# Calculation and Allocation of Unaccounted for Energy (UFE)

## Fact Sheet

The National Electricity Amendment (Global Settlements and Market Reconciliation) Rule 2018 requires AEMO to determine the amount of unaccounted for energy (UFE) for each distribution network local area.

This fact sheet provides a high-level overview of how UFE is calculated and can be used as a reference on how to allocate UFE to a market load.

## What is UFE?

UFE is the difference between all adjusted metered energy entering a local area, compared to all adjusted metered energy consumed within the local area.

These differences could be caused by energy theft, inaccurate or faulty meters, estimation errors associated with unmetered devices, profiling of reads to the trading interval (5 minute) level or errors in the distribution loss factor (DLF).

## What is adjusted metered energy?

The delivery of energy through any distribution network incurs losses, which occur due to long wire lengths or transforming energy to different voltages, known as technical losses.

Each distribution network calculates the technical losses and provides a DLF to AEMO. During the settlements process, all distribution connected metered energy (ME) is adjusted by this loss factor.

Adjusted metered energy is calculated at every distribution network connection point using the formula ME × DLF.

## What is a local area?

A local area is a geographical network area that connects to the transmission network via a collection of transmission connection points, commonly called TNIs. The local areas usually align with a distribution network; however, it can include additional connection points within the same electrical network.

## How is UFE calculated?

UFE must be calculated at the local area level, rather than at the TNI level, due to the existence of virtual TNIs. A virtual TNI is a grouping of connection points assigned to a TNI code that does not have a physical connection to the transmission network. This means the energy is supplied from one of the other TNIs and since the load is not recorded against the same TNI, UFE calculation at the TNI level is impossible.

The calculation for determining UFE is:

$$UFE = TME - DDME - ADME \ ^{[1]}$$

where from the distribution network perspective the values are:

- TME = All energy flowing at each transmission network connection point into the local area
- DDME = All adjusted energy flowing at a distribution connection point into the local area which is connected to an adjacent local area
- ADME = All adjusted energy flowing at a distribution connection point within the local area which is assigned to a TNI or Virtual TNI

Below is a simple example of the UFE calculation:

$$UFE = TME - DDME - ADME$$
$$1kWh = 100kWh - 9kWh - 90kWh$$

## How is UFE allocated?

The net metered energy (ME) can record energy flows in two directions, towards the connection point (load) or away from the connection point (generation). The above calculation of UFE uses all net metered energy, considering both energy flow directions.

UFE is only allocated to those connection points that are consuming energy in the trading interval, where the flow of the net metered energy is towards the connection point. In the rules this value is given the abbreviation **ME-** [2].

DME is then defined as the DLF adjusted **ME-** value, so represents the adjusted energy flowing towards the connection point. This is the value used for the allocation of UFE and is calculated with the following formula:

$$DME = ME\text{-} \ x \ DLF$$

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[1] National Electricity Amendment (Global settlement and market reconciliation) Rule 2018 No.14, NER 3.15.5 (a)

[2] For settlements the ME flow is expressed as a positive value where the flow is towards the transmission network (generation) and a negative value when flow is away from the transmission network (load). The negative sign in **ME-** refers to this negative settlement energy load value, NER 3.15.5(c). Metering data at the end user connection point for distribution systems are expressed from the end user's point of view, therefore the signs are reversed. Clause 3.15.4 (b).

For connection points where the local generation (for example from solar panels) exceeds the load, then the calculated DME will be zero and so no UFE will be allocated to that connection point for that trading interval.

Generators, including embedded generators (where the NMIClassCode in MSATS is "GENERATR" or "NREG") are excluded from UFE allocation under the rules, even in the trading intervals where they are consuming energy.

Below is a simple example of a DME calculation:

$$DME = ME\text{-} \times DLF$$

$$9.09kWh = 9kWh \times 1.01$$

## How are transmission connected sites excluded from UFE allocation?

Where transmission connected sites are a part of TNI containing only transmission connection points, that TNI is allocated to a *GRID local area (for example VICGRID, SAGRID). These *GRID local areas should always have a UFE calculated at zero.

There are also a very limited number of transmission connected sites that are a part of a TNI containing both transmission and distribution connection points. These TNIs belong to one of the standard local areas and these transmission connected sites are excluded from UFE allocation based on their NMIClassCode in MSATS being "WHOLESAL".

## How is the UFE allocation (UFEA) calculated?

UFE is allocated to each connection point based on the share of that connections point DME of the total DME of the local area in that trading interval, so the calculation for allocating UFE is:

$$UFEA = UFE \times (DME / ADMELA) \text{ [3]}$$

Where the values:

- UFE = unaccounted for energy for the local area
- DME = the adjusted energy flowing towards the relevant connection point for each trading interval.
- ADMELA = the aggregate of all DME values for each trading interval for the local area.

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[3] National Electricity Amendment (Global settlement and market reconciliation) Rule 2018 No.14, Clause 3.15.5 (c)

## How can I calculate the UFEA for a connection point?

With every settlement case AEMO publishes the UFE components within the RM46 UFE Validation Report.

To apply the UFE allocation calculation the following information is required:

- Identify the DLF code for the connection point and the associated DLF value
- Calculate DME for each trading interval for the connection point for the settlement period.
  - Remembering that DME = **ME-** (energy towards the connection point) x DLF
- Identify the UFE and ADMELA values for each trading interval
  - Available within the MSATS RM46 report, which can be subscribed to
- Calculate the allocation using the UFE allocation formula: UFEA = UFE x (DME / ADMELA)

Below is a simple example of the UFEA calculation:

$$UFEA = UFE \times (DME / ADMELA)$$

$$0.1kWh = 1kWh \times (9.09kWh / 90.09kWh)$$

## Is there an alternative way to calculate UFEA for a connection point?

To assist in the calculation of UFEA, AEMO has created a UFE factor (UFEF) that can be applied to the DME values to determine the UFEA values. The UFEF values are available within the MSATS RM46 UFE validation or RM43 UFE factor by local area reports.

The factor uses the same allocation logic by transposing local area values within the UFEA formula, the transposed formula is:

UFEA = UFE x (DME / ADMELA) can be expressed as:

UFEA = DME x (UFE / ADMELA)

Since the UFE and ADMELA are calculated at a local area level, these values can be converted to a factor by using the following formula:

$$UFEF = UFE / ADMELA$$

Below is a simple example of the UFEF calculation:

$$UFEF = UFE / ADMELA$$

$$0.011001 = 1kWh / 90.09kWh$$

By replacing UFE / ADMELA with UFEF in the UFEA calculation, the following formula can be used:

$$UFEA = DME \times UFEF$$

Below is a simple example of the UFEA calculation using the UFEF:

$$UFEA = DME \times UFEF$$

$$0.1kWh = 9.09kWh \times 0.011001$$

## How is the total energy for the connection point calculated?

The calculation of the total energy, which is referred to in the rules as the adjusted gross energy (AGE), is performed using the following formula:

$$AGE = (ME \times DLF) + UFEA \ ^{[4]}$$

Below is a simple example of the AGE calculation:

$$AGE = (ME \times DLF) + UFEA$$

$$9.19kWh = (9kWh \times 1.01) + 0.1kWh$$

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[4] National Electricity Amendment (Global settlement and market reconciliation) Rule 2018 No.14, NER 3.15.4 (b)

## Where can the settlements system UFE data be found?

The MMS Data Model now includes additional data in the below tables to publish the global settlements data produced from the settlements system:

- SETLOCALAREATNI (new) contains the TNIs included in each local area for each settlement date and run number
- SETLOCALAREAENERGY (new) contains the local area data for each trading interval and each settlement run, including fields for the UFE, TME, DDME, ADME calculated by the retail solution (with the opposite sign) and the ADMELA value calculated by the settlements system
- SETCPDATA (altered) new fields UFEA, DME, AFE (accounted for energy) and AGE added, with the UFEA now included in some existing fields as well, since the beginning of global settlements on 1 May 2022

## Why does the settlements system UFE data have the opposite sign?

The settlement statements are created with negative energy representing the loads and positive energy values representing generation.

A positive UFE, as calculated earlier, represents less energy being charged for than is required. For the settlements system to increase the load being charged, the positive UFE amount must be changed to a negative value.

Similarly, when the UFE as calculated earlier is negative, the settlements system must apply a positive value to ensure the energy load charged for is reduced.

## How does the settlements system calculate the UFE Allocation (UFEA)?

The settlements calculations are performed at the trading interval (5 minute) level, with the output stored in the SETCPDATA table. The UFEA is then added to the required energy fields so that the energy volume billed is a UFE inclusive value. An example of the calculations for a single trading interval is shown below.

**Data From SETLOCALAREAENERGY**

| Settlement Date | Settlement RunNo | LocalAreaId | Period Id | UFE | TME | DDME | ADME | ADMELA |
|---|---|---|---|---|---|---|---|---|
| 17/07/2022 | 10 | ENERGEX | 100 | -14.0064 | -195.66 | -0.703861 | -180.9518 | -196.4706 |
| 17/07/2022 | 10 | UMPLP | 100 | -0.42802 | -83.853 | -0.077197 | -83.34815 | -90.91604 |
| 17/07/2022 | 10 | POWERCOR | 100 | 1.554456 | -70.961 | 1.012595 | -73.52773 | -113.9055 |

**Data From SETLOCALAREATNI**

| Settlement Date | Settlement RunNo | LocalAreaId | TNI |
|---|---|---|---|
| 17/07/2022 | 10 | ENERGEX | QMGL |
| 17/07/2022 | 10 | UMPLP | SJP1 |
| 17/07/2022 | 10 | POWERCOR | VRC6 |

**Data From SETCPDATA**

| SETTLEMENTDATE | VERSIONNO | PERIODID | PARTICIPANTID | TCPID | REGIONID | IGENERGY | XGENERGY | INENERGY | XNENERGY | RRP | TLF | TA | EP | UFEA | DME | AFE | AGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17/07/2022 | 10 | 100 | XXXX | QMGL | QLD1 | 0 | 0.2 | 0 | 0.2014258 | 129.67 | 1.0083 | -0.201426 | -26.34 | -0.001426 | -0.02 | -0.2 | -0.201426 |
| 17/07/2022 | 10 | 100 | XXXX | SJP1 | SA1 | 0.02 | 0.7 | 0.02 | 0.7032955 | 74.2 | 0.9962 | -0.683295 | -50.51 | -0.003295 | -0.7 | -0.68 | -0.683295 |
| 17/07/2022 | 10 | 100 | XXXX | VRC6 | VIC1 | 0.1 | 0.3 | 0.1040941 | 0.3 | -38 | 0.9744 | -0.195906 | 7.2538 | 0.004094 | -0.3 | -0.2 | -0.195906 |

Note that all read values in the settlements system are already adjusted for the DLF and converted from the kWh values in the metering systems to MWh in the settlements system.

- The "gross" read values are UFE Exclusive:

$$IGENERGY - XGENERGY = AFE$$

Where the value:

$$AFE = \text{accounted for energy}$$

- The "net" read values are UFE Inclusive:

$$INENERGY - XNENERGY = AGE = TA$$

Where the values:

$$AGE = \text{adjusted gross energy}$$

$$TA = \text{trading amount (this is an old energy volume field name; "Trading Amount" is also}$$
$$\text{used for the energy charge/payment dollar amounts in the Settlement Report)}$$

When UFE is negative (so a positive value in settlements data) it is the INENERGY (net imports to grid, so representing generation) read value that is altered, as per the VRC6 TNI example above.

Below is an example of the UFEA calculation using the QMGL TNI data above, which is in the ENERGEX local area:

$$UFEA = UFE \times (DME / ADMELA)$$

$$-0.001426\text{MWh} = -14.0064\text{MWh} \times (-0.02\text{MWh} / -196.4706\text{MWh})$$

Note that DME excludes any NMIs that are generating in the interval, so it can vary slightly from the aggregate export reads value, though this is not shown in the above examples.

Below is an example of the energy purchase (EP) calculation for the cost of the UFEA inclusive energy volume billed, again using the QMGL TNI example data from above:

$$EP = AGE \times RRP \times TLF$$

$$\$26.34 = -0.201426MWh \times \$129.67 \times 1.0083$$

Where the values:

RRP = regional reference price in \$/MWh

TLF = transmission loss factor

## How do the settlements statements present UFE?

UFE is not included in the statements as a separate line item, it forms a part of the total main "Energy" line item by altering the volume of load that has been charged for.

The detailed Settlement Report (SR) issued at the same time as the statements includes separated UFEA data for information only, the main "Aggregate Energy (MWh)" field reported in the SR is a UFE Inclusive energy volume.

## Why does the UFE alter so much between the statements of the same week?

Occasionally, metering data with large errors is received by AEMO from the market. If these errors cannot be fixed by the MDP prior to the statement needing to be posted, this known poor-quality data will be included in the statements.

Previously, under the settlements by difference methodology, the impacts of such errors would only be seen by the FRMP and LR of the meter with the impacted read. Now under global settlements, any errors directly impact the FRMP and all retailers active in that local area, if the incorrect read significantly alters the UFE calculated. These errors should be corrected in the following statement, though even more rarely new errors can be introduced in the later statements.

The other likely cause will only impact those local areas with remaining large populations of BASIC and MRIM meters. These may cause significant variations between the PRELIM/FINAL/REVISE statements where the estimated reads used prior to these meters being read are significantly different to the actual reads. In these cases, the UFE in the earlier statements will differ from the final UFE outcome, after all actual reads have been received.

Given that UFE allocation impacts all end user meter types, large end users who are accustomed to being billed entirely from actual metering data, may now be impacted by estimated metering data affecting the calculated UFE.