



Viable Energy Harvesting Solutions for use in Low Light Levels

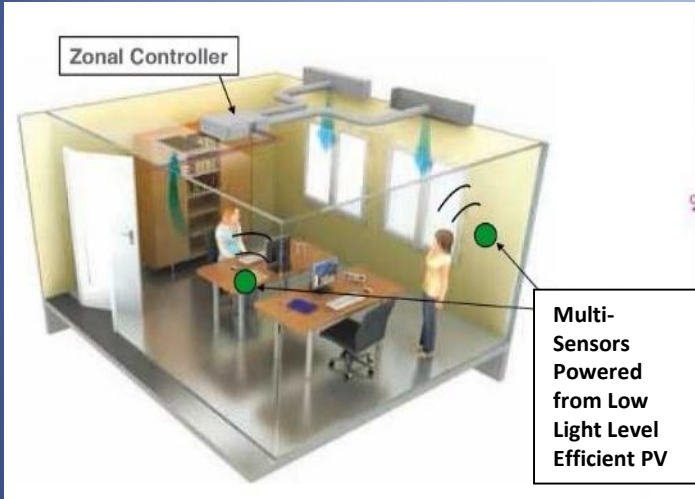
Des Gibson

Gas Sensing Solutions Ltd

www.gassensing.co.uk

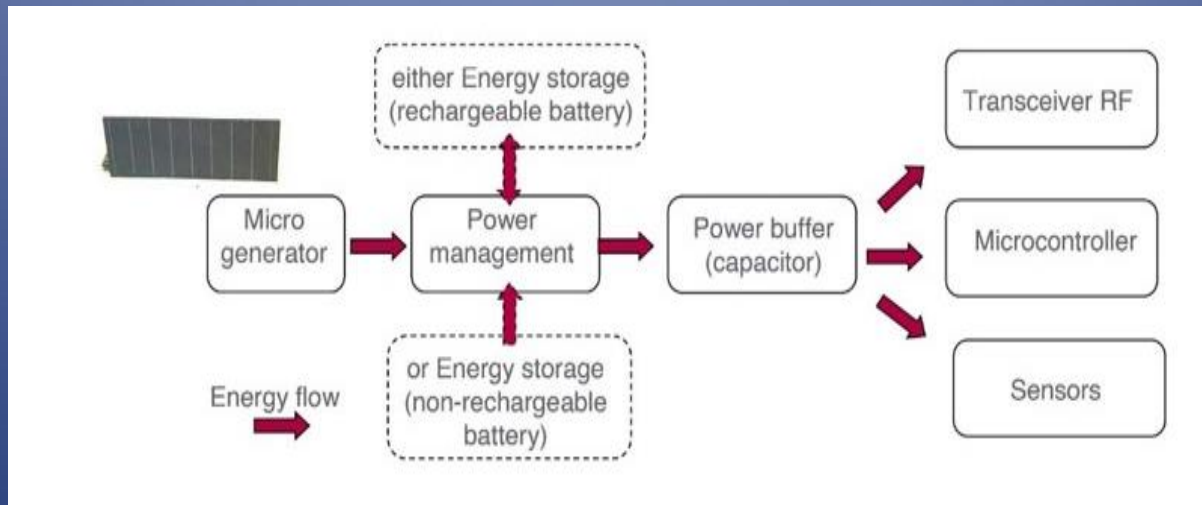
Energy Harvesting Event – 19th March 2015

Indoor Multi-Sensors Powering from Low Light Level PV



Market Driver: Self Powered Wireless Smart Sensors

- People wellbeing & comfort: temperature, humidity, carbon dioxide
- Building management systems information: occupancy & usage
- Efficient control of air handling and lighting systems



Typical Energy Requirements 1mJ per measurement
Measurement frequency circa 10 to 50 per hour

Low Light Level PV: Considerations & Testing

PV material systems spectral absorption bands

Wavelength (nm)	Junction	c-Si (Mono & Multi)	a-Si	CdTe	CIGS	CZTS	DSSC	OPV	Quantum Dot	GaAs & III - V
350 - 750	SJ		█				350-850	█	█	█
350 - 1100	SJ, TJ, MJ	█	█	█	█	█		█	█	█
350 - 1800	MJ		█					█	█	█

SJ: Single Junction TJ: Tandem Junction MJ: Multi Junction

Test Parameters

Optical Power Density (to emulate different light intensities)

Spectral Bandwidth & Weighting (to emulate different light sources)

Pulse Characteristics (to emulate flicker)

Common Indoor Light Sources

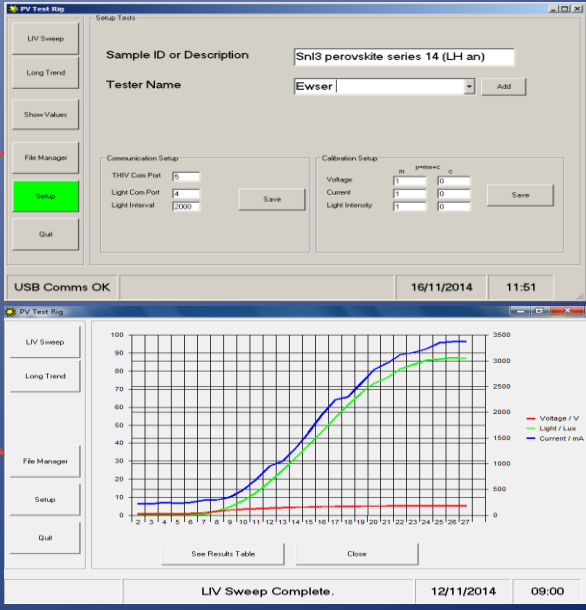
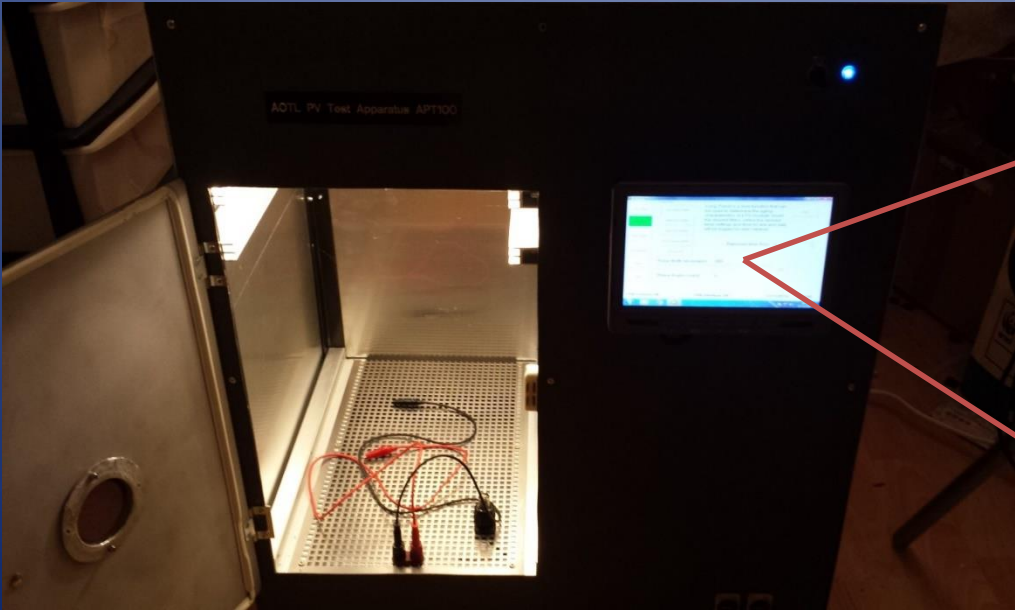
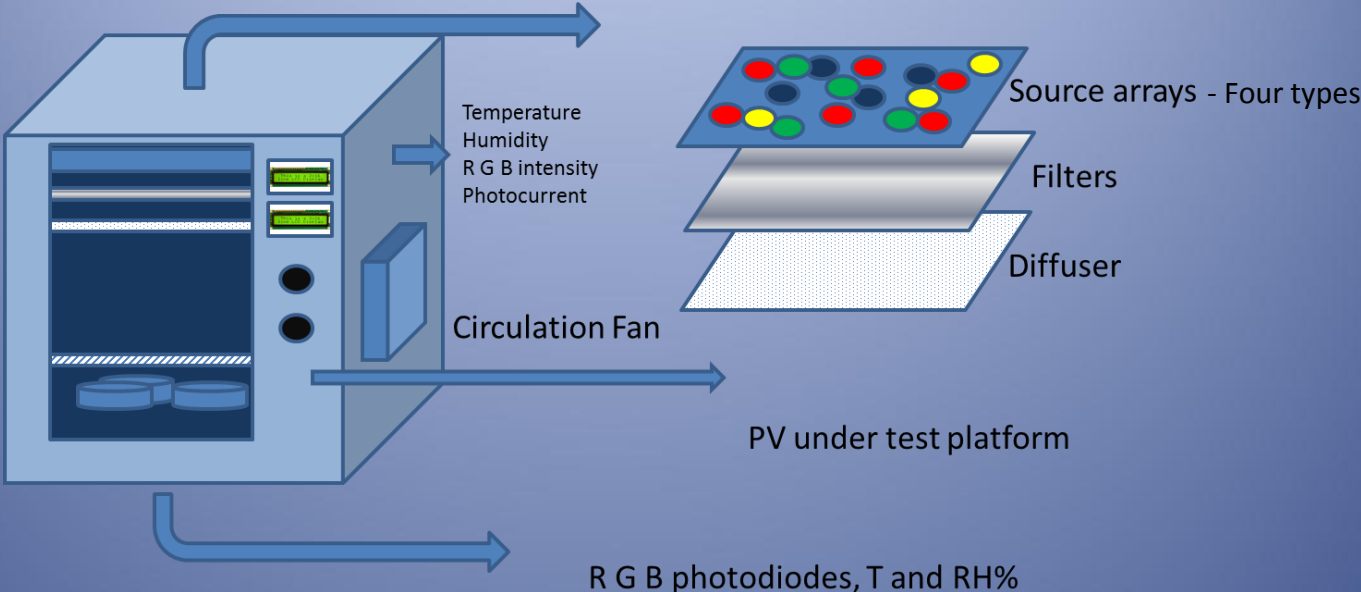
Incandescent lamps with a colour temperature of approx. 2700K

LED array with colour temperature of approx. 2700K

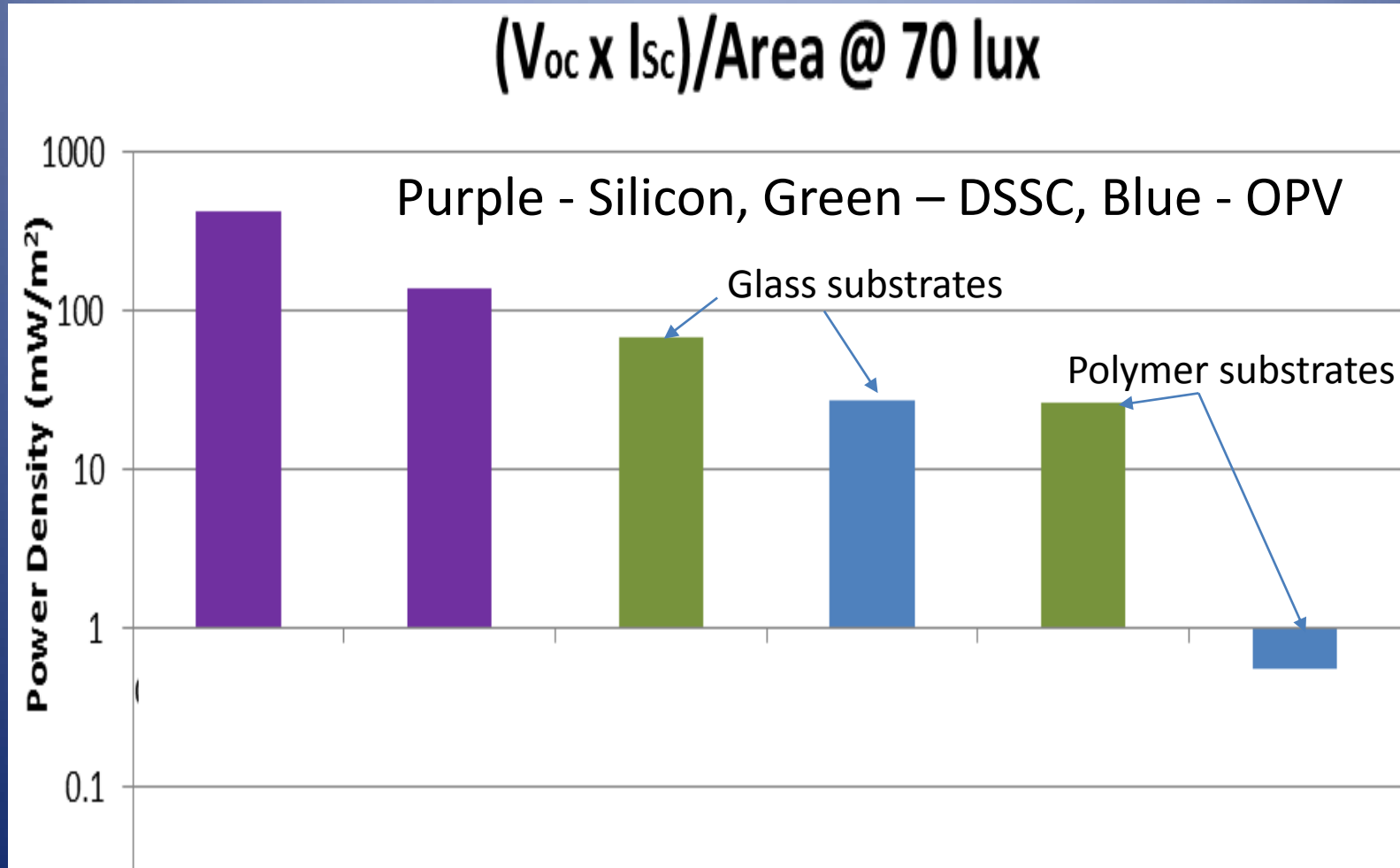
LED array with colour temperature of approx. 7000K (and 500-750nm)

CFL lamp array with colour temperature of approx. 4000K (and 550-700nm)

Test System Emulating Indoor (Low) Lighting



Power Density Generation Performance for Various PV Strategies at Low [70 lux] Light Levels



Self Powered Configuration

RF Module



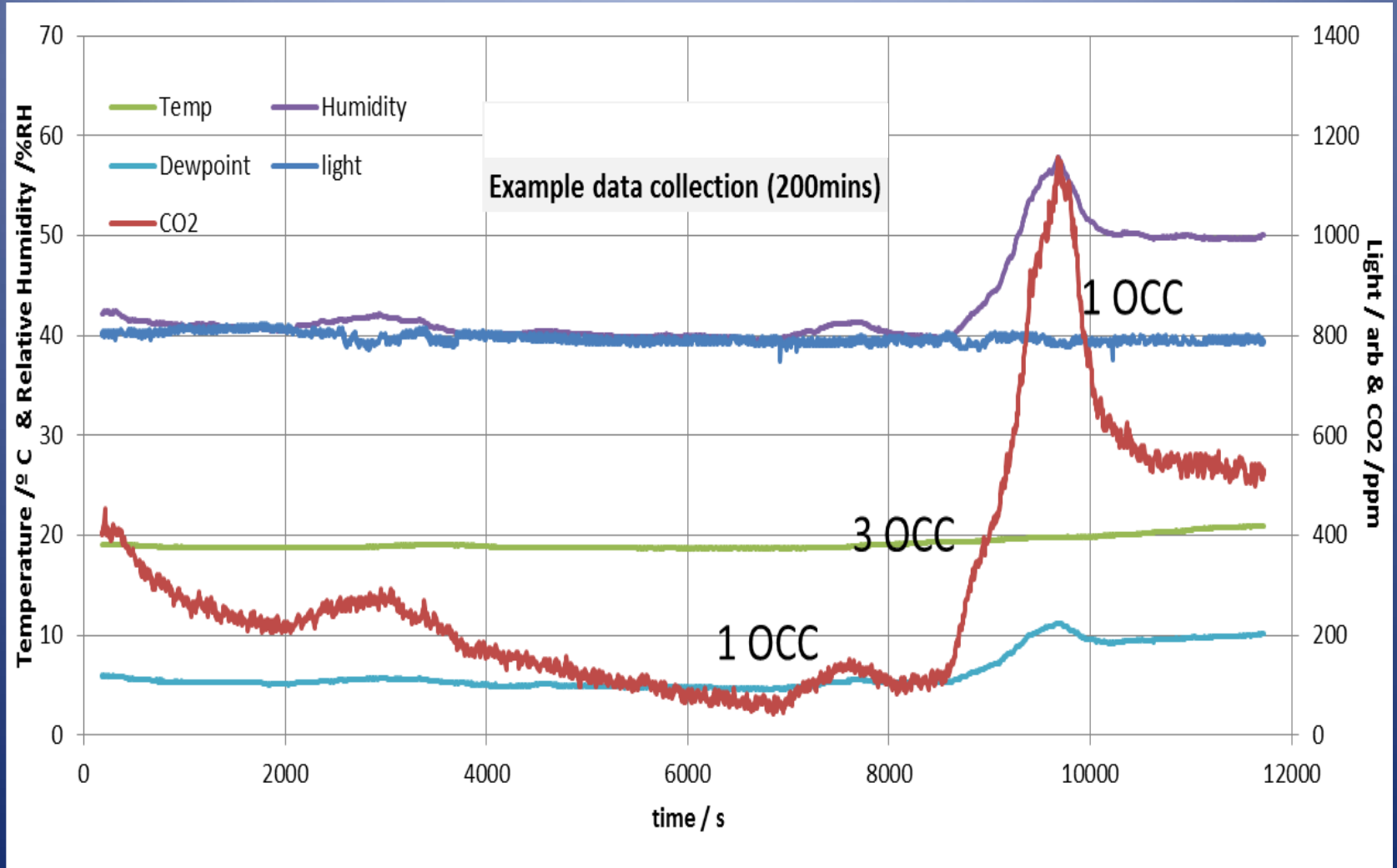
Solar cell



Ambient

- Using available room light three measurement taken every 10 mins
- Values sent wirelessly to a receiver
- When no room light sensor operates on stored energy mode
- Each sensor identified by a 32-bit transmitter ID

Typical indoor data collected: 5s data burst and Si PV



Conclusions & Future Work

- Silicon PV provides viable performance at low light level
- DSSC`s and OPV`s on glass potentially offer viable performance
- DSSC low light level performance improvement underway through use of controlled mesoporous titania nano-anode structures to enhance light trapping
- Innovate UK project underway to investigate III-V PV for use in low light level and energy storage based on rechargeable thin film batteries