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## POE + Monitoring including the 1<sup>st</sup> Scottish Passive House



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## POE + Monitoring including the 1<sup>st</sup> Scottish Passive House

### Abstract

- Project has been running since March 2011.
- Three dwellings monitored include the first Scottish Passive house, a Low Energy House (no MVHR), and a 1950s dwelling; located in Dunoon, Scotland.
- Monitoring includes: energy use; internal and external conditions (Temperatures, RH and CO2 levels inside and temperature and solar radiation outside); and systems performance (including solar hot water).
- Post occupancy evaluation (POE) carried out through inspection and questionnaire.
- Energy used, CO2 and relative humidity levels compared.
- Operation of the different ventilation schemes highlighted.
- Costs and electricity tariffs highlighted.
- Learnings identified include ventilation, heat pump, solar and auxiliary hot water services.
- Improvements to current processes are suggested.
- POE and monitoring are essential feedback for the building design and construction process.



## CEPHEUS-SCOT: Location of dwellings



1 – Passive House (et)

2 – Code level 4 House (mt)

3 – 1950s House (et)

all-electric heating and hw

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## POE: Passive House



### Snagging:

- MVHR intake and exhaust duct insulation
- Air Source Heat Pump winter performance
- Solar / Electric Water Heating
- Tariff

The resolution of these snags is underway.....

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## POE: Passive House



### Snagging:

- MVHR intake and exhaust duct insulation



## POE: Passive House

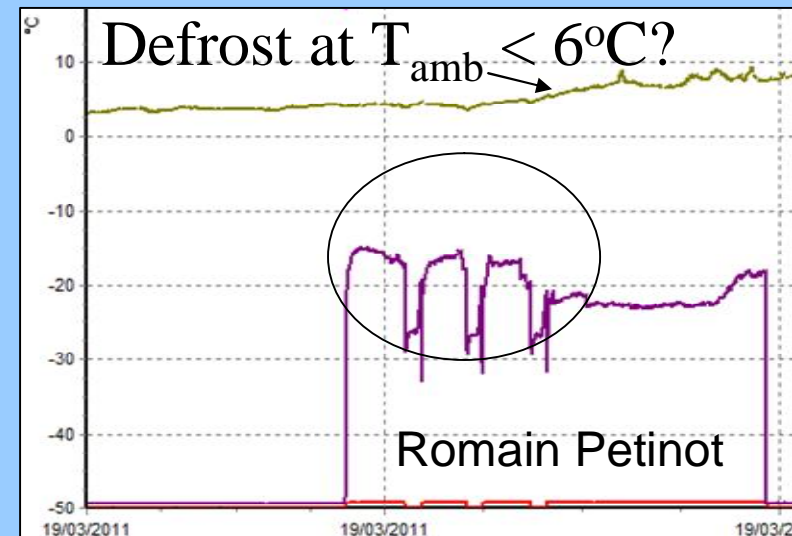


### Snagging:

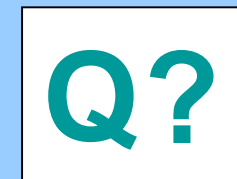
- Air Source Heat Pump winter performance



Annual Coefficient of Performance - Heat Pump	2.50
Total System Performance Ratio of Heat Generator	0.40



H/P type	Emitter Type	Test conditions set out in EN14511					
		Lowest source temp		Highest source temp			
		Sink	Source	Sink	Source	Sink	Source
Air to Water (Source -ambient air only)	UFH	35/a	-7/-8	35/a	2/1	35/30	7/6
	Convactor	45/a	-7/-8	45/a	2/1	45/a	7/6
	Radiator	55/a	-7/-8	55/a	2/1	55/a	7/6

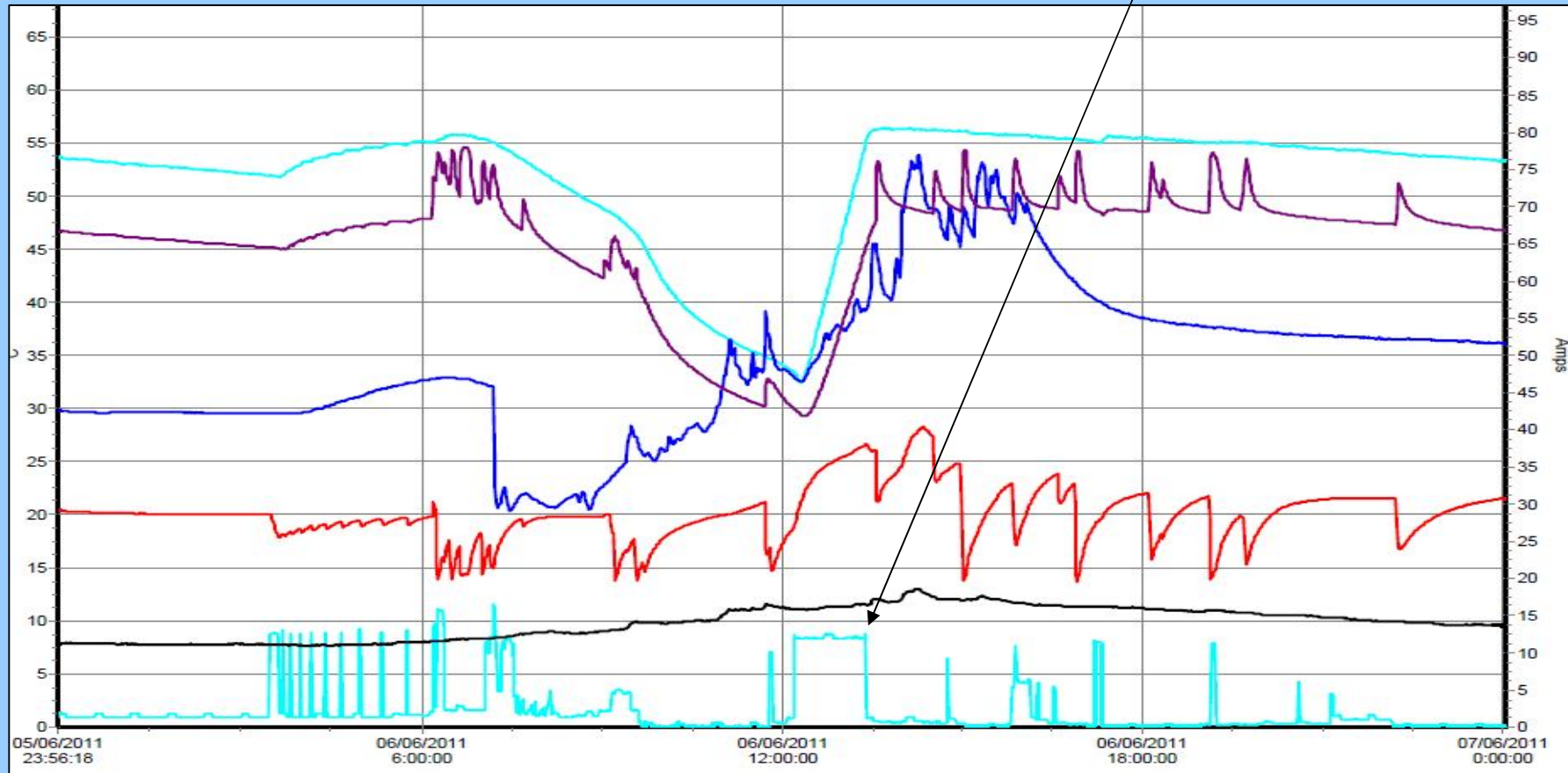


## POE: Passive House



### Snagging:

- Solar / Electric Water Heating – electric heater on in middle of June day?



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## POE: Passive House



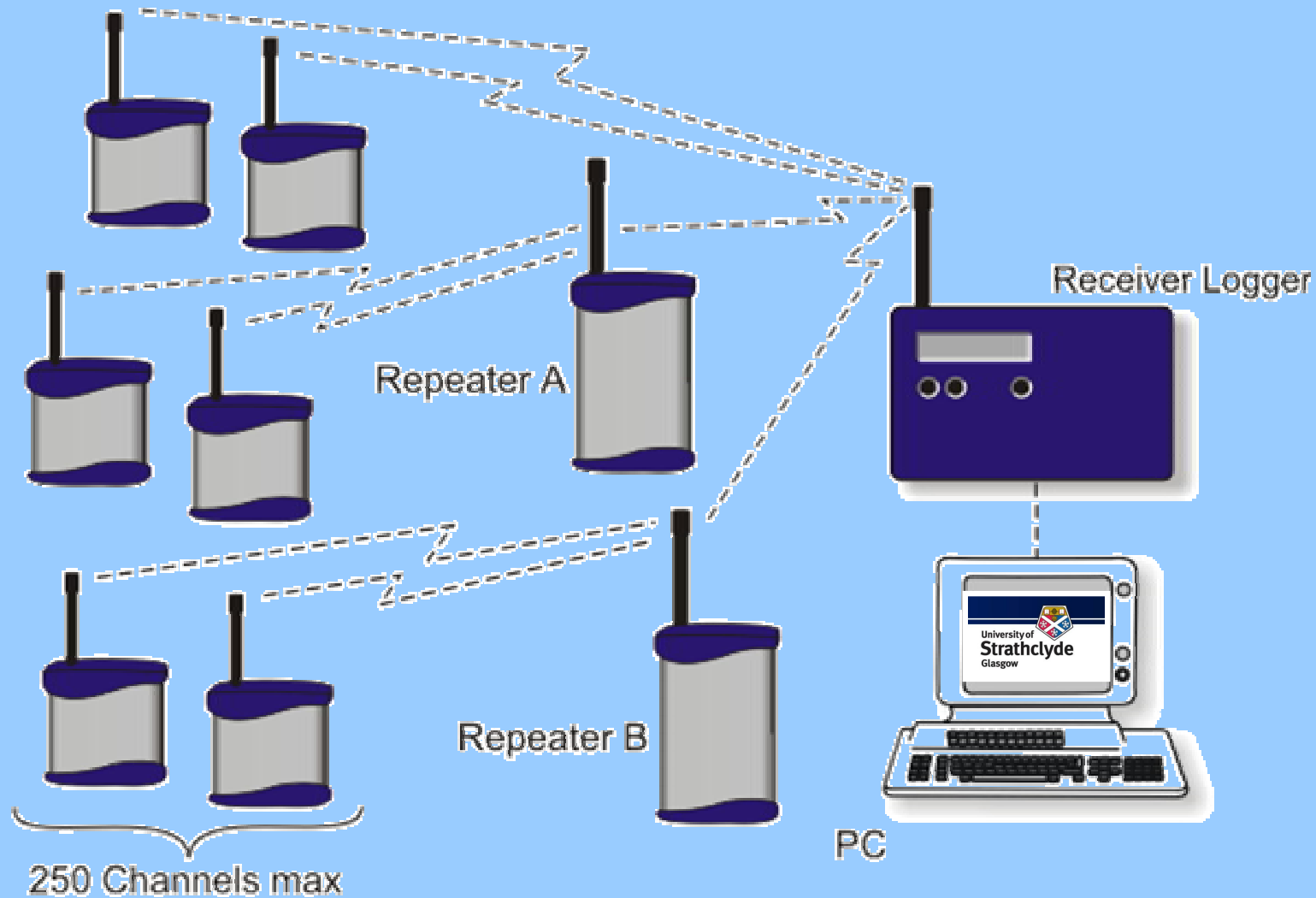
### Snagging:

- Tariffs – THTC 7p/kWh vs Standard 12p/kWh for space and water heat





# CEPHEUS-SCOT: Monitoring kit



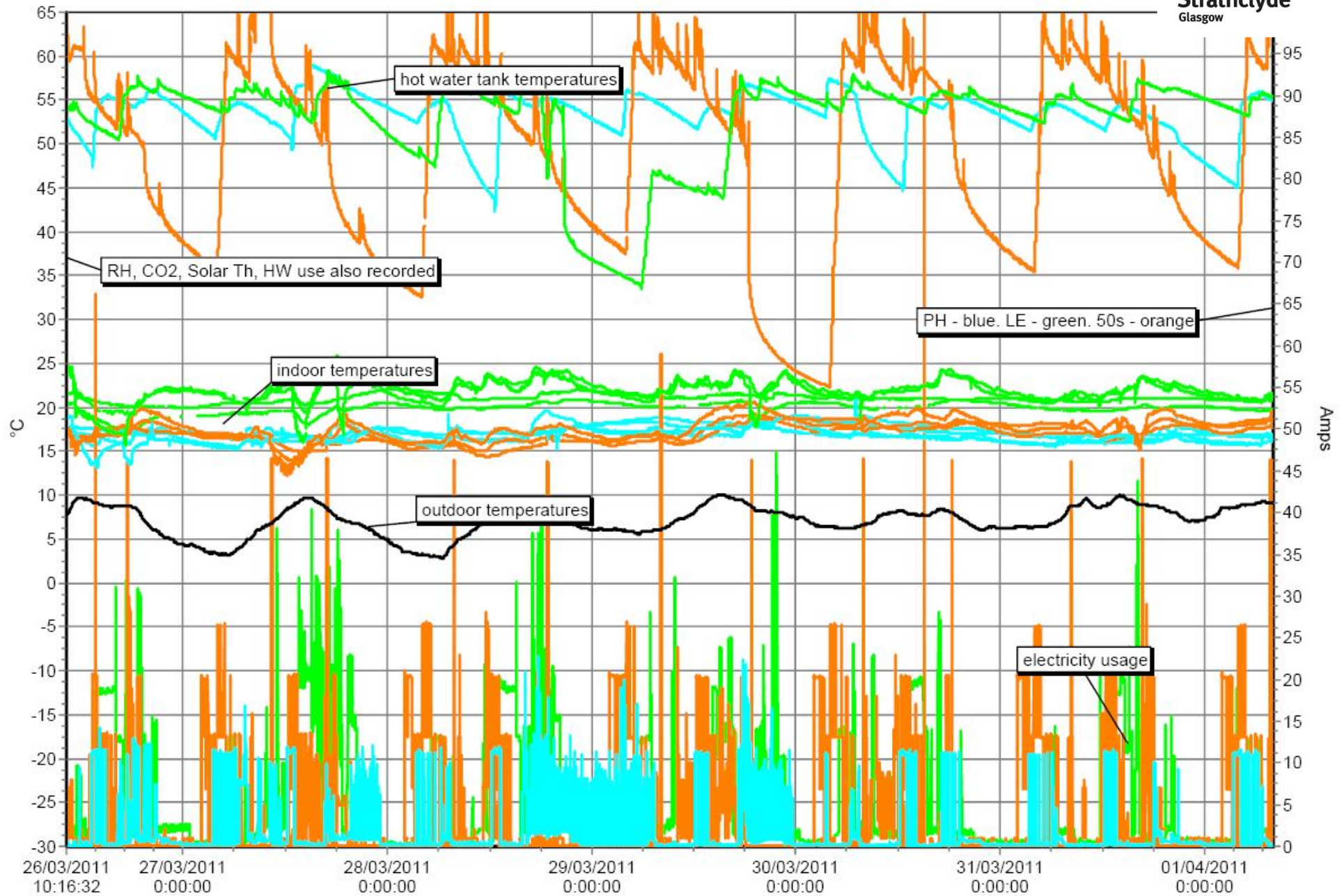
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## CEPHEUS-SCOT: Monitoring kit



# MONITORING OUTPUTS – LOTS!!



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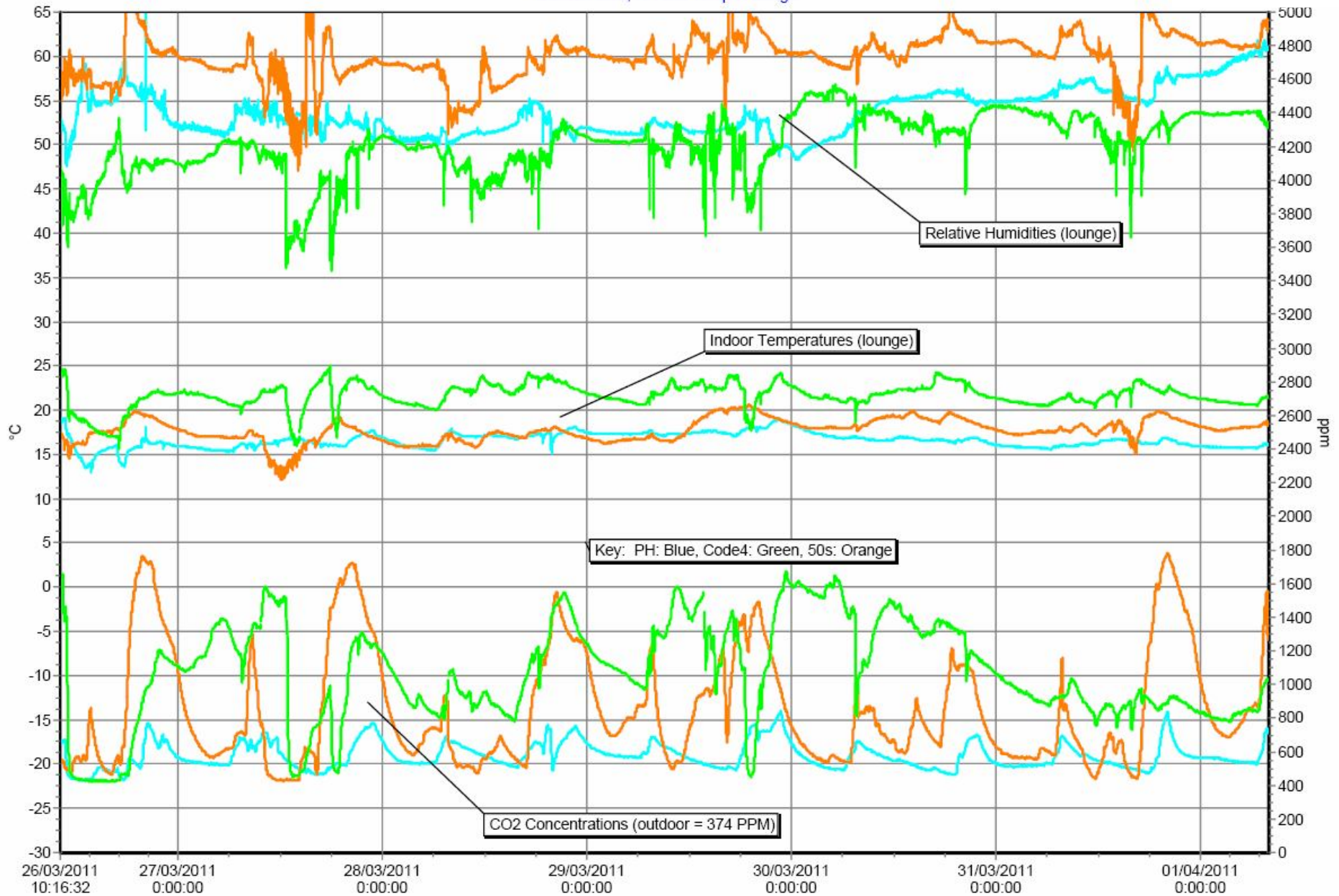


## INITIAL OBSERVATIONS



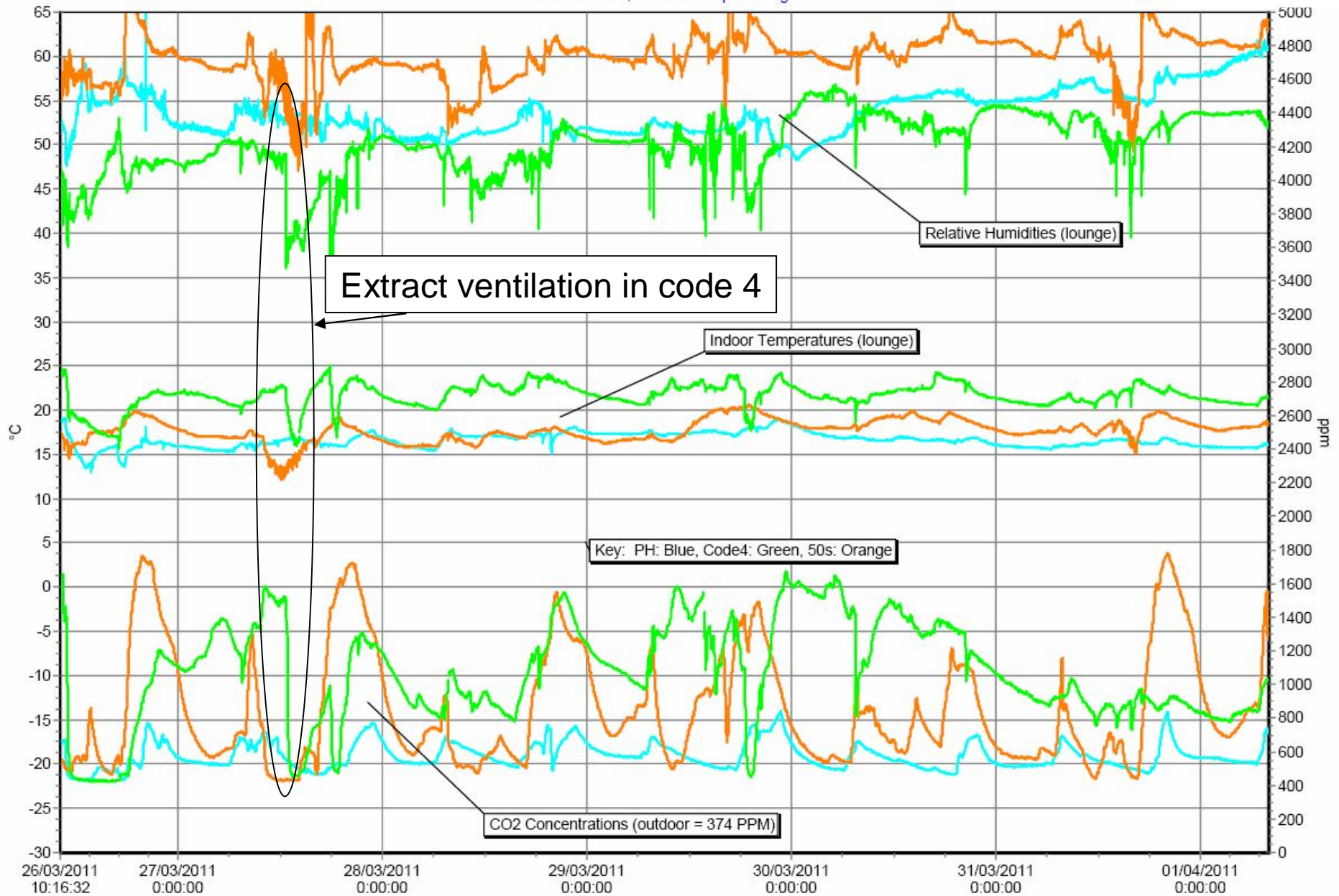
# COMFORT CONDITIONS – PH COOL? BUT GOOD CO2!

Dunoon CO2, RH and Temp in lounge.



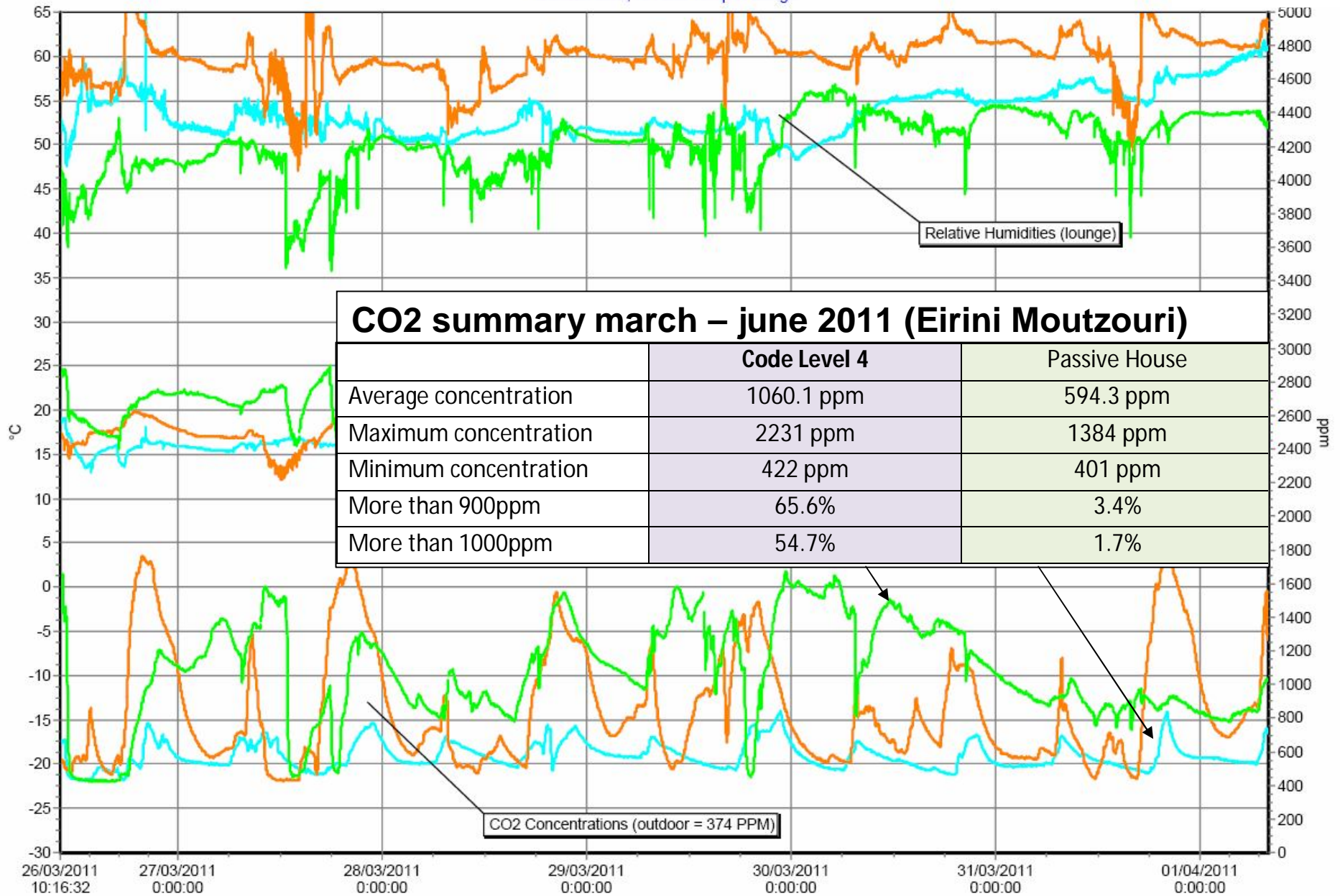
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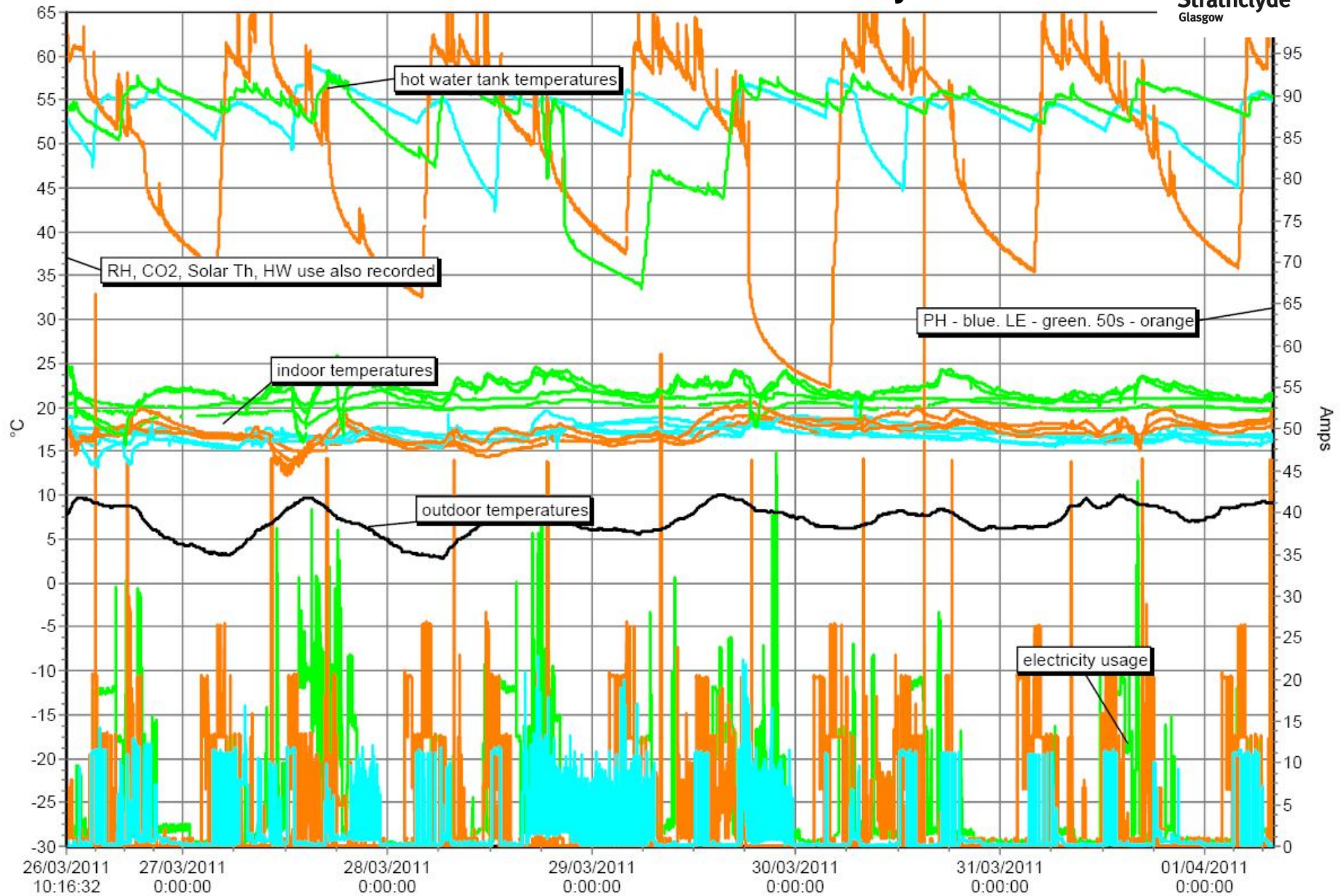
Dunoon CO2, RH and Temp in lounge.



## CO2 summary march – june 2011 (Eirini Moutzouri)

	Code Level 4	Passive House
Average concentration	1060.1 ppm	594.3 ppm
Maximum concentration	2231 ppm	1384 ppm
Minimum concentration	422 ppm	401 ppm
More than 900ppm	65.6%	3.4%
More than 1000ppm	54.7%	1.7%

## MONITORING OUTPUTS – Electricity use?



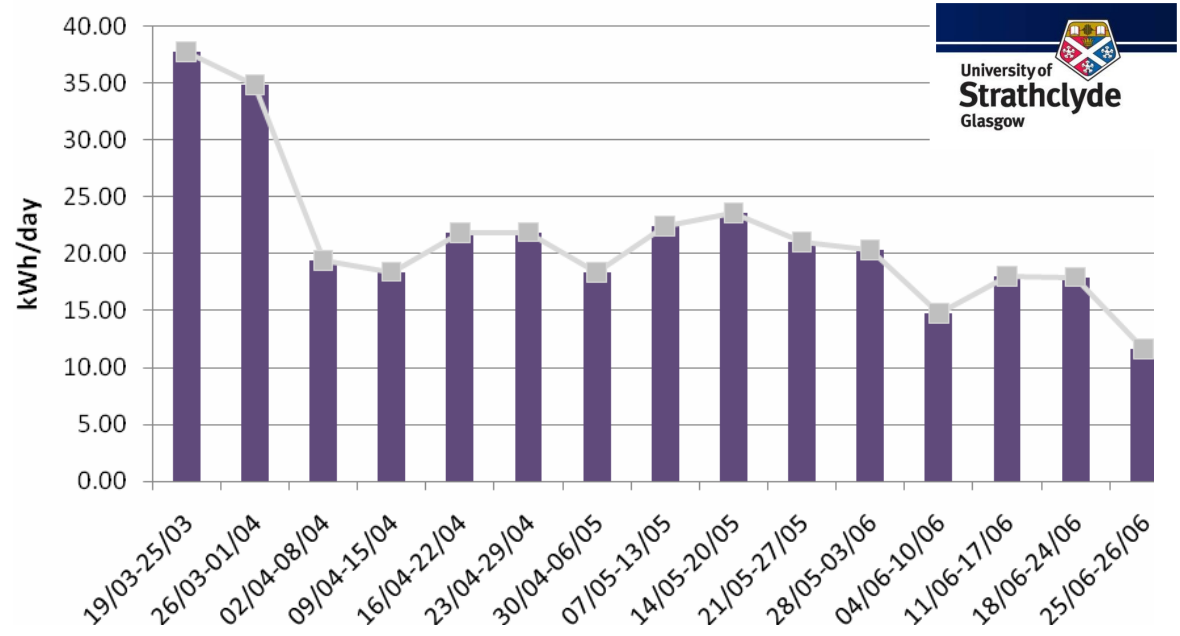


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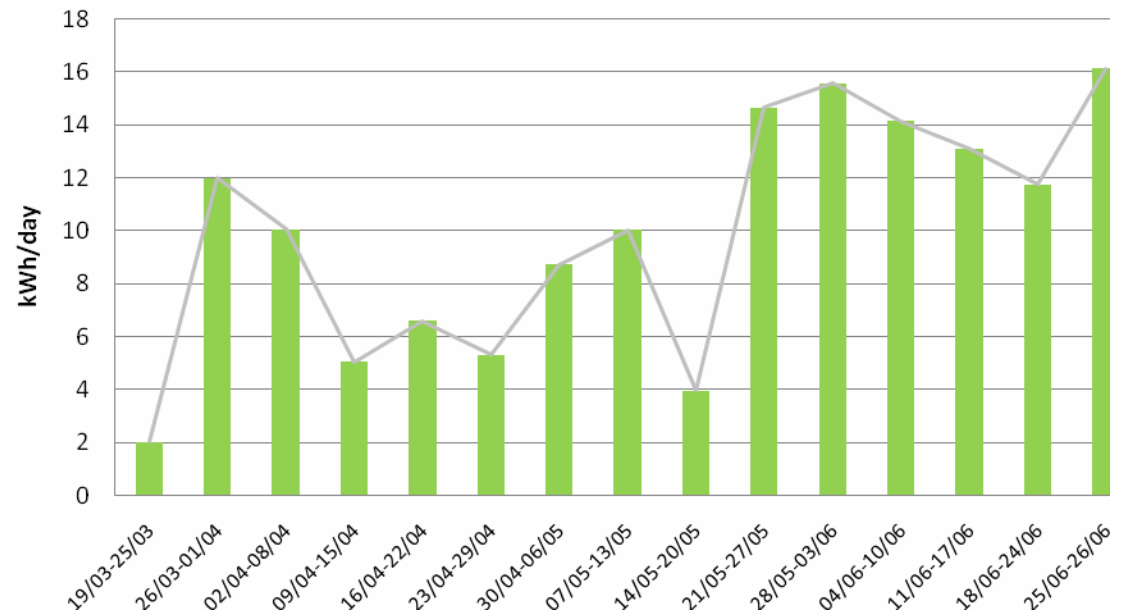
# Electricity summary March – June 2011

(Eirini  
Moutzouri)

### Average Daily Electric Consumption (Code level 4 dwelling)



### Average Daily Electric Consumption (Passive House)

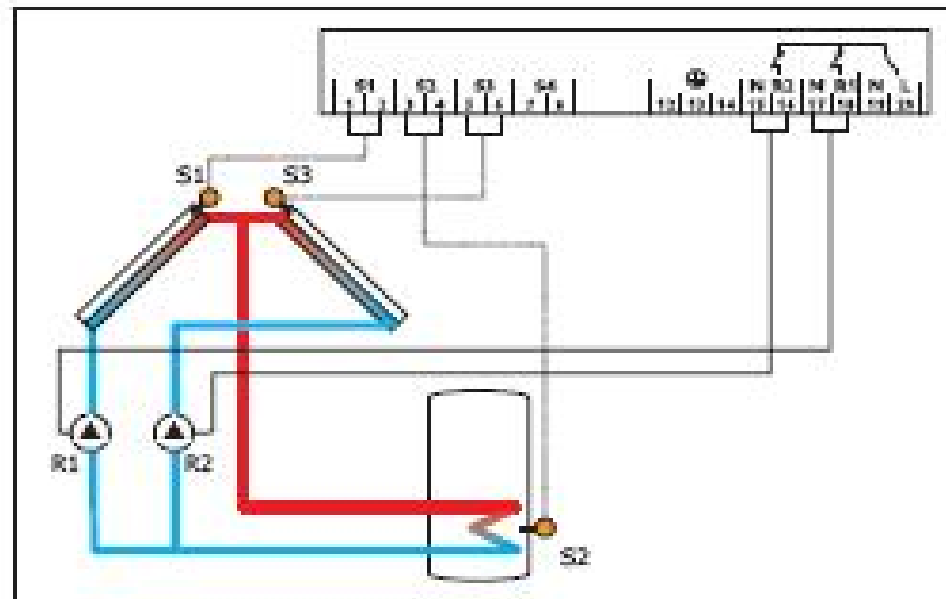


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## SOLAR THERMAL – EXPECT 55% ANNUAL CONTRIBUTION - PHPP



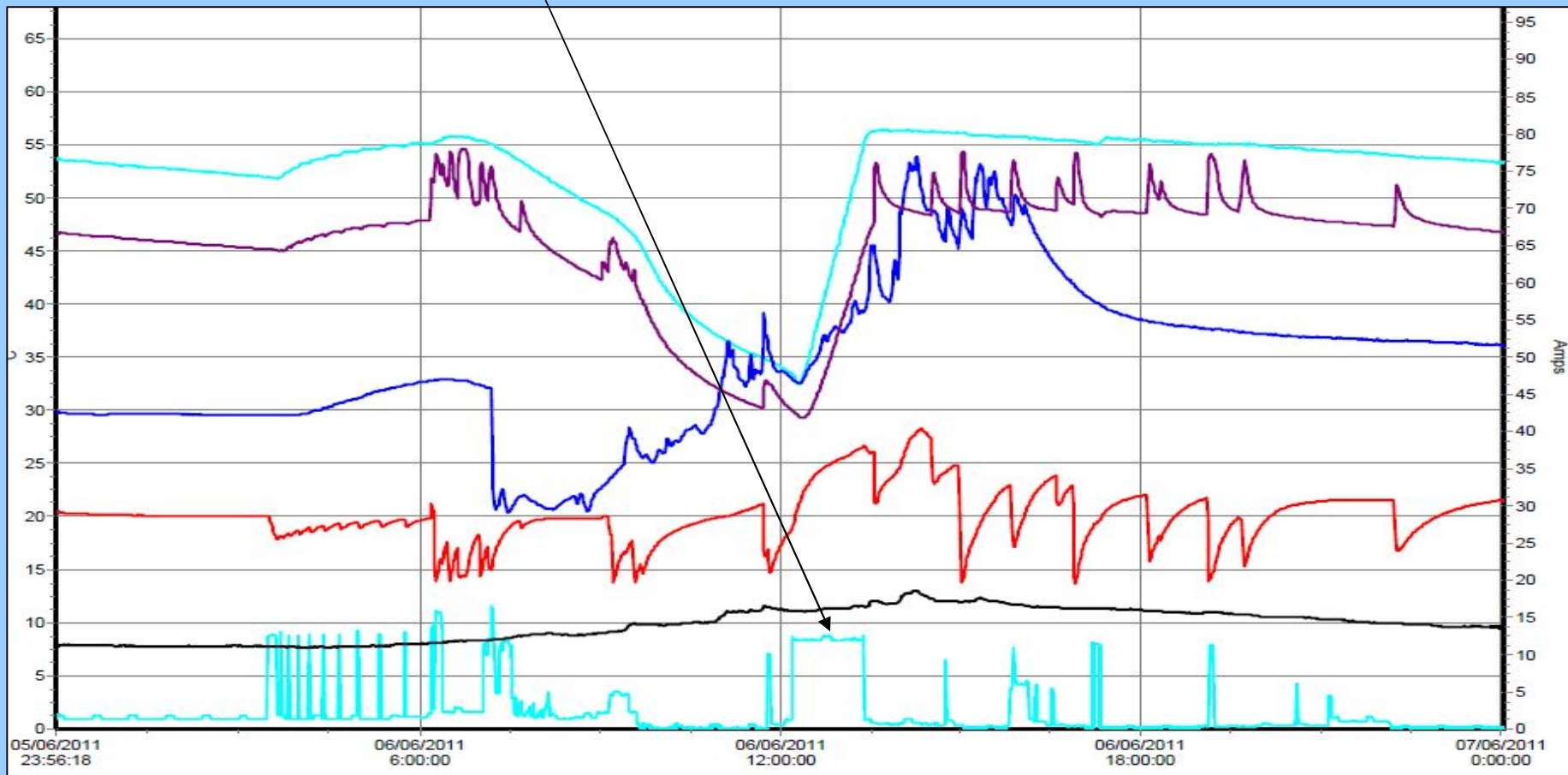
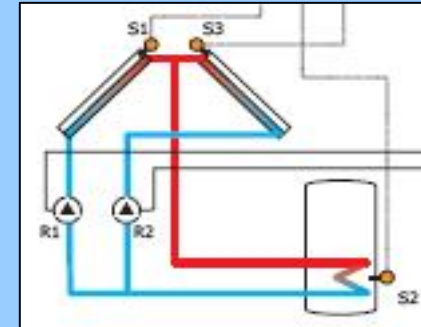
Symbol	Specification
S1	Collector sensor 1
S2	Store sensor
S3	Collector sensor 2
S4	Measuring sensor (optionally)
R1	Solar pump collector 1
R2	Solar pump collector 2



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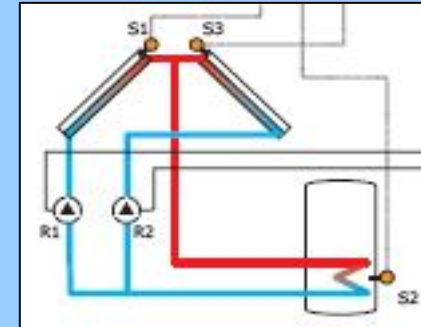
# SOLAR THERMAL – 55% ANNUAL CONTRIBUTION - PHPP

Electric immersion heater controls not optimised



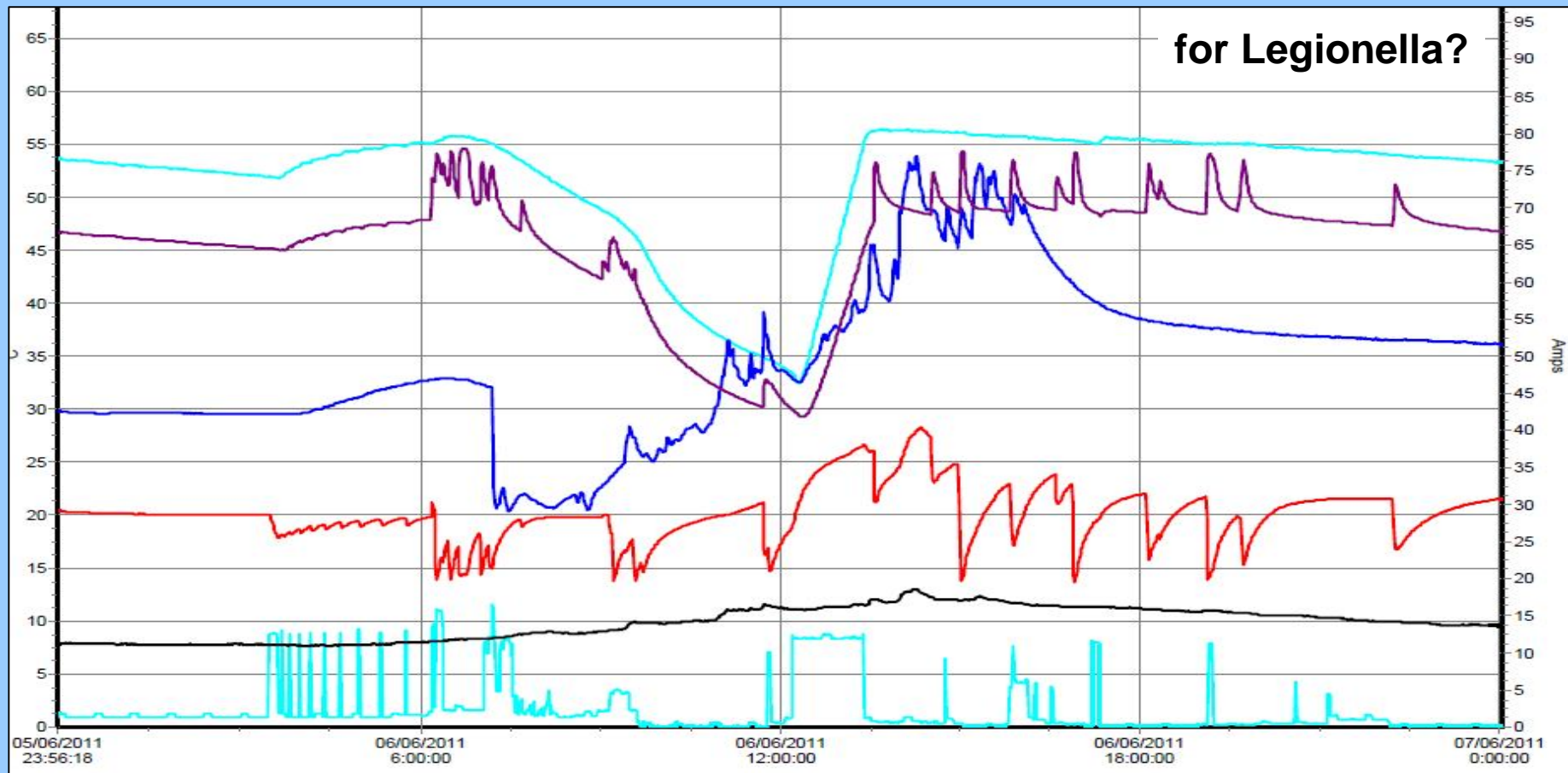
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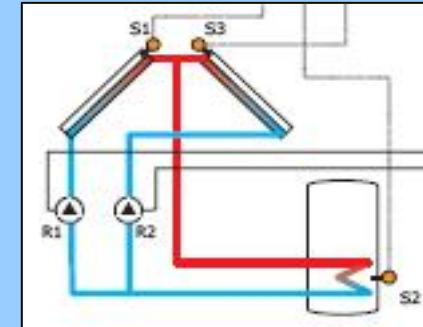
Electric immersion heater controls – fixed?

But still not optimised? Now 60°C 2x per day 5-6 am and pm



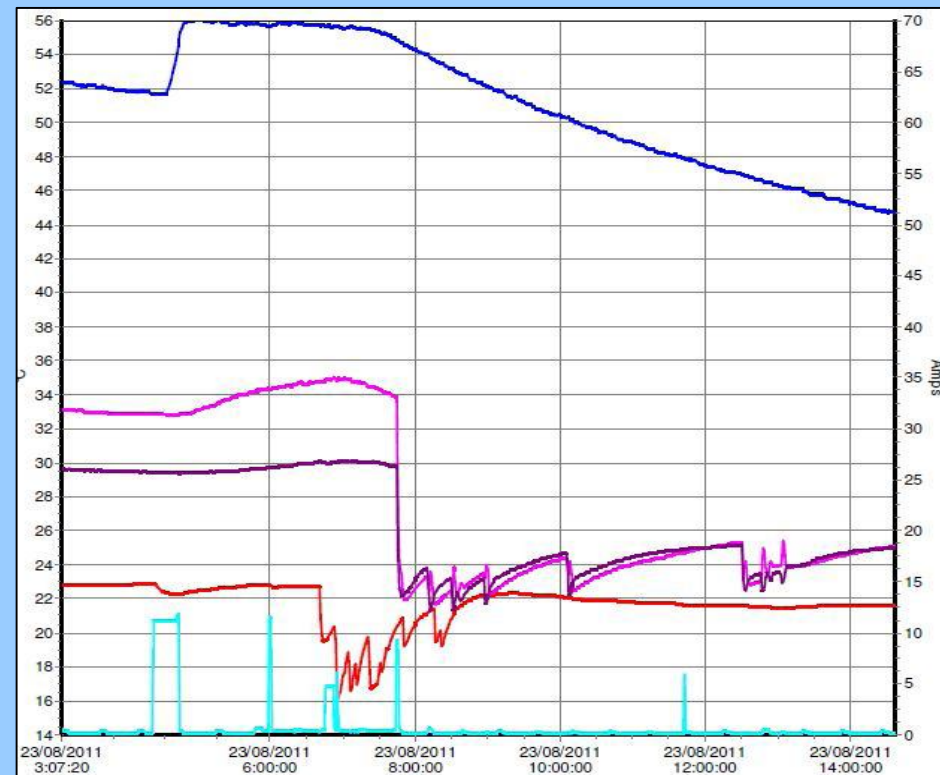
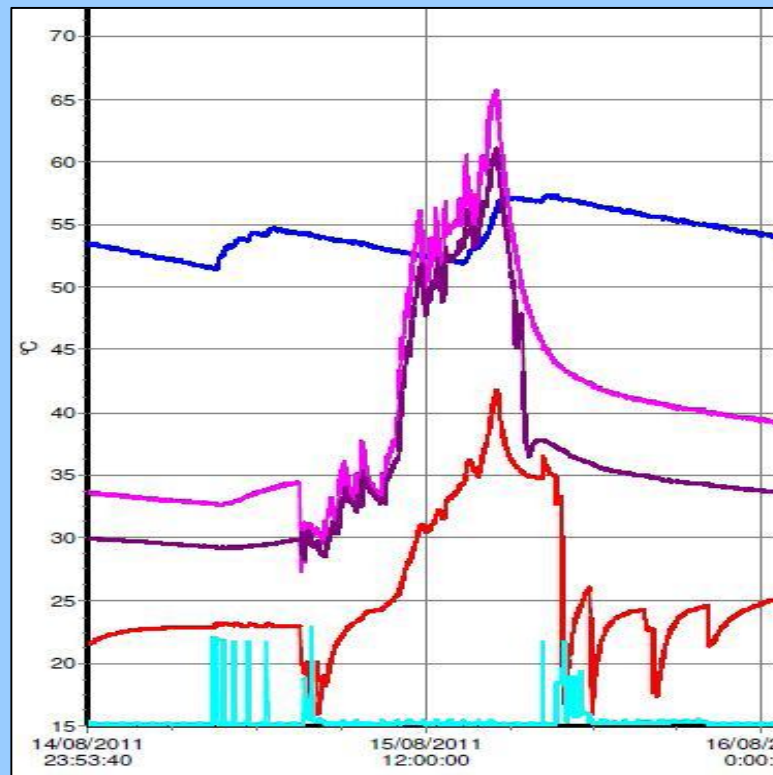
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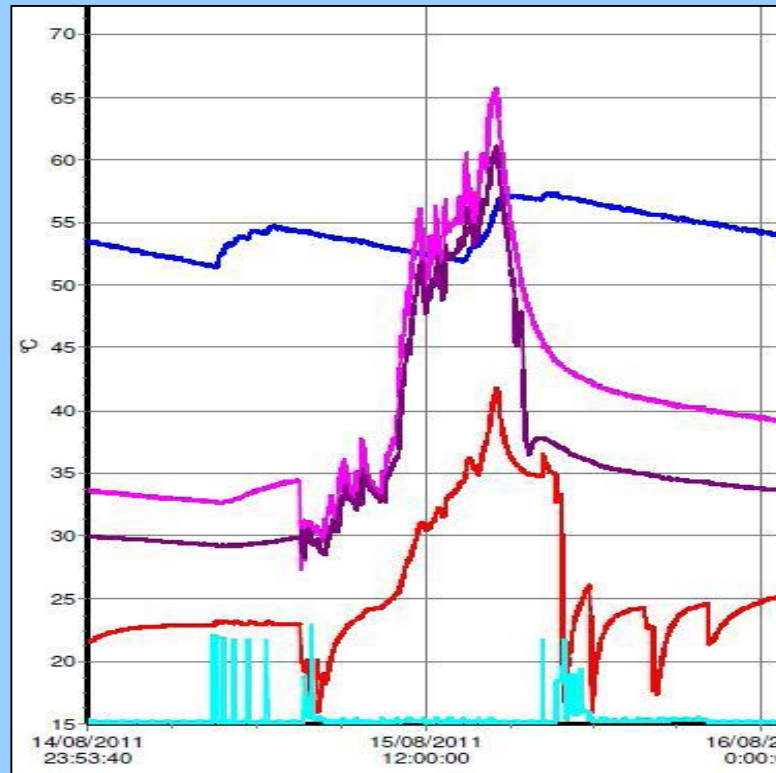
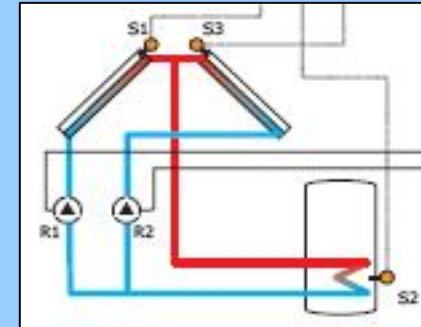
Solar system controls – if panels  $6^{\circ}\text{C} >$  bottom tank sensor then pump is on – can flow water as cool as  $15^{\circ}\text{C}$

**Pink** = flow from solar panel, **Purple** = return to panel from tank



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## SOLAR THERMAL – 55% ANNUAL CONTRIBUTION - PHPP



**Published results suggest 40% solar fraction for Solar plus Aux heating to 60°C 2x per day (Dublin climate)**

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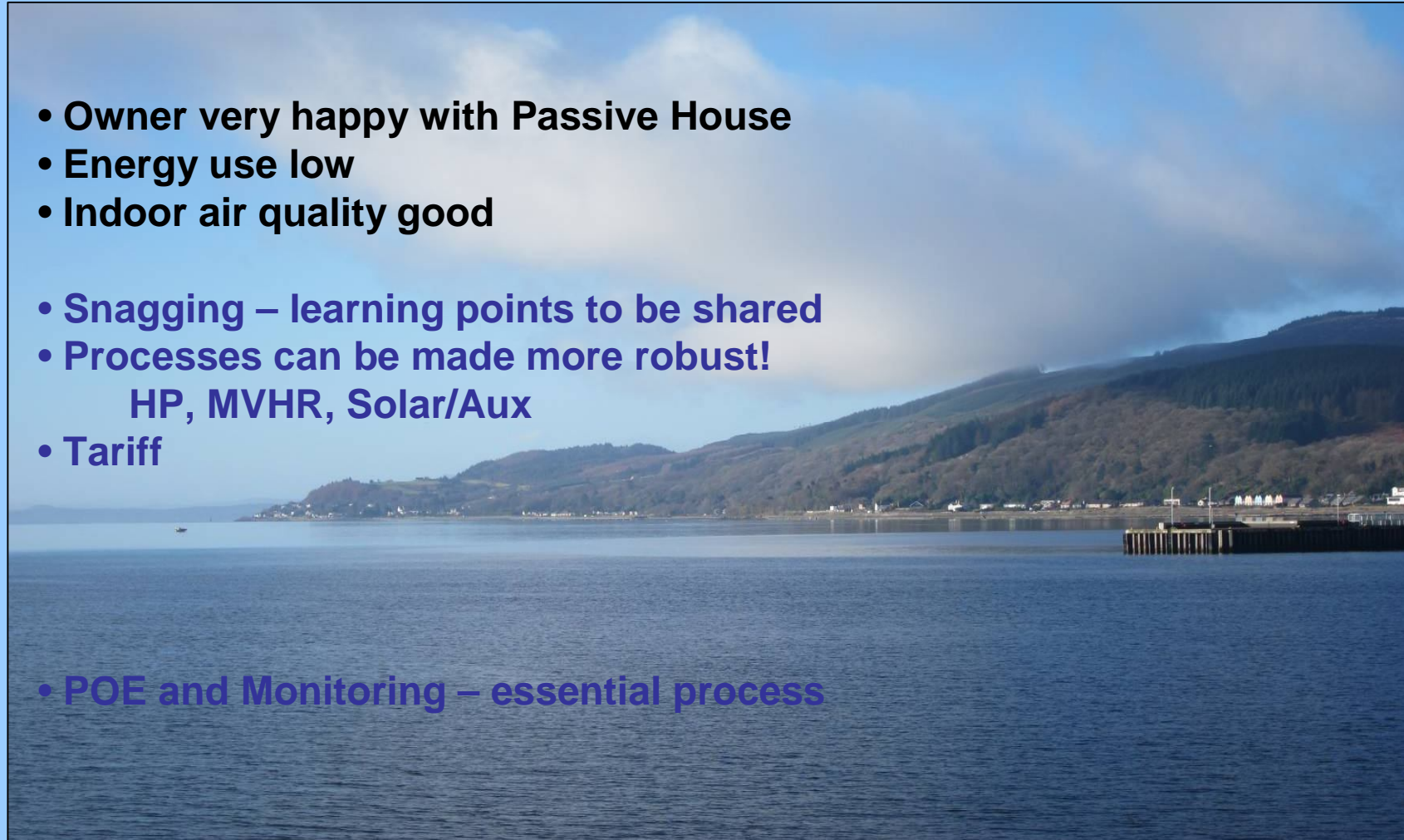


## CONCLUSIONS



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- Owner very happy with Passive House
- Energy use low
- Indoor air quality good
  
- Snagging – learning points to be shared
- Processes can be made more robust!  
    HP, MVHR, Solar/Aux
- Tariff
  
- POE and Monitoring – essential process



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*Quality Approved  
Passive House  
Dr. Wolfgang Feist*

**Standard can be made more robust!**

- POE and Monitoring – essential process

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