Processing, cleaning and saving NZ GREEN Grid project 1 minute electricity power data

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Last run at: 2018-06-05 13:00:47

Contents

1 Status

Full run using all data from /Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/ refreshData = 0 so re-using previous output. Should be relatively quick.

2 Citation

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

- Anderson, B. (2018) Processing, cleaning and saving NZ GREEN Grid project 1 minute electricity power data, 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)
- save the cleaned data out as a single file per household
- produce summary data quality statistics

The resulting cleaned data has *no* identifying information such as names, addresses, email addresses, telephone numbers and is therefore safe to share across all partners.

The data contains a unique household id which can be used to link it to the NZ GREEN Grid time use diaries and dwelling/appliance surveys. With some additional non-disclosure checks it should also be safe to archive all of these linkable datasets for re-use via the UK reshare service.

3.2 Requirements:

- grid spy 1 minute data downloads

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 Obtain listing of files

In this section we generate a listing of all 1 minute data files that we have received. If we are running over the complete dataset then we will be using data from:

- /hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/

In this run we are using data from:

- /Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/

If these do not match then this may be a test run.

```
## [1] "Re-using filelist"
```

```
## [1] "Overall we have 22376 files from 44 households."
```

Overall we have 22,376 files from 44 households. Of the 22,376, 13,080 (58.46%) were *not* loaded/checked as their file sizes indicated that they contained no data.

4.1 Date format checks

We now need to check how many of the loaded files have an ambiguous or default date - these could introduce errors.

Table 1: Number of files and min/max date (as char) with given date column names by inferred date format

dateColName	dateFormat	nFiles	minDate	maxDate
date NZ	dmy - definite	1	27/03/2015	27/03/2015
date NZ	mdy - definite	2	5/26/2016	5/26/2016
date NZ	ymd - default (but day/month value <= 12)	12	2014-01-06	2016-06-07
date NZ	ymd - definite	67	2014-05-24	2016-07-13
date UTC	ambiguous	28	11-10-16	27/07/14
date UTC	ymd - default (but day/month value <= 12)	3607	2014-11-03	2018-05-12
date UTC	ymd - definite	5579	2015-03-26	2018-05-28
unknown - do not load (fsize = 2751)	NA	1812	NA	NA
unknown - do not load (fsize = 43)	NA	11268	NA	NA

Results to note:

- There are 28 ambiguous files
- The non-loaded files only have 2 distinct file sizes, confirming that they are unlikely to contain useful data.

We now inspect the ambiguous and (some of) the default files.

To help with data cleaning the following table lists files that have ambiguous dates.

```
# list ambigious files
aList <- fListCompleteDT[dateFormat == "ambiguous",
                         .(file, dateColName, dateExample, dateFormat)]

cap <- paste0("All ", nrow(aList),
              " files with an ambiguous dateFormat")

knitr::kable(caption = cap, aList)
```

Table 2: All 28 files with an ambiguous dateFormat

file	dateColName	dateExample	dateFormat
rf_06/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_07/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous

file	dateColName	dateExample	dateFormat
rf_08/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_10/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_11/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_13/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_19/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_21/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_22/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_23/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_24/15Jul2014-25May2016at1.csv	date UTC	27/07/14	ambiguous
rf_25/12Oct2016-20Nov2017at1.csv	date UTC	11-10-16	ambiguous
rf_26/15Jul2014-25May2016at1.csv	date UTC	14/07/14	ambiguous
rf_27/15Jul2014-25May2016at1.csv	date UTC	27/07/14	ambiguous
rf_29/24Mar2015-25May2016at1.csv	date UTC	25/03/15	ambiguous
rf_30/15Feb2016-25May2016at1.csv	date UTC	14/02/16	ambiguous
rf_30/24Mar2015-25May2016at1.csv	date UTC	27/03/15	ambiguous
rf_31/24Mar2015-25May2016at1.csv	date UTC	25/03/15	ambiguous
rf_34/18Jan2016-25May2016at1.csv	date UTC	17/01/16	ambiguous
rf_34/20Jul2015-25May2016at1.csv	date UTC	19/07/15	ambiguous
rf_34/24Mar2015-25May2016at1.csv	date UTC	26/03/15	ambiguous
rf_35/24Mar2015-25May2016at1.csv	date UTC	23/03/15	ambiguous
rf_39/24Mar2015-25May2016at1.csv	date UTC	27/03/15	ambiguous
rf_43/24Mar2015-25May2016at1.csv	date UTC	26/03/15	ambiguous
rf_43/27Mar2015-18Oct2015at1.csv	date UTC	26/03/15	ambiguous
rf_44/24Mar2015-25May2016at1.csv	date UTC	24/03/15	ambiguous
rf_46/12Oct2016-20Nov2017at1.csv	date UTC	11-10-16	ambiguous
rf_47/24Mar2015-25May2016at1.csv	date UTC	24/03/15	ambiguous

Check against file names to see what is reasonable and then fix them.

```
fListCompleteDT <- nzGREENGrid::fixAmbiguousDates(fListCompleteDT)
```

```
## [1] "Fixed 28 files with an ambiguous dateFormat"
```

The following table lists up to 10 of the 'date NZ' files which are set by default - do they look OK to assume the default dateFormat? Compare the file names with the dateExample...

```
# list default files with NZ time
aList <- fListCompleteDT[dateColName == "date NZ" & dateFormat %like% "default",
                         .(file, fSize, dateColName, dateExample, dateFormat)]

cap <- paste0("First 10 (max) of ", nrow(aList),
              " files with dateColName = 'date NZ' and default dateFormat")

knitr::kable(caption = cap, head(aList))
```

Table 3: First 10 (max) of 12 files with dateColName = 'date NZ' and default dateFormat

file	fSize	dateColName	dateExample	dateFormat
rf_01/1Jan2014-24May2014at1.csv	6255737	date NZ	2014-01-06	ymd - default (but day/month value <=
rf_02/1Jan2014-24May2014at1.csv	6131625	date NZ	2014-03-03	ymd - default (but day/month value <=
rf_06/24May2014-24May2015at1.csv	19398444	date NZ	2014-06-09	ymd - default (but day/month value <=
rf_10/24May2014-24May2015at1.csv	24386048	date NZ	2014-07-09	ymd - default (but day/month value <=

file	fSize	dateColName	dateExample	dateFormat
rf_11/24May2014-24May2015at1.csv	23693893	date NZ	2014-07-08	ymd - default (but day/month value <=
rf_12/24May2014-24May2015at1.csv	21191785	date NZ	2014-07-09	ymd - default (but day/month value <=

The following table lists up to 10 of the 'date UTC' files which are set by default - do they look OK to assume the default dateFormat? Compare the file names with the dateExample...

```
# list default files with UTC time
aList <- fListCompleteDT[dateColName == "date UTC" & dateFormat %like% "default",
                         .(file, fSize, dateColName, dateExample, dateFormat)]

cap <- paste0("First 10 (max) of ", nrow(aList),
              " files with dateColName = 'date UTC' and default dateFormat")

knitr::kable(caption = cap, head(aList, 10))
```

Table 4: First 10 (max) of 3607 files with dateColName = 'date UTC' and default dateFormat

file	fSize	dateColName	dateExample	dateFormat
rf_06/10Apr2018-11Apr2018at1.csv	156944	date UTC	2018-04-09	ymd - default (but day/month value <= 1
rf_06/10Dec2017-11Dec2017at1.csv	156601	date UTC	2017-12-09	ymd - default (but day/month value <= 1
rf_06/10Feb2018-11Feb2018at1.csv	153353	date UTC	2018-02-09	ymd - default (but day/month value <= 1
rf_06/10Jan2018-11Jan2018at1.csv	153982	date UTC	2018-01-09	ymd - default (but day/month value <= 1
rf_06/10Mar2018-11Mar2018at1.csv	156471	date UTC	2018-03-09	ymd - default (but day/month value <= 1
rf_06/10May2018-11May2018at1.csv	156683	date UTC	2018-05-09	ymd - default (but day/month value <= 1
rf_06/10Nov2017-11Nov2017at1.csv	155639	date UTC	2017-11-09	ymd - default (but day/month value <= 1
rf_06/11Apr2018-12Apr2018at1.csv	157181	date UTC	2018-04-10	ymd - default (but day/month value <= 1
rf_06/11Dec2017-12Dec2017at1.csv	157814	date UTC	2017-12-10	ymd - default (but day/month value <= 1
rf_06/11Feb2018-12Feb2018at1.csv	153859	date UTC	2018-02-10	ymd - default (but day/month value <= 1

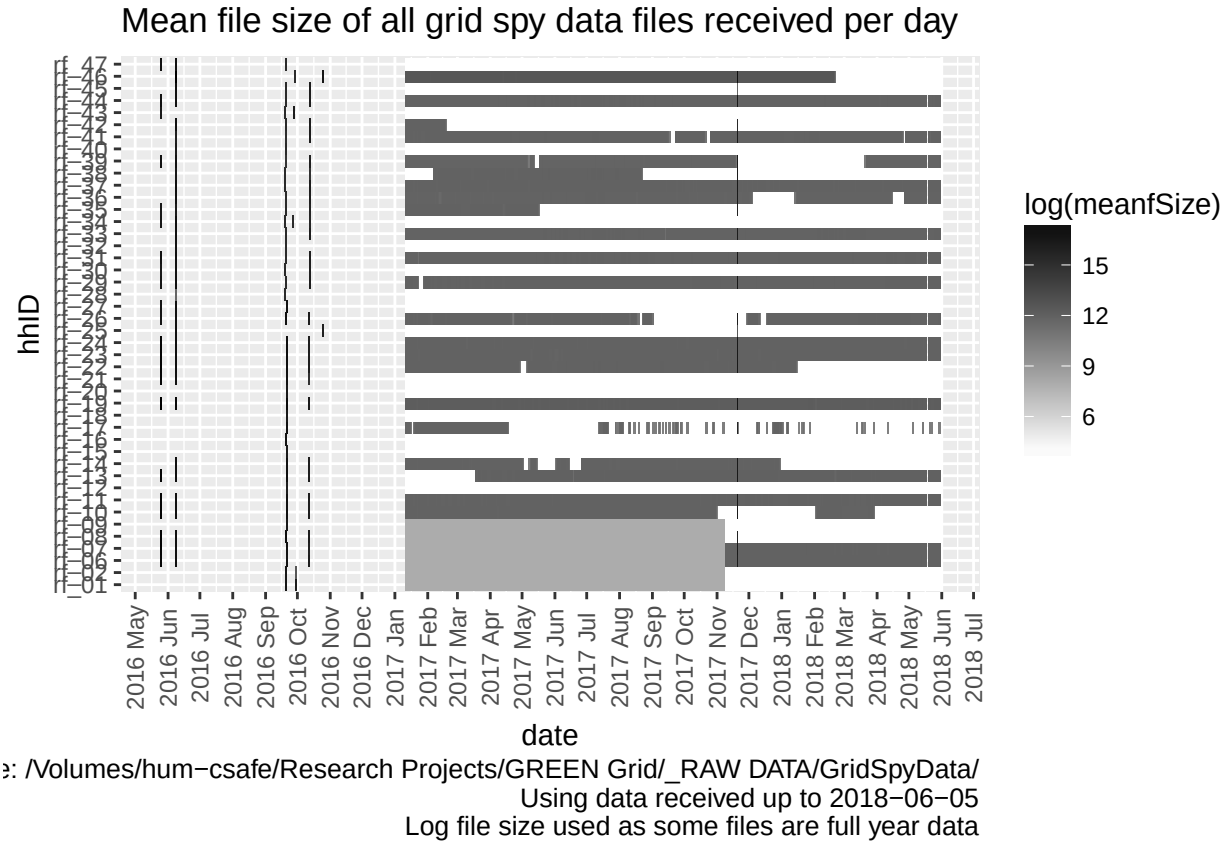
Check final date formats:

Table 5: Number of files & min/max dates (as char) with given date column names by final imputed date format

dateColName	dateFormat	nFiles	minDate	maxDate
date NZ	dmy - definite	1	27/03/2015	27/03/2015
date NZ	mdy - definite	2	5/26/2016	5/26/2016
date NZ	ymd - default (but day/month value <= 12)	12	2014-01-06	2016-06-07
date NZ	ymd - definite	67	2014-05-24	2016-07-13
date UTC	dmy - inferred	28	11-10-16	27/07/14
date UTC	ymd - default (but day/month value <= 12)	3607	2014-11-03	2018-05-12
date UTC	ymd - definite	5579	2015-03-26	2018-05-28
unknown - do not load (fsize = 2751)	NA	1812	NA	NA
unknown - do not load (fsize = 43)	NA	11268	NA	NA

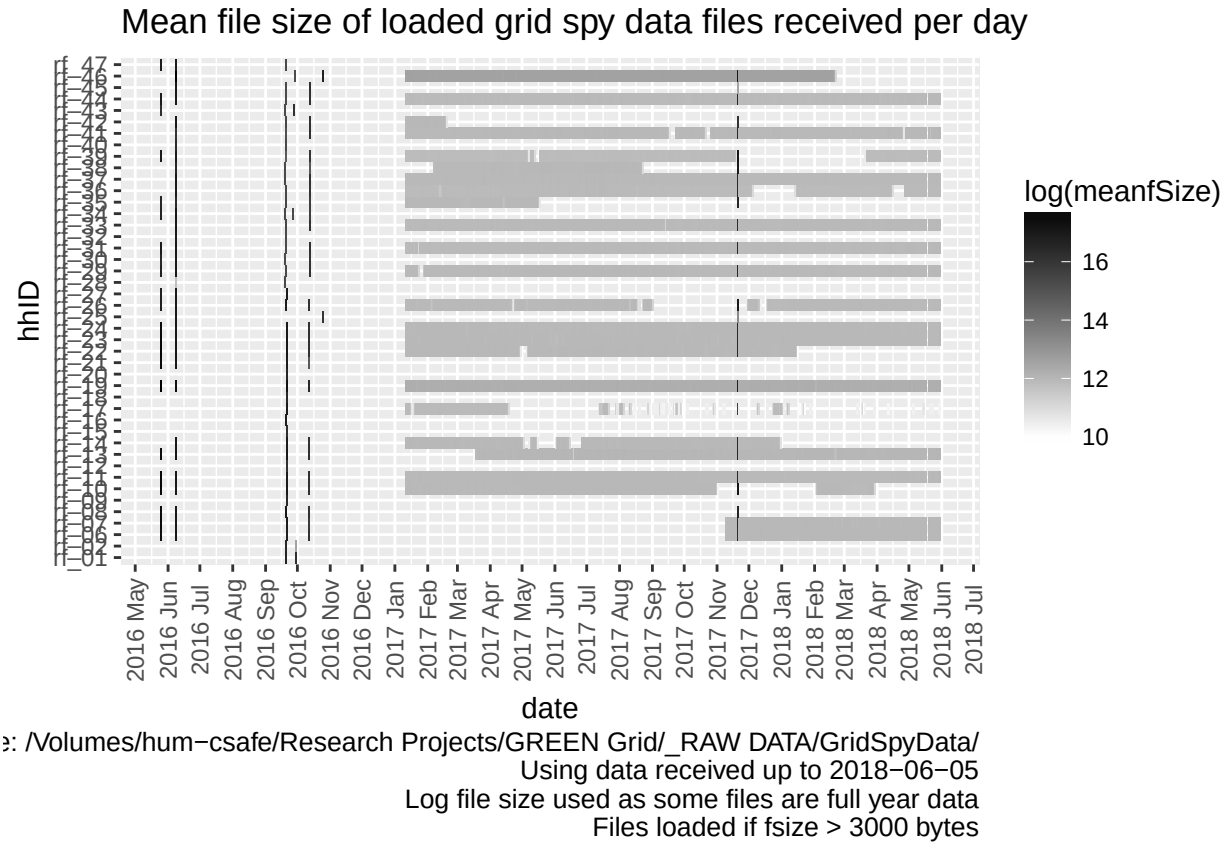
4.2 Data file quality checks

The following chart shows the distribution of these files over time using their sizes. Note that white indicates the presence of small files which may not contain observations.




```
## Saving 6.5 x 4.5 in image
```

The following chart shows the same chart but only for files which we think contain data.




```
## Saving 6.5 x 4.5 in image
```

5 Load data files

5.1 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.

Table 6: Meta data for sample

sample	hhID	Adults	Teenagers	Children	removed
Unison	rf_28	2	NA	3(12,8,4)	NA
Unison	rf_29	2	NA	1 (7 months old)	live
Unison	rf_30	2	0	0	NA
Unison	rf_31	2 (Plus cousin)	NA	NA	live
Unison	rf_32	2	NA	2 (7 and 4years old)	NA
Unison	rf_33	2	1(14yold)	1 (6yold)	live
Unison	rf_34	3	NA	NA	NA
Unison	rf_35	2	NA	NA	42322
Unison	rf_36	1	2 (14 and 12)	NA	live
Unison	rf_37	2	NA	NA	live
Unison	rf_38	NA	NA	NA	NA
Unison	rf_38	2	NA	2 (<12)	NA
Unison	rf_39	2	1 (16 YO)	NA	live

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

5.2 Grid Spy data

In this section we load the data files that have a file size > 3000 bytes. Things to note:

- We assume that any files smaller than this value have no observations. This is based on:
  - Manual inspection of several small files
  - The identical (small) file sizes involved
  - *But* we should probably test the first few lines to double check...
- We have to deal with quite a lot of duplication some of which has caused the different date formats. See our repo issues list.

The following table shows the number of files per household that we will load.

```
# check files to load
t <- fListCompleteDT[dateColName %like% "do not load", .(nFiles = .N,
                        meanSize = mean(fSize),
                        minFileDate = min(fMDate),
                        maxFileDate = max(fMDate)), keyby = .(hhID)]
```

```
knitr::kable(caption = "Summary of household files to load", t)
```

Table 7: Summary of household files to load

hhID	nFiles	meanSize	minFileDate	maxFileDate
rf_01	506	1659.237	2017-01-11	2018-05-30
rf_02	506	1659.237	2017-01-11	2018-05-30
rf_06	302	2751.000	2017-01-11	2017-11-08
rf_07	302	2751.000	2017-01-11	2017-11-08
rf_08	505	1662.438	2017-01-11	2018-05-30
rf_09	506	1659.237	2017-01-11	2018-05-30
rf_10	152	43.000	2017-11-03	2018-05-30
rf_12	506	43.000	2017-01-11	2018-05-30
rf_13	68	43.000	2017-01-11	2017-03-18
rf_14	180	43.000	2017-05-04	2018-05-30
rf_15	506	43.000	2017-01-11	2018-05-30
rf_16	506	43.000	2017-01-11	2018-05-30
rf_17	296	43.000	2017-01-18	2018-05-28
rf_18	506	43.000	2017-01-11	2018-05-30
rf_20	506	43.000	2017-01-11	2018-05-30
rf_21	506	43.000	2017-01-11	2018-05-30
rf_22	139	43.000	2017-05-01	2018-05-30
rf_25	505	43.000	2017-01-11	2018-05-30
rf_26	94	43.000	2017-08-21	2017-12-17
rf_27	506	43.000	2017-01-11	2018-05-30
rf_28	506	43.000	2017-01-11	2018-05-30
rf_29	3	43.000	2017-01-25	2017-01-27
rf_30	506	43.000	2017-01-11	2018-05-30
rf_32	506	43.000	2017-01-11	2018-05-30
rf_34	506	43.000	2017-01-11	2018-05-30
rf_35	376	43.000	2017-05-19	2018-05-30
rf_36	49	43.000	2017-12-06	2018-04-26
rf_38	308	43.000	2017-01-11	2018-05-30
rf_39	124	43.000	2017-05-14	2018-03-20
rf_40	506	43.000	2017-01-11	2018-05-30
rf_41	8	43.000	2017-09-19	2018-04-27
rf_42	464	43.000	2017-02-20	2018-05-30
rf_43	506	43.000	2017-01-11	2018-05-30
rf_45	505	43.000	2017-01-11	2018-05-30
rf_46	98	43.000	2018-02-22	2018-05-30
rf_47	506	43.000	2017-01-11	2018-05-30

Now load, clean and save the valid data giving feedback where appropriate.

```
# process the data & update the fListCompleteDT
# get a few rows of data as an example
# refresh the data depending on refreshData (set in ./setup.R)

if(refreshData){
  print(paste0("'refreshData' = ", refreshData, " so re-building filelist"))
  # returns the updated file list into fListCompleteDT
  # creates hhStatDT (used below)
  # puts top 6 rows of last file into lastOfHeadDT
```

```
  fListCompleteDT <- nzGREENGrid::processGridSpyDataFiles(fListCompleteDT, fListFinal)
} else {
  print(paste0("'refreshData' = ", refreshData, " so re-using filelist"))
  fListCompleteDT <- fread(paste0(outPath,fListFinal))

  # need to create hhStatDT
  ofile <- paste0(outPath, "hhDailyObservationsStats.csv")
  hhStatDT <- fread(ofile)

  # need to get lastOfHeadDT
  # do this by getting the first in the processed list
  dPath <- paste0(outPath,"data/")
  fList <- list.files(path = dPath, pattern = "csv.gz")
  print(paste0("Re-using saved data file..."))
  lastOfHeadDT <- head(read_csv(paste0(dPath, fList[1])))
}
```

```
## [1] "'refreshData' = 0 so re-using filelist"
## [1] "Re-using saved data file..."
```

```
## Parsed with column specification:
## cols(
##   hhID = col_character(),
##   r_dateTime = col_datetime(format = ""),
##   circuit = col_character(),
##   powerW = col_double()
## )
```

```
# test
kable(caption = "Example data rows", lastOfHeadDT)
```

Table 8: Example data rows

hhID	r_dateTime	circuit	powerW
rf_01	2014-01-06 03:03:00	Kitchen power$1632	45.58
rf_01	2014-01-06 03:04:00	Kitchen power$1632	45.58
rf_01	2014-03-07 02:56:00	Kitchen power$1632	45.58
rf_01	2014-03-07 02:57:00	Kitchen power$1632	54.13
rf_01	2014-03-07 02:58:00	Kitchen power$1632	136.26
rf_01	2014-03-07 02:59:00	Kitchen power$1632	141.96

6 Data quality analysis

Now produce some data quality plots & tables.

6.1 Circuit label checks

The following table shows the number of data files with different circuit labels by household. In theory there should only be one unique list per household and it should be present in every data file. If this is not the case then this implies that:

- some of the circuit labels for these households may have been changed during the data collection process;

- some of the circuit labels may have character conversion errors which have changed the labels during the data collection process;
- at least one file from one household has been saved to a folder containing data from a different household (unfortunately the raw data files do *not* contain household IDs in the data or the file names which would enable checking/preventative filtering). This will be visible in the table if two households appear to share *exactly* the same list of circuit labels.

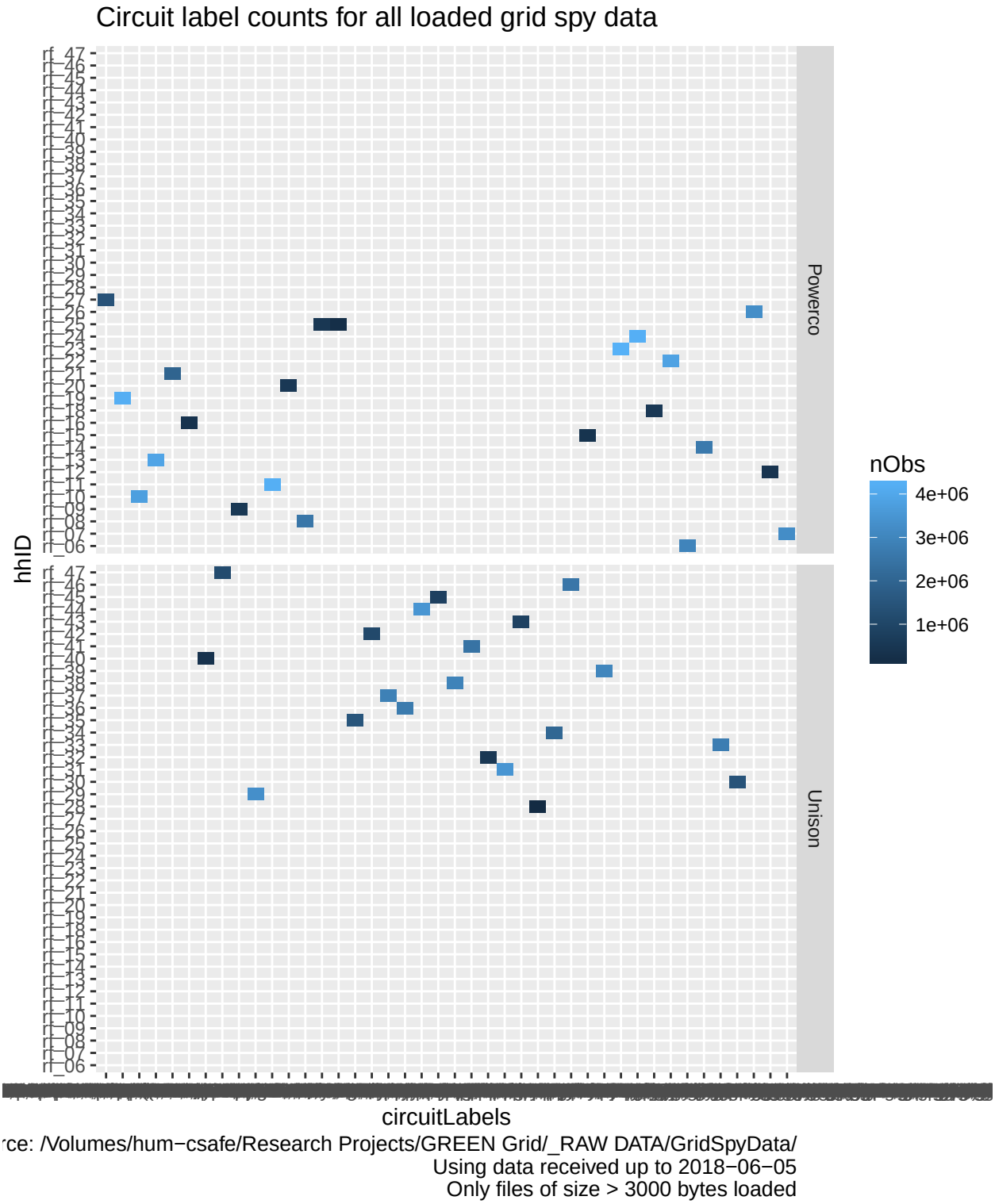
Some or all of these may be true at any given time!

> NB: This table is only legible in the html version of this report because latex does a very bad job of wrapping table cell text. A version is saved in /Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/safe/gridSpy/1min/circuitLabelCheck.csv for viewing in e.g. xl.

Bed 2, 2nd Fridge$2828, Heat Pump$2826, Hot Water - Controlled$2825, Incomer - Uncontrolled$2824, Kitchen, Laundry &
Bedroom & Lounge Heat Pumps$2741, Incomer 1 - All$2738, Incomer 2 - All$2737, Kitchen Appliances$2735, Laundry$273
Bedrooms & Lounge$2602, Heat Pump$2598, Incomer - All$2599, Kitchen Appliances$2601, Laundry & Garage$2597, Oven
Downstairs (inc 1 Heat Pump)$2212, Hot Water - Controlled$2208, Incomer - Uncontrolled$2209, Kitchen & Laundry$2213
Fridge$2752, Heat Pump & Washing Machine$2750, Incomer - All$2748, Kitchen Appliances & Garage$2753, Lower Bedroo
Hallway & Washing Machine$2683, Hot Water - Controlled$2679, Incomer 1 - Uncont inc Oven$2681, Incomer 2 - Uncont in
Heat Pump (x2) & Lounge Power$4166, Hot Water - Controlled$4167, Incomer - Uncontrolled$4168, Kitchen Appliances$41
Heat Pump & 2 x Bathroom Heat$4171, Incomer - All$4170, Kitchen Power & Heat, Lounge$4174, Laundry, Garage & 2 B
Heat Pump & Bedroom 2$2731, Incomer 1 - Uncont - Inc Hob$2729, Incomer 2 - Uncont - Inc Oven$2730, Kitchen Applian
Heat Pump & Kitchen Appliances$4186, Hot Water - Controlled$4184, Incomer - Uncontrolled$4181, Laundry$4185, Lighti
Heat Pump & Lounge$2590, Hob$2589, Hot Water Cpbd Heater- Cont$2586, Incomer - Uncontrolled$2585, Kitchen Applia
Heat Pump & Misc$2107, Hob$2109, Hot Water - Controlled$2110, Incomer 1 - Uncontrolled$2112, Incomer 2 - Uncontrolle
Heat Pump$2092, Hot Water - Controlled$2094, Incomer - Uncontrolled$2093, Kitchen$2089, Laundry & 2nd Fridge Freeze
Heat Pump$2758, Hob & Kitchen Appliances$2759, Hot Water - Controlled$2761, Incomer 1 - Uncontrolled $2763, Incomer
Heat Pump$2758, Hob & Kitchen Appliances$2759, Hot Water - Controlled$2761, Incomer 1 - Uncontrolled $2763, Incomer
Heat Pump$4124, Hot Water - Uncontrolled$4125, Incomer - Uncontrolled$4126, Kitchen Appliances$4121, Laundry, Garag
Heat Pump$4130, Hot Water - Uncontrolled$4131, Incomer - All$4132, Kitchen Appliances$4127, Laundry & Freezer$4128,
Heat Pump$4134, Hot Water - Controlled$4135, Incomer -Uncontrolled$4136, Kitchen Appliances$4137, Laundry & Fridge
Heat Pump$4150, Hot Water - Uncontrolled$4147, Incomer - All$4148, Kitchen Appliances$4145, Lighting$4149, Washing M
Heat Pump$4154, Hot Water - Controlled$4155, Incomer - Uncontrolled$4156, Kitchen Appliances$4151, Laundry $4152, Li
Heat Pump$4160, Hot Water - Controlled$4158, Incomer - Uncontrolled$4157, Kitchen Appliances$4161, Laundry & Garag
Heat Pump$4175, Hot Water - Controlled$4178, Incomer - Uncontrolled$4177, Kitchen, Dining & Office$4179, Laundry, Lou
Heat Pump$4190, Incomer - All$4192, Kitchen Appliances$4187, Laundry$4188, Lighting$4189, Oven$4191
Heat Pump$4196, Hot Water - Controlled$4198, Incomer - All$4193, Kitchen Appliances$4195, Laundry$4194, Lighting$419
Heat Pump$4204, Hot Water - Controlled$4200, Incomer - All$4199, Kitchen Appliances$4201, Laundry$4202, Lighting$420
Heat Pump$4211, Incomer - All$4213, Kitchen Appliances$4210, Laundry, Garage & Guest Bed$4215, Lighting$4212, Oven
Heat Pump$4219, Incomer - All$4221, Kitchen Appliances$4216, Laundry$4217, Lighting$4218, PV & Garage$4220
Heat Pump$4223, Hot Water - Uncontrolled$4224, Incomer - All$4225, Kitchen Appliances$4226, Laundry & Garage Freeze
Heat Pumps (2x) & Power$4232, Heat Pumps (2x) & Power$4399, Hot Water - Controlled$4231, Hot Water - Controlled$4
Hob$3954, Hot Water$3952, Incomer 1$3956, Incomer 2$3955, Laundry & Kitchen Appliances$3951, Oven$3953
Hot Water (2 elements)$4247, Incomer - Uncontrolled$4248, Kitchen Appliances$4244, Lighting & 2 Towel Rail$4245, Oven
Hot Water - Controlled (HEMS)$2081, Incomer - Uncontrolled$2082, Kitchen, Laundry & Ventilation$2084, Oven$2085, PV
Hot Water - Controlled$2102, Incomer - Uncontrolled$2101, Kitchen$2104, Laundry, Fridge & Freezer$2105, Oven & Hob$2
Hot Water - Controlled$2129, Incomer 1 - Uncontrolled$2128, Incomer 2 - Uncontrolled$2130, Kitchen Appliances & Ventila
Hot Water - Controlled$2236, Incomer - Uncontrolled$2237, Kitchen & Laundry$2234, Lighting$2232, Oven$2235, Ventilati
Hot Water - Controlled$2248, Incomer - Uncontrolled$2249, Kitchen$2246, Laundry, Downstairs & Lounge$2245, Lighting$
Hot Water - Controlled$2719, Incomer 1 - Uncont inc Stove$2718, Incomer 2 - Uncont inc Oven$2717, Kitchen Appliances$
Hot Water - Controlled$4144, Incomer - Uncontrolled$4143, Kitchen Appliances & Heat Pump$4140, Laundry & Teenagers
Hot Water - Controlled$4238, Incomer - All$4239, Kitchen Appliances$4234, Laundry & Kitchen$4235, Lighting$4236, Oven

Incomer 1 - All$2703, Incomer 2 - All$2704, Kitchen Appliances$2706, Laundry, Sauna & 2nd Fridge$2707, Oven$2705, Spa
Incomer 1 - Hot Water - Cont$2626, Incomer 2 - Uncontrolled$2625, Incomer 3 - Uncontrolled$2627, Kitchen Appliances &
Incomer 1 - Uncontrolled$2726, Incomer 2 - Uncontrolled$2725, Kitchen Appliances & Laundry$2722, Microwave$2721, Ove

Errors are easy to spot in the following plot where a hhID spans 2 or more circuit labels.




```
## Saving 6.5 x 8 in image
```

The following table provides more detail to aid error checking. Check for:

- 2+ adjacent rows which have exactly the same circuit labels but different hh_ids. This implies some data from one household has been saved in the wrong folder;
- 2+ adjacent rows which have different circuit labels but identical hh_ids. This could imply the same

thing but is more likely to be errors/changes to the circuit labelling.

If the above plot and this table flag a lot of errors then some re-naming of the circuit labels (column names) may be necessary.

> NB: As before, the table is only legible in the html version of this report because latex does a very bad job of wrapping table cell text. A version is saved in /Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/safe/gridSpy/1min/circuitLabelMetaDataCheckTable.csv for viewing in e.g. xl.

circuitLabels
Bed 2, 2nd Fridge$2828, Heat Pump$2826, Hot Water - Controlled$2825, Incomer - Uncontrolled$2824, Kitchen, Laundry &
Bedroom & Lounge Heat Pumps$2741, Incomer 1 - All$2738, Incomer 2 - All$2737, Kitchen Appliances$2735, Laundry$273
Bedrooms & Lounge$2602, Heat Pump$2598, Incomer - All$2599, Kitchen Appliances$2601, Laundry & Garage$2597, Over
Downstairs (inc 1 Heat Pump)$2212, Hot Water - Controlled$2208, Incomer - Uncontrolled$2209, Kitchen & Laundry$2213
Fridge$2752, Heat Pump & Washing Machine$2750, Incomer - All$2748, Kitchen Appliances & Garage$2753, Lower Bedroo
Hallway & Washing Machine$2683, Hot Water - Controlled$2679, Incomer 1 - Uncont inc Oven$2681, Incomer 2 - Uncont in
Heat Pump & 2 x Bathroom Heat$4171, Incomer - All$4170, Kitchen Power & Heat, Lounge$4174, Laundry, Garage & 2 B
Heat Pump & Bedroom 2$2731, Incomer 1 - Uncont - Inc Hob$2729, Incomer 2 - Uncont - Inc Oven$2730, Kitchen Applian
Heat Pump & Kitchen Appliances$4186, Hot Water - Controlled$4184, Incomer - Uncontrolled$4181, Laundry$4185, Lightin
Heat Pump & Lounge$2590, Hob$2589, Hot Water Cpbd Heater- Cont$2586, Incomer - Uncontrolled$2585, Kitchen Applian
Heat Pump & Misc$2107, Hob$2109, Hot Water - Controlled$2110, Incomer 1 - Uncontrolled$2112, Incomer 2 - Uncontrolle
Heat Pump (x2) & Lounge Power$4166, Hot Water - Controlled$4167, Incomer - Uncontrolled$4168, Kitchen Appliances$41
Heat Pump$2092, Hot Water - Controlled$2094, Incomer - Uncontrolled$2093, Kitchen$2089, Laundry & 2nd Fridge Freeze
Heat Pump$2758, Hob & Kitchen Appliances$2759, Hot Water - Controlled$2761, Incomer 1 - Uncontrolled $2763, Incomer
Heat Pump$2758, Hob & Kitchen Appliances$2759, Hot Water - Controlled$2761, Incomer 1 - Uncontrolled $2763, Incomer
Heat Pump$4124, Hot Water - Uncontrolled$4125, Incomer - Uncontrolled$4126, Kitchen Appliances$4121, Laundry, Garag
Heat Pump$4130, Hot Water - Uncontrolled$4131, Incomer - All$4132, Kitchen Appliances$4127, Laundry & Freezer$4128,
Heat Pump$4134, Hot Water - Controlled$4135, Incomer -Uncontrolled$4136, Kitchen Appliances$4137, Laundry & Fridge
Heat Pump$4150, Hot Water - Uncontrolled$4147, Incomer - All$4148, Kitchen Appliances$4145, Lighting$4149, Washing M
Heat Pump$4154, Hot Water - Controlled$4155, Incomer - Uncontrolled$4156, Kitchen Appliances$4151, Laundry $4152, Li
Heat Pump$4160, Hot Water - Controlled$4158, Incomer - Uncontrolled$4157, Kitchen Appliances$4161, Laundry & Garag
Heat Pump$4175, Hot Water - Controlled$4178, Incomer - Uncontrolled$4177, Kitchen, Dining & Office$4179, Laundry, Lou
Heat Pump$4190, Incomer - All$4192, Kitchen Appliances$4187, Laundry$4188, Lighting$4189, Oven$4191
Heat Pump$4196, Hot Water - Controlled$4198, Incomer - All$4193, Kitchen Appliances$4195, Laundry$4194, Lighting$419
Heat Pump$4204, Hot Water - Controlled$4200, Incomer - All$4199, Kitchen Appliances$4201, Laundry$4202, Lighting$420
Heat Pump$4211, Incomer - All$4213, Kitchen Appliances$4210, Laundry, Garage & Guest Bed$4215, Lighting$4212, Oven
Heat Pump$4219, Incomer - All$4221, Kitchen Appliances$4216, Laundry$4217, Lighting$4218, PV & Garage$4220
Heat Pump$4223, Hot Water - Uncontrolled$4224, Incomer - All$4225, Kitchen Appliances$4226, Laundry & Garage Freeze
Heat Pumps (2x) & Power$4232, Heat Pumps (2x) & Power$4399, Hot Water - Controlled$4231, Hot Water - Controlled$4
Hob$3954, Hot Water$3952, Incomer 1$3956, Incomer 2$3955, Laundry & Kitchen Appliances$3951, Oven$3953
Hot Water (2 elements)$4247, Incomer - Uncontrolled$4248, Kitchen Appliances$4244, Lighting & 2 Towel Rail$4245, Oven
Hot Water - Controlled (HEMS)$2081, Incomer - Uncontrolled$2082, Kitchen, Laundry & Ventilation$2084, Oven$2085, PV
Hot Water - Controlled$2102, Incomer - Uncontrolled$2101, Kitchen$2104, Laundry, Fridge & Freezer$2105, Oven & Hob$2
Hot Water - Controlled$2129, Incomer 1 - Uncontrolled$2128, Incomer 2 - Uncontrolled$2130, Kitchen Appliances & Ventila
Hot Water - Controlled$2236, Incomer - Uncontrolled$2237, Kitchen & Laundry$2234, Lighting$2232, Oven$2235, Ventilati
Hot Water - Controlled$2248, Incomer - Uncontrolled$2249, Kitchen$2246, Laundry, Downstairs & Lounge$2245, Lighting$
Hot Water - Controlled$2719, Incomer 1 - Uncont inc Stove$2718, Incomer 2 - Uncont inc Oven$2717, Kitchen Appliances$
Hot Water - Controlled$4144, Incomer - Uncontrolled$4143, Kitchen Appliances & Heat Pump$4140, Laundry & Teenagers
Hot Water - Controlled$4238, Incomer - All$4239, Kitchen Appliances$4234, Laundry & Kitchen$4235, Lighting$4236, Over
Incomer 1 - All$2703, Incomer 2 - All$2704, Kitchen Appliances$2706, Laundry, Sauna & 2nd Fridge$2707, Oven$2705, Spa
Incomer 1 - Hot Water - Cont$2626, Incomer 2 - Uncontrolled$2625, Incomer 3 - Uncontrolled$2627, Kitchen Appliances &

circuitLabels
Incomer 1 - Uncontrolled$2726, Incomer 2 - Uncontrolled$2725, Kitchen Appliances & Laundry$2722, Microwave$2721, Ove

Things to note:

- rf_25 has an aditional unexpected "Incomer 1 - Uncontrolled$2757" circuit in some files but it's value is always NA so we have not 'corrected' this.

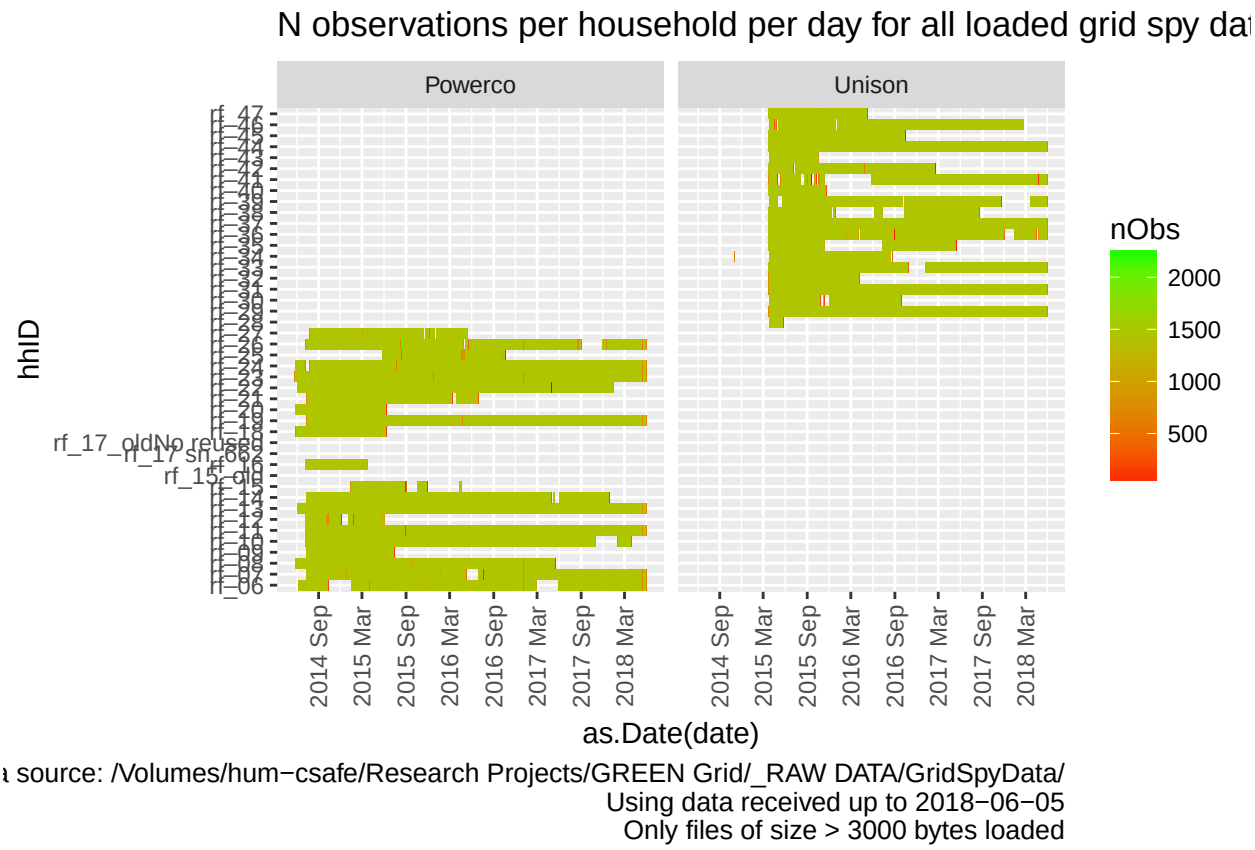
6.2 Observations

The following plots show the number of observations per day per household. In theory we should not see:

- dates before 2014 or in to the future. These may indicate:
  - date conversion errors;
- more than 1440 observations per day. These may indicate:
  - duplicate time stamps - i.e. they have the same time stamps but different power (W) values or different circuit labels;
  - observations from files that are in the 'wrong' rf_XX folder and so are included in the 'wrong' household as 'duplicate' time stamps.

If present both of the latter may have been implied by the table above and would have evaded the de-duplication filter which simply checks each complete row against all others within it's consolidated household dataset (a *within household absolute duplicate* check).

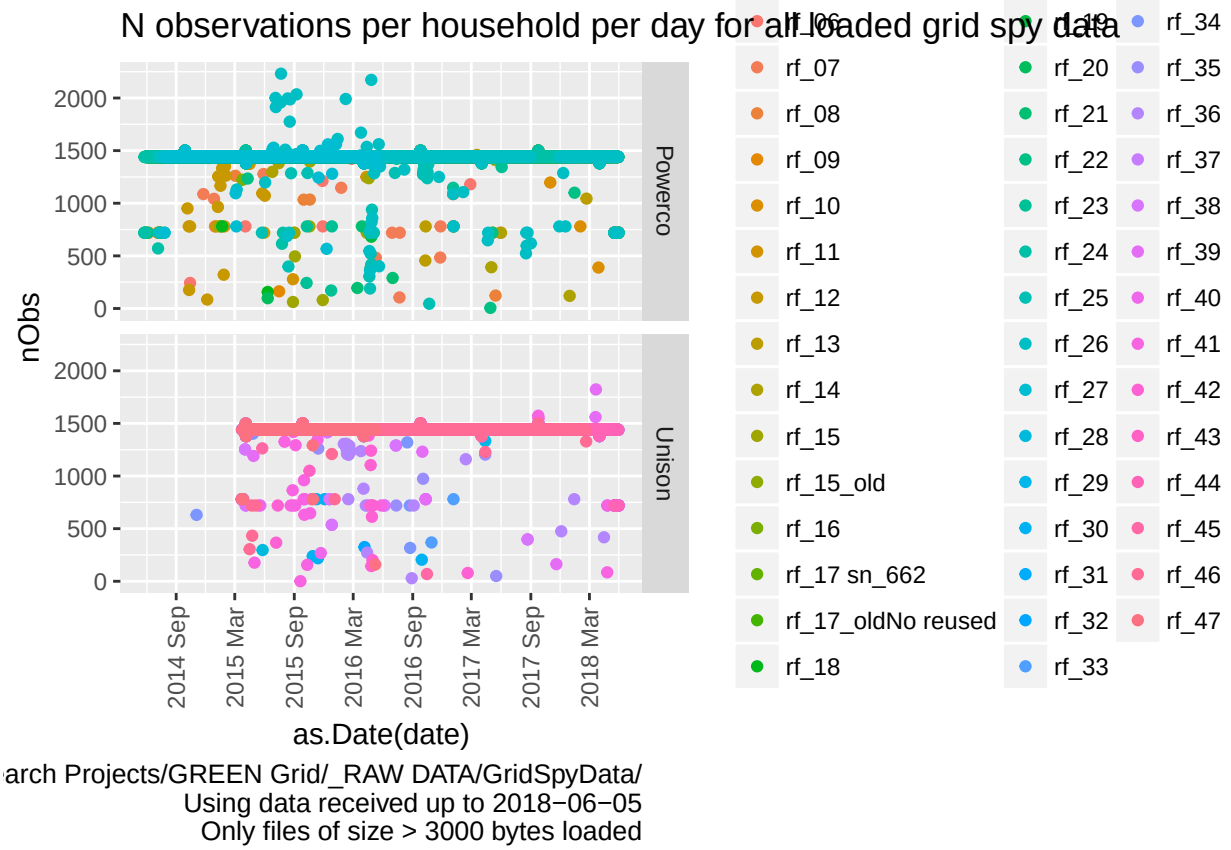
```
## Warning: Removed 3 rows containing missing values (geom_tile).
```




```
## Saving 6.5 x 4.5 in image
```

```
## Warning: Removed 3 rows containing missing values (geom_tile).
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```




```
arch Projects/GREEN Grid/_RAW DATA/GridSpyData/
Using data received up to 2018-06-05
Only files of size > 3000 bytes loaded
```

```
## Saving 6.5 x 4.5 in image
```

```
## Warning: Removed 3 rows containing missing values (geom_point).
```

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!

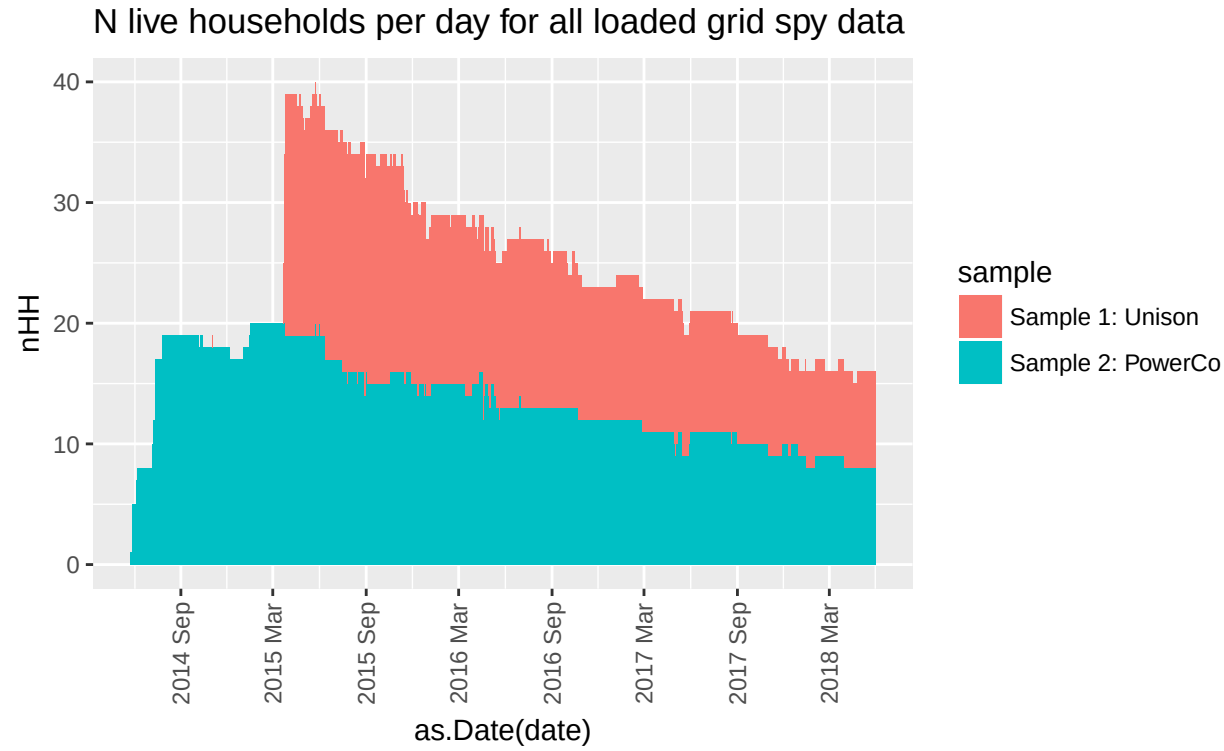
Table 11: Summary observation stats by hhID (sorted by date last heard from)

hhID	sample	minObs	maxObs	meanNDataColumns	minDate	maxDate
rf_16	Powerco	720	1500	6	2014-07-09	2015-03-25
rf_28	Unison	297	1440	6	2015-03-26	2015-05-26
rf_12	Powerco	85	1500	6	2014-07-08	2015-06-02
rf_18	Powerco	157	1500	6	2014-05-29	2015-06-11
rf_20	Powerco	98	1500	6	2014-05-28	2015-06-11
rf_09	Powerco	163	1500	6	2014-07-13	2015-07-16
rf_43	Unison	780	1495	6	2015-03-26	2015-10-18

hhID	sample	minObs	maxObs	meanNDataColumns	minDate	maxDate
rf_40	Unison	268	1500	6	2015-03-24	2015-11-22
rf_32	Unison	325	1500	6	2015-03-25	2016-04-05
rf_15	Powerco	62	1440	6	2015-01-14	2016-04-18
rf_47	Unison	159	1500	6	2015-03-24	2016-05-08
rf_27	Powerco	567	1560	6	2014-07-27	2016-05-13
rf_21	Powerco	195	1500	6	2014-07-14	2016-07-01
rf_34	Unison	317	1500	6	2014-11-03	2016-08-24
rf_30	Unison	205	1500	6	2015-03-27	2016-09-29
rf_45	Unison	69	1499	6	2015-03-24	2016-10-15
rf_25	Powerco	45	1500	6	2015-05-24	2016-10-22
rf_42	Unison	79	1500	6	2015-03-23	2017-02-18
rf_08	Powerco	123	1500	6	2014-05-28	2017-05-15
rf_35	Unison	50	1500	6	2015-03-22	2017-05-17
rf_38	Unison	398	1500	6	2015-03-24	2017-08-22
rf_14	Powerco	120	1500	6	2014-07-13	2017-12-30
rf_22	Powerco	6	1500	6	2014-06-05	2018-01-14
rf_46	Unison	305	1500	13	2015-03-26	2018-02-19
rf_10	Powerco	389	1500	6	2014-07-08	2018-03-29
rf_06	Powerco	243	1500	6	2014-06-08	2018-05-30
rf_07	Powerco	105	1500	6	2014-07-13	2018-05-30
rf_11	Powerco	278	1500	6	2014-07-07	2018-05-30
rf_13	Powerco	456	1500	6	2014-06-05	2018-05-30
rf_19	Powerco	387	1500	9	2014-07-14	2018-05-30
rf_23	Powerco	171	1500	6	2014-05-25	2018-05-30
rf_24	Powerco	571	1500	6	2014-05-28	2018-05-30
rf_26	Powerco	362	2231	6	2014-07-10	2018-05-30
rf_29	Unison	720	1500	6	2015-03-25	2018-05-30
rf_31	Unison	720	1500	6	2015-03-25	2018-05-30
rf_33	Unison	369	1500	6	2015-03-23	2018-05-30
rf_36	Unison	29	1500	6	2015-03-23	2018-05-30
rf_37	Unison	720	1500	6	2015-03-23	2018-05-30
rf_39	Unison	163	1823	5	2015-03-27	2018-05-30
rf_41	Unison	1	1573	6	2015-03-25	2018-05-30
rf_44	Unison	720	1500	6	2015-03-24	2018-05-30
rf_15_old	Powerco	NA	NA	NA	NA	NA
rf_17 sn_662	Powerco	NA	NA	NA	NA	NA
rf_17_oldNo reused	Powerco	NA	NA	NA	NA	NA

Finally we show the total number of households which we think are still sending data.

```
## Warning: Removed 1 rows containing missing values (position_stack).
```




```
## Saving 6.5 x 4.5 in image
```

```
## Warning: Removed 1 rows containing missing values (position_stack).
```

7 Summary

The cleaned data has been saved as gzipped .csv files to /Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/safe/gridSpy/1min/ in 'long' form so that each file only has 4 columns:

- hhID: household id
- r_dateTime: time of observation
- circuit: the circuit label
- powerW: power observation (Watts)

Each file has data for one household and there should be one file per household.

As an example, here are the first few rows of one of the files:

Table 12: Example data rows

hhID	r_dateTime	circuit	powerW
rf_01	2014-01-06 03:03:00	Kitchen power$1632	45.58
rf_01	2014-01-06 03:04:00	Kitchen power$1632	45.58
rf_01	2014-03-07 02:56:00	Kitchen power$1632	45.58
rf_01	2014-03-07 02:57:00	Kitchen power$1632	54.13
rf_01	2014-03-07 02:58:00	Kitchen power$1632	136.26
rf_01	2014-03-07 02:59:00	Kitchen power$1632	141.96

This format makes it much easier to do future data extraction in R as we can select by date and circuit label as we load. It also means we can load a lot of data in memory without breaking R's memory limits as R likes 'long' rather than wide data.

8 Runtime

Analysis completed in 35.3 seconds (0.59 minutes) using knitr in RStudio with R version 3.5.0 (2018-04-23) running on x86_64-apple-darwin15.6.0.

The time taken will have depended on:

> Full run using all data from /Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/
>
> refreshData = 0 so re-using previous output. Should be relatively quick.

9 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 10.13.4
##
## 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] knitr_1.20        readr_1.1.1       ggplot2_2.2.1     data.table_1.11.2
## [5] nzGREENGrid_0.1.0
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.17      cellranger_1.1.0  highr_0.6
##  [4] pillar_1.2.2      compiler_3.5.0    plyr_1.8.4
```

```
##  [7] bindr_0.1.1       prettyunits_1.0.2 tools_3.5.0
## [10] progress_1.1.2    digest_0.6.15     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       yaml_2.1.19
## [19] bindrcpp_0.2.2    dplyr_0.7.5       stringr_1.3.1
## [22] hms_0.4.2         rprojroot_1.3-2   grid_3.5.0
## [25] tidyselect_0.2.4  glue_1.2.0        R6_2.2.2
## [28] readxl_1.1.0      rmarkdown_1.9     purrr_0.2.4
## [31] reshape2_1.4.3    magrittr_1.5      backports_1.1.2
## [34] scales_0.5.0      htmltools_0.3.6   assertthat_0.2.0
## [37] colorspace_1.3-2  labeling_0.3      stringi_1.2.2
## [40] lazyeval_0.2.1    munsell_0.4.3
```

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