How it fits

The history or cultural use of the practice or technology.

In 1767, Horace de Saussure, a French-Swiss scientist, built a miniature greenhouse. It consisted of 5 layers of glass boxes turned upside down on a black table. The device was used to cook fruit.

Later Saussure built a cooker. He used 2 pine boxes covered with 3 layers of glass. The design was later improved by adding wool insulation between the two boxes.

Saussure predicted, “Someday some usefulness might be drawn from this device …(for it) is actually quite small, inexpensive, (and) easy to make” (Saussure, pp 55,59).

A French contemporary of Saussure, DuCarlu, added mirrors to the design and the reflective and insulating ability of the Solar Oven was reported to cook meat within one hour (Source: Halacy, 1992, p. 3).

The ‘African Sun Stove’ still uses this same basic design of reflective and insulating principles.

How it works

Solar Ovens combine the reflective energy directing ability of a Parabolic Solar Cooker with the heat retention insulating ability of Hotboxes

Radiant energy from the sun is reflected to a focal point using a reflective surface. The reflective surface is often NOT parabolic or spherical thus the focusing ability of the reflective surface is compromised – only a ‘fuzzy’ focus is achieved.

A transparent cover and insulated sides provides good heat retention ability of the solar oven.

How is it used?

Using a dark pot in a Solar Oven is more effective.

Position the Solar Oven to take full advantage of the sunshine.

More than one pot can be placed in the oven at a time.

Solar Bread - 1 Tb yeast, 1 cup milk, 1½tp salt, 2 Tb honey, ¼ cup wheat germ, ¼ cup warm water, ½ cup rolled oats, 2 Tb oil, 1 egg, 2¾ cups whole-wheat flour.

Grease a deep metal or glass bowl. Dissolve the yeast in water and combine it with the milk, oats, salt, oil, honey, egg and wheat germ. Add the flour and knead the dough until it is smooth and elastic. Turn the dough into the bowl and cover it with foil. Place the bowl in the Sun Stove on a pre-heated brick or tile and bake until done (Source: SUNSTOVE 2000).

Nature’s solutions

Example of the principle enabling this technology in nature - www.asknature.org

“Begonias, which also grow on the floor of Asiatic forests, have a trick. Some cells in the upper surface of their leaves are transparent and act as tiny lenses, gathering the feeble light and focussing it on to the grains of chlorophyll within." (Attenborough 1995:48)

"One of the warmest nests in the world, the eider duck's nest is lined with soft down from the female eider duck's breast” (Foy and Oxford Scientific Films 1982:111).

Audit

to check current practice related to this technology

Type of stove used: ....

Cost of stove: .... Safety rating 1,2,3 ....

Day	Time used for day	Amount of fuel used for day	Cost of fuel for day
1			
2			
3			
4			
5			
6			
7			

Measure the amount and cost of fuel used per day for a week and calculate the cost per year.

Calculate the amount of CO_2 emitted by the stove per year.

Investigation

experiment and model: Design a simple experiment and model to test the range of Solar Oven technology.

1. Record the temperature of 1 litre (1kg) of water: ....

2. Record time, in seconds, for how long it takes to boil the water (raise the temperature to 100°C) in the solar oven:............................

3. Calculate how many Joules of energy it took to boil the water: 4200 x 1 x temp change =......... Joules

4. How much electricity? 1 Watt = 1 Joule / second ....

Solar Ovens can be purchased from:

Sunstove Organisation

(011) 969 2818 sunstove@iafrica.com

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Gas cooker				
2. Biomass cooker				
3. Solar cooker – Parabolic Solar Cooker				
4. Solar Oven				
5. Induction stove				

Ceramic Wood Stoves

How it fits

The history or cultural use of the practice or technology.

A 2008 Clay Stove study in southern Africa showed some interesting outcomes of using fuel efficient ceramic stoves. The study acknowledged itself as a 'snap shot' of a transition process as it takes a long time to change traditional cooking practices.

After the introduction of more efficient clay cooking stoves to households, often more than one type of cooking stove was used. Households started using traditional open cooking fires together with the new clay stoves.

The introduction of more fuel efficient clay stoves, and adjustment in cooking habits, has not necessarily resulted in less fuel (wood) being used because the number of cooking points increased. The frequency of cooking per day, however, was unaffected by the introduction of more efficient clay stoves.

How it works

1. Clay stoves are ceramic. Ceramic is a porous material so it contains many small air pockets. Air is a poor conductor of heat so the ceramic behaves as a good insulator, retaining the heat within the stove making the stove more efficient and thus needing less fuel (wood).

2. The atomic structure of ceramic material is what gives the ceramic the ability to retain heat in itself. The configuration of bound atoms gives a less crystalline structure which will result in less heat being transferred.

How is it used?

A ceramic stove can be constructed in the following way:

1. Construct the body of the stove using coils of clay. Smooth the clay and keep the stove round. Make the stove body about 40 cm high.

2. Attach pot-rests in points on the rim of the stove. Make the pot-rests about 1 finger higher than the rim.

3. Allow to dry for one day and cut a fire hole in the side of the stove. Keep the cut-out as a door and attach a small handle on the door. Allow the stove to dry before use. Clay stove last much longer if they are fired in a kiln.

http://www.hedon.info/PortableClayStoveConstruction

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"The surface of the nest of wood ants (*Formica rufa*) has numerous holes which serve as entrances and ventilation holes; at night and in cold weather the ants plug the holes to keep heat in. The workers also keep the slope of the nest at the right angle to obtain the maximum amount of solar heat. The ants bring extra warmth into their nests as live heaters by basking in the sun in large numbers and taking the heat energy collected in their bodies into the nest" (Pallasmaa 1995:35).

Audit

to check current practice related to this technology

Type of stove used: ....

Cost of stove: .... Safety rating 1, 2, 3 ....

Day	Time used for day	Amount of fuel used for day	Cost of fuel for day
1			
2			
3			
4			
5			
6			
7			

Measure the amount and cost of fuel used per day for a week and calculate the cost per year.

Calculate the amount of CO_2 emitted by the stove per year.

Investigation

experiment and model: Design a simple experiment and model to test the range of ceramic technology.

1. Mass the wood to be used .... grams
2. Boil 1 litre of water.
3. Mass the wood remaining .... grams
4. Calculate the amount of wood used to boil 1 litre of water.

Compared to an average household cooking fire, the Stovetec ceramic wood stove uses 50% less wood and produces 70% less smoke.

Ceramic Wood Stoves can be purchased from:

Restio Energy, and other agents in SA

021 850 0771 info@restio.co.za

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Clay oven				
2. Ceramic wood stove				
3. Gas cooker				
4. Paraffin stove				
5. Induction stove				

Clay Stove

How it fits

The history or cultural use of the practice or technology.

A 2008 Clay Stove study in southern Africa showed some interesting outcomes of using fuel efficient ceramic stoves. The study acknowledged itself as a 'snap shot' of a transition process as it takes a long time to change traditional cooking practices.

After the introduction of more efficient clay cooking stoves to households, often more than one type of cooking stove was used. Households started using traditional open cooking fires together with the new clay stoves.

The introduction of more fuel efficient clay stoves, and adjustment in cooking habits, has not necessarily resulted in less fuel (wood) being used because the number of cooking points increased. The frequency of cooking per day, however, was unaffected by the introduction of more efficient clay stoves.

How it works

1. Clay stoves are ceramic. Ceramic is a porous material so it contains many small air pockets. Air is a poor conductor of heat so the ceramic behaves as a good insulator retaining the heat within the stove, making the stove more efficient and thus needing less fuel (wood).

2. The atomic structure of ceramic material is what gives the ceramic the ability to retain heat in itself. The configuration of bound atoms gives a less crystalline structure, which will have less heat transferred.

How is it used?

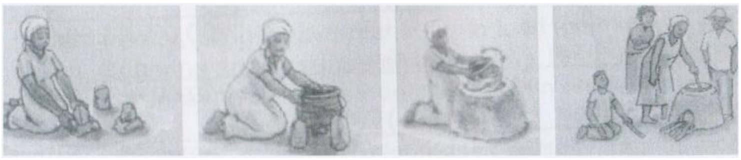
A ceramic stove can be constructed in the following way:

1. Place 3 stones in a clay base.

2. Balance the cooking pot on the stones for size.

3. Build up the clay around the pot covering the stones. Leave a hole between 2 stones for the wood feed.

4. Remove the pot and complete the stove.



Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"The surface of the nest of wood ants (*Formica rufa*) has numerous holes which serve as entrances and ventilation holes; at night and in cold weather the ants plug the holes to keep heat in. The workers also keep the slope of the nest at the right angle to obtain the maximum amount of solar heat. The ants bring extra warmth into their nests as live heaters by basking in the sun in large numbers and taking the heat energy collected in their bodies into the nest" (Pallasmaa 1995:35).

Audit

to check current practice related to this technology

Type of stove used: ....

Cost of stove: .... Safety rating 1, 2, 3 ....

Day	Time used for day	Amount of fuel used for day	Cost of fuel for day
1			
2			
3			
4			
5			
6			
7			

Measure the amount and cost of fuel used per day for a week and calculate the cost per year.

Calculate the amount of CO_2 emitted by the stove per year.

Investigation

experiment and model: Design a simple experiment and model to test the range of ceramic technology.

1. Record the temperature of 1 litre (1kg) of water: ....

2. Record time, in seconds, for how long it takes to boil the water (raise the temperature to 100 °C) on the Ceramic Clay Stove:............................

3. Calculate how many Joules of energy it took to boil the water: 4200 x 1 x temp change=......... Joules

4. How much electricity would have been used to do the same work? 1Watt = 1Joule/second ....

Clay Stoves which use good quality clay tend to last longer. Most art supply stores will have very good quality clay. Clay stoves which are 'fired' will also last longer.

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1.Clay oven				
2. Ceramic wood stove				
3. Gas cooker				
4. Paraffin stove				
5. Induction stove				

Solar Water Heater – Evacuated vacuum tubes

How it fits

The history or cultural use of the practice or technology.

In 212 BC, the Greek scientist, Archimedes, used bronze shields to set fire to wooden ships. The Roman Empire's fleet was besieging Syracuse. Archimedes used the reflective properties to focus a concentrated beam of sunlight onto the wooden hulls of the Roman war ships. The radiant heat from the reflected sun rays caused the wooden ships to ignite and burn.

No proof of this event exists, however the Greek navy recreated the experiment in 1973. The experiment proved successful and a wooden boat was set alight at a distance of 50 meters.
http://www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf

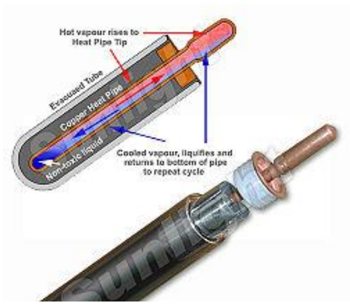
Records show that in 400 BC the Greeks orientated their houses to make use of the sun to trap solar heat during winter. Although many cultures across the world may have arranged their living conditions to take advantage of the sun's warmth, few records of this practice are available.
http://www.centreforenergy.com/AboutEnergy/Solar/History.asp

How it works

Evacuated tubes absorb solar energy from the sun. The inner tube is coated with an aluminium nitride compound (Al-N/Al) which absorbs almost all light and reflects very little. A copper 'heat-pipe' inside the inner glass tube contains an anti-freeze which vaporises and rises up the 'heat-pipe' to the heat exchanger.

The water in the heat exchanger then removes the heat from the 'heat-pipe'. The anti-freeze cools and condenses and runs back down the 'heat-pipe' to be heated once again. The evacuation of the glass tube produces a very good heat insulator so very little heat is 'lost' to the air.

A Barium ring is placed inside the vacuum tube and acts as an indicator for when the vacuum is compromised. The Barium ring reacts with air particles and turns white.



How is it used?

Position the vacuum tube array facing north and at about 30° to the earth's surface. This allows for the most direct radiation from the sun. The cylindrical tubes allow for incoming sun light to be perpendicular to the tube for most of the day thus improving the efficiency of heat collection.

Nature's solutions

Example of the principle enabling this technology in nature -
www.asknature.org

"The ommatidia, in the eyes of insects, absorb incidental light to prevent it from reaching the lens via scattering pigment. There is a layer of transparent cuticle on the outside, which allows light into a lens beneath it. This is usually surrounded by cells containing 'scattering pigment' which absorbs scattered or incidental light rays, so that the only light entering the ommatidium is directly parallel to its axis. This beam of light is directed by the lens down the narrow visual centre where it reacts with pigment, stimulating the nerve cells. The nerve cells pass the message to the optical centre in the insect's 'brain' where it is interpreted" (Foy and Oxford Scientific Films 1982:122-123).

Audit
to check current practice related to this technology

Type of hot water heater used: ....

Cost of fuel: .... Safety rating 1, 2, 3 ....

Day	Time used for day	Amount of fuel used for day	Cost of fuel for day
1			
2			
3			
4			
5			
6			
7			

Measure the amount and cost of fuel used per day for a week and calculate the cost per year.

Calculate the amount of CO_2 emitted by the hot water heater per year.

Investigation
experiment and model: Design simple experiments to test the range of this technology. Build simple models to illustrate the practice or technology.

1. Paint the outside of one 2lt coke bottle black and another silver/white (reflective).

2. Place a few stones in each bottle to prevent them from falling over.

3. Place a stopper in each bottle with a thermometer in each bottle.

4. Keep the bottles covered and take them into the sun. Record the temperatures for each bottle every 30 sec once the cover is removed in direct sunlight for 15 minutes.

5. Repeat the experiment immediately when the bottles are taken indoors.

Solar water heaters can be purchased from most hardware stores. Eskom's solar water heating programme gives a rebate when buying an SABS tested solar water heater:
http://www.eskom.co.za/c/56/eskom-solar-water-heating-programme/
http://www.solarisesolutions.co.za/

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Turning down the temperature on a geyser				
2. Geyser blanket				
3. Gas geyser				
4. Wood fired boiler				
5. Solar water heater				

Hot Water Pipes & Plastic Bottles

How it fits

The history or cultural use of the practice or technology.

José Alano is a model of creativity in tackling environmental problems in Brazil. In 2002, the retired mechanic transformed a pile of plastic bottles and cartons into a solar water heater. Since then, thousands of people in southern Brazil have benefited from Alano's invention, saving money while reducing waste.

The idea came from the lack of recycling collection services in his small home town of Tubarão. Refusing to throw plastic bottles, cartons and other recyclable waste into the landfill, José Alano soon realised he had a problem: a room full of rubbish.

'Being 59 years old, I have had the opportunity to witness the technological advances of science, which improved food storage. But nowadays, some packaging weighs almost the same as the food itself! Years ago, my wife and I realised that we were not prepared for this new form of consumption.'

Using his basic knowledge on solar water heating systems, he and his wife built an alternative version using 100 plastic bottles and 100 milk cartons. 'It worked perfectly well, and we got rid of our waste in a responsible way,' he says.

How it works

We see objects because they reflect light. We see colours because objects (through the interaction of light with their pigment) reflect some of the light which strikes them. Green objects absorb all light except green. Dark objects absorb almost all light.

Light is a form of energy and so any object absorbing light will be 'absorbing' energy.

Black PVC piping absorbs much of the radiant energy which strikes it, making the water in the pipe hot.

The clear plastic bottles act to inhibit the 'loss' of heat to the air – like a greenhouse.

How is it used?

Plastic bottles are carefully cut and pushed into one another to form a 'chain' of bottles. The Black PVC pipe is pushed through the tops of the plastic bottles and connected to a water source. The hot water can be fed into a hot water storage tank (insulated) or with a long enough pipe, simply stored in the pipe.

Using the pipe as the storage: To calculate the volume of water –

1. Measure the inside diameter of the pipe.
2. Calculate the cross sectional area using πr^2.
3. Calculate the volume of water by multiplying the length x area. (Keep the units the same!)

It is best to work in centimetres: Area = cm^2 , Volume = cm^3

$1000 cm^3$ = 1 litre: so divide the volume in cm^3 by 1000 to get the amount of water in litres.

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"Cushion Plants deal with cold by packing their stems tightly together. By doing so, the plant creates a miniature ecosystem where the resources of warmth, humidity and nourishment are significantly better than in the world outside it. The plant may even add to that by expending a little of its food reserves in slightly raising the internal temperature. The sheer bulk of fibres of the cushion retains water like a sponge and the fierce winds do not dry it out. Nor is the nutriment embodied in the leaves lost when they die. Instead of being shed, they remain within the cushion and the upper part of the stems puts out lateral rootlets to reabsorb much of the leaves' constituents just as soon as decay releases them." (Attenborough 1995:255)

Audit

to check current practice related to this technology

Method of water heating used: ....

Fuel used: .... Safety rating 1, 2, 3 ....

Day	Amount of hot water used per day	Amount of fuel used to heat water per day	Total cost of fuel per day
1			
2			
3			
4			
5			
6			
7			

Measure the amount and cost of fuel used per day for a week and calculate the cost per year.

Calculate the amount of CO_2 emitted by the hot water geyser per year.

Investigation

experiment and model: Design a simple experiment and model to test the efficiency of black PVC piping technology.

On what promises to be a bright clear day:

1. Record the temperature of the water in the Black PVC pipe every 2 hours from sunrise until sunset: ....

2. Record the length of time for the water to reach its highest temperature: ....

3. Calculate the volume of water in the pipe. Area of inside cross section x length of pipe: ....

4. Calculate how much energy was needed to heat the water to its highest temp:

   4200 x volume of water x temp change = ... Joules

5. How much electricity would have been used to do the same work? 1Watt = 1Joule/second ....

Black PVC piping and all fittings can be purchased from most hardware stores. Recycling centres have an abundance of plastic bottles.
http://www.youtube.com/watch?v=ehDgXrp

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Hot water Pipe – Black PVC pipe				
2. Solar Water Heater				
3. Geyser Blanket				
4. Gas Geyser				
5. Electric instant water heater				

Heat Pumps

How it fits

The history or cultural use of the practice or technology.

Lord Kelvin's Law of Thermodynamics gives theoretical support for heat pumps. Heat pumps are used in all types of resources including air conditioning systems and refrigerators. Robert C. Webber, an American inventor, is credited with building the first heat pump during the late 1940s. Webber got the idea for the heat pump by accident when he was experimenting with his deep freezer, and burned his hand after unintentionally touching the outlet pipes of the cooling system. The burning of his hands gave him ideas for the basic mechanics of how he would build the heat pump. Webber followed multiple steps to create the first heat pump. According to MasterTherm, "He connected the outlet piping from a freezer to a hot water heater and, since the freezer was producing constant excess heat, he hooked up the heated water to a piping loop." Then Webber used a small fan to propel the warm air in the building. After he saw that his invention was successful, he built a full size heat pump to provide heat for his entire home. (Source: http://www.ehow.com/about_6682179_history-heat-pump.html)

How it works

The second law of thermodynamics explains that heat will travel from a warm body to a cooler body, but not the reverse. It is impossible for a system to transfer heat from a cooler object to a warmer object unless energy is added to the system. A heat pump is designed to make warm bodies warmer and cool bodies cooler by "pumping" heat from one place to another.

The main ingredient in a heat pump is a cold fluid, such as freon or ammonia, called a refrigerant. The refrigerant travels between the cooler area and the warmer area. The refrigerant absorbs heat via an evaporator and is pumped to a condenser; here, the heat collected is released. The refrigerant then passes through a valve that lowers its pressure and, subsequently, its temperature, and the process is repeated.

How is it used?

- A heat pump offers you a way to use electricity to heat water efficiently.

- Where a geyser uses three units of electrical energy to produce three units of heat energy, a heat pump converts just one unit of electrical energy into three units of heat energy. This creates a 67% saving on electrical energy use to produce the required heat energy.

Electric Geyser:	3 electric units = 3 heat units
Heat Pump:	1 electric unit = 3 heat units

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"The narrow passage within the petiole between thorax and abdomen is anatomically constructed so that counter-current exchange should retain heat in the thorax despite blood flow to and from the cool abdomen. However, the counter-current heat exchanger can be physiologically circumvented. Exogenously heated bumblebees prevented overheating of the thorax by shunting heat into the abdomen. They also regurgitated fluid, which helped to reduce head temperature but had little effect on thoracic temperature" (Heinrich 1976:561).

Audit

to check current practice related to this technology

Method of water heating used: ....

Fuel used: .... Safety rating 1, 2, 3 ....

Day	Amount of hot water used per day	Amount of fuel used to heat water per day	Total cost of fuel per day
1			
2			
3			
4			
5			
6			
7			

Measure the amount and cost of fuel used per day for a week and calculate the cost per year.

Calculate the amount of CO_2 emitted by the heat pump per year.

Investigation

experiment and model: Design a simple experiment and model to test the theory of heat pump technology.

1. Make a hole in the cap of a 2lt plastic bottle, large enough for a car tyre valve to be inserted.
2. Using a drawing pin, make a hole in the bottom of the plastic bottle. Leave the drawing pin in the hole as a stop.
3. Pump air into the plastic bottle until it is pressurised. It should feel hard to the touch.
4. Feel the temperature of the bottle.
5. Remove the drawing pin and allow all the air to escape.
6. Feel the temperature again.
7. Using the idea of air particles, explain the difference in the temperature.

Heat pumps can be purchased from most electrical supply stores.

087 802 7134 info@itsheatpumps.co.za

Home comforts 086 111 4169

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Turning down the temperature of the geyser				
2. Solar Water Heater				
3. Geyser Blanket				
4. Heat pump				
5. Electric instant water heater				

Photo voltaic systems – solar electric systems

How it fits

The history or cultural use of the practice or technology.

In 1873 Willoughby Smith discovered the photoconductivity of selenium. Three years later in 1876, William Grylls Adams and Richard Evans Day discovered that selenium produces electricity when exposed to light. Although selenium solar cells failed to convert enough sunlight to power electrical equipment, the scientists proved that a solid material could change light into electricity without heat or moving parts.

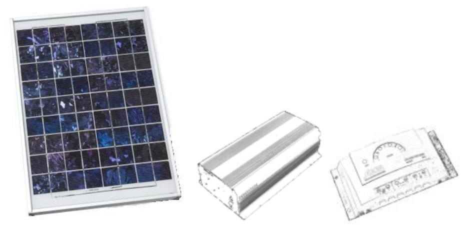
In 1905 Albert Einstein published his paper on the photoelectric effect (along with a paper on his theory of relativity). In 1954 Photovoltaic technology was born in the United States when Daryl Chapin, Calvin Fuller, and Gerald Pearson developed the silicon photovoltaic (PV) cell at Bell Labs. This was the first solar cell capable of converting enough of the sun's energy into power to run everyday electrical equipment. Bell Telephone Laboratories produced a silicon solar cell with 4% efficiency and later achieved 11% efficiency.

How it works

Photo-electric effect is the primary principle which enables the production of an electric current from a Photo Voltaic Cell.

When a photon (packet) of light strikes an electron in the metal surface, all the energy of the photon is transferred to the electron. The photon no longer exists after the interaction. Energy of the photon is given as $E = hf$

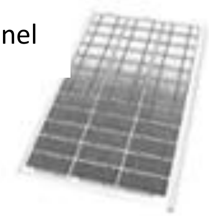
The metal exerts an attractive force on the electron (work function W) and if the energy from the photon is sufficient, the electron is able to break free of the metal surface. If the electron is given a path, a current is created. $E = hf = W + ½mv^2$



How is it used?

Draw lines between the components to connect the Photo Voltaic System

Solar panel



Printer

Regulator

Inverter

Battery

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"Bacteria in sediment at the bottom of the sea use an electric current to link together the chemical reactions of oxygen in water with those of sediment nutrients deeper down. A chain of bacteria work together to transport electrons from marine sediment to the overlying water up to two centimeters away. The electrons are produced by reactions between organic matter and hydrogen sulphide in the sediment, and transported to the sediment surface where they react with oxygen. This means that throughout the entire system, the top layers of sediment 'breathe' for the whole, and those at the bottom 'eat' for the whole. Another way of saying this is that bacteria can grow tiny 'wires' to form a biogeobattery — a giant natural battery that generates electrical currents" (Sanderson 2010).

Audit

to check current practice related to this technology

Method of lighting used: ....

Fuel used: .... Safety rating 1, 2, 3 ....

Day	Total Watt rating for lighting used per day	Total time for lights used per day	Total Kilowatt hours for lighting per day
1			
2			
3			
4			
5			
6			
7			

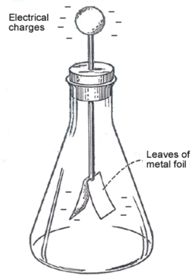
Calculate the Kilowatt hours used per year on lighting in the household.

Calculate the amount of CO_2 emitted by the lights per year.

Investigation

experiment and model: Design a simple experiment and model to illustrate the power of solar electricity.

1. Charge an electroscope.
2. Use fine sand paper to 'shine' a section of Zinc metal.
3. Place the Zinc metal on the electroscope's metal conductor.
4. Cover the electroscope and then remove the cover in sunlight or UV light.
5. Record any changes to the 'leaves' of the electroscope.



1.

Photo Voltaic Systems can be purchased at most electrical supply stores.

www.midlandssolar.co.za

033 342 5896

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Candles or spirit lamps				
2. Incandecent lights				
3. Low energy CFLs				
4. LED (Light Emitting Diodes)				

Composting

How it fits

The history or cultural use of the practice or technology.

Composting, as a recognised practice, dates back to the early Roman Empire. Traditionally, composting was to pile organic materials until the next planting season, at which time the materials would have decayed enough to be ready for use in the soil. The advantage of this method is that little working time or effort is required from the composter and it fits in naturally with agricultural practices in temperate climates.

The modernization of composting began in the 1920s in Europe as a tool for organic farming. The first industrial station for the transformation of urban organic materials into compost was set up in Wels, Austria in 1921. Germany's Rudolf Steiner was cited for propounding composting within farming and was the founder of a farming method called biodynamics. Annie Francé-Harrar, who was appointed on behalf of the government in Mexico, supported the country from 1950 to 1958 in setting up a large humus organization towards the fight against soil erosion and degradation. In the English-speaking world Sir Albert Howard worked extensively in India on sustainable practices, and Lady Eve Balfour was a huge proponent of composting.

How it works

During composting, micro-organisms eat the organic (carbon containing) waste and break it down to produce fiber-rich, carbon-containing humus with inorganic nutrients such as nitrogen, phosphorus and potassium. The micro-organisms break the material down through aerobic respiration, and require oxygen that they get from the air in the compost. The micro-organisms also require water to live and multiply.

Through the respiration process, the micro-organisms give off carbon dioxide and heat - temperatures in the compost pile can be as high as 38 to 66 ^{o}C. If the compost pile or bin is actively managed by turning and watering it often, the process of decomposing into compost can occur within two to three weeks (otherwise, it may take months).

How is it used?

Compost is generally recommended as an additive to soil, supplying humus and nutrients. It provides a rich growing medium, or a porous, absorbent material that holds moisture and soluble minerals. This provides the support and nutrients that plants need to flourish although it is rarely used alone. Compost is primarily mixed with soil, sand, grit, bark chips, vermiculite, perlite, or clay granules to produce loam. Compost can be tilled directly into the soil or growing medium to boost the level of organic matter and the overall fertility of the soil. Compost that is ready to be used as an additive is dark brown or even black with an earthy smell.

Generally, direct seeding into compost is not recommended due to the speed at which it may dry out, the possible presence of phytotoxins may inhibit germination and the possible tie up of nitrogen by incompletely decomposed lignin. It is very common to see blends of 20–30% compost used for transplanting seedlings at cotyledon stage or later.

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

Composting is part of the Earth's biological cycle of growth and decay. Energy from the sun, carbon dioxide from the air, and nutrients from water and soil make plants grow. When they die and decompose through a complex process involving microorganisms such as fungi, bacteria, insects, mites and worms; nutrients go back into the soil, and carbon dioxide moves back into the air. The humus remaining from this decay process provides soil with organic matter that can hold water and nutrients in the soil, ready for use for the next generation of plants.

Audit

to check current practice related to this technology

Measure your food waste for one week.

Carry a plastic bag around with you all day. Put all the food scraps from any food you eat, into the bag at the end of each day and weigh the bag. Record the weights for a whole week.

Day	Weight of waste	CO_2 produced by 1kg	TOTAL CO_2 emissions
1		0.62 kg CO_2	
2		0.62 kg CO_2	
3		062 kg CO_2	
4		0.62 kg CO_2	
5		0.62 kg CO_2	
6		0.62 kg CO_2	
7		0.62 kg CO2	

__________kg of CO_2 released by me in one day.

__________kg of CO_2 released by me in one week.

Investigation

experiment and model:

Part 1. Do a ‘top soil analysis’ of the compost by spreading a few handfuls of compost on some paper and record everything that makes up compost.

Part 2. Temperature is one of the key indicators in composting. Heat is generated as a byproduct of microbial breakdown of organic material.

Take readings in several locations in the compost. Compost may have hotter and colder pockets depending on the moisture content and chemical composition of ingredients.

1. Draw a temperature versus depth graph for your compost.
2. Draw a temperature versus time graph for your compost.

By graphing compost temperature over time, you can tell how far along the decomposition has progressed. A well constructed compost system will heat up to 40 or 50°C within two to three days. As readily decomposable organic matter becomes depleted, the temperature begins to drop and the process slows considerably.

Compost bins can be purchased from most hardware stores.

DIY compost bins from scrap – see WESSA Share-Net How To ‘Build a compost bin’

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Shop bought composting bin				
2. Home-made composting bin				
3. Wormery				
4. Compost heap				
5. Compost dump which is not aerated				

Biochar

How it fits

The history or cultural use of the practice or technology.

The term "biochar" was coined by Peter Read to describe charcoal used as a soil improvement.

During the preparation of mummies for burial, ancient Egyptians used a mixture of substances. The embalming process required methanol which is a product of the process of the pyrolysis of wood. The solid that remained after the pyrolysis of wood is what we now call biochar.

Traditional Nguni women would discard the remains of the cooking fire in the same place near the household called *ezaleni*. Once the coals and ash have cooled, and when needed, the ash is used on crops like potatoes as a fertiliser. To some extent the ash and coals from the fire contained biochar which provided a fertile area at *ezaleni* for the growth of edible green leafy foods called *imfino* and more specifically *imbuya*.

For an African review of small scale biochar production see the Nigerian researchers:

Odesola, I. F., & Owoseni, A. T. (2010). Small Scale Biochar Production Technologies: A Review. *Journal of Emerging Trends in Engineering and Applied Science*, *1*(2), 151-156.

How it works

Biochar, liquids and gases are produced through the process of pyrolysis.

Pyrolysis is the heating of organic biomass in a low oxygen environment. The lack of oxygen prevents the combustion (burning) of the biomass. Higher temperatures produce more liquids and gases (gasification) and less biochar.

Pyrolysis is the decomposition of organic matter by heat. It is a process of chemical and physical change and is irreversible.

How is it used?

Biochar is simply mixed with the soil as a 'fertilizer' to improve soil quality.

Biochar also helps to improve the water quality in soils and to reduce the emissions of greenhouse gases such as nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2).

Biochar also reduces nutrient leaching and increases the pH thus reducing the acidity levels in the soil.

Biochar is known to improve crop production particularly in nutrient-poor soils.

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"Wetlands annually store carbon at rates that can be 10-20 times faster than in terrestrial systems. These high rates are due to slower decomposition rates under anaerobic conditions and cooler temperatures in boreal and arctic regions where most wetlands are found. As a consequence, today wetlands may contain as much as 40% of global soil carbon, most of it in peatlands and forested wetlands. Although they cover only 3% of the world's land area, peatlands alone may contain as much as 25% of the soil carbon pool. So much carbon is stored in northern peatlands that changes in the amount of carbon stored in peatlands have been hypothesized to be linked to global ice-age cycles (Frazen 1994). Although wetlands are an important sink for carbon, they are not expected to sequester much additional carbon as global $C0_2$ levels increase. In other words, wetlands are not expected to ameliorate global climate change. In fact, the opposite is predicted." (van der Valk 2006:142-143)

Audit

to check current practice related to this technology

Method of organic waste disposal currently used:

……………………………………………………………………

Day	Amount of organic waste produced per day	Amount of organic waste composted per day	Amount of organic waste sent to landfill or dumped per day
1			
2			
3			
4			
5			
6			
7			

Record the total amount of organic waste produced in one year.

Investigation

experiment and model:

Construct a small biochar kiln and make some biochar for use as activated carbon in a home-made water filter.

1. Cut the bottom off a large coffee tin and place the tin on a bed of sand.
2. Build a small fire in the tin and, once going, well add wood to the fire until the tin is full.
3. Cover the tin with the bottom of the tin (removed earlier) and place a small rock on top to 'seal' the 'lid'.
4. Make 4 small holes in the sand under the sides of the tin to allow a small amount of air into the tin.
5. Allow it to burn for 30min and then block the holes in the sand and wait until cool.
6. Remove the biochar, crush and add to water filter as activated carbon.

Activated carbon is very porous, and is used to clean water with a high organic content.

Portable biochar kilns:

http://vuthisa.com/biochar/

Vuthisa Technologies cc
Tel: +27 (0)33 3442 216
Cell: 083 6328 635

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Small backyard organic waste dump				
2. Compost heap (organic waste that is regularly aerated)				
3. Landfill site with separate organic waste section				
4. General landfill dump				
5. Biochar production for organic waste				

Bio-digester

How it fits

The history or cultural use of the practice or technology.

1630 - Von Helmont found that flammable gases could evolve from decaying organic matter.

1667 - Shirley notes his findings on biogas then known as marsh gas. It is said that Marco Polo wrote about covered sewage tanks in China but it is unclear if they captured the gas and used it. Some sources also tell of the Assyrians and Persians using this gas to heat bath water in ancient times.

1808 - Sir Humphrey Davy found that methane was present in the gases that are formed by the anaerobic digestion of manure.

1884 - Louis Pasteur presents his student's work to the Academy of Science and tells how this gas can be used for heating and lighting. His student, Ulysse Gayon, performed the anaerobic fermentation of manure and water at 35°C and obtained 100 litres of Biogas per cubic meter of manure.

How it works

Bio-digesters are effectively anaerobic (no oxygen) digestion chambers. The anaerobic digestion occurs in two steps:

1. Organic matter is converted by hydrolytic and acidogenic bacteria to intermediate compounds such as acetic acid, carbon dioxide and hydrogen.
2. The intermediate compounds are converted to methane by methanogenic bacteria.

Anaerobic digestion is compromised when the two microorganism populations for the two steps are not in balance. Disturbances like sudden temperature changes, toxic substances, too much organic matter can result in a digester overload. The disturbances mainly affect methanogenic bacteria.

Bio-digester failure occurs when the bacterial populations are not in balance.

How is it used?

The bio-digester is fed by kitchen waste. Vegetable cuttings, fruit peelings and leftovers are used. These are chopped up into small pieces before they're put into the bio-digester. This allows for faster decomposition in the anaerobic environment. The process produces methane which is then used as an alternative fuel source to LPG (Liquid Petroleum Gas).

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"The anaerobic oxidation of methane is performed by at least two phylogenetically distinct groups of archaea, the ANME-1 and ANME-2. These archaea are frequently observed as consortia with sulfate-reducing bacteria, and the metabolism of these consortia presumably involves a syntrophic association based on interspecies electron transfer. The archaeal member of a consortium apparently oxidizes methane and shuttles reduced compounds to the sulfate-reducing bacteria. Despite recent advances in understanding anaerobic methane oxidation, uncertainties still remain regarding the nature and necessity of the syntrophic association, the biochemical pathway of methane oxidation, and the interaction of the process with the local chemical and physical environment" (Valentine 2002:271).

Audit

to check current practice related to this technology

Method of organic waste disposal currently used:

…………………………………………………………………………

Day	Amount of organic waste produced per day	Amount of organic waste composted per day	Amount of organic waste sent to landfill or dumped per day
1			
2			
3			
4			
5			
6			
7			

Calculate the total amount of organic waste produced in one year.

Investigation

experiment and model:

Build a simple model bio-digester using a 2lt plastic bottle.

1. Place 3 cups of finely chopped vegetable matter in a 2lt coke bottle and add a cup of water and leave for a day.
2. Place a balloon over the top of the bottle.
3. Wrap thick material around the bottle so that no light may enter the bottle.
4. Check the inflation of the balloon after a few days.

Plans and systems can be purchased from:

http://www.completebiogas.com/B_ARTI.html

www.agama.co.za

AGAMA Biogas 021 701 3364

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Small backyard organic waste dump				
2. Compost heap (organic waste that is regularly aerated)				
3. Bio-digester				
4. Biochar production for organic waste				
5. General landfill dump				

Vegetable Garden Tunnels

How it fits

The history or cultural use of the practice or technology.

Bush Pigs Education Centre in Limpopo are experimenting with a Green Tunnel System kit, but are also making liquid fertilizer using chicken manure and comfrey leaves. The manure and leaves are placed in separate bags and then into their own drum of water. The water is then used to 'feed' the plants using a small can as a measuring jug.

How it works

Simple small scale tunnel gardens provide the advantage of protection against the elements.

If a simple hydroponic system is used the advantage is extended to the benefits of a non nutrient growing medium and water saving regime.

The main principle of the tunnel is to protect against nature.

How is it used?

Small scale tunnels are erected so that they have substantial 'give' or movement. The local conditions determine the degree of support the tunnel will need.

The Green Tunnel System is a simple, kit form of growing your own vegetables. It is a small-scale, low-cost, shade tunnel that measures 9 x 4 meters and uses nutrient poor, river sand as a growing medium. A simple hydroponics system ensures water and nutrient optimisation in the tunnels. Seed or seedlings are planted above ground in bags. The liquid fertilizer is given to each plant twice daily. The shade cloth acts as protection from excessive heat, wind, rain and even hail (Source: Sakhisizwe Eco Developments cc, t/a Cairns Inc.CK 2007/009286/23).

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

"When the hagfish is provoked, slime oozes from the hundred or so glands that line its body. The secretion swells in contact with sea water until it forms a slimy cocoon around the fish. The glands also secrete fine fibres that reinforce the slime and allow it to stretch without breaking. Each thread is more than 2 inches (5 cm) long, but the hagfish employs a neat method to prevent tangling - the threads are played out from the glands in winding layers, like a nautical rope stacked into a figure eight" (Downer 2002:104-105).

Audit

to check current practice related to this technology –

Find out the 3 best growing vegetables in your area:

1...............................2...........................3.....................

Record the number of times in one week that you eat vegetables which **could** grow in a backyard garden

Day	Vegetable 1	Vegetable 2	Vegetable 3
1			
2			
3			
4			
5			
6			
7			

Calculate the number of times (on average) in one year you would eat the 3 vegetables identified.

Investigation

experiment and model:

Prepare and test liquid *Comfrey* fertiliser:

1. Grow enough Comfrey to supply leaves to fill a large orange or onion bag.

2. Fill the bag with fresh Comfrey leaves and tie the bag to hang in a large drum of water for 2 week.

3. Dilute the liquid fertilizer at 3 different concentrations:

- 1 part liquid to 10 parts water
- 5 parts liquid to 10 parts water
- 10 parts liquid to 10 parts water

4. Feed a test sample of spinach plants with the different concentrations of liquid fertilizer and compare results after 6 weeks.

Green tunnel garden kits can be purchased from Cairns Inc

(076) 558 2641 info@cairnsinc.co.za

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Home grown vegetables using herbicides and insecticides				
2. Home grown vegetables using organic insecticides and mulching				
3. Home grown vegetables using protective tunnel				
4. Purchase organic produce				
5.Purchase organic local produce				

Tyre Gardens

How it fits

The history or cultural use of the practice or technology.

The original container gardens were "hanging gardens". The containers did not actually "hang" but were plants that when planted would hang over the edge of the terrace or platform in which they were planted.
In 604 BC in Babylonia, on the banks of the Euphrates River, you would have found lush gardens overflowing with beautiful flowers and vegetation, seemingly just hanging off the stone columns above. Water streamed down from the top of the structure, watering all the plants from what seemed like an unending and unknown water supply.
From China to England: Pruning trees to become miniature versions of themselves while growing in a container was practiced as early as 200 A.D. in China. In 1660 in England, pineapples were growing well in containers found in greenhouses.
As early as 375 A.D. in Greece, there is proof of people having rooftop gardens. These were yet another form of container gardens, as such structures were usually placed in brick containers allowing plants to grow and flourish where they usually wouldn't. The National Museum of Scotland was noted for its beautiful rooftop gardens in the early 1700s.
Planting in pots therefore has a long history dating back to the first Egyptian, Roman and Oriental cultures. Tyre gardening is another method of container gardening which has the added advantage of helping to protect the environment by reusing vehicle tyres.

How it works

Tyre gardens are well suited to households that have limited yard space and require an efficiently laid out garden. They are also very useful in gardens with no soil or very poor soil.

A number of tyres stacked together are able to prevent soil erosion by holding back soil and establishing plant root systems which help bind the soil.

Tyre gardens and walls offer effective soil protection for tree root exposure, and have been known to reclaim and save old trees from root exposure.

How is it used?

1. Cut one side of the tyre off and fill the tyre with soil and compost.
2. Make sure the tyre is level as this helps with even drainage.
3. A plastic sheet can be placed under the tyre.
4. Plant vegetables, herbs, flowers or grasses in the tyre.
5. Water as often as needed. Mulching will reduce the need to water.

Potatoes can be planted in a tyre garden and as the plant grows about 20cm above the soil, a new tyre can be placed on top of the first tyre. The new tyre is filled with soil and compost almost covering the potato plant. This can be repeated for up to 4 tyres. As the plant grows, potatoes will develop through the entire tyre stack.

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

The Vetiver Grass System a is-low cost and efficient system for erosion control and water conservation, soil stabilization, pollution control, waste water treatment, mitigation and prevention of storm damage and many other applications. Vetiver Grass, *Vetiveria zizanioides*, (recently reclassified as *Chrysopogon zizanioides*) is the main component to all Vetiver Grass Systems based bioengineering and conservation applications. The grass is unique and can be used in the tropics and semi tropics, and areas outside the latter where there are hot summers, and winters that do not include permanently frozen soil conditions.

http://hydromulch.co.za/vetiver-grass.htm

Audit

to check current practice related to this technology

Determine how much of the food eaten it is possible to grow at home.

Record the types of foods eaten over a week that will grow in the area. Record the amount of the food for a week.

Day	Type of food eaten.	Amount of food.	Unit for food. (single item, cup, kg, packet)
1			
2			
3			
4			
5			
6			
7			

Investigation

experiment and model:

A tyre which is turned inside-out provides more volume and more space for plants. For vegetables, this provides a larger crop per tyre.

1. Cut one side (edging) of a tyre off. Use a short sharp blade such as a 'Stanley' knife.
2. Cut the rubber gently and smoothly with repeated cuts in the same groove. This is easier than trying a single cut through the rubber.
3. Turn the tyre inside-out (Hint: its a one person job and use a knee)

Most exhaust and tyre companies will gladly give used tyres away.

http://www.motto.org.za/tyregarden.pdf is a useful manual for building a tyre garden

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Home grown vegetables in a backyard garden				
2. Home grown vegetables in a tyre garden				
3. Locally grown vegetables from supermarket				
4. Locally grown organic vegetables form market				
5. Vegetables from supermarket – not local				

Mother Trees & Micro Nurseries

How it fits

The history or cultural use of the practice or technology.

A short book, The Man Who Planted Trees, tells the story of one shepherd's long and successful singlehanded effort to re-forest a desolate valley. The story is set in the foothills of the Alps near Provence during the first half of the 20th century. The story itself is so touching that many readers have believed that the shepherd was a genuine historical figure. The author, Giono, enjoyed allowing people to believe that the story was real, and considered it as a tribute to his skill as a writer. However, Giono himself explained, in a 1957 letter, that the man who planted trees was a fictional person. The aim of the story was to make planting trees likeable.

However, we have a local (and very real) example of a similar story.

Near the small KZN coastal town of Mtunzini a young farmer named Ian Garland began planting indigenous trees over 60 years ago. As a sugarcane farmer he became concerned that the streams on his farm were drying up even with good summer rains. He decided to stop growing sugarcane and began planting indigenous trees. What he has achieved is momentous. All the water ways for an entire catchment including wetlands have been rehabilitated. Ian Garland also started taking school children and teachers on 'nature outings' on his farm with the aim of teaching young people about their environment and ways of taking care of water resources through planting indigenous trees.

How it works

Mother Trees offer protection to young saplings which begin to grow in the shade of the Mother tree branches. Often the saplings are unable to mature, as they compete for light, water and nutrients from the Mother Tree itself.

Removing the saplings saves the young seedlings and increases biodiversity. The saplings are given the protection they need to grow to maturity through simple Micro Nurseries. The young trees can then later be planted in more suitable areas.

How is it used?

1. Dig up seedlings when the soil is damp.
2. Make sure the root hairs are not damaged by digging a generous amount of 'mother soil' with the young tree.
3. Re-plant the seedlings in pots or bags with extra soil and compost.
4. Water the seedlings to keep the soil damp.
5. Cover the seedlings with shade cloth
6. A micro-nursery provides a simple low cost mobile protective cover from the elements and animals.



Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

The principle of protection is in general 'natural' to trees! The form of protection trees offer varies according to the present need and thus the present value. As an example, protection from the sun on a bright day, protection from wind on a gusty day etc. The protection trees offer the seedings may be more than is first obvious – water through low evaporation rates, light but cool temperatures etc.

Audit

to check current practice related to this technology

Diversity is often an indication of healthy ecosystems. Healthy ecosystems provide services for which we seldom need to pay, like pollination, clean water, and clean air.

Conduct a biodiversity audit of the area. Record the type and number for each category

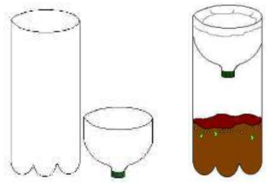
Animals including birds and reptiles	Number	Plants – trees bushes & shrubs	Number	Insects	Number

Investigation

experiment and model:

Build a model of an ecosystem in a bottle.

1. Cut the top section of a 2lt plastic bottle off.
2. Place soil and compost in the bottom third of the bottle.
3. Plant a few different types of small plants in the bottle.
4. Water the plants with about a cup of water – not too wet.
5. Replace the top section by inverting it into the bottle and seal it with wide tape.
6. Leave in a sunny spot to grow.



This model could represent the Earth. How are the plants able to live in the sealed system? The CO_2 concentrations would decrease every day and increase every night, why would this happen?

Shade cloth can be purchased from most hardware stores.

Orange fruit bags sewn together make very good shade cloth.

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies.

3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1. Collecting and planting Mother Tree seedlings				
2. Collecting and giving away Mother Tree seedlings				
3. Purchasing and planting indigenous plants				
4. Propagating indigenous plants				
5. Purchasing and planting exotic plants				

Name of Technology or Practice:____________________

How it fits

Describe the history or cultural use of the practice or technology

How it works

Find out about the principle which enables this technology to function

Draw a diagram of the technology or practice

How is it used?

Describe a way to use this practice or technology

Nature's solutions

Example of the principle enabling this technology in nature - www.asknature.org

Audit

to check current practice related to this technology

Day			
1			
2			
3			
4			
5			
6			
7			

Investigation

experiment and model: Design simple experiments to test the range of this technology

Contact details

for further information or availability

Innovative practice or technology

Use the table to score **risks** and **impacts** of the practices and technologies

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	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1.				
2.				
3.				
4.				
5.				

Name of Technology or Practice:____________________

How it fits
Describe the history or cultural use of the practice or technology

How it works
Find out about the principle which enables this technology to function

Draw a diagram of the technology or practice

How is it used?
Describe a way to use this practice or technology

Nature's solutions
Example of the principle enabling this technology in nature - www.asknature.org

Audit

to check current practice related to this technology

Day			
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1.				
2.				
3.				
4.				
5.				

Name of Technology or Practice:____________________

How it fits
Describe the history or cultural use of the practice or technology

How it works
Find out about the principle which enables this technology to function

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Nature's solutions
Example of the principle enabling this technology in nature - www.asknature.org

Audit

to check current practice related to this technology

Day			
1			
2			
3			
4			
5			
6			
7			

Investigation

experiment and model: Design simple experiments to test the range of this technology

Contact details

for further information or availability

Innovative practice or technology

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3=Significant, 2=Moderate, 1=Slight, 0=None

	Quality of life enhanced 	Resource use reduced 	Ecological services restored 	Carbon footprint mitigated 
1.				
2.				
3.				
4.				
5.				

Notes

WESSA Share-Net Resources

HANDS-ON SERIES (field guides to ecosystems) • Stream & Pond Life (Z) • Soil and Compost Life (Z) • Grassland Life (Z) Common Household Life • A Forest Community (Z) • East Coast Estuaries and Mangroves • Life around a Waterhole • East Coast Rocky Shores • East Coast Reefs • East Coast Dune Plants • East Coast Sandy Shores • Schoolyard Life • Vlei and Marsh Wetlands • Fynbos life

BEGINNER'S GUIDES • Common Freshwater Fishes of KwaZulu-Natal • Common Marine Fish • Ferns of Ferncliffe: a rambler's guide • Some Common Spiders • Owls • Dragonflies and Damselflies • Some Common Trees of the Okavango • Trees of the Umgeni Valley • Some Common Waterbirds • Common Butterflies • Seaweeds (Algae) • Highveld Spiders • Common Orchids • Flowers of the KZN Midlands Grasslands • Equip. for Measuring Weather Conditions • Marine Reptile life of southern Africa

WATER RESOURCES • SWAP Starter Kit • miniSASS Sheets • Water Quality Monitoring in southern Africa • Wetlands Pack • Water Supply Services in KZN: an overview of legislation • Peatlands in South Africa • Wetlands and People • How Wet is a Wetland?

TEACHERS' GUIDES • Soil is Life! • Water is life! • Forest Fun • Arbor Day • The Greenhouse Effect • Creative Encounters (Jnr Primary) • Nocturnal Encounters (Snr Primary) • Making Meaning (Trail Tips) • Learning to Grow - Books 1, 2 and 3 • "Wild about Birds" Pack • Energy for Keeps • Hadeda Island Curriculum Pack • Water - school lesson plans (grades R to 12) • Puzzling Climate Change: A start-up pack of pictures • Fat Plants and Thin Plants • People, Biodiversity Patterns and Ecological Processes • My Carbon Footprint (auditing our electricity, travel, water use, waste and food) • Waste Education in Schools (Packs for Foundation, Intermediate and Senior phases) • Waste Resource Pack • Learning Support Materials for Rural Health and Sanitation • The Organic Classroom: foundation phase • Ideas for Energy Projects • Nutrition in Schools • Science on Sea: Grades 7-12 • The Treasure Chest: an educator's guide • Puzzling Climate Change: A start-up pack of pictures • Taxonomy and classification ... the backbone to biodiversity knowledge • Handprint Resource Books: Action towards sustainability - Creative garden design; The buzz on honeybee economics; Recycling, waste reduction and creative re-use; Have you sequestrated your carbon? Worming waste; The secret of a spring; Did you grow your greens? The secret of a disappearing river; Reusing shower and bath water; Clearing invasive weeds; Growing mother-tree seedlings; Rooibos: a biodiversity economy at risk. (*Z- Zulu supplements)*

HOW TO SERIES: a set of 8 instruction sheets for practical projects, such as How to make a trench garden.

From Food & Trees for Africa • The Permaculture Booklet • My Nursery (how to set up and run a community nursery) • The Greening Booklet (a general guide to planting trees in SA)

INDIGENOUS KNOWLEDGE SERIES • Series of 4 South African Stories: *From Grain Pits to Silos*; *Trees, Goats and Spirits; Beer, Ants and Ancestors; Sweet Water* • IK EEASA Monograph (1999) • IK Systems in EE within Communities in Southern Africa • Schools within the Community • Collection of IK perspectives – Tanzania • Tales of Indigenous Trees of Zimbabwe • Soil conservation through IK practices in Swaziland

ACTION SERIES • 28 Alien Plant Invaders in KZN • Eradicating Invading Alien Plants (KZN) • Riverine Vegetation in Natal • Management and control of invasive alien plants • Health Gardening • Growing iNcema • Knowing and Growing Muthi Plants • Greening the KwaZulu-Natal Coast (Z) • Greening the KwaZulu-Natal Midlands • Hack Attack Pack • Grasslands • Greening SA Schools • Veldcare • Sustainable Urban Greening Strategies

OTHER RESOURCES • 60 Enviro Fact Sheets • Enviro-Picture Building Games & Puzzles • Eco Puzzles (environmental board games) • Eco-Office Kit • The AIDS Healer • E-Info Box • A Tale of our Tree World • Action Bingo • Vanishing Species: SA's Threatened Invertebrates • Eco Footprint Game • Household Environmental Management • Sustainable Development for Durban • Dictionary of Popularly Traded Plants • Bridging the Gap (handbook with ideas and activities for env. interpretation • Interactive Drama for Env. Educators • A quiet time: creative solitaire writing • Remnants (poems) • A sense of wonderful (poems) • African ecological footprint challenge • Eating for the Earth (vegetarian recipes) • State of the Environment in SA for Schools • SA guide for producing a State of the Environment Report

EE AND OBE RESOURCES • Environment and Methods (Trends in EE) • Environment, Development and EE • Enviro Clubs Action Pack • Enabling EE: Guidelines for EE Policy & Strategy in SADC States • Developing Curriculum Frameworks • Environment & Active Learning in OBE • Enabling EE Processes in Teacher Ed • Lesson Planning for a Healthy Environment • Methods, Activities & Theories for EE Centres • Eco-Schools Toolkit • EE, Ethics & Action: a workbook to get started • Teacher Education Workbook for Environment & Sustainability Education (Book and CD)

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Stepping Up to Sustainability

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'Sustainability Commons' across South Africa

A 'Sustainability Commons' is a rich and diverse pool of sustainability-focused learning, technologies, and tools; whose resources are deployed locally for the benefit of the community and the environment.

A 'Sustainability Commons' is more than a physical space. It is the culmination of historical trends and practices within the field of environmental education; it is an experiment in social learning, and an argument for and against science and technology. It is a meaning- making exercise in facing environmental risks, and a movement towards social ecological justice through sustainability practices. It supports the communal 'moments' of learning.