ANNEX A

WESM Manual on Load Forecasting Methodology Issue 3.0 (version for enhanced market design)						
Title	**Section**	**Provision**	**Proposed Amendment**	**Rationale**	**Stakeholder Recommendation**	**Stakeholder Rationale**
NET LOAD FORECASTS	6.2.3	The *Market Operator* shall develop relevant procedures in the preparation of the LDFs.	The *Market Operator* shall ~~develop relevant procedures in the preparation of~~ **prepare and update** the LDF~~s~~ **of each *customer market trading node* in accordance with Appendix F**.	Provide reference to the procedures for determining the load distribution factors that would be proposed for inclusion in this manual		
Procedures for the Preparation and Updating of Nodal Load Distribution Factors	**Appendix F** (new)	(new)	*See attached document*	Provide details on the procedure that will be used by the Market Operator to determine the load distribution factors.		

Appendix F. Procedures for the Preparation and Updating of Nodal Load Distribution Factors (LDF)

LDF Day Types and Hour

1. There are nine (9) day types available, namely:

Table 2. LDF Day Types

Day Type	Day Type Description
1	Monday
2	Tuesday
3	Wednesday
4	Thursday
5	Friday
6	Saturday
7	Sunday
8	Special Day 1
9	Special Day 2

2. By default, a certain day shall have a day type corresponding to its day of the week. For example, 12/19/2019 falls on a Thursday, hence, it shall have a day type of 4 as prescribed in **Table 2. LDF Day Types**.

3. The Market Operator may choose to update a certain day type that is different from its default type. For example, 12/25/2019 has a default day type of 3 (Wednesday). However, the Market Operator may instead define it as belonging to day type 8 (Special Day 1).

4. Day Type 8 and 9 are Special Days that the Market Operator may choose in grouping days that represent holidays, or days with significant events. The Market Operator shall first evaluate the load profile of candidate days (holidays or days with significant events), then eventually establish which day type the relevant day shall belong to.

5. For this procedure, an hour covers the twelve (12) dispatch intervals from the start of that hour (i.e., hour 14 covers the dispatch interval ending at 14:05 until the dispatch interval ending at 15:00).

Defining Data Source Type of Nodal Loads

1. Each nodal load, except those defined in Section 7.1.6, shall have load distribution factors (LDFs) for each hour of each day type.

2. Each nodal load, except those defined in Section 7.1.6, shall have their respective LDFs updated every five (5) minutes based on either the (a) latest real-time data or (b) from an estimated value.

3. The LDF of a nodal load shall be updated based on latest real-time data if the Market Operator assesses that the real-time data for that nodal load is updated regularly; otherwise, the LDF of the nodal load shall be updated based from an estimated value.

Procedure in Updating the Load Distribution Factor

1. Get the day type and hour of the timestamp of the latest available real-time snapshot

For example, if the timestamp of the latest available real-time snapshot is “2019-12-17 14:25”, then its day type is 2 by default (12/17/2019 is on a Tuesday), while its hour is 14. The day type and hour obtained here shall be considered as the ***reference day type*** and ***reference hour***.

2. Obtain base MW values for each nodal load

   2.1. For nodal loads with a data source type based on real-time data, the base MW value shall be the latest real-time MW value measured at that nodal load

$$Base\_MW_{b,D,H,FA} = Nodal\_Actual\_MW_{b,t,FA}$$

   Where:

   $Base\_MW_{b,D,H,FA}$ refers to the base MW for nodal load *b* at reference day type *D* and reference hour *H* in Forecast Area *FA*

   $Nodal\_Actual\_MW_{b,t,FA}$ refers to the MW value measured at nodal load *b* based on the latest actual system snapshot at time *t* in Forecast Area *FA*

   2.2. For nodal loads with a data source type based on an estimated value, the base MW value shall be obtained using the following steps:

      2.2.1. Get the actual demand of the *Forecast Area* considering any import/export from its adjacent *Forecast Area*

$$Actual\_Demand_{t,FA} = \sum_{i=1}^{n} P_{i,t,FA} + \sum_{a=1}^{p} import_{a,FA,t} - \sum_{a=1}^{p} export_{a,FA,t}$$

      Where:

      $P_{i,t,FA}$ refers to the real power (MW) output of generator *i* based on the latest actual system snapshot at time *t* in Forecast Area *FA*

      $import_{a,FA,t}$ refers to the MW imported from Forecast Area *a* onto Forecast Area *FA* based on the latest actual system snapshot at time *t*

$export_{a,FA,t}$ refers to the MW exported to Forecast Area *a* from Forecast Area *FA* based on the latest actual system snapshot at time *t*

2.2.2. Obtain the pre-defined estimated loss percentage for the *reference day type* and *reference hour* for the relevant *Forecast Area*. The pre-defined estimated loss percentage is based on historical power flow losses in the real-time dispatch (RTD) solution and is updated regularly by the Market Operator. Then, compute for the estimated net load as follows:

$$Est\_Net\_Load_{t,FA} = \left(1 - Est\_Loss_{FA,D,H,}\right) \times Actual\_Demand_{t,FA}$$

Where:

$Est\_Loss_{FA,D,H}$ refers to the loss percentage estimated for Forecast Area *FA* at day type *D* and hour *H*

2.2.3. The base MW for nodal loads with a data source type based on an estimated value shall be obtained by multiplying its pre-defined load distribution factor at the *reference day type* and *reference hour* to the aforementioned estimated net load. The pre-defined load distribution factor for nodal loads having an estimated value is based on historical metered quantities and is updated regularly by the Market Operator.

$$Base\_MW_{b,D,H,FA} = LDF_{b,D,H,FA} \times Est\_Net\_Load_{t,FA}$$

Where:

$LDF_{b,D,H,FA}$ refers to the load distribution factor of nodal load *b* at day type *D* and hour *H* at Forecast Area *FA*

3. Once all base MW values are obtained for each nodal load b, compute for the new LDFs using the following formula

$$LDF\_new_{b,D,H,FA} = \left[\left(\frac{Base\_MW_{b,D,H,FA}}{\sum_{k=1}^{n} Base\_MW_{k,D,H,FA}}\right) \times \alpha\right] + \left[\left(LDF\_old_{b,D,H,FA}\right) \times (1-\alpha)\right]$$

Where:

$LDF\_new_{b,D,H,FA}$ refers to the new load distribution factor of nodal load *b* for day type *D* and hour *H* at Forecast Area *FA*

$Base\_MW_{b,D,H,FA}$ refers to the base MW of nodal load *b* for day type *D* and hour *H* at Forecast Area *FA*

$Base\_MW_{k,D,H,FA}$ refers to the base MW of nodal load *k* for day type *D* and hour *H* at Forecast Area *FA*

α	refers to the smoothing factor (from 0 to 1, is initially set 1, and shall be updated by the Market Operator based on a regular assessment to improve forecast accuracy)
$LDF\_old_{b,D,H,FA}$	refers to the old/current load distribution factor of nodal load *b* for day type *D* and hour *H* at Forecast Area *FA*
n	refers to the total number of nodal loads for forecasting area *FA*

4. The new LDFs shall also be applied for the next hour *H+1*

$$LDF\_new_{b,D,H+1,FA} = LDF\_new_{b,D,H,FA}$$

Where:

$LDF\_new_{b,D,H+1,FA}$ refers to the load distribution factor of nodal load *b* for day type *D* and hour *H+1* at Forecast Area *FA*

For example, if the timestamp of the latest available real-time snapshot is "2019-12-17 14:25", then its *reference day type* is 2 by default (12/17/2019 is on a Tuesday), while its *reference hour* is 14. The next immediate hour belongs to day type 2 and hour 15.

For example, if the timestamp of the latest available real-time snapshot is "2019-12-19 00:45", then its *reference day type* is 3 and reference hour is 24. The next immediate hour belongs to day type 4 and hour 1. The latest snapshot in this example has Hour 0 of 12/19/2019. This is translated as Hour 24 of 12/18/2019. 12/18/2019 falls on a Wednesday, hence, its default day type is 3.

Sample Updating of the Load Distribution Factor

In order to better understand the aforementioned processes in updating the load distribution factors of each nodal load, let us use the following example.

1. Let us assume that the latest time stamp *t* is 14:25 of 12/19/2019:

   a) The reference day type is 4
   b) The reference hour is 14

2. Let us also assume that the following loads reside in Forecast Area *FA*, each having a defined data source type, along with their MW load at timestamp *t* and their most recent LDF values for day type 4 and hour 14.

Table 3. Sample Nodal Load Profile and MW values at Timestamp t

Nodal Load	Data Source Type	MW Load @ t	Current LDF
Load_A	Real-Time	950	0.2000
Load_B	Real-Time	1425	0.3000

Load_C	Real-Time	1900	0.4000
Load_D	Estimated	--	0.1000

Note: The assumption here is that Load_D's base MW is being estimated since its snapshot data is persistently non-updating.

3. The Base MW of Load_A, Load_B, and Load_C shall be equal to their respective MW Load at timestamp *t*.

4. The Base MW of Load_D shall be obtained as follows.

   a) If the actual demand of the latest snapshot at 14:25 of 12/19/2019 at Forecast Area *FA* is 5000 MW, whereas the estimated loss percentage is 0.02 at day type 4 and hour 14, then:

$$\text{Est\_Net\_Load}_{t,FA} = \left(1\text{-Est\_Loss}_{FA,D,H,}\right) \text{ x Actual\_Demand}_{t,FA}$$
$$\text{Est\_Net\_Load}_{t,FA} = (1\text{-}0.02) \text{ x } 5000 = 4900$$

   b) With this, we can now derive the Base MW of Load_D

$$\text{Base\_MW}_{Load\_D,4,14,FA} = 0.1000 \text{ x } 4900 = 490 \text{ MW}$$

5. Let us then assume that the smoothing factor is 0.8. With this, we can now derive the new LDFs using the established formula:

$$\text{LDF\_new}_{b,D,H,FA} = \left[\left(\frac{\text{Base\_MW}_{b,D,H,FA}}{\sum_{k=1}^{n} \text{Base\_MW}_{k,D,H,FA}}\right) \text{ x } \alpha\right] + \left[\left(\text{LDF\_old}_{b,D,H,FA}\right) \text{ x } (1\text{-}\ \alpha)\right]$$

For example, for Load_A:

$$\text{LDF\_new}_{Load\_A,4,14,FA} = \left[\left(\frac{950}{4765}\right) \text{ x } 0.8\right] + [(0.2000\ ) \text{ x } (1 - 0.8)] = 0.19950$$

The following new LDFs shall be obtained for all nodal loads defined in Forecast Area *FA:*

Table 4. Sample Updated LDF Values for Day Type D and Hour H

Nodal Load	Data Source Type	Current LDF	New LDF

Load_A	Real-Time	0.2000	0.19950
Load_B	Real-Time	0.3000	0.29924
Load_C	Real-Time	0.4000	0.39899
Load_D	Estimated	0.1000	0.10227

6. The same LDFs shall be updated for the next immediate hour.

Manual Override

The Market Operator may provide overriding LDFs to specific nodal loads for a specific day and hour.

Should an overriding LDF value be defined for a specific day and hour, it shall be used regardless of the calculations used in the processes above.

Use of LDF in Nodal Forecast

The LDFs to be used in Section 6.2.6 of this Manual shall be based on the latest updated LDF at the day type and hour representing the projected dispatch interval. Note that the day type and hour shall be based on the start time of the projected dispatch interval.

For example, if the dispatch interval covers a start time of 19:55 and an end time of 20:00 of 12/04/2019, then its reference day type and reference hour shall be based on 19:55 of 12/04/2019. Thus, the day type shall be 3 (12/04/2019 is Wednesday), while the hour is 19. As such, in this example, the LDFs of day type 3 and hour 19 shall be used to project the nodal loads for dispatch interval 19:55-20:00 of 12/04/2019.