CEREI: Help File

June 27, 2023

1 Aim

The aim of CEREI is to calculate:

1. The energy bill with a given tariff structure (e.g., NSP81/NSP82/NSP83)
2. Price Efficiency Index (PEI)
3. Potential savings from comparison of business-as-usual bill with the bill calculated with a given tariff structure (e.g., NSP81/NSP82/NSP83)
4. Life-cycle cost assessment

2 Building CEREI from source code

Building CEREI from source code requires technical knowledge of developing java applications. The following describes the method used to build the version on the tool on the repository, although other methods can be used.

1. Download the source code from the repository.
2. Compile the code.
3. Create a .jar file.
4. Optional - Create a java run-time environment that contains the java base and desktop modules as a minimum. The repository has a functional jre in the sub-directory `smalljre`.
5. Optional - Use Launch4j (or similar) to create a Windows executable that references the small jre. The repository has a launch4j configuration file (at dist/energyCalculator3.xml) that can be edited and used with launch4j.
6. Optional - Create a .zip archive that contains the Windows executable and two sub-directories:
   - **smalljre** (or as configured in the launch4j configuration file) - that contains the java run-time environment.
   - **help** - that contains html help instructions. This directory must contain `EnergyCalculator.htm` as the initial entry point into the help instructions.

3 Tool Installation

3.1 Installation on systems with jdk 18, openjdk 18 or later installed

Download CEREI.jar from the repository. CEREI.jar has been tested with openjdk 18, 19 and 20. The jar file can be run from a terminal/command window using the command:

```
java -jar CEREI.jar
```

It is also possible to run CEREI by clicking on CEREI.jar by changing the configuration of your device. Follow the relevant instructions provided by the manufacturer of your device and/or operating system.

Note that CEREI was developed using jdk 18 and has been tested with openjdk19 and openjdk 20.

3.2 Installation of jdk or openjdk

Install jdk 20 (or later) from `https://www.oracle.com/au/java/technologies/downloads` or openjdk 20 (or later) from `https://openjdk.org/projects/jdk/`, taking note and complying with the licence conditions and instructions associated with jdk or openjdk as appropriate.

You may need administrative or superuser (root) privileges to install jdk or openjdk.

Run CEREI as described in Subsection 3.1 above.

3.3 Installation of standalone CEREI (Windows only)

Download the CEREI.zip file from the repository. Extract all the files and subdirectories to a known location. Double-click on CEREI.exe to run the tool. You do not need administrative privileges to install and run CEREI using this method.

4 Tool Interface and Operation

The interface for CEREI is presented in Figure 1.

CEREI can be operated in two simple steps:

- **Step 1:** Click on each button, within the red highlighted box in Figure 1, and select the relevant input file.
- **Step 2:** Click "Calculate". This is highlighted by the blue font button in Figure 1. This will generate the output(s) in the relevant tab(s) and produce a pop-up, stating "*Calculation Complete. Results in relevant tabs*".

The user needs to click on the "Reset Input Files" button in Figure 1 to reset all input files.

If any individual file(s) needs to be replaced, then only the relevant button(s) (within the red highlighted box in Figure 1) needs to be clicked to select the new file.

CEREI generates four outputs, highlighted by the green box as shown in Figure 1. Each of these outputs is discussed in detail in Section 6. To generate the output(s), the tool allows for seven user inputs, which are highlighted by the red box, as illustrated in Figure 1. Each of these inputs are discussed in detail in Section 5.

The functionalities of CEREI are explained in Section 7.

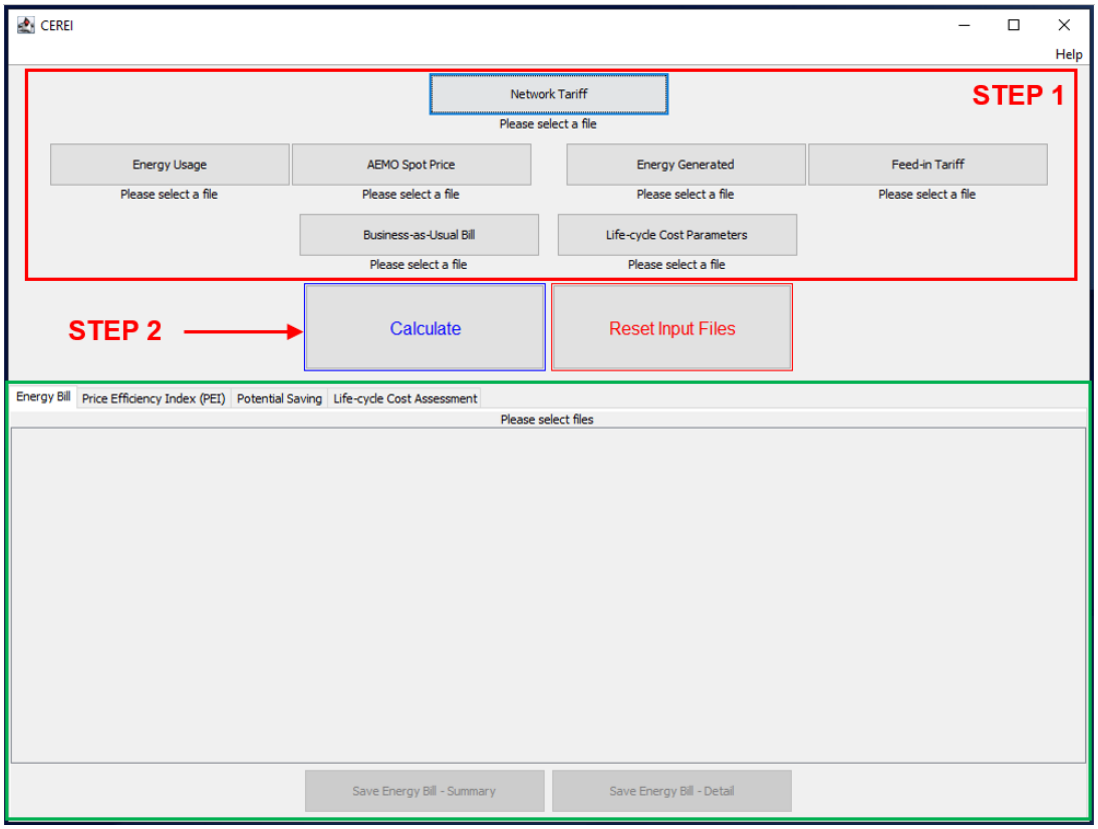


Figure 1: CEREI tool interface.

5 Input

CEREI requires 7 structured input files, which must be in the CSV format. CEREI is developed following data resolution of 30 minutes.

To test CEREI, sample input files are provided. The user can also test CEREI with their industry-specific data. For such cases, blank templates are provided. Instructions on how to fill up each of the input file(s) with the necessary data is provided within the file(s).

For CEREI to operate as designed, it is important that the data format, provided in the template, is followed.

5.1 Input 1: Network Tariff

The network tariff defines the tariff structure, the network tariff parametres and the configuration of the metres. The tariff structures covered by CEREI are as follows: NSP81, NSP82, or NSP83.

The model requires data for 1 complete year. The list of network parameters, including unit and time resolution, is listed in Table 1.

Table 1: Network tariff parameters

Category	**Parameter (Unit, Resolution)**
Tariff structure and meter configuration	1. Tariff Name 2. Peak, Shoulder, and Off-peak Periods 3. Meter Configuration
Energy charges	1. Loss Ratio - Spot Price (c/kWh, monthly) 2. Loss Ratio - Feed-in Tariff (c/kWh, monthly) 3. Service and Admin Charge ($/Day, monthly)
Network charges	1. Standing Charge ($/Yr, monthly) 2. Peak Rate (c/kWh, monthly) 3. Shoulder Rate (c/kWh, monthly) 4. Off-peak Rate (c/kWh, monthly) 5. Demand Critical Peak Rate ($/kVA/Mth, monthly) 6. Demand Critical Peak (kVA, monthly) 7. Demand Capacity Rate ($/kVA/Mth, monthly) 8. Demand Capacity (kVA, monthly)

Market charges	1. Victorian Energy Efficient Target (VEET) Charge (c/kWh, monthly) 2. VEET Loss Ratio (c/kWh, monthly) 3. Small-scale Renewable Energy Scheme (SRES) Charge (c/kWh, monthly) 4. SRES Loss Ratio (c/kWh, monthly) 5. Large-scale Renewable Energy Target (LRET) Charge (c/kWh, monthly) 6. LRET Loss Ratio (c/kWh, monthly) 7. Australian Energy Market Operator (AEMO) Pool and Reliability and Emergency Reserve Trader (RERT) Charge (GST Exempt) (c/kWh, monthly) 8. AEMO and RERT Loss Ratio (c/kWh, monthly) 9. Ancillary Services (c/kWh, monthly) 10. Ancillary Services Loss Ratio (c/kWh, monthly)
Other charges	1. Meter Charge ($/Yr, monthly) 2. CT Compliance Testing Levey ($/Yr, monthly)

The "Input 1 – Network Tariff" file is broken down into three parts.

5.1.1 Part 1: Definition of the Tariff Structure and Meter Configuration

This part defines the tariff structure and meter-specific information. This is shown in Figure 2.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	#Tariff is mandatory and must contain the name of the tariff.																					
2	Tariff	NSP83																				
3																						
4	# This section sets the Times where Peak and Sholder rates apply. All other times are Offpeak. Both "Peak" and "Shoulder" are optional.																					
5		# There can be muliple "Timestamps" - one per cell to the right of the key word "Peak" or "Shoulder". Each timestamp consists of three values - separated by a space: <day> <starttime> <endtime>																				
6		# Each timestamp consists of three values - separated by a space: <day> <starttime> <endtime>																				
7		# <day> uses 3 letter days - Mon through to Sun. <day> can be a single day (e.g. Tue), multiple discrete days separated by a ";" (e.g. Mon;Wed) or a range of days with start and end days separated by a "-" (e.g. Mon-Fri).																				
8		# If <day> is a range , the start day must be a day in the week (Mon-Sun) before the end day in the week. E.g. Sun-Mon is invalid, Wed-Tue is invalid.																				
9		# <starttime> and <endtime> use the standard 24 hour clock notation, e.g. 08:00, 14:00. The minute parts of <starttime> and <endtime> are ignored. <starttime> must be before <endtime>.																				
10		# <startime> must not exceed 23:00. <endtime> must be grater than or equal to 01:00. <endtime> can be 24:00 - meaning midnight.																				
11	Peak	Mon-Fri 0	Mon-Fri 16:00 23:00																			
12	Shoulder	Mon-Fri 10:00 16:00																				
13	Offpeak	Other																				
14																						
15	# Generation is optional. If present and the second cell is "Distributed", then Energy Generated will be distributed across the meters in the Energy Usage file according to the following priorities.																					
16		# If there are entries in the third and subseqeunt cells of the "Generation" Line, Energy Generated will be distributed across only these meters in the priorty order in which they are listed.																				
17		# If there are no entries in the third and subsequent cells and there is a "Business as Usual" File, Energy will be distibuted across all meters in the priority order given by the highest to lowest annual cost in the Business as usual file																				
18		# If there are no entries in the third and subsequent cells and there is no "Business as Usual" File, Energy will be distibuted across all meters in the priority order given by their appearance in the Energy Usage file																				
19	Generatio	Distributed																				

Figure 2: Part 1 of Input 1 - Network Tariff.

Figure 2 contains the following items:

1. Tariff Name - Please note that CEREI only facilitates tariffs having the same structure as NSP81, NSP82, or NSP83.
2. Peak, shoulder and off-peak periods. If the tariff structure does not have shoulder period, then the row that shows shoulder period (Row 12 in Figure 2) should be empty.
3. Meter configuration based on the four scenarios highlighted in Table 2.

- To simulate Scenario 1 (Table 2), the user need to make sure Row 19 (Figure 2) is empty and the word "Generation" is not present.
- To simulate Scenario 2 (Table 2), the user should just include the word "Generation" in Row 19 (Figure 2) and leave the rest of the row blank. Since in Scenario 2, the generated energy on site is connected to its own meter, the user should indicate the National Meter Identification (NMI) number in Input 4 (Section 5.4).
- To simulate Scenario 3 (Table 2), the user should just include the word "Generation" in Row 19 (Figure 2) and leave the rest of the row blank. Since in Scenario 3, the generated on-site energy is connected to an existing on-site meter, the user should state the NMI number of the existing meter in Input 4 (Section 5.4).
- To simulate Scenario 4 (Table 2), the user should include the word "Distributed" followed by "Generation" in Row 19 (Figure 2). Within Scenario 4, there are three different meter selection options:
  - The energy generated can be distributed among the existing meters based on the priority order provided by the user. In this case, following the words "Generation" and "Distributed" in Row 19 (Figure 2), the user should list the NMIs in the descending order of priority.
  - The energy generated can be distributed among existing metres according to the order in which they are listed in Input 2 (Section 5.2). In this case, the user need to leave the row blank following the words "Generation" and "Distributed" in Row 19 (Figure 2). The user must also ensure Input 6 (Section 5.6) is not provided to CEREI.
  - The energy generated can be distributed among the existing meters based on the priority list created by the highest to lowest annual cost of the meter provided in Input 6. In this case, the user need to leave the row blank following the words "Generation" and "Distributed" in Row 19 (Figure 2). The user must ensure Input 6 is provided to CEREI.

5.1.2 Part 2: Definition of tariff and network charges

This part defines the tariff and network charges that are applicable for all NMIs for an entire year (12 months). This is shown in Figure 3.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
22	General																				
23	Month	Service an	Standing C	Demand C	Demand C	VEET Char	VEET Loss	SRES Char	SRES Loss	LRET Char	LRET Loss	AEMO Poc	AEMO + RI	Ancillary S	Ancillary S	Meter Cha	CT Compli	Peak Rate	Shoulder F	Off-peak Rate (c/kWh)	
24	January	2.09	5962	0.345	0.57	0.74	0.07568	0.97535	0.07551	0.78934	0.07684	0.24563	0.06667	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
25	February	2.09	5962	0.345	0.57	0.66	0.07576	0.97535	0.07551	0.74477	0.07684	0.04781	0.06667	5.76835	0.07778	1039.5	121	11.7	5.43	1.62	
26	March	2.09	5962	0.345	0.57	0.65	0.07538	0.98	0.07551	0.72	0.075	0.045	0.06667	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
27	April	2.09	5962	0.345	0.57	0.72	0.075	0.98	0.07551	0.7	0.07571	0.045	0.06667	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
28	May	2.09	5962	0.345	0.57	0.65	0.07538	0.98	0.07551	0.69	0.07536	0.045	0.06667	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
29	June	2.09	5962	0.345	0.57	0.57	0.07544	0.98	0.07551	0.74	0.07568	0.045	0.06667	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
30	July	2.09	5962	0.345	0.57	0.66	0.07576	0.98	0.07551	0.88	0.07614	0.048	0.0625	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
31	August	2.09	5962	0.345	0.57	0.65	0.07538	0.98	0.07551	0.9	0.07556	0.048	0.0625	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
32	Septembe	2.09	5962	0.345	0.57	0.65	0.07538	0.98	0.07551	1.04	0.07596	0.048	0.0625	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
33	October	2.09	5962	0.345	0.57	0.66	0.07576	0.98	0.07551	0.93	0.07527	0.048	0.0625	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
34	November	2.09	5962	0.345	0.57	0.7	0.07571	0.98	0.07551	0.82	0.07561	0.048	0.0625	0.09	0.07778	1039.5	121	11.7	5.43	1.62	
35	December	2.09	5962	0.345	0.57	0.8	0.07625	0.98	0.07551	0.81	0.07531	0.048	0.0625	0.09	0.07778	1039.5	121	11.7	5.43	1.62	

Figure 3: Part 2 of Input 1 - Network Tariff.

Figure 3 contains the following items:

1. Service and Admin Charge ($/Day, monthly) (Column B)
2. Standing Charge ($/Yr, monthly) (Column C)
3. Demand Capacity Rate ($/kVA/Mth, monthly) (Column D)
4. Demand Critical Peak Rate ($/kVA/Mth, monthly) (Column E)
5. VEET Charge (c/kWh, monthly) (Column F)
6. VEET Loss Ratio (c/kWh, monthly) (Column G)
7. SRES Charge (c/kWh, monthly) (Column H)
8. SRES Loss Ratio (c/kWh, monthly) (Column I)
9. LRET Charge (c/kWh, monthly) (Column J)

10. LRET Loss Ratio (c/kWh, monthly) (Column K)
11. AEMO Pool and RERT Charge (GST Exempt) (c/kWh, monthly) (Column L)
12. AEMO and RERT Loss Ratio (c/kWh, monthly) (Column M)
13. Ancillary Services (c/kWh, monthly) (Column N)
14. Ancillary Services Loss Ratio (c/kWh, monthly) (Column O)
15. Meter Charge ($/Yr, monthly) (Column P)
16. CT Compliance Testing Levey ($/Yr, monthly) (Column Q)
17. Peak Rate (c/kWh, monthly) (Column R)
18. Shoulder Rate (c/kWh, monthly) (Column S) - if the given tariff structure does not have any shoulder rate, then values of this column should be set to 0
19. Off-peak Rate (c/kWh, monthly) (Column T)

5.1.3 Part 3: Definition of the Meter-Specific Parameters

This part defines the monthly meter-specific parameters for an entire year (12 months) for each meter. An extract from one single meter is shown in Figure 4.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
37	# Each meter in the Energy Usage File must appear in this file. The meter name must be the same as in the Energy Usage File and must be followed by 13 lines (1 header and 12 months) of parameters that apply to the specific meter.																					
38	# Columns must be in the order specifed																					
39	# It is OK to have meters described below if they don't appear in the Energy Usage File.																					
40	Meter	NMI1																				
41	Month	Loss Ratio	Loss Ratio	Demand C	Demand Critical Peak ($/kVA/Mth)																	
42	Jan	0.06856	0.06856	110	14.3326																	
43	February	0.06845	0.06845	110	24.6356																	
44	March	0.06848	0.06848	110	21.4164																	
45	April	0.06855	0.06855	110	19.474																	
46	May	0.06847	0.06847	110	20.7766																	
47	June	0.06851	0.06851	110	20.6685																	
48	July	0.07081	0.07081	110	22.9212																	
49	August	0.07596	0.07596	110	19.8745																	
50	Septembe	0.0709	0.0709	110	20.2224																	
51	October	0.07089	0.07089	110	20.5617																	
52	November	0.07088	0.07088	110	21.0041																	
53	December	0.07088	0.07088	110	14.3599																	

Figure 4: Part 3 of Input 1 - Network Tariff.

Against each meter number, the NMI number is provided, along with the following parameter information:

1. Loss Ratio - Spot Price (c/kWh, monthly) (Column B)
2. Loss Ratio - Feed-in Tariff (c/kWh, monthly) (Column C)
3. Demand Critical Peak (kVA, monthly) (Column D)
4. Demand Capacity (kVA, monthly) (Column E)

An unlimited number of meters can be listed. Meter information, as shown in Figure 4, simply needs to be replicated below sequentially.

Information relation to all the meters listed in the Input 2 (Section 5.1) and Input 4 (Section 5.4) files must be provided in this Input 1 file.

5.2 Input 2: Energy Usage

Input 2 provides the energy usage data, in kWh, from the grid, per meter. The data resolution is 30 minutes. For multiple meters, each meter's energy usage needs to be placed in separate column, the NMI number as the column heading. An extract from a sample energy usage file is shown in Figure 5.

Please note that the NMI number should match the NMIs listed in Input 1 (Section 5.1).

	A	B	C	D	E	F	G
1	Date and Time	NMI1 (kWh)	NMI2 (kWh)	NMI3 (kWh)	NMI4 (kWh)	NMI5 (kWh)	NMI6 (kWh)
2	1/01/2020 0:30	0.8	2.6	4.7	7.2	0.03	4.6
3	1/01/2020 1:00	0.833333333	2.633333333	4.4	7.033333333	0.033333333	4.7
4	1/01/2020 1:30	0.92	2.6	3.8	6.68	0.038	4.84
5	1/01/2020 2:00	0.942857143	2.228571429	3.942857143	6.571428571	0.03	4.514285714

Figure 5: Input 2 - Energy usage.

5.3 Input 3: Energy Cost

The input provides the price data for the spot market in $/kWh. In this study, Australian Energy Market Operator (AEMO) spot market price data were used. The data resolution is 30 minutes. An extract from a sample energy cost file is shown in Figure 6.

	A	B
1	Date and Time	PriceAEMO ($/kWh)
2	1/01/2020 0:30	0.06476
3	1/01/2020 1:00	0.06336
4	1/01/2020 1:30	0.06521
5	1/01/2020 2:00	0.06445

Figure 6: Input 3 - Energy cost.

5.4 Input 4: Energy Generated

The input provides the on-site energy generation data in kWh. The data resolution is 30 minutes. Taking into account the different scenarios in Table 2,

1. **Scenario 2** - If the energy generated on site is connected to its own separate meter different from the ones listed in Input 2 (Section 5.2), then the specific meter name should be provided as the column heading. In this example (Figure 7), it is called "Virtual NMI".

2. **Scenario 3** - If the generated energy on site is connected to any existing meter listed in Input 2 (Section 5.2), then the same NMI should be provided as column heading.

3. **Scenario 4** - If the generated energy on site is distributed among existing meters listed in Input 2 (Section 5.2), then the heading of the column becomes irrelevant. This should be clearly stated in Input 1 (Section 5.1.1 when defining the meter configuration.

	A	B
1	Date and Time	Virtual NMI (kWh)
2	1/01/2020 0:30	225
3	1/01/2020 1:00	225
4	1/01/2020 1:30	225
5	1/01/2020 2:00	225

Figure 7: Input 4 - Energy generated.

5.5 Input 5: Feed-in Tariff

The input provides the data on the input tariff rate in $/kWh. The data resolution is 30 minutes. An extract of a sample energy cost file is shown in Figure 8.

	A	B
1	Date and Time	Feed-in Tariff Rate ($/kWh)
2	1/01/2020 0:30	0.06476
3	1/01/2020 1:00	0.06336
4	1/01/2020 1:30	0.06521
5	1/01/2020 2:00	0.06445

Figure 8: Input 5 - Feed-in tariff.

5.6 Input 6: Business-as-Usual Bill

The input provides the summary of the reference energy bill (business as usual bill) for an entire year considering all meters listed in Input 2 (Section 5.2). This file is the basis of which all economic parameters would be calculated. An extract of a sample energy cost file is shown in Figure 9.

	A	B	C	D	E	F	G	H	I	J
1	Year	Quarter	Month	Days	Business as Usual					
2					Total IncGST ($)					
3					NMI1	NMI2	NMI3	NMI4	NMI5	NMI6
4	2020	Q1	January	31	6094.552	59413.1247	24677.4553	17459.0482	17284.79	2902.1289
5			February	29	4315.0385	43891.679	23497.1064	18444.9688	18565.16	2175.9722
6			March	31	4119.5548	32553.1905	22861.4848	17494.3893	17714.352	2137.2457
7			Quarterly	91	14529.1453	135857.994	71036.0465	53398.4063	53564.302	7215.3468
8		Q2	April	30	3287.5001	30187.6384	19379.4521	15446.7481	16010.019	1693.9137
9			May	31	3741.3778	32570.8332	20518.9335	17590.6745	18581.777	1767.269
10			June	30	3869.8055	36655.876	23033.1219	18914.3321	20650.591	1953.5022
11			Quarterly	91	10898.6833	99414.3476	62931.5075	51951.7547	55242.387	5414.6849
12		Q3	July	31	4780.0147	43778.017	28267.3586	23610.8791	24467.325	1881.8221
13			August	31	3921.8679	38994.5183	24915.0379	21924.8362	20831.692	1582.8843
14			September	30	3470.9276	31055.072	17952.7159	14978.7768	15863.388	1272.8307
15			Quarterly	92	12172.8102	113827.607	71135.1124	60514.4921	61162.405	4737.5371
16		Q4	October	31	3835.664	37696.8348	23294.748	16939.4397	21449.327	2251.6011
17			November	30	3558.8567	33568.797	20039.1296	11216.3968	17855.364	1835.2165
18			December	31	2826.2105	24426.5361	13765.0258	8135.5023	13621.855	1937.9226
19			Quarterly	92	10220.7312	95692.1679	57098.9034	36291.3388	52926.545	6024.7403
20		Annual		366	47821.37	444792.117	262201.57	202155.992	222895.64	23392.309

Figure 9: Input 6 - Business-as-Usual Bill.

5.7 Input 7: Life-cycle Cost Parameters

The input provides all component details and the associated essential economic parameters necessary for life-cycle cost assessment. There are two categories of information provided in the file.

- Category 1: The default parameters that apply to all components. These parameters are listed below.

  1. Lifetime
  2. Real discount rate (%)
  3. General inflation rate (%)
  4. Degradation rate (%)

  A sample extract is shown in Figure 10.

- Category 2: Component-specific parameters. These parameters are listed below.

1. Component name - It is a mandatory parameter.
2. Cost code - It is an optional parameter. It can be a specific string to match accounting cost codes - defaults to the next number in sequence.
3. Number of units - It is an optional parameter. The default value is 1.
4. Capital cost ($) - It is an optional parameter.
5. Installation cost ($) - It is an optional parameter.
6. Fixed operation and maintenance (O&M) cost ($) - It is an optional parameter.
7. Replacement cost ($) - It is an optional parameter and requires a supplementary parameter - replacement frequency.
8. Future cost ($) - It is an optional parameter and requires a supplementary parameter - future frequency.
9. Discount rate (%) - It is an optional parameter. If nothing is mentioned against each parameter, CEREI defaults to the default discount rate of Category 1 (Figure 10).
10. Inflation rate (%) - It is an optional parameter. If nothing is mentioned against each parameter, CEREI will default to the default inflation rate of Category 1 (Figure 10).

Note that unlimited number of components can be listed, one after the other. Each component must be followed by an empty row.

Although each of the listed cost is an optional parameter, however, against each of the defined component, at least one of Capital Cost, Installation Cost, Fixed O&M Cost, Replacement Cost, and / or Future Cost must be defined.

A sample extract is shown in Figure 11.

	A	B	
1	# Investment name is mandatory		
2	Investment Name	Biopower	
3			
4	# Lifetime, Discount Rate and Inflation Rate are all mandatory		
5	Lifetime	30	years
6	Discount Rate	5.5	
7	Inflation Rate	1.79	
8	Degradation Rate	4	

Figure 10: Default parameters within Input 7 - Life-cycle Cost Parameters.

	A	B	C
10	# There must be at one Component that can have the following optional or mandatory parameters. Each component must be followed by an empty row.		
11	# Component	Mandatory	Component Name
12	# Cost Code	Optional	Can be a specific string to match accounting cost codes - defaults to the next number in sequence
13	# Number of Units	Optional	Defaults to 1
14	# Capital Cost	Optional	Note that there must be at least one of Capital Cost, Installation Cost, Fixed O&M Ccst, Replacement Cost or Future Cost
15	# Installation Cost	Optional	
16	# Fixed O&M Cost	Optional	
17	# Replacement Cost	Optional	Requires a thrid parameter - replacement freqeuncy
18	# Future Cost	Optional	Requires a thrid parameter - future freqeuncy
19	#Discount Rate	Optional	Defaults to project Discount Rate
20	#Inflation Rate	Optional	Defaults to project Inflation Rate

Figure 11: Component specific parameters within Input 7 - Life-cycle Cost Parameters.

6 Output

CEREI produces four outputs (See Figure 1). The outputs can be generated separately from CEREI based on the inputs provided by the user. Figure 12 illustrates the inputs required to calculate each output.

Outputs	Inputs						
	Input 1: Network Tariff	Input 2: Energy Usage	Input 3: AEMO Spot Price	Input 4: Energy Generated	Input 5: Feed-in Tariff	Input 6: Business-as - Usual Bill	Input 7: Life-cycle Cost Parameters
Output 1 Energy Bill	Needed	Needed	Needed	*If there is an on-site generation (optional)*			
Output 2 Price Efficiency Index (PEI)	Needed	Needed	Needed	*If there is an on-site generation (optional)*			
Output 3 Potential Saving	Needed	Needed	Needed	*If there is an on-site generation (optional)*		Needed	
Output 4 Life-cycle Cost Assessment	Needed	Needed	Needed	*If there is an on-site generation (optional)*		Needed	Needed

Figure 12: Necessary inputs needed to produce the required output(s).

Each of the four are briefly discussed below.

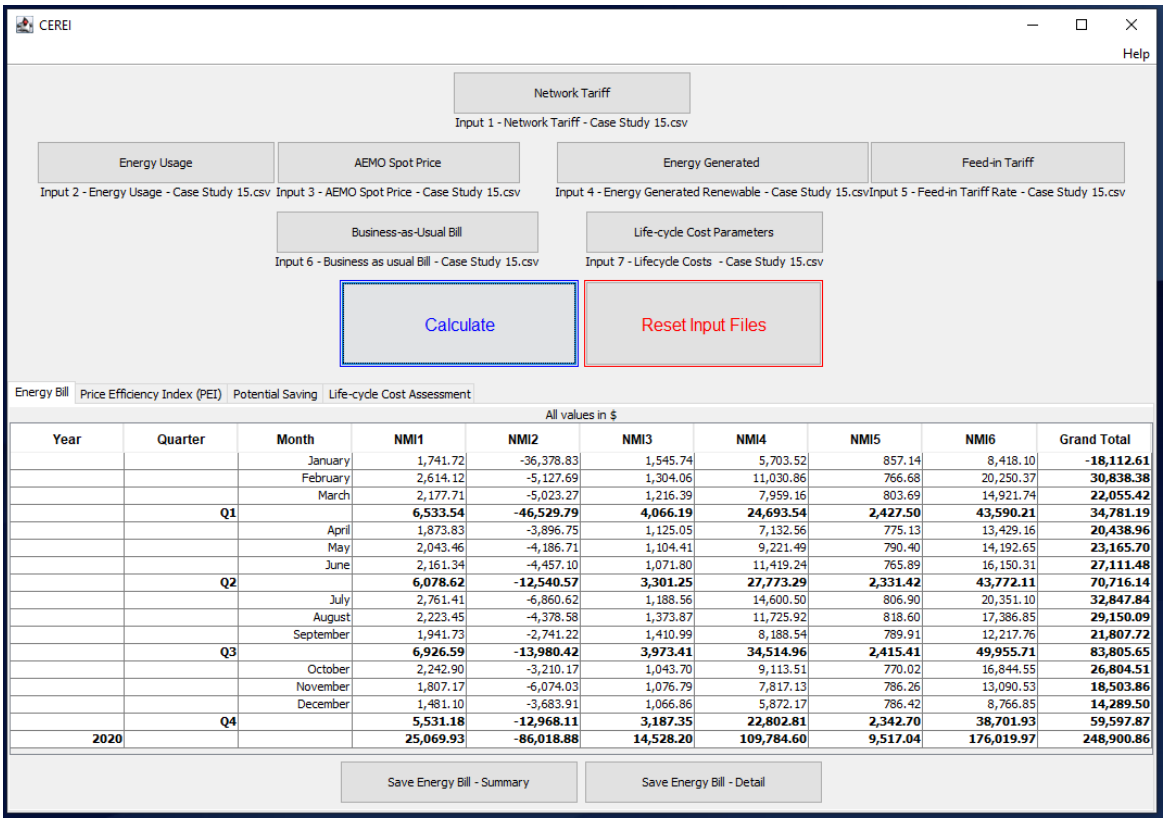
6.1 Output 1: Energy Bill

Output 1 provides the detailed and annual summary of the energy bill in the 'Energy Bill' tab in the CEREI interface (Figure 1).

The positive $ values indicate cost, while the negative $ values indicate credit.

Inputs required to generate Output 1 can be found in Figure 12.

A sample annual summary energy bill is shown in Figure 13. This annual summary can be exported and saved as a CSV file by clicking the 'Save Cost Summary' button in Figure 13.



Year	Quarter	Month	NMI1	NMI2	NMI3	NMI4	NMI5	NMI6	Grand Total
		January	1,741.72	-36,378.83	1,545.74	5,703.52	857.14	8,418.10	**-18,112.61**
		February	2,614.12	-5,127.69	1,304.06	11,030.86	766.68	20,250.37	**30,838.38**
		March	2,177.71	-5,023.27	1,216.39	7,959.16	803.69	14,921.74	**22,055.42**
	Q1		**6,533.54**	**-46,529.79**	**4,066.19**	**24,693.54**	**2,427.50**	**43,590.21**	**34,781.19**
		April	1,873.83	-3,896.75	1,125.05	7,132.56	775.13	13,429.16	**20,438.96**
		May	2,043.46	-4,186.71	1,104.41	9,221.49	790.40	14,192.65	**23,165.70**
		June	2,161.34	-4,457.10	1,071.80	11,419.24	765.89	16,150.31	**27,111.48**
	Q2		**6,078.62**	**-12,540.57**	**3,301.25**	**27,773.29**	**2,331.42**	**43,772.11**	**70,716.14**
		July	2,761.41	-6,860.62	1,188.56	14,600.50	806.90	20,351.10	**32,847.84**
		August	2,223.45	-4,378.58	1,373.87	11,725.92	818.60	17,386.85	**29,150.09**
		September	1,941.73	-2,741.22	1,410.99	8,188.54	789.91	12,217.76	**21,807.72**
	Q3		**6,926.59**	**-13,980.42**	**3,973.41**	**34,514.96**	**2,415.41**	**49,955.71**	**83,805.65**
		October	2,242.90	-3,210.17	1,043.70	9,113.51	770.02	16,844.55	**26,804.51**
		November	1,807.17	-6,074.03	1,076.79	7,817.13	786.26	13,090.53	**18,503.86**
		December	1,481.10	-3,683.91	1,066.86	5,872.17	786.42	8,766.85	**14,289.50**
	Q4		**5,531.18**	**-12,968.11**	**3,187.35**	**22,802.81**	**2,342.70**	**38,701.93**	**59,597.87**
2020			**25,069.93**	**-86,018.88**	**14,528.20**	**109,784.60**	**9,517.04**	**176,019.97**	**248,900.86**

Figure 13: A sample annual summary energy bill as part of Output 1 (Energy Cost).

The detailed monthly energy bill can also be exported and saved as a CSV file by clicking the "Save Energy Bill - Detail" button in Figure 13. A sample extract of the detailed January energy bill for NMI1 is presented in Figure 14.

Details for meter NMI1								
January 2020 for meter NMI1								
Energy Charges	Rate	Rate (Inc. Loss)	Unit	Usage	Unit	Loss ratio	Loss ratio (%)	Price($)
Pool Pass Through Charges import to site	Spot Price	Spot price + (Spot price x Loss ratio)	c/kWh	5276.93	kWh	0.07	6.86	354.55
Feed-in Charges from energy generated	Feed-in Tariff Rate	Feed-in Tariff Rate + (Feed-in Tariff Rate x Loss ratio)	c/kWh	0	kWh	0.07	6.86	0
Service and Admin Charge		2.09	$/Day	31	days			64.79
Network Charges								
Standing Charge		5962	$/Yr	31	days			504.98
Peak Energy		11.7	c/kWh	1860.64	kWh			217.7
Shoulder Energy		5.43	c/kWh	2111.54	kWh			114.66
Off Peak Energy		1.62	c/kWh	1304.74	kWh			21.14
Demand Critical Peak		0.57	$/kVA/Mth	14.33	kVA			8.17
Demand Capacity		0.34	$/kVA/Mth	110	kVA			37.95
Market Charges								
VEET Charge	0.74	0.8	c/kWh	5276.93	kWh	0.08	7.57	42
SRES Charge	0.98	1.05	c/kWh	5276.93	kWh	0.08	7.55	55.36
LRET Charge	0.79	0.85	c/kWh	5276.93	kWh	0.08	7.68	44.85
AEMO Pool Charge (GST Exempt)+AEMO RERT	0.25	0.26	c/kWh	5276.93	kWh	0.07	6.67	13.83
Ancillary Services	0.09	0.1	c/kWh	5276.93	kWh	0.08	7.78	5.12
Other Charges								
Meter Charge		1039.5	$/Yr	31	days			88.05
CT Compliance Testing Levy		121	$/Yr	31	days			10.25
Total (Ex GST)								1583.38
GST								158.34
Total (Inc GST)								1741.72

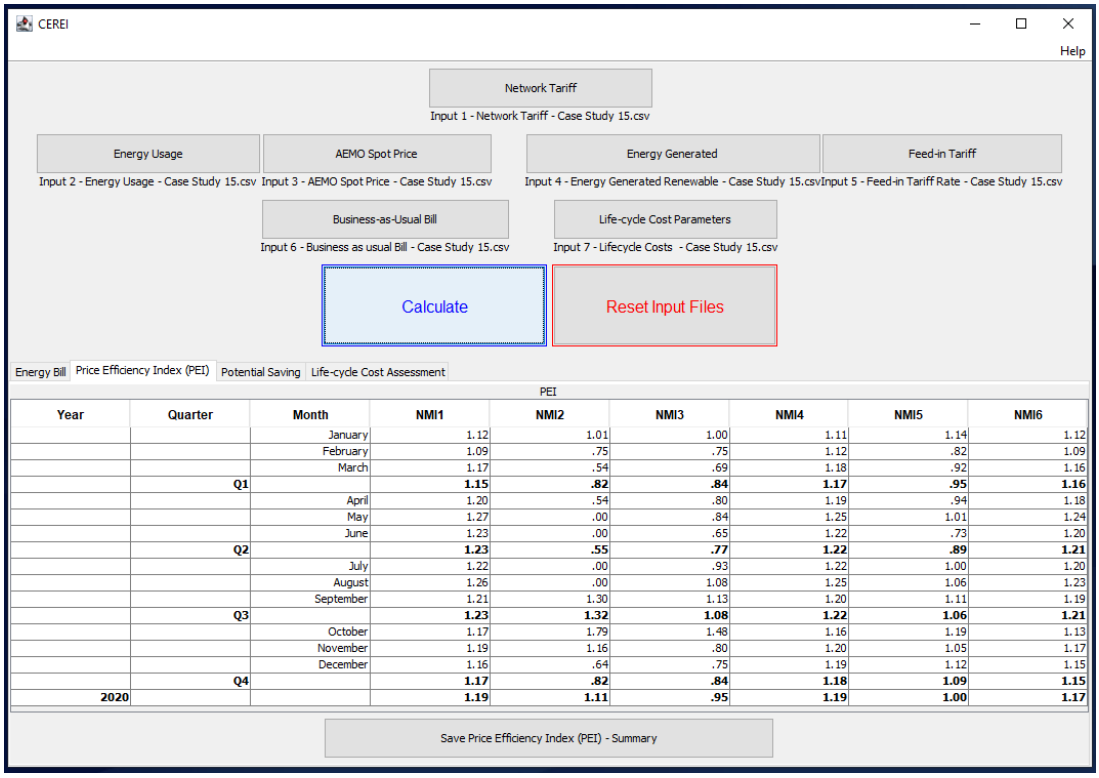
Figure 14: A sample extract of the monthly detailed energy bill for NMI1 - as part of Output 1 (Energy Cost).

6.2 Output 2: Price Efficiency Index (PEI)

Output 2 provides the annual summary of the Price Efficiency Index (PEI) in the 'Price Efficiency Index (PEI)' tab in the CEREI interface (Figure 1).

Inputs required to generate Output 2 can be found in Figure 12.

A sample annual summary PEI is shown in Figure 15. This summary of results can be exported and saved as a CSV file by clicking the "Save Price Efficiency Index (PEI) - Summary" button in Figure 15.



Year	Quarter	Month	NMI1	NMI2	NMI3	NMI4	NMI5	NMI6
		January	1.12	1.01	1.00	1.11	1.14	1.12
		February	1.09	.75	.75	1.12	.82	1.09
		March	1.17	.54	.69	1.18	.92	1.16
	Q1		**1.15**	**.82**	**.84**	**1.17**	**.95**	**1.16**
		April	1.20	.54	.80	1.19	.94	1.18
		May	1.27	.00	.84	1.25	1.01	1.24
		June	1.23	.00	.65	1.22	.73	1.20
	Q2		**1.23**	**.55**	**.77**	**1.22**	**.89**	**1.21**
		July	1.22	.00	.93	1.22	1.00	1.20
		August	1.26	.00	1.08	1.25	1.06	1.23
		September	1.21	1.30	1.13	1.20	1.11	1.19
	Q3		**1.23**	**1.32**	**1.08**	**1.22**	**1.06**	**1.21**
		October	1.17	1.79	1.48	1.16	1.19	1.13
		November	1.19	1.16	.80	1.20	1.05	1.17
		December	1.16	.64	.75	1.19	1.12	1.15
	Q4		**1.17**	**.82**	**.84**	**1.18**	**1.09**	**1.15**
2020			**1.19**	**1.11**	**.95**	**1.19**	**1.00**	**1.17**

Figure 15: A sample Output 2 - Price Efficiency Index (PEI).

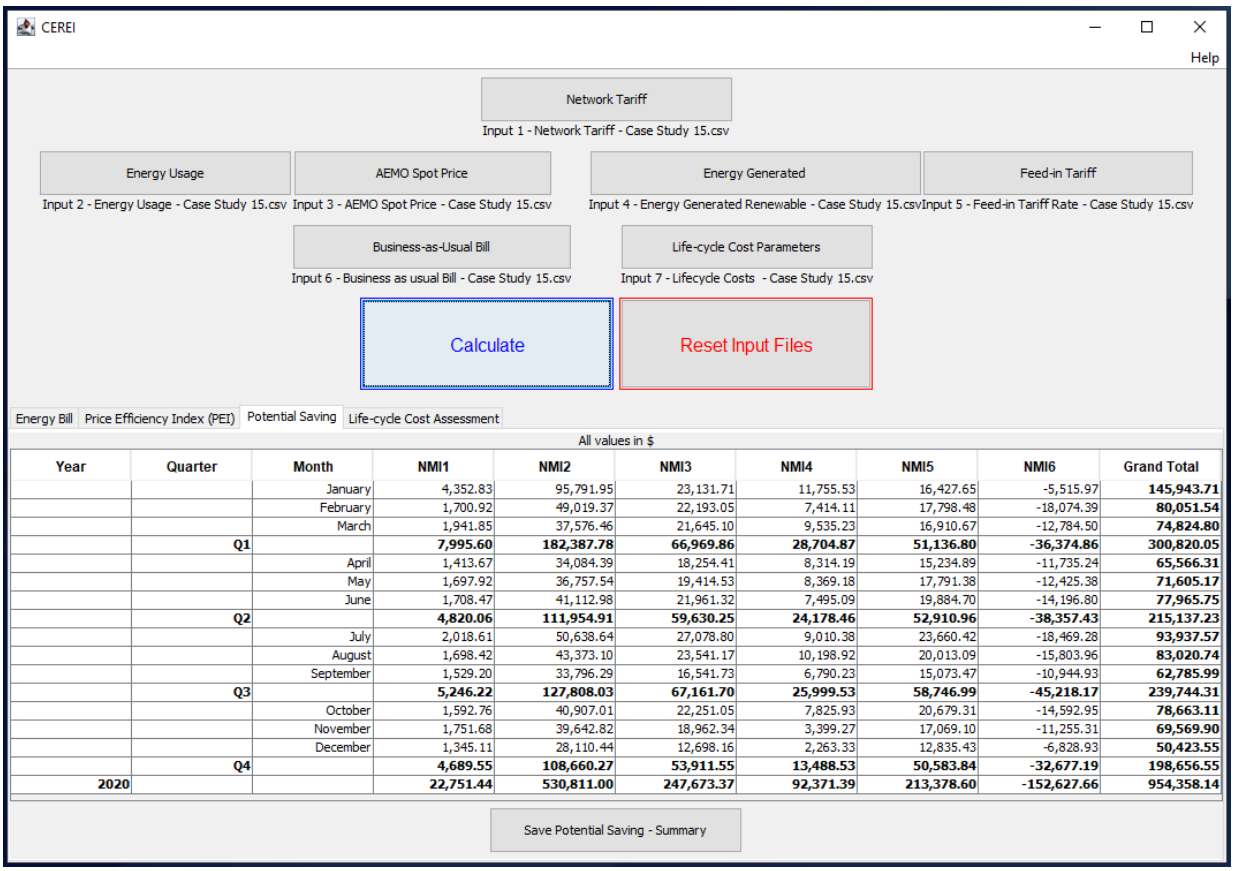
6.3 Output 3: Potential Saving

Output 3 provides annual summary of the potential savings by comparing the summary annual energy bill from Output 1 (Section 6.1) with the user-provided business-as-usual bill in Input 6 (Section 5.6). The summary is displayed under the 'Potential Saving' tab on the CEREI interface (Figure 1).

The positive $ values indicate cost, while the negative $ values indicate credit.

Inputs required to generate Output 3 can be found in Figure 12.

A sample annual summary of potential savings is shown in Figure 13. This result can be exported and saved as a CSV file by clicking the "Save Potential Saving - Summary" button in Figure 16.



Year	Quarter	Month	NMI1	NMI2	NMI3	NMI4	NMI5	NMI6	Grand Total
		January	4,352.83	95,791.95	23,131.71	11,755.53	16,427.65	-5,515.97	**145,943.71**
		February	1,700.92	49,019.37	22,193.05	7,414.11	17,798.48	-18,074.39	**80,051.54**
		March	1,941.85	37,576.46	21,645.10	9,535.23	16,910.67	-12,784.50	**74,824.80**
	Q1		**7,995.60**	**182,387.78**	**66,969.86**	**28,704.87**	**51,136.80**	**-36,374.86**	**300,820.05**
		April	1,413.67	34,084.39	18,254.41	8,314.19	15,234.89	-11,735.24	**65,566.31**
		May	1,697.92	36,757.54	19,414.53	8,369.18	17,791.38	-12,425.38	**71,605.17**
		June	1,708.47	41,112.98	21,961.32	7,495.09	19,884.70	-14,196.80	**77,965.75**
	Q2		**4,820.06**	**111,954.91**	**59,630.25**	**24,178.46**	**52,910.96**	**-38,357.43**	**215,137.23**
		July	2,018.61	50,638.64	27,078.80	9,010.38	23,660.42	-18,469.28	**93,937.57**
		August	1,698.42	43,373.10	23,541.17	10,198.92	20,013.09	-15,803.96	**83,020.74**
		September	1,529.20	33,796.29	16,541.73	6,790.23	15,073.47	-10,944.93	**62,785.99**
	Q3		**5,246.22**	**127,808.03**	**67,161.70**	**25,999.53**	**58,746.99**	**-45,218.17**	**239,744.31**
		October	1,592.76	40,907.01	22,251.05	7,825.93	20,679.31	-14,592.95	**78,663.11**
		November	1,751.68	39,642.82	18,962.34	3,399.27	17,069.10	-11,255.31	**69,569.90**
		December	1,345.11	28,110.44	12,698.16	2,263.33	12,835.43	-6,828.93	**50,423.55**
	Q4		**4,689.55**	**108,660.27**	**53,911.55**	**13,488.53**	**50,583.84**	**-32,677.19**	**198,656.55**
2020			**22,751.44**	**530,811.00**	**247,673.37**	**92,371.39**	**213,378.60**	**-152,627.66**	**954,358.14**

Figure 16: A sample Output 3 - Potential Savings.

6.4 Output 4: Life-cycle Cost Assessment

Output 4 provides the detailed and annual life-cycle cost assessment under the 'Lifecycle Cost Assessment' tab in the CEREI interface (Figure 1).

The negative $ values indicate cost, while the positive $ values indicate revenue.

Inputs required to generate Output 4 can be found in Figure 12.

A summary of the life cycle cost assessment sample is shown in Figure 17. This annual summary can be exported and saved as CSV file by clicking the "Save Life-cycle Cost Assessment - 'Summary' button in Figure 17. The detailed life-cycle assessment results (see Figure 18) can also be exported and saved by clicking on the "Save Life-Cycle Cost Assessment - Detail" button as shown in Figure 17.

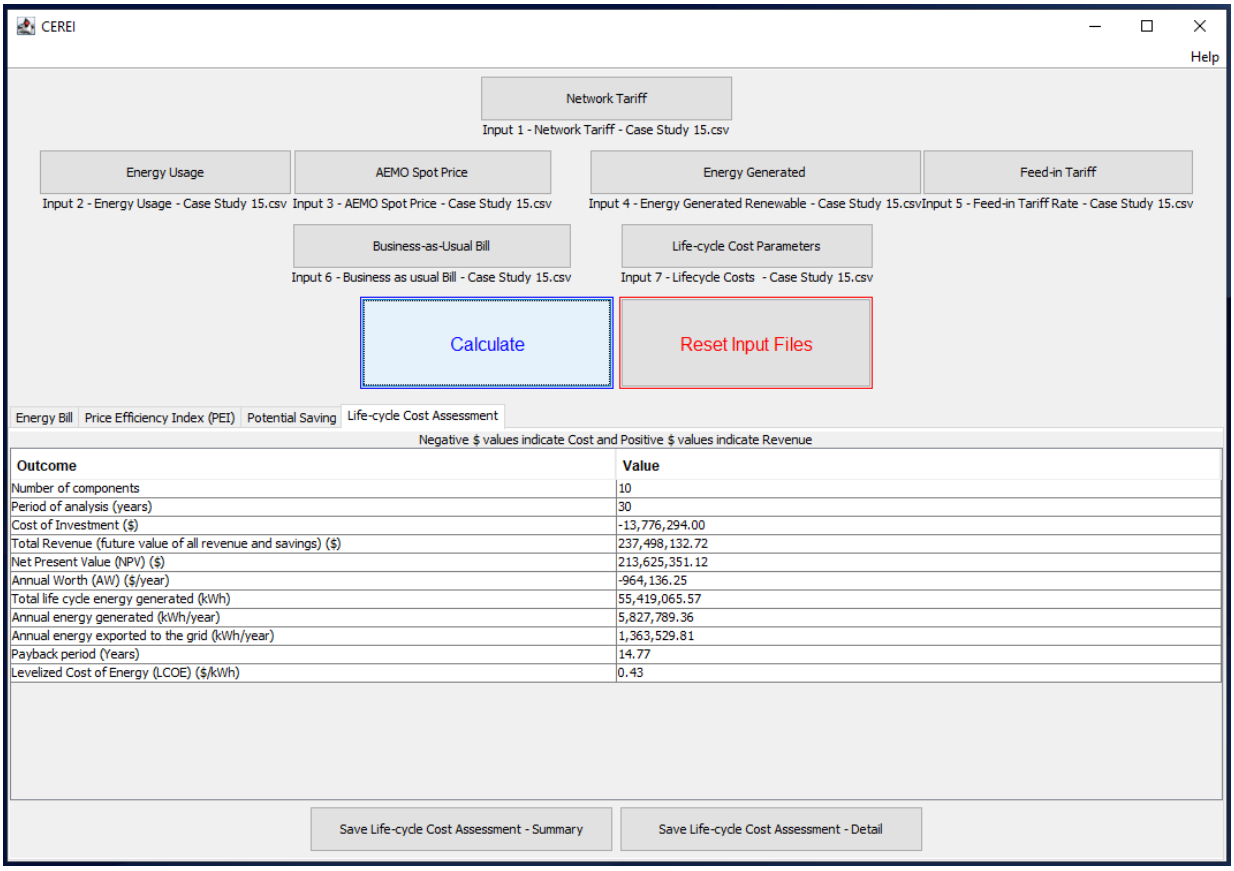


Figure 17: A sample Output 4 - Life-cycle cost analysis summary.

7 Functionalities

The tariffs considered in for the development of CEREI are: (i) Tariff G1 (e.g., NSP81); and (ii) Tariff G2 (e.g., NSP82 and NSP83), which are structured as follows:

Tariff G1: The components within this tariff structure are:

- Standing charge ($/year)
- Peak rate (c/kWh) is considered between 7am to 11pm, Monday to Friday
- Off-peak rate (c/kWh) is considered at all other times
- Capacity ($/KVA/year)
- Critical peak demand ($/KVA/year)

Tariff G2: The components within this tariff structure are:

- Standing charge ($/year)
- Peak rate (c/kWh) is considered between 7am to 10am and 4pm to 11pm, Monday to Friday
- Shoulder rate (c/kWh) is considered between 10am to 4pm, Monday to Friday
- Off-peak rate (c/kWh) is considered at all other times
- Capacity ($/KVA/year)
- Critical peak demand ($/KVA/year)

The calculation of the outputs can vary widely depending on the interconnection of the meters and the existence of the renewable energy generation on site. CEREI has been developed on the basis of four scenarios considering both the presence and the absence of renewable energy generation on site. These scenarios are described in the following and are graphically presented in Table 2.

Details for Biopower and NSP83 for 2020											
Cost Code	Component	Unit Cost (	Unit	No of Unit	Payment (	Year of An	Total Cost	Discount F	Inflation F	Inflation a	NPV (AUD)	ATLCC (AUD)
1	Component 1											
1.1	Captial Cost	185000	AUD/Unit	2	0	30	370000	5.5	1.79	7.39	-370000	-30988.82
1.2	Installation Cost	40000	AUD/Unit	2	0	30	80000	5.5	1.79	7.39	-80000	-6700.29
2	Component 2											
2.1	Captial Cost	320000	AUD/Unit	4	0	30	1280000	5.5	1.79	7.39	-1280000	-107204.57
2.2	Installation Cost	128000	AUD/Unit	4	0	30	512000	5.5	1.79	7.39	-512000	-42881.83
3	Component 3											
3.1	Captial Cost	32400	AUD/Unit	1.8	0	30	58320	5.5	1.79	7.39	-58320	-4884.51
3.2	Installation Cost	12960	AUD/Unit	1.8	0	30	23328	5.5	1.79	7.39	-23328	-1953.8
4	Component 4											
4.1	Captial Cost	300000	AUD/Unit	1	0	30	300000	5.5	1.79	7.39	-300000	-25126.07
4.2	Installation Cost	120000	AUD/Unit	1	0	30	120000	5.5	1.79	7.39	-120000	-10050.43
4.3	Replacement Cost	420000	AUD/Unit	1	20	30	420000	5.5	1.79	7.39	-143946.16	-12056
5	Component 5											
5.1	Captial Cost	120000	AUD/Unit	1	0	30	120000	5.5	1.79	7.39	-120000	-10050.43
5.2	Installation Cost	48000	AUD/Unit	1	0	30	48000	5.5	1.79	7.39	-48000	-4020.17
5.3	Replacement Cost	168000	AUD/Unit	1	20	30	168000	5.5	1.79	7.39	-57578.47	-4822.4
6	Component 6											
6.1	Captial Cost	1860890	AUD/Unit	1	0	30	1860890	4.9	1.79	6.78	-1860890	-146627.83
6.2	Installation Cost	744356	AUD/Unit	1	0	30	744356	4.9	1.79	6.78	-744356	-58651.13
6.3	Fixed O&M Costs	260081	AUD/Unit	1	1 ... 29	30	260081	4.9	1.79	6.78	-4044064.12	-318649.86
6.4	Replacement Cost	2605246	AUD/Unit	1	15	30	2605246	4.9	1.79	6.78	-1271207.41	-100164.1
7	Component 7											
7.1	Captial Cost	5980000	AUD/Unit	1	0	30	5980000	4.9	1.79	6.78	-5980000	-471190.88
7.2	Installation Cost	2272400	AUD/Unit	1	0	30	2272400	4.9	1.79	6.78	-2272400	-179052.54
7.3	Replacement Cost	8252400	AUD/Unit	1	20	30	8252400	4.9	1.79	6.78	-3170082.08	-249784.91
8	Component 8											
8.1	Captial Cost	5000	AUD/Unit	1	0	30	5000	4.9	1.79	6.78	-5000	-393.97
8.2	Installation Cost	2000	AUD/Unit	1	0	30	2000	4.9	1.79	6.78	-2000	-157.59
8.3	Replacement Cost	7000	AUD/Unit	1	15	30	7000	4.9	1.79	6.78	-3415.59	-269.13
9	Component 9											
9.1	Fixed O&M Costs	83892	AUD/Unit	1	1 ... 29	30	83892	4.9	1.79	6.78	-1304457.56	-102784.03
10	Component 10											
10.1	Fixed O&M Costs	7000	AUD/Unit	1	1 ... 29	30	7000	5.5	1.79	7.39	-101736.22	-8520.77
11	Scenario Equipment Totals										-23872781.6	-1896986.05

Figure 18: A sample Output 4 - Life-cycle cost analysis details.

Scenario 1: There is no on-site generation. In this scenario, the user can use the tool to calculate and analyse the monthly, quarterly, and annual energy costs based on the new nominated tariff structure.

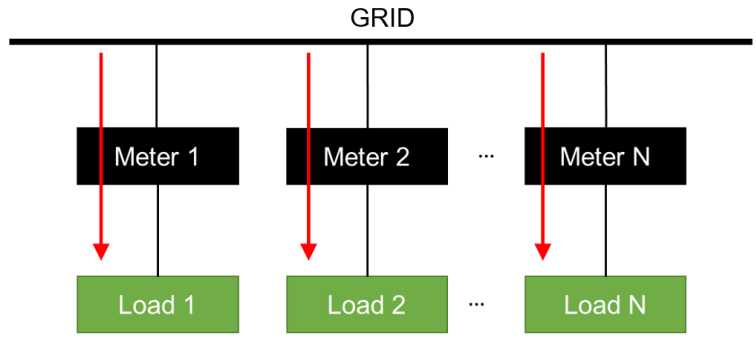
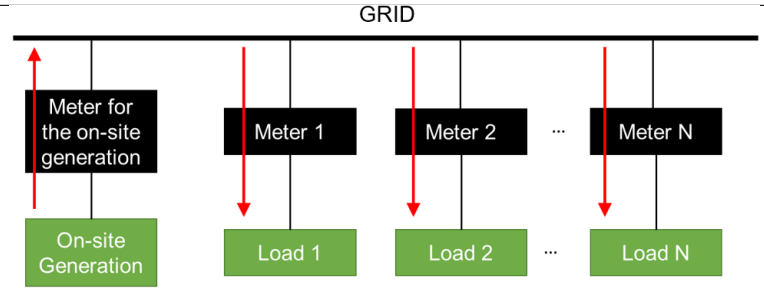
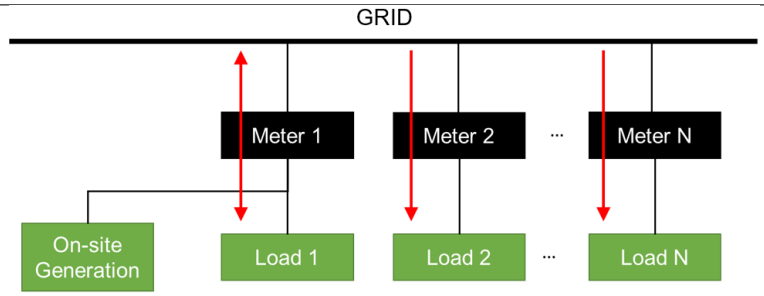
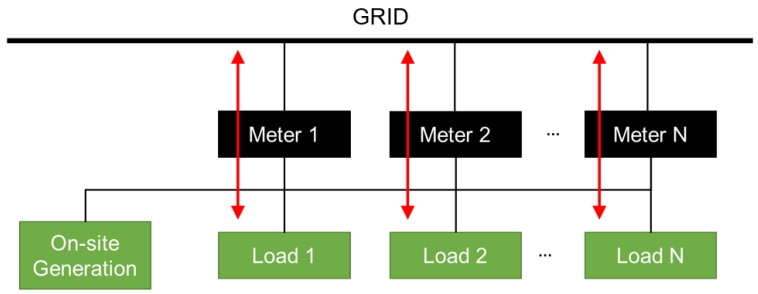
Scenario 2: There is on-site generation, but the energy produced is not consumed on-site. In this scenario, the user can consider that the distributed energy resource (DER) is connected to the grid through its own meter. In this case, all the energy generated by the DER will be exported to the grid on the basis of the feed-in tariff rate.

Scenario 3: There is an on-site generation, and it is connected to one existing meter. In this scenario, the generated energy can be consumed by the loads connected to the selected meter only and the remaining energy will be exported to the grid based on the feed-in tariff rate.

Scenario 4: There is on-site generation and it is distributed among the existing meters. In this scenario, the energy generated will be consumed by the selected meters and the remaining energy will be exported to the grid based on the feed-in tariff rate. The selection of the meters should be specified by the user in the Input 1 file. Accordingly, there are three different meter selection options as follows:

- The energy generated is distributed among the existing meters based on the priority order provided by the user (user allocated on percentage).
- If Input 6 is provided, the energy generated is automatically distributed among existing meters based on the priority created by the highest to lowest annual cost of the meter from Input 6.
- Otherwise, the energy generated is distributed among the existing meters automatically based on the priority obtained from the order of the meters' appearance in Input 2.

Table 2: Meter connection

Scenario	Meter Connection
Scenario 1 - No generation	
Scenario 2 - On-site generation connected to a separate meter	
Scenario 3 - On-site generation connected with one existing meter	
Scenario 4 - On-site generation connected with all existing meters	

8 Case Studies

To test CEREI, 15 case studies have been designed simulating all possible real world scenarios (see Table 2) the tool can be used for. The list of the developed 15 case studies are summarised in Table 3. The sample input files for all the case studies in Table 3 and blank input file templates are available with CEREI.

Table 3: Case studies

Case Study	Scenario	Outputs Generated
Case Study 1	Scenario 1	Output 1 (New Energy Bill) and Output 2 (Price Efficiency Index (PEI)) - not considering on-site renewable energy generation.

Case Study 2	Scenario 2	Output 1 (New Energy Bill) and Output 2 (Price Efficiency Index (PEI)) - considering on-site renewable energy generation. The energy generated on-site is connected to a Virtual NMI. There is no load connected to the Virtual NMI.
Case Study 3	Scenario 3	Output 1 (New Energy Bill) and Output 2 (Price Efficiency Index (PEI)) - considering on-site renewable energy generation. The energy generated on-site is connected to one existing meter.
Case Study 4	Scenario 4	Output 1 (New Energy Bill) and Output 2 (Price Efficiency Index (PEI)) - considering on-site renewable energy generation. The energy generated on-site is connected to all the existing meters (energy generated is distributed among the existing meters by the user supplied priority ranking of the meters via Input 1 (Network Tariff)).
Case Study 5	Scenario 4	Output 1 (New Energy Bill) and Output 2 (Price Efficiency Index (PEI)) - considering on-site renewable energy generation. The energy generated on-site is connected to all the existing meters (energy generated is distributed among the existing meters by the priority raking of meters obtained from the order of their listing in Input 2 (Energy Usage)).
Case Study 6	Scenario 1	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), and Output 3 (Savings in Energy Bill) - not considering on-site renewable energy generation.
Case Study 7	Scenario 2	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), and Output 3 (Savings in Energy Bill) - considering on-site renewable energy generation. The energy generated on-site is connected to a Virtual NMI. There is no load connected to the Virtual NMI.
Case Study 8	Scenario 3	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), and Output 3 (Savings in Energy Bill) - considering on-site renewable energy generation. The energy generated on-site is connected to one existing meter.
Case Study 9	Scenario 4	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), and Output 3 (Savings in Energy Bill) - considering on-site renewable energy generation. The energy generated on-site is connected to all the existing meters (energy generated is distributed among the existing meters by the user supplied priority ranking of the meters via Input 1 (Network Tariff)).
Case Study 10	Scenario 4	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), and Output 3 (Savings in Energy Bill) - considering on-site renewable energy generation. The energy generated on-site is connected to all the existing meters (energy generated is distributed among the existing meters by the priority raking of meters obtained from highest to lowest annual energy cost obtained from Input 6 (Business as Usual)).
Case Study 11	Scenario 1	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), Output 3 (Savings in Energy Bill), and Output 4 (Life-cycle Cost Analysis) - not considering on-site renewable energy generation.
Case Study 12	Scenario 2	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), Output 3 (Savings in Energy Bill), and Output 4 (Life-cycle Cost Analysis) - considering on-site renewable energy generation. The energy generated on-site is connected to a Virtual NMI. There is no load connected to the Virtual NMI.
Case Study 13	Scenario 3	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), Output 3 (Savings in Energy Bill), and Output 4 (Life-cycle Cost Analysis) - considering on-site renewable energy generation. The energy generated on-site is connected to one existing meter.

Case Study 14	Scenario 4	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), Output 3 (Savings in Energy Bill), and Output 4 (Life-cycle Cost Analysis) - considering on-site renewable energy generation. The energy generated on-site is connected to all the existing meters (energy generated is distributed among the existing meters by the user supplied priority ranking of the meters via Input 1 (Network Tariff)).
Case Study 15	Scenario 4	Output 1 (New Energy Bill), Output 2 (Price Efficiency Index (PEI)), Output 3 (Savings in Energy Bill), and Output 4 (Life-cycle Cost Analysis) - considering on-site renewable energy generation. The energy generated on-site is connected to all the existing meters (energy generated is distributed among the existing meters by the priority raking of meters obtained from highest to lowest annual energy cost obtained from Input 6 (Business as Usual)).