GREEN Grid Hot Water Profiles

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Last run at: 2018-06-06 23:15:05

Contents

1 Status

Test run using reduced data from ~/Data/NZGreenGrid/gridspy/1min_orig/

2 Citation

If you wish to use any of the material from this report please cite as:

- Anderson, B. (2018) GREEN Grid Hot Water Profiles, University of Otago: Dunedin, NZ.

3 Introduction

Report circulation:

- Restricted to: NZ GREEN Grid project partners and contractors.

3.1 Purpose

This report is intended to:

- load and clean the project electricity power data (Grid Spy)
- select the Hot Water circuits (via their labels)
- build exploratory demand profiles

3.2 Requirements:

- cleaned and safe grid spy 1 minute data processed via https://git.soton.ac.uk/ba1e12/nzGREENGrid/blob/master/dataProcessing/processNZGGElecCons1minData.Rmd

3.3 History

Generally tracked via our git.soton repo:

- history
- issues

3.4 Support

This work was supported by:

- The University of Otago
- The New Zealand Ministry of Business, Innovation and Employment (MBIE)
- SPATIALEC - a Marie Skłodowska-Curie Global Fellowship based at the University of Otago's Centre for Sustainability (2017-2019) & the University of Southampton's Sustainable Energy Research Group (2019-202).

We do not 'support' the code but if you have a problem check the issues on our repo and if it doesn't already exist, open one. We might be able to fix it :-)

4 Load data files

4.1 Grid Spy metadata

In this section we load metadata from /Users/ben/Syncplicity Folders/Green Grid Project Management Folder/Gridspy/Master list of Gridspy units.xlsx to link to the power data.

```
##    sample  hhID          Adults Teenagers             Children removed
## 1: Unison rf_28              2      <NA>            3(12,8,4)    <NA>
## 2: Unison rf_29              2      <NA>     1 (7 months old)    live
## 3: Unison rf_30              2         0                    0    <NA>
```

```
## 4: Unison rf_31 2 (Plus cousin)      <NA>                 <NA>    live
## 5: Unison rf_32               2      <NA> 2 (7 and 4years old)    <NA>
## 6: Unison rf_33               2 1(14yold)            1 (6yold)    live
```

```
##     sample  hhID Adults Teenagers Children  removed
## 1: Powerco rf_12      1      <NA>     <NA> 3/6/1015
## 2: Powerco  <NA>      1      <NA>     <NA>     <NA>
## 3: Powerco rf_25      1      <NA>     <NA>     <NA>
## 4: Powerco  <NA>     NA      <NA>     <NA>     <NA>
## 5: Powerco  <NA>      1      <NA>   1(5mo)     <NA>
## 6: Powerco  <NA>     NA      <NA>     <NA>     <NA>
```

4.2 Grid Spy data

In this section we load the cleaned data files from ~/Data/NZGreenGrid/safe/gridSpy/1min/data/. If we loaded all the data at once and then filtered out what we want we might run out of memory so we filter as we load. Set the filters here:

```
circuitPattern <- "Hot Water"
dateFrom <- "2015-04-01"
dateTo <- "2016-03-31"

plotCaption <- paste0("Source: ", fpath,
                      "\nCircuits: ", circuitPattern, " from ", dateFrom, " to ", dateTo)
```

So we are looking for Hot Water circuits between 2015-04-01 and 2016-03-31. We do this by checking to see if the extract file has already been created. If so we load it. If not, we create it.

The file we are looking for is: Hot Water_2015-04-01_2016-03-31_observations.csv

```
## [1] "~/Data/NZGreenGrid/safe/gridSpy/1min/dataExtracts/Hot Water_2015-04-01_2016-03-31_observations.
## [1] "# Loaded 14,496,831 rows of data"
```

The following table summarises the Hot Water data we have found.

This table will have a large number (14,496,831) of obserations caused by the number of different circuit labels as shown by the following table.

Note that some households may have more than one Hot Water circuit.

4.3 Test Hot Water data

This section tests the availability of Hot Water data by replicating the standard data quality checks used for the whole gridSpy dataset.

The following plot shows loaded data observation plots - just to confirm what Hot Water data we have.

Table 1: Meta data for sample

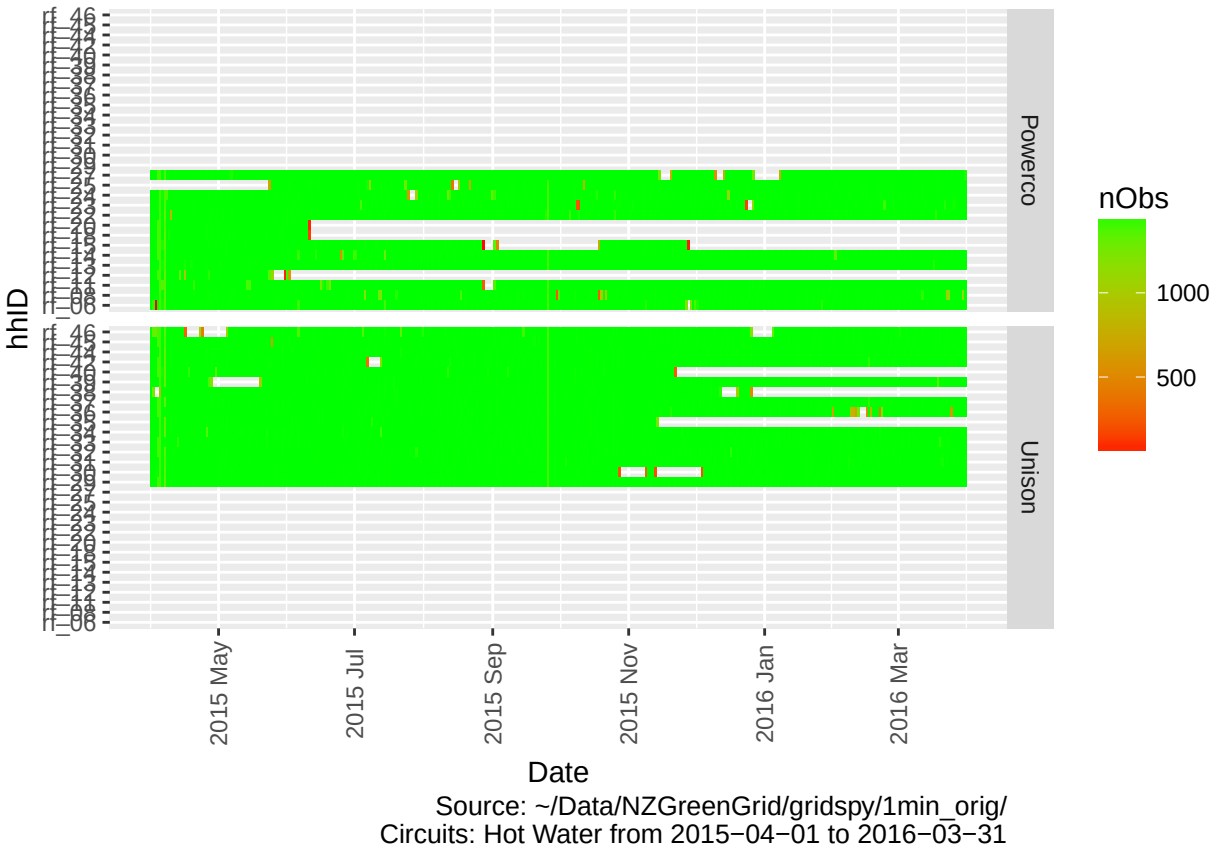
sample	hhID	Adults	Teenagers	Children	removed	nAdults
Powerco	rf_06	2	NA	NA	NA	2
Powerco	rf_07	2	NA	2	NA	2
Powerco	rf_08	2	NA	NA	NA	2
Powerco	rf_09	2	NA	1	42171	2
Powerco	rf_10	2	NA	1(3yo)	NA	3
Powerco	rf_11	NA	NA	NA	NA	1
Powerco	rf_12	1	NA	NA	3/6/1015	1
Powerco	rf_13	2	1(16yo)	1(11)	NA	2
Powerco	rf_14	1	NA	1 (11 yo)	NA	1
Powerco	rf_15	NA	NA	NA	42462	1
Powerco	rf_15_old	1	NA	NA	42019	1
Powerco	rf_16	2	NA	NA	42089	2
Powerco	rf_17 sn_662	NA	NA	NA	NA	1
Powerco	rf_17_oldNo reused	2	1(13yo)	1(11yo)	42457	2
Powerco	rf_18	2	NA	1(1yo)	42532	2
Powerco	rf_19	1	NA	NA	NA	1
Powerco	rf_20	2	NA	2	42166	2
Powerco	rf_21	2	NA	NA	42821	2
Powerco	rf_22	2	NA	NA	NA	2
Powerco	rf_23	1	NA	NA	NA	1
Powerco	rf_24	2	NA	2	NA	2
Powerco	rf_25	1	NA	NA	NA	1
Powerco	rf_26	2	NA	NA	NA	2
Powerco	rf_27	2	1	1	NA	2
Unison	rf_28	2	NA	3(12,8,4)	NA	3
Unison	rf_29	2	NA	1 (7 months old)	live	2
Unison	rf_30	2	0	0	NA	2
Unison	rf_31	2 (Plus cousin)	NA	NA	live	2
Unison	rf_32	2	NA	2 (7 and 4years old)	NA	2
Unison	rf_33	2	1(14yold)	1 (6yold)	live	2
Unison	rf_34	3	NA	NA	NA	1
Unison	rf_35	2	NA	NA	42322	2
Unison	rf_36	1	2 (14 and 12)	NA	live	1
Unison	rf_37	2	NA	NA	live	2
Unison	rf_38	NA	NA	NA	NA	1
Unison	rf_38	2	NA	2 (<12)	NA	2
Unison	rf_39	2	1 (16 YO)	NA	live	2
Unison	rf_40	2	NA	NA	42330	2
Unison	rf_41	2	NA	2 (11 and 8)	live	2
Unison	rf_42	2	NA	3 (<12 yold, 1 10 YO)	NA	3
Unison	rf_43	2	NA	NA	42296	2
Unison	rf_44	2	NA	2 (10 and 7)	NA	2
Unison	rf_45	2	NA	3 (<12 years old)	NA	3
Unison	rf_46	2	NA	1 (4yold-50%)	live	2
Unison	rf_47	3	2	NA	NA	1

Table 2: Summary of household grid spy data for: Hot Water

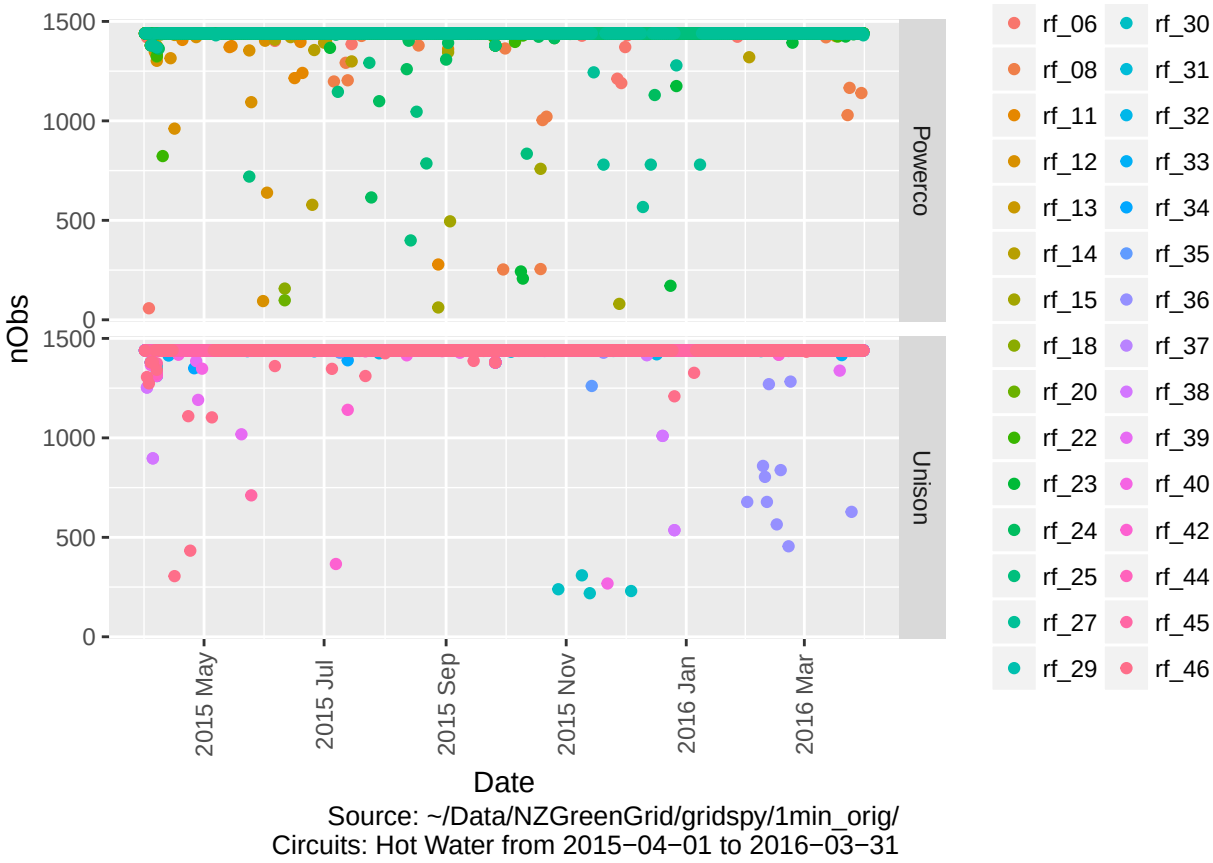
hhID	nObs	nHouseholds	nCircuits	meanPower	minDate	maxDate
rf_02	81647	1	1	390.7312904	2015-04-01	2015-05-28
rf_06	523312	1	1	387.3524992	2015-04-01	2016-03-31
rf_08	521843	1	1	307.4189980	2015-04-01	2016-03-31
rf_11	519185	1	1	67.1572238	2015-04-01	2016-03-31
rf_12	80081	1	1	418.5545972	2015-04-01	2015-06-02
rf_13	526929	1	1	152.3181436	2015-04-01	2016-03-31
rf_14	525470	1	1	235.1927161	2015-04-01	2016-03-31
rf_15	273252	1	1	448.6198651	2015-04-01	2015-11-28
rf_17	520028	1	1	0.0002596	2015-04-01	2016-03-28
rf_18	102202	1	1	390.3190006	2015-04-01	2015-06-11
rf_20	102188	1	1	292.2748598	2015-04-01	2015-06-11
rf_22	526097	1	1	530.7474282	2015-04-01	2016-03-31
rf_23	519906	1	1	206.0260549	2015-04-01	2016-03-31
rf_24	520556	1	1	478.1132036	2015-04-01	2016-03-31
rf_25	443936	1	1	230.5553235	2015-05-24	2016-03-31
rf_27	497806	1	1	137.8961919	2015-04-01	2016-03-31
rf_29	526780	1	1	358.8502211	2015-04-01	2016-03-31
rf_30	477491	1	1	194.0280348	2015-04-01	2016-03-31
rf_31	526878	1	1	194.3654428	2015-04-01	2016-03-31
rf_32	526785	1	1	284.6575412	2015-04-01	2016-03-31
rf_33	526863	1	1	326.9971683	2015-04-01	2016-03-31
rf_34	526677	1	1	319.3515297	2015-04-01	2016-03-31
rf_35	327974	1	1	251.4110126	2015-04-01	2015-11-14
rf_36	516242	1	1	262.2140651	2015-04-01	2016-03-31
rf_37	526771	1	1	344.2228600	2015-04-01	2016-03-31
rf_38	373722	1	1	472.3660753	2015-04-01	2015-12-26
rf_39	495806	1	1	377.7922476	2015-04-01	2016-03-31
rf_40	338289	1	1	338.7696737	2015-04-01	2015-11-22
rf_42	518179	1	1	377.6124709	2015-04-01	2016-03-31
rf_44	526850	1	1	463.7929726	2015-04-01	2016-03-31
rf_45	526110	1	1	300.3924577	2015-04-01	2016-03-31
rf_46	950976	1	2	102.9197503	2015-04-01	2016-03-31

Table 3: Counts of Hot Water observations by label and household

	rf_02	rf_06	rf_08	rf_11	rf_12	rf_13	rf_14	rf_15	rf_17
Hot Water (2 elements)$4247	0	0	0	0	0	0	0	0	0
Hot Water - Controlled (HEMS)$2081	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$2094	0	0	521843	0	0	0	0	0	0
Hot Water - Controlled$2102	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$2110	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$2129	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$2150	0	0	0	0	0	0	0	0	520028
Hot Water - Controlled$2208	0	0	0	0	0	526929	0	0	0
Hot Water - Controlled$2236	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$2248	0	523312	0	0	0	0	0	0	0
Hot Water - Controlled$2719	0	0	0	0	0	0	525470	0	0
Hot Water - Controlled$2761	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$2825	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4135	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4144	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4155	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4158	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4167	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4178	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4184	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4198	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4200	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4231	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4238	0	0	0	0	0	0	0	0	0
Hot Water - Controlled$4400	0	0	0	0	0	0	0	0	0
Hot Water - Uncontrolled$4125	0	0	0	0	0	0	0	0	0
Hot Water - Uncontrolled$4131	0	0	0	0	0	0	0	0	0
Hot Water - Uncontrolled$4147	0	0	0	0	0	0	0	0	0
Hot Water - Uncontrolled$4224	0	0	0	0	0	0	0	0	0
Hot Water Cpbd Heater- Cont$2586	0	0	0	519185	0	0	0	0	0
Hot Water$1574	81647	0	0	0	0	0	0	0	0
Hot Water$3952	0	0	0	0	0	0	0	273252	0
Incomer 1 - Hot Water - Cont$2626	0	0	0	0	80081	0	0	0	0



The next plot shows the same data but as a dot plot to highlight those households and dates where we did not receive 60 * 24 = 1440 observations per day.



Source: ~/Data/NZGreenGrid/gridspy/1min_orig/
Circuits: Hot Water from 2015−04−01 to 2016−03−31

The following table shows the min/max observations per day and min/max dates for each household. As above, we should not see:

- dates before 2014 or in to the future (indicates date conversion errors)
- more than 1440 observations per day (indicates potentially duplicate observations)
- non-integer counts of circuits as it suggests some column errors

We should also not see NA in any row (indicates date conversion errors).

If we do see any of these then we still have data cleaning work to do!

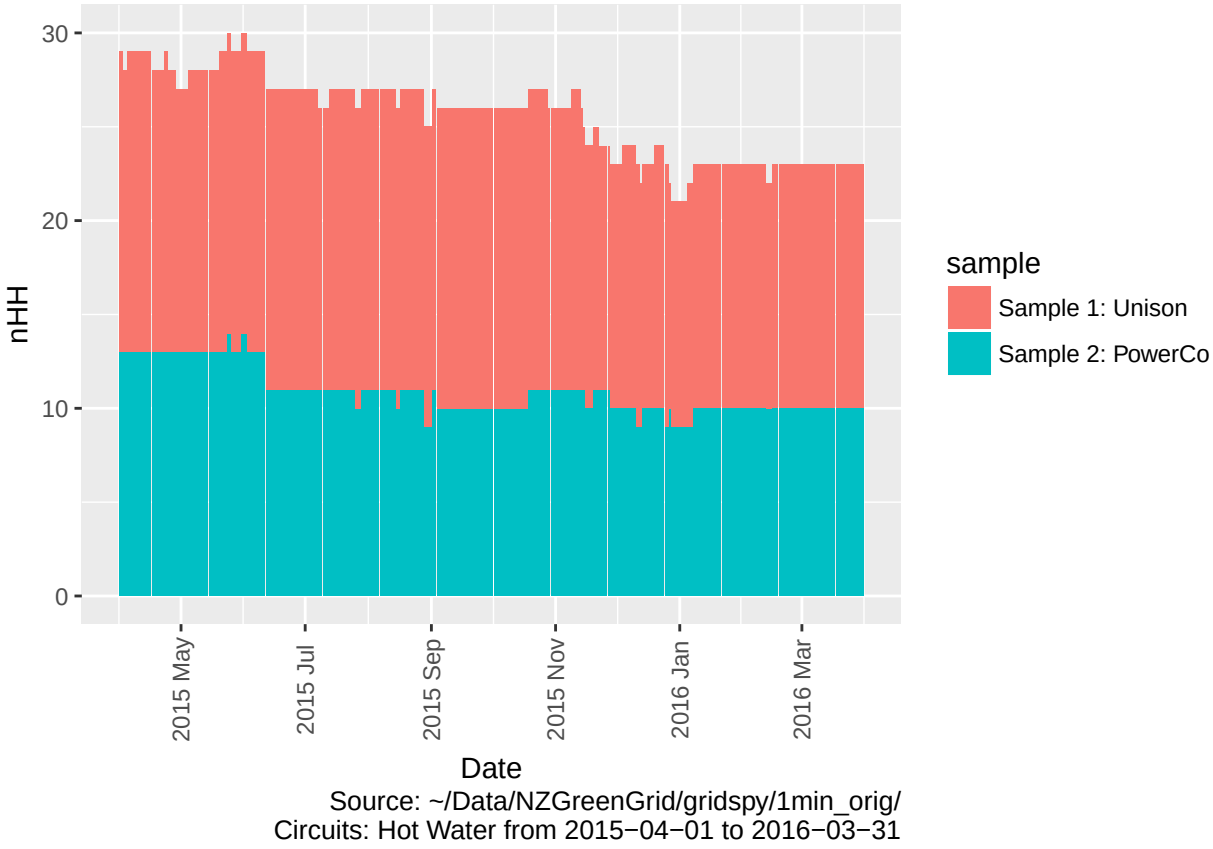
Finally we show the total number of households which we think we have Hot Water data for.

Table 4: Summary observation stats by hhID (sorted by date last heard from) for: Hot Water

hhID	sample	nObs	minDate	maxDate
rf_12	Powerco	80081	2015-04-01T00:00:00Z	2015-06-02T20:07:00Z
rf_20	Powerco	102188	2015-04-01T00:00:00Z	2015-06-11T01:37:00Z
rf_18	Powerco	102202	2015-04-01T00:00:00Z	2015-06-11T02:36:00Z
rf_35	Unison	327974	2015-04-01T00:00:00Z	2015-11-14T21:00:00Z
rf_40	Unison	338289	2015-04-01T00:00:00Z	2015-11-22T04:27:00Z
rf_15	Powerco	273252	2015-04-01T00:00:00Z	2015-11-28T01:19:00Z
rf_38	Unison	747444	2015-04-01T00:00:00Z	2015-12-26T08:55:00Z
rf_06	Powerco	523312	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_08	Powerco	521843	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_11	Powerco	519185	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_13	Powerco	526929	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_14	Powerco	525470	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_22	Powerco	526097	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_23	Powerco	519906	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_24	Powerco	520556	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_25	Powerco	443936	2015-05-24T12:00:00Z	2016-03-31T23:59:00Z
rf_27	Powerco	497806	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_29	Unison	526780	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_30	Unison	477491	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_31	Unison	526878	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_32	Unison	526785	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_33	Unison	526863	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_34	Unison	526677	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_36	Unison	516242	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_37	Unison	526771	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_39	Unison	495806	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_42	Unison	518179	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_44	Unison	526850	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_45	Unison	526110	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z
rf_46	Unison	950976	2015-04-01T00:00:00Z	2016-03-31T23:59:00Z

Table 5: Summary of Hot Water circuits

	hhID	r_dateTime	circuit	powerW	obsHourMin
	Length:14496831	Length:14496831	Length:14496831	Min. :-1110.0	Length:14496831
	Class :character	Class :character	Class :character	1st Qu.: 0.0	Class :character
	Mode :character	Mode :character	Mode :character	Median : 0.0	Mode :character
	NA	NA	NA	Mean : 283.8	NA
	NA	NA	NA	3rd Qu.: 0.0	NA
	NA	NA	NA	Max. : 4076.0	NA

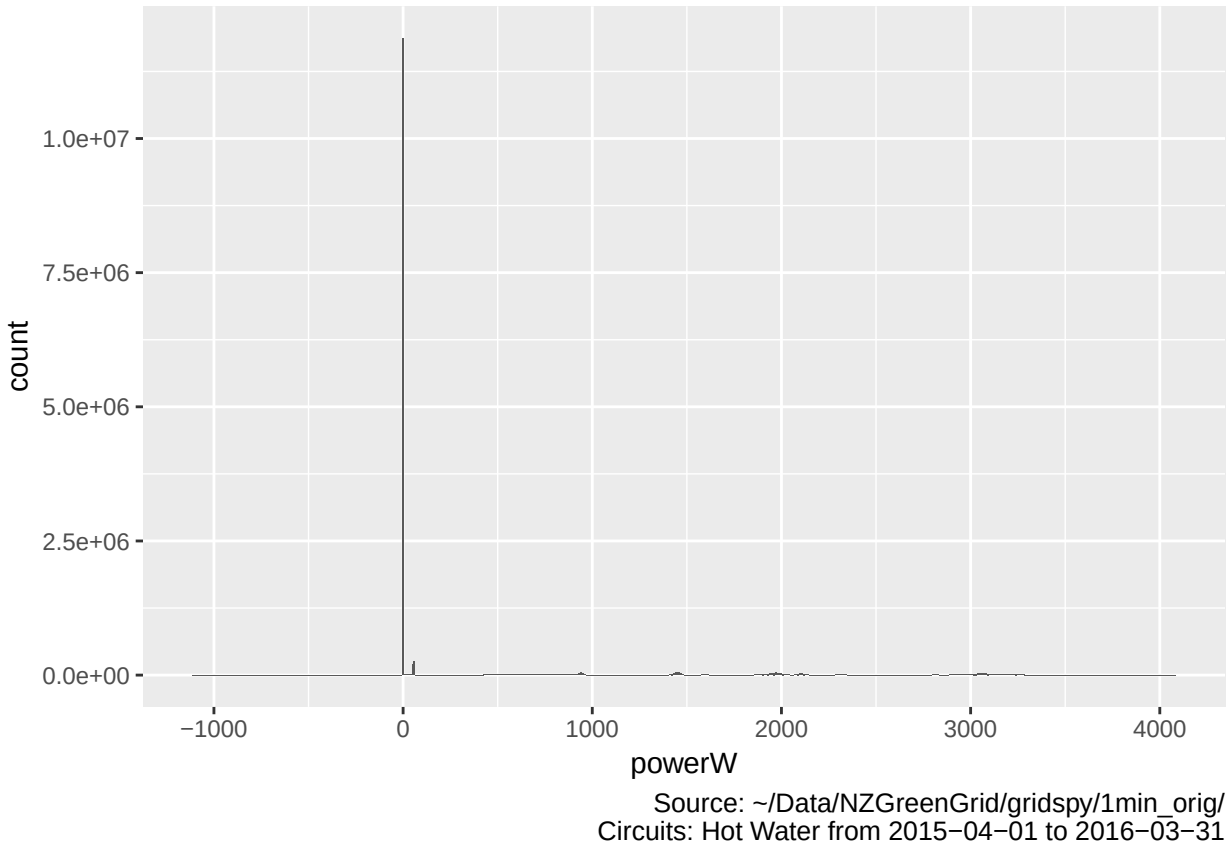


The following table summarises the Hot Water data. Any surprises?

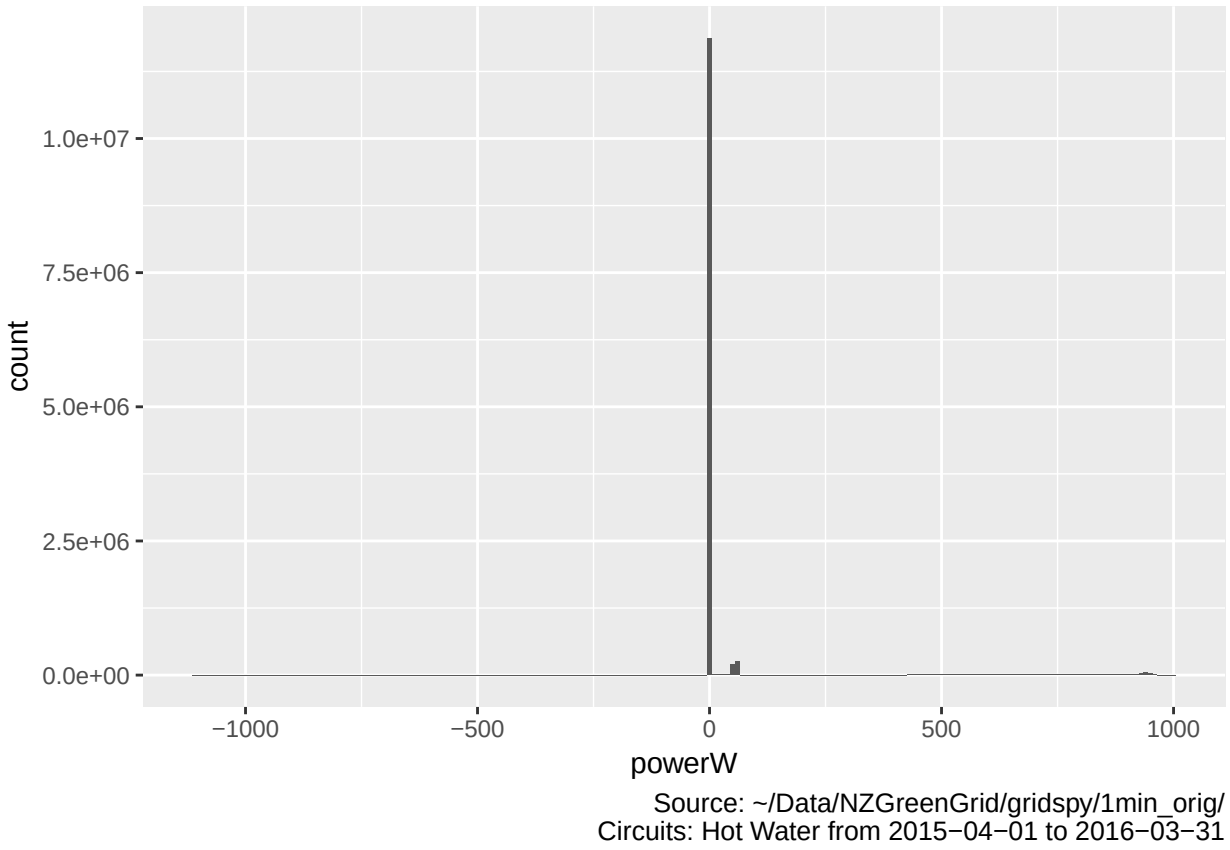
```
t <- summary(gs1MinDT)
kable(caption = paste0("Summary of ", circuitPattern, " circuits"), t)
```

We seem to have some negative powerW values and at least one very large power value.

Nasty surprises often lurk in histograms... The following histogram shows all observations.



The next shows the histogram for powerW < 1000W...



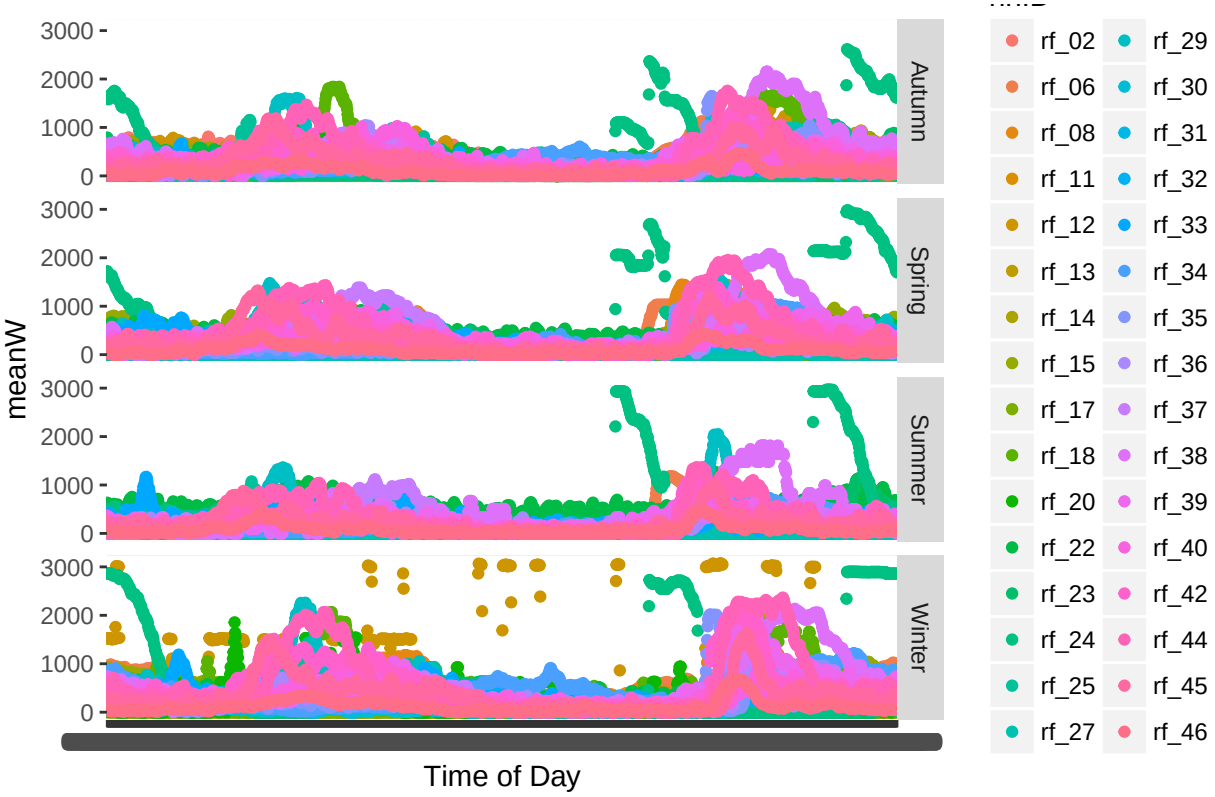
There are a lot of zeros (as we'd expect) but why are there negative values?

5 Hot Water profiles

This section produces the profiles as one for each HH but averaged over each season. Data is kept at 1 minute intervals. Note definition of season below...

```
# add season
gs1MinDT <- gs1MinDT[, month := lubridate::month(r_dateTime, label = TRUE)]
gs1MinDT <- gs1MinDT[, season := "Summer"]
gs1MinDT <- gs1MinDT[, season := ifelse(month == "Mar" |
                                        month == "Apr" |
                                        month == "May", "Autumn", season)]
gs1MinDT <- gs1MinDT[, season := ifelse(month == "Jun" |
                                        month == "Jul" |
                                        month == "Aug", "Winter", season)]
gs1MinDT <- gs1MinDT[, season := ifelse(month == "Sep" |
                                        month == "Oct" |
                                        month == "Nov", "Spring", season)]
```

Profile plots:



Source: ~/Data/NZGreenGrid/gridspy/1min_orig/
Circuits: Hot Water from 2015−04−01 to 2016−03−31

```
## [1] "Saving profile data used to build this plot to: /Users/ben/git.soton/ba1e12/nzGREENGrid/data/Ho
```

```
## [1] "Gzipped /Users/ben/git.soton/ba1e12/nzGREENGrid/data/Hot Water_2015-04-01_2016-03-31_meanW_hhID
```

The plots could be repeated or re-facted e.g. by household size.

Note that the code saves a high definition version of the chart and the average profiles out to the repo (in /Users/ben/git.soton/ba1e12/nzGREENGrid/data/Hot Water_2015-04-01_2016-03-31_meanW_hhID_profiles_by_season.csv.gz) for future re-use.

The .csv.gz file can be loaded using the following code:

- `df <- readr::read_csv("/Users/ben/git.soton/ba1e12/nzGREENGrid/data/Hot Water_2015-04-01_2016-03-31`
  or
- `dt <- data.table::as.data.table(readr::read_csv("/Users/ben/git.soton/ba1e12/nzGREENGrid/data/Hot Water_2015-04-01_2016-03-31_meanW_hhID_profiles_by_season.csv.gz"))` if you prefer data.table

6 Runtime

Analysis completed in 587.62 seconds (9.79 minutes) using knitr in RStudio with R version 3.5.0 (2018-04-23) running on x86_64-apple-darwin15.6.0.

7 R environment

R packages used:

- base R - for the basics (R Core Team 2016)
- data.table - for fast (big) data handling (Dowle et al. 2015)
- lubridate - date manipulation (Grolemund and Wickham 2011)
- ggplot2 - for slick graphics (Wickham 2009)
- readr - for csv reading/writing (Wickham, Hester, and Francois 2016)
- dplyr - for select and contains (Wickham and Francois 2016)
- progress - for progress bars (Csárdi and FitzJohn 2016)
- knitr - to create this document & neat tables (Xie 2016)
- kableExtra - for extra neat tables (Zhu 2018)
- nzGREENGrid - for local NZ GREEN Grid project utilities

Session info:

```
## R version 3.5.0 (2018-04-23)
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
## Running under: macOS High Sierra 10.13.5
##
## Matrix products: default
## BLAS: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_GB.UTF-8/en_GB.UTF-8/en_GB.UTF-8/C/en_GB.UTF-8/en_GB.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] kableExtra_0.9.0  knitr_1.20        readr_1.1.1       ggplot2_2.2.1
## [5] dplyr_0.7.5       data.table_1.11.2 nzGREENGrid_0.1.0
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.17      cellranger_1.1.0  pillar_1.2.2
##  [4] compiler_3.5.0    plyr_1.8.4        bindr_0.1.1
##  [7] prettyunits_1.0.2 tools_3.5.0       progress_1.1.2
## [10] digest_0.6.15     viridisLite_0.3.0 lubridate_1.7.4
## [13] evaluate_0.10.1   tibble_1.4.2      gtable_0.2.0
## [16] pkgconfig_2.0.1   rlang_0.2.0       rstudioapi_0.7
## [19] yaml_2.1.19       bindrcpp_0.2.2    xml2_1.2.0
## [22] httr_1.3.1        stringr_1.3.1     hms_0.4.2
## [25] rprojroot_1.3-2   grid_3.5.0        tidyselect_0.2.4
## [28] glue_1.2.0        R6_2.2.2          readxl_1.1.0
## [31] rmarkdown_1.9     purrr_0.2.4       reshape2_1.4.3
## [34] magrittr_1.5      backports_1.1.2   scales_0.5.0
## [37] htmltools_0.3.6   rvest_0.3.2       assertthat_0.2.0
## [40] colorspace_1.3-2  labeling_0.3      stringi_1.2.2
## [43] lazyeval_0.2.1    munsell_0.4.3
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