Impact of Cool Roofs on the Performance of Solar Water Heaters

Professor Xiaohua Xia

Centre of New Energy Systems
University of Pretoria

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Agenda

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II. Existing studies
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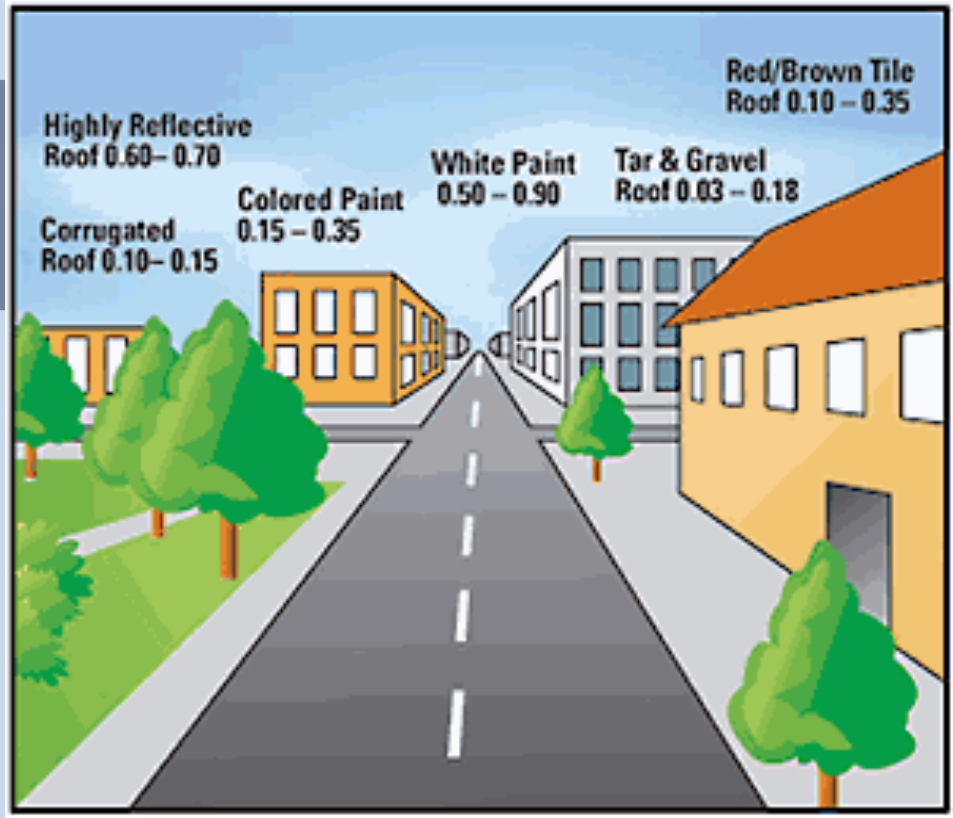
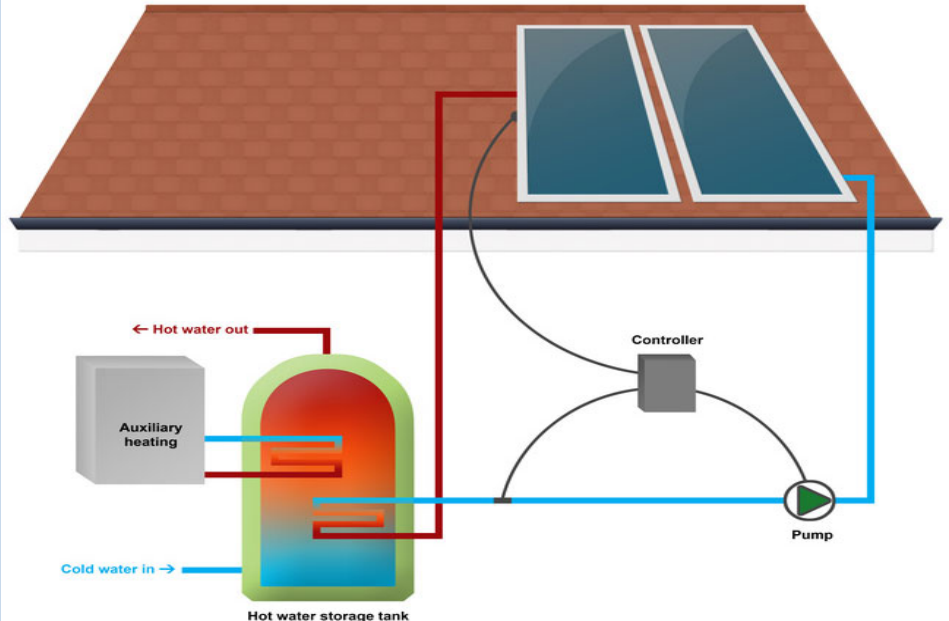
I. Introduction

- Cool roof: a kind of reflexive roof
  - Reduce the effects of solar radiation on building interiors,
  - lowering summer cooling loads and thus reduce air conditioning expenses
- Purpose of study:
  - To investigate the effect of cool roofs on the solar water heating system performance in South Africa (e.g. solar incidence, usage,…, are different with others,)





- Cool roofs:
  - reflect most of the incident sunlight
  - efficiently emit some of the absorbed radiation back into the atmosphere instead of transferring it to the building
  - reduce air temperatures in surrounding areas in summer due to the reflection and emission of absorbed radiation as infrared radiation
- Cool roof & solar system: cool roofs reflect sunlight while solar panels absorb it;
  - cool roofs reflect light to the panels from all directions
  - Improved reflected and diffuse radiation incident on the collector
  - collector efficiency due to reduced temperatures in the vicinity of the collector

II Existing studies

- Different kinds of sustainable roofs exit (white roofs, green roofs, and roofs with solar panels and/or solar hot water systems)
- It is widely acknowledged in the United States, that highly reflective roofs provide energy cost savings
- Advanced Powering Services Inc. (California) installed a cool roof/solar panel test site on the roof of a local industrial building:
  - reports that the cool roofs increase the energy output of the solar panels

- physical principles govern the technology of solar thermal collectors are:
  - Heat loss is predominantly governed by the thermal gradient between the temperature of the collector surface and the ambient temperature
  - Efficiency of a solar thermal collector is directly related to heat losses from the collector surface.
- Comparison of Traditional and Cool Roof Options is shown in the following table

Comparison of Traditional and Cool Roof Options

Warmer Roof Options	Cooler Roof Options
Built-up Roof **•dark gravel** **•smooth asphalt surface** **•aluminium coating**	Built-up Roof •white gravel •gravel and cementitious coating •smooth surface with white roof coating
Single-Ply Membrane **Black (PVC)**	Single-Ply Membrane •White (PVC) Colour with cool pigments
Modified Bitumen **With mineral surface cap sheet (SBS, APP)**	Modified Bitumen White coating over a mineral surface (SBS, APP)
Metal Roof **Unpainted, corrugated** **Dark-painted, corrugated**	Metal Roof •White painted •colour with cool pigments
Asphalt Shingle: Black or dark brown with conventional pigments	Asphalt Shingle: White (light gray); or Medium gray or brown with cool pigments
Liquid Applied Coating: Smooth black	Liquid Applied Coating: Smooth white; Smooth, off-white; Rough white
Concrete Tile **•Dark colour with conventional pigments**	Concrete Tile: •White; colour with cool pigments
Clay Tile: **•Dark colour with conventional pigments**	Clay Tile: •White Terra cotta (unglazed red tile)
Wood Shake: Painted dark colour with conventional pigment	Wood Shake: •Bare

III. Project plan

- Installation of cool roofs and solar thermal systems
- Experiments and monitoring of solar system performance
- Solar thermal system optimal design under cool roofs: for new system design; possibility to downscale systems for less investment due to improved thermal efficiency
- Solar thermal system optimal operation under cool roofs: for existing solar systems; optimised electrical load operation

Materials needed

- Cool roof material
- Two low-pressure solar water heating systems
- Two high-pressure solar water heating systems
- Temperature sensors/Thermocouples
- Flow meters
- Voltmeters
- Ammeters
- Pyranometers
- Data loggers

Details

- Part of the building roof will be retrofitted with cool roofing material
- Four experimental models will be set up on the roof
- Evacuated tubes and/or flat plate collectors will be tested
- Data sensing and collection systems be installed
- A control model will be developed to simulate the performance of the system

- Different tilt angles and orientations will be tested
- Electricity output, pressure, flow rate and temperature changes of water will be monitored
- Thermocouples will be used to sense the temperature of the water in the tank as well as ambient temperature
- System efficiency; load calculation; for different combinations of system components
- Thermal Analysis of the storage systems and economic analysis will be done
- Optimal system designs
- Optimal electric load operation (back up, auxiliary, etc)

Validity/Repeatability/Reproducibility

- use of experimentally proven data;
- use of control experiments;
- repetition of experiments in different conditions
- trial runs of systems
- assimilation of critiques obtained from active participation in conferences, departmental presentations, seminars, and journal paper writings;
- Reference to the internationally standards (ISOs).

Project management

- Team at the EEDSM Hub to work on the project
- EEDSM's Energy lab to be installed the testing systems
- Key team members:
  - Prof X Xia and 1 faculty member, 1 PhD student, 1 Master's, plus
  - supporting staff and students

IV Outcomes

- Support for government policy formulation with regards to cool roof and solar water heating system in RSA
- Recommendations/Results on the use of a combination of cool roofs and solar modules
- Efficiency and reliability of the system
- Contributions of such a system towards the energy demand per household
- Contributions of such a system towards peak energy demand in the country
- Economic analysis of the system
- Publications

THANK YOU!

QUESTIONS?