

## Summary of monitoring

6<sup>th</sup> Oct 2014

### Summary of the Monitoring Strategy

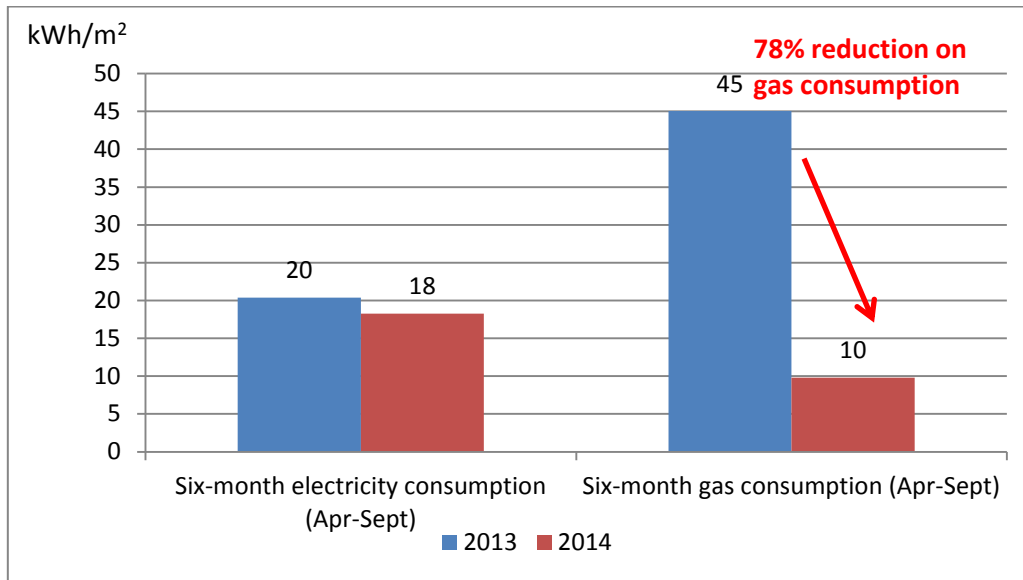
A variety of monitoring devices and systems have been installed in the Garth building, post-refurbishment in order to systematically monitor the physical, energy and environmental performance of the building:

1. **Orsis energy monitoring system** is a web-based remote system for monitoring gas and electricity consumption, sub-metered electricity usage of MVHR and 2 electric water heaters. (5-min data start from 11/04/2014)
2. **Omnisense moisture monitoring system:** This is a web-based remote monitoring system for buildings to measure temperature, relative humidity, moisture content in the cavity construction formed behind the internal wall insulation. It is used to monitor the physical performance of behind the internal wall insulation. 12nr sensors have been installed to measure moisture content of external wall, timber stud and floor joist at various locations. (5-min data start from 25/03/2014)
3. **Omnisense environmental monitoring system:** This is a web-based remote system for monitoring indoor/outdoor air temperature and relative humidity and external solar radiation. 11nr sensors have been installed at various locations. This is assisted by 4 additional local temperature/RH data logger at the north end of the building. (5-min data start from 18/04/2014)
4. **Monitoring of indoor air quality through monitoring of CO<sub>2</sub> levels:** CO<sub>2</sub> data loggers were installed in Rooms G25, F13, F19 and F21 to monitor CO<sub>2</sub> levels at 5-min interval. (5-min data start from 26/04/2014)
5. **Window opening behaviour** monitoring (door and windows opening): 15 local HOBO data loggers have been installed to measure door/windows opening at key space (main entrance, G25, F13, F19 and F21). (data start from 26/04/2014)
6. **Heating behaviour** monitoring (heating on/off): Four local iButton data loggers have been installed to measure the temperature of radiators at G24, G25, F13 and F21). (15-min data start from 26/04/2014)

### Key findings of monitoring results (up to 30<sup>th</sup> September 2014)

#### Energy assessment

Post-refurbishment for the period 11<sup>th</sup> April to 30<sup>th</sup> September 2014 (nearly six months), Garth building had consumed 5,676 kWh of electricity and 3058kWh of gas, which equates to about 78% reduction in gas and 11% reduction in electricity consumption as compared to April-September 2013 (pre-refurbishment). Gas consumption (which was the primary focus of the refurbishment) has been reduced to 10kWh/m<sup>2</sup> over the last 6 months from 45kWh/m<sup>2</sup> for the same period in 2013. However these are preliminary results for the non-heating season and the performance of the building during winter 2014-15 will be analysed in early 2015.



### Internal environmental conditions

Indoor temperature and relative humidity levels in 7 rooms of Garth building have been monitored from 18<sup>th</sup> April 2014 to 5<sup>th</sup> Oct 2014. The data shows that south facing rooms (F20, F21) are significantly warmer than other spaces. More than half of the occupied hours in room F13, F19, F20 and F21 are higher than 24°C. Detailed results are shown in the table below.

	External	F13	F19	F20	F21	G23	G25
Percentage of occupied hours over operative temp. of 28°C	4.9%	3.2%	0.9%	7.6%	10.0%	0.0%	3.5%
Percentage of hours above 24 °C	23.8%	96.0%	57.6%	79.7%	58.0%	28.8%	29.4%
Percentage of hours within 22-24 °C	15.9%	3.9%	39.9%	18.1%	30.7%	61.4%	42.5%
Percentage of hours below 22 °C	59.3%	0.2%	2.6%	2.1%	11.3%	9.7%	28.1%