

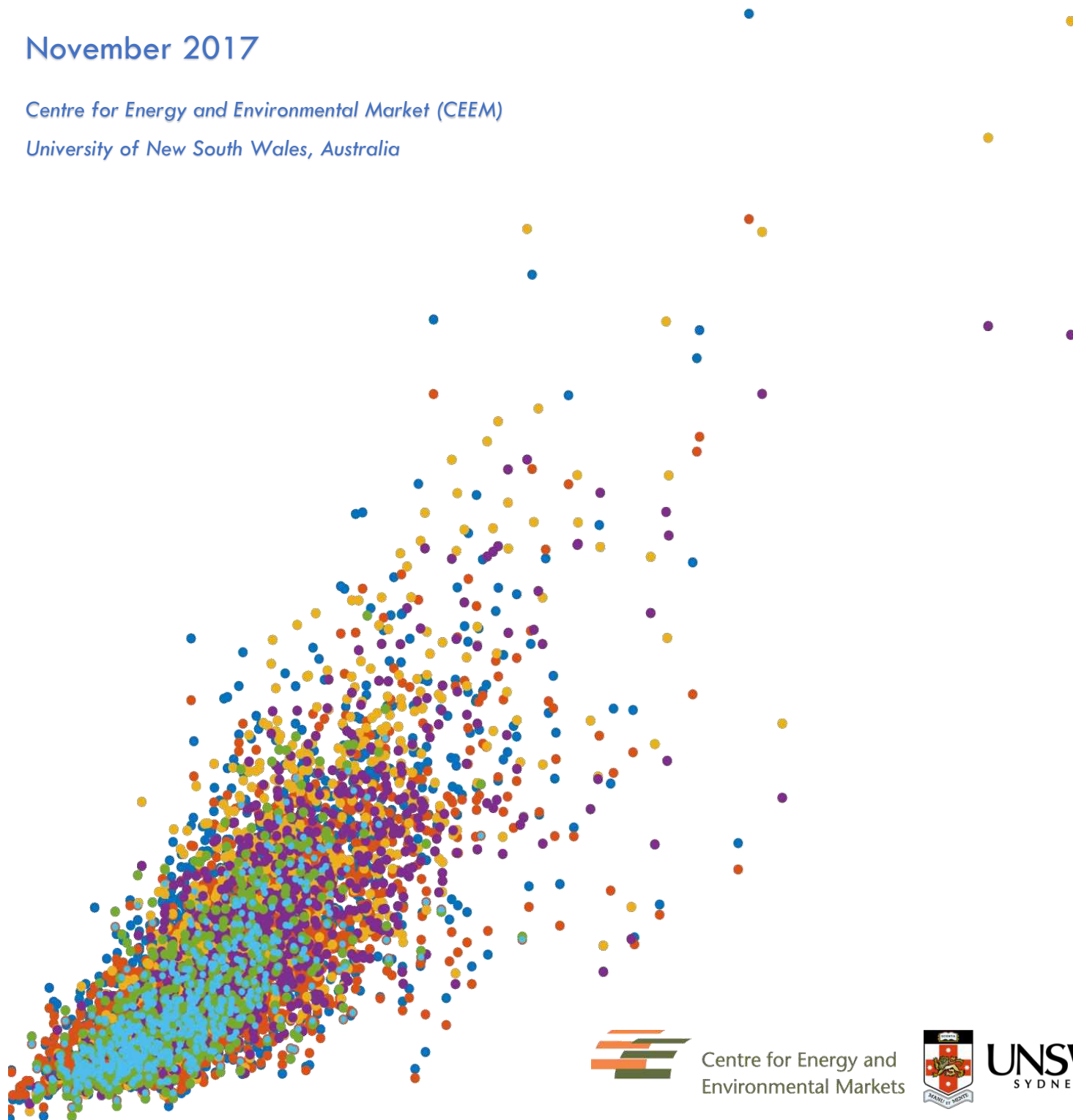
Tariff Design and Assessment Tool

User Guide

November 2017

Centre for Energy and Environmental Market (CEEM)

University of New South Wales, Australia



Centre for Energy and
Environmental Markets



UNSW
SYDNEY

EXECUTIVE SUMMARY

This document introduces the Tariff Design and Analysis (TDA) tool, developed by Centre for Energy and Environmental Markets (CEEM), at the University of New South Wales with support from the Australian PV Institute (APVI). The TDA project was supported by Energy Consumers Australia. The open source TDA tool aims to assist stakeholders, including consumer advocates and researchers, to investigate how different tariff structures impact on the expected bills of different types of residential consumers, while also estimating how well the tariffs align these customer bills with their impact on longer-term network costs. The tool builds on research and analysis currently being undertaken by CEEM and aims to support submissions to network pricing and tariff structure proposals.

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1 INTRODUCTION

Recent regulatory reform efforts in the Australian National Electricity Market (NEM) have included a number of rule changes aiming to contain electricity price rises driven by network investment by distributed network service providers (DNSPs). One focus area has been the economic inefficiencies of current network tariff arrangements, particularly for residential and small business consumers. These tariffs are typically shaped by limited metering capabilities and equity considerations and have generally involved a major volumetric consumption component. This tariff structure doesn't clearly reflect the role of consumer contributions to network peak demand and hence in overall DNSP expenditure.

As part of the regulatory reform efforts, a distribution network pricing rule change has been implemented, effective for the current regulatory periods. The new rule requires that network tariffs should be more 'cost reflective', motivated by the idea that efficient prices will change consumer behaviour, which in turn will improve load factors, reduce network congestion and lower average costs for consumers. DNSPs are given considerable discretion over the specific implementation of the rule, which provides broad pricing principles only. The rule states that network tariffs should be based on the long-run marginal costs (LRMC) of providing the service, and that the revenue to the network should reflect the efficient costs of providing the services to each consumer class. However, DNSPs are able to determine how to calculate their LRMC, how this is reflected in the tariff design and how residual costs should be collected. As DNSP tariff structures must balance efficient pricing considerations with fairness and the ability of consumers to understand and respond to the tariffs, there is considerable scope for a variety of tariff designs to emerge. In recent submissions, DNSPs have put forward a number of tariffs of varying structure and complexity. It is challenging to assess how each tariff will impact on different consumer groups, and how well they can provide efficient price signals and address existing cross-subsidy issues.

Preliminary analysis indicates that many of the tariff proposals now being put forward by DNSPs under the new rule might not provide appropriate price signals to consumers regarding their investment and behaviour, and may disadvantage some consumer groups. For instance, in the majority of proposed network tariffs, the fixed daily charge component is being increased, resulting in high unavoidable costs, particularly for low energy consuming (often vulnerable) customers. Special tariffs are also being proposed for certain classes of customers (e.g. Solar PV System owners), while in some areas, customers are being transferred to new tariffs under opt-out arrangements, leaving them vulnerable to potentially disadvantageous new tariffs. In addition, there are concerns that even what are claimed to be cost-reflective tariffs might not effectively target peak network loads (either local or region wide), and therefore may not provide an appropriate price signal regarding the associated network costs of consuming energy at different times and locations. Poorly designed tariffs that do not appropriately align benefits and costs may lead to inefficient investment in both networks and demand side options, and hence not be in the best interests of consumers. Specifically, they might act to reduce the consumer incentives to deploy solar PV, energy efficiency, and other load management systems that can reduce network expenditure while also delivering wider economic and environmental benefits.

Advocacy groups have expressed concern that many of the new tariffs appear to be better designed to protect the revenue of DNSPs in a context of falling demand and uptake of demand-side technologies,

rather than to encourage efficient use of the network and future investment. This is of particular concern as these distributed energy technologies have the potential to provide competition for network services in the interests of consumers, enabling new participants, opportunities for innovation, and reduced emissions.

It is possible for groups or individuals to make submissions to the regulator regarding tariff design. However, given significant information asymmetry between network service providers and other stakeholders, including both consumers and regulators; advocacy organisations lack the resources to put forward robust, evidence-based analysis of the impact of proposed tariffs on different electricity consumer groups and the incentives these tariffs might provide to customers.

The tariff design and assessment tool (TDA) is developed by CEEM, UNSW, to assist stakeholders, including consumer advocates and researchers, to investigate how different tariff structures impact on the expected bills of different types of residential consumers, while also estimating how well the tariffs align these customer bills with their impact on longer-term network costs. The tool builds on research and analysis currently being done by CEEM and APVI, and aims to support submissions to network pricing and tariff structure proposals.

This version of the TDA uses load and survey data from over 4000 homes, collected under the Smart Grid Smart City program, to:

- Under existing and proposed tariffs, calculate and compare for different user groups, the distribution of:
 - electricity bills,
 - annual demand
 - seasonal variations
- Select consumer groups on the basis of annual demand, peak load, income level, dwelling type, household size, air conditioning type or if they use gas or have a solar PV system.
- Assess price signals from different tariffs: i.e. how well bills are correlated with variables such as annual demand and peak load under different tariff designs.
- Compare outcomes for different consumer groups, and under different tariffs.

This document introduces different parts of the tool and provides some example analyses which can be undertaken.

2 TERM OF USE

TDA is open source software for assessing existing and proposed new tariffs. It offers a range of analyses as described in this document to assist energy market stakeholders and the wider community to analyse the impact of different tariffs on different user groups. TDA is free software and you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation version 3. For more information about GPL 3 please refer to: <https://www.gnu.org/licenses/gpl-3.0.en.html>.

All load and tariff data currently in the tool are publicly available and free to use. The terms of use for any further load and/or tariff data will be disclosed if added later to the tool. The Centre for Energy and Environmental Markets (CEEM) does not guarantee the accuracy of the data nor the outputs generated by the tool and therefore accept no responsibility for any liability arising from its use.

This is the first public stable version of the TDA and we would appreciate feedback on any issues as well as any suggestions for new features to be added to the tool. Please use the feedback button on the tool or send an email directly to n.haghdadi@unsw.edu.au should you have any questions/suggestions.

2.1 ACKNOWLEDGMENT

Development of the TDA was founded by Energy Consumers Australia, project 'Tariff Assessment Tool' No 814. We acknowledge AusGrid for making available the load data.

3 INSTALLATION

TDA tool is developed in MATLAB 2016b and packaged in an executable function file so that it can be run from any Windows/Mac platform (even from a USB flash memory). You can find the software one of the following ways:

- 1- GitHub platform where you can also download the Matlab source code.
<https://github.com/UNSW-CEEM>
- 2- CEEM website along with description of the project and related research undergoing at CEEM
<http://ceem.unsw.edu.au/cost-reflective-tariff-design>
- 3- ResearchGate project page where you can follow the project to track ongoing updates.
<https://www.researchgate.net/project/Tariff-Design-and-Analysis-TDA-Tool>

Please download the TDA.zip and unzip it in a non-shared folder on your own computer and keep the whole contents of the folder as deleting the original files of the software may result in its failure. If the Matlab 2016b or later version is already installed, the TDA software will most likely run without any prerequisite. Otherwise you will need to install the Matlab Compiler Runtime (MCR) version 9.1 to run the TDA application. MCR is a standalone set of shared libraries that enables the execution of compiled MATLAB applications or components on computers that do not have MATLAB installed. The latest version of MCR can be downloaded and installed for free from link below (size ~900mb):

<http://au.mathworks.com/products/compiler/mcr/>

If you have administrator rights on your computer:

- Download, unzip and run the MCR_R2016b_win64_installer.exe (for windows) or MCR_R2016b_maci64_installer.dmg.zip (for Mac) and follow the interactive install (you may need to use comment “./install” and probably your computer username and password for macOS).

To install the MATLAB Runtime as a user without administrator rights on Windows follow the steps below:

- 1- Use the MATLAB Runtime installer to install it on a Windows machine where you have administrator rights.
- 2- Copy the folder where the MATLAB Runtime was installed to the machine without administrator rights. You can compress the folder into a zip file and distribute to multiple users.
- 3- On the machine without administrator rights, add the mcr_root\runtime\arch directory onto the user's path environment variable (You don't need administrator rights for adding directories to a user's path environment variable).

More information can be found here: https://au.mathworks.com/help/compiler_sdk/dotnet/install-the-matlab-runtime.html. The MCR needs to be installed only once. For any additional updates of the software, it is only necessary to run the software.

4 DATABASE

There are different sources of data available in the tool. It includes load data and tariff data. The original load data (available in TDA v1) includes Ausgrid 300 homes (three years, with and without solar contribution), and Smart Grid Smart City load profiles. The tariff data was obtained from multiple documents available in network businesses tariff structure explanations, and is updated each year.

4.1 SMART GRID SMART CITY

The Smart Grid Smart City (SGSC) project aimed to collect data from more than 8000 residential homes. Some of the homes also have demographic survey data. In this tool we have used 4050 homes which had data available for 2013, and their survey data. The half hourly power consumption of residential users as well as their demographic information are available within the tool. For more information regarding this dataset refer to: <https://data.gov.au/dataset/smart-grid-smart-city-electric-vehicle-trial-data>

4.2 AUSGRID 300 SOLAR HOMES

The half hourly data of Ausgrid 300 solar homes spans from July 2010 to June 2013 and can be selected for one year at a time. As the gross solar generation is also available for these homes, the new net load (subtracting PV generation from load) is also made available in the tool. Information about the 300 solar homes is available at: <http://www.ausgrid.com.au/Common/About-us/Corporate-information/Data-to-share/Solar-home-electricity-data.aspx#.WcSaPcgjGUK>

4.3 ELECTRICITY NETWORK TARIFFS

A large number of existing and proposed network tariffs from different states are available in the tool. For information regarding the tariff parameters refer to Menu: **Tariff > Tariff Info**. You can also click on the “i” button beside the list of tariffs (when selecting a tariff) to open a folder with information about the tariff. The tool also currently has six retail tariffs. The list of tariffs currently in the tool is shown below. You can however modify any of the tariffs in the tool or create a new tariff as described later in this document.

No.	State	Provider	Type	Name	Date
1	ACT	ActewAGL	Demand Charge	ActewAGL Demand Charge 2017/18	2017/18
2	ACT	ActewAGL	Flat Rate	ActewAGL Flat Rate 2017/18	2017/18
3	ACT	ActewAGL	TOU	ActewAGL TOU 2017/18	2017/18
4	NSW	AGL	Flat Rate	AGL Flat Rate	2017/18
5	NSW	AGL	TOU	AGL TOU	2017/18
6	NSW	AusGrid	Block Quarterly	AusGrid Block 2015/16	2015/16
7	NSW	AusGrid	Flat Rate	AusGrid Flat Rate 2017/18	2017/18
8	NSW	AusGrid	TOU	AusGrid TOU 2015/16	2015/16
9	NSW	AusGrid	TOU	AusGrid TOU 2017/18	2017/18
10	NSW	Endeavour Energy	Block Quarterly	Endeavour Block Q 2015/16	2015/16
11	NSW	Endeavour Energy	Flat Rate	Endeavour Flat Rate 2017/18	2017/18

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12	NSW	Endeavour Energy	TOU	Endeavour TOU 2015/16	2015/16
13	NSW	Endeavour Energy	TOU	Endeavour TOU 2017/18	2017/18
14	NSW	Energy Australia	Flat Rate	Energy Australia Flat Rate	2017/18
15	NSW	Energy Australia	TOU	Energy Australia TOU	2017/18
16	NSW	Essential Energy	Block Quarterly	Essential Energy Block 2015/16	2015/16
17	NSW	Essential Energy	Flat Rate	Essential Energy Flat Rate 2017/18	2017/18
18	NSW	Essential Energy	TOU	Essential Energy TOU 2015/16	2015/16
19	NSW	Essential Energy	TOU	Essential Energy TOU 2017/18	2017/18
20	NSW	Origin	Flat Rate	Origin Flat Rate	2017/18
21	NSW	Origin	TOU	Origin TOU	2017/18
22	QLD	Energex	Demand Charge	Energex Demand Charge 2017/18	2017/18
23	QLD	Energex	Demand Charge	Energex Demand 2015/16	2015/16
24	QLD	Energex	Flat Rate	Energex Flat Rate 2017/18	2017/18
25	QLD	Energex	Flat Rate	Energex Flat Rate 2015/16	2015/16
26	QLD	Energex	TOU	Energex TOU 2017/18	2017/18
27	QLD	Energex	TOU	Energex TOU 2015/16	2015/16
28	QLD	Ergon Energy	Block Annual	Ergon Block (East) 2017/18	2017/18
29	QLD	Ergon Energy	Block Annual	Ergon Block (West) 2017/18	2017/18
30	QLD	Ergon Energy	Block Annual	Ergon Block 2015/16	2015/16
31	QLD	Ergon Energy	Demand Charge	Ergon Residential Demand 2015/16	2015/16
32	QLD	Ergon Energy	TOU Seasonal	Ergon TOU Seasonal 2015/16	2015/16
33	QLD	Ergon Energy	TOU Seasonal	Ergon TOU seasonal (East) 2017/18	2017/18
34	QLD	Ergon Energy	TOU Seasonal	Ergon TOU seasonal (West) 2017/18	2017/18
35	QLD	Ergon Energy	Demand Charge	Ergon Demand Charge (East Region 1) 2017/18	2017/18
36	QLD	Ergon Energy	Demand Charge	Ergon Demand Charge (East Region 2) 2017/18	2017/18
37	QLD	Ergon Energy	Demand Charge	Ergon Demand Charge (East Region 3) 2017/18	2017/18
38	QLD	Ergon Energy	Demand Charge	Ergon Demand Charge (West Region 1) 2017/18	2017/18
39	QLD	Ergon Energy	Demand Charge	Ergon Demand Charge (West Region 2) 2017/18	2017/18
40	QLD	Ergon Energy	Demand Charge	Ergon Demand Charge (West Region 3) 2017/18	2017/18
41	SA	SAPN	Block Quarterly	SAPN Block Quarterly 2017/18	2017/18
42	SA	SAPN	Demand Charge	SAPN Demand charge 2017/18	2017/18
43	TAS	TasNetworks	Flat Rate	TasNetworks Flat rate 2017/18	2017/18
44	TAS	TasNetworks	TOU	TasNetworks TOU 2017/18	2017/18
45	TAS	TasNetworks	Demand Charge	TasNetworks Demand Charge 2017/18	2017/18
46	VIC	AusNet	Block Quarterly	AusNet Block Quarterly 2017/18	2017/18
47	VIC	AusNet	TOU Seasonal	AusNet TOU Seasonal 2015/16	2015/16
48	VIC	AusNet	TOU Seasonal	AusNet TOU seasonal 2017/18	2017/18
49	VIC	CitiPower	Demand Charge	CitiPower Demand charge 2017/18	2017/18
50	VIC	CitiPower	Flat Rate	CitiPower Flat Rate 2017/18	2017/18
51	VIC	CitiPower	TOU	CitiPower TOU 2017/18	2017/18
52	VIC	Jemena	Demand Charge	Jemena Demand Charge 2017/18	2017/18

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53	VIC	Jemena	Flat Rate	Jemena Flat Rate 2017/18	2017/18
54	VIC	Jemena	TOU	Jemena TOU 2017/18	2017/18
55	VIC	Powercor	Demand Charge	Powercor Demand Charge 2017/18	2017/18
56	VIC	Powercor	Flat Rate	Powercor Flat Rate 2017/18	2017/18
57	VIC	Powercor	TOU	Powercor TOU 2017/18	2017/18
58	VIC	United Energy	Demand Charge	United Energy Demand Charge 2017/18	2017/18
59	VIC	United Energy	Flat Rate Seasonal	United Energy Flat rate seasonal 2017/18	2017/18
60	VIC	United Energy	TOU Seasonal	United Energy TOU Seasonal 2017/18	2017/18

5 GETTING STARTED!

The tariff analysis tool is designed to assist stakeholders to investigate how different tariff structures impact on the expected bills of different types of residential consumers. The tool offers a range of different analysis and result visualisations as described in this section. In summary the tool allows users to:

- Create projects and add analysis to different projects for later referral
- Choose from the existing load profiles (more than 5000 annual household load profiles)
- Filter the load profiles based on the available demographic information
- Import new load profile and demographic information
- Visualise the individual and aggregate load profiles using multiple methods including seasonal pattern, peak analysis, annual energy distribution, daily interquartile range, etc
- Apply the network tariffs available in the tool (60+ tariffs for different Australian States) to calculate the annual bill based on any subset of the load profiles
- Apply the retail tariffs available in the tool
- Modify the parameters of the tariffs to investigate the impacts on annual bills
- Investigate different components of the network bill (DUOS, TUOS, and NUOS) to calculate the revenue for different sectors (distribution, transmission, etc). This can also be done for the retail component where retail tariffs are available
- Adjusting the network peak time to see the impact on the tariffs based on the coincident peak demand
- Create different types of new tariffs including, flat rate, time of use, block usage, demand charge, etc
- Compare the results of multiple analyses in different visualisation platforms including single variable comparison, dual variable comparison, and individual cases
- Export the figures, and copy them into clipboard to incorporate in any report
- Export the results to excel file to do further analysis on the results outside the tool

The rest of this section introduces different parts of the tool and gives instructions on how to work with the tool.

5.1 RUNNING THE TOOL

The TDA tool does not need to be installed in your computer. You only need to run the tool and do the analysis. In order to import and export the data properly (such as selecting load data, exporting result, etc), you need to keep all contents of the TDA folder. If you save a project, or create a new load/tariff, it will be also saved in this folder. Windows users need to run the TDA.exe and work with the tool. But if you are using Mac, each time you open the software, it will ask you to locate the TDA folder in your computer. Once asked, you should find the TDA folder and open it and then work with the tool.

5.2 MENU BAR

5.2.1 PROJECT

While you are working with the tariff tool, you may want to save your current session for later referral. You can “**save**” the project, and later “**open**” the project with your saved analysis loaded in the tool. You can also delete any of the previously saved projects. You can also restart the tool to delete all analysis currently displaying on the tool and restart your analysis. If you do not save the project, the project name will be shown as “**undefined**” and any analysis will be lost if you close the software. Restarting the tool does not delete any project or load data. But any analyses after the last save will be lost. You cannot restore any deleted projects!

5.2.2 LOAD

Using this menu, you can import new load data, delete any of the existing load data, or restore to the original load data list. Section 5.4 explains how to import new load data. You can also define the network load as described in 5.5. We will provide new load data as it becomes available. In that case you can just download the load data (.mat file) and put it in the “Data” directory in the TDA folder. You can check for new updates by clicking on Menu: **Help > Check for Update**.

You can also set the maximum amount of missing data allowed as well as the down-sample rate (where a smaller percentage of the sample can be randomly selected, as described in section 5.3). By restoring the load data, any new load data you created will be lost.

5.2.3 TARIFF

You can create new tariffs, obtain the excel file with all the parameters of all the tariffs used in this tool and also reset the tariff lists to the original list of tariffs. We will provide new tariff data as it becomes available. As new tariffs are generally introduced every year, new versions will be made available and you can download them and copy them in the “Data” directory in the TDA folder as advised in the update page.

NOTE. By resetting the tariffs, any new tariffs you have created or modified will be lost and this cannot be undone!

5.2.4 EXPORT

You can **export** the figure currently showing in the tool (ctrl+E) or **copy** it to the clipboard (ctrl+C) so you can paste it in another document, email, etc. You can also export the data directly from the figure (ctrl+D) or export the whole case's results as described in section 5.8.

5.2.5 PREFERENCES

Using this menu, you can specify some options such as 'ask to name new cases', 'confirm before exiting the tool', and 'confirm before deleting some items'.

5.2.6 HELP

The option **"About"** provides information about the software. You can click on any of three options (CEEM webpage, Researchgate project page, or GitHub page) for more information, updates, and comments about the software. You can also open the instruction file via the **"Users' Guide"** option and give **feedback** on the software, and **subscribe** to receive the latest news of the software.

Please note that due to some issues with internet security programs, the options to send **feedback** or **subscribe** may not work properly in some cases. If you experience this issue and receive any error message, or if you successfully submit your request but don't receive an email confirmation, please send an email to n.haghdadi@unsw.edu.au with your feedback or subscription request.

5.3 SELECTING LOAD

You can select one of the existing load datasets in the tool by choosing from the dropdown list as shown in Figure 1. Before importing, you can specify the maximum allowed missing data from the menu: **Load > Maximum Allowed Missing Data (%)**. The default value is 5%, which means only homes with less than 5% missing intervals will be loaded. You can change this each time you select a new load. You can also down-sample the load data to speed up the calculation by selecting from menu: **Load > Down-sample Users (Random Selection)**. The default option is 100% (full data) which loads the whole dataset. 50% means randomly selecting 50% of the homes, and so forth. Please note, each time you press **"Set"**, a new subset will be randomly selected, so multiple selection of one load dataset with the same down-sample value will result in different users being selected.

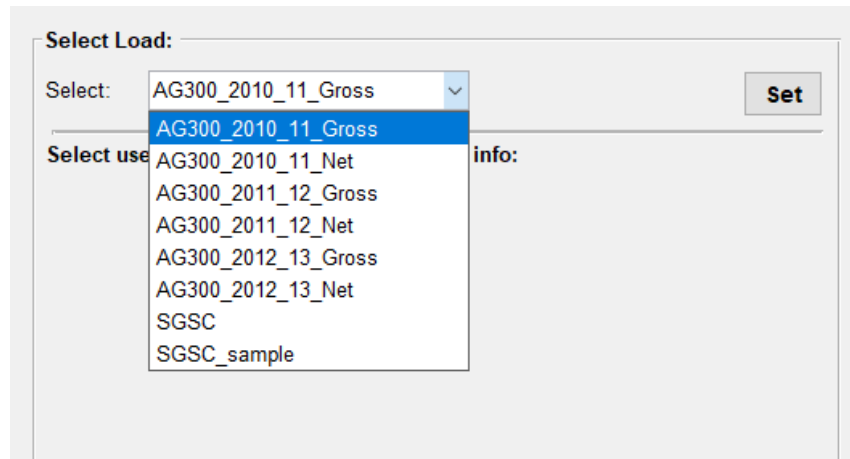


Figure 1 Selecting load data

You can see the number of homes loaded into the software in the below part of the “Select Load” panel. Each dataset can be selected, and the analysis can be done based on the whole or part of that dataset which is grouped by demographic information. If the demographic information is available for any load data, it will be shown below the dropdown list (see Figure 1). You can then filter the load based on any part of the demographic information. The number of homes obtained with any particular filter is shown. There is also a set of diagrams which show the individual or aggregate behaviour of the selected load profile. So, you can see the load pattern while selecting the filters. In some of the figure options, you can see and compare the filtered load (by missing data%, down-sampling, and demographic filters) with the whole dataset. This is particularly useful if you want to check if important information (e.g. load profile on a peak day) is similar in the down-sampled load and the whole dataset. If you see a significant difference you may load the demand data again to randomise the users and load a new group. You can change the diagram type from the dropdown list. You can choose the following options (Figure 2):

- Annual Average Profile
- Daily Profiles
- Daily Profile Interquartile Range (25%, 50%, and 75% of load)
- Daily kWh Histogram
- Average Load Duration Curve (sorted aggregate load profile in kW in descending order)
- Average Peak Day Profile (daily pattern in highest aggregate peak day)
- Monthly Average kWh
- Seasonal Daily Pattern (average daily load pattern in summer and winter months)

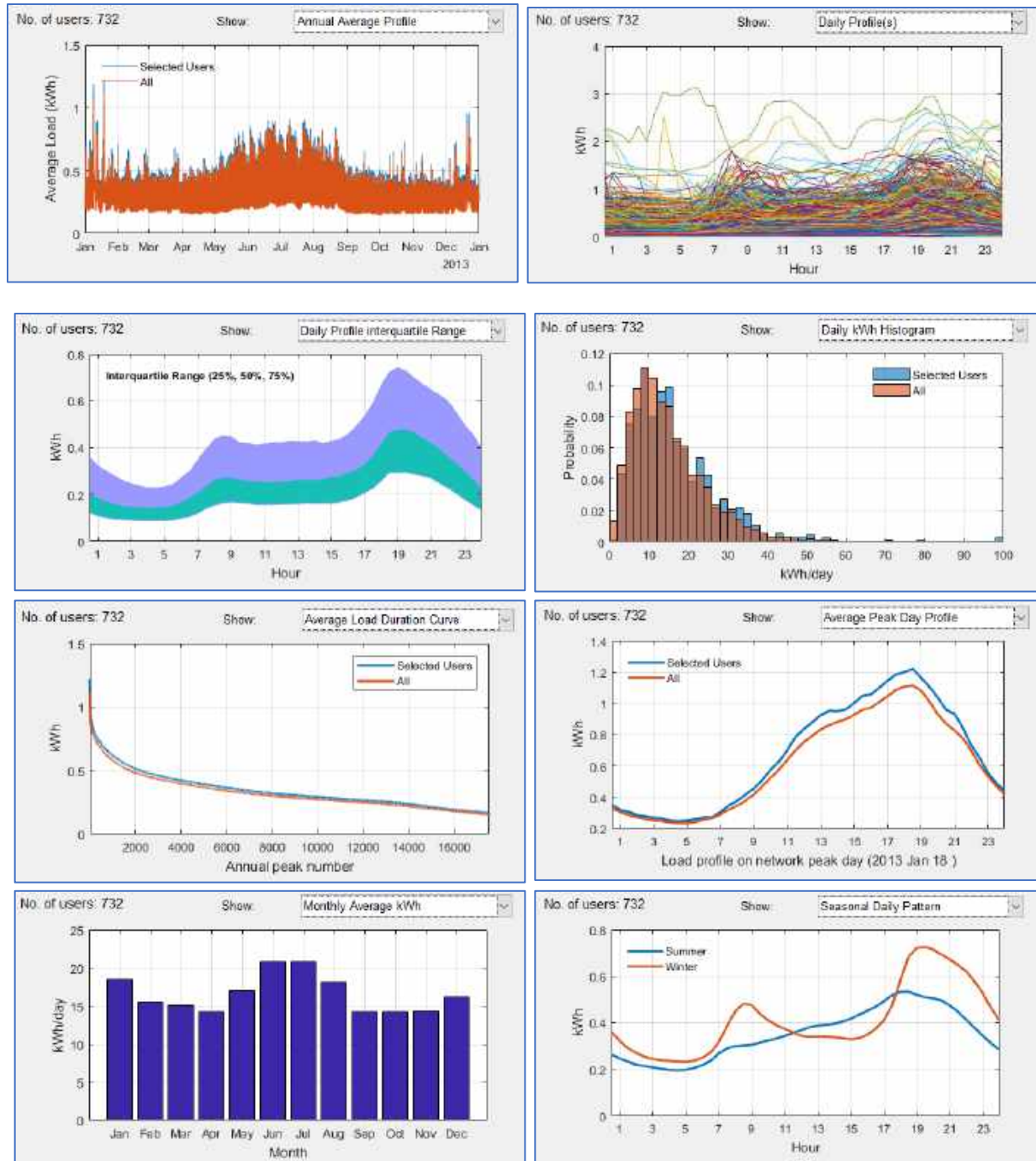


Figure 2 Load graph options

5.4 CREATING NEW LOAD DATA

You can also import a new load data by clicking on the “**Import load data**” on the main menu option “**Load**”. Press the “**Create new**” button and upload the excel file containing the load profile from your computer. The excel file should contain two sheets with names “**Load**”, and “**Info**” containing the half

hourly data and demographic information. If there is no “**Info**” sheet, the software will not import the demographic information, and if there is no “**Load**” sheet, the import will not be processed and an error message will be shown.

5.4.1 “LOAD” SHEET FORMAT

The first column of the load data sheet should contain the timestamp of the load profile and it should be exactly one-year of data. The data should be half hourly with the timestamp showing the end of each time period. Therefore, for example if the data is for year July 2012 to June 2013, it should start with 1 July 2012 00:30:00 and end with 30 June 2013 00:00:00.

Please note the tool can handle only one year of data. However, you can analyse more years of load data individually by uploading them as separate years.

The first row of the “**Load**” sheet should contain the home numbers and the following rows will contain the actual load data in **kWh**. Any empty cell or non-numeric data will be considered as a missing value. Any negative values will be considered but please note the tariff tool does not calculate any premium for exporting power, so the negative values will be ignored in the tariff calculation, but they will have an impact on the network load if you choose the network load to be calculated based on the aggregation of the household load data. The network load is described in more detail in section 5.5.

Please note the tool only works with a half hourly load profile. You should convert your load data to half hourly (by averaging higher resolution data such as 15 min data or repeating lower resolution data such as hourly).

5.4.2 “INFO” SHEET FORMAT

Any information about the household can be put in this sheet, and once imported it will show up in the demographic information section. This can be the type of household, dwelling type, income group, etc. A maximum of 10 types of demographic info can be put in the excel file. The tool will group the information and let the tool operator filter the homes based on any of the demographic info when selecting the load data. If you want to include more than 10 types of demographic info, you can upload the same load profile but with different demographic info. The first row of this sheet should contain the type of info (for example: “Dwelling type”). The first row contains the Home numbers (to match with the home number in the “Load” sheet).

5.4.3 SAMPLE FILE

A sample file is also provided that you can use as a reference for the required format. You can also paste your load and info data into this file and save as a new file on your computer and load that when creating a new load dataset. You can open this file by pressing “**Open sample file**” option.

Please note, failing to follow the required format will result in an unsuccessful load import. If you receive an error, make sure you follow the instructions carefully. The home IDs should be in “number” format (i.e. do not use home 1, etc.) and these numbers will be used to match the load and demographic information

so please make sure they are identical. If you have or know of any load data which can be made available, please let us know so we can put the load data into the tool. Another option is to send us your excel files containing the load and demographic data, and we will create the “.Mat” file for you - so you just need to put the mat file in the TDA folder, Data directory instead of importing the load yourself. We won't of course make the data available without your permission.

5.5 NETWORK LOAD

When you create a new load file, an assumed network load profile is also created by summing all the households' data over the year. You can specify in the tool if you want to use this network load for finding the network peak time or instead use a new network load. Under the menu “**Load**”, select the option “**Network load**”. You can select the network load profile to be the aggregation of the selected database load profiles, or the aggregation of the filtered load profile (only selected homes with specified demographic information), or based on a synthetic network load profile which you have previously created (see Figure 3). You can create a new synthetic network load profile by uploading a new csv file. You can have only one synthetic network load profile at a time so if you want to check multiple network load profiles you will need to upload the desired load profile each time. In order to create the new synthetic network load profile, put the network load in a csv file with the first column being the timestamp, and the second column being the network load. The first row will be ignored. You can also open the sample file, paste your new network load (or only adjust the load at timestamps you want) in that and save it as a new file in your computer, then import it as the synthetic network load file. The sample file provided has a flat rate of value 1 so you can increase the values in different months, days, and hours to see the impact of different network load peak times. As the tool analyses only one year of load data, the network load should also be one-year of data. Also, the “year” of each timestamp is not considered. e.g. you can import network load for 2014, and use the load of 2013 and the tool will assume the network load is for 2013.

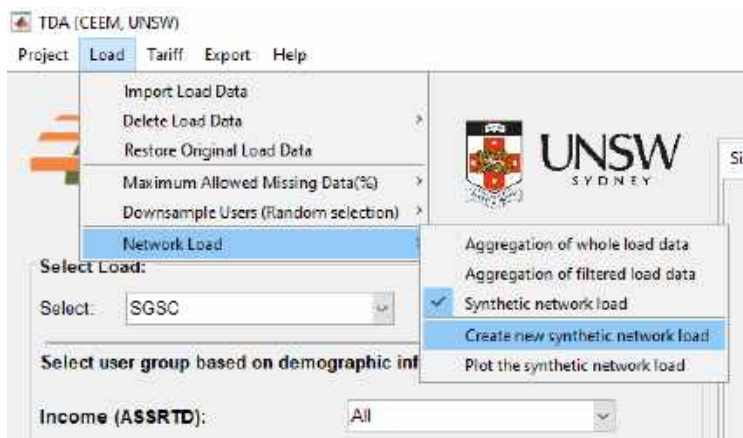


Figure 3 Network load options

Once you create a new synthetic network load profile, you can plot it and see the load pattern as well as the monthly peak times and value (Figure 4). It will allow you to quickly observe the monthly peak time and confirm if the network load profile looks correct. You can also plot the synthetic network load profile

(or the network load profile based on the other two options) by choosing it in menu “**Load > Network Load > Plot network load pattern**”.

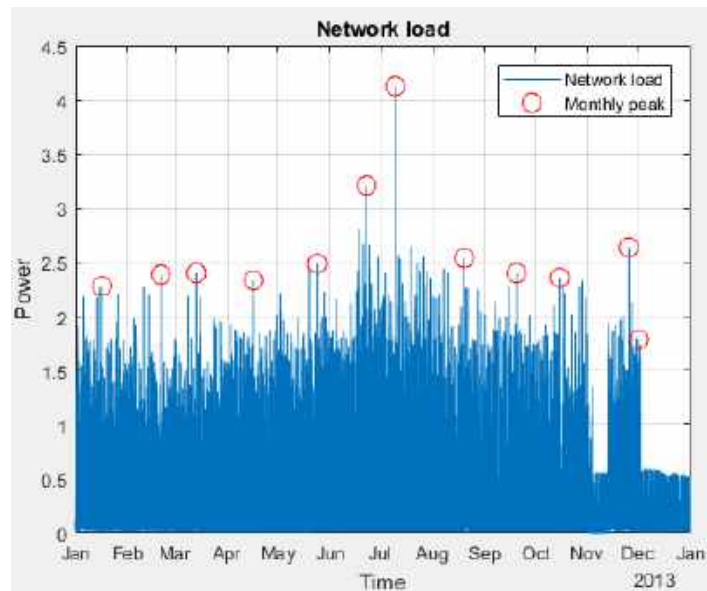


Figure 4 Plotting the synthetic network load

5.6 SELECTING A TARIFF

Once the load data has been selected, the tariff should be selected. The **state**, **type**, **provider**, and **year** can be used to filter the tariffs. Figure 5 shows the tariff selection panel. The “**Tariff Info**” option in the “**Tariff**” menu will open an excel file containing all the information and parameters of the network tariffs used in this tool. The rates shown are GST inclusive. If you want to exclude the GST, you can tick the “**Exclude GST**” option. Once a tariff is selected, the options for deleting the tariff or the available information for the tariff will appear in the “**x**” and “**i**” buttons respectively located beside the tariff dropdown list. The info button will open a folder with all the documents used to provide the tariff details for the selected provider (e.g. AusGrid).

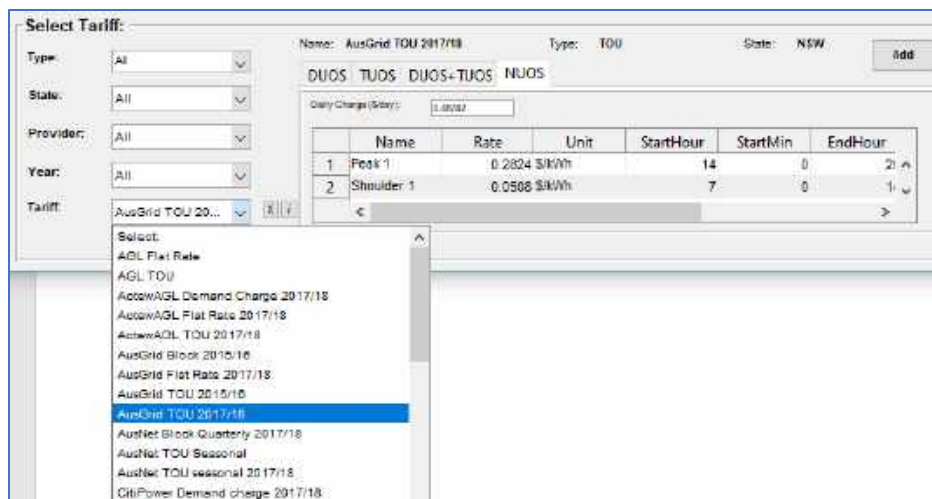


Figure 5 Selecting tariff

5.6.1 TARIFF COMPONENTS

When using a network tariff, you can choose whether you want to apply the whole tariff (NUOS) or only a component of the tariff. NUOS is “Network Use Of System” which is made up of DOUS, “Distribution Use of System”, and TUOS, the “Transmission Use of System”. Some NUOS tariffs might include other components (e.g. NSW Climate Change Fund or the Qld Solar Bonus Scheme). You can choose DUOS (to evaluate the distribution revenue), TUOS (to evaluate the transmission revenue), DUOS+TUOS (to evaluate both), and NUOS (to evaluate the actual tariff). By moving between tabs you can choose which component you want to apply. When using a retail tariff, you can only use the entire tariff (which is in DUOS tab, so you should select DUOS tab for those).

5.6.2 ADDING ANALYSIS

Once you have selected the tariff (from the dropdown list) and the tariff component (by selecting the tab), you can click on “**Add**” to add the analysis to the graphs. This will apply the selected component of the tariff to the selected subset of the load and perform a variety of analyses which are described later in this document.

Please note when you add the analysis, the tool will generate the network load data based on the option you have selected (i.e. based on the whole database, filtered databased, or synthetic network load which was described in section 5.5). Before adding the analysis, make sure the network load profile is selected properly. Once the analysis has been added to the diagrams, you cannot change the network load for this analysis. In order to do so, you may consider deleting the analysis (case) and then undertaking the analysis again using a new network load profile. When you add a new case, the tool will ask (Figure 6) if you want to pick a name for the new case. If you choose No, or close the dialog box, the new case will be named as Case + number. You can disable this option (asking for naming the new case) in menu **Options**.

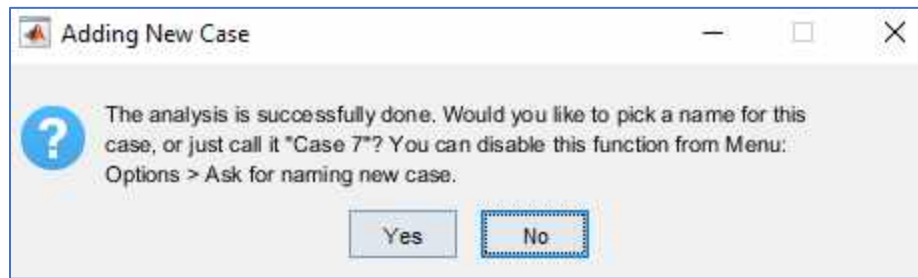


Figure 6 Selecting name for new case

5.7 CREATING NEW TARIFF

The components of the tariff including daily charge, energy cost, and others are shown in the panel. Any of the shown components can be adjusted to create a new tariff. Once any component of a tariff is changed, the modified tariff can be saved with a new name into the list of existing tariffs. When you edit a component, the saving option will appear. Please note, if you change any component of a tariff it won't automatically change in other components of that tariff. For instance, if you edit the demand window starting hour in DUOS, it won't change this parameter in the TUOS, DUOS+TUOS, and NUOS even if you save the tariff. As a result, the DUOS+TUOS might no longer be the addition of DUOS and TUOS.

You can also create a new tariff from scratch by selecting it from menu, "**Tariff > Create New Tariff**". There are currently seven types of tariff which you can create:

- **Flat rate**, where a flat constant rate applies to the kWh usage
- **Flat rate seasonal**, where the rates are different in different seasons
- **Block**, where the rates are different for different levels of kWh
- **Block quarterly**, where rates are different for different levels of kWh in each quarter
- **Time of use**, where rates are different in different times of the day
- **Time of use seasonal**, where rates are different in different times of the day and different months
- **Demand charge**, where the tariff is applied to the household peak demand (kW) or the household demand at the time of the network peak (kW) instead of (or in addition to) the kWh

The following tables show the tariff options and parameters.

Table 5-1 Flat rate tariff parameters

Parameters	Values
Daily charge (\$/day)	Non-negative value
Energy cost (\$/kWh)	Non-negative value

Table 5-2 Flat rate seasonal tariff parameters

Parameters	Values	Comment
Daily charge (\$/day)	Non-negative value	
Energy cost (\$/kWh)	Non-negative value	
StartMonth	1 to 12	Start month of the season
EndMonth	1 to 12	End month of the season

Table 5-3 Block tariff parameters

Parameters	Values	Comment
Daily charge (\$/day)	Non-negative value	
Energy cost (\$/kWh)	Non-negative value	
High Bound	Non-negative value	The high bound of the block

Table 5-4 Block Quarterly tariff parameters

Parameters	Values	Comment
Daily charge (\$/day)	Non-negative value	
Energy cost (\$/kWh)	Non-negative value	
High Bound	Non-negative value	The high bound of the block in quarter

Table 5-5 Time of Use tariff parameters

Parameters	Values	Comment
Daily charge (\$/day)	Non-negative value	
Energy cost (\$/kWh)	Non-negative value	
StartHour	0 to 23	Start hour of the time period
StartMin	0 or 30	Start minute of the time period
EndHour	0 to 23	End hour of the time period
EndMin	0 or 30	End minute of the time period
Weekday	Logical (true or false)	Select if the tariff should be applied on weekdays

Weekend	Logical (true or false)	Select if the tariff should be applied on weekends
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Table 5-6 Time of Use Seasonal tariff parameters

Parameters	Values	Comment
Daily charge (\$/day)	Non-negative value	
Energy cost (\$/kWh)	Non-negative value	
StartHour	0 to 23	Start hour of the time period
StartMin	0 or 30	Start minute of the time period
EndHour	0 to 23	End hour of the time period
EndMin	0 or 30	End minute of the time period
StartMonth	1 to 12	Start month
EndMonth	1 to 12	End month
Weekday	Logical (true or false)	Select if the tariff should be applied on weekdays
Weekend	Logical (true or false)	Select if the tariff should be applied on weekends

Table 5-7 Demand Charge tariff parameters

Parameters	Values	Comment
Daily charge (\$/day)	Non-negative value	
Energy cost (\$/kWh)	Non-negative value	
Demand charge (\$/kW/month)	Non-negative value	
StartHour	0 to 23	Start hour of the time period
StartMin	0 or 30	Start minute of the time period
EndHour	0 to 23	End hour of the time period
EndMin	0 or 30	End minute of the time period
StartMonth	1 to 12	Start month
EndMonth	1 to 12	End month
Weekday	Logical (true or false)	Select if the tariff should be applied on weekdays
Weekend	Logical (true or false)	Select if the tariff should be applied on weekends
NetworkPeak	Logical (true or false)	Select if the tariff should be applied on the demand at network peak (coincident peak)

NumberOfPeaks	Natural number (1,2,...)	Number of peak periods on which tariff should be applied
DemandWindowTSNo	Natural number (1,2,...)	The average of this number of half hourly periods before the peak demand (including the peak demand timestamp) will be considered. Default value is 1.
MinDemandkW	Non-negative value	Minimum demand in kW. Any value below this will convert to this limit.
MinDemandCharge	Non-negative value	Minimum demand charge in \$. Any charge below this will convert to this limit.
TimeGroup	Natural number (1,2,...)	Condition groups. All rows with the same TimeGroup will be considered as one demand charge. For example you can specify the demand charge based on 7-10am and 4-9pm in two rows and then use the same TimeGroup for both of them. This means one demand charge will be applied to the peak and both time periods will be considered to find the peak demand.
DayAverage	Logical (true or false)	Select if the tariff should be applied on the average demand in the time period of the day (instead of just the peak demand).

You can select a name and specify the provider, state, and year. You can also include some info about the tariff for your own reference. Once you save the tariff and select this tariff from the dropdown list, you can hover over the tariff name and the info will appear.

You should put the DUOS, TUOS, and NUOS “rates” separately and they can be different and even zero in some components (e.g. demand charge in the TUOS component in some demand tariffs is zero). However, the other parameters (such as **StartHour**, ..) cannot be different in different components. As opposed to the “modify tariff” option, here if you change a tariff parameter (e.g. start hour, end hour, etc) in one component (e.g. DUOS) it will change in other components as well. So if you really need a different parameter in different tariff components you can create the tariff, select it in the “**Select Tariff**” panel, and then edit the parameter in only one component.

If you need to add more rows to the parameters table, you can press ‘+’ to add a row. This will add the row to all components tabs. You can also delete the last row by pressing ‘-’. If the NUOS component of your tariff is equivalent to DUOS+TUOS, you can click on the button below to fill the NUOS rates based on the DUOS+TUOS. You can also modify the rates afterwards. Once you finish everything you can press “Add” to save this tariff in the list of tariffs. The new tariff will be checked for consistency and the software will prompt an error message if it finds any problem in the tariff.

You may later delete this tariff by selecting it from the select tariff dropdown list and press -. You can also reset all tariff lists to the original list provided by this tool by selecting from menu, **Tariff > Reset Tariff**.

	Name	Rate	Unit	StartHour	StartMin	EndHour
1	Summer peak	0	\$/kW/Month	0	0	

Figure 7 Example of creating a demand charge tariff

Please note the tool may not be able to catch all possible errors in the tariff design, so please make sure all components of the tariff are designed as intended before saving the tariff.

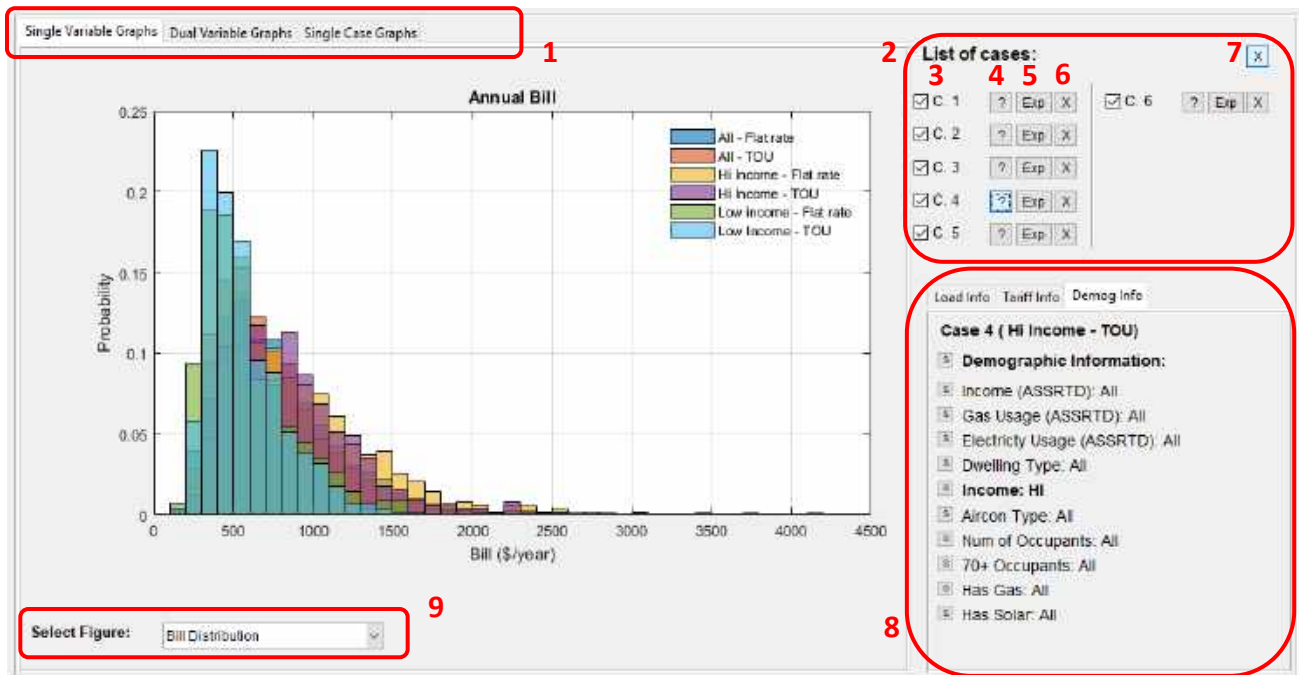
5.8 VISUALISING THE ANALYSIS

After selecting the data and adjusting the tariff (if applicable), the analysis can be performed, and the results can be shown on the graphs by pressing the **“Add”** button. Depending on the load size, complexity of the tariff, and your computer’s specification, adding the analysis to the plot window may take up to a few minutes. When you add a new case, the tool will ask if you would like to pick a name for the new case. It will appear in the graphs, exported data, and case information panels. If you select **“No”**, it will be saved as **“Case + the number of case”**. Please note, when you delete one case, the name of the other cases will be updated. So for instance, if you delete case 3, case 4 and 5 will be renamed to case 3 and 4 respectively and so on.

More analyses can be added to the plot by selecting a different user group or tariff and pressing **“Add”** again. Up to 10 analyses can be added to the diagrams. There are three types of diagrams used for analysis, titled **“Single Variable Graphs”**, **Dual Variable Graphs”**, and **“Single Case Graphs”**.

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When adding the analyses (cases), you can see the list of all cases beside the plotting panel where you can show/hide the graphs, display the information of the cases, export the case to excel file, and delete the case. Figure 8 shows different components of the plotting panel.



1- Select the graph type, 2- List of cases, 3- Hide/show one case, 4- Display the case information in info panel, 5- Export the result to excel, 6- Delete the case, 7- Clear all cases, 8- Info panel, 9- Select the plot option

Figure 8 Different components of the Plotting panel

5.8.1.1 EXPORT FIGURE

You can export the figure currently displayed on the plotting panel. The figure will pop out of the panel with more options (zoom, pan, etc). Also, you can save the figure in multiple standard figure formats. For this option, click on menu **Export > Export Figure** or simply press **ctrl + E**.

5.8.1.2 COPY FIGURE

You can also copy the figure in the clipboard and then paste it in any document (word, email, etc). The figure might not be exactly the same as what is being shown on the panel for some figure options (aspect ratio, etc). You can also take a screenshot of the figure, or export the figure and then insert it into your document. You can also print the figure to pdf after exporting it for better quality. For this option refer to menu: **Export > Copy Figure** (**Ctrl + C**).

5.8.1.3 COPY DATA

If you want to access the underlying data of the figures you can copy the data of the current figure to the clipboard and paste it in any excel file, etc. You can find this option in menu: **Export > Copy Data** (Ctrl + D).

5.8.2 INFO PANEL

In the info panel, you can see the load info (Case number, Number of users, load database, and network peak time calculation method), Tariff info (Tariff name, type, State, selected component, and tariff parameters), and Demographic info based on the available demographic information. If any of the demographic options were selected to filter the load, it will be shown in **bold** font (Figure 9). You can click on the “S” buttons beside the demographic information items to run a quick statistical analysis on the results grouped by the options available for that demographic info. For example, Figure 10 shows the statistical analysis results of one case for demographic information “**Income**”. You can copy the table in the clipboard by clicking on “**Copy Data**”. You can then paste in an Excel file, or any document for any further work on the statistical analysis results. The table contains the mean, standard deviation, min and max of analysis results (annual kWh, annual peak, demand at network peak, average daily kWh, annual bill, and Unitised annual bill) for all users within the same demographic option. By clicking on the “S” button beside “Demographic Information” you can see a statistical analysis of all the homes in this case (not grouped based on any demographic information). Of course, for demographic information items which have already been selected in filtering the load (and shown in **bold** font in the list), there will be only one group in the statistical analysis.

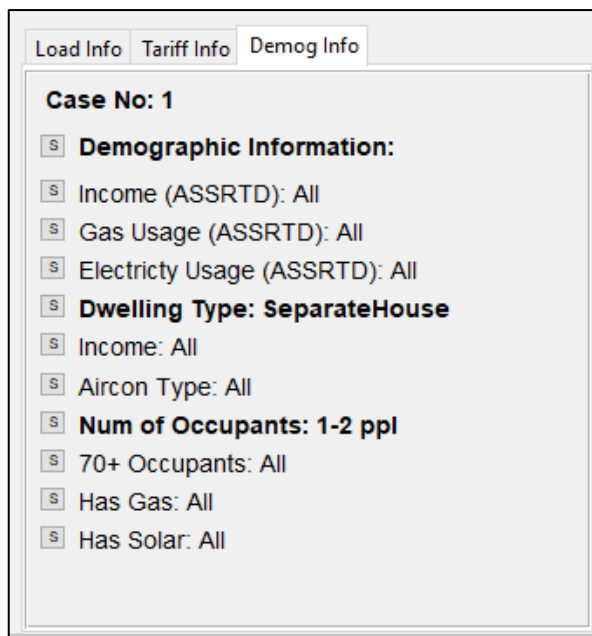


Figure 9 List of demographic information

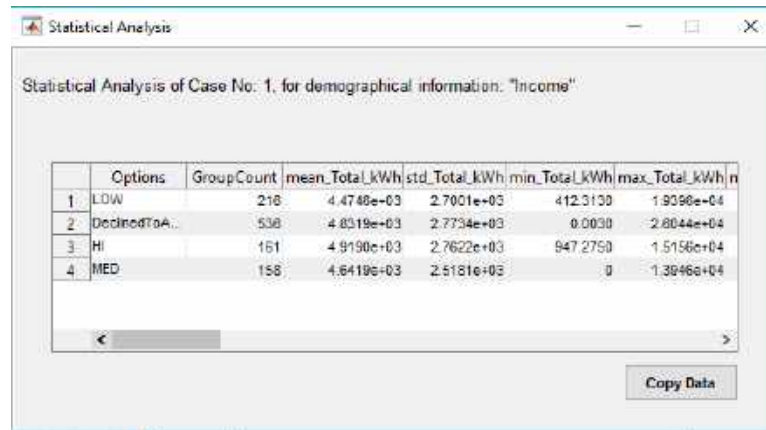


Figure 10 statistical Analysis of one case grouped by demographic information "Income"

In the following, different graph types are introduced.

5.8.3 SINGLE VARIABLE GRAPHS

In this diagram panel, the graphs based on one variable are shown. You can select one of the following variables from the dropdown list:

- Average Annual Profile
- Daily kWh Histogram
- Monthly Average kWh
- Seasonal Daily Pattern
- Monthly Peak Time
- Average Load Duration Curve
- Bill Distribution
- Bill Box Plot

Figure 11 shows a sample figure of all options. Once you add more analyses to the diagram, they will show up together in both single variable and dual variable diagram panels. If you click on any point in a graph the values of x and y axis will be shown in a data tip. You can add multiple data tips to the graph by holding shift and clicking on a new point in the graph. You can see two sample data tips showing in “**Monthly Peak Time**” graph in Figure 11 representing the hour of peak in March in two cases. You can use left and right arrow keys to move between points (or groups in boxplot option). Please note if you use a similar load profile for multiple cases (e.g. to test the impact of different tariffs on similar user group), the graphs showing the characteristics of the load (and not the bill), will be similar and therefore you will see one plot for them. As an example, in the graph mentioned above we have two sets of monthly peak points instead of three. In boxplot you can see the Median, Maximum, Minimum, number of points and number of finite outliers.

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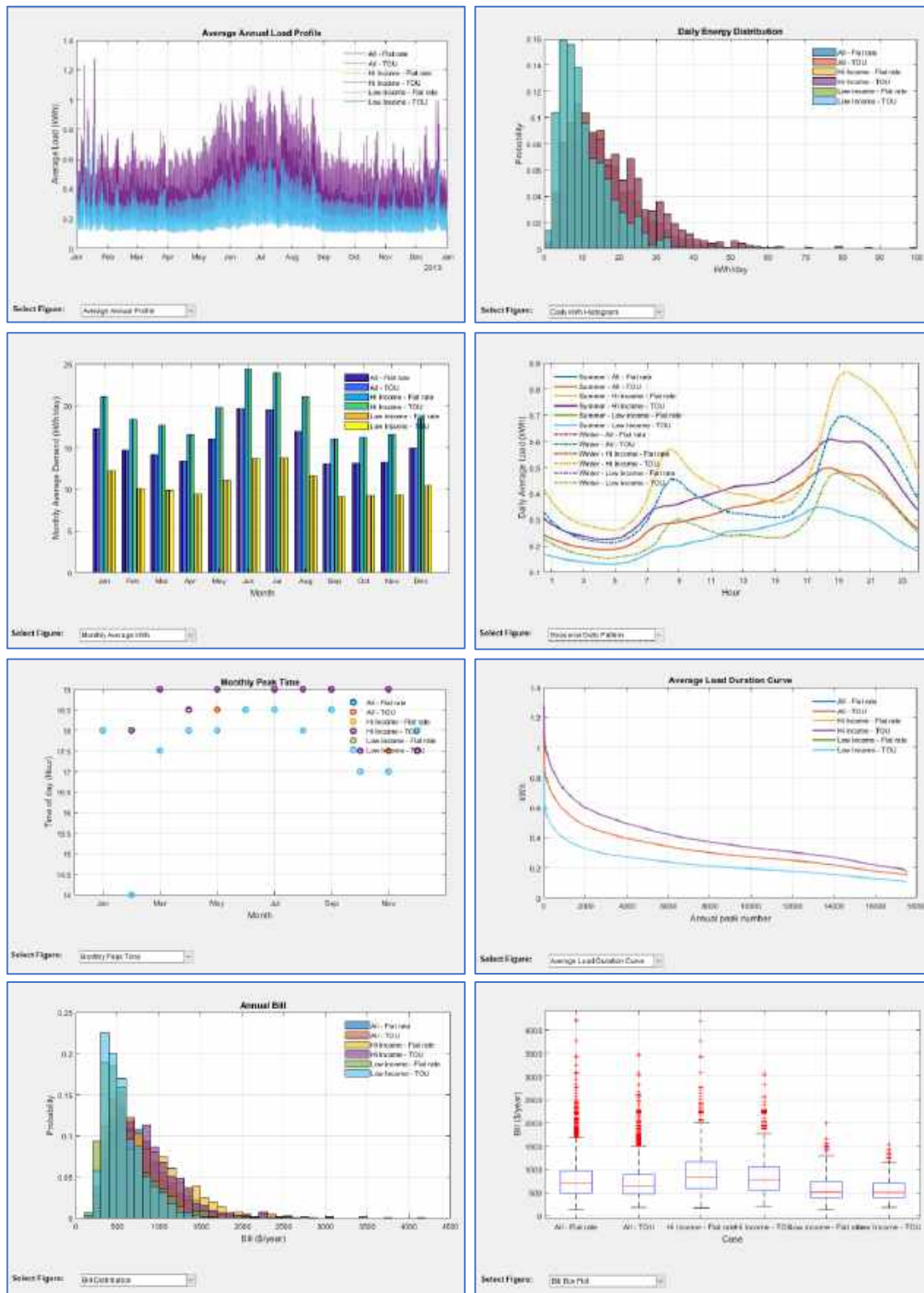


Figure 11 Single Variable figure options

5.8.4 DUAL VARIABLE GRAPHS

In this diagram panel, multiple variables can be compared together by selecting them in the x or y axis. The following results can be shown:

- Annual kWh
- Average Demand at “N” Network Peaks (coincident demand)
- Average Demand at “N” Network Monthly Peaks (coincident demand)
- Average Demand at Top “N” Peaks (non-coincident demand)
- Average Demand at Top “N” Monthly Peaks (non-coincident demand)
- Average Daily kWh
- Average Daily Peak
- Bill (\$/year)
- Unitised Bill (kW)

Average demand at “N” network peaks (and “N” monthly peaks) is calculated based on the network peak option selected (refer to section 5.5 for options for Network load). You can select the number of peaks (N) from the dropdown list. You can also specify if you want to allow only one peak period per day. Please note if you don’t tick this option, multiple peak periods in a single day may be considered. You can also specify which season is included.

Average Demand at Top “N” peaks (and “N” monthly peaks) are the average demand at the top peaks of each home. Again you can allow more than one peak per day and also filter the seasons. Average daily kWh and average daily peaks are also calculated for each home and can be selected from the dropdown list.

Unitised Bill is defined as the customers’ annual bill divided by the annual bill of a reference customer with constant demand throughout the year (1 kW or 0.5kWh in all half hour periods). The purpose of this unitised bill is to make it independent of the value of the tariff components, so different tariffs with different component values can be compared to each other based only on their structure and not their rates. The unit for this bill is kW as the reference customer’s bill considered is \$/kW. For more info about the application of the Unitised Bill refer to our paper on cost-reflective tariff design [here](#).

The correlation coefficient (CC) of the X and Y data of the plot is also calculated and shown in the legend for each case.

Figure 12 shows some examples of different plotting options. Please note that while you can change the number of peaks, multiple peaks per day, and seasonal filtering and update the figure, they are not updated in the saved data for exporting to an excel file. However, you can access this updated data by copying the data from figure (as described in 5.8.1.3).

Please note, if the number selected for “N” is higher than the total available peaks (e.g. selecting 100 peaks for the monthly peak and selecting one peak/day), a warning will be shown, and the total available peak times will be considered instead of “N”. Therefore if this happens, the x or y label (showing the number of peaks) may not be valid for all cases. For example it may be Average of top 100 peaks while the actual number of available peaks for different cases currently showing in the graph could be lower.

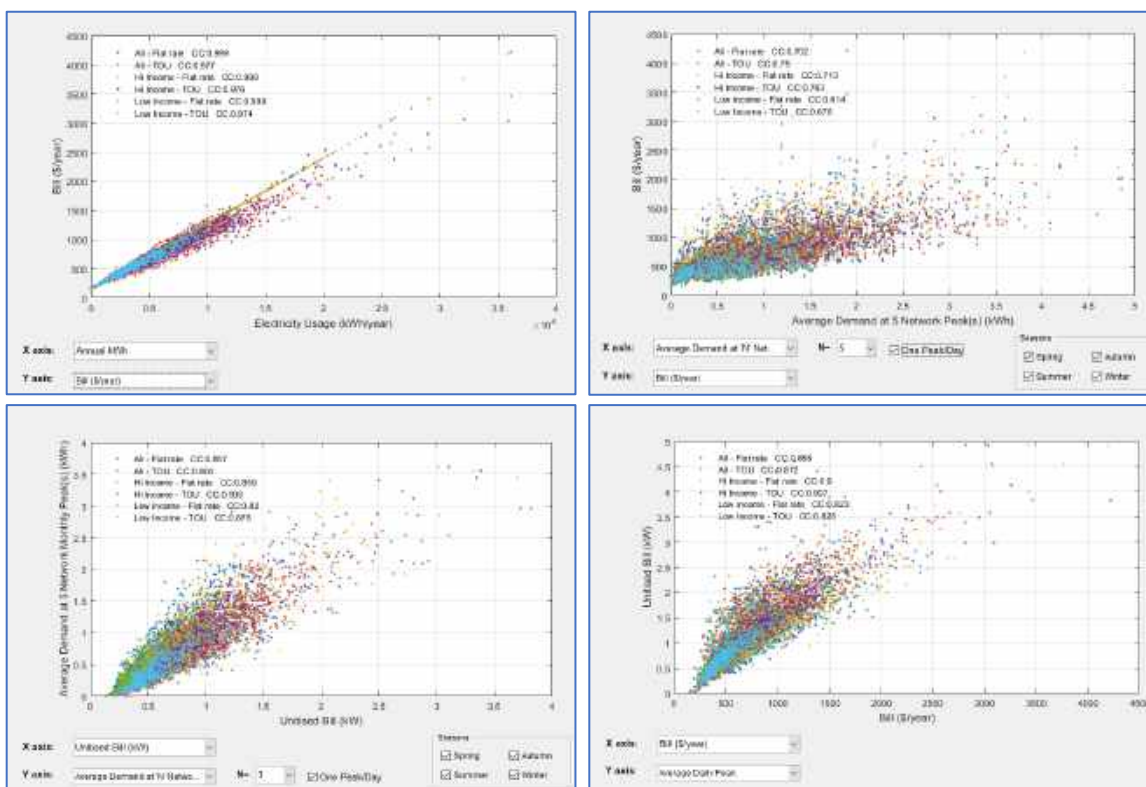


Figure 12 Dual Variable Diagram examples

5.8.5 SINGLE CASE GRAPHS

As some results can not be plotted for more than one case, a third type of diagram can be used for single cases. You can select the case number and the variable to be shown on the plot. The following options are possible:

- Bill Components
- Bill Components Pie Chart
- Daily Profile Interquartile Range

Please note, Bill Component here means the portion of the bill (Daily, Energy, Capacity Charge, etc) and should not to be confused with DUOS, TUOS, etc.

In the first option (Bill Components), you can specify the parameter used to sort the bills. The default parameter is the total bill.

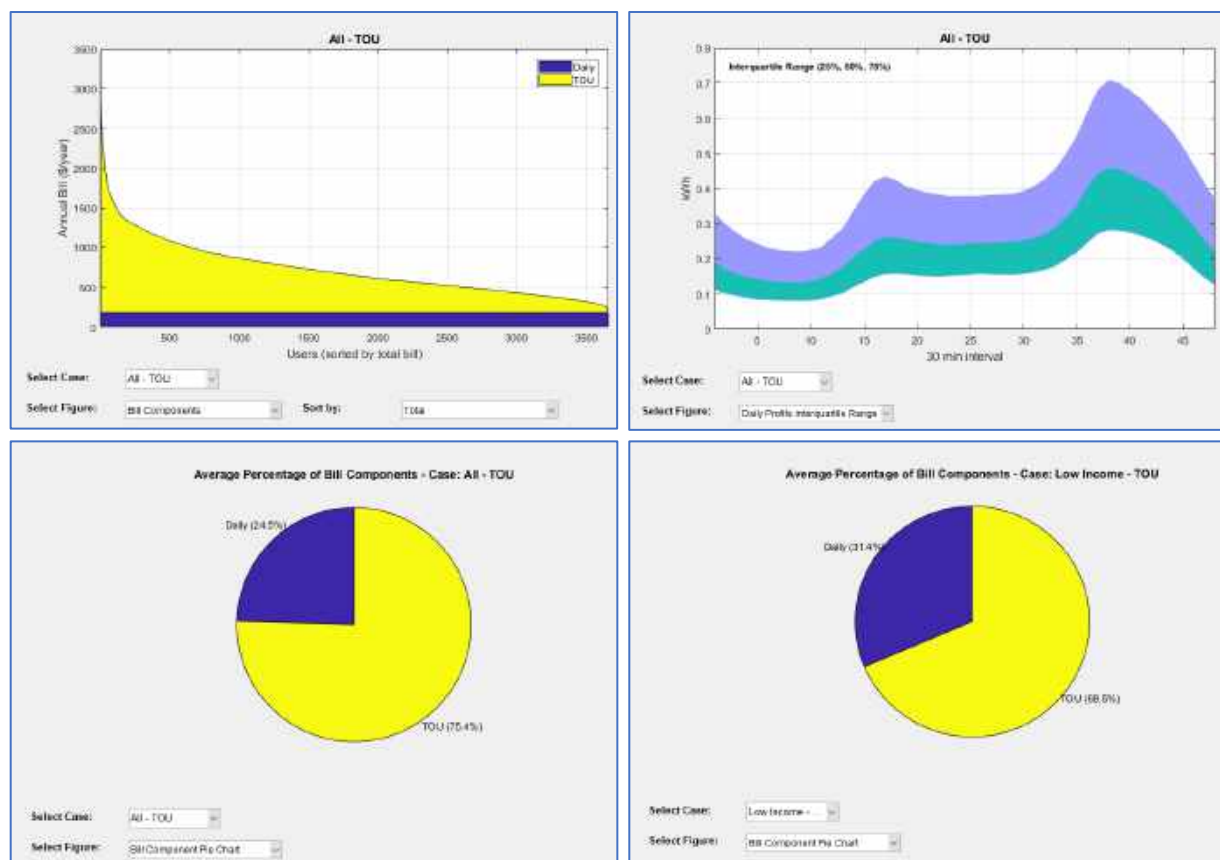


Figure 13 Some examples of single case charts

5.9 EXPORTING THE RESULTS

While you can directly copy the data of the current figure to the clipboard and paste it where you want, you can also export the result of individual or all cases to an excel file. You can click on the “Exp” button beside the case name in the list of cases to export the result of that case. Alternatively, you can use the menu: **Export > Export Results**. Figure 14 shows an example of an exported result. Please note there currently seems to be an issue with saving the results while working in a network drive or shared folder (e.g. OneDrive folder, etc) due to automatic syncing, etc. It is therefore recommended that you place and run the TDA folder on a non-shared folder which is not being synced with the internet.

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A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Results produced by TDA developed by Centre for Environmental and Energy Market (CEEM) UNSW on: 17 Nov 2017																			
Tariff: AusGrid Flat Rate 2017/18																			
No. of Use 566																			
Database: SGSC																			
Customer	Income	Gas Usage	Electricity	Dwelling	Income	Aircon Typ	Num of Occup	Has Gas	Has Solar	Annual_ki	Demand	Demand	Annual_P	Monthly	Average	Average	Bill	Unutilised	Bill
8145887	MED	MED	MED	Separate	LOW	SplitSyste	1-2 ppl	N	Y	N	3253.448	0.051	0.2235	3.161	2.262167	8.913556	1.331178	510.9914	0.451005
8145997	MED	MED	MED	Separate	LOW	SplitSyste	3-4 ppl	N	Y	N	2118.828	0.541	0.185167	2.528	1.9585	5.805008	0.917359	382.8258	0.337885
8147011	MED	MED	HI	Separate	LOW	SplitSyste	3-4 ppl	N	Y	N	7416.716	0.162	0.539667	3.289	2.668917	26.31977	1.735805	981.27	0.866077
8147859	HI	LOW	MED	Separate	LOW	Ducted	1-2 ppl	N	N	N	5857.307	0.281	0.472667	2.976	2.615333	16.04742	2.007132	805.1207	0.710600
8148065	HI	MED	LOW	Separate	LOW	SplitSyste	3-4 ppl	N	N	N	3219.678	0.135	0.23225	2.838	2.320917	8.821030	1.105849	507.1768	0.447638
8150103	MED	MED	LOW	Separate	LOW	SplitSyste	1-2 ppl	Y	N	N	4500.238	0.323	0.566	2.894	2.24675	12.32942	1.245616	651.8275	0.575308
8154329	LOW	LOW	MED	Separate	LOW	SplitSyste	3-4 ppl	N	N	Y	6376.311	1.271	0.730167	3.302	2.756	17.46935	1.753003	863.7469	0.76235
8154379	HI	LOW	LOW	Separate	LOW	SplitSyste	1-2 ppl	Y	N	N	1540.434	0.099	0.169083	2.904	2.01575	4.220367	0.96394	317.491	0.28022
8155143	LOW	LOW	LOW	Separate	LOW	No Aircon	1-2 ppl	N	Y	N	3549.595	0.131	0.425083	2.96	2.101667	9.724918	1.155427	544.4439	0.48053
8156681	LOW	MED	LOW	Separate	LOW	No Aircon	1-2 ppl	Y	N	N	2753.196	0.134	0.12675	2.242	2.038833	7.543003	1.527814	454.4834	0.401131
8158061	LOW	MED	MED	Separate	LOW	SplitSyste	1-2 ppl	N	Y	N	5003.256	0.923	0.616667	2.661	1.873867	13.70755	1.010537	708.6479	0.625458
8158169	LOW	MED	LOW	Separate	LOW	SplitSyste	1-2 ppl	Y	N	N	4981.792	0.342	0.778167	4.128	2.5795	13.64875	1.693389	706.2234	0.623318

Figure 14 A sample of exported result to excel

6 FEEDBACK ON THE SOFTWARE

We always aim to improve the TDA and make it useful for a wider range of stakeholders. Therefore, any feedback on the current features of the software as well as any ideas for new features would be very valuable to us. In order to give us your feedback and thoughts, including any errors, please use the “feedback” button and provide your name, email and message. We will try our best to reply to you as soon as possible. If you want to be informed about any future updates of the software please send us a message using this option or directly to n.haghdadi@unsw.edu.au.