GUIDELINES ON THE IMPLEMENTATION OF INTERVAL BILLING MECHANISM

[11.12.2023]

Registration Record

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ELECTRICITY SUPPLY ACT 1990
[*Act 447*]

GUIDELINES ON THE IMPLEMENTATION OF INTERVAL BILLING MECHANISM

GP/ST/No.36/2023

In exercise of the powers conferred by section 50C of the Electricity Supply Act 1990 [*Act 447*], the Commission issues the following guidelines:

Purpose

1. The purpose of these guidelines is to describe the Interval Billing Mechanism and to provide guidelines on the framework and its implementation.

Citation and commencement

2. These guidelines may be cited as the Guidelines on the Implementation of Interval Billing Mechanism and shall come into operation on the date of registration.

Dated: 11.12.2023

DATO' IR. TS. ABDUL RAZIB BIN DAWOOD
Chief Executive Officer
Energy Commission

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1.0 Interpretation

1.1 In these Guidelines, the following terms shall bear the following meanings:

Term	Definition
Act 447	means the Electricity Supply Act 1990 [*Act 447*]*;*
Average Daily Usage	refers to the average of consumption during the billing period;
Advanced Metering Infrastructure	means an integrated system of equipment, communications, and management systems for utilities to remotely collect customer usage data in real time;
Commission	means the Energy Commission established under the Energy Commission Act 2001 [*Act 610*]*;*
consumer	has the same meaning assigned to it in section 2 of Act 447;
Estimation Needed	means an alarm or indicator triggered from the Meter Data Management system for operator to manually check the usage data;
ETOU	means the Enhanced Time of Use Tariff Scheme, a tariff scheme as approved by the Minister in respect of the electricity supply provided by the licensee;
Interval Data	means a record of energy consumption, with readings made every 30 minutes intervals throughout the day, everyday;
Interval Billing Mechanism	means a mechanism using Interval Data for billing purposes;
Large Power Consumer	refers to any Consumer taking more than 100A per phase and require current transformers for metering scheme;
licensee	has the same meaning assigned to it in section 2 of Act 447;
Meter Data Management System	means a system that performs data storage and management for the vast quantities of metering data;

Meter Flags Check	means an alarm or indicator triggered from the Meter Data Management system to indicate the meter condition;
Ordinary Power Consumer	means any Consumer taking less than or 100A per phase and does not require current transformers for metering scheme;
Partial Interval	means an alarm or indicator in the Meter Flags Check which will be triggered when the measurement did not complete 30 minutes interval;
Power Outage	means the type of alarm or indicator in the Meter Flags Check which will be triggered when no electricity supply incoming to the meter;
SMOC	means the Smart Meter Operation Centre, which is a central location that manages the metering data;
Time Change	means the type of alarm or indicator in the Meter Flags Check which will be triggered when the meter time is changed; and
VEE	means the Validation, Estimation and Editing Rules as set out in Schedule 1.

1.2 Subject to paragraph 1.1 and unless expressly indicated to the contrary or unless the context otherwise requires, terms adopted and used in these Guidelines shall bear the same meaning as they are defined in the Act.

1.3 If there is any conflict between the provisions of these Guidelines and of those contained in the Act, the provisions in the Act shall prevail.

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2.0 Application

These Guidelines shall apply to the licensee and the consumer.

3.0 Introduction

The Interval Billing Mechanism is a mechanism that uses the Interval Data for billing purposes which enables the licensee to offer more complex tariff scheme such as the ETOU scheme for low voltage industrial, smart meter, ordinary power consumer and to support future flexible tariff structure.

4.0 Implementation of the Interval Billing Mechanism

The Interval Billing Mechanism is applicable to the consumer and licensee with the following criteria:

(a) a consumer who enrolls in the ETOU scheme or any other scheme that is based on Interval Data as approved by the licensee; and

(b) any consumer whose premise has a good quality of network coverage or any other communication for the meter as approved by the licensee.

5.0 Metering

5.1 The licensee shall perform validation of Interval Data in accordance with the procedures of VEE.

5.2 In the event of any missing of or error in Interval Data, the licensee shall perform an estimation or editing in accordance with the procedures of VEE.

5.3 In the event of a combination of actual and estimated Interval Data in a whole month consumption —

(a) if the estimated Interval Data is within the allowable maximum of 10% of the whole month consumption, the actual bill shall be rendered to consumer; or

(b) if the estimated Interval Data exceeds the allowable maximum of 10% of the whole month consumption, the licensee shall conduct an inspection at the premise and obtain its load profile data and an actual bill shall be rendered to the consumer based on the new load profile data.

SCHEDULE 1: VALIDATION, ESTIMATION AND EDITING (VEE) RULES

1.0 Introduction

1.1. The Interval Data is a record of energy consumption, with readings made every 30 minutes intervals throughout the day, every day. The Meter Data Management System will typically read the Interval Data every day and perform VEE before making it available for billing purposes. Irregularities may happen in the Interval Data due to meter and communication issues. Irregularities in the Interval Data can be detected through validation rules set in the Meter Data Management System in which estimation or editing will be triggered to rectify the irregular Interval Data reading. VEE is applied in Meter Data Management System to ensure all meter data is complete and with integrity.

1.2. The Meter Data Management System shall validate the edited data before saving the new values to the database. The Meter Data Management System stores the edited data as a new version of the data and archives the original data as a historical version of the data for auditing.

1.3. The applicable VEE rules shall be used for Large Power Consumer and Ordinary Power Consumer accordingly.

2. VEE Process

2.1. The Interval Data shall be retrieved periodically and validated in accordance with validation rules. Once the validation process is successful, the Interval Data shall be stored in the Meter Data Management System database with pass validation status.

2.2. In the event that the validation process detects and/or indicates any irregularities in the Interval Data, the estimation process in accordance with estimation or editing method shall be performed.

3. Large Power Consumer

3.1. **Validation Rules**

There are six validation rules applicable for Large Power Consumer, which are as follows:

(a) Gap Check

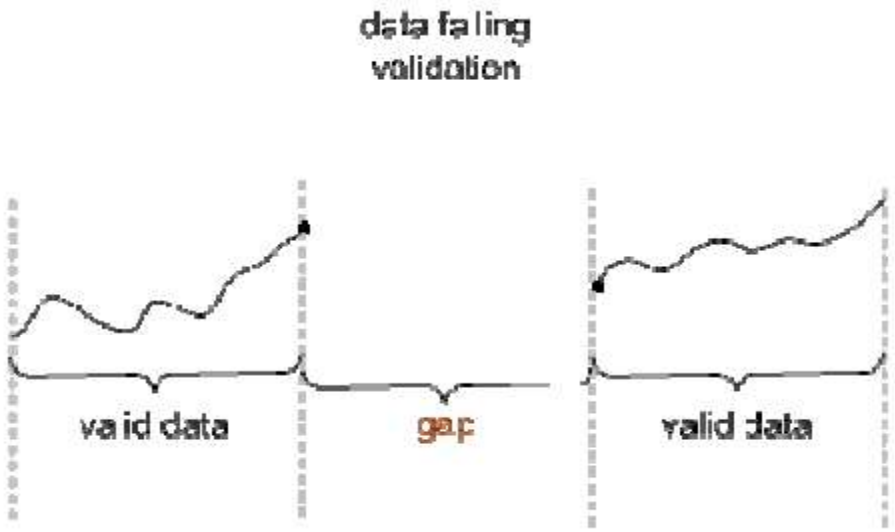
The Gap Check rule searches for data gaps caused by missing intervals, communications issues and other scenarios. The following are some of the examples where data gaps could occur:

(i) An incorrect date and time setting in the meter might cause the starting of the

new data not to match the end date of the data already in the database;

(ii) A system that sends the data may lose a file; and

(iii) An intermittent communication issue may exist within a fixed network or Advanced Metering Infrastructure network.



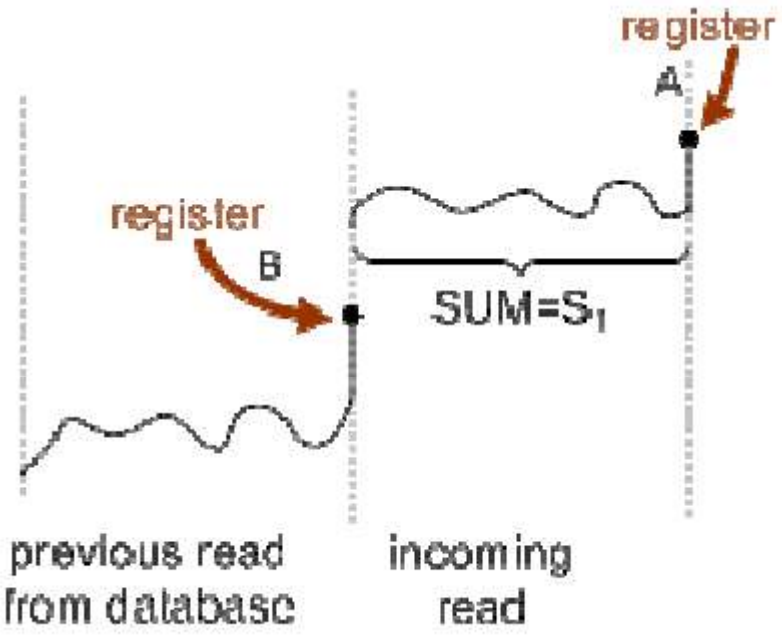
(b) Status Count Check

The Status Count Check simply counts interval status flags, such as power outages and the Cyclic Redundancy Check status (error such as error in memory or storage meter) in a chunk of data. This rule is used to find meters with excessive alarms or other status flag which indicates meter conditions that need to be corrected.

(c) Usage Tolerance Check

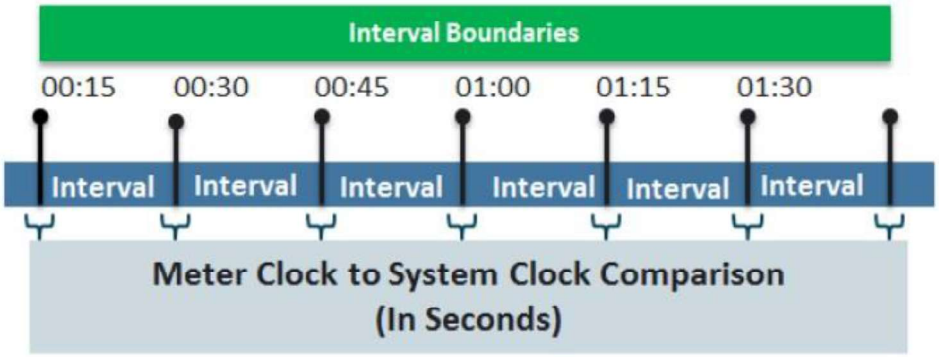
The Usage Tolerance Check compares the energy usage from the Interval Data to the usage from the register data as calculated from the start until the end of meter readings to verify that the Interval Data accurately reflects the energy usage as determined by the meter.

This rule is used for meters which provide Interval Data to verify that the correct meter multiplier and current transformer/potential transformer (CT/PT) ratios are set up correctly in Meter Data Management System. This validation will not be applicable once the multiplier is standardized.



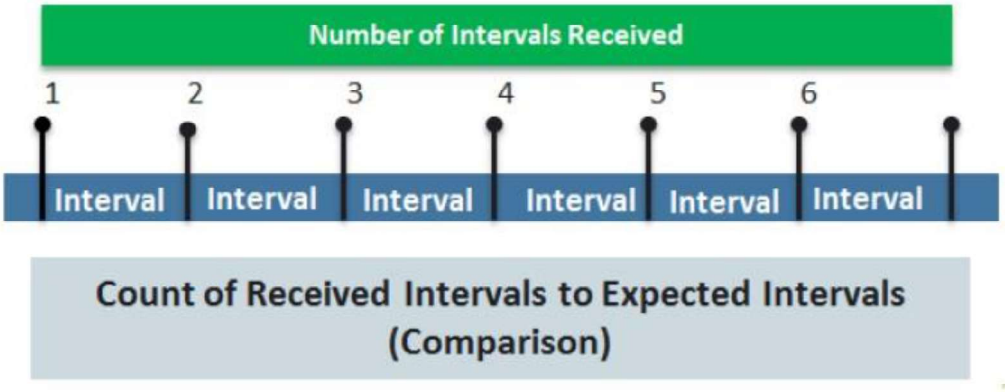
(d) Time Tolerance Checks

The Time Tolerance Check is used to determine whether incoming data is aligned on interval boundaries. This verifies the time difference between the meter clock and the system clock. This rule is used to find time drift in a meter.



(e) Interval Tolerance Check

The Interval Tolerance Check is to determine that the number of intervals being sent is equal to the number of intervals expected. This check does not use historical or reference data. This check is used to identify incorrect programmed meter.



(f) Implausible Reading Validation

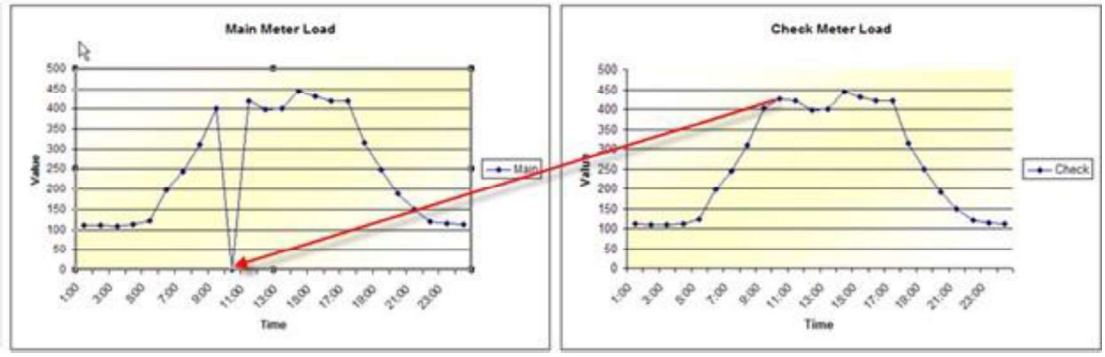
The Implausible Reading Validation rule searches for unusual usage by comparing monthly usage from the current period with the average historical monthly usage (as available). The historical monthly range is taken from the last 6 months previous or less to the incoming data.

3.2. Estimation

When validation fails, automatic estimation will be triggered to correct bad data or fill in missing data before it is used in Meter Data Management System calculations or submitted to other systems. Estimation routines can be performed automatically or to have an analyst to evaluate the case. Below are the four estimation routines:

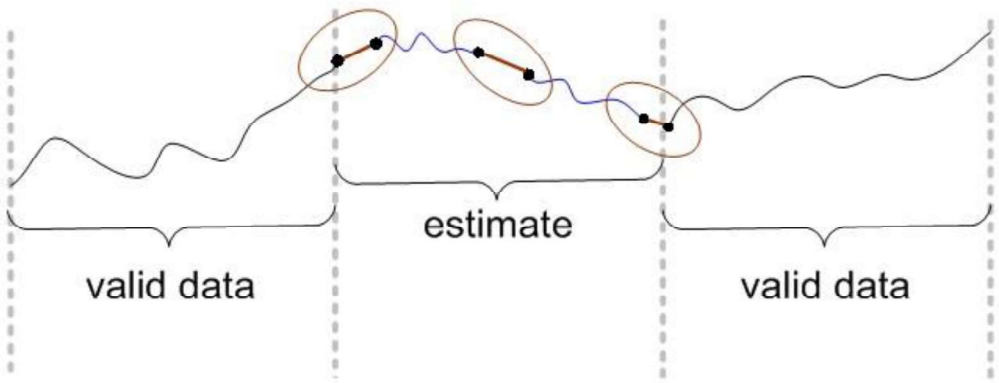
(a) Check Meter

The Check Meter estimation routine replaces all intervals marked "Estimation Needed" with the corresponding intervals from the check meter.



(b) Linear Interpolation

Linear interpolation is the simplest estimation algorithm. The routine establishes the two valid intervals on either side of a gap as reference points. It uses a straight-line approximation to resolve small gaps by creating estimated intervals of equal length between the two reference points. The readings created by this routine fill the gaps with no peaks or valleys. For this estimation routine, only applicable for one interval gap.



For example, the defined limit is half an hour. There are two gaps in your data: Gap A, from 8:00 to 8:30, and Gap B, from 13:15 to 17:30. The linear interpolation routine can fill Gap A. The routine cannot fill Gap B, because Gap B exceeds the maximum size of half an hour.

(c) Multi-Week Average

The Multi-Week Average estimation routine finds and averages all valid reference intervals for the same day of week and time stamp, for the four weeks. If reference intervals fallon public holidays, reference intervals are not included in the average. In addition, reference intervals marked with Estimation Needed or Power Outage are not includedin the average. Only data that has passed validation or been manually accepted is used in the estimation.

Target Day (a Tuesday)			Last Tuesday		Tues. 2 Weeks Prior		Tues. 3 Weeks Prior		Tues. 4 Weeks Prior		Four Week Average
DateTime	Value	Status	Value	Status	Value	Status	Value	Status	Value	Status	
4:00	1000	FV	980	*FV*	0	PV,PO	950	PV	990	PV	-
5:00	6000	FV, ESN	1078	*FV*	0	PV,PO	1045	PV	1089	PV	1067
6:00	1210	FV	1186	*FV*	0	PV,PO	1150	PV	1136	PV	-
7:00	1500	FV	1470	*FV*	1650	PV	1425	PV	1485	PV	-
8:00	1755	FV	1720	*FV*	1931	PV	1667	PV	1737	PV	-
9:00	1800	FV	1764	*FV*	1980	PV	1710	PV	1782	PV	-
10:00	1830	FV	1793	*FV*	2013	PV	1739	PV	1812	PV	-
11:00	1900	FV	1862	*FV*	2090	PV	1805	PV	1881	PV	-
12:00	1600	FV	1568	*FV*	1760	PV	1520	PV	1584	PV	-
13:00	1800	FV	1764	*FV*	1980	PV	1710	PV	1782	PV	-
14:00	2000	FV	1960	*FV*	2200	PV	1900	PV	1980	PV	-
15:00	2130	FV	2087	*FV*	2343	PV	2024	PV	2109	PV	-
16:00	50	FV, ESN	2058	*FV*	2310	PV	1995	PV	2079	PV	2128
17:00	1800	FV	1764	*FV*	1980	PV	1710	PV	1782	PV	-
18:00	1600	FV	1568	*FV*	1760	PV	1520	PV	1584	PV	-
19:00	1300	FV	1274	*FV*	1430	PV	1235	PV	1287	PV	-

Legend:

ESN	Estimation Needed
PV	Passed Validation
FV	Failed Validation
#	Contributes to Avg.

(d) Two-Week Like Day Historical

The Two-Week Like Day Historical estimation routine replaces intervals that need estimation with data from like-days in the designated reference week and like-day set. This estimation routine uses the two weeks immediately preceding the intervals to estimate. This estimation routine only uses reference data that has passed validation or that has been manually accepted.

For example, if the data needing estimation is Tuesday data, and the Tuesday of the prior week is considered a like-day, then the Meter Data Management System uses the corresponding intervals from that Tuesday. If the data from Tuesday of the prior week is missing, then the Meter Data Management System uses the data from the Tuesday of two weeks prior.

3.3. **Editing**

Data editing function modes that allow to improve meter data integrity. The Meter Data Management System will validate the edited data before saving the new values to the Meter Data Management System database.

4. Ordinary Power Consumer:

4.1. **Validation Rules**

All meter data entering the Meter Data Management System is validated using validation rules to determine if the data accurately reflects actual or expected usage. Validation rules are used to identify malfunctioning or damaged meters, account set-up or configuration issues, incorrectly programmed meters, bad reads caused by various eventssuch as meter tests or tampering and suspicious usage patterns. Validation rules are mentioned below:

(a) Maximum Demand Check

This method checks if the meter's average demand (derived from consumption) exceeds the rated capacity of the meter. The interval value is tested against the maximum demand value adjusted for an interval length of 30 minutes.

The maximum demand value is based on the type of connection at a premise and subsequently the meter used at that premise (Single Phase Meter or a Three Phase Meter). For Ordinary Power Consumer Three phase meters, the maximum demand is set to 70kW for a three-phase meter and 40kW for a single-phase meter.

Example: Single phase Meter
Formula: Fail validation if Calculated Average Max demand > 40 kW for an interval

30-minute Interval Meter Read	Calculated Average Demand	Validation (Fail if Calculated Average Demand > 40)	Outcome
10 kWh	20 kW	Calculated average demand 20 is not greater than 40	Pass
20 kWh	40 kW	Calculated average demand 40 is not greater than 40	Pass
30 kWh	60 kW	Calculated average demand 60 is greater than 40	Fail

Example: Three phase Meter
Formula: Fail validation if Calculated Average Max demand > 70 kW for an interval

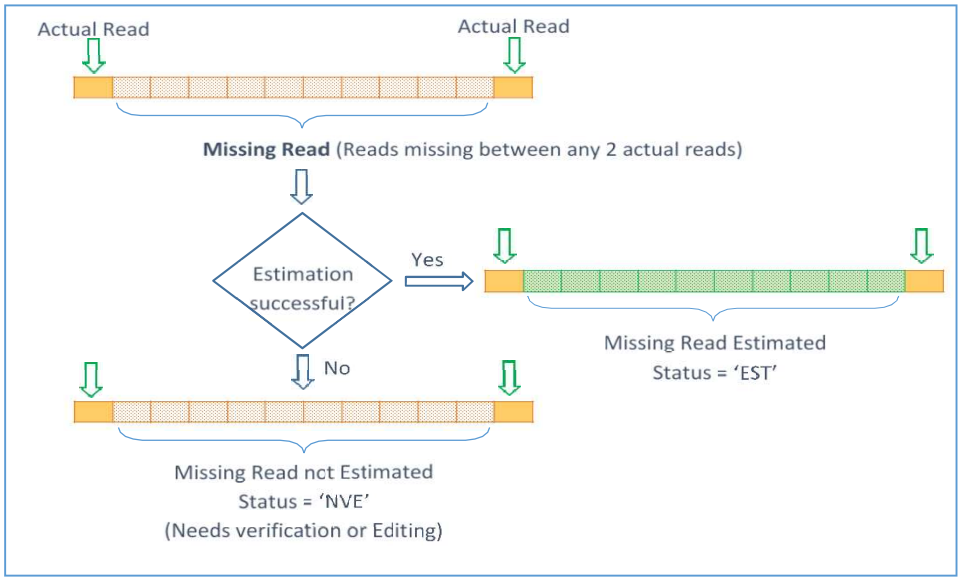
30-minute Interval Meter Read	Calculated Average Demand	Validation (Fail if Calculated Average Demand > 70)	Outcome
30 kWh	60 kW	Calculated average demand 60 is not greater than 40	Pass
40 kWh	80 kW	Calculated average demand 80 is greater than 70	Fail
50 kWh	100 kW	Calculated average demand 80 is greater than 70	Fail

(b) Missing interval (Gap Check)

The Gap Check looks for data gaps caused by missing intervals, communications issues, and other scenarios. The following are some of the examples of situations where gaps could occur:

(i) A system that collects and sends the data may lose few meter data elements or a data file due to unexpected error or a system failure; and

(ii) An intermittent communication issue that impacts read collection within the Advanced Metering Infrastructure network.



The Gap Check is continuously performed as part of VEE process in Ordinary Power Consumer.

(c) Status Count Check (Flag Based Validation)

The Meter Flags Check looks for interval status flags such as Power Outages, Partial Interval, Time Change, Advanced Metering Infrastructure error as part of the interval meter reads coming from the meter.

This rule is used to find meters with alarms or other status flag which would indicate meter conditions which will then require to take appropriate actions such as auto estimate or a SMOC operator to validate the reason for failure.

(d) Time Tolerance (Meter Flags Check)

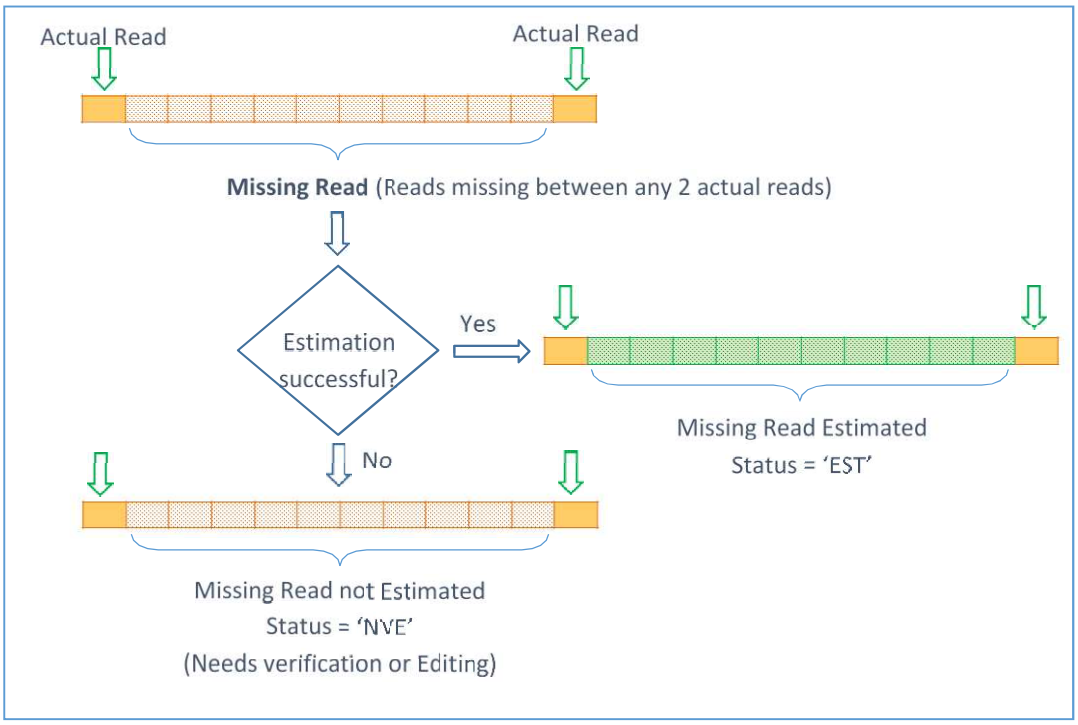
The time tolerance check or Time Change check is also part of meter flag-based check where action is taken once the meter reads coming have a flag to signal that there has been a time change during this interval, hence the consumption recorded might not be for the full interval.

The table below lists the meter flags that will be checked and actions that Meter Data Management System will perform when detected:

No.	Flag to be checked	Action
1.	Time Change	Auto Estimate

(e) Interval Tolerance

The interval tolerance check is similar to missing interval check and ensures that there is no missing interval in the day. If any interval is missing during the day or at the end of the day, then it will be estimated in the system.



This check is continuously performed as default and is part of overall VEE processing in Ordinary Power Consumer.

(f) High Low Usage Check

The monthly billing High-Low check runs during billing calculation and ensures that the Average Daily Usage is based on the billing determinants for the current billing period does not sway higher or lower than the accepted levels from the historical usage based on the earlier bills.

As per the acceptable criteria defined, the check fails if:

Current bill period Average Daily Usage is > 4 x (6 months Average Daily Usage)

Failure of high low check will lead to the bucketed reads being put on hold from bill generation for a SMOC operator to validate and take corrective actions.

4.2. Estimation

4.2.1 Estimation is part of the VEE process and is initiated when validation fails or if there is a gap in the data and the next course action is defined as estimation. Automatic estimation can be triggered to correct bad data or calculate missing data before it is used in Meter Data Management System calculations or submitted to other systems. Estimation routines can be performed automatically or to have an analyst to evaluate the case.

4.2.2 Not all estimation methods are tried for each interval rather methods are used in sequenceand if estimation is successful using a method then other methods are skipped. Only If an interval cannot be estimated using an estimation method in the sequence of methods, thenext method is tried. This process continues until all the estimation methods have been tried for estimating an interval.

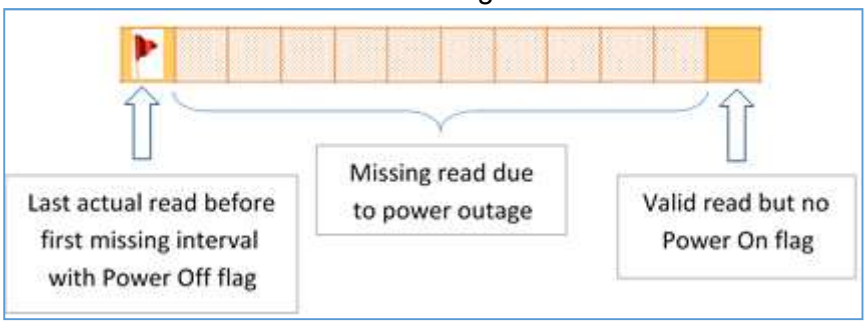
4.2.3 Below are the estimation routines defined for Ordinary Power Consumer:

(a) Power Outage Flag Based Estimation

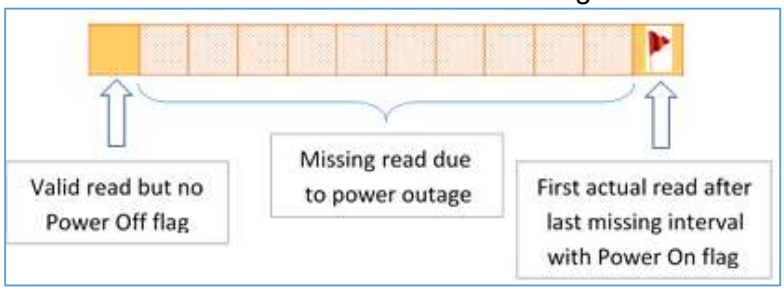
This estimation method estimates only missing intervals and are contiguous in nature. If the last interval before the first missing interval or first interval after the last missing interval has power on/ off flag set (i.e., indicating a power outage), the estimation method estimates the missing intervals and sets the interval value to 0.0 kWh.

Also, the estimated values are marked with VAL (actual) status as it is not possible for a consumer to use electricity when the meter is experiencing power outage. This method of estimation is applicable when the following situations occur:

(i) The last interval read before the Outage started indicates “Power Off”.



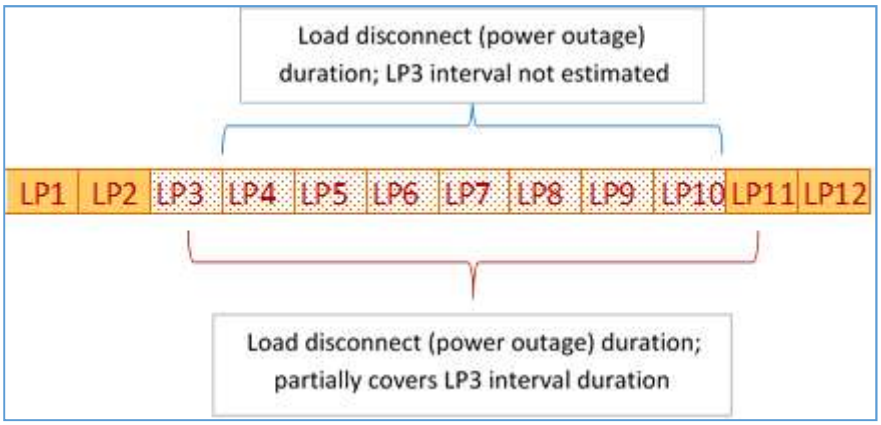
Particular interval indicates “Power On” indicating end of Power Outage”.



(b) Device Event Based De-Energized Zero Reads

The method looks for load disconnect/ connect events in the database representing disconnect / connect operations that are executed for the meter. Disconnect/ connect event is generated if the meter is disconnected due to non-payment or if the meter is reconnected once the payment is made.

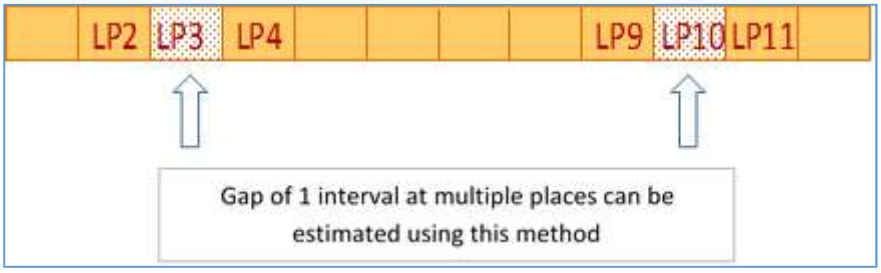
Based on the events and their timings, power outage duration is calculated. If the power outage covers the interval duration completely, it is estimated with zero consumption (0.0kWh). Any interval that falls partially in this duration is not estimated as there could be some consumption during the rest of the duration where power is available.



The Device Event Based De-Energized Zero Reads method is tried only if “Power Outage FlagBased Estimation” method fails or is not applicable.

(c) Linear Interpolation

The Linear interpolation is the simplest estimation algorithm. This routine establishes the two valid intervals on either side of a gap as reference points. It uses a straight-line approximation to resolve small gaps by creating estimated intervals of equal length between the two reference points. The readings created by this routine fill the gaps with no peaks or valleys. This estimation method is applicable for 1 interval gap only.



The defined limit for this estimation method is a half an hour (30 mins) interval gap. For example, there are two gaps in the incoming data: Gap A, from 8:00 to 8:30, and Gap B, from 13:15 to 17:30. The linear interpolation method can fill Gap A. This estimation method cannot fill Gap B, because Gap B exceeds the maximum size of half an hour.

The linear Interpolation method is tried only if "Device Event Based De-Energized Zero Reads estimation" method fails or is not applicable.

(d) Multi-Week Average

The Multi-Week Average estimation routine finds and averages all valid reference intervals for the same day of week and time stamp, for multiple weeks. This method is executed using the Same Day Historical method and the Historical method as follows:

(i) **The Same Day Historical method**, where to average for a day (any of the 7 days) last 4 same days are picked. Example for a Monday only last 4 valid Mondays are picked or to average a Saturday only valid 4 Saturdays are picked.

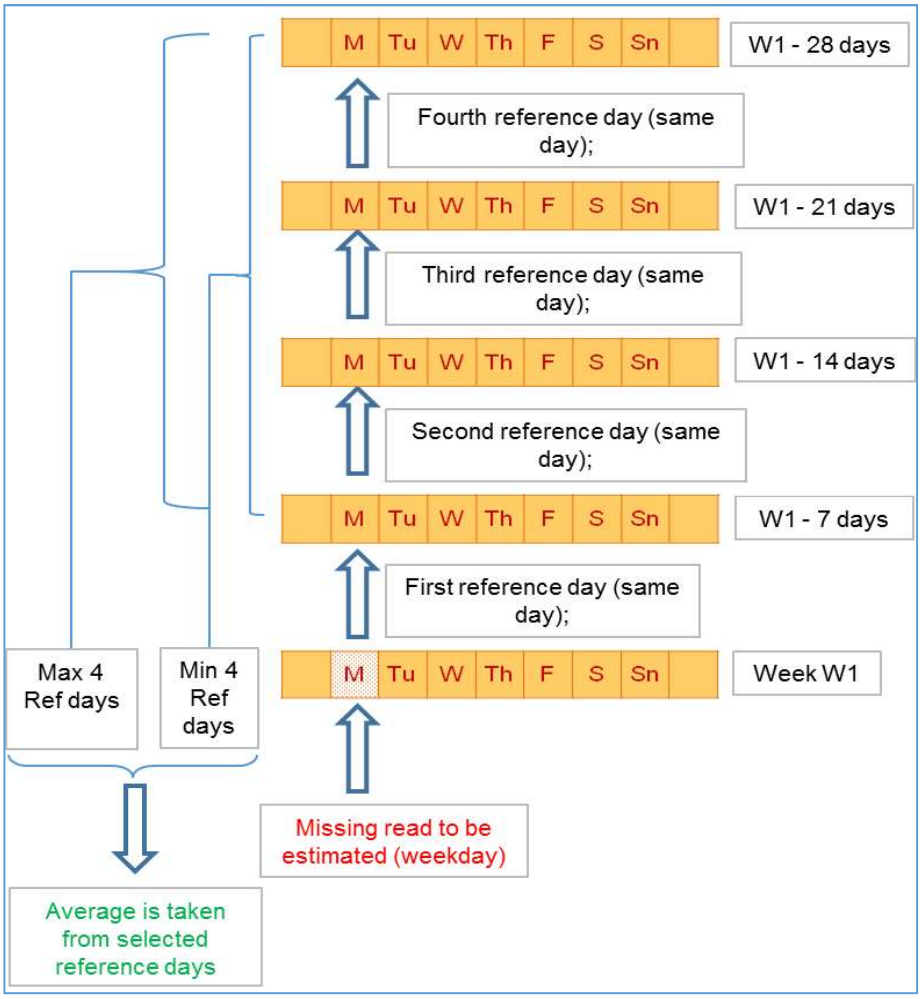
Method	Number of reference days	Oldest same/like Day
Same Day Historical	4	1 year (52 weeks)

The estimation process under this method uses interval history to find "Same days". Same days are only considered if corresponding intervals for that day are in a VAL status (validated) and are matched against the same day only(weekday to weekday, weekend to weekend). For example, for data missing on Monday, only Mondays will be used as reference days.

It then selects the number of reference same days from valid data closest in time to the day with the data needing estimation. It then calculates the average daily profile using the selected reference days.

A minimum of 4 reference days would be selected from a period of 1 yearin the past. Only customer's own consumption is considered as reference. If enough

reference days cannot be obtained, the method is skipped and the next method in the sequence is picked to estimate the missing reads.



Same day will be selected from the immediate preceding week until 1-year historical data.

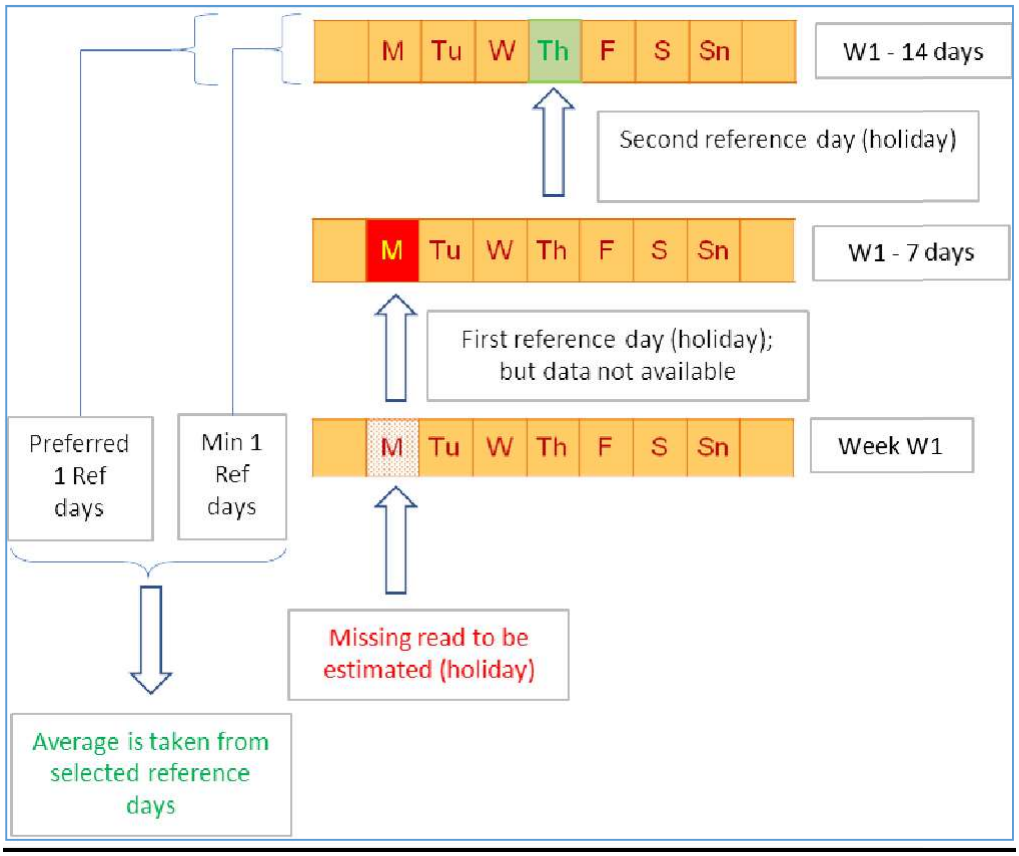
(ii) **The Holiday Historical method**, where if the day to be estimated is a holiday, then only holidays are taken as reference for this calculation.

Method	Number of reference days	Oldest same/like Day
Holiday Historical	1	1 year (52 weeks)

This estimation method works in a similar way as the Same Day Historical method. It uses interval data history to find days that are either Holidays or non-operational days. Days are only considered if corresponding intervals for that day are in a VAL status (validated) and are matched against the like day (Holiday to Holiday or Holiday to non-operational days).

Holidays are prioritized over non-operational days, but in case enough holidays are not found in the customers load profile records, data from the non-operational days would be used for estimation purposes.

A minimum of 1 reference day would be selected from a period of 1 year in the past. Only customer's actual consumption is considered as reference just like other historical estimation methods.



The Multi-Week Average method is tried only if the Linear Interpolation method fails or is not applicable.

(e) Two Week Like Day Historical

The Two-Week Like Day Historical estimation process is achieved by estimating using average data from valid reference intervals for the like day of week and time stamp, for multiple weeks.

For the Like Day Historical, the calculation method is where to average for a Monday, if enough Mondays are not found, then any other weekday can be taken which is nearest to a Monday.

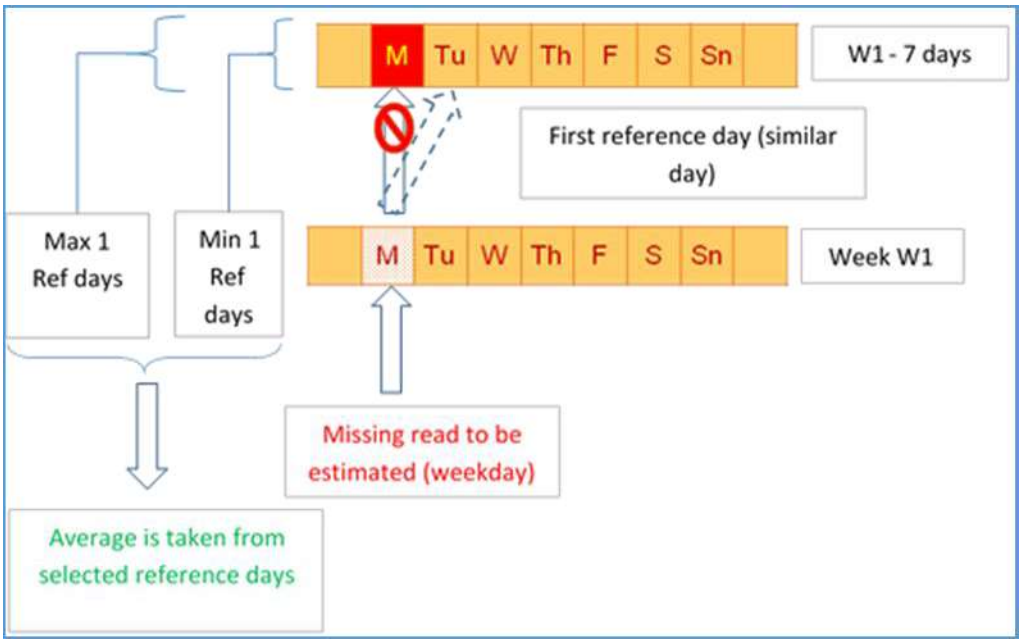
Method	Maximum Reference days	Oldest Like Day
Like Day Historical	1	2 weeks

The Like Day Historical estimation method works in similar way as the Same Day Historical method. It uses interval data history to find "like days". Like days are only considered if corresponding intervals for that day are actual consumptions and are matched against the like day (weekday to weekday, weekend to weekend).

It then selects the number of Like days (reference days) from valid data closest in time (chronologically) to the day with the interval data that requires estimation. It then calculates the average daily profile using the selected reference days.

For example, if the interval data that requires estimation is from Monday, then Tuesday of the prior week is considered a like-day, and Meter Data Management System uses the corresponding intervals from that Tuesday. If the data from Tuesday of the prior week is missing, then Meter Data Management System uses the data from the Tuesdayof two weeks prior.

A minimum of one reference day would be selected from a period of two weeks of historical data. Only the customer's actual consumption is considered as reference for the estimation calculation.



The Two Week Like Day Historical method is tried only if “Multi-Week Average” method fails or is not applicable.

4.3. **Editing**

Data editing is a manual function which allows a SMOC Operator the ability to enhance meter data integrity. Editing can be used by an operator to correct, restore, or estimate meter data in interval channels.