

# Renewable PPA Tool Set

## User Manual

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## 1. Introduction

The PPA Tool Set consists of a series of Microsoft Excel workbooks developed to assist in the creation of cash flow models for Renewable PPAs. Multiple workbooks are used to allow the tool to be implemented in MS Excel despite the large amount of data required. Each workbook is briefly described below and then in more detail in subsequent sections.

**Multi-factor Sensitivity Analysis Tool for Renewable PPAs (MSAT-PPA)** – This workbook is broken down into three sections:

1. PPA Yearly Framework: This set of tabs creates the contract structures and calculates the cashflows on yearly basis
2. PPA Templates: This set of tabs enables the users to easily model a set of predefined PPA contract structures based on templates, that are then analysed automatically by the Yearly Framework.
3. Sensitivity Analysis: This tab enables the user to create and analyse large sets of alternative scenarios in order to determine the sensitivity of cashflows to contract variables.

**NEM RE Generation Data** – This workbook provides half-hourly historical utility-scale solar and wind data from the NEM. It provides the data pre-formatted for compatibility with the Yearly Framework workbook and the Yearly Templates workbook.

**NEM Price Data** – This workbook provides half-hourly historical wholesale price data from the NEM. It provides the data pre-formatted for compatibility with the Yearly Framework workbook and the Yearly Templates workbook.

## 2. Quick start guide

This section of the manual aims to provide a concise guide for first time users. It assumes users are following one of the two recommended approaches outlined below, but it may still be helpful for those adopting another approach.

### *Users who do not currently have a PPA*

For users who have not signed a PPA, it is easiest to start using the tool by modelling their current retail arrangement. This allows the user to check the modelling results against electricity bills they have already received, an important step in ensuring the model has been set up correctly.

Afterwards, the user can implement different PPA frameworks and compare them to their current retail contract.

### *Users who have already signed a PPA*

For users who have signed a PPA but wish to use the tool to model future scenarios, it is easiest to begin by using the tool to model their current PPA. This allows the user to check the modelling results against current electricity bills they have already received under the PPA, an important step in ensuring the model has been set up correctly.

### 2.1 Data requirements

The tool requires the appropriate data in order to produce meaningful results, including load data, renewable generation data, tariffs, etc. The subsections below describe in detail the data requirements.

#### *Data for standard retail agreement modelling*

A user starting by modelling their current retail arrangement would require the following data.

**Load profile:** a half-hourly load profile that covers at least one historical billing period. This should be in a two-column format, with the first column a datetime format like “YYY/MM/DD HH:MM”, or a format that is similarly interpretable by Excel. The second column should be the energy used over the preceding half hour in kWh. Note this example assumes that there is not onsite generation and hence the user does not need to consider whether the load profile is gross or net.

**Tariff details:** a summary of the tariffs paid under the current retail agreement. These are usually provided as part of an electricity bill. Additional documents may be needed if the bill does not provide the time of use parameters i.e. during which hours do peak and off-peak charges apply.

#### *Data for PPA modelling*

A user starting by modelling their current PPA would require the data listed above in addition to the data described below. Note that if an onsite generation PPA is being modelled, then a gross load profile is needed.

**Renewable energy generation profile:** a half hourly generation profile, using the same format described above for the load profile. Profiles for NEM registered scheduled and semi-scheduled generators can be accessed in the Generation Data workbook (for calendar years 2011 - 2018).

**NEM price:** a half-hourly wholesale price profile using the same format described above for the load profile. The profile should be for the region in which the load and generator are situated. Profiles for NEM regions can be accessed in the NEM Price Data workbook (for calendar years 2011 - 2018).

**PPA structure and details** – A detailed description of how the PPA is structured, answering questions such as does the PPA operate through a Contract for Difference (CFD), a tariff pass through, a physical hedge, or on-site provision of generation. How is the volume traded through the PPA determined? How are LGCs traded? Are there financial penalties/compensation for the generator missing production targets etc. The details would also need to include any prices and volumes specified in the contract.

## 2.2 Step by step implementation

### 1. Color scheme guide

The screenshots in this section follow the legend shown below.

Label
Input: select option
Input: select profile
Input: numeric
Input: text
Input: datetime
Not available due to current selection

### 2. Adding a new load profile

- Delete all data and profile IDs from the inputs section of '3.2 - Load & Gen Profiles' tab, the result should be as below.

Profile ID							
Datetime	Energy (kWh)						

- Copy datetime and load columns into the sheet, also provide a ID for the profile, the result should be as below. Note the first datetime is half an hour into the year because it records the total kWh for the preceding half hour. Also, note all subsequent load and generator profiles need to cover the same time period.

Profile ID	Input Load						
Datetime	Energy (kWh)						
1/01/2018 0:30	7,171.00						
1/01/2018 1:00	7,102.00						
1/01/2018 1:30	7,843.00						
1/01/2018 2:00	7,586.00						
1/01/2018 2:30	7,132.00						
1/01/2018 3:00	8,385.00						

### 3. Adding a generator profile (if required for PPA modelling)

Copy the generator profile into the '3.2 - Load & Gen Profiles' tab, as for the load profile.

Profile ID	Input Load	RE Generator					
Datetime	Energy (kWh)						
1/01/2018 0:30	7,171.00	0.00					
1/01/2018 1:00	7,102.00	0.00					
1/01/2018 1:30	7,843.00	0.00					
1/01/2018 2:00	7,586.00	0.00					
1/01/2018 2:30	7,132.00	0.00					
1/01/2018 3:00	8,385.00	0.00					

#### 4. Adding a price profile (if required for PPA modelling)

In the '3.3 - Wholesale Price Profiles' tab, delete any pre-existing data, including datetimes, then copy the datetime and price data into the sheet and provide an ID for the profile. Then select if the profile should be scaled and to what value. The result should be as below.

Normalise	TRUE
-----------	------

Normalise to:	80.00
---------------	-------

Price Profile ID	NSW 2018					
Datetime	Price (\$/MWh)					
1/01/2018 0:30	91.86					
1/01/2018 1:00	88.83					
1/01/2018 1:30	73.62					
1/01/2018 2:00	71.49					
1/01/2018 2:30	69.27					
1/01/2018 3:00	69.44					

#### 5. Selecting the PPA template

- On the '3.1 - Contract Details' tab, if the user is modelling their standard retail agreement then the active template should be set to 'No PPA'.

#### Select PPA template

Select active template:	No PPA
-------------------------	--------

#### Provide PPA details

Off-site - Contract for Difference	
Off-site - Tariff Pass Through	
Off-site - Physical Hedge	
On-site RE Generator	
No PPA	
Wholesale Price ID	NSW 2018
Wholesale Exposure Volume	All RE
Load ID	Input Load
Generator ID	RE Generator
PPA Volume	RE Uptill Load
PPA Price	50.00
Excess RE Purchase Price (\$/MWh)	1.00
Excess RE Sale Price (\$/MWh)	2.00
LGC Volume Type	Frac Load
LGC Purchase Volume (MWh, Fraction)	1.00
LGC Purchase Price (\$/MWh)	0.00
Yearly Target (MWh)	33,000.00
Target Period	Monthly
Short Fall Penalty (\$/MWh)	15.00
Yearly LGC target (LGC)	0.00
Yearly LGC short fall penalty (\$/LGC)	0.00

- b. If the user is modelling a PPA, then they need to select the relevant template at this point. This will activate the required inputs, as shown below. Further information on each template and the inputs required are provided in section 3.1.

### Select PPA template

Select active template:	Off-site - Contract for Difference
-------------------------	------------------------------------

### Provide PPA details

Off-site - Contract for Difference	
Off-site - Tariff Pass Through	
Off-site - Physical Hedge	
On-site RE Generator	
No PPA	
Wholesale Price ID	NSW 2018
Wholesale Exposure Volume	All RE
Load ID	Input Load
Generator ID	RE Generator
PPA Volume	RE Uptill Load
PPA Price	50.00
Excess RE Purchase Price (\$/MWh)	1.00
Excess RE Sale Price (\$/MWh)	2.00
LGC Volume Type	Frac Load
LGC Purchase Volume (MWh, Fraction)	1.00
LGC Purchase Price (\$/MWh)	0.00
Yearly Target (MWh)	33,000.00
Target Period	Monthly
Short Fall Penalty (\$/MWh)	15.00
Yearly LGC target (LGC)	0.00
Yearly LGC short fall penalty (\$/LGC)	0.00

### 6. Setting loss factors

- a. If just a retail agreement is being modelled, then only the load's loss factors are required. The result should be as shown.

### Provide loss factor details

Loss factor details	
Load MLF	0.90
Load DLF	1.00
Generator MLF	1.00
Generator DLF	1.00

- b. In the case of modelling a physical hedge PPA, the RE Generators' MLF and DLF must also be provided.

### Provide loss factor details

Loss factor details	
Load MLF	0.90
Load DLF	1.00
Generator MLF	1.00
Generator DLF	1.00

### 7. Setting time of use tariffs

In most cases, a set of Time of Use Tariffs that cover both the energy and network components of the user's retail agreement will be needed. Network and Energy components should be separated, and then further broken down into Peak, Shoulder and Off-Peak components. Note, if some charges don't apply in the retail agreement, i.e. there is no Shoulder component, then these do not need to be specified. Additionally, Peak, Shoulder and Off-Peak charges need to be further broken down, into Weekday and Weekend versions, and potentially into AM and PM versions if they apply to separate time periods throughout the day. An example set of tariffs is shown below to illustrate this.

### Provide time of use tariff details

Time of Use Tariffs				
Charge Type	Charge Name	Charge Version	Volume Type	Rate
Energy	Off Peak	Weekday	Energy (\$/MWh)	65.00
Energy	Shoulder		Energy (\$/MWh)	70.00
Energy	Peak	AM	Energy (\$/MWh)	85.00
Energy	Peak	PM	Energy (\$/MWh)	85.00
Energy	Off Peak	Weekend	Energy (\$/MWh)	65.00
Network	Shoulder		Energy (\$/MWh)	24.00
Network	Off Peak	Weekday	Energy (\$/MWh)	15.00
Network	Peak		Energy (\$/MWh)	30.00
Network	Off Peak	Weekend	Energy (\$/MWh)	15.00

Tariffs are broken down into subcomponents. Note the combination of Charge Type, Charge Name and Charge Version is unique for each row, this allows the tool to accurately attribute a cost to each charge.

Time of Use Tariffs				Weekday Hours of Applicability																								
Charge Name	Charge Version	Volume Type	Rate	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Off Peak	Weekday	Energy (\$/MWh)	65.00	1	1	1	1	1	1	1																	1	1
Shoulder		Energy (\$/MWh)	70.00												1	1	1	1	1	1	1							
Peak	AM	Energy (\$/MWh)	85.00								1	1	1															
Peak	PM	Energy (\$/MWh)	85.00																		1	1	1	1	1			
Off Peak	Weekend	Energy (\$/MWh)	65.00																									
Shoulder		Energy (\$/MWh)	24.00																									
Off Peak	Weekday	Energy (\$/MWh)	15.00	1	1	1	1	1	1	1																		
Peak		Energy (\$/MWh)	30.00								1	1	1	1	1	1	1											
Off Peak	Weekend	Energy (\$/MWh)	15.00																		1	1	1	1	1	1	1	1

The Weekend Hours of Applicability table allows the user to set the weekday hours during which each charge applies. Note charges that are discontinuous such as the 'Energy Peak' charge, are broken into separate versions. Charges that are discontinuous only over the 23 h to 0 h step, such as the 'Network Off Peak' charge, can be represented in a single charge.

Time of Use Tariffs			
Charge Name	Charge Version	Volume Type	Rate
Off Peak	Weekday	Energy (\$/MWh)	65.00
Shoulder		Energy (\$/MWh)	70.00
Peak	AM	Energy (\$/MWh)	85.00
Peak	PM	Energy (\$/MWh)	85.00
Off Peak	Weekend	Energy (\$/MWh)	65.00
Shoulder		Energy (\$/MWh)	24.00
Off Peak	Weekday	Energy (\$/MWh)	15.00
Peak		Energy (\$/MWh)	30.00
Off Peak	Weekend	Energy (\$/MWh)	15.00

↑  
Expand to set Time of Use Parameters

Weekend Hours of Applicability																							
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

The Weekend Hours of Applicability table allows the user to set the weekend hours during which each charge applies. The same rules apply to the use of this table as for the corresponding weekday table. Note that charges applying to the weekend need to be separate versions to those applying to the weekdays.

### 8. Setting the flat rate tariffs

Flat rate tariffs are set similarly to time of use tariffs, except they apply at all times, this means there is no need to break charges down into multiple versions.

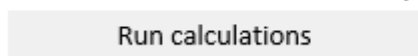
Provide flat rate tariff details

Flat Rate Charges				
Charge Type	Charge Name	Charge Version	Volume Type	Rate
Network	Access		Fixed (\$/day)	45.00
Network	Peak Demand		Max Demand (\$/MVA/day)	50.00
Market	NEM Adm		Energy (\$/MWh)	0.80
Market	NEM Ancillary Serv.		Energy (\$/MWh)	0.10
Environmental	LREC		Energy (\$/MWh)	7.00
Environmental	SRES		Energy (\$/MWh)	1.00
Environmental	NESC		Energy (\$/MWh)	1.00
Metering and Other	Meter Charge		Fixed (\$/day)	1.00

### 9. Running the calculations

The online version of the tool is saved with automatic calculations turned off to improve the user experience. Calculations can be run by using the button provided, or by using the F9 key on windows.

Press to run calculations (use F9 to run the model from any tab)



### 10. Review the outputs

The outputs can be reviewed in the "4.2 - Bills" tab.



## 2.3 Performing a sensitivity analysis

A sensitivity analysis can be performed using the '2 - Sensitivity Analysis' tab.

1. Use the 'Import Base Case' button, to setup the sensitivity analysis with a base case scenario that reflects the current state of the 'Template' tabs

### Control panel

Scenario count	1	Import Base Case	Run Scenarios
Scenarios done	0		
Time per scenario (s)	5.00	Update Estimates	Activate Scenario -> 0
Estimated runtime (min)	0.08		
Time left (min)	0.08		

### Multi-factor Sensitivity Analysis Input Variants

Input name ranges	Input ID						
	1	2	3	4	5	6	
PPA	Off-site - Contract for Difference						
Wholesale_Price_ID	NSW 2018						
Average_Wholesale_Price	80.00						
Wholesale_Exposure_Volume	All RE						
Load_ID	Input Load						
Generator_ID	RE Generator						
PPA_Volume	RE Uptill Load						
PPA_Price	50.00						
Excess RE Purchase Price	1.00						

2. Then use Input ID columns 2 to 10 to add additional input variants, you do not need to add extra variants for all inputs, but each input should have an input in column 1, which can be zero if needed. Press 'Update Estimates' to get the number of scenarios and expected runtime, note using 5 s as the 'Time per scenario' should result in a pessimistic runtime estimates, good quality laptops can achieve 3 s.

### Control panel

Scenario count	24	Import Base Case	Run Scenarios
Scenarios done	0		
Time per scenario (s)	5.00	Update Estimates	Activate Scenario -> 0
Estimated runtime (min)	2.00		
Time left (min)	2.00		

### Multi-factor Sensitivity Analysis Input Variants

Input name ranges	Input ID						
	1	2	3	4	5	6	
PPA	Off-site - Contract for Difference	No PPA					
Wholesale_Price_ID	NSW 2018	Noon Trough					
Average_Wholesale_Price	80.00	140.00	180.00				
Wholesale_Exposure_Volume	All RE	RE Uptill Load					
Load_ID	Input Load						
Generator_ID	RE Generator						
PPA_Volume	RE Uptill Load						
PPA_Price	50.00						
Excess RE Purchase Price	1.00						

- The scenarios can then be run using the 'Run Scenarios' button, this should update 'Scenario Results' table, which can also be expanded, to show each scenarios input variables. Scenario '0' provides the base case results.

### Scenario Results

Scenario ID	Retail_Cost	PPA_Cost	Carbon_Abatment	Total Cost
0	\$12,635,567.06	\$1,558,077.89	0	\$ 14,193,644.95
1	\$12,635,567.06	\$1,504,038.64	0	\$ 14,139,605.70
2	\$12,635,567.06	\$1,391,201.69	0	\$ 14,026,768.75
3	\$12,635,567.06	\$1,295,518.33	0	\$ 13,931,085.39
4	\$12,635,567.06	\$1,279,950.88	0	\$ 13,915,517.94
5	\$12,635,567.06	\$1,156,504.79	0	\$ 13,792,071.85
6	\$12,635,567.06	\$1,641,026.90	0	\$ 14,276,593.96
7	\$12,635,567.06	\$1,607,329.17	0	\$ 14,242,896.23

## 3. PPA Templates

The aim of the PPA Templates is to provide a detailed model of the cash flows resulting from a set of predefined PPA structures for one year of data. Currently, the cash flows are only considered from the perspective of the buyer (or 'load'). The '3.1 - Contract Details' tab allows the user to choose between various PPA contract templates and edit the contract details, the Yearly Framework tabs then read these inputs and construct the underlying cash flow model. If more fine-tuned control of the model is needed, the user can edit the links between the '3.1 - Contract Details' tab and the Framework tabs. The resulting cash flows can be viewed on the '4.2 - Bills' tab.

### 3.1 PPA templates and associated inputs

This section describes the PPA templates and the associated inputs on the '3.1 - Contract Details' tab. The effect of each input depends on the template selected. The selection of an active template on the '3.1 - Contract Details' tab controls the cash flow model implemented in the Yearly Framework tabs by moving various clauses on and off the 'Active' contract, while updating the inputs of each clause to match the selected template. First, the No PPA template is described, this acts as the base template, and the PPA templates subsequently described are implemented by adding clauses to the base template.

#### 3.1.1 No PPA Template

This template models a standard retail agreement. It implements the following default configuration of the Yearly Framework tabs.

- A Set of configurable Time of Use charges are placed on the contract**

These are implemented in the '5.4.1 - Clauses Tariffs' tab, up to 10 Time of Use charges can be configured. The following variables in this tab are linked to the corresponding inputs on the '3.1 - Contract Details' tab, the Charge Type, Charge Name, Charge Version, Volume Type and Rate. The variables Start Day, End Day, Start Hour and End Hour are linked to the tables 'Weekday Hours of Applicability' and 'Weekend Hours of Applicability' via the '7.2 - Tariff Start and End Calc' tab. The variables MLF and DLF are set the values given on the '3.1 - Contract Details' tab where the Charge Type is Energy, but no MLF or DLF values are used for other Charge Types. Note the following default settings, the Start Month and End Month are set so each charge applies to the whole year.

## 2. **A Set of configurable Flat Rate Charges are placed on the contract**

These are implemented in the '5.4.1 - Clauses Tariffs' tab, up to 8 flat rate charges can be configured. The following variables in this tab are linked to the corresponding inputs on the '3.1 - Contract Details' tab, the Charge Type, Charge Name, Charge Version, Volume Type, Rate. The variable MLF is not applied to any flat rate charges and the DLF variable is set to the value given on the '3.1 - Contract Details' tab where the Charge Type is Environmental, no DLF values are used for other Charge Types.

### 3.1.2 Off-site PPA – Contract for Difference template

This template models a PPA implemented through a Contract for Difference (CFD) between the buyer and a RE Generator or Retailer. The cash flow implications for the buyer should be the same regardless of who the CFD is signed with (RE generator or Retailer). This template triggers the following changes in the Yearly Framework tabs:

#### 1. **Set Tariff Energy Charges to only apply to the 'firming energy', so the buyer is only charged their regular energy charges when they are not buying energy at the wholesale price**

This is done in the '5.4.1 - Clauses Tariffs' tab by setting the Alt Load Profiles of Energy charges to values which override the default use of the user-specified load profile. The Alt Load Profile used is determined by the user-specified Wholesale Exposure Volume on the '3.1 - Contract Details' tab.

#### 2. **Add an Excess RE charge to the contract to model the sale of excess energy**

Predefined Excess RE charges in the '5.4.1 - Clauses Tariffs' tab are moved onto the 'Active' contract. The following variables for these charges are linked to the '3.1 - Contract Details' tab, the Rate is set to minus one times the Excess RE Sale Price. Note the following default settings, time of use parameters are set so the charge always applies, MLF and DLF variables are not used.

#### 3. **Add a CFD clause to the contract**

Predefined inputs in the '5.4.3 - Clauses Offsite PPA CFD' tab are moved onto the 'Active' contract. The following variables in this tab are linked to the '3.1 - Contract Details' tab, the Strike Price is set to the PPA Price, the Volume is set to the PPA Volume and the Price Profile is set to the Wholesale Price ID.

#### 4. **Add a Wholesale Energy clause to the contract, that exposes the load to the wholesale price**

Predefined inputs in the '5.4.5 - Clauses Wholesale' tab are moved onto the 'Active' contract. The following variables in this tab are linked to the '3.1 - Contract Details' tab, the Price Profile is set to equal Wholesale Price ID, MLF set to equal the load MLF, DLF is set to equal load DLF and the Alt Load Profile is set to value that depends on the Wholesale Exposure Volume.

#### 5. **Add an LGC Purchasing clause to the contract**

Predefined inputs in the '5.4.4 - Clauses LGC Purchasing' tab are moved onto the 'Active' contract. The following variables in this tab are linked to the '3.1 - Contract Details' tab, the Volume Type is set to LGC Volume Type, Volume is set to LGC Purchase Volume, Price is set to LGC Purchase Price. Note the following default settings, the Period is set to 'Yearly' and the NEM Carbon Intensity is set to 0.8 t/MWh.

#### 6. **Add an Energy Production Penalties clause to the contract**

Predefined inputs in the '5.4.6 - Clauses Penalties' tab are moved onto the 'Active' contract. The following variables in this tab are linked to the '3.1 - Contract Details' tab, the Volume is

set to Yearly Target divided by the number of target periods per year, the Period is set to the Target Period, and the Price is set to Yearly Short Fall Penalty.

7. **Add an LGC Production Penalties clause to the contract**

Predefined inputs in the '5.4.6 - Clauses Penalties' tab are moved onto the 'Active' contract. The following variables in this tab are linked to the '3.1 - Contract Details' tab, Volume is set to Yearly LGC Target, Price is set to Yearly LGC Short Fall Penalty.

### 3.1.3 Off-site PPA – Tariff Pass Through Template

This template models a PPA implemented with a Tariff Pass Through arrangement between the buyer and retailer. In this arrangement when RE is available the retailer offers the buyer a special tariff set at the PPA Price. The retailer may be able to offer this arrangement because they have a CFD with the RE Generator or because they own the RE Generator (a physical hedge), in either case, the retailer accepts the wholesale exposure and passes a fixed price through to the buyer. This template triggers the following changes in the Yearly Framework:

1. **Set Tariff Energy Charges to only apply to the 'firming energy', so the buyer is only charged their regular energy charges when RE is not available**

This is done in the '5.4.1 - Clauses Tariffs' tab by setting the Alt Load Profiles of Energy charges to the 'Black' volume (the residual load volume after subtracting the RE volume, bounded by zero) which overrides the default use of the user-specified load profile.

2. **Add an Excess RE charge to the contract to model the sale of excess energy**

As per point 2 for the Off-site – Contract for Difference

3. **Add an LGC Purchasing clause to the contract**

As per point 5 for the Off-site – Contract for Difference

4. **Add an Energy Production Penalties clause to the contract**

As per point 6 for the Off-site – Contract for Difference

5. **Add an LGC Production Penalties clause to the contract**

As per point 7 for the Off-site – Contract for Difference

6. **Add an Energy Charge called RE Price to the contract, to charge the buyer the PPA Price when RE is available**

A predefined time of use charge in '5.4.1 - Clauses Tariffs' tab is moved onto the 'Active' contract. The following variables in this tab are linked to the '3.1 - Contract Details' tab, the Rate is set to the PPA Price, the Alt Load Profile is set to value that depends on the PPA Volume. Note the following default settings, the time of use parameters (Start Month, End Month, Start Day, End Day, Start Hour, End Hour) are set so that the charge always applies.

### 3.1.4 Off-site PPA – Physical Hedge Template

This template models a PPA implemented through a Physical Hedge arrangement where the buyer owns both the load and the RE Generator. In most circumstances, this arrangement would be implemented by having the retailer act as the NEM participant for the RE Generator, while passing on the wholesale market revenue to the buyer/owner and simultaneously passing through the wholesale cost of energy through to the buyer/owner's load. This template triggers the following changes in the Yearly Framework:

1. **Set Tariff Energy Charges to only apply to the 'firming energy', so the buyer is only charged their regular energy charges when they are not buying energy at the wholesale price**

As per point 1 for the Off-site – Contract for Difference

2. **Add an LGC Purchasing clause to the contract**

As per point 5 for the Off-site – Contract for Difference

3. **Add an Energy Production Penalties clause to the contract**  
As per point 6 for the Off-site – Contract for Difference
4. **Add an LGC Production Penalties clause to the contract**  
As per point 7 for the Off-site – Contract for Difference
5. **Add a Wholesale Energy clause to the contract, that exposes the load to the wholesale price**  
As per point 3 for the Off-site – Contract for Difference
6. **Add a Wholesale Energy clause to the contract, that exposes the RE generator to the wholesale price**  
Predefined inputs in the '5.4.5 - Clauses Wholesale' tab are moved onto the 'Active 2' contract, note the use of an additional contract ID, this is because the '5.4.5 - Clauses Wholesale' tab only allows one set of inputs per contract per scenario. The following variables in this tab are linked to the '3.1 - Contract Details' tab, the Price Profile is set to equal Wholesale Price ID, MLF set to equal the RE Generator MLF, DLF is set to equal RE Generator DLF and the Alt Load Profile is set to the RE Generator profile.

### 3.1.5. On-site PPA Template

This template models a PPA implemented through the installation of an on-site RE Generator, assuming the generator is built by a third party and the buyer then pays for the energy produced. This template triggers the following changes in the Yearly Framework:

1. **Add Excess RE Charges to the contract to model the sale of excess energy (feed-in tariff)**  
As per point 2 for the Off-site – Contract for Difference
2. **Add an LGC Purchasing clause to the contract**  
As per point 5 for the Off-site – Contract for Difference
3. **Add an Energy Production Penalties clause to the contract**  
As per point 6 for the Off-site – Contract for Difference
4. **Add an LGC Production Penalties clause to the contract**  
As per point 7 for the Off-site – Contract for Difference
5. **Add an On-site PPA clause to the contract**  
Predefined inputs in the 'Clauses 2 On-site PPA' tab are moved onto the 'Active' contract. The following variables in this tab are linked to the '3.1 - Contract Details' tab, Price Self Consumption is set to the PPA Price, Price RE Export is set to the Excess RE Purchase Price.

## 3.2 Load Profiles

The user can define load and generator profiles in the '3.2 - Load & Gen Profiles' tab. The actual profile used in the cash flow calculations is specified in the '3.1 - Contract Details' tab using the Load ID input.

## 3.3 Wholesale Price Profiles

The user can define wholesale price profiles in the '3.3 - Wholesale Price Profiles' tab. They can also choose to scale the profiles to set average values. The actual profile used in the cash flow calculations is specified in the '3.1 - Contract Details' tab using the Wholesale Price ID input.

## 4. Sensivity Analysis

Once a base case has been created using the template tabs a multi-factor sensitivity can be performed using the '2 - Sensivity Analysis' tab.

- This is constructed by importing the current input variables from the '3.1 - Contract Details' tab into the sensitivity analysis tab, using the 'Import Base Case' button. Then up to 10 additional input varaints can be defined for each variable. Scenarios are constructed using all combinations of the input varaints.
- The runtime can be estimated using the 'Update Estimates' button, changing the the 'Time per scenario' input to a pessimistic value, like 5 s, should make sure that the run-time is not under estimated. Once the sensitivity analysis has been used on a given computer a more realistic value will automatically be provided in the 'Time per scenario' input.
- The full set of scenarios can be run by using the 'Run Scenarios' button. Results will be saved to the 'Scenario Results' table. The '0' scenario corresponds to the imported base case.
- A particular scenario can be copied into the templates tab using the 'Activate Scenario' button and associated drop down cell. This allows the user to inspect the cashflows of a particular in more detail.

## 5. Renewable PPA Yearly Framework

The aim of this set of tabs is to provide a framework that can be flexibly configured to model the cash flows resulting from a wide variety of potential PPA structures. Cash flows can be modelled for time periods of up to 1 year in length. The user can define scenarios, contracts and contract parties on the '5.1 - Contracts' tab. The '5.3 - Load Profiles' tab can be used to assign load and generation profiles to parties, it can also be used to define profiles such the 'firming energy' that can be referenced in the contract's clauses. The '5.2 - Wholesale Prices' tab can be used to define wholesale price profiles on a regional basis. The clause tabs can be used to add clauses to contracts and specify the details of each cause such as the agreed prices and volumes.

### 5.1 Contracts

The '5.1 - Contracts' tab allows the user to define scenarios and contracts. Up to three parties can be added to each contract, a buyer (such as an electricity consumer), a seller (such as an electricity retailer) and a RE generator. At least 2 parties are needed on a contract. Note that cash flows throughout the workbook are defined in terms of the cost to the buyer. The name of the buyer is used as the default ID to identify the load profile to be used in cash flow calculations, similarly, the name of the RE generator is used as the ID to identify the generation profile to be used, some clauses allow these profiles to overridden with alternative profiles. The cash flow for each clause type is also summarised on this tab.

### 5.2 Load Profiles

Half-hourly profiles for load and RE Generator are entered into the '5.3 - Load Profiles' tab. This tab is part of the Yearly Framework tab set, however, when used in the MSAT workbook the tab is pre-populated with inputs and calculations needed to implement the templates. Two columns take the raw input data profiles specified by the user in the the '3.1 - Contract Details' tab. The rest of the columns are used to calculate input profiles needed by the templates; the calculated profiles are:

- Excess RE: The RE Generator volume in excess of the Load volume. Used in the model if the buyer onells excess renewable energy.

- **Black:** The Load volume after the subtraction of the RE Generator volume, if the RE Generator Volume meets or exceeds the Load volume then the Black volume is zero. Used in the model if energy tariffs apply only to the load not met by RE generation or the purchase of energy at wholesale prices. This can also be thought of as the 'firming energy'.
- **Used RE:** The RE volume after the subtraction of the Excess RE, e.g. the RE volume that could be used by the load. Used in the model as an optional PPA Volume and Wholesale Exposure Volume, this option is called 'RE Uptill Load'.

### 5.3 Regional NEM Prices

Half-hourly NEM price profiles are entered into the '5.2 - Wholesale Prices' tab, this tab is part of the Yearly Framework tab set, used in the MSAT workbook it also scales the user price profiles in the '3.3 - Wholesale Price Profiles' tab and make them available to be used in cash flow model.

### 5.4 Tariffs and Charges

This '5.4.1 - Clauses Tariffs' tab allows tariffs and their associated charges to be added to contracts on a scenario basis. The tariffs and charges are split into two tables depending on their type, one for the time of use charges, and one for the flat rate charges. The two tables operate in the same way, except that time of use parameters cannot be set for the flat rate charges so the charges will apply during all times of the day, week and year. The variables for each charge can be broadly grouped into the following categories:

- **Identifying variables:** The Charge Type, Charge Name and Charge Version. These three variables must form a unique combination for each charge on a scenario and contract basis. The Charge Type and Charge Name are restricted to a predefined set of values, they impact which category the charge costs are aggregated into on the '4.2 - Bills' tab. The Charge Version variable can be left unset, it is used when there is a need to distinguish between two charges with the same Charge Type and Charge Name.
- **Rate variables:** The Rate, Marginal Loss Factor (MLF) and Distribution Loss Factor (DLF). The rate is the cost in dollars per unit of volume for the charge, the MLF and DLF act as scaling factors on the rate. Note if a blank or zero MLF or DLF is set then this variable is not applied.
- **Time of use variables:** The Start Month, End Month, Start Day, End Day, Start Hour and End Hour. The variables determine which sections of the load profile the charge applies to. The charge only applies to the time between the start and end month, on the days of the week between the start and end day and on hours of the day between the start and end hour. Note Monday is treated as day 1 and all time windows are inclusive.
- **Volume type variables:** The Volume Type and Alt Load Profile. The Volume Type determines how the rate is applied to the profile. If the Volume Type is 'Energy (\$/MWh)' then the rate is applied to the volume of the load profile (ignoring any negative/export values), if the Volume Type is 'Net RE Feed in Tariff' the rate is applied to the volume of an onsite RE Generator in excess of the load on an half-hourly basis, if the Volume Type is 'Fixed (\$/day)' then the rate is applied to each half hour in the load profile on a fixed basis, i.e.  $\text{rate} \times \frac{1}{48} \times$  number of half-hour periods and if the Volume Type is 'Max Demand (\$/MVA/day)' then the rate applies to the . If the Alt Load Profile is not specified, then the profile the user assigned to the buyer in the '3.2 - Load & Gen Profiles' tab is used and if the Alt Load Profile is specified then this load profile instead.

## 5.5 Onsite PPA

The 'Clauses 2 Onsite PPA' tab allows onsite PPA clauses to be added to the contract. The addition of an onsite PPA clause assumes that the RE Generator is located behind the meter at the site of the load. Under this clause, the buyer agrees to purchase the energy produced on site. Two variables can be set for this clause Price Self Consumption and Price Export. The Price Self Consumption applies to the RE Generator profile where it is equal to or lower than the load profile. The Price Export applies to RE Generator profile where it exceeds the load profile.

The addition of this clause has several side effects on other parts of the cash flow model. In other calculations, such as for tariff charges, wholesale energy costs and offsite PPAs, where the default load profile of the buyer would normally be used, instead the buyer's load profile after the subtraction of onsite generation is used, if onsite generation is greater than the load profile then the volume used in the calculation for that half hour is zero. This applies even where the buyer's load profile is used by default in the same scenario but on another contract. The implementation of this behaviour in the model means that **onsite PPA clauses and offsite PPA clauses should always be modelled as appearing on separate contracts to avoid erroneous results.**

## 5.6 Offsite PPA (CFD)

The 'Clauses 3 Offsite PPA (CFD)' tab allows Contract for Difference (CFD) clauses to be added to the contract. In most cases, the addition of a CFD to a contract would occur when the contract also contains a wholesale energy clause. If the volume (half-hourly) of the CFD and the wholesale energy exposure is matched, then the cash flow from the CFD acts to balance the wholesale energy cash flow such the buyer effectively pays a fixed price per MWh for the given volume, this price would be equal to the strike price of the CFD. The inputs allow the user to specify the Strike Price, Volume and NEM Region.

- The Strike Price effects the half-hourly compensation rate via the formula:  
$$\text{Cost to buyer} = (\text{Strike Price} - \text{Wholesale NEM Price}) \times \text{volume}$$
- The Volume variable effects how the half-hourly volume for the CFD is calculated, if the option 'All RE' is chosen the volume is always equal to the RE Generator's volume and if option 'RE Uptill Load' is chosen then the volume is equal to the RE Generators volume, unless this exceeds the load volume and then volume is capped at the load volume
- The NEM Region effects which price profile is used from the '3.3 - Wholesale Price Profiles' tab.

## 5.7 LGC Purchasing

The '5.4.4 - Clauses LGC Purchasing' tab allows LGC purchasing clauses to be added to the contract. The following details can then be set, Price, Volume Type, Use Net Load and NEM Carbon Intensity, they affect the clause in the following ways:

- The Price sets the (\$/LGC) cost, if a situation where the buyer is selling LGCs needs to be modelled then this price can be set to a negative value and the buyer will register the revenue as a negative cost
- Volume Type determines how the volume of LGC to be purchased is calculated. If the 'RE Uptill Load' option is chosen then the volume is equal to the total LGCs produced by the volume of the RE Generator over the duration of model, unless this exceeds the total volume of the load and then the volume is capped at the load's volume. Note that 1 LGC and 1 MWh of electricity are being equated. If the option 'Frac RE' is chosen, the volume of LGCs is equivalent to a fraction of the total RE volume. If the option 'Frac Load' is chosen,



the volume of LGCs is equivalent to a fraction of the total load. If the option 'Fixed' is chosen, the volume is equal to that specified in the Volume input

- The Volume input acts as either a fraction or a fixed volume of LGCs depending on the Volume Type chosen
- The Use Net Load input allows the user to choose if the load profile used in the volume calculations is after the subtraction of onsite generation
- The NEM Carbon Intensity input determines the carbon abatement additional to the Large Scale Renewable Energy Target achieved by purchasing and retiring LGCs, this is reported in the 'Output – Bills' tab. Note this means if LGCs are being paid for as part of a bundled price with energy, then a purchasing clause should be added at a price of 0 \$/LGC such that the abatement is calculated correctly.

## 5.8 Wholesale Energy

The '5.4.5 - Clauses Wholesale' tab allows wholesale energy purchasing clauses to be added to the contract. Under a wholesale energy clause, the buyer pays the wholesale energy price for each MWh consumed in a given half hour. The following details can be set for this clause the Party, NEM Region, MLF, DLF and Alt Load Profile, these affect the clause in the following ways:

- The Party determines the default energy profile used in the calculations
- The Alt Load Profile allows the default load profile to be overridden with a specific profile from the '3.2 - Load & Gen Profiles' tab
- The NEM Region determines which price profile from the '3.3 - Wholesale Price Profiles' tab is used
- The MLF and DLF act as price multipliers.

## 5.9 Penalties

The '5.4.6 - Clauses Penalties' tab allows energy and LGC production penalty clauses to be added to the contract. Under such a clause if the targets for energy and LGC generation are not met then the buyer is paid a fixed price per unit of the shortfall. The following details can be set the Volume, Unit, Price and Period, these affect the clause in the following ways:

- The Volume sets the production target to be met
- The Unit specifies if the target applies to LGCs or MWh of electricity
- The Price specifies the amount to be paid per unit of the shortfall
- The Period specifies the time window over which the target applies, and penalties are calculated, this can be Yearly, Quarterly or Monthly.

## 5.10 Outputs

Cash flow and volume outputs can be accessed in several ways. Unaggregated outputs on a per scenario, per clause and per month basis are available on the clause tabs. These are summarised in an energy bill format on the 'Output – Bills' tab, which is described below.

### 5.10.1 Bills

The 'Output – Bills' tab is provided to make the outputs easily comparable to the user's current electricity bills. The 'Tariff Bill', 'PPA and Associated Costs' and 'Carbon Abatement' tables summarise the results associated with the entire duration of the profiles provided by the user, a per month summary of the costs associated with each component of these tables can be optionally displayed by the user. If the full detail of the tables is needed for a month or quarter, then the input profiles should be restricted to this time period.

The tables summarise the volume, effective rate, DLF, MLF and cost associated with the contract clauses. The volume and cost columns summarise the results as given on the clauses tabs. The effective rate column gives the average cost per unit of volume, for tariff charges this can be used to check the calculations as the effective rate should be equal to the user-specified rate, for other components such as wholesale energy, this allows the cost to be more fairly compared to that of other components. The DLF and MLF columns summarise which components these factors were applied to and allow the user to cross-check if they were applied as expected.

#### 5.10.2 Load Plots

The 'Output - Load Plots' tab allows the user to view average weekly profiles from the '3.2 - Load & Gen Profiles' tab on a seasonal basis.

## 6. NEM RE Generation Data

The aim of this workbook is to provide easy access to historical NEM solar and wind generation data, in a format compatible with the Renewable PPA Yearly Framework and the Renewable PPA Yearly Templates workbooks. The data available is separated on a yearly and generation type basis into different tabs, this is needed to ensure the data can be filtered on a Station basis without crashing the excel workbook. If a station needs to be selected based on region or technology type the 'Station Details' can be used to filter for station based on these details. Once a station is selected by a user its output can optionally be scaled, based on its registered capacity and a target capacity. When copying data from this workbook to another the far right two columns should be used, and care should be taken to paste the data as values only.

Lastly, the user should note the methodology by which the energy values in this dataset are obtained. AEMO does not publish half hourly meter data for stations so an estimate must be made using the instantaneous output values that are published. The average MW output recorded in this dataset is the average of six readings taken during the half-hour period, these are taken at the start of the half hour and then subsequently at 5 min intervals. The data is published in this format by AEMO, this workbook converts this to an energy value for the half hour by dividing by 2.

## 7. NEM Price Data

The aim of this workbook is to provide easy access to historical NEM price data, in a format compatible with the Renewable PPA Yearly Framework and the Renewable PPA Yearly Templates workbooks. The workbook can be used to load six yearlong half-hourly price profiles at a time. The user can set a historical year to access prices from, and for each profile can select the NEM region and apply a scaling factor. Note when this data is copied across to another workbook care should be taken to paste only values.