Method for measuring energy savings on highly reflective coatings

Cool Roof Congress, Milano 25th June 2015

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Objectives

Methodology Development for Energy Savings Quantification

Monetary Savings Quantification

Agenda

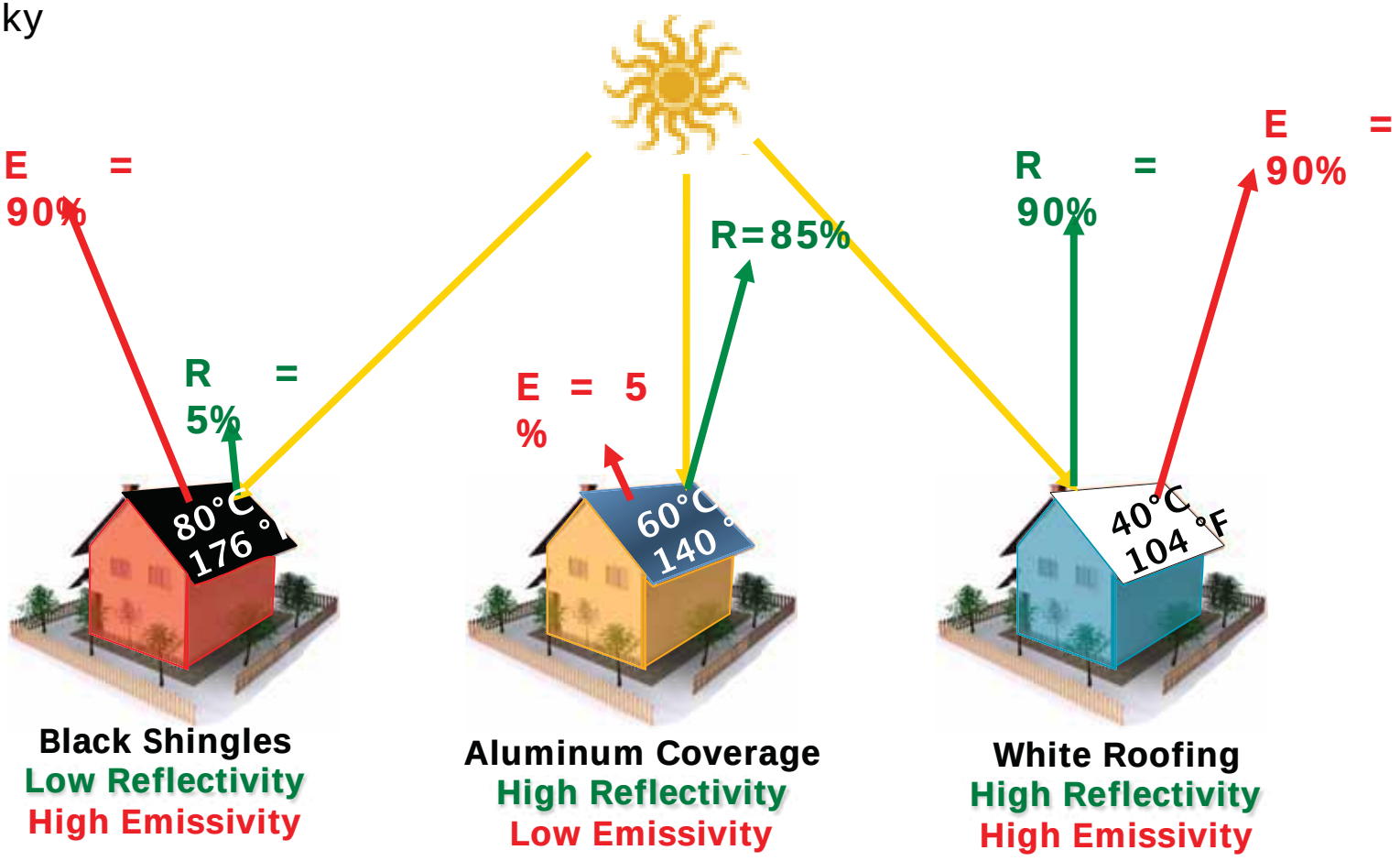
- **Introduction**
  - Highly reflective roof coatings - Concept
- **Experimental Part**
  - Mexican Climate Zones
  - Experimental House Setup
  - Results
- **Conclusions**

INTRODUCTION

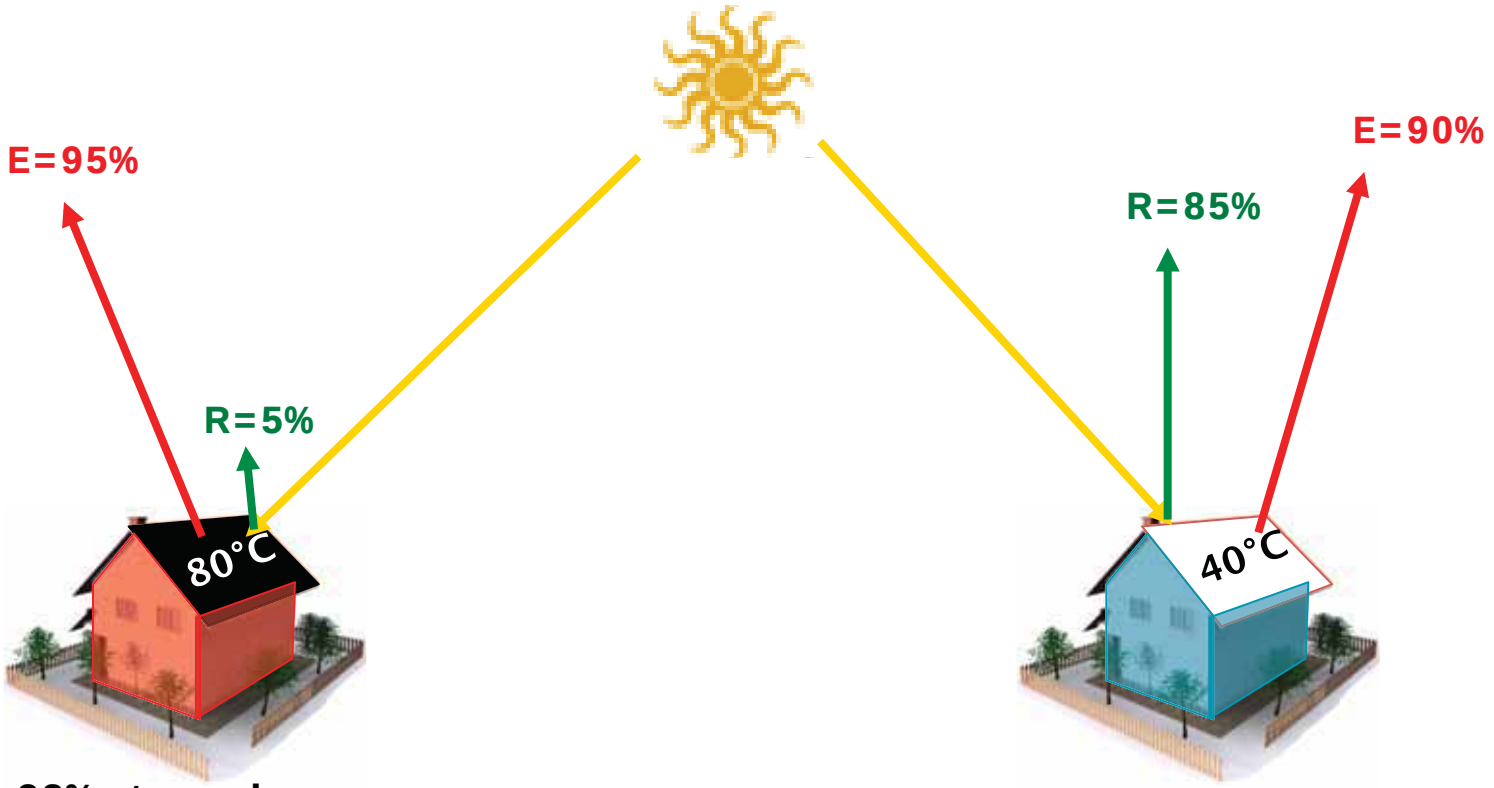
Highly Reflective Roof Coatings - Concept

E= Emissivity: Amount of energy radiated back as thermal radiation

R= Reflectance: Amount of energy reflected back to the sky

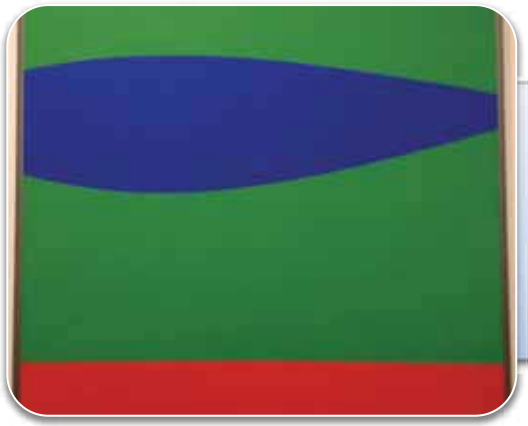


Energy gains in buildings



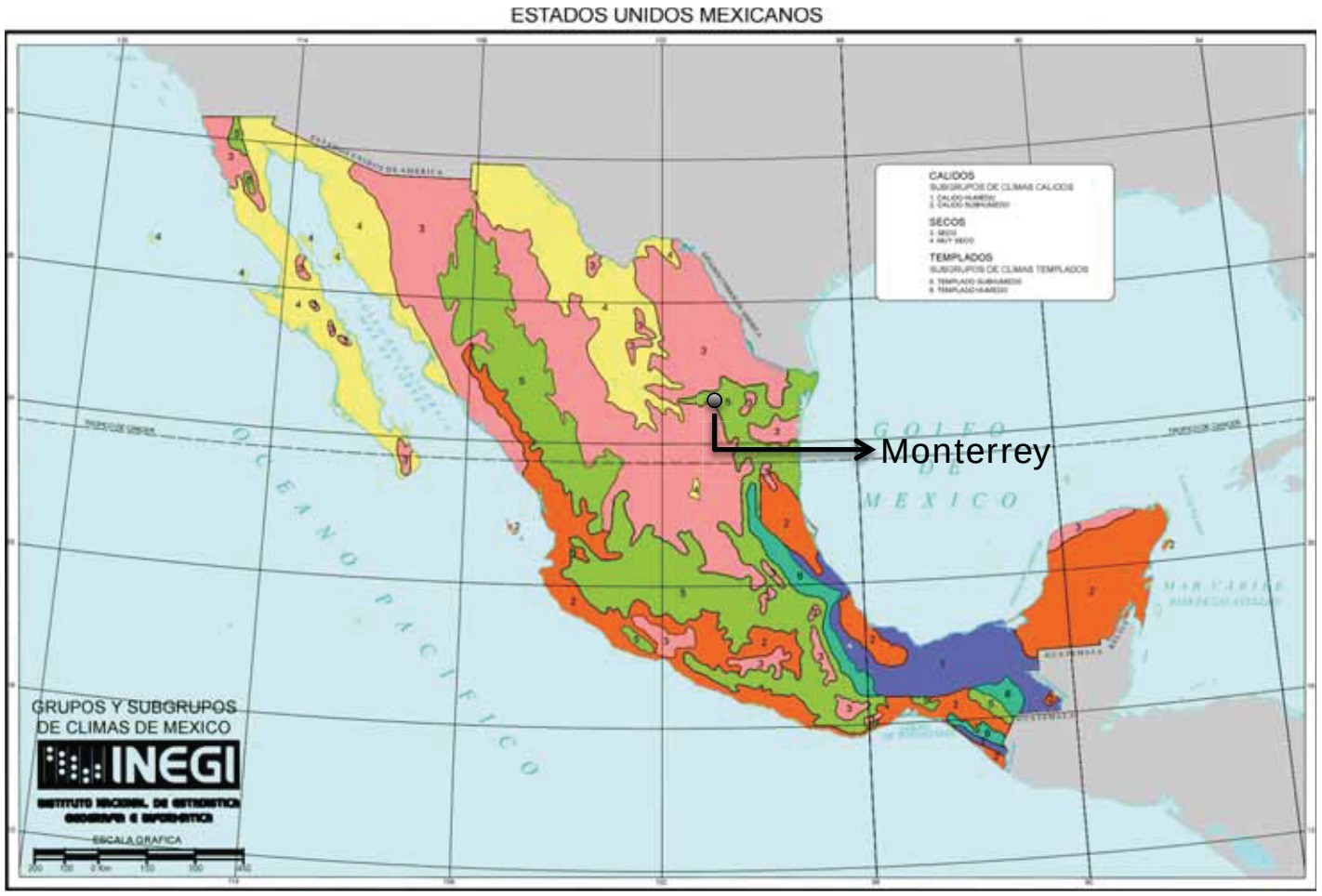
38% atmosphere
52% transferred to the air
4.5% enters the building

10% atmosphere
8% transferred to the air
1.5% enters the building



EXPERIMENTAL PART

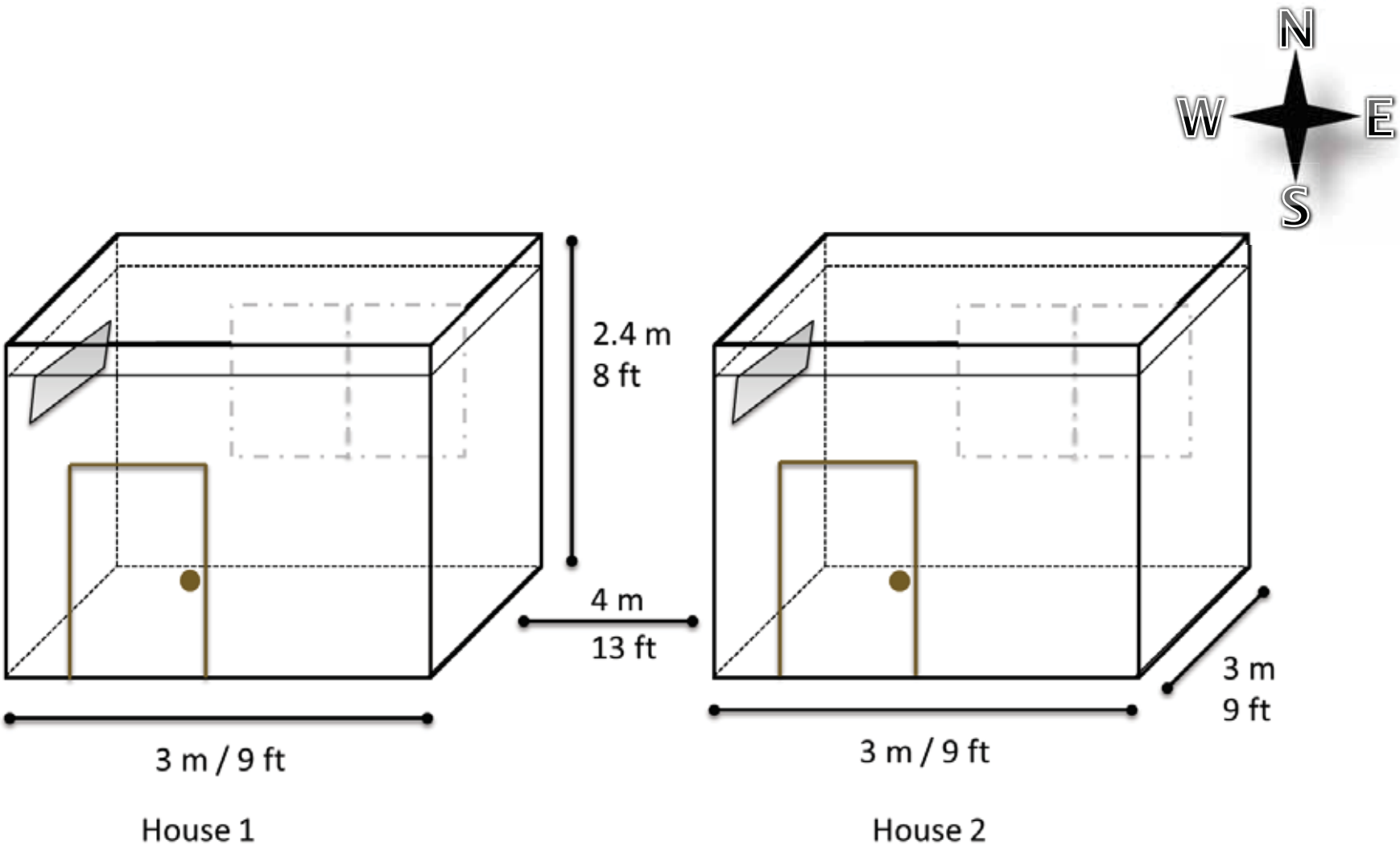
Mexican Climate Zones



Source: National Institute for Geography, Statistics and Informatics.

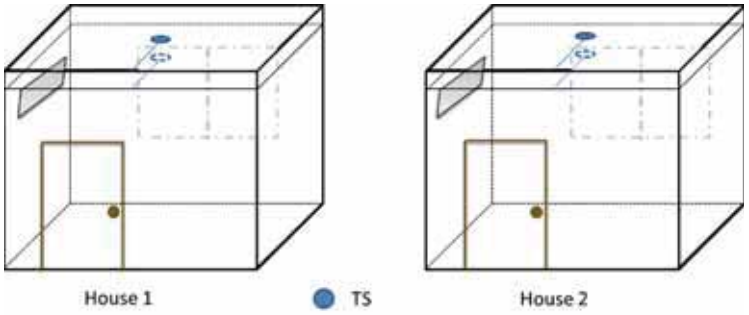
- Dry arid climate.
- 8.5% of national energy consumption.
- Average Electrical Energy price of $0.1 USD/kWh.
- Highest residential rate $ 0.25 USD/ kWh.
- Region with the highest energy consumption in the country (both residential and industrial).

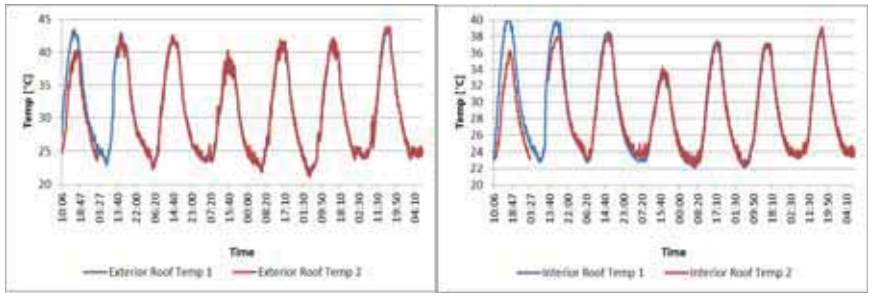
Experimental House Setup



Stage 0 – Measurement System Validation (No AC)

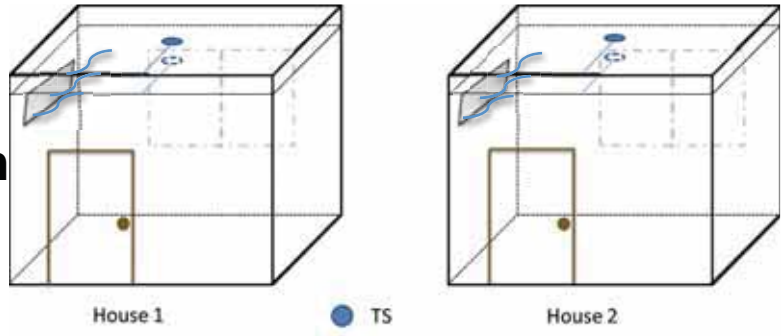
No AC





- Measurement period: June 7 to June 16 2013.
- No significant differences found.
- P-value (external) = 0.361
- P-value (internal) = 0.965

AC on

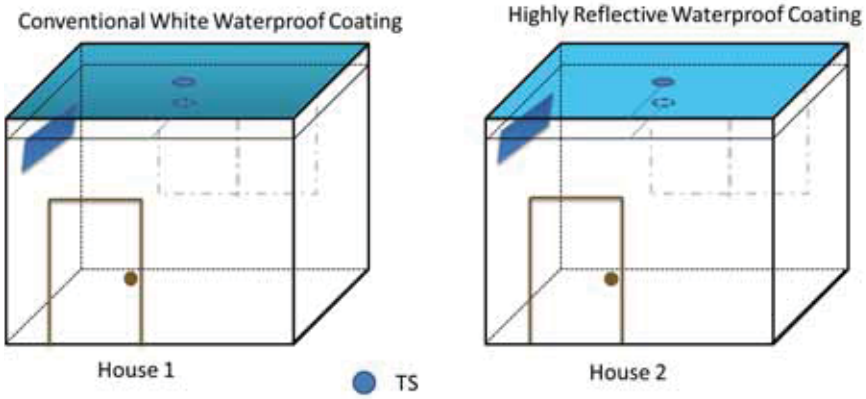


- AC turned on. Set point = 23°C (77 °F).
- Measurement period: June 17 to June 26, 2013.
- No significant difference found between the measurements.
- P-value = 1.00

Day	kWh House 1	kWh House 2
1	4	3
2	8	8
3	9	8
4	9	9
5	9	8
6	8	9
7	9	9
8	8	8
9	7	8
10	8	9
TOTAL	79	79

Stage 1 – Conv. White Waterproof vs Highly Reflective Coatings

Setup



Solar Reflectance = 0.72

Solar Reflectance = 0.80

Results – Energy consumption

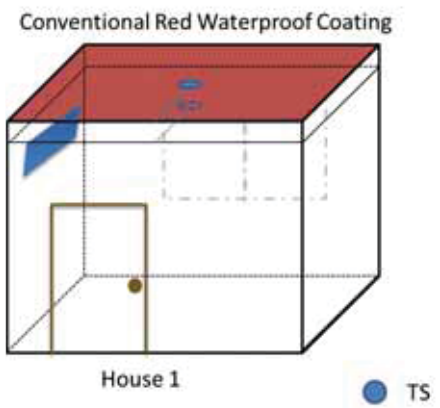
Date	Energy Reading House 1	Energy Reading House 2	kWh House 1	kWh House 2
28-jun	2014	120	9	9
29-jun	2023	128	9	8
30-jun	2031	136	8	8
01-jul	2038	141	7	5
02-jul	2044	147	6	6
03-jul	2048	150	4	3
04-jul	2053	155	5	5
05-jul	2059	160	6	5
06-jul	2066	166	7	6
08-jul	2079	177	13	11
09-jul	2083	180	4	3
10-jul	2089	186	6	6
		Total kWh	84	75

- AC turned on. Set point = 23°C (77 °F).
- Measurement period:

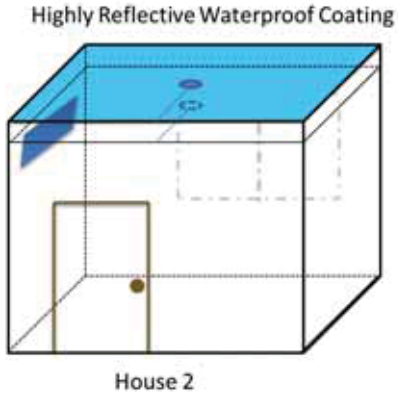
  June 28 to July 10 2013
- Significant difference found between kWh readings.
- P-value = 0.005
- 12% energy savings.
- Potential energy savings of $ 0.03

Stage 2 – Conv. Red Waterproof vs Highly Reflective Coatings

Setup



Solar Reflectance = 0.32



Solar Reflectance = 0.80

Results – Energy consumption

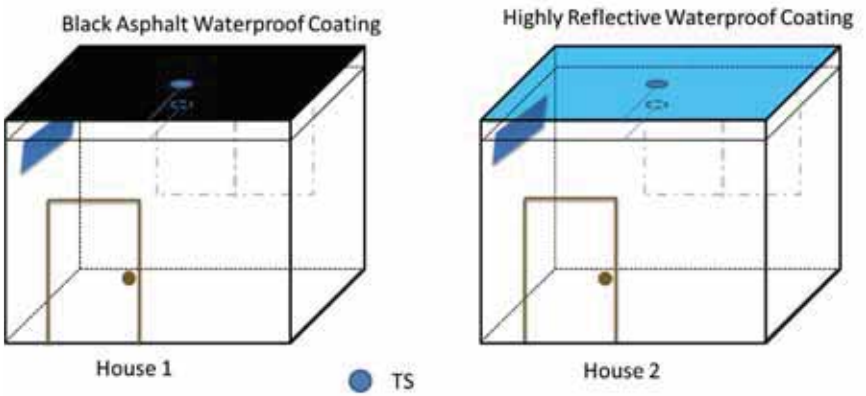
Date	Energy Reading House 1	Energy Reading House 2	kWh House 1	kWh House 2
12-jul	2104	198	9	7
13-jul	2114	205	10	7
14-jul	2123	211	9	6
15-jul	2133	218	10	7
16-jul	2142	224	9	6
17-jul	2149	229	7	5
18-jul	2152	231	3	2
19-jul	2155	233	3	2
20-jul	2161	237	6	4
22-jul	2171	243	10	6
23-jul	2179	248	8	5
24-jul	2186	254	7	6
		Total kWh	91	63

- AC turned on. Set point = 23°C (77 °F).
- Measurement period:

  July 12 to July 24 2013.
- Significant difference found between kWh readings.
- P-value = 0.000
- 45% energy savings.
- Potential energy savings of $ 0.11

Stage 3 – Black Asphalt Waterproof vs Highly Reflective Coatings

Setup



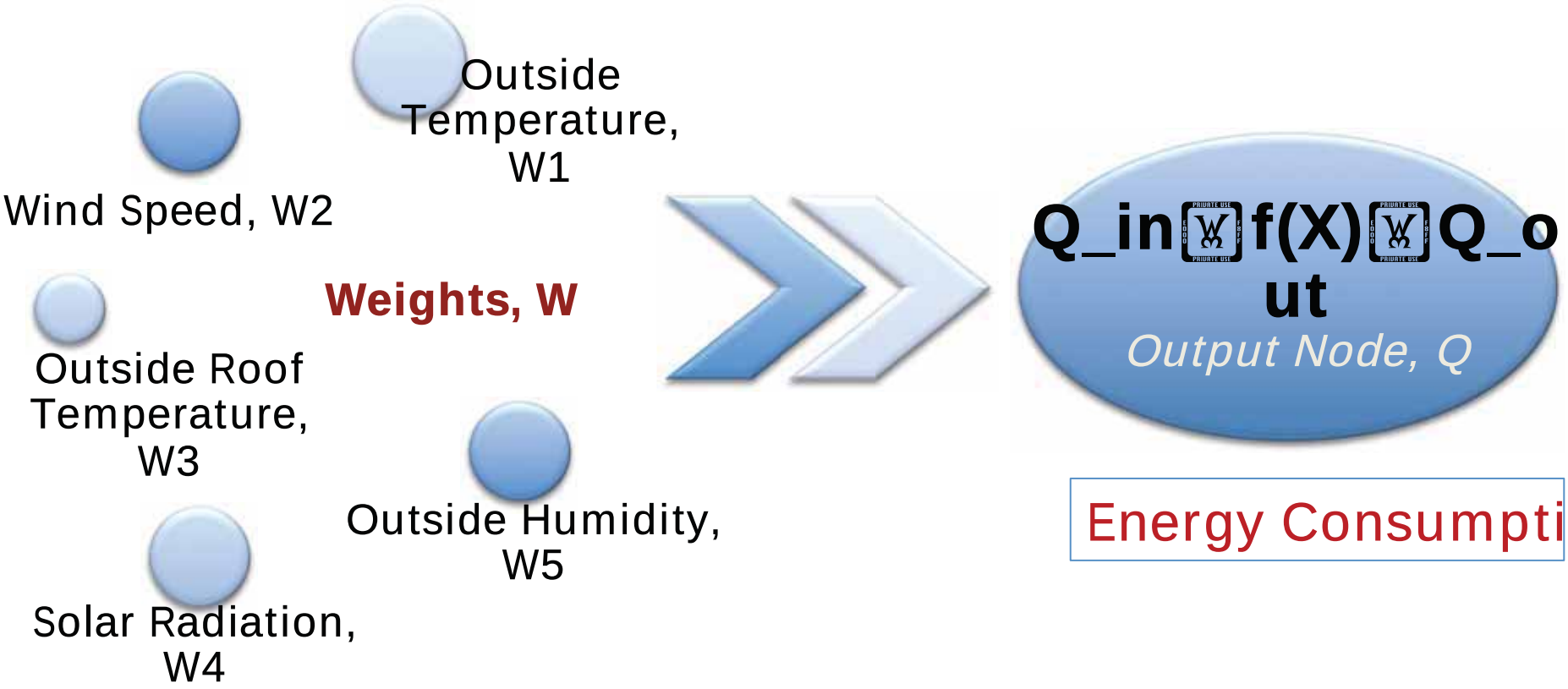
Solar Reflectance = 0.05 Solar Reflectance = 0.80

Results – Energy consumption

Date	Energy Reading House 1	Energy Reading House 2	kWh House 1	kWh House 2
26-jul	2206	267	11	7
27-jul	2218	275	12	8
28-jul	2229	283	11	8
29-jul	2240	290	11	7
30-jul	2250	297	10	7
31-jul	2261	304	11	7
01-ago	2272	311	11	7
02-ago	2283	319	11	8
05-ago	2316	341	33	22
06-ago	2327	349	11	8
07-ago	2338	356	11	7
08-ago	2350	365	12	9
09-ago	2362	373	12	8
12-ago	2387	388	25	15
13-ago	2393	392	6	4
14-ago	2403	398	10	6

- AC turned on. Set point = 23°C (77 °F).
- Measurement period: July 26 to Aug 14 2013.
- Significant difference found between kWh readings.
- P-value = 0.000
- 51% energy savings.
- Potential energy savings of $ 0.13

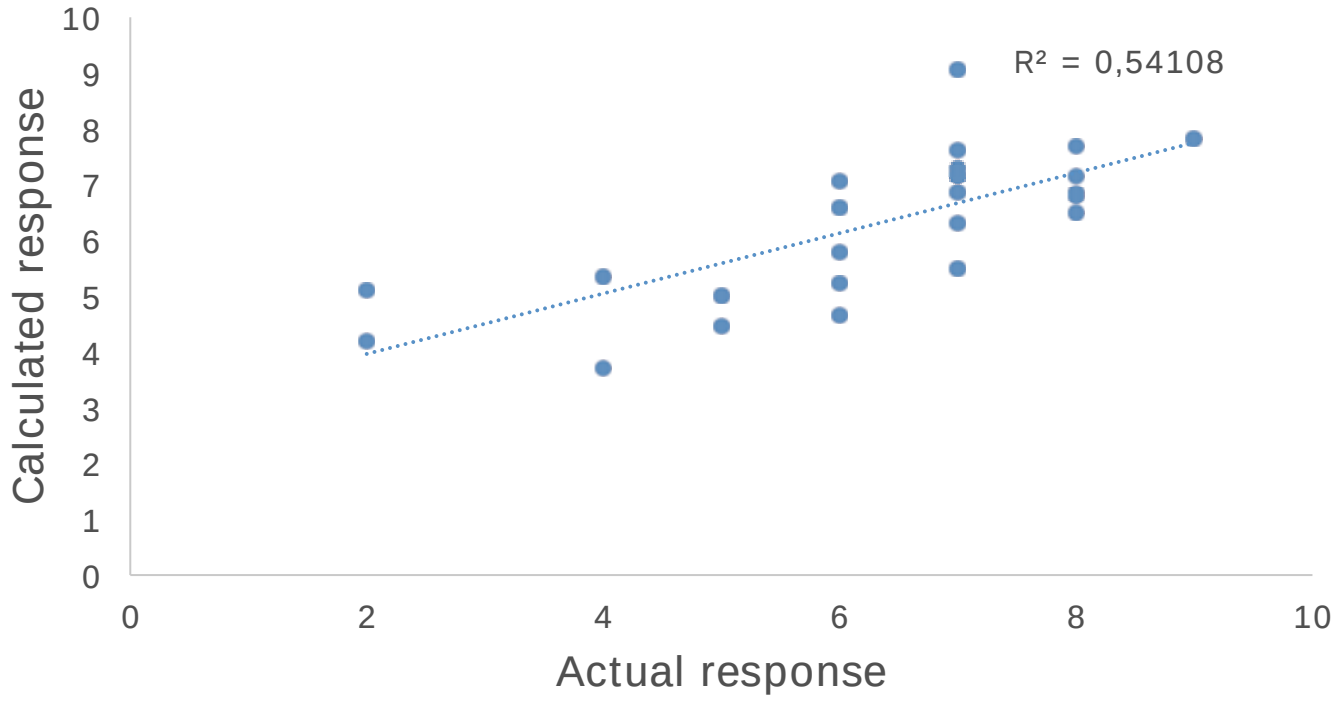
Artificial neural network development



Artificial neural network development

Mathematical Model

Response plot for Total energy consuption, kWh



Conclusions

- Quick, cost-efficient methodology was developed to demonstrate the value of using highly reflective coatings.
- The generated mathematical model, will allow researchers to provide an estimate of potential energy savings in different weather conditions
- The use of titanium dioxide in highly reflective coatings can represent very interesting electricity savings for home owners, commercial buildings and offices, reducing costs, diminishing the heat island effect and decrease of the Greenhouse Gas Emissions.
- Enhancement of the development of new products.
- Monetary savings can be as high as 600 USD/year.

Acknowledgements

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Thank you for your attention!

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