Temperature Improvement Project

Tangentyere Council Inc.

Sponsored by Virgin Unite

Data Analysis from Temperature & Power Monitoring Equipment

12th of September 2011 : HEALTHABITAT

Background

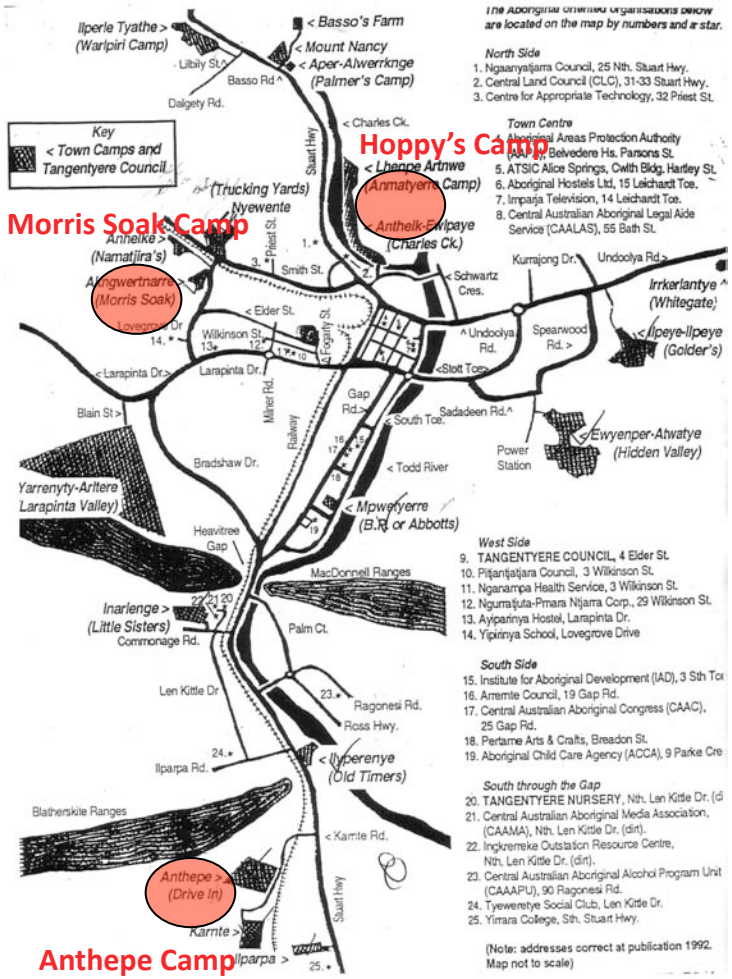
Between 10th-13th of March 2009 temperature & power monitoring equipment was installed in four houses across three different Alice Spring Town Camps, see diagram right. The four selected houses provide a cross section of differing house types, household sizes and levels of previous solar upgrade work.

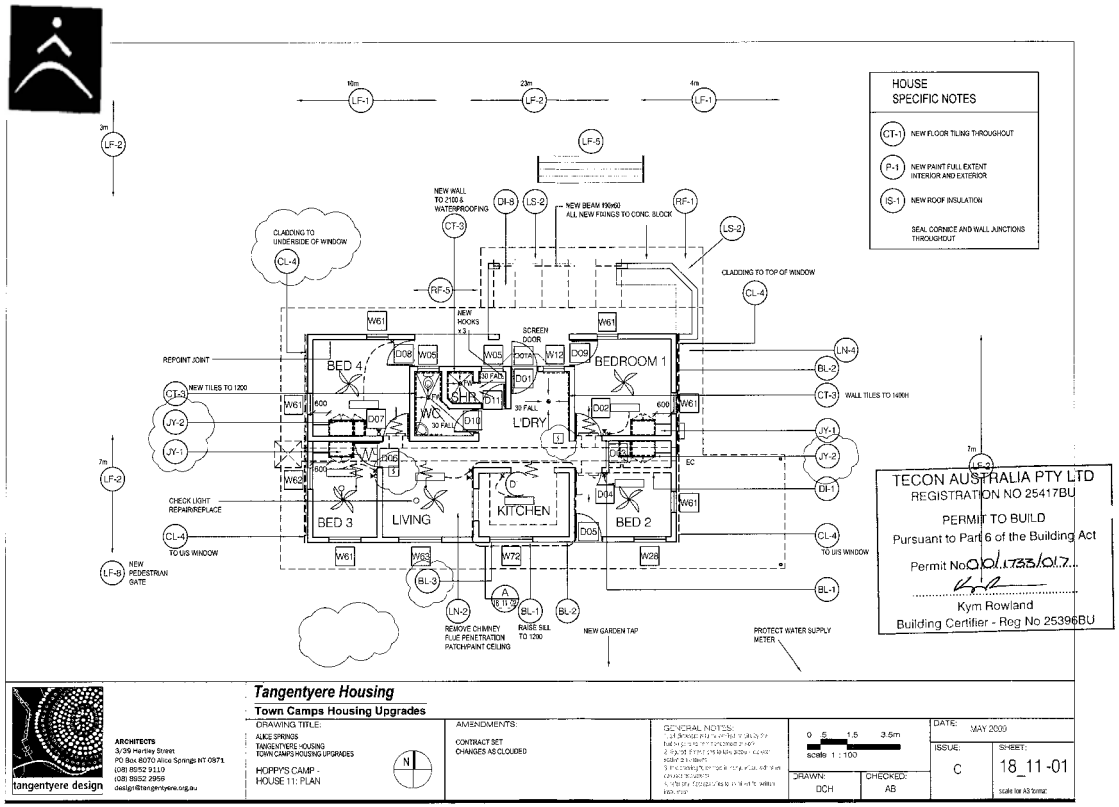
This project carries on from previous Temperature Improvement Projects undertaken by the FHBH Research & Development Project, in which the thermal environment of habitable rooms were monitored, evaluated, and a strategy for thermal improvement through architectural modifications was proposed, built and evaluated.

The current project examines the additional factor of electricity consumed in moderating the internal environment of the houses. It is anticipated that this data will assist in the design and quantitative evaluation of mechanical-based thermal improvements proposed for the four subject houses and a number of other Town Camp residences.

The following report documents works relating to thermal upgrades only (not the full scope of upgrade works), analysis of data before & after modifications were made to houses & energy use of active heating & cooling systems.

Special thanks to Tangentyere Design for providing drawings, information & photos.





House Tan 1 before thermal upgrades west elevation

House Tan 1 after thermal upgrades west elevation. New shade wall, new ducted evaporative cooling system, new pergola roof to north

House TAN1

4 bed single storey concrete block, slab-on-ground, verandah to 2 sides, no thermal upgrades prior to current project

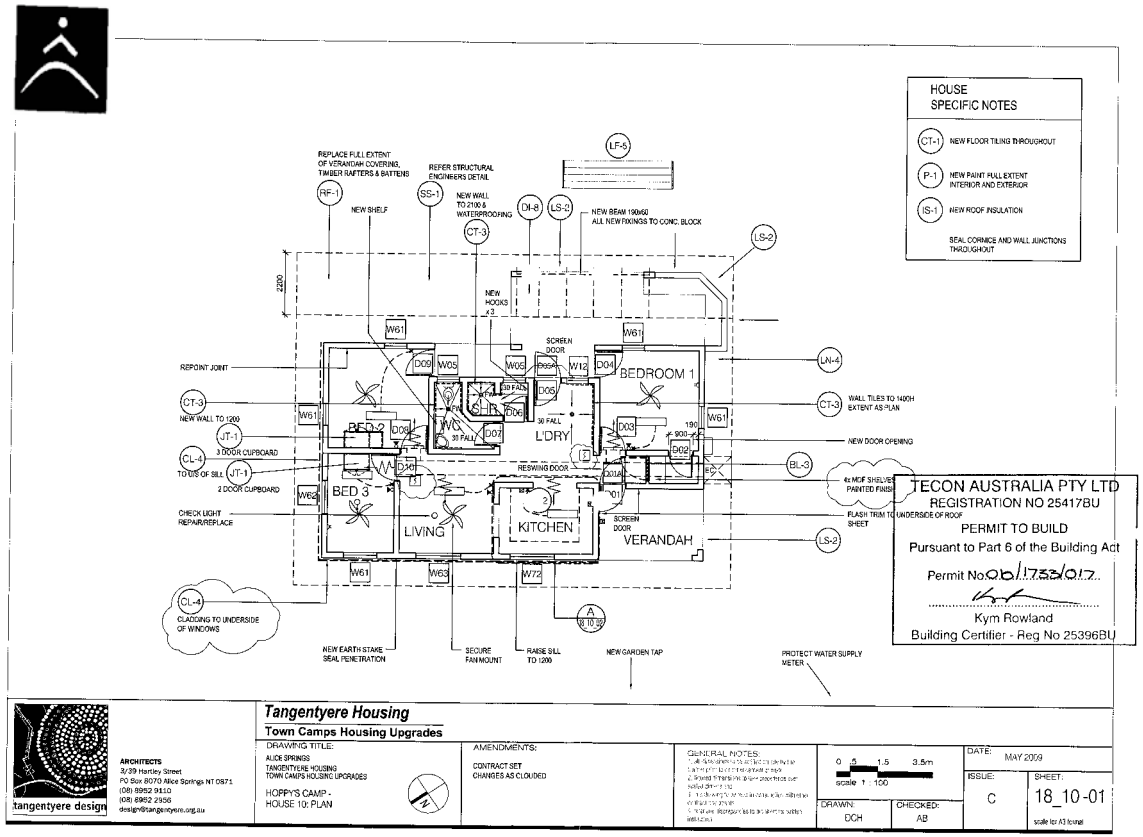
New works affecting thermal performance: (not full scope of works)

Passive heating & cooling

- new roof insulation
- new shade wall (new colorbond cladding on battens with aircell behind to underside of windows to west & east - above windows as well to east)
- new roof cladding to pergola to north
- seal cornice & wall junctions throughout
- new paint full extent interior & exterior
- new floor tiling throughout
- new screen door, new external front door
- new windows throughout
- repair/ new fence/ new pedestrian gates etc.(yard works)

Active heating & cooling

- new ducted evaporative cooling system & 4 new ceiling mounted fans
- new ceiling mounted radiant heaters in bedrooms, kitchen & living (6 total)



House TAN2

3 bed single storey concrete block, slab-on-ground, verandah to 2 sides, no thermal upgrades prior to current project

New works affecting thermal performance:
(not full scope of works)

Passive heating & cooling

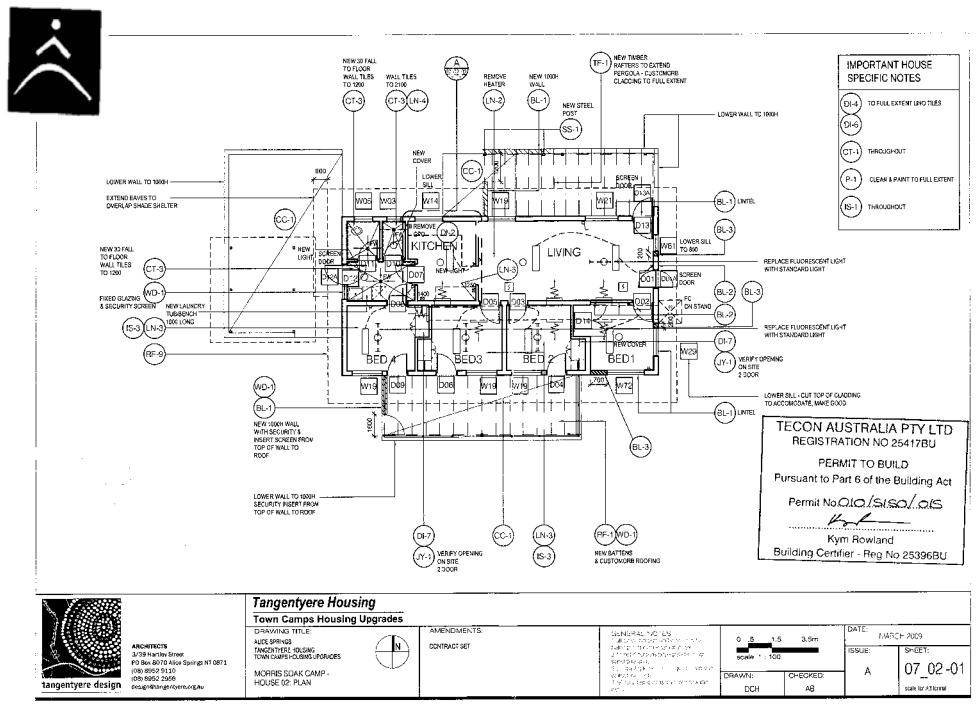
- new roof insulation
- new shade wall (new colorbond cladding on battens with aircell behind to underside window to north east & north west wall)
- new verandah covering, timber rafters & battens
- seal cornice & wall junctions throughout
- new paint full extent interior & exterior
- new floor tiling throughout
- new screen doors
- new windows throughout

Active heating & cooling

- new ducted evaporative cooling system & 3 new ceiling mounted fans
- new ceiling mounted radiant heaters in bedrooms, kitchen & living (5 total)

House Tan 2 before thermal upgrades

House Tan 2 after thermal upgrades - new evaporative cooling system, new shade wall



House TAN3

4 bed single storey concrete block, slab-on-ground, verandah to 3 sides including new thermal upgrade shade structure to west, wall shade to north & east as part of previous temperature control project

New works affecting thermal performance: (not full scope of works)

Passive heating & cooling

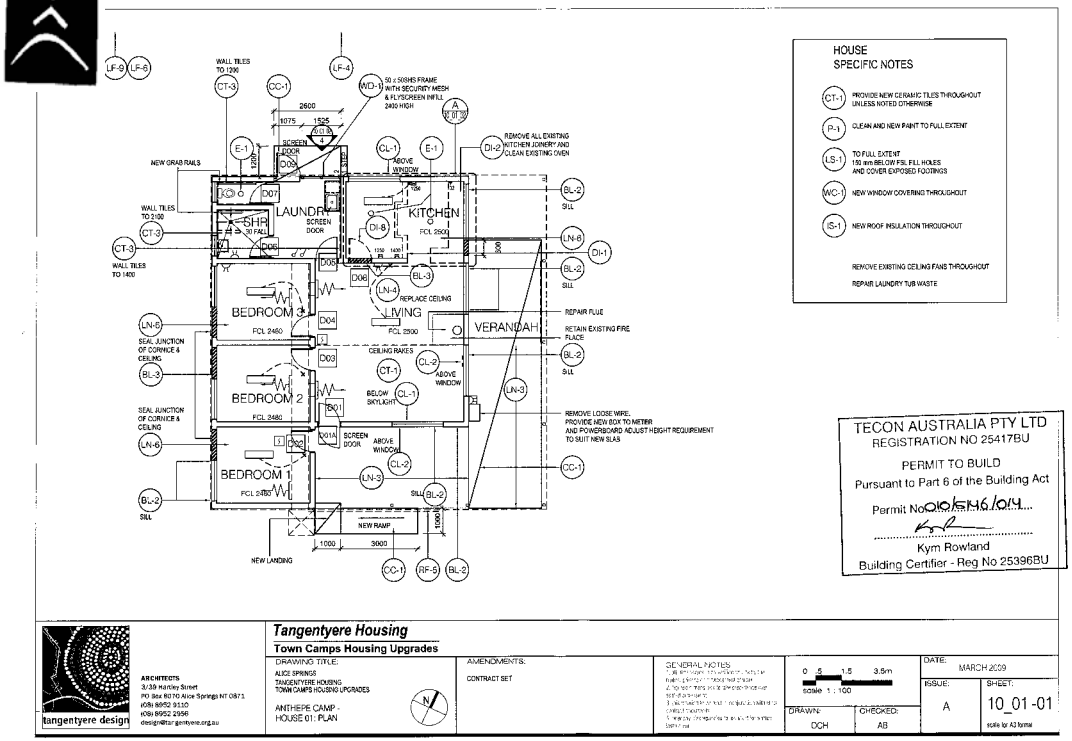
- new roof insulation
- existing pergola- (previous temperature control project) new slab, wall lowered
- new low wall to south external area, security insert from top of wall to roof, new slab, new customorb roof lining
- north external area- new timber rafters to extend pergola, customorb roof, new low wall
- lino tiles to full extent
- Repair/ replace cornice
- clean & paint to full extent
- New crimsafe security screens where indicated
- new ceiling insulation & new panelrib lining to bedrooms
- new/ repaired blockwork where indicated
- repair or replace external doors , new screen doors where indicated
- new windows, lower some window sills
- remove heater in living room

Active heating & cooling

- new ducted evaporative cooling system, 4 existing ceiling fans retained
- new ceiling mounted radiant heaters in bedrooms, kitchen & living (7 total)

House Tan3 before thermal upgrades

House Tan3 after thermal upgrades



House tan4 before thermal upgrades

House Tan4 after thermal upgrades

House TAN4

4 bed single storey concrete block, slab-on-ground, verandah to 2 sides, thermal upgrade window awnings to north & west, wall shade to west as part of previous temperature control project

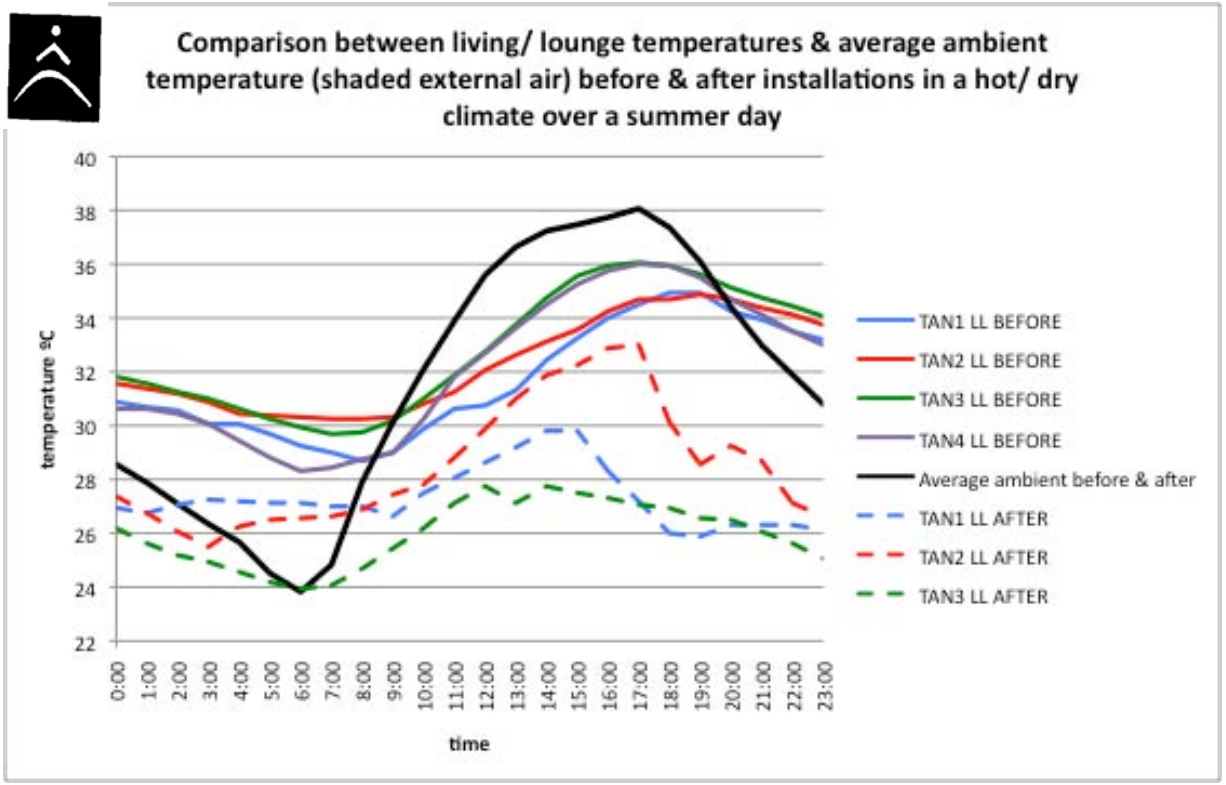
New works affecting thermal performance: (not full scope of works)

Passive heating & cooling

- new roof insulation throughout
- existing shade wall & awning to north & west walls part of previous temp. control project
- provide new ceramic floor tiling throughout
- clean & new paint to full extent
- new window covering throughout (canvas curtains)
- seal cornice & wall
- new screen doors
- new windows throughout
- new verandah slab to east
- replace fc sheet ceiling lining in living room
- repaired wall cladding
- replaced drainage pit for tap- (yard woks)

Active heating & cooling

- new ducted evaporative cooling system
- remove existing ceiling fans throughout
- new ceiling mounted radiant heaters in bedrooms, kitchen & living (5 total)
- retained existing fireplace in living room & repaired flue



Three of the four houses had data available before & after thermal upgrade works

Data Analysis-summer

All 3 houses are showing significant temperature improvement after thermal upgrades.

House TAN3 showed the most improvement- up to 9ºC cooler before than after thermal upgrades. Ambient temperatures ranged from 24ºC to 38ºC. House TAN3 ranged from 30ºC to 36ºC before and 24ºC to 28ºC after thermal upgrades.

Thermal upgrade works included passive (non energy using) & active (energy &/ or water using) heating & cooling. See pages 2-5 for a description of works. It is essential to make passive modifications to houses before active modifications. See page 9 for a discussion of energy use by active cooling systems in summer.

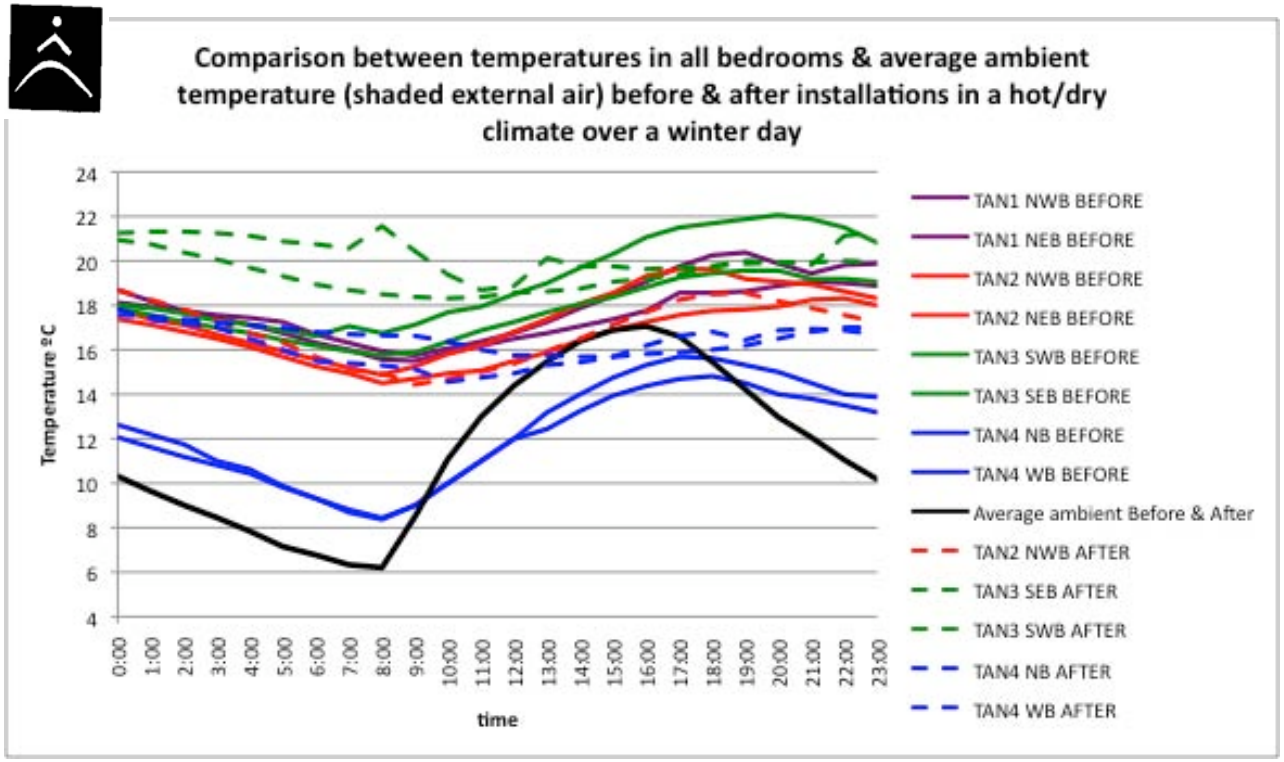
TAN1

TAN2

TAN3

TAN4

Photos of houses monitored after thermal upgrade works



Three of the four houses had data available before & after thermal upgrade works

Data Analysis-winter

All 3 houses are warmer than ambient temperatures after thermal upgrades.

House TAN4 is showing the most temperature improvement (max. 8ºC). Internal temperatures follow ambient 8.5ºC to 16ºC before & are 15.5ºC to 16.5ºC after thermal upgrades. The temperature range has significantly narrowed.

House TAN3 is also warmer after thermal upgrades. TAN2 has similar temperatures before & after thermal upgrades.
See page 10 for a discussion of energy use by active heating systems in winter.

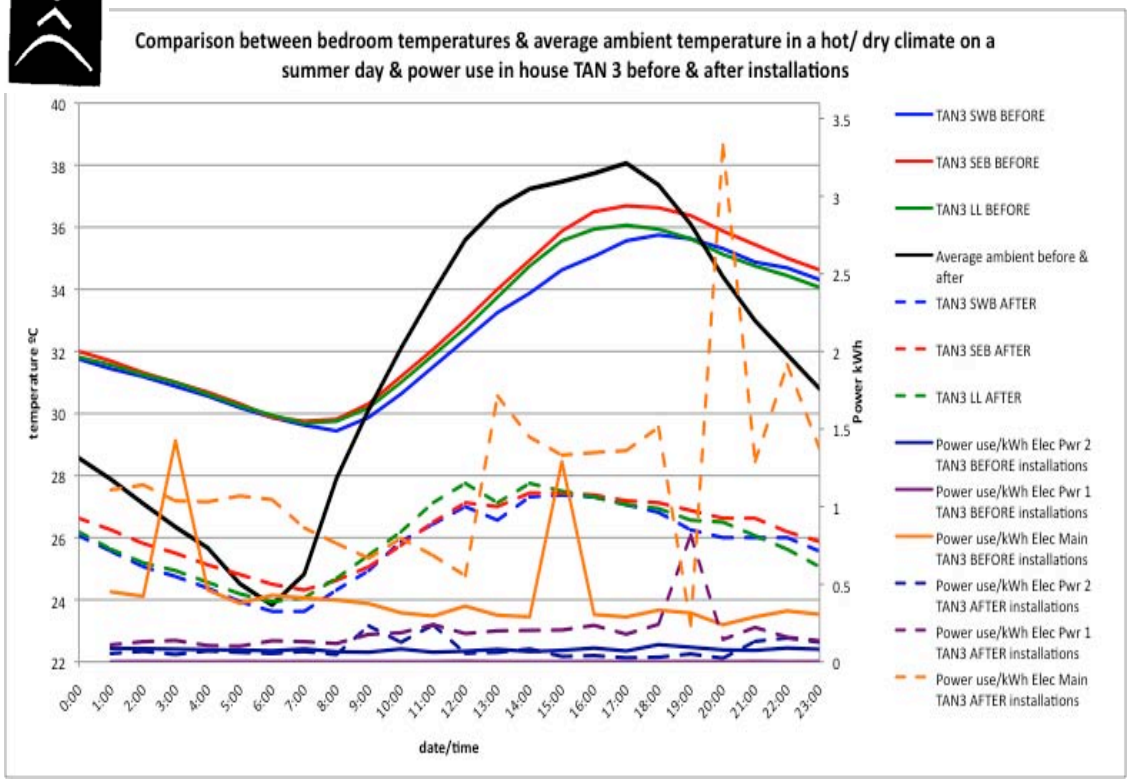
TAN1

TAN2

TAN3

TAN4

Photos of houses monitored after thermal upgrade works



Data Analysis- temperature & power use in summer in one house

House TAN3 is significantly cooler (max. 9ºC) with more power being used after thermal upgrades than before, in summer.

Total energy used in the house over a summer day (not just for cooling):
Before thermal upgrades=10kWh/day (included 4 in-wall reverse cycle a/c units & 4 ceiling fans)
After thermal upgrades= 28kWh/day (included new ducted evap. cooing units with timer switches set to 8 hours, existing ceiling fans retained) . This is an increase from $2.40/day to $5.85/day for total electricity costs for the house.

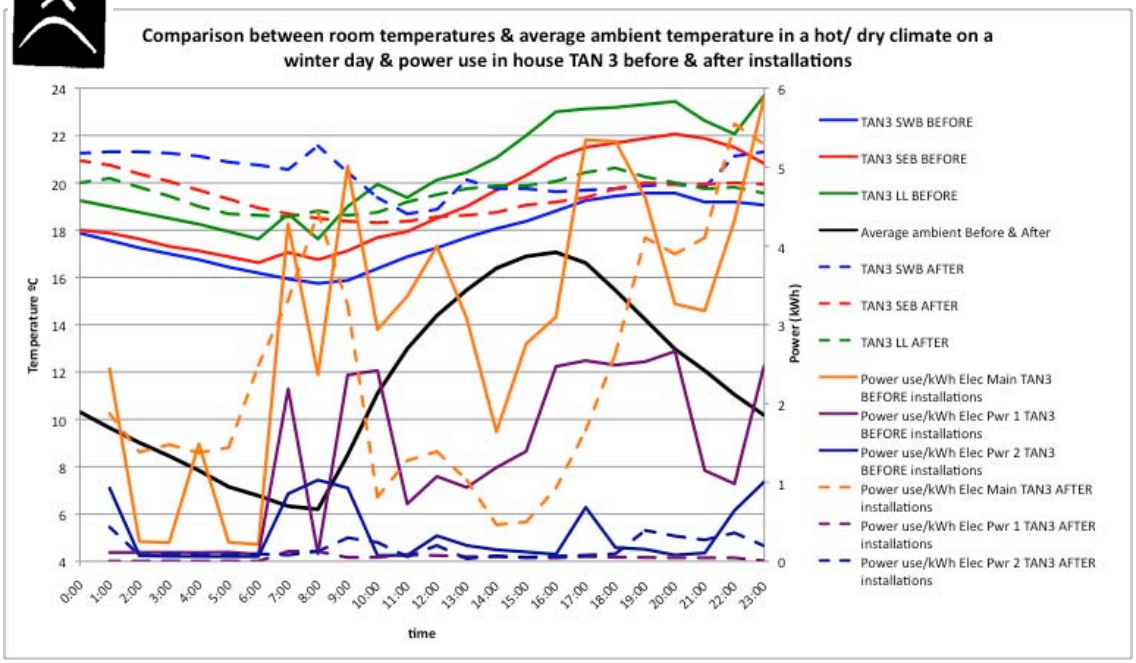
Evaporative cooling systems are more energy efficient than reverse cycle air conditioners. The increase in total power use after thermal upgrades may be because existing a/c units may have not been working & the houses were being used more due to the upgrades.

Tan3 new ducted evaporative cooling system

Tan3 existing in-window a/c systems x4 before installations

TAN3- poorly installed in-window air conditioning systems removed

TAN3 plug in wall mounted fan used before installation of new cooling system



Data Analysis- temperature & power use in winter in one house

House TAN3 is warmer overnight (max. 6ºC) with LESS power being used after thermal upgrades than before, in winter. Temperatures are warmer in the early evening (max. 2ºC) before than after thermal upgrades.

Total energy used in the house over a winter day (not just for heating):
Before thermal upgrades=69kWh/day (included 4 in-wall reverse cycle air conditioning units)
After thermal upgrades= 55kWh/day (included new ceiling mounted radiant heaters in bedrooms, kitchen & living (7 total) with 8 hour timed cut off switch)
This is a decrease from $14.10/day to $11.20/day for total electricity costs for the house after thermal upgrades.

Radiant heaters use significantly less power than reverse cycle air conditioners for winter heating. A greater difference in power use is not seen after thermal upgrades compared to before because existing a/c units may have not been working & the houses are being used more due to the upgrades.

new ceiling mounted radiant heaters in bedrooms, kitchen & living, new evaporative cooling system ducting, existing ceiling fan

Tan3 existing in-window reverse cycle (heating & cooling) air conditioning systems x4 before thermal upgrades (removed after installation of new cooling system)

Discussion & Recommendations

• Generally, houses are showing temperature improvement after passive & active thermal upgrades in summer (up to 9ºC cooler) and winter (up to 8ºC warmer) compared to before thermal upgrades.

Passive heating & cooling is any heating or cooling method that requires no energy input either by the house resident or a mechanical device. ie. A verandah roof may shade a wall & window reducing the inside temperature of the house, a concrete slab that can be warmed by the sun during the day in winter may keep the house warm at night.

Active heating & cooling involves the input of energy to the house. Ideally all active systems are as energy & water efficient as possible. Evaporative cooling systems are an example of active cooling that is recommended for use in hot/dry climate zones due to low humidity levels. Evaporative coolers have low power use but in areas of poor water quality, have high water use. This is because as the water evaporates in the evaporative cool cycle, mineral deposits build up & clog the air/ water filter pads. Evaporative coolers can use 450 litres/day under poor water quality conditions. Water quality & quantity are a consideration when selecting this cooling method.

• Summer cooling is the primary climatic issue when designing thermal upgrades in the hot/dry zone. Bureau of Meteorology data shows that cooling may be used an estimated 50% of the year & heating an estimated 33% of the year

• More power was used in total by the house selected for power/ temperature analysis (House TAN3) in summer after than before thermal upgrades. Although the cooling method was more efficient after thermal upgrades, the data does not show a reduction in total energy use as existing a/c units may not have been working before being removed as part of the upgrades. The houses were also being used more after the upgrades increasing total power use/house.

Pergola- passive cooling

Reverse cycle air conditioning- active cooling (used before thermal upgrades)

new ceiling mounted radiant heaters, new evaporative cooling system ducting, ceiling fan- active cooling

Discussion & Recommendations (cont.)

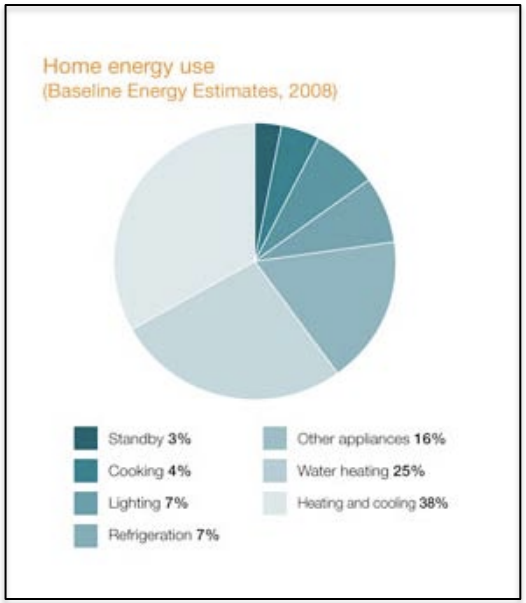
• Total power use/ house- The three highest energy uses in a house are for: heating & cooling, hot water & food preparation (cooking & refrigeration). As use of the upgraded house has increased, power use would have increased in all these areas, not just an increase in active heating & cooling. eg. new solar hot water systems would have an electric booster which would increase power use

• Less power was used in total by the house selected for power/ temperature analysis (House TAN3) in winter after than before thermal upgrades. Heating may have been provided by inefficient blow heaters or bar heaters before upgrades. Although the heating method was more efficient after thermal upgrades, the data does not show a dramatic reduction in energy use as the houses were being used more. eg. more power may have been used for cooking in the upgraded kitchen

• More power was used by the house in winter than summer. Total power use/day after thermal upgrades: *Summer*= 28kWh/day, *Winter*= 55kW/day

• Temperature improvement in houses in summer with the previous temperature control project was up to 7ºC below shaded air temperature with relatively minor passive modifications. Temperature improvement in summer for the current project with extensive passive & active modifications, was up to 11ºC below shaded air temperature. It is essential to make passive modifications to houses before active modifications otherwise energy (& water) costs will be unaffordable by householders.

• This project shows that an extensive upgrade program including thermal upgrades mean that houses are used more & that the results are measureable.



Graph from *Your Home technical manual 6.1 Energy Use*
www.your**home.gov.au/technical/fs61.html**

Appendix

Includes:

- Photos of before & after installations
- Legend for house plans detailing scope of works for plans on pages 2-5 of this report (2 pages)

1

3

2

North west facade

4

South east facade

New polycarbonate sheet windows with new crimsafe security screens

1] north façade; 2] north west façade; 3] south east façade & logger basestation installed at meterbox; 4] south façade

Before thermal upgrade works

After thermal upgrade works

New evaporative cooling ductwork

1

2

North facade

3

4

1] north west façade; 2] south east façade; 3] north façade; 4] south façade & logger basestation installed at meterbox

North west facade

Before thermal upgrade works

After thermal upgrade works

1

2

3

4

1] east façade with wall shade; 2] north façade with wall shade; 3] south façade with portable AC units; 4] west façade with shade structure & logger basestation installed at meterbox

Before thermal upgrade works

South elevation

West elevation

After thermal upgrade works

New pergola was part of previous temperature control project

1

2

South elevation

3

4

East elevation

1] south façade; 2] west façade with wall shade and eaves structure; 3] east façade & location of logger basestation installed at meterbox; 4] north façade with eave structure

Before thermal upgrade works

West elevation

North elevation (to right side)

After thermal upgrade works

SITE	
Demolition	
DS-1	Demolish fence
DS-2	Demolish wall
DS-3	Remove existing cladding
DS-4	Remove existing wiring
DS-5	Demolish item
Landscape - fences	
LF-1	New fence – length indicative. Confirm on site.
LF-2	Repair fence – length indicative. Confirm on site.
LF-3	New prototype shade structure
LF-4	Repair clothes line
LF-5	New clothes line
LF-6	Replace drainage pit for tap
LF-7	Repair/replace vehicular gates
LF-8	Repair/replace pedestrian gates
Landscape – soft surfaces	
LS-1	Regrade to fall away from house
LS-2	Regrade to match level of veranda
LS-3	Regrade to match level of door

Tangentyere Housing Upgrades Work Scope Legend

SITE	
Demolition	
DS-1	Demolish fence
DS-2	Demolish wall
DS-3	Remove existing cladding
DS-4	Remove existing wiring
DS-5	Demolish item
Landscape - fences	
LF-1	New fence – length indicative. Confirm on site.
LF-2	Repair fence – length indicative. Confirm on site.
LF-3	New prototype shade structure
LF-4	Repair clothes line
LF-5	New clothes line
LF-6	Replace drainage pit for tap
LF-7	Repair/replace vehicular gates
LF-8	Repair/replace pedestrian gates
Landscape – soft surfaces	
LS-1	Regrade to fall away from house
LS-2	Regrade to match level of veranda
LS-3	Regrade to match level of door

Tangentyere Design 1 Revision A

Tangentyere Housing Upgrades Work Scope Legend

SITE	
Demolition	
DS-1	Demolish fence
DS-2	Demolish wall
DS-3	Remove existing cladding
DS-4	Remove existing wiring
DS-5	Demolish item
Landscape - fences	
LF-1	New fence – length indicative. Confirm on site.
LF-2	Repair fence – length indicative. Confirm on site.
LF-3	New prototype shade structure
LF-4	Repair clothes line
LF-5	New clothes line
LF-6	Replace drainage pit for tap
LF-7	Repair/replace vehicular gates
LF-8	Repair/replace pedestrian gates
Landscape – soft surfaces	
LS-1	Regrade to fall away from house
LS-2	Regrade to match level of veranda
LS-3	Regrade to match level of door

Tangentyere Design 1 Revision A

SITE	
Demolition	
DS-1	Demolish fence
DS-2	Demolish wall
DS-3	Remove existing cladding
DS-4	Remove existing wiring
DS-5	Demolish item
Landscape - fences	
LF-1	New fence – length indicative. Confirm on site.
LF-2	Repair fence – length indicative. Confirm on site.
LF-3	New prototype shade structure
LF-4	Repair clothes line
LF-5	New clothes line
LF-6	Replace drainage pit for tap
LF-7	Repair/replace vehicular gates
LF-8	Repair/replace pedestrian gates
Landscape – soft surfaces	
LS-1	Regrade to fall away from house
LS-2	Regrade to match level of veranda
LS-3	Regrade to match level of door

Tangentyere Housing Upgrades Work Scope Legend

SITE	
Demolition	
DS-1	Demolish fence
DS-2	Demolish wall
DS-3	Remove existing cladding
DS-4	Remove existing wiring
DS-5	Demolish item
Landscape - fences	
LF-1	New fence – length indicative. Confirm on site.
LF-2	Repair fence – length indicative. Confirm on site.
LF-3	New prototype shade structure
LF-4	Repair clothes line
LF-5	New clothes line
LF-6	Replace drainage pit for tap
LF-7	Repair/replace vehicular gates
LF-8	Repair/replace pedestrian gates
Landscape – soft surfaces	
LS-1	Regrade to fall away from house
LS-2	Regrade to match level of veranda
LS-3	Regrade to match level of door

Tangentyere Design 1 Revision A

Tangentyere Housing Upgrades Work Scope Legend

SITE	
Demolition	
DS-1	Demolish fence
DS-2	Demolish wall
DS-3	Remove existing cladding
DS-4	Remove existing wiring
DS-5	Demolish item
Landscape - fences	
LF-1	New fence – length indicative. Confirm on site.
LF-2	Repair fence – length indicative. Confirm on site.
LF-3	New prototype shade structure
LF-4	Repair clothes line
LF-5	New clothes line
LF-6	Replace drainage pit for tap
LF-7	Repair/replace vehicular gates
LF-8	Repair/replace pedestrian gates
Landscape – soft surfaces	
LS-1	Regrade to fall away from house
LS-2	Regrade to match level of veranda
LS-3	Regrade to match level of door

Tangentyere Design 1 Revision A