

NZ GREEN Grid Household Power Demand Profiles: Hot Water

Data extraction and preliminary plots

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1 Status

Full run using all data from /Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/

2 Citation

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

- Anderson, B. (2018) GREEN Grid Heat Pump 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 Heat Pump 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/bale12/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).

This work is (c) 2018 the University of Southampton.

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>

```

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
```

4.2 Grid Spy data

In this section we load the cleaned data files from /Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/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 <- params$circuitPattern  
dateFrom <- params$dateFrom  
dateTo <- params$dateTo  
  
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] "/Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/safe/gridSpy/1min/dataExtracts/Hot W  
## [1] "# Loaded 14,496,831 rows of data"
```

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

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

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

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

rf_18

rf_20

rf_22

rf_23

rf_24

rf_25

rf_27

rf_29

rf_30

rf_31

rf_32

rf_33

rf_34

rf_35

rf_36

rf_37

rf_38

rf_39

rf_40

rf_42

rf_44

rf_45

rf_46

Hot Water (2 elements)\$4247

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Hot Water - Controlled \$2102

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Hot Water - Controlled\$2129

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Hot Water - Controlled \$2150

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520028

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Hot Water - Controlled \$2208

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526929

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Hot Water - Controlled\$2236

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Hot Water - Controlled\$2248

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523312

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Hot Water - Controlled\$2719

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525470

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Hot Water - Controlled\$2761

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Hot Water - Controlled\$2825

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497806

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Hot Water - Controlled\$4135

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526771

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Hot Water - Controlled \$4144

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Hot Water - Controlled\$4155

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526850

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Hot Water - Controlled \$4158

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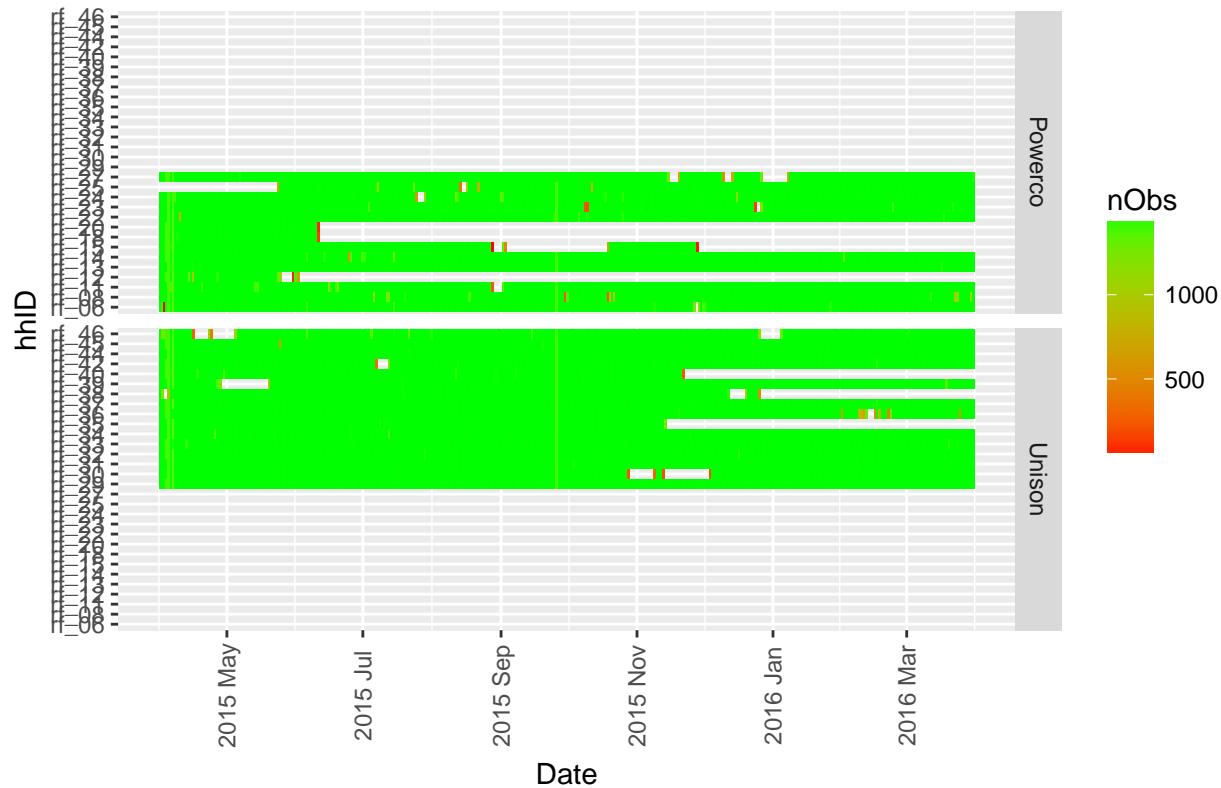
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Note that some households may have more than one Hot Water circuit.

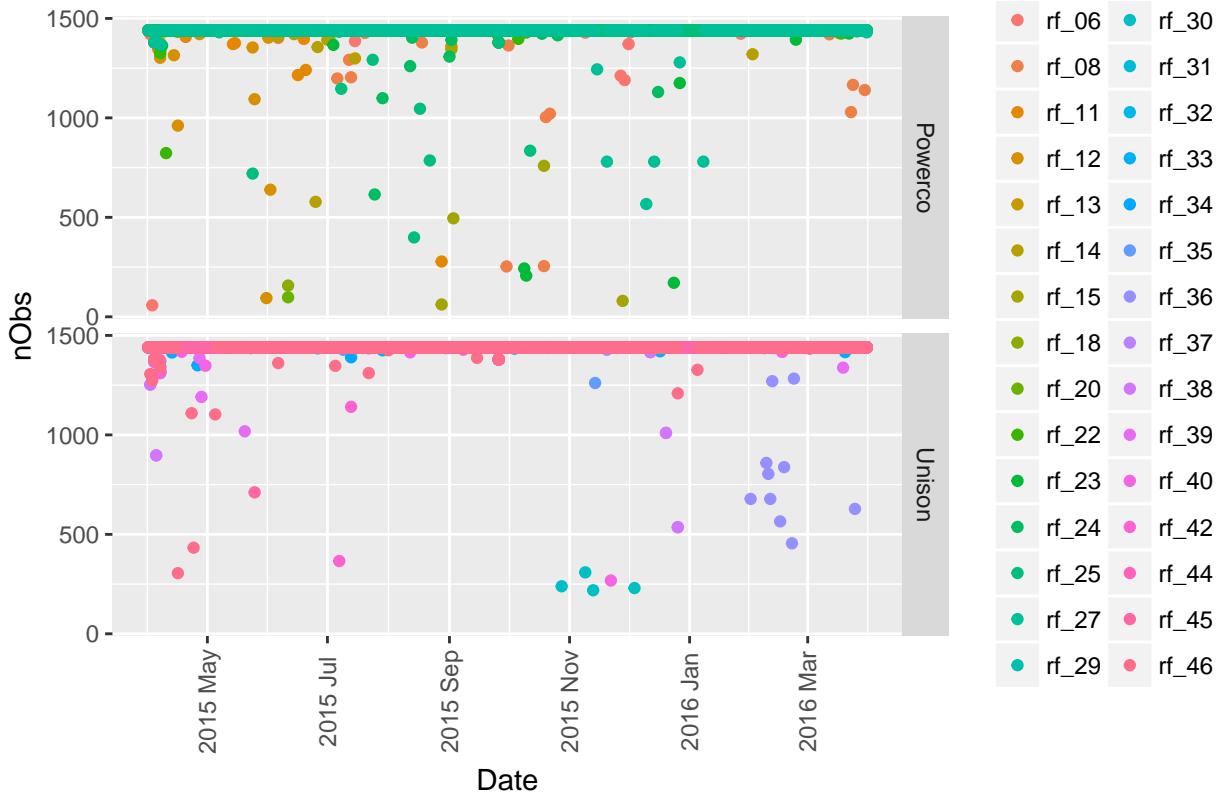
4.3 Test Hot Water data

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.



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.



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

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

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2015-04-01T00:00:00Z

2016-03-31T23:59:00Z

rf_37

Unison

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495806

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rf_42

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518179

2015-04-01T00:00:00Z

2016-03-31T23:59:00Z

rf_44

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2015-04-01T00:00:00Z

2016-03-31T23:59:00Z

rf_45

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rf_46

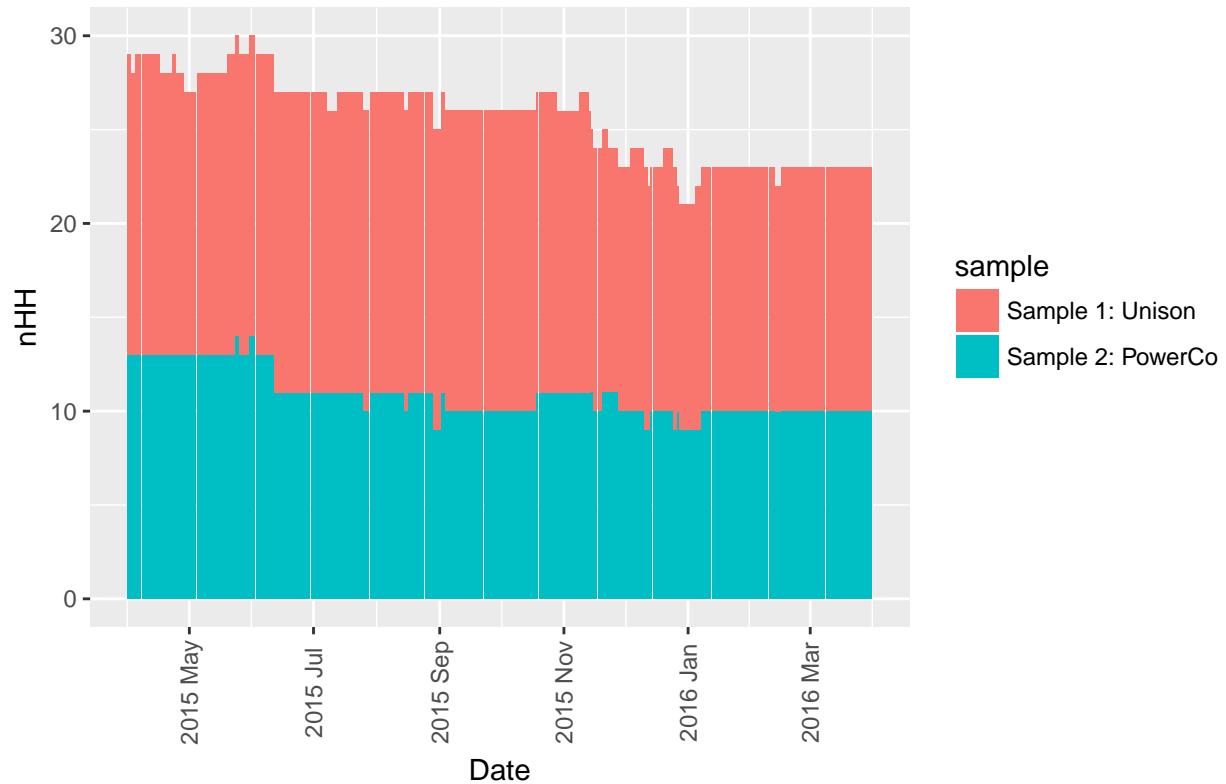
Unison

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2015-04-01T00:00:00Z

2016-03-31T23:59:00Z

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



umes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/
Circuits: Hot Water from 2015-04-01 to 2016-03-31

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

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

Summary of Hot Water circuits

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circuit

powerW </th>

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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

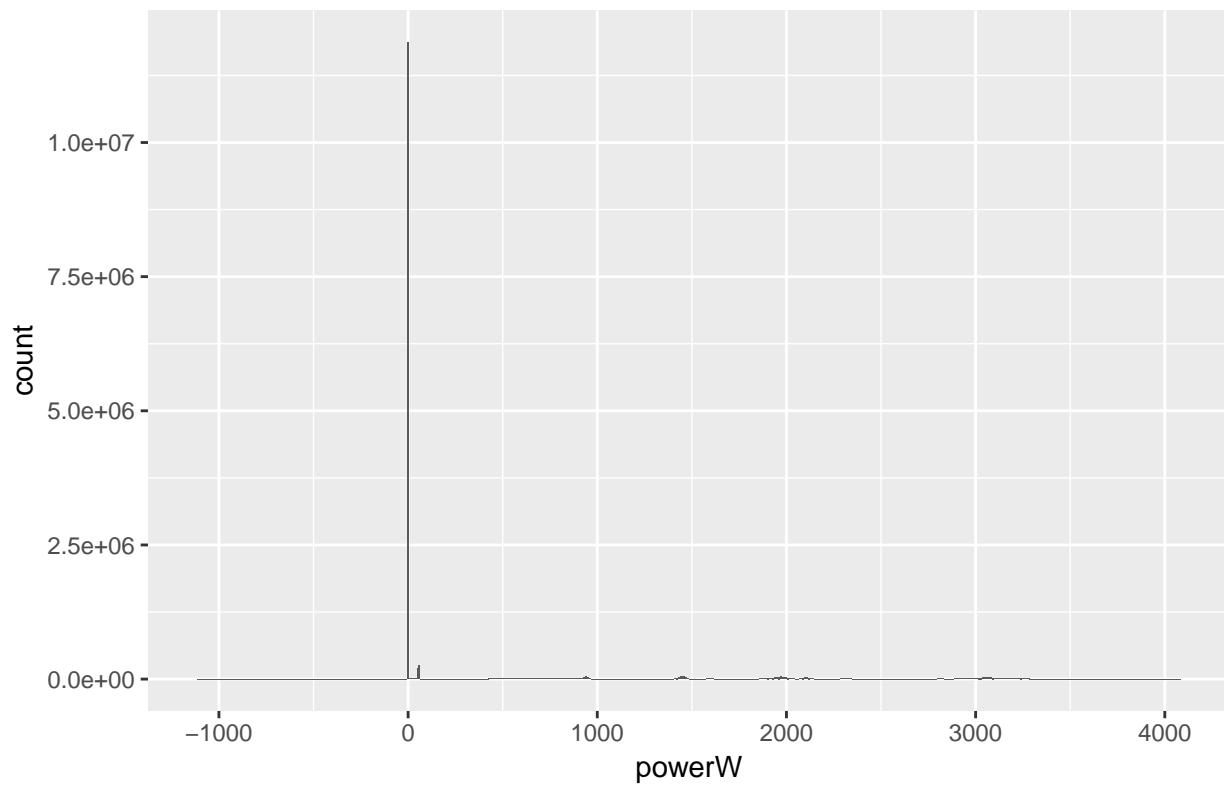
NA

Max. : 4076.0

NA

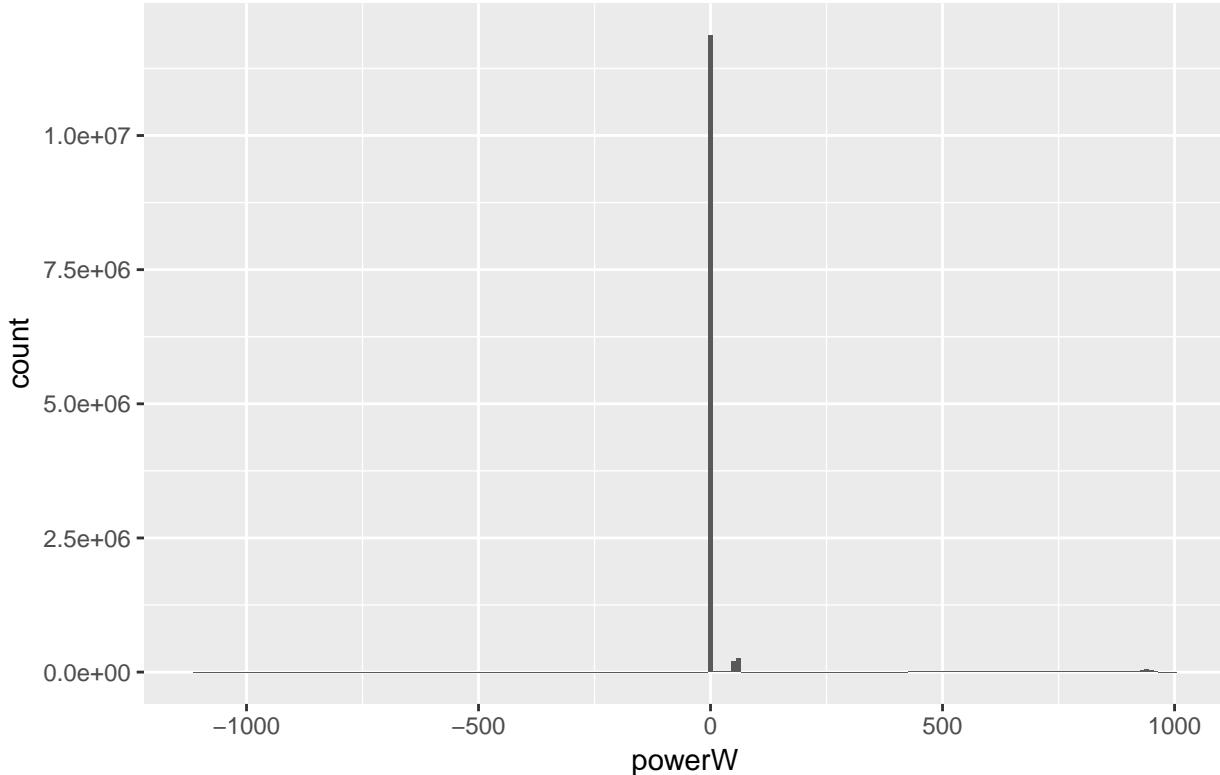
We seem to have some negative powerW values and at least one very large power value.

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



Source: /Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/
Circuits: Hot Water from 2015-04-01 to 2016-03-31

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



Source: /Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/
Circuits: Hot Water from 2015-04-01 to 2016-03-31

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

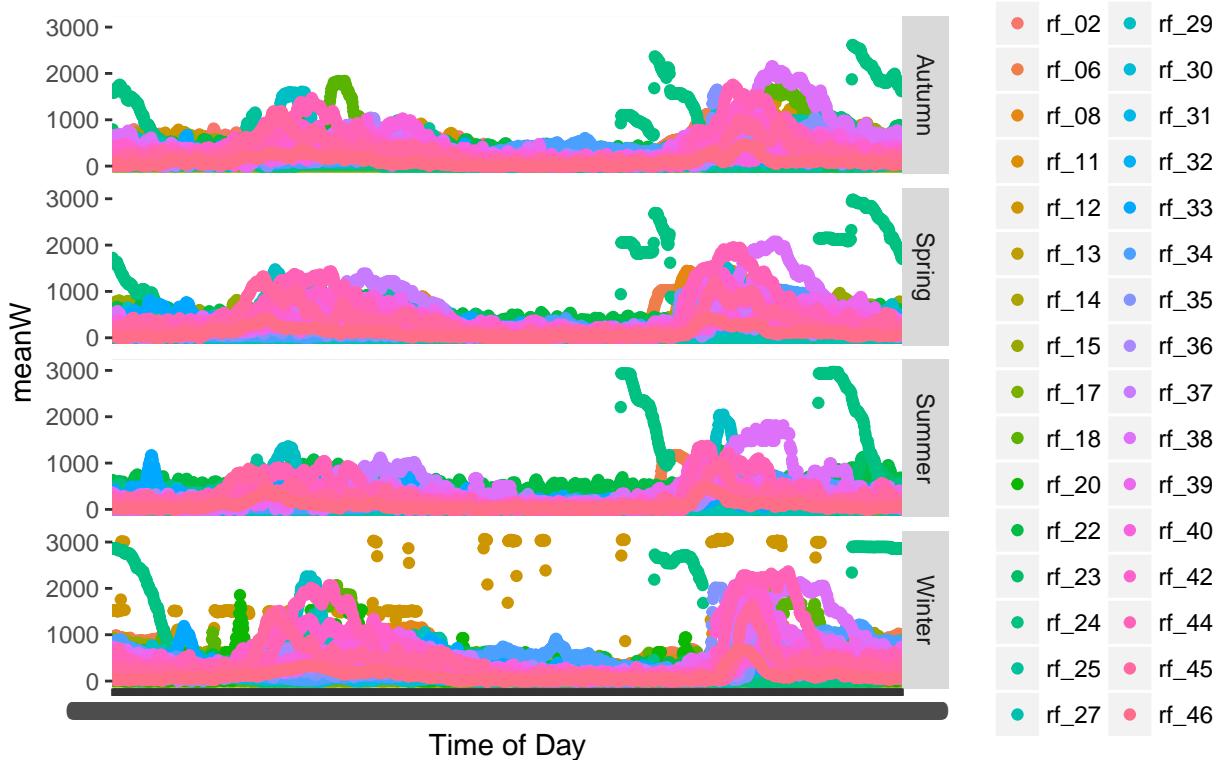
5 Hot Water profiles

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)]
```

5.1 Profile plots: means per household

This section shows a plot of mean profiles for each household by season.



/Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/
Circuits: Hot Water from 2015-04-01 to 2016-03-31
n households = 32

```
## [1] "Saving plot to Hot Water_2015-04-01_2016-03-31_byHouseholdSeasonalProfilePlot.png"
## [1] "Saving profile data used to build this plot to: /Volumes/hum-csafe/Research Projects/GREEN Grid/
## [1] "Gzipped /Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/safe/gridSpy/1min/profiles/H
Summary of household level mean profiles for Hot Water

hhID </th>
obsHourMin
season </th>
meanW </th>
Length:167011
Length:167011
Length:167011
Min. : -8.417
Class :character
Class :character
Class :character
1st Qu.: 70.890
Mode :character
Mode :character
```

Mode :character

Median : 197.851

NA

NA

NA

Mean : 293.928

NA

NA

NA

3rd Qu.: 396.325

NA

NA

NA

Max. :3072.650

As we can see there is considerable variation between households in both the level and timing of heat pump demand.

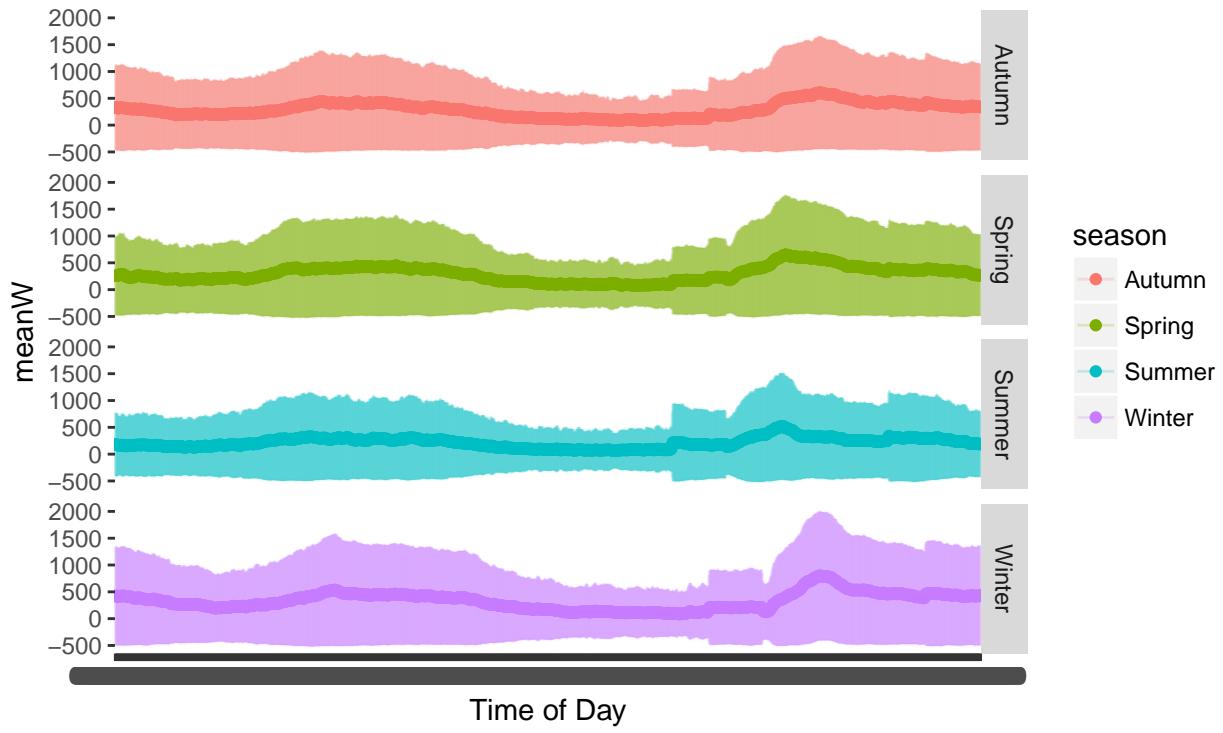
Note that the code saves a high definition version of the plot and the profiles for future re-use.

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

- df <- readr::read_csv("/Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/safe/gridSpy/1min/Water_2015-04-01_2016-03-31_byHouseholdSeasonalProfiles.csv.gz") or
- dt <- data.table::as.data.table(readr::read_csv("/Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/safe/gridSpy/1min/profiles/Hot Water_2015-04-01_2016-03-31_byHouseholdSeasonalProfiles.csv.gz")) if you prefer data.table

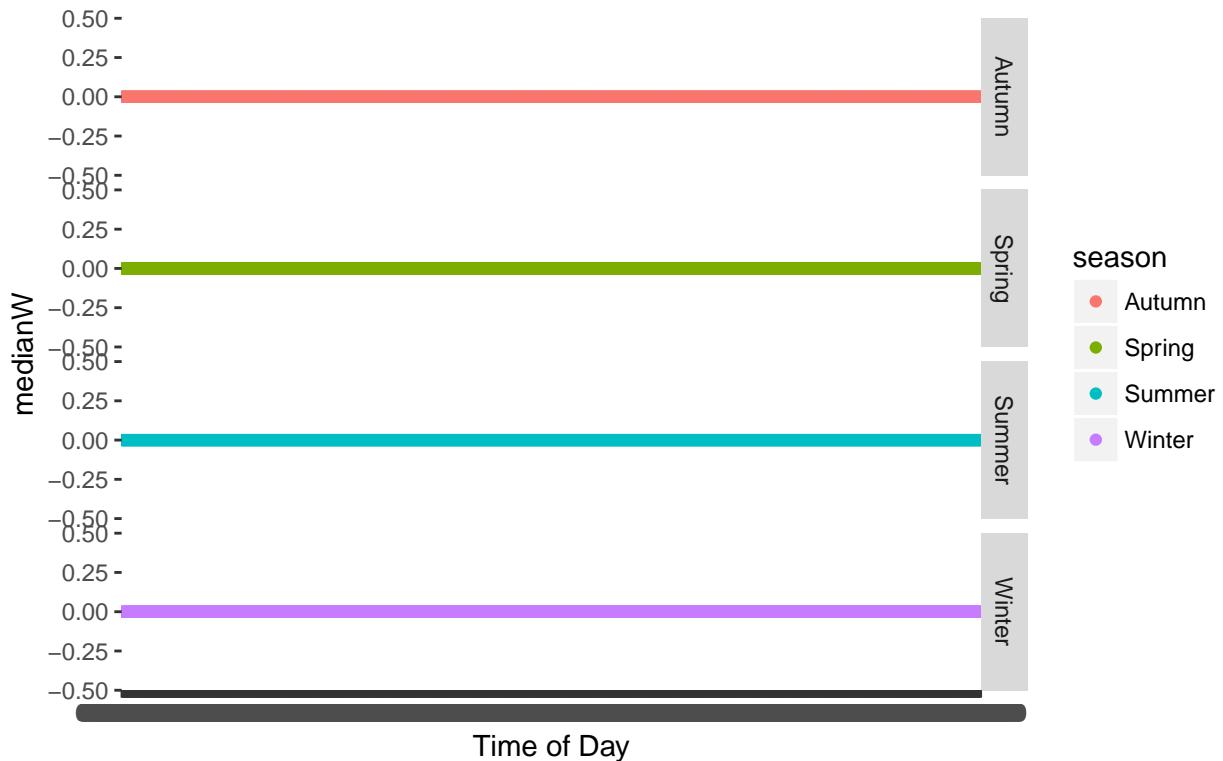
5.2 Profile plots: overall household mean

This section shows a plot of mean and median profiles across all household by season. The mean profile also shows the level of variance by plotting error bars at +/- 1 s.d.



```
e: /Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/
Circuits: Hot Water from 2015-04-01 to 2016-03-31
n households = 32
Error bars = +/- 1 s.d.
```

```
## [1] "Saving plot to Hot Water_2015-04-01_2016-03-31_overallMeanSeasonalProfilePlot.png"
```



e: /Volumes/hum-csafe/Research Projects/GREEN Grid/_RAW DATA/GridSpyData/
Circuits: Hot Water from 2015-04-01 to 2016-03-31
n households = 32

```
## [1] "Saving plot to Hot Water_2015-04-01_2016-03-31_overallMedianSeasonalProfilePlot.png"
## [1] "Saving profile data used to build this plot to: /Volumes/hum-csafe/Research Projects/GREEN Grid/
## [1] "Gzipped /Volumes/hum-csafe/Research Projects/GREEN Grid/Clean_data/safe/gridSpy/1min/profiles/H
Summary of overall profiles for Hot Water
obsHourMin
season </th>
meanW </th>
medianW </th>
nObs </th>
sdW </th>
Length:5760
Length:5760
Min. : 58.62
Min. :0
Min. :2230
Min. : 320.4
Class :character
Class :character
```

1st Qu.:168.06

1st Qu.:0

1st Qu.:2432

1st Qu.: 578.2

Mode :character

Mode :character

Median :264.90

Median :0

Median :2570

Median : 731.1

NA

NA

Mean :281.18

Mean :0

Mean :2517

Mean : 723.0

NA

NA

3rd Qu.:390.05

3rd Qu.:0

3rd Qu.:2661

3rd Qu.: 879.5

NA

NA

Max. :805.88

Max. :0

Max. :2671

Max. :1208.5

The difference between the mean and median plots is instructive - it suggests that the mean plots for summer are skewed by a few higher heat pump-using households.

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

As before, the code saves a high definition version of the plot and the profiles for future re-use.

6 Runtime

Analysis completed in 645.07 seconds (10.75 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: /System/Library/Frameworks/Accelerate.framework/Versions/A/Frameworks/vecLib.framework/Versions/A/Libraries/libBLAS.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] rmarkdown_1.9     kableExtra_0.9.0  knitr_1.20       readr_1.1.1
## [5] ggplot2_2.2.1    dplyr_0.7.5     data.table_1.11.2 nzGREENGrid_0.1.0
##
## loaded via a namespace (and not attached):
##  [1] progress_1.1.2      tidyselect_0.2.4
##  [4] reshape2_1.4.3      purrrr_0.2.4
##  [7] lattice_0.20-35    colorspace_1.3-2
## [10] viridisLite_0.3.0   yaml_2.1.19
## [13] survival_2.42-3    rlang_0.2.0
## [16] foreign_0.8-70     glue_1.2.0
## [19] readxl_1.1.0       bindrcpp_0.2.2
## [22] plyr_1.8.4          stringr_1.3.1
## [25] gtable_0.2.0        cellranger_1.1.0
## [28] htmlwidgets_1.2     evaluate_0.10.1
## [31] latticeExtra_0.6-28 htmlTable_1.11.2
## [34] Rcpp_0.12.17        acepack_1.4.1
## [37] backports_1.1.2    scales_0.5.0
## [40] gridExtra_2.3       hms_0.4.2
## [43] stringi_1.2.2      grid_3.5.0
## [46] tools_3.5.0         magrittr_1.5
## [49] tibble_1.4.2        cluster_2.0.7-1
## [52] pkgconfig_2.0.1     Matrix_1.2-14
## [55] prettyunits_1.0.2   lubridate_1.7.4
```

```
## [58] httr_1.3.1           rstudioapi_0.7      rpart_4.1-13
## [61] R6_2.2.2              nnet_7.3-12         compiler_3.5.0
```

References

- Csárdi, Gábor, and Rich FitzJohn. 2016. *Progress: Terminal Progress Bars*. <https://CRAN.R-project.org/package=progress>.
- Dowle, M, A Srinivasan, T Short, S Lianoglou with contributions from R Saporta, and E Antoneyan. 2015. *Data.table: Extension of Data.frame*. <https://CRAN.R-project.org/package=data.table>.
- Grolemund, Garrett, and Hadley Wickham. 2011. “Dates and Times Made Easy with lubridate.” *Journal of Statistical Software* 40 (3): 1–25. <http://www.jstatsoft.org/v40/i03/>.
- R Core Team. 2016. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. <https://www.R-project.org/>.
- Wickham, Hadley. 2009. *Ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. <http://ggplot2.org>.
- Wickham, Hadley, and Romain Francois. 2016. *Dplyr: A Grammar of Data Manipulation*. <https://CRAN.R-project.org/package=dplyr>.
- Wickham, Hadley, Jim Hester, and Romain Francois. 2016. *Readr: Read Tabular Data*. <https://CRAN.R-project.org/package=readr>.
- Xie, Yihui. 2016. *Knitr: A General-Purpose Package for Dynamic Report Generation in R*. <https://CRAN.R-project.org/package=knitr>.
- Zhu, Hao. 2018. *KableExtra: Construct Complex Table with 'Kable' and Pipe Syntax*. <https://CRAN.R-project.org/package=kableExtra>.