The Center for Urban Waters Building Energy Budget

MICHAEL LIVINGSTON

Research Intent

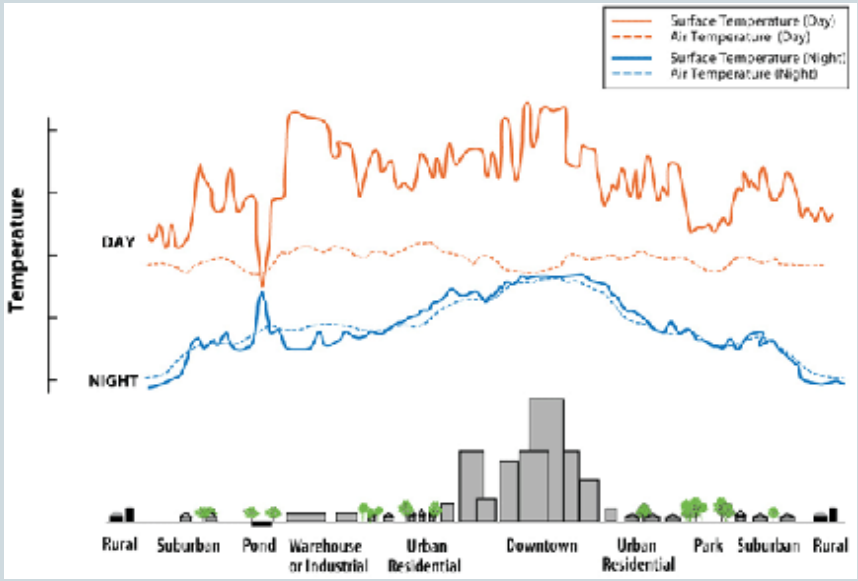
- To observe the different temperatures of various roof surfaces.
- To determine the overall influence of the green roof on the building's interior temperature.
- Present a comparison between annual, building energy usage rates.

Research Intent

- Buildings are an integral part of the urban setting.
- Urban settings present environmental conditions that create a unique set of localized climate conditions.
- One of the largest effects produced by the urban habitat is the Urban Heat Island effect.

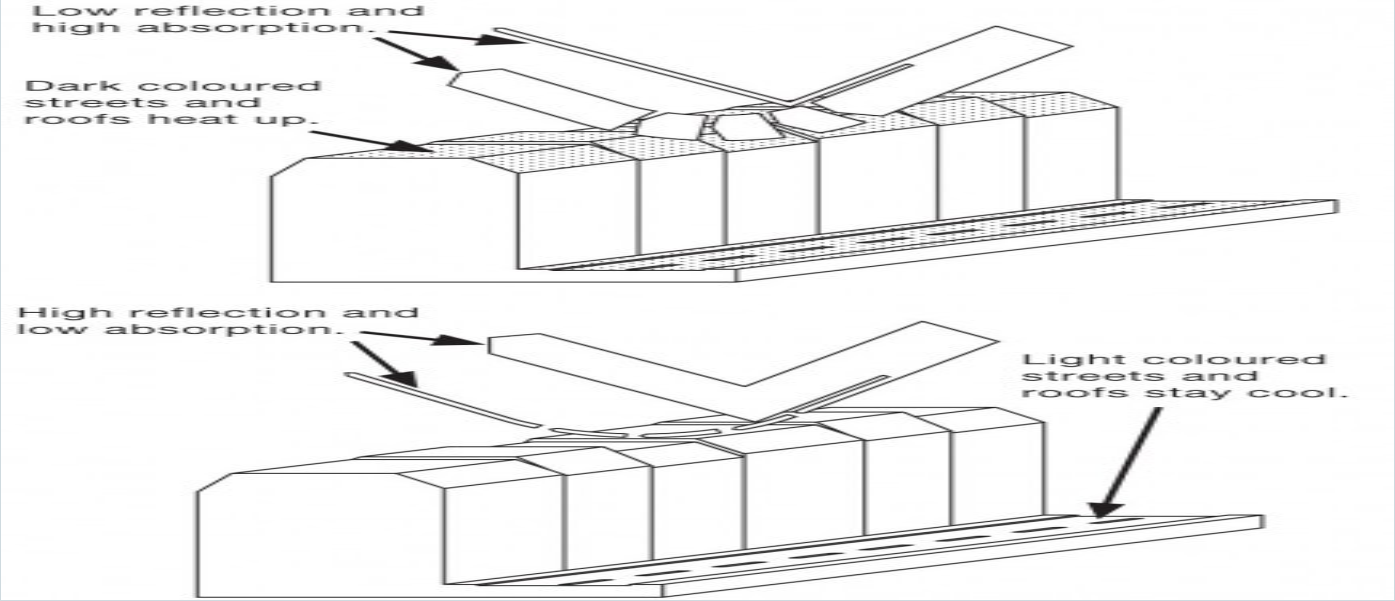
Urban Heat Island Effect

- Urban Heat Island effect is caused primarily by the covering of large, surface areas with low albedo materials.
- Another cause of the Urban Heat Island effect is the removal of vegetation.



The Albedo effect

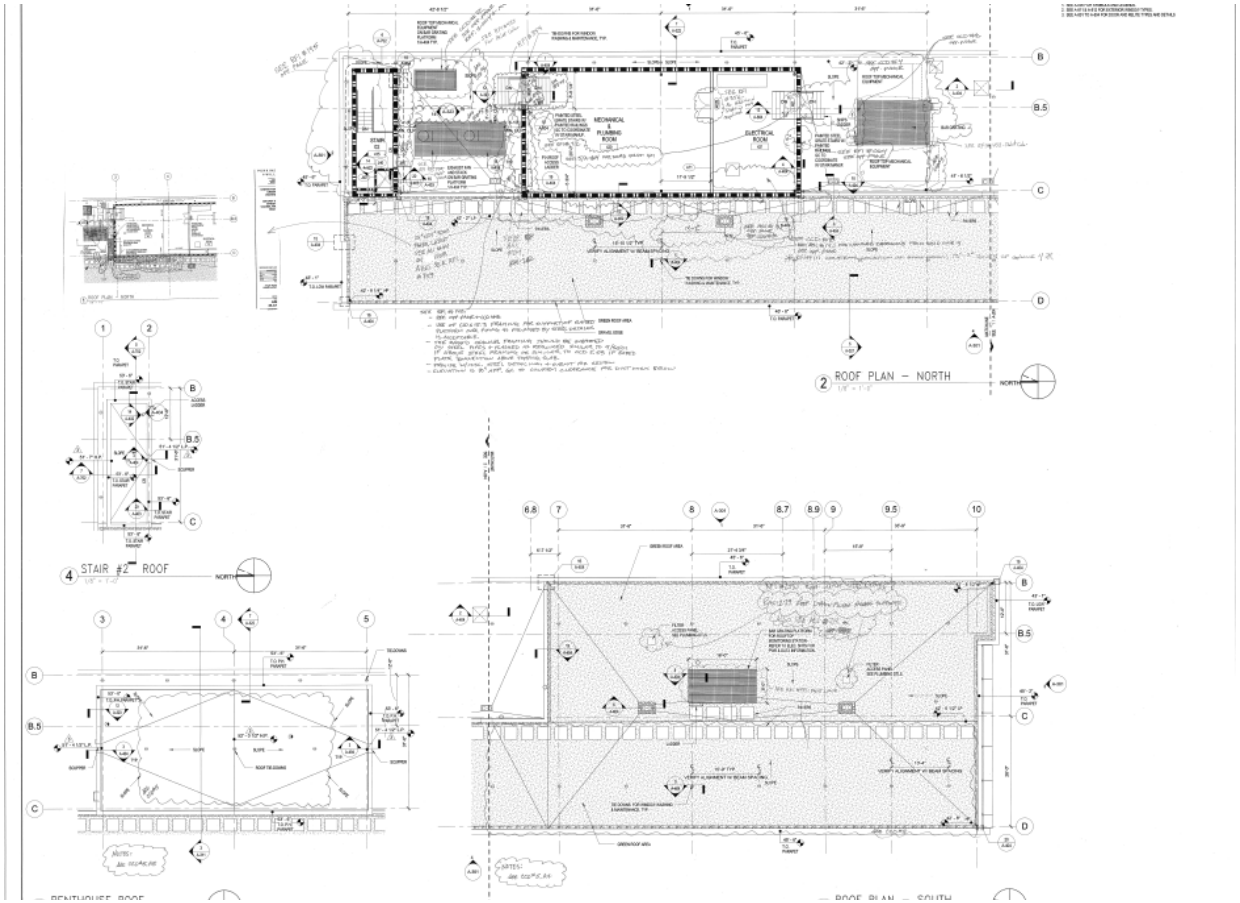
- Albedo, or 'diffuse reflectivity' is the reflecting power of a given surface. It's generally given in the form of a 0-1 scale with low albedo surfaces being closer to 0 and high albedo surfaces measuring closer to 1.



Vegetation and the Urban Heat Island effect

- Vegetation plays a unique role in the cooling of a municipal area.
- While plants generally have a low albedo, it cools an area through evapotranspiration and shading.
- The value of plants to cities are something that we're are only just becoming aware of.

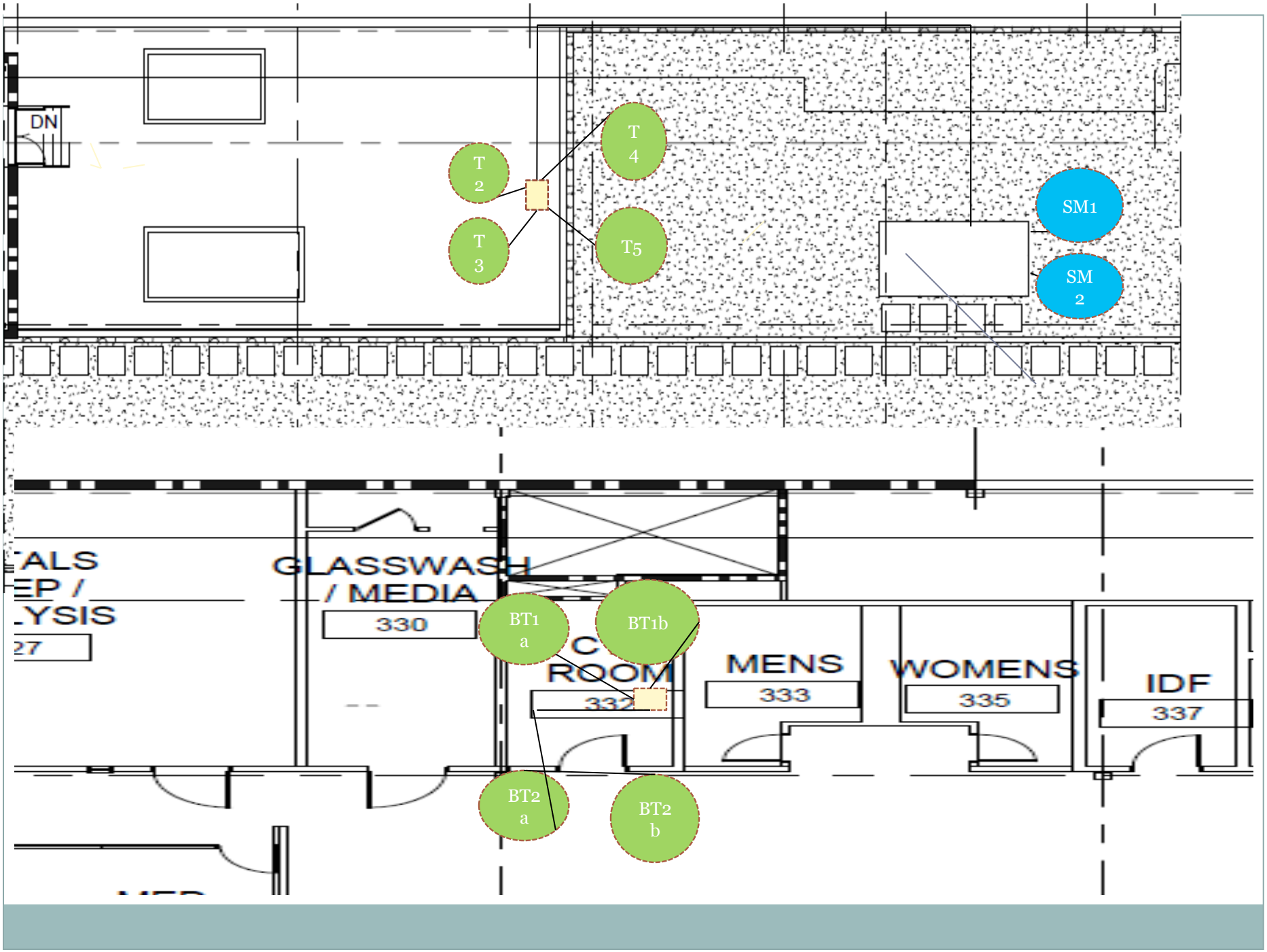
The Center for Urban Waters roof measures at its widest 274 feet and an average length of 61 feet, with an additional section of green roof measuring 64 feet by 24 feet and six inches. It has an approximate surface area of about 16,048 sq.ft.



Roof layout

Data Collection Equipment

Sensor	type	ID (at datalogger)	Location
T1	temperature	T108_10ft_C	short cable – likely won't reach desired location.
T2	temperature	T109_25ft_C	surface of green roof
T3	temperature	T108_60ft_A_C	under green roof layer
T4	temperature	T108_60ft_B_C	surface of white torch-down (high albedo)
T5	temperature	T108_60ft_C_C	surface of low albedo roofing material
BT1a	temperature	Onset HOBO U12 4-Channel Datalogger, w/ four TMCXX-HD temp sensors	inside building, underneath RT-2, insulated, Room 332
BT1b	temperature		inside building, underneath RT-2, ambient air, Room 332
BT2a	temperature		inside building, underneath RT-1, insulated, vicinity of UWT offices
BT2b	temperature		inside building, underneath RT-1, ambient air, vicinity of UWT offices
SM1	soil moisture & temperature	CS65X	mid-point of media on green roof
SM2	soil moisture & temperature	CS65X_2	mid- point of gravel media on pathway on green roof


DN
T 2
T 3
T 4
T5
SM1
SM 2
GLASSWASH / MEDIA
330
BT1 a
BT1b
C ROOM
332
MENS
333
WOMENS
335
IDF
337
BT2 a
BT2 b

The majority of the roof is comprised of a growing media covered in various, semi-arid plants that occur in the northern hemisphere such as Achillea millefolium and various grasses. It compromises about 9,912 sq. ft. or 62 % of the surface of the roof.

Green Roof

The majority of the remaining roof (appx. 5,800 sq. ft.) consists of highly reflective roofing surface. The material is referred to as Soprastar Flam 180 and is comprised of polyester, a blend of bitumen and highly reflective reinforcement film.

RT2 & RT3 (Reflective Roof Surface)

There are several gravel pathways on the roof averaging about 3 feet across and cross the 33 foot length of the roof.

Gravel Pathways

Not represented on the Center for Urban Waters Roof, this building material represents the traditional roofing material found on most roofs. It consists of a bitumen membrane with a granulated topside.

Sopralene Flam 180 FR GR

Temperature readings (June –September 2011)

- Roof temperatures taken from buried sensors averaged 21 and 19 degrees Celsius on temperature sensors T109 and T108 respectively(Between 70 and 66 degrees Fahrenheit).
- Air temperatures averaged about 16 degrees Celsius (or about 62 degrees Fahrenheit).

Expected Results

- Better idea of how our roof operates in comparison to a traditional roof.
- Determine how reflective the individual sections of the rooftop are.
- Darker, less reflective surfaces are expected to be hotter.
- Soprastar Flam expected to have a cooler surface.
- Vegetation cools the green roof more than other parts of the roof.

Roof to Ceiling thermal transfer

- In a 2003 report on the thermal performance of green roofs, it was found that green roofs can reduce heat gained in summer months by as much as 95% (Liu & Beskaran, 2003).
- Data collected from temperature sensors placed on the ceiling in the cylinder room will be compared to the data collected from temperature sensors located on the roof.

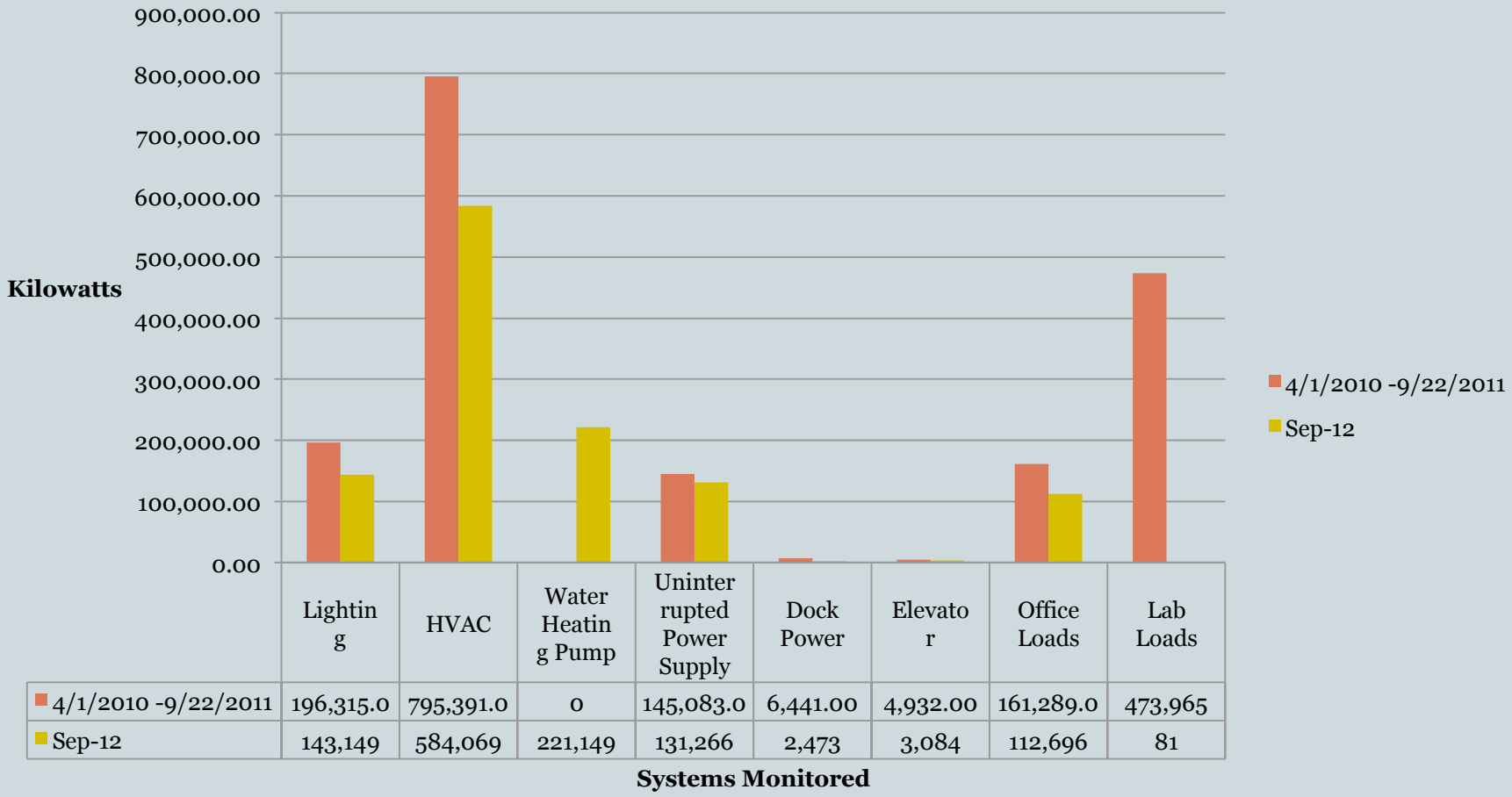
Expected Results

- The interior ceiling of the building will be lower in temperature than any of the roof top surfaces.
- The temperature difference will not be as significant at night as it will be during the day.
- Possible insulation properties to the green roof.

Energy Analysis

- Last year, analysis of energy usage rates involved direct observations of the nine sub-meters and main meter as well as collecting data from 2010's electric bills.
- This year, data trending software is used to gather energy use rates.

Energy Usage Rates for comparison



	Lighting	HVAC	Water Heating Pump	Uninterrupted Power Supply	Dock Power	Elevator	Office Loads	Lab Loads
4/1/2010 -9/22/2011	196,315.0	795,391.0	0	145,083.0	6,441.00	4,932.00	161,289.0	473,965
Sep-12	143,149	584,069	221,149	131,266	2,473	3,084	112,696	81

Results

- The elevator consumed close to similar kilowatts while the other non-automated systems fluctuated significantly .
- HVAC, WHP-1,UPS and Lighting systems are likely consuming slightly more than they did last year.

Acknowledgements

- Joel Baker, PhD, Science Director
- Kurt Marx, Emerging Technologies Coordinator
- Dale Shepard, Building Engineer, Kidder Mathews
- Thank you all for listening!!

Questions?