



# RESEARCH REPORT

Experiment data of Direct Current (DC) and Alternative Current (AC)  
lighting in housing

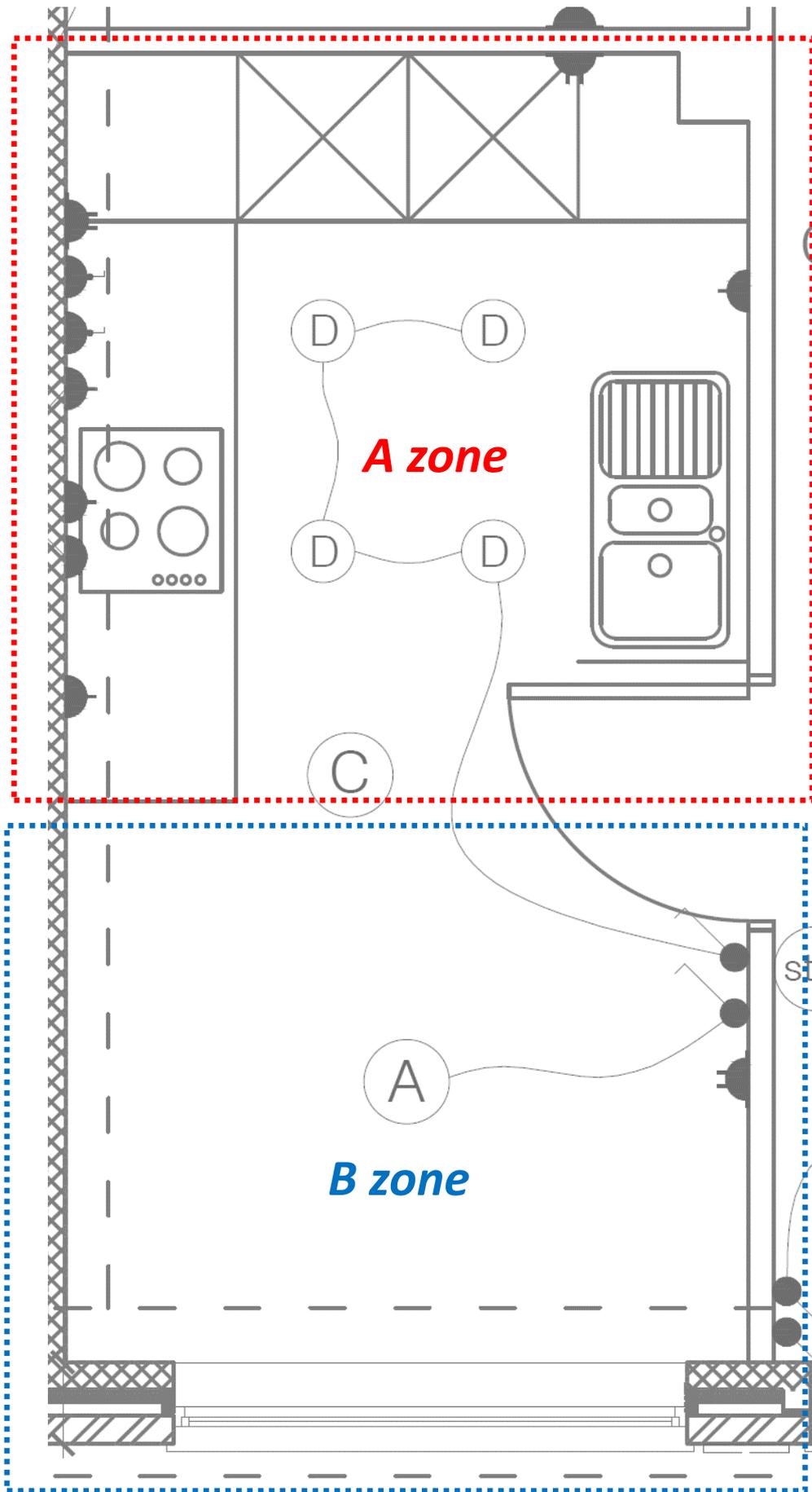
For  
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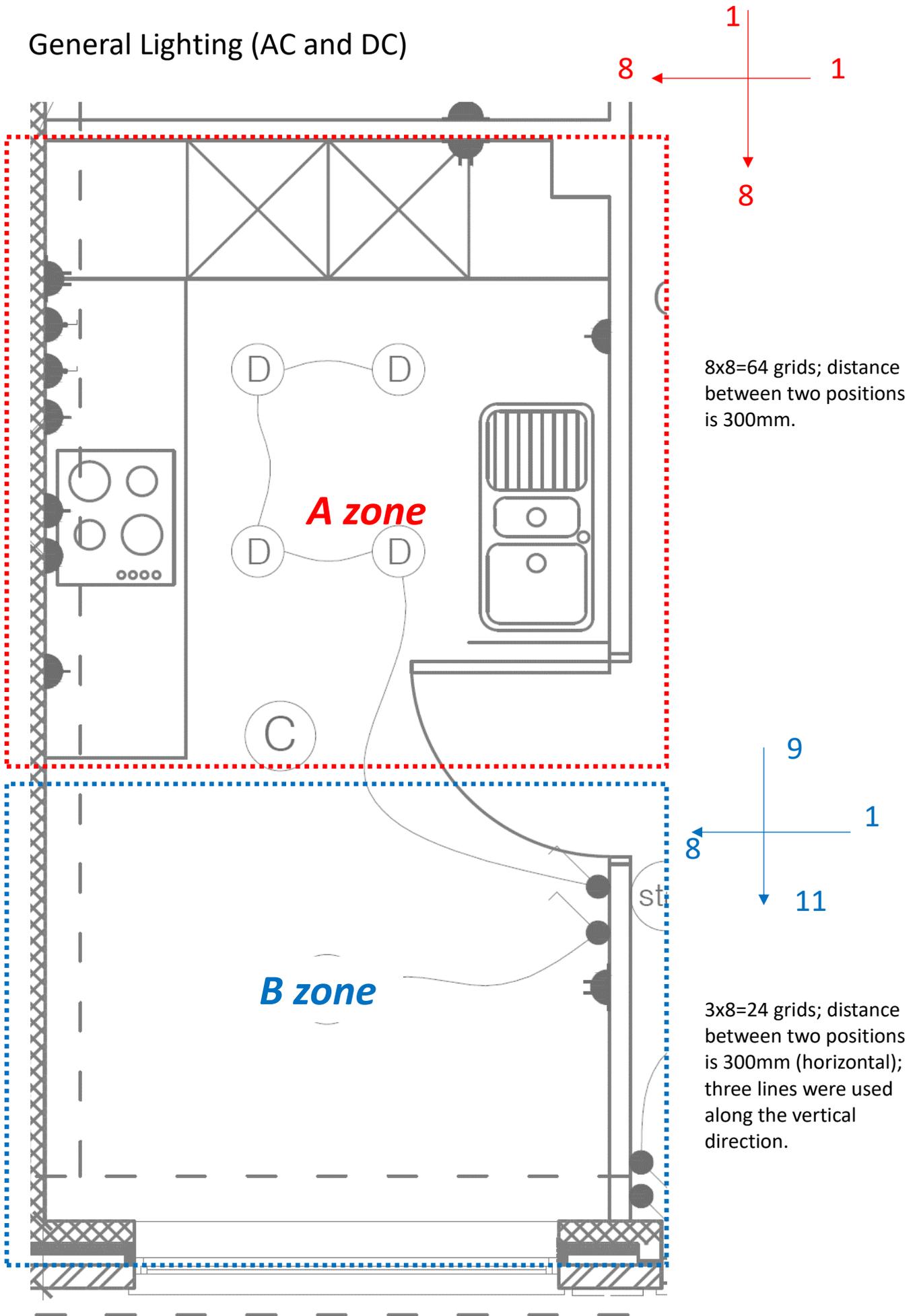


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# General Lighting (AC and DC)



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8x8=64 grids; distance between two positions is 300mm.

3x8=24 grids; distance between two positions is 300mm (horizontal); three lines were used along the vertical direction.

## General Lighting (DC)

Illuminance levels (at the working plane 0.9 m above floor)

	Horizontal positions	8	7	6	5	4	3	2	1
Vertical positions									
1		139.6	170.5	197.7	211.3	212.7	203.7	181.2	183.5
2		180.3	220.1	259.4	274.8	281.9	257.2	248.7	219
3		199.2	237.1	278.1	299	305	294	263.5	227.1
4	<b>A zone</b>	203.2	238.6	271.9	301	310	296	267	228.4
5		191.5	230.6	264.3	287.1	290.2	284	250.3	210.2
6		176.1	205.8	291.5	254.5	268.8	256.1	231.8	181.4
7		141.1	174.4	192	221	218.6	208	193.3	169.7
8		98.6	102.3	104.8	122.4	121	109.8	106.5	94.2
9		50.6	58.1	61.2	59.6	53.7	52.9	48.5	45.8
10	<b>B zone</b>	32.3	32.7	35.3	30.2	36.6	35.3	27.4	25
11		26	26	27	26	26	24	21	21

Average Illuminance levels:

A zone: 217.4 lux

B zone: 36.8 lux

Uniformity:

A zone: 0.43

B zone: 0.57

## General Lighting (AC)

Illuminance levels (at the working plane 0.9 m above floor)

	Horizontal positions	8	7	6	5	4	3	2	1
Vertical positions									
1		145	178	204	209	211.2	204.9	196.2	208.7
2		211.8	260.6	261	277	283	275	233.3	219.8
3		228.3	225.2	286.2	281	268	297	285	256
4	<b>A zone</b>	221	253	284	286.5	283	272.8	246	239.1
5		201.2	223	245	252	246	237	220.1	199.5
6		172.3	190.7	203.3	205	206.1	196.4	205	183
7		138.1	144.8	160.1	158.1	160	147	130	121.0
8		106.9	111.9	109.4	117.2	109.3	102	93	90
9		46.3	45.5	47.4	47.3	50	47.3	43.4	44.8
10	<b>B zone</b>	30.1	29.0	32	36.4	35.8	41.5	35.1	30.3
11		24	26	26	27	25.8	22.34	20.51	24.64

Average Illuminance levels:

A zone: 205.86 lux

B zone: 34.94 lux

Uniformity:

A zone: 0.44

B zone: 0.59

# Energy Consumption test

Energy consumption of four, 5W LED bulbs were measured when powered through Extreme Low Energy Ltd's DC power kit (rectifier and control unit) in comparison to single phase AC power input. Energy consumption was calculated by measuring Volts (V) and Current (A) on both AC and DC. The readings were taken for 1 hour with 15min intervals. Two handheld multi-meters were used to measure volts and amps and a plug-in watt meter was used for the DC test to measure the input from AC source (Figure 1). Same meters were used for both tests to keep the uniformity of the readings.

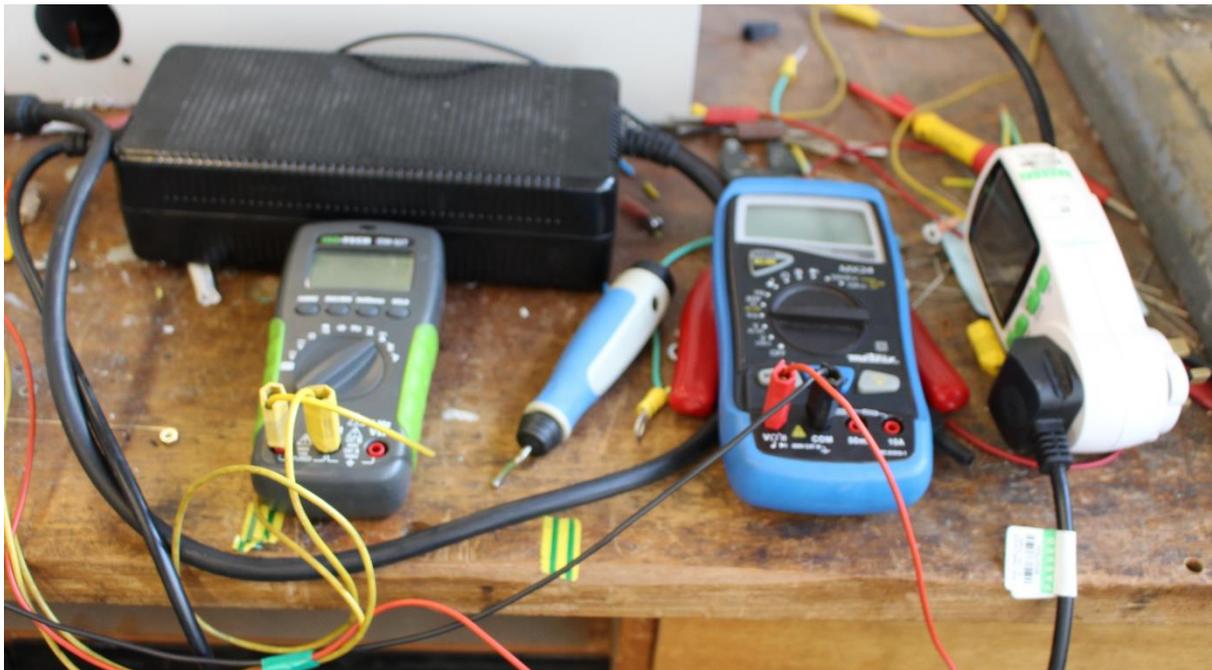


Figure 1: Equipment used to measure V,A and W

## Direct Current (DC) energy consumption

DC powered lighting system which includes the Extreme Low Energy Ltd's rectifier and control unit used for illuminance test was used to measure its energy consumption to conduct a direct comparison between input (power consumption) and output (illuminance). The measurements were taken from the AC source to measure the energy consumption of the whole system (including the consumption of rectifier) and at the DC source to measure the energy consumption of four DC LED lights.

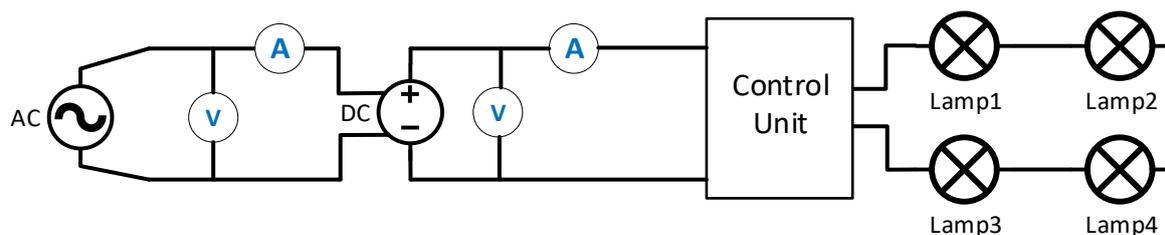


Figure 2: DC Energy test wiring diagram

## Alternative Current (AC) energy consumption test

In order to compare benefit of using Extreme Low Energy Ltd's DC power kit, four LED lights with the same illuminance and power range was arranged to measure the amps and volts for 1 hour time period. Readings were taken every 15minutes for 1 hour to detect any change in energy consumption with the duration of lights being ON. Below figures show a wiring diagram (Figure 3) and actual test set up (Figure 4). Same meters were used for both tests to keep the integrity of the readings when comparing the benefits of AC and DC Lighting system.

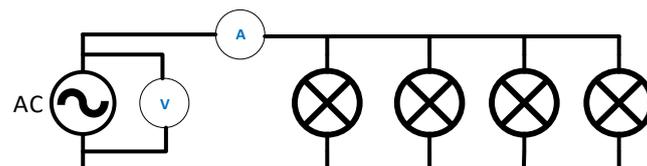


Figure 3: AC energy test - wiring diagram

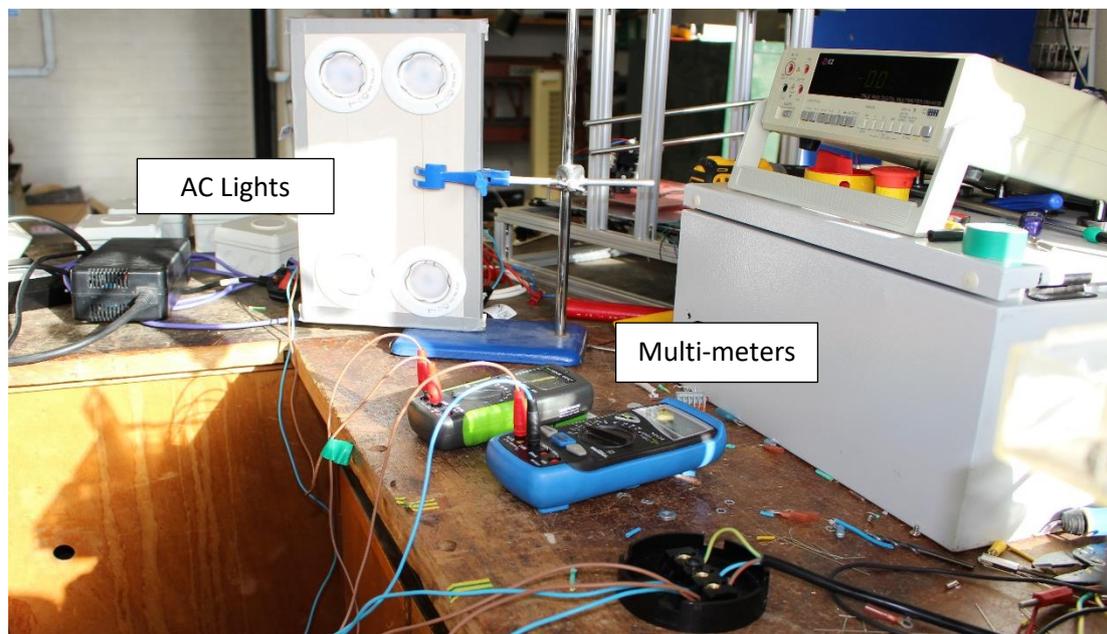


Figure 4: AC energy test set-up

## Assumptions made for the “per year cost” calculation

**Number of lamps per household** - Since illuminance measurements were taken in a kitchen in 3-bed house, assumptions for energy consumption were also made accordingly. Three bedroom house with 120m<sup>2</sup> is assumed to have 50 lamps per property.

**Usage per year** – 30% of lights (15nos) in the property is assumed to be in use for 2,920hrs per year under an estimate of 8hrs per day for 365 days

Energy consumption data

<b>4 Lamps</b>		Start	15mins	30mins	45mins	60mins	Average	Price per kWh	Cost per hour	Energy cost for lighting per year	Saving (£)
AC	Current (A)	0.098	0.094	0.088	0.092	0.093	0.093	£0.17			
	Voltage (v)	244.0	243.7	242.3	241.8	246.6	243.68				
	Watts (W)	23.912	22.907	21.322	22.245	22.933	22.663		<b>£0.0038</b>	<b>£42.18</b>	<b>Base</b>
DC	Current (A)	0.428	0.407	0.405	0.405	0.405	0.410				
	Voltage (v)	48.69	48.70	48.70	48.70	48.71	48.70				
	Watts (W)	20.839	19.820	19.723	19.723	19.727	19.966		<b>£0.0033</b>	<b>£37.16</b>	<b>5.02</b>
<b>With the rectifier</b>											
*DC	Watts (W)	29.9	28.9	28.2	28.3	27.5	28.56		<b>£0.0048</b>	<b>£53.16</b>	<b>-10.98</b>
**DC	Watts (W)	17.7	16.7	16.8	16.9	16.0	16.82		<b>£0.0028</b>	<b>£62.62</b>	<b>-20.44</b>
<b>2 Lamps</b>											
DC	Current (A)	0.225	0.215	0.213	0.213	0.213	0.215				
	Voltage (v)	48.55	48.57	48.57	48.58	48.59	48.57				
	Watts (W)	10.923	10.442	10.345	10.347	10.203	10.452	<b>£0.0017</b>	<b>£38.91</b>	<b>3.27</b>	

\*DC – Energy consumption of 4 lamps

\*\*DC – Energy consumption of 2 lamps

## Summary

### Illuminance (output)

- There was no considerable difference between AC and DC illuminance levels. Precisely, DC average lux level was higher than AC average lux level. Therefore, it is possible to conclude that altering AC LEDs into DC will give the same output as desired from AC
- Kitchen lighting is assumed to be design to fit for purpose. That is to perform tasks including cutting, washing, cooking. Therefore the illuminance readings taken in Zone A are also considered as measurements of task lighting
- DC powered lighting system is recommended to be installed for all the lights in domestic use to provide a detail guidance on lighting design and performance

### Energy consumption (input)

- It was evident that to produce the same output, DC LED lamps consume less energy than AC lamps. Therefore, changing from AC to DC lights will bring an economic benefit
- Economic benefit of moving from AC to DC will be much visible in large-scale applications such as office buildings, commercial property, etc. where larger number of lamps are used for longer hours.
- The disadvantage of having to convert AC to DC was noted. Having directly powered by a DC power source (such as solar panels) would be beneficial. On the other hand, larger scale applications will minimise this disadvantage
- Economic benefit from the energy saving against the cost of equipment will be a consideration