



Charles Sturt
University

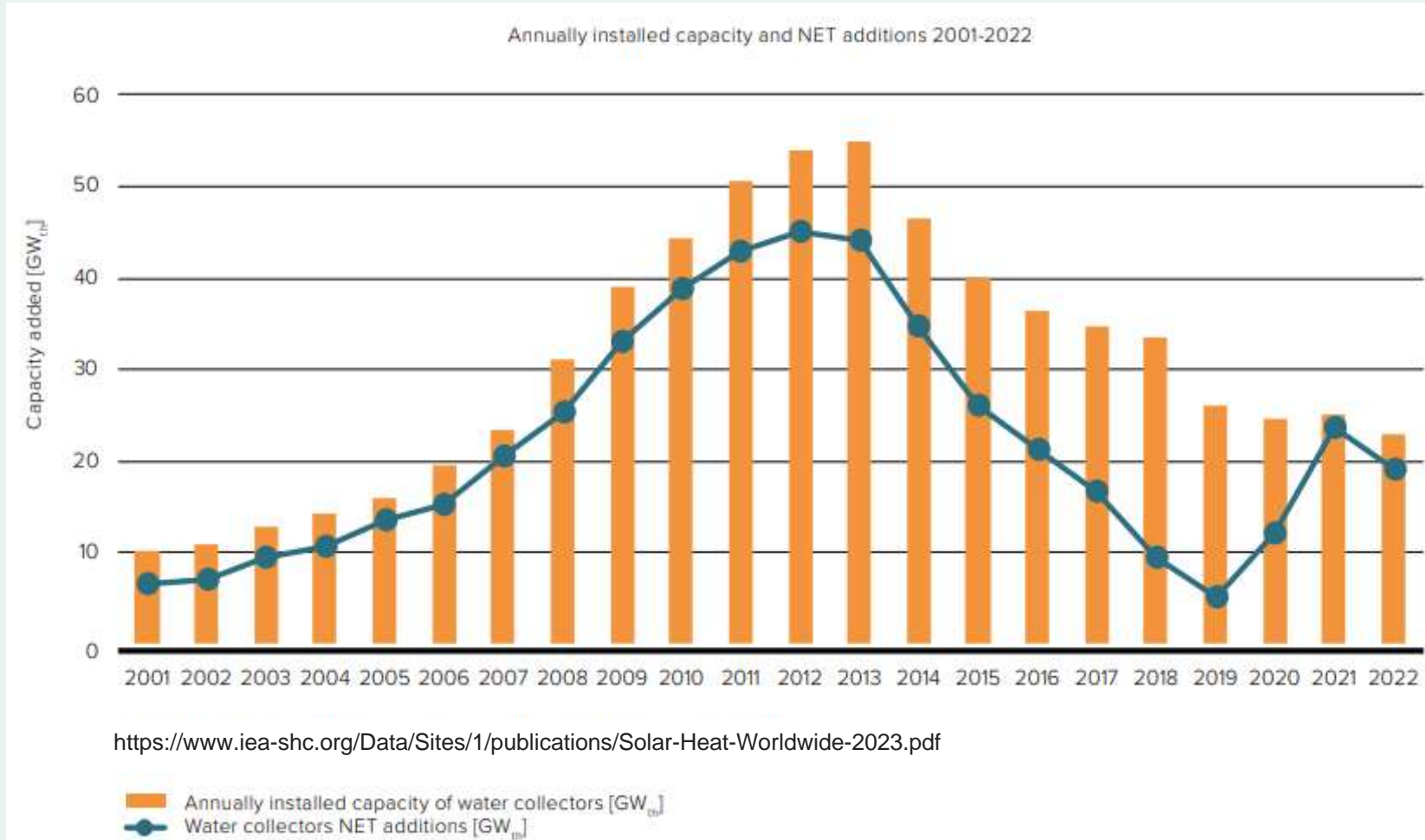
Solar thermal energy systems and the built environment: Opportunities, challenges and the role of engineering design

TIM ANDERSON

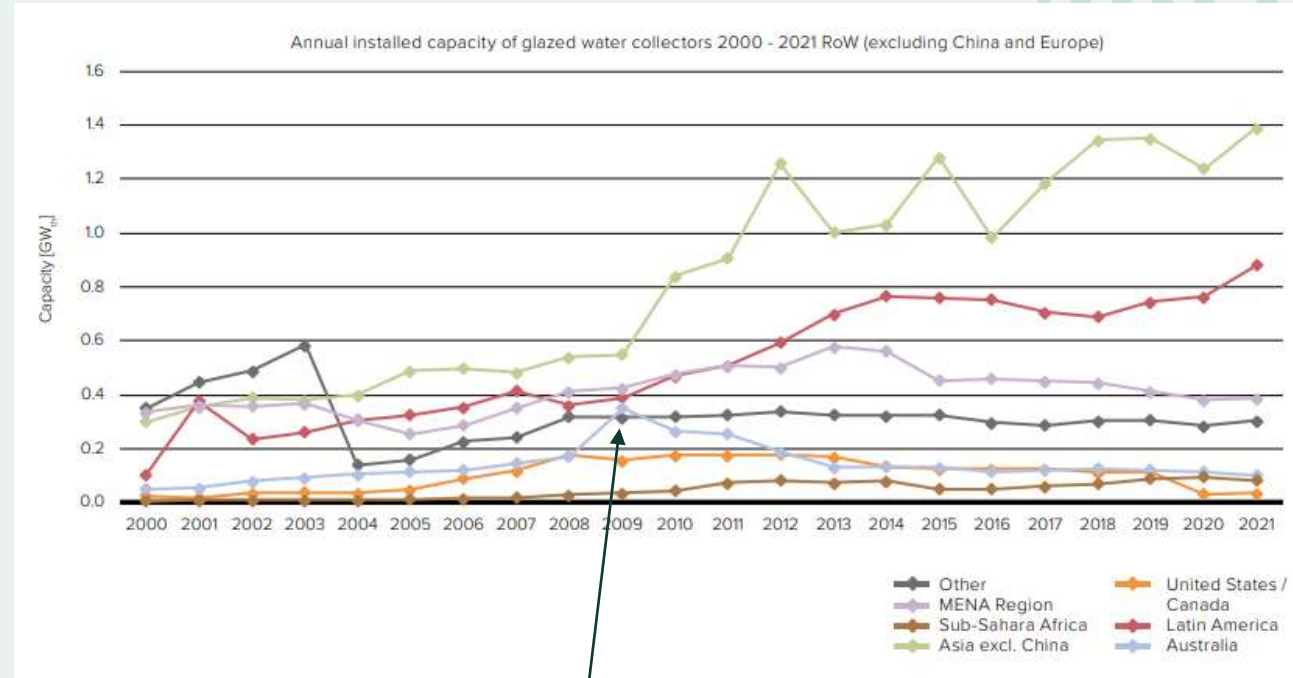
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Introduction - Global solar water heating



Introduction - Solar thermal a global perspective



Australia going backwards since GFC

<https://www.iea-shc.org/Data/Sites/1/publications/Solar-Heat-Worldwide-2023.pdf>

Serious challenges or serious opportunities?



<https://news.csu.edu.au/>



<https://www.greenmatch.co.uk/>



<https://metaefficient.com/uncategorized/90-of-israel-homes-have-solar-water-heaters.html>



BreakingNews.com

A decade (and more) of domestic solar thermal research at the ends of the earth (or at least Aotearoa/NZ)

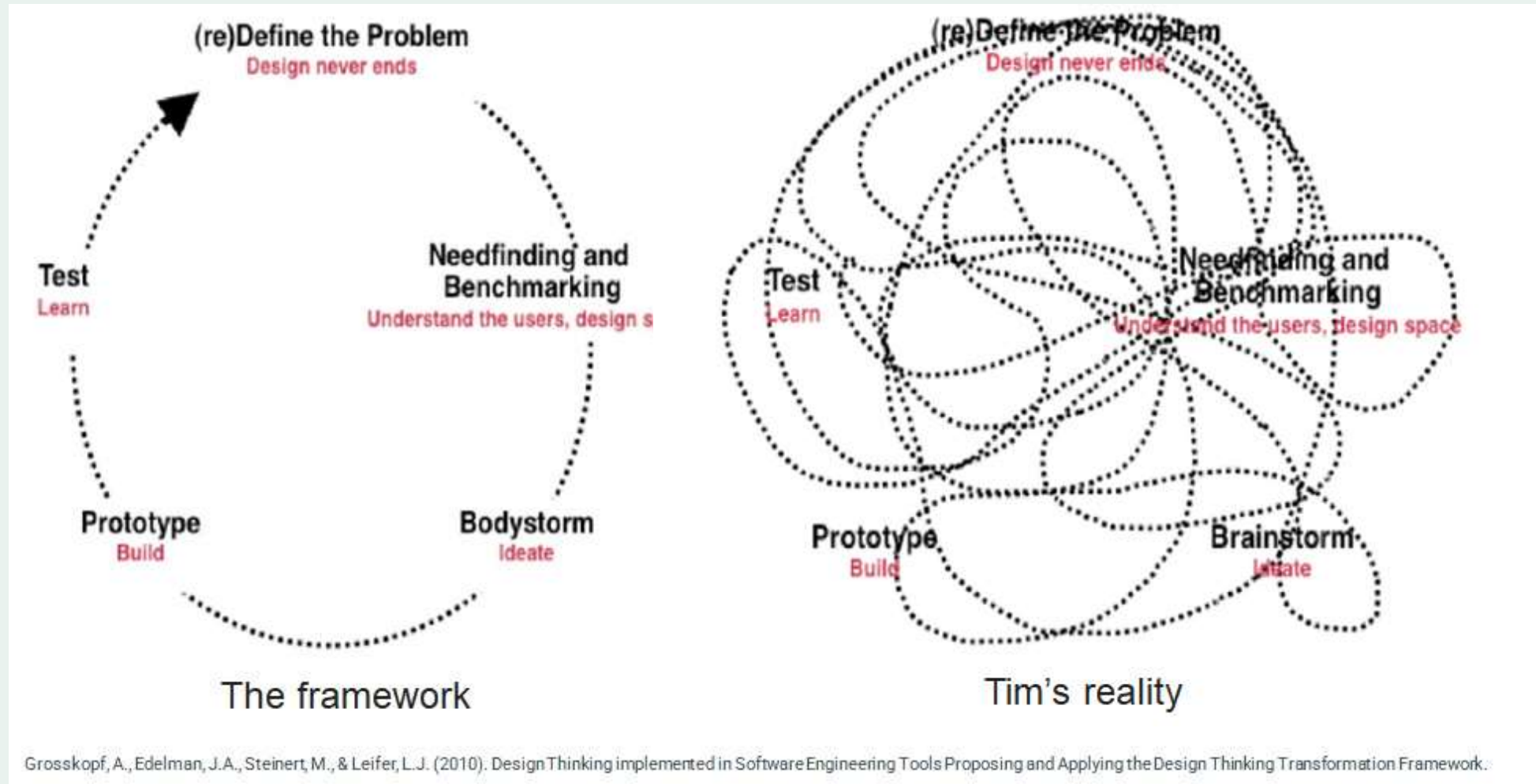


We've got no money, so we've got to think.

(Ernest Rutherford)

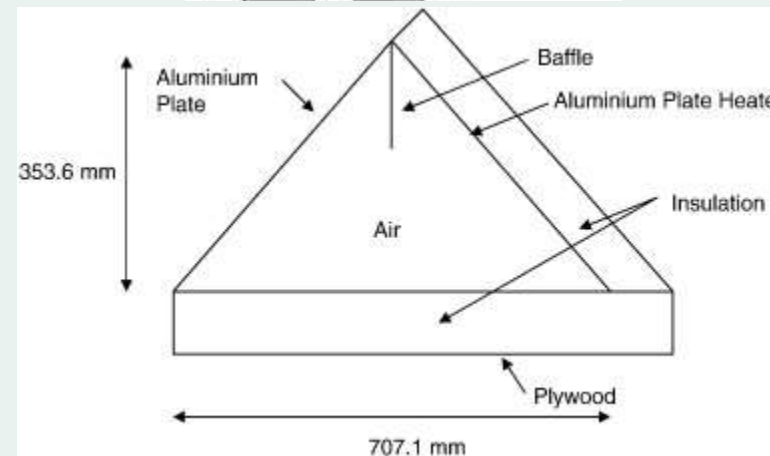
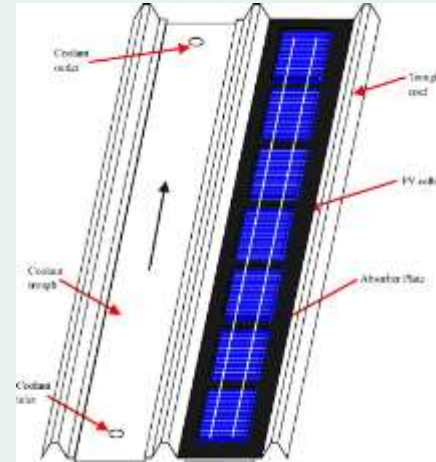
izquotes.com

Addressing the challenges and the opportunities



Let's start at the very beginning - A very good place to start

- Cost/PV or SWH/Aesthetics
- Building integrated photovoltaic/thermal – water cooled
- Commodity building material (\$)
- Reduction in materials - insulation (\$)
- Need for revised thinking – Integration vs onto-gration
- Manufacturing challenges



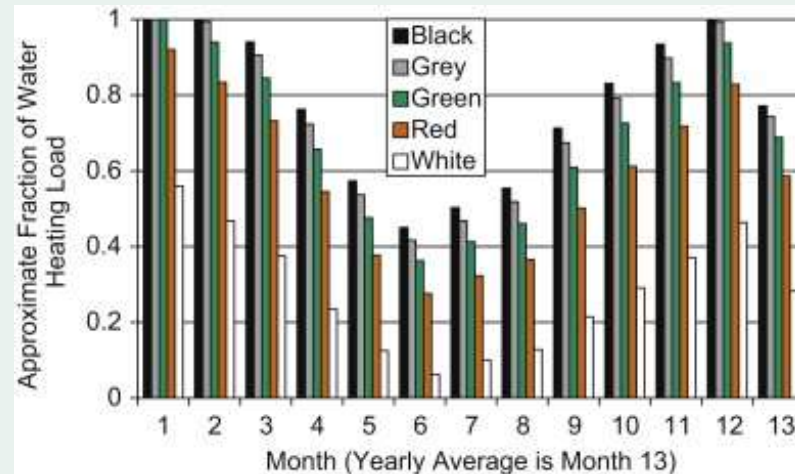
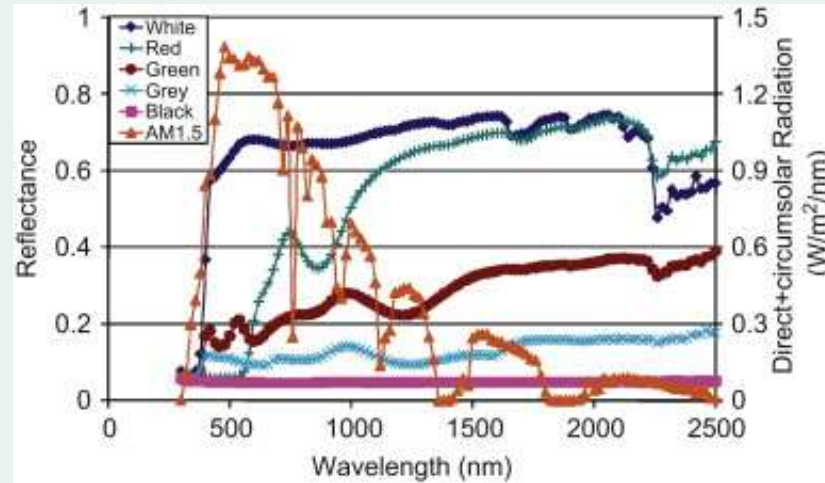
From domestic BIPVT to pool heating

- Large areas = large amounts of heat
- Aesthetics/load imbalance
- Removed PV for cost
- Utilisation of commodity building materials
- Performance is good
- Manufacturing still a challenge
- Can use unglazed collectors as preheaters for DHW?



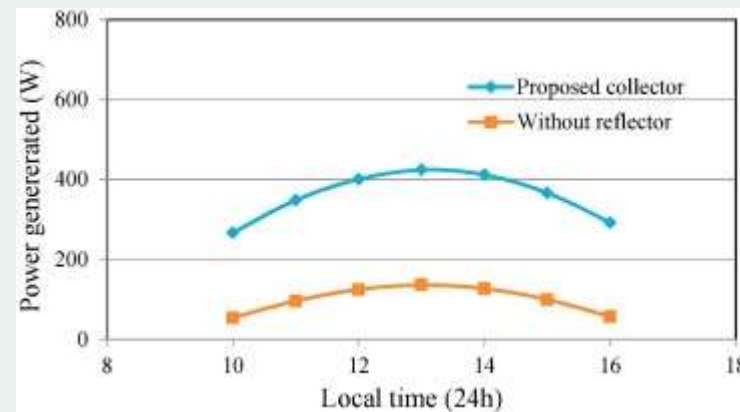
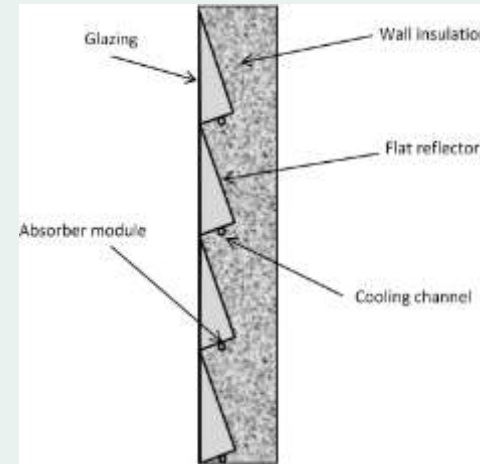
Colourful collectors

- You can have your solar collector in any colour – so long as it's black
- Aesthetics
- Integration – not everyone wants a black roof
- Colour is not as big a determinant of system performance as you might think!
- Take home message - Maybe we can sacrifice optical efficiency for improvements in aesthetics



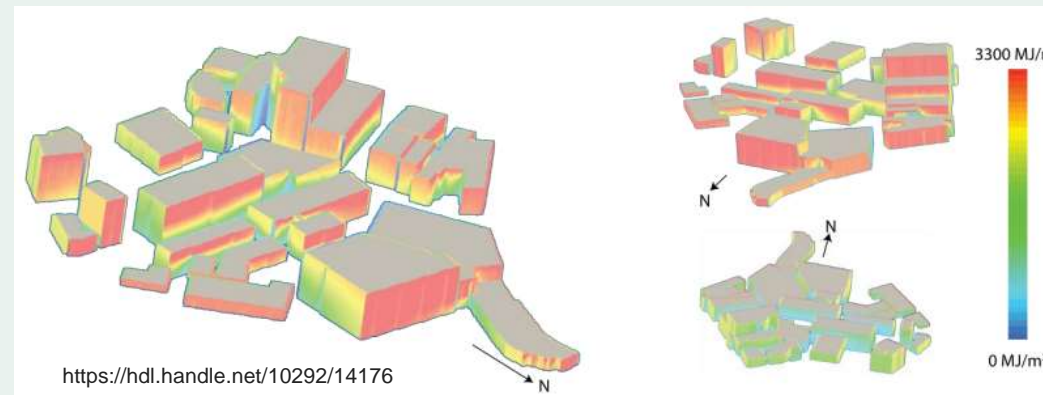
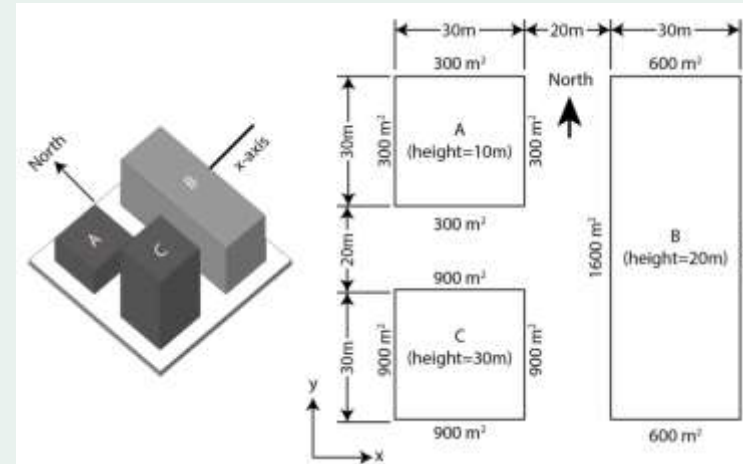
Why just stick to the roof?

- Façade integration
- BIPVT walls? But what to do about the optical penalty?
- Flat passive reflector
- Possible modularity
- Improved winter performance
- Increased use of building surfaces, good for built-up areas with low roof area
- How to quantifying solar on the facade in a built-up area?



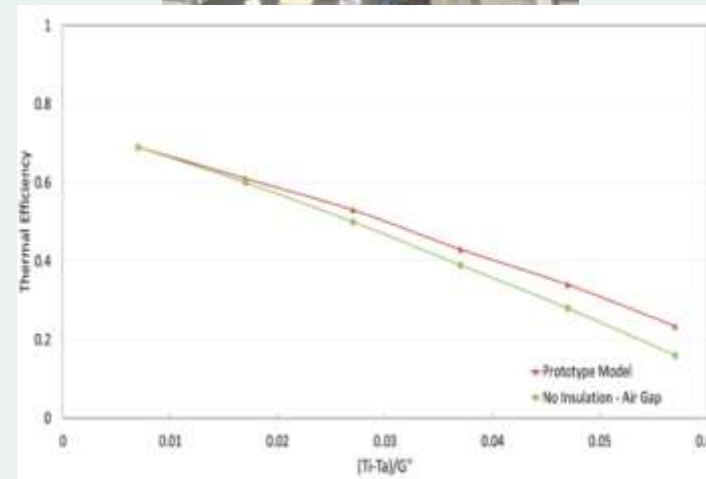
Solar radiation on façades

- How to quantify the scale of the resource?
- Large-scale DEM/ray-tracing
- New ray-tracing method for improved computational efficiency
- Able to assess solar potential of façades in large urban areas (tool for urban planning)



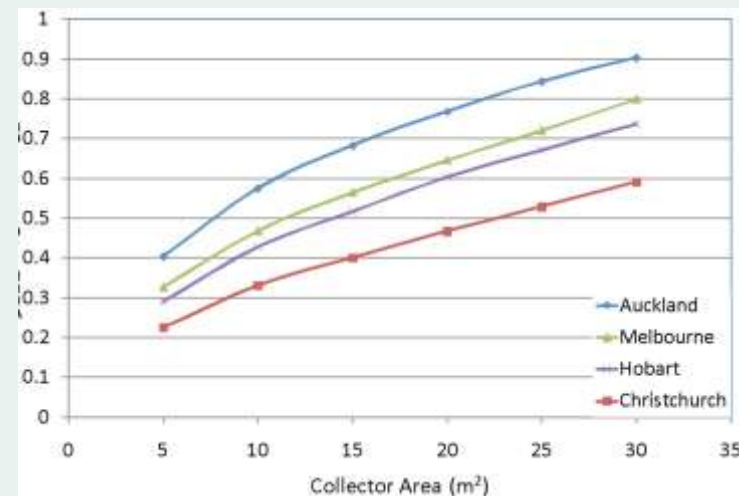
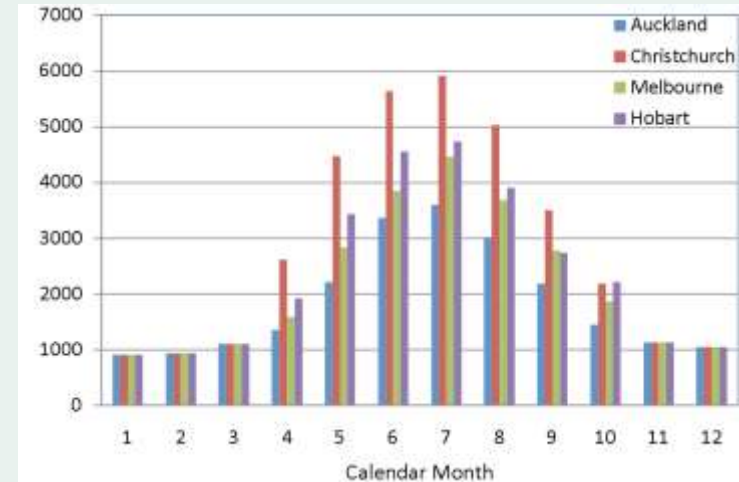
What if I don't want building integration?

- Low-cost polymer collector
- Rotational moulded pillow type absorber
- Performance similar to 'typical' collector designs
- May be possible to develop an insulation-free polymer collector with similar performance
- Lower costs through innovative design – cost/performance trade-off



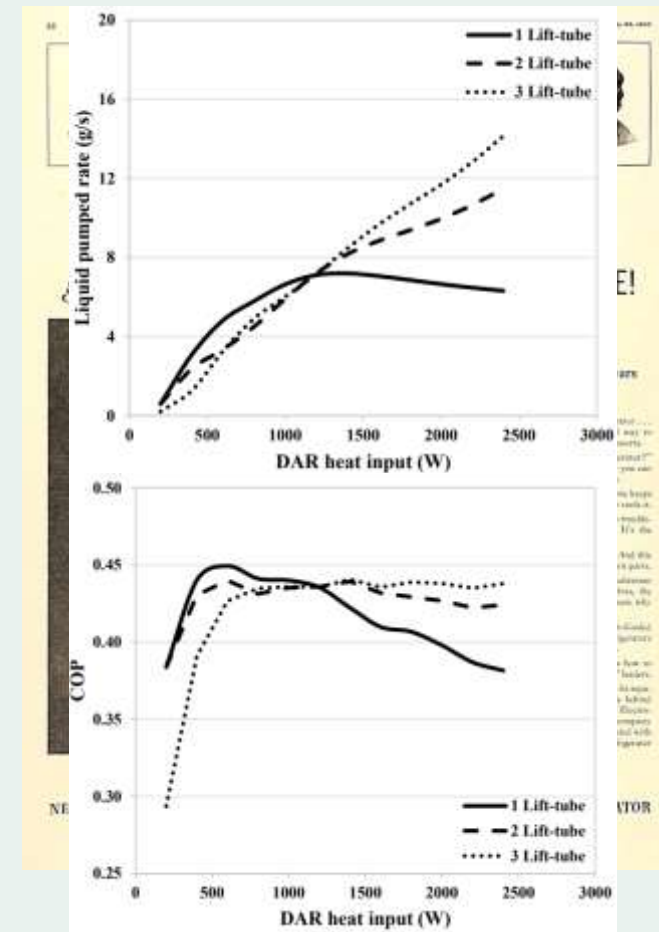
Great.... But what to do with all the heat?

- Building integrated solar combisystem for space and water heating
- Large requirement for space and water heating in Aus/NZ (5000+ MJ in winter)
- Opportunity to utilise larger areas with building integrated collectors
- Excess heat in summer



Opportunities for excess heat?

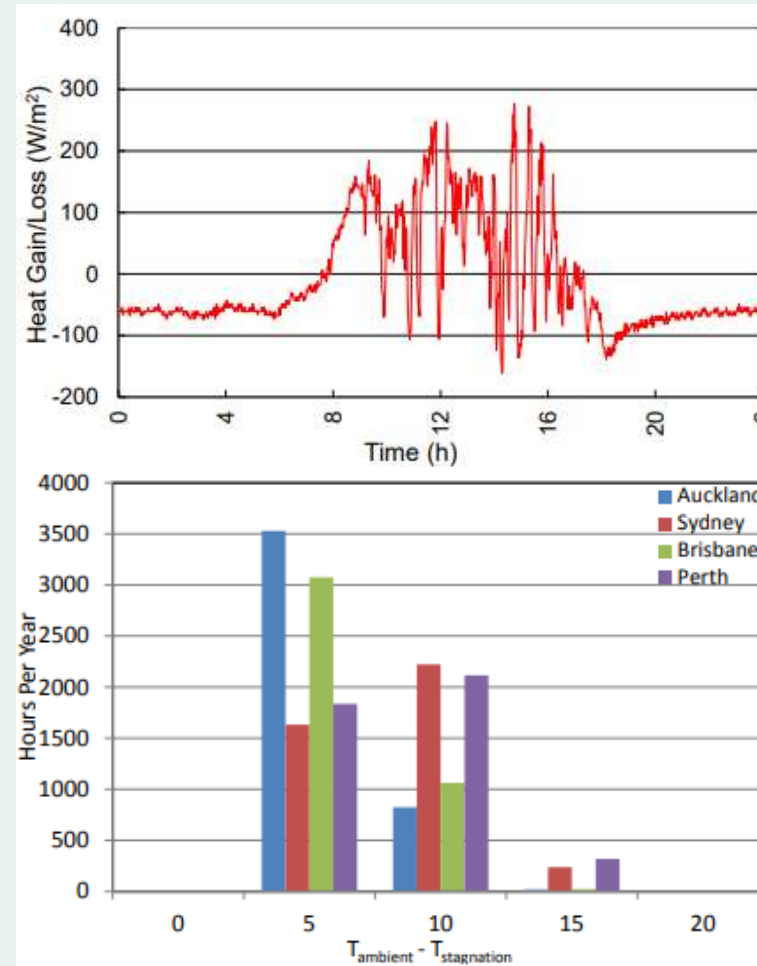
- Load imbalance – lots of heat, but all in summer.....
- Thermally driven cooling
- Diffusion absorption refrigeration – no electricity required, but poor cooling capacity due to thermal bubble pump
- More pumping = more cooling
- Use of ANN to solve pumping prediction and cooling
- Old tech – new opportunity



<https://hdl.handle.net/10292/10975>

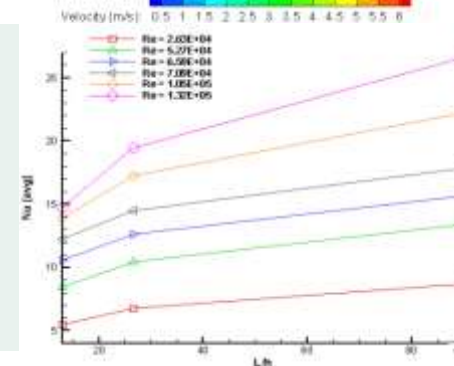
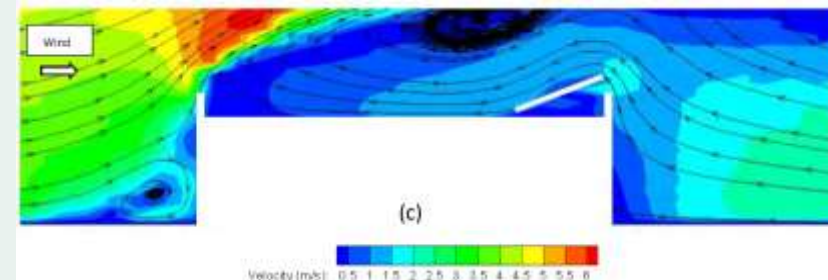
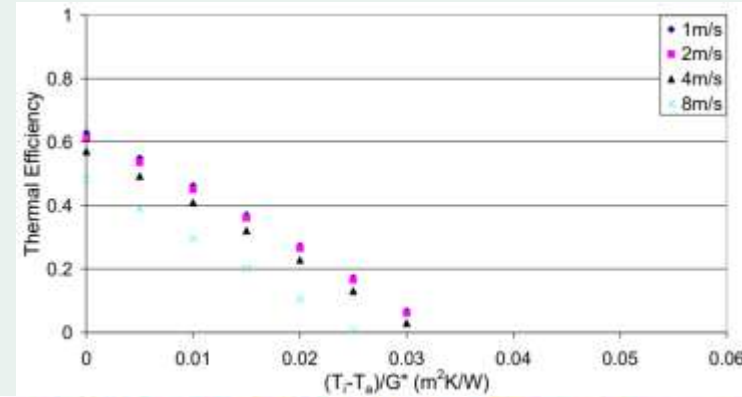
What about those unglazed collectors you mentioned.....

- Unglazed collectors for radiant cooling?
- Simple, low cost, dual use
- Preheating DHW by day, cooling water at night for use with ventilation/AC
- Low cooling capacity ($\sim 80 \text{ W/m}^2$)
- Dependent on sky temperature depression
- Optimistic estimation – 10 MWh p.a. of cooling
- Low tech – new opportunity



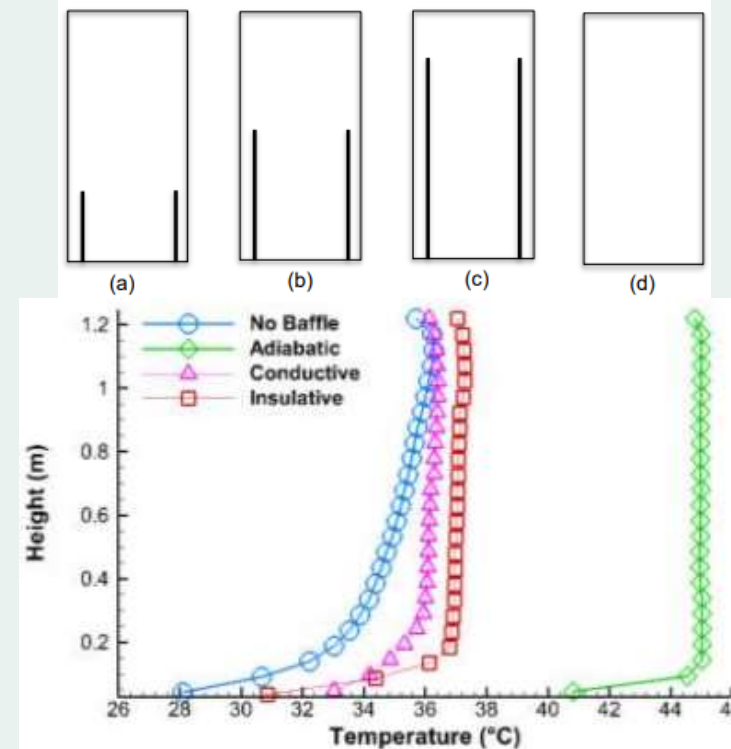
More on the unglazed collector.....

- Radiant cooling is okay, but how to deal with the convection bit?
- Better integration with the building
- Parapets as passive windbreaks
- Can use architectural features of the building to modify flow over unglazed collector and so modify heat loss/gain, depending on location of collector



Opportunities for thermal energy storage

- Reducing the cost of thermal storage
- Can we use less insulation? No insulation?
- Tanks with no external insulation and internal adiabatic baffles subject to standing heat loss
- Not realistic, so checked with conduction
- Passive baffles can be used to suppress convection and reduce heat loss even for insulated tanks
- Definite opportunities to reduce costs of thermal storage



So.....Is research into domestic solar thermal still a thing?

Reports of my death are greatly exaggerated



https://commons.wikimedia.org/wiki/File:Flat-plate_solar_thermal_collector,_viewed_from_roof-level.png

Success is a team effort - Acknowledgements

- Mike Duke
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Questions?

