

## Burn Hours Review: Methodology Statement

### Background

The burn hours published on the ELEXON website were calculated from historic PECU array data. The data appears to contain a number of anomalies. In order to re-calculate the data on an equitable basis by GSP region and PECU type a methodology is required that will provide a reasonable estimate of the expected Burn Hours.

### The Methodology

The methodology consists of a number of steps:

**Step 1: Defining a baseline set of data for each GSP Group for the most common PECU type (70/35);**

**Step 2: Defining a baseline set of data for each GSP Group removing deemed weather effects;**

**Step 3: Defining the net annual effect of weather by GSP;**

**Step 4: Defining the minutes per lux difference effects for PECUs;**

**Step 5: Extrapolating the data to different PECU types.**

#### Step 1: Calculating the average offset at the PECU Array.

PECU array data was provided to ELEXON by Meter Administrators.

The data provided the following information:

The average 'Burn Hours' per day and the count of the number of PECUs.

Active Date	Type	Hours	Count of PECUs
01/09/2006	821	10.042	23
02/09/2006	821	10.185	23
03/09/2006	821	10.236	23
04/09/2006	821	10.399	23
05/09/2006	821	10.25	23
06/09/2006	821	10.461	23

The Latitude and longitude for the PECU Array:

ARRAY ID	LATITUDE		LONGITUDE		
	DEGREES	MINUTES	DEGREES	MINUTES	
0201	50	12	5	17	W
0203	50	42	3	28	W
0204	51	1	3	5	W
0205	50	18	4	5	W
0206	51	27	2	34	W

The Sunrise and Sunset times at the array are calculated and the hours between Sunset and Sunrise are calculated for each day to facilitate the calculation of an 'Offset' minutes for each day of data provided for the array:

Active Date	Type	Hours	Count of PECUs	Offset Minutes
01/09/2006	821	10.042	23	24.48
02/09/2006	821	10.185	23	19.9
03/09/2006	821	10.236	23	21.84
04/09/2006	821	10.399	23	15.06
05/09/2006	821	10.25	23	28
06/09/2006	821	10.461	23	18.34

The offset values are then 'cleaned' by exclusion and any values that are outside the 5<sup>th</sup> and 95 percentile of the distribution of the offsets at the array. An average offset for the array over a two year period can then be calculated:

Cleaned offset
-23.62

The process is repeated across 10 arrays with the same type of PECUs (70/35s) with 2 years of data.

## Step 1: Extrapolating the results by GSP Group

In order to extrapolate the data to other GSP Groups a standardised set to latitude and longitudes were defined based on one previously used in Settlement for profiling:

Region	GSP Group	Site	Latitude	Longitude
Eastern	_A	Bury St Edmunds	52:15:00 N	00:43:00 E
East Midlands	_B	Nottingham	52:58:00 N	01:10:00 W
London	_C	London	51:30:00 N	00:10:00 W
Merseyside & North Wales	_D	Rhyl	53:19:00 N	03:29:00 W
Midlands	_E	Birmingham	52:30:00 N	01:50:00 W
Northern	_F	Newcastle	54:59:00 N	01:35:00 W
North Western	_G	Manchester	53:30:00 N	02:15:00 W
Southern	_H	Andover	51:13:00 N	01:28:00 W
South Eastern	_J	Tunbridge Wells	51:08:00 N	00:16:00 E
South Wales	_K	Carmarthen	51:52:00 N	04:19:00 W
South Western	_L	Exeter	50:43:00 N	03:31:00 W
Yorkshire	_M	Leeds	53:50:00 N	01:35:00 W
South Scotland	_N	Glasgow	55:52:00 N	04:15:00 W
North Scotland	_P	Inverness	57:27:00 N	04:14:00 W

Calculation of the hours between sunset and sunrise for a 365 day year gives the following set of results:

GSP Group	Sunset To Sunrise
_A	4283
_B	4280
_C	4285
_D	4279
_E	4282
_F	4273
_G	4278
_H	4286
_J	4286
_K	4284

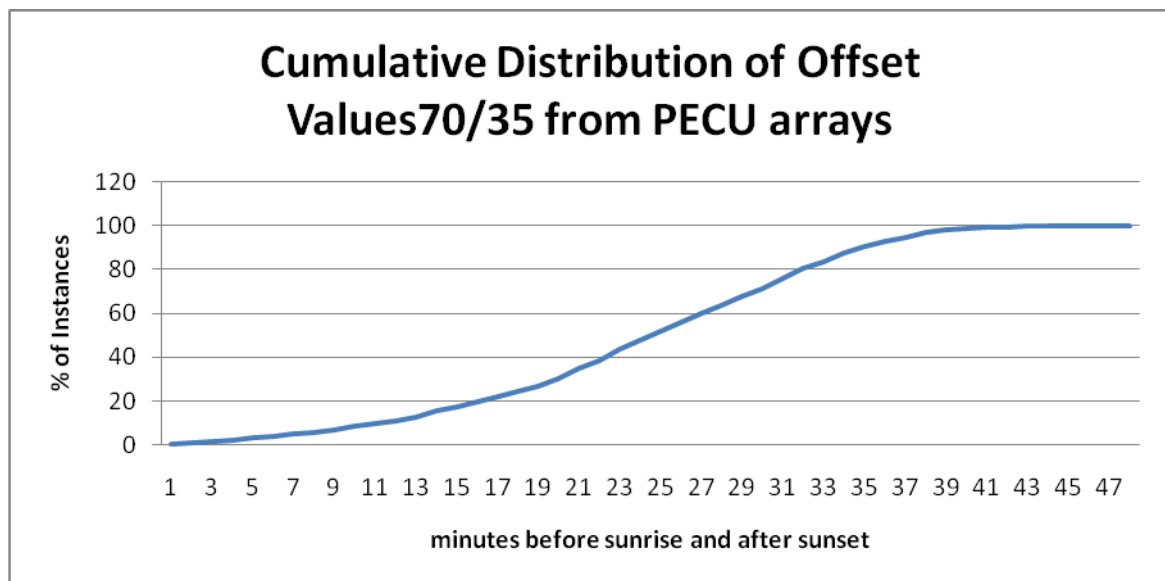
_L	4287
_M	4277
_N	4269
_P	4262

The average 'Offset' values per data at each array were applied to the Sunset to Sunrise hours. The data was then averaged over the 10 Arrays to give the following baseline estimate for 70/35 PECUs:

GSP Group	PECU Array 821
_A	4151
_B	4149
_C	4153
_D	4147
_E	4150
_F	4141
_G	4147
_H	4154
_J	4154
_K	4152
_L	4156
_M	4145
_N	4138
_P	4130

## Step 2: Defining a baseline set of data for each GSP Group removing deemed weather effects

Analysis of the PECU array data was undertaken to find the distribution of offset values:



The 95<sup>th</sup> Percentile of this distribution (37 minutes) was taken as the point at which the PECU would operate under favourable conditions (e.g. clear skies or light cloud cover). It was recognised that reflected light from light cloud cover can give offset values higher than the figure taken for the purpose of this review.

Applying the offset value to the hours between sunset and sunrise for the year gave the following base lined estimate for the 70/35 PECU with the deemed weather effects removed:

GSP Group	OFFSET 37mins
_A	4057
_B	4055
_C	4059
_D	4053
_E	4056
_F	4047
_G	4053
_H	4060
_J	4061
_K	4058
_L	4062
_M	4051
_N	4044
_P	4036

### Step 3: Defining the net annual effect of weather by GSP

Differencing the values in Steps 1 and 2 gives an estimate of the additional burn hours caused by weather effects. The rationale for stripping out the weather effects is to facilitate different values of weather uplift per GSP Group should suitable data become available at a future point. It should be noted that the available PECU array data was limited in its national coverage. The differencing gave the following results:

GSP	Weather Uplift
_A	94
_B	94
_C	94
_D	94
_E	94
_F	94
_G	94
_H	94
_J	93
_K	94
_L	94
_M	94
_N	94

### Step 4: Defining the minutes per Lux difference effects for PECUs

It was recognised that in reality the minutes different per lux would vary according to weather affects and proximity to sunrise or sunset. As a pragmatic solution a linear approach was undertaken for the review as it would be equitable and provide a clear relationship between the different PECU ratings.

An estimate of 0.15 minutes per lux was derived following consultation with several Meter Administrators. Additionally, where the calculated daily minutes per lux exceed half the offset minutes (37/2 = 18.5) then the calculation is defaulted to 18.5 minutes per day. This approach was introduced to prevent unrealistic extrapolation at some of the higher lux ratings.

### Step 5: Extrapolating the data to different PECU types: Annual difference by PECU type

To derive the difference per year, for PECUs with different ratings, the difference in the lux levels of the PECU ratings at sunset and sunrise was multiplied by the minutes per lux value and 365 (for each day) to get an estimate of the annual difference in hours attributable to the PECU rating. So for a 35/18 PECU the calculation would be as follows:

	Base Lux	New Lux	Lux Diff	Mins per lux	Hours per year difference
After Sunset (On)	70	35	-35	0.15	-31.9375
Before Sunrise (Off)	35	18	-17	0.15	-15.5125

The estimate shows that a 35/18 is deemed to switch the lamp on for 47 hours less per year than the 70/35.

### Step 5: Extrapolating the data to different PECU types: Completing the calculation

The calculation was then completed by applying the Annual PECU 'Offset' to the base lined 70/35 values calculated in Step 2 and adding in the weather effects calculated in Step 3. So the results for the calculated 35/18 are as follows:

GSP	Avg. PECU Array 70/35	Sunset To Sunrise	OFFSET 37mins	Weather Uplift	Calculated Values
_A	4151	4283	4057	94	4103
_B	4149	4280	4055	94	4101
_C	4153	4285	4059	94	4106
_D	4147	4279	4053	94	4100
_E	4150	4282	4056	94	4103
_F	4141	4273	4047	94	4094

<b>_G</b>	4147	4278	4053	94	4099
<b>_H</b>	4154	4286	4060	94	4107
<b>_J</b>	4154	4286	4061	93	4107
<b>_K</b>	4152	4284	4058	94	4105
<b>_L</b>	4156	4287	4062	94	4108
<b>_M</b>	4145	4277	4051	94	4098
<b>_N</b>	4138	4269	4044	94	4090
<b>_P</b>	4130	4262	4036	94	4083
					<b>Average</b>
					4100

It should be noted the same results are achieved by differencing the PECU Offset value to the values in the Average PECU array data for the 70/35 in the first column. However, the weather uplift values may be adjusted by GSP group in the future should suitable data become available.

### Part Night PECUs

The hours for the part night PECUs are calculated by deducting off the appropriate number of hours from the out-turn calculations taking into account GMT and Clock time.