

Multiple challenges!

- ◆ Climate change
- ◆ Oil supply and price
- ◆ National and international security
- ◆ Air quality
- ◆ Sustainable development

Intergovernmental Panel on Climate Change

has forecast that by 2100 (relative to 1990) :

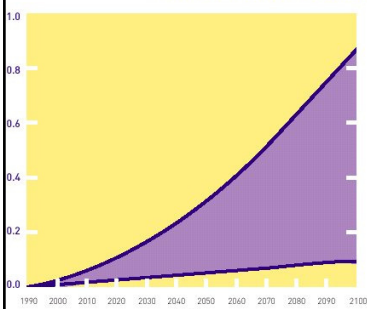
- ◆ mean surface temperature rise of 1.4 to 5.8 C
- ◆ global mean sea level rise of 9 – 88 cm
- ◆ More rain N. hemis (mid+high lat.) and Antarctica
- ◆ extreme events (drought, floods, tropical cyclone) more severe and more frequent
- ◆ less snow and ice cover
- ◆ weakened density-driven ocean currents

Increased extreme climatic events



DROUGHT, BUSHFIRES, CYCLONES, FLOODS....

FUTURE SCENARIOS FOR GLOBAL WARMING



Based on a range of possible future scenarios for global warming, scientists predict that sea levels will rise between 9 and 88 cm by the year 2100 as oceans expand and glaciers melt.

These graphs have been adapted and simplified from the Intergovernmental Panel on Climate Change Third Assessment Report 2001. The original graphs can be accessed at: www.ipcc.ch/





GARNAUT CLIMATE CHANGE REVIEW
INTERIM REPORT TO THE
COMMONWEALTH, STATE AND
TERRITORY GOVERNMENTS OF
AUSTRALIA
Interim Report February 2008
Final Report September 2008

Global mean surface temperature increase since 1990 has been measured at 0.33°C, which is in the upper end of the range predicted by the IPCC in the Third Assessment Report in 2001.

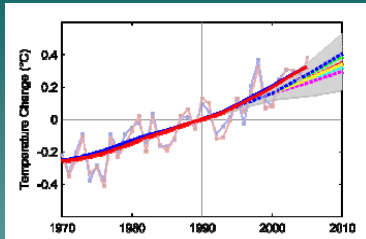
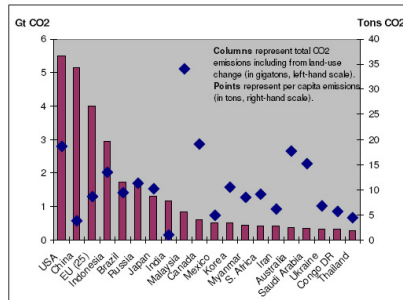


Figure 5: Observed temperature data against IPCC predictions
Future temperature as projected by the IPCC in 2001, indicated by the grey regions and dashed lines. The oscillating solid lines show observed changes in annual global-mean land and ocean combined surface temperature from GISS (red) and Hadley Centre (blue), with their trends shown in bold.
Source: Rahmstorf et al. (2007).

Figure 8: CO₂ emissions including land-use change, 20 largest emitters, and per-capita emissions



Note: Total emissions combine fossil fuel emissions for 2004 and land-use change emissions for 2000. Per capita emissions divide this total by 2004 population. Note that estimates of land-use change (deforestation) are subject to large uncertainties in many of the main emitting countries.

Data source: World Resources Institute.

Garnaut Review: Final Report

- ◆ Two alternative stabilisation goals analysed:
 - 450 ppm CO₂-e. Offers 50% chance of limiting the global mean temperature increase to +2°C above pre-industrial levels, already endorsed by the European Union in 2007
 - 550 ppm CO₂-e. Likely to lead to an equilibrium global mean temperature of +3°C above pre-industrial levels
- ◆ Report hedges bets between these two goals
- ◆ **We really need to go for 450 ppm!**

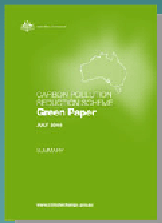
Garnaut Review: Final Report

Achieving the 450 ppm level will require following targets:

- ◆ 25 per cent reduction in emissions by 2020 from 2000 levels
- ◆ 90 per cent reduction by 2050 from 2000 levels
- ◆ Note both of these are substantially higher than what had previously been canvassed (20% by 2020, 60% by 2050)
- ◆ **But escape clause:** go for only -5% by 2020 if no comprehensive agreement in Copenhagen in 2009

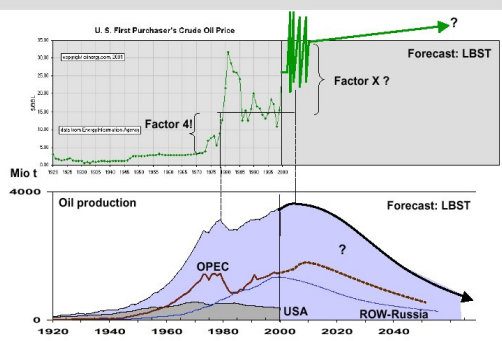
Australian Government Position:

- ◆ Reduce global greenhouse by 60% compared to 2000 by 2050 (adopted December 2007)
- ◆ Reinstated Mandatory Renewable Energy target: 20% extra renewables in electricity supply by 2020.



- Introduce Carbon Pollution Reduction Scheme legislation into Parliament in 2009
- Passage of the Bill by mid 2009, with consultation on regulations
- Scheme starts in 2010
- **Impact on fuel prices depends critically on 2020 target!**

Oil price and oil production



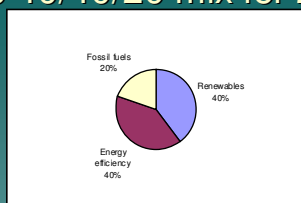
Yesterday's crude oil price (Nymex crude future): \$83.26 /bl

L-B-Systemtechnik

- ◆ We are in the midst of an historic conflict between obsolescent fossil fuel based technologies and industries and the nascent energy efficiency and renewables alternative

Energy efficiency and renewable energy can do it!

The 40/40/20 mix for 2050

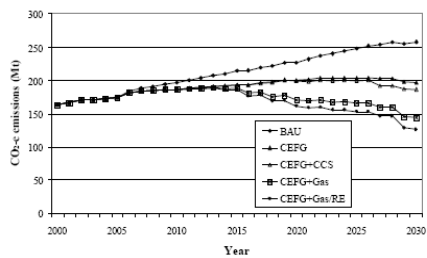


- Steadily phase out coal, both brown and black. **I do not believe Carbon Capture and Storage will be an economically viable and physically practical means of reducing the net emissions from hundreds if not thousands of 1000 MW coal power stations worldwide**
- No need for nuclear power



Kilcunda ~1974

Figure 9 CO₂ emissions from coal-fired electricity generation: BAU, CEF, CEF+CCS, CEF+Gas, CEF+Gas/RE



Source: Saddler, H., Riedy, C. and Passy, R., 2004, Geosequestration: What is it and how much can it contribute to a sustainable energy policy for Australia, The Australia Institute, Discussion Paper No. 72, Pg 44

BAU: Business as usual CEF: Clean Energy Future Group CCS: carbon capture and storage

Table 12 Current generation and abatement costs of low emission electricity generation technologies

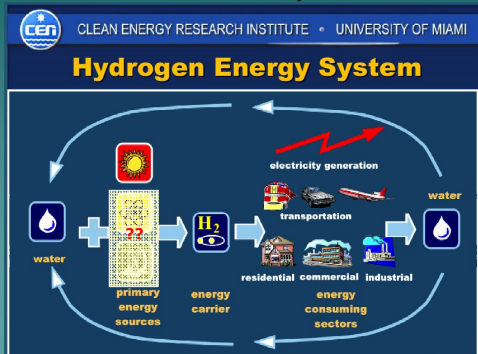
Generation technology	Generation cost (\$/MWh sent out)	Marginal abatement cost (\$/tonne CO ₂ -e)
CCGT	40-42	12-21
Wind	75-90	51-71
Black coal IGCC + CCS	100 (middle of range)	53-110

Source: Saddler, H., Riedy, C. and Passy, R., 2004, Geosequestration: What is it and how much can it contribute to a sustainable energy policy for Australia, The Australia Institute, Discussion Paper No. 72, Pg 50

CCGT: combined cycle gas turbine

IGCC: integrated gasification combined cycle

The vision: a sustainable hydrogen economy?



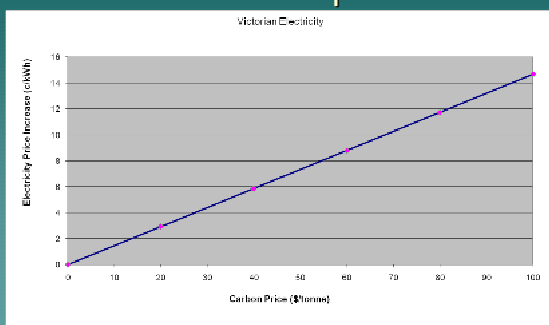
Is your business ready to tackle the challenges posed by climate change?

The challenges

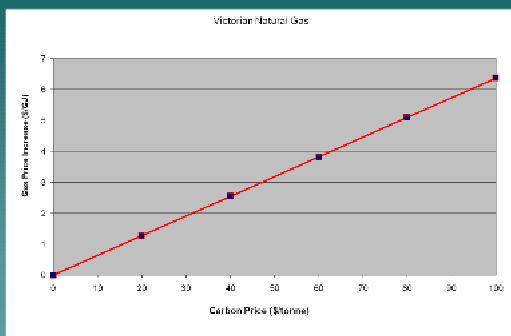
- ◆ Rising conventional fuel prices arising from Emissions Trading Scheme and other factors
- ◆ Growing the business while meeting emission reduction targets (ultimately zero!) and other governmental regulatory requirements
- ◆ Structural economic changes arising from national and global response to climate change
- ◆ Seizing new business opportunities created by this response
- ◆ Professional development and training of staff in sustainable practices
- ◆ Creating a sustainability culture in your firm

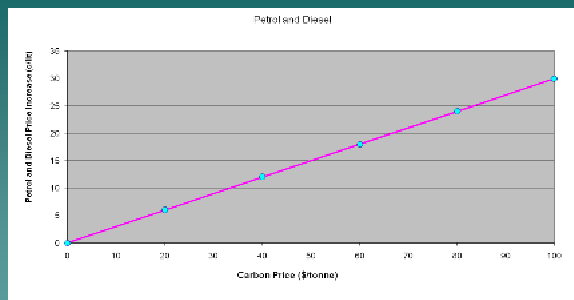
Rising conventional fuel prices due to Emissions Trading Scheme and other factors

Impact of carbon price on Victorian fuel prices



Current industrial electricity price = 10 c/kWh





Growing the business while meeting emission reduction targets (ultimately zero!) and other governmental regulatory requirements

Deep cuts (up to 90% compared to 2000) in greenhouse gas emissions by 2050 are now seen as essential to avoid catastrophic climate change

globally
nationally
by **each company/organisation**
individually

The Northern Hospital
Epping, Victoria



Student: Tom Doherty and Low Eng Wah

Project Aim:

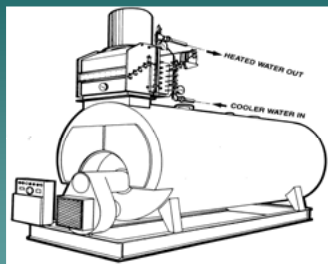
- ◆ **To reduce energy used for water and space heating**
- ◆ **Solar water heating**
- ◆ **Economisers for boilers**

The Northern Hospital: Outcomes 1

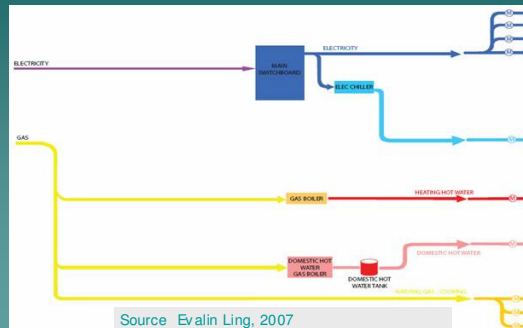
- ◆ Flow control valves could cut hot water consumptions by 35%, and greenhouse emissions by 70 Tonnes CO₂-e/year
- ◆ Solar water heating plus demand management would save an additional 58 tonnes/year
- ◆ Total emission reduction ~1% of hospital's total
- ◆ Total investment: \$210 000
- ◆ Payback period: Flow control valves - 2 years; solar water heating - just over 10 years

The Northern Hospital: Outcomes 2

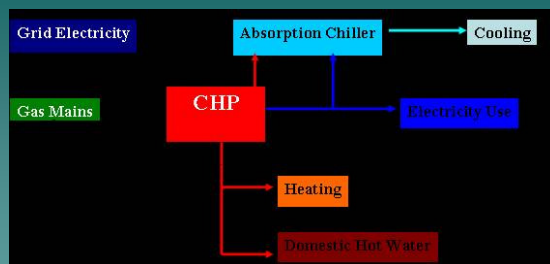
- ◆ Installation of an economizer on the main boiler supplying hot water for both space and domestic water heating would reduce total emissions by up to 60 Tonnes/year
- ◆ Capital cost \$25 000
- ◆ Payback period ~5 years



Conventional or 'tri-generation'?



Tri-generation



Note Printing Australia Ltd (Cragieburn, Victoria)



- ◆ A global producer of currency and security products supplying Australia with polymer currency and passports.
- ◆ Alex Kim project:
 - Reduce emissions by cutting spoilage rate
 - Rationalise boilers

Note Printing Australia Ltd: Outcomes

- ◆ Reduce spoilage rate from 15% to 5%
- ◆ Cut greenhouse gas emissions by ~ 70 Tonnes CO₂-e /year, plus additional reductions due to lower usage of inks and polymer substrate
- ◆ Capital cost \$1.3 m, annual savings ~\$3 m
- ◆ Payback: less than 6 months

P&O Ports: West Swanson Terminal

- ◆ Reducing diesel fuel consumption and greenhouse gas emissions of straddle carriers
- ◆ Student: Tasman Higgins



P&O Ports: Outcomes

- ◆ Limiting the over-lifting of containers reduces greenhouse gas emissions by approximately 150 tonnes annually
- ◆ Installing limit switches to each machine: \$7,500
- ◆ Annual fuel saving \$80,000
- ◆ Payback period: just over one month

ORICA LAVERTON PLANT

- ◆ Produces chlorine through electrolysis
 - High electricity consumption
 - Emissions well over 100 000 tonnes/y
 - produces hydrogen gas as a by-product
- ◆ Student: Andrew O'Dea
- ◆ Using vented hydrogen for electricity production and heat

Greenhouse gas reduction options

Utilise wasted hydrogen to offset electricity and gas consumption by:

- producing electricity through:
 - ◆ a fuel cell, or
 - ◆ a gas turbine generator
- reducing natural gas usage by fuelling the boiler with hydrogen

PEM hydrogen fuel cell



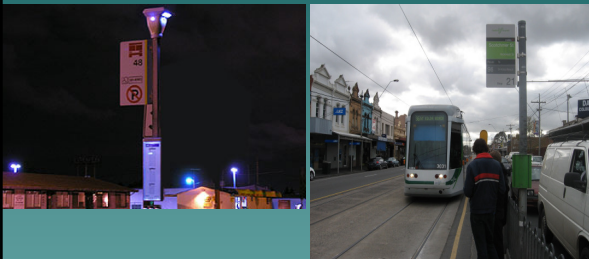
- ◆ Electrochemical device (no burning)
- ◆ Latest technology
- ◆ No CO₂ emissions
- ◆ Produces electricity and hot water

Potential savings

	Annual CO ₂ reduction	Payback period
Fuel cell	~20 000 tonnes	~ 5 years
Gas turbine	~12 000 tonnes	~ 3 years

*** Solar-hydrogen system demo

Solar Lighting at Tram Stops for Yarra Trams: Student: Andrew Devene



Yarra Trams: Outcomes

Environment

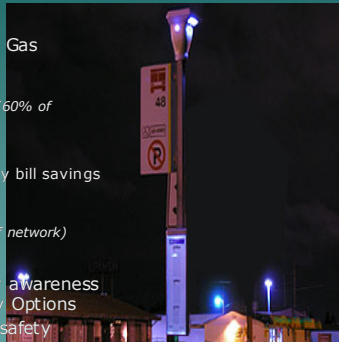
- Potential Greenhouse Gas Emission savings:
 - 328 kg CO₂-e/yr/light
 - 335 tonnes CO₂-e/yr (60% of Network)

Financial

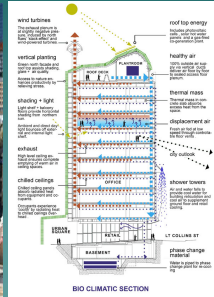
- Estimated Annual energy bill savings (\$0.08/kWh):
 - \$60/year/light
 - \$60,373/year (60% of network)

Social

- Increased community awareness of Sustainable Energy Options
- Increased security & safety



Passive solar conservation building design



Melbourne City Council CH2 building, 218-242 Little Collins Street

Source: <http://www.melbourne.vic.gov.au/info.cfm?top=171&pg=1933>

Passive-solar conservation building retrofitting

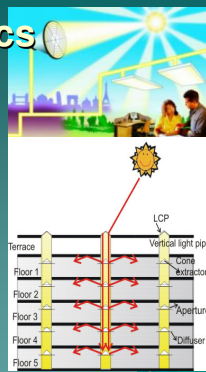


Szencorp building, 40 Albert Rd, South Melbourne

Source: <http://www.ourgreenoffice.com>

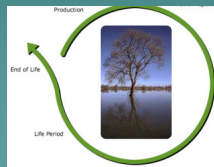
Helioptics

- ◆ Roof mounted Heliostat collects sunlight
- ◆ Sunlight is beamed down vertical light-pipes
- ◆ Light is then drawn off at each level
- ◆ And can be siphoned off at desired point
- ◆ System is passive and
- ◆ Can be installed easily
- ◆ A backup lighting system is required

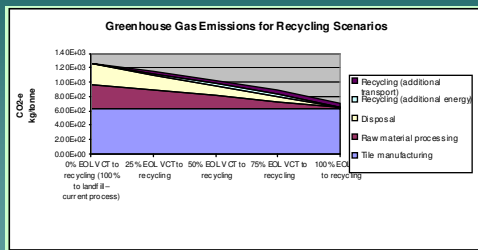


Source: Habagaan, 2006

Comparison of Environmental Impacts of vinyl tiles made from virgin and recycled materials using Life Cycle Assessment

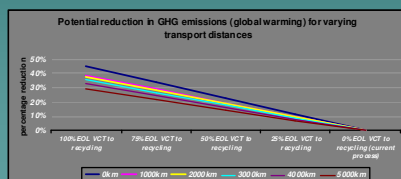


Life cycle greenhouse gas emissions



Potential reduction in environmental impacts through recycling

	Global warming	Carcinogens	Landfill	Non-renewable resources
100% EOL VCT to recycling	-45%	-71%	-95%	-60%
75% EOL VCT to recycling	-34%	-53%	-71%	-45%
50% EOL VCT to recycling	-23%	-36%	-47%	-30%
25% EOL VCT to recycling	-11%	-18%	-24%	-15%
0% EOL VCT to recycling (current process)	0%	0%	0%	0%



Conclusions

- Annual Greenhouse Saving of **2,716 tonnes CO₂-e**
 - Recycling 70 – 80% tiles
 - Average distance from store to plant of 1,500km
- Life cycle assessment assesses all the environmental impacts associated with a product, process or activity during its lifetime
- Require a combination of support tools to evaluate social and economic aspects eg. risk management & cost-benefit analysis

Wind power for Honda at Tullamarine?



Diameter of no more than 10 m would be realistic



Project Scope

- ◆ Two projects with the following aims:
 1. Algae growing, harvesting and processing into oil and biomass.
 2. Bio-solid utilisation to generate heat/electricity.

Minis Patankar - S.0176580 - 7/25/2016

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A Commonwealth Government cooperative program with industry to encourage greenhouse gas abatement

The Australian Greenhouse Office (Now Dept of Climate Change) has provided funding over the past five years for RMIT and the northern region's business network, NORTHLink, to help firms in Melbourne's north reduce their greenhouse gas emissions

2007 program achievements

- ◆ annual fuel savings of up to \$1 million if all recommendations implemented
- ◆ annual emission reduction of 46 000 tonnes (all measures investigated); 27 000 tonnes (neglecting long payback measures)
- ◆ for just over \$4 million investment

GH Program: Firms hosting projects 2008

- ◆ Armstrong World Industries
- ◆ Ferguson Plarre
- ◆ Honda Australia
- ◆ Melbourne Water
- ◆ Linfox
- ◆ NCI
- ◆ Royal Botanical Gardens
- ◆ RMIT Property Services
- ◆ Shire of Nillumbik
- ◆ Visy
- ◆ Willow Ware
- ◆ V/Line

To participate in the RMIT-NORTHLink Greenhouse Challenge program next year

- ◆ Contacts:
Dr John Andrews, SAMME
RMIT University
Ph: 03 9925 6085
john.andrews@rmit.edu.au
- ◆ **Mick Butera**, NORTHLink, 03 9479 3337;
m.butera@latrobe.edu.au

Structural economic changes arising from national and global response to climate change

- ◆ Energy efficiency and renewables growth
- ◆ Coal and oil industry decline?
- ◆ Zero/low emission vehicle industry growth; conventional vehicle decline
- ◆ Biomass resources and technologies?
- ◆ The renewable-energy hydrogen economy
- ◆ Recycling industry growth

Seizing new business opportunities created by this response

- ◆ Sustainable energy and emission reduction technologies and services (energy efficiency, cogen/trigen, solar, wind, biomass, geothermal, tidal, wave...)
- ◆ Enhancing reputation of your firm by being a leader in emission-reduction
- ◆ Early adopters of low-emission technology will position themselves for cost-competitiveness as carbon price rises

Professional development and training of staff in sustainable practices



M Eng (Sustainable Energy) at RMIT

- ◆ By coursework
- ◆ 1.5 y full time, 3 y part-time
- ◆ Graduate Certificate (1 y part time) and Graduate Diploma (2 y part-time) options
- ◆ Now over 60 students enrolled
- ◆ Students have got jobs in wind energy companies, energy consultants, government agencies, local government, energy distribution businesses

Expert presenters

Dr Sukhinder Battoo

Chief Research Scientist, CSIRO
Energy Technology, leader of
hydrogen fuel cell group, on
hydrogen

Professor Robin Barthelemy, RMIT
(formerly Chief Government
Scientist), on energy futures and
carbon geosequestration

Professor Adrian Bradbrook
University of Adelaide, on
sustainable energy law

• **Brian Barnett**
Senior Consultant, Sinclair Knight
Merz, on geothermal energy

◆ **Alan Pears**
Sustainable Solutions, energy
efficiency

◆ **Deni Greene**,
Deni Greene and Associates

Ken Guthrie, Principal Project
Manager, Sustainability
Victoria, on solar thermal
systems

Geoff Andrews, Director, Genesis
Now, passive solar
conservation building design

Graham White, Garrad Hassan,
on wind power and wind farm
design

Ron Mendelsohn, Director,
Sunspun, on biomass fuels

Dr Patrick Moriarty, Department
of Mechanical Engineering,
Monash University, on
sustainable transport





Creating a sustainability culture in your firm

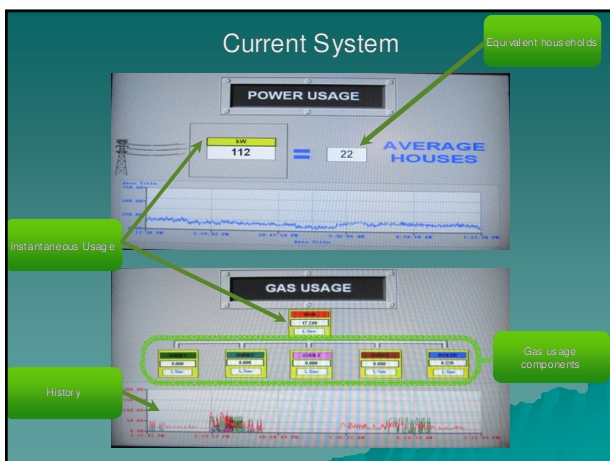
Energy Monitoring System Ferguson Plarre Bakery

◆ Iain Pople



Background

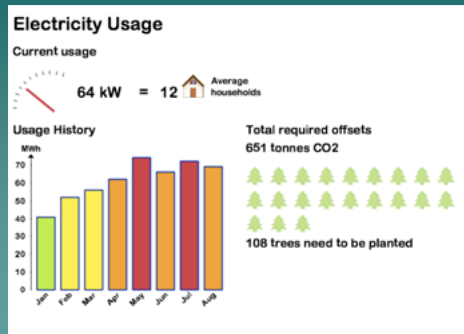
- New bake-house factory built to be energy efficient
 - Heat recovery from refrigeration system
 - Rainwater tanks
 - Solar hot water
- Energy Monitoring System installed to raise staff consciousness of energy use
- Project aims to evaluate current system and make recommendations for improvement



Design Approach

- Incorporate feedback from staff survey and principles of 'eco-visualisation'
- Simplify display
- Use colours to catch eye and add meaning to data
- Use familiar visual elements
- Use units that are meaningful to people

New Design



Benefits

- Studies have shown that providing realtime feedback on energy use can reduce consumption by up to 12%
(McClelland, L & Cook 1980)
- Potential reduction in greenhouse emissions of 84 tonnes annually
- Annual savings of \$10,000. Simple payback period of 3 years.

Questions, comments, examples
of what you are doing?